ENVIRONMENTAL NOISE IMPACT ASSESSMENT

551-557 Finchley Road

Proposed Residential-led development

Produced by XCO2 for Hampstead Properties Ltd c/o Delta Properties

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EXECUTIVE SUMMARY

It is proposed to redevelop the existing building at 551-557 Finchley Road. The proposal is for the part change of use from Use Class E and F1 and remodelling of the existing building to provide residential apartments (C3) along with flexible commercial (Class E)/pub/wine bar/drinking establishments/pub with expanded food provision (Sui Generis) uses, alterations including partial demolition and extensions at the rear at lower ground, ground and first floor levels, extension to provide an additional storey at roof level, levelling of the lower ground floor level, remodelling and restoration of front façade, amenity space, cycle parking and all associated works (Site does not include 1st to 3rd floor of 551 Finchley Road).

An assessment is required of the acoustic suitability of the site for residential use, including outline acoustic specifications for the external building fabric and guidance on plant noise and sound insulation requirements between the commercial units and the apartments.

ENVIRONMENTAL NOISE ASSESSMENT

In order to reduce intrusive noise to acceptable levels inside the flats, glazing with an enhanced performance is required to windows overlooking Finchley Road, with attenuated mechanical ventilation also required on the first and second floors. The provision of background ventilation using acoustic trickle ventilators would be acceptable for rooms on the third and fourth floors. The required performance is given in Table 18 and Table 19 in the body of this report. Standard thermal double glazing and standard “non acoustic” trickle ventilators would be acceptable for windows on the rear façade.

PLANT NOISE GUIDANCE

Plant noise limits have been given to enable initial design work to commence. The limits are based on meeting London Borough of Camden’s requirements for noise from new services plant.

An initial calculation shows that, with appropriate attenuation (to be finalised during detailed design), the local authority’s usual criteria are achievable.

SOUND INSULATION BETWEEN PLANTROOMS AND APARTMENTS

Recommendations are given for the minimum sound insulation that should be provided between the plantrooms and adjacent dwellings to meet the requirements of Building Regulations Approved Document E and the recommendations in BS 8233:2014. Initial guidance has been provided for the control of plant vibration into the building structure.

SOUND INSULATION BETWEEN COMMERCIAL SPACES AND APARTMENTS

Recommendations are given for the minimum sound insulation that should be provided between the commercial units and adjacent bedrooms above to meet the requirements of Building Regulations Approved Document E and the recommendations in BS 8233:2014. Recommended limits have been given for noise within the commercial units that would provide reasonable noise levels in the dwellings.

INTRODUCTION

It is proposed to redevelop the existing building at 551-557 Finchley Road. The proposal is for part change of use from Use Class E and F1 and remodelling of the existing building to provide residential apartments (C3) along with flexible commercial (Class E)/pub/wine bar/drinking establishments Sui Generis) uses, alterations including partial demolition and extensions at the rear at lower ground, ground and first floor levels, extension to provide an additional storey at roof level, levelling of the lower ground floor level, remodelling and restoration of front façade, amenity space, cycle parking and all associated works (Site does not include 1st to 3rd floor of 551 Finchley Road).

SITE LOCATION

The site is located on the west side of Finchley Road, south of its junction with Fortune Green Road, within the London Borough of Camden (See Figure 1 below).

Figure 1: Site location image

PLANNING POLICIES

A great deal of change has occurred in recent years in the assessment of noise impacts and their relationship with planning decisions. The following sections introduce the applicable policies, either national or local, which ought to be considered to support the planning application. It should be highlighted that the assessment is mainly addressed to the local planning authority.

NOISE POLICY STATEMENT FOR ENGLAND

The Noise Policy Statement for England (NPSE[1]), published in March 2010, sets out the long-term vision of Government noise policy. The Noise Policy aims, as presented in this document, are: " *Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:*

- *avoid significant adverse effects on health and quality of life;*
- *mitigate and minimise adverse effects on health and quality of life; and*
- *where possible, contribute to the improvement of health and quality of life."*

The NPSE makes reference to the concepts of NOEL (No Observed Effect Level) and LOAEL (Lowest Observed Adverse Effect Level) as used in toxicology but applied to noise impacts. It also introduces the concept of SOAEL (Significant Observed Adverse Effect Level) which is described as the level above which significant adverse effects on health and quality of life occur.

The first aim of the NPSE is to avoid significant adverse effects, taking into account the guiding principles of sustainable development (as referenced in Section 1.8 of the NPSE). The second aim seeks to provide guidance on the situation that exists when the potential noise impact falls between the LOAEL and the SOAEL, in which case: *"...all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development."*

Importantly, the NPSE goes on to state that: " *This does not mean that such adverse effects cannot occur."*

The NPSE does not provide a noise-based measure to define SOAEL, acknowledging that the SOAEL is likely to vary depending on the noise source, the receptor and the time in question. NPSE advises that: *"Not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available."*

It is therefore likely that other guidance will need to be referenced when applying objective standards for the assessment of noise, particularly in reference to the SOAEL, whilst also taking into account the specific circumstances of a proposed development.

[1] Noise Policy Statement for England, Defra, March 2010

NATIONAL PLANNING POLICY FRAMEWORK

A new edition of NPPF was published in February 2019 and came into effect immediately. The original National Planning Policy Framework (NPPF[2]) was published in March 2012, with a revision in July 2018 - this document replaced the existing Planning Policy Guidance Note 24 (PPG 24) "Planning and Noise." The 2019 revised edition contains no new directions or guidance with respect to noise, and hence, all previous references remain extant. The paragraph references quoted below relate to the February 2019 edition.

Paragraph 170 of the NPPF states that the planning system should contribute to and enhance the natural and local environment by, (amongst others) *"preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, water or noise pollution or land stability."*

The NPPF goes on to state in Paragraph 180 "*planning policies and decisions 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 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 …*

The NPPF document does not refer to any other documents or British Standards regarding noise other than the NPSE.

Paragraph 2 of the NPPF states that "*planning law requires that applications for planning permission must be determined in accordance with the development plan unless material considerations indicate otherwise."*

Paragraph 12 of the NPPF states that "The presumption in favour of sustainable development does not change the statutory status of the development plan as the starting point for decision making. Where a planning application conflicts with an up-to-date development plan (including any neighbourhood plans that form part of the development plan), permission should not usually be granted. Local planning authorities may take decisions that depart from an up-to-date development plan, but only if material considerations in a particular case indicate that the plan should not be followed*"*

Paragraph 117 states that *"Planning policies and decisions should promote an effective use of land in meeting the need for homes and other uses, while safeguarding and improving the environment and ensuring safe and healthy living conditions. Strategic policies should set out a clear strategy for accommodating objectively assessed needs, in a way that makes as much use as possible of previously-developed or 'brownfield' land.*

[2] National Planning Policy Framework, DCLG, March 2012

PLANNING PRACTICE GUIDANCE – NOISE

An updated Planning Practice Guidance (PPG[3]) for noise was published on 22 July 2019 and provides additional guidance and elaboration on the NPPF. It advises that when plan-making and decision-taking, the Local Planning Authority should consider the acoustic environment in relation to:

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

This guidance introduced the concepts of NOAEL (No Observed Adverse Effect Level), and UAEL (Unacceptable Adverse Effect Level). NOAEL differs from NOEL in that it represents a situation where the acoustic character of an area can be slightly affected (but not such that there is a perceived change in the quality of life). UAEL represents a situation where noise is 'very disruptive' and should be 'prevented' (as opposed to SOAEL, which represents a situation where noise is 'disruptive', and should be 'avoided').

As exposure increases above the LOAEL, the noise begins to have an adverse effect and consideration needs to be given to mitigating and minimising those effects, taking account of the economic and social benefits being derived from the activity causing the noise. As the noise exposure increases, it will then at some point cross the SOAEL boundary.

The LOAEL is described in PPG[4] as the level above which "noise starts to cause small changes in behaviour and attitude, for example, having to turn up the volume on the television or needing to speak more loudly to be heard".

PPG identifies the SOAEL as the level above which "noise causes a material change in behaviour such as keeping windows closed for most of the time or avoiding certain activities during periods when the noise is present."

In line with the Explanatory Note of the NPSE, the PPG goes on to reference the LOAEL and SOAEL in relation to noise impact. It also provides examples of outcomes that could be expected for a given perception level of noise, plus actions that may be required to bring about a desired outcome. However, in line with the NPSE, no objective noise levels are provided for LOAEL or SOAEL although the PPG[5] acknowledges that "…the subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation."

The relevant guidance in the PPG in relation to the adverse effect levels is summarized in Table 1.

[3] Planning Practice Guidance – Noise, https://www.gov.uk/guidance/noise--2, 22 July 2019
[4] Paragraph: 005 Reference ID: 30-005-20190722
[5] Paragraph: 006 Reference ID: 30-006-20190722

Table 1. PPG guidance on adverse effect levels

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

The Planning Practice Guidance[6] states the following in relation to mitigation measures:

"For noise sensitive developments, mitigation measures can include avoiding noisy locations in the first place; designing the development to reduce the impact of noise from adjoining activities or the local environment; incorporating noise barriers; and optimising the sound insulation provided by the building envelope."

[6] Paragraph: 010 Reference ID: 30-010-20190722

In addition, the Guide notes that it may also be relevant to consider[7]:

"... whether any adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time (and the effect this may have on living conditions). In both cases a suitable alternative means of ventilation is likely to be necessary. Further information on ventilation can be found in the Building Regulations".

THE LONDON PLAN 2016

The London Plan 2016 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. London Plan's Policy 7.15 states the following:

STRATEGIC

The transport, spatial and design policies of this plan will be implemented in order to reduce and manage noise to improve health and quality of life and support the objectives of the Mayor's Ambient Noise Strategy.

PLANNING DECISIONS

Development proposals should seek to manage 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.*

LOCAL DEVELOPMENT FRAMEWORK PREPARATION

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*[1].

[7] Paragraph: 006 Reference ID: 30-006-20190722

NEW LONDON PLAN

An “Intend to publish” version of The London Plan was published in December 2019.

The intent of The London Plan is to set out “an integrated economic, environmental, transport and social framework for the development of London over the next 20-25 years”.

Policy D3 Optimising site capacity through the design-led approach requires that:

B Development proposals should: ...

9) help prevent or mitigate the impacts of noise and poor air quality

Policy D13 Agent of Change requires that:

A The Agent of Change principle places the responsibility for mitigating impacts from existing noise and other nuisance-generating activities or uses on the proposed new noise-sensitive development. Boroughs should ensure that Development Plans and planning decisions reflect the Agent of Change principle and take account of existing noise and other nuisance-generating uses in a sensitive manner when new development is proposed nearby.

B Development should be designed to ensure that established noise and other nuisance-generating uses remain viable and can continue or grow without unreasonable restrictions being placed on them.

C New noise and other nuisance-generating development proposed close to residential and other noise-sensitive uses should put in place measures to mitigate and manage any noise impacts for neighbouring residents and businesses.

D Development proposals should manage noise and other potential nuisances by:
1) ensuring good design mitigates and minimises existing and potential nuisances generated by existing uses and activities located in the area
2) exploring mitigation measures early in the design stage, with necessary and appropriate provisions including ongoing and future management of mitigation measures secured through planning obligations
3) separating new noise-sensitive development where possible from existing noise-generating businesses and uses through distance, screening, internal layout, sound-proofing, insulation and other acoustic design measures.

E Boroughs should not normally permit development proposals that have not clearly demonstrated how noise and other nuisances will be mitigated and managed.

Policy D14 *Noise* states:

A In order to reduce, manage and mitigate noise to improve health and quality of life, residential and other non-aviation development proposals should manage noise by:
1) avoiding significant adverse noise impacts on health and quality of life
2) reflecting the Agent of Change principle as set out in Policy D13 Agent of Change
3) mitigating and minimising the existing and potential adverse impacts of noise on, from, within, as a result of, or in the vicinity of new development without placing unreasonable restrictions on existing noise-generating uses
4) Improving and enhancing the acoustic environment and promoting appropriate soundscapes (including Quiet Areas and spaces of relative tranquillity)

5) separating new noise-sensitive development from major noise sources (such as road, rail, air transport and some types of industrial use) through the use of distance, screening, layout orientation, uses and materials – in preference to sole reliance on sound insulation
6) where it is not possible to achieve separation of noise-sensitive development and noise sources without undue impact on other sustainable development objectives, then any potential adverse effects should be controlled and mitigated through applying good acoustic design principles
7) promoting new technologies and improved practices to reduce noise at source, and on the transmission path from source to receiver.

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

The narrative to Policy D14 includes the advice[8] that:

The management of noise also includes promoting good acoustic design of the inside of buildings. Section 5 of BS 8233:2014 provides guidance on how best to achieve this. The Institute of Acoustics has produced advice Pro:PG Planning and Noise (May 2017) that may assist with the implementation of residential developments. BS 4142 provides guidance on monitoring noise issues in mixed residential/industrial areas.

BRITISH STANDARD 8233: 2014

This report has been commissioned to recommend measures to be taken so as to ensure that reasonable standards of peace and quiet are achieved within the dwellings when constructed.

This has been achieved by measuring the existing sound levels on the site and then considering the amount of sound insulation required of the building envelope so as to ensure that target noise levels within the residential flats are achieved. This is based on the guidance set out within BS 8233: 2014 "British Standard Code of practice for Sound insulation and noise reduction for buildings", which states that:

This British Standard provides guidance for the control of noise in and around buildings. It is applicable to the design of new buildings, or refurbished buildings undergoing a change of use, but does not provide guidance on assessing the effects of changes in the external noise levels to occupants of an existing building.
This British Standard does not cover:
a) Specialist applications, such as auditoria and cinemas (for cinemas, see BS ISO 9568);
b) Vibration control, except where it is evident in the form of radiate sound; or
c) Noise that breaks out from the building that might affect external receptors.

[8] Paragraph 3.14.3, The London Plan (Intend to publish), December 2019

BS 4142:2014 METHODS FOR RATING AND ASSESSING INDUSTRIAL AND COMMERCIAL SOUND

The method employed for assessing the likelihood of noise impact from the unit at the nearest noise-sensitive receptors (as identified above) is a standard method laid out in BS 4142: 2014: "Methods for rating and assessing industrial and commercial sound".

This British Standard describes a methodology to be exercised on the outside of a building for determining:

a. *Sound levels from factories, industrial premises or fixed installations and sources of an industrial nature in commercial premises; and*
b. *Background sound level.*

This standard also describes a method for assessing the impact of the sound referred to within (a) on the nearby residents. The likelihood of sound provoking complaints depends on its level relative to the background sound level and whether or not it has certain tonal or impulsive audible characteristics, such as a distinctive whine, bangs, thumps or clatters. Such sounds are assumed to increase the sound depending how perceptible these sounds are. BS 4142 states that Reference to paragraph 11 "Assessment of the impacts" gives the following conclusion:

a. *Typically, the greater this difference, the greater the magnitude of the impact.*
b. *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*
c. *A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.*
d. *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.*

The standard states that a sound 10 dB or greater than background sound would be likely to be an indication of a significant adverse impact. Around 5 dB would be an adverse impact, whereas a sound equal to background would be a low impact.

Section 8 of BS 4142: 2014 states,

8.1 In using the background sound level in the method for rating and assessing industrial and commercial sound it is important to ensure that values are reliable and suitably represent both the particular circumstances and periods of interest. For this purposes, the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods …
Since the intention is to determine a background sound level in the absence of the specific sound that is under consideration, it is necessary to understand that the background sound level can in some circumstances legitimately include industrial and/or commercial sounds that are present as separate to the specific sound…
8.1.4 The monitoring duration should reflect the range of background sound levels for the period being assessed. In practice, there is no "single" background sound level as this is a fluctuating parameter. However, the background sound level used for the assessment should be representative of the period being assessed.
… A representative level ought to account for the range of background sound levels and ought not automatically to be assumed to be either the minimum or modal value."

LONDON BOROUGH OF CAMDEN

Section 6 of the Camden Planning Guidance Amenity, published March 2018, gives guidance on noise and vibration.

Clause 6.8 refers noise thresholds within Appendix 3 of the Local Plan and to refers to the principles of No observed effect level (NOEL), Lowest observable adverse effect level (LOAEL) and Significant observed adverse effect level (SOAEL) and defines their meanings. Specifically, in the context of this report, LOAEL is defined as:

The level above which changes in behaviour (e.g. closing windows for periods of the day) and adverse effects on health (e.g. sleep disturbance) and quality of life can be detected.

SOEAL is defined as:

The level above which adverse effects on health and quality of life occur. This could include psychological stress, regular sleep deprivation and loss of appetite.

Appendix 3 within the Camden Local Plan published 2017 includes thresholds for noise assessments.

Table B of the Appendix sets out suitable noise levels for residential development, as shown below:

Table 2: Camden Council criteria table "Noise levels applicable to noise sensitive residential development proposed in areas of existing noise.

Dominant noise source	Assessment Location	Design Period	LOAEL (green)	LOAEL to SOAEL (Amber)	SOAL (Red)
Anonymous noise such as general environmental noise, road traffic and rail traffic	Noise at 1 metre from noise sensitive façade / free field	Day	<50 dB $L_{Aeq, 16hr}$*	50 to 72dB $L_{Aeq\ 16hr}$	>72dB $L_{Aeq,16hr}$
		Night	<45dB $L_{Aeq, 8hr}$ <40dB $L_{Amax, fast}$**	45 to 62dB $L_{Aeq, 8hr}$* >40 dB L_{night}**	>62dB $L_{Aeq, 8hr}$
	Inside a bedroom	Day	<35 dB $L_{Aeq, 16hr}$	35 to 45dB $L_{Aeq\ 16hr}$	>45dB $L_{Aeq,16hr}$
		Night	<30dB $L_{Aeq, 8hr}$ 42dB $L_{Amax, fast}$	30 to 40dB $L_{Aeq, 8hr}$ 40[9] to 73dB $L_{AMax, fast}$	>40dB $L_{Aeq, 8hr}$ >73dB $L_{AMax, fast}$
	Outdoor living space (free field)	Day	<50dB $L_{Aeq,16hr}$	50 to 55 dB $L_{Aeq, 16hr}$	>55 dB $L_{Aeq, 16hr}$
Non-anonymous noise	See guidance note on non-anonymous noise				

$L_{Aeq,T}$ values specified for outside a bedroom window are façade levels
**L_{night} values specified for outside a bedroom window are free field*

For plant noise, Appendix 3 says:

[9] This is assumed to be a typographical error in the Camden document and it is assumed should read "42 to 73dB"

A relevant standard or guidance document should be referenced when determining values for LOAEL and SOAEL for non-anonymous noise. Where appropriate and within the scope of the document it is expected that British Standard 4142:2014 'Methods for rating and assessing industrial and commercial sound' (BS 4142) will be used. For such cases a 'Rating Level' of 10 dB below background (15dB if tonal components are present) should be considered as the design criterion).

Table C of the appendix states the criteria at which development related noise levels will be acceptable:

Table 3: Camden Council criteria table

Existing Noise sensitive receptor	Assessment Location	Design Period	LOAEL (green)	LOAEL to SOAEL (Amber)	SOAL (Red)
Dwellings**	Garden used for main amenity (free field) and Outside living or dining or bedroom window (façade)	Day	'Rating level' 10dB* below background	'Rating level' between 9dB below and 5dB above background	'Rating level' greater than 5dB above background
Dwellings**	Outside bedroom window (façade)	Night	'Rating level' 10dB* below background and no events exceeding 57dBLAmax	'Rating level' between 9dB below and 5dB above background or noise events between 57dB and 88dBLAmax	'Rating level' greater than 5dB above background and/or events exceeding 88dBLAmax

**10dB should be increased to 15dB if the noise contains audible tonal elements (day and night). However, if it can be demonstrated that there is no significant difference in the character of the residual background noise and the specific noise from the proposed development then this reduction may not be required. In addition, a frequency analysis (to include, the use of Noise Rating (NR) curves or other criteria curves) for the assessment of tonal or low frequency noise may be required.*
***levels given are for dwellings, however, levels are use specific and different levels will apply dependent on the use of the premises.*

DESIGN NOISE LEVELS

INSTITUTE OF ACOUSTICS PROFESSIONAL PRACTICE GUIDANCE

The Institute of Acoustics published a guidance document for new residential development in May 2017, in conjunction with the ANC and the Chartered Institute of Environmental Health, "*to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England*". While this guidance is specifically for new residential developments it is generally used to inform designs for hotels and similar accommodation which are sensitive to intrusive noise in the same way as dwellings.

The document advocates a two-stage process for consideration of noise affecting new residential developments. Stage 1 is an initial risk assessment of the proposed development site, based on the ambient noise levels in the area. Stage 2 recommends consideration of four main elements:

- demonstration of a "good acoustic design process"
- observation of internal noise guidelines
- an assessment of noise affecting external amenity areas
- consideration of other relevant issues

The initial risk assessment considers the indicative day-time and night-time equivalent continuous noise levels which indicates an "increasing risk of adverse effect" with increasing noise levels[10].

For Stage 2, the ProPG document recommends that the guidance in BS 8233:2014 is followed.

Noise control in and around buildings is discussed in the British Standard guides on an objective and quantifiable basis. The guides suggest criteria, such as suitable sleeping/resting conditions, and propose noise levels that normally satisfy these criteria for most people.

BS 8233:2014 GUIDANCE ON SOUND INSULATION AND NOISE REDUCTION FOR BUILDINGS

This Standard provides recommended guideline values for internal noise levels within dwellings which are similar in scope to guideline values contained within the World Health Organisation (WHO) document, Guidelines for Community Noise (1999[11]). These guideline noise levels are shown in Table 4, below:

Table 4. BS 8233 Desirable Internal Ambient Noise Levels for Dwellings

Activity	Location	07:00 to 23:00 hours	23:00 to 07:00 hours
Resting	Living room	35 dB $L_{Aeq,16h}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16h}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16h}$	30 dB $L_{Aeq,8h}$

[10] Figure 1, IoA ProPG for New Residential Development, May 2017
[11] World Health Organisation Guidelines for Community Noise, 1999

BS 8233:2014 advises that: "regular individual noise events…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." The assessment of individual noise events during the night-time may only be considered necessary for intermittent environmental sources such as aircraft of train pass-bys for which there is research available to assist with the quantification of the impact.

The standard also provides advice in relation to design criteria for external noise. It states that:

"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.

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."

WORLD HEALTH ORGANISATION, GUIDELINES FOR COMMUNITY NOISE, 1999 (WHO)

The World Health Organisation (WHO) Guidelines for Community Noise (1999) recommends suitable internal and external noise levels based on dose response research. The levels recommended in this guidance could be correlated to the LOAEL. Relevant guidance from this document is presented below:

SLEEP DISTURBANCE (NIGHT-TIME INTERNAL LOAEL)

If negative effects on sleep are to be avoided, the equivalent sound pressure level should not exceed 30 dBA indoors for continuous noise.

INTERFERENCE WITH COMMUNICATION (DAYTIME INTERNAL LOAEL)

Noise tends to interfere with auditory communication, in which speech is a most important signal. However, it is also vital to be able to hear alarming and informative signals such as door bells, telephone signals, alarm clocks, fire alarms etc., as well as sounds and signals involved in occupational tasks. The effects of noise on speech discrimination have been studied extensively and deal with this problem in lexical terms (mostly words but also sentences). For

communication distances beyond a few metres, speech interference starts at sound pressure levels below 50 dB for octave bands centred on the main speech frequencies at 500, 1,000 and 2,000 Hz. It is usually possible to express the relationship between noise levels and speech intelligibility in a single diagram, based on the following assumptions and empirical observations, and for speaker-to-listener distance of about 1 metre:

- *Speech in relaxed conversation is 100% intelligible in background noise levels of about 35 dBA, and can be understood fairly well in background levels of 45 dBA.*
- *Speech with more vocal effort can be understood when the background sound pressure level is about 65 dBA.*

ANNOYANCE RESPONSES (DAYTIME EXTERNAL LOAEL FOR PRIVATE AMENITY AREAS)

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

THE NOISE INSULATION REGULATIONS 1975

The Noise Insulation Regulations 1975 define the conditions under which dwellings are eligible for noise insulation to control internal noise levels. The conditions relate to the level of traffic noise at the façade, the increase in noise levels as a result of the highway and the contribution of the new or altered scheme to the noise level received at the façade.

Noise insulation qualification criteria must abide by a few tests which include the following two:

- The facade noise threshold of 68dB $L_{A10\ 18h}$ is met or exceeded;
- That there must be a noise increase of at least 1dB(A) compared to the prevailing noise level immediately before the construction of a highway or an additional carriageway were begun;

SOAELS FOR TRANSPORTATION AIRBORNE NOISE

Based on the noise insulation regulations a façade noise level of 69dB $L_{A10,\ 18h}$ is therefore considered as unacceptable and can trigger the provision of mitigation measures by the government. This level can therefore be used as the SOAEL in relation to transportation noise in England. This level relates to a level of 64 dB $L_{Aeq,\ 16h}$. Based on guidance[12] in BS8233:2014, an external noise level of 64 dB $L_{Aeq,\ 16h}$ would roughly equate to an internal level of 49 dB $L_{Aeq\ 16h}$, assuming partially open windows for ventilation. As daytime and night-time desirable target levels differ by 5 dB, a night-time SOAEL could be 44 dB $L_{Aeq,\ 8h}$. It should be noted that these internal SOAEL values may be deemed pessimistic since partially open windows for background ventilation do not offer compliance with the relevant building regulations.

[12] BS8233:2014 states that "If partially open windows were relied upon for background ventilation, the insulation would be reduced to approximately 15 dB"

PROPOSED LOAEL AND SOAEL FOR TRANSPORTATION AIRBORNE NOISE AFFECTING ROOMS USED FOR RESIDENTIAL PURPOSES.

A summary of the proposed LOAEL and SOAEL values are provided in Table 5 below. It should be highlighted that the Secretary of State's approved assessment methodology for the HS2 project includes a SOAEL of 65 dB $L_{Aeq,16h}$. The HS2 project also includes a LOAEL of 50 dB $L_{Aeq,16h.}$ Therefore, the difference between the LOAEL and SOAEL for transportation noise in the secretary of state's approved HS2's environmental statement is 15dB.

Table 5. Proposed LOAEL and SOAEL for transportation noise affecting dwellings

Level	Daytime (07:00 hours to 23:00 hours)	Night-time (23:00 hours to 07:00 hours)
LOAEL Internal	35 $L_{Aeq,16h}$ (dB)	30 $L_{Aeq,8h}$ (dB)
SOAEL Internal	49 $L_{Aeq,16h}$ (dB)	44 $L_{Aeq,8h}$ (dB)
LOAEL External	50 $L_{Aeq,16h}$ (dB)	40 $L_{Aeq,8h}$ (dB)
SOAEL External	65 $L_{Aeq,16h}$ (dB)	55 $L_{Aeq,8h}$ (dB)

The LOAEL and SOAEL values above are related to the first two aims in Paragraph 123 of the NPPF.

BUILDING REGULATIONS

Part L of the Building Regulations mandates that buildings become more airtight, and Part F stipulates ventilation requirements. Even though there appears to be a contradiction in this, Part L limits uncontrollable ventilation, and while Part F ensures that ventilation requirements are provided in a controlled manner.

VENTILATION REQUIREMENTS FOR HABITABLE ROOMS

Background ventilation

Three types of ventilation are required under Part F. Whole building ventilation provides nominally continuous air exchange which may be reduced or ceased when the building is not occupied. It can be provided via background ventilators operating alone, or together with:

- passive stack ventilators;
- continuous mechanical extract; or
- continuous mechanical supply and extract with heat recovery.

Extract ventilation is applicable to rooms where most water vapour and/or pollutants are released (e.g. kitchens and bathrooms). It can be provided by intermittent fans, passive stack or continuous mechanical extract with or without mechanical supply and heat recovery.

The four systems described in Part F do not present solutions which utilise the use of opening windows for background ventilation. Opening windows do not provide a controllable means of ventilation and also pose security risks. Therefore, it is not possible to offer to the market a residential dwelling which utilises opening windows for background ventilation.

Purge ventilation

Purge ventilation is required throughout the building to aid the removal of high concentrations of pollutants and water vapour. It is commonly provided simply by opening windows and doors.

Even though purge ventilation is recommended via opening windows, the temporary and intermittent occurrence of this does not normally result in an unacceptable increase of internal noise levels.

Part F goes on to say[13] that "*Purge ventilation provisions may also be used to improve thermal comfort, although this is not controlled under the Building Regulations*."

SUMMARY IN RELATION TO VENTILATION

In summary, background ventilation for new residential dwellings should be provided via one of the four systems in Approved Document F. The composite external building fabric should be designed to ensure that appropriate internal noise levels due to external incident noise are met during background ventilation. This can be secured via a planning condition if deemed necessary.

Purge ventilation for new residential dwellings should be provided via open windows. The slight increase of internal noise levels should be considered acceptable.

SOUND INSULATION CRITERIA

Airborne noise from the non-residential spaces to the apartments bedrooms must be controlled in order to meet the statutory requirements in the current Building Regulations. In addition, it is recommended that guidance values in BS 8233:2014 are also met or exceeded.

BUILDING REGULATIONS APPROVED DOCUMENT E

The building regulations Approved Document E *Resistance to the passage of sound* gives minimum acoustic performance requirements for separating walls and floors between dwellings and other spaces within the same building.

For a new-build development, the airborne sound insulation provided by any separating floor must be at least 45 dB $D_{nT,w} + C_{tr}$. For any separating wall, the requirement is a sound insulation of at least 45 dB $D_{nT,w} + C_{tr}$. For dwellings formed by a material change of use, the requirement for separating walls and floors is a sound insulation of at least 43 dB $D_{nT,w} + C_{tr}$.

BS 8233:2014 GUIDANCE ON SOUND INSULATION AND NOISE REDUCTION FOR BUILDINGS

The requirements of Approved Document E are intended for use in residential and mixed-use buildings where noise levels are not expected to be high. Where such a situation occurs, additional guidance is taken from section 7.5 in BS 8233:2014.

[13] Paragraph 4.15 in Approved Document F

This states:

... sound from adjacent spaces can affect the intended use, depending on the noise activity, noise sensitivity and privacy requirement. A matrix may be used to determine the sound insulation requirement of separating partitions once the noise activity, noise sensitivity and privacy requirements for each room and space. An example matrix, which can be adapted according to the specific building use, is given in [BS 8223] Table 3. Each room may be both a source and a receiving room. Where adjacent rooms have different uses, the worst-case sound insulation should be specified.

Table 3 **Example on-site sound insulation matrix (dB $D_{nT,w}$)**

Privacy requirement	Activity noise of source room	Noise sensitivity of receiving rooms		
		Low sensitivity	Medium sensitivity	Sensitive
Confidential	Very high	47	52	57 A)
	High	47	47	52
	Typical	47	47	47
	Low	42	42	47
Moderate	Very high	47	52	57 A)
	High	37	42	47
	Typical	37	37	42
	Low	No rating	No rating	37
Not private	Very high	47	52	57 A)
	High	37	42	47
	Typical	No rating	37	42
	Low	No rating	No rating	37

*NOTE Background noise can also influence privacy. See also **7.7.6.3**.*

A) $D_{nT,w}$ 55 dB or greater is difficult to obtain on site and room adjacencies requiring these levels should be avoided wherever practical.

The commercial demises within the development are on the ground and lower ground floors, and may include a pub/wine bar or similar. In addition, there are plantrooms on the lower ground floor, and on the fourth floor.

There is an element of professional judgment to be made when categorising the room activity noise level, required privacy and noise-sensitivity. This is described in more detail in the sections on ***Sound Insulation Between plantrooms and dwellings*** and ***Sound Insulation Between Commercial spaces and bedrooms*** later in this report.

MEASUREMENT OF NOISE LEVELS

The following section describes the methodology undertaken in order to establish the environmental noise levels around the site.

DETAILS OF ENVIRONMENTAL SOUND SURVEYS

INITIAL SOUND SURVEY

Continuous measurements of the incident sound pressure levels at the site were undertaken from 14.40 hours on Monday 11th November to 09.45 hours on Tuesday 12th November 2019. The sound level meter was programmed to record the A-weighted L_{eq}, L_{90}, L_{10} and L_{max} noise indices and corresponding octave band frequency information (for L_{eq}) for consecutive sample periods for the duration of the survey. A measurement interval of 5 minutes was used to discriminate for the effect of existing plant in the area.

MEASUREMENT POSITION

The measurement of incident sound levels was undertaken at the approximate location in the aerial photograph below and Table 6 describes the measurement position. In accordance with BS 7445-2:1991 'Description and measurement of environmental noise – Part 2: Guide to the acquisition of data pertinent to land use', the measurements were undertaken under free-field conditions.

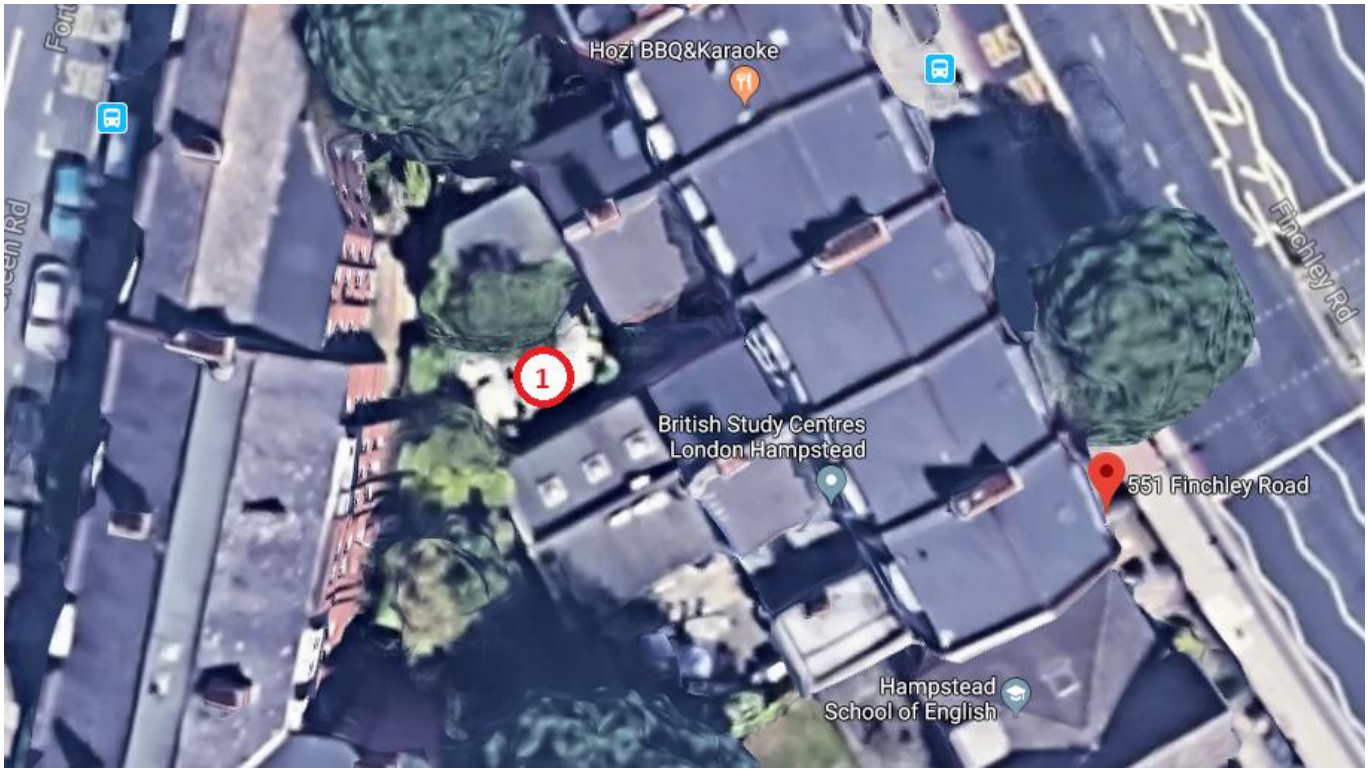


Figure 2: On site sound pressure level measurement positions (initial survey)

Table 6. Description of measurement position (initial survey)

Position	Description
1	Within courtyard at rear of premises

EQUIPMENT

Details of the equipment used during the survey are provided in Table 7 below. The sound level meters were calibrated before and after the survey; no significant change (+/-0.2 dB) in the calibration level was noted.

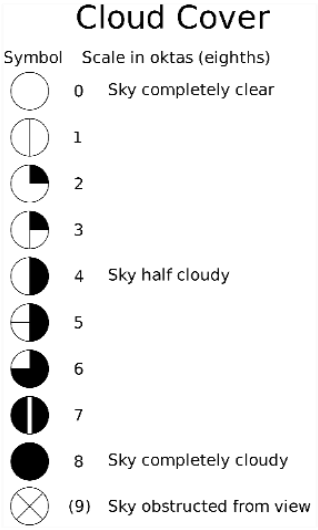
Table 7. On site instrumentation (initial survey)

Position	Description	Model / serial no.	Calibration date	Calibration certificate no.
1	Class 1 Sound level meter	Rion NL-52 / 00654035	29/05/2019	UCRT19/1634
	Condenser microphone	Rion UC-59 /08290		
	Preamplifier	Rion NH-25 / 54080		
	Calibrator	Rion NC-74 /34535932	24/05/2019	TCRT19/1409

WEATHER CONDITIONS

Weather conditions were determined both at the start and on completion of the survey. It is considered that the meteorological conditions were appropriate for environmental noise measurements. Table 8 presents the weather conditions recorded on site at the beginning and end of the survey.

Table 8. Weather Conditions (initial survey)

Date/Time	Description	Beginning of Survey	End of Survey
14.40 11 Nov – 09.45 12 Nov 2019	Temperature (°C)	10	7
	Precipitation:	No	No
	Cloud cover (oktas - see guide)	7	2
	Presence of fog/snow/ice	No	No
	Presence of damp roads/wet ground	No	No
	Wind Speed (m/s)	2	3
	Wind Direction	E	E
	Conditions that may cause temperature inversion (i.e. calm nights with no cloud)	No	No

RESULTS

Noise levels were observed to be predominantly due to road traffic and intermittent services plant, with voices and aircraft also audible.

MEASURED NOISE LEVELS

The time history of the main sound pressure level indices recorded are presented in Appendix B. The relevant results of the survey have been summarised in Table 9.

Table 9. Summary of survey results (free field levels) (initial survey)

Position	Measurement period	Range of recorded sound pressure levels (dB)			
		$L_{Amax,5min}$	$L_{Aeq,\ 5\ min}$	$L_{A10,\ 5\ min}$	$L_{A90,\ 5\ min}$
1, Rear of premises	Daytime (07.00 – 23.00 hours)	51-86	46-67	48-70	42-53
	Night-time (23.00 – 07.00 hours)	46-76	42-53	43-54	38-52

ADDITIONAL SOUND SURVEY

Continuous measurements of the incident sound pressure levels (at 2 locations) at the site were undertaken between 15.45 hours on Monday 7th September and 16.45 hours on Tuesday 8th September 2020. The sound level meters were

programmed to record the A-weighted L_{eq}, L_{90}, L_{10} and L_{max} noise indices and corresponding octave band frequency information (for L_{eq} and L_{max}) for consecutive sample periods for the duration of the survey.

MEASUREMENT POSITIONS

The measurements of incident sound levels were undertaken at two locations. The approximate locations of the sound level meters are indicated in the aerial photograph below and Table 10 describes the two measurement positions.

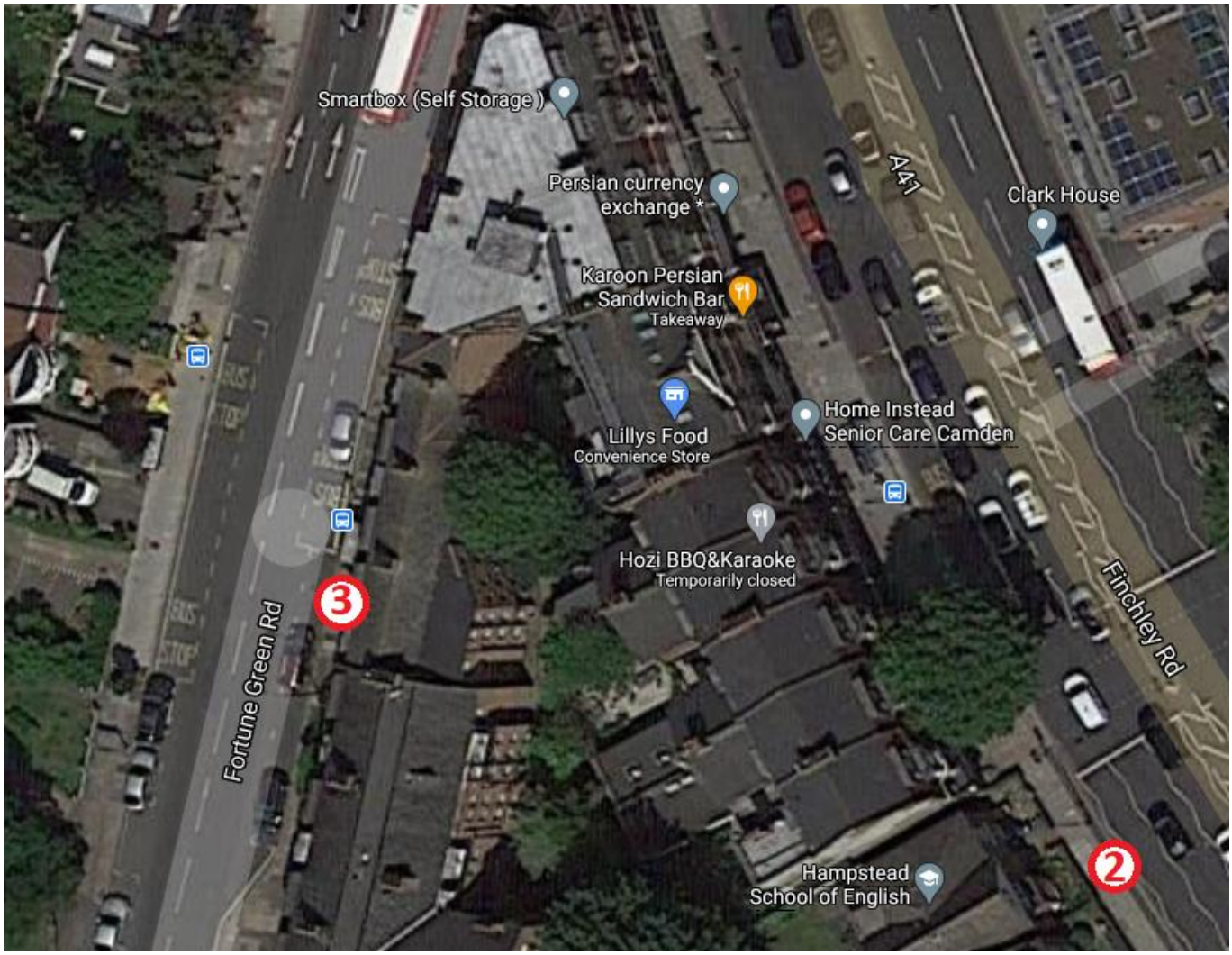


Figure 3: On site sound pressure level measurement positions (additional survey)

Table 10. Description of measurement positions (additional survey)

Position	Description
2	Lamp-post on Finchley Road
3	Lamp-post on Fortune Green Road

EQUIPMENT

Details of the equipment used during the survey are provided in Table 11 below. The sound level meters were calibrated before and after the survey; no significant change (+/-0.2 dB) in the calibration level was noted.

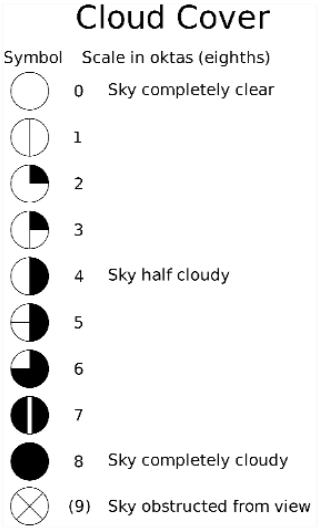
Table 11. On site instrumentation (additional survey)

Position	Description	Model / serial no.	Calibration date	Calibration certificate no.
2	Class 1 Sound level meter	Svantek 977 / 36190	16/07/2020	TCRT20/1383
	Condenser microphone	ACO Pacific 7052E / 57366		
	Preamplifier	Svantek SV12L / 41504		
	Calibrator	Svantek SV33A / 73430	15/07/2020	TCRT/1380
3	Class 1 Sound level meter	Svantek 949 / 12262	12/04/2019	TCRT19/1290
	Condenser microphone	MCE212 / 42528		
	Preamplifier	Svantek SV12L / 13163		
	Calibrator	Svantek SV 30A / 10847	15/07/2020	TCRT20/1381

WEATHER CONDITIONS

Weather conditions were determined both at the start and on completion of the survey. It is considered that the meteorological conditions were appropriate for environmental noise measurements. Table 12 presents the weather conditions recorded on site at the beginning and end of the survey.

Table 12. Weather Conditions (additional survey)

Date/Time	Description	Beginning of Survey	End of Survey
15.45 7 Sep 20 to 16.45 8 Sep 20	Temperature (°C)	22	26
	Precipitation:	No	No
	Cloud cover (oktas - see guide)	7	6
	Presence of fog/snow/ice	No	No
	Presence of damp roads/wet ground	No	No
	Wind Speed (m/s)	<1	1
	Wind Direction	S	SE
	Conditions that may cause temperature inversion (i.e. calm nights with no cloud)	No	No

*no influence in the conclusions of the assessment

RESULTS

At both positions, the main source of noise was local road traffic.

EXTERIOR NOISE LEVELS

The single figure free field noise indices recorded are presented in tabular format within Appendix B. The relevant results of the survey have been summarised in Table 13.

Table 13. Summary of survey results (free field levels) (additional survey)

Position	Measurement period	Range of recorded sound pressure levels (dB)			
		$L_{Amax, T}$	$L_{Aeq, T}$	$L_{A10, T}$	$L_{A90, T}$
2 Finchley Road	Daytime (07.00 – 23.00 hours)	80 - 102	71 - 77	75 - 80	59 - 67
	Night-time (23.00 – 07.00 hours)	79 - 100	66 - 75	70 - 77	41 - 65
3 Fortune Green Road	Daytime (07.00 – 23.00 hours)	76 - 98	63 - 72	67 - 71	45 - 60
	Night-time (23.00 – 07.00 hours)	72 - 95	52 - 69	53 - 70	37 - 53

Table 14 below presents the incident free field noise levels at the measurement positions in terms of daytime and night-time levels measured during the monitoring period at the two locations

Table 14. Daytime and night-time equivalent levels (free field levels) (additional survey)

Measurement Period		Free field sound pressure levels (dB)	
		Position 2	Position 3
7 September (day)*	$L_{Aeq,T}$	74	66
7-8 September (night)	$L_{Aeq\ (8\ hours)}$	70	61
8 September (day)*	$L_{Aeq,T}$	74	67
Overall – day	**$L_{Aeq,T}$**	**74**	**66**
Overall - night	**$L_{Aeq,T}$**	**70**	**61**

*not complete 16 hour measurements.

SOUND LEVELS USED IN ASSESSMENT

The data from the two surveys have been used to predict the noise levels incident at the front (Finchley Road) and rear façades, based on the octave band sound pressure levels measured at the survey locations and corrected for distance and, in the case of the rear façade, buildings between the site and the survey location.

Table 15. Summary of free field facade incident environmental noise levels at octave band centre frequencies.

Façade	Period	Incident free field sound pressure levels (dB) at Octave Band Centre Frequencies (Hz)								dB(A)
		63	125	250	500	1000	2000	4000	8000	
Front 1st and 2nd Floors	Daytime $L_{eq,\ 16\ hours}$	72	70	67	65	68	63	56	52	71
	Night-time $L_{eq,8\ hours}$	65	62	62	61	64	60	51	43	67
	Typical Night-time L_{Max}	75	77	71	70	70	67	59	60	74
Front 3rd and 4th Floors	Daytime $L_{eq,\ 16\ hours}$	71	69	66	64	67	62	55	51	70
	Night-time $L_{eq,8\ hours}$	64	61	61	60	63	59	50	42	66
	Typical Night-time L_{Max}	71	73	67	66	66	63	55	56	70
Rear	Daytime $L_{eq,\ 16\ hours}$	59	53	51	50	51	47	41	37	54
	Night-time $L_{eq,8\ hours}$	52	45	45	45	46	42	34	27	49
	Typical Night-time L_{Max}	72	63	70	63	63	57	55	48	67

BACKGROUND SOUND LEVELS

The initial noise survey data has been analysed to determine representative background sound levels at the nearest noise-sensitive receptors. The statistical distributions of daytime and night-time background sound levels are shown in Figure 4 and Figure 5 and Table 16.

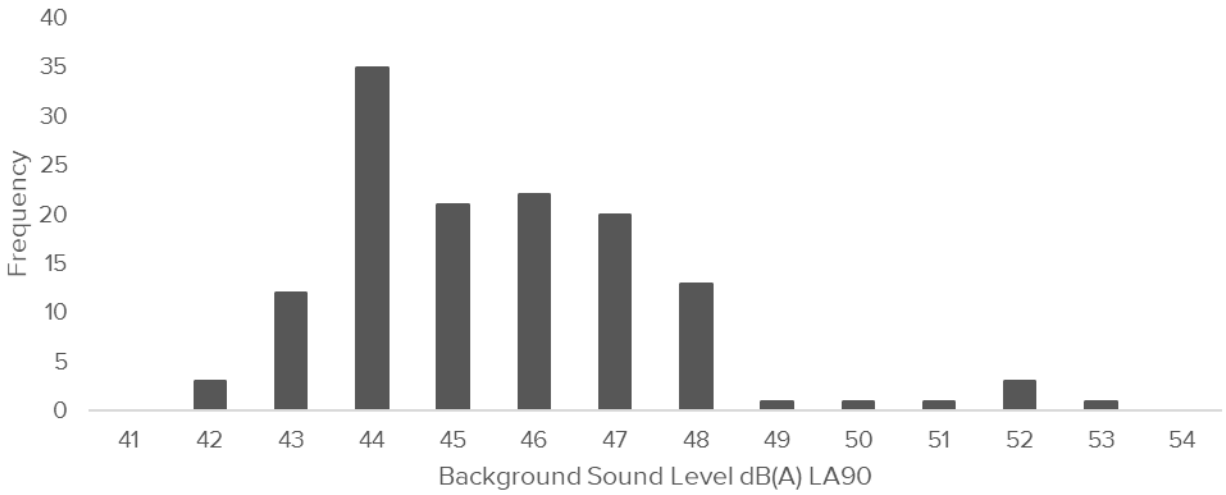


Figure 4. Histogram of daytime L_{A90} background sound pressure levels

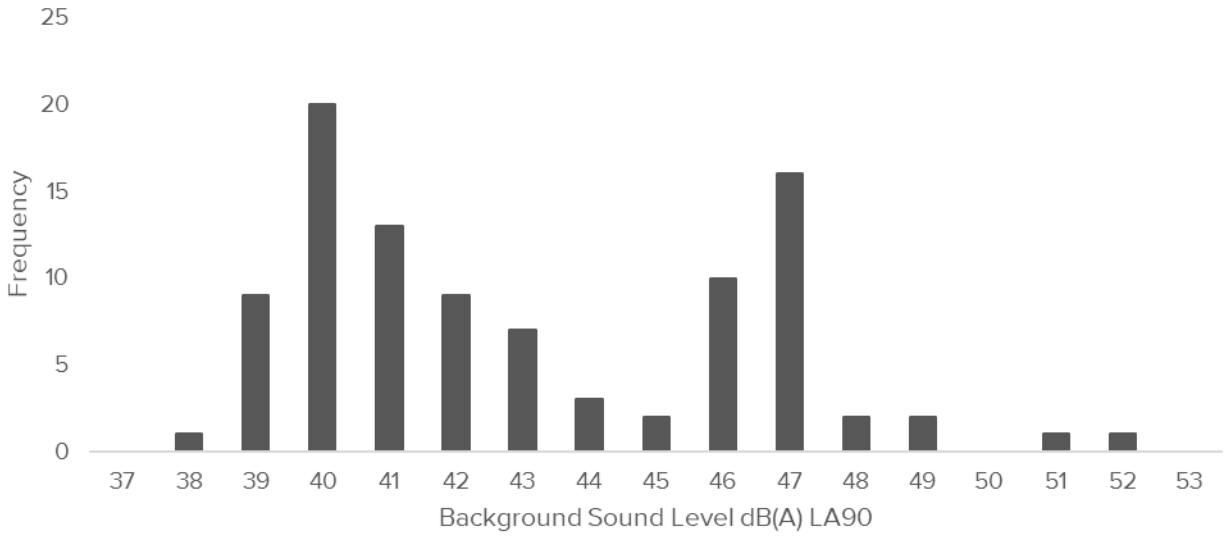


Figure 5. Histogram of night-time L_{A90} background sound pressure levels

Table 16. Statistical analysis of background sound levels

Parameter	dB $L_{A90, 5min}$	
	Daytime (07.00 – 23.00 hours)	Night-time (23.00 – 07.00 hours
mean	46	43
modal	44	40
median	45	42

Therefore, the following values are considered representative of the existing background sound pressure levels at nearby noise sensitive premises:

- 44dB L_{A90} during the daytime period; and
- 40dB L_{A90} during the night-time period.

ASSESSMENT OF ENVIRONMENTAL NOISE IMPACTS

The following section presents the assessment of the various noise impacts in line with the methodology outlined in the preceding sections.

INITIAL RISK ASSESSMENT

As noted in Table 15, predicted daytime incident noise levels vary from 71 dB $L_{Aeq,16hr}$ at low levels overlooking Finchley Road to 54 dB $L_{Aeq,16hr}$ at the rear of the site, while night-time levels are in the range 67 dB $L_{Aeq,8hr}$ to 49 dB $L_{Aeq,8hr}$ at the same locations.

The highest noise levels are within the "high" range of noise levels in Figure 1 of the IoA ProPG document, while at the rear noise levels are within the "low" range of values.

The ProPG document notes that "high noise levels indicate that there is an increased risk that development may be refused on noise grounds". The ProPG document notes that even where noise levels are high "the risk may be reduced by following a "good acoustic design process" which "confirms how the adverse impacts of noise will be mitigated and minimised."

ASSESSMENT OF REQUIRED GLAZING AND VENTILATION

In order to assess the site in relation to the applicable policy aims, it is important to review the internal noise levels due to incident noise ingress inside the proposed dwellings.

The composite acoustic performance required of any portion of the building envelope will depend on its location relative to the principal noise sources around the site and the nature of the spaces behind it (noise criteria, size, room finishes etc.).

Due to the layout, orientation, size, location and varying noise climate around the development it is implied that each façade and probably each window and ventilator (if present) on a facade should have a different sound insulation performance level in order for a specific internal ambient noise level to be reached. Logistically, this could result in increased costs for the development due to bespoke solutions, effects on programme and increase of errors during construction. National policy on noise does not insist on compliance with a specific level but rather it suggests that reasonable practicable mitigation measures should be put in place in order to approach a certain target level (assuming the non-mitigated impact is predicted to lie above this target level) when this level is below the SOAEL. Slight exceedances of this level are deemed acceptable under national policy on noise which supports sustainable development.

Therefore, it is not practical to specify a large number of different external building fabric constructions and this is also not supported by national policy on noise. It should be highlighted that, assuming there are no specific requirements for the acoustic performance of individual elements which make up the external building fabric, compliance with the building regulations would imply the use of double-glazed thermal glazing and trickle ventilators of the hit and miss type as a minimum (in relation to sound insulation). Therefore, compliance with the building regulations already implies a certain level of sound insulation from external noise which was not historically present (i.e. when partially open windows were considered an acceptable measure to provide background or primary ventilation into dwellings).

The detailed calculation methodology described in BS 8233:2014 will be used in the assessment using the following equation[14] as detailed in the British Standard:

$$L_{eq,2} = L_{eq,ff} + 10log_{10}\left(\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_{w1}}{S}10^{\frac{-R_{w,i}}{10}} + \frac{S_{ew}}{S}10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S}10^{\frac{-R_o}{10}}\right) + 10log_{10}(\frac{S}{A}) + 3$$

To calculate the internal noise levels, and thereby determine the acoustic performance required for glazing, the rooms with the worst-case combination of window area and room volume on each façade have been assessed. These are as shown in Table 17, and have been derived from the current layout and elevation drawings.

Table 17. Room information required for the noise break in assessment.

Bedroom	Finchley Road façade 1st and 2nd Floors	Finchley Road façade 3rd and 4th floors	Rear façade
Room	Not applicable – no bedrooms on this façade / floors	Unit 4A	Unit LG1 Bedroom 3
Room Volume (m³)		31	17
Room Furnishings		Curtains, bed, timber floor finish	
Area of window (m²)		2.9	4.4
Kitchen / Living Room			
Room	Unit 2B	Unit 4A	Unit LG2
Room Volume (m³)	50	70	58
Room Furnishings	Curtains, sofa, timber floor finish		
Area of window (m²)	5.3	5.3	4.4

Different types of glazing will control noise to differing amounts and will vary according to the type of noise that should be reduced. The performance of glazing is established by measurement in the laboratory.

The minimum glazing and ventilation specifications required to provide the internal noise levels recommended in BS 8233:2014 are shown in Table 18. The minimum acoustic performance required for each glazing and ventilator type is shown in Table 19.

Where MVHR or similar systems are specified in the table, or are required for non-acoustic reasons such as provision of suitable internal air quality, intake and exhaust ducts must incorporate appropriate attenuation to control intrusive noise to meet the criteria in Table 4.

[14] See page 65 and 66 of BS8233:2014 for an explanation of the various terms used in the equation.

Table 18. Glazing and ventilation types

Façade	Room type	Façade Specifications (See Table 11)	
		Glazing Type	Ventilator Type
Finchley Road 1st and 2nd floors	Kitchen/Living/Dining Rooms	Type B	Attenuated mechanical ventilation required
Finchley Road 3rd and 4th floors	Kitchen/Living/Dining Rooms	Type B	High performance acoustic trickle ventilator
	Bedrooms	Type B	High performance acoustic trickle ventilator
Rear	Kitchen/Living/Dining Rooms	Type A	Non-acoustic trickle ventilator
	Bedrooms	Type A	Non-acoustic trickle ventilator

GLAZING AND VENTILATOR PERFORMANCE

Octave band performance required for the glazing and ventilation categories above are shown in Table 19. Performance requirements for windows must be met inclusive of frames, seals etc.

Table 19. Octave band performance specification for external building elements

Item		Attenuation (dB) at Octave Band Centre Frequency (Hz)							
		63	125	250	500	1000	2000	4000	8000
Type A Glazing [typically 4/16/4]	SRI	21	24	20	25	34	37	40	40
Type B Glazing [typically 10/16/6]	SRI	19	24	24	31	39	39	43	43
Standard "non-acoustic" trickle ventilator	D_{ne}	30	32	32	31	33	31	31	31
High performance acoustic trickle ventilator	D_{ne}	33	35	35	43	45	45	45	45
Non-vision wall – all areas **Cavity brick-block construction (or cladding with dry-lining with similar acoustic performance)**	SRI	35	41	45	45	54	58	55	55

These are minimum sound reduction indices and higher acoustic specifications could be used if required for other reasons.

RESULTING INTERNAL NOISE LEVELS

The predicted internal sound pressure levels, based on the above are shown in Table 20.

Table 20: Internal sound levels (closed windows)

Façade	Room Type	Period	Sound pressure level, dB(A)			
			External façade level	Internal	BS 8233:2014 guidance	Excess
Finchley Road 1st and 2nd floors	Kitchen-Living	Daytime $L_{eq, 16\ hours}$	71	35	35	0
Finchley Road 3rd and 4th floors	Kitchen-living	Daytime $L_{eq, 16\ hours}$	70	34	35	-1
	Bedroom	Daytime $L_{eq, 16\ hours}$	70	35	35	0
		Night-time $L_{eq, 8\ hours}$	66	30	30	0
		Night-time L_{max}	70	40		
Rear	Kitchen-living	Daytime $L_{eq, 16\ hours}$	54	24	35	-11
	Bedroom	Daytime $L_{eq, 16\ hours}$	54	28	35	-7
		Night-time $L_{eq, 8\ hours}$	49	23	30	-7
		Night-time L_{max}	67	43		

It should be noted that the assessment is based on the worst-case combination of window and room volume, and in other rooms of the same type on the façades noted intrusive noise levels will be lower than shown.

The assessment has shown that the resultant internal noise levels meet the guidance in BS 8233:2014 and therefore the second aim of the NPPF will be met in relation to internal amenity.

OUTDOOR LEVELS

Many of the proposed apartments will have access to amenity spaces at the rear of the property.

The external noise levels within the amenity spaces are likely to be around 55 dB $L_{Aeq,16hours}$ and therefore around the upper guidance value described in BS 8233:2014. BS8233:2014 does suggest that:

> *"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".*

SUMMARY AGAINST LONDON BOROUGH OF CAMDEN APPENDIX 3

A comparison of the predicted internal and external sound levels against the Threshold Values in their Appendix 3 Table C (Table 2 in this report) is given below. Since the predominant noise source affecting the site is road traffic, the "non anonymous source" advice is not applicable.

Table 21: Assessment of noise levels against Camden Council criteria Table B

Assessment Location	Design Period	Location	Sound Pressure Level	London Borough of Camden criterion category
Noise at 1 metre from noise sensitive façade / free field	Day	Finchley Road façade	70dB $L_{Aeq\ 16hr}$	Amber
		Rear façade	54dB $L_{Aeq\ 16hr}$	Amber
	Night	Finchley Road façade	66dB $L_{Aeq\ 8hr}$	Red
		Rear façade	49 dB $L_{Aeq\ 8hr}$	Amber
Inside a bedroom	Day	Finchley Road façade	35 dB $L_{Aeq\ 16hr}$	Green
		Rear façade	28 dB $L_{Aeq\ 16hr}$	Green
	Night	Finchley Road façade	30 dB $L_{Aeq\ 8hr}$ 40 dB $L_{Amax,\ fast}$	Green
		Rear façade	23 dB $L_{Aeq\ 8hr}$ 43 dB $L_{Amax,\ fast}$	Amber
Outdoor living space (free field)	Day	Rear	55 dB $L_{Aeq\ 16hr}$	Amber

While incident sound levels are predicted to be within or above the “amber” category, internal noise levels will be within the “green category”, when the mitigation set out above in terms of glazing and ventilation is implemented, with the exception of a minor 1dB exceedance over the L_{Amax} criteria for bedrooms at the rear at night. It should also be noted that there are existing residential properties at a similar distance from Finchley Road, so there is precedent for provision of homes within the area, despite the existing ambient sound levels.

PLANT NOISE GUIDANCE

It is understood that selection of services plant will be made during detailed design. The following outline guidance is made in order to permit initial plant selections and identify at an early stage the likely need for attenuation.

PLANT LOCATIONS AND NEAREST NOISE-SENSITIVE RECEPTORS

External plant will comprise an Air Source Heat Pump (ASHP) to serve each of the 4no. lower ground floor properties. These units will be located within the respective lower ground floor terraces.

CRITERIA

As noted previously, Appendix 3 within the Camden Local Plan published 2017 states:

> *"A relevant standard or guidance document should be referenced when determining values for LOAEL and SOAEL for non-anonymous noise. Where appropriate and within the scope of the document it is expected that British Standard 4142:2014 'Methods for rating and assessing industrial and commercial sound' (BS 4142) will be used. For such cases a 'Rating Level' of 10 dB below background (15dB if tonal components are present) should be considered as the design criterion)."*

SURVEY

As described previously, representative background sound levels are considered to be 44dB $L_{A90,5min}$ during the day (07.00 – 23.00) and 40 dB $LA_{90,5min}$ at night.

PLANT NOISE LIMITS

In order to comply with the London Borough of Camden criteria above, the BS 4142:2014 rating level due to new plant, at the nearest noise-sensitive façades should not exceed 34dB during the day and 30dB at night. These limits assume the plant installed does not exhibit any tonality. These values are significantly below the level at which BS 4142:2014 predicts there is likely to be a "low impact".

INITIAL FEASIBILITY ASSESSMENT

Plant selections are to be finalised. Initial feasibility designs envisage one Daikin ERLQ004CV3 ASHP serving each lower ground floor flat. These have a sound power level of 58 dB(A) each.

The ground floor windows at the rear of the site are screened from all ASHPs by the ground floor terrace. All lower ground floor windows are screened from the ASHPs serving adjacent flats by the walls between the lower ground floor terraces. Therefore, the most-affected windows will be on the first floor. These may have an unobstructed view of all four ASHPs. At worst, middle windows on the elevation may be approximately 10m from three of the units and 13m from the fourth; windows at the north and south ends of the rear elevation will be further from the units.

Taking distance and surface acoustic reflections into consideration, the sound pressure level at the worst-affected first floor window is calculated in Table 22.

Table 22: Calculation of ASHP sound pressure level at worst-affected window

Unit	Sound power level, dB(A)	Distance to window		Surface reflections terrace wall) (dB)	Screening (dB)	Sound pressure level at window dB(A)
		Distance (m)	Correction (dB)			
ASHP	58	10	-28	+3	0	33
ASHP	58	10	-28	+3	0	33
ASHP	58	10	-28	+3	0	33
ASHP	58	13	-30	+3	0	31
Cumulative plant sound pressure level						**39**

The resulting unattenuated sound pressure level at the worst-affected window is therefore 9dB(A) above the plant noise limit established above. Attenuation will therefore be provided such that the local authority's requirements will be met. Details of the attenuation will be finalised during detailed design.

ADDITIONAL CONSIDERATIONS

All internal plant should be fitted with suitable vibration isolators, to prevent vibration from entering the structure and re-radiating in the apartments. Mounts should be specified and designed to provide at least 95% isolation efficiency.

SOUND INSULATION BETWEEN PLANTROOMS AND DWELLINGS

Airborne noise from the plantrooms to the dwellings must be controlled in order to meet the statutory requirements in the current Building Regulations. In addition, it is recommended that guidance values in BS 8233:2014 are also met or exceeded.

Plantrooms are located on the lower ground floor and fourth floor.

BUILDING REGULATIONS APPROVED DOCUMENT E

As noted previously, the airborne sound insulation of separating walls between bedrooms and other spaces within the same building must be at least 43 dB $D_{nT,w} + C_{tr}$, with the airborne sound insulation provided by the corresponding separating floors being at least 45 dB $D_{nT,w} + C_{tr}$.

BS 8233:2014

The plantrooms may be considered to be “not private” spaces with a “high” activity noise level. Dwellings would be considered as “sensitive” spaces with “typical” noise levels requiring a confidential level of privacy.

Using the matrix table in BS 8233:2014, the separating walls and floors between the plantrooms and the adjacent dwellings must have an airborne sound insulation of at least 47 dB $D_{nT,w}$. In practice, meeting the requirements of Approved Document E will mean the recommendations based on BS 8233:2014 will also be met.

This assessment is based on reverberant noise levels within the plantrooms not exceeding 70 dB(A), with no individual octave band sound pressure level exceeding 75 dB. In the event that reverberant sound pressure levels within a plantroom are higher, additional acoustic treatment of the separating walls/floors may be required (depending on the actual sound insulation of the proposed wall / floor).

DOORS TO PLANTROOMS

To control plantroom noise transmission into corridors also serving dwellings it is recommended that purpose-made and type-tested acoustic doorsets are provided to the lower ground floor plantroom and any commercial plantrooms. The sound insulation should be at least R_w 40 dB.

SOUND INSULATION BETWEEN COMMERCIAL SPACES AND BEDROOMS

Airborne noise from the commercial demises to the bedrooms must be controlled in order to meet the statutory requirements in the current Building Regulations. In addition, it is recommended that guidance values in BS 8233:2014 are also met or exceeded.

The potentially-noisy non-residential spaces within the development are on the ground and lower ground floors and may include a pub/wine bar. These spaces have separating walls to Unit LG3 at lower ground floor level and Units LG1, LG3 and LG4 at ground floor level and separating floors to Units 1B and 1C on the first floor.

BUILDING REGULATIONS APPROVED DOCUMENT E

As noted previously, the airborne sound insulation of separating walls and floors between dwellings and other spaces within the same building must be at least 45 dB $D_{nT,w} + C_{tr}$.

BS 8233:2014

Assuming that high music noise levels are not proposed within the commercial units, these may be considered to be "not private" spaces with a "high" activity noise level. The apartments would be considered as "sensitive" spaces with "typical" noise levels requiring a confidential level of privacy.

Using the matrix table in BS 8233:2014, the separating first floor between the commercial units and the apartments must have an airborne sound insulation of at least 47 dB $D_{nT,w}$. In practice, meeting the requirements of Approved Document E will mean the recommendations based on BS 8233:2014 will also be met.

The recommended minimum airborne sound insulation performance noted above will typically result in acceptable internal levels in the bedrooms above, where the reverberant sound level in the non-residential space is no higher than the levels given in Table 23.

Table 23 Permissible reverberant sound pressure levels in commercial units (without additional acoustic treatment to ceiling)

	Reverberant sound pressure level (dB) at octave band centre frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
$L_{eq,15min}$ (07:00 – 23:00)	75	75	75	75	75	70	70	70	75
$L_{Max,f}$ (07:00 – 23:00)	85	85	85	85	85	80	80	80	85
$L_{eq,15min}$ (23:00 – 07:00)	70	70	70	70	70	65	65	65	70
$L_{Max,f}$ (23:00 – 07:00)	80	80	80	80	80	75	75	75	80

The above limits will typically permit the majority of commercial uses, including a restaurant or bar, but preclude playing loud/amplified music.

In the event that higher noise levels are likely, for example if the tenant(s) of any of the commercial space wishes to be able to play music at noise levels higher than the above, additional sound insulation would be required.

CONCLUSION

Measurements of environmental noise at the proposed development site at 551-557 Finchley Road have been used to assess its suitability for residential development.

ENVIRONMENTAL NOISE ASSESSMENT

Suitable internal noise levels can be provided to habitable rooms at the rear of the building by the use of standard thermal double glazing and standard “non acoustic” trickle ventilators.

An enhanced glazing performance is required to windows overlooking Finchley Road, with attenuated mechanical ventilation also required on the first and second floors. The provision of background ventilation using acoustic trickle ventilators would be acceptable for rooms on the third and fourth floors.

The required performance is given in Table 18 and Table 19 in the body of this report.

PLANT NOISE GUIDANCE

Plant noise limits have been given to enable initial design work to commence. The limits are based on meeting London Borough of Camden’s usual requirements for noise from new services plant.

An initial calculation shows that, with appropriate attenuation (to be finalised during detailed design), the local authority’s usual criteria are achievable.

SOUND INSULATION BETWEEN PLANTROOMS AND APARTMENTS

Recommendations are given for the minimum sound insulation that should be provided between the plantrooms and adjacent dwellings to meet the requirements of Building Regulations Approved Document E and the recommendations in BS 8233:2014. Initial guidance has been provided for the control of plant vibration into the building structure.

SOUND INSULATION BETWEEN COMMERCIAL SPACES AND APARTMENTS

Recommendations are given for the minimum sound insulation that should be provided between the commercial units and adjacent bedrooms above to meet the requirements of Building Regulations Approved Document E and the recommendations in BS 8233:2014. Recommended limits have been given for noise within the commercial units that would provide reasonable noise levels in the dwellings.

APPENDIX A

Table 24. Acoustic Terminology

Parameter	Description
Ambient Noise Level	The totally encompassing sound in a given situation at a given time, usually composed of a sound from many sources both distant and near ($L_{Aeq,T}$).
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1/s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20μPa. The threshold of normal hearing is in the region of 0 dB and 140 dB is the threshold of pain. A change of 1 dB is only perceptible under controlled conditions.
dB(A), L_{Ax}	Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessment of loudness. A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background noise in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).
Fast Time Weighting	Setting on sound level meter, denoted by a subscript F, that determines the speed at which the instrument responds to changes in the amplitude of any measured signal. The fast time weighting can lead to higher values than the slow time weighting when rapidly changing signals are measured. The average time constant for the fast response setting is 0.125 (1/8) seconds.
Free-field	Sound pressure level measured outside, far away from reflecting surfaces (except the ground), usually taken to mean at least 3.5 metres
Façade	Sound pressure level measured at a distance of 1 metre in front of a large sound reflecting object such as a building façade.
$L_{Aeq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level recorded during a noise event with a period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise. $L_{A10,18h}$ is the A –weighted arithmetic average of the 18 hourly $L_{A10,1h}$ values from 06:00-24:00.
$L_{90,T}$	A noise level index. The noise level that is exceeded for 90% of the measurement time interval, T. It gives an indication of the lower levels of fluctuating noise. It is often used to describe the background noise level and can be considered to be the "average minimum" noise level and is a term used to describe the level to which non-specific noise falls during quiet spells, when there is lull in passing traffic for example.

APPENDIX B

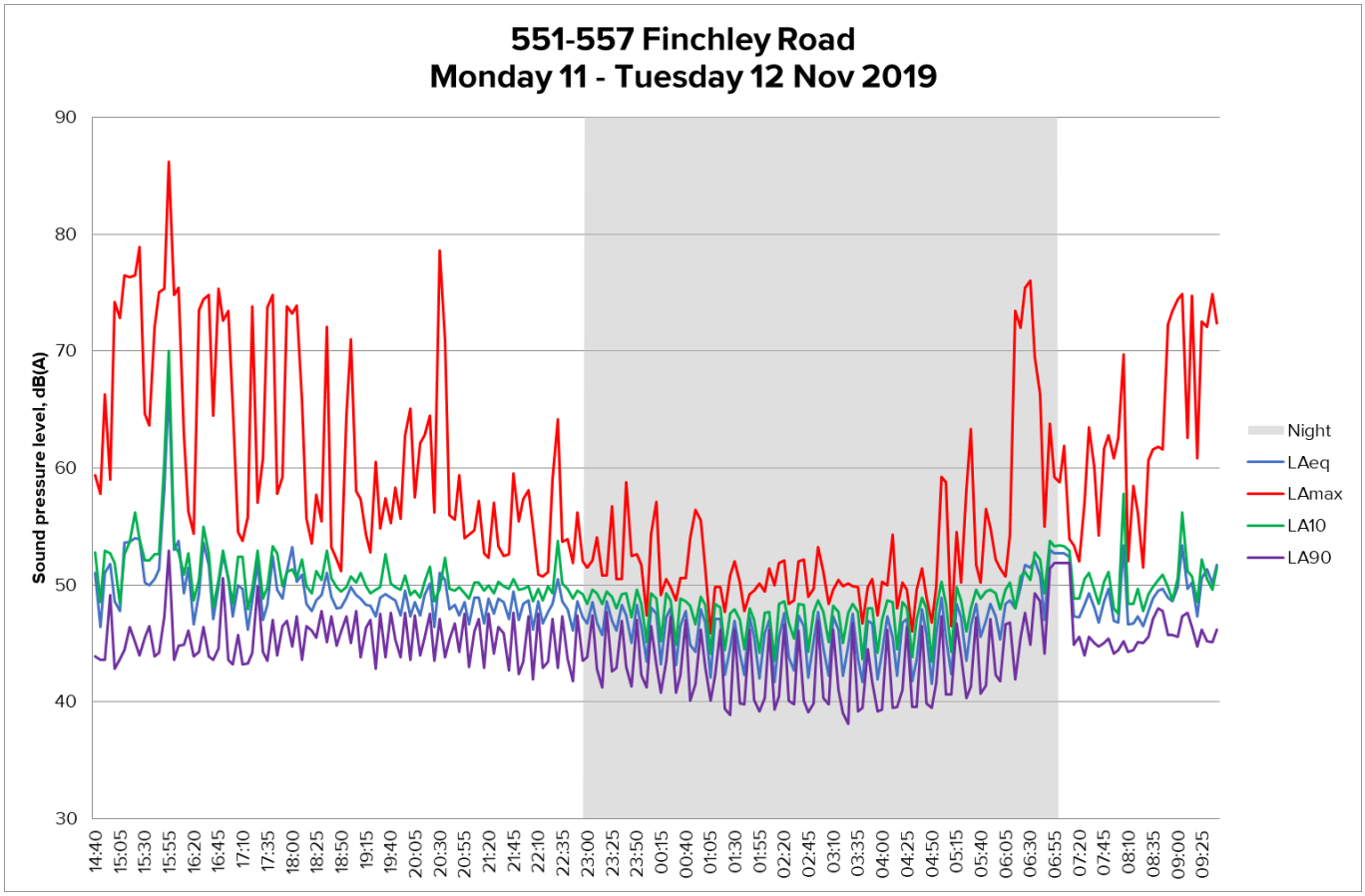


Figure 6 Time history of sound measurements at Position 1 (initial survey)

Table 25. Results of environmental noise measurements at Position 2

Date & time	L_{Aeq} [dB]	$L_{AF,max}$ [dB]	L_{A10} [dB]	L_{A90} [dB]
07/09/2020 15:45	77.1	94.5	80.1	62.4
07/09/2020 16:00	74.8	95.3	77.9	64.1
07/09/2020 16:15	73.9	86.1	77.4	64.2
07/09/2020 16:30	74.3	90.9	77.3	64.6
07/09/2020 16:45	74.1	87.6	77.5	64.7
07/09/2020 17:00	73.0	84.7	76.5	62.1
07/09/2020 17:15	74.2	93.5	76.7	63.4
07/09/2020 17:30	74.6	90.0	77.5	64.1
07/09/2020 17:45	73.8	86.9	77.3	63.8
07/09/2020 18:00	74.8	90.9	77.2	67.0
07/09/2020 18:15	74.0	90.6	77.0	63.0

Date & time	L_{Aeq} [dB]	$L_{AF,max}$ [dB]	L_{A10} [dB]	L_{A90} [dB]
07/09/2020 18:30	74.0	86.3	77.0	65.4
07/09/2020 18:45	74.5	87.4	77.7	64.5
07/09/2020 19:00	73.8	85.2	77.3	63.7
07/09/2020 19:15	73.4	85.0	76.7	63.2
07/09/2020 19:30	73.3	81.9	76.5	63.7
07/09/2020 19:45	73.3	86.8	76.5	63.0
07/09/2020 20:00	72.7	87.8	76.5	63.7
07/09/2020 20:15	75.7	96.7	76.3	64.5
07/09/2020 20:30	72.2	81.3	75.5	63.2
07/09/2020 20:45	72.1	82.2	75.8	62.4
07/09/2020 21:00	71.8	83.0	75.4	63.0
07/09/2020 21:15	72.8	91.7	75.3	64.1
07/09/2020 21:30	71.9	84.7	75.1	62.8
07/09/2020 21:45	72.0	82.8	75.4	61.7
07/09/2020 22:00	74.4	100.6	75.8	61.6
07/09/2020 22:15	71.7	79.8	75.1	61.3
07/09/2020 22:30	72.7	89.9	75.8	61.2
07/09/2020 22:45	71.0	80.4	75.1	58.6
07/09/2020 23:00	73.1	99.7	74.9	62.2
07/09/2020 23:15	71.4	89.3	75.1	58.2
07/09/2020 23:30	71.1	82.4	75.4	56.3
07/09/2020 23:45	70.0	84.3	73.9	57.1
08/09/2020 00:00	69.5	81.2	74.0	52.8
08/09/2020 00:15	69.1	81.2	73.4	53.9
08/09/2020 00:30	70.7	96.7	73.8	55.7
08/09/2020 00:45	68.4	78.8	73.0	51.6
08/09/2020 01:00	68.2	81.8	72.4	52.3
08/09/2020 01:15	66.8	81.5	71.8	46.6
08/09/2020 01:30	67.2	82.6	72.2	47.8
08/09/2020 01:45	66.5	79.7	71.0	47.6
08/09/2020 02:00	66.6	82.5	71.5	47.5
08/09/2020 02:15	66.9	83.0	71.5	46.8
08/09/2020 02:30	66.6	83.5	71.5	43.6
08/09/2020 02:45	66.5	85.4	70.3	45.0
08/09/2020 03:00	65.7	80.9	70.2	43.6
08/09/2020 03:15	67.2	81.6	71.9	47.6

Date & time	L_{Aeq} [dB]	$L_{AF,max}$ [dB]	L_{A10} [dB]	L_{A90} [dB]
08/09/2020 03:30	66.9	81.7	71.7	49.6
08/09/2020 03:45	66.3	82.6	70.4	46.4
08/09/2020 04:00	66.6	82.9	71.2	41.0
08/09/2020 04:15	67.0	83.0	71.7	47.5
08/09/2020 04:30	67.8	80.3	73.0	49.5
08/09/2020 04:45	68.0	83.1	72.7	51.9
08/09/2020 05:00	68.8	82.8	73.6	51.1
08/09/2020 05:15	68.2	81.9	73.2	48.6
08/09/2020 05:30	69.9	79.5	74.5	55.3
08/09/2020 05:45	70.4	80.4	74.9	55.3
08/09/2020 06:00	72.3	83.4	76.4	57.2
08/09/2020 06:15	73.8	88.8	76.6	62.5
08/09/2020 06:30	74.2	80.7	77.2	64.6
08/09/2020 06:45	75.3	98.9	77.4	63.7
08/09/2020 07:00	74.5	85.8	77.7	62.4
08/09/2020 07:15	74.7	87.3	77.9	65.0
08/09/2020 07:30	74.6	86.0	77.6	64.5
08/09/2020 07:45	71.6	83.4	75.4	62.4
08/09/2020 08:00	72.0	87.6	75.3	62.4
08/09/2020 08:15	74.3	96.6	76.6	62.4
08/09/2020 08:30	71.5	82.5	75.5	61.7
08/09/2020 08:45	73.2	86.3	76.5	65.3
08/09/2020 09:00	71.2	83.4	74.9	62.5
08/09/2020 09:15	73.2	84.5	76.4	65.3
08/09/2020 09:30	71.4	81.5	74.9	62.6
08/09/2020 09:45	73.3	85.9	76.8	64.3
08/09/2020 10:00	73.9	89.8	76.9	65.0
08/09/2020 10:15	73.4	89.8	76.2	65.9
08/09/2020 10:30	76.3	101.9	76.7	63.3
08/09/2020 10:45	73.3	85.4	76.5	65.6
08/09/2020 11:00	74.5	91.9	77.0	62.8
08/09/2020 11:15	72.2	87.0	75.5	64.1
08/09/2020 11:30	74.4	97.3	76.2	63.1
08/09/2020 11:45	72.8	84.2	76.3	63.1
08/09/2020 12:00	72.7	85.4	76.2	61.6
08/09/2020 12:15	74.7	93.5	77.0	62.6

Date & time	L_{Aeq} [dB]	$L_{AF,max}$ [dB]	L_{A10} [dB]	L_{A90} [dB]
08/09/2020 12:30	73.0	82.1	76.7	62.7
08/09/2020 12:45	72.8	90.6	75.8	63.7
08/09/2020 13:00	73.6	84.3	76.9	64.6
08/09/2020 13:15	73.3	86.4	76.9	62.4
08/09/2020 13:30	72.9	80.8	76.6	63.6
08/09/2020 13:45	73.5	84.5	76.7	63.7
08/09/2020 14:00	72.9	86.1	76.6	63.7
08/09/2020 14:15	73.5	92.3	76.5	63.5
08/09/2020 14:30	72.5	85.0	75.8	63.7
08/09/2020 14:45	75.0	96.9	76.6	63.2
08/09/2020 15:00	73.1	87.4	76.3	63.5
08/09/2020 15:15	73.6	88.1	76.8	62.0
08/09/2020 15:30	75.1	98.5	77.3	63.1
08/09/2020 15:45	73.2	88.9	76.2	63.1
08/09/2020 16:00	73.0	85.1	76.4	63.6
08/09/2020 16:15	74.1	91.2	77.1	65.2
08/09/2020 16:30	74.2	90.1	77.3	64.8

Table 26. Results of environmental noise measurements at Position 3

Date & time	L_{Aeq} [dB]	$L_{AF,max}$ [dB]	L_{A10} [dB]	L_{A90} [dB]
07/09/2020 15:45	65.7	80.8	69.5	56.3
07/09/2020 16:00	68.0	84.3	70.9	58.5
07/09/2020 16:15	66.3	78.6	70.0	56.3
07/09/2020 16:30	65.4	77.3	69.4	55.3
07/09/2020 16:45	66.7	81.1	69.7	60.0
07/09/2020 17:00	66.7	80.4	69.8	59.4
07/09/2020 17:15	66.6	83.6	69.9	56.0
07/09/2020 17:30	65.6	77.5	69.3	55.9
07/09/2020 17:45	68.0	94.2	69.8	57.4
07/09/2020 18:00	66.6	80.1	69.9	56.2
07/09/2020 18:15	65.4	79.8	69.5	55.2
07/09/2020 18:30	66.6	79.8	69.9	58.0
07/09/2020 18:45	65.4	82.5	69.3	54.3
07/09/2020 19:00	65.7	89.1	69.0	56.6
07/09/2020 19:15	66.3	79.1	70.3	53.6

Date & time	L_{Aeq} [dB]	$L_{AF,max}$ [dB]	L_{A10} [dB]	L_{A90} [dB]
07/09/2020 19:30	65.2	77.3	69.4	53.3
07/09/2020 19:45	65.5	76.2	69.9	52.2
07/09/2020 20:00	65.2	79.5	69.6	52.0
07/09/2020 20:15	65.6	77.2	69.5	55.2
07/09/2020 20:30	65.0	79.4	69.6	51.2
07/09/2020 20:45	64.0	79.2	68.3	51.4
07/09/2020 21:00	63.8	77.9	68.6	50.0
07/09/2020 21:15	64.5	76.1	68.9	50.1
07/09/2020 21:30	64.8	82.5	68.9	50.7
07/09/2020 21:45	63.7	83.0	68.2	49.0
07/09/2020 22:00	62.9	76.5	67.5	50.4
07/09/2020 22:15	63.3	76.2	68.1	49.7
07/09/2020 22:30	63.4	79.4	68.1	48.8
07/09/2020 22:45	62.7	80.4	67.0	45.3
07/09/2020 23:00	68.9	94.9	68.5	48.1
07/09/2020 23:15	62.0	75.5	66.8	46.0
07/09/2020 23:30	61.9	83.6	65.1	46.5
07/09/2020 23:45	60.6	77.6	65.1	44.3
08/09/2020 00:00	60.4	77.4	64.5	44.6
08/09/2020 00:15	60.6	79.4	63.5	44.1
08/09/2020 00:30	58.2	71.9	61.9	43.9
08/09/2020 00:45	58.6	78.9	61.2	40.5
08/09/2020 01:00	60.2	77.1	64.0	41.4
08/09/2020 01:15	60.1	78.4	63.2	40.8
08/09/2020 01:30	56.6	75.2	58.4	39.2
08/09/2020 01:45	58.8	80.7	57.4	39.0
08/09/2020 02:00	56.1	74.4	56.8	40.2
08/09/2020 02:15	58.0	75.5	59.3	41.9
08/09/2020 02:30	56.8	74.8	58.4	38.4
08/09/2020 02:45	55.9	73.9	55.8	37.7
08/09/2020 03:00	55.2	74.5	55.4	37.2
08/09/2020 03:15	57.5	78.7	57.2	37.2
08/09/2020 03:30	56.3	76.8	57.7	37.7
08/09/2020 03:45	52.2	72.3	53.3	37.1
08/09/2020 04:00	58.8	78.1	60.4	37.6
08/09/2020 04:15	55.6	74.1	56.4	39.2

Date & time	L_{Aeq} [dB]	$L_{AF,max}$ [dB]	L_{A10} [dB]	L_{A90} [dB]
08/09/2020 04:30	58.5	76.4	61.7	41.7
08/09/2020 04:45	57.1	74.6	57.7	39.9
08/09/2020 05:00	57.5	74.9	58.9	39.9
08/09/2020 05:15	58.6	75.8	60.8	39.0
08/09/2020 05:30	61.4	81.6	64.8	44.3
08/09/2020 05:45	62.4	78.1	66.7	46.4
08/09/2020 06:00	61.2	76.0	65.9	46.2
08/09/2020 06:15	62.9	78.4	67.7	51.3
08/09/2020 06:30	65.7	87.4	69.8	52.6
08/09/2020 06:45	65.7	82.0	69.7	52.7
08/09/2020 07:00	65.8	80.8	69.9	53.6
08/09/2020 07:15	67.1	83.4	70.6	55.5
08/09/2020 07:30	66.2	86.4	69.3	53.7
08/09/2020 07:45	66.8	80.0	70.4	55.7
08/09/2020 08:00	66.3	79.7	70.0	54.5
08/09/2020 08:15	67.7	82.4	71.3	56.5
08/09/2020 08:30	65.9	82.1	69.2	57.4
08/09/2020 08:45	64.4	81.0	66.8	57.5
08/09/2020 09:00	66.7	91.0	69.3	56.0
08/09/2020 09:15	71.8	97.6	70.7	57.4
08/09/2020 09:30	66.5	82.0	69.8	56.6
08/09/2020 09:45	65.4	82.6	68.5	55.6
08/09/2020 10:00	66.0	81.2	68.6	57.4
08/09/2020 10:15	65.8	87.3	68.4	55.5
08/09/2020 10:30	64.9	80.8	67.9	55.1
08/09/2020 10:45	65.2	86.1	68.0	56.2
08/09/2020 11:00	68.9	92.1	70.2	58.1
08/09/2020 11:15	66.9	91.4	69.4	55.6
08/09/2020 11:30	67.7	95.9	67.9	55.7
08/09/2020 11:45	65.5	89.8	67.8	56.0
08/09/2020 12:00	66.9	86.7	68.7	58.1
08/09/2020 12:15	64.5	88.2	67.3	55.3
08/09/2020 12:30	65.7	82.6	68.6	55.5
08/09/2020 12:45	65.1	82.1	67.9	56.2
08/09/2020 13:00	65.0	81.1	68.1	55.9
08/09/2020 13:15	65.6	90.9	68.4	57.4

Date & time	L_{Aeq} [dB]	$L_{AF,max}$ [dB]	L_{A10} [dB]	L_{A90} [dB]
08/09/2020 13:30	70.7	94.9	69.3	55.2
08/09/2020 13:45	66.6	85.3	68.1	55.4
08/09/2020 14:00	65.7	84.1	68.6	56.6
08/09/2020 14:15	66.4	86.5	68.6	55.5
08/09/2020 14:30	66.2	85.3	68.9	56.8
08/09/2020 14:45	67.7	91.8	69.0	57.2
08/09/2020 15:00	66.3	91.2	68.0	56.2
08/09/2020 15:15	64.8	90.3	66.5	56.4
08/09/2020 15:30	64.9	89.8	67.3	57.8
08/09/2020 15:45	67.2	94.5	68.9	57.3
08/09/2020 16:00	66.2	81.6	68.8	58.8

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