

Project:	Development of land at the rear of 303-313 Oxford Road & 3 Western Elms Ave, Reading RG30 1AU	Date:	19/05/2021
Client:	First Avenue Estates Ltd	Ref:	4741



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Report Title:	Environmental Noise Assessment		
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Revision:	A		
Report Status:	Rev A		
Reference:	20210818_4741_ENA01_ land at the rear of 303-313 Oxford Road_ Acoustic Report_A		

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Limitations

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- a) The date on which this assessment was undertaken; and
- b) The date on which the final report is delivered.

Paragon Acoustic Consultants Ltd makes no representation whatsoever concerning the legal significance of its findings or to other legal matters referred to in the following report.

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Opinions included herein are based on information gathered during the study and from our experience. If additional information becomes available which may affect our comments, conclusions or recommendations, Paragon Acoustic Consultants Ltd reserves the right to review the information, reassess any new potential concerns and modify our opinions accordingly.

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1.0 Introduction

It is proposed that a new build block of apartments be constructed on a plot of land at the rear of 303-313 Oxford Road & 3 Western Elms Ave, Reading RG30 1AU.

This impact assessment covers the environmental noise considerations associated with the development in the context of national and local planning policy and guidance. This report should be read in conjunction with any other accompanying documents, plans and technical studies as appropriate.

The assessment contained within this report is based upon the principles and recommendations contained within the following documents:

- National Planning Policy Framework;
- National Policy Statement for England;
- National Planning Practice Guidance, Noise;
- BS8233: 2014: Guidance on sound insulation and noise reduction for buildings;
- World Health Organisation, Guidelines for Community Noise, 1999;

As part of this assessment, the sound insulation requirements of the external fabric of the building will be quantified in the context of Reading Borough Council Pre-application advice reference 201869/PREAPP dated 19th April 2021

2.0 Site Description

The site is located at Development of land at the rear of 303-313 Oxford Road & 3 Western Elms Ave, Reading RG30 1AU, lying in an area that is of mixed residential, commercial, and retail premises. The site location is illustrated below.

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Figure 1: Site Location



To the north of the proposed site lie the rear facades of properties of addresses 305-315 Oxford Road. To the west lies Western Elms Avenue. To the East lies the retail outlet, car parking spaces and loading bay of the Lidl store, beyond which lies a McDonalds Restaurant and Reading West Trail Station. To the south lie other residential properties.

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3.0 Planning Policy Context

3.1 National Planning Policy Framework 2021

The [NPPF](#) sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally prepared plans for housing and other development can be produced.

There are a number of paragraphs in the NPPF that directly mention noise.

Paragraph 174 states that Planning policies and decisions should contribute to and enhance the natural and local environment by:

- e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and

Paragraph 174 states that Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

- a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life^[65];
- 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

^[65] See Explanatory Note to the Noise Policy Statement for England (Department for Environment, Food & Rural Affairs, 2010).

Paragraph 187 requires that:

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

3.2 Noise Policy Statement for England 2010

The Noise Policy Statement for England (NPSE) sets out the long-term vision of Government noise policy, which is to:

"Promote good health and a good quality of life through the management of noise within the context of Government policy on sustainable development".

This long term vision is supported by the following aims:

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“Through the effective management of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

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

When discussing the meaning of “significant adverse” and “adverse”, within an Explanatory Note the NPSE states:

“There are two established concepts from toxicology that are currently being applied to noise impacts for example, by the World Health Organisation. They are

NOEL – No Observed Effect Level - This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

LOAEL – Lowest Observed Adverse Effect Level - This is the level above which adverse effects on health and quality of life can be detected.”

For the purposes of the NPSE, the Government added the following related concept:

“SOAEL – Significant Observed Adverse Effect Level - This is the level above which significant adverse effects on health and quality of life occur.”

It is also noted that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different sources, for different receptors and at different times.

3.3 National Planning Practice Guidance 2014

The National Planning Practice Guidance (NPPG) was published as an online resource in 2014. It includes guidance on how to recognise when noise could be a concern in planning decisions and includes advice that the planning process should be used to “avoid” significant observed adverse effects occurring, by use of appropriate mitigation such as altering design and layout.

The NPPG also states that the planning process should be used to “prevent” unacceptable adverse effects where noise is noticeable and very disruptive leading to extensive and regular changes in behaviour and/or an inability to mitigate the effect of noise leading to psychological stress or physiological effects.

The NPPG provides a summary table setting out the noise exposure hierarchy based on the likely average response, reproduced below.

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Perception	Examples of outcomes	Increasing effect level	Action
Not noticeable	No effect	No observed effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No observed adverse effect	No specific measures required
<i>Lowest Observed Adverse Effect Level</i>			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; 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 perceived change in the quality of life.	Observed adverse effect	Mitigate and reduce to a minimum
<i>Significant Observed Adverse Effect Level</i>			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, 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
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

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4.0 Reading Borough Pre-application advice

The Pre-application advice for flatted development comprising 14 apartments together with parking reference 201869/PREAPP dated 19th April 2021 advises the following

Noise impact on development

A noise assessment should be submitted in support of applications for new residential proposed in noisy areas. The proposal site is located close to Oxford Road and the fairly busy Western Elms Avenue junction as well as in close proximity to the Lidl supermarket delivery yard.

The noise assessment will be assessed against the recommendations for internal noise levels within dwellings and external noise levels within gardens / balconies in accordance with BS 8233:2014 and WHO guidelines for Community Noise. The report should identify any mitigation measures that are necessary to ensure that the recommended standard is met.

Where appropriate, the noise assessment data should also include noise events (L_{AMax}) and the design should aim to prevent noise levels from noise events exceeding 45dB within bedrooms at night. Noise levels above 45dB are linked with sleep disturbance.

It may be possible through clever design to reduce the need for additional noise mitigation measures, for example, ensuring that noise sensitive rooms are located on the quieter façades and bathrooms, kitchens, hallways and cupboards etc on the noisiest façades.

Noise mitigation is likely to focus on the weak point in the structure; glazing. Given that the acoustic integrity would be compromised should the windows be opened, ventilation details must also be provided, where mitigation relies on closed windows. Ventilation measures should be selected which do not allow unacceptable noise ingress and should provide sufficient ventilation to avoid the need to open windows in hot weather, however non-openable windows are not considered an acceptable solution due to the impact on living standards.

Internal noise criteria (taken from BS8233:2014)

Room	Design criteria	Upper limit
Bedrooms (23:00 to 07:00)	<30dB LAeq,8hour	
Living rooms (07:00 - 23:00)	<35dB LAeq,16hour	
Gardens & Balconies	<50dB LAeq,T	<55dB LAeq,T

5.0 Guidance on the Assessment of Noise

5.1 BS 8233:2014: Guidance on sound insulation and noise reduction for buildings

This British Standard came into effect on 28 February 2014 and supersedes BS 8233:1999, which is withdrawn.

The standard draws on the results of research and experience to provide information on the design of buildings that have internal acoustic environments appropriate to their functions. It deals with control of noise from outside the building, noise from plant and services within it, and room acoustics for non-critical situations. 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.

Indoor ambient noise levels for dwellings are set out at Section 7.7.2, Table 4, reproduced below.

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Table 1: Indoor ambient noise levels for dwellings (source: BS 8233:2014, Table 4)

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

A series of notes provide context to the guideline values of Table 4. Note 1 advises that the indoor ambient noise levels are “the sum total of structure-borne and airborne noise sources. Groundborne noise is assessed separately and is not included as part of these targets, as human response to groundborne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity.”

Note 3 states “These levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events, such as fireworks night or New Year’s Eve.”

Note 4 deals with individual events and advises that “Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$, depending on the character and number of events per night. Sporadic noise events could require separate values”.

Note 5 states that if relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation arrangement that does not compromise the façade insulation or the resulting noise level.

Note 7 provides a rider to the guideline values of Table 4, “Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved”.

5.2 World Health Organisation

The recommended indoor ambient noise levels given at Table 4 of BS 8233:2014 do not included a specified value for noise events. Although not explicitly covered in the pre-application advice, it is considered prudent to make an allowance for night noise events as it is often that case this will dictate facade sound insulation requirements for bedrooms.

Guidance on event noise is given in the World Health Organisation (WHO) Guidelines for Community Noise, as below.

The WHO document provided a review of the effects of noise and a description of the principles of health criteria.

Table 1 of the document presents guideline values arranged according to specific environments and critical health effects. Noise indices to be adopted and the accompanying time base to be used for the assessment are also presented.

The guideline values consider all health effects for a specific environment. An adverse health effect refers to any temporary or long-term impairment of physical, psychological or social functioning associated with noise exposure. The specific noise limits were set for each health “using the lowest noise level that produces an adverse health effect”

Table 2: Guideline values for community noise (source: WHO Guidelines for Community Noise Table 1)

Specific environment	Critical health effect(s)	L_{Aeq} [dB]	Time base [hours]	L_{Amax} Fast [dB]
Dwelling, indoors	Speech intelligibility & moderate annoyance daytime & evening	35	16	45
	Sleep disturbance, night-time	30	8	

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For noise events, the guideline value was set at 45 dB L_{Amax} , with research cited in the text advising that this value should not be exceeded by more than 10 to 15 times per night to ensure “good sleep”.

5.3 Pre-application Advice

The Reading Borough Council Pre-application advice advises that *“The noise assessment will be assessed against the recommendations for internal noise levels within dwellings and external noise levels within gardens / balconies in accordance with BS 8233:2014 and WHO guidelines for Community Noise. The report should identify any mitigation measures that are necessary to ensure that the recommended standard is met”*

The Internal noise criteria (taken from BS8233:2014) and external noise criteria are advised in the pre-application advice as follows;

Room	Design criteria	Upper limit
Bedrooms (23:00 to 07:00)	<30dB LAeq,8hour	
Living rooms (07:00 - 23:00)	<35dB LAeq,16hour	
Gardens & Balconies	<50dB LAeq,T	<55dB LAeq,T

The pre-app also advises:

“Where appropriate, the noise assessment data should also include noise events (L_{Amax}) and the design should aim to prevent noise levels from noise events exceeding 45dB within bedrooms at night. Noise levels above 45dB are linked with sleep disturbance”

In the absence of documented guidance of the measurement assessment for 45 dB L_{Amax} , this practice is proposing adoption of a typical highest value. In respect of 45 dB L_{Amax} , transient noise, it should be noted that it is standard design practice to adopt a typical maximum noise level and not the absolute worst-case. Adoption of the above design limits would not provide absolute control of transient noise sources such as emergency vehicle sirens, thunder, inappropriately silenced motorbikes, etc, which may occasionally occur however, the final building design should nevertheless minimise any resultant disturbance due to external noise.

The Reading Borough Council Pre-application document advises that *“non-openable windows are not considered an acceptable solution due to the impact on living standards”*. It is advised that the internal noise limits given in the Pre-application document will not be achieved with windows open.

6.0 Environmental Noise Surveys

6.1 Environmental Noise

Detailed noise surveys have been carried out at site to determine the extant noise climate in the area. Measurements were made 7th May 2021 at the locations described below.

- MP1: Front of site in the garden of 311 Oxford Road
- MP2: In the siding off Western Elms Avenue
- MP3: At the rear of the site

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Figure 2: Measurement Locations



Sound pressure level measurements were obtained using the following instrumentation, complying with the Type 1 specification of BS EN 60804, BS EN 60651, BS EN 60942, BS EN 61260, and BS EN 61672-1, as follows:

- **Position MP1:** Norsonic Type 118 Sound level analyser, serial number 31990 Norsonic Microphone serial number 29831
- **Position MP2:** Norsonic Type 118 Sound level analyser, serial number 31322. Norsonic Microphone serial number 72929
- **Position MP3:** Norsonic Type 118 Sound level analyser, serial number 31322. Norsonic Microphone serial number 72929

Calibration checks were made prior to and after completion of measurements using a Norsonic Type 1251 acoustical calibrator complying with Class 1 of BS EN 60942, calibration level 114.0 dB $\pm$ 0.3 dB, @ 1.0 kHz. All instrumentation carries a current manufacturer's certificate of conformance a copy of which is available upon request.

Various statistical broad-band and spectral sound pressure level measurements were obtained during the survey, including:

- $L_{Aeq,T}$: the equivalent continuous noise level over a measurement period, T
- L_{AFmax} : the maximum sound pressure level over a measurement period, T
- $L_{AF90\%,T}$: the noise level exceeded for 90% of the measurement period, T

Weather conditions for the survey were mild and dry with a slight breeze.

6.2 Daytime Noise Levels – Front and Rear of the Site

Calculation of Road traffic noise sets out a shortened method whereby LA1018h noise levels can be determined from 3 hourly values measured between 10:00-17:00 hours. The measured daytime noise data have been processed as set out below. The daytime values of LA10 have been converted to values of LA10,18h using the following relation:

$$L_{10,18h} = L_{10,3h} - 1 \text{ dB(A)}$$

[1]

where:

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$$L_{10,3h} = \frac{1}{3} \sum_{10 \leq t \leq 14}^{t+2} L_{10(\text{hourly})t}$$

[2]

and t signifies the start time of the individual hourly LA10 values. The calculated LA10,18h values can then be converted to LAeq 16h values following PPG24, equation 3 refers:

$$L_{Aeq,16h} = L_{A10,18h} - 2 \text{ dB(A)} \quad [3]$$

6.3 Night-Time Noise Levels – Front of Site

Access was not available to allow secure monitored noise monitoring therefore the shortened measurement period was used for 05:00-07:00 as detailed in a paper produced for an IAO conference titled: “Investigation Into The Relationship Between Long And Short Measurements For The Assessment Of Road Traffic Noise” compiled by S Bird of Bird Acoustics, Princes Risborough, Bucks and M Fillery of the Symonds Group Ltd, Altringham, Manchester. Three simple equations are detailed that can be used to predict the long term LAeq values from the short ones and are reproduced as follows:

- $L_{Aeq} (0700 - 2300 \text{ hours}) = L_{Aeq} (3 \text{ hour between } 1000 \text{ and } 1700 \text{ hours}) + 0$
- $L_{Aeq} (2300 - 0700 \text{ hours}) = L_{Aeq} (2 \text{ hour between } 2300 \text{ and } 0100 \text{ hours}) + 0.5$
- $L_{Aeq} (2300 - 0700 \text{ hours}) = L_{Aeq} (2 \text{ hour between } 0500 \text{ and } 0700 \text{ hours}) - 3.5$

7.0 Results and Data Analysis

7.1 Environmental Noise Survey Results

Measurement results have been processed to determine day and night LAeq values, together with the typical night maximum noise levels.

Table 3: Summary of Environmental Noise Levels

Measurement Position	Day LAeq,16h *	Night LAeq,8h*	LAfmax Typical Highest
MP1	67 dB	63 dB	78 dB
MP2	66 dB	60 dB	78 dB
MP3	57 dB	51 dB	65 dB

* Day LAeq,16h and Night-time LAeq,8h based on the processing of results of surveying partial periods as confirmed herein.

7.2 Lidle Delivery Noise

In order to predict the Lidle servicing noise levels this practice has acoustically modelled a servicing event for the unloading and loading. The noise data have been taken from the extensive in-house database of this practice. The client has determined that Lidl were granted planning in 2015 to extend their opening hours to 6am-9pm as follows:

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**TOWN AND COUNTRY PLANNING ACT 1990
PLANNING AND COMPENSATION ACT 1991
THE TOWN & COUNTRY PLANNING
(DEVELOPMENT MANAGEMENT PROCEDURE) ORDER 2010**

**APPLICATION TO VARY/REMOVE CONDITION UNDER SECTION 73 OF THE TOWN
AND COUNTRY PLANNING ACT 1990**

To: Lidl UK GmbH
1 St Floor Property Office
33 London Road
Cowplain
PO8 8DF

Application No: 141545
Application type: Variation of Condition

Applicant: Lidl UK GmbH

READING BOROUGH COUNCIL as local planning authority hereby **GRANT** planning permission for the development as described below:-

Proposal: Application for variation of condition 18 following grant of planning permission (96/0130/FD). Current condition restricts deliveries to between 6am and 7pm. This application seeks to amend this to allow deliveries between 6am and 9pm.

At: Lidl UK GmbH 291 Oxford Road Reading RG30 1AS

Subject to such conditions and for such reasons as may be attached

As such, the assessment of deliver loading and unloading noise is included in the night-time period as well as the daytime period.

The Pre-application advice reference 201869/PREAPP dated 19th April 2021 advises the following:

"The noise assessment will be assessed against the recommendations for internal noise levels within dwellings and external noise levels within gardens / balconies in accordance with BS 8233:2014 and WHO guidelines for Community Noise. The report should identify any mitigation measures that are necessary to ensure that the recommended standard is met."

BS8233:2014 advises:

7.7.1 Dwelling houses, flats and rooms in residential use (when unoccupied)

This subclause applies to external noise as it affects the internal acoustic environment from sources without a specific character, previously termed "anonymous noise". Occupants are usually more tolerant of noise without a specific character than, for example, that from neighbours which can trigger complex emotional reactions. For simplicity, only noise without character is considered in Table 4. For dwellings, the main considerations are:

a) for bedrooms, the acoustic effect on sleep; and

b) for other rooms, the acoustic effect on resting, listening and communicating.

NOTE: *Noise has a specific character if it contains features such as a distinguishable, discrete and continuous tone, is irregular enough to attract attention, or has strong low-frequency content, in which case lower noise limits might be appropriate.*

BS8233 Table 4 is reproduced below:

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Table 4: Indoor ambient noise levels for dwellings (source: BS 8233:2014, Table 4)

Table 4 Indoor ambient noise levels for dwellings

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

It can therefore be argued that lower limits may be appropriate to the east side of the building, that will potentially have line of sight to the Lidl service yard where the noise may have specific characters.

The Local Authority has advised that the noise assessment will be assessed against the recommendations for internal noise levels within dwellings and external noise levels within gardens / balconies in accordance with BS 8233:2014 and WHO guidelines for Community Noise.

It is noted that the general transportation noise source levels are approximately 10 dB higher on the west side of the development than the east side of the development, this being primarily due to the vehicular traffic noise along the Western Elms Avenue. If the worst-case noise levels impinging on the west side of the building were used as the basis of façade noise mitigation on the east side of the building this would in practice lower the predicted internal noise by approximately 10 dB to spaces with fenestration on the east side facing the Lidl service yard. These lower internal noise levels have been considered based on the possibility of Lidl Delivery Noise potentially having specific characters. Based on a 6 dB correction for impulses (as derived from Nordtest Method NT ACOU 112 [7]) and 3dB correction for intermittency this would provide a 9 dB difference. The 10 dB difference between the west and east façade noise level predictions would potentially give rise to predicted internal noise levels circa 20 dBA for bedrooms and 25 dBA for living rooms, thus being compliant with the advice provided in BS8233 that advises if the noise has a specific character “*lower noise limits might be appropriate*”.

Noise levels external to the building will obviously not be reduced by the above proposed approach.

8.0 With-scheme Noise Levels

Due to the layout of the proposed scheme it is evident that noise levels will be subject to variation at the front and rear of the building, being affected by source-receiver distance, screening due to the proposed building itself, reflection effects and so forth.

To determine noise levels across the application site attributable to ground based transportation sources (road), a detailed three-dimensional computer model of the locality has been constructed using CadnaA software, which implements the procedures contained in a number of pertinent documents including Calculation of Road Traffic Noise (CRTN), and ISO 9613-2: Acoustics to Abatement of sound propagation outdoors, Part 2: General method of calculation, etc.

The measurement data obtained during the surveys has been input to the model to assess how ground-based transport noise will propagate across the proposed scheme. In addition, the servicing noise of Lidl predicted has been input into the model.

In order to quantify such effects in relation to the measurement positions, a detailed three-dimensional computer model of the locality has been constructed using CadnaA software, illustrated in Figure 3 (rendered view) for the “with-scheme” situation.

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Figure 3: 3D Screenshot of CadnaA 3D model of the site, viewed from south-east at a height of 75m



Building evaluation has subsequently been undertaken to determine day, night L_{Aeq} and night L_{AFmax} noise levels on a facade-by-facade basis, Figures 4, 5 and 6 refer accordingly. For brevity, noise levels illustrated are the worst case and thus are independent of storey height.

Figure 4: Predicted with-scheme Façade $L_{Aeq,16h}$ Noise Levels day



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Figure 5: Predicted With-scheme Façade LAeq,8h Noise Levels night

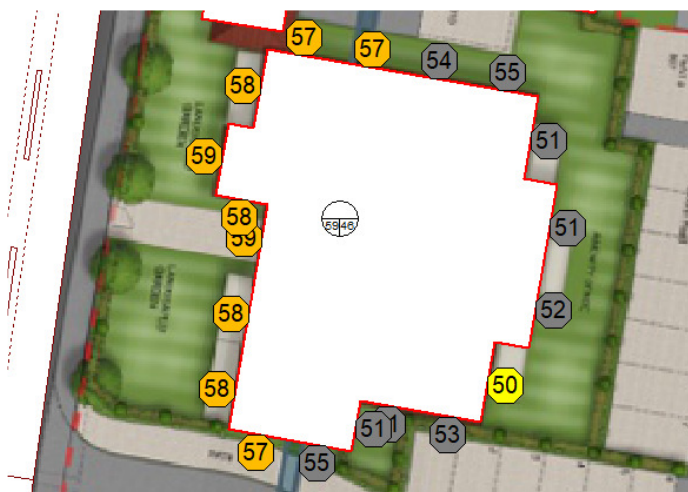
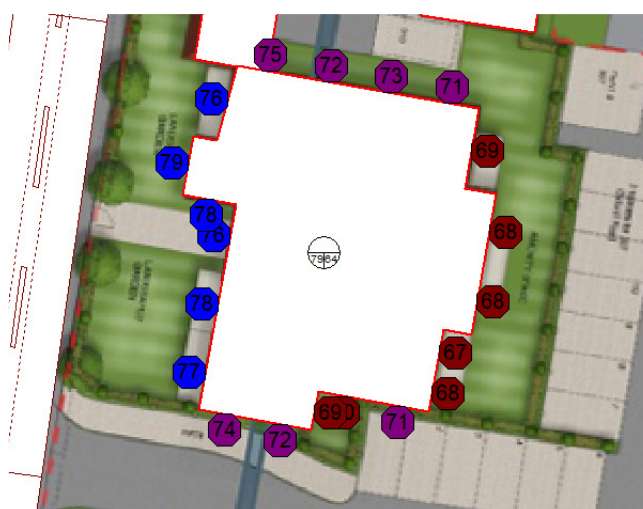


Figure 6: Predicted With-scheme Façade LAFmax Noise Levels night



The processed measurement data discussed above have been used as input emission values for the road network. Day and night LAeq and night LAFmax noise levels have been computed for the “with scheme” situation and represent noise levels at 1 metre from the façade of the proposed building.

For the calculation purposes, two orders of mirror source reflection have been allowed for using ray tracing as opposed to the uniform +1.5 dB reflection allowance given in CRTN. Experience has shown that this approach more accurately models noise propagation in situations where multiple plane reflecting surfaces are present and thus better assesses the “worst-case”.

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9.0 Facade Sound Insulation

The overall building envelope sound insulation requirements may be quantified using appropriate single figure quantities such as those described below.

Table 5: Sound Insulation Descriptors

Quantity	Definition	Description
R	Sound Reduction Index	The sound reduction index R is a property of the building element, independent of its surface area and absorption within the receiving room. R is obtained from the results of Laboratory tests, thus eliminating flanking transmission, such that the sound insulation performance of the test sample only is established.
R_w	Weighted Sound Reduction Index	Single figure sound insulation value derived from the measured sound reduction index R .
$D_{2m,nT}$	Standardised level difference	The difference between the outdoor sound pressure level at 2m and the sound level in the receiving room, corresponding to a reference value of the reverberation time.
$D_{2m,nT,w}$	Weighted, standardised level difference	Single figure sound insulation value derived from the Standardised level difference
$C; C_{tr}$	Spectrum adaptation terms 1 & 2. Used with single figure ratings as defined by ISO717-1:1996	C - calculated with spectrum No. 1 (A-weighted pink noise); C_{tr} - calculated with spectrum No. 2 (A-weighted urban traffic noise). The spectra of most commonly encountered indoor and outdoor noise sources lie in the range of spectra Nos. 1 and 2; the spectrum adaptation terms C and C_{tr} may therefore be used to characterize sound insulation with respect to many types of noise.

10.0 Outline Building Envelope Sound Insulation Performance

To determine the sound insulation requirements of the constituent facade elements detailed calculations to BS EN 12354-3 (or alternatively as per BS 8233:2014) will need to be undertaken **at an appropriate stage of the project**.

However, to demonstrate that external noise ingress may be adequately attenuated, the overall facade sound insulation requirement has been determined using single figure quantities, in this case $R_w + C_{tr}$ has been used where R_w is the Weighted Sound Reduction Index and C_{tr} is the spectrum adaptation term.

Based on the total site noise levels illustrated by Figures 4, 5 and 6 above, the outline facade sound insulation performances for the scheme are given in Table 6.

Section 7.2 provides the consideration as to why all facades including the east façade shall be designed to the worst-case external noise level. As such, the following façade sound insulation requirements are presented on the basis that living and bedroom spaces may be exposed to noise incident on all of the building facades, with the facades on the east potentially achieving lower internal noise criteria as a result:

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Table 6: Outline Façade Sound Insulation Requirement

Building Elevation	Space	Design intent		Predicted Noise exposure (worst case figures on façade used)		Target** Outline Façade Sound Insulation Requirement $R_w + C_{tr}$
		$L_{Aeq,T}$	L_{AFmax}	$L_{Aeq,T}$	L_{AFmax}	
All, including roof structures	Living room	35	-	67 dB	-	32 dB
	Bedroom	30	45	59 dB	79 dB	34 dB

Notes:

Day time reference time interval T = 16 hours (07:00 to 23:00)

Night-time reference time interval T = 8 hours (23:00 to 07:00)

Examination of Table 6 shows a worst-case facade sound insulation requirement of $R_w + C_{tr} = 34$ dB. Acoustic performances can in theory be maintained by suitably selected building constructions of the walls, roof, ventilation products and glazing systems. Experience of comparable projects has shown that the required $R_w + C_{tr}$ values identified in Table 6 are achievable for glazed elements.

An example of a roof structure that is capable of achieving dB $R_w + C_{tr}$ values provided in Table 6 is provided as follows:

- 14mm thick roofing tiles (2392Kg/m³ density) on 150mm deep joists (minimum) with min 75mm thick mineral wool (min 16kg/m³ density). British Gypsum Resilient Bars to the inside face of joists. 2 number layers of 12.5mm thick British gypsum SoundBloc fixed to the inner surface on the resilient bars and skimmed.

An example of a wall structure that is capable of achieving dB $R_w + C_{tr}$ values provided in Table 6 is provided as follows:

- 1 x 70.0 mm Brick + Butterfly Tie + 100 mm Rockwool (33kg/m³ density) + 1 x 140.0 mm Concrete Block. Finish to inner surface

NB: These examples are based on acoustic assessment of noise transfer from external areas to internal areas only. All other matters such as structural, weathering, fire resistance, moisture resistance etc are to be considered by others. PIR insulation shall not be used as this acoustically couples the inner and outer mass layers of the structure. Structures may require enhancement to minimise noise flanking between flats in order to meet the requirements of the Building Regulations Document E which should be assessed by a suitably qualified consultant at the appropriate stage of the project. **All** structures must be subject to a final assessment at RIBA stages 3 and 4 to be undertaken in conjunction with the glazing acoustic performance requirements.

The Reading Borough Council Pre-application advice document provided by the Local Authority states that non-openable windows are not considered an acceptable solution due to the impact on living standards. It is confirmed that internal noise criteria cannot be maintained with the windows open.

The glazing and ventilation are discussed in the following Sections.

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10.1 Glazing

Examination of Figures 6 shows worst case target façade $R_w + C_{tr}$ value of 33 dB. Based on Saint Gobain published data, the values of the glazing could potentially be attained by the following example glazing configurations (please note that the glazing is only one component of any window system^[B]):

6 (15) 8.8A	[Glass mm (Airgap mm Glass mm)]
6 (12) 9.5 A	[Glass mm (Airgap mm Glass mm)]
6 (12) 8.8	[Glass mm (Airgap mm Glass mm)]
10 (12) 10.8	[Glass mm (Airgap mm Glass mm)]
6.8A (15) 6.8A	[Glass mm (Airgap mm Glass mm)]

An 'A' after the glazing configuration denotes the use of SGG Stadip Silence acoustic laminate glass.

^[B] For avoidance of doubt, the acoustic performance specification relates to the glazing system which is hereby duly defined as the parts, components, hardware, and/or accessories that yield a complete, fully functional assembly.

Trickle vents shall not be used within window systems.

The performance of the system will depend on many factors such as the glazing configuration, size of window panels, quality of framing, quality of sealing, etc. It should be noted that that identical sound insulation is obtained irrespective of which way round insulating units are installed. Thus, for example a 6/12/6.4pvb unit gives the same performance as a 6.4pvb/12/6 unit. Over the usual cavity width range of 6 to 20mm for insulating units, there is little variation in acoustic performance although there is a more significant change in thermal insulation. This acoustic performance plateau is due to the relatively strong coupling of the component glasses.

In practice, glazed elements may not need to fully attain these targets as the external elevation will not comprise 100% fenestration area to day spaces and bedrooms. This shall be assessed at RIBA stages 3 -4.

Single number quantities for sound insulation shall be derived in accordance with BS EN ISO 717-1: 1997 Acoustics – Rating of sound insulation in buildings and of building elements Part 1: Airborne sound insulation and should include relevant spectrum adaptation terms.

A detailed specification for façade sound insulation across the whole scheme shall be developed at an appropriate stage of the project by a suitably qualified acoustic consultant, i.e., RIBA works stages 3 and 4.

11.0 Ventilation

The Reading Borough Council Pre-application advice advises the following:

“Ventilation measures should be selected which do not allow unacceptable noise ingress and should provide sufficient ventilation to avoid the need to open windows in hot weather, however non-openable windows are not considered an acceptable solution due to the impact on living standards”

This practice is not able to select ventilation measures, as this is beyond the area of expertise of the practice. However, the general acoustic principles are discussed to allow others to consider.

It is suggested that continuous mechanical supply and extract with heat recovery (System 4 - MVHR) and cooling (if necessary) be used. Background ventilators are not required with system 4. It is understood that System 4 - MVHR provides background ventilation. At the appropriate stage of the project others are to assess whether ventilation / cooling is required

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for an 'overheating condition' influenced by the location, orientation, type and design of the building and may be required for sustained periods of time, or not at all, depending on the overheating risk.

The Reading Borough Council Pre-application document advises that "*non-openable windows are not considered an acceptable solution due to the impact on living standards*". It is reiterated that the internal noise limits given in the pre-application document will not be achieved with windows open.

It is noted that Approved document F advises that adequate purge ventilation may be achieved by the use of openable windows and /or doors. The Association of Noise Consultants document Acoustics Ventilation and Overheating RESIDENTIAL DESIGN GUIDE Draft for consultation dated February 2018 confirms that for Purge Ventilation no desirable noise levels are currently proposed based on the lack of evidence of acceptable noise levels when providing purge ventilation for the purpose of rapidly diluting indoor pollutants. As such, the Local Authority may consider that openable windows could potentially be used for purge ventilation.

Any such system shall be designed by others such that the systems do not undermine the building envelope acoustic properties discussed herein, and any external equipment used shall be suitably attenuated in order to give a low adverse impact to the occupiers of all properties.

The ventilation shall be by means of a continuous mechanical supply and extract with heat recovery (MVHR) and cooling (where deemed necessary). The specialist contractor shall ensure that self-generated noise from the mechanical ventilation system meets the guidance given at paragraph 4.3.6 of Approved Document F 2010 and that attenuators are incorporated to reduce external noise sources to appropriate internal levels. The ventilation system shall be designed such that its overall noise level contribution in any living room is no more than 25 dB(A), and in any bedroom no more than 20 dB(A). This includes the combined, total noise levels due to self-generated noise from powered elements, aerodynamic noise, external noise ingress via the system itself and break-out noise levels.

12.0 External Amenity Spaces

The Reading Borough Council Pre-application advise advised:

"The noise assessment will be assessed against the recommendations for internal noise levels within dwellings and external noise levels within gardens / balconies in accordance with BS 8233:2014 and WHO guidelines for Community Noise. The report should identify any mitigation measures that are necessary to ensure that the recommended standard is met."

The Table in the Pre-application advise advises the following:

Room	Design criteria	Upper limit
Bedrooms (23:00 to 07:00)	<30dB LAeq,8hour	
Living rooms (07:00 - 23:00)	<35dB LAeq,16hour	
Gardens & Balconies	<50dB LAeq,T	<55dB LAeq,T

BS 8233:2014 Guidance on sound insulation and noise reduction for buildings advises:

7.7.3.2 Design criteria for external noise

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 LAeq,T, with an upper guideline value of 55 dB LAeq,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

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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.....

Whilst the noise limits of 50dB LAeq (upper limit 55dB LAeq) cannot be achieved at the front of the property (west side of the property) it is noted that BS8233 advises:

“.....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”

The development is considered desirable, and the site lies in an urban area adjoining strategic transport networks, therefore it is argued that in the space at the front of the property may be acceptable to the Local Authority when considering these factors. It is recommended that this information be forwarded to the Local Authority for their consideration.

With regard to the amenity space to the east of the main building proposed, sample point prediction of noise levels in the amenity space at 1.5m above ground level have been undertaken. The following CadnaA model screenshot provides predicted noise levels in the rectangular markers.

Figure 7: Predicted With-Scheme Daytime Amenity Space Noise Levels To The East Of The Building



It will be seen that the predicted levels at sample positions range 51-55 dB, therefore being in line with the Reading Borough Council Pre-application upper limit advise

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In terms of the roof terrace, the predictions indicate that the noise levels will be in the order 53-55 dBA, therefore being in line with the Reading Borough Council Pre-application upper limit advise

13.0 Conclusions

A detailed review of facade sound insulation requirements has been carried in respect of Development of land at the rear of 303-313 Oxford Road & 3 Western Elms Ave, Reading RG30 1AU.

It is concluded that subject to adoption of the recommendations set out herein, external noise ingress to internal areas with windows closed should be controlled to values as per the guidance provided in the pre-application as set out in BS 8233:2014 and hence adequate internal residential amenity should in principle prevail. Details of the ventilation assessment have been provided for the Local Authority consideration.

Comments have been provided regarding external amenity space predicted noise levels for the Local Authority consideration.

Sufficient information is considered to be presented herein to allow Reading Borough Council to technically review the proposals.

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