Pentavia, Mill Hill

London NW7 2ET

Noise and Vibration Assessment

Date: 15/03/19

mayer brown

MEADOW RESIDENTIAL

PENTAVIA RETAIL PARK
MILL HILL, LONDON

NOISE AND VIBRATION ASSESSMENT

MARCH 2019

the journey is the reward

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MEADOW RESIDENTIAL
PENTAVIA RETAIL PARK, MILL HILL, LONDON
PROPOSED MIXED USE DEVELOPMENT
NOISE AND VIBRATION ASSESSMENT

MARCH 2019

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1 Introduction

1.1 Mayer Brown Ltd has been instructed by Meadow Residential to prepare this Noise Assessment for the proposed re-development of the Pentavia Retail Park in Mill Hill.

1.2 The proposed development seeks the demolition of the existing buildings and the creation of up to 844 residential units, commercial floorspace and associated amenity and infrastructure development.

1.3 The scope of this noise impact assessment has been discussed with the London Borough of Barnet and is structured as follows:

- **Section 2** describes the location of the site in relation to the existing transport infrastructure and neighbouring land uses.
- **Section 3** outlines the development proposals.
- **Section 4** discusses national and local planning policy and 'industry standard' design guidance relevant to noise.
- **Section 5** presents the results of environmental noise monitoring at the site to determine existing noise levels.
- **Section 6** presents the results of computational noise modelling.
- **Section 7** assesses the suitability of the site for the proposed development.
- **Section 8** presents a more detailed assessment of noise intrusion into the proposed accommodation and outlines the mitigation that will be implemented within the scheme design.
- **Section 9** considers noise levels affecting external amenity areas to be provided by the development.
- **Section 10** assesses the operational (traffic) noise impacts of the scheme;
- **Section 11** discusses the control of plant noise;

- **Section 12** discusses possible noise impacts associated with the mixed use nature of the development;
- **Section 13** discusses how the temporary construction impacts of the scheme will be controlled;
- **Section 14** deals with vibration; and
- Conclusions are presented in **Section 15**.

2 Site Location

2.1 The location of the proposed development in relation to the local highway network is shown in **Figure 2.1** below:

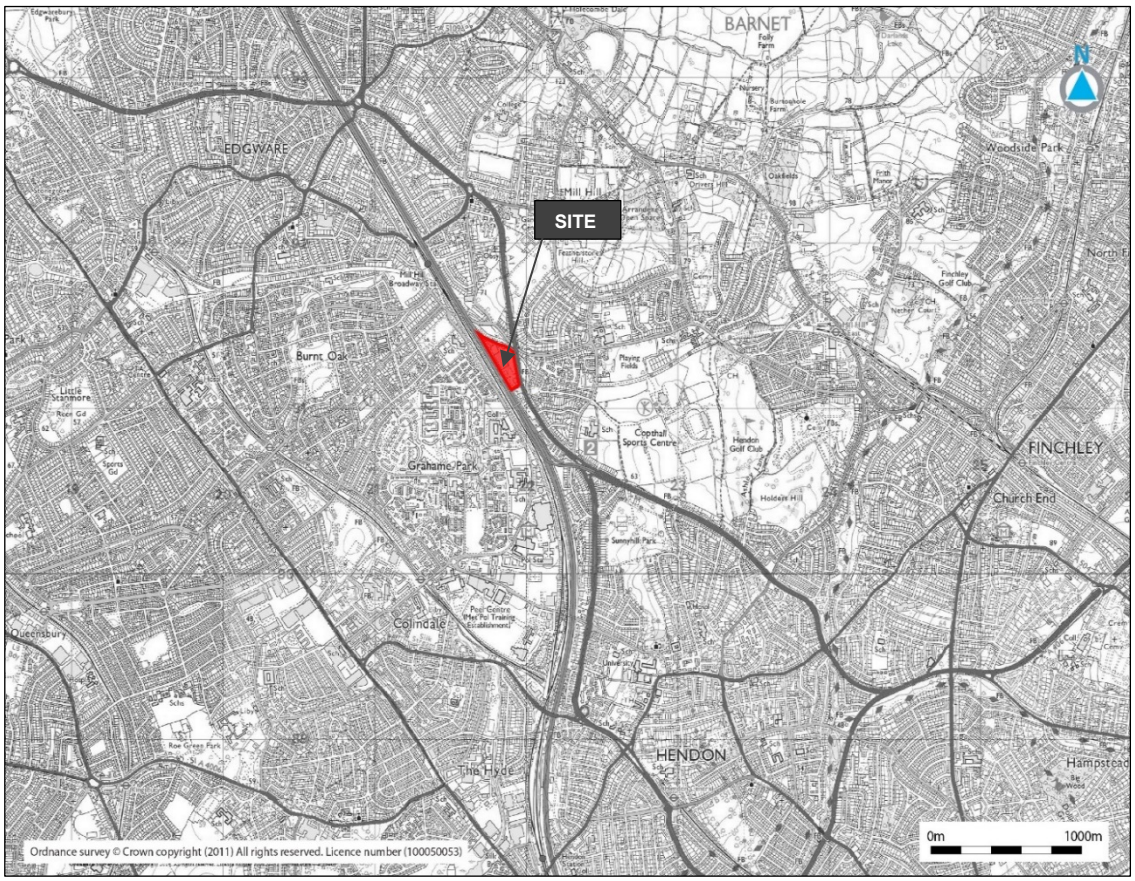


Figure 2.1: Site in Relation to the Local Highway Network

2.2 The Pentavia Retail Park site is located to the south of Mill Hill town centre, in north London.

2.3 The site is bordered by M1 motorway to the west, beyond which is the Midland Mainline railway and beyond that the residential area of Grahame Park.

2.4 To the east, the site adjoins the A1 (Watford Road), beyond which land usage in predominantly residential (with the closest properties to the site fronting Brancaster Drive/Longfield Avenue).

2.5 The northern boundary of the site is formed with Bunn's Lane. Land usage is, again, predominantly residential, but there is also a childcare nursery ("Bright Little Stars Nursery").

2.6 To the south, the site adjoins an existing petrol filling station.

2.7 **Figure 2.2** below presents a more detailed plan showing the location of site relative to existing land uses.

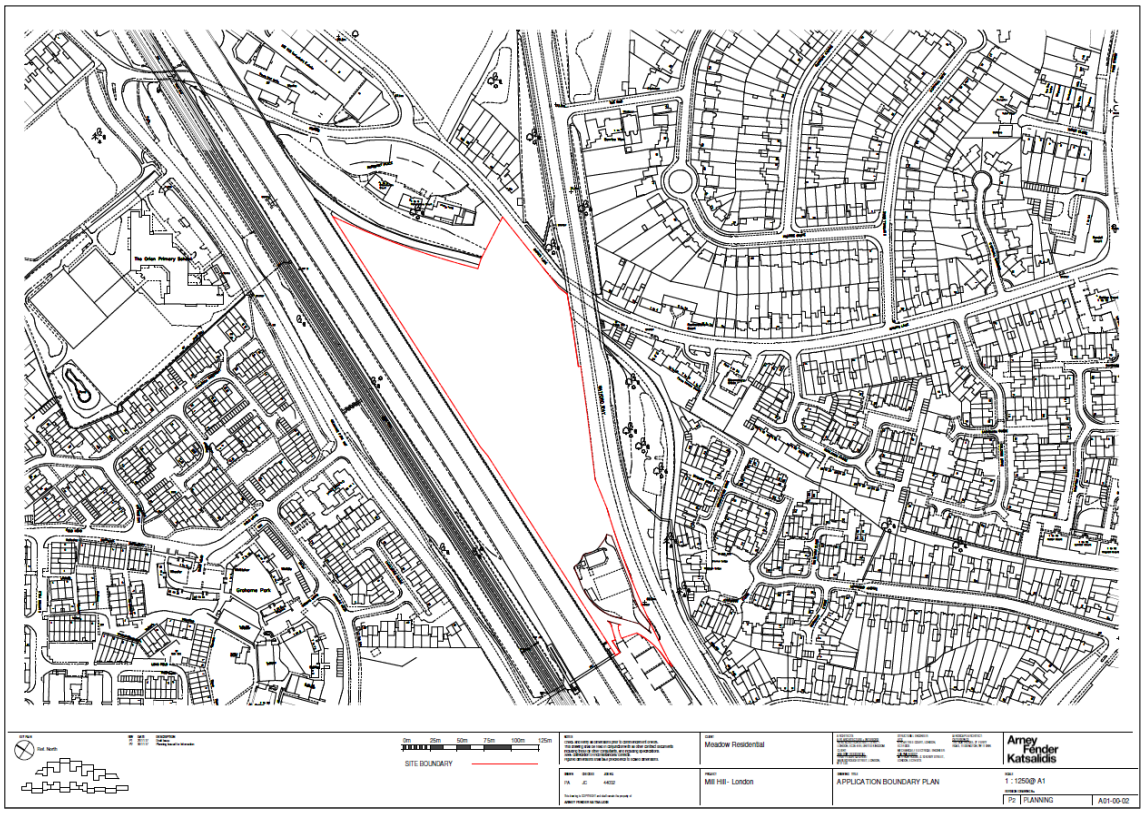


Figure 2.2: Site Location Plan

3 Proposed Development

3.1 The proposed development seeks full planning permission for the demolition of existing buildings on the site and erection of a residential led mixed use development consisting of residential, commercial, leisure and community uses, as shown in **Figure 3.1** below:

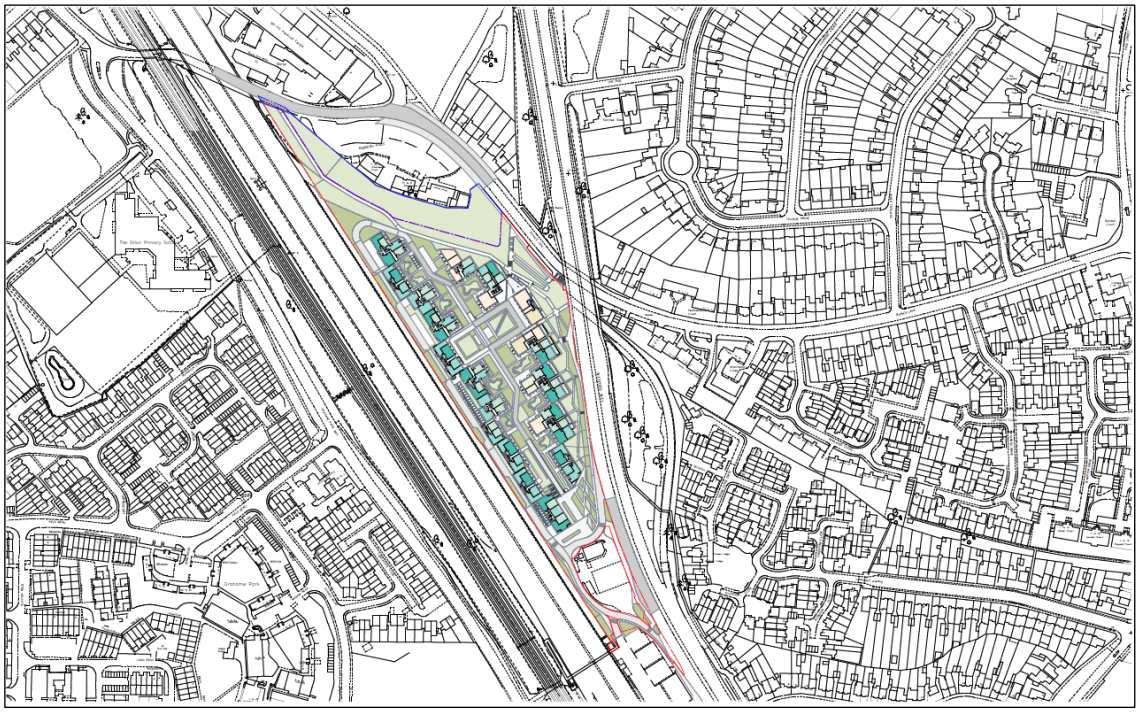


Figure 3.1: Proposed General Arrangement of Site

3.2 The proposed development will provide:

- 844 dwellings (Use Class C3);
- 401m^2 (GIA) of Use Class A1 floorspace;
- 322m^2 (GIA) of flexible Use Class A3/A4 floorspace;
- 294m^2 (GIA) of Use Class D1 floorspace;
- Car parking; and
- Residential amenity and ancillary uses.

3.3 Commercial uses are general located at lower ground and ground floor levels, with residential units above. The indicative layout at lower ground and ground floors is shown in **Figure 3.1** below:

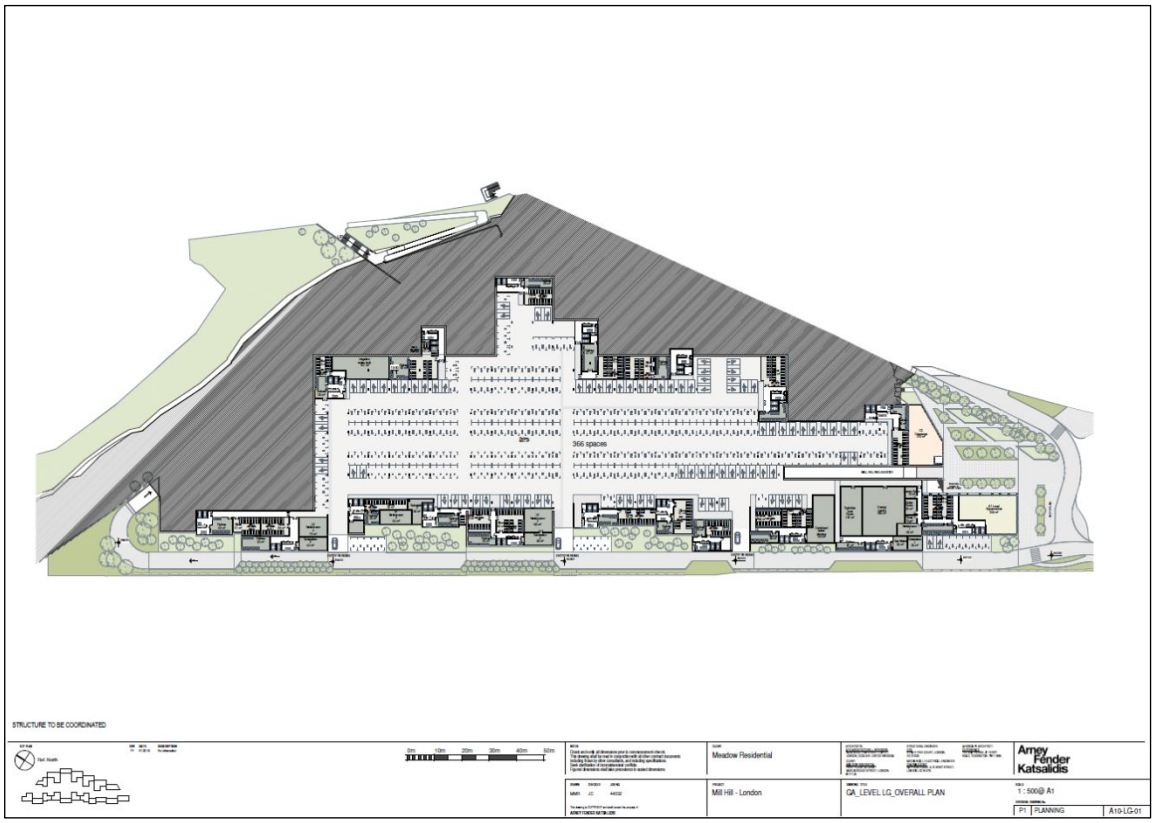


Figure 3.2: Proposed Lower Ground Floor Layout

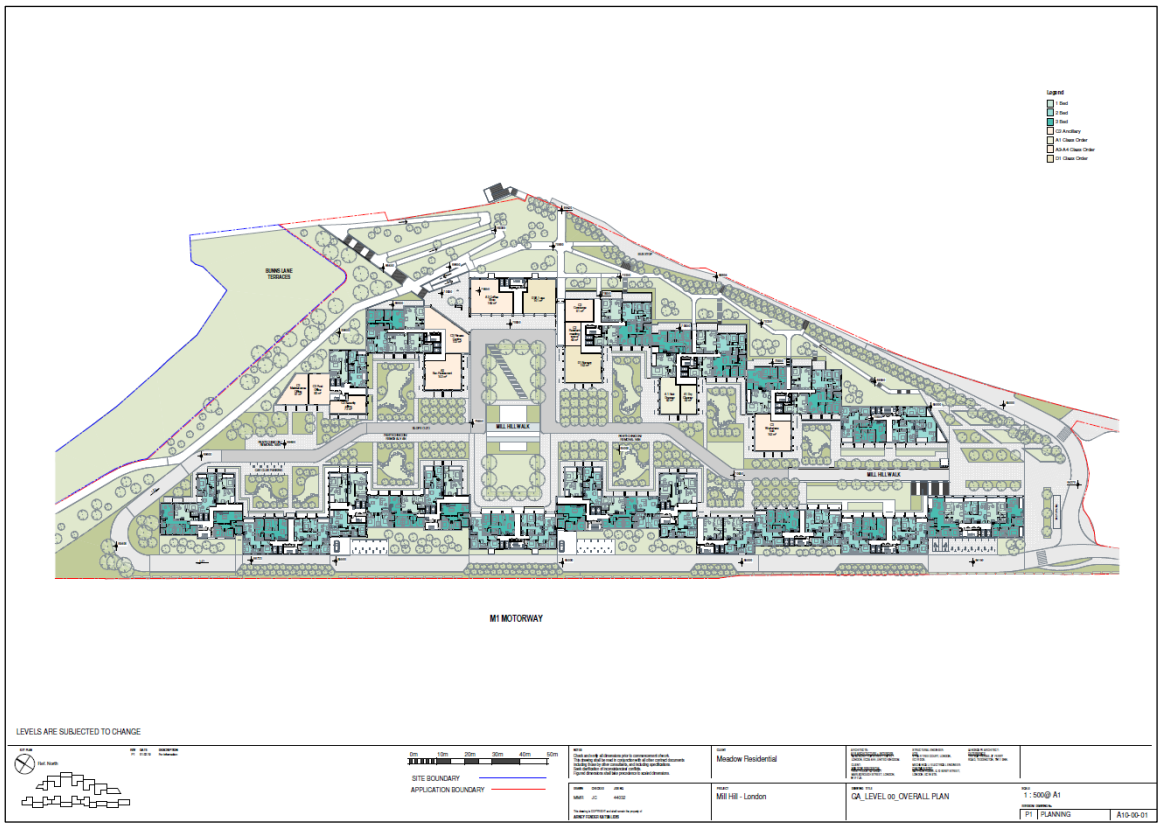


Figure 3.3: Proposed Ground Floor Layout

4 Planning Policy Context

National Planning Policy

National Planning Policy Framework, (NPPF, 2019)

4.1 Current governmental guidance for the determination of planning applications is given in the revised "National Planning Policy Framework" (NPPF), published in February 2019.

4.2 Paragraph 170 of the NPPF advises:

> *"Planning policies and decisions should contribute to and enhance the natural and local environment by:*
>
> *….. e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability."*

4.3 With specific regard to noise, 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;*
>
> *b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and*
>
> *c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation."*

4.4 Paragraph 182 of the NPPF draw specific attention to the need to ensure that new development is compatible with existing businesses and community facilities and introduces and "agent of change" principle:

> *"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."

4.5 With regard to 'adverse' impacts and 'significant adverse' impacts, the NPPF directs the reader to the advice contained in DEFRA's "*Noise Policy Statement for England*" (NPSE). This Policy Statement introduces the concept of a "*Significant Observed Adverse Effect Level*" (SOAEL), "*Lowest Observed Adverse Effect Level*" (LOAEL) and "*No Observed Adverse Effect Level*" (NOAEL). These are concepts aligned with toxicology outcomes derived from guidance given by the World Health Organisation..

Noise Policy Statement for England

4.6 Whilst the intent of the NPSE in relation to the NPPF is clear, the NPSE does not, at this time, provide any quantitative threshold values for each identified level of *"effect"*. Indeed, the NPSE carefully highlights that:

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

National Planning Practice Guidance

4.7 The application of national planning is amplified in the governments *"National Planning Practice Guidance"* (NPPG). This seeks to help clarify understanding the perception of noise effects, outcomes and actions that should be taken to align decision making with the NPPF. In line with the NPPF concept of basing decision making on the identification of "significant" or "other" impacts on health and quality of life, the NPPG aligns its guidance with the NPSE.

4.8 The table below summarises this guidance:

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

Table 4.1: NPSE Guidance

4.9 Whilst the NPPF and associated planning practice guidance sets out stringent imperatives to ensure the satisfactory development of land in relation to possible noise impacts, this policy and guidance does not generally provide any detailed technical guidance defining what may be considered to constitute a *"significant"* or *"other"* adverse impact. In the absence of such technical guidance, reference needs to be been made to sustainable development standards set out in local policy and/or relevant 'industry standard' guidance.

Regional Planning Policy

The London Plan[1] (2016)

4.10 The London Plan is the overall strategic plan for London, setting out an integrated economic, environmental, transport and social framework for the development of London over the next 20–25 years.

4.11 In Chapter 3 – London's People, paragraph 3.11 states the following:

> *"Housing has a major impact on the health of residents, and the policies in this Plan are intended to enable Londoners to live in well designed, high quality homes, appropriately sized and energy efficient, warm and dry, safe, providing good access to high quality social infrastructure, green spaces, and limiting disturbance from noise…"*

4.12 Policy 5.3, Sustainable design and construction states:

> *"Major development proposals should meet the minimum standards outlined in the Mayor's supplementary planning guidance and this should be clearly demonstrated within a design and access statement. The standards include measures to achieve other policies in this Plan and the following sustainable design principles:*
>
> *(…) minimising pollution (including noise, air and urban run-off)"*

4.13 Chapter 7 – London's Living Spaces and Places, paragraph 7.18, states the following:

> *"The effects of traffic can have a significant impact on the quality of the public realm in terms of air quality, noise and amenity of a space. The negative effects of traffic should be minimised to ensure people's enjoyment of public realm is maximised."*

4.14 Policy 7.15 – Reducing and managing noise, improving and enhancing the acoustic environment and promoting appropriate soundscapes states that:

[1] The Greater London Authority (GLA) (2016) The London Plan.

*"**Strategic***

A). The transport, spatial and design policies of this plan will be implemented in order to reduce noise and support the objectives of the Mayor's Ambient Noise Strategy."

Planning decisions

B. Development proposals should seek to reduce noise by:

a) avoiding significant adverse noise impacts on health and quality of life as a result of new development;

b) 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 development or adding unduly to the costs and administrative burdens on existing businesses;

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

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

e) 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 the application of good acoustic design principles;

f) having particular regard to the impact of aviation noise on noise sensitive development;

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

LDF preparation

C. Boroughs and others with relevant responsibilities should have policies to:

a) manage the impact of noise through the spatial distribution of noise making and noise sensitive uses;

b) identify and nominate new Quiet Areas and protect existing Quiet Areas in line with the procedure in Defra's Noise Action Plan for Agglomerations"

4.15 The Mayor of London published an update to the Draft New London Plan in August 2018, to help inform the Examination in Public of the plan which commenced in January 2019. Draft policy D12 of the replacement plan introduces an "Agent of Change" principle which places the responsibility for mitigating noise impacts associated with new development on the applicant (reflecting paragraph 180 of the NPPF). Draft Policy D13 broadly reflects current policy requirements for developments to implement 'good acoustic design'. Adoption of the New London Plan is forecast for the end of 2019.

Greater London Authority Ambient Noise Strategy[2] (2004)

4.16 The Greater London Authority Ambient Noise Strategy considers a wide range of issues relating to noise which may affect this particular development. These include noise from transportation sources, known as ambient noise, and construction activities, which are described as neighbourhood noise.

4.17 The general objectives are identified as minimising the adverse impacts of road traffic noise and improving noise environments in London's neighbourhoods, especially for housing, schools, hospitals and other noise sensitive uses.

4.18 The strategy states the following policies for urban noise sensitive development:

> *"Policy 69*
>
> *The London Plan, 2004 (Policy 4A.14) states that the Mayor will and boroughs should reduce noise by:*
>
> - *Minimising the existing and potential adverse impacts of noise on, from, within, or in the vicinity of, development proposals;*
> - *Separating new noise sensitive development from major noise sources wherever practicable;*
> - *Supporting new technologies and improved practices to reduce noise at source, especially in road, rail and air transport;*
> - *Reducing the impact of traffic noise through highway management and transport policies;*
> - *Containing noise from late night entertainment and other 24-hour activities, and where appropriate promoting well-managed designated locations."*
>
> *"Policy 70*

[2] Greater London Authority (GLA). (2004).The Mayor's Ambient Noise Strategy.GLA, London.

The Mayor will, in strategic referrals which include residential development on sites with noise levels higher than Noise Exposure Category A of Planning Policy Guidance Note 24, or the equivalent level in any revision of guidance, seek specific evidence on the action to be taken to address noise."

Local Planning Policy

The Local Plan includes a suite of Development Plan Documents (DPDs) and Supplementary Planning Documents (SPDs). Documents including relevant noise policies include:

- The Core Strategy DPD which sets out the LPA's vision, objectives and related strategic policies
- The Development Management Policies DPD which sets out the policy framework for decision making on planning applications.
- A number of Supplementary Planning Documents and Design Guidance notes which provide more detailed guidance on determining planning applications and S106 requirements.

Core Strategy DPD (2012)

Policy CS13: Ensuring the efficient use of natural resources

…….

- *We will improve air and noise quality by requiring Air Quality Assessments and Noise Impact Assessments from development in line with Barnet's SPD on Sustainable Design and Construction.*

Development Management Policies DPD (2012)

Policy DM04: Environmental considerations for development

……

d. Proposals to locate development that is likely to generate unacceptable noise levels close to noise sensitive uses will not normally be permitted. Proposals to locate noise sensitive development in areas with existing high levels of noise will not normally be permitted. Mitigation of noise impacts through design, layout, and insulation will be expected where appropriate.

……

Sustainable Design and Construction SPD (2016)

4.19 This SPD was adopted in October 2016. The document promotes that an initial site risk assessment should be undertaken to determine the potential noise risk category of the site (were no further noise mitigation to take place). Where a noise risk is considered significant, the guidance recommends that a suitably qualified acoustic consultant is employed to identify the optimum mitigation measures necessary to reduce the noise impacts to an acceptable level.

4.20 Following this advice, the SPD lists a set of 'Noise Design Principles' such as location of development, internal layouts, exposure within buildings and appropriate noise insulation having regard to guidance within BS8233:2014 'Guidance on sound insulation and noise reduction for building' and the need to consider noise levels in external amenity areas, not just noise levels within buildings.

4.21 With regard to external amenity areas, item F of the "Noise Design Principles" section of the SPD states:

> *"Noise levels in external private and communal outdoor amenity areas should comply with the good standards according to the British Standards BS8233: 2014. This includes a recommended limit of 55dBA in these external spaces including; balconies, roof gardens, terraces and communal gardens. BS8233: 2014 recognises that these guideline values are not achievable in all circumstances where development might be desirable, therefore where outdoor amenity areas cannot achieve this level then winter gardens or other solutions such as not siting balconies on most affected facades could be considered. The Residential Design SPD supports a flexible approach to outdoor amenity space recognising that the rigid application of amenity space standards can sometimes restrict creative design and layout of new residential developments, particularly on smaller development sites. The Planning Obligations SPD also recognises that in town centres and for some higher density schemes including tall buildings it may not be feasible for development to provide adequate private or communal outdoor amenity space. In these circumstances the development may make a financial contribution to the nearest appropriate public open space to compensate for the lack of outdoor amenity space."*

4.22 The SPD details that noise from plant or machinery should be 5dB below the background noise level (L_{A90}) at 1 metre from the window of any room of a neighbouring property.

LBB Draft Planning Brief – Pentavia Retail Park, Mill Hill (2016)

4.23 LBB's Draft Planning Brief for Pentavia Retail Park, Mill Hill (2016)[3] (The Planning Brief) sets out the Council's objectives for the redevelopment of the Pentavia Retail Park Site. The objectives for the Site focus on the provision of a sustainable mixed use development that will generate a range of affordable housing, new employment space, retail and leisure uses to serve the needs of the development, amenity and community spaces, and improvements to existing transport infrastructure.

4.24 With regard to noise and vibration, the Planning Brief raises the issue of acoustic problems generated due to the Site's constrained nature between transport corridors, and highlights the need for on-site assessment to assess the level of severity and appropriate mitigation measures required.

Design Guidance

4.25 The Borough's guidance outlined above makes reference to a number of formative British Standard and design guidance documents, including:

BS 8233: 2014; "Sound Insulation and Noise Reduction for Buildings

4.26 BS 8233: 2014 *"Sound* Insulation *and Noise Reduction for Buildings"* offers the following design guidance for indoor ambient noise levels within dwellings:

Activity	Location	07.00 to 23.00 hours	23.00 t0 07.00 hours
Resting	Living Room	35dB $L_{Aeq,16hour}$	--
Dining	Dining Room/Area	40dB $L_{Aeq,16hour}$	--
Sleeping (daytime resting)	Bedroom	35dB $L_{Aeq,16hour}$	30dB $L_{Aeq,8hour}$

Table 4.2: BS 8233 Indoor Ambient Noise Level Design Guidance

4.27 Whilst the above guidance is given for dwellings, the above values are also considered to be appropriate for *"rooms for residential purposes"*, such as student accommodation.

4.28 A note accompanying the above Table states:

> *"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 $L_{Amax,F}$ depending on the character and number of events per night. Sporadic noise events could require separate values."*

[3] London Borough of Barnet, (2016). Pentavia Retail Park, Mill Hill: Draft Planning Brief, September 2016.

4.29 Despite identifying that maximum values *'may'* be set, guidance values for differing types of noise/frequency of events is not given. It can, however, be noted that the recommendations of BS8233 are aligned with guidance set out in the World Health Organisation's *"Guidelines for Community Noise"*. On that basis, it would seem appropriate to seek to limit night-time noise intrusion such that maximum noise levels do not normally exceed a maximum internal value of 45dB $L_{Amax,fast}$. Section 3.4 of the WHO guidelines implies that *'not normally'* would be an occurrence of more than 10-15 times per night.

4.30 A further note to the above Table indicates that where *"development is considered necessary or desirable"*, the above guideline values can be relaxed by 5dB and *"reasonable"* internal conditions still be achieved.

4.31 With regard to external amenity spaces, Section 7.7.3.2 of BS 8233: 2014 states:

> *"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.*

"Guidelines for Community Noise" (World Health Organisation, 1999)

4.32 The criteria outlined in this document provide a summary of research regarding the effects of noise on the community. Section 2 of the Guidelines presents a general discussion regarding the types of noise affecting communities and their measurement. The guidelines promote the use of the $L_{Aeq,T}$ noise index. However, where there are distinct events to the noise, such as with aircraft or railway noise, the guidelines recommend that measures of the individual events should be obtained (using, for example, L_{Amax} or L_{AE}), in addition to $L_{Aeq,T}$ measurements.

4.33 The guidelines identify three critical effects of noise on residential dwellings – speech interference, annoyance and sleep disturbance.

4.34 With regard to ***'speech intelligibility'***, section 4.2 of the Guidelines identifies that:

"Speech in relaxed conversation is 100% intelligible in background noise levels of about 35dB(A) and can be understood fairly well in background levels of 45dB(A).

Speech with more vocal effort can be understood when the background sound pressure level is about 65dB(A)."

4.35 With regard to ***'annoyance'***, section 3.8 of the Guidelines states:

"Annoyance in populations exposed to environmental noise varies not only with the acoustical characteristics of the noise (source, exposure), but also with many non-acoustical factors of social, psychological, or economic nature. These factors include fear associated with the noise source, conviction that the noise could be reduced by third parties, individual noise sensitivity, the degree to which an individual feels able to control the noise (coping strategies) and whether the noise originates from important economic activity."

4.36 Section 4.2.7 of the Guidelines further states that:

"The annoyance response to noise is affected by several factors, including the equivalent sound pressure level and the highest sound pressure level of the noise, the number of such events, and the time of day. Methods for combining these effects have been extensively studied. The results are not inconsistent with the simple, physically based energy equivalent energy theory, which is represented by the L_{Aeq} noise index.

…….

During the daytime, few people are seriously annoyed by activities with L_{Aeq} levels below 55dB; or moderately annoyed with L_{Aeq} levels below 50dB".

4.37 With regard to ***'sleep disturbance'***, Section 3.4 of the guidelines states:

"If negative effects on sleep are to be avoided the equivalent sound pressure level should not exceed 30dB(A) indoors for continuous noise. If the noise is not continuous, sleep disturbance correlates best with L_{Amax} and effects have been observed at 45dB or less. This is particularly true if the background noise level is low. Noise events exceeding 45dB(A) should therefore be limited if possible. For sensitive people an even lower limit would be preferred. It should be noted that it should be possible to sleep with a bedroom window slightly open (a reduction of outside to inside of 15dB). To prevent sleep disturbance, one should thus consider

the equivalent sound pressure level and the number and level of sound events. Mitigation targeted to the first part of the night is believed to be effective for the ability to fall asleep".

4.38 In section 4.3.1, the above guidelines are presented in terms of external noise levels incident on buildings:

"At night, sound pressure levels at the outside facades of the living spaces should not exceed 45dB L_{Aeq} and 60dB L_{Amax}, so that people may sleep with windows open".

BS 4142: 2014: "Methods for Rating and Assessing Industrial and Commercial Sound"

4.39 BS 4142 provide a rating and assessment methodology for assessing the potential adverse impact of industrial and commercial noise sources on neighbouring dwellings.

4.40 The assessment procedure initially compares the ***'Rating Level'*** of the source with the '***Background*** Noise ***Level'*** when the source is not present.

4.41 The ***'Rating*** Level' (L_{Ar}) referred to is the specific noise level of the noise source under investigation (in terms of the L_{Aeq} noise index), to which corrections are applied if the noise has certain audible characteristics. The following corrections (based on a subjective assessment of noise source characteristics is given:

Character Correction				
Feature / Perception	**Tonality**	**Impulsivity**	**Intermittency**	**Other acoustic characteristics**
Just Perceptible	+2dB	+3dB	When the specific sound has identifiable On/Off conditions that are readily distinctive. +3dB	+3dB
Clearly Perceptible	+4dB	+6dB		
Highly Perceptible	+6dB	+9dB		

Table 4.3: BS4142 Character Correction for Rating Level Calculation

4.42 The **'**Background ***Noise Level'*** (L_{A90}) represents the noise level that is exceeded for 90% of the stated measurement period. For assessment purposes, the background noise level needs to be determined without the noise source under investigation operating.

4.43 The time of operation needs to be taken into account. During the day (normally taken to be 07.00 to 23.00 hours) a one hour measurement period is considered appropriate.

During the night (normally taken to be 23.00 – 07.00 hours) a 15 minute time period is normally used.

4.44 The following guidance is then offered based on the outcome of this initial assessment:

- 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.

4.45 A note accompanying the above guidance states:

> *"Adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact."*

4.46 The initial estimate of the impact should then be modified to account for its context. Such considerations include:

- The absolute level of the sound - 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 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.
- The character and level of the residual sound compared to the character and level of the specific sound.

- 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.

Design Manual for Roads and Bridges

4.47 The Highways Agency guidance for assessing transport-related environmental impacts is set out in the "Design Manual for Roads and Bridges". Volume 11, Section 3, Part 7 (HD 213/11) sets out assessment procedures for assessing noise impacts.

4.48 Clauses 3.33 of that document identifies that:

> *"A change in road traffic noise of 1 dB(A) in the short term (e.g. when a project is opened) is the smallest that is considered perceptible. In the long term, a 3 dB(A) change is considered perceptible. The magnitude of impact should, therefore, be considered different in the short term and long term. The classification of magnitude of impacts to be used for traffic noise is given in Table 3.1 (short term) and Table 3.2 (long term)."*

4.49 The guidance in **Tables 4.4** and **4.5** is set out below:

Noise Change, $L_{A10,18hour}$	Magnitude of Impact
0	No Change
0.1 – 0.9	Negligible
1 – 2.9	Minor
3 – 4.9	Moderate
5+	Major

Table 4.4: Classification of Magnitude of Noise Impacts in the Short Term

Noise Change, $L_{A10,18hour}$	Magnitude of Impact
0	No Change
0.1 – 2.9	Negligible
3 – 4.9	Minor
5 – 9.9	Moderate
10+	Major

Table 4.5: Classification of Magnitude of Noise Impacts in the Long Term

PropPG: Professional Practice Guidance on Planning and Noise

4.50 ProPG: Planning & Noise was published in May 2017. The guidance was authored by representatives from the Chartered Institute of Environmental Health (CIEH), Institute of Acoustics (IOA) and Association of Noise Consultants (ANC) and seeks to consolidate and standardise existing industry best practice in order to expedite the planning process with regard to the consideration of noise. The consultation draft version of this guidance appears to have been formative in relation to the guidance set out in the LPA's adopted Sustainable Design and Construction SPD.

4.51 The ProPG document promotes a two stage methodology for the acoustic assessment of a proposed residential development.

4.52 Stage 1 involves an "Initial Site Risk Assessment", to identify the likely risk of adverse effects from noise, were no subsequent mitigation to be included as part of the development proposal. The categorisation of potential risk is presented in Figure 1 of the guidance which is reproduced in **Figure 4.1** below:

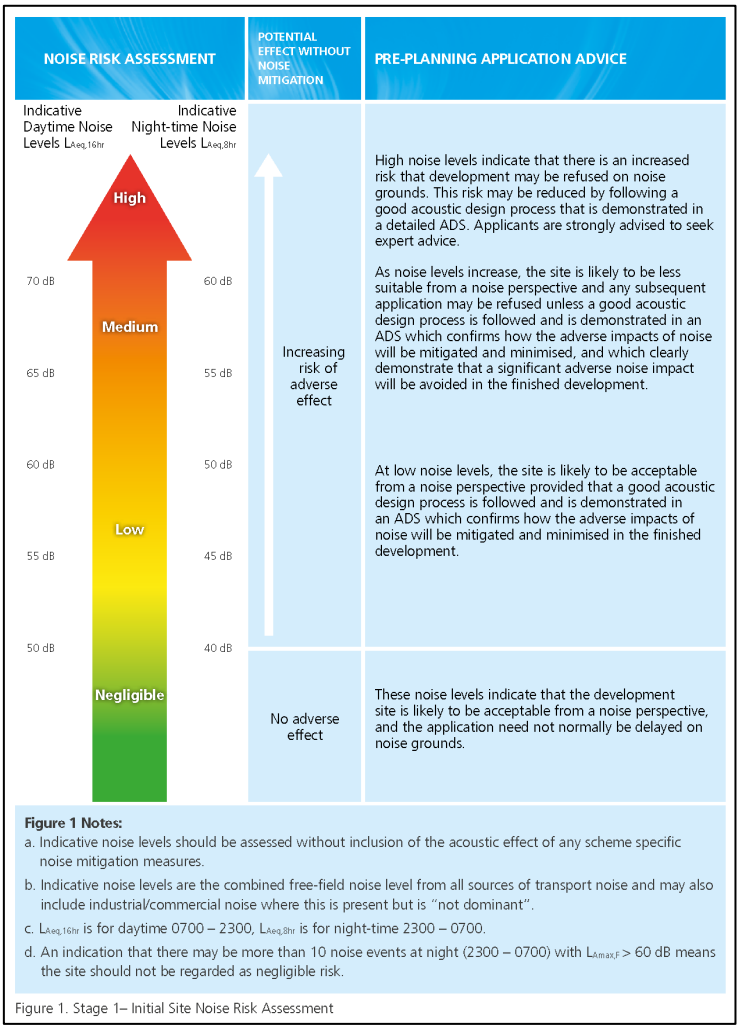


Figure 4.1: ProPG Initial Site Noise Risk Assessment

4.53 Where the Stage 1 assessment indicates that there is a potential for adverse effect, a Stage 2 “Full Assessment” should then be undertaken. This requires four elements to be considered:

- **Element 1**: Good Acoustic Design
- **Element 2**: Internal Noise Level Guidelines
- **Element 3**: External Amenity Area Noise Assessment
- **Element 4**: Assessment of Other Relevant Issues

5 Baseline Conditions

5.1 Existing baseline noise conditions at the site have been established using a combination of automated and manned noise surveys.

Automated Noise Monitoring

5.2 Automated noise monitoring was undertaken over a five day period between 12.00 hours on Wednesday 15th July 2015 to 12.00 hours on Monday 20th July 2015.

5.3 Noise levels were monitored at three measurement locations (on the northern, eastern and western boundaries of the site) as shown in **Figure 5.1** and described in **Table 5.1** below.

Figure 5.1: Noise Monitoring Locations

Monitoring Location	Description
A1	Located at the eastern boundary of the Site at approximately 12m from the A1. The microphone was at approximately 1.8 m above the ground in a free field position away from reflecting surfaces. The microphone was fitted with the manufacturer's windshield.
A2	Located at the western boundary of the Site at approximately 13m from the M1. The microphone was at approximately 1.8 m above the ground in free field away from reflecting surfaces. The microphone was fitted with the manufacturer's windshield.
A3	Located at the northern boundary of the application site at approximately 26m from the Bunns Lane and approximately 50m from the A1. The microphone was at approximately 1.8 m above the ground in a free field position away from reflecting surfaces. The microphone was fitted with the manufacturer's windshield.

Table 5.1: Automated Noise Survey Locations

Survey Procedure

5.4 The sound level analysers were configured to record the L_{A90}, $L_{Aeq,}$ and $L_{Amax,fast}$ sound levels over consecutive 1 second periods to provide a detailed time history profile showing fluctuations in noise levels. The analysers were also configured to make real-time contemporaneous audio recordings to assist in identifying the source of specific higher magnitude noise "events" observed in the time history profiling.

5.5 The measurement data was post-analysed using Norsonic "Nor-Review" data analysis software to determine appropriate period measurements.

Instrumentation

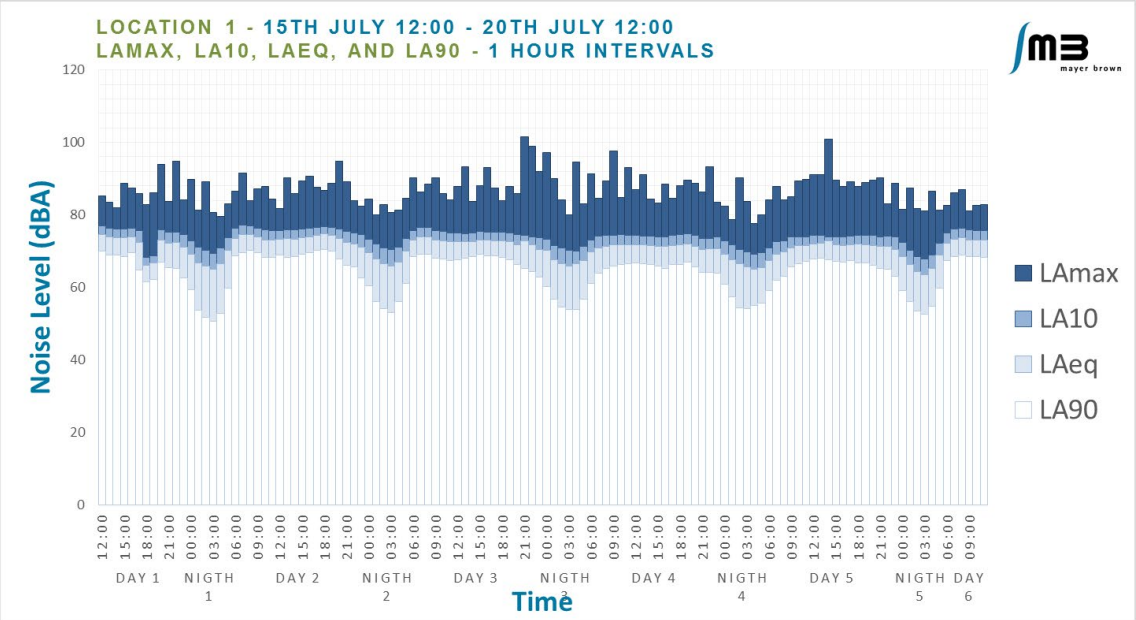
5.6 The following instrumentation was used for the surveys:

Position	Description	Make	Model	Serial No.	Calibration Date
A1	Sound Level Analyser	Norsonic	Nor140	1405947	20/03/2014
	Microphone	Norsonic	Nor1225	208220	
	Preamplifier	Norsonic	Nor1209	15793	
	Outdoor Microphone Kit	Norsonic	Nor 1217	--	--
A2	Sound Level Analyser	Norsonic	Nor140	1405946	20/03/2014
	Microphone	Norsonic	Nor1225	414889	
	Preamplifier	Norsonic	Nor1209	15799	
	Outdoor Microphone Kit	Norsonic	Nor 1217	--	--
A3	Sound Level Analyser	Norsonic	Nor150	15030164	03/12/2016
	Microphone	Norsonic	Nor1225	212922	
	Preamplifier	Norsonic	Nor1209	20343	
	Outdoor Microphone Kit	Norsonic	Nor 1217	--	--
All	Calibrator	Norsonic	Nor 1251	34058	26/03/2014

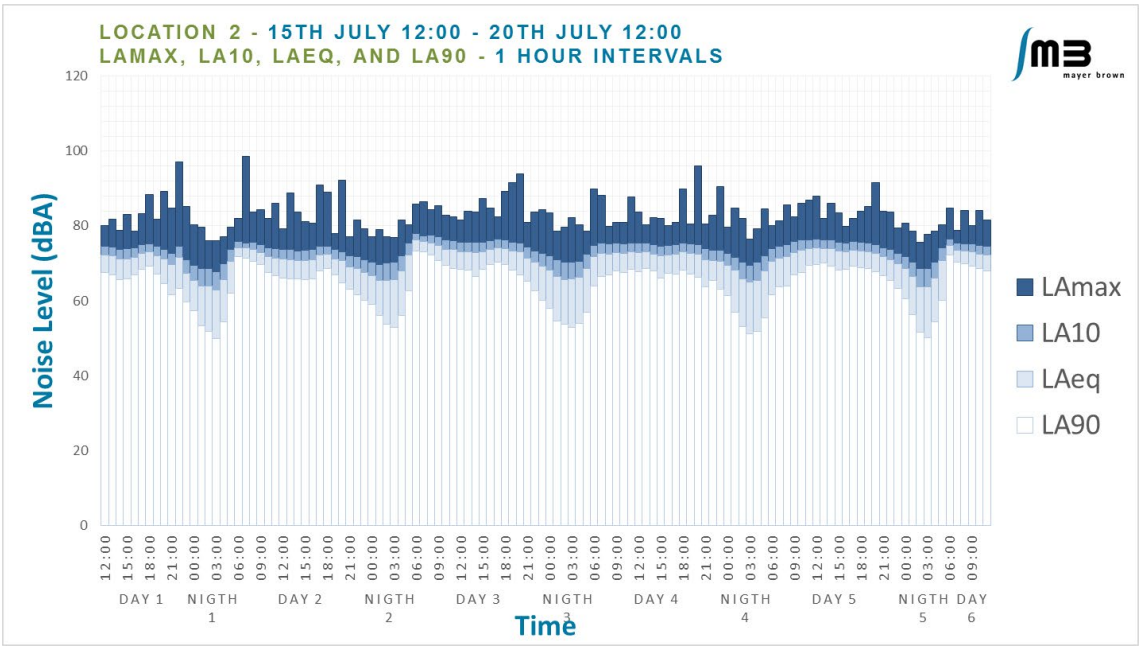
Table 5.2: Instrumentation Details

Noise Monitoring Results

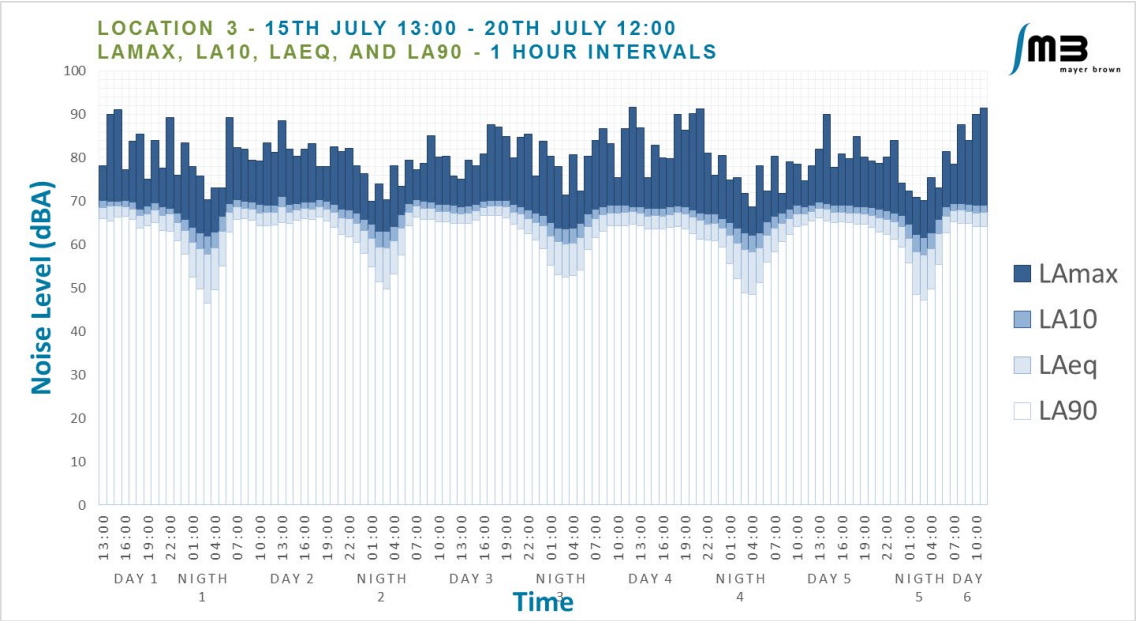
5.7 Measured noise levels (over consecutive 15 minute periods) are presented in full on **Time History Graphs A1, A2** and **A3** below.



Time History Graph A1



Time History Graph A2



Time History Graph A3

Weather

5.8 Due to the nature of the survey, i.e. unmanned, it is not possible to accurately comment on the weather conditions throughout the entire survey period. However, observations at the time of site attendances and publically available historic online data, suggest that weather conditions were typically characterised as set out in **Table 5.3** below:

Parameter	Temperature (°C)	Wind Speed (mph)	Wind Direction (°)	Humidity (%)	Atmospheric Pressure (mb)
Min.	12.0	2	SW	69	1009
Max.	25.1	17		38	1018
Average	17.9	11		97	1012

Table 5.3: Weather Conditions during the Survey Period

5.9 Short periods of light rain occurred on the Friday 17th of July between 09:00 to 10:00 hours and from Sunday 19th July to Monday 20 July between 16:00 to 07:00 hours according to the meteorological data. These periods were not considered when the noise monitoring data was evaluated.

Manned Noise Measurements

5.10 To assist in validating computational modelling of the site and possible traffic impacts that may be associated with operational traffic generated by the development, short-term manned noise measurements were also undertaken at the site between 12.00 to 13.00 hours on 5 May 2016, in accordance with the *'shortened measurement procedure'* of the

"Calculation of Road Traffic Noise" [4]. Measurements were undertaken at two locations, as described on **Table 5.4** and shown in **Figure 5.2** below:

Monitoring Location	Description
M1	On the western boundary of the site overlooking the M1 motorway. The measurement microphone was positioned approximately 1m above the existing boundary fencing in free field conditions.
M2	Towards the eastern boundary of the site overlooking the A1. The measurement microphone was fixed to a microphone boom and positioned approximately 4m above ground level with a direct line of site to the road in field conditions.

Table 5.4: Automated Noise Survey Locations

Figure 5.2: Manned Noise Survey Locations

[4] Department of Transport. (1998) Calculation of Road Traffic Noise (CRTN). HMSO. London.

Instrumentation

5.11 The following instrumentation was used for the survey:

Position	Description	Make	Model	Serial No.	Calibration Date
M4	Sound Level Analyser	Norsonic	Nor140	1405947	24/03/20164
	Microphone	Norsonic	Nor1225	208220	
	Preamplifier	Norsonic	Nor1209	15793	
	Outdoor Microphone Kit	Norsonic	Nor 1217	--	--
M5	Sound Level Analyser	Norsonic	Nor140	1405946	24/03/2016
	Microphone	Norsonic	Nor1225	414889	
	Preamplifier	Norsonic	Nor1209	15799	
	Outdoor Microphone Kit	Norsonic	Nor 1217	--	--
Both	Calibrator	Norsonic	Nor 1251	34058	24/03/2016

Table 5.5: Instrumentation Details

5.12 The sound level analysers were calibrated prior to the surveys and the calibration was checked upon completion. No drift in calibration was observed.

Survey Procedure

5.13 The sound level analyser was configured to measure the L_{A90}, L_{A10}, L_{Aeq} and $L_{Amax,fast}$ noise indices over consecutive notional 15 minute time periods.

Noise Monitoring Results

5.14 Measured noise levels are summarised in **Table 5.6** below:

Measured Sound Levels (dB)		
Measurement Location	**Time**	**$L_{A10, 15min}$**
M1	10.00 – 11.00	69.3
	11.00 – 12.00	70.0
	12.00 – 13.00	70.3
M2	10.00 – 11.00	68.5
	11.00 – 12.00	67.6
	12.00 – 13.00	67.7

Table 5.6: Noise Measurement Results for Manned Survey Locations

Weather

5.15 Weather conditions during the survey were not measured, but were fine and dry with light winds, and suitable for conducting environmental noise measurements.

Analysis of Data

5.16 The measurement data has been processed to determine daytime ($L_{Aeq,16hour}$) and night-time ($L_{Aeq,8hour}$) values.

5.17 For Positions A1 to A3, values have been calculated for each day/night time period during the automated monitoring.

5.18 For Position M4 and M5, daytime and night-time values have been estimated from the short term L_{A10} measurement results. Daytime values have been determined in accordance with the shortened measurement procedure of CRTN[5] to yield an estimated $L_{A10,18hour}$ value from which the $L_{Aeq,16hour}$ and $L_{Aeq,8hour}$ values have been estimated using the procedures developed by TRL/Casella Stanger for DEFRA[6].

5.19 Calculated values are summarised in **Tables 5.7** to **5.8** below.

Position Period	Daytime Noise Level, $L_{Aeq,16hour}$ (dB)		
	A1	A2	A3
15 July 2015	72.7(1)	71.7(1)	67.9(1)
16 July 2015	73.8	72.1	67.9
17 July 2015	72.9	74.0	68.0
18 July 2015	71.5	72.5	66.8
19 July 2015	71.2	73.0	66.7
20 July 2015	73.1(1)	72.9(1)	67.6(1)
Average	**72.5**	**72.7**	**67.5**
Notes:	(1) Value is average of available data for period		

Table 5.7: Daytime ($L_{Aeq,16hour}$) Noise Levels

[5] Department of Transport. (1988) *"Calculation of Road Traffic Noise"*. HMSO, London.

[6] TRL/Casella Stanger (2006) for DEFRA. Method for Converting the UK Road Traffic Noise Index $L_{A10,18h}$ to the EU Noise Indices for Road Noise Mapping.

Position Period	Night-time Noise Level, $L_{Aeq,6hour}$ (dB)		
	A1	A2	A3
15 - 16 July 2015	69.4	68.5	63.0
16 - 17 July 2015	69.5	70.3	63.4
17 - 18 July 2015	68.4	68.2	62.7
18 - 19 July 2015	67.6	68.4	61.8
19 - 20 July 2015	68.4	69.5	65.3
Average	**68.7**	**69.0**	**63.2**

Table 5.8: Night-time ($L_{Aeq,8hour}$) Noise Levels

5.20 Estimated daytime ($L_{Aeq,16hour}$) and night-time ($L_{Aeq,8hour}$) noise levels at positions M4 and M5 are summarised in **Table 5.9** below:

Position Location	Estimated Sound Level	
	Daytime Sound Level $L_{Aeq,16hour}$ dB	Night-time Sound Level $L_{Aeq,8hour}$ dB
M4	66.9	58.2
M5	64.9	56.5

Table 5.9: Estimated Daytime and Night-time Sound Levels

Observations and Discussion

5.21 Noise levels across the development site are dominated by local road traffic.

5.22 The highest noise levels are experienced on the western side of the site overlooking the M1 motorway. Noise levels at this location are also influenced by railway noise, but the dominant noise source is assessed to be attributable to vehicular road traffic.

5.23 Noise levels attenuate naturally over distance and the screening from intervening buildings.

5.24 The lowest noise levels are typically measured at the northern boundary of the site, further from neighbouring roads.

6 Acoustic Modelling

6.1 In order to assist in reviewing potential acoustic design implications for the site, an acoustic noise model of the site and surrounding area has been developed using CadnaA® noise modelling software. This software implements calculation methodologies of ISO 9613[7] for calculation of outdoor sound propagation, the *"Calculation of Road Traffic Noise"*[8] (CRTN) and *"Calculation of Railway Noise"*[9] (CRN).

6.2 The noise model was constructed using OS topographic data and the existing and commercial buildings at the surroundings have been included.

Noise Sources

6.3 The CadnaA® noise model includes the following noise from the surrounding road network including the M1 motorway, A1 Watford Way, Bunns Lane and other local roads (based on the results of traffic counts undertaken to inform the Transport Assessment for the application) and measured train pass-by data and timetable information for the adjoining railway.

Study Scenarios

6.4 Two computational noise models have been created:

- A baseline model of existing 2016 noise levels at the site (which has been validated against the noise survey data);
- An operational model including the indicative layout of buildings, and forecast traffic flows for 2021 (including both factored baseline values, committed development and future trips that will be generated by the development).

Modelling Results

6.5 **Figures 6.1** and **6.2 below** illustrate the 2016 baseline day-time noise model (with the calculation grid set at 1.5m above local ground floor level) and the night-time noise model (with the calculation grid set at 4m above local ground level).

[7] International Organization for Standardization, ISO 9613-1:1993: ***"****Acoustics -- Attenuation of sound during propagation outdoors - Part 1: Calculation of the absorption of sound by the atmosphere and Part 2: General method of calculation"*.
[8] Department of Transport. (1988). *"Calculation of Road Traffic Noise"*. HMSO, London.
[9] The Department of Transport (1995). *"Calculation of Railway Noise"*. HMSO, London.

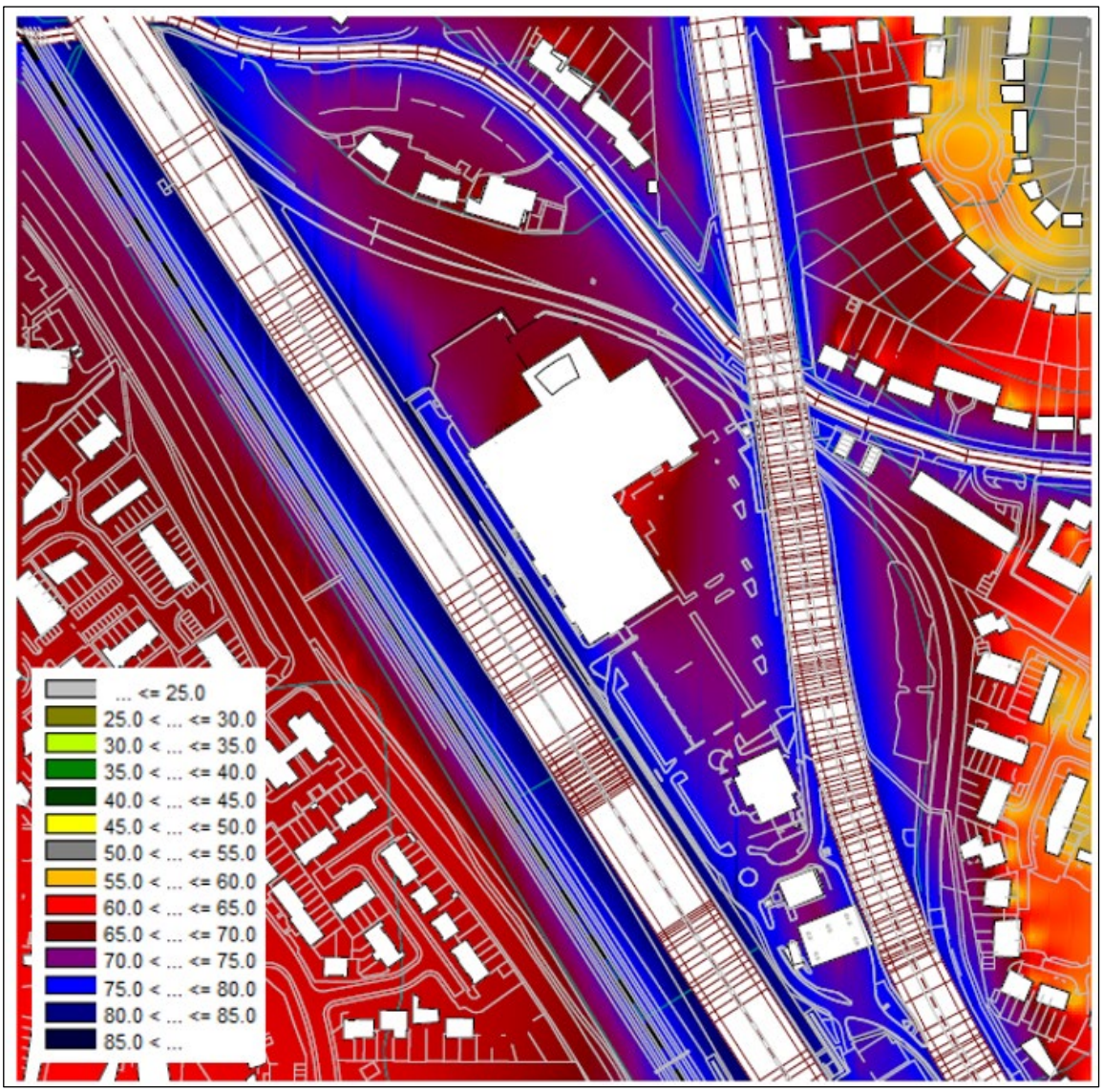


Figure 6.1: Baseline 2016 Daytime Noise Levels ($L_{Aeq,16hour}$) at 1.5m

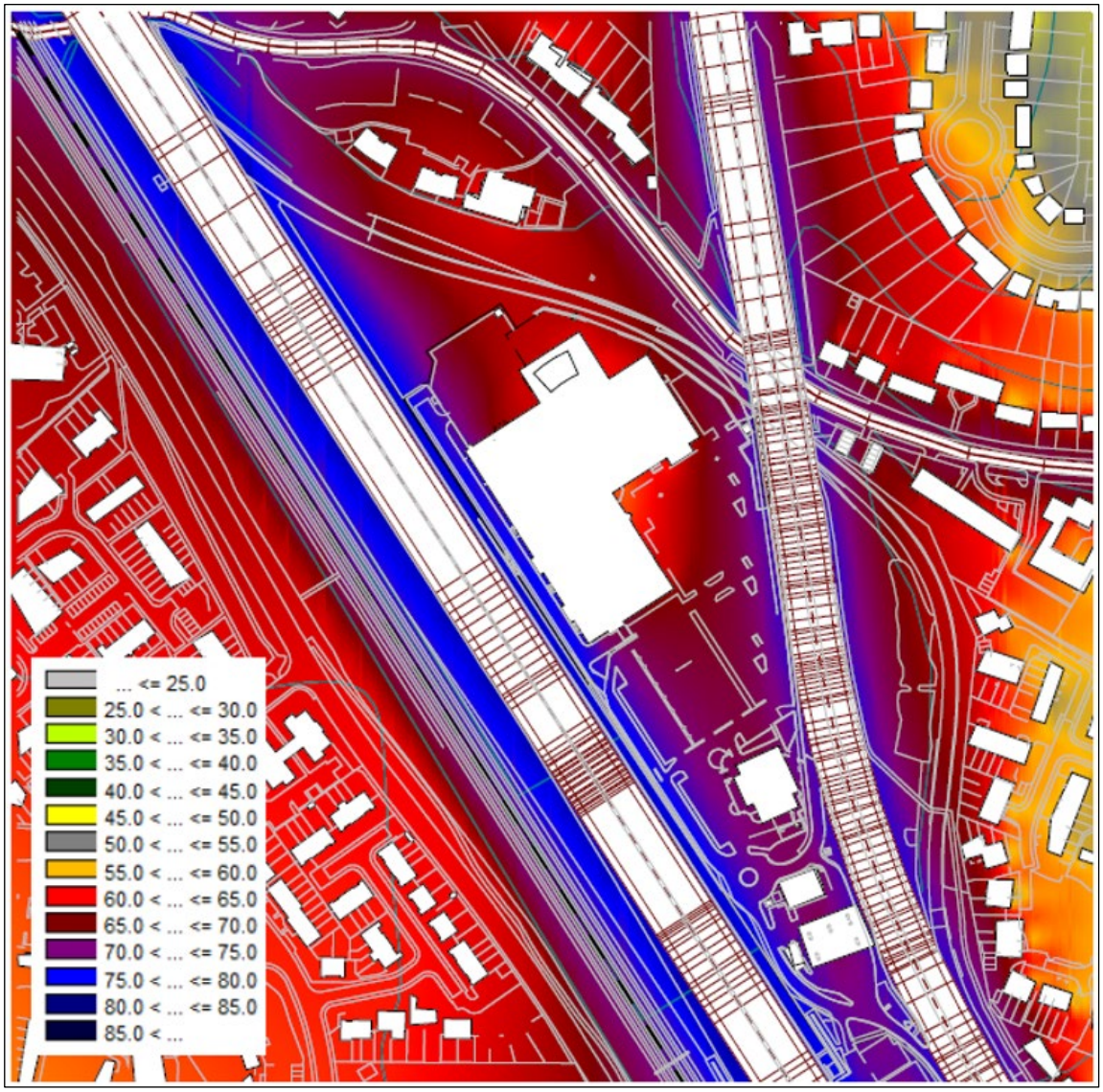


Figure 6.2: Baseline 2016 Night-time Noise Levels ($L_{Aeq,8hour}$) at 4m

6.6 **Figures 6.3** and **6.4** illustrate operational day-time noise model (with the calculation grid set at 1.5m above local ground floor level) and the night-time noise model (with the calculation grid set at 4m above local ground level).

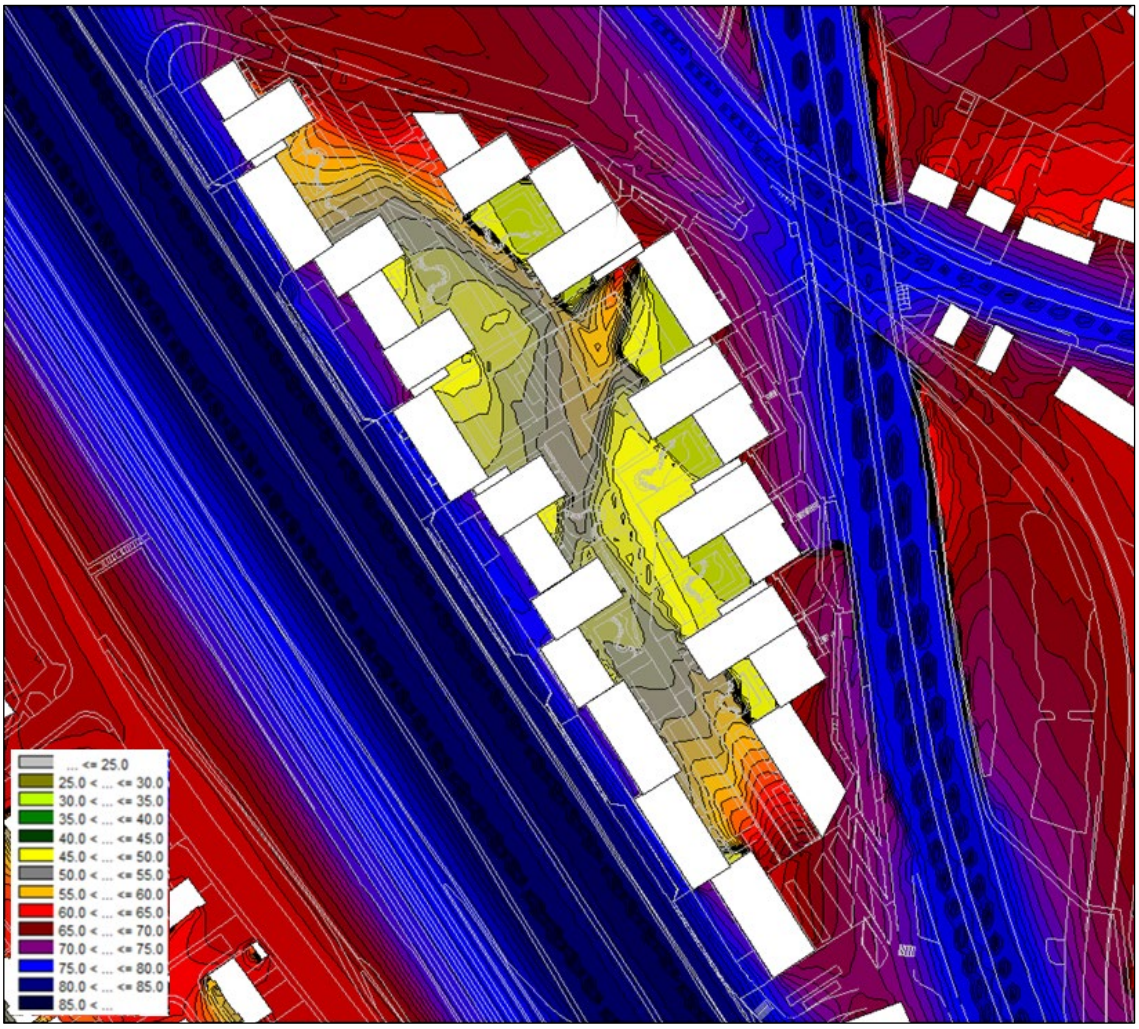


Figure 6.3: Operational (2021) Daytime Noise Levels ($L_{Aeq,16hour}$) at 1.5m

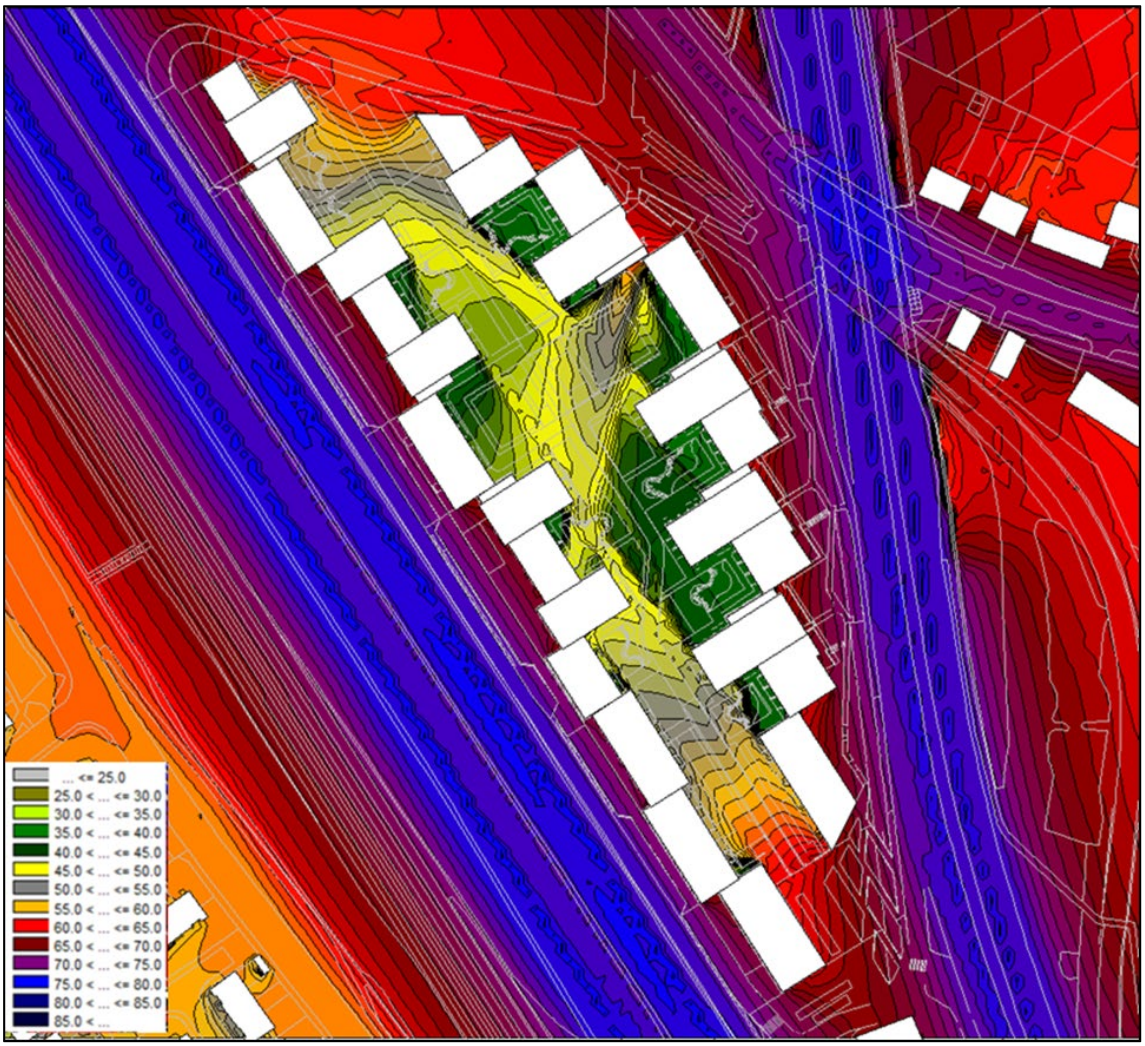


Figure 6.4: Operational 2021 Night-time Noise Levels ($L_{Aeq,8hour}$) at 4m

7 Site Suitability

7.1 The London Borough of Barnet's *"Sustainable Design and Construction SPD"* recommends that an initial site risk assessment is undertaken to determine the potential need and extent of noise mitigation. The approach essentially classifies noise in four "noise risk" bands – "Negligible", "Low", "Medium" and "High". **Figure 7.1** below presents an analysis of noise levels around the proposed development in line with this classification promoted in the SPD:

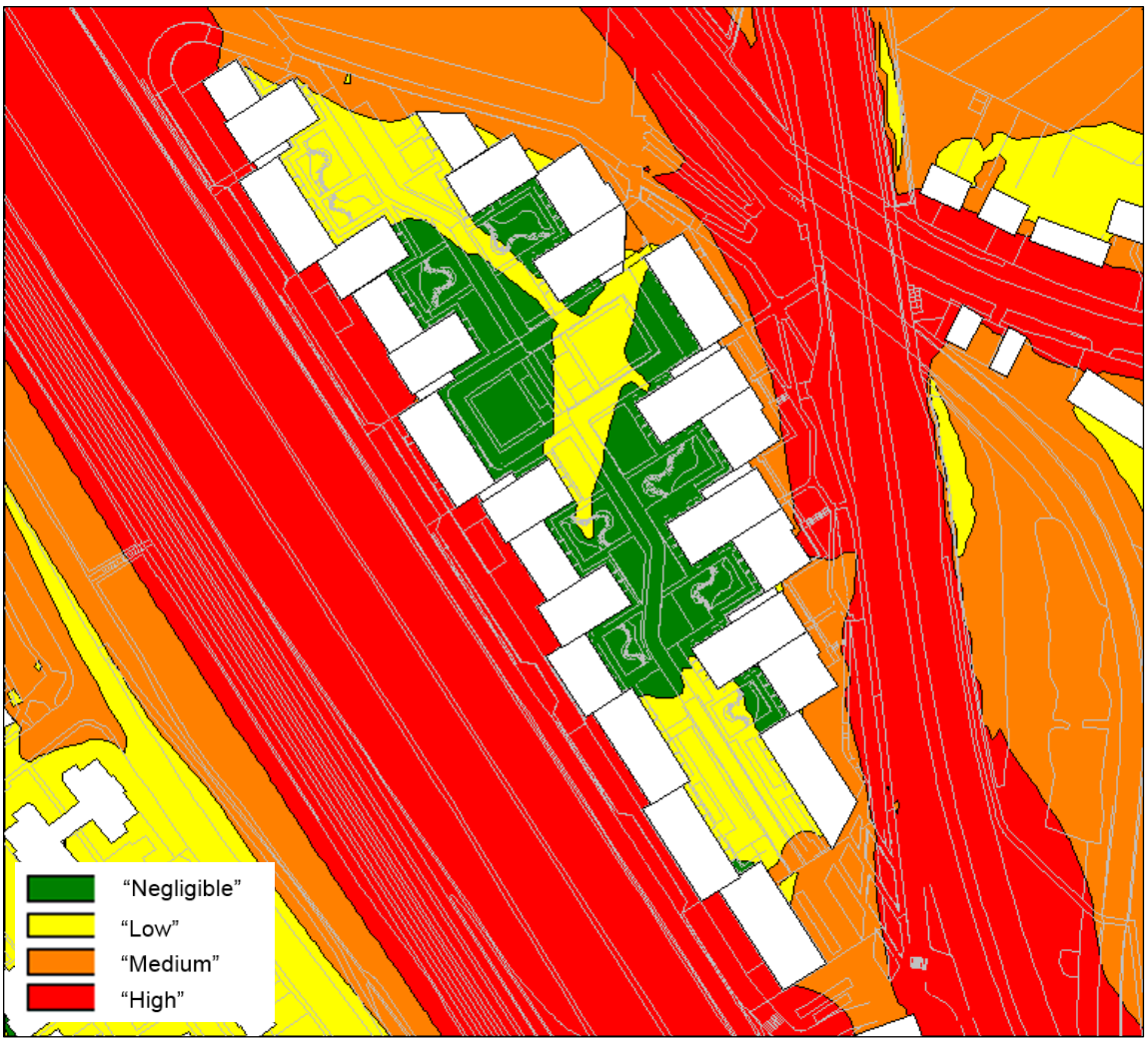


Figure 7.1: Daytime "Noise Risk" Assessment (in line with SPD Classifications)

7.2 Night-time NEC contours are presented in **Figure 7.2** below:

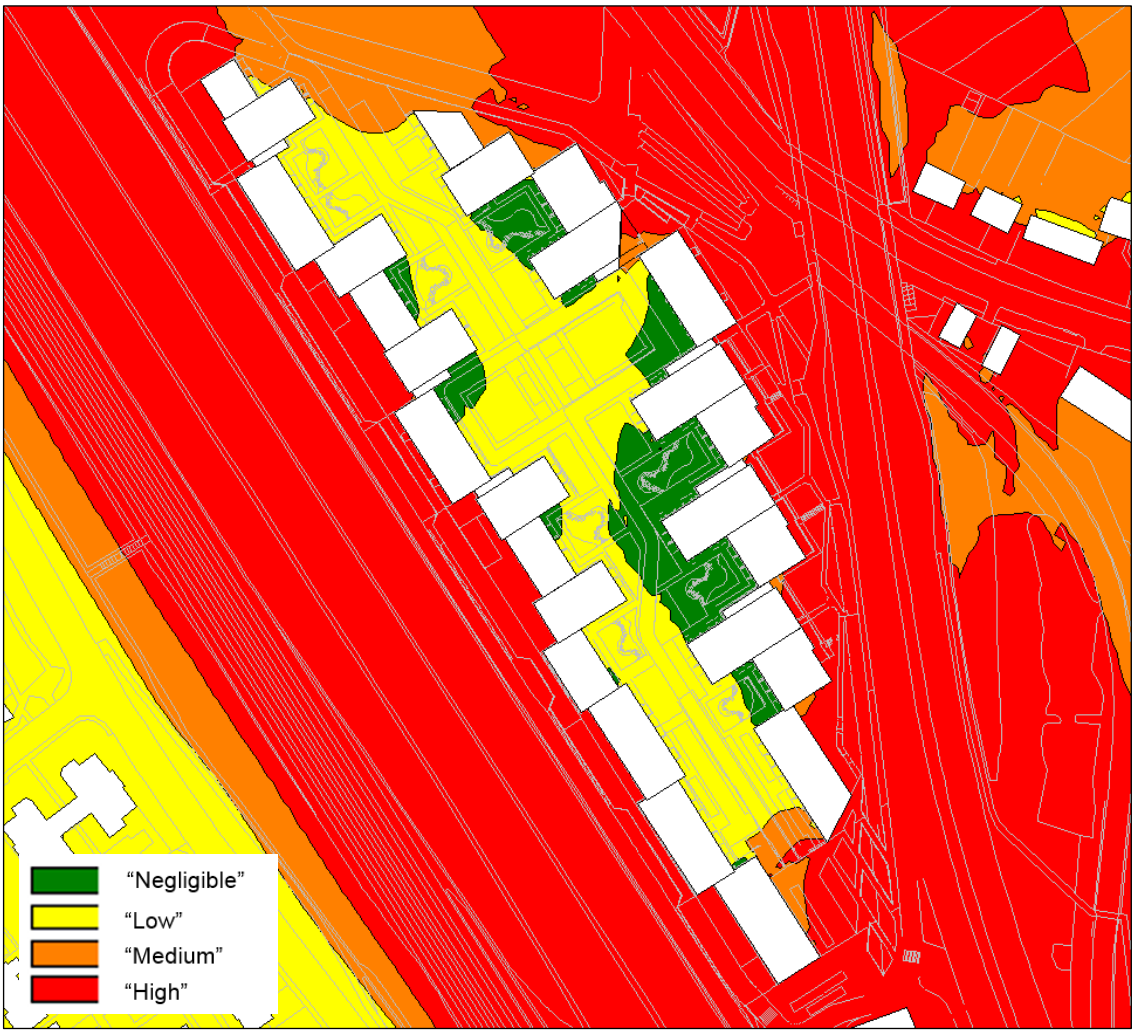


Figure 7.2: Night-time "Noise Risk" Assessment (in line with SPD Classifications)

7.3 The above indicates that the 'external' building elevations facing into the M1 and A1 will generally be exposed to noise levels that would be considered to represent a "medium" to "high" risk, whilst 'internal' elevations (which will also represent amenity locations) will generally experience noise levels that represent a "negligible" to "low" risk.

7.4 In light of the above, and in line with the guidance of LBB's adopted Sustainable Design and Construction SPD, it is therefore concluded that the site is compatible with residential development, provided that the proposed scheme implements an appropriate scheme of mitigation, commensurate with the existing noise climate.

8 Mitigation (Noise Intrusion Into Dwellings)

Design Guidance

8.1 In order to ensure a good standard of residential amenity within dwellings, BS 8233: 2014 recommends that daytime noise levels should be below 35dB $L_{Aeq,16hour}$ and night-time values in bedrooms should be below 30dB $L_{Aeq,8hour}$. These values are considered to represent a LOAEL, in line with national planning policy guidance.

Incident Noise Levels

8.2 The operational noise model has an in-built "building evaluation" function which enables the incident noise levels on a building to be quantified.

Sound Insulation

General

8.3 The level of sound insulation required will be determined by:

- **The noise levels incident on a particular area of façade.** In the case of this development, it is clear that higher levels of sound insulation will be required for units overlooking the M1 and A1 than units overlooking the central courtyard areas.
- **The sound insulation capabilities of the constituent building elements.** For windows set within masonry external walls, noise intrusion will generally be determined by the acoustic performance of the windows.
- **The relative proportion of building elements.** The sound insulation required will increase as the façade area to a room increases. The sound insulation required of weaker performing elements (e.g. windows) will also increase when the proportional area of these is increased.
- **The acoustic conditions of the receiving room.** Noise intrusion into acoustically hard (reverberant) rooms, will increase sound insulation requirements.

8.4 In order to assess sound insulation, noise intrusion calculations have been undertaken in accordance with BS EN 12354-3:2000 *"Estimation of acoustic performance of buildings from the performance of elements- Part 3: Airborne Sound Insulation Against Outdoor Sound"*.

8.5 The baseline data and assumptions used in these calculations are outlined in the following sections.

Architectural Design Information

8.6 All calculations are based on relevant drawings for each block of flats prepared by AFK Architects.

Room Acoustic Conditions

8.7 As noted earlier, noise intrusion into flats/houses will also be partially determined by the internal room finishes, which will determine the reverberation times within the building. For the purpose of this assessment, a reverberation time of 0.5 seconds has been assumed for all rooms, in line with the standardised reverberation time implemented in Approved Document E of the Building Regulations 2010.

External Walls

8.8 All external walls are understood to comprise a notional 450mm overall thickness, comprising an outer 150mm pre-cast concrete panel, with internal metal studwork and plasterboard drylining. It is recommended that allowance is made for 2 x 12.5mm layers of 'dense' plasterboard (e.g. British Gypsum "Soundbloc". Insulation will be required to the cavity to prevent resonance effects but it is recommended that this is costed for on the basis of thermal requirements which are likely to be more onerous than acoustic performance requirements.

Glazing

8.9 **Figure 8.3** shows a preliminary zoning arrangement for glazing. Each zone would have the following typical performance requirements:

- **Type A** – Windows rated at R_w 46dB. (This could typically be achievable with double glazed units comprising 12.8mm laminated glass / 24mm cavity / 8.8mm laminated glass)
- **Type B** – Windows rated at R_w 36dB. (This could typically be achievable with double glazed units comprising 6mm glass / 16mm airspace / 6mm glass)

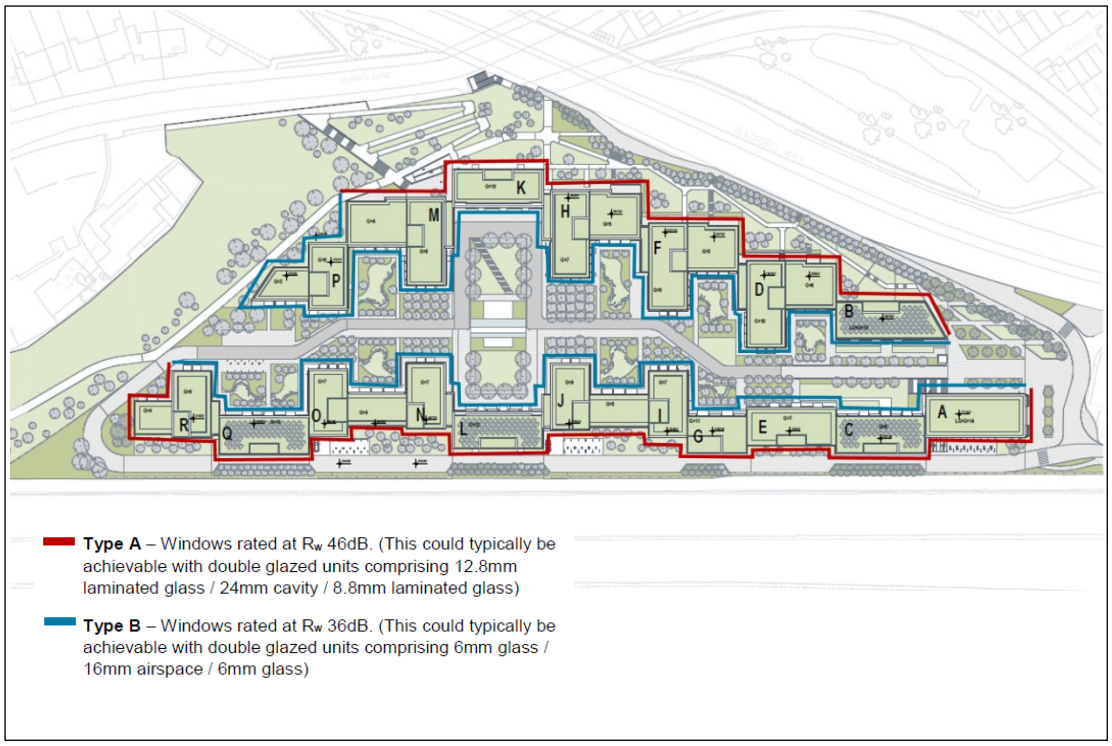


Figure 8.3: Preliminary Glazing Zoning

Alternative Means of Ventilation

8.10 Approved Document F (ADF) of the Building Regulations 2010 requires that all habitable rooms in dwellings have background ventilation. A partially open window will typically reduce traffic noise by around 10-15dB(A). It is clear, therefore, that reliance on openable windows to provide background ventilation will not be compatible with maintaining acceptable internal noise levels within the flats. As such, alternative means of ventilation will need to be provided to deliver the statutory requirements of ADF.

8.11 Alternative means of ventilation is proposed by means of whole house heat recovery (MVHR) systems. The systems will be ducted to fresh air inlet and exhaust termination on the quieter, internal 'courtyard' elevations of the building to limit the 'break-in' of external noise.

8.12 Approved Document F also requires that adequate provision is made for purge ventilation. Purge ventilation is process of removing high concentrations of pollutants and water vapour released from occasional activities (such as painting and decorating) or accidental releases (such as smoke from burnt food or spillage of water). Since the need for purge ventilation is by its definition "occasional", this is normally achieved by giving residents the ability to open their windows. Whilst noise intrusion will increase as a result of windows being open, the occasional and temporary occurrence of such a

situation can be readily accepted, particularly since occupants are *"in control"* of both the timing and duration of purge ventilation being required.

8.13 However, the proposed mechanical ventilation strategy has been designed to provide a purge ventilation function, giving residents the ability to keep windows closed. This will also provide thermal control for the units, without the need for residents to open windows.

8.14 Notwithstanding this, it should also be noted that units are either dual aspect (i.e. overlooking the motorway but also having windows on the quieter courtyard elevation of the building) whilst single aspect units have been specifically designed so that they overlook the quieter courtyard area only. As noted earlier, noise levels within the courtyard represent a negligible to low noise risk. As such, whilst residents do not need to open windows for whole house, purge or thermal control purposes, should residents wish to open windows overlooking the internal courtyard, noise intrusion would be reasonably controlled, in line with ProPG guidance.

Conclusions

8.15 The above assessment demonstrates that noise intrusion into the proposed dwellings can be appropriately mitigated through the selection of appropriately specified external building fabric elements (i.e. the use of acoustic double glazing) and alternative means of ventilation.

8.16 It is therefore clear that whilst noise intrusion to the residential areas of the proposed development is a material planning consideration, this can directly controlled/enforced by means of an appropriate planning condition (e.g. the submission and approval of the sound insulation scheme developed during the detailed design stage of the project).

8.17 As such, the proposed residential development of the site is considered to comply fully with national, regional and local planning policy.

9 External Amenity Areas

Design Considerations

9.1 Guidance in the World Health Organisation's "Guidelines for Community Noise" recommends that, to avoid serious annoyance during the daytime and evening, noise levels in external amenity areas should not exceed 55dB $L_{Aeq,16hour}$.

9.2 Section 7.7.3.2 of BS 8233: 2014 states

> *"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 noisy 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."*

9.3 Given that the site is a noisier urban environment, the development has been designed to reduced noise levels to the lowest practicable levels, with an aspirational design target of 55dB $L_{Aeq,16hour}$.

9.4 In order to deliver this intent, particular attention has been given to the massing and general arrangement of the buildings on the site. The site is arranged with two "barrier" blocks placed along the M1 and A1 sides of the site. Blocks A, C, E, G, I, J, L, N, O, Q and R lie parallel to M1 and range in height from GF+4 to GF+15 storeys (the height of the blocks increasing towards the southern end of the Site. Blocks B, D, F, H and K lie parallel to the A1, with two additional blocks projecting north-west to close the openness of the Site towards Bunn's Lane.

9.5 The Site is further protected by living "Green Walls" along the M1 and A1 boundaries of the Site which comprise an acoustic barrier with woodland planting.

9.6 The massing and design of the buildings help provide acoustic screening the central communal amenity spaces at the heart of the development.

WHO/BS8233 Assessment

9.7 **Figure 9.1** below shows the operational daytime noise model, shading areas compliant with the WHO/BS8233 aspirational level of 55dB(A) in green, and areas exceeding that value in red.

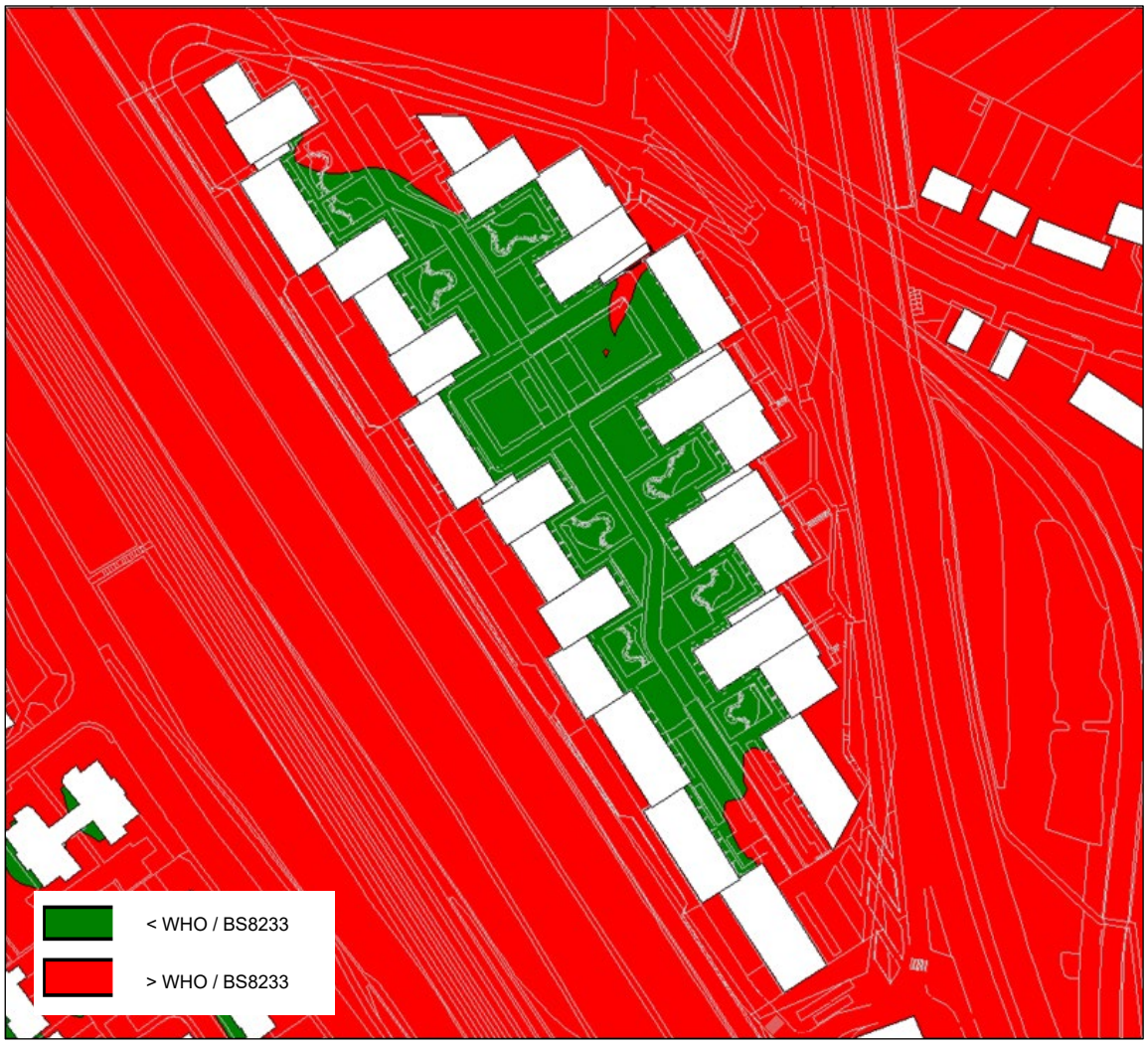


Figure 9.1: Outdoor Amenity Space Assessment (Ground Level)

9.8 The above figure clearly demonstrates the effectiveness of the proposed massing of the development, and how an extensive area WHO/BS8233 compliant amenity space has been created within the central courtyard areas.

9.9 In addition to the main communal amenity space at the heart of the development, additional community spaces are proposed in the form of roof gardens. The roof gardens are to have a 2m high glazed screen around the perimeter of the roof - enabling roof top planting to soften the visual appearance of the building whilst providing acoustic protection to users of the amenity space, as illustrated in **Figure 9.2** below

Figure 9.2: Image Showing Proposed Perimeter Screening Around Roof Gardens

9.10 **Figures 9.3** to **9.15** below show predicted noise levels in these areas:

Figure 9.3: Outdoor Amenity Space Noise Assessment: 4th Floor Roofs

Figure 9.4: Outdoor Amenity Space Noise Assessment: 5th Floor Roofs

Figure 9.5: Outdoor Amenity Space Noise Assessment: 6th Floor Roof

Figure 9.6: Outdoor Amenity Space Noise Assessment: 7th Floor Roof

Figure 9.7: Outdoor Amenity Space Noise Assessment: 9th Floor Roof

Figure 9.8: Outdoor Amenity Space Noise Assessment: 10th Floor Roof

Planning Policy Context

9.11 In order to align with the principles of national planning policy, the 55dB $L_{Aeq,16hour}$ value promoted by WHO/BS8233 is considered to be the *"Lowest Observed Adverse Effect Level"* (LOAEL). On this basis, it can be concluded that the majority of the amenity space to be provided will offer acoustic conditions that are below than the LOAEL.

9.12 It is, however, also important to note that a level exceeding the LOAEL does not that there will be a "significant" adverse noise impact. Indeed, this is reflected in the guidance of BS8233 which notes *"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"* should be taken into account and that in such situation *"development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited."*

9.13 In reality, a *"Significant Adverse Observed Effect Level"* (SOALE) will normally occur when there is a substantial exceedance of the LOAEL. To help quantify this, reference can be made to LBB's adopted *"Sustainable Design and Construction SPD".* This infers that the SOAEL for residential amenity would occur at an external sound level of around 63dB $L_{Aeq,16hour}$.

9.14 Taking account of the above, **Figure 9.9** below presents a modified view of the assessment presented in **Figure 9.1**, zoning the site in terms of:

- Areas below the LOAEL (i.e. WHO/BS8233 compliant);
- between the LOAEL and adopted SOAEL; and
- Above the adopted SOAEL.

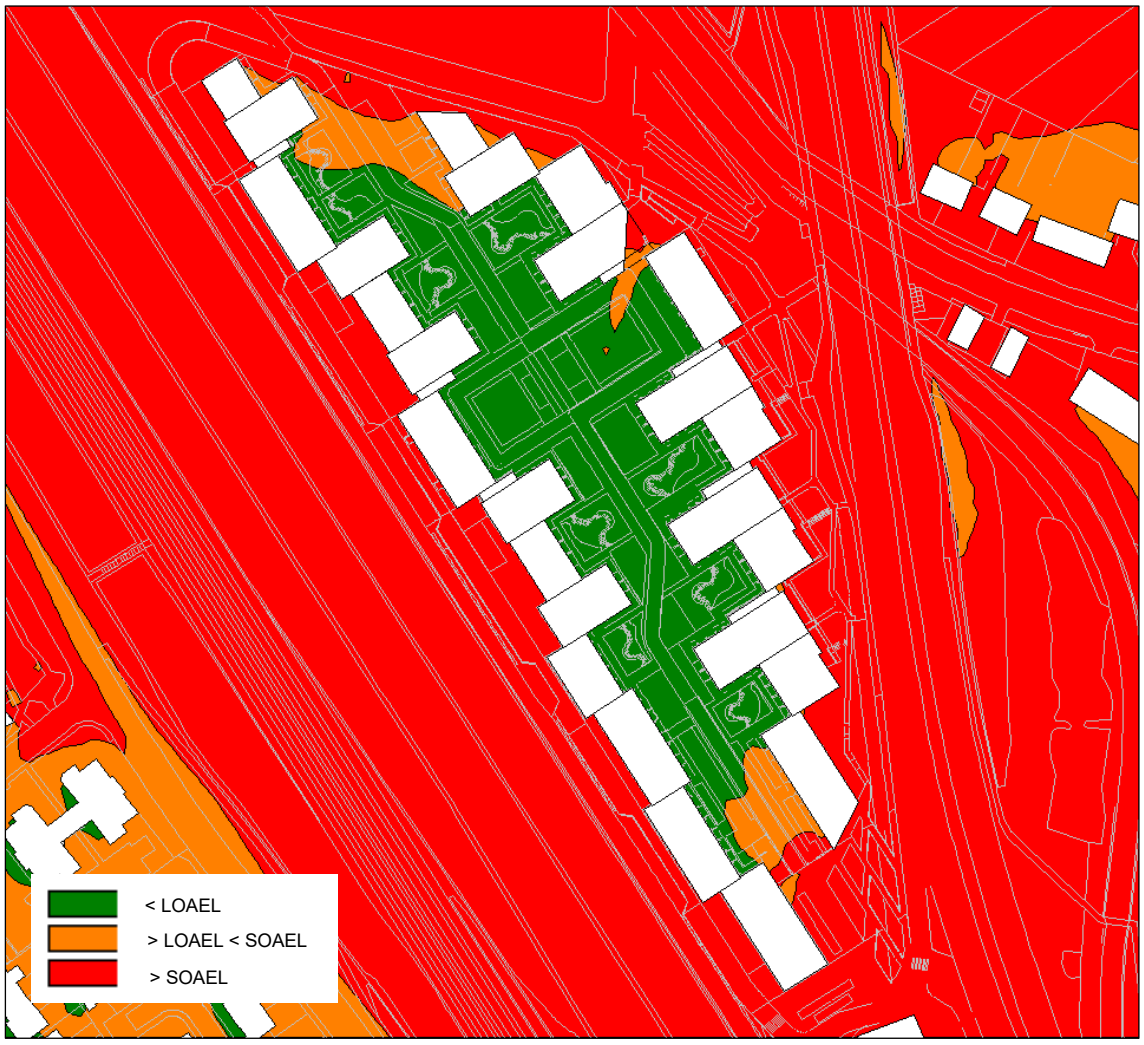


Figure 9.9: Noise Map Areas Above, Below and Between LOAEL / SOAEL

Figure 9.10: 4th Floor Roofs - Areas Above, Below and Between LOAEL / SOAEL

Figure 9.11: 5th Floor Roofs - Areas Above, Below and Between LOAEL / SOAEL

Figure 9.12: 6th Floor Roofs - Areas Above, Below and Between LOAEL / SOAEL

Figure 9.13: 7th Floor Roof - Areas Above, Below and Between LOAEL / SOAEL

Figure 9.14: 9th Floor Roof - Areas Above, Below and Between LOAEL / SOAEL

Figure 9.15: 10th Floor Roof - Areas Above, Below and Between LOAEL / SOAEL

9.15 The above figures demonstrate that:

- The majority of the amenity space at the central "heart" of the proposed development offers noise levels below the LOAEL;
- Noise levels in other areas are reduced to the lowest practicable level – generally between the LOAEL and SOAEL, other than the areas of the site closest to the adjoining roads which are above the SOAEL.

Balconies

9.16 In addition to communal amenity areas, all flats will also benefit from private amenity spaces (terraces/balconies).

9.17 Section 7.7.3.2 of BS 8233: 2014 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."

9.18 In order to reduce balcony noise levels to the lowest practicable levels, the following These are generally located on the "quiet" side of each building (i.e. overlooking the "internal" courtyard and amenity spaces) to avoid direct noise from the adjoining motorway and dual carriageway.

9.19 #'In addition to the above, national planning policy guidance (Paragraph 010 Reference ID: 30-010-20140306 of PPG-N) also indicates that further the impact of noise on residential developments can also be partially offer set where residents have access to *"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 minutes walking distance)."* In that regard, it is considered relevant to note that, in addition to the communal and private amenity spaces provided within the development, future occupants will also be located in close proximity to the extensive grounds of Mill Hill Park.

10 Operational Impacts (Traffic)

General

10.1 The proposed development will generate additional traffic on the local road network. In order to test the potential noise impacts of these traffic volume changes, Velocity Transport Consultants have provided "Baseline" 2016 traffic flows and future year operational flows in 2021 and 2026, allowing for general traffic growth and operational traffic that will be generated by the development. Information has been provided for eighteen road links, as shown in **Figure 10.1** below

Figure 10.1: Road Link Identification

Noise Impact Assessment

10.2 Two noise impact scenarios have been considered:

- A "short term" assessment comparing 2021 traffic flows (including factored growth, committed development and Pentavia development traffic) with existing 2016 baseline flows. The significance of any noise change is assessed in line with the DMRB "short term" significance criteria (as per **Table 4.4** of this report);

- A “long term” assessment comparing 2026 traffic flows (including factored growth, committed development and Pentavia development traffic) with existing 2016 baseline flows. The significance of any noise change is assessed in line with the DMRB “long term” significance criteria (as per **Table 4.5** of this report);

10.3 The results of these assessments are presented in **Tables 10.1** and **10.2** below:

Road Link	Baseline 2016		Future Year 2021 + Committed Development + Development Traffic		Relative change in Traffic Noise Level	Magnitude of Effect
	AADT	%HGV's	AADT	%HGV's		
Link 1	17655	6.0%	18581	6.0%	0.2	Negligible
Link 2	9842	7.5%	10469	7.4%	0.3	Negligible
Link 3	11813	6.7%	12476	6.6%	0.2	Negligible
Link 4	13885	8.5%	14600	8.5%	0.2	Negligible
Link 5	36182	5.3%	38305	5.2%	0.2	Negligible
Link 6	8986	3.0%	9536	2.9%	0.3	Negligible
Link 7	59274	5.5%	62967	5.4%	0.3	Negligible
Link 8	3638	6.3%	3850	6.3%	0.2	Negligible
Link 9	14245	0.5%	14952	0.5%	0.2	Negligible
Link 10	4723	26.0%	4993	25.8%	0.2	Negligible
Link 11	10042	3.0%	10537	3.0%	0.2	Negligible
Link 12	4694	1.2%	5024	1.2%	0.3	Negligible
Link 13	16166	1.7%	17024	1.7%	0.2	Negligible
Link 14	14774	1.8%	15757	1.8%	0.3	Negligible
Link 15	37526	5.0%	40439	4.8%	0.3	Negligible
Link 16	605	14.3%	633	14.3%	0.2	Negligible
Link 17	44916	5.9%	47257	5.9%	0.2	Negligible
Link 18	20400	3.2%	21604	3.2%	0.2	Negligible

Table 10.1: Assessment of “Short Term” Traffic Noise Changes

Road Link	Baseline 2016		Future Year 2026 + Committed Development + Development Traffic		Relative change in Traffic Noise Level	Magnitude of Effect
	AADT	%HGV's	AADT	%HGV's		
Link 1	17655	6.0%	19494	6.0%	0.4	Negligible
Link 2	9842	7.5%	11000	7.4%	0.5	Negligible
Link 3	11813	6.7%	13059	6.6%	0.4	Negligible
Link 4	13885	8.5%	15292	8.5%	0.4	Negligible
Link 5	36182	5.3%	40062	5.2%	0.4	Negligible
Link 6	8986	3.0%	9972	3.0%	0.5	Negligible
Link 7	59274	5.5%	65845	5.4%	0.5	Negligible
Link 8	3638	6.3%	4037	6.2%	0.5	Negligible
Link 9	14245	0.5%	15662	0.5%	0.4	Negligible
Link 10	4723	26.0%	5241	25.7%	0.5	Negligible
Link 11	10042	3.0%	11032	3.0%	0.4	Negligible
Link 12	4694	1.2%	5297	1.2%	0.5	Negligible
Link 13	16166	1.7%	17863	1.6%	0.4	Negligible
Link 14	14774	1.8%	16628	1.8%	0.5	Negligible
Link 15	37526	5.0%	42261	4.8%	0.5	Negligible
Link 16	605	14.3%	662	14.3%	0.4	Negligible
Link 17	44916	5.9%	49464	5.9%	0.4	Negligible
Link 18	20400	3.2%	22621	3.2%	0.4	Negligible

Table 10.2: Assessment of "Long Term" Traffic Noise Changes

Conclusions

10.4 Whilst traffic flows on local roads will generally increase as a result of the proposed development, the change in noise level associated with future forecast traffic volumes will be "negligible" for both short and long term assessments. DMRB guidance indicates that such changes would not be perceptible.

11 Noise from Plant/Machinery

11.1 The proposed residential development is to include a quantum of commercial uses.

11.2 It is likely that such uses may require the installation of building services installations and it is therefore critical that noise from such plant is adequately controlled to minimise the risk of an adverse impact on existing dwellings in the vicinity of the site and future residents of the development.

11.3 At the time or preparing this assessment, detailed information relating to proposed building services is not available. Notwithstanding this, effective control over the proposed development can be retained by ensuring that noise emissions from plant are designed in accordance with appropriate noise emissions design targets.

11.4 The London Borough of Barnet's "Sustainable Design and Construction SPD" recommends that:

> *"Any proposed plant and machinery shall be operated so as to ensure that any noise generated is at least 5dB(A) below the background level, as measured from any point 1 m outside the window of any room of a neighbouring residential property. Plant should also be installed to ensure that no perceptible noise or vibration is transmitted through the structure to adjoining premises."*

11.5 Based on the results of the environmental noise survey undertaken at the site, it is therefore recommended that noise emissions from proposed plant should be controlled in line with the following acoustic design targets:

Period	Design Level, dB(A)
Daytime (07.00 – 23.00 hours)	48
Night-time (23.00 – 07.00 hours)	36

Table 11.1: Recommended Building Services Noise Emission Limits

11.6 The above targets should be achieved at a distance of 1m from the nearest window of any adjoining dwelling (proposed or existing) with all plant operating normally.

11.7 It is also recommended that noise emissions from any grille opening onto an amenity space or the public realm are controlled such that they do not exceed a sound level

greater than 55dB(A), as measured at a distance of 1.5m. In addition to this requirement, it is recommended that noise levels incident on adjoining commercial windows do not exceed a level of 50-55dB(A) in order to preserve the amenity of office use within those premises.

11.8 Specific noise control requirements necessary to deliver the above design targets will need to be assessed during the detailed design phase of the project once specific plant selections have been made.

Conclusions

11.9 Adoption of the environmental acoustic design targets set out above will ensure that building services installations associated with the proposed development scheme will not have an adverse noise impact on existing adjoining dwellings in the vicinity of the site. As such, the proposed development is considered to comply fully with local, regional and national planning policy guidance. If considered necessary,

11.10 No site specific or technological difficulties are envisaged with regard to the feasibility of complying with the above design targets. However, if considered necessary, the control of building services noise emissions can be readily enforced by means of an appropriate Planning Condition.

12 Vibration

12.1 There is very little national guidance on identifying screening distances for operational ground-borne vibration effects for operational railways. However, a number of recent major UK infrastructure projects have aligned screening criteria with guidance issued by the United States' Department for Transportation and Federal Transport Administration (FTA).

12.2 The FTA's *"Transit Noise and Vibration Impact Assessment Guidance Manual"* (2006) includes guidance on scoping distances for various types of transit project. For conventional railways, this guidance indicates that significant adverse vibration impacts are unlikely to be experienced in residential dwellings where these are greater than 200ft (61m) from the railway.

12.3 The Midland Mainline railway is located approximately 65m from the proposed build line of the closest residential building.

12.4 An initial scoping assessment therefore indicates that the site should generally not experience any significant adverse impact associated with ground-borne vibration from the Midland Mainline railway beyond the western boundary of the site. As such, vibration from train movements is not considered to represent a constraint with regard to the proposed residential development of the site and a detailed assessment of vibration has been scoped out of this assessment.

12.5 Notwithstanding the above, it should be noted that the proposed development is to comprise a concrete framed construction with full density concrete slabs, with the external building fabric will include pre-cast concrete and masonry elements. As such, the building will, as a matter of course, be constructed to minimise any effects of groundborne vibration and building amplification effects.

13 Commercial to Residential Separation

General

13.1 From a planning perspective, there is some degree of inherent conflict between residential and commercial uses. The ability of mixed-uses to satisfactorily co-exist is therefore ultimately determined by a complex number of factors, such as:

- The level of sound insulation afforded by separating structures (at 'shell and core' stage);
- The operational noise levels of venues (an operation characterised by amplified "foreground" music will need to be more rigorously controlled than an operation where noise levels are characterised by the general "hubbub" of human speech);
- Operating hours (uses wanting to operate at "night", i.e. after 23.00 hours, will require more stringent control than uses finishing earlier);
- The ability for additional sound insulation to be provided (i.e. the ability to "enhance" shell and core structures to increase sound insulation); and
- General management controls that operators will adhere to.

13.2 It is clear that many of the above influencing factors are under the control of future tenants and thus no substantive information is normally available at an outline development stage.

13.3 Notwithstanding that, it is normally feasible to implement effective sound insulation between differing use classes, by ensuring that the separating structure offers a good, inherent level of sound insulation and that any incoming tenant has the ability to enhance that structure to be compatible with their operational aspirations for the unit. Both matters can be adequately addressed by imposing a planning condition requiring the submission and approval of a sound insulation scheme to protect dwellings,

14 Construction Noise and Vibration

14.1 Construction activities have the potential to cause noise and vibration disturbance to both residential and commercial uses in the vicinity of a site.

14.2 The current indicative development programme for construction works would take approximately 48 months, commencing in the third quarter 2019 with completion in the third quarter of 2023.

14.3 Whilst all details regarding future construction have not been finalised at this stage, it is possible to provide general information about the anticipated construction activities and programming, as summarised in **Table 14.1** below.

Activity	Approximate Duration (months)
Enabling Works	
Services Disconnections & Diversion	2.5
Demolition	4.5
Site works, road infrastructure and services	5
Energy Centre Fit-Out and Distribution	4
Commissioning	2
Construction Period	15
Phase 1	
Undercroft Carpark and Podium	3
Superstructure, and Fit Out	15.5
Commissioning	1.5
Construction Period	19
Phase 2	
Undercroft Carpark and Podium	3
Superstructure, and Fit Out	15.5
Commissioning	1
Construction Period	18
Phase 3	
Undercroft Carpark and Podium	3
Superstructure, and Fit Out	15.5
Commissioning	1
Construction Period	22

Activity	Approximate Duration (months)
Phase 4	
Undercroft Carpark and Podium	3
Superstructure, and Fit Out	15.5
Commissioning	1
Construction Period	21

Table 14.1 – Indicative enabling, demolition and construction activities and phasing duration

14.4 A Post Planning Submission Programme, Volume 2 of the EA Appendix 5.1, has been prepared which illustrates the various stages of the enabling, demolition and construction works and their indicative timeframes for completion.

Enabling Works, Demolition, Infrastructure and Services

14.5 The following works will be undertaken during the enabling works, demolition, infrastructure and services stage:

- Hoarding will be erected around the boundary of the Site;
- All relevant enabling works to utilities will be carried out and this will involve capping-off or removal of redundant utilities, diversions, new supplies and connections as agreed with the statutory authorities;
- Existing buildings will be soft stripped back to the structural shell, prior to being demolished;
- Existing hardstanding (concrete/asphalt parking areas, concrete floor slabs and foundations) will be broken up. During the course of these activities, large quantities of materials including concrete, asphalt, sub-base material, engineered fill material, aggregates, soils and sub-soils are to be generated;
- To achieve the required site levels during enabling works, there will be some general civil engineering groundwork activities including excavation, grading and preparation of surfaces, and the placement / compaction of fill undertaken. Aggregate material, i.e. concrete, asphalt, brick, sub-base material, engineering fill, aggregate, from the demolition activities will be incorporated into the construction of the Development, for example, concrete and brick will be crushed to form re-usable secondary aggregates for the new building programme and incorporated into the sub-base for roads, foundations and to bring up site levels in existing depressions;

- Following completed of the engineering groundwork activities, construction of the circle road, car parking area and access points to the Site will be undertaken; and
- Following the completion of enabling and demolition works, construction will commence on Phase 1.

Plant and Equipment

14.6 An indicative list of large plant and equipment that are likely to be used at various stages of construction across the phases have been considered, these are shown in Table 7.6.2.

Plant and Equipment	Stage of Works				
	Demolition	Substructure	Superstructure	Facade	Fit-Out
Concrete Crusher	✓	✗	✗	✗	✗
360^0 Excavator	✓	✓	✓	✗	✗
Tower / Mobile Crane	✗	✓	✓	✓	✓
Breaker	✓	✗	✗	✗	✗
Compressor & Air Tools	✓	✓	✓	✓	✓
Drills / Cutters	✓	✓	✓	✓	✓
Compacter / Roller	✗	✓	✗	✗	✗
Piling Rigs	✗	✓	✗	✗	✗
Concrete Pumps	✗	✓	✓	✗	✗
Generators	✓	✓	✓	✓	✓
Concrete Vibration Equipment	✗	✓	✓	✗	✗
Scaffolding	✓	✓	✓	✓	✓
Asphalt Plant	✓	✓	✗	✗	✗
Fork Lift Truck	✓	✓	✓	✓	✓
Goods/ Passenger Hoist	✗	✓	✓	✓	✓
Mast-climber Platforms	✗	✓	✓	✗	✗
Mechanical Road Sweeper	✓	✓	✓	✓	✓
Floodlights	✓	✓	✓	✓	✓
Hydraulic benders and cutters	✓	✓	✓	✗	✗
Lorries and Vans	✓	✓	✓	✓	✓
Ready mix concrete trucks	✗	✓	✓	✗	✗

Table 14.2 – Indicative list of large equipment and plant to be used during the Development

Construction Noise Assessment

14.7 Based on the above initial programming, phasing and work stage information, preliminary assumptions have been made in relation to plant selections, based on data published in BS 5228-1:2009+A1:2014. These have been used to determine typical construction noise levels for each stage of the works at distances of 25m, 50m and 100m from the site, which typically covers the range of distances between the site and closest noise sensitive receptors in each direction.

14.8 **Table 14.3** below summarises the predicted noise levels and assessment of significance:

Distance	Construction Stage Noise Level, $L_{Aeq,10hour}$				
	Demolition	Substructure	Superstructure	Facade	Fit-Out
25m	75	73	70	69	60
50m	69	67	64	63	54
100m	63	61	58	57	48

Table 14.3 Preliminary Assessment of Unmitigated Construction Phase Noise Impacts

14.9 For this type of development, it is considered most appropriate to assess the potential impact of construction noise by reference to fixed noise limits, as promoted in Annex E.2 of BS 5228-1:2009 +A1:2014: *"Code of Practice for Noise and Vibration Control on Construction and Open Sites - Part 1: Noise"*. This states:

> *"Noise from construction and demolition sites should not exceed the level at which conversation in the nearest building would be difficult with the windows shut. […] Noise levels, between say 07.00 and 19.00 hours, outside the nearest window of the occupied room closest to the site boundary should not exceed:*
>
> - *70 decibels (dBA) in rural, suburban and urban areas away from main road traffic and industrial noise;*
> - *75 decibels (dBA) in urban areas near main roads in heavy industrial areas."*

14.10 Since the proposed development is located adjacent to main roads, a value of 75 dB $L_{Aeq,10hours}$ is considered to represent the SOAEL for construction noise.

14.11 The LOAEL is taken to 55dB $L_{Aeq,10hours}$, being aligned with the upper guideline value for daytime noise level determined WHO/BS8233 guidance for external daytime environmental noise levels of 55 dB $L_{Aeq,16hr}$.

14.12 Whilst construction noise will be "temporary", the effect of such noise will also be influenced by the duration of the works, i.e. the greater the period of noise exposure, the greater the potential impact on neighbouring receptors. Based on advice given in Annex E of BS 5228-1, it is therefore considered that additional significance should be given to an impact exceeding the SOAEL of 75dB, where such a noise magnitude is predicted to occur on 10 or more days of working in any 15 consecutive days, or for a total of 40 days in any six month period.

14.13 Combining the above magnitude and temporal criteria, gives the following refined noise effect matrix for construction noise:

Combined Noise Magnitude and Temporal Criteria	Magnitude of Effect
Daytime noise level less than 55dB $L_{Aeq,T}$	Negligible
Daytime noise level between 55 and 75 dB $L_{Aeq,T}$	Minor
Daytime noise level greater than 75 dB $L_{Aeq,T}$ (For a period less than 10 days of working in any 15 consecutive days, or for a total of less than 40 days in any six month period)	Moderate
Daytime noise level greater than 75 dB $L_{Aeq,T}$ (For a period more than 10 days of working in any 15 consecutive days, or for a total of more than 40 days in any six month period)	Major

Table 14.4 Definitions of Magnitude of Effect – Construction Noise

14.14 Based on the above, it is concluded that there is constructions works are likely to have a negligible to moderate adverse effect on neighbouring noise sensitive properties, subject to the intervening distance between the specific work locations and receptor.

Construction Vibration

14.15 Two potential effects of construction vibration have been assessed – (a) the potential effect of vibration on the structure of neighbouring buildings and (b) the potential effect of vibration on occupants within those buildings.

14.16 With regard to buildings, vibration can potentially cause cosmetic damage and in the extreme, structural damage. Criteria for a significant vibration effect have therefore been aligned with guidance for cosmetic damage set out in BS 5228-2. Such criteria should safeguard building from structural damage, whilst vibration below the threshold can be

considered negligible since there would not be no effect. Adopted values are presented in **Table 14.5** below:

Type of Building	Peak Particle Velocity (PPV) in Frequency Range of 4 Hz to 15 Hz	Peak Particle Velocity (PPV) in Frequency Range of 15 Hz and Above
Reinforced or framed structures	50 mm/s at 4 Hz and above	
Industrial and heavy commercial buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz.	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above.

Table 14.5 Vibration Thresholds for Cosmetic Damage to Buildings

14.17 The potential effect of vibration on occupants within buildings has been assessed based on the guidance of Annex B of BS 5228-2, as set out in **Table 14.6** below:

Peak Particle Velocity (PPV)	Impact	Magnitude of Effect
0.14mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.	Negligible
0.3 mm/s	Vibration might be just perceptible in residential environments	Minor
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.	Medium
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level in most building environments.	Major

Table 14.6 Definitions of Magnitude of Effect – Construction Vibration: Human Comfort

14.18 Whilst demolition and construction activities have the ability result in potentially significant impacts (i.e. cosmetic/structural and/or cause disturbance to building occupants), such impacts are normally experienced in relatively close proximity to works and for relatively limited durations. In that regard, guidance in BS 5228-1:2009+A1:2014 suggests that vibration effects will not normally be significant beyond a distance of around 20m from the construction works. The nearest noise sensitive receptors to the site are beyond this initial scoping distance and, as such, it is considered unlikely that vibration associated with construction works will have any significant adverse impact on neighbouring noise sensitive receptors.

Mitigation

14.19 Notwithstanding the above conclusions, the potential temporary impacts of construction activities can be minimised through the implementation of appropriate construction management procedures. Such procedures can include:

- A general need for any contractor to implement the "best practicable means" for undertaking the works in line with the general guidance of BS5228:2009+A1:2014 (Parts 1 and 2);
- The use of prefabricated materials wherever possible;
- Optimising the site layout to locate noise generating activities as far as possible away from sensitive receptors; and
- Good housekeeping and management, i.e.
- Review of plant and activities to ensure noise minimisation measures are in place and operating;
- Controlling of site traffic and setting up of access routes away from sensitive receptors;
- Provision of noise monitoring during activities likely to affect sensitive receptors; and
- The use of 'silenced' plant and equipment to be used;
- The provision of screening around those parts of the site at which activities are likely to generate noise;
- Noise generating plant should be located at a low level and as distant as possible from sensitive receptor;
- Plant should operate at low speeds, where possible, and incorporate automatic low speed idling;
- All plant should be properly maintained (greased, blown silencers replaced, saws kept sharpened, teeth set and blades flat, worn bearings replaced, etc.);
- Consideration to be given to temporary screening or enclosures for static noisy plant to reduce noise emissions and plant should be certified to meet any relevant standards;
- Early and good public relations with the adjacent tenants and occupants of buildings will also reduce the likelihood of complaints; and
- Controlling the opening hours of the site.

14.20 Given the nature and scale of the proposed development and subject to the implementation of the good practice guidance outlined above, significant adverse noise and vibration impacts during the construction works are not anticipated. If considered necessary, however, the potential impact construction phase noise and vibration could

be controlled by means of appropriate planning condition(s), e.g. restricting the working hours of the site, or through the submission of a Construction Environmental Management Plan (CEMP), which could include detailed noise and vibration control proposals for the site. The implementation of a CEMP could be secured through the use of an appropriate planning condition.

15 Conclusions

Existing Noise Environment

15.1 Detailed noise monitoring has been undertaken to determine the existing environmental noise climate at the site. The dominant noise source is road traffic noise from the M1 and A1 which adjoin the site to the west and east respectively.

Planning Policy Context and Design Guidance

15.2 The requirements of national and local planning policy relevant to the proposed scheme are discussed. Reference has also been made to industry standard design guidance.

Site Suitability

15.3 The suitability of the site for residential development has been reviewed in the context of national planning policy and the particular requirements of LBB's *"Sustainable Design and Construction SPD"*. This concludes that the site is suitable for residential development, subject to the implementation of appropriate mitigation.

Noise Intrusion

15.4 Preliminary calculations confirm that noise intrusion can be adequately controlled using appropriately specified external wall construction, windows with acoustic double glazed units and alternative means of ventilation.

External Amenity Areas

15.5 Noise levels in communal amenity spaces has been controlled through the careful design of the development including using the general arrangement and massing of buildings to act as "barrier" blocks to provide acoustic screening and use of green walls along the M1 and A1 sides of the site.

15.6 Noise levels in private amenity spaces have been reduced to the lowest practicable levels by generally locating these on the quieter "internal" elevations of the buildings and the creation of winter gardens where these are exposed to higher noise levels.

Operational Noise

15.7 Environmental acoustic design targets for building services installations associated with the development have been recommended in accordance with the technical requirements of LBB's Sustainable Design and Construction SPD.

Traffic

15.8 An assessment of the relative changes in traffic noise levels on local roads has been assessed in both the short and long term. It is concluded that any noise increases are negligible.

Vibration

15.9 The proposed development is located at a sufficient distance from the Midland Mainline Railway such that vibration associated with train movements will not cause vibration of a sufficient magnitude that would attract adverse comment from the occupants of the proposed flats.

15.10 Notwithstanding the above, the proposed development will, as a matter of course, be constructed to minimise groundborne vibration and building amplification effects.

Commercial to Residential Separation

15.11 Potential sound transfer between the commercial and residential elements of the development has been reviewed. It is concluded that such a separation does not raise any particular acoustic difficulty or constraint with regard to the principle of the proposed development. If considered necessary, the implementation of appropriate sound insulation between the differing uses of the building could be enforced by means of an appropriate planning condition, consistent with national planning policy.

Construction Noise and Vibration

15.12 The nature and scale of the proposed development is not expected to give rise to any significant adverse noise impacts during construction works. If considered necessary, however, the potential impact construction phase noise and vibration could be controlled by means of appropriate planning condition(s), e.g. restricting the working hours of the site, or through the submission of a Construction Environmental Management Plan, which could include detailed noise control proposals for the site

Conclusion

15.13 In light of the above, it is concluded that the proposed development should not raise any residual significant or other adverse impacts on the health and/or quality of life for existing residential and commercial neighbours of the site arising from noise. It is therefore concluded that the proposed development complies fully with noise related national, regional and local planning policy and any mitigation can, if considered necessary, be enforced by means of appropriate planning conditions, consistent with paragraph 123 of the National Planning Policy Framework.

APPENDIX A: Glossary of Acoustic Terminology

GLOSSARY OF ACOUSTIC TERMINOLOGY

General

A vibrating surface or turbulent fluid flow will cause pressure fluctuations in the surrounding air. These pressure fluctuations are perceived by the human ear as “sound”.

Measurement Units

The human ear can detect sound pressures as low as about 20 µPa, and can tolerate (for short periods) sound pressures as high as 200 Pa, an amplitude range of 10 million times. To take account of this huge amplitude range, sound pressure levels (often written in “acoustic shorthand” as SPL or Lp) are quantified using a logarithmic scale, the decibel (dB) scale. This is based on a reference pressure of 20µPa, thus a sound pressure of 20µPa would equate to 0dB and a pressure of 200Pa would equate to 140dB.

Frequency (Pitch) Characteristics

The sound received at any particular location is not solely influenced by the sound pressure level, the frequency characteristics (pitch) of the noise is also an important factor. Noise audible to a human (with “normal” hearing), typically covers the frequency range 20 Hertz to 20,000 Hertz. Hertz (Hz) are defined as the number of times the sound pressure fluctuates in one second. “Low” pitched sounds fluctuate less times per second than “high” pitched sounds. Whilst humans are capable of detecting a wide range of frequencies, the ear is not equally sensitive to all frequencies – the ear is most sensitive at frequencies towards the middle of the audible range and less sensitive to the lower and higher frequencies.

To take account of this frequency response, sound pressure fluctuations are normally quantified by applying a frequency-weighting network or filter which simulates the frequency response of the ear. In essence, this means that more significance is given to the frequencies at which the ear is most sensitive and less significance to those at which the ear is less sensitive. Noise measurements relating to human reaction are generally made using an “A-weighting” network. These measurements are reported as A-weighted decibels or dB(A). The A-weighted sound pressure level is written in “acoustic shorthand” as L_A.

Variation of Sound with Time

It will be appreciated that the sound pressure level of most noise sources will fluctuate with time. In order to take account of the way in which the human ear perceives noise, it is normal for the sound pressure level to be quantified using a time weighting network, to mimic the speed of response of the human ear. The standardised setting for most types of noise is a “Fast” time weighting.

The manner in which sound fluctuates with time can also influence the subjective manner in which noise is perceived. Noise can be continuous (showing no significant variation with time as in the case of a fan), intermittent (i.e. the noise is transient in it’s nature, such as a train pass-by) or impulsive (i.e. there is a sudden build up of noise - this can range from “clanking” types sounds as might be experienced next to railway goods yard or a high energy discharge such as an explosion)

Measurement of Sound

Sound pressure levels are measured using equipment comprising a pressure-sensitive microphone, associated amplifier, frequency weighting network, time weighted network and output indicator. In its simplest form this is a small hand-held instrument called a sound level meter. More sophisticated instrumentation (a sound level analyser) is also available which allows the real-time output of the frequency characteristics of the sound to be quantified.

Comparison of Sound Levels

To put the significance of noise measurement into context, the following Table presents the A-weighted sound pressure level of some typical sources:

Sound Pressure Level, dB(A)	Typical Noise Source . Activity
160	Saturn Rocket Taking Off
140	Military Jet Taking Off at 30m
100	Nightclub
90	Heavy goods vehicle driving past at 7m
80	Busy urban road
70	Domestic vacuum cleaner at 3m
60	Busy office environment
55	Normal speech at 1m
40	Whispered conversation at 2m
30	Bedroom at night (BS 8233: 1999)
20	Remote country location
0	Threshold of hearing – a very eery silence

Addition of Sound Levels

It is important to note that the use of a logarithmic scale to describe noise does not allow normal arithmetic addition. This means that two noise sources each generating a level of, say, 60dB(A) will not generate a combined sound level of 120dB(A). The values must be added logarithmically, which would actually yield a combined sound level of 63dB(A) in this example.

Subjective Perception of Sound Levels Changes

With regard to the human perception of sound level changes, the human ear:

- Cannot generally perceive a sound level difference of less than 3dB(A)
- Will perceive a sound level difference of 4-5dB(A) as “noticeable”
- Will perceive a sound level difference of 10dB(A) as a doubling (or halving) of loudness.

Acoustic Terminology

As stated previously, most sources of noise will fluctuate with time. In order to characterize such noise, it is therefore normal to represent the noise climate using a variety of noise parameters and statistical indices. The most commonly adopted noise parameters are described below:

$L_{Aeq,T}$ This is the equivalent continuous A-weighted sound level measured over a specified time period "T". This is the notional continuous sound level which, over the time T, contains the same amount of energy as the actual fluctuating sound being measured. This parameter is widely accepted as being the most appropriate noise descriptor for most environmental noise and the effects of noise on humans.

$L_{Amax,fast}$ This is maximum A-weighted sound pressure measured with a fast frequency response recorded during the stated measurement period. It is typically used to characterise the highest sound level caused during a noise event.

$L_{A90,T}$ This is the A-weighted sound pressure level exceeded for 90% of the specified time period "T". It is normally used to describe the underlying background noise level of an environment since it inherently excludes the effects of transient noise sources.

Noise Rating (NR) Level

When describing noise from building services installations, it is common to express noise levels in terms of a Noise Rating (NR) Level. The NR level is determined by plotting the measured frequency spectrum of a noise against a series of reference curves, which roughly approximate to equal loudness values. This method permits higher sound levels at low frequencies corresponding to the sensitivity of the human ear. The NR level is defined as the value of the highest curve "touched" by the plotted frequency spectrum. For typical sources of building services noise, the overall A-weighted sound level is numerically around 5-6dB higher than the NR level of the noise.

Airborne Sound Insulation Measurement Parameters

The ability of a building element to reduce airborne noise can be described by a number of different parameters relevant to both laboratory and on-site performance evaluation. In general, the higher these values, the better the resistance of the construction to the transmission of airborne sound. The most commonly used parameters include:

R_w The **"Weighted Sound Reduction Index"** (R_w) is a single value measure of the intrinsic sound reduction capabilities of a construction, as measured in an acoustic laboratory. Measurement values are determined in accordance with the BS EN ISO 10140 series of standards and weighted in accordance with BS EN ISO 717-1: 2013.

R'_w The **"Weighted Apparent Sound Reduction Index"** (R'_w) is a single value measure of the apparent sound reduction capabilities of a construction, when installed on-site (which will normally be some way lower than the laboratory value due to less favourable installation conditions, the quality of workmanship, etc.). Measurement values are determined in accordance with the BS EN ISO 10140 series of standards and weighted in accordance with BS EN ISO 717-1: 2013. In practice, the R'_w of a construction can only be reliably determined if "direct" sound transfer through the partition can confidently be taken as the dominant noise transfer path (i.e. there is no "flanking" sound transmission.

D_w The **"Weighted Sound Level Difference"** (D_w) is a single value measure of the on-site sound reduction between two rooms. This value inherently includes "direct" sound transmission through any separating construction and "flanking" transmission through other building elements. Measurement values are determined in accordance with BS EN ISO 140-4: 1998 (for Building Regulations compliance purposes) or BS EN ISO 16283-1: 2014 and weighted in accordance with BS EN ISO 717-1: 2013.

$D_{n,fw}$ The "**Weighted Normalised Flanking Level Difference**" ($D_{nf,w}$) is a single figure measure of the sound reduction between two rooms solely due to sound transmission through a specified flanking path. This parameter is frequently used to provide an indication of the sound reduction capabilities of suspended ceiling and raised access floor constructions where there is common void between adjacent rooms or as a measure of sound that may be transmitted between rooms through external curtain walling. Measurements are undertaken in accordance with BS EN ISO 10848-2: 2017 and weighted in accordance with BS EN ISO 717-1: 2013.

Impact Sound Insulation Measurement Parameters

Some building elements also have the potential to generate "impact" noise, for example due to human "footfall" on floor structures, or the impact of rainfall on lightweight roofing components. A variety of parameters are again available to define the amount of noise likely to be generated. In general, the lower these values, the less sound the construction will generate as a result of impacts. Typical measurements parameters include:

$L_{nT,w}$ The "**Standardised Impact Sound Pressure Level**" is a "single number" rating describing the intrinsic impact sound insulation capabilities of a construction (such as a floor system) as measured in an acoustics laboratory. Values are determined in a vertical sound transmission suite by locating a "tapping machine" in the upper room of the suite and measuring the amount of sound radiated by the floor in the room below. Measurement values are determined in accordance with the BS EN ISO 10140 series of standards and weighted in accordance with BS EN ISO 717-2: 2013.

$L_{nf,w}$ The "**Normalised Flanking Impact Sound Pressure Level**" is a "single number" rating describing the amount of flanking sound that would be transmitted to an adjoining space (separated by a partition) due to impacts on the test sample. It is, for example, used to indicate the amount of noise that may be generated due to footfall noise on a raised access floor system. Values are determined in a horizontal sound transmission suite by locating a "tapping machine" one side of a separating partition built off the test sample and measuring the amount of noise radiated by the floor in the adjoining space on the other side of the partition. Measurement values are determined in accordance with BS EN ISO 10848-2: 2017 and weighted in accordance with BS EN ISO 717-2: 2013.

Room Acoustic Measurements

T The "**Reverberation Time**" (T) of a room is defined as the time taken for the sound energy produced by a source Time (RT)to decay by 60 dB after the source has been switched off. The reverberation time of a space can be calculated by considering the volume of the room and the areas and sound absorption qualities of room surface finishes. Small, "soft" rooms tend to give low reverberation times, whilst large, "hard" rooms tend to give long reverberation times.

α_p The "**Practical Acoustic Absorption Coefficient**" (α_p) is a measure of how much sound energy is absorbed by a building element at a particular frequency, as measured in accordance with BS EN ISO 354: 2003.

α_w The "**Weighted Absorption Coefficient**" (α_w) is a single figure measure of the overall sound absorption capabilities of a building element determined in accordance with BS EN ISO 11654: 1997.