

Land North of Bunting Lane, Old Sarum, Salisbury

Residential Noise Assessment

November 2023





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Residential Noise Assessment

Revision	Date	Notes	Author	Checked	Approved
Ver. 8a	03-11-23	E2867	SP	ND	ND

Entran Limited
2nd & 3rd Floors
Northgate House
Upper Borough Walls
Bath
BA1 1RG

T: 0117 937 4077
www.entranltd.co.uk



CONTENTS	PAGE
1 Introduction	1
2 Assessment Methodology	4
3 Environmental Noise Measurements	10
4 Noise Assessment	13
5 Conclusions	23
APPENDIX A – Introduction to noise	24
APPENDIX B – Noise Survey	26
APPENDIX C – Façade Calculations	28



1 INTRODUCTION

- 1.1 Entrant Limited was commissioned by Persimmon Homes (Wessex) to undertake a noise assessment for a proposed residential development (known as 'Land North of Bunting Lane') located to east of Salisbury FC's ground and is mainly affected by road traffic noise from the A345 during non-match days (550m north-west of the site) and occasional light aircraft using Old Sarum Airfield (400m south of the site). Figure 1 shows the site in relation to the above noise sources. Figure 2 shows the current masterplan (October 2023) of the proposed development.
- 1.2 The assessment has been undertaken to consider the noise levels at the proposed residential development. The assessment considers the existing ambient noise and the suitability of the site for residential use. Following earlier discussions with the Council's Environmental Officer (Katherine Fowler) for a previous masterplan, this report addresses the concerns of the EHO and proposes further mitigation measures.
- 1.3 The potential noise impacts are assessed in accordance with the most relevant national and local standards and guidelines.
- 1.4 The noise levels are assessed using criteria provided within BS 8233:2014 and the WHO Guidelines. This report is necessarily technical in nature and contains terminology relating to acoustics and noise. Therefore, a glossary together with a brief introduction to the subject of noise has been provided in Appendix A.

Figure 1 Site Location



Figure 2 Revised Masterplan (October 2023)





2 ASSESSMENT METHODOLOGY

National Policy

National Planning Policy Framework (NPPF) (July 2021)

2.1 The National Planning Policy Framework (NPPF) sets out the Government's economic, environmental and social planning policies for England. It attempts to summarise in a single document all previous national planning policy advice. Taken together, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations.

2.2 Under Section 15; Conserving and enhancing the natural environment, the following is stated in paragraph 174:

"Planning policies and decisions should contribute to and enhance the natural and local environment by: ...

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..."

2.3 The NPPF goes on to state in paragraph 185 that:

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

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;

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



Noise Policy Statement for England NPSE (March 2010)

2.4 The Government is committed to sustainable development and the Department for Environment Food and Rural Affairs (Defra) plays an important role in this by working to secure a healthy environment in which current and future generations can prosper. One aspect of meeting these objectives is the need to manage noise for which Defra has the overall responsibility in England.

2.5 In March 2010, the Noise Policy Statement for England (NPSE) set out the long-term vision of Government noise policy as to:

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

2.6 The long-term vision is supported by the following aims:

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

- *Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life: and,*
- *Where possible, contribute to the improvement of health and quality of life.'*

2.7 The explanatory note to the policy statement emphasises that sustainable development is a core principle underpinning all government policy. In this respect, there is a need to integrate consideration of the economic and social benefit of the activity under examination with proper consideration of the adverse environmental effects.

2.8 To achieve these objectives the NPSE sets out three noise conditions to be determined by the assessor:

NOEL - No Observed Effect Level

2.9 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

2.10 This is the level above which adverse effects on health and quality of life can be detected.



SOAEL - Significant Observed Adverse Effect Level

- 2.11 This is the level above which significant adverse effects on health and quality of life occur.
- 2.12 The NPSE considers that noise levels above the SOAEL would be seen to have, by definition, significant adverse effects and would be considered unacceptable.
- 2.13 Where the assessed noise levels fall between the LOAEL and the SOAEL noise levels, the NPSE 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.... This does not mean that such adverse effects cannot occur.'

- 2.14 No objective values are offered within the NPSE, as the document does indicate that each site should be considered on its own merits. Consequently, consideration of the observed effects is made through an assessment methodology as detailed below.

British Standard BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings (2014)

- 2.15 The scope of BS 8233 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.
- 2.16 This Standard suggests suitable internal noise levels within different types of buildings, including residential dwellings. It suggests that an internal noise level of 30 dB $L_{Aeq, T}$ within bedrooms is a 'desirable' standard. For living areas during the daytime, the standard recommends 35 dB $L_{Aeq, T}$ as a desirable standard for resting.
- 2.17 Whilst BS 8233 recognises that a guideline value may be set in terms of SEL or L_{AFmax} for the assessment of regular individual noise events that can cause sleep disturbance during the night-time, a specific criterion is not stipulated. Accordingly, reference has been made in this assessment to the World Health Organisation (WHO) 1999: *Guidelines for Community Noise*.



2.18 The Standard also states that “*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.*”

The Professional Practice Guidance on Planning and Noise

2.19 The ‘Professional Practice Guidance on Planning and Noise’ (ProPG) was produced by a Working Group consisting of representatives of the Association of Noise Consultants (ANC), Institute of Acoustics (IOA) and Chartered Institute of Environmental Health (CIEH) to provide acoustical practitioners with guidance on the management of noise within the planning system in England.

2.20 The reparation of the ProPG acknowledges and reflects the Government’s overarching NPSE, the NPPF and Planning Practice Guidance (including PPG-Noise), as well as other authoritative sources of guidance. It provides advice for Local Planning Authorities (LPAs) and developers, and their respective professional advisers which complements Government planning and noise policy and guidance and, in particular, aims to:

- advocate full consideration of the acoustic environment from the earliest possible stage of the development control process;
- encourage the process of good acoustic design in and around new residential developments;
- outline what should be taken into account in deciding planning applications for new noise-sensitive developments;
- promote appropriate noise exposure standards; and,
- assist the delivery of sustainable development.

Site Suitability

2.21 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 2.1; 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 2.1 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.			

2.22 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.

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



3 ENVIRONMENTAL NOISE MEASUREMENTS

- 3.1 Noise conditions in the vicinity of the Proposed Development have been determined by environmental noise surveys conducted on 22nd April (attended, football match, Salisbury Town V Weston-Super-Mare) and on 24/25th April 2023 (ambient noise survey).
- 3.2 All noise measurements were undertaken by competent individuals with experience in environmental noise monitoring. Measurements were obtained in accordance with the principles of BS 7445: 2003: '*Description and measurement of environmental noise*'. The microphones were fitted with a protective windshield and the sound level meters were situated in a weatherproof case.
- 3.3 All acoustic measurement equipment used during the noise surveys conformed to Type 1 specification of British Standard 61672: 2013: *Electroacoustics. Sound level meters. Part 1 Specifications*. The noise measurement equipment used during the survey was calibrated at the start and end of the measurement period. There was no significant drift in calibration measurements observed during the survey period.
- 3.4 The attended measurements were obtained to understand the football noise levels on the development site (adjacent to the north-west stand). Ambient noise levels were also measured at the east of the football ground boundary with the site. The monitors were situated approximately 1.8m above local ground and in free-field conditions.
- 3.5 The monitoring positions are indicated in Figure 3.

Figure 3 – Monitoring Locations



3.6 The summary results of the noise survey are presented below (detailed ambient survey is presented in Appendix B).

Table 3.1: Summary of Attended Noise Measurements (Football Match)

Time	Measured Free-Field Sound Pressure Level, dB re. 2×10^{-5} Pa.			
	$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A10,T}$	$L_{A90,T}$
15:00:00	84.2	67.9	71	56.5
15:15:00	76.4	65.2	68.9	56
15:30:00	75.9	63.4	67.2	53.5
15:45:00	83.2	65.9	69.4	53.4
16:00:00	84.1	61.9	64.4	50.7
16:15:00	82.3	65.2	68.4	51.9
16:30:00	77.2	63.1	66.9	52.1
Average	80.5	65.1	68.0	53.4

Maximum levels represent the highest $L_{Amax,F}$ sound level during the given period.
The period $L_{Aeq,T}$ is obtained from the logarithmic average of measured sound levels.
The period $L_{A90,T}$ is obtained from the average of the measured sound levels.



Table 3.2: Noise Measurement Results (Ambient, Without Stadium Events)

Time Period	L _{Aeq}	L _{Amax,f}	L _{A10}	L _{A90}
	dB			
Day (0700-2300hrs)	54.0	69.9	57.1	42.7
Night (2300-0700hrs)	49.5	65.9	52.8	29.9

- 3.7 The football match attendance was 711 patrons which is higher than the season average of just under 500 patrons for the 22/23 Season and 580 patrons for the 23/24 Season (so far).
- 3.8 The noise monitoring was undertaken to validate a noise computer model for both the football match and the ambient climate.



4 NOISE ASSESSMENT

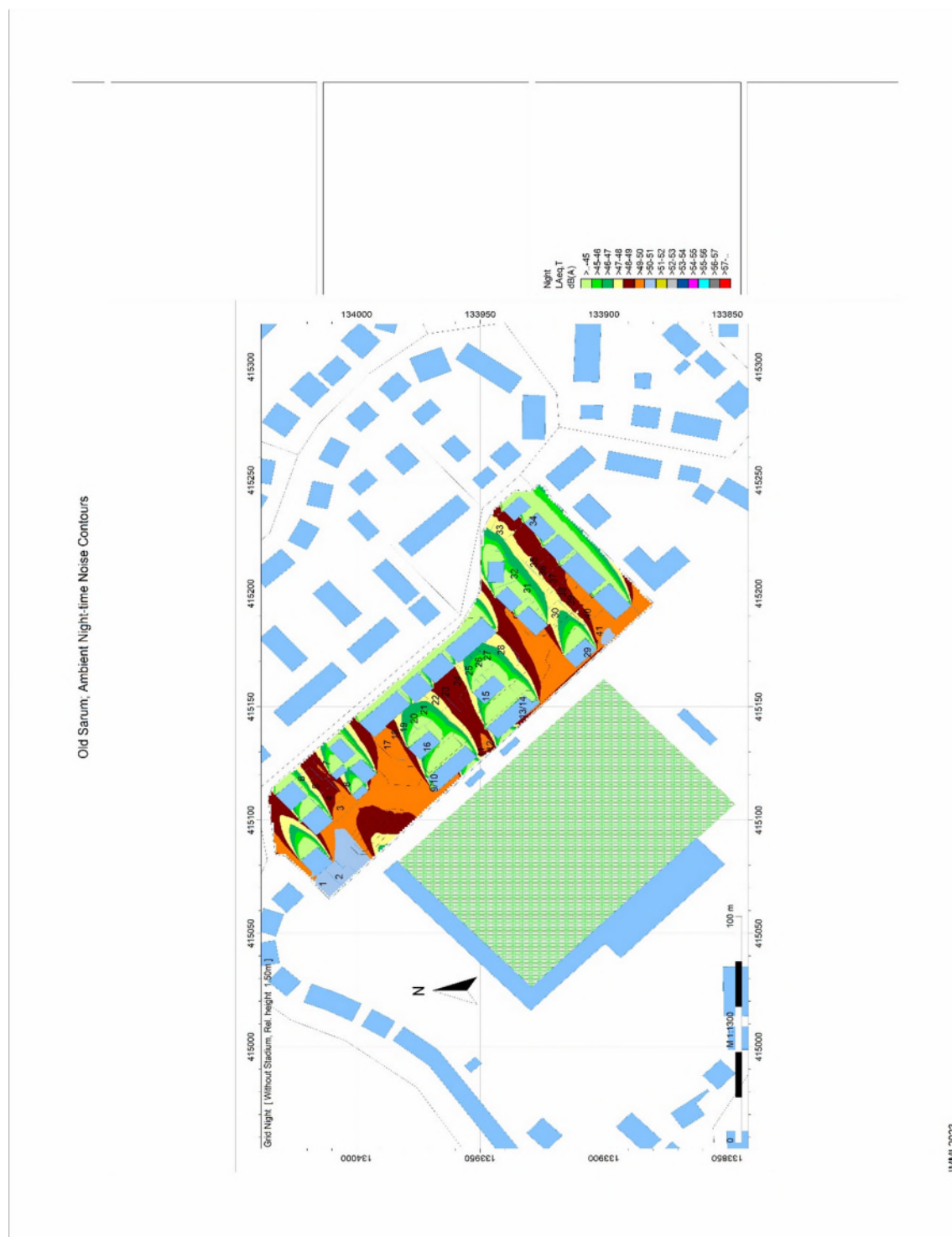
Ambient Noise Levels

- 4.1 As described in Section 2 of this report, the ambient noise levels without events at the Raymond McEnhill Stadium are above LOAEL but below SOAEL which represents a low to medium risk and therefore internal noise levels will need to be reduced to comply with the criteria outlined in BS8233. External noise levels for most of the gardens, without events at the stadium, comply with the aspirational guidelines of the WHO.
- 4.2 The ambient noise measurement results presented above have been used to calculate noise levels at the façade of the proposed buildings, and to consider the effects of any acoustic screening provided by existing buildings and the topography.
- 4.3 In addition to the derived road traffic source noise levels (the only noise source in the vicinity during non-event day at the stadium) used in the calculations, the model also considers the effects of the topographical conditions throughout the area, ground absorption, atmospheric absorption, acoustic reflections, acoustic screening as well as applying a light downwind propagation correction to represent worst case.
- 4.4 The model has been used to determine the daytime $L_{Aeq,16\text{-hour}}$ (07:00 to 23:00) and night-time $L_{Aeq,8\text{-hour}}$ (23:00 to 07:00).
- 4.5 To allow determination of the suitability of the Site for residential development, the output from the daytime and night-time baseline noise models has been presented in the form of noise contours projected onto the development site.
- 4.6 Figures 4 and 5 represent the calculated noise levels for the 16-hour (07:00 to 23:00) daytime and 8-hour night-time (23:00 to 07:00) respectively across the development site.
- 4.7 Internal noise levels from ambient noise sources are discussed later in this section.

Figure 4 Daytime Noise Contours (Ambient, without football match)



Figure 5 Night-time Noise Contours (Ambient)



Noise Levels during a Football Match

- 4.8 The noise survey data gathered at the football match were utilised to gauge the potential noise levels in the gardens and within the dwellings of the proposed development.

4.9 Discussions with the EHO indicated that both internal and external noise levels were of concern regardless of the finite time of football matches. To address these concerns, the current masterplan has been amended whereby private amenity spaces are minimised for access to storage spaces. However, for the purposes of this assessment, the rear spaces for plots 9, 10, 11, 12, 13, 14 and 29 are considered to be private amenity spaces. For those plots adjacent to the stadium, the following mitigation measures is recommended (see Figure 6):

- a 2.5m high purpose-built noise barrier (superficial mass of 10 to 15 Kg/m²) to further reduce garden noise levels from events at the football stadium.

Figure 6 Acoustic Fence Locations



4.10 Notwithstanding the above masterplan changes, further mitigation measures are incorporated as per earlier discussions with the EHO:

- **reduce** the BS8233 criteria from 35 dB $L_{Aeq,T}$ to 32 dB $L_{Aeq,T}$ during daytime football matches (0700 to 2300 hrs) and therefore increase the window attenuation required by the proposed buildings.

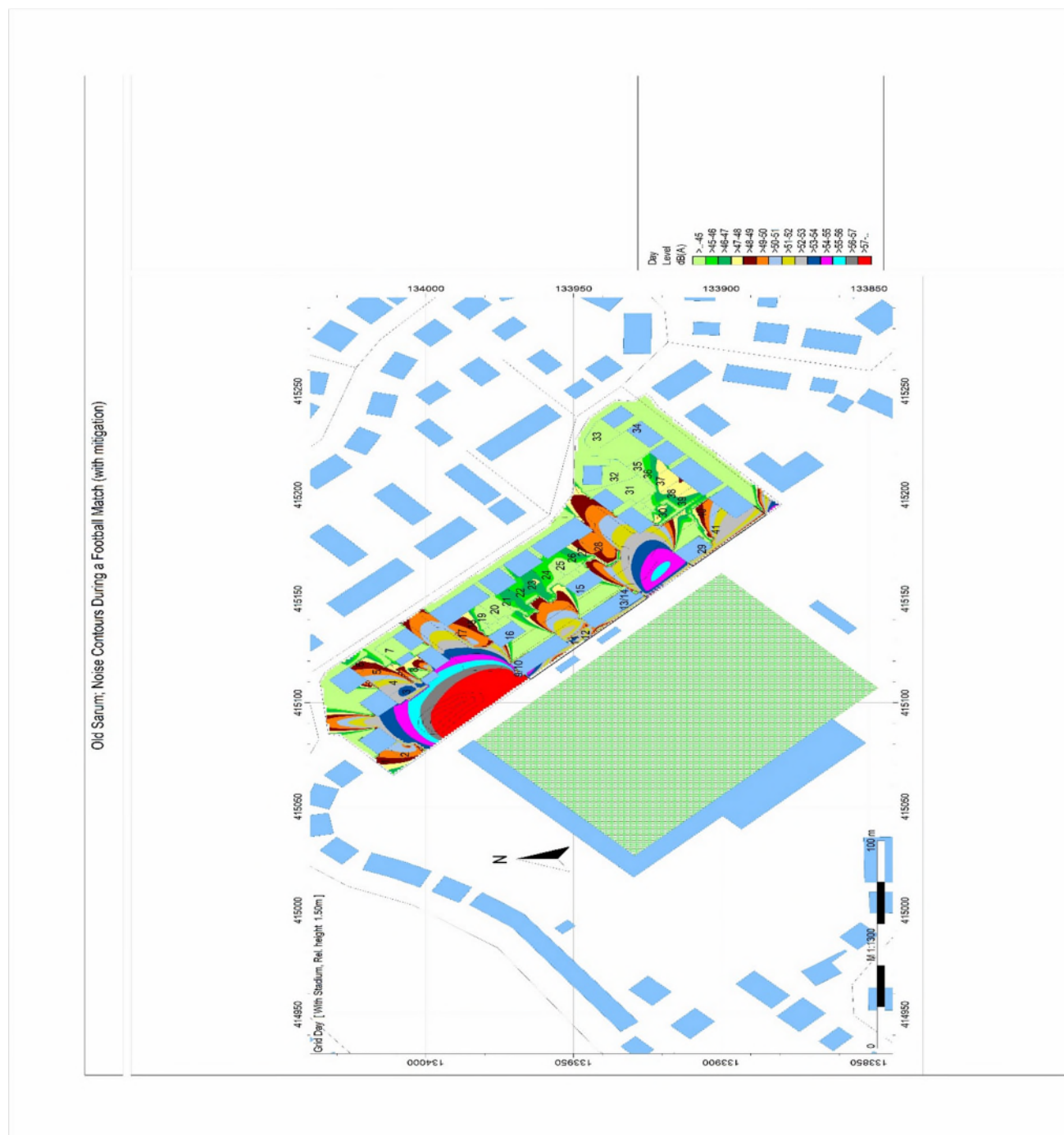
4.11 A validated noise model was constructed to evaluate the potential levels in the gardens during a football match. The ISO9613 noise model includes the topography, noise barrier (for the plots adjacent to the stadium) and distance corrections together with the noise sources (e.g., supporters in the stands and the noise levels on the pitch) to produce the noise contours shown in Figure 7.

4.12 The noise contours of Figure 7 show noise levels in all gardens are compliant with the 55 dB criterion (as a consequence of the masterplan changes and the garden barriers).

4.13 Discussions with the EHO also considered the noise increase for a short time at the development site during football matches. It is not only the increase in noise levels that need to be considered but the absolute noise levels that may be experienced by nearby residents that need to be considered in the context of adopted guidance such as BS8233 (albeit we are further proposing an even lower internal limit during football matches). Persimmon Homes have put forward reasonable mitigation measures in terms masterplan changes, the noise fence for the plots adjacent to the Stadium, lowering the internal limit and hence increasing window attenuation to counter the noise from the stadium. We are not aware of any scientific/social studies on such events nor is there any evidence to suggest that noise increases next a sports venue is unacceptable for short durations and further, potential house buyers would be aware that a football stadium is located nearby and that there will noise associated with the stadium for short durations.

4.14 Internal noise levels during a football match are considered later in this section.

Figure 7 Daytime Noise Contours during a typical football match





Noise Levels from the Stadium Function Suite/Bar

- 4.15 The EHO had also raised concerns with regards to the noise egress from the first-floor function suite/bar situated in the main stand which is 90m from the nearest dwelling of the proposed development.
- 4.16 A short sample survey was undertaken at the development site at 2145hrs. The measured noise level was 42 dB $L_{Aeq,30min}$ (between traffic events). However, for the purposes of this assessment, we have assumed a worst-case internal noise level at the bar of 100 dB $L_{Aeq,T}$. This equates to an external sound power level of 93 dB(A) at each of the five windows of the function suite that face the proposed development (all five windows are assumed to be partially open giving an attenuation of 15 dB each).
- 4.17 Using ISO9613 methodology, noise egress from the bar has modelled to produce ground floor noise contours at the development site (see Figure 8). As be seen from Figure 8, noise levels in private amenity spaces are below the 55 dB criterion and therefore further mitigation measures not required. It is noted that there is an existing property (newly constructed) approximately 30m west of the main grandstand (which includes the bar) and therefore closer than the proposed development. This property does not appear to have any special ameliorative measures other than thermal double glazing.
- 4.18 Internal noise levels as a consequence of the noise egress from the bar area are considered later in this section.

Figure 8 Noise Contours due to Function Suite/Bar noise





Noise From Outdoor Events at the Stadium

- 4.19 Another concern discussed with EHO was potential noise from outdoor events (on the football pitch) at the stadium. Example events include wedding functions/fairs and pop concerts.
- 4.20 We have not witnessed an outdoor event at the football stadium and therefore, for the purposes of a worst-case assessment, we have assumed that noise levels at the façade of any dwellings of the proposed development shall not exceed 75 dB $L_{Aeq,T}$ or music noise level (MNL) as per the criteria outlined in Noise Council's Code of Practice on Environmental Noise Control at Concerts for 3 concerts a year. Provided this limit is achieved via routine licencing mechanisms, such events can be held at the stadium for three days a year without effecting the commercial sensitivities or stadium sustainability. This also applies to existing properties 40m from the south-east corner of the stadium on Bunting Lane and again these properties do not have appear to have any special ameliorative measures.
- 4.21 Similarly, for weddings or other similar events on the football pitch, provided noise levels do not exceed 60 dB $L_{Aeq,T}$ (worst-case, based upon our experience adjacent to non-related residential properties) at the proposed noise barrier, internal noise levels will comply with the criteria outlined in BS8233 (see below). Noise levels in the gardens will also comply with the 55 dB criterion (the noise fence will give a minimum attenuation of 8-10 dB – see above). Again, such limits can be achieved via the licencing mechanisms without effecting the commercial sensitivities or stadium sustainability (in view of the existing properties on Bunting Lane).

Noise from Training Sessions

- 4.22 For the assessment of training sessions at the stadium, we have utilised the criteria outlined in Sports England's publication 'Artificial Grass Pitches Acoustics Planning Implications Guide'. We note that the guidance is for artificial grass pitches (and not for a normal sized football pitches). Nonetheless, for training at the stadium, the 2.5m high noise barrier located at the boundary for the plots adjacent to the Stadium as well as 1.8m garden fences for the rest of the development, the noise levels would be within the Sports England's adopted aspirational guidance value (assuming a source level of 58 dB $L_{Aeq,1hr}$ at 10m).

Internal Noise Levels & Mitigation Measures

- 4.23 Internal noise levels due ambient noise sources, football matches and the function suite/bar have calculated and presented in Appendix C.



4.24 Appendix C also shows the required window attenuation to comply with noise levels adopted for this report (3 dB below the daytime BS8233:2014 guidelines and 30 dB $L_{Aeq,T}$ at night).

4.25 The window requirements shown in Appendix C indicates that thermal/acoustic double glazing will be required for the proposed dwellings to comply with the 32 dB daytime and night-time 30 dB criteria. In summary, the following window configuration will be necessary:

- For those facades that require a minimum window attenuation of up to 29 dB R_{w+ctr} : *for example*, 4/6/4mm or similar. This applies to the majority of the proposed dwellings;
- For those facades that require a window attenuation greater than 30 dB, the following window configurations would need to be considered:

Table 4.1 Façade Requirement greater than 30 dB

Plot No	Floor	Facade	Required Window Attenuation (To meet with a lower adopted criterion during a match day) R_{w+ctr} dB	<u>Example</u> of Window type*
12_14	First Fl	S/W	30	4/8/4mm

*window providers may have their own constructions to meet with the required window attenuation and therefore their advice should be sought before procurement.

4.26 The above window arrangement applies noise levels from ambient noise sources, football matches and the noise egress from the function suite/bar to comply with the adopted 32 dB daytime and 30 dB night-time criteria. With closed windows, the proposed buildings (exposed façades) will require an additional means of ventilation. Any ventilation provided will comply with the current Building Regulations (Approved Document F). The $D_{n,e,w}$ ventilation specifications per plot are also shown in Appendix C.



5 CONCLUSIONS

- 5.1 Ambient noise levels adjacent to the development site known as 'Land North of Bunting Lane', Old Sarum, Salisbury have been measured and assessed relative to the criteria documented in BS8233:2014 and WHO. In addition, noise levels were sampled during a football to gauge the potential effects on future residents at the development site.
- 5.2 The calculated window requirements for each façade of the proposed residential spaces indicates that thermal and acoustic double glazing will be sufficient to comply with a daytime noise limit of 32 dB $L_{Aeq,T}$ (lower than BS8233:2014 for ambient, football and the stadium's function suite/bar) and night-time internal noise limit of 30 dB $L_{Aeq,T}$. With closed windows, the proposed buildings (exposed façades) will require an additional means of ventilation. Any ventilation provided will comply with the current Building Regulations (Approved Document F).
- 5.3 For ambient noise sources, noise levels in the gardens comply with the aspirational guidelines of the WHO. However, to comply with the WHO limits, noise levels in the gardens from the stadium's bar and outdoor events such as weddings, a 2.5m high noise barrier is specified for the gardens of the plots directly adjacent to the stadium. The changes in the masterplan, with mitigation, also ensures that noise levels in the gardens remain below 55 dB $L_{Aeq,T}$ during football matches.
- 5.4 Consequently, based on this assessment and the above mitigation measures, noise does not pose a material constraint to the development of the site.



APPENDIX A – INTRODUCTION TO NOISE

In order to assist the understanding of acoustic terminology and the relative change in noise, the following background information is provided.

The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale is used. The decibel scale typically ranges from 0 dB (the threshold of hearing) to over 120 dB.

The ear is less sensitive to some frequencies than to others. The A-weighting scale is used to approximate the frequency response of the ear. Levels weighted using this scale are commonly identified by the notation dB(A).

A noise impact on a community is deemed to occur when a new noise is introduced that is out of character with the area, or when a significant increase above the pre-existing ambient noise level occurs. For levels of noise that vary with time, it is necessary to employ a statistical index that allows for this variation. These statistical indices are expressed as the sound level that is exceeded for a percentage of the time period of interest.

In the UK, traffic noise is measured as the L_{A10} , the noise level exceeded for 10% of the measurement period. The L_{A90} is the level exceeded for 90% of the time and has been adopted to represent the background noise level in the absence of discrete events. An alternative way of assessing the time varying noise levels is to use the equivalent continuous sound level, L_{Aeq} . This is a notional steady level that would, over a given period of time, deliver the same sound energy as the actual fluctuating sound.

To put these quantities into context, where a receiver is predominantly affected by continuous flows of road traffic, a doubling or halving of the flows would result in a just perceptible change of 3dB, while an increase of more than 25%, or a decrease of more than 20%, in traffic flows represent changes of 1dB in traffic noise levels (assuming no alteration in the mix of traffic or flow speeds).

Note that the time constant and the period of the noise measurement should be specified. For example, BS 4142 specifies background noise measurement periods of 1 hour during the day and 5 minutes during the night. The noise levels are commonly symbolised as $A_{90(1\text{hour})}$ and $L_{A90(5\text{mins})}$. The noise measurement should be recorded using a 'FAST' time response equivalent to 0.125 ms.



Table A1: Glossary of Terms

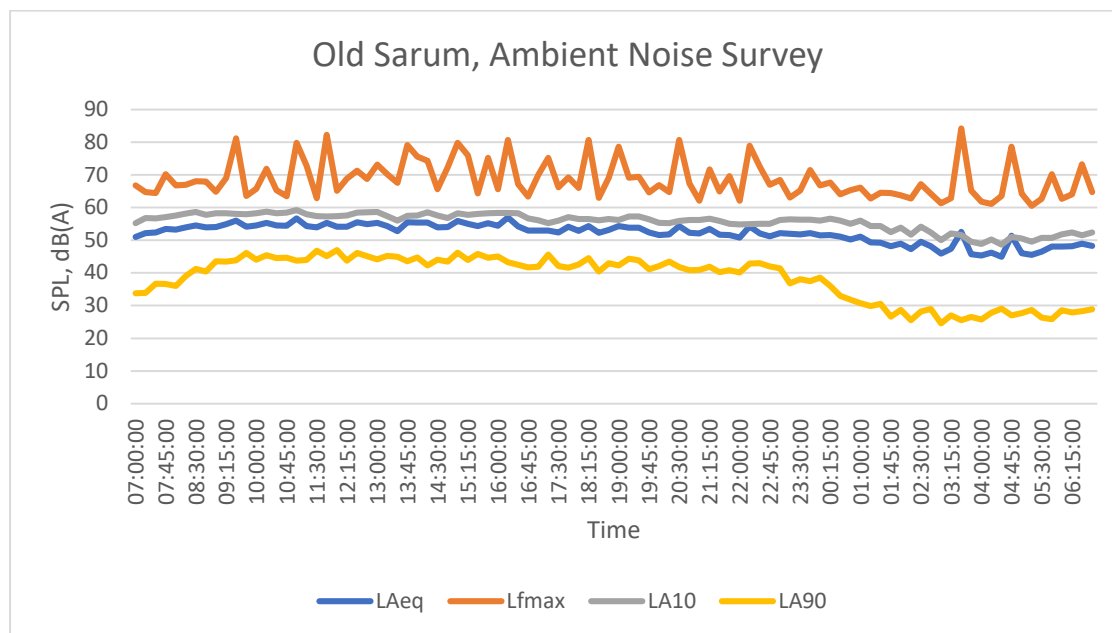
Term	Definition
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by $20 \log_{10} (s_1/s_2)$. The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is $20\mu\text{Pa}$.
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.
$L_{eq,T}$	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.
$L_{max,F}$	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.
$L_{90,T}$	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.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Ambient Noise Level	The totally encompassing sound in a given situation at a given time, usually composed of a sound from many sources both distant and near ($L_{Aeq,T}$).
Residual Noise Level	The ambient noise remaining at a given position in a given situation when specified sources are suppressed to a degree such that they do not contribute to the ambient noise level ($L_{Aeq,T}$)
Specific Noise Level	The equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source (the noise source under investigation) over a given time interval ($L_{Aeq,T}$)
Rating Noise Level	The specific noise level plus any adjustment for the characteristic features of the noise ($L_{Ar,T,r}$).



APPENDIX B – NOISE SURVEY



Ambient Noise Survey, Development Site.





APPENDIX C – FAÇADE CALCULATIONS



Calculated Façade Noise Levels

			Façade Corrected Noise Levels							
			L _{Aeq,T} dB				Overall Window Requirement (worst-case)	Ventilation		Ventilation Spec
			Ambient Sources		Football Match	Music from Bar Suite				
Plot No	Floor	Façade					Day or night	Required?		Dn,e,w+Ctr
			Day	Night	Day	Day/Night	Rw+Ctr dB	Day	Night	
1 2	Gnd Fl	S/E	51.3	48.1	52.8	38.3	21	Y	Y	26
1 2	First Fl	S/E	53.4	50.2	53.8	40.5	22	Y	Y	27
1 2	Gnd Fl	S/W	55.9	52.7	50.2	33.1	24	Y	Y	29
1 2	First Fl	S/W	57.4	54.2	52.5	37.7	25	Y	Y	30
1 2	Gnd Fl	N/W	55.5	52.3	34.3	25.4	23	Y	Y	28
1 2	First Fl	N/W	57.1	53.9	36.7	26.4	25	Y	Y	30
1 2	Gnd Fl	N/E	46.2	43.0	40.2	27.5	14	N	N	19
1 2	First Fl	N/E	49.6	46.4	41.3	28.2	18	Y	Y	23
3 4	Gnd Fl	S/E	50.1	46.9	52.6	45.1	21	Y	Y	26
3 4	First Fl	S/E	52.7	49.5	54.7	46.4	23	Y	Y	28
3 4	Gnd Fl	S/W	55.3	52.1	53.7	46.1	23	Y	Y	28
3 4	First Fl	S/W	57.0	53.8	54.6	46.6	25	Y	Y	30
3 4	Gnd Fl	N/W	53.7	50.5	39.3	34.4	22	Y	Y	27
3 4	First Fl	N/W	55.9	52.7	40.5	35.3	24	Y	Y	29
3 4	Gnd Fl	N/E	46.0	42.8	35.3	27.0	14	N	N	19
3 4	First Fl	N/E	49.4	46.2	39.0	30.3	17	Y	Y	22
5 6	Gnd Fl	S/E	48.2	45.0	49.5	44.2	17	Y	Y	22
5 6	First Fl	S/E	51.6	48.4	51.5	45.4	20	Y	Y	25
5 6	Gnd Fl	S/W	50.9	47.7	45.8	35.9	19	Y	Y	24
5 6	First Fl	S/W	53.6	50.4	48.8	37.3	22	Y	Y	27
5 6	Gnd Fl	N/W	54.4	51.2	34.8	28.4	22	Y	Y	27
5 6	First Fl	N/W	56.1	52.9	36.6	29.3	24	Y	Y	29
5 6	Gnd Fl	N/E	45.9	42.7	33.2	28.3	14	N	N	19
5 6	First Fl	N/E	49.3	46.1	35.8	29.1	17	Y	Y	22
7	Gnd Fl	S/E	48.1	44.9	49.4	45.5	17	Y	N	22
7	First Fl	S/E	51.3	48.1	50.4	46.0	19	Y	Y	24
7	Gnd Fl	S/W	48.9	45.7	39.2	32.9	17	Y	Y	22
7	First Fl	S/W	51.9	48.7	41.3	34.1	20	Y	Y	25
7	Gnd Fl	N/W	50.3	47.1	44.1	33.2	18	Y	Y	23
7	First Fl	N/W	53.4	50.2	45.8	34.1	21	Y	Y	26
7	Gnd Fl	N/E	45.7	42.5	35.4	29.4	14	N	N	19
7	First Fl	N/E	49.1	45.9	36.3	30.1	17	Y	Y	22
8	Gnd Fl	S/E	49.6	46.4	52.3	46.5	20	Y	Y	25



			Façade Corrected Noise Levels							
			L _{Aeq,T} dB				Overall Window Requirement (worst-case)	Ventilation		Ventilation Spec
			Ambient Sources		Football Match	Music from Bar Suite	Day or night	Required?		Dn,e,w+Ctr
Plot No	Floor	Façade	Day	Night	Day	Day/Night	Rw+Ctr dB	Day	Night	
8	First Fl	S/E	52.2	49.0	53.4	47.0	21	Y	Y	26
8	Gnd Fl	S/W	54.8	51.6	54.6	46.8	23	Y	Y	28
8	First Fl	S/W	56.5	53.3	55.9	47.3	25	Y	Y	30
8	Gnd Fl	N/W	51.2	48.0	49.1	39.2	19	Y	Y	24
8	First Fl	N/W	53.9	50.7	50.4	39.9	22	Y	Y	27
8	Gnd Fl	N/E	45.8	42.6	37.3	30.4	14	N	N	19
8	First Fl	N/E	49.3	46.1	38.5	31.3	17	Y	Y	22
9_11	Gnd Fl	S/E	49.6	46.4	50.6	44.6	19	Y	Y	24
9_11	First Fl	S/E	52.3	49.1	58.9	49.7	27	Y	Y	32
9_11	Gnd Fl	S/W	55.4	52.2	52.3	32.1	23	Y	Y	28
9_11	First Fl	S/W	56.9	53.7	60.5	45.4	28	Y	Y	33
9_11	Gnd Fl	N/W	55.2	52.0	59.9	49.2	28	Y	Y	33
9_11	First Fl	N/W	56.9	53.7	61.0	49.8	29	Y	Y	34
9_11	Gnd Fl	N/E	45.9	42.7	39.0	28.0	14	N	N	19
9_11	First Fl	N/E	49.4	46.2	41.8	29.7	17	Y	Y	22
12_14	Gnd Fl	N/E	45.7	42.5	38.0	27.2	14	N	N	19
12_14	First Fl	N/E	49.2	46.0	41.7	30.5	17	Y	Y	22
12_14	Gnd Fl	S/E	52.5	49.3	52.1	35.4	21	Y	Y	26
12_14	First Fl	S/E	54.7	51.5	61.1	45.9	29	Y	Y	34
12_14	Gnd Fl	S/W	54.3	51.1	52.6	42.2	22	Y	Y	27
12_14	First Fl	S/W	56.4	53.2	62.4	49.6	30	Y	Y	35
12_14	Gnd Fl	N/W	53.3	50.1	49.0	33.0	21	Y	Y	26
12_14	First Fl	N/W	55.1	51.9	57.0	42.9	25	Y	Y	30
15	Gnd Fl	N/E	45.6	42.4	35.7	26.0	14	N	N	19
15	First Fl	N/E	49.1	45.9	39.0	28.1	17	Y	Y	22
15	Gnd Fl	S/E	46.7	43.5	48.2	26.4	16	Y	N	21
15	First Fl	S/E	50.4	47.2	51.0	30.4	19	Y	Y	24
15	Gnd Fl	S/W	50.6	47.4	40.9	29.5	19	Y	Y	24
15	First Fl	S/W	53.7	50.5	46.6	34.4	22	Y	Y	27
15	Gnd Fl	N/W	52.6	49.4	46.4	30.2	21	Y	Y	26
15	First Fl	N/W	54.8	51.6	49.8	36.4	23	Y	Y	28
16	Gnd Fl	S/E	47.1	43.9	42.1	30.4	15	Y	N	20
16	First Fl	S/E	50.8	47.6	48.4	35.6	19	Y	Y	24
16	Gnd Fl	S/W	51.2	48.0	43.8	29.9	19	Y	Y	24
16	First Fl	S/W	53.9	50.7	47.1	34.2	22	Y	Y	27
16	Gnd Fl	N/W	54.1	50.9	46.3	29.1	22	Y	Y	27



			Façade Corrected Noise Levels							
			L _{Aeq,T} dB				Overall Window Requirement (worst-case)	Ventilation Required?		Ventilation Spec
			Ambient Sources		Football Match	Music from Bar Suite				
Plot No	Floor	Façade	Day	Night	Day	Day/Night	Day or night	Day	Night	Dn,e,w+Ctr
							Rw+Ctr dB			
16	First Fl	N/W	55.7	52.5	52.4	36.4	24	Y	Y	29
16	Gnd Fl	N/E	45.8	42.6	37.0	26.8	14	N	N	19
16	First Fl	N/E	49.2	46.0	38.7	28.3	17	Y	Y	22
17_20	Gnd Fl	S/E	47.8	44.6	44.2	33.0	16	Y	N	21
17_20	First Fl	S/E	51.2	48.0	46.4	38.3	19	Y	Y	24
17_20	Gnd Fl	South	53.1	49.9	44.7	29.5	21	Y	Y	26
17_20	First Fl	South	55.0	51.8	48.6	34.4	23	Y	Y	28
17_20	Gnd Fl	West	54.9	51.7	48.9	35.7	23	Y	Y	28
17_20	First Fl	West	56.5	53.3	51.2	38.9	24	Y	Y	29
17_20	Gnd Fl	N/W	54.6	51.4	49.9	36.3	23	Y	Y	28
17_20	First Fl	N/W	56.4	53.2	50.8	37.2	24	Y	Y	29
17_20	Gnd Fl	N/E	45.6	42.4	33.9	24.9	14	N	N	19
17_20	First Fl	N/E	49.0	45.8	35.0	26.1	17	Y	Y	22
21_22	Gnd Fl	N/W	50.1	46.9	40.0	32.9	18	Y	Y	23
21_22	First Fl	N/W	53.5	50.3	44.7	38.7	21	Y	Y	26
21_22	Gnd Fl	N/E	45.5	42.3	33.6	24.9	14	N	N	19
21_22	First Fl	N/E	49.0	45.8	35.2	27.9	17	Y	Y	22
21_22	Gnd Fl	S/E	48.7	45.5	43.5	41.1	17	Y	Y	22
21_22	First Fl	S/E	51.4	48.2	46.5	44.2	19	Y	Y	24
21_22	Gnd Fl	S/W	53.2	50.0	46.1	43.4	21	Y	Y	26
21_22	First Fl	S/W	55.4	52.2	48.9	45.6	23	Y	Y	28
23_24	Gnd Fl	N/E	45.5	42.3	33.4	24.7	13	N	N	18
23_24	First Fl	N/E	48.9	45.7	35.4	28.8	17	Y	Y	22
23_24	Gnd Fl	S/E	46.8	43.6	35.7	24.7	15	N	N	20
23_24	First Fl	S/E	50.4	47.2	42.5	28.4	18	Y	Y	23
23_24	Gnd Fl	S/W	54.2	51.0	46.1	42.0	22	Y	Y	27
23_24	First Fl	S/W	56.0	52.8	48.6	45.1	24	Y	Y	29
23_24	Gnd Fl	N/W	51.6	48.4	45.7	44.9	20	Y	Y	25
23_24	First Fl	N/W	54.0	50.8	47.5	46.1	22	Y	Y	27
25_28	Gnd Fl	N/E	45.3	42.1	33.1	24.7	13	N	N	18
25_28	First Fl	N/E	48.8	45.6	34.9	25.8	17	Y	Y	22
25_28	Gnd Fl	S/E	47.9	44.7	47.8	24.9	16	Y	N	21
25_28	First Fl	S/E	50.8	47.6	49.4	30.2	19	Y	Y	24
25_28	Gnd Fl	South	53.3	50.1	49.3	33.3	21	Y	Y	26
25_28	First Fl	South	55.5	52.3	51.0	38.5	24	Y	Y	29
25_28	Gnd Fl	West	52.0	48.8	46.4	29.1	20	Y	Y	25



			Façade Corrected Noise Levels							
			L _{Aeq,T} dB				Overall Window Requirement (worst-case)	Ventilation Required?		Ventilation Spec
			Ambient Sources		Football Match	Music from Bar Suite				
Plot No	Floor	Façade	Day	Night	Day	Day/Night	Day or night	Day	Night	Dn,e,w+Ctr
							Rw+Ctr dB			
25_28	First Fl	West	54.5	51.3	49.5	34.4	22	Y	Y	27
25_28	Gnd Fl	N/W	50.0	46.8	39.4	31.4	18	Y	Y	23
25_28	First Fl	N/W	53.2	50.0	44.6	37.4	21	Y	Y	26
29	Gnd Fl	N/E	45.5	42.3	36.2	25.7	14	N	N	19
29	First Fl	N/E	49.0	45.8	43.0	31.4	17	Y	Y	22
29	Gnd Fl	S/E	48.5	45.3	41.2	26.5	17	Y	Y	22
29	First Fl	S/E	51.2	48.0	51.1	35.6	19	Y	Y	24
29	Gnd Fl	S/W	55.2	52.0	52.5	41.4	23	Y	Y	28
29	First Fl	S/W	56.9	53.7	60.8	47.5	29	Y	Y	34
29	Gnd Fl	N/W	55.5	52.3	54.5	44.8	24	Y	Y	29
29	First Fl	N/W	56.8	53.6	60.0	47.6	28	Y	Y	33
30	Gnd Fl	N/E	45.3	42.1	33.4	24.8	13	N	N	18
30	First Fl	N/E	48.8	45.6	37.5	30.9	17	Y	Y	22
30	Gnd Fl	S/E	46.2	43.0	34.7	24.7	14	N	N	19
30	First Fl	S/E	49.9	46.7	42.7	33.8	18	Y	Y	23
30	Gnd Fl	S/W	55.1	51.9	51.7	44.9	23	Y	Y	28
30	First Fl	S/W	56.5	53.3	53.8	46.2	25	Y	Y	30
30	Gnd Fl	N/W	55.0	51.8	51.1	44.7	23	Y	Y	28
30	First Fl	N/W	56.4	53.2	52.8	45.9	24	Y	Y	29
31	Gnd Fl	N/E	45.2	42.0	32.3	24.9	13	N	N	18
31	First Fl	N/E	48.7	45.5	35.9	29.0	17	Y	Y	22
31	Gnd Fl	S/E	45.9	42.7	34.1	24.9	14	N	N	19
31	First Fl	S/E	49.7	46.5	38.8	29.0	18	Y	Y	23
31	Gnd Fl	S/W	48.9	45.7	34.2	26.5	17	Y	Y	22
31	First Fl	S/W	51.8	48.6	40.7	35.2	20	Y	Y	25
31	Gnd Fl	N/W	54.5	51.3	48.9	39.5	22	Y	Y	27
31	First Fl	N/W	56.1	52.9	50.2	43.4	24	Y	Y	29
32	Gnd Fl	North	49.0	45.8	32.6	29.4	17	Y	Y	22
32	First Fl	North	51.5	48.3	37.6	30.1	19	Y	Y	24
32	Gnd Fl	East	45.0	41.8	31.3	25.6	13	N	N	18
32	First Fl	East	48.4	45.2	33.6	26.3	16	Y	Y	21
32	Gnd Fl	South	49.9	46.7	35.2	27.4	18	Y	Y	23
32	First Fl	South	53.3	50.1	41.0	32.7	21	Y	Y	26
32	Gnd Fl	West	49.2	46.0	32.9	27.1	17	Y	Y	22
32	First Fl	West	52.3	49.1	39.4	32.7	20	Y	Y	25
33	Gnd Fl	N/E	44.8	41.6	29.7	23.8	13	N	N	18



			Façade Corrected Noise Levels							
			L _{Aeq,T} dB				Overall Window Requirement (worst-case)	Ventilation Required?		Ventilation Spec
			Ambient Sources		Football Match	Music from Bar Suite				
Plot No	Floor	Façade	Day	Night	Day	Day/Night	Day or night	Day	Night	Dn,e,w+Ctr
							Rw+Ctr dB			
33	First Fl	N/E	48.3	45.1	31.6	24.5	16	Y	Y	21
33	Gnd Fl	S/E	45.5	42.3	30.4	25.4	13	N	N	18
33	First Fl	S/E	49.2	46.0	32.9	26.4	17	Y	Y	22
33	Gnd Fl	S/W	50.0	46.8	33.9	28.0	18	Y	Y	23
33	First Fl	S/W	52.3	49.1	40.1	36.2	20	Y	Y	25
33	Gnd Fl	N/W	54.1	50.9	41.4	32.7	22	Y	Y	27
33	First Fl	N/W	55.8	52.6	44.6	38.4	24	Y	Y	29
34	Gnd Fl	N/E	44.9	41.7	30.3	24.2	13	N	N	18
34	First Fl	N/E	48.4	45.2	33.3	29.0	16	Y	Y	21
34	Gnd Fl	S/E	45.4	42.2	31.3	23.6	13	N	N	18
34	First Fl	S/E	49.1	45.9	33.5	24.8	17	Y	Y	22
34	Gnd Fl	S/W	45.5	42.3	31.1	25.2	13	N	N	18
34	First Fl	S/W	49.1	45.9	35.1	28.0	17	Y	Y	22
34	Gnd Fl	N/W	54.2	51.0	44.1	42.3	22	Y	Y	27
34	First Fl	N/W	55.7	52.5	46.7	43.2	24	Y	Y	29
35_36	Gnd Fl	N/E	45.0	41.8	31.1	25.1	13	N	N	18
35_36	First Fl	N/E	48.5	45.3	34.9	27.8	17	Y	Y	22
35_36	Gnd Fl	S/E	45.6	42.4	32.2	24.1	14	N	N	19
35_36	First Fl	S/E	49.3	46.1	34.4	26.1	17	Y	Y	22
35_36	Gnd Fl	S/W	46.1	42.9	32.0	24.3	14	N	N	19
35_36	First Fl	S/W	49.9	46.7	37.5	27.5	18	Y	Y	23
35_36	Gnd Fl	N/W	54.6	51.4	47.0	36.0	23	Y	Y	28
35_36	First Fl	N/W	56.1	52.9	48.7	41.6	24	Y	Y	29
37_39	Gnd Fl	N/E	45.1	41.9	31.9	24.2	13	N	N	18
37_39	First Fl	N/E	48.6	45.4	36.1	26.3	17	Y	Y	22
37_39	Gnd Fl	S/E	45.6	42.4	33.7	25.0	14	N	N	19
37_39	First Fl	S/E	49.3	46.1	35.6	26.5	17	Y	Y	22
37_39	Gnd Fl	S/W	46.3	43.1	34.0	25.5	14	N	N	19
37_39	First Fl	S/W	50.1	46.9	41.0	33.5	18	Y	Y	23
37_39	Gnd Fl	N/W	54.9	51.7	47.5	31.9	23	Y	Y	28
37_39	First Fl	N/W	56.3	53.1	50.5	38.0	24	Y	Y	29
40_41	Gnd Fl	N/E	45.3	42.1	33.5	24.5	13	N	N	18
40_41	First Fl	N/E	48.8	45.6	38.8	31.1	17	Y	Y	22
40_41	Gnd Fl	S/E	45.8	42.6	36.4	27.3	14	N	N	19
40_41	First Fl	S/E	49.5	46.3	39.5	30.2	17	Y	Y	22
40_41	Gnd Fl	S/W	55.4	52.2	52.4	43.6	23	Y	Y	28



			Façade Corrected Noise Levels							
			L _{Aeq,T} dB				Overall Window Requirement (worst-case)	Ventilation		Ventilation Spec
			Ambient Sources		Football Match	Music from Bar Suite	Day or night	Required?		Dn,e,w+Ctr
Plot No	Floor	Façade	Day	Night	Day	Day/Night	Rw+Ctr dB	Day	Night	
40_41	First Fl	S/W	56.6	53.4	56.1	45.8	25	Y	Y	30
40_41	Gnd Fl	N/W	55.2	52.0	51.1	44.3	23	Y	Y	28
40_41	First Fl	N/W	56.5	53.3	54.1	45.7	25	Y	Y	30