ENVIRONMENTAL NOISE AND IMPACT ASSESSMENT

Ossory Road

Produced by XCO2 for Pocket Living

August 2021

CONTENTS

	01	02	03	04	05	06
Remarks	Draft	Draft	Draft	Draft	For planning	Updated plans
Prepared by	NAC	NAC	NAC	NAC	NAC	NAC
Checked by	DAM/SG	DAM/SG	DAM/SG	DAM/SG	JS/SG	SP
Authorised by	RM	RM	RM	RM	RM	RM
Date	29/03/2019	18/09/2019	09/12/2019	16/12/2019	19/12/2019	11/08/2021
Project reference	9.257	9.257	9.257	9.257	9.257	9.257

EXECUTIVE SUMMARY

It is proposed to redevelop the site at 2-10 Ossory Road, Southwark. The proposed development is an 11-storey building with a commercial unit and ancillary and plant spaces on the ground floor and 117 homes across ten upper floors.

In order to assess the potential for the impact of environmental noise on the new apartments and give minimum acoustic performance specifications for the external building fabric, a noise survey has been undertaken. Guidance on permissible internal noise levels has been taken from London Borough of Southwark's requirements and BS 8233: 2014 'Guidance on sound insulation and noise reduction for buildings'.

ENVIRONMENTAL NOISE ASSESSMENT

In order to assess the potential for the impact of environmental noise on the new apartments and give minimum acoustic performance specifications for the external building fabric, a noise survey has been undertaken.

A system of mechanical ventilation with heat recovery is proposed for all residential dwellings. The results of the noise survey, show that, to achieve desirable internal noise levels in the flats the glazing should achieve a minimum standard of 27dB $R_w + C_{tr}$. The full performance requirements are given in Table 11. Any manufacturer of glazing could be specified provided that they have tested their products to ascertain whether they achieve the above targets; the final choice should be made based on incorporation of all environmental and aesthetic factors.

To control intrusive noise to acceptable levels, the mechanical ventilators must include suitable attenuation. The attenuation must control intrusive noise (entering through fresh air and exhaust ducts) and noise generated by the fan(s) to no higher than 25 dB L_{Aeq} and no higher than 40dB L_{Amax}.

The assessment has indicated that with the appropriate mitigation in the form of the specified glazing and ventilation, internal noise levels within the proposed dwellings will be acceptable.

PLANT NOISE LIMITS

Plant noise limits have been given in Table 13 to enable initial design work to commence. The limits are based on meeting London Borough of Southwark's usual requirements. Since these are more onerous than the requirements of BREEAM Credit Pol05, meeting the former will mean the latter is met "by default".

SOUND INSULATION BETWEEN COMMERCIAL AND RESIDENTIAL SPACES

Recommendations are given for the minimum sound insulation that should be provided between the commercial unit and the dwellings 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 residential units.

NOISE BREAK-IN TO AND BREAK-OUT FROM COMMERCIAL UNIT

Use of typical thermal double-glazed windows to the commercial unit will permit intrusive noise levels inside to meet the recommendations for private offices in BS 8233:2014 to be achieved and thereby allow BREEAM Credit Hea05 to be awarded.

Levels of noise break-out through the building envelope, based on the internal limits established within this report and the use of thermal double-glazed windows, will result in noise levels outside the nearest residential windows that are below the existing ambient noise levels and should therefore be acceptable.

INTRODUCTION

It is proposed to redevelop the site at 2-10 Ossory Road, Southwark. The proposed development is an 11-storey building with a commercial unit and ancillary and plant spaces on the ground floor and 117 homes across ten upper floors.

SITE LOCATION

The site is located on the west side of Ossory Road, within the London Borough of Southwark (See Figure 1 below).

The proposed development comprises the demolition of the existing building and erection of an 11-storey building providing 117 homes and a commercial unit on the ground floor, with associated communal amenity spaces.

The approximate location and boundary of the application site is shown in the figure below.

Figure 1: Site location map

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 July 2021 and came into effect immediately. The original National Planning Policy Framework (NPPF[2]) was published in March 2012, with revisions in July 2018 and February 2019 - this document replaced the existing Planning Policy Guidance Note 24 (PPG 24) "Planning and Noise." The 2021 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 July 2021 edition.

Paragraph 174 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 185 that:

> "*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 119 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) 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 'noticeable', 'very disruptive' and should be 'prevented' (as opposed to SOAEL, which represents a situation where noise is 'noticeable' and '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 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 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.

Table 1. PPG guidance on adverse effect levels

Response	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	Observed Adverse Effect	Mitigate and reduce to a minimum

Response	Examples of Outcomes	Increasing Effect Level	Action
	acoustic character of the area such that there is a small actual or perceived change in the quality of life.		
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 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."

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

"... 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 2021

The London Plan 2021 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.

POLICY D3 OPTIMISING SITE CAPACITY THROUGH THE DESIGN-LED APPROACH REQUIRES THAT:

D 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[3] 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.

LOCAL PLAN POLICY

London Borough of Southwark's policy for noise affecting residential properties is given in the Technical Guidance for Noise rev 3, issued November 2019. Noise criteria for residential dwellings are set out in section 5.3 of the TGN and summarised in the section entitled

London Borough of Southwark Criteria.

The Borough's current normal planning condition relating to noise from fixed plant is that the rating noise level, using the method described in BS 4142:2014 + A1:2019, is not higher than the lowest relevant measured $L_{A90\ (15min)}$ at the nearest noise sensitive premises. In addition, the specific plant sound level must be at least 10dB(A) or more below the background sound level.

[3] Paragraph 3.14.3, The London Plan 2021

DESIGN NOISE LEVELS

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.

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*".

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[4].

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

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[5]). These guideline noise levels are shown in Table 2, below:

Table 2 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	35dB $L_{Aeq,16h}$	-
Dining	Dining room/area	40dB $L_{Aeq,16h}$	-
Sleeping (daytime resting)	Bedroom	35dB $L_{Aeq,16h}$	30dB $L_{Aeq,8h}$

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

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

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. Individual noise events associated with night-time typical road traffic are not considered to be associated with the rise of significant adverse effects on health and quality of life, and this is indeed the case even if the site is located near a motorway. Therefore, an assessment of individual noise events during the night-time for this site is not deemed appropriate or necessary.

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 55dB $L_{Aeq,T}$ 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 30dBA 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 50dB 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 35dBA, and can be understood fairly well in background levels of 45dBA.*
- *Speech with more vocal effort can be understood when the background sound pressure level is about 65dBA.*

ANNOYANCE RESPONSES (DAYTIME EXTERNAL LOAEL FOR PRIVATE AMENITY AREAS)

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.

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 64dB $L_{Aeq,\ 16h}$. Based on guidance[6] in BS8233:2014, an external noise level of 64dB $L_{Aeq,\ 16h}$ would roughly equate to an internal level of 49dB $L_{Aeq\ 16h}$, assuming partially open windows for ventilation. As daytime and night-time desirable target levels differ by 5dB, a night-time SOAEL could be 44dB $L_{Aeq,\ 8h}$. 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.

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 3 below. It should be highlighted that the Secretary of State's approved assessment methodology for the HS2 project includes a SOAEL of 65dB $L_{Aeq,16h}$. The

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

HS2 project also includes a LOAEL of 50dB $L_{Aeq,16h}$. 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 3. 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

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[7] 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 can be provided via open windows. The slight increase of internal noise levels should be considered acceptable.

SOUND INSULATION BETWEEN COMMERCIAL SPACES AND DWELLINGS

Airborne noise from the commercial demises to the dwellings above 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.

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.

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.*

[7] Paragraph 4.15 in Approved Document F

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 proposed use and internal arrangement of the commercial space is not known at present. Depending on the use it may range from noise-sensitive confidential spaces with low noise levels, such as private offices, to “not private” spaces with a very high activity noise level but low sensitivity, such as workshops. The dwellings above can be considered as “sensitive” spaces with “typical” noise levels requiring a confidential level of privacy.

Based on these considerations, it is recommended that the sound insulation of the separating floors between the commercial units and the dwellings should not be lower than 57dB $D_{nT,w}$ based on the matrix table in BS8233. This recommended requirement is in addition to the criterion in Building Regulations; in practice, achieving a $D_{nT,w}$ of 57 dB is likely to mean that the Approved Document E requirement is also achieved.

BREEAM CREDITS

Two acoustics-related Credits are targeted for the commercial units within the building.

HEALTH AND WELL-BEING HEA05 ACOUSTIC PERFORMANCE

This requires that the indoor ambient noise levels comply with the design ranges given in Section 7 of BS 8233:2014. This can be demonstrated either

- a) Via pre-completion testing which considers noise from both internal sources and eternal sources. However, it excludes noise from occupants and office equipment.
- b) Alternatively: a suitably qualified acoustician (SQA) must carry out a quantifiable assessment of the specification of the build form, construction and any external factors likely to affect the indoor ambient noise levels. The SQA must then confirm the developer's works will enable a future tenant utilising a typical fit-out and specification to meet the levels required to demonstrate compliance.

POLLUTION POL05 REDUCTION OF NOISE POLLUTION

To secure this credit it must be shown that either:

- a) No noise sensitive receptors within 800m radius of the building

- b) The building has no external plant and therefore does not represent a new noise source
- c) If there are sensitive receptors and external plant then:
  - i. Noise assessment carried out in accordance with BS 4142:2014 to determine noise levels at nearest / most exposed sensitive receptors
  - ii. Calculate noise level/rating from assessed building
  - iii. Demonstrate that the noise level from the assessed building, as measured in the locality of the nearest or most exposed noise-sensitive development, is at least 5dB lower than the background noise throughout the day and night

It should be noted that meeting London Borough of Southwark's usual criteria for plant noise will result in plant noise levels at least 5 dBA below background and therefore permit the credit to be awarded.

LONDON BOROUGH OF SOUTHWARK CRITERIA

London Borough of Southwark's requirements are given in section 5.3 of their Technical Guidance for Noise (Rev 3, November 2019).

INTERNAL NOISE LEVELS

Internal noise levels within dwellings are to meet the BS 8233:2014 recommended criteria given in Table 2 above.

In addition:

> *Regular individual noise events (for example, passing aircraft, trains, and loud road vehicles) can cause sleep disturbance. Buildings shall be designed to ensure that individual noise events do not exceed 45dB L_{AFmax} more than 10 times in any night inside any bedroom. The 10th highest individual L_{AFmax} event in any night shall be determined and the noise level from this event shall be used to inform the mitigation design target.*

The TGN also states:

> *Where it is unavoidable to rely on closed windows to achieve L.B. Southwark environmental noise standards there must be a suitable alternative means of ventilation provided which is sufficient to ventilate the premises and to adequately control excess heat in the summer months. When designing ventilation to mitigate noise, due consideration must be given to the impact of local air quality and the need to minimise exposure to poor air quality.*

This implies that the internal noise limits should be met even under purge/rapid ventilation requirements. In practice this means that opening windows would not be acceptable as a means of providing purge/rapid ventilation to prevent overheating, though they may be openable at the occupants' discretion.

EXTERNAL NOISE LEVELS

The TGN requires that external noise levels, in private residential amenity areas should not normally exceed 50dB $L_{Aeq16hour}$.

It does, however, recognise that:

Where this is not possible to achieve despite implementing all reasonable mitigation measures, the standard can be relaxed by 5dB so that the sound level in private gardens and balconies does not exceed 55dB $L_{Aeq, 16hr}$.

In very high noise areas where the less stringent standard of 55dB $L_{Aeq\ 16hr}$ cannot reasonably be achieved, with careful design it should be achieved in some parts of the amenity space.

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 SURVEY

Continuous measurements of the incident sound pressure levels (at two locations) at the site were undertaken from Monday 11th February to Tuesday 12th February 2019. 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}) 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 location of the sound level meters is indicated in the aerial photograph below, describing the two measurement positions.

Figure 2: On site sound pressure level measurement positions

Table 4. Description of measurement positions

Position	Description
1	Lamp post to north of site
2	Lamp post to east of site, adjacent to Asda store

EQUIPMENT

Details of the equipment used during the survey are provided in Table 5. The sound level meters were calibrated before and after the survey; no significant change (+/-0.2dB) in the calibration level was noted.

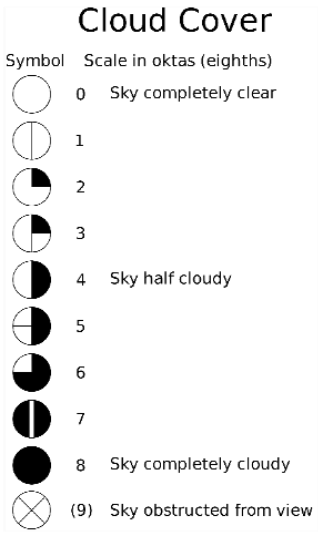
Table 5. On site instrumentation

Position	Description	Model / serial no.	Calibration date	Calibration certificate no.
1	Class 1 Sound level meter	Svantek 977/ 69587	06/07/2018	Factory conformity declaration
	Condenser microphone	ACO Pacific 7052E / 71209		
	Preamplifier	Svantek SV12L / 73514		
	Calibrator	Svantek SV33A / 73430	02/08/2018	Factory conformity declaration
2	Class 1 Sound level meter	Svantek 977 / 36190	06/07/2018	15444
	Condenser microphone	ACO Pacific 7052E / 57366		
	Preamplifier	Svantek SV12L / 41504		
	Calibrator	CEL 284/2 /4/03326334	06/07/2018	15443

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 6 below presents the weather conditions recorded on site at the beginning and end of the survey.

Table 6. Weather Conditions

Date/Time	Description	Beginning of Survey	End of Survey
10:45 11 Feb – 11:45 12 Feb 2019	Temperature (°C)	8	7
	Precipitation:	No	No
	Cloud cover (oktas - see guide)	1	7
	Presence of fog/snow/ice	No	No
	Presence of damp roads/wet ground	No	No
	Wind Speed (m/s)	<1	<1
	Wind Direction	-	-
	Conditions that may cause temperature inversion (i.e. calm nights with no cloud)	No	No

*no influence in the conclusions of the assessment

RESULTS

The main noise source was observed to be traffic on Ossory Road and Old Kent Road to the north. At position 1, construction work on a site on the north side of Old Kent Road was occasionally audible. Some activity in the Asda delivery yard was also audible at position 1. At position 2, noise from Asda plant was also audible.

It should be noted that the noise survey includes noise generated from all nearby sources, including other existing commercial premises in the area.

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 7.

Table 7. Summary of survey results (free field levels)

Position	Measurement period	Range of recorded sound pressure levels (dB)			
		$L_{Amax, T}$	$L_{Aeq, T}$	$L_{A10, T}$	$L_{A90, T}$
1, North of site	Daytime (07.00 – 23.00 hours)	74 - 95	62 - 69	66 - 73	50 - 60
	Night-time (23.00 – 07.00 hours)	73 - 93	59 - 69	63 - 70	45 - 59
2, East of site	Daytime (07.00 – 23.00 hours)	68 - 93	59 - 67	61 - 68	53 - 62
	Night-time (23.00 – 07.00 hours)	67 - 89	55 - 63	59 - 65	50 - 57

Table 8 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 8. Daytime and night-time equivalent levels (free field levels)

Position	Measurement period	Free field sound pressure levels (dB)	
		$L_{Aeq\ (16\ hours)}$*	$L_{Aeq\ (8\ hours)}$
1	Monday 11th Feb - Tuesday 12th Feb	65.9	63.4
2		62.5	59.2

*not complete 16-hour measurements.

Octave band data used in the assessment of intrusive noise and acoustic specification for the external building fabric are given in Table 9. Corrections for distance and, where appropriate, screening from the local noise sources have been made, to enable façade incident sound pressure levels to be calculated, as shown. Façade identifications are shown in Figure 3.

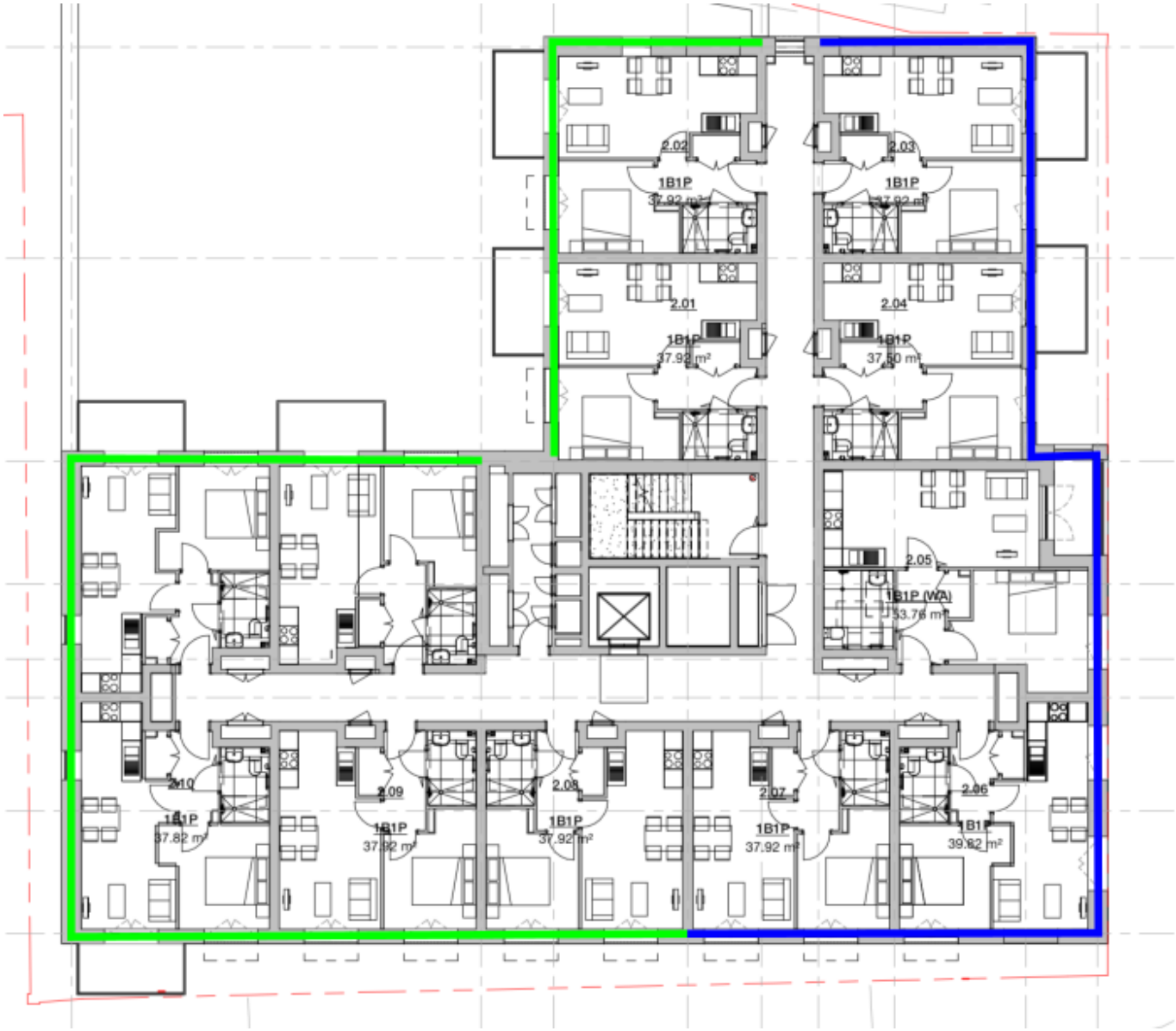


Figure 3: Façade identification (applies to residential façades at all levels)

Table 9. Summary of free field facade incident environmental noise levels at octave band centre frequencies

Period	Incident free field sound pressure levels (dB) at Octave Band Centre Frequencies (Hz)								dB(A)
	63	125	250	500	1000	2000	4000	8000	
1 North of site									
Daytime $L_{Aeq, 16\ hours}$	71	67	64	62	62	59	52	46	66
Night-time $L_{Aeq, 8\ hours}$	66	62	61	59	60	56	48	41	63
Spectrum of typical night-time L_{Amax}	81	85	76	76	89	73	63	57	89
2 East of site									
Daytime $L_{Aeq, 16\ hours}$	69	64	61	59	58	55	49	44	63
Night-time $L_{Aeq, 8\ hours}$	63	61	59	56	55	52	44	37	60
Spectrum of typical night-time L_{Amax}	80	79	84	80	85	82	72	64	88
Blue façade (to Level 5)									
Daytime $L_{Aeq, 16\ hours}$	68	64	61	59	59	56	49	43	63
Night-time $L_{Aeq, 8\ hours}$	63	59	58	56	57	53	45	38	60
Spectrum of typical night-time L_{Amax}	75	79	70	70	83	67	57	51	83
Blue façade (Level 6 and above)									
Daytime $L_{Aeq, 16\ hours}$	63	58	55	53	52	49	43	38	57
Night-time $L_{Aeq, 8\ hours}$	57	55	53	50	49	46	38	31	53
Spectrum of typical night-time L_{Amax}	69	68	73	69	74	71	61	53	77
Green façade (to Level 5)									
Daytime $L_{Aeq, 16\ hours}$	65	61	58	56	56	53	46	40	60
Night-time $L_{Aeq, 8\ hours}$	60	56	55	53	54	50	42	35	57
Spectrum of typical night-time L_{Amax}	69	73	64	64	77	61	51	45	77
Green façade (Level 6 and above)									
Daytime $L_{Aeq, 16\ hours}$	60	55	52	50	49	46	40	35	54
Night-time $L_{Aeq, 8\ hours}$	54	52	50	47	46	43	35	28	50
Spectrum of typical night-time L_{Amax}	59	58	63	59	64	61	51	43	67

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.

INDOOR LEVELS

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 BS8233:2014 will be used in the assessment using the following equation[8] as detailed in the British Standard:

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

Based on the room layouts available at the time of writing, the internal noise levels have been calculated for worst-case combinations of room volume and window area. Table 10 presents the input data[9] used to predict the resultant internal noise level in habitable rooms. It is understood that all dwellings in the proposed development will have background ventilation provided by a mechanical ventilation with heat recovery system.

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

Table 10. Room information required for the noise break in assessment.

	BLUE FAÇADE	GREEN FAÇADE
Bedroom		
Room Volume (m^3)	24	29
Room Type	Bedroom (worst-case)	
Room Furnishings	Curtains, bed, carpet or timber floor finish	
Area of window (m^2)	2.1	2.1
Area of unglazed external wall (m^2)	5.2	5.2
Kitchen / Living Room		
Room Volume (m^3)	44	45
Room Type	Kitchen/Living Room/Dining (worst-case)	
Room Furnishings	Curtains, sofa, part-timber floor finish	
Area of window (m^2)	3.9	6.0
Area of unglazed external wall (m^2)	19.6	19.3

The starting point in all similar assessments is to review whether an external building fabric comprising elements with the lowest possible sound reduction properties required to meet the Building Regulations (in relation to thermal and ventilation provisions) will be acceptable.

Table 11 below presents the sound reduction indices used in the assessment for these low performing (in terms of sound reduction) elements.

Table 11. Elements of external building fabric

External building fabric element	Construction element	Sound reduction indices (dB) at Octave band Centre Frequencies (Hz)				
		125	250	500	1000	2000
All habitable rooms						
Glazing configuration, glass mm/airgap mm/glass mm	4mm glass, 16 mm airgap, 4 mm glass	24	23	30	33	33
Non-vision wall	Cavity brick-block construction (or cladding with dry-lining with similar acoustic performance)	41	45	45	54	58

The results of the assessment are shown in Table 12. In all cases the 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. It should be noted that the assessments are based on the worst-case combination of external noise level, area of windows and room volume, and in the majority of cases internal noise levels will be lower than those tabulated. Internal noise levels with open windows are based on guidance in BS 8233:2014 as noted previously.

Table 12. Predicted internal noise levels

Room Type	Reference*	External noise levels, dB	Predicted noise levels, dB	Proposed criterion dB	Difference, dB
Blue Façade – to Level 5					
Kitchen/Living	L_{Aeq}, daytime	63	32	35	-3
Bedroom	L_{Aeq}, daytime	63	30	35	-5
	L_{Aeq}, night-time	60	27	30	-3
	L_{Amax}, night-time	83	45	45	0
Blue Façade – Level 6 and above					
Kitchen/Living	L_{Aeq}, daytime	57	26	35	-9
Bedroom	L_{Aeq}, daytime	57	24	35	-11
	L_{Aeq}, night-time	53	21	30	-9
	L_{Amax}, night-time	77	41	45	-4
Green Façade – to Level 5					
Kitchen/Living	L_{Aeq}, daytime	60	30	35	-5
Bedroom	L_{Aeq}, daytime	60	27	35	-8
	L_{Aeq}, night-time	57	24	30	-6
	L_{Amax}, night-time	77	39	45	-6
Green Façade – Level 6 and above					
Kitchen/Living	L_{Aeq}, daytime	54	24	35	-11
Bedroom	L_{Aeq}, daytime	54	21	35	-14
	L_{Aeq}, night-time	50	18	30	-12
	L_{Amax}, night-time	67	31	45	-14

*Daytime $L_{Aeq,16hr}$, night-time $L_{Aeq,8hr}$

As noted previously, the environmental survey data upon which the above are based includes noise from all noise sources affecting the site, including nearby commercial premises.

NOISE FROM AND THROUGH MECHANICAL VENTILATORS

To control intrusive noise to acceptable levels, the mechanical ventilators must include suitable attenuation. The attenuation must control intrusive noise (entering through fresh air and exhaust ducts) and noise generated by the fan(s) to no higher than 25 dB L_{Aeq} and no higher than 40dB L_{Amax}.

OUTDOOR LEVELS

The communal amenity space at the north west corner of the site is screened from Ossory Road and Old Kent Road and the daytime noise levels are therefore expected to be around 55-60dB $L_{Aeq,16hrs}$ are therefore above the upper guidance level given in BS 8233:2014 and the requirements in Southwark's TGN. In the areas toward the south east

corner of the amenity space, where the screening is greatest, noise levels will be lowest, and around the 55dB $L_{Aeq16hour}$ limit recommended in the TGN.

On this basis, the amenity benefits of providing convenient, usable outdoor space in a central urban location outweigh any potential exceedances in noise levels and should not preclude the use of the site for residential premises.

PLANT NOISE GUIDANCE

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

LIKELY PLANT LOCATIONS AND NEAREST RESIDENTIAL RECEPTORS

A substation is proposed to be located in an internal plantroom on the ground floor with louvres on the east elevation. An energy centre is proposed for the ground floor. External plant may also be located on the roof.

The nearest residential windows to the substation louvres are on the first floor above, approximately 4.5m from the louvre.

The roof plant is approximately 7m from the nearest residential windows at the development and is screened from it by the building geometry.

Due to the building layout, no residential window can be subject to noise from all plant areas and therefore limits from each can be calculated separately without the need to consider cumulative effects.

CRITERIA

London Borough of Southwark's plant noise criteria is outlined in the 'London Borough of Southwark Technical Guidance for Noise' rev 3 dated November 2019. Section 5.2 'Noise from Fixed Plant and Industry' states:

> *"In order for planning permission to be recommended it is required that the assessment Rating sound level does not exceed the typical minimum $L_{A90\ (15\ minute)}$ background sound level at any time. Furthermore, in order to prevent gradually creeping background levels over time it is required that the unrated 'Specific' sound level does not exceed 10dB below the typical minimum $L_{A90\ (15\ minute)}$ background sound level at any time. The 'Specific', 'Rating' and 'Background' sound levels shall be calculated fully in accordance with the methodology of BS4142:2014 + A1:2019."*

SURVEY

Background sound levels were measured on 11th-12th February 2019. The lowest representative background sound levels are considered to be 52dB $L_{A90,15min}$ during the day (07.00 – 23.00) and 46 dB $LA_{90,15min}$ at night.

PLANT NOISE GUIDANCE

In order to comply with London Borough of Southwark's usual requirements, the BS4142:2014 rating level due to new plant, at the nearest noise-sensitive residential façades should not exceed 52dB during the day and 46dB at night. In addition, the specific level of the plant at those locations should not exceed 42dB during the day and 36dB at night.

Typically, plant used for this type of development is not anticipated to exhibit any tonal or impulsive characteristics provided it is well maintained. A penalty of 3dB as described in BS 4142:2014 would typically be applied for the possible presence of "...characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual acoustic environment...".

In addition, it is recommended that where plant or louvres are close to pedestrian access the noise level does not exceed 50 dBA at 5m.

Taking account of the distance and potential screening between the plant and the nearest receptors, noise from the plant serving the development should not exceed the following limits in order to demonstrate compliance with the criteria described above:

Table 13: Guidance on maximum plant and louvre noise emission limits

Plant	Period	Maximum plant emission level dB(A)
Substation louvres (total)	Day (07.00 – 23.00 hours)	38dB @ 10m
	Night (23.00 – 07.00 hours)	32dB @ 10m
Roof plant (total)	Day (07.00 – 23.00 hours)	49dB at 10m
	Night (23.00 – 07.00 hours)	43dB at 10m

BREEAM POL05 CREDIT

The above limits are derived to limit plant noise such that it meets London Borough of Southwark's usual requirement that plant noise should be at least 10dB(A) below the existing background sound levels. This is a more onerous requirement than is specified for the awarding of BREEAM Pol05 credit, and therefore meeting the above limits will mean that the BREEAM credit may be awarded.

When plant has been selected a full plant noise assessment will be required by the local authority, and to demonstrate compliance with the BREEAM credit requirements.

ADDITIONAL CONSIDERATIONS

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

Airborne noise transmission from the plant into the bedrooms must also be considered as part of the acoustic design of the building structure, including the floors above or below any internal plant rooms and any columns or risers passing through plant rooms.

SOUND INSULATION BETWEEN COMMERCIAL SPACE AND DWELLINGS

Airborne noise from the commercial unit to the dwellings above 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 the separating floor must be at least 45 dB $D_{nT,w} + C_{tr}$.

BS 8233:2014

As noted previously, the sound insulation of the floors separating the commercial and residential spaces should not be lower than 57dB $D_{nT,w}$ based on the matrix table in BS8233. This recommended requirement is in addition to the criterion in Building Regulations.

REVERBERANT SOUND LEVELS IN COMMERCIAL SPACE

The recommended minimum airborne sound insulation performance noted above will typically result in acceptable internal levels in the dwellings above, where the reverberant sound level in the commercial unit is no higher than the levels given in Table 14.

Table 14 Permissible reverberant sound pressure levels in commercial unit (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)	80	80	80	80	80	75	75	75	80
$L_{Max,f}$ (07:00 – 23:00)	90	90	90	90	90	85	85	85	90
$L_{eq,15min}$ (23:00 – 07:00)	75	75	75	75	75	70	70	70	75
$L_{Max,f}$ (23:00 – 07:00)	85	85	85	85	85	80	80	80	85

The above limits will typically permit the majority of commercial uses, but preclude the extended use of power tools, hammering etc.

To limit the risk of structure-borne noise entering the dwellings all columns and flanking walls should be lined with one layer of 15mm thick dense gypsum-based board (BG SoundBloc or similar) spaced 25mm from the structure and with 25mm mm thick mineral/glass wool quilt in the cavity. It should be noted that “by default” this is likely to be required to achieve the statutory requirements within Building Regulations Approved Document E.

In the event that higher noise levels are likely, for example due to high levels of workshop noise, additional sound insulation would be required.

NOISE BREAK-IN TO AND BREAK-OUT FROM COMMERCIAL UNIT

NOISE BREAK-IN TO COMMERCIAL UNIT

In order that BREEAM Credit Hea05 may be awarded, it is necessary for intrusive noise in the commercial unit to meet the guidance values in Section 7 of BS 8233:2014.

The proposed use and internal arrangement of the commercial unit is not known at present. Depending on the use it may range from spaces where concentration is required (e.g. private offices and conference rooms) to workshops where the need to control intrusive noise levels is of negligible importance. For the former case, BS 8233:2014 recommends intrusive noise levels should be in the range 35-40 dB $L_{Aeq,T}$, with the reference time, T, being representative of a proposed hours of use and pattern of activities. For work requiring concentration it is reasonable to consider the typical working day (between 08:30 hours and 18:00 hours) and use a reference time period of 30 minutes.

Analysis of the $L_{Aeq,30min}$ sound levels at measurement position 1 shows that the typical ambient sound level at that location during the working day considered is 68 dB $L_{Aeq,30min}$, giving an incident sound level of 68 dB $L_{Aeq,30min}$ at the most-exposed commercial windows.

Based on a typical private office with a floor area of approximately 12m^2 on the most-exposed façade, the glazing sound insulation required to provide the recommended internal sound level (up to 40 dB $L_{Aeq,30min}$) may be calculated.

Standard thermal double-glazing (e.g. two panes of 4mm thick glass with 16mm deep cavity), with the sound insulation shown in Table 15, is capable of controlling internal noise levels within a private office to meet the proposed criteria and would therefore be acoustically acceptable to control noise break-in to all commercial units.

Table 15. Octave band performance specification for external glazing to commercial units (based on worst-case requirements)

Element		Attenuation (dB) at Octave Band Centre Frequencies (Hz)					$R_w + C_{tr}$ / $D_{ne,w} + C_{tr}$*
		125	250	500	1000	2000	
Typical 4 / 16 / 4 double glazing	SRI	24	20	25	34	37	27

NOISE BREAK-OUT FROM COMMERCIAL UNIT

NOISE BREAK-OUT THROUGH CLOSED WINDOWS

As noted previously with regard to the residential façades, the acoustically-weakest element of the external building envelope of the commercial units will be the windows. The worst-case situation is where a residential window is directly above the nearest commercial window; in this case, the distance between the two windows will be approximately 5m. Based on the limiting internal sound pressure levels established in Table 14 and the glazing sound insulation in Table 15, the resulting incident sound pressure levels at the closest residential façades above would be below 40 dB $L_{Aeq,T}$ and below 50 dB $L_{Amax,F}$ at any time and therefore significantly below the incident sound pressure levels due to existing sources in the area.

CONCLUSION

ENVIRONMENTAL NOISE ASSESSMENT

In order to assess the potential for the impact of environmental noise on the new apartments and give minimum acoustic performance specifications for the external building fabric, a noise survey has been undertaken.

A system of mechanical ventilation with heat recovery is proposed for all residential dwellings. The results of the noise survey, show that, to achieve desirable internal noise levels in the flats the glazing should achieve a minimum standard of 27dB R_w + C_{tr}. The full performance requirements are given in Table 11. Any manufacturer of glazing could be specified provided that they have tested their products to ascertain whether they achieve the above targets; the final choice should be made based on incorporation of all environmental and aesthetic factors.

To control intrusive noise to acceptable levels, the mechanical ventilators must include suitable attenuation. The attenuation must control intrusive noise (entering through fresh air and exhaust ducts) and noise generated by the fan(s) to no higher than 25 dB L_{Aeq} and no higher than 40dB L_{Amax}.

The assessment has indicated that with the appropriate mitigation in the form of the specified glazing and ventilation, internal noise levels within the proposed dwellings will be acceptable.

PLANT NOISE LIMITS

Plant noise limits have been given in Table 13 to enable initial design work to commence. The limits are based on meeting London Borough of Southwark's usual requirements. Since these are more onerous than the requirements of BREEAM Credit Pol05, meeting the former will mean the latter is met "by default".

SOUND INSULATION BETWEEN COMMERCIAL AND RESIDENTIAL SPACES

Recommendations are given for the minimum sound insulation that should be provided between the commercial unit and the dwellings 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 residential units.

NOISE BREAK-IN TO AND BREAK-OUT FROM COMMERCIAL UNIT

Use of typical thermal double-glazed windows to the commercial unit will permit intrusive noise levels inside to meet the recommendations for private offices in BS 8233:2014 to be achieved and thereby allow BREEAM Credit Hea05 to be awarded.

Levels of noise break-out through the building envelope, based on the internal limits established within this report and the use of thermal double-glazed windows, will result in noise levels outside the nearest residential windows that are below the existing ambient noise levels and should therefore be acceptable.

APPENDIX A

Table 16. 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

Table 17. Results of environmental noise measurements at Position 1

Date & time	L_{Aeq} [dB]	L_{AFmax} [dB]	L_{A10} [dB]	L_{A90} [dB]
11/02/2019 11:00	64.3	76.5	67.2	58.5
11/02/2019 11:15	64.9	77.3	67.9	58.9
11/02/2019 11:30	64.7	84.0	67.1	56.7
11/02/2019 11:45	65.5	84.8	67.9	58.1
11/02/2019 12:00	64.3	77.8	67.3	58.2
11/02/2019 12:15	65.6	82.1	68.5	59.9
11/02/2019 12:30	65.2	80.5	68.0	58.7
11/02/2019 12:45	63.5	73.9	66.3	57.9
11/02/2019 13:00	65.1	79.2	67.7	59.6
11/02/2019 13:15	67.3	86.5	69.9	59.5
11/02/2019 13:30	66.6	82.9	69.2	57.6
11/02/2019 13:45	64.3	78.7	67.0	57.7
11/02/2019 14:00	67.5	90.8	68.2	57.2
11/02/2019 14:15	64.0	77.9	67.2	56.1
11/02/2019 14:30	67.5	87.2	69.4	60.4
11/02/2019 14:45	66.5	91.0	67.3	58.9
11/02/2019 15:00	65.0	80.3	67.4	58.3
11/02/2019 15:15	64.8	78.2	67.5	58.1
11/02/2019 15:30	64.8	81.6	67.5	59.0
11/02/2019 15:45	64.6	76.9	67.5	58.7
11/02/2019 16:00	66.8	92.3	68.0	57.9
11/02/2019 16:15	64.3	83.3	66.6	58.0
11/02/2019 16:30	64.6	84.8	66.4	57.2
11/02/2019 16:45	65.1	85.5	67.7	56.8
11/02/2019 17:00	63.4	77.3	66.6	57.1
11/02/2019 17:15	67.8	93.3	67.7	58.0
11/02/2019 17:30	64.4	85.7	66.1	58.2
11/02/2019 17:45	64.1	85.8	66.3	56.7
11/02/2019 18:00	64.0	78.8	66.8	57.5
11/02/2019 18:15	67.7	88.8	68.7	57.6
11/02/2019 18:30	64.1	80.7	66.5	56.2
11/02/2019 18:45	63.7	80.9	65.7	57.7
11/02/2019 19:00	66.0	88.1	67.2	58.1
11/02/2019 19:15	68.1	85.1	70.6	56.1

Date & time	L_{Aeq} [dB]	L_{AFmax} [dB]	L_{A10} [dB]	L_{A90} [dB]
11/02/2019 19:30	65.5	85.0	67.3	55.8
11/02/2019 19:45	69.4	87.0	72.9	56.3
11/02/2019 20:00	68.3	87.3	72.6	58.1
11/02/2019 20:15	65.8	87.5	67.0	54.1
11/02/2019 20:30	63.8	86.2	65.7	55.5
11/02/2019 20:45	63.3	79.0	66.2	54.4
11/02/2019 21:00	63.6	79.0	66.6	52.5
11/02/2019 21:15	63.8	80.8	66.6	55.2
11/02/2019 21:30	64.5	80.7	67.9	55.4
11/02/2019 21:45	62.3	77.9	65.5	52.0
11/02/2019 22:00	63.5	86.9	65.6	49.5
11/02/2019 22:15	66.4	95.2	65.9	51.8
11/02/2019 22:30	63.9	87.0	65.9	51.5
11/02/2019 22:45	68.8	91.5	66.6	51.6
11/02/2019 23:00	62.3	80.7	65.3	51.7
11/02/2019 23:15	62.6	79.1	65.4	52.1
11/02/2019 23:30	63.8	85.2	66.1	49.7
11/02/2019 23:45	62.3	83.7	65.3	49.9
12/02/2019 00:00	62.6	79.0	66.2	50.6
12/02/2019 00:15	62.0	80.8	65.3	48.1
12/02/2019 00:30	62.3	81.5	65.6	49.8
12/02/2019 00:45	60.6	72.8	64.8	47.3
12/02/2019 01:00	60.6	74.8	64.5	46.9
12/02/2019 01:15	62.0	78.7	65.5	46.7
12/02/2019 01:30	61.0	75.7	65.4	46.7
12/02/2019 01:45	61.0	74.9	65.3	47.8
12/02/2019 02:00	63.2	78.6	67.0	46.3
12/02/2019 02:15	59.3	78.7	63.8	46.3
12/02/2019 02:30	58.5	72.7	62.9	44.9
12/02/2019 02:45	62.3	82.3	65.7	46.9
12/02/2019 03:00	59.4	74.4	64.1	45.9
12/02/2019 03:15	60.0	77.1	64.0	46.5
12/02/2019 03:30	62.2	90.1	65.2	46.8
12/02/2019 03:45	62.0	87.7	65.1	49.1
12/02/2019 04:00	62.9	81.9	66.6	47.3
12/02/2019 04:15	62.0	77.2	66.3	45.6
12/02/2019 04:30	61.2	75.1	65.2	47.6

Date & time	L_{Aeq} [dB]	L_{AFmax} [dB]	L_{A10} [dB]	L_{A90} [dB]
12/02/2019 04:45	63.9	80.7	67.3	50.3
12/02/2019 05:00	63.4	78.7	67.2	49.0
12/02/2019 05:15	64.8	85.3	67.7	50.2
12/02/2019 05:30	65.5	81.3	68.2	54.8
12/02/2019 05:45	63.6	76.1	66.9	55.9
12/02/2019 06:00	69.3	93.1	69.1	57.7
12/02/2019 06:15	67.5	83.8	70.2	56.9
12/02/2019 06:30	66.3	82.0	69.1	57.6
12/02/2019 06:45	64.8	78.3	67.4	58.7
12/02/2019 07:00	67.0	90.8	67.6	57.6
12/02/2019 07:15	66.2	91.8	68.0	57.4
12/02/2019 07:30	65.2	81.3	68.4	57.7
12/02/2019 07:45	66.2	85.2	68.9	57.8
12/02/2019 08:00	66.3	83.6	68.7	57.8
12/02/2019 08:15	66.8	87.2	68.8	57.8
12/02/2019 08:30	64.0	82.2	66.7	56.5
12/02/2019 08:45	66.0	80.7	69.1	57.5
12/02/2019 09:00	68.9	89.8	69.3	58.4
12/02/2019 09:15	67.8	91.7	68.7	56.9
12/02/2019 09:30	64.0	81.2	66.4	56.3
12/02/2019 09:45	65.5	85.8	68.0	56.7
12/02/2019 10:00	66.5	84.6	68.9	59.0
12/02/2019 10:15	66.1	85.6	68.8	58.6
12/02/2019 10:30	67.6	88.8	69.0	60.2
12/02/2019 10:45	66.5	82.3	69.3	59.2
12/02/2019 11:00	67.1	90.2	68.5	58.2
12/02/2019 11:15	67.4	86.3	70.0	58.4
12/02/2019 11:30	64.6	79.2	67.7	55.2

Table 18. Results of environmental noise measurements at Position 2

Date & time	L_{Aeq} [dB]	L_{AFmax} [dB]	L_{A10} [dB]	L_{A90} [dB]
11/02/2019 10:45	62.2	82.8	64.6	55.8
11/02/2019 11:00	62.7	82.8	64.3	56.3
11/02/2019 11:15	61.2	77.3	64.0	56.0
11/02/2019 11:30	61.6	83.0	63.4	55.6
11/02/2019 11:45	62.3	82.5	64.3	56.3
11/02/2019 12:00	66.1	86.7	66.2	56.8
11/02/2019 12:15	64.7	73.8	66.9	62.0
11/02/2019 12:30	64.7	76.3	66.8	61.2
11/02/2019 12:45	62.1	70.9	63.6	60.2
11/02/2019 13:00	64.3	75.3	66.3	61.3
11/02/2019 13:15	64.9	78.4	67.0	60.8
11/02/2019 13:30	63.2	84.3	64.6	56.3
11/02/2019 13:45	60.6	84.4	62.4	55.2
11/02/2019 14:00	63.1	81.8	64.6	56.2
11/02/2019 14:15	60.1	77.7	62.7	55.4
11/02/2019 14:30	61.8	85.0	62.8	57.3
11/02/2019 14:45	61.0	80.1	62.9	55.5
11/02/2019 15:00	60.9	74.5	63.5	56.3
11/02/2019 15:15	61.8	80.6	63.8	56.4
11/02/2019 15:30	61.3	76.1	63.7	57.0
11/02/2019 15:45	63.3	77.2	65.7	57.5
11/02/2019 16:00	64.9	87.8	66.7	57.5
11/02/2019 16:15	60.0	75.0	62.4	55.9
11/02/2019 16:30	59.6	79.1	61.9	54.8
11/02/2019 16:45	60.7	77.6	62.9	55.9
11/02/2019 17:00	58.9	68.3	61.5	55.4
11/02/2019 17:15	62.1	82.0	63.2	56.2
11/02/2019 17:30	60.1	77.9	62.5	55.3
11/02/2019 17:45	59.3	77.3	62.4	52.9
11/02/2019 18:00	60.7	82.1	63.3	54.1
11/02/2019 18:15	62.0	80.8	64.1	54.3
11/02/2019 18:30	61.0	75.8	63.7	54.7
11/02/2019 18:45	60.5	76.7	62.6	56.4
11/02/2019 19:00	61.0	82.9	63.0	56.3
11/02/2019 19:15	63.9	85.3	64.2	55.3
11/02/2019 19:30	62.5	83.6	65.2	55.3

Date & time	L_{Aeq} [dB]	L_{AFmax} [dB]	L_{A10} [dB]	L_{A90} [dB]
11/02/2019 19:45	64.2	84.6	65.1	55.5
11/02/2019 20:00	62.6	88.4	64.5	56.0
11/02/2019 20:15	63.4	89.5	64.0	55.5
11/02/2019 20:30	61.4	87.7	63.1	55.3
11/02/2019 20:45	60.4	83.4	62.6	56.2
11/02/2019 21:00	61.0	84.2	63.0	55.2
11/02/2019 21:15	60.6	80.5	62.8	55.3
11/02/2019 21:30	59.9	72.3	62.4	55.4
11/02/2019 21:45	59.3	73.3	61.9	54.3
11/02/2019 22:00	58.9	77.3	61.2	53.0
11/02/2019 22:15	59.9	80.9	61.4	53.3
11/02/2019 22:30	60.9	80.9	62.9	54.2
11/02/2019 22:45	66.6	93.1	63.4	53.3
11/02/2019 23:00	58.6	77.1	61.2	53.2
11/02/2019 23:15	58.4	71.7	60.9	53.0
11/02/2019 23:30	58.9	79.8	61.1	52.3
11/02/2019 23:45	59.0	85.1	60.8	53.1
12/02/2019 00:00	57.4	69.6	60.6	51.0
12/02/2019 00:15	57.8	73.6	60.3	50.5
12/02/2019 00:30	57.6	74.5	60.4	51.1
12/02/2019 00:45	56.5	66.5	59.8	50.8
12/02/2019 01:00	56.5	69.5	59.7	49.8
12/02/2019 01:15	59.2	88.9	61.0	51.4
12/02/2019 01:30	60.4	86.9	62.3	51.4
12/02/2019 01:45	60.0	87.2	62.3	52.1
12/02/2019 02:00	60.0	86.2	61.7	51.1
12/02/2019 02:15	56.2	68.5	59.4	51.0
12/02/2019 02:30	55.4	71.1	58.5	49.8
12/02/2019 02:45	58.1	73.8	61.0	52.0
12/02/2019 03:00	56.5	71.1	59.8	51.3
12/02/2019 03:15	56.1	69.5	59.1	50.7
12/02/2019 03:30	57.4	82.7	59.5	51.2
12/02/2019 03:45	57.9	84.4	59.3	52.2
12/02/2019 04:00	57.6	77.2	60.8	50.9
12/02/2019 04:15	57.5	71.4	61.2	50.1
12/02/2019 04:30	58.8	73.8	62.6	51.5
12/02/2019 04:45	60.9	82.5	63.6	51.9

Date & time	L_{Aeq} [dB]	L_{AFmax} [dB]	L_{A10} [dB]	L_{A90} [dB]
12/02/2019 05:00	58.3	71.4	61.8	51.6
12/02/2019 05:15	60.5	79.3	63.4	52.1
12/02/2019 05:30	60.5	77.0	63.0	52.9
12/02/2019 05:45	58.7	72.8	61.4	53.8
12/02/2019 06:00	63.4	82.3	64.9	56.3
12/02/2019 06:15	62.6	75.5	65.3	56.7
12/02/2019 06:30	62.3	74.9	65.0	56.5
12/02/2019 06:45	60.9	75.5	63.1	56.2
12/02/2019 07:00	63.5	85.2	65.7	56.3
12/02/2019 07:15	62.6	82.8	65.4	56.3
12/02/2019 07:30	61.3	77.8	64.2	56.5
12/02/2019 07:45	62.4	84.8	64.5	56.5
12/02/2019 08:00	61.3	77.5	64.0	55.4
12/02/2019 08:15	62.6	84.2	65.0	56.7
12/02/2019 08:30	60.8	76.9	63.5	55.3
12/02/2019 08:45	63.4	80.0	66.2	56.5
12/02/2019 09:00	64.0	81.1	65.9	56.5
12/02/2019 09:15	63.3	86.3	64.9	55.7
12/02/2019 09:30	60.9	85.3	62.3	54.4
12/02/2019 09:45	62.7	87.3	64.0	56.3
12/02/2019 10:00	64.0	80.7	66.4	58.0
12/02/2019 10:15	63.1	76.8	65.9	57.9
12/02/2019 10:30	64.1	88.8	65.8	58.1
12/02/2019 10:45	64.8	81.6	67.6	57.4
12/02/2019 11:00	62.2	74.2	65.2	56.1
12/02/2019 11:15	63.9	84.4	65.9	57.6
12/02/2019 11:30	61.9	77.0	64.3	56.2

XCO2
56 Kingsway Place, Sans Walk
London EC1R 0LU

+44 (0)20 7700 1000
mail@xco2.com
xco2.com

XCO2
56 Kingsway Place, Sans Walk
London EC1R 0LU

+44 (0)20 7700 1000
mail@xco2.com
xco2.com