

Old Sarum, Salisbury
Noise Assessment

February 2021





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Noise Assessment

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**Entran Limited
12 Greenway Farm
Bath Road
Wick
Bristol
BS30 5RL**

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



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1 INTRODUCTION

- 1.1 Entrant Limited was commissioned by Persimmon Homes (SouthWest) to undertake a noise assessment for a proposed residential development at the site known as 'Site A & F, Old Sarum', Salisbury, Wiltshire. The site is 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.
- 1.2 The purpose of this assessment is to establish whether existing noise levels (ambient and during football events) at the site pose a constraint to residential development. Relevant national guidance on noise sources is presented in Section 2. Section 3 of this report presents the results of the surveys undertaken for the site. The assessment of noise on the proposed residential development is considered in Section 4 together with our recommendations for mitigation. Our conclusions are summarised in Section 5.
- 1.3 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





2 NOISE ASSESSMENT CRITERIA

National Planning Policy

- 2.1 The National Planning Policy Framework (NPPF) was initially published on March 27th 2012, with an updated version published in February 2019. It sets out the Government's planning policies for England and 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 The NPPF sets out the Government's requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so. It provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.
- 2.3 Under Section 15; Conserving and enhancing the natural environment, the following is stated:

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. 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 (paragraph 170e)

- 2.4 The document goes on to state:

Planning policies and decisions should aim to:



-
- 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; and
 - limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation (Paragraph 180)

2.5 As stated above, this document makes reference to avoiding noise generation from new developments that would adversely impact on health and quality of life. It effectively supersedes Planning Policy Guidance (PPG) 24 but does not set absolute criteria. As a result, the guidance and criteria in other relevant documents have been adopted, as a point of specific reference.

Noise Policy Statement for England NPSE (March 2010)

2.6 The Noise Policy Statement for England is published by the Department for Environment, Food and Rural Affairs (Defra) and sets out the approach to noise within the Government's sustainable development strategy.

2.7 The significance of impacts from noise within the NPSE are defined as follows:

There are two established effects that are currently being applied to noise impacts, for example, by the WHO. These 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*

2.8 Extending the above concepts, the NPSE defines the following:



SOAEL – Significant Observed Adverse Effect Level:

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

The three aims of the NPSE are stated as:

- *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.*
- *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.*
- *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*

2.9 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.”

ProPG

2.10 *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.

2.11 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:
 - o Element 1: demonstrating a 'Good Acoustic Design Process';
 - o Element 2: observing internal 'Noise Level Guidelines';
 - o Element 3: undertaking an 'External Amenity Area Noise Assessment';
and
 - o Element 4: consideration of 'Other Relevant Issues'

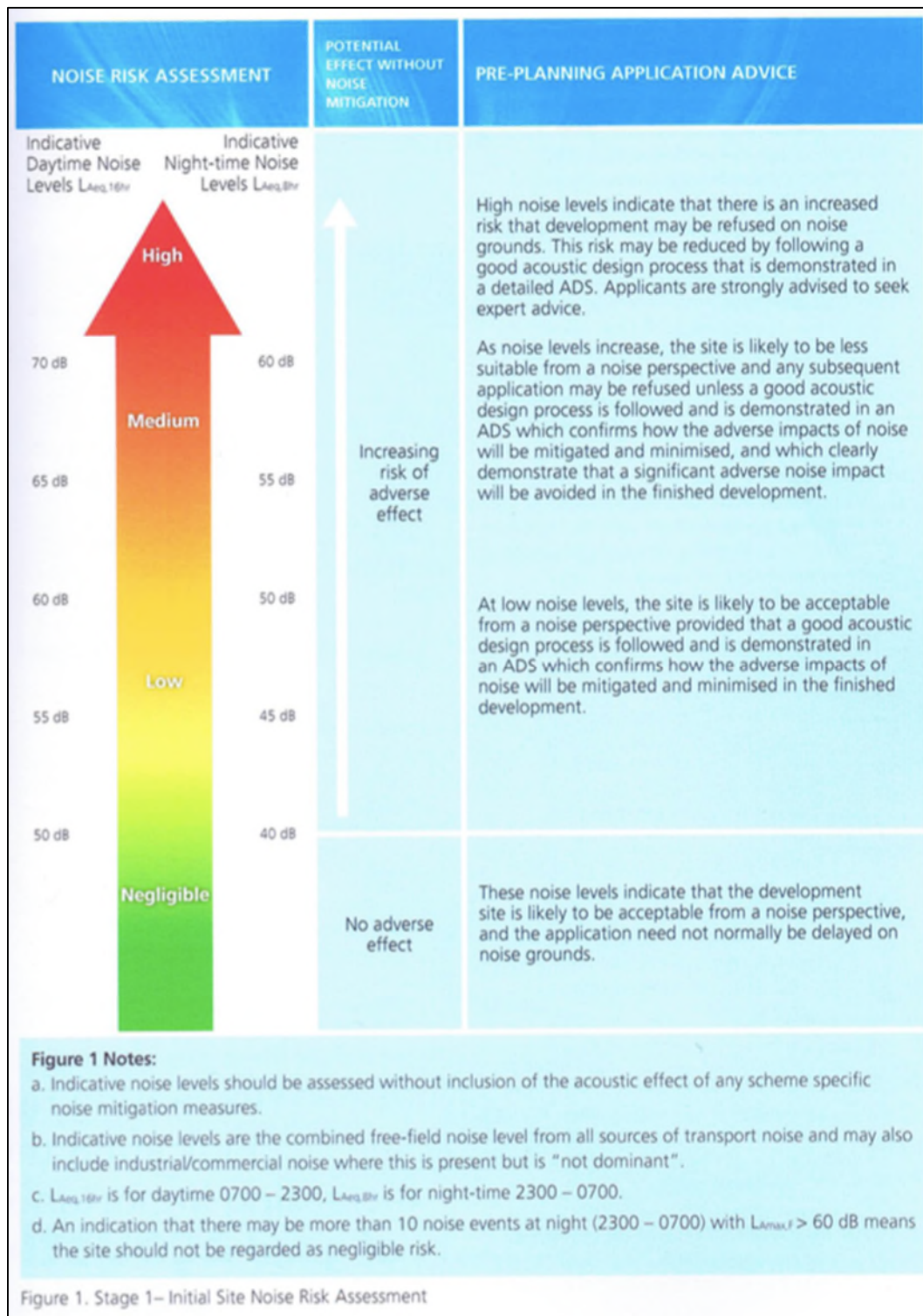
2.12 The Stage 1 initial noise risk assessment should provide an indication of the likely risk of adverse effects from noise should no mitigation be included as part of the development proposals.

2.13 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.

2.14 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.

2.15 Figure 1 of the ProPG, which is replicated here as Figure 2, presents the risk hierarchy, with indicative noise levels that broadly equate to the different risk categories.

Figure 2 ProPG Stage 1 Risk Assessment.





- 2.16 The Stage 2 full assessment should consider good acoustic design, internal noise levels, external amenity area noise levels, and assessment of any other issues.
- 2.17 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.
- 2.18 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."*
- 2.19 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.
- 2.20 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.”

2.21 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.

2.22 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).”

2.23 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.”

2.24 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.”

2.25 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.

- 2.26 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.

World Health Organisation: Guidelines for Community Noise

- 2.27 The 'Guidelines for Community Noise' identify that, in dwellings, the critical effects of noise are on sleep, annoyance and speech interference. For noise affecting dwellings the guidelines state:

“To protect the majority of people from being seriously annoyed during the daytime, the sound pressure level on balconies, terraces and outdoor living areas should not exceed 55 dB L_{Aeq} for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB L_{Aeq} ”.

- 2.28 Consequently, to avoid any possibility of sleep disturbance, indoor guideline values for bedrooms are 30 dB L_{Aeq} for continuous noise and 45 dB L_{Amax} for single sound events. These correspond to sound pressure levels at the outside façades of the living spaces which do not exceed 45 dB L_{Aeq} and 60 dB L_{Amax} , so that people may sleep with bedroom windows open. These values have been obtained by assuming that the noise reduction from outside to inside with the window partly open is 15 dB.
- 2.29 The recently published WHO Environmental Noise Guidelines for the European Region (2018) advocate the following:

Table 2.1 WHO (European Region)

Source	Day (L_{den}) dB	Night (L_{Night}) dB
Road Traffic	53	45
Rail Traffic	54	44



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

- 2.30 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.
- 2.31 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.
- 2.32 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*.
- 2.33 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.*
- 2.34 BS8233:2014 also qualifies the application of the outdoor criteria:

“For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq, T}$, with an upper guideline value of 55 dB $L_{Aeq, T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise



levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited. Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB LAeq,T or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space.

Site Suitability

2.35 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 2.2; 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 2.2 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.			



2.36 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.

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

3 NOISE SURVEYS

- 3.1 Due to the current COVID-19 restrictions, noise levels from the A345 are approximately 4 dB lower than those sampled in 2017 and further, the noise from the Salisbury FC ground is much lower due to crowd restrictions and therefore, the noise surveys undertaken in 2017 are applied for assessment purposes.
- 3.2 Ambient noise surveys have been undertaken on the 10/11th November 2017 at the north-west corner of the eastern employment parcel (See Figure 3.1). Noise levels were also sampled adjacent to the football ground (at the boundary with football ground and the proposed development) during a football match (Salisbury V Larkhall Athletic) on the 11th November 2017.

Figure 3.1 Ambient Noise Survey Location



- 3.3 The purpose of the noise monitoring was to provide sufficient acoustic information to undertake an assessment in accordance with BS8233 and therefore to determine the potential mitigation measures (façade treatment) that may be necessary.



- 3.4 All noise measurements were undertaken by an experienced consultant competent in environmental noise monitoring, and, in accordance with the principles of BS 7445: 2003: *Description and measurement of environmental noise*.
- 3.5 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*. A full inventory of this equipment is shown in Table 3.1 below:

Table 3.1: Inventory of Acoustic Measurement Equipment

Item	Make & Model	Serial Number
Sound Level Meter	Larson Davis 824	1419
Sound Level Meter	Larson Davis 820 x2	350/1144
Calibrator	Larson Davis Cal200 x2	3723/3724

- 3.6 The noise measurement equipment used during the surveys were calibrated at the start and end of the measurement period. The calibrator used had itself been calibrated by an accredited calibration laboratory within the twelve months preceding the measurements. No significant drift in calibration was found to have occurred on the sound level meter.
- 3.7 The microphone was positioned at a height of 1.2 m in a free-field location, i.e. excluding the effect of reflections from buildings or structures and on hard ground. Weather conditions during the survey period were suitable for environmental noise surveys.
- 3.8 The summary results of the noise survey are presented below (detailed surveys are presented in Appendix B) and the measurement locations are shown in Figure 2. Apart from traffic on local roads, there were no other significant noise sources (for the ambient surveys). It is noted that road traffic noise dominates the ambient noise climate.

Table 3.2: Noise Measurement Results

Location	Time Period	L _{Aeq}	L _{Amax,f}	L _{A10}	L _{A90}
		dB			
Location 1	Day	54.7	70.6	56.6	46.5
	Night	45.0	59.6	46.5	36.4

- 3.9 During the football match, noise levels at the boundary of the eastern plot were measured to be, at the most, 71 dB L_{Aeq,105min} with PA announcements (Home team goal at 31min (70 dB(A)); home team sending off 39min (66 dB(A)), half-time announcements (68 dB(A)), away



team goals at 43 and 80min (65 dB(A)). On average, noise level from football audience (without PA announcements) was estimated to be 65 dB $L_{Aeq,105min}$. The crowd was estimated (by the ground staff) to be approximately 700 fans.



4 NOISE ASSESSMENT

Façade and Internal Noise Levels

- 4.1 The baseline 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.
- 4.2 The predictions have been carried out using the noise-modelling suite IMMI2020, in accordance with the CRTN prediction methodology for road traffic noise and ISO 9613 methodology for the football match.
- 4.3 In addition to the derived road traffic source noise levels 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 $L_{Aeq,16-hour}$ (07:00 to 23:00) and night-time $L_{Aeq,8-hour}$ (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 3 and 4 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) across the development site.

Figure 3 Daytime Noise Contours (Ambient, without football match)



Figure 4 Night-time Noise Contours (Ambient, without football match).



4.7 Figure 5 shows the project noise contours during a football match.

Figure 5 Football Match Noise Contours (105 minutes)



4.8 To place the noise levels in Figures 3 and 4 in context, they accord to the following, typically adopted consideration criteria of planning authorities throughout England:

- Daytime levels of below 50 dB(A) and night-time of 45 dB(A) are the threshold for NOAEL (suitable). BS8233-compliant internal noise levels achieved with windows open for ventilation. External amenity criteria comfortably met;
- 50 to 55 dB(A) by day and 45 to 50 dB(A) by night are LOAEL (suitable with mitigation). BS8233 plus 5dB relaxation internal noise levels achieved with windows open for ventilation. External amenity criteria met;
- 55 to 60 dB(A) by day and 50 to 55 dB(A) by night are SOAEL (mitigation required). BS8233-compliant internal noise levels achieved with standard thermally insulating windows shut and ventilation provided by an alternative means to an open window. External amenity criteria marginally exceeded; and



- Over 60 dB(A) by day and 55 dB(A) by night are SOAEL (normally unsuitable). Detailed facade consideration and design may be required in order to achieve BS8233-compliant internal noise levels and Part F (UK Building Regulations).

- 4.9 In terms of the level of noise risk, as described in the ProPG, it is considered that the site is in the range of low to medium risk.
- 4.10 The site is considered acceptable for residential use, subject to the incorporation of suitable mitigation.

Mitigation Measures

- 4.11 Predicted façade levels at the receptors at the application site are presented in Appendix C. Façade attenuation required to comply with BS8233:2014 guidance is also shown in Appendix C (for both ambient noise levels as well as during the football match).
- 4.12 The window requirements shown in Appendix C indicates that thermal double glazing will be required to comply with the ambient day and night-time internal noise criteria of BS8233:2014 as well as the night-time L_{Amax} criterion of the WHO. In summary, the following window configuration will be necessary:
- For those facades that require a minimum window attenuation of up to 32 dB R_{w+ctr} : 4/6/4mm or similar.
- 4.13 The above attenuation due to closed double glazed windows will reduce internal noise levels to be below the BS8233 criteria during the ambient day and night (please note that the above window configuration is an example only and window providers may offer a different configuration to meet with the required performance standard). With closed windows, the proposed buildings (exposed façades) will require an additional means of ventilation compliant with the building regulations (e.g. trickle vents).
- 4.14 As can be seen from Appendix C, during a football match, thermal double glazing (32 dB R_{w+ctr}) will also be sufficient for the majority of the proposed receptors. Small increase over the BS8233 daytime criteria for some receptors are likely to be acceptable for short time periods during the football matches (2 or 3 times a month during the winter).





5 CONCLUSIONS

- 5.1 Ambient noise levels adjacent to the development site known as the 'Old Sarum', Salisbury, Newbury, 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 double glazing will be sufficient to comply with the day and night-time internal noise criteria of BS8233:2014 as well as the night-time L_{Amax} criterion of the WHO. With closed windows, the proposed buildings (exposed façades) will require an additional means of ventilation compliant with the building regulations (e.g. trickle vents).
- 5.3 During a football match, thermal double glazing will also be sufficient for the majority of the proposed receptors. Small increase over the BS8233 daytime criteria for some receptors are likely to be acceptable for short time periods during the football matches (2 or 3 times a month during the winter).
- 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.
$L_{max,T}$	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.
$L_{90,T}$	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 ($L_{Ar,Tr}$).



APPENDIX B – NOISE SURVEY DETAILS



Location 1 Noise Survey Results

Date	Time	L _{Aeq,T} dB	L _{Amax} dB	L _{A10,T} dB	L _{A90,T} dB
10-Nov-17	10:00:00	54.4	62.3	57.2	49.3
10-Nov-17	10:15:00	56.6	70.6	59.9	52.2
10-Nov-17	10:30:00	56.2	71.2	61.5	53.7
10-Nov-17	10:45:00	55.4	65.0	58.3	50.5
10-Nov-17	11:00:00	54.9	67.1	57.6	48.0
10-Nov-17	11:15:00	55.0	67.7	57.9	48.7
10-Nov-17	11:30:00	55.6	70.1	57.8	49.3
10-Nov-17	11:45:00	56.3	78.3	57.8	49.2
10-Nov-17	12:00:00	56.0	71.6	58.2	48.3
10-Nov-17	12:15:00	55.2	66.4	57.9	49.5
10-Nov-17	12:30:00	55.4	65.8	58.2	48.9
10-Nov-17	12:45:00	56.3	74.5	57.9	48.1
10-Nov-17	13:00:00	54.0	63.4	57.1	47.8
10-Nov-17	13:15:00	56.4	76.5	57.9	46.5
10-Nov-17	13:30:00	56.4	76.3	57.8	48.4
10-Nov-17	13:45:00	55.1	74.7	57.4	47.2
10-Nov-17	14:00:00	54.9	73.2	56.5	46.8
10-Nov-17	14:15:00	56.6	84.4	58.8	52.3
10-Nov-17	14:30:00	56.9	88.1	59.2	47.7
10-Nov-17	14:45:00	54.3	68.7	57.0	46.3
10-Nov-17	15:00:00	56.6	76.1	58.5	47.0
10-Nov-17	15:15:00	56.8	76.0	56.7	46.7
10-Nov-17	15:30:00	58.8	75.3	58.0	47.9
10-Nov-17	15:45:00	54.6	71.9	56.7	46.4
10-Nov-17	16:00:00	54.8	72.0	56.0	44.9
10-Nov-17	16:15:00	55.8	75.3	56.8	47.0
10-Nov-17	16:30:00	54.4	71.8	55.9	46.3
10-Nov-17	16:45:00	52.9	67.4	56.0	44.7
10-Nov-17	17:00:00	56.2	71.3	58.2	47.4
10-Nov-17	17:15:00	52.5	65.4	55.7	45.0
10-Nov-17	17:30:00	53.3	68.0	56.1	45.6
10-Nov-17	17:45:00	54.7	70.9	57.3	44.7
10-Nov-17	18:00:00	52.0	64.4	55.5	43.7
10-Nov-17	18:15:00	52.1	66.5	55.2	43.9
10-Nov-17	18:30:00	53.2	69.0	56.2	45.8
10-Nov-17	18:45:00	53.2	69.6	55.8	45.2
10-Nov-17	19:00:00	51.6	69.9	54.9	43.5
10-Nov-17	19:15:00	53.4	69.1	56.1	44.9
10-Nov-17	19:30:00	54.4	76.1	56.3	47.0
10-Nov-17	19:45:00	54.3	69.9	56.4	47.7



10-Nov-17	20:00:00	52.4	66.9	54.9	44.6
10-Nov-17	20:15:00	56.4	79.1	57.4	47.5
10-Nov-17	20:30:00	52.7	67.7	55.7	44.8
10-Nov-17	20:45:00	53.4	72.3	55.5	43.3
10-Nov-17	21:00:00	52.2	65.9	55.4	44.7
10-Nov-17	21:15:00	52.1	67.3	54.7	43.6
10-Nov-17	21:30:00	51.9	62.7	55.5	44.1
10-Nov-17	21:45:00	52.5	73.6	54.9	43.0
10-Nov-17	22:00:00	51.2	71.2	53.9	43.3
10-Nov-17	22:15:00	49.9	61.6	53.5	41.8
10-Nov-17	22:30:00	50.0	67.3	53.3	41.3
10-Nov-17	22:45:00	51.0	69.9	54.2	40.9
10-Nov-17	23:00:00	46.6	59.9	50.9	38.6
10-Nov-17	23:15:00	46.3	55.9	50.3	37.8
10-Nov-17	23:30:00	44.0	58.9	47.8	36.8
10-Nov-17	23:45:00	48.2	65.1	51.7	40.9
10-Nov-17	00:00:00	47.6	68.8	50.0	36.6
11-Nov-17	00:15:00	47.2	60.2	50.7	38.6
11-Nov-17	00:30:00	48.7	65.1	52.4	40.0
11-Nov-17	00:45:00	44.6	59.8	49.0	34.7
11-Nov-17	01:00:00	45.0	59.6	49.2	34.7
11-Nov-17	01:15:00	39.8	53.1	43.3	33.3
11-Nov-17	01:30:00	41.8	53.8	46.3	33.6
11-Nov-17	01:45:00	39.0	58.5	41.1	33.4
11-Nov-17	02:00:00	40.3	53.8	44.4	33.5
11-Nov-17	02:15:00	38.3	52.4	40.8	33.2
11-Nov-17	02:30:00	38.1	54.4	38.9	32.3
11-Nov-17	02:45:00	36.0	51.6	36.9	32.5
11-Nov-17	03:00:00	37.5	52.9	37.7	33.4
11-Nov-17	03:15:00	42.5	56.6	46.3	34.9
11-Nov-17	03:30:00	45.6	66.6	47.6	42.3
11-Nov-17	03:45:00	42.1	68.5	44.6	36.1
11-Nov-17	04:00:00	38.9	54.5	40.4	34.1
11-Nov-17	04:15:00	40.1	63.9	42.4	34.1
11-Nov-17	04:30:00	42.2	55.2	46.8	34.1
11-Nov-17	04:45:00	41.1	56.8	42.8	35.2
11-Nov-17	05:00:00	43.3	57.8	47.5	35.2
11-Nov-17	05:15:00	43.9	56.7	48.1	36.4
11-Nov-17	05:30:00	43.8	55.4	48.0	36.8
11-Nov-17	05:45:00	44.8	59.3	48.5	37.2
11-Nov-17	06:00:00	44.0	68.2	47.8	35.8
11-Nov-17	06:15:00	47.0	66.2	49.5	42.9
11-Nov-17	06:30:00	47.9	67.6	51.3	42.7



11-Nov-17	06:45:00	52.0	69.9	53.7	42.8
11-Nov-17	07:00:00	49.2	64.7	52.5	44.6
11-Nov-17	07:15:00	54.2	72.4	56.4	45.5
11-Nov-17	07:30:00	52.8	69.5	55.1	43.6
11-Nov-17	07:45:00	54.2	68.5	57.0	44.8
11-Nov-17	08:00:00	53.3	72.1	55.0	44.2
11-Nov-17	08:15:00	53.8	69.4	56.9	44.8
11-Nov-17	08:30:00	54.1	68.2	56.6	47.1
11-Nov-17	08:45:00	55.9	73.6	57.8	50.0
11-Nov-17	09:00:00	52.9	61.3	55.8	46.0
11-Nov-17	09:15:00	54.9	69.9	57.5	49.4
11-Nov-17	09:30:00	54.3	66.6	57.5	48.3
11-Nov-17	09:45:00	59.8	85.1	58.0	49.8



APPENDIX C – FAÇADE CALCULATIONS



Calculated Façade Noise Levels

Plot No	Floor	Façade	Façade corrected Noise Levels			Window Attention required to comply with BS8233.		
			Day	Night	During a football Match	Day	Night	During a football Match
			L _{Aeq,T} dB			dB, R _w +C _{tr}		
1_3	Ground Floor	N/W	57.1	47.4	65.0	22	17	30
1_3	First Floor	N/W	58.4	48.7	67.9	23	19	33
1_3	Ground Floor	N/E	45.5	35.8	48.2	11	6	13
1_3	First Floor	N/E	49.2	39.5	52.8	14	10	18
1_3	Ground Floor	S/E	46.0	36.3	51.0	11	6	16
1_3	First Floor	S/E	49.8	40.1	53.3	15	10	18
1_3	Ground Floor	S/W	57.1	47.4	67.1	22	17	32
1_3	First Floor	S/W	58.5	48.8	68.7	23	19	34
4_5	Ground Floor	N/W	54.7	45.0	57.3	20	15	22
4_5	First Floor	N/W	57.4	47.7	62.9	22	18	28
4_5	Ground Floor	N/E	45.3	35.6	47.4	10	6	12
4_5	First Floor	N/E	49.0	39.3	50.8	14	9	16
4_5	Ground Floor	S/E	45.9	36.2	48.4	11	6	13
4_5	First Floor	S/E	49.7	40.0	51.8	15	10	17
4_5	Ground Floor	S/W	54.1	44.4	59.6	19	14	25
4_5	First Floor	S/W	56.5	46.8	62.2	21	17	27
6	Ground Floor	N/W	55.4	45.7	59.5	20	16	25
6	First Floor	N/W	57.3	47.6	61.8	22	18	27
6	Ground Floor	N/E	45.3	35.6	47.2	10	6	12
6	First Floor	N/E	49.0	39.3	50.6	14	9	16
6	Ground Floor	S/E	45.8	36.1	47.9	11	6	13
6	First Floor	S/E	49.6	39.9	51.2	15	10	16
6	Ground Floor	S/W	45.3	35.6	47.4	10	6	12
6	First Floor	S/W	49.0	39.3	50.8	14	9	16



7	Ground Floor	N/W	53.4	43.7	54.9	18	14	20
7	First Floor	N/W	55.9	46.2	59.6	21	16	25
7	Ground Floor	N/E	45.0	35.3	46.5	10	5	12
7	First Floor	N/E	48.7	39.0	50.0	14	9	15
7	Ground Floor	S/E	46.5	36.8	47.8	11	7	13
7	First Floor	S/E	50.0	40.3	51.2	15	10	16
7	Ground Floor	S/W	53.8	44.1	54.8	19	14	20
7	First Floor	S/W	56.3	46.6	58.8	21	17	24
8	Ground Floor	N/W	50.5	40.8	51.4	16	11	16
8	First Floor	N/W	53.9	44.2	55.3	19	14	20
8	Ground Floor	N/E	45.1	35.4	46.7	10	5	12
8	First Floor	N/E	48.8	39.1	49.9	14	9	15
8	Ground Floor	S/E	46.9	37.2	48.6	12	7	14
8	First Floor	S/E	50.2	40.5	53.9	15	10	19
8	Ground Floor	S/W	53.0	43.3	57.0	18	13	22
8	First Floor	S/W	55.2	45.5	59.0	20	15	24
9_10	Ground Floor	North	50.6	40.9	51.5	16	11	16
9_10	First Floor	North	53.4	43.7	54.5	18	14	20
9_10	Ground Floor	East	45.1	35.4	46.9	10	5	12
9_10	First Floor	East	48.7	39.0	50.3	14	9	15
9_10	Ground Floor	South	54.5	44.8	59.0	20	15	24
9_10	First Floor	South	56.5	46.8	61.1	22	17	26
11_12	Ground Floor	North	48.4	38.7	49.8	13	9	15
11_12	First Floor	North	52.2	42.5	53.5	17	12	19
11_12	Ground Floor	South	54.0	44.3	59.2	19	14	24
11_12	First Floor	South	56.3	46.6	61.8	21	17	27
13	Ground Floor	North	52.1	42.4	54.1	17	12	19
13	First Floor	North	54.8	45.1	58.6	20	15	24
13	Ground Floor	East	45.4	35.7	47.8	10	6	13
13	First Floor	East	49.0	39.3	51.7	14	9	17
13	Ground Floor	South	55.9	46.2	62.2	21	16	27



13	First Floor	South	57.6	47.9	64.3	23	18	29
13	Ground Floor	West	56.1	46.4	63.2	21	16	28
13	First Floor	West	57.9	48.2	64.8	23	18	30
14_18	Ground Floor	N/W	56.9	47.2	66.0	22	17	31
14_18	First Floor	N/W	58.5	48.8	68.7	23	19	34
14_18	Ground Floor	N/E	45.6	35.9	48.9	11	6	14
14_18	First Floor	N/E	49.3	39.6	53.1	14	10	18
14_18	Ground Floor	S/E	46.2	36.5	57.4	11	6	22
14_18	First Floor	S/E	50.2	40.5	62.5	15	10	27
14_18	Ground Floor	S/W	56.9	47.2	68.0	22	17	33
14_18	First Floor	S/W	58.5	48.8	72.4	23	19	37
19_22	Ground Floor	N/W	56.8	47.1	65.4	22	17	30
19_22	First Floor	N/W	58.6	48.9	69.0	24	19	34
19_22	Ground Floor	N/E	45.9	36.2	49.5	11	6	14
19_22	First Floor	N/E	49.5	39.8	54.2	15	10	19
19_22	Ground Floor	South	49.6	39.9	66.6	15	10	32
19_22	First Floor	South	52.4	42.7	71.0	17	13	36
19_22	Ground Floor	S/W	56.9	47.2	69.0	22	17	34
19_22	First Floor	S/W	58.7	49.0	74.1	24	19	39
23	Ground Floor	N/W	52.0	42.3	56.6	17	12	22
23	First Floor	N/W	55.2	45.5	61.5	20	15	27
23	Ground Floor	N/E	45.6	35.9	48.1	11	6	13
23	First Floor	N/E	49.3	39.6	51.9	14	10	17
23	Ground Floor	S/E	48.7	39.0	60.8	14	9	26
23	First Floor	S/E	51.5	41.8	62.7	16	12	28
23	Ground Floor	S/W	54.5	44.8	62.7	19	15	28
23	First Floor	S/W	56.9	47.2	64.7	22	17	30
24_25	Ground Floor	N/W	55.0	45.3	57.3	20	15	22
24_25	First Floor	N/W	57.3	47.6	62.7	22	18	28
24_25	Ground Floor	N/E	45.7	36.0	48.2	11	6	13
24_25	First Floor	N/E	49.3	39.6	52.0	14	10	17



24_25	Ground Floor	S/W	53.6	43.9	60.4	19	14	25
24_25	First Floor	S/W	56.3	46.6	64.3	21	17	29
26_27	Ground Floor	N/W	54.3	44.6	57.1	19	15	22
26_27	First Floor	N/W	56.8	47.1	62.6	22	17	28
26_27	Ground Floor	N/E	45.7	36.0	48.2	11	6	13
26_27	First Floor	N/E	49.4	39.7	51.8	14	10	17
26_27	Ground Floor	S/E	48.8	39.1	55.2	14	9	20
26_27	First Floor	S/E	51.7	42.0	61.6	17	12	27
26_27	Ground Floor	S/W	55.2	45.5	62.4	20	16	27
26_27	First Floor	S/W	57.5	47.8	64.5	22	18	30
28_29	Ground Floor	N/E	45.8	36.1	48.1	11	6	13
28_29	First Floor	N/E	49.5	39.8	51.8	14	10	17
28_29	Ground Floor	S/E	49.2	39.5	56.0	14	9	21
28_29	First Floor	S/E	52.1	42.4	62.7	17	12	28
28_29	Ground Floor	S/W	53.7	44.0	61.7	19	14	27
28_29	First Floor	S/W	56.5	46.8	64.1	21	17	29
30	Ground Floor	N/W	56.0	46.3	61.2	21	16	26
30	First Floor	N/W	58.0	48.3	63.0	23	18	28
30	Ground Floor	N/E	45.9	36.2	48.0	11	6	13
30	First Floor	N/E	49.5	39.8	52.0	15	10	17
30	Ground Floor	S/E	49.0	39.3	52.1	14	9	17
30	First Floor	S/E	51.9	42.2	60.9	17	12	26
30	Ground Floor	S/W	55.9	46.2	61.6	21	16	27
30	First Floor	S/W	58.0	48.3	63.9	23	18	29
31_35	Ground Floor	West	56.2	46.5	66.8	21	17	32
31_35	First Floor	West	58.4	48.7	71.5	23	19	37
31_35	Ground Floor	N/E	46.0	36.3	49.2	11	6	14
31_35	First Floor	N/E	49.7	40.0	54.0	15	10	19
31_35	Ground Floor	S/E	48.1	38.4	65.3	13	8	30
31_35	First Floor	S/E	51.5	41.8	68.9	17	12	34
31_35	Ground Floor	S/W	56.4	46.7	69.3	21	17	34



31_35	First Floor	S/W	58.5	48.8	74.0	24	19	39
36_39	Ground Floor	N/W	56.1	46.4	57.7	21	16	23
36_39	First Floor	N/W	58.2	48.5	61.9	23	18	27
36_39	Ground Floor	N/E	46.2	36.5	49.0	11	7	14
36_39	First Floor	N/E	49.9	40.2	54.1	15	10	19
36_39	Ground Floor	S/E	49.0	39.3	66.5	14	9	31
36_39	First Floor	S/E	52.1	42.4	69.8	17	12	35
36_39	Ground Floor	S/W	53.8	44.1	67.6	19	14	33
36_39	First Floor	S/W	56.7	47.0	72.7	22	17	38
40	Ground Floor	N/W	54.1	44.4	56.9	19	14	22
40	First Floor	N/W	57.8	48.1	61.2	23	18	26
40	Ground Floor	N/E	45.9	36.2	47.9	11	6	13
40	First Floor	N/E	49.6	39.9	51.8	15	10	17
40	Ground Floor	S/E	50.2	40.5	60.7	15	10	26
40	First Floor	S/E	52.7	43.0	62.7	18	13	28
40	Ground Floor	S/W	55.4	45.7	62.2	20	16	27
40	First Floor	S/W	58.1	48.4	64.4	23	18	29
41_42	Ground Floor	N/W	55.8	46.1	56.0	21	16	21
41_42	First Floor	N/W	57.8	48.1	58.1	23	18	23
41_42	Ground Floor	N/E	46.1	36.4	47.7	11	6	13
41_42	First Floor	N/E	49.7	40.0	51.3	15	10	16
41_42	Ground Floor	S/E	48.3	38.6	53.5	13	9	18
41_42	First Floor	S/E	51.8	42.1	60.4	17	12	25
41_42	Ground Floor	S/W	51.4	41.7	53.7	16	12	19
41_42	First Floor	S/W	54.8	45.1	58.5	20	15	24
43_44	Ground Floor	N/W	55.6	45.9	55.9	21	16	21
43_44	First Floor	N/W	57.8	48.1	58.5	23	18	23
43_44	Ground Floor	N/E	46.2	36.5	48.1	11	7	13
43_44	First Floor	N/E	49.8	40.1	51.6	15	10	17
43_44	Ground Floor	S/E	50.0	40.3	53.3	15	10	18
43_44	First Floor	S/E	52.8	43.1	59.6	18	13	25



43_44	Ground Floor	S/W	57.3	47.6	60.0	22	18	25
43_44	First Floor	S/W	59.3	49.6	62.9	24	20	28
45_46	Ground Floor	N/W	55.7	46.0	55.9	21	16	21
45_46	First Floor	N/W	58.1	48.4	58.4	23	18	23
45_46	Ground Floor	N/E	46.4	36.7	48.1	11	7	13
45_46	First Floor	N/E	50.0	40.3	51.9	15	10	17
45_46	Ground Floor	S/E	51.2	41.5	59.2	16	12	24
45_46	First Floor	S/E	53.5	43.8	61.9	19	14	27
45_46	Ground Floor	S/W	57.1	47.4	61.1	22	17	26
45_46	First Floor	S/W	59.1	49.4	63.6	24	19	29