

Noise Assessment

S Wokingham Parcel R10
Land South of Waterloo Crescent

February 2025

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1. Introduction

Client & Project

- 1.1 Phlorum Limited have been commissioned by Miller Homes to undertake a noise and vibration assessment to discharge condition 40 for a residential development at South Wokingham, Parcel R10, Land South of Waterloo Crescent. The proposal is for 215 residential units.

- 1.2 Condition 40 states that:

"The reserved matters for any phase of the development which includes noise sensitive premises shall be accompanied by a Noise Mitigation Plan demonstrating how appropriate internal and external noise levels will be achieved."

- 1.3 The existing noise and vibration climate at the site has been established by direct measurement and the future noise impact by noise modelling. The suitability of the site for the proposed development has been considered against national and local planning policy, and guidelines on noise and vibration. Where necessary, mitigation measures have been recommended so that a noise climate suitable for the proposed development can be achieved.
- 1.4 Whilst reasonable efforts have been made to produce a report that is easy to understand, it is technical in nature. To assist the reader, an introduction to noise, and an explanation of the terminology used in this report are contained in Appendix A.

2. Site Description

Existing Site Conditions

- 2.1 The existing site for Parcel R10 has a northern boundary with a railway line and a western boundary with William Heelas Way, which is elevated as it passes over the railway lines. There are isolated residential and commercial properties to the south of the site and some commercial/industrial operations approx. 180m from the eastern boundary.
- 2.2 The existing noise at the site was observed to include a contribution from local traffic, trains, aircraft and children playing in the school playground on the far side of the railway.
- 2.3 A Location Plan showing the noise & vibration measurement locations is included as Figure 1 and the Site Layout is shown on Figure 2.

3. Guidance

Local Authority

- 3.1 The Wokingham Borough Council (WBC) Borough Design Guide, Supplementary Planning Document, June 2012 discusses noise for residential development in general terms but does not specify any local guidance or target levels for noise from residential developments and so the guidance and noise targets provided in ProPG: Planning & Noise and BS8233:2014 have been used to assess the noise impact of the development and to determine appropriate noise mitigation measures. The following noise criteria applies:
- 👁 Bedrooms - 30dB $L_{Aeq,8hr}$ (23:00 to 07:00 hours);
 - 👁 Living rooms - 35dB $L_{Aeq,16hr}$ (07:00 to 23:00 hours); and
 - 👁 All habitable rooms - 45dB L_{Amax} (not to be exceeded more than ten times per night).
- 3.2 Policy CC06: Noise of the Wokingham Managing Development Delivery Local Plan (2014) provides the following policies relating to noise:

Proposals must demonstrate how they have addressed noise impacts to protect noise sensitive receptors (both existing and proposed) from noise impacts in line with Appendix 1 of the Management Development Delivery Local Plan (MDD).

Noise impact of the development must be assessed. Where there is no adverse impact (No Observed Effect Level) then noise will be a material consideration.

Where there is an adverse effect (Lowest Observed Adverse Effect Level to Significant Observed Adverse Effect level), then

The development layout must be reviewed. Where this results in there no longer being an adverse impact then design and mitigation measures should be incorporated accordingly.

Where there is still an adverse impact then internal layout must be reviewed. Where this results in there no longer being an adverse impact then design and measures should be incorporated accordingly.

Where there is still an adverse impact then physical mitigation measures such as barriers/mechanical ventilation must be reviewed. Where this results in there no longer

being an adverse impact then design and measures should be incorporated accordingly.

Where there is still an adverse impact and the development falls within significant observed adverse effect level then planning permission will normally be refused.

- 3.3 The MDD also states that Policy CC06: Noise should be read alongside policy CP1 – Sustainable Development (specifically criterion 8) of the Core strategy, which states that:

8) Avoid areas where pollution (including noise may impact upon the amenity of future occupiers.

National Planning Policy Framework

- 3.4 The Department for Communities and Local Government published the *National Planning Policy Framework* (NPPF) on 27th March 2012 and upon its publication, the majority of planning policy statements and guidance notes were withdrawn, including Planning Policy Guidance (PPG) 24 *Planning and Noise*, which until the emergence of the NPPF, set out the Government's position on how noise should be dealt with in the planning system.
- 3.5 The NPPF was revised on 24th July 2018, with the earlier 2012 version immediately withdrawn. The latest update was published in December 2024.
- 3.6 The general guiding principle in the NPPF is contained in Section 15 under the heading Conserving and enhancing the natural environment. Paragraph 187 states:

"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;"

- 3.7 The noise planning policy is contained in paragraph 198, which also appears in Section 15 of the NPPF:

"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as

the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

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

b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason;”

- 3.8 A footnote to paragraph 198 refers to the Explanatory Note of the Noise Policy Statement for England (Department for Environment, Food & Rural Affairs, 2010), which defines both “*significant adverse impacts on health and quality of life*” and “*adverse impacts on health and quality of life*”.

Noise Policy Statement for England

- 3.9 The Department for Environment, Food and Rural Affairs published the *Noise Policy Statement for England* (NPSE) in March 2010. The explanatory note of the NPSE defines the terms used in the NPPF:

“2.20 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.

2.21 Extending these concepts for the purpose of this NPSE leads to the concept of a significant observed adverse effect level.

SOAEL – Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur.”

- 3.10 The NPSE does not define the SOAEL numerically, stating at paragraph 2.22:

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

- 3.11 There is no local or national guidance on how the three terms should be defined numerically.
- 3.12 There are three aims in the NPSE, two of which expand upon the first bullet point in paragraph 180 of the NPPF:

"The first aim of the Noise Policy Statement for England

Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

2.23 The first aim of the NPSE states that significant adverse effects on health and quality of life should be avoided while also taking into account the guiding principles of sustainable development (paragraph 1.8).

The second aim of the Noise Policy Statement for England

Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

2.24 The second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It requires that 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 (paragraph 1.8). This does not mean that such adverse effects cannot occur.

The third aim of the Noise Policy Statement for England

Where possible, contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

2.25 This aim seeks, where possible, positively to improve health and quality of life through the pro-active management of noise while also taking into account the guiding principles of sustainable development (paragraph 1.8), recognising that there will be opportunities for such measures to be taken and that they will deliver potential benefits to society. The protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim.”

Planning Practice Guidance

3.13 In March 2014, the Government released Planning Practice Guidance (PPG) on noise, entitled ‘Noise’. This document sets out a number of principles in the form of questions and answers, and reinforces the guidance set out in the NPPF and the NPSE. The noise PPG was last updated in December 2014.

3.14 The noise PPG notes that:

“Noise needs to be considered when new development may create additional noise and when new developments would be sensitive to the prevailing acoustic environment.”

3.15 It goes on to note that:

“Local planning authorities’ plan-making and decision taking should take account of the acoustic environment and in doing so consider:

• *whether or not a significant adverse effect is occurring or likely to occur;*

• *whether or not an adverse effect is occurring or likely to occur; and*

• *whether or not a good standard of amenity can be achieved.”*

3.16 The noise PPG broadly repeats the NPSE definitions of the NOEL, LOAEL and SOAEL and it provides a summary table to explain how the terms relate to each other and to typical human reactions to sound. The table is replicated below in Table 3.1.

Table 3.1 Planning Practice Guidance summary of noise exposure hierarchy

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	No observed adverse effect	No specific measures required

Perception	Examples of Outcomes	Increasing Effect Level	Action
	acoustic character of the area but not such that there is a perceived change in the quality of life.		
		Lowest observed adverse effect level	
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
		Significant observed adverse effect level	
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 the windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting back 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

- 3.17 It is noted that the text in paragraph 005 of the PPG for noise reiterates the point illustrated in Table 3.1, that there are degrees of adverse effect above the SOAEL. Table 3.1 defines two degrees of significant adverse effect: a significant observed adverse effect, which is deemed noticeable and disruptive, and an unacceptable adverse effect, which is deemed noticeable and very disruptive.
- 3.18 The distinction between these two degrees of significant adverse effect is expanded upon in the text in paragraph 005 of the PPG for noise:

“005 Increasing noise exposure will at some point cause the significant observed adverse effect level boundary to be crossed. Above this level the 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. If the exposure is above this level the planning process should be used to avoid this effect occurring, by use of appropriate mitigation such as by altering the design and layout. Such decisions must be made taking account of the economic and social benefit of the activity causing the noise, but it is undesirable for such exposure to be caused.

At the highest extreme, noise exposure would cause extensive and sustained changes in behaviour without an ability to mitigate the effect of noise. The impacts on health and quality of life are such that regardless of the benefits of the activity causing the noise, this situation should be prevented from occurring.”

- 3.19 The PPG, which is the most recent manifestation of Government advice on how noise should be treated within the planning system, as opposed to a policy position as stated in the more recent NPPF, is clear that a significant adverse effect, which lies above the SOAEL but below an unacceptable adverse effect, can be addressed (or ‘avoided’ in the terms of the PPG) through the provision of mitigation, including noise insulation; it is not until an unacceptable adverse effect is reached that the cause of the effect should be prevented.
- 3.20 The noise PPG provides advice on how to mitigate the effects of noise, noting that there are options to reduce noise at source, to optimise site layouts, to use planning conditions, and provide insulation within affected properties.
- 3.21 The noise PPG also notes that:

“The noise impact may be partially offset if the residents of those dwellings have access to:

- a relatively quiet façade (containing windows to habitable rooms) as part of their dwelling, and/or*
- a relatively quiet external amenity space for their sole use, (e.g. a garden or balcony). Although the existence of a garden or balcony is generally desirable,*

the intended benefits will be reduced with increasing noise exposure and could be such that significant adverse effects occur, and/or

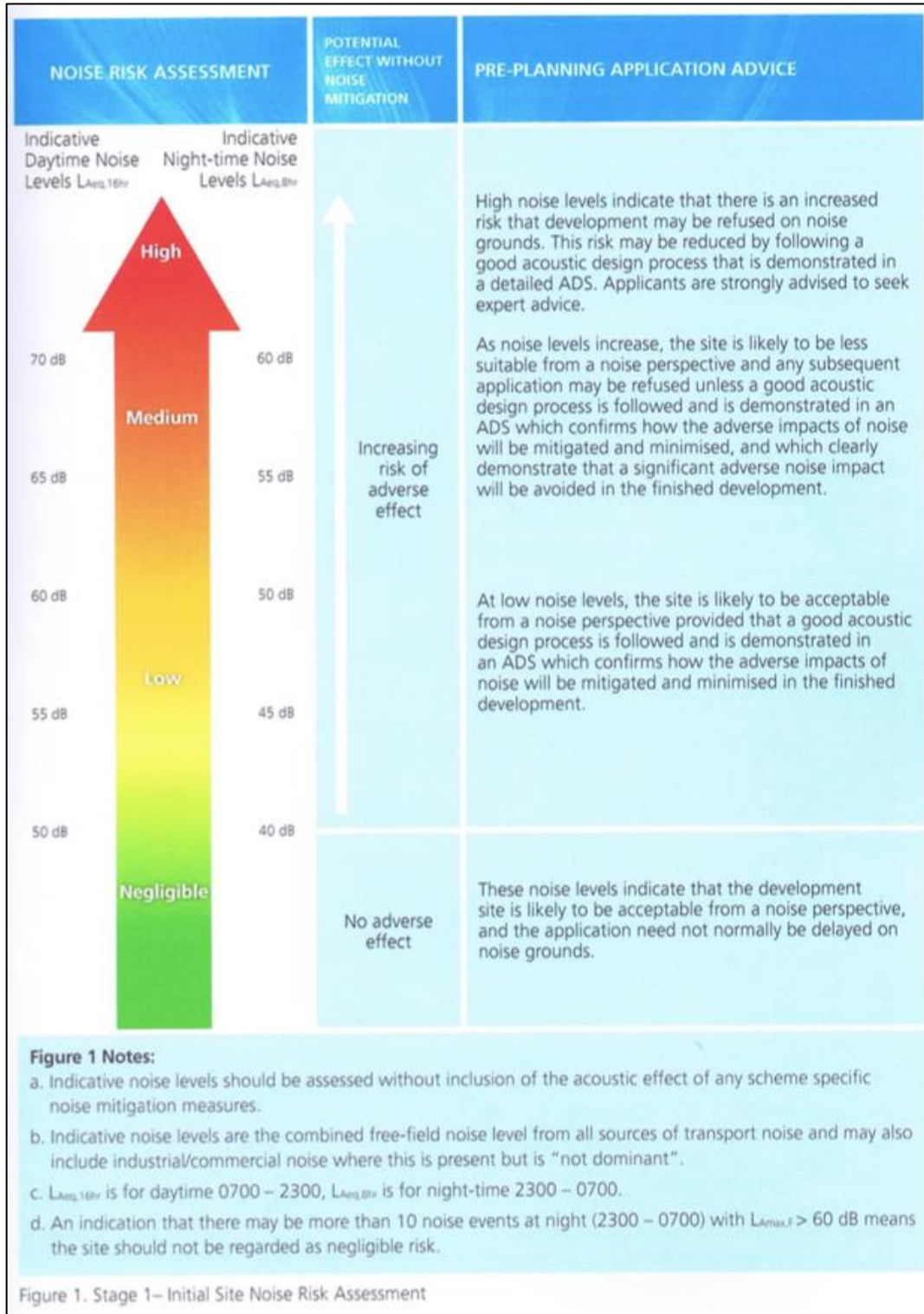
- ☞ *a relatively quiet, protected, nearby external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings, and/or*
- ☞ *a relatively quiet, protected, external publically accessible amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5 minutes walking distance)."*

ProPG

- 3.22 *Professional Practice Guidance on Planning and Noise* (ProPG) was released in May 2017. A joint publication by the Chartered Institute of Environmental Health, the Institute of Acoustics, and the Association of Noise Consultants, the document sets out a recommended approach for the management of noise within the planning system in England.
- 3.23 ProPG sets out a two-stage risk based approach for new residential development:
- ☞ **Stage 1:** initial noise risk assessment of the proposed development;
 - ☞ **Stage 2:** a systematic consideration of four key elements:
 - Element 1: demonstrating a 'Good Acoustic Design Process';
 - Element 2: observing internal 'Noise Level Guidelines';
 - Element 3: undertaking an 'External Amenity Area Noise Assessment'; and
 - Element 4: consideration of 'Other Relevant Issues'.
- 3.24 The Stage 1 initial noise risk assessment should provide an indication of the likely risk of adverse effects from noise should no mitigation be included as part of the development proposals.
- 3.25 ProPG provides an illustrative noise risk scale, derived from current guidelines values and experience. The scale suggests that the risks are negligible where noise levels are below 50dB L_{Aeq} during the daytime and 40dB L_{Aeq} during the night-time. The scale suggests that a site would start to tend from a medium to a high risk when noise levels are above approximately 70dB L_{Aeq} during the daytime and above approximately 60dB L_{Aeq} during the night-time. Between these values, the level of risk increases through low to medium as noise levels increase. These values are all stated as indicative in the ProPG.
- 3.26 The ProPG states that this initial noise risk assessment is intended to support wider Government planning and noise policies and guidance, i.e. the NPPF, NPSE and PPG-Noise.

3.27 Figure 1 of the ProPG, which is replicated here as Figure 3, presents the risk hierarchy, with indicative noise levels that broadly equate to the different risk categories.

Figure 3: ProPG Stage 1 Risk Assessment



- 3.28 The Stage 2 full assessment should consider good acoustic design, internal noise levels, external amenity area noise levels, and assessment of any other issues.
- 3.29 The ProPG states that good acoustic design should consider factors such as reducing noise at source, site layouts, and building orientation. Solely relying on the sound insulation of building fabric to achieve acceptable acoustic conditions is not considered good acoustic design. Noise control measures should be considered against other requirements, such as ventilation, fire regulation and cost.
- 3.30 The ProPG refers to the criteria set out in BS8233: 2014 and the World Health Organisation's *Guidelines for Community Noise* for internal noise levels and noise levels in external amenity areas. The ProPG notes that internal noise levels should always be considered alongside requirements for ventilation and overheating. Note 5 under Figure 2 in the ProPG, which sets out the internal noise level guidelines replicated from BS8233: 2014 and the WHO guidelines, states:

"Designing the site layout and the dwellings so that the internal target levels can be achieved with open windows in as many properties as possible demonstrates good acoustic design. Where it is not possible to meet internal target levels with windows open, internal noise levels can be assessed with windows closed, however any façade openings used to provide whole dwelling ventilation (e.g. trickle ventilators) should be assessed in the "open" position and, in this scenario, the internal LAeq target levels should not normally be exceeded, subject to the further advice in Note 7."

- 3.31 It is clear that the internal noise guidelines should be met for 'whole dwelling ventilation' conditions, which are effectively background ventilation. 'Whole dwelling ventilation' is defined in Approved Document F of the Building Regulations 2010.
- 3.32 Note 7 under Figure 2 of the ProPG states:

"Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal LAeq target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved."

- 3.33 The ProPG allows for the relaxation of the internal guideline noise levels by up to 5dB and the internal noise levels would still be regarded as reasonable.
- 3.34 For 'purge ventilation' conditions, the ProPG does not specify internal noise criteria, stating at paragraph 2.35:

"It should also be noted that the internal noise level guidelines are generally not applicable under "purge ventilation" conditions as defined by Building Regulations Approved Document F, as this should only occur occasionally (e.g. to remove odour from painting and decorating or from burnt food)."

- 3.35 For thermal control, i.e. overheating conditions, ProPG states that the potential noise levels should be assessed, stating at paragraph 2.38:

"Where mechanical services are used as part of the ventilation or thermal comfort strategy for the scheme, the impact of noise generated by these systems on occupants should also be assessed."

- 3.36 The ProPG goes on to state in paragraph 2.72(h):

"Reasonable steps should be taken to minimise overheating during summer months through good design. Where openable windows / ventilators are proposed to mitigate overheating and where the internal noise level guidelines are likely to be exceeded when they are open a more detailed assessment of the potential impact on occupants during the overheating condition should be provided in the ADS. This more detailed assessment may include: (i) the alternative design measures considered / applied to reduce noise impact on occupants, (ii) the expected internal noise levels when windows / ventilators are opened to provide relief from overheating, and (iii) an estimate of the amount of time that windows are likely to be open to provide relief from overheating."

- 3.37 Consideration of overheating issues is outside the scope of this noise assessment. However, it is clear that while the ProPG does require internal noise levels to be considered under thermal control conditions, no internal noise criteria are applied.
- 3.38 The ProPG states that other relevant issues include compliance with relevant national and local policies, magnitude of compliance with the ProPG itself, the likely occupants of the development, acoustic design against unintended adverse consequences and acoustic design against wider planning objectives.

British Standard 8233

- 3.39 The scope of British Standard (BS) 8233: 2014 *Guidance on sound insulation and noise reduction for buildings* is the provision of recommendations for the control of noise in and around buildings. It suggests appropriate criteria and limits for different situations, which are primarily intended to guide the design of new or refurbished buildings undergoing a change of use rather than to assess the effect of changes in the external noise climate.
- 3.40 BS8233: 2014 suggests suitable internal noise levels within different types of buildings, including residential dwellings, as shown in Table 3.2.

Table 3.2: BS8233 recommended internal noise levels, dB

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35dB LAeq,16hour	-
Dining	Dining room/area	40dB LAeq,16hour	-
Sleeping (daytime resting)	Bedroom	35dB LAeq,16hour	30dB LAeq,8hour

- 3.41 BS8233 contains the following relevant guidance in footnotes to the above information:

"Note 4: Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or LAmax,F, depending on the character and number of events per night. Sporadic noise events could require separate values.

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

Note 7: 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."

- 3.42 Although Note 4 above refers to setting a guideline value for maximum noise levels, BS8233: 2014 does not provide any guidance on a suitable criterion.
- 3.43 Placing the BS8233: 2014 guidance into the context required by the NPPF and the NPSE, it is considered that where the internal noise levels meet the guideline values set out in Table 3.2, there is considered to be no observed effect.
- 3.44 Since BS8233: 2014 allows for a 5dB relaxation in the guideline values in Table 3.2 (Note 7 above), it is considered that internal noise levels up to 5dB above the guideline values in Table 3.2 may still be acceptable.
- 3.45 Section 7.7.3.2 of BS8233, titled Design criteria for external noise states:

"For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50dB LAeq,T, with an

upper guideline value of 55dB LAeq,T which would be acceptable in noisier environments."

- 3.46 BS8233: 2014 goes on to note that the upper guideline value may be exceeded in certain circumstances:

"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."

- 3.47 Achieving the lowest practicable noise levels in gardens is deemed acceptable in BS8233: 2014 in circumstances where development is needed in areas where the upper 55dB limit cannot be achieved.
- 3.48 As BS8233: 2014 states that it is desirable that garden noise levels do not exceed 50dB LAeq,T, this implies some adverse effect above this level. Therefore, an external daytime noise level of 50dB LAeq,16hrs can be defined as the LOAEL.
- 3.49 However, it would not be appropriate to equate the 55dB criterion with the SOAEL, since it is clear from BS8233: 2014 that 55dB is not a threshold that should never be exceeded. Equating the 55dB criterion to the SOAEL would mean that, in national policy terms, exceeding this threshold should be avoided, which is not what the standard requires.

World Health Organisation

- 3.50 The World Health Organisation (WHO) *Guidelines for Community Noise* (1999) also sets out guidance on suitable internal and external noise levels in and around residential properties. The guidance on internal and external noise levels is the same as set out in BS8233: 2014 in terms of LAeq values, but the WHO guidelines also provide guidance on night-time maximum noise levels, stating:

"For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB LAFmax more than 10-15 times per night."

- 3.51 The WHO guidelines suggest the possibility of sleep disturbance if continuous noise in bedrooms exceeds 30dB $L_{Aeq,8hrs}$ during the night-time, and therefore internal noise levels above this value can be considered to be above the LOAEL. This internal value can be translated to an external value by the addition of 10dB, to account for the typical reduction through an open window. Therefore, external night-time noise levels of 40dB $L_{Aeq,8hrs}$ can be defined as the LOAEL.
- 3.52 The WHO published their *Night Noise Guidelines for Europe* in 2009. This document sets an external 'night noise guideline' (NNG) of 40dB. This is consistent with the LOAEL value determined above. The NNG also sets an interim target of 55dB in situation where the 40dB value cannot be met. Above 55dB the NNG notes that the situation is considered increasingly dangerous for public health. On the basis of the above, a free-field external value of 55dB $L_{Aeq,8hrs}$ is considered to be the night-time SOAEL.

Noise Insulation Regulations

- 3.53 The Noise Insulation Regulations 1975 (as amended 1988) set out conditions, which if satisfied, require the promoter of a new road to offer affected residents sound insulation or a grant in respect of sound insulation.
- 3.54 Although legislation framed with reference to new roads is not directly relevant to the proposed development considered here, the noise levels at which sound insulation must be offered provide an indication of what constitutes a significant level of noise from these sources; these values may be used to define the level at which significant adverse effects occur, i.e. the SOAEL.
- 3.55 The Noise Insulation Regulations indicate that sound insulation should be offered when, inter alia, road traffic noise exceeds a façade noise level of 68dB $L_{A10,18hrs}$. This value can be converted to a 16 hour L_{Aeq} to match the form of the guidance recommended in BS8233 by subtracting 5dB. This correction includes a -3dB correction to remove the façade correction, a further -3dB correction to convert the 18 hour L_{A10} noise level to an 18 hour L_{Aeq} noise level, and a +1dB correction to convert the 18 hour L_{Aeq} to a 16 hour L_{Aeq} . The resulting value of 63dB $L_{Aeq,16hrs}$ is considered to be the daytime SOAEL.
- 3.56 Since noise levels of 63dB $L_{Aeq,16hrs}$ can be controlled through the provision of appropriate ventilation, as required by the Noise Insulation Regulations, it is reasonable to suggest that the point at which an unacceptable adverse effect occurs is higher than this value.
- 3.57 The sound insulation package specified in the Noise Insulation Regulations is known to give a sound reduction of approximately 35dB. At external noise levels in excess of 70dB at night the internal noise levels will exceed the reasonable criterion in BS8233 of 35dB. A noise level 1dB below this value is therefore taken to be the upper limit of acceptability for residential properties at night.

- 3.58 This 69dB $L_{Aeq,8hrs}$ limit has been converted to a free-field value of 66dB to be consistent with the free-field values used elsewhere in this report.
- 3.59 On this basis, and in the absence of any local definition, the point at which night-time noise levels result in an unacceptable adverse effect is considered to be 66dB $L_{Aeq,8hrs}$.

BRE Research Paper

- 3.60 A Building Research Establishment (BRE) survey titled *The effectiveness and acceptability of measures for insulating dwellings against traffic noise* (Utley W et al, Journal of Sound and Vibration (1986) Vol 109(1), pages 1-18) found that the insulation package supplied under the Noise Insulation Regulations is inadequate for road traffic noise levels of 78dB $L_{A10,18hrs}$ and above at a façade.
- 3.61 This figure is equivalent to a free-field level of 75dB $L_{A10,18hrs}$; which in turn is equivalent to 73dB $L_{Aeq,16hrs}$. If mitigation specified under the Noise Insulation Regulations becomes ineffectual at 73dB $L_{Aeq,16hrs}$, it can be concluded that 72dB $L_{Aeq,16hrs}$ is the highest noise level at which the mitigation remains effective.
- 3.62 On this basis, and in the absence of any local definition, the point at which daytime noise levels result in an unacceptable adverse effect is considered to be 72dB $L_{Aeq,16hrs}$.

Summary

- 3.63 The suitability of the site has been assessed in the following ways:
- ☞ Determining the external noise levels across the site, to compare with the LOAEL and SOAEL, as defined above. For clarity, the LOAEL and SOAEL adopted for this site are shown in Table 3.3; and
 - ☞ Calculating the sound reduction performances required of the external building fabric, particularly the glazing units, so that suitable internal noise levels are achieved;

Table 3.3: LOAEL and SOAEL for this site

Effect	Daytime L _{Aeq,16hrs} (dB)	Night-time L _{Aeq,8hrs} (dB)	Comments
No Observed Effect	<50	<40	The parts of the site that have noise levels below these values are considered acceptable for residential development without the need for further mitigation
LOAEL	50	40	
Observed Adverse Effect	50-55	40-45	Although the parts of the site that have noise levels between these values are above the LOAEL, BS8233 suggests that they would be acceptable.
	55-63	45-55	The parts of the site that have noise levels between these values are above the LOAEL, and are considered acceptable for residential development, although mitigation may be required.
SOAEL	63	55	
Significant Observed Adverse Effect	63-72	55-66	The parts of the site that have noise levels between these values are above the SOAEL but below the point at which an unacceptable adverse effect occurs. Planning policy states that Significant Adverse Effects should be avoided and the Noise PPG states that the planning process should be used to do this by use of appropriate mitigation.
Unacceptable Adverse Effect	>72	>66	The noise PPG states that this situation should be prevented; however, no indication is given of how to do this.
Notes: (1): Below these ranges adverse comment is not expected. (2): Above these ranges adverse comment is very likely.			

3.64 It is considered that the above values can also be related to the levels of risk described in the ProPG:

- ☞ noise levels below the LOAEL, i.e. below 50dB L_{Aeq,16hrs} during the daytime and below 40dB L_{Aeq,8hrs} during the night-time, are considered to be a negligible risk;

- ☞ noise levels above the LOAEL but below the SOAEL, i.e. between 50dB $L_{Aeq,16hrs}$ and 63dB $L_{Aeq,16hrs}$ during the daytime and between 40dB $L_{Aeq,8hrs}$ and 55dB $L_{Aeq,8hrs}$ during the night-time, are considered to range from a low to medium risk;
- ☞ noise levels above 63dB $L_{Aeq,16hrs}$ i.e. the SOAEL, but below 72dB $L_{Aeq,16hrs}$ during the daytime, and above 55dB $L_{Aeq,8hrs}$, i.e. the SOAEL, but below 66dB $L_{Aeq,8hrs}$ during the night-time, are considered to range from a medium to high risk; and
- ☞ noise levels that result in an unacceptable adverse effect, i.e. above 72dB $L_{Aeq,16hrs}$ during the daytime and above 66dB $L_{Aeq,8hrs}$ during the night-time, are considered to be a high risk.

3.65 The lower and upper ends of these ranges, representing negligible and high risks respectively, accord with the advice set out the ProPG.

Vibration

- 3.66 The vibration effects of the adjacent railway line have been assessed against the criteria provided in BS6472-1:2008.
- 3.67 BS6472-1:2008 Evaluation of human exposure to vibration in buildings. Part 1 contains a methodology for assessing the human response to vibration in terms of either the vibration dose value, or in terms of the acceleration or the peak velocity of the vibration, which is also referred to as peak particle velocity.
- 3.68 The advice contained in BS6472 states that when the vibration is intermittent, as is the case at this site, the vibration dose value, or VDV, may be used to assess the potential for impacts. The vibration dose value is a single figure descriptor that represents the cumulative dose of transient vibrations, taking into account the frequency spectrum and duration of each event.
- 3.69 The vibration dose value is determined over a 16 hour daytime period or 8 hour night-time period, and the guidance in BS6472 is set out as follows:

Table 3.4 - Vibration Dose Values (ms^{-1.75}) Above which Various Degrees of Adverse Comment may be Expected in Residential Buildings

Place and time	Low Probability of Adverse Comment	Adverse Comment Possible	Adverse Comment Probable
Residential Buildings 16 h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential Buildings 8 h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

- 3.70 The above guidance relates to vibration measured at the point of entry into the human body, which is usually taken to mean the ground surface or at a point mid-span of an upper storey floor, rather than the point of entry into the building, for example a foundation element. Where the vibration is measured at another location, BS6472 states that a transfer function should be applied; however, BS6472 does not contain any guidance on suitable transfer functions.
- 3.71 Transfer functions, after a correction for geometric spreading is applied, take into account the vibrational energy losses that occur with ground and foundations together with an amplification factor as the energy travels through the building to the mid-span of an upper storey floor. The value of the transfer functions will therefore depend on the soil, the type of foundations and the type of building (e.g. wooden or metal framed, masonry etc.) and the type of flooring.
- 3.72 Transfer functions have been referenced from the following sources:
- Handbook of Urban Rail Noise and Vibration Control (HURNVC), published by the Federal Transit Administration, USA, written by H J Saurenham, J T Nelson and G P Wilson (also reproduced in the Transportation Noise Reference Book (1987);
 - Methods For Predicting Groundborne Noise & Vibration From Trains In Tunnels, LARIF 1999 by Richard Greer; and
 - Transmission of Ground-borne Vibration in Buildings by Jorgen Jakobsen, Journal of Low Frequency Noise and Vibration, Vol. 8 No. 3, 1989.
- 3.73 In assessing the effect that the foundations may have, guidance has been sought from HURNVC. The HURNVC sets out attenuation factors that can be applied to calculate the transfer function between vibrations measured on unloaded ground and vibration at a foundation. It is noted that the multiplication factor for strip deep trench foundation is approximately -6 dB and for a piled foundation approximately -8dB (both based on the 31.5 Hz frequency band). For a conservative worst case scenario, -6 dB has been applied for foundation losses.
- 3.74 Greer advocates +10.2 dB and Jakobsen suggests a value of +15.5 dB for amplification on an upper storey suspended floor. For a conservative worst case scenario, +15.5 dB has been applied for amplification at the upper storey mid span floor level.
- 3.75 Taking the above into account gives an overall multiplication factor of 2.98 for a worst case scenario (a best case scenario would be 1.29).

4. Environmental Surveys

Noise

- 4.1 A noise survey was undertaken to establish typical sound levels at the site. The measurements were taken over a 48 hour period starting at 12:30 hours on Monday 28th October 2024 to provide the day and night-time noise levels at the site.
- 4.2 The survey methods and results are set out below.

Sound Survey Method

- 4.3 The equipment used during the survey is summarised in Appendix B. The sound level meter was field-calibrated immediately before and after the measurements using the listed acoustic calibrator. No significant calibration drifts were found to have occurred.
- 4.4 The sound level meter had been laboratory-calibrated to a traceable standard within the two years preceding the survey. The acoustic calibrator had been laboratory-calibrated to a traceable standard within the year preceding the survey.
- 4.5 Noise measurements were carried out at three 24 hour locations that were selected to represent the nearest proposed residential properties to the dominant noise sources and also selected for the security of the sound equipment. The measurement locations are described as follows:
- 👁 Position 1. The microphone was located in a free-field location on the northern boundary of the development site adjacent to the railway with the school on the far side of the railway. The mic was 1.5m above the ground and approx. 10m from the nearside rail line.
 - 👁 Position 2 The microphone was located in a free-field location approx. 32m from William Heelas Way. The mic was 1.5m above both the ground and approx. 2m below the road height (which rises to pass over the rail lines).
 - 👁 Position 3 The microphone was located in a free-field location approx. 11m from Waterloo Road. The mic was 1.5m above both the ground and level with the road height.

Sound Survey Results

- 4.6 The weather during the survey was suitable for noise measurement, it being dry with wind speeds of less than 5m/s.

- 4.7 The dominant sound source at position 1 was from trains and other sources included traffic on William Heelas Way, aircraft and occasional outdoor activities at the school. At positions 2 and 3 the noise was dominated by traffic on William Heelas Way and Waterloo Road with a contribution from trains and aircraft.
- 4.8 The sound survey results are summarised in Table 4.1, aggregated across the daytime and night-time periods. Full survey results are set out graphically in Appendix C.

Table 4.1 Summary of measured sound levels, free-field dB

Measurement Location	Date	Period	Duration, T	L _{Aeq,T}	L _{AFmax}	L _{A10,T}	L _{A90,T}
1	28 to 30 October 2024	Night	8 hours	56.5	64.3	38.8	32.3
		Day	16 hours	60.4	78.1	50.3	42.6
		Night	8 hours	55.1	56.1	41.4	35.3
2		Night	8 hours	35.6	61.0	31.3	24.8
		Day	16 hours	43.5	57.9	43.9	34.2
		Night	8 hours	35.5	46.3	36.1	29.3
3		Night	8 hours	41.0	56.7	34.3	26.8
		Day	16 hours	49.7	64.8	52.2	37.4
		Night	8 hours	41.1	52.8	38.8	31.9
Note: ⁽¹⁾ – The L _{A90,T} , L _{Amax} and L _{A10,T} and values are the arithmetic means of the L _{A90,T} , L _{Amax} and L _{A10,T} measurements for each period.							

- 4.9 The following free field noise levels have been used in the ProPG noise assessment of the existing noise:
- ☛ Daytime Noise Level – Position 1 L_{Aeq,16 hr} 60 dB, Position 2 L_{Aeq,16 hr} 44 dB, Position 3 L_{Aeq,16 hr} 50 dB.
 - ☛ Night-time noise level – Position 1 L_{Aeq,8 hr} 56 dB, Position 2 L_{Aeq,8 hr} 36 dB, Position 2 L_{Aeq,8 hr} 41 dB.
 - ☛ 10th highest maximum noise level at night – Position 1 L_{Amax,f} 78 dB, Position 2 L_{Amax,f} 69 dB, Position 3 L_{Amax,f} 59 dB (derived from the measured night-time noise levels shown in Appendix C).

Vibration

- 4.10 The baseline vibration measurements were undertaken alongside the noise meter at Position 1 over a 24-hour period with the geophone located approx. 10m from the nearside rail. This location is closer than the nearest proposed residential dwellings to the rail lines but was selected for reasons of equipment security and provides 'worst case' vibration levels. The vibration measurement location is shown on Figure 1.

- 4.11 The tri-axial vibration transducer was set up on the ground such that the Y-direction was parallel with the railway lines, the X-direction was perpendicular to the railway lines and the Z-direction was vertical.
- 4.12 The noise equipment comprised a Vibrock 901 Digital Seismograph with a Tri-axial Geophone. All equipment is within current manufacturer's periods of calibration. The V901 is a self-calibrating meter capable of simultaneously measuring vibration in the three orthogonal axes. The equipment, which has a frequency range of 1Hz to 200Hz, was set to record vibration dose values over the day and night-time periods in each orthogonal direction.
- 4.13 The transducers was firmly coupled to the ground and positioned such that there was no movement of the geophone. A summary of the measured VDV levels for the day and night-time periods is shown in Table 4.2, below.

Table 4.2 – Baseline Vibration Levels

Date	Period	Vibration Dose Value (VDV) $\text{ms}^{-1.75}$		
	Hours	X	Y	Z
28 & 29 Oct 2024	2300-0700	0.026	0.018	0.049
29 Oct 2024	0700-2300	0.027	0.022	0.080

- 4.14 Subjectively, the vibration from passing passenger trains was observed to be imperceptible at the site. The passenger trains speeds were observed to be around 50mph and the trains were observed to consist of 8 carriages.

5. Noise & Vibration Assessment

Existing Noise

- 5.1 The noise assessment has considered the existing noise climate against guidance and noise targets in ProPG: Planning and Noise.
- 5.2 At Position 1, located on the northern boundary of the site and 10m from the nearside rail an acoustic correction is required to the measured noise levels to account for the nearest residential properties being approx. 32m from the nearest rail. The correction accounts for the additional distance, assuming the rail line is the dominant noise and acts as a line source and provides 5 dB sound attenuation. The corrected daytime value of 55 dB $L_{Aeq,16h}$ and the corrected night-time value of 51 dB L_{Aeq8hr} are between the adopted LOAEL and SOAEL and the noise levels are considered acceptable for residential properties, although mitigation may be required.
- 5.3 At Position 2 the day and night-time values 44 dB $L_{Aeq,16hr}$ and 36 dB L_{Aeq8hr} respectively are below the adopted LOAEL and are considered acceptable for residential development without the need for further mitigation.
- 5.4 At Position 3 the day and night-time values 50 dB $L_{Aeq,16hr}$ and 41 dB L_{Aeq8hr} respectively are just above the adopted LOAEL and BS8233 suggests that noise would be acceptable for residential development.
- 5.5 In terms of the level of noise risk, as described in ProPG, it is considered that overall the site is between a negligible to low/medium risk.
- 5.6 The site is considered acceptable for residential use, subject to the incorporation of suitable mitigation, which is considered in the next section of this report.

Future Traffic Noise

- 5.7 The proposals include a new road through Parcel R10 as shown on Figure 2 and the existing Waterloo Road will be closed. The noise impact of the surrounding road network has been considered using IMMI noise modelling software, which takes the site topography and any intervening noise barriers into account. The model utilises the methodology outlined in ISO 9613 and takes into account the effects of geometric divergence, ground and atmospheric absorption and acoustic screening. The following assumptions have been used for the noise predictions:

- Traffic data has been provided by the projects traffic consultants for the future year 2036 including day and night flows, signed speeds and %HGV's.
- Acoustic fences have been included in the noise model and the locations and heights are shown on the Enclosures Layout Plan, Drg No P1914.R10.07, dated June 2024, Rev L, see Figure 4.
- Hard ground cover, 10 Degrees C; 70% RH.
- Site topography is a combination of client supplied data and EA lidar data.
- All sources are ISO 9613 with a downwind noise propagation.
- One degree of reflections off hard surfaces has been included in the noise model.

- 5.8 The traffic data for the future year of 2036 with the development has been provided by the transport consultants, Pegasus to provide a 'worst case' scenario for noise and the relevant traffic data for the noise model is shown in Table 5.1, below.

Table 5.1: Traffic Noise Data for 2036 with Development

Road Link	18 hr Daytime AAWT (0600- 0000 hrs)	Daytime % HGV	6 hr Night Flows	Night % HGV	Signed Speed Limits
					Mph
Link 1 - Waterloo Road	13980	0.8%	202	1.4%	30
Link 2 - William Heelas Way	11474	1.1%	160	1.3%	30

- 5.9 The day and night-time noise contours for the year 2036 based on future traffic flows and including noise from the railways lines to the north of the development site are shown in Appendix D, Figures D1 and D2.
- 5.10 The noise model indicates that mitigation measures will be required at elevations overlooking both the roads and the railway to reduce both internal noise levels within the residential units and external noise levels in amenity areas to within acceptable levels. These noise mitigation measures are discussed in Section 6.

Vibration

- 5.11 The below-ground structure of a building or hard surface will affect the levels of vibration present due to a remote source. Different types of foundation will affect the amount of vibration that is transferred from the ground to either the building or the hard surface.

- 5.12 The vibration measurements were taken 10m from the nearside railway line. The nearest proposed buildings are located 32m from the nearside rail line and significantly further away from the railway line than the measurement position and should therefore be subject to lower levels of vibration.
- 5.13 As discussed above, it is necessary to use a transfer function that would represent the likely effect that a different foundation would have on the transfer of vibration from the ground into the proposed dwellings.
- 5.14 The table below shows the likely vibration level within a habitable room located on the upper storey of a residential property at the measurement position. The figures presented below equate to the measured values amplified by a transfer function of 2.98. The estimated VDV's are shown in Table 5.2, below.

Table 5.2 – Estimated Vibration Dose Values

Location	Period	Range of VDV's	Transfer Function	Resulting eVDV	Probability of Adverse Comments on Vibration
Position 1 Boundary with railway lines	Daytime	0.080	2.98	0.238	Low probability of adverse comment
	Night-time	0.049	2.98	0.146	Low probability of adverse comment

- 5.15 The estimated VDV's at the representative measurement location with the transfer function of 2.98 applied provide vibration levels that BS6472 considers are less than a low probability of adverse comment in both the day and night-time periods.
- 5.16 It was observed that the vibration from train pass-bys was imperceptible at the site boundary with the railway lines.
- 5.17 Based on both the baseline vibration measurements and observation on the site it is considered that no additional mitigation measures are required to reduce the vibration effects of passing trains at the development site.

6. Noise Mitigation Plan

Internal Noise Targets

- 6.1 Condition 40 requires a Noise Mitigation Plan demonstrating how appropriate internal and external noise levels will be achieved. The external noise levels have been predicted in the day and night-time periods at each elevation and floor level of each property at the development and these predicted noise levels are shown in Appendix E.
- 6.2 Based on the internal noise targets provided in BS8233:2014 in the day and night-time periods, the required sound insulation for each elevation and floor level has also been calculated and is shown in Appendix E.
- 6.3 A plan showing the highest predicted free-field external noise levels on each elevation of each building is shown in Figure 5.

Figure 5: Highest Predicted Noise Free-Field Levels on each elevation



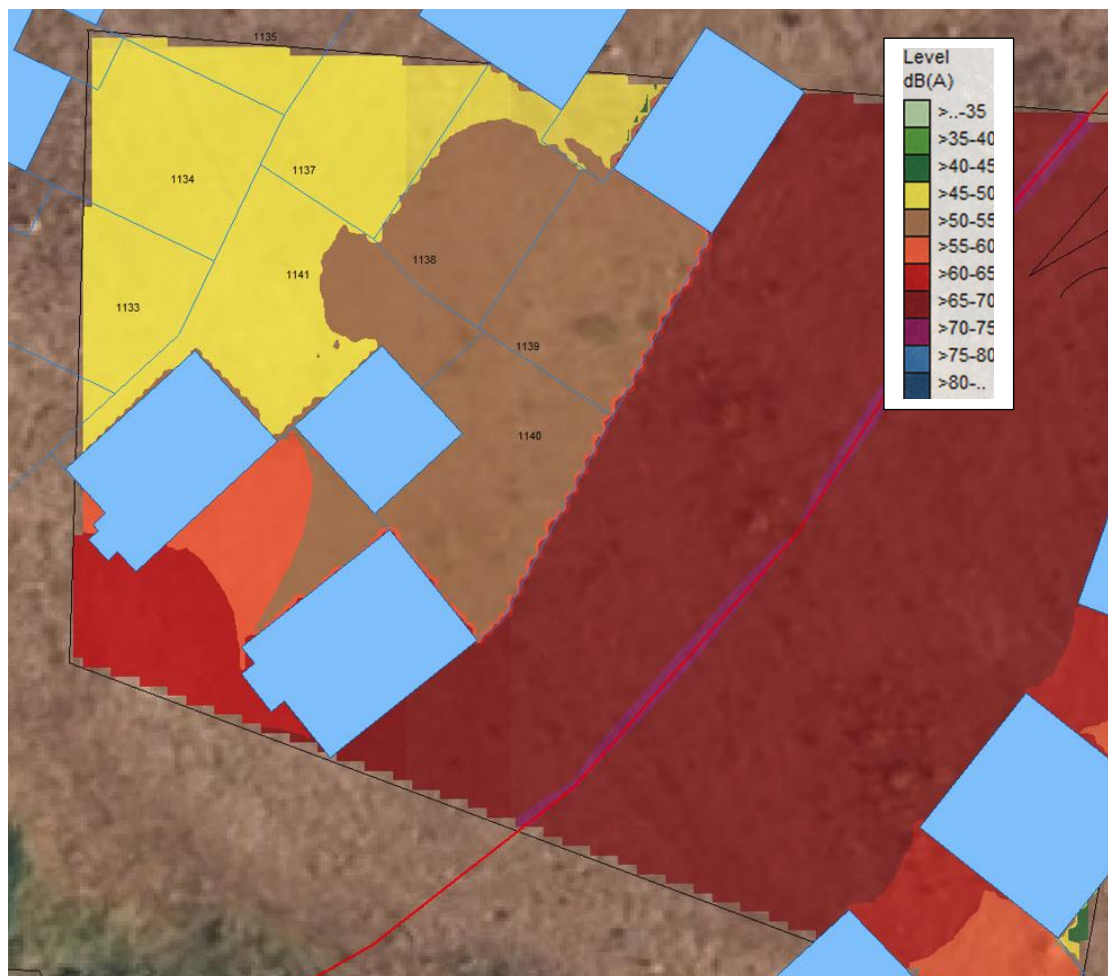
- 6.4 It should be noted that a façade noise correction of 2.5 dB has been added to the noise levels shown in Appendix E to determine appropriate sound insulation targets to meet the internal noise targets.
- 6.5 The calculated sound reduction performance requirements apply to the whole external building fabric. However, since windows are typically the weakest link in the external building fabric, in terms of acoustic performance, the values below will particularly apply to the windows.
- 6.6 Windows do not reduce noise equally across the entire frequency spectrum, so the frequency content of the sound will influence the overall sound reduction performance of a given window, and by extension, the resulting noise levels within the property.
- 6.7 However, many glazing manufacturers test their products under laboratory conditions using a typical road traffic noise frequency spectrum source. The resultant measured noise attenuation, in dB, gives a very useful guide to in-situ sound reduction performance of the window for situations where road traffic noise dominates, known as $R_w + C_{tr}$ or R_{TRA} .
- 6.8 As shown in Appendix E the highest predicted façade noise level is on the south/east elevation of plot 1140 with a 1st floor noise level of $L_{Aeq,16\text{ hr}}$ 70.9 dB, which requires the glazing to provide $R_w + C_{tr}$ 36 dB. Acoustic glazing such as 8mm/16mm argon/9.1mm Pilkington Optiphon provides $R_w + C_{tr}$ 36 dB and R_w 43 dB and is predicted to meet the internal noise target provided by BS8233:2014. Glazing requiring this acoustic specification is only required on the closest elevations facing towards the spine road that passes through the site.
- 6.9 For elevations facing towards William Heelas Way the highest predicted façade noise level is $L_{Aeq,16\text{ hr}}$ 65.0 dB at 2nd floor level of plot 1084, which requires the glazing to provide $R_w + C_{tr}$ 30 dB. Acoustic glazing such as 10mm/6-16mm/4mm provides $R_w + C_{tr}$ 30 dB and R_w 35 dB.
- 6.10 For elevations facing towards the railway line the highest predicted façade noise level is $L_{Aeq,16\text{ hr}}$ 61.0 dB at 3rd floor level of plot 1001-1011, which requires the glazing to provide $R_w + C_{tr}$ 26 dB. Acoustic glazing such as 6mm/6-16mm/4mm provides $R_w + C_{tr}$ 28 dB and R_w 32 dB.
- 6.11 As shown in Appendix E, the noise levels at the majority of the elevations that are shielded from the railway, William Heelas Way and the spine road are below a façade noise level of $L_{Aeq,16\text{ hr}}$ 60 dB. At these properties, standard thermal glazing such as 4mm/6-16mm/4mm construction will provide sound insulation of $R_w + C_{tr}$ 25 dB and will meet the internal noise targets in BS8233:2014.

- 6.12 The 10th highest predicted maximum noise level at night due to trains at the nearest elevation facing the railway line (32m), extrapolated from the measured noise levels at 10m from the rail, is L_{Amax} 68 dB. The required sound insulation to meet the internal noise target is R_w 23 dB, which is achieved using the glazing proposed for the elevations facing the rail lines. For the future year 2036 it is assumed that the sound insulation measures will be determined by the predicted daytime noise level rather than the maximum noise levels. This approach is verified by the noise measurements at position 3, which is dominated by traffic noise from Waterloo Road where the required sound insulation would be lower for maximum noise levels than for the 16 hour daytime noise level.
- 6.13 It is noted that the sound reduction performances stated as achievable by the identified glazing units are based on laboratory tests. In practice, the actual on-site performance may be lower, depending on the quality of the fitting. The sound reduction performances in Appendix E should be interpreted as in-situ sound reduction performances.
- 6.14 Glazing units other than those suggested may be suitable and it is the responsibility of the glazing manufacturer to recommend and provide appropriate systems. The above analysis demonstrates that a design solution is feasible at the site for the purposes of a planning application. Further detailed calculations may be necessary to inform glazing procurement decisions.
- 6.15 Internal noise levels should be considered in the context of room ventilation and overheating requirements. As the sound reduction performance requirements are greater than 10dB, to achieve the internal noise criteria the windows will need to be closed. However, the windows should be openable so that the choice of opening or closing windows is with the occupants. Therefore, an alternative form of ventilation and/or cooling will be required so that occupants can retain access to fresh air and retain thermal comfort without compromising their noise climate. The ventilation and/or cooling system chosen should be designed so that it does not compromise the sound insulation performance of the building fabric.
- 6.16 The acoustic specification for ventilation is provided as a weighted normalised level difference, shown as $D_{n,e,w}$ dB. The noise target for ventilation is 10 to 15 dB higher than the sound insulation (R_w) target for glazing. For individual elevations and floor levels the required ventilation specification can be derived by adding 10 to 15 dB to the sound insulation values that are shown in Appendix E.
- 6.17 On the noisiest elevations overlooking the spine road and William Heelas Way the acoustic specification will require mechanical ventilation. On the quieter elevations acoustically treated trickle vents will meet the acoustic specification for vents.

Amenity Areas

- 6.18 BS8233:2014 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 50dB $L_{Aeq,T}$, with an upper guideline value of 55dB $L_{Aeq,T}$ which would be acceptable in noisier environments.
- 6.19 The proposed site layout is shown in Figure 2 and has taken the noise limit for amenity areas and balconies into account in the design such that the only location where the upper guideline value of 55dB $L_{Aeq,T}$ is predicted to be exceeded is at plots 1039 and 1040, which are protected by a 1.8m high acoustic barrier. To mitigate the noise from the spine road the acoustic barrier has been increased to a height of 2.5m and as shown in Figure 6, the majority of the garden is at or below 55dB $L_{Aeq,T}$ with this 2.5m acoustic barrier.

Figure 6: Daytime Noise Contours with 2.5m acoustic barrier at plots 1139 & 1140



Vibration

- 6.20 It was observed that the vibration from train pass-bys was imperceptible at the site boundary, 10m from the railway lines. The nearest proposed residential development buildings are 32m from the railway lines and based on both the baseline vibration measurements and observation on the site it is considered that no additional mitigation measures are required to reduce the vibration effects of passing trains at the development site.

7. Conclusion

- 7.1 Phlorum Limited have been commissioned by Miller Homes to undertake a noise and vibration assessment to discharge condition 40 for a residential development at South Wokingham, Parcel R10, Land South of Waterloo Crescent. The proposal is for 215 residential units.
- 7.2 As required by condition 40 a 'Noise Mitigation Plan' showing predicted noise levels at each elevation and floor level of each individual residential property along with the required sound insulation levels that are required to meet the internal noise targets has been provided.
- 7.3 The design of the proposed site layout has taken the noise limit for amenity areas and balconies into account. With the proposed noise mitigation measures the garden and balcony noise levels are at or below the upper guideline value of 55dB $L_{Aeq,T}$.
- 7.4 Vibration from train pass-bys was observed to be imperceptible at the site boundary, 10m from the railway lines. The nearest proposed residential development buildings are 32m from the railway lines and based on both the baseline vibration measurements and site observations it is considered that no additional mitigation measures are required to reduce the vibration effects of passing trains at the development site.
- 7.5 On the basis of this noise assessment, it is considered that with appropriate noise mitigation measures, as specified in this report, noise and vibration does not pose a constraint to the proposed development and the report discharges condition 40.

Figures



Noise & Vibration monitoring Position 1

Noise monitoring Position 2

Noise monitoring Position 3



Location Plan showing Noise Measurement Positions

Job No. 13253

Figure No. 1

Noise monitoring Position 2

Noise & Vibration monitoring Position 1

Noise monitoring Position 3



Proposed Layout & N&V Measurement Locations

Job No. 13253

Figure No. 2

Appendix A

Introduction to Noise & Glossary of Terminology

Noise is defined as unwanted sound. The human ear is able to respond to sound in the frequency range 18Hz (deep bass) to 18,000Hz (high treble) and over the audible range of 0dB (the threshold of perception) to 140dB (the onset of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting (filtering) mechanism is used. This reduces the importance of lower and higher frequencies, approximating the response of the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. Noise can be perceived to be louder or more noticeable if the source of the noise is observed; e.g. roads, trains, factories, building sites etc. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source. Various noise indices have been derived to describe the fluctuation of noise levels that vary over time. Usually, these noise indices relate to specific types of noise, and as such different noise indices are used to describe road traffic noise, background noise, construction noise, etc.

The weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement and the levels are denoted as dB(A) or L_{Aeq} , L_{A10} , etc, according to the parameter being measured.

Noise is measured on the decibel scale, which is logarithmic rather than linear. As a result of this, a 3dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3dB(A) is generally regarded as the minimum difference needed to perceive a change. Table A.1 sets out examples of noise levels typically experienced during everyday activities. Table A.2 sets out an explanation of the terminology used in this report.

Table A1: Typical sound levels found in the environment.

Sound Level	Location
0 to 10dB(A)	Threshold of hearing
10 to 20dB(A)	Broadcasting studio
20 to 30dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50dB(A)	Typical office
50 to 60dB(A)	Inside a car
60 to 70dB(A)	Typical high street
70 to 90dB(A)	Inside a factory or noisy pub
100 to 110dB(A)	Burglar Alarm at 1m
110 to 130dB(A)	Pneumatic drill at 1m away
140dB(A)	Threshold of Pain

Table A2: Terminology relating to noise

Term	Description
Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of 20µPa (20×10^{-6} Pascals) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by $20 \log_{10} (s_1/s_2)$. 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.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{Aeq,T}$	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 during the 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.
$L_{90,T}$ or Background Noise Level	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	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.
Free-field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5 metres
Façade	At a distance of 1 metre in front of a large sound reflecting object such as a building façade.
Fast Time Weighting	An averaging time used in sound level meters. Defined in BS EN 61672.

Appendix B Monitoring Equipment

Table B1: Noise monitoring equipment

Position	Equipment	Serial Number	Calibration Date
1	LD824 Sound Analyser	A1420	22/10/2024
	Mic	37023	
	Preamp	1812	
2	LD820 Sound Meter	A1350	22/10/2024
	Mic	37024	
	Preamp	1568	
3	LD820 Sound Meter	A1144	22/10/2024
	Mic	31825	
	Preamp	2054	
All positions	LD CAL200 Calibrator	3054	22/10/2024

Appendix C

Full Noise Survey Results

Figure C1: Measured noise levels at Position 1, free-field dB

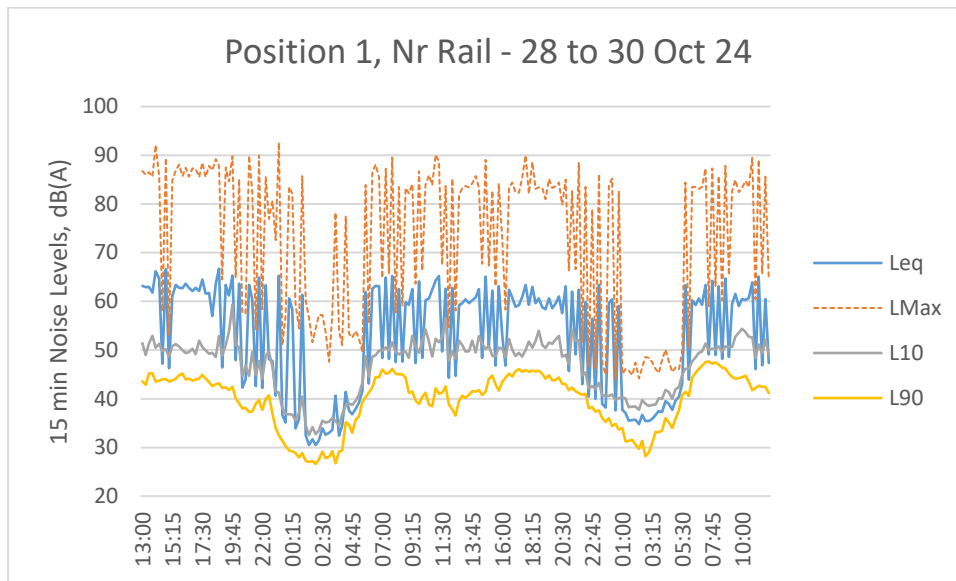


Figure C2: Measured noise levels at Position 2, free-field dB

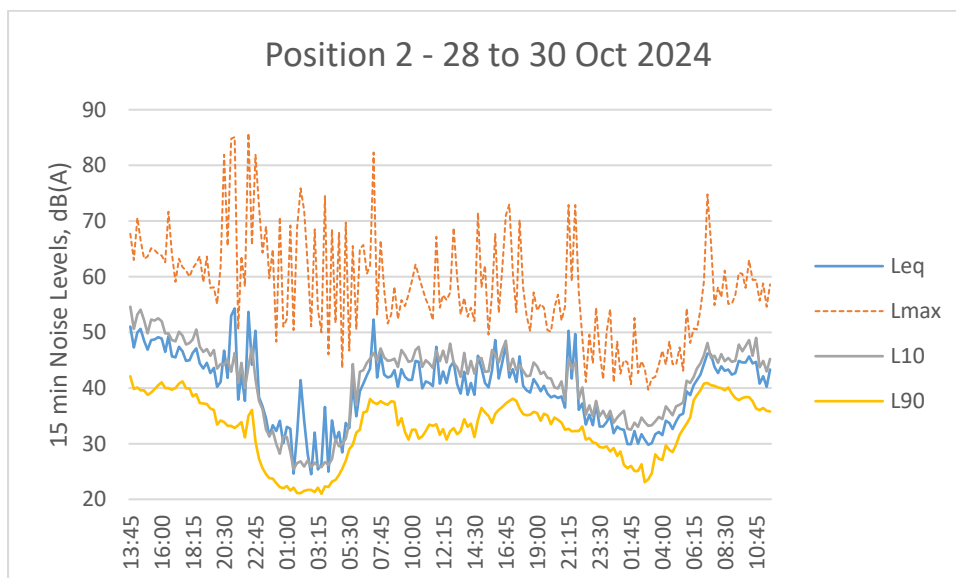
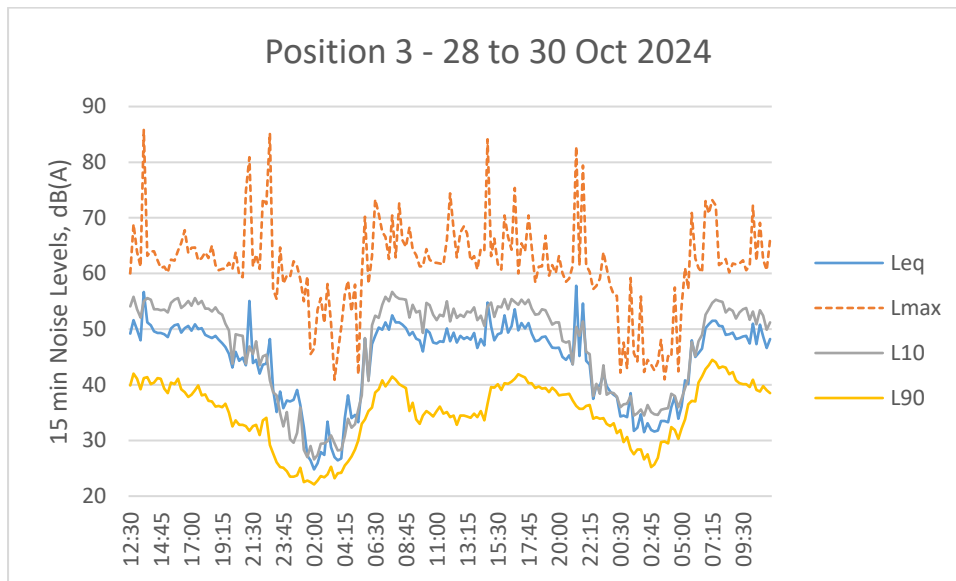


Figure C3: Measured noise levels at Position 3, free-field dB



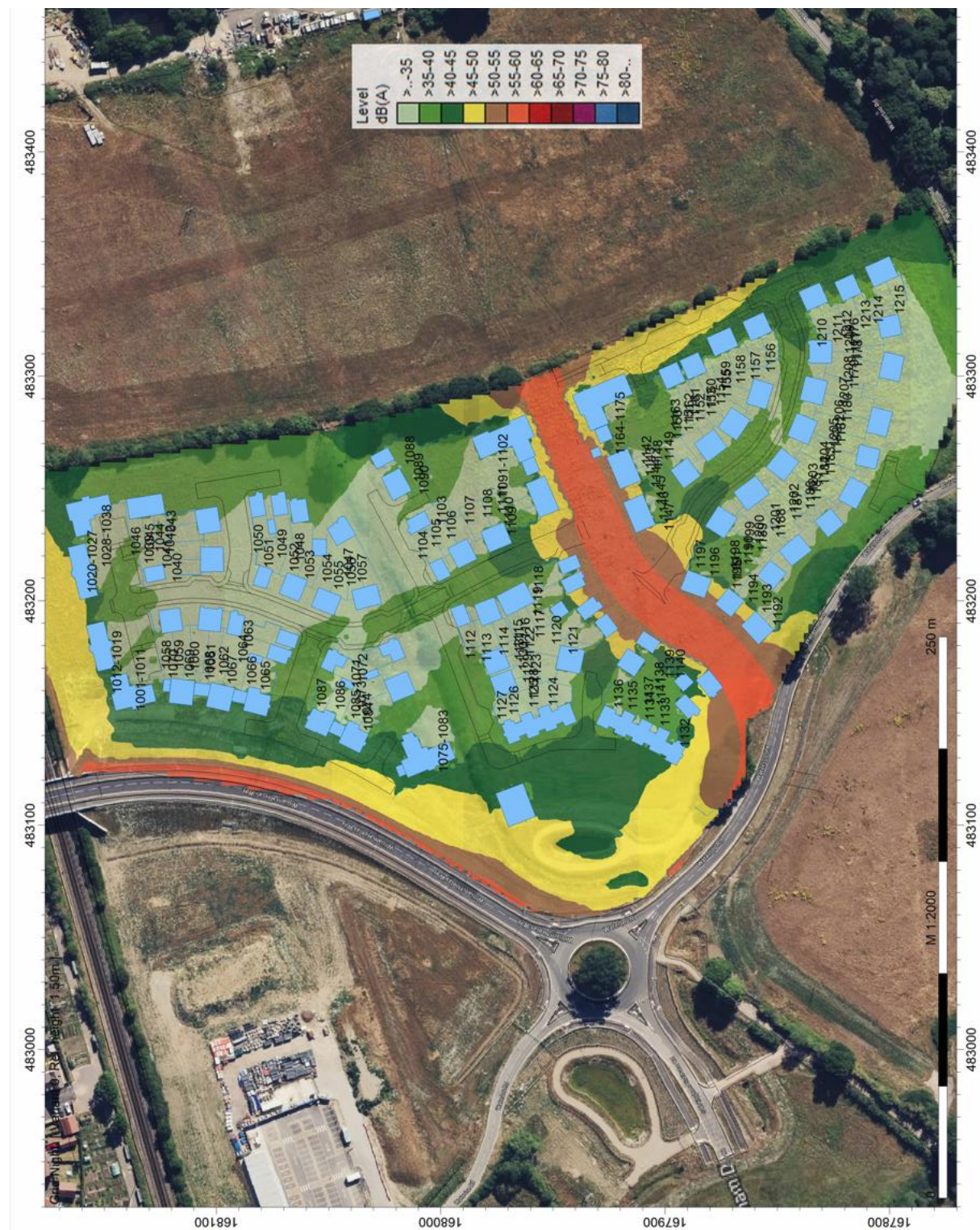
Appendix D

Noise Model Results

Figure D1: Daytime free-field noise contours



Figure D2: Night-time free-field noise contours



Appendix E

Predicted Noise Levels on Each Elevation and Floor Level

Table E1: Predicted noise levels at each floor and elevation of development and associated required sound insulation values

Plot No	Floor	Elevation	Façade		Window Req		Window Req Overall	Plot No	Floor	Elevation	Façade		Window Req		Window Req Overall
			Day	Night	Rw+Ctr	Rw+Ctr					Day	Night	Rw+Ctr	Rw+Ctr	
1001_1011	GroundFl	S/W	56.3	46.2	21.3	16.2	21	1044_1046	SecondFl	South	53.1	41.1	18.1	11.1	18
1001_1011	FirstFl	S/W	59.9	50.4	24.9	20.4	25	1044_1046	GroundFl	West	43.5	35.4	8.5	5.4	9
1001_1011	SecondFl	S/W	63.0	53.1	28.0	23.1	28	1044_1046	FirstFl	West	46.0	38.3	11.0	8.3	11
1001_1011	ThirdFl	S/W	64.2	54.2	29.2	24.2	29	1044_1046	SecondFl	West	47.6	39.5	12.6	9.5	13
1001_1011	GroundFl	N/W	54.2	47.3	19.2	17.3	19	1047	GroundFl	N/W	43.7	33.0	8.7	3.0	9
1001_1011	FirstFl	N/W	60.0	54.0	25.0	24.0	25	1047	FirstFl	N/W	46.3	35.4	11.3	5.4	11
1001_1011	SecondFl	N/W	59.6	52.7	24.6	22.7	25	1047	GroundFl	East	43.9	33.2	8.9	3.2	9
1001_1011	ThirdFl	N/W	60.9	53.8	25.9	23.8	26	1047	FirstFl	East	47.4	36.2	12.4	6.2	12
1001_1011	GroundFl	N/E	43.6	37.5	8.6	7.5	9	1047	GroundFl	S/E	44.5	32.8	9.5	2.8	10
1001_1011	FirstFl	N/E	46.2	40.0	11.2	10.0	11	1047	FirstFl	S/E	47.5	35.7	12.5	5.7	13
1001_1011	SecondFl	N/E	49.2	42.0	14.2	12.0	14	1047	GroundFl	S/W	44.3	33.3	9.3	3.3	9
1001_1011	ThirdFl	N/E	52.5	44.9	17.5	14.9	17	1047	FirstFl	S/W	46.3	35.1	11.3	5.1	11
1001_1011	GroundFl	South	48.3	36.3	13.3	6.3	13	1048	GroundFl	North	42.5	32.1	7.5	2.1	8
1001_1011	FirstFl	South	55.4	42.6	20.4	12.6	20	1048	FirstFl	North	45.3	34.4	10.3	4.4	10
1001_1011	SecondFl	South	58.3	45.4	23.3	15.4	23	1048	GroundFl	East	52.6	40.3	17.6	10.3	18
1001_1011	ThirdFl	South	60.5	47.8	25.5	17.8	25	1048	FirstFl	East	54.0	41.8	19.0	11.8	19
1012_1019	GroundFl	West	53.3	47.0	18.3	17.0	18	1048	GroundFl	South	52.5	40.2	17.5	10.2	17
1012_1019	FirstFl	West	56.1	50.1	21.1	20.1	21	1048	FirstFl	South	53.7	41.4	18.7	11.4	19
1012_1019	SecondFl	West	56.9	50.6	21.9	20.6	22	1048	GroundFl	West	44.2	33.5	9.2	3.5	9
1012_1019	ThirdFl	West	58.1	51.7	23.1	21.7	23	1048	FirstFl	West	46.4	35.4	11.4	5.4	11
1012_1019	GroundFl	North	54.4	48.4	19.4	18.4	19	1049	GroundFl	North	41.8	31.1	6.8	1.1	7
1012_1019	FirstFl	North	56.4	50.5	21.4	20.5	21	1049	FirstFl	North	44.7	34.0	9.7	4.0	10
1012_1019	SecondFl	North	57.7	51.8	22.7	21.8	23	1049	GroundFl	East	52.8	40.7	17.8	10.7	18
1012_1019	ThirdFl	North	59.0	53.2	24.0	23.2	24	1049	FirstFl	East	54.1	42.0	19.1	12.0	19
1012_1019	GroundFl	East	46.5	41.2	11.5	11.2	11	1049	GroundFl	South	49.5	37.3	14.5	7.3	14
1012_1019	FirstFl	East	48.8	43.4	13.8	13.4	14	1049	FirstFl	South	50.5	38.4	15.5	8.4	15
1012_1019	SecondFl	East	51.9	45.9	16.9	15.9	17	1049	GroundFl	West	43.0	32.8	8.0	2.8	8
1012_1019	ThirdFl	East	54.9	48.9	19.9	18.9	20	1049	FirstFl	West	45.5	34.8	10.5	4.8	10
1012_1019	GroundFl	South	43.1	33.3	8.1	3.3	8	1050	GroundFl	North	42.7	33.5	7.7	3.5	8
1012_1019	FirstFl	South	45.3	34.9	10.3	4.9	10	1050	FirstFl	North	45.0	35.4	10.0	5.4	10
1012_1019	SecondFl	South	48.8	37.8	13.8	7.8	14	1050	GroundFl	East	52.4	40.4	17.4	10.4	17
1012_1019	ThirdFl	South	52.0	41.5	17.0	11.5	17	1050	FirstFl	East	53.9	41.9	18.9	11.9	19
1020_1027	GroundFl	West	51.9	46.4	16.9	16.4	17	1050	GroundFl	South	40.7	30.2	5.7	0.2	6
1020_1027	FirstFl	West	53.0	47.5	18.0	17.5	18	1050	FirstFl	South	44.4	33.5	9.4	3.5	9
1020_1027	SecondFl	West	54.1	48.7	19.1	18.7	19	1050	GroundFl	West	44.1	33.4	9.1	3.4	9
1020_1027	ThirdFl	West	55.6	50.2	20.6	20.2	21	1050	FirstFl	West	46.4	35.5	11.4	5.5	11
1020_1027	GroundFl	North	55.4	50.0	20.4	20.0	20	1051	GroundFl	North	42.0	33.5	7.0	3.5	7
1020_1027	FirstFl	North	54.5	49.2	19.5	19.2	19	1051	FirstFl	North	45.0	35.7	10.0	5.7	10
1020_1027	SecondFl	North	56.1	51.0	21.1	21.0	21	1051	GroundFl	East	43.8	32.6	8.8	2.6	9
1020_1027	ThirdFl	North	57.5	52.4	22.5	22.4	23	1051	FirstFl	East	46.9	35.6	11.9	5.6	12
1020_1027	GroundFl	East	45.5	40.4	10.5	10.4	10	1051	GroundFl	South	46.8	34.9	11.8	4.9	12
1020_1027	FirstFl	East	47.8	42.6	12.8	12.6	13	1051	FirstFl	South	50.8	38.8	15.8	8.8	16
1020_1027	SecondFl	East	50.3	45.1	15.3	15.1	15	1051	GroundFl	West	45.5	35.0	10.5	5.0	11
1020_1027	ThirdFl	East	53.0	47.4	18.0	17.4	18	1051	FirstFl	West	47.9	37.1	12.9	7.1	13
1020_1027	GroundFl	South	46.6	35.3	11.6	5.3	12	1052_1053	GroundFl	North	43.5	33.1	8.5	3.1	9
1020_1027	FirstFl	South	50.3	38.5	15.3	8.5	15	1052_1053	FirstFl	North	46.4	35.7	11.4	5.7	11
1020_1027	SecondFl	South	51.0	39.3	16.0	9.3	16	1052_1053	GroundFl	East	43.1	32.0	8.1	2.0	8
1020_1027	ThirdFl	South	52.2	41.2	17.2	11.2	17	1052_1053	FirstFl	East	46.1	34.9	11.1	4.9	11
1028_1038	GroundFl	West	44.6	37.5	9.6	7.5	10	1052_1053	GroundFl	South	45.9	33.9	10.9	3.9	11
1028_1038	FirstFl	West	46.7	40.2	11.7	10.2	12	1052_1053	FirstFl	South	48.1	36.3	13.1	6.3	13
1028_1038	SecondFl	West	48.5	42.2	13.5	12.2	14	1052_1053	GroundFl	West	44.8	34.3	9.8	4.3	10
1028_1038	ThirdFl	West	50.6	44.2	15.6	14.2	16	1052_1053	FirstFl	West	47.2	36.4	12.2	6.4	12
1028_1038	GroundFl	North	50.9	45.9	15.9	15.9	16	1054_1055	GroundFl	North	43.9	33.3	8.9	3.3	9
1028_1038	FirstFl	North	52.3	47.3	17.3	17.3	17	1054_1055	FirstFl	North	45.4	35.1	10.4	5.1	10
1028_1038	SecondFl	North	53.9	49.0	18.9	19.0	19	1054_1055	SecondFl	North	47.8	37.4	12.8	7.4	13
1028_1038	ThirdFl	North	55.7	50.7	20.7	20.7	21	1054_1055	GroundFl	East	44.5	32.9	9.5	2.9	10
1028_1038	GroundFl	S/E	51.0	38.9	16.0	8.9	16	1054_1055	FirstFl	East	47.4	35.5	12.4	5.5	12
1028_1038	FirstFl	S/E	52.0	39.8	17.0	9.8	17	1054_1055	SecondFl	East	50.0	38.2	15.0	8.2	15
1028_1038	SecondFl	S/E	52.3	40.2	17.3	10.2	17	1054_1055	GroundFl	South	48.8	36.3	13.8	6.3	14
1028_1038	ThirdFl	S/E	52.8	41.2	17.8	11.2	18	1054_1055	FirstFl	South	51.1	38.7	16.1	8.7	16
1028_1038	GroundFl	East	51.2	41.4	16.2	11.4	16	1054_1055	SecondFl	South	53.1	40.8	18.1	10.8	18
1028_1038	FirstFl	East	52.2	43.0	17.2	13.0	17	1054_1055	GroundFl	West	48.5	36.5	13.5	6.5	14
1028_1038	SecondFl	East	52.7	44.0	17.7	14.0	18	1054_1055	FirstFl	West	49.8	38.0	14.8	8.0	15
1028_1038	ThirdFl	East	53.6	45.7	18.6	15.7	19	1054_1055	SecondFl	West	51.6	40.0	16.6	10.0	17
1039	GroundFl	North	43.5	35.3	8.5	5.3	9	1056_1057	GroundFl	North	47.3	34.9	12.3	4.9	12
1039	FirstFl	North	46.4	37.6	11.4	7.6	11	1056_1057	FirstFl	North	49.1	36.9	14.1	6.9	14
1039	GroundFl	East	41.5	32.3	6.5	2.3	7	1056_1057	GroundFl	East	45.4	33.7	10.4	3.7	10
1039	FirstFl	East	45.1	35.2	10.1	5.2	10	1056_1057	FirstFl	East	48.5	36.7	13.5	6.7	13
1039	GroundFl	South	43.5	33.0	8.5	3.0	9	1056_1057	GroundFl	South	45.2	33.4	10.2	3.4	10
1039	FirstFl	South	46.3	35.7	11.3	5.7	11	1056_1057	FirstFl	South	47.8	35.9	12.8	5.9	13
1039	GroundFl	West	45.3	36.6	10.3	6.6	10	1056_1057	GroundFl	West	48.9	36.9	13.9	6.9	14
1039	FirstFl	West	47.3	38.3	12.3	8.3	12	1056_1057	FirstFl	West	50.5	38.5	15.5	8.5	15
1040_1041	GroundFl	North	42.2	33.3	7.2	3.3	7	1058_1059	GroundFl	North	45.8	37.4	10.8	7.4	11
1040_1041	FirstFl	North	45.0	35.5	10.0	5.5	10	1058_1059	FirstFl	North	49.0	40.5	14.0	10.5	14
1040_1041	GroundFl	East	42.2	32.0	7.2	2.0	7	1058_1059	GroundFl	East	43.2	35.3	8.2	5.3	8
1040_1041	FirstFl	East	45.7	35.1	10.7	5.1	11	1058_1059	FirstFl	East	46.2	37.7	11.2	7.7	11
1040_1041	GroundFl	South	44.9	33.4	9.9	3.4	10	1058_1059	GroundFl	South	45.2	34.2	10.2	4.2	10
1040_1041	FirstFl	South	47.6	36.2	12.6	6.2	13	1058_1059	FirstFl	South	48.3	37.2	13.3	7.2	13
1040_1041	GroundFl	West	44.6	35.2	9.6	5.2	10	1058_1059	GroundFl	West	46.6	36.1	11.6	6.1	12
1040_1041	FirstFl	West	46.8	37.0	11.8	7.0	12	1058_1059	FirstFl	West	48.9	38.2	13.9	8.2	14
1042_1043	GroundFl	North	41.6	33.0	6.6	3.0	7	1060_1061	GroundFl	North	44.0	33.9	9.0	3.9	9
1042_1043	FirstFl	North	44.6	35.3	9.6	5.3	10	1060_1061	FirstFl	North	47.1	36.5	12.1	6.5	12
1042_1043	GroundFl	East	52.1	40.1	17.1	10.1	17	1060_1061	GroundFl	East	43.1	32.6	8.1	2.6	8
1042_1043	FirstFl	East	52.9	41.0	17.9	11.0	18	1060_1061	FirstFl	East	46.6	35.8	11.6	5.8	12
1042_1043	GroundFl	South	51.2	39.0	16.2	9.0	16	1060_1061	GroundFl	South	43.4	32.6	8.4	2.6	8
1042_1043	FirstFl	South	52.0	40.0	17.0	10.0	17	1060_1061	FirstFl	South	46.9	35.9	11.9	5.9	12
1042_1043	GroundFl	West	42.2	32.7	7.2	2.7	7	1060_1061	GroundFl	West	46.7	35.7	11.7	5.7	12
1042_1043															

Noise Assessment
S Wokingham Parcel R10, Land South of Waterloo Crescent



Plot No	Floor	Elevation	Façade		WindowReq		WindowReq	Plot No	Floor	Elevation	Façade		WindowReq		WindowReq
			Day	Night	Rw+Ctr	Night	Rw+Ctr				Day	Night	Rw+Ctr	Night	Rw+Ctr
1063	GroundFl	North	42.2	32.9	7.2	2.9	7	1084 1085	GroundFl	East	43.2	31.8	8.2	1.8	8
1063	FirstFl	North	45.8	35.7	10.8	5.7	11	1084 1085	FirstFl	East	45.6	33.8	10.6	3.8	11
1063	GroundFl	East	44.2	33.0	9.2	3.0	9	1084 1085	SecondFl	East	48.7	36.8	13.7	6.8	14
1063	FirstFl	East	46.5	35.4	11.5	5.4	12	1084 1085	GroundFl	S/W	56.6	43.6	21.6	13.6	22
1063	GroundFl	South	51.1	38.6	16.1	8.6	16	1084 1085	FirstFl	S/W	60.0	47.0	25.0	17.0	25
1063	FirstFl	South	52.3	40.0	17.3	10.0	17	1084 1085	SecondFl	S/W	62.2	49.2	27.2	19.2	27
1063	GroundFl	S/W	51.4	38.9	16.4	8.9	16	1084 1085	GroundFl	N/W	59.2	46.4	24.2	16.4	24
1063	FirstFl	S/W	52.7	40.4	17.7	10.4	18	1084 1085	FirstFl	N/W	63.0	50.2	28.0	20.2	28
1063	GroundFl	West	41.1	31.0	6.1	1.0	6	1084 1085	SecondFl	N/W	65.0	52.5	30.0	22.5	30
1063	FirstFl	West	45.1	34.7	10.1	4.7	10	1086 1087	GroundFl	N/W	58.9	46.1	23.9	16.1	24
1064	GroundFl	North	43.4	33.3	8.4	3.3	8	1086 1087	FirstFl	N/W	62.2	49.3	27.2	19.3	27
1064	FirstFl	North	47.7	36.7	12.7	6.7	13	1086 1087	SecondFl	N/W	64.6	51.9	29.6	21.9	30
1064	GroundFl	East	41.8	31.5	6.8	1.5	7	1086 1087	GroundFl	North	55.8	43.2	20.8	13.2	21
1064	FirstFl	East	45.6	34.9	10.6	4.9	11	1086 1087	FirstFl	North	58.9	46.3	23.9	16.3	24
1064	GroundFl	South	51.8	39.2	16.8	9.2	17	1086 1087	SecondFl	North	61.6	49.8	26.6	19.8	27
1064	FirstFl	South	53.1	40.7	18.1	10.7	18	1086 1087	GroundFl	S/E	44.0	32.6	9.0	2.6	9
1064	GroundFl	West	49.8	37.4	14.8	7.4	15	1086 1087	FirstFl	S/E	46.5	34.8	11.5	4.8	11
1064	FirstFl	West	52.6	40.2	17.6	10.2	18	1086 1087	SecondFl	S/E	49.3	37.5	14.3	7.5	14
1065 1066	GroundFl	North	55.7	43.2	20.7	13.2	21	1086 1087	GroundFl	South	57.2	44.3	22.2	14.3	22
1065 1066	FirstFl	North	58.4	46.0	23.4	16.0	23	1086 1087	FirstFl	South	60.6	47.6	25.6	17.6	26
1065 1066	SecondFl	North	61.3	49.9	26.3	19.9	26	1086 1087	SecondFl	South	63.0	50.0	28.0	20.0	28
1065 1066	GroundFl	East	42.6	32.1	7.6	2.1	8	1088	GroundFl	N/W	44.5	34.0	9.5	4.0	10
1065 1066	FirstFl	East	45.1	34.2	10.1	4.2	10	1088	FirstFl	N/W	46.5	35.7	11.5	5.7	12
1065 1066	SecondFl	East	48.7	37.6	13.7	7.6	14	1088	GroundFl	N/E	55.6	43.3	20.6	13.3	21
1065 1066	GroundFl	South	56.2	43.3	21.2	13.3	21	1088	FirstFl	N/E	57.2	44.9	22.2	14.9	22
1065 1066	FirstFl	South	58.6	45.7	23.6	15.7	24	1088	GroundFl	S/E	51.1	38.8	16.1	8.8	16
1065 1066	SecondFl	South	61.3	48.4	26.3	18.4	26	1088	FirstFl	S/E	57.7	45.4	22.7	15.4	23
1065 1066	GroundFl	West	58.0	45.3	23.0	15.3	23	1088	GroundFl	S/W	46.1	34.7	11.1	4.7	11
1065 1066	FirstFl	West	61.1	48.3	26.1	18.3	26	1088	FirstFl	S/W	50.8	38.8	15.8	8.8	16
1065 1066	SecondFl	West	64.0	51.8	29.0	21.8	29	1089 1090	GroundFl	N/W	45.2	34.3	10.2	4.3	10
1067 1068	GroundFl	North	54.4	42.7	19.4	12.7	19	1089 1090	FirstFl	N/W	47.2	36.1	12.2	6.1	12
1067 1068	FirstFl	North	57.3	46.5	22.3	16.5	22	1089 1090	GroundFl	N/E	49.8	37.7	14.8	7.7	15
1067 1068	SecondFl	North	60.0	49.8	25.0	19.8	25	1089 1090	FirstFl	N/E	56.4	44.1	21.4	14.1	21
1067 1068	GroundFl	East	42.8	32.5	7.8	2.5	8	1089 1090	GroundFl	S/E	50.1	37.9	15.1	7.9	15
1067 1068	FirstFl	East	45.3	34.5	10.3	4.5	10	1089 1090	FirstFl	S/E	56.4	44.1	21.4	14.1	21
1067 1068	SecondFl	East	49.0	38.1	14.0	8.1	14	1089 1090	GroundFl	S/W	45.9	34.5	10.9	4.5	11
1067 1068	GroundFl	South	55.8	42.9	20.8	12.9	21	1089 1090	FirstFl	S/W	48.3	36.7	13.3	6.7	13
1067 1068	FirstFl	South	59.0	46.0	24.0	16.0	24	1091 1102	GroundFl	North	43.4	33.0	8.4	3.0	8
1067 1068	SecondFl	South	61.9	49.0	26.9	19.0	27	1091 1102	FirstFl	North	45.3	34.6	10.3	4.6	10
1067 1068	GroundFl	West	57.6	45.1	22.6	15.1	23	1091 1102	SecondFl	North	48.0	36.9	13.0	6.9	13
1067 1068	FirstFl	West	60.8	48.4	25.8	18.4	26	1091 1102	GroundFl	North	55.8	43.5	20.8	13.5	21
1067 1068	SecondFl	West	63.9	52.2	28.9	22.2	29	1091 1102	FirstFl	North	61.3	49.0	26.3	19.0	26
1069 1070	GroundFl	North	54.6	44.6	19.6	14.6	20	1091 1102	SecondFl	North	61.9	49.5	26.9	19.5	27
1069 1070	FirstFl	North	57.4	47.8	22.4	17.8	22	1091 1102	GroundFl	S/E	62.0	49.5	27.0	19.5	27
1069 1070	SecondFl	North	60.3	50.9	25.3	20.9	25	1091 1102	FirstFl	S/E	69.8	57.3	34.8	27.3	35
1069 1070	GroundFl	East	42.0	32.4	7.0	2.4	7	1091 1102	SecondFl	S/E	69.4	57.0	34.4	27.0	34
1069 1070	FirstFl	East	44.5	34.4	9.5	4.4	9	1091 1102	GroundFl	S/W	60.9	48.5	25.9	18.5	26
1069 1070	SecondFl	East	49.0	38.4	14.0	8.4	14	1091 1102	FirstFl	S/W	66.7	54.2	31.7	24.2	32
1069 1070	GroundFl	South	55.3	42.4	20.3	12.4	20	1091 1102	SecondFl	S/W	67.1	54.6	32.1	24.6	32
1069 1070	FirstFl	South	58.2	45.3	23.2	15.3	23	1103	GroundFl	N/W	45.8	34.2	10.8	4.2	11
1069 1070	SecondFl	South	61.3	48.4	26.3	18.4	26	1103	FirstFl	N/W	47.8	36.3	12.8	6.3	13
1069 1070	GroundFl	West	57.0	45.8	22.0	15.8	22	1103	GroundFl	N/E	48.7	36.8	13.7	6.8	14
1069 1070	FirstFl	West	60.1	49.1	25.1	19.1	25	1103	FirstFl	N/E	53.8	41.7	18.8	11.7	19
1069 1070	SecondFl	West	63.3	52.4	28.3	22.4	28	1103	GroundFl	S/E	47.7	35.5	12.7	5.5	13
1071	GroundFl	North	50.3	37.9	15.3	7.9	15	1103	FirstFl	S/E	53.2	41.0	18.2	11.0	18
1071	FirstFl	North	52.0	39.8	17.0	9.8	17	1103	GroundFl	S/W	45.8	34.2	10.8	4.2	11
1071	GroundFl	East	47.1	35.2	12.1	5.2	12	1103	FirstFl	S/W	48.3	36.6	13.3	6.6	13
1071	FirstFl	East	48.6	36.9	13.6	6.9	14	1104	GroundFl	N/W	46.8	35.0	11.8	5.0	12
1071	GroundFl	South	46.8	34.7	11.8	4.7	12	1104	FirstFl	N/W	48.6	36.9	13.6	6.9	14
1071	FirstFl	South	50.6	38.3	15.6	8.3	16	1104	GroundFl	N/E	44.7	33.7	9.7	3.7	10
1071	GroundFl	N/W	51.3	38.8	16.3	8.8	16	1104	FirstFl	N/E	49.6	37.9	14.6	7.9	15
1071	FirstFl	N/W	53.3	40.9	18.3	10.9	18	1104	GroundFl	S/E	42.7	31.1	7.7	1.1	8
1072	GroundFl	North	48.2	36.1	13.2	6.1	13	1104	FirstFl	S/E	46.1	34.5	11.1	4.5	11
1072	FirstFl	North	52.1	39.6	17.1	9.6	17	1104	GroundFl	S/W	52.2	39.9	17.2	9.9	17
1072	GroundFl	East	48.7	36.8	13.7	6.8	14	1104	FirstFl	S/W	52.9	40.7	17.9	10.7	18
1072	FirstFl	East	50.2	38.3	15.2	8.3	15	1105 1106	GroundFl	N/W	42.1	31.0	7.1	1.0	7
1072	GroundFl	South	46.4	34.3	11.4	4.3	11	1105 1106	FirstFl	N/W	45.9	34.6	10.9	4.6	11
1072	FirstFl	South	49.7	37.5	14.7	7.5	15	1105 1106	GroundFl	N/E	43.7	32.8	8.7	2.8	9
1072	GroundFl	S/W	46.2	34.6	11.2	4.6	11	1105 1106	FirstFl	N/E	46.5	35.4	11.5	5.4	11
1072	FirstFl	S/W	49.8	37.7	14.8	7.7	15	1105 1106	GroundFl	S/E	44.1	32.3	9.1	2.3	9
1073 1074	GroundFl	North	49.1	36.6	14.1	6.6	14	1105 1106	FirstFl	S/E	47.1	35.2	12.1	5.2	12
1073 1074	FirstFl	North	52.5	39.8	17.5	9.8	18	1105 1106	GroundFl	S/W	53.3	40.9	18.3	10.9	18
1073 1074	SecondFl	North	54.7	42.1	19.7	12.1	20	1105 1106	FirstFl	S/W	53.9	41.6	18.9	11.6	19
1073 1074	GroundFl	East	44.1	34.2	9.1	4.2	9	1107 1108	GroundFl	North	42.9	31.4	7.9	1.4	8
1073 1074	FirstFl	East	46.7	35.6	11.7	5.6	12	1107 1108	FirstFl	North	46.5	35.1	11.5	5.1	11
1073 1074	SecondFl	East	51.1	40.8	16.1	10.8	16	1107 1108	GroundFl	East					

Noise Assessment
S Wokingham Parcel R10, Land South of Waterloo Crescent



Plot No	Floor	Elevation	Façade		Window Req		Window Req
			Day	Night	Rw+Ctr		
			L _{Aeq}	L _{Aeq}	Day	Night	Overall
1112	FirstFl	West	51.2	38.8	16.2	8.8	16
1113 1114	GroundFl	North	45.6	33.4	10.6	3.4	11
1113 1114	FirstFl	North	49.7	37.4	14.7	7.4	15
1113 1114	GroundFl	East	51.1	38.9	16.1	8.9	16
1113 1114	FirstFl	East	52.5	40.3	17.5	10.3	17
1113 1114	GroundFl	South	42.3	30.7	7.3	0.7	7
1113 1114	FirstFl	South	46.1	34.4	11.1	4.4	11
1113 1114	GroundFl	West	46.4	34.6	11.4	4.6	11
1113 1114	FirstFl	West	50.5	38.4	15.5	8.4	16
1115 1117	GroundFl	N/W	41.9	30.3	6.9	0.3	7
1115 1117	FirstFl	N/W	45.9	34.2	10.9	4.2	11
1115 1117	GroundFl	N/E	52.6	40.4	17.6	10.4	18
1115 1117	FirstFl	N/E	53.9	41.7	18.9	11.7	19
1115 1117	GroundFl	S/E	48.6	36.4	13.6	6.4	14
1115 1117	FirstFl	S/E	53.7	41.4	18.7	11.4	19
1115 1117	GroundFl	S/W	47.5	35.5	12.5	5.5	13
1115 1117	FirstFl	S/W	51.9	39.7	16.9	9.7	17
1118	GroundFl	N/W	45.3	33.6	10.3	3.6	10
1118	FirstFl	N/W	49.0	37.2	14.0	7.2	14
1118	GroundFl	East	63.2	50.8	28.2	20.8	28
1118	FirstFl	East	63.8	51.4	28.8	21.4	29
1118	GroundFl	S/E	68.0	55.6	33.0	25.6	33
1118	FirstFl	S/E	68.2	55.8	33.2	25.8	33
1118	GroundFl	S/W	51.4	39.2	16.4	9.2	16
1118	FirstFl	S/W	58.6	46.2	23.6	16.2	24
1119	GroundFl	N/W	45.5	33.8	10.5	3.8	10
1119	FirstFl	N/W	48.9	37.1	13.9	7.1	14
1119	GroundFl	N/E	50.1	37.9	15.1	7.9	15
1119	FirstFl	N/E	56.9	44.5	21.9	14.5	22
1119	GroundFl	S/E	67.7	55.3	32.7	25.3	33
1119	FirstFl	S/E	67.9	55.4	32.9	25.4	33
1119	GroundFl	West	62.5	50.1	27.5	20.1	27
1119	FirstFl	West	62.6	50.2	27.6	20.2	28
1120	GroundFl	N/E	61.9	49.5	26.9	19.5	27
1120	FirstFl	N/E	62.0	49.6	27.0	19.6	27
1120	GroundFl	South	67.6	55.2	32.6	25.2	33
1120	FirstFl	South	67.6	55.2	32.6	25.2	33
1120	GroundFl	S/W	60.3	47.9	25.3	17.9	25
1120	FirstFl	S/W	60.6	48.2	25.6	18.2	26
1120	GroundFl	N/W	45.8	34.2	10.8	4.2	11
1120	FirstFl	N/W	49.1	37.4	14.1	7.4	14
1121	GroundFl	N/E	61.2	48.8	26.2	18.8	26
1121	FirstFl	N/E	61.3	48.9	26.3	18.9	26
1121	GroundFl	S/E	67.0	54.6	32.0	24.6	32
1121	FirstFl	S/E	67.0	54.6	32.0	24.6	32
1121	GroundFl	S/W	60.7	48.2	25.7	18.2	26
1121	FirstFl	S/W	60.9	48.5	25.9	18.5	26
1121	GroundFl	N/W	46.1	34.0	11.1	4.0	11
1121	FirstFl	N/W	50.6	38.2	15.6	8.2	16
1122 1123	GroundFl	North	45.1	33.4	10.1	3.4	10
1122 1123	FirstFl	North	47.3	35.5	12.3	5.5	12
1122 1123	SecondFl	North	50.0	38.0	15.0	8.0	15
1122 1123	GroundFl	East	47.2	34.9	12.2	4.9	12
1122 1123	FirstFl	East	51.7	39.4	16.7	9.4	17
1122 1123	SecondFl	East	53.6	41.3	18.6	11.3	19
1122 1123	GroundFl	South	54.9	42.4	19.9	12.4	20
1122 1123	FirstFl	South	55.7	43.3	20.7	13.3	21
1122 1123	SecondFl	South	56.5	44.0	21.5	14.0	21
1122 1123	GroundFl	West	46.8	36.8	11.8	6.8	12
1122 1123	FirstFl	West	48.7	38.1	13.7	8.1	14
1122 1123	SecondFl	West	51.0	39.9	16.0	9.9	16
1124 1127	GroundFl	North	43.8	32.4	8.8	2.4	9
1124 1127	FirstFl	North	45.9	34.4	10.9	4.4	11
1124 1127	SecondFl	North	48.7	37.2	13.7	7.2	14
1124 1127	GroundFl	N/E	44.2	32.6	9.2	2.6	9
1124 1127	FirstFl	N/E	46.1	34.5	11.1	4.5	11
1124 1127	SecondFl	N/E	48.6	37.1	13.6	7.1	14
1124 1127	GroundFl	East	45.5	33.8	10.5	3.8	10
1124 1127	FirstFl	East	48.8	36.9	13.8	6.9	14
1124 1127	SecondFl	East	50.7	38.8	15.7	8.8	16
1124 1127	GroundFl	S/E	46.7	34.5	11.7	4.5	12
1124 1127	FirstFl	S/E	51.8	39.5	16.8	9.5	17
1124 1127	SecondFl	S/E	52.9	40.7	17.9	10.7	18
1124 1127	GroundFl	South	52.8	40.4	17.8	10.4	18
1124 1127	FirstFl	South	53.9	41.5	18.9	11.5	19
1124 1127	SecondFl	South	54.7	42.4	19.7	12.4	20
1124 1127	GroundFl	South	54.1	41.5	19.1	11.5	19
1124 1127	FirstFl	South	56.2	43.7	21.2	13.7	21
1124 1127	SecondFl	South	57.3	44.9	22.3	14.9	22
1124 1127	GroundFl	S/W	54.3	41.7	19.3	11.7	19
1124 1127	FirstFl	S/W	56.5	44.0	21.5	14.0	22
1124 1127	SecondFl	S/W	57.9	45.4	22.9	15.4	23
1124 1127	GroundFl	West	54.4	41.9	19.4	11.9	19
1124 1127	FirstFl	West	56.9	44.5	21.9	14.5	22
1124 1127	SecondFl	West	58.4	45.9	23.4	15.9	23
1124 1127	GroundFl	N/W	54.6	42.0	19.6	12.0	20
1124 1127	FirstFl	N/W	57.1	44.7	22.1	14.7	22
1124 1127	SecondFl	N/W	58.8	46.3	23.8	16.3	24
1124 1127	GroundFl	N/W	53.9	41.3	18.9	11.3	19
1124 1127	FirstFl	N/W	56.2	43.6	21.2	13.6	21
1124 1127	SecondFl	N/W	58.5	45.8	23.5	15.8	23
1128 1129	GroundFl	East	42.4	31.2	7.4	1.2	7
1128 1129	FirstFl	East	46.0	34.3	11.0	4.3	11
1128 1129	GroundFl	South	45.3	33.3	10.3	3.3	10
1128 1129	FirstFl	South	48.7	36.5	13.7	6.5	14
1128 1129	GroundFl	West	47.3	35.2	12.3	5.2	12
1128 1129	FirstFl	West	51.4	39.2	16.4	9.2	16
1128 1129	GroundFl	North	50.4	37.8	15.4	7.8	15
1128 1129	FirstFl	North	52.3	39.7	17.3	9.7	17
1130 1131	GroundFl	North	49.9	37.3	14.9	7.3	15
1130 1131	FirstFl	North	51.6	39.1	16.6	9.1	17
1130 1131	GroundFl	East	44.6	33.0	9.6	3.0	10
1130 1131	FirstFl	East	47.7	35.9	12.7	5.9	13
1130 1131	GroundFl	South	46.4	34.2	11.4	4.2	11
1130 1131	FirstFl	South	49.1	36.9	14.1	6.9	14
1130 1131	GroundFl	West	42.5	31.3	7.5	1.3	7
1130 1131	FirstFl	West	46.0	34.4	11.0	4.4	11
1132 1136	GroundFl	N/E	53.0	40.5	18.0	10.5	18
1132 1136	FirstFl	N/E	54.6	42.3	19.6	12.3	20
1132 1136	SecondFl	N/E	55.9	43.6	20.9	13.6	21
1132 1136	GroundFl	N/E	49.1	36.8	14.1	6.8	14
1132 1136	FirstFl	N/E	52.6	40.2	17.6	10.2	18
1132 1136	SecondFl	N/E	54.9	42.5	19.9	12.5	20
1132 1136	GroundFl	N/E	50.2	37.9	15.2	7.9	15
1132 1136	FirstFl	N/E	54.2	41.8	19.2	11.8	19
1132 1136	SecondFl	N/E	56.8	44.4	21.8	14.4	22
1132 1136	GroundFl	S/E	51.3	39.0	16.3	9.0	16
1132 1136	FirstFl	S/E	56.1	43.7	21.1	13.7	21
1132 1136	SecondFl	S/E	58.2	45.8	23.2	15.8	23
1132 1136	GroundFl	South	52.5	40.2	17.5	10.2	18
1132 1136	FirstFl	South	58.9	46.5	23.9	16.5	24
1132 1136	SecondFl	South	60.2	47.8	25.2	17.8	25
1132 1136	GroundFl	South	55.1	42.7	20.1	12.7	20
1132 1136	FirstFl	South	61.8	49.4	26.8	19.4	27
1132 1136	SecondFl	South	62.1	49.7	27.1	19.7	27
1132 1136	GroundFl	S/W	61.9	49.4	26.9	19.4	27
1132 1136	FirstFl	S/W	62.8	50.4	27.8	20.4	28
1132 1136	SecondFl	S/W	63.2	50.7	28.2	20.7	28
1132 1136	GroundFl	S/W	58.2	45.8	23.2	15.8	23
1132 1136	FirstFl	S/W	59.6	47.2	24.6	17.2	25
1132 1136	SecondFl	S/W	60.6	48.3	25.6	18.3	26
1132 1136	GroundFl	S/W	55.6	43.2	20.6	13.2	21
1132 1136	FirstFl	S/W	57.4	45.1	22.4	15.1	22
1132 1136	SecondFl	S/W	58.7	46.4	23.7	16.4	24
1132 1136	GroundFl	N/W	55.2	42.9	20.2	12.9	20
1132 1136	FirstFl	N/W	57.2	44.8	22.2	14.8	22
1132 1136	SecondFl	N/W	58.2	45.9	23.2	15.9	23
1132 1136	GroundFl	North	54.8	42.3	19.8	12.3	20
1132 1136	FirstFl	North	56.8	44.3	21.8	14.3	22
1132 1136	SecondFl	North	57.7	45.3	22.7	15.3	23
1132 1136	GroundFl	North	54.3	41.8	19.3	11.8	19
1132 1136	FirstFl	North	56.3	43.9	21.3	13.9	21
1132 1136	SecondFl	North	57.2	44.9	22.2	14.9	22
1137 1138	GroundFl	N/E	60.8	48.4	25.8	18.4	26
1137 1138	FirstFl	N/E	61.0	48.6	26.0	18.6	26
1137 1138	GroundFl	S/E	59.5	47.1	24.5	17.1	25
1137 1138	FirstFl	S/E	60.2	47.8	25.2	17.8	25
1137 1138	GroundFl	S/W	52.7	40.3	17.7	10.3	18
1137 1138	FirstFl	S/W	57.9	45.5	22.9	15.5	23
1137 1138	GroundFl	N/W	47.6	35.7	12.6	5.7	13
1137 1138	FirstFl	N/W	51.2	39.2	16.2	9.2	16
1139	GroundFl	N/E	65.1	52.7	30.1	22.7	30
1139	FirstFl	N/E	65.0	52.6	30.0	22.6	30
1139	GroundFl	S/E	69.2	56.7	34.2	26.7	34
1139	FirstFl	S/E	69.0	56.6	34.0	26.6	34
1139	GroundFl	S/W	57.4	45.0	22.4	15.0	22
1139	FirstFl	S/W	64.9	52.5	29.9	22.5	30
1139	GroundFl	N/W	47.4	35.2	12.4	5.2	12
1139	FirstFl	N/W	51.8	39.5	16.8	9.5	17
1140	GroundFl	N/E	58.7	46.3	23.7	16.3	24
1140	FirstFl	N/E	66.8	54.3	31.8	24.3	32
1140	GroundFl	S/E	70.9	58.4	35.9	28.4	36
1140	FirstFl	S/E	70.7	58.3	35.7	28.3	36
1140	GroundFl	S/W	66.5	54.1	31.5	24.1	31
1140	FirstFl	S/W	66.8	54.4	31.8	24.4	32
1140	GroundFl	N/W	55.2	42.8	20.2	12.8	20
1140	FirstFl	N/W	59.1	46.7			

phlorum

Plot No	Floor	Elevation	Façade		Window Req		Window Req Overall	Plot No	Floor	Elevation	Façade		Window Req		Window Req Overall
			Day Laeq	Night Laeq	Day	Night					Day	Night	Day	Night	
1150_1151	FirstFl	S/E	45.8	33.8	10.8	3.8	11	1188_1189	GroundFl	S/W	53.7	41.3	18.7	11.3	19
1150_1151	GroundFl	S/W	52.0	39.6	17.0	9.6	17	1188_1189	FirstFl	S/W	55.8	43.4	20.8	13.4	21
1150_1151	FirstFl	S/W	53.2	40.9	18.2	10.9	18	1188_1189	GroundFl	N/W	46.0	33.8	11.0	3.8	11
1150_1151	GroundFl	N/W	47.0	34.8	12.0	4.8	12	1188_1189	FirstFl	N/W	50.1	37.9	15.1	7.9	15
1150_1151	FirstFl	N/W	50.8	38.6	15.8	8.6	16	1190_1191	GroundFl	N/E	46.9	34.9	11.9	4.9	12
1152_1153	GroundFl	N/E	47.2	35.3	12.2	5.3	12	1190_1191	FirstFl	N/E	52.7	40.4	17.7	10.4	18
1152_1153	FirstFl	N/E	50.7	38.6	15.7	8.6	16	1190_1191	GroundFl	S/E	43.1	30.9	8.1	0.9	8
1152_1153	GroundFl	S/E	45.1	32.9	10.1	2.9	10	1190_1191	FirstFl	S/E	46.6	34.5	11.6	4.5	12
1152_1153	FirstFl	S/E	50.0	37.7	15.0	7.7	15	1190_1191	GroundFl	S/W	47.7	35.4	12.7	5.4	13
1152_1153	GroundFl	S/W	50.5	38.1	15.5	8.1	15	1190_1191	FirstFl	S/W	55.0	42.6	20.0	12.6	20
1152_1153	FirstFl	S/W	52.0	39.7	17.0	9.7	17	1190_1191	GroundFl	N/W	49.1	36.9	14.1	6.9	14
1152_1153	GroundFl	N/W	43.8	31.7	8.8	1.7	9	1190_1191	FirstFl	N/W	55.5	43.1	20.5	13.1	20
1152_1153	FirstFl	N/W	48.3	36.2	13.3	6.2	13	1192_1193	GroundFl	N/E	62.3	49.9	27.3	19.9	27
1154_1155	GroundFl	North	47.3	35.4	12.3	5.4	12	1192_1193	FirstFl	N/E	62.4	50.0	27.4	20.0	27
1154_1155	FirstFl	North	51.3	39.1	16.3	9.1	16	1192_1193	GroundFl	S/E	44.1	32.0	9.1	2.0	9
1154_1155	GroundFl	East	45.2	33.0	10.2	3.0	10	1192_1193	FirstFl	S/E	48.1	35.8	13.1	5.8	13
1154_1155	FirstFl	East	50.2	37.9	15.2	7.9	15	1192_1193	GroundFl	S/W	63.5	51.1	28.5	21.1	29
1154_1155	GroundFl	South	41.1	29.1	6.1	-0.9	6	1192_1193	FirstFl	S/W	63.9	51.4	28.9	21.4	29
1154_1155	FirstFl	South	44.6	32.6	9.6	2.6	10	1192_1193	GroundFl	N/W	68.0	55.6	33.0	25.6	33
1154_1155	GroundFl	West	43.3	31.3	8.3	1.3	8	1192_1193	FirstFl	N/W	68.1	55.7	33.1	25.7	33
1154_1155	FirstFl	West	46.5	34.6	11.5	4.6	11	1194_1195	GroundFl	N/E	61.7	49.3	26.7	19.3	27
1156_1157	GroundFl	N/W	55.1	42.7	20.1	12.7	20	1194_1195	FirstFl	N/E	61.7	49.3	26.7	19.3	27
1156_1157	FirstFl	N/W	55.9	43.5	20.9	13.5	21	1194_1195	GroundFl	S/E	44.6	32.5	9.6	2.5	10
1156_1157	GroundFl	N/E	58.9	46.8	24.2	16.8	24	1194_1195	FirstFl	S/E	44.6	32.5	9.6	2.5	10
1156_1157	FirstFl	N/E	59.6	47.2	24.6	17.2	25	1194_1195	GroundFl	S/W	62.7	50.5	27.7	20.3	28
1156_1157	GroundFl	S/E	55.0	42.6	20.0	12.6	20	1194_1195	FirstFl	S/W	63.0	50.6	28.0	20.6	28
1156_1157	FirstFl	S/E	55.5	43.1	20.5	13.1	20	1194_1195	GroundFl	N/W	68.0	55.6	33.0	25.6	33
1156_1157	GroundFl	S/W	47.3	32.1	8.7	2.1	9	1194_1195	FirstFl	N/W	68.1	55.7	33.1	25.7	33
1156_1157	FirstFl	S/W	46.3	31.7	8.7	2.1	9	1196_1197	GroundFl	North	60.0	53.6	31.0	23.6	31
1158_1159	GroundFl	N/W	57.1	44.7	22.1	14.7	22	1196_1197	FirstFl	North	60.0	53.6	31.0	23.6	31
1158_1159	FirstFl	N/W	58.1	45.7	23.1	15.7	23	1196_1197	GroundFl	East	47.3	35.0	12.3	5.0	12
1158_1159	GroundFl	N/E	59.2	46.8	24.2	16.8	24	1196_1197	FirstFl	East	55.9	43.5	20.9	13.5	21
1158_1159	FirstFl	N/E	60.0	47.6	25.0	17.6	25	1196_1197	GroundFl	South	62.7	50.3	27.7	20.3	28
1158_1159	GroundFl	S/E	55.5	43.1	20.5	13.1	20	1196_1197	FirstFl	South	63.0	50.6	28.0	20.6	28
1158_1159	FirstFl	S/E	56.0	43.6	21.0	13.6	21	1196_1197	GroundFl	West	68.7	56.2	33.7	26.2	34
1158_1159	GroundFl	S/W	43.8	31.8	8.8	1.8	9	1196_1197	FirstFl	West	68.6	56.2	33.6	26.2	34
1158_1159	FirstFl	S/W	46.5	34.7	11.5	4.7	12	1198_1199	GroundFl	N/E	58.3	45.9	23.3	15.9	23
1160_1161	GroundFl	N/W	45.2	33.0	10.2	3.0	10	1198_1199	FirstFl	N/E	58.5	46.1	23.5	16.1	23
1160_1161	FirstFl	N/W	51.3	38.9	16.3	8.9	16	1198_1199	GroundFl	S/E	44.4	32.2	9.4	2.2	9
1160_1161	GroundFl	N/E	59.1	46.7	24.1	16.7	24	1198_1199	FirstFl	S/E	44.1	32.9	9.1	5.9	13
1160_1161	FirstFl	N/E	60.0	47.6	25.0	17.6	25	1198_1199	GroundFl	S/W	46.4	34.1	11.4	4.1	11
1160_1161	GroundFl	S/E	47.4	35.1	12.4	5.1	12	1198_1199	FirstFl	S/W	50.9	38.6	15.5	8.6	16
1160_1161	FirstFl	S/E	54.8	42.5	19.7	12.5	19	1198_1199	GroundFl	N/W	57.4	45.0	22.4	15.0	22
1160_1161	GroundFl	S/W	48.0	36.1	13.0	6.1	13	1198_1199	FirstFl	N/W	59.1	46.7	24.1	16.7	24
1162_1163	GroundFl	N/W	51.0	38.7	16.0	8.7	16	1200_1201	GroundFl	N/E	52.0	39.7	17.0	9.7	17
1162_1163	FirstFl	N/W	57.9	45.5	22.9	15.5	23	1200_1201	FirstFl	N/E	53.1	40.9	18.1	10.9	18
1162_1163	GroundFl	N/E	59.6	47.2	24.6	17.2	25	1200_1201	GroundFl	S/E	42.1	30.1	7.1	0.1	7
1162_1163	FirstFl	N/E	60.3	47.9	25.3	17.9	25	1200_1201	FirstFl	S/E	45.6	33.6	10.5	3.6	11
1162_1163	GroundFl	S/E	45.2	33.0	10.2	3.0	10	1200_1201	GroundFl	S/W	45.3	33.1	10.3	3.1	10
1162_1163	FirstFl	S/E	51.1	38.8	16.1	8.8	16	1200_1201	FirstFl	S/W	48.3	36.2	13.3	6.3	13
1162_1163	GroundFl	S/W	46.7	34.8	11.7	4.8	12	1200_1201	GroundFl	N/W	45.8	33.7	10.8	3.7	11
1162_1163	FirstFl	S/W	49.3	37.3	14.3	7.3	14	1200_1201	FirstFl	N/W	49.0	36.9	14.0	6.9	14
1164_1175	GroundFl	North	61.7	49.3	26.7	19.3	27	1202_1203	GroundFl	N/E	49.3	37.2	14.3	7.2	14
1164_1175	FirstFl	North	69.6	57.2	34.6	27.2	35	1202_1203	FirstFl	N/E	51.2	39.1	16.2	9.1	16
1164_1175	SecondFl	North	69.3	56.9	34.3	26.9	34	1202_1203	GroundFl	S/E	42.1	30.0	7.1	0.0	7
1164_1175	GroundFl	East	60.5	48.1	25.5	18.1	26	1202_1203	FirstFl	S/E	45.5	33.4	10.5	3.4	11
1164_1175	FirstFl	East	63.6	51.2	28.6	21.2	29	1202_1203	GroundFl	S/W	43.8	31.6	8.8	1.6	9
1164_1175	SecondFl	East	63.9	51.5	28.9	21.5	29	1202_1203	FirstFl	S/W	46.6	34.5	11.6	4.5	12
1164_1175	GroundFl	S/E	55.6	43.2	20.6	13.2	21	1202_1203	GroundFl	N/W	44.3	32.3	9.3	2.3	9
1164_1175	FirstFl	S/E	56.9	44.5	21.9	14.5	22	1202_1203	FirstFl	N/W	47.3	35.3	12.3	5.3	12
1164_1175	SecondFl	S/E	57.2	44.8	22.2	14.8	22	1204_1205	GroundFl	North	51.2	38.9	16.2	8.9	16
1164_1175	GroundFl	West	62.6	50.2	27.6	20.2	28	1204_1205	FirstFl	North	53.3	41.0	18.3	11.0	18
1164_1175	FirstFl	West	66.4	54.0	31.4	24.0	31	1204_1205	GroundFl	East	42.7	30.6	7.7	0.6	8
1164_1175	SecondFl	West	66.7	54.3	31.7	24.3	32	1204_1205	FirstFl	East	46.4	34.3	11.4	4.3	11
1176_1177	GroundFl	North	46.4	34.4	11.4	4.3	11	1204_1205	GroundFl	South	41.8	31.5	6.8	1.5	7
1176_1177	FirstFl	North	52.3	40.0	17.3	10.0	17	1204_1205	FirstFl	South	44.8	33.7	9.8	3.7	10
1176_1177	GroundFl	East	44.6	32.4	9.6	2.4	10	1204_1205	GroundFl	West	43.0	32.5	8.0	2.5	8
1176_1177	FirstFl	East	50.7	38.4	15.7	8.4	16	1204_1205	FirstFl	West	46.1	35.0	11.1	5.0	11
1176_1177	GroundFl	South	37.2	25.6	2.2	-4.4	2	1206_1207	GroundFl	North	53.0	40.7	18.0	10.7	18
1176_1177	FirstFl	South	41.7	29.9	6.7	-0.1	7	1206_1207	FirstFl	North	54.7	42.0	18.7	11.7	19
1176_1177	GroundFl	West	41.6	30.2	6.6	0.2	7	1206_1207	GroundFl	East	47.0	34.7	12.0	4.7	12
1176_1177	FirstFl	West	44.3	32.9	9.3	2.9	9	1206_1207	FirstFl	East	48.9	36.6	13.9	6.6	14
1178_1179	GroundFl	North	45.9	33.9	10.9	3.9	11	1206_1207	GroundFl	South	39.9	28.0	4.9	-2.0	5
1178_1179	FirstFl	North	49.6	37.5	14.6	7.5	15	1206_1207	FirstFl	South	43.6	31.6	8.6	1.6	9
1178_1179	GroundFl	East	42.8	30.6	7.8	0.6	8	1206_1207	GroundFl	West	42.3	31.0	7.3	1.0	7
1178_1179	FirstFl	East	47.2	35.0	12.2	5.0	12	1206_1207	FirstFl	West	45.6	34.1	10.6	4.1	11
1178_1179	GroundFl	South	37.3	25.7	2.3	-4.3	2	1208_1209	GroundFl	North	54.7	42.3	19.7	12.3	20
1178_1179	FirstFl	South	41.7	30.0	6.7	0.0	7	1208_1209	FirstFl	North	55.4	43.1	20.4	13.1	20
1178_1179	GroundFl	West	42.9	31.3	7.9	1.3	8	1208_1209	GroundFl	East	53.0	40.6	18.0	10.6	18
1178_1179	FirstFl	West	45.3	33.8	10.3	3.8	10	1208_1209	FirstFl	East	54.1	41.8	19.1	11.8	19
1180_1181	GroundFl	North	45.3	33.4	10.3	3.4	10	1208_1209	GroundFl	South	38.3	26.6	3.3	-3.4	3
1180_1181	FirstFl	North	50.1	38.0	15.1	8.0	15	1208_1209	FirstFl	South	42.8	30.9	7.8	0.9	8
1180_1181	GroundFl	East	43.1	30.9	8.1	0.9	8	1208_1209	GroundFl	West	41.9	30.5	6.9	0.5	7
1180_1181	FirstFl	East	46.5	34.3	11.5	4.3	11	1208_1209	FirstFl	West	45.2	33.8	10.2	3.8	10
1180_1181	GroundFl	South	37.5	25.9	2.5	-4.1	3	1210_1211	GroundFl	N/W	56.9	44.5	21.9	14.5	22
1180_1181	FirstFl	South	42.0	30.2	7.0	0.2	7	1210_1211	FirstFl						



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