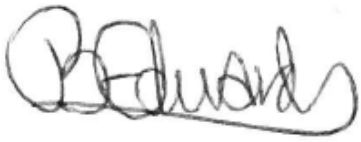
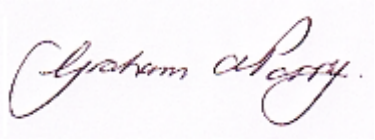
Report for:

London Borough of Camden

Tybalds Estate, London

Noise and Vibration Assessment

Status: Final **Date: 17.06.2021**

Authors	 Rebecca Edwards Senior Acoustic Consultant	 Angela Lamacraft Principal Acoustic Consultant
Reviewed and Approved By	 Graham Parry Managing Director	
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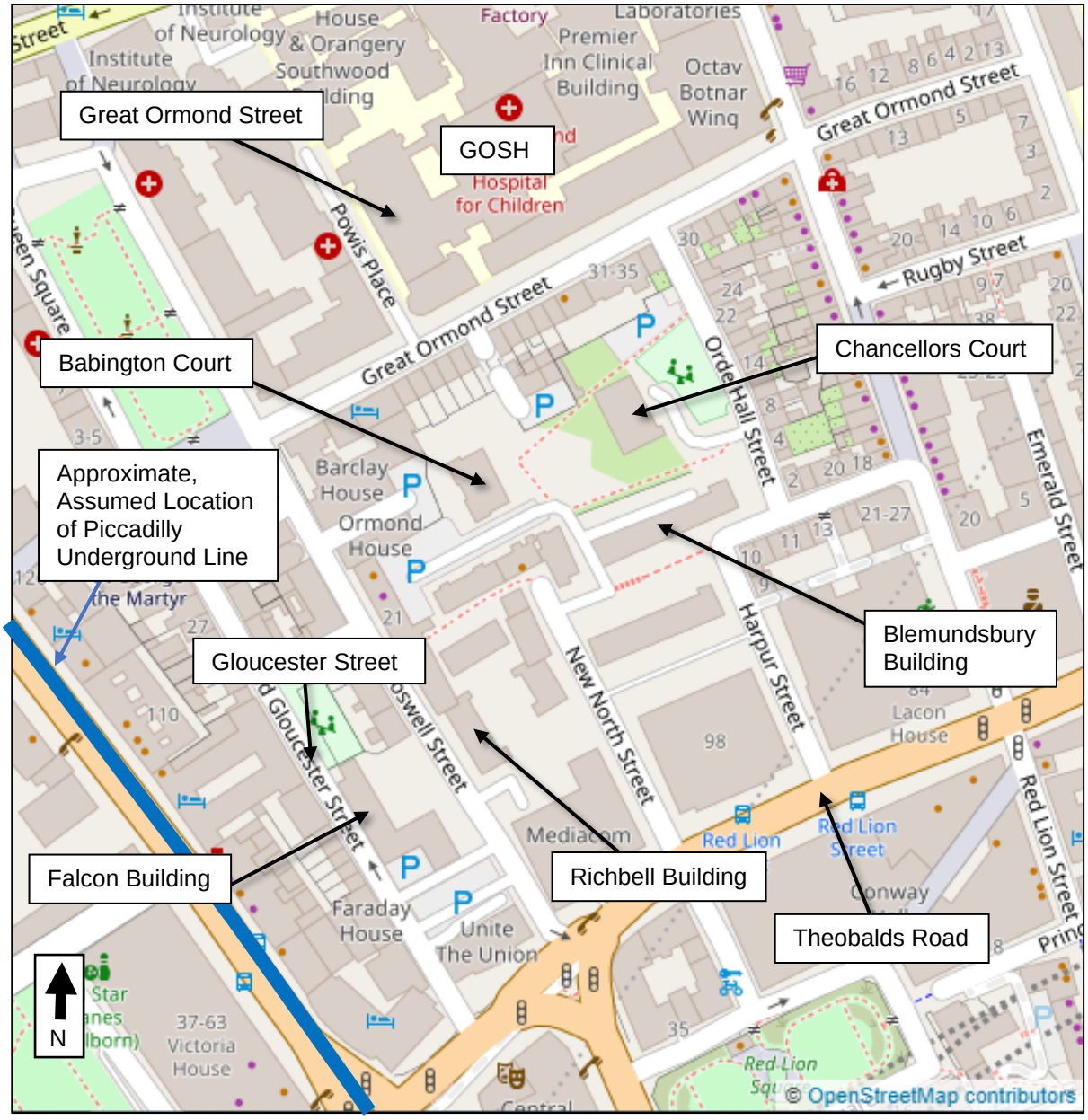
1. INTRODUCTION

ACCON UK Limited (ACCON) has been commissioned by the London Borough of Camden to carry out a noise and vibration assessment for a development scheme at Tybalds Estate, London. The noise and vibration assessment is required to support a planning application for 56 new residential units, community space/facilities, new entrances to the existing tower blocks and a lift to the Devonshire block, and a bulky waste store. The site is located within the administrative boundary of the London Borough of Camden (LBC).

The site location and proposed layout are illustrated in **Figure 1.1**.

Figure 1.1: Site Location Plan



The site is located approximately 60 m to the north of the A401 Theobald's Road and approximately 25 m to the south of Great Ormond Street. The site is located within a

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residential area with medical facilities (such as Great Ormond Street Hospital (GOSH)) approximately 40 m to the north of the site and large office buildings separating the existing residential area from Theobald's Road. The London Underground Piccadilly Line is located underground at a distance of approximately 50 m to the west of the Falcon Building.

Three new blocks of flats are proposed (Blocks B, C and D) comprising 36 new units. Two blocks of mews are proposed (eastern mews and western mews) which will comprise 10 houses. Beneath three of the existing blocks (Blemundsbury, Falcon and Richbell) an additional 10 units are proposed within the existing basement areas (underbuild). Beneath part of Falcon and at the ground floor of Block C, community facilities are proposed comprising residents association halls and associated facilities.

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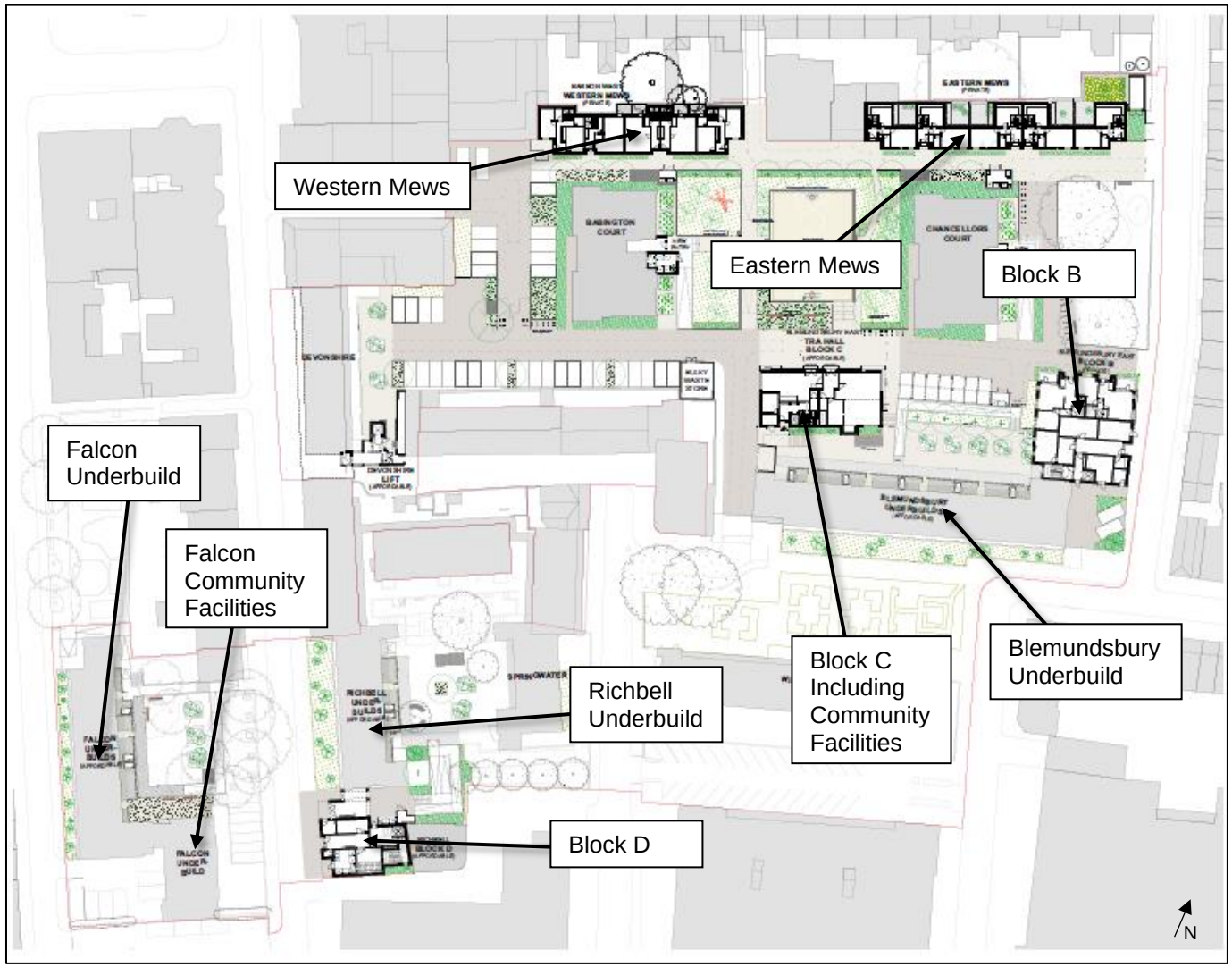
Figure 1.2: Proposed Site Layout Plan



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An environmental noise measurement survey has been carried out at the site and road traffic noise (primarily from Theobalds Road and to a lesser extent Great Ormond Street and the surrounding side roads) has been identified as the dominant noise source. The results of the noise measurement survey have been utilised in order to assess the impact of road traffic noise on the proposed development. Where appropriate, recommendations for mitigation have been provided.

Furthermore, a vibration measurement survey has been carried out at the site in order to determine the impact of ground-borne vibration caused by an operational underground railway line on the proposed development.

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2. THE NATURE, MEASUREMENT AND EFFECT OF NOISE AND VIBRATION

2.1. Noise

Noise is often defined as sound that is undesired by the recipient. Whilst it is impossible to measure nuisance caused by noise directly, it is possible to characterise the loudness of that noise. '*Loudness*' is related to both sound pressure and frequency, both of which can be measured. The human ear is sensitive to a wide range of sound levels. The sound pressure level of the threshold of pain is over a million times that of the quietest audible sound. In order to reduce the relative magnitudes of the numbers involved, a logarithmic scale of decibels (dB) is normally used, based on a reference level of the lowest audible sound.

The response of the human ear is not constant over all frequencies. It is therefore usual to weight the measured frequencies to approximate the human response. The resulting 'A' weighted decibel, dB(A), has been shown to correlate closely to the subjective human response.

When related to changes in noise, a change of ten decibels, for example from 60 dB(A) to 70 dB(A), would represent a doubling in 'loudness'. Similarly, a 10 dB(A) decrease in noise, for example from 70 dB(A) to 60 dB(A), would represent a halving in 'loudness'. A change of 3 dB(A) is generally considered to be just perceptible[1]. **Table 2.1** provides typical noise levels of common sources.

Table 2.1: Typical Noise Levels

Approximate Noise Level (dB(A))	Example
0	Limit of hearing
30	Rural area at night
40	Library
50	Quiet office
60	Normal conversation at 1 m
70	In car noise without radio
80	Household vacuum cleaner at 1 m
100	Pneumatic drill at 1 m
120	Threshold of pain

[1] Institute of Environmental Management and Assessment (2014). Guidelines for environmental noise impact assessment.

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2.2. Vibration

When two objects come into contact through movement (such as a train wheel acting on a rail), the mechanical energy from the movement causes vibrations in the vicinity of the two objects. Vibrations in the air cause sound, but some vibration can be felt through the ground or through structures, especially when a large amount of energy is exerted, such as the passing of heavy good vehicles over an uneven surface.

Ground-borne vibration, especially within structures, has a number of effects both on people and to the structures themselves.

The effects of ground-borne vibration on buildings are dependent upon a range of factors, not least the magnitude and duration of the vibration, the structure of the soil, the properties and quality of the building materials, the design of the structure, as well as the general condition and age of the structure. In extreme cases, vibration can cause sever structural damage, but most vibration damage manifests itself in minor cosmetic damage such as cracks in rendering or roof tiles slipping. Ground-borne vibration on buildings is generally measured using the Peak Particle Velocity (PPV, expressed in mm/s). This is the maximum instantaneous velocity of a particle at a point during a given time interval.

Human exposure to vibration can cause annoyance, disruption to activity and discomfort. In the most extreme cases, prolonged exposure to vibration can harm health. Humans are known to be very sensitive to vibration, with a threshold of perception typically in the particle velocity range of 0.14 mm/s to 0.3 mm/s at frequencies between 1 Hz and 80 Hz. Human exposure to vibration is measured and assessed using a Vibration Dose Value (VDV expressed in $m/s^{1.75}$). This measures the overall exposure to vibration that a person might receive over a given time period within a building.

It should be noted that the threshold levels at which vibration becomes perceptible to humans is significantly lower than the levels of vibration which would need to be achieved in order to cause cosmetic damage to buildings (approximately 15 mm/s to 20 mm/s between 4 Hz and 15 Hz for a residential or light commercial building[2]).

A Glossary of Acoustic Terminology is provided in **Appendix 1**.

[2] British Standard 5228-2: 2009 + A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration

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3. NOISE ASSESSMENT CRITERIA

3.1. National Planning Policy Framework

The revised National Planning Policy Framework (NPPF, June 2019) supersedes the 2012 and 2018 versions of the NPPF. The purpose of the planning system is to contribute to the achievement of sustainable development. There are three dimensions to sustainable development: economic, social and environmental. The environmental role is to contribute to protecting and enhancing our natural, built and historic environment; and as part of this, make effective use of land, help to improve biodiversity, use natural resources prudently, minimise waste and pollution, and mitigate to adapt to climate change including moving to a low carbon economy.

One of the core planning principles is to contribute to conserving and enhancing the natural environment. Allocations of land for development should prefer land of lesser environmental or amenity value, where consistent with other policies in the Framework (Paragraph 171). The planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability (Paragraph 170).

Paragraph 180 of the NPPF 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 impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life (see Explanatory Note to the Noise Policy Statement for England (Department for Environment, Food and Rural Affairs, 2010));

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."

Additionally, Paragraph 182 states:

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

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3.2. Noise Policy Statement for England

The Noise Policy Statement for England (NPSE) aims to "*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; and*
- *Where possible, contribute to the improvement of health and quality of life*".

Based on concepts from toxicology, it introduces three 'Effect Levels' relevant to the assessment of noise. These are:

- 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;
- LOAEL: Lowest Observed Adverse Effect Level: This is the level above which adverse effects on health and quality of life can be detected; and
- SOAEL: Significant Observed Adverse Effect Level: This is the level above which significant adverse effects on health and quality of life occur.

3.3. Planning Practice Guidance

The Planning Practice Guidance for Noise (PPG-N) was published in March 2014 and most recently updated in July 2019. The PPG-N suggests that the most appropriate and cost-effective solutions to potential noise issues are best identified when good acoustic design needs to be considered early in the planning process.

The PPG-N provides the following advice on how to determine the noise impact on development:

"*Plan-making and decision making need to take account of the acoustic environment and in doing so consider:*

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

*In line with the Explanatory note of the noise policy statement for England, this would include identifying whether the overall effect of the noise exposure (including the impact during the construction phase wherever applicable) is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation. As noise is a complex technical issue, it may be appropriate to seek experienced specialist assistan*ce when applying this policy." (Paragraph 003 Reference ID 30-003-20190722).

The document goes on to acknowledge the levels of noise exposure at which an effect may occur as provided in the NPSE and introduces a fourth effect level:

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- UAE: Unacceptable Adverse Effect: Extensive and regular changes in behaviour and/or an inability to mitigate the effect of noise lead to psychological stress or physical effects.

It is important to understand that as the PPG-N does not specifically provide any advice with respect to noise levels/limits for different sources of noise, it is appropriate to consider other sources of advice and guidance documents when considering whether new developments would be sensitive to the prevailing acoustic environment and the PPG-N signposts a number of appropriate guidance documents.

3.4. Greater London

3.4.1. The Mayor of London's Environment Strategy

The Mayor of London's *Environment Strategy* was published in 2018. Chapter 9 of the Environment Strategy relates to *Ambient Noise* with the aim that "*Londoners' quality of life will be improved by reducing the number of people adversely affected by noise and promoting more quiet and tranquil spaces*". The primary objectives include:

- Reducing the adverse impacts of noise from transport and non-transport sources;
- Promoting good acoustic design and quiet and tranquil spaces, giving people respite from the noise of everyday city life.

The Environment Strategy strongly emphasises the reduction of noise at various sources, for example, road traffic noise can be reduced through reducing the number of car vehicle trips and promotion of the use of public transport. Of relevance to the proposed development specifically is the objective of reducing noise through good acoustic design. Proposal 9.3.3a states:

"*The London Plan promotes the use of good acoustic design and the protection of soundscapes.*

All dwellings should be built with acoustic insulation. However, acoustic insulation should not solely be relied upon. Through the Local Plan, the Mayor encourages the separation of new noise sensitive development from major noise sources, where possible, rather than relying on the use of soundproofing alone. Separation of a development can be achieved through distance, internal layout, or screening."

This proposal goes on to state:

"*Good acoustic design not only applies to individual buildings; it also applies to how the city runs*".

And that:

"*Development should seek to protect and improve the acoustic environment by introducing a soundscape that is relevant to the local environment.*"

3.4.2. The London Plan

The current version of the *London Plan* was published in March 2021. It provides the overall Spatial Development Strategy for London, setting out an integrated economic,

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environmental, transport and social framework for the development of London over the next 20–25 years, and provides a strategic, London-wide policy context within which boroughs should set their detailed local planning policies.

The following policies are relevant in respect of noise:

Policy D1 *London's form, character and capacity for growth* identifies under Item A that "*Area assessments should cover the elements listed below:*

…

5) air quality and noise levels

…"

The primary policy on noise is Policy D14 which states:

"***Policy D14 Noise***

A) In order to reduce, manage and mitigate noise to improve health and quality of life, residential 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.*"

Paragraph 3.14.3 of the London Plan advocates "*promoting good acoustic design of the inside buildings*" and recommends utilising the guidance in BS 8233:2014 (outlined in **Section 3.6.2**), the Professional Practice Guidance on Planning and Noise: New Residential

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Development (summarised in **Section 3.6.1**) and BS 4142:2014 (outlined in **Section 3.6.6**) to achieve good acoustic design.

3.4.3. Mayor of London's Housing Supplementary Planning Guidance

The Mayor of London's *Housing Supplementary Planning Guidance* (SPG) was published in 2016 and references the key noise policy (Policy 7.15) of the former London Plan 2016. In Paragraph 1.2.57 it advises that: "*Where housing is located either above or adjacent to an established noise generating land use, appropriate design mitigation measures should be required*". It also advises that: "*Enclosing balconies as glazed, ventilated winter gardens can be considered an acceptable alternative to open balconies*".

Standard 29 sets out that: "*Single aspect dwellings that are north facing, or exposed to noise levels above which significant adverse effects on health and quality of life occur, or which contain three or more bedrooms should be avoided*."

Standard 30 (and Policy 7.15) states that: "*The layout of adjacent dwellings and the location of lifts and circulation spaces should seek to limit the transmission of noise to sound sensitive rooms within dwellings*." The note to this requirement advises that "*acoustic insulation should not be relied upon as the only means of limiting noise and the layout and placement of rooms within the building should be considered at an early stage in the design process to limit the impact of external noise on bedrooms and living rooms. The impact of noise should also be considered in the placement of private external spaces.*"

Whilst Standard 33 specifically relates to air quality, it is pertinent that the note to the requirement advises that where schemes cannot have openable windows careful consideration needs to be given to any increased potential for overheating in the summer due to the reduced opportunities for natural ventilation.

3.5. London Borough of Camden

The consultation with the London Borough of Camden (LBC) took the form of an email transmission between ACCON UK and Camilo Castro-Llach, Noise Officer (dated 16 April 2019) detailing the specifics of the proposed methodology for the noise and vibration measurement survey and assessment. The LBC Noise Officer approved the noise and vibration survey and assessment methodology and provided a copy of the Local Plan *Appendix 3: Noise Thresholds* which outlines LBC's noise and vibration assessment criteria.

3.5.1. Vibration

Table A of *Appendix 3* of the Local Plan identifies the vibration levels from sources "*such as railways, roads, leisure and entertainment premises and/or plant or machinery at which planning permission will not normally be granted*". **Table 3.1** presents the LBC vibration criteria applicable to this assessment.

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Table 3.1: Vibration Levels from Uses such as Railways inside Dwellings

Period	Vibration Dose Value ($m/s^{1.75}$)
Day and evening 0700 hrs to 2300 hrs	0.2 to 0.4
Night 2300 hrs to 0700 hrs	0.13

3.5.2. Proposed Developments Likely to be Sensitive to Noise

Table B of *Appendix 3* identifies the noise levels applicable to noise sensitive residential development proposed in areas of existing anonymous noise (such as general environmental noise, road traffic and rail traffic). **Table 3.2** presents the noise guidance relevant to this development.

Table 3.2: Noise Levels Applicable to Noise Sensitive Residential Development Proposed in Areas of Existing Anonymous Noise

Assessment Location	Design Period	LOAEL (Green)	LOAEL to SOAEL (Amber)	SOAEL (Red)
Noise at 1 metre from noise sensitive façade	Day	<50 dB $L_{Aeq,16hr}$*	50 dB to 72 dB $L_{Aeq,16hr}$*	>72 dB $L_{Aeq,16hr}$*
	Night	<45 dB $L_{Aeq,8hr}$* <40 dB L_{night}**	45 dB to 62 dB $L_{Aeq,8hr}$* >40 dB L_{night}	>62 dB $L_{Aeq,8hr}$*
Inside a bedroom	Day	<35 dB $L_{Aeq,16hr}$	35 dB to 45 dB $L_{Aeq,16hr*}$	>45 dB $L_{Aeq,6hr}$
	Night	<30 dB $L_{Aeq,8hr}$ 42 dB L_{AFmax}	30 dB to 40 dB $L_{Aeq,8hr}$ 40 dB(1) to 73 dB L_{AFmax}	>40 dB $L_{Aeq,8hr}$ >73 dB L_{AFmax}
Outdoor living space (free-field)	Day	<50 dB $L_{Aeq,16hr}$	50 dB to 55 dB $L_{Aeq,6hr}$	>55 dB $L_{Aeq,16hr}$

* $L_{Aeq,T}$ values specified for outside a bedroom window are façade levels
** L_{night} values specified for outside a bedroom window are free-field levels
Note (1): ACCON assume that this is a mis-type and should be 42 dB

It should be noted that "*the levels given above are for dwellings, however, levels are user specific and different levels will apply dependent on the use of the premises.*"

3.5.3. Industrial and Commercial Noise Sources

Where appropriate, LBC expects that British Standard 4142 *Methods for rating and assessing industrial and commercial sound* will be used to assess the impact of noise from industrial and commercial sound sources. Table C of *Appendix 3* is reproduced in **Table 3.3**.

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Table 3.3: Noise levels applicable to proposed industrial and commercial developments (including plant and machinery)

Assessment Location	Design Period	LOAEL (Green)	LOAEL to SOAEL (Amber)	SOAEL (Red)
Garden used for main amenity (free-field) and Outside of living room, dining room or bedroom window (façade)	Day	Rating level 10 dB below background(1)	Rating level between 9 dB below and 5 dB above background	Rating level greater than 5 dB above background
Outside bedroom window (façade)	Night	Rating level 10 dB below background and no events exceeding 57 dB L_{AFmax}(1)	Rating level between 9 dB below and 5 dB above background or noise events between 57 dB and 88 dB L_{AFmax}	Rating level greater than 5 dB above background and/or events exceeding 88 dB L_{AFmax}

Note (1): 10 dB should be increased to 15 dB if the noise contains audible tonal elements. However, if it can be demonstrated that there is no significant difference in the character of the residual background noise and the specific noise from the proposed development then this reduction may not be required. In addition, a frequency analysis (to include the use of Noise Rating curves or other criteria curves) for the assessment of tonal or low frequency noise may be required.

Appendix 3 also states: "*there are certain smaller pieces of equipment on commercial premises, such as extract ventilation, air conditioning units and condensers, where achievement of the rating levels (ordinarily determined by a BS 4142 assessment) may not afford the necessary protection. In these cases, the Council will generally also require a NR curve specification of NR35 or below, dependent on the room (based upon measured or predicted $L_{eq,5mins}$ noise levels in octave bands) 1 metre from the façade of affected premises, where the noise sensitive premise is located in a quiet background area.*"

3.5.4. Entertainment Noise

The proposed development includes new community spaces which will generally be used for a range of purposes including meetings, religious meetings, groups and social gatherings. LBC provide the following noise criteria for entertainment noise. Entertainment noise is considered to include: "*amplified and unamplified music, human voices, footfall and vehicle movements, and other general activity*".

Table 3.4 summarises the LBC criteria for entertainment noise impacts in private external amenity spaces (i.e., gardens).

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Table 3.4: Noise levels applicable to entertainment noise in private amenity spaces

Design Period	LOAEL (Green)	LOAEL to SOAEL (Amber)	SOAEL (Red)
Day	The higher of 55 dB $L_{Aeq,5min}$ or 10 dB below existing $L_{Aeq,5min}$ without entertainment noise	56 dB to 60 dB $L_{Aeq,5min}$ or 9 dB to 3 dB below existing $L_{Aeq,5min}$ without entertainment noise	The higher of 61 dB $L_{Aeq,5min}$ or 2 dB below existing $L_{Aeq,5min}$ without entertainment noise
Evening	The higher of 50 dB $L_{Aeq,5min}$ or 10 dB below existing $L_{Aeq,5min}$ without entertainment noise	51 dB to 55 dB $L_{Aeq,5min}$ or 9 dB to 3 dB below existing $L_{Aeq,5min}$ without entertainment noise	The higher of 56 dB $L_{Aeq,5min}$ or 2 dB below existing $L_{Aeq,5min}$ without entertainment noise
Night	The higher of 45 dB $L_{Aeq,5min}$ or 10 dB below existing $L_{Aeq,5min}$ without entertainment noise	46 dB to 50 dB $L_{Aeq,5min}$ or 9 dB to 3 dB below existing $L_{Aeq,5min}$ without entertainment noise	The higher of 51 dB $L_{Aeq,5min}$ or 2 dB below existing $L_{Aeq,5min}$ without entertainment noise

Table 3.5 summarises the LBC criteria for entertainment noise impacts inside residential dwellings.

Table 3.5: Noise levels applicable to entertainment noise inside residential dwellings

Room	Noise Rating Curve	Design Period
Bedrooms	NR 25	Night-time 2300 hrs to 0700 hrs
All habitable rooms	NR 35	Daytime 0700 hrs to 2300 hrs

3.6. Noise Guidance

3.6.1. Professional Practice Guidance on Planning and Noise: New Residential Development

The ProPG was published in May 2017 and has been produced to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England. The scope of the ProPG is applicable to the consideration of new residential development that will be exposed predominantly to airborne noise from transport sources.

The recommended approach detailed in the ProPG includes a framework to enable situations where noise is not an issue to be clearly determined, and to help identify the extent of risk at

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noisier sites. The recommended approach provides opportunities to incorporate effective design interventions that will enable residential development to proceed in areas that might otherwise have been considered unsuitable.

The ProPG provides advice for Local Planning Authorities and developers, and their respective professional advisers. It aims to complement Government planning and noise policy and guidance. In particular, it strives to:

- Advocate full consideration of the acoustic environment from the earliest possible stage of the development control process;
- Encourage the process of good acoustic design in and around new residential developments;
- Outline what should be taken into account in deciding planning applications for new noise-sensitive developments;
- Improve understanding of how to determine the extent of potential noise impact and effect; and
- Assist the delivery of sustainable development.

The two sequential stages of the recommended approach are:

- Stage 1: an initial noise risk assessment of the proposed development site; and
- Stage 2: a systematic consideration of four key elements.

The four key elements to be undertaken in parallel during Stage 2 of the recommended approach are:

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

Details of how the above four elements have been considered should be included in a supporting Acoustic Design Statement (ADS).

The ProPG is one of the guidance documents which has been highlighted in PPG-N (Paragraph 015 Reference ID: 30-015-20190722)

Figure 3.1 below identifies the guidance given in the ProPG when undertaking the risk assessment stage for a site.

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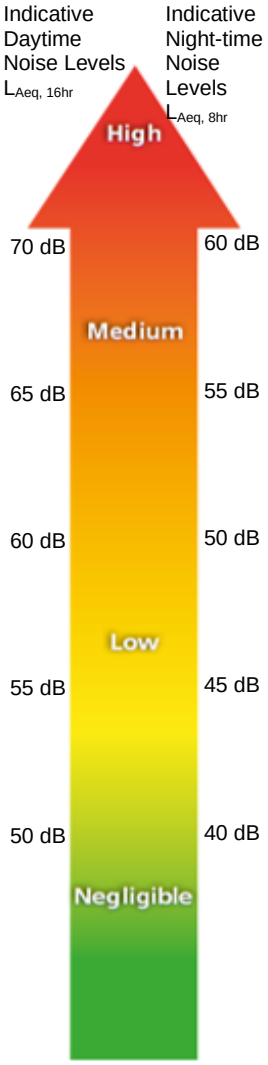
Figure 3.1: Stage 1 – Noise Risk Assessment

Noise Risk Assessment	Potential Effect Without Noise Mitigation	Pre-Planning Application Advice
	Increasing risk of adverse effect	High noise levels indicate that there is an increased risk that development may be refused on noise grounds. This risk may be reduced by following a good acoustic design process that is demonstrated in a detailed ADS. Applicants are strongly advised to seek expert advice. As noise levels increase, the site is likely to be less suitable from a noise perspective and any subsequent application may be refused unless a good acoustic design process is followed and is demonstrated in an ADS which confirms how the adverse impacts of noise will be mitigated and minimised, and which clearly demonstrates that a significant adverse noise impact will be avoided in the finished development. At low noise levels, the site is likely to be acceptable from a noise perspective provided that a good acoustic design process is followed and is demonstrated in an ADS which confirms how the adverse impacts of noise will be mitigated and minimised in the finished development.
	No adverse effect	These noise levels indicate that the development site is likely to be acceptable from a noise perspective, and the application need not normally be delayed on noise grounds.

Notes:

1. Indicative noise levels should be assessed without inclusion of the acoustic effect of any scheme specific noise mitigation measures.
2. Indicative noise levels are the combined free-field noise levels from all sources of transport noise and may also include industrial/commercial noise where this is present but is “not dominant”.
3. $L_{Aeq, 16hr}$ is for daytime 0700 - 2300, $L_{Aeq, 8hr}$ is for night-time 2300 - 0700.
4. An indication that there may be more than 10 noise events at night (2300 - 0700) with L_{AFmax} > 60 dB means the site should not be regarded as negligible risk.

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Figure 3.2 below identifies the internal noise level criteria provided in the ProPG.

Figure 3.2: ProPG Noise Levels

Activity	Location	0700-2300 Hours	2300-0700 Hours
Resting	Living room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$ 45 dB L_{AFmax} Note 4

Notes:

1. The Table provides recommended internal L_{Aeq} target levels for overall noise in the design of a building. These are the sum total of structure-borne and airborne noise sources. Ground-borne noise is assessed separately and is not included as part of these targets, as human response to ground-borne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity.
2. The internal L_{Aeq} target levels shown in the Table are based on the existing guidelines issued by the World Health Organization 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 internal L_{Aeq} target levels recommended in the Table.
3. These internal L_{Aeq} target levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events, such as fireworks night or New Year's Eve.
4. Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or L_{AFmax}, depending on the character and number of events per night. Sporadic noise events could require separate values. 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_{AFmax} 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 (see Appendix A of ProPG).
5. Designing the site layout and the dwellings so that the internal target levels can be achieved with open windows in as many properties as possible demonstrates good acoustic design. Where it is not possible to meet internal target levels with windows open, internal noise levels can be assessed with windows closed, however any façade openings used to provide whole dwelling ventilation (e.g. trickle ventilators) should be assessed in the "open" position and, in this scenario, the internal L_{Aeq} target levels should not normally be exceeded, subject to the further advice in Note 7.
6. Attention is drawn to the requirements of the Building Regulations.
7. Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal L_{Aeq} target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved. The more often internal L_{Aeq} levels start to exceed the internal L_{Aeq} target levels by more than 5 dB, the more that most people are likely to regard them as "unreasonable". Where such exceedances are predicted, applicants should be required to show how the relevant number of rooms affected has been kept to a minimum. Once internal L_{Aeq} levels exceed the target levels by more than 10 dB, they are highly likely to be regarded as "unacceptable" by most people, particularly if such levels occur more than occasionally. Every effort should be made to avoid relevant rooms experiencing "unacceptable" noise levels at all and where such levels are likely to occur frequently, the development should be prevented in its proposed form (see Section 3.D of ProPG).

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3.6.2. British Standard BS 8233:2014

BS 8233 *Guidance on sound insulation and noise reduction for buildings* has a number of design criteria for intrusive external noise without a specific character. The guidelines are designed to achieve reasonable resting/sleeping conditions in bedrooms and good listening conditions in other rooms. The most appropriate noise levels for the residential environment are reproduced in **Table 3.6**.

Table 3.6: Indoor Ambient Noise Levels for Dwellings

Activity	Location	Daytime 0700 hrs to 2300 hrs	Night-time 2300 hrs to 0700 hrs
Resting	Living room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$

Although there are no limits set for external noise levels in BS 8233 the following guidance is provided at paragraph 7.7.3.2:

"*For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.*"

Regarding balconies, BS 8233 states:

"*Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space.*"

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3.6.3. World Health Organization Guidelines for Community Noise (1999)

The World Health Organization (WHO) has developed the *Guidelines for Community Noise* (CNG) designed to minimise the adverse effects of noise. The guidelines relevant to residential noise exposure are detailed in **Table 3.7**. For each specific environment, the stated noise levels are the maximum noise levels to avoid the health effect noted.

Table 3.7: WHO Community Noise Guideline Values

Specific Environment	Critical Health Effect(s)	Period Noise Level	Maximum Noise Level
Outdoor Living Area	Serious annoyance, daytime and evening	55 dB $L_{Aeq,16hr}$	-
	Moderate annoyance, daytime and evening	50 dB $L_{Aeq,16hr}$	-
Dwelling, Indoors	Speech intelligibility and moderate annoyance, daytime and evening	35 dB $L_{Aeq,16hr}$	
Inside bedrooms	Sleep disturbance, night-time	30 dB $L_{Aeq,8hr}$	45 dB L_{AFmax}
Outside bedrooms	Sleep disturbance with window open	45 dB $L_{Aeq,8hr}$	60 dB L_{AFmax}

The WHO guidelines state, with respect to the L_{Amax} threshold, that "*for a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10-15 times per night (Vallet and Vernet 1991)*". Therefore, ACCON consider that it is appropriate to assess against the tenth highest L_{AFmax} level during the night-time period as opposed to the highest level in order to represent typical L_{AFmax} levels and provide a realistic compromise between protection from sleep disturbance and achievable mitigation.

3.6.4. World Health Organization Environmental Noise Guidelines for the European Region

The World Health Organization (WHO) issued the *Environmental Noise Guidelines for the European Region* (ENG) in October 2018. The guidelines state that the main intended purpose is to "*provide recommendations for protecting human health from exposure to environmental noise…*" As the guidelines, which are source specific and not environment specific, are intended to be suitable for policy-making they focus on the most used noise indicators L_{den} and/or L_{night} for exposure at the most exposed façade outdoors. The ENG recommends that indoor guideline values within the WHO CNG (see **Section 3.6.3**) and "*any values not covered by the current guidelines*" should remain valid.

Table 3.8 provides a summary of the WHO ENG recommendations for road traffic noise, railway noise, aircraft noise and wind turbine noise.

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Table 3.8: WHO Environmental Noise Guidelines Recommendations

Source	Average Noise Exposure (External)	Night Noise Exposure (External)
Road traffic noise	53 dB L_{den}	45 dB L_{night}
Railway noise	54 dB L_{den}	44 dB L_{night}
Aircraft noise	45 dB L_{den}	40 dB L_{night}
Wind turbine noise	45 dB L_{den}	No recommendation made
Leisure noise	70 dB $L_{Aeq,24h}$	Not applicable

In addition to the specific recommendations the following guiding principles have been developed:

- "*Reduce exposure to noise, while conserving quiet areas;*
- *Promote interventions to reduce exposure to noise and improve health;*
- *Coordinate approaches to control noise sources and other environmental health risks;*
- *Inform and involve communities potentially affected by a change in noise exposure*".

3.6.5. Acoustics Ventilation and Overheating Guide

The Acoustics Ventilation and Overheating Guide (AVO Guide) was published in January 2020. It is intended to be used by acoustics practitioners as well as all those involved in the planning, development, and design and commissioning of new dwellings. It aims to assist designers to adopt an integrated approach to the acoustic design within the context of the ventilation and thermal comfort requirements. The AVO Guide is intended to demonstrate good acoustic design as described in the ProPG when considering internal noise level guidelines.

For the purpose of the document, overheating is taken to mean:

"*The phenomenon of excessive or prolonged high temperatures in homes, resulting from internal or external heat gains, which may have adverse effects on the comfort, health or productivity of occupants.*"

The AVO Guide is intended for new residential development predominantly exposed to transportation noise sources.

The AVO Guide includes:

- An explanation of the ventilation requirements under The Building Regulations as described in *Approved Document F – Means of Ventilation 2010 Edition* (ADF) along with typical ventilation strategies and associated noise considerations;

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- An explanation of the overheating assessment methodology described in the Chartered Institute of Building Services Engineers (CIBSE) *Design methodology for the assessment of overheating risk in homes* (TM59);
- A potential acoustic scale and guidance relating to different ventilation and overheating conditions, for both environmental noise ingress and building services noise; and
- A worked example of the application of the AVO Guide, including indicative design constraints for different ventilation and overheating mitigation strategies.

The AVO Guide provides a two-level assessment procedure for the overheating condition. The first level assessment is a site risk assessment based on external noise levels and the assumption that the opening of windows is the primary means of mitigating overheating. A scale is provided which is related to the ProPG initial site noise risk assessment. **Figure 3.3** presents a copy of the AVO Guide Level 1 risk assessment scale.

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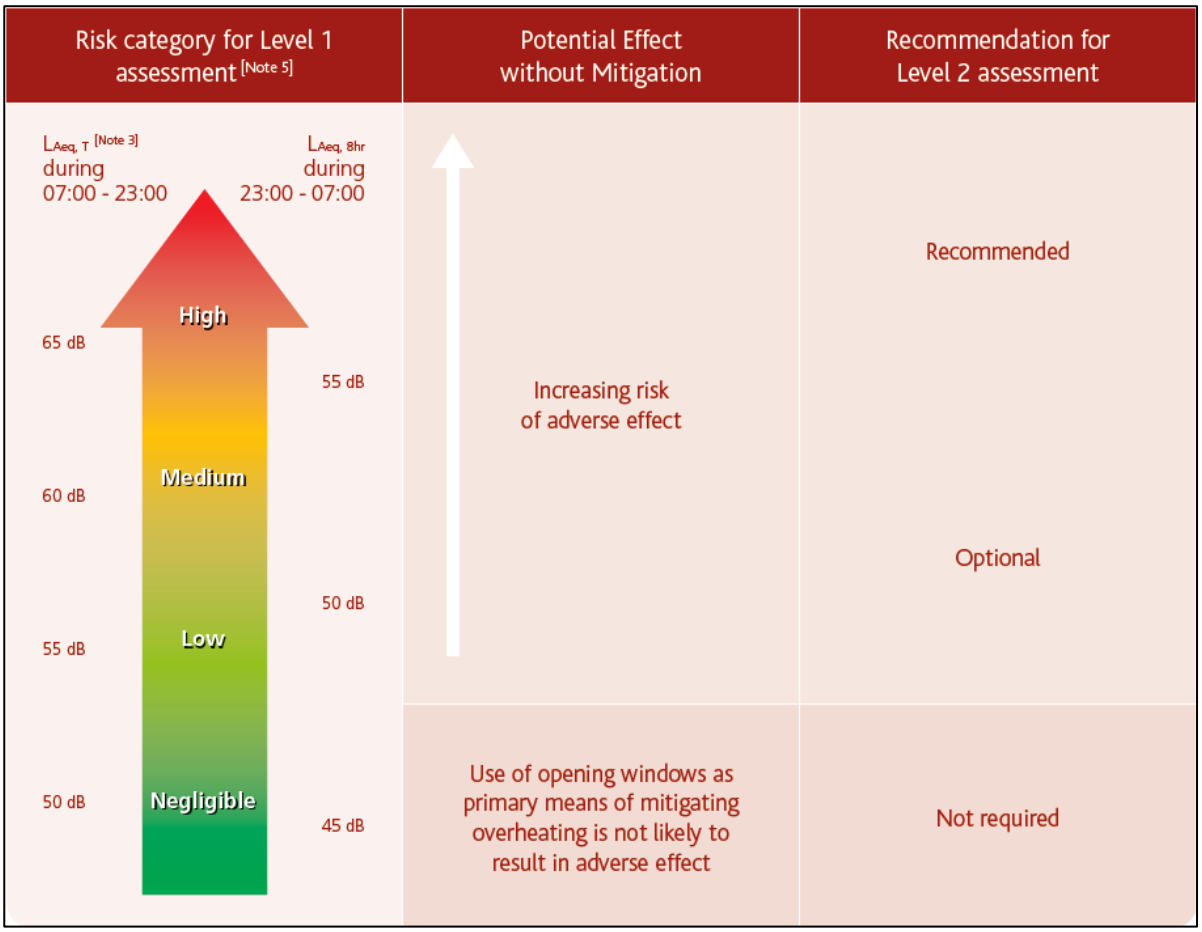
Figure 3.3: AVO Guide Level 1 Risk Assessment Guidance



Note 1: The noise levels suggested assume a steady road traffic noise source but may be adapted for other types of transport. All levels are external free-field noise levels.
Note 2: The values presented in this table should not be regarded as fixed thresholds and reference can also be made to relevant dose-response relationships.
Note 3: A decision must be made regarding the appropriate averaging period to use. The averaging period should reflect the nature of the noise sources, the occupancy profile and times at which overheating might be likely to occur. Further guidance can be found within the 2014 IEMA Guidelines.
Note 4: Where 78 dB L_{AFmax} is normally exceeded during the night-time period (2300 hrs to 0700 hrs), a Level 2 assessment is recommended.
Note 5: The risk of an adverse effect occurring will also depend on how frequently and for what duration the overheating condition occurs.
Note 6: To evaluate the risk category for a dwelling, all three aspects of external noise exposure (i.e. daytime, night-time and individual noise events) should be evaluated. The highest risk category for any of these aspects applies.

The Level 2 assessment considers the potential for adverse effect on occupants based on the internal ambient noise levels. LOAELs are identified as the typical target internal noise levels as outlined in ProPG, BS 8233 and the WHO Guidelines. SOAELs can be derived from a variety of sources including published research, guidance and dose-response relationships. In general, the SOAEL will depend on the duration of the overheating event. A lower SOAEL will be more applicable where the overheating condition will occur for a longer duration and as a result, adverse noise impacts could cause greater behavioural changes. Higher SOAEL levels are more applicable where the overheating condition will rarely occur

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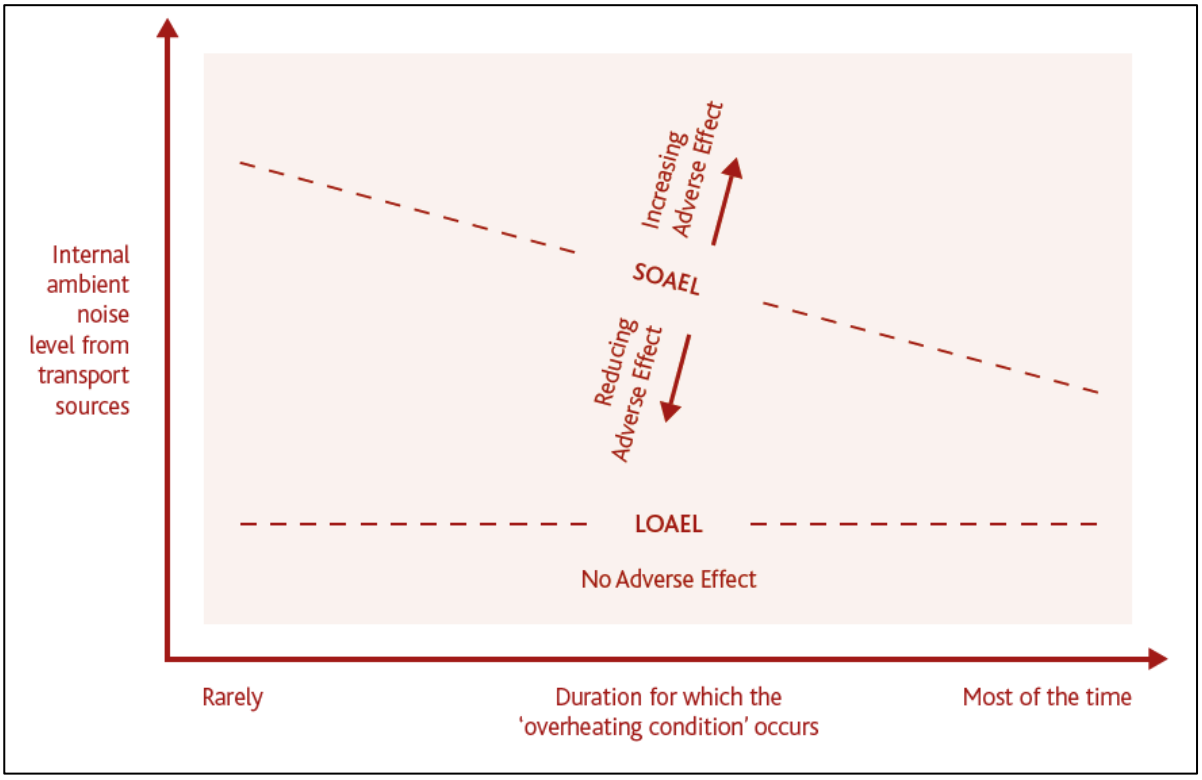
as the likelihood of experiencing such high noise levels will be for a much more limited amount of time, thus resulting in reduced adverse effects such as changes in behaviour.

The AVO Guide provides qualitative guidance on the combined effect of internal ambient noise level and duration for the overheating situation. **Figure 3.4** presents the example identified in Figure 3-2 of the guide. The relevant LOAEL and SOAEL noise levels can be ascribed to the vertical axis. A point can be located where the associated internal noise level and overheating condition meet. If the point is located above the SOAEL line, a combination of noise mitigation and overheating mitigation can be considered to bring the point within the LOAEL-SOAEL range.

Figure 3.4: AVO Guide Qualitative Guidance on Combined Effect of Internal Ambient Noise Level and Duration for the Overheating Situation



3.6.6. British Standard BS 4142: 2014

British Standard 4142:2014 *Methods for rating and assessing industrial and commercial sound* provides a method for the measurement and rating of industrial and/or commercial type noise sources and background noise levels outside dwellings. The rating level (defined in the BS) is used to rate the noise source (the 'specific sound level') outside residential dwellings.

It should be noted, however, that the standard is not intended to be applied to the rating and assessment of sound from the types of activities that would occur within the proposed community spaces.

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The rating level is determined by assessing the character of the noise and applying an acoustic feature correction, if appropriate. Corrections are applied for the tonality, impulsivity and intermittency of the noise source which can all make noise more noticeable.

The initial assessment described in BS 4142 to determine whether an adverse impact is likely is based on establishing the difference between the rating level and the background noise level outside the residential property of interest. The BS states that the following points should be considered:

- *Typically, the greater this difference, the greater the magnitude of the impact.*
- *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*
- *A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.*
- *The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.*"

Where it is considered that the initial assessment of the impact needs to be modified due to the context in which the noise is occurring, BS 4142 suggests that all pertinent factors are taken into consideration, including:

1) *The absolute level of sound. For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low.*

   Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.
   Where residual sound [3] levels are very high, the residual sound might itself result in adverse impacts or significant adverse impacts, and the margin by which the rating level exceeds the background might simply be an indication of the extent to which the specific sound source is likely to make those impacts worse.

2) *The character and level of the residual sound compared to the character and level of the specific sound. Consider whether it would be beneficial to compare the frequency spectrum and temporal variation of the specific sound with that of the ambient or residual sound, to assess the degree to which the specific sound source is likely to be distinguishable and will represent an incongruous sound by comparison to the acoustic environment that would occur in the absence of the*

[3] The residual sound is defined as the ambient sound level at the assessment location in the absence of the specific sound source.

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specific sound. Any sound parameters, sampling periods and averaging time periods used to undertake character comparisons should reflect the way in which sound of an industrial and/or commercial nature is likely to be perceived and how people react to it.

3) *The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions, such as:*

   i) facade insulation treatment;

   ii) ventilation and/or cooling that will reduce the need to have windows open so as to provide rapid or purge ventilation; and

   iii) *acoustic screening*

3.7. Vibration

3.7.1. British Standard BS 6472:2008 Part 1

British Standard BS 6472:2008 *Guide to evaluation of human exposure to vibration in buildings, Part 1 Vibration sources other than blasting* is the British Standard methodology used for measuring and evaluating human exposure to vibration from sources such as railways. **Table 3.9** below summarises the levels of vibration dose values (VDV) and the corresponding probability of adverse comments suggested by the BS.

Table 3.9: Vibration Dose Values Which Might Result in Various Probabilities of Adverse Comment within Residential Buildings.

Place and Time	Low Probability of Adverse Comment ($m/s^{1.75}$)	Adverse Comment Possible ($m/s^{1.75}$)	Adverse Comment Probable ($m/s^{1.75}$)
Residential buildings - 16hr day	0.2 - 0.4	0.4 - 0.8	0.8 - 1.6
Residential buildings - 8hr night	0.1 - 0.2	0.2 - 0.4	0.4 - 0.8

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4. NOISE AND VIBRATION MEASUREMENT SURVEY

A noise and vibration measurement survey has been carried out across the site in order to determine the extent to which the proposed development site is currently affected by noise and vibration. Noise and vibration measurements were previously carried out from 1100 hrs on Tuesday 30th April 2019 to 1400 hrs on Wednesday 1st May 2019. One semi-permanent noise monitoring position, one semi-permanent vibration monitoring position and four short-term noise monitoring positions were utilised. The noise and vibration measurement locations are identified in **Figure F.1**.

The weather conditions recorded during the daytime on Tuesday 30th April 2019 were dry with approximately 50% cloud cover. The wind speed was less than 0.5 m/s from a south-westerly direction and a temperature of approximately 14°C was recorded. During the night-time the weather was dry with a wind speed of less than 0.3 m/s. The weather conditions recorded during the daytime on Wednesday 1st May 2019 were dry with approximately 0% cloud cover. The wind was from a south-westerly direction with a speed of less than 0.5 m/s and a temperature of approximately 18°C was recorded. These weather conditions are considered suitable for the noise measurement survey.

4.1. Semi-Permanent Noise Monitoring

The semi-permanent noise measurement utilised a Svantek 971 Class 1 Sound Level Meter. The sound level meter holds a current certificate of calibration, which is available upon request. The equipment was field calibrated before and after the measurement period to ensure that it had remained within reasonable calibration limits (±0.5 dB).

Measurement Position 1 (MP1) was located at a height of approximately 7 m above ground level on the second floor balcony of the Blemundsbury building on the southern façade of the building.

The daytime and night-time free-field noise levels calculated from measurements at MP1 are summarised in **Table 4.1**: 3 dB has been subtracted from the measured noise levels to convert the levels to free-field. The detailed noise measurement results are presented in **Appendix 2**.

Table 4.1: Summary of Free-Field Semi-Permanent Noise Levels at MP1

Period (hrs)	$L_{Aeq,T}$ (dB)	Tenth Highest L_{Amax} (dB)	Average $L_{A10,5mins}$ (dB)	Average $L_{A90,5mins}$ (dB)	Typical $L_{A90,5mins}$ (dB)
Day (0700–2300)	51	72	52	45	45
Night (2300-0700)	46	66	47	41	40

Note: The noise measurements were carried out over consecutive five-minute periods. The $L_{Aeq,T}$ is subsequently logarithmically averaged over the time periods indicated in **Table 4.1**. The L_{AFmax} is the tenth highest L_{AFmax} measured in each period (see **Section 3.6.3**). The average $L_{A10,5mins}$ and $L_{A90,5mins}$ are arithmetical averages of the five-minute $L_{A10,T}$ and $L_{A90,T}$ noise levels. The typical $L_{A90,5mins}$ is the lowest most commonly occurring $L_{A90,5mins}$ in the associated time period.

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The highest L_{AFmax} noise levels measured at MP1 during the night-time were typically due to: distant, loud car engines, assumed to be driving along Theobald's Road; people talking and shouting nearby, for example on adjacent balconies or within the ground level garden areas; helicopters; sirens on Theobald's Road; and some localised activities such as refuse lorries and scooters on the adjacent roads (such as New North Street, Harpur Street and site car park accesses).

4.2. Short Term Noise Measurements

Four short-term noise measurements were carried out in accordance with Paragraph 43 '*Shortened measurement procedure*' of the Department for Transport's Technical Memorandum '*Calculation of Road Traffic Noise'* (CRTN) in order to determine the level of road traffic noise at various locations around the site.

The short-term noise measurement study utilised a Rion NL-52 Class 1 Sound Level Meter and a Norsonic 118 Class 1 Sound Level Meter. Both of these sound level meters hold current certificates of calibration, which are available upon request. The equipment was field calibrated before and after the measurement period to ensure that it had remained within reasonable calibration limits (±0.5 dB).

Table 4.2 identifies the measurement locations.

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Table 4.2: Noise Measurement Location Descriptions

Measurement Position	Date of Measurement	Description of Measurement Location	Dominant Noise Sources
ST1	Tuesday 30th April 2019	The microphone was located at a height of 1.5 m above ground level in a free-field position approximately 4 m from the northern carriageway edge of Great Ormond Street.	Road Traffic Noise. Occasional ambulance sirens and car horns were also audible.
ST2	Tuesday 30th April 2019	The microphone was located at a height of 1.5 m above ground level in a free-field position in the centre of the development site between Chancellors Court and Babington Court.	General neighbourhood noise including residents arriving/departing the adjacent buildings. Very occasional road traffic movements were also audible.
ST3	Wednesday 1st May 2019	The microphone was located at a height of 1.5 m above ground level in a free-field position on Old Gloucester Street, adjacent to the Falcon building. A construction site located approximately 40 m to the north-west of the site resulted in closure of Old Gloucester Street at the time of the noise measurement survey.	Road traffic noise on Theobald's Road. Construction noise including intermittent use of powered tools and hammering. This noise measurement is not considered to be representative of the usual road traffic noise climate at Old Gloucester Street.
ST4	Wednesday 1st May 2019	The microphone was located at a height of 1.5 m above the ground level in a free-field position on Theobalds Road approximately 6 m to the north of the carriageway.	Road traffic noise including regular emergency vehicle sirens and car horns.

Table 4.3 summarises the daytime free-field noise levels measured in the above positions.

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Table 4.3: Summary of Free-Field Short-Term Noise Levels

Measurement Position	Period (hrs)	$L_{Aeq,T}$ (dB)	L_{AFmax} (dB)	$L_{A10,T}$ (dB)	$L_{A90,T}$ (dB)
ST1	1220 hrs to 1520 hrs	62	84	64	55
ST2	1200 hrs to 1500 hrs	49	70	51	45
ST3	1000 hrs to 1300 hrs	64	86	65	56
ST4	1000 hrs to 1300 hrs	73(1)	102	72(1)	64

Note: The noise measurements were carried out over consecutive five-minute periods. The $L_{Aeq,T}$ was subsequently logarithmically averaged over the time periods indicated in **Table 4.13**. The L_{AFmax} is the arithmetic average of the highest L_{AFmax} in each 1-hour period. The average $L_{A10,T}$ and $L_{A90,T}$ are arithmetical averages of the five-minute $L_{A10,T}$ and $L_{A90,T}$ noise levels.
(1): It is not common for an $L_{Aeq,3hr}$ noise level to exceed the $L_{A10,3hr}$ noise level, however, the high number of loud discrete noise events and the different averaging methods utilised over the measurement period have resulted in a higher $L_{Aeq,T}$ noise level than $L_{A10,T}$ noise level.

4.3. Vibration Monitoring

A 24-hour vibration measurement survey was carried out between 1115 hrs on Tuesday 30th April 2019 and 1340 hrs on Wednesday 1st May 2019 to obtain the Vibration Dose Values (VDV) at Vibration Position VP1. VP1 was located within the lower ground floor of the Falcon building where proposed residential units will be located. The Falcon building is located within approximately 50 m of the Piccadilly London Underground Line and it is the closest location of the proposed dwellings to this source of railway vibration and therefore considered likely to be subject to higher vibration levels than other areas of the site.

A Svantek SV106 vibration meter was utilised with a PCB tri-axial accelerometer. The meter was set to measure for consecutive one-minute periods during the 24-hour period. The accelerometer was mounted on a metal plate on the ground in accordance with ISO 14837-1:2005 *Mechanical vibration – Ground-borne noise and vibration arising from rail systems – Part 1: General guidance*. The mounting plate (DIN plate) meets the requirements identified in the DIN standard 45669-2:2005 '*Measurement of Vibration Immission - Part 2: Measuring Method*'.

The total VDV levels over the daytime and night-time periods are presented in **Table 4.4**.

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Table 4.4: Total VDV for Each Period

Period (hrs)	Vibration Dose Value (VDV, $m/s^{1.75}$)		
	X	Y	Z
Day (0700 hrs to 2300 hrs)	0.04	0.04	0.04
Night (2300 hrs to 0700 hrs)	0.03	0.03	0.03

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5. NOISE IMPACT ASSESSMENT

5.1. Noise Modelling

The CadnaA noise modelling software has been utilised to calculate the external noise levels from road traffic movements at the proposed development site. CadnaA is a three-dimensional noise model developed by DataKustik and has been extensively used by ACCON and others to develop noise models for a wide variety of situations and noise sources. CadnaA utilises the methodology in the Department of Transport's Technical Memorandum *Calculation of Road Traffic Noise* (CRTN, 1988) to predict noise from road traffic and ISO 9613 *Acoustics – Attenuation of sound during propagation outdoors* to predict noise from point, line and area sources such as proposed plant and building services equipment.

The results of the noise measurement survey detailed in **Section 4** have been utilised to calibrate the noise model predictions of the existing site.

5.2. Stage 1: ProPG Initial Site Noise Risk Assessment

For the purpose of the initial site noise risk assessment, it has been assumed that the site topography will not be significantly altered from the current topography. The proposed buildings are not included in the initial site noise risk assessment. Existing buildings are included in the initial site noise risk assessment unless they are to be demolished to facilitate the proposed development.

Figure F.2 presents the daytime ($L_{Aeq,16hr}$) and night-time ($L_{Aeq,8hr}$) period noise contours for the site at a relative height of 1.5 m. This noise contour height represents the noise levels at ground level residential units, including outside of the proposed underbuild properties at the Falcon, Blemundsbury and Richbell buildings.

Figure F.2 indicates that the site is generally of negligible to low risk of adverse noise effect from road traffic noise during the daytime period, including at the façades of the current lower ground floor levels of the Blemundsbury, Falcon and Richbell buildings where new dwellings will be developed. Where new buildings will front onto the existing roads (i.e. Orde Hall Street and Boswell Street) the initial site noise risk assessment identifies a medium risk of adverse noise effect.

Figure F.2 also indicates that the site is generally of a negligible risk of adverse noise effect from road traffic noise when considering the $L_{Aeq,8hr}$ during the night-time period. However, with reference to **Table 4.1**, the tenth highest L_{AFmax} noise level measured at MP1 during the night-time exceeds 60 dB and therefore, the site should not be regarded as "*negligible risk*" (refer to note d of **Figure 3.1**) .

Figure F.3 presents the daytime ($L_{Aeq,16hr}$) and night-time ($L_{Aeq,8hr}$) period noise contours for the site at a height of 10.5 m. This noise contour height represents the noise levels at approximately third floor level (assuming a 3 m floor to floor height) although it is noted that not all of the proposed blocks are this tall and some blocks will be taller in height. Noise levels at higher or lower floor levels are unlikely to be significantly higher or lower than those identified in **Figure F.3**.

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Figure F.3 indicates that the site is generally of negligible to low risk of adverse noise effect from road traffic noise during the daytime at all locations where new buildings are proposed.

Figure F.3 also indicates that the site is generally of negligible to low risk of adverse noise effect during the night-time. Where new buildings will front onto the existing roads (i.e. Orde Hall Street and Boswell Street) the initial site noise risk assessment identifies a medium risk of adverse noise effect from road traffic noise when considering the $L_{Aeq,8hr}$. As with the initial site noise risk assessment for ground floor, the L_{AFmax} noise levels measured at MP1 suggest that the noise risk should not be regarded as negligible.

5.3. Stage 2: Noise Impact Assessment

5.3.1. External Noise Levels

All proposed residential units will be provided with a private amenity space in the form of either a small ground level garden, a roof terrace/garden, a balcony, or private patio. There are also various existing communal external amenity spaces which will be updated and landscaped as part of the development.

Figure F.4 presents the daytime external noise contours at a height of 1.5 m above ground level for the proposed development. It can be identified from **Figure F.4** that the majority of the site would experience noise levels below the LOAEL of 50 dB $L_{Aeq,16hr}$.

Table 5.1 below, identifies the daytime external noise levels for various communal level amenity areas at the Tybalds Estate. These amenity areas are identified in **Figure F.4**.

Table 5.1: Daytime noise levels in the different amenity areas

Receptors	Daytime External Noise Levels $L_{Aeq,16hr}$ (dB)
R1: Tybalds Square	46
R2: North of Blemundsbury	40
R3: East of Richbell	44
R4: East of Falcon	54

Table 1 of **Appendix 3** identifies the predicted external noise levels at the various private amenity spaces which will be provided for the proposed development. It can be identified that for many of the balconies on the east side of Block B and the west side of Block D, external noise levels are predicted to exceed the SOAEL by up to 5 dB. The following balconies will exceed the SOAEL:

- Block B north balconies (adjacent to Orde Hall Street) at first to third floor.
- Block B south-east balconies (adjacent to Orde Hall Street) at first to fourth floor.
- Block D north-west balconies (adjacent to Boswell Street) at first to fourth floor.
- Block D south-west balconies (adjacent to Boswell Street) at first to sixth floor.

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External noise levels for all other private amenity areas are predicted to be below the LOAEL or between the LOAEL and SOAEL. Mitigation measures for external amenity areas are outlined in **Section 6.1**.

5.3.2. Internal Noise Levels

The highest predicted external noise levels have been extracted from the CadnaA noise model for each relevant façade of the proposed development. Noise levels for façades with windows into living rooms and bedrooms have been presented in **Table 1** of **Appendix 4**. The L_{AFmax} noise levels have been predicted from line sources on the roads representing those discrete traffic movements which resulted in the highest maximum noise levels. The L_{AFmax} source noise levels have been calibrated against the noise levels measured at all positions.

A Level 1 AVO Assessment has also been carried out with regard to the LBC criteria. Where relevant, the minimum building façade sound reduction has been identified to ensure that internal noise levels are below the LOAEL when windows are closed. **Table 5.2** summarises the methodology considered.

Table 5.2: Internal Noise Level Assessment Methodology and Mitigation

Noise Level	Level 1 AVO Assessment	Commentary
External noise level below the LOAEL	Negligible	External noise levels are below the LOAEL identified by LBC (**Table 3.2**). Internal noise levels with windows open are likely to also be below the relevant internal noise LOAELs. No specific acoustic mitigation measures will be required to these façades. Open windows are suitable for overheating mitigation.
External noise level between the LOAEL and SOAEL	Low to Medium	External noise levels are between the LOAEL and SOAEL identified by LBC. Standard double glazed window systems and appropriate means of ventilation as described by the Building Regulations Approved Document F will achieve the internal noise levels below the relevant LOAELs for most habitable rooms. Some specific acoustic mitigation measures will be required to some façades. Further details can be identified in **Section 6.2**. In most cases, internal noise levels with open windows should be reasonable i.e., they are within 5 dB of the LOAELs which is considered reasonable with reference to the ProPG (**Figure 3.2** Note 7). For a small number of façades, internal noise levels may become unreasonable if open windows are required for extended periods of time and a Level 2 AVO Assessment may be required.

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External noise level exceeds the SOAEL	High	External noise levels are greater than the SOAEL identified by LBC. Specific acoustic mitigation measures will to be required to achieve internal noise levels below the LOAEL. Open windows for overheating mitigation may not be reasonable for extended periods of time and a Level 2 AVO Assessment must be carried out to assist in informing the mitigation strategy.

Note: BS 8233 states that "if partially open windows were relied upon for background ventilation, the insulation would be reduced to approximately 15 dB". The WHO guidelines also state that a slightly open window would result in "a [sound] reduction from outside to inside of 15 dB".

Table 1 of **Appendix 4** indicates that all of habitable rooms would experience external noise levels below the LOAEL (Green) or between the LOAEL and SOAEL (Amber). There are no façades for which external noise levels exceeding the SOAEL have been identified.

Therefore, internal noise levels with windows open would also be below the LOAEL or between the LOAEL and SOAEL. However, for some rooms, where noise levels are closer to the SOAEL than the LOAEL, leaving windows open for extended periods of time to mitigate overheating may not be considered reasonable. A Level 2 AVO Assessment has been carried out for bedrooms in:

- Eastern Mews EM01 north façade oriented towards Great Ormand Street
- Western Mews EM01 east façade
- Block B east façade overlooking Orde Hall Street
- Block D
- Falcon Underbuild west façade overlooking Old Gloucester Street
- Blemundsbury Underbuild south façade overlooking Harpur Street/Dombey Street

ACCON has been provided with the anticipated number of hours that windows will need to be open to reduce overheating by TGA Consulting Engineers for the rooms identified by the ACCON report reference A4217/N/001 as requiring a Level 2 AVO Assessment. These values are presented in **Table 5.3**.

Table 5.3: Duration with Windows Open

Room Reference	Full Room Reference	Duration Windows Open (Hours)	Percentage of Annual Hours with Windows Open
1	B 01 2 Single Bedroom	2108	24%
2	B 01 3 Double Bedroom	2097	24%
3	B 01 3 Single Bedroom	2153	25%
4	D 01 1 DLK 2B3P	1913	22%

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Room Reference	Full Room Reference	Duration Windows Open (Hours)	Percentage of Annual Hours with Windows Open
5	D 01 1 Single Bedroom	2139	24%
6	D 01 2 DLK 1B2P	1757	20%
7	D 01 2 Double Bedroom	2085	24%
8	EM.01 02 Double Bedroom	2366	27%
9	UB.05 Double Bedroom	2527	29%
10	UF.03 Double Bedroom 1	2678	31%
11	UR.01 Double Bedroom 1	2589	30%
12	UR.02 Double Bedroom 1	1956	22%
13	UR.02 Double Bedroom 2	2522	29%

The assumption that the sound reduction from outside to inside when windows are partially open is 15 dB(A) is considered to be applicable.

It is assumed that opening windows for thermal comfort outside of the period May to September will be limited in both the frequency of occurrence and the duration of time that they will remain open. It is more likely that windows will be open for purge ventilation rather than as overheating mitigation. In this case, internal noise levels are considered to be reasonable.

Figure F.6, **Figure F.7** and **Figure F.8** illustrate that the internal noise levels are below the SOAEL for daytime and night-time.

For all of the proposed development, internal noise levels below the LOAEL will be readily achieved with windows closed. Further details on the building façade sound reduction requirements is provided in **Section 6.2**.

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5.4. Plant Sound Sources

5.4.1. Existing Sources of Plant Sound

No existing sources of industrial or commercial sound (i.e. air handling plant, kitchen extract plant etc.) which could adversely impact the proposed development were noticeable at the time of the noise measurement survey.

5.4.2. Proposed Sources of Plant Sound

The proposed development plans prepared by Matthew Lloyd Architects LLP indicate a plant room at ground level of Blocks B, C and D. These will house water tanks and booster pumps to supply the new residential units. It is unlikely that noise breakout from the use of the pumps will be audible outside of the plant room and no further assessment has been carried out.

The new blocks and mews will be heated using direct electric central heating. Hot water will be provided by domestic hot water (DHW) air source heat pumps (ASHP) located in utility cupboards. The DHW ASHPs emit relatively low levels of noise: a Dimplex Edel Hot Water Heat Pump Unit is understood to generate noise levels of 37 dB to 40 dB at 2 m[4]. Air intakes and exhaust ducts will provide some further reduction in noise and noise levels outside of the building are likely to be no worse than a domestic gas boiler flue. No further assessment has been carried out.

The underbuild development will be connected into an existing community heating network. Therefore, there are no new sources of noise to be assessed.

Block C incorporates community hall spaces for which an air handling unit (AHU) and variable refrigerant flow (VRF) systems are proposed. These will be located on the roof of Block C and surrounded by acoustic screening. The precise items of plant and details of the acoustic screening are unknown therefore, a detailed calculation will be required at a later stage.

The combined sound generated by externally mounted plant (AHU and VRF) should not exceed the LOAEL criteria in **Table 3.3**.

Additionally, plant sound and vibration have the potential to transmit through the building structure into residential units above or adjacent to (where applicable) the plant room.

Appropriate mitigation measures for consideration as the detailed design progresses are discussed in **Section 6.3**.

The typical daytime background sound level identified in **Table 4.1** is considered to be 45 dB $L_{A90,5mins}$. The typical night-time background sound level is considered to be 40 dB $L_{A90,5mins}$. These were the lowest most frequently occurring $L_{A90,5mins}$ sound levels. Based on a review of the local area, the nearest residential properties are immediately adjacent to the proposed site. The measured background levels are assumed to be typical for this location, particularly

[4] Retrieved from https://www.dimplex.co.uk/sites/default/files/assets//edl_spec_sheet_-_issue_1.pdf 27th May 2021

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as any quiet periods as identified from the $L_{A90,\ 5\ min}$, even if they were of a short duration, have been considered.

5.4.3. Rating Levels of Plant Sound Sources

With reference to **Table 3.3** and on the basis of the typical background sound levels measured at MP1, the target LOAEL rating level for the daytime for all proposed sources of plant sound would be 35 dB $L_{Ar,Tr}$. For the night-time the target LOAEL rating level would be 30 dB $L_{Ar,Tr}$ with no maximum noise events exceeding 57 dB L_{AFmax}. Whilst the rating level will already consider the acoustic character of the sound including tonal features, LBC may require an additional 5 dB correction if the sound contains audible tonal elements (refer to Note 1 of **Table 3.3**). Accordingly, any plant sound sources associated with the development should not exceed these rating noise levels in order to ensure that existing sensitive receptors in the vicinity of the development and new sensitive receptors will not be adversely affected by noise from any plant. It is therefore likely that plant noise mitigation measures, as outlined in **Section 6.3**, will be required.

5.5. Entertainment Noise

The community halls will be used for a range of purposes including meetings, religious meetings, groups and social gatherings. LBC characterise entertainment noise to include: "*amplified and unamplified music, human voices, footfall and vehicles movements, and other general activity*". The community halls (Block C and Falcon) should be designed to minimise breakout noise and sound transmission into immediately adjacent flats and good noise management policies should be implemented to ensure that other sources of noise such as human voice and vehicles are appropriately addressed.

The target external noise levels in private amenity spaces (i.e. balconies or gardens) should be below the LOAEL set out in **Table 3.4**. Based on the results of this noise assessment, **Table 5.4** outlines the target noise levels for private amenity spaces adjacent to Block C and Falcon.

Table 5.4: Target External Noise Levels from Entertainment Noise at Private Amenity Spaces

Receptor	Period	External $L_{Aeq,5mins}$ (dB)	Entertainment Noise LOAEL
Block C			
Block C Balconies	Day	43-50 dB	55 dB $L_{Aeq,5mins}$
	Evening	35-50 dB	50 dB $L_{Aeq,5mins}$
	Night-time	35-46 dB	45 dB $L_{Aeq,5mins}$
Block B Balconies	Day	36-50 dB	55 dB $L_{Aeq,5mins}$
	Evening	30-50 dB	50 dB $L_{Aeq,5mins}$
	Night-time	30-42 dB	45 dB $L_{Aeq,5mins}$

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Receptor	Period	External $L_{Aeq,5mins}$ (dB)	Entertainment Noise LOAEL
Falcon			
Falcon Balconies	Day	51-58 dB	55 dB $L_{Aeq,5mins}$
	Evening	42-58 dB	50 dB $L_{Aeq,5mins}$
	Night-time	42-49 dB	45 dB $L_{Aeq,5mins}$
Richbell Balconies	Day	58 dB	55 dB $L_{Aeq,5mins}$
	Evening	50-58 dB	50 dB $L_{Aeq,5mins}$
	Night-time	50 dB	45 dB $L_{Aeq,5mins}$
Block D Balconies	Day	55-60 dB	55 dB $L_{Aeq,5mins}$
	Evening	46-60 dB	50 dB $L_{Aeq,5mins}$
	Night-time	46-51 dB	45 dB $L_{Aeq,5mins}$

For all receptors, the internal noise levels should not exceed NR25 during the night-time in bedrooms and NR35 in any habitable room during the daytime. These NR curves are provided in **Table 5.5**.

Table 5.5: NR Curves Targets for Internal Entertainment Noise Impacts

NR Curve	Octave Band Centre Frequency (dB)							
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
NR25	55.2	43.7	35.2	29.2	25.0	21.9	19.5	17.7
NR35	63.1	52.4	44.5	38.9	35.0	32.0	29.8	28.0

The community halls in Block C are noted to incorporate AHU and VRF systems which have been assessed as part of **Section 5.4**. These have been provided specifically to ensure that windows can be kept closed during noisier events and activities. Therefore, the sound insulation properties of the building construction are likely to be the determining factor to achieving the relevant criteria along with good noise management policies, as appropriate. A detailed calculation should be carried out as the detailed design is developed. Examples of appropriate noise migration measures are provided in **Section 6.4**.

5.6. Vibration Levels

The vibration levels were measured internally on the lower ground floor within the Falcon building, in which location residential units are proposed as part of the development. The Falcon building is the closest development building to the Piccadilly London Underground Line. The proposed residential units at the Falcon building are therefore considered to be the

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worst affected residential receptors of the proposed development with regard to the existing source of railway-induced ground-borne vibration. The measured vibration data represents the VDVs which would be expected to be experienced by future residents of the residential units at lower ground floor level. The measured vibration data (**Table 4.4**) has been compared against the criteria presented in **Section 3.5.1**. The results of the comparison are presented in **Table 5.6**.

Table 5.6: Vibration Impact Assessment of Underground Railway Movements

Direction	Measured VDV ($m/s^{1.75}$)		Residential Criterion (Section 3.5.1)		Within or below Criterion?	
	Daytime	Night-time	Daytime	Night-time	Daytime	Night-Time
X	0.04	0.03	0.2 to 0.4 $m/s^{1.75}$ or lower	<0.13 $m/s^{1.75}$	Below criterion	Below criterion
Y	0.04	0.03			Below criterion	Below criterion
Z	0.04	0.03			Below criterion	Below criterion

It can be identified from **Table 5.6** that the measured VDVs are significantly below the target VDV ranges identified in **Table 3.1**. It is concluded that vibration mitigation would not be required to the underbuild residential units at the lower ground floor of the Falcon building.

By extension, all other development areas (both new build and under-build) are located at a greater distance from the London Underground Line to the Falcon building. Even when taking into consideration the potential for amplification of vibration levels from ground level to higher floors, vibration levels are highly likely to be lower than measured on the lower ground floor of the Falcon building. It is therefore highly likely that vibration levels at these proposed units will be lower than those measured at the Falcon building. As a result, vibration mitigation measures are not required for the proposed development.

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6. MITIGATION MEASURES

6.1. External Noise Levels

Table 5.1 and **Figure F.4** indicate that the majority of communal external amenity areas will achieve a noise level below the LOAEL or between the LOAEL and SOAEL.

The predicted external noise levels within the external area outside Falcon are only marginally higher than the LOAEL. The predicted external noise levels are not considered to be unreasonable and typical noise mitigation measures such as acoustic barriers are unlikely to be practicable in this area.

For balconies, where the predicted noise level exceeds the SOAEL, solid brick upstands are proposed to a height of 1.1 m at lower floor levels (Block B to third floor and Block D to second floor) which may provide a further marginal reduction in noise level. At higher floor levels open balustrades are proposed. Potential noise mitigation measures have been explored with the architects (Matthew Lloyd Architects) and building services engineers (TGA Consulting Engineers) including increasing the heights of solid balustrades, providing solid balustrades at all balconies and providing winter gardens. However, it cannot be guaranteed that such measures would achieve a noise level below the SOAEL and such design interventions are likely to adversely affect the overheating and daylight assessments, for example.

Paragraph 11 of the PPG-N explores further considerations relating to the mitigation of noise impacts on residential developments. Paragraph 11 (reference ID: 30-011-20190722) states:

"*Noise impacts may be partially offset if residents have access to one or more of:*

- *A relatively quiet façade (containing windows to habitable rooms) as part of their dwelling;*
- *A relatively quiet external amenity space for their sole use, (e.g. a garden or balcony). Although the existence of a garden or balcony is generally desirable, the intended benefits will be reduced if this area is exposed to noise levels that result in significant adverse effects;*
- *A relatively quiet, protected, nearby external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings; and/or*
- *A relatively quiet, protected, external publically accessible amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5 minute walking distance).*"

Where balcony noise levels exceed the SOAEL, residents would also benefit from a relatively quiet façade containing windows to habitable rooms in some Blocks. All residents will also benefit from access to the variety of ground level external amenity areas across the Tybalds Estate which achieve noise levels below the LOAEL or between the LOAEL and SOAEL. Therefore, the development partially offsets the noise impacts on the small number of private balconies where the SOAEL would be exceeded by providing relatively quiet and protected open spaces for use by residents and the public.

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6.2. Internal Noise Levels

Table of **Appendix 4** identifies that the highest combined building façade sound reduction required for the new blocks (Eastern and Western Mews, Block B, Block C and Block D) is 28 dB(A). This should be readily achieved with a typical double glazed window system (i.e., in a 4 mm glass/6-16 mm air gap/6 mm glass formation) and a ventilation system which complies with the requirements of the Building Regulations Approved Document F. It is assumed that the external wall build-ups will achieve a minimum sound reduction of 50 dB R_w. This level of sound reduction would typically be achievable with a brick and block cavity walls; other types of construction such as curtain walling and cladding constructions should be assessed on a case-by-case basis.

For the underbuild development, the highest combined building façade sound reduction required is 34 dB(A) on the west façade of Falcon. A sound reduction of 32 dB(A) is required for the south façade of Blemundsbury (Flat 04 and Flat 05). Provided that the external wall build-up provides a sufficiently high sound reduction, the glazing and any ventilation opens will be the weakest acoustic elements of the building façade. Double-glazing in a 6 mm glass/6-16 mm air gap/ 10 mm glass formation, for example, would be expected to achieve 32 dB(A) sound reduction. A laminated pane may be required to achieve the marginally higher 34 dB(A). Ventilation should be provided in accordance with the Building Regulations Approved Document F. ACCON recommend mechanical means of ventilation (System 3 or 4) for these types of units.

In respect of overheating effects, the internal noise levels with windows open are not predicted to exceed the SOAEL. However, a Level 2 AVO Assessment has indicated that all bedrooms of previous concern are expected to experience reasonable daytime and night-time internal noise conditions for the duration that windows may need to be open for thermal comfort.

Figure F.5 identifies the noise mitigation strategy for each façade of the proposed development.

6.3. Plant Sound Sources

6.3.1. Plant Room Breakout Sound to Outside

Depending on the items of plant which may be installed within the plant rooms, sound breakout to outside can be minimised by consideration of the following design measures:

- Selecting appropriate plant for the building requirements and, as far as practicable, inherently quiet plant;
- Ensuring that the external wall build-up provides a reasonable level of sound reduction;
- Avoiding mounting any plant items directly onto the walls (and floors) of the plant room by using appropriate mounts and fixings (i.e. anti-vibration mounts);
- Utilising acoustically treated ventilation louvres, air intakes/extract ducts and flues, where necessary.

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6.3.2. Sound Transmission to Residential Units

Where residential units are proposed above or adjacent to the plant rooms, measures should be taken to minimise the transmission of sound and vibration from the plant room into these habitable areas. The following design measures should be considered:

- Selecting appropriate plant for the building requirements and, as far as practicable, inherently quiet plant;
- Ensuring that the walls and floor separating the plant rooms from habitable rooms of residential units provide a sufficient level of sound insulation;
- Avoiding mounting any plant items directly onto the walls (and floors) of the plant room by using appropriate mounts and fixings (i.e. anti-vibration mounts).

6.3.3. Externally Mounted Plant and Equipment

For all externally mounted plant and equipment including the AHU and VRF systems at Block C, as well as any ASHPs, the following design measures should be considered:

- Selecting appropriate plant for the building requirements and, as far as practicable, inherently quiet plant;
- Choosing locations that minimise the number of noise sensitive receptors that could be adversely impacted by sound from the plant source;
- Installing plant on appropriate mounts and fixings to avoid transmission of sound and vibration into building structures;
- The provision of acoustic screening or enclosures to reduce sound generated by the operation of the plant (it is noted that acoustic screening is proposed to the plant area on the roof of Block C).

6.4. Entertainment Noise

Good acoustic design measures to minimise the impact of entertainment noise on residential receptors are likely to take the form of:

- Building façade design to ensure high levels of sound insulation to minimise the impacts of breakout noise;
- Internal floor (and wall, if applicable) constructions to ensure high levels of sound insulation to minimise the transmission of sound into connected residential units;
- A noise management policy/plan which could include:
    - A suitable late-night curfew when noisy events are required to end;
    - Providing signage to remind patrons that they are entering a residential area when departing the premises;
    - The provision of noise limiting technology to ensure any amplified music does not exceed any agreed limits;
    - Details on how to use of the ventilation system during a noisier event/activity.

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As the community spaces are managed by the residents of Tybalds Estate, the noise management plan should be developed and maintained in line with the requirements of the community. It is understood that events requiring loud amplified music are not currently permitted, however, there is the potential for this to change in the future. Therefore, the building should be designed to account for a reasonable worst-case with appropriate noise management policies drafted accordingly.

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7. CONSTRUCTION NOISE AND VIBRATION

7.1. Construction Phasing

The proposed development will be constructed in three phases:

- Phase 1a comprises the underbuild development at Falcon, Blemundsbury and Richbell
- Phase 1b comprises the eastern and western mews, as well as the new entrances at Babington Court, Devonshire and Chancellors Court
- Phase 2 comprises the construction of Blocks B and C as well as the bulky waste store.

7.2. Construction Noise and Vibration

It is inevitable that there will be some disturbance caused to noise sensitive receptors within the vicinity of the proposed development site during the construction phases. Distruption due to construction activities is generally a localised phenomenon and is temporary and relatively short-term in nature.

The nearest noise sensitive receptors to the various areas of construction include existing residential dwellings immediately above (where underbuild is proposed) or adjacent to the development areas within and around the Tybalds Estate. Consideration should also be given to any nearby non-residential buildings which are used for medical related uses particularly where sensitive equipment or processes are used and where patients convalesce.

The exact construction plant types and programme of works is currently unknown and a detailed assessment has not been carried out at this time.

Best practicable means mitigation as recommended in BS 5228:2009+A1:2014 ‘Code of practice for noise and vibration control on construction and open sites Part 1: Noise’ and ‘Part 2: Vibration should be implemented along with any LBC construction noise policies’.

7.2.1. Construction Noise

The following noise mitigation measures are likely to be relevant to this development:

- Unless agreed in advance, demolition and construction works will be carried out during the following hours:
    - 0800 hrs to 1800 hrs Monday to Friday;
    - 0800 hrs to 1300 hrs Saturday and,
    - No noisy work on Sundays, or Bank Holidays[5].
- The least intrusive methods of work will be used where practicable.

[5] Retrieved from https://www.camden.gov.uk/noise#cnxb 27th May 2021

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- Inherently quiet plant should be used where appropriate – all major compressors and generators will be 'sound reduced' models fitted with properly lined and sealed acoustic covers, which will be kept closed whenever the machines are in use, and all ancillary pneumatic percussive tools will be fitted with mufflers or silencers of the type recommended by the manufacturers.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and will be maintained in good efficient order.
- Machines in intermittent use will be shut down in the intervening periods between use or throttled down to a minimum.
- All ancillary plant such as generators and pumps will be positioned so as to cause minimum noise disturbance, and where necessary, acoustic enclosures will be provided.
- Localised noise barriers will be erected as necessary around items such as generators or high duty compressors.
- Construction compounds will be laid out so as to minimise noise impacts to neighbouring noise sensitive receptors, by locating noisy operations well away from receptors and using on-site structures and materials to screen noise where practicable and necessary.
- Channels of communication will be established between the contractor / developer, local authority and residents with a Site Representative appointed responsible for matters relating to noise (and vibration).
- If necessary, noise levels will be monitored during critical periods and at sensitive locations on agreement and approval from LBC.
- In the worst-case, day shelters, particularly during periods of inclement weather, will be provided for persons likely to be affected by the works for prolonged periods. Temporary rehousing may be offered where residents are likely to be exposed to unacceptable disturbance for prolonged periods.

People are generally more tolerant of higher noise levels if they know that they are only going to be of a short duration. Therefore, it is important to maintain good communication with the local residents.

The identified mitigation measures could be implemented through a Construction Environmental Management Plan (CEMP).

Where necessary, applications for Prior Consent under the Control of Pollution Action 1974 should be submitted for each relevant stage of the construction works.

7.2.2. Construction Vibration

The following vibration mitigation measures are likely to be relevant to this development:

- Where reasonably practicable, plant and/or methods of work causing significant levels of vibration at sensitive receptors should be replaced by other less intrusive plant and/or methods of working.

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- Where vibration from stationary plant (e.g. generators, pumps, compressors) may cause disturbance to nearby sensitive receptors, equipment should be relocated or isolated using resilient mountings.
- Generally, vibrating equipment should be located as far from sensitive receptors as possible.
- Where necessary, restricting the duration of the relevant activity and carrying out the activity within agreed 'core hours'.
- Channels of communication will be established between the contractor / developer, local authority and residents with a Site Representative appointed responsible for matters relating to noise and vibration.
- If necessary, vibration levels will be monitored during critical periods and at sensitive locations on agreement and approval from LBC.

As with noise, people may be more tolerant of construction vibration if they are informed in advance and know that it will only occur for a short duration. Therefore, it is important to maintain good communication with the local residents.

The identified mitigation measures could be implemented through a Construction Environmental Management Plan (CEMP).

Where necessary, applications for Prior Consent under the Control of Pollution Action 1974 should be submitted for each relevant stage of the construction works.

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8. ACOUSTIC DESIGN STATEMENT

An environmental noise and vibration survey has been carried out at the site and a detailed noise model has been prepared for the site. The noise model has been calibrated utilising the measured noise levels.

The noise modelling has been used to inform the initial site noise risk assessment and noise impact assessment for the proposed development. The assessments should be considered as part of the good acoustic design process.

8.1. Initial Site Noise Risk Assessment

The initial site noise risk assessment identified that the site is generally of negligible to low risk of adverse noise impact from road traffic noise during the daytime with some small areas increasing to medium risk at ground level. At night-time the risk is negligible to low; however, the measured maximum noise levels during the night-time regularly exceeded 60 dB L_{AFmax} due to a variety of noise sources both localised and from the wider transportation network. Therefore, the site should not be considered as "*negligible risk*" during the night-time.

8.2. External Noise Levels

The external noise levels within ground level communal amenity areas are generally predicted to achieve a noise level below the LOAEL or between the LOAEL and SOAEL set by LBC. The exceedance of the LOAEL is not considered to be unreasonable for a communal amenity space and noise mitigation measures such as acoustic screening may not be appropriate for the area.

The majority of residential units are proposed to have private balconies. Where balconies overlook Orde Hall Road or Boswell Road, the external noise levels are predicted to exceed the SOAEL by up to 5 dB. Where practicable, solid balustrades and sound absorbing material installed to the soffit should be considered, however, this is unlikely to reduce the noise levels on the worst-affected balconies to below the SOAEL. Taller balustrades or winter gardens could be considered in these worst-affected areas. However, all residents will benefit from access to the ground level communal external areas, the majority of which have been predicted to experience a noise level below the LOAEL or between the LOAEL and SOAEL level. Therefore, if noise levels on the worst-affected balconies cannot be reduced to below the SOAEL, the impact can be partially off-set by the provision of these communal spaces.

8.3. Internal Noise Levels

For all habitable rooms, an internal noise level below the LOAEL or between the LOAEL and SOAEL has been predicted with open windows for ventilation. No specific acoustic mitigation measures have been identified for the majority of the development: those habitable rooms will experience internal noise levels below the LOAEL with closed windows assuming a typical double-glazed window system and an appropriate means of ventilation in line with the Building Regulations Approved Document F.

Two façades within underbuild areas of the development require specific acoustic mitigation measures to achieve noise levels below the LOAEL with windows closed: west façade of

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Falcon (34 dB(A)) and south façade of Blemundsbury (32 dB(A)). ACCON recommend the use of mechanical means of ventilation for these units (i.e. Building Regulations Approved Document F System 3 or 4).

A small number of façades have been identified as requiring a Level 2 AVO Assessment in line with the Acoustics, Ventilation and Overheating Guide. Habitable rooms (mainly bedrooms) on these façades will experience the highest internal noise levels of the development with windows open for overheating mitigation. The Level 2 AVO Assessment indicates that all bedrooms highlighted by the Level 1 AVO Assessment are expected to experience reasonable daytime and night-time internal noise conditions for the duration that windows may need to be open for thermal comfort..

8.4. Plant Sound Levels

There were no existing sources of plant sound noticeable at the time of the noise measurement survey which would significantly impact the proposed development.

It is noted that there are plant rooms proposed at the ground floor of the new residential blocks and a plant area on the roof the Block C for plant associated with the community halls. It is also proposed to install air source heat pumps for the new residential units and a detailed noise assessment of these will be required when details of the items have been finalised.

In line with the criteria set by LBC, the target LOAEL levels for plant sound from all proposed sources have been determined based on the measured noise levels at MP1, external to the Blemundsbury building. Recommendations for consideration in the design of the plant room and specification of the equipment have been provided.

8.5. Entertainment Noise

Subject to the likely uses of the community hall spaces in the ground floor of Block C and Falcon building, the LBC criteria have been identified for noise breaking out of the halls and impacting residential receptors. A series of noise mitigation measures have been identified to consideration where they are applicable to the proposed uses. A detailed noise assessment may be required depending on the proposed community hall uses.

8.6. Vibration

The vibration levels measured at the lower ground floor level of the Falcon building are below the residential vibration criteria specified by LBC. The Falcon building is the closest part of the development to the London Underground Piccadilly Line. Vibration levels at all other underbuild and new build development areas across the site are high likely to be lower than at Falcon, even when the potential for amplification at higher floors of the new blocks is considered. Therefore, it is considered that vibration mitigation measures are not required for the proposed development.

8.7. Recommendations to the Decision Maker

On the basis of the above, it is recommended that there should be no objection to granting planning consent for the proposed development on noise or vibration grounds.

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ADDITIONAL FIGURES

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Figure F.1: Vibration and Noise Measurement Locations

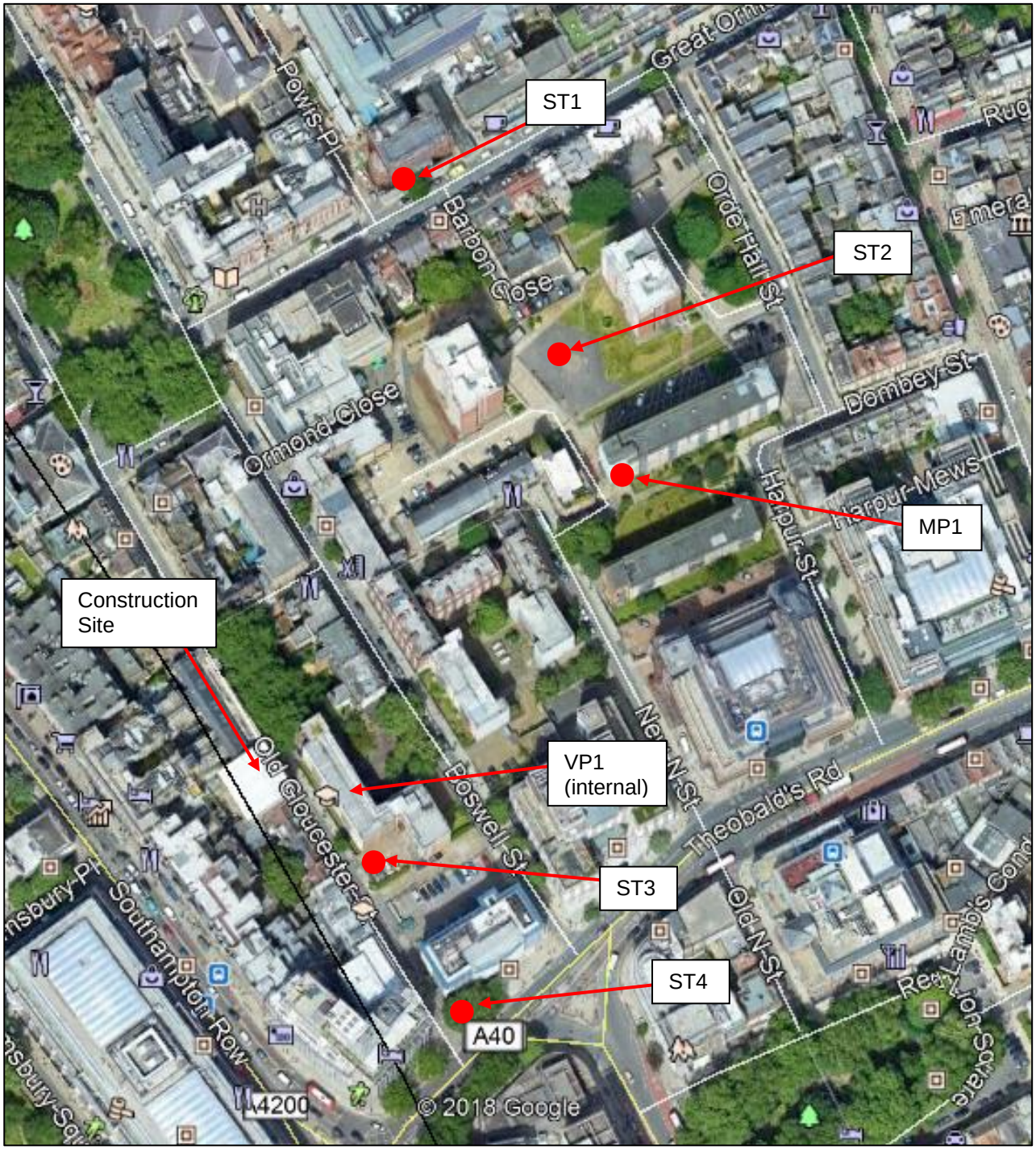

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Figure F.2: ProPG Initial Site Noise Risk Assessment at Ground Floor Level

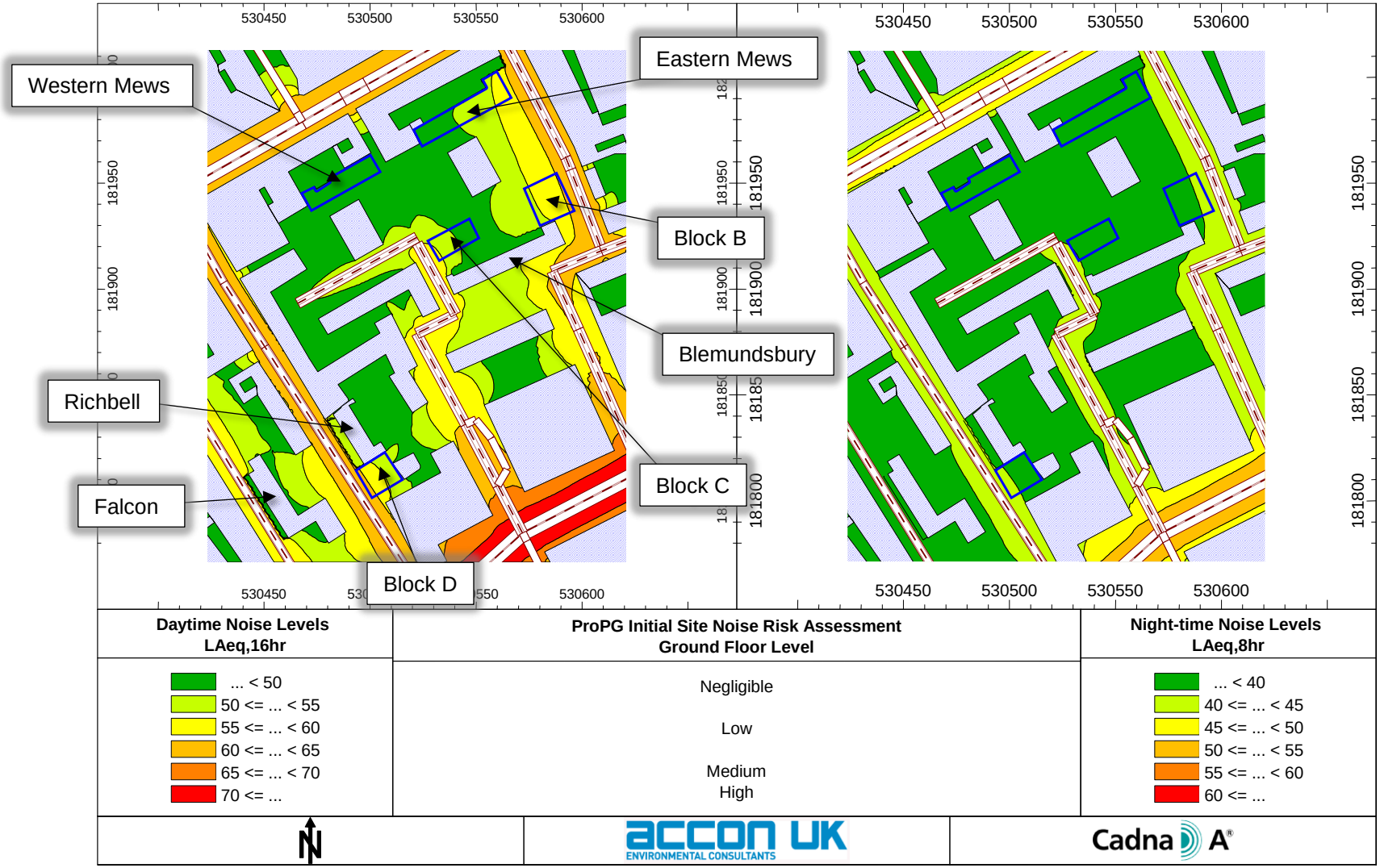

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Figure F.3: ProPG Initial Site Noise Risk Assessment at Third Floor

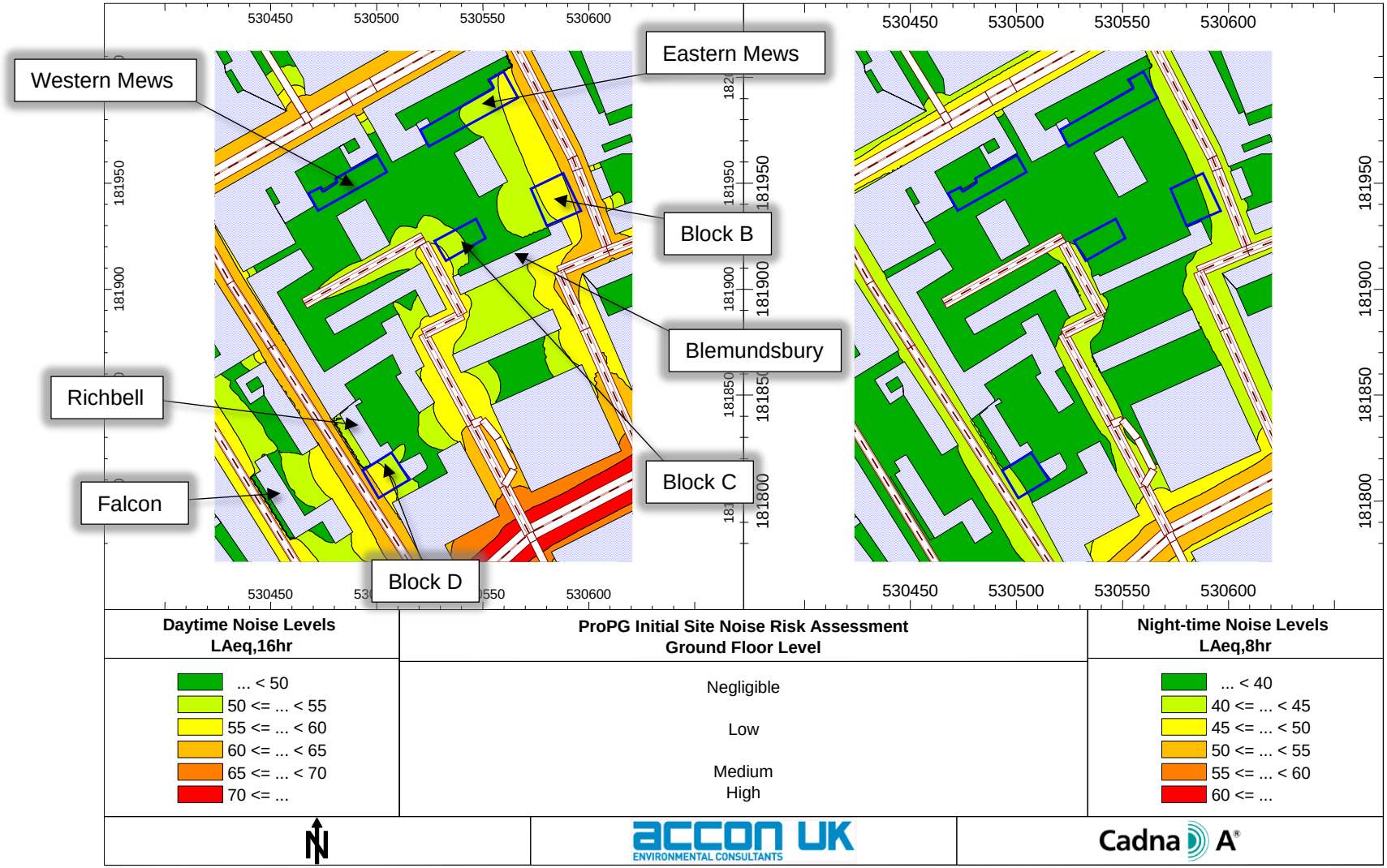

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Figure F.4: Daytime External Noise Levels with Amenity Area Receptors

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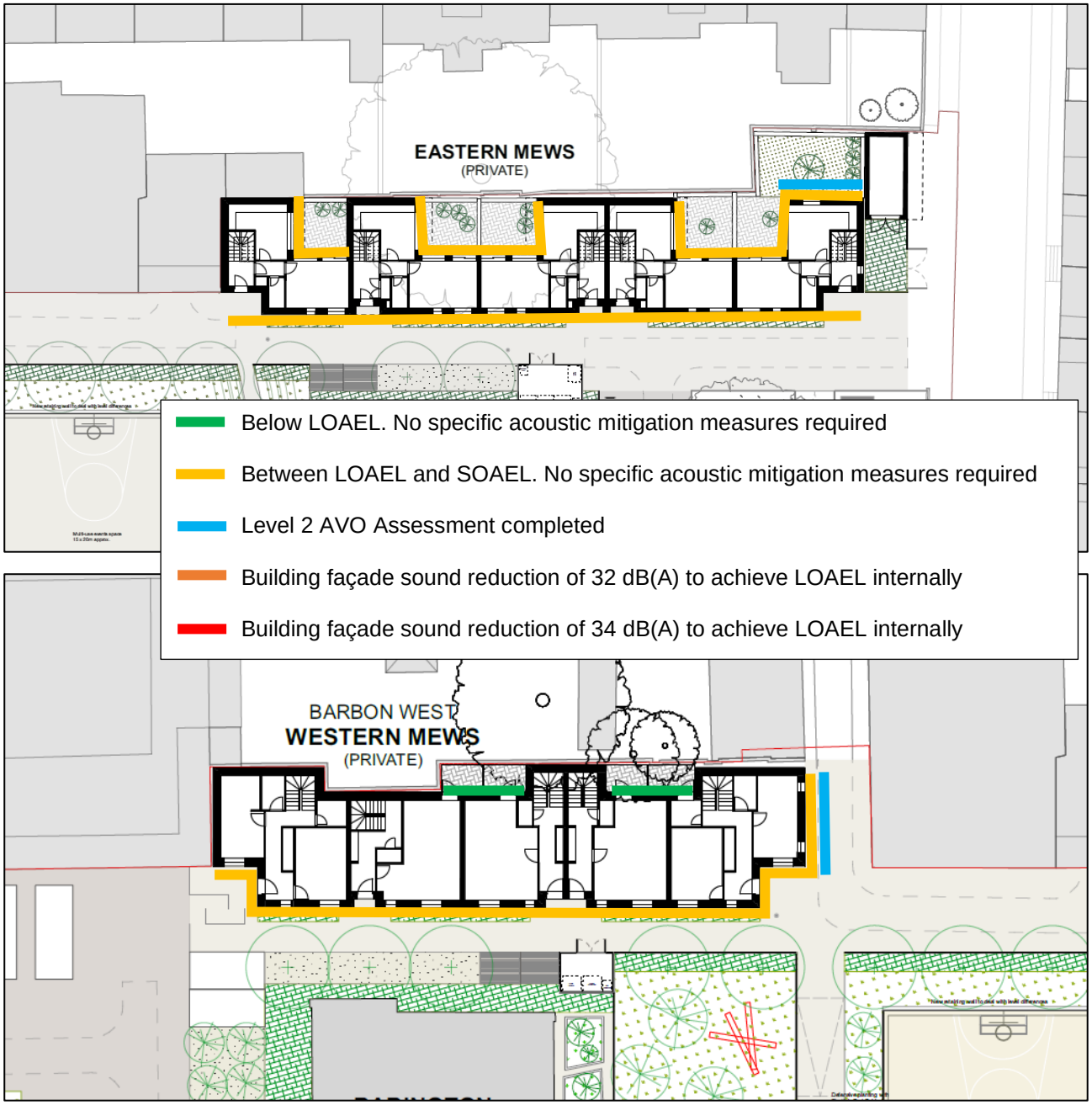
Figure F.5: Noise Mitigation Scheme for Proposed Development



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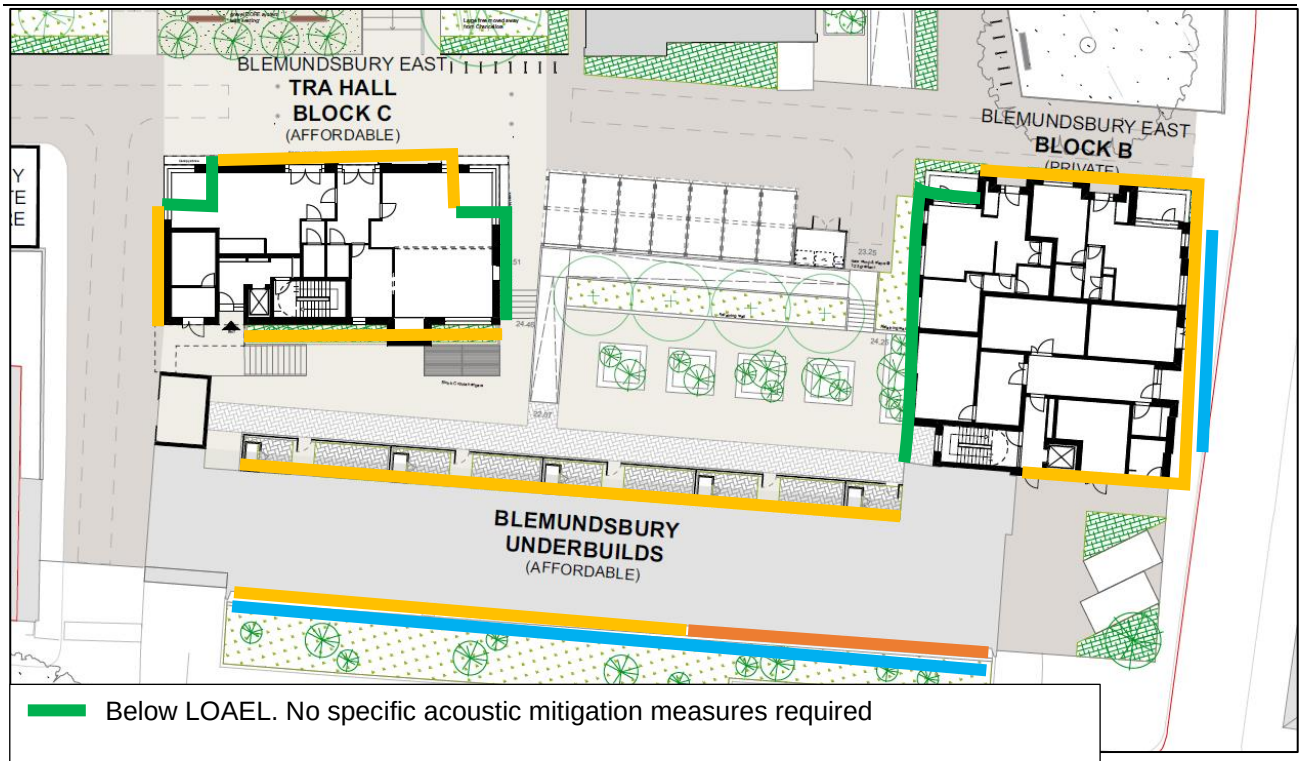

- Below LOAEL. No specific acoustic mitigation measures required
- Between LOAEL and SOAEL. No specific acoustic mitigation measures required
- Level 2 AVO Assessment completed
- Building façade sound reduction of 32 dB(A) to achieve LOAEL internally
- Building façade sound reduction of 34 dB(A) to achieve LOAEL internally

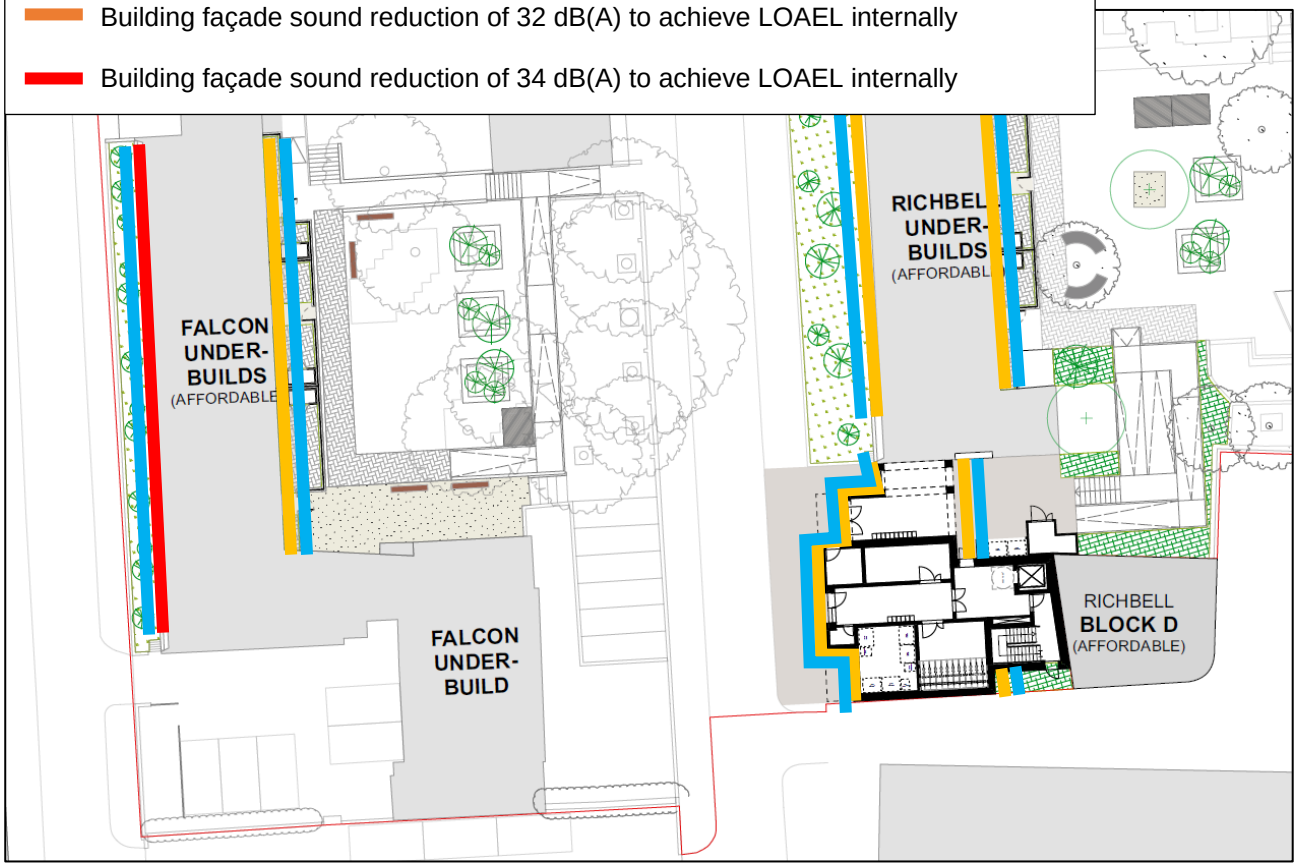

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Figure F.6: Daytime ($L_{Aeq, 16h}$) Level 2 AVO Assessment

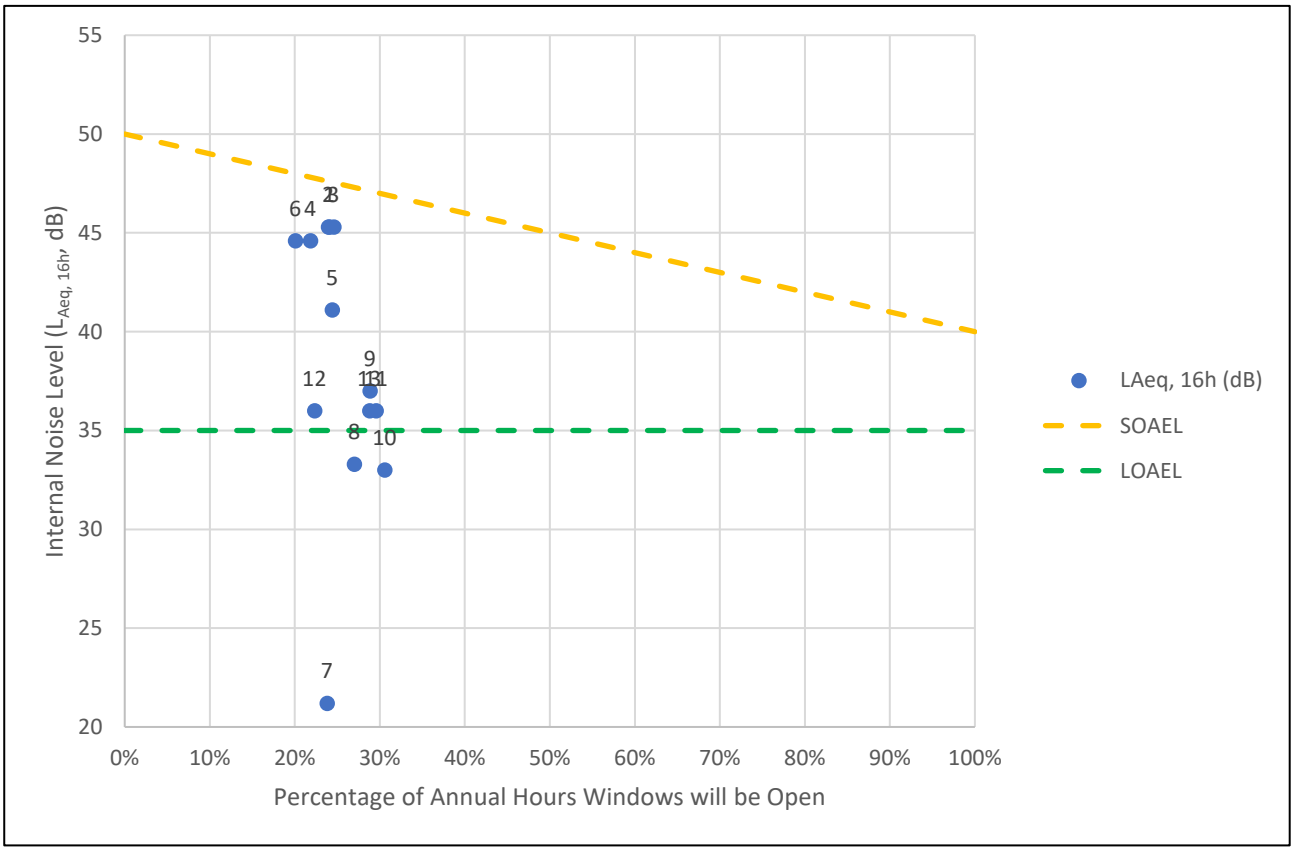

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Figure F.7: Night-Time ($L_{Aeq, 8h}$) Level 2 AVO Assessment

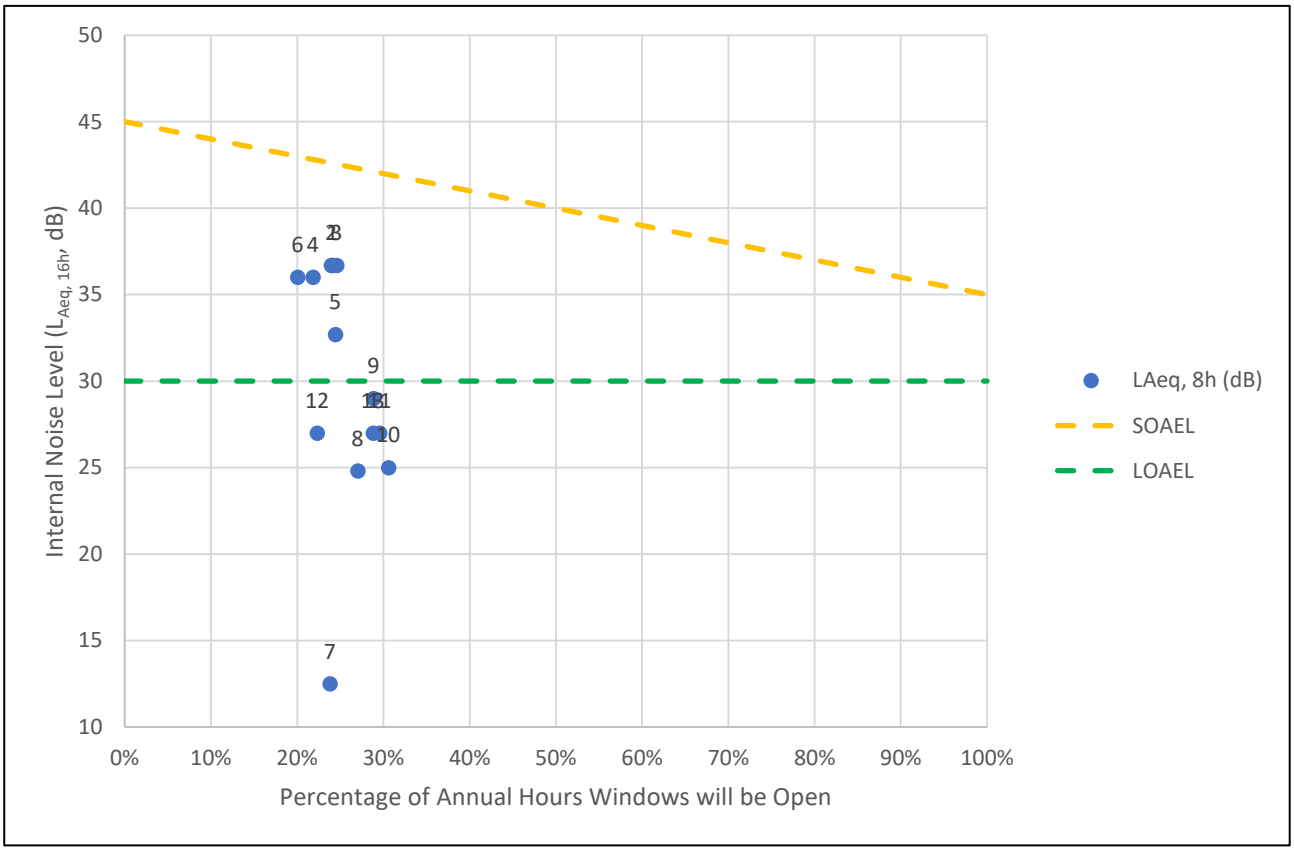

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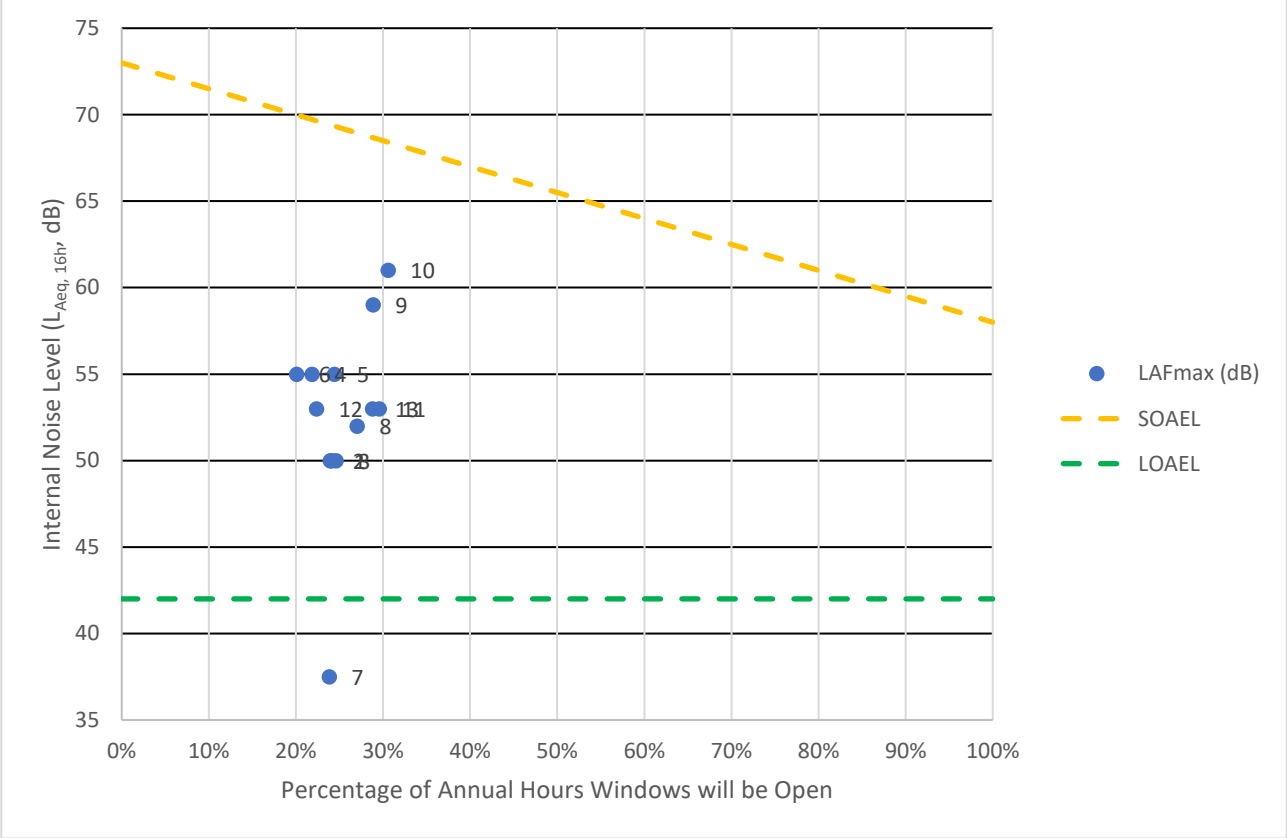
Figure F.8: Night-Time (L_{AFmax}) Level 2 AVO Assessment



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Appendix 1
Glossary of Acoustic Terminology

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Term	Description
'A'-Weighting	This is the main way of adjusting measured sound pressure levels to take into account human hearing, and our uneven frequency response.
Decibel (dB)	This is a tenth (deci) of a bel. Decibel can be a measure of the magnitude of sound, changes in sound level and a measure of sound insulation. Decibels are not an absolute unit of measurement but are an expression of ratio between two quantities expressed in logarithmic form.
$L_{Aeq,T}$ (Ambient/Period Sound Level)	The equivalent steady sound level in dB containing the same acoustic energy as the actual fluctuating sound level over the given period, T. T may be as short as 1 second when used to describe a single event, or as long as 24 hours when used to describe the noise climate at a specified location. $L_{Aeq,T}$ can be measured directly with an integrating sound level meter.
$L_{A10,T}$ (Road Traffic Noise Level)	The 'A'-weighted sound pressure level of the residual noise in decibels exceeded for 10 per cent of a given time. The $L_{A10,T}$ is used to describe road traffic noise levels at a particular location.
$L_{A90,T}$ (Background Sound Level)	The 'A'-weighted sound pressure level of the residual noise in decibels exceeded for 90 per cent of a given time. The $L_{A90,T}$ is used to describe the background noise levels at a particular location.
L_{Amax}	The 'A'-weighted maximum sound pressure level measured over a measurement period. Typically measured with 'fast' weighting (125 ms) or 'slow' weighting (1 s).
Rating Level, $L_{Ar,Tr}$	The specific sound level plus any adjustment for the characteristic features of the sound.
Residual Sound Level, $L_r = L_{Aeq,T}$	Ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound.
Specific Sound Level, $L_s = L_{Aeq,Tr}$	The equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr.
R	Sound reduction index. Laboratory measure of the sound insulating properties of a material or building element in a stated frequency band
R_w	Weighted sound reduction index, a single number quantity for the airborne sound insulation in buildings and of building elements such as wall, doors and windows. The quantity is intended for rating the airborne sound insulation and for simplifying the formulation of acoustical requirements in building codes, when measured in the presence of flanking sound transmission, denoted R'_w.

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Appendix 2
Noise Measurement Results

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Table 1: Hourly Noise Measurement Results for MP1

Time	$L_{Aeq,T}$ (dB)	L_{AFmax} (dB)	$L_{A10,T}$ (dB)	$L_{A90,T}$ (dB)
Façade Noise Levels				
0700 – 0800	57	77	59	50
0800 – 0900	54	73	56	50
0900 – 1000	54	71	55	49
1000 – 1100	54	75	56	49
1100 – 1200	54	79	56	48
1200 – 1300	54	72	56	49
1300 – 1400	54	76	55	49
1400 – 1500	55	73	57	50
1500 – 1600	59	86	58	50
1600 – 1700	55	81	56	48
1700 – 1800	53	72	55	48
1800 – 1900	50	67	53	47
1900 – 2000	52	76	54	47
2000 – 2100	52	74	53	47
2100 – 2200	49	70	51	46
2200 – 2300	53	71	54	46
2300 – 0000	48	67	50	43
0000 – 0100	47	68	49	43
0100 – 0200	47	73	48	43
0200 – 0300	46	59	48	43
0300 – 0400	46	60	48	43

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Time	$L_{Aeq,T}$ (dB)	L_{AFmax} (dB)	$L_{A10,T}$ (dB)	$L_{A90,T}$ (dB)
0400 – 0500	48	62	50	44
0500 – 0600	52	71	53	46
0600 – 0700	53	74	55	48
Day (0700 – 2300)	**54**	**75**	**55**	**48**
Night (2300 –0700)	**49**	**69**	**50**	**44**
Free-field Noise Levels (-3 dB Façade Correction)				
Day (0700 – 2300)	**51**	**72**	**52**	**45**
Night (2300 –0700)	**46**	**66**	**47**	**41**

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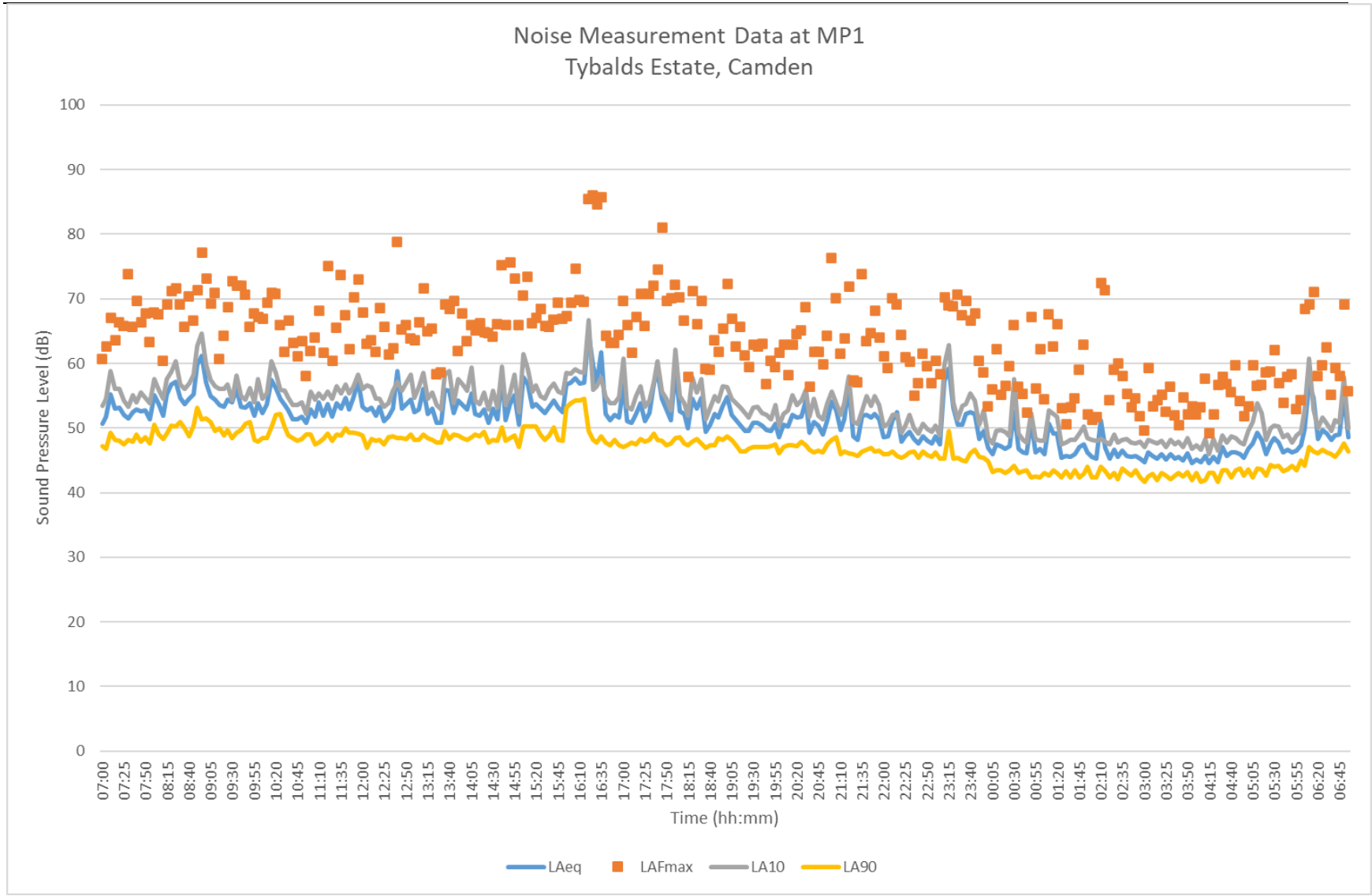

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Appendix 3

External Noise Assessment Results for Balconies

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Table 1: External Noise Assessment Results for Balconies

Amenity Area	Predicted External Noise Levels $L_{Aeq,16hr}$ (dB)
Eastern Mews	
EM01 Garden	43
EM02 Garden	38
EM02 Roof Garden	49
EM03 Garden	36
EM03 Roof Garden	48
EM04 Garden	36
EM04 Roof Garden	47
EM05 Garden	35
EM05 Roof Garden	44
Western Mews	
WM01 Roof Garden	43
WM02 Roof Garden	43
WM03 Roof Garden	39
WM04 Roof Garden	37
WM05 Roof Garden	39
Block B	
North-West Balconies	49-50
North-East Balconies	55-58 (Note: Winter garden proposed at ground floor level, noise levels highly likely to be below the LOAEL within winter garden)
South-East Balconies	56-59
South-West Balconies	36-37

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Amenity Area	Predicted External Noise Levels $L_{Aeq,16hr}$ (dB)
Block C	
North-East Balconies	43
North-West Balconies	49-50
Block D	
North-West Balconies	55-59
South-West Balconies	56-60
Underbuilds	
Richbell Private Patios	43
Falcon Private Patios	50
Blemundsbury Private Patios	40

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Appendix 4
Internal Noise Assessment Results

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Table 1: Predicted Internal Noise Levels with Open Windows for Ventilation

Building Façade	Predicted External Free-Field Noise Levels (dB)			Level 1 AVO	Predicted Internal Noise Levels (dB) With Open Windows for Ventilation[1]			Combined Façade Sound Reduction Required[2] dB(A)	Level 2 AVO Required?[3]
	Daytime $L_{Aeq,16hr}$	Night-time $L_{Aeq,8hr}$	Night-time L_{AFmax}		Daytime $L_{Aeq,16hr}$	Night-time $L_{Aeq,8hr}$	Night-time L_{AFmax}		
Eastern Mews									
North	35-52	27-44	62-67	Low	20-37	12-29	47-52	25	Yes: North façade EM01
South	46-54	39-45	62	Low	31-39	24-30	47	20	No
Western Mews									
North	34	27	No bedrooms	Negligible	19	12	No bedrooms	No specific measures	No
East	43	35	67	Low	28	20	52	25	Yes: East façade WM01 only
South	37-44	29-39	62-63	Low	24-28	14-24	47-48	21	No
Block B									
North	38-55	34-47	65	Low	23-40	19-32	50	23	No

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Building Façade	Predicted External Free-Field Noise Levels (dB)			Level 1 AVO	Predicted Internal Noise Levels (dB) With Open Windows for Ventilation[1]			Combined Façade Sound Reduction Required[2] dB(A)	Level 2 AVO Required?[3]
	Daytime $L_{Aeq,16hr}$	Night-time $L_{Aeq,8hr}$	Night-time L_{AFmax}		Daytime $L_{Aeq,16hr}$	Night-time $L_{Aeq,8hr}$	Night-time L_{AFmax}		
East	55-59	47-50	65	Low	40-44	32-35	50	24	Yes: Bedrooms overlooking Orde Hall Road
South	54	46	No bedrooms	Low	39	31	No bedrooms	19	No
West	36-37	28-30	64	Low	21-22	13-15	49	22	No
Block C									
North	43-49	34-45	64-65	Low	28-34	19-30	49-50	23	No
East	43-44	34-35	64	Low	28-29	19-20	49	22	No
South	34-47	26-41	64-65	Low	19-32	11-26	49-50	23	No
West	55	50	No bedrooms	Low	40	35	No bedrooms	20	No
Block D									
East	36-44	28-36	70	Low	21-29	13-21	55	28	Yes: Bedrooms

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Building Façade	Predicted External Free-Field Noise Levels (dB)			Level 1 AVO	Predicted Internal Noise Levels (dB) With Open Windows for Ventilation(1)			Combined Façade Sound Reduction Required(2) dB(A)	Level 2 AVO Required?(3)
	Daytime $L_{Aeq,16hr}$	Night-time $L_{Aeq,8hr}$	Night-time L_{AFmax}		Daytime $L_{Aeq,16hr}$	Night-time $L_{Aeq,8hr}$	Night-time L_{AFmax}		
West	53-60	45-52	70	Low	38-45	30-37	55	28	Yes: Bedrooms
Blemundsbury Building									
North	37-40	29-32	65	Low	22-25	14-17	50	23	No
South	48-52	41-44	66-74	Low	33-37	26-29	51-59	32	Yes: Bedrooms
Richbell Building									
East	40-41	30-33	68	Low	25-26	15-18	53	26	Yes: Bedrooms
West	50-51	42	67-68	Low	35-36	27	52-53	26	Yes: Bedrooms
Falcon Building									
East	48	40	68-69	Low	33	25	53-54	27	Yes: Bedrooms
West	48	40	75-76	Low	33	25	60-61	34	Yes: Bedrooms

Notes (1): A sound reduction of 15 dB has been assumed for partially open windows based on the guidance in BS 8233 and WHO Guidelines
(2): The minimum combined façade sound reduction (including glazing, ventilation openings and external wall build-up) required to achieve the internal LOAEL noise levels where these are not achieved with open windows for ventilation.
(3): Where a façade is within the Level 1 Negligible risk category, a Level 2 assessment is not required because the internal noise levels are likely to be below the LOAEL. Where a façade is within the Level 1 Low or Medium risk category, a Level 2 assessment has been identified if there is the potential for an exceedance of the SOAEL if open

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windows are likely to be required for extended periods of time as overheating mitigation. Where a façade is within the Level 1 High risk category, a Level 2 assessment is required.

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