



Land & Development Advisory Ltd

AGEAS BOWL, SOUTHAMPTON

Noise Impact Assessment





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WSP

4th Floor
6 Devonshire Square
London
EC2M 4YE

Phone: +44 20 7337 1700

Fax: +44 20 7337 1701

WSP.com

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1 INTRODUCTION

1.1 INSTRUCTION

- 1.1.1. WSP UK Ltd (WSP) has been commissioned by Land & Development Advisory Ltd to provide noise services for the development at the Ageas Bowl, Southampton (hereafter referred to as the 'Proposed Development').

1.2 SCOPE OF NOISE SERVICES

- 1.2.1. Consideration is given in this report to relevant national and local planning policy, appropriate professional guidance and the specific assessment requirements which have been determined through consultation with Eastleigh Borough Council (EBC). Details are provided in Section 2.
- 1.2.2. Baseline noise conditions have been quantified through a combination of noise measurements at the site of the Proposed Development (hereafter referred to as 'The Site') and through the use of road traffic data, both of which have been used to inform a 3D acoustic model of The Site and surrounding area. Details are provided in Section 3.
- 1.2.3. The approach to the modelling of road traffic and local industrial and commercial noise sources is also provided in Section 4 of this report.
- 1.2.4. The assessment of the suitability of The Site for residential use (i.e. assessment of internal noise conditions and noise across external amenity) is provided in Section 5.
- 1.2.5. A summary of the findings is provided in Section 6.
- 1.2.6. This report is necessarily technical in nature, therefore a glossary of acoustic terms is provided in Appendix A.

1.3 SITE DESCRIPTION

- 1.3.1. The southern and western areas of The Site are currently used, in the main, as car parks for patrons of the Ageas Bowl on event days. The north-eastern area is currently occupied by the Boundary Lakes Golf Course and Marshall Drive Parking.
- 1.3.2. Adjacent to the site boundary in the western area of The Site, is the premises for Pitter Commercials and the car park associated with David Lloyd Southampton West End Gym. Approximately 56m from the eastern site boundary lies the M27 and located at the centre of The Site is the Ageas Bowl.

1.4 PROPOSED DEVELOPMENT

- 1.4.1. The development proposals include for a mixed-use development, comprising; 185 dwellings, a 71-bedroom care home (Use Class C2), a 142-bedroom hotel (Use Class C1), a well-being centre (Use Class E / F2), a new pavilion building and improvements to existing stadium, new vehicular access, car parking, pedestrian circulation and processional ramp, together with tree planting, landscaping, SuDs and biodiversity enhancements.
- 1.4.2. The Layout Plan for the Proposed Development is provided in Appendix B, for reference.

2 POLICY, GUIDANCE AND CONSULTATION

2.1 NATIONAL AND LOCAL POLICY AND PROFESSIONAL GUIDANCE

- 2.1.1. For reference, a summary of the national and local policy and professional guidance which has been considered in this noise assessment is provided, below, with full details provided in Appendix C.

NATIONAL POLICY

- National Planning Policy Framework (NPPF) (2021);
- Noise Policy Statement for England (NPSE) (2010); and
- Planning Practice Guidance (PPG) (2019).

LOCAL POLICY

- Eastleigh Borough Local Plan 2016-2036 (adopted June 2018)

PROFESSIONAL GUIDANCE

- Association of Noise Consultants, Chartered Institute of Environmental Health, Institute of Acoustics - Professional Practice Guidance on Planning and Noise: New Residential Development (ProPG) (2017);
- World Health Organisation - Guidelines for Community Noise (WHO Guidelines) (1999);
- British Standards Institution - British Standard 8233:2014 - Guidance on sound insulation and noise reduction for buildings (BS 8233) (2014);
- Association of Noise Consultants - Acoustics Ventilation and Overheating – Residential Design Guide Version 1.1 (AVO Guide) (2020);
- Department of Transport Welsh Office - Calculation of Road Traffic Noise (CRTN) (1988);
- Transport Research Laboratory - Converting the UK traffic noise index $LA_{10,18h}$ to EU noise indices for noise mapping (TRL Conversions Document) (2002); and
- British Standards Institution - British Standard 4142:2014+A1:2019 – Methods for rating and assessing industrial and commercial sound (BS 4142) (2019).

2.2 CONSULTATION

- 2.2.1. The acting Environmental Health Officer (EHO) for noise at EBC was consulted on 14th September 2021, with details of the proposed assessment approach being provided.
- 2.2.2. It was confirmed that the assessment should be undertaken in line with current professional guidance, namely, ProPG, BS 8233 and BS 4142, the latter with regard to noise from nearby commercial premises and from the Ageas Bowl.
- 2.2.3. Through pre-application discussions held between EBC and the project team for the Proposed Development, it is understood that the issue of noise from the Ageas Bowl stadium across external amenity spaces (particularly private garden spaces) has been raised and should be minimised as far as practicable.

3 BASELINE ENVIRONMENT

3.1 EXISTING NOISE SOURCES

- 3.1.1. The key existing sources of noise in proximity to The Site are:
- Road traffic noise from the M27;
 - Noise from events held at the Ageas Bowl;
 - Vehicle movements within the car park associated with David Lloyd Southampton; and
 - Operational noise generated within the premises of Pitter Commercials.
- 3.1.2. Road traffic noise has been quantified based on traffic data which have been supplied by the project transport consultant, WSP.
- 3.1.3. Noise from the Ageas Bowl has been quantified based on attended noise measurements obtained during a 'The Hundred' cricket event. The use of noise measurements obtained during a 'The Hundred' event is considered to represent a robust assessment case, as such events include music played through the stadium PA system (which is atypical for some other forms of cricket) and the matches are understood to be high-capacity attendance. The format for such cricket matches is also fast-paced and geared towards 'high-scoring' innings, which draws greater noise from the crowds in response.
- 3.1.4. Operational noise from Pitter Commercials and vehicle noise from the David Lloyd Southampton car park have been quantified through the acoustic modelling of key noise-generating activities and based on information provided by the owner of Pitter Commercials. Unattended noise measurements were also undertaken at the boundary of Pitter Commercials to aid in the calibration of modelled noise sources.
- 3.1.5. Further details of these sources of noise and the key modelling assumptions are presented in Section 5, below.

3.2 ATTENDED NOISE MEASUREMENTS

- 3.2.1. Attended noise measurements were undertaken by WSP at two locations in proximity to the Ageas Bowl stadium on Monday 16th August 2021 to establish noise levels during a 'The Hundred' cricket event. The measurements were undertaken concurrently during the match at the two locations, such that the predicted noise levels generated by the acoustic model could be calibrated and verified.
- 3.2.2. Each microphone was protected with a foam windshield and each kit had been calibrated by a UKAS accredited laboratory within the previous 24 months. The kit was also field calibrated at the commencement and conclusion of the survey using calibrators, which had themselves been calibrated by a UKAS accredited laboratory within the previous twelve months. No significant drift in the calibration signal was noted. The survey equipment used is tabulated in Appendix D.
- 3.2.3. The weather during the attended survey was conducive to the measurement of noise, with wind speeds below 5 m/s and dry conditions throughout. As such, the weather is considered not to have significantly affected the noise measurements.

3.2.4. Details of the two measurement locations are provided, below, and they are indicated graphically in Appendix E.

- **Short-Term Measurement Location 1 (STML1)** - located at the crest of a bund approximately 80m to the west of the stadium concourse area. There was a direct line of sight from the measurement location to the cricket pitch, albeit with a limit angle of view. The microphone was located on a tripod, approximately 1.5m above local ground level. The measurement data have been obtained under free field conditions, i.e. 3.5m or more from any hard, acoustically reflective surfaces other than the ground. The measurements commenced at 18:54 hrs in order to capture the full match which began at 19:00 hrs and measurements ceased at 21:49 hrs following the conclusion of the match. The dominant sources of noise during the match were brief excerpts of music which coincided with events during the match (e.g. runs being scored, change-over of batsmen, interval between innings) and noise from the crowd during key points (e.g. runs being scored, batsmen being given out).
- **Short-Term Measurement Location 2 (STML2)** - located in proximity to the Hampshire Wellbeing Centre approximately 80m to the south of the stadium concourse area. There was a direct line of sight from the measurement location to the cricket pitch and a wide angle of view of the crowd. The microphone was fixed to a pole, approximately 2m above local ground level. The measurement data have been obtained under free field conditions, i.e. 3.5m or more from any hard, acoustically reflective surfaces other than the ground. The measurements commenced at 17:23 hrs in order to capture the full match which began at 19:00 hrs and measurements ceased at 22:00 hrs following the conclusion of the match. The dominant sources of noise during the match were the same as those noted at Measurement Location 1.

RESULTS

3.2.5. The noise survey results for each of the locations described above are summarised below in Tables 3-1 and 3-2. The results are presented as hourly ambient noise levels ($L_{Aeq,1h}$) and background noise levels ($L_{AF90,1h}$).

Table 3-1: Hourly measured results at STML1

Time	Noise levels (dB)	
	$L_{Aeq,1h}$	$L_{A90,1h}$
19:00	51	49
20:00	51	49
21:00*	53	48
*- Incomplete measurement period. Measurements ceased at 21:49 following the conclusion of the match		

Table 3-2: Hourly measured results at STML2

Time	Noise levels (dB)	
	L _{Aeq,1h}	L _{A90,1h}
19:00	55	52
20:00	56	52
21:00	57	52

3.3 UNATTENDED NOISE MEASUREMENTS

- 3.3.1. Unattended noise measurements were undertaken by WSP at the shared boundary between The Site and the premises of Pitter Commercials between 12th January and 18th January 2022 to establish the baseline noise conditions towards the western area of The Site where private dwellings are proposed.
- 3.3.2. Details of the measurement location are provided, below.
- **Long-Term Measurement Location 1 (LTML1)** - located on a tripod, approximately 1.5m above local ground level and approximately 4m from the boundary of Pitter Commercials. The measurement period was from 15:00 hrs on 12th January to 13:00 hrs on 18th January 2022.
- 3.3.3. The measurement data have been obtained under free field conditions, i.e. 3.5m or more from any hard, acoustically reflective surfaces other than the ground.
- 3.3.4. The microphone was protected with a foam windshield and the kit had been calibrated by a UKAS accredited laboratory within the previous 24 months. The kit was also field calibrated at the commencement and conclusion of the survey using a calibrator, which had itself been calibrated by a UKAS accredited laboratory within the previous twelve months. No significant drift in the calibration signal was noted. The survey equipment used is tabulated in Appendix D.
- 3.3.5. Weather conditions were conducive to the measurement of noise throughout the survey period, with no precipitation noted and wind speeds generally below 5 ms⁻¹.
- 3.3.6. The measurement location is indicated graphically in Appendix E.

RESULTS

- 3.3.7. The noise survey results are summarised, below, in Table 3-3 and in more detail in Appendix F.
- 3.3.8. The typical daytime (L_{Aeq,16h}) and night-time (L_{Aeq,8h}) ambient noise levels have been derived by taking the arithmetic average of all the 16 hour (07:00 – 23:00) or 8 hour (23:00 – 07:00) ambient noise level values throughout the survey period.
- 3.3.9. The typical night-time maximum (L_{AFmax}) noise level has been derived by taking the arithmetic average of the L_{AFmax,5min} value which is exceeded 10 times during the night-time period.
- 3.3.10. The typical background (L_{AF90,T}) noise levels have been derived by taking the arithmetic average of the lowest modal values of the L_{A90,15m} levels measured during each daytime (07:00 – 23:00) and night-time (23:00 – 07:00) period.

Table 3-3: Long-term measurement results at LTML1

Measurement Location	Daytime Noise levels (dB)		Night-time Noise levels (dB)		
	L _{Aeq,16h}	L _{A90,15min}	L _{Aeq,8h}	L _{A90,15min}	L _{AFmax,5min}
LTML1	53	48	49	42	65

4 ACOUSTIC MODELLING AND NOISE SOURCES

4.1 MODELLING APPROACH AND GENERAL ASSUMPTIONS

- 4.1.1. A detailed acoustic model of the Proposed Development and surrounding area has been produced to help quantify the level of noise at the proposed residential properties. The model has been produced using CadnaA® noise mapping software and the modelled site layout is based upon site layout plan provided by Calderpeel Architects, which is presented in Appendix B.
- 4.1.2. The base mapping has been established using Ordnance Survey open data and the topography across the area surrounding the site has been based on 1m Digital Terrain Model (DTM) data.
- 4.1.3. The following assumptions have been adopted in the acoustic model:
- Ground absorption has been set at 1 to approximate the predominantly acoustically-absorbent ground cover between the noise sources and the facades of the proposed residential properties.
 - All buildings are reflecting, with the order of reflections set within the model at 2;
 - The heights of existing buildings located near to the Proposed Development been approximated individually using online mapping software;
 - Heights of the proposed residential properties have been determined from elevations provided by Calderpeel Architects.
 - Noise levels have been predicted at the facades of each of the proposed residential properties at heights of 1.2m above ground floor level and 1.2m above each floor level.

4.2 ROAD TRAFFIC NOISE

- 4.2.1. The road traffic noise across The Site is dominated by the M27 (J6 to J7). Therefore, road traffic noise has been modelled based on traffic data for the M27 provided by the project transport consultant, WSP.
- 4.2.2. The 18-hour annual average weekday traffic (AAWT) flow has been provided along with the average vehicle speed and the percentage of heavy vehicles for both the westbound and eastbound carriageways. These data have been forecast for the future baseline scenario in the year 2027. As a general rule, road traffic flows increase naturally over time, therefore baseline road traffic flows (and by extension, road traffic noise) for the current year could reasonably be expected to be lower than that which has been predicted for the year 2027. Therefore, the use of future baseline data for the year 2027 represents a robust assessment case.
- 4.2.3. Table 4-1 presents the 18-hour AAWT traffic data for each of the modelled roads.

Table 4-1: Road traffic data for the road network surrounding the site

Direction	18-Hour AAWT	Percentage of HDV	Avg. Speed (kph)
Westbound	76,471	3%	97
Eastbound	76,752	3%	97

- 4.2.4. In the model, road traffic has been set at a height of 0.5m to account for the approximate height of noise from the vehicles.
- 4.2.5. Noise levels from road traffic within the model have been calculated using the CRTN methodology. As the CRTN methodology predicts noise levels in terms of the dB $L_{A10,18h}$, corrections are required in order to derive the daytime and night-time average equivalent noise levels in line with the BS 8233 criteria. In order to calculate the daytime (07:00 – 23:00 hours) $L_{Aeq,16h}$, 2 dB has been subtracted from the predicted dB $L_{A10,18h}$. TRL method 3¹ has been used to convert the predicted dB $L_{A10,18h}$ value into the night-time (23:00 – 07:00 hours) dB $L_{Aeq,8h}$ value.

4.3 NOISE FROM COMMERCIAL PREMISES

- 4.3.1. In Section 3.1, sources of commercial noise have been identified which warrant consideration with respect to the potential for noise impacts on the Proposed Development. These sources of noise are:
- Noise from events held at the Ageas Bowl;
 - Vehicle movements within the car park associated with David Lloyd Southampton; and
 - Operational noise generated within the premises of Pitter Commercials.
- 4.3.2. In accordance with the '*agent of change*' principle set out in Paragraph 182 of the NPPF, consideration will be given to noise from these sources in Section 5. This is to establish whether noise generated by commercial operations has the potential to give rise to complaint from future occupants of the Proposed Development. Below are details of the sources of noise which are considered in the assessment and the associated assumptions which have been made.
- 4.3.3. Note that as these are commercial sources of noise, consideration is given to corrections or penalties which should be levied to account for any acoustic features of noise generated within these sources. These corrections are generally applied where acoustic features serve to heighten the perceptibility of a given source of noise.

NOISE FROM AGEAS BOWL

- 4.3.4. Observations made during site attendance of a 'The Hundred' cricket event on 16th August 2021 indicated that noise during the match primarily consisted of music from the PA system located around the ground and noise from the crowd. Consequently, noise from the event has been modelled as discrete area sources which cover each of the seating areas immediately around the perimeter of the pitch.
- 4.3.5. The sound power has been assumed to be the same for each of the discrete modelled area sources to create an equal distribution of noise around the stadium.
- 4.3.6. The sound power levels of the area sources were adjusted so that the typical hourly ambient noise levels obtained at the two attended measurement positions STML1 and STML2 (52 dB and 56 dB, respectively) were obtained.

¹ Transport Research Laboratory, Converting the UK traffic noise index $LA_{10,18h}$ to EU noise indices for noise mapping, 2002

- 4.3.7. A +4 dB correction has then been applied to account for what is considered to be ‘clearly perceptible’ tonal character (i.e. low frequency aspect) of the brief excerpts of music which are played over the PA system at points during the match.

NOISE FROM THE DAVID LLOYD CAR PARK

- 4.3.8. The David Lloyd facilities open daily at 06:00 hrs, which is considered, in assessment terms, to fall within the night-time period for one hour (i.e. 06:00 – 07:00).
- 4.3.9. Based on experience of assessing such facilities, the main sources of noise are car door slams, vehicle engines starting up and vehicles travelling in and out of the site. The car park is noted as having 189 spaces.
- 4.3.10. It has been assumed that for the night-time hour of 06:00 – 07:00, the car park will at most be at 50% capacity (i.e. 95 spaces used, when rounded to the nearest integer). For the worst-case daytime hour, it has been assumed that the car park will be at 100% capacity.
- 4.3.11. Using representative source noise data for car door slams and engines starting up, from previous surveys undertaken by WSP of similar facilities, a sound power level of 64 dB, per space, has been determined. Additionally, 95 cars have been modelled as travelling into the car park between 06:00 and 07:00 and 189 cars during the worst-case daytime hour. The source noise data, which have been converted to Sound Exposure Levels (SELs) for use in this assessment, are presented in Table 4-2, below.

Table 4-2: Noise source data used to model the vehicle activity in the David Lloyd car park

Noise Source	Measurement Distance (m)	L _{Aeq} (dB)
Car door slam	10	70
Car engine starting	10	69
Car pass by	10	65

- 4.3.12. It is considered that the noise from car door slams would be a ‘clearly perceptible’ impulsive source of noise at the nearest proposed residential properties, but only for a small number of vehicles (i.e. those parked in the nearest bays, towards the south-west and south-east of the car park). For the majority of vehicles parked further into the car park, the noise generated is considered to be either ‘just perceptible’ or not perceptible. Therefore, a +3 dB correction for has been applied to noise from the car park.

NOISE FROM PITTER COMMERCIALS

- 4.3.13. Pitter Commercials operates as a commercial Large and Heavy Good Vehicles service and hire company, which is open between 06:00 and 21:00 Monday to Friday and 06:00 and 14:00 on Saturdays.

Noise from operations

- 4.3.14. Details of the key noise-generating activities were discussed in a telephone call with Mr C. Pitter, owner of Pitter Commercials, on 25th January 2022, and these have informed the noise modelling assumptions for the premises.

- 4.3.15. Below are the assumptions for a typical hour which have been made based on the information provided:
- 5 HGV arrivals within the parking area, travelling at 10 kph;
 - Forklifts loading and unloading for 20 minutes;
 - HGV engines starting up for 30 seconds every 6 minutes
 - 5 HGV departures from the parking area, travelling at 10 kph
- 4.3.16. It should be noted that operational activities at Pitter Commercials are, by nature, varied in frequency and location and the modelling assumptions stated above are taken as a reasonable representation of the key activities during a typical hour.
- 4.3.17. During the installation of the unattended noise survey equipment, attempts were made to discern the location and nature of activities. However, given the poor line of sight to activities within the premises, coupled with the influence of noise from David Lloyd car park, the individual operational activities stated above could not be clearly distinguished from the measured data.
- 4.3.18. Therefore, representative source noise data have been adopted from previous noise surveys undertaken by WSP for activities which are similar to those stated as taking place at Pitter Commercials. These data, which have been converted to SELs for use in this assessment, are provided below in Table 4-3.

Table 4-3: Noise source data used to model the operational activity at Pitter Commercials

Noise Source	Measurement Distance (m)	L _{Aeq} (dB)
HGV engine starting up	10	72
HGV pass-by	10	70
Forklift Loading/unloading	10	51

- 4.3.19. To ensure that these data are representative of the stated activities, the source noise levels have been modelled at a central location within the Pitter Commercials yard, based on the assumptions listed above for a typical hour. The ambient noise level has then been predicted at Long-Term Unattended Location 1 (LTML1) within the model. The results have then been compared with the average, or 'typical' hourly ambient noise level measured between 06:00 and 21:00 hrs at LTML1 which is 55 dB. The predicted noise level within the model for a typical hour, based on the adopted source noise data is 56.4 dB, which overpredicts the typical noise level at LTML1 by a minimum of 1.4 dB.
- 4.3.20. Therefore, based on the results of this validation procedure, the predicted noise levels from the acoustic model, for a typical hour, are considered robust and suitable for use in this assessment.
- 4.3.21. It is considered that the noise from HGV and the forklift would be 'clearly perceptible' at the nearest proposed residential properties. Such noise sources are considered to be impulsive, therefore a correction of 6 dB has been added to the noise from Pitter Commercials.

5 NOISE ASSESSMENT

5.1 INTRODUCTION

- 5.1.1. This section provides the assessment of the suitability of the site for residential use and follows the guidance set out in ProPG. The assessment takes into consideration road traffic noise from the M27 and commercial noise from the Ageas Bowl, David Lloyd car park and Pitter Commercial.
- 5.1.2. As in ProPG, the assessment is undertaken in two stages:
- Stage 1, which provides an initial site noise risk assessment, based on the predicted levels from the noise model across the undeveloped site; and
 - Stage 2, which provides an assessment of the developed site, comprising the following four elements:
 - good acoustic design;
 - internal noise levels;
 - external noise levels; and
 - any other relevant issues.
- 5.1.3. The assessment of any other relevant issues considers the potential for noise complaints from future occupants of the Proposed Development as a result of noise generated at nearby commercial premises (i.e. the Ageas Bowl, David Lloyd car park and Pitter Commercial), in accordance with the Agent of Change Principle set out in the NPPF.
- 5.1.4. The predicted daytime noise levels in this assessment account for the following:
- noise generated from an event at the Ageas Bowl;
 - noise generated in the worst-case hour within David Lloyd car park (100% capacity);
 - noise generated during a typical hour at Pitter Commercial (based on information provided by the owner); and
 - road traffic noise from the M27.
- 5.1.5. The predicted night-time noise levels in this assessment account for the following:
- noise generated within David Lloyd car park (50% capacity);
 - noise generated during a typical hour at Pitter Commercial (based on information provided by the owner); and
 - road traffic noise from the M27.
- 5.1.6. It is understood that vents at the Ageas Bowl do not take place during the night-time period, based on information provided by the Operations Director.

5.2 PROPG STAGE 1 ASSESSMENT

INITIAL SITE NOISE RISK ASSESSMENT

- 5.2.1. The initial site noise risk assessment has been based on the predicted daytime and night-time noise levels across the undeveloped site. The initial site noise risk assessment compares the predicted noise levels across the site against the risk of adverse effect categories set out in Figure 1 of ProPG (this figure has been produced as Figure C-1 in Appendix C for reference).

- 5.2.2. Figure G1 in Appendix G, presents the predicted daytime ambient noise levels across the undeveloped site at ground-floor level. It can be seen that the noise levels are typically between 55 and 60 dB nearest to the shared boundary with Pitter Commercials and David Lloyd car park and in the area to the south of the Ageas Bowl, which fall within ProPG's low risk of adverse effect category. For majority of the site to the west of the Ageas Bowl, noise levels are predicted to be between 50 and 55 dB, which fall within the negligible to low risk categories. In the small area to the north-east of the Ageas Bowl, noise levels are predicted to be between 60 and 65 dB, which falls within the low to medium risk categories.
- 5.2.3. Figure G2 in Appendix G, presents the predicted night-time ambient noise levels across the undeveloped site at ground-floor level. It can be seen that the noise levels are typically between 50 and 55 dB nearest to the shared boundary with Pitter Commercials and David Lloyd car park and in the area to the south of the Ageas Bowl, which fall within ProPG's low to medium risk of adverse effect category. For majority of the site to the west of the Ageas Bowl, noise levels are predicted to be between 45 and 50 dB, which fall within the low risk category. In the small area to the north-east of the Ageas Bowl, noise levels are predicted to be between 55 and 60 dB, which falls within the medium risk category.
- 5.2.4. ProPG's initial site noise risk assessment states that:
- "An indication that there may be more than 10 noise events at night (2300 – 0700) with $L_{Amax,F} > 60$ dB means the site should not be regarded as negligible risk"*
- 5.2.5. The 10th highest maximum noise level measured at LTML1 (i.e. at the shared boundary with Pitter Commercials) is 65 dB and so The Site should not be regarded as having a negligible risk of adverse effect.
- 5.2.6. The maximum noise level from a car door slamming which has been assumed within the assessment is 72 dB L_{Amax} at a distance of 10m (i.e. the approximate distance between the nearest car space within the car park and The Site). This level has been obtained from survey measurements which have been undertaken previously by WSP and which have been used for previous assessments. As this value is in excess of 60 dB, The Site should not be regarding as having a negligible risk of adverse effect.
- 5.2.7. The maximum noise levels measured at STML1 and 2 (i.e. in proximity to the Ageas Bowl) are 77 dB and 79 dB, respectively, which are both in excess of the 60 dB threshold which would indicate a negligible risk.
- 5.2.8. In summary, noise levels within the site are predicted to exceed the negligible risk of adverse effect, particularly in proximity to Pitter Commercials, the David Lloyd car park and the southern and north-eastern portions of The Site. Consequently, a more detailed assessment has been undertaken in accordance with Stage 2 of ProPG, as set out below.

5.3 PROPG STAGE 2 ASSESSMENT

GOOD ACOUSTIC DESIGN

- 5.3.1. In accordance with local policy, and professional guidance, it is important that the scheme design has been influenced at the earliest possible opportunity, by an understanding of local noise constraints. The applicant has engaged with WSP at the masterplanning stage and the following design features have been included, as shown on the site layout plan in Appendix B:

- Residential buildings have been configured such that most garden spaces are located away from the dominant sources of noise (i.e. the M27 and Ageas Bowl). The only exceptions to this are a small number of gardens in proximity to Pitter Commercial and the David Lloyd car park, however there are other design considerations which prevent the dwellings and their associated gardens from being located in an alternative part of The Site, or orientated differently.
- The car parking provision associated with the Ageas Bowl is to be relocated to the east, in proximity to the M27. The effect of this is that event attendees, who access or exit the stadium at the north-west and south-east points are drawn to the north-east, away from the proposed residential properties, minimising potential noise generated before and after events, both from those on foot and those using a car.

INTERNAL NOISE LEVELS

Summary of Criteria

- 5.3.2. Table 5-1 presents the criteria for noise levels within internal habitable spaces of the proposed sensitive receptors during the daytime and night-time periods. These levels are taken from BS 8233 and WHO guidance and are in accordance with the requirements of EBC.

Table 5-1: Summary of the applicable criteria for internal habitable noise levels

Period	Times	Sound Pressure Level, dB ⁽¹⁾
Day	07:00 – 23:00	35 dB L _{Aeq,16hr}
Night	23:00 – 07:00	30 dB L _{Aeq,8hr}
		45 dB L _{AFmax}

- 5.3.3. For noise levels across private external amenity spaces, a noise limit of 55 dB has been assumed which is equivalent to the upper guideline limit for noise levels across external amenity space as set out in BS 8233 and WHO guidance.

Daytime

- 5.3.4. Based on the adopted daytime internal criterion of 35 dB (L_{Aeq,16h}), the equivalent external level is 50 dB L_{Aeq,16h}, based on a partially open window providing 15 dB sound reduction.
- 5.3.5. Figures G3 to G7 in Appendix G present the predicted noise levels across the site during the daytime at ground, 1st, 2nd, 3rd and 4th floor, respectively.
- 5.3.6. It can be seen that the daytime levels at facades of a significant number of the private residential properties in the western area of The Site are no more than 50 dB (indicated by the blue contour), whereby acceptable internal noise levels would be achieved with windows partially open. For dwellings that fall within this contour, it is anticipated that habitable internal noise levels can be achieved with standard thermal double glazing and ventilation achieved naturally, through open windows. The facades of properties within the Proposed Development whereby acceptable internal noise levels would be achieved with windows partially open are indicated in Figures H-1 to H-5 of Appendix H.

- 5.3.7. For properties located within the mustard, orange and red contours, noise levels during the daytime are predicted to exceed 50 dB and consequently, consideration is given in the section titled 'Internal Ambient Noise Levels with Closed Windows' to acoustic performances of glazing and ventilation systems in order to achieve habitable noise levels within sensitive spaces of those properties.

Night-time

- 5.3.8. Based on the adopted night-time internal criterion of 30 dB ($L_{Aeq,16h}$), the equivalent external level is, therefore, 45 dB $L_{Aeq,8h}$.
- 5.3.9. Figures G8 to G12 in Appendix G present the predicted noise levels across the site during the night-time at ground, 1st, 2nd, 3rd and 4th floor, respectively.
- 5.3.10. As is the case with the predicted daytime levels, the night-time levels outside a significant number of properties are no more than 45 dB, (indicated by the green contour), whereby acceptable internal sound levels would be achieved with windows partially open. For dwellings that fall within this contour, it is anticipated that habitable internal noise levels can be achieved with standard thermal double glazing and ventilation achieved naturally, through open windows. The facades of properties within the Proposed Development whereby acceptable internal sound levels would be achieved with windows partially open are indicated in Figures H-1 to H-5 of Appendix H..
- 5.3.11. For properties located within the blue, mustard and orange contours, noise levels during the night-time are predicted to exceed 45 dB and consequently, consideration is given in the section titled 'Internal Ambient Noise Levels with Closed Windows' to acoustic performances of glazing and ventilation systems in order to achieve habitable noise levels within sensitive spaces of those properties.

Internal Ambient Noise Levels with Closed Windows

- 5.3.12. It is identified above that habitable internal noise levels can be achieved in a significant proportion of properties with open windows. For dwellings exposed to external ambient noise levels in excess of 50 dB $L_{Aeq,16h}$ during the daytime and 45 dB $L_{Aeq,8h}$ during the night-time, it is appropriate to undertake a detailed assessment which assumes windows are closed. Consideration is also given to maximum noise levels from individual events such as car door slams within the David Lloyd car park, engines starting in the Pitter Commercials premises.
- 5.3.13. This section presents the acoustic performance requirements relating to the sound insulation of the dwelling facades such that internal ambient noise levels within habitable rooms comply with the criteria presented in Table 5-1. The assessment has been undertaken in accordance with the general method set out in BS EN 12354-3:2017 - *Building acoustics. Estimation of acoustic performance of buildings from the performance of elements. Airborne sound insulation against outdoor sound*.
- 5.3.14. It is assumed that the non-glazed elements of the building envelope will provide a sufficient sound insulation performance against external noise sources and that it is the glazing and ventilation that are likely to be the acoustic 'weak link' of the building façade. Consequently, it is these elements that have been considered further.
- 5.3.15. The following assumptions have been used for the assessment of the sound insulation requirements of the building envelope:

- The sound insulation performance has been based on specific manufacturers' data. It has been assumed that the on-site performance will be comparable with the manufacturer's claimed performance;
- The predictions assume good quality workmanship, for example that windows, doors and opening lights are well sealed. Poor workmanship or low-quality seals may result in predicted internal noise levels being exceeded;
- External walls are assumed to be of brick construction;
- Bedrooms are assumed to have a single unit ventilator;
- Living rooms are assumed to have two unit ventilators;
- All rooms are assumed to have a reverberation time of 0.5 s;
- A low frequency correction has been applied to all calculations to account for the frequency spectrum of road traffic; and
- Room and glazing dimensions have been based on drawings provided by PRP Architects.

5.3.16. Details of the recommended acoustic performance requirements of the glazing and ventilation systems are given in Table 5-2, below, for the properties exposed to external ambient noise levels in excess of 50 dB $L_{Aeq,16h}$ during the daytime and 45 dB $L_{Aeq,8h}$ during the night-time and properties exposed to maximum noise levels in excess of 60 dB during the night-time.

5.3.17. Figures H-1 to H-5 in Appendix H indicate the facades of the proposed dwellings to which the glazing and ventilation systems set out in Table 5-2 should be assigned.

Table 5-2: Glazing and ventilation acoustic performance requirements

Key Colour in Figure H1 in Appendix H	Acoustic Performance Requirements	
	Window Units	Ventilation Strategy
	Standard thermal double-glazing system.	Natural ventilation (i.e. open windows)
	Standard thermal double-glazing system with a minimum performance of 31 dB R_w and 27 dB $R_w + C_{tr}$	ADF System* 1 (Background ventilators [acoustic trickle vents] and intermittent extract fans) with a minimum performance of 32 dB $D_{n,e,w}$
	Improved performance double-glazing system with a minimum performance of 35 dB R_w and 31 dB $R_w + C_{tr}$	ADF System* 1 (Background ventilators [acoustic trickle vents] and intermittent extract fans) with a minimum performance of 32 dB $D_{n,e,w}$
	Improved performance double-glazing system with a minimum performance of 35 dB R_w and 31 dB $R_w + C_{tr}$	ADF System* 3 Continuous mechanical extract (MEV) with a minimum performance of 36 dB $D_{n,e,w}$

	Improved performance double-glazing system with a minimum performance of 34 dB R _w and 30 dB R _w + C _{tr}	ADF System* 4 Continuous mechanical supply and extract with heat recovery (MVHR)
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* - "ADF System" is the name given to various ventilation strategies set out in Approved Document F (ADF) – Means of Ventilation, 2010 Edition. These systems are described further in Table 5-3.

- 5.3.18. Details of the proposed ventilation systems for all ventilation requirements (i.e. whole dwelling, extract and purge ventilation) are provided below in Table 5-3.

Table 5-3: Details of the proposed ADF systems

Ventilation System	Provision with ADF system / purpose		
	Whole Dwelling Ventilation	Extract Ventilation	Purge Ventilation
System 1 – Background ventilators [acoustic trickle vents] and intermittent extract fans	Background ventilators [acoustic trickle vents]	Intermittent extract fans for room where excess vapour or pollutants are released (e.g. bathrooms and kitchens)	Typically provided by opening windows
System 3 – Continuous mechanical extract (MEV)	Continuous mechanical extract – minimum low rate. Trickle vents provide inlet air	Continuous mechanical extract – minimum high rate. Trickle vents provide inlet air	Typically provided by opening windows
System 4 – Continuous mechanical supply and extract with heat recovery (MVHR)	Continuous mechanical supply and extract – minimum low rate	Continuous mechanical supply and extract – minimum high rate	Typically provided by opening windows

- 5.3.19. Windows can be opened when purge ventilation is required for the rapid removal/dispersal of odour or pollutants (e.g. water vapour, burnt toast, paint vapours). The noise criteria are likely to be exceeded in some rooms at this time; however, ProPG states that the internal noise criteria are generally not applicable during purge ventilation conditions, as this condition would only arise occasionally, last for a short period of time, and is at the occupier's discretion.
- 5.3.20. It should be noted that where Systems 3 (both centralised or decentralised systems) and 4 are proposed, consideration of the mechanical and structure-borne noise generated by the system itself, will be required at the detailed design stage, to ensure that the recommended acoustic performance of the façade is not undermined by the ventilation system.
- 5.3.21. With regard to overheating, noise levels at the facades of a significant number of properties in the western portion of the Proposed Development are sufficiently low that internal habitable spaces can be cooled passively, through the use of openable windows (i.e. where noise levels are predicted to fall below 50 dB L_{Aeq,16h} during the daytime and 45 dB L_{Aeq,8h} during the night-time).
- 5.3.22. For the proposed hotel, which is exposed to elevated noise levels from the M27, it is proposed that rooms are comfort cooled.

- 5.3.23. For dwellings closest to the boundary with Pitter Commercials and the David Lloyd car park, it is predicted that internal habitable noise levels at first and second floor level will be exceeded if windows are opened to provide thermal comfort. However, it is noted that those facades which are most exposed to elevated noise levels are north and north-east facing, which are generally considered to be of a low risk of overheating in comparison to facades which face the south-east and south-west (i.e. where noise levels are sufficiently low enough that overheating can be passively controlled). Consequently, it is anticipated that windows would not need to be opened to control overheating for prolonged periods.

EXTERNAL AMENITY AREA NOISE LEVELS

- 5.3.24. Figure G-1 in Appendix G indicates that noise levels during the daytime in the vast majority of private garden spaces associated with two and three storey properties meet the upper guideline noise limit in BS 8233 of 55 dB $L_{Aeq,16h}$.
- 5.3.25. There are a limited number of private gardens (9 of 102), however, where noise levels are predicted to exceed 55 dB $L_{Aeq,16h}$. Noise levels in these garden spaces are predicted to exceed the 55 dB limit only by up to 1.9 dB.
- 5.3.26. With regard to external amenity space, BS 8233 states that:
- “...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”*
- 5.3.27. In this case, noise levels are influenced to some degree by the M27, which is a strategic road. It is acknowledged that a garden fence in excess of 2m would be needed to mitigate noise level contributions from the nearby David Lloyd car park, however there are other design constraints (e.g. visual) which are likely prevent this from being an acceptable solution. Given the relatively small exceedance in these garden spaces, further mitigation is not considered necessary.
- 5.3.28. Predicted noise levels during the daytime are predicted to exceed the 55 dB limit across the majority of balcony spaces associated with the apartment blocks to the west of the Ageas Bowl and in the independent living facility to the south. Exceedances range from 1 dB to 9 dB, however it is important to note that noise from the Ageas Bowl is a significant contributor in these areas. The number of events at the Ageas Bowl which are likely to generate noise levels of the order of magnitude of those used in this assessment will be very limited over the course of the year. For reference, the number of cricket events anticipated to generate noise levels comparable with those assumed in this assessment are approximately 21 (7 international matches, 7 T20 matches, as occurred in 2019, and 7 The Hundred matches which began in 2021). Furthermore, international matches, whilst well-attended, do not have music over the PA system. Without the contribution from the Ageas Bowl, noise levels are significantly lower and meet the 55 dB limit across the majority of balconies. Small exceedances are noted at the northernmost and southernmost apartment blocks, however, these exceedances are predicted to be no greater than 1 dB. Where balcony spaces do still exceed the 55 dB limit, the following guidance from BS 8233 is relevant:

“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.”

5.3.29. BS 8233 further states that:

“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.”

5.3.30. In summary, noise levels are predicted to fall below 55 dB for the vast majority of private external amenity spaces, with minor exceedances predicted in only 9 of 102 gardens. In these spaces, there are design constraints which limit solutions to reduce these minor exceedances. In balcony spaces, noise levels are predicted to exceed 55 dB during an event at the Ageas Bowl, though fall below 55 dB across the majority of spaces when no events take place. It should be noted that events are likely to be very limited in number over the course of the year and so exposure to elevated noise levels on balcony spaces will be very infrequent. Furthermore, in light of guidance in BS 8233 which suggests that imposing noise limits in balcony spaces is not always appropriate, it is considered, on balance, that further mitigation is not necessary.

ANY OTHER RELEVANT ISSUES

5.3.31. In accordance with the ‘agent of change’ principle set out in NPPF, it is important to demonstrate that noise from existing, established businesses in proximity to new residential development is not likely to result in complaints from occupants of the proposed properties.

5.3.32. Based on the assumptions presented in section 4.3, noise from the Ageas Bowl, the David Lloyd car park and Pitter Commercials, has been predicted at the receptors within the Proposed Development using the 3D acoustic model.

NOISE FROM THE AGEAS BOWL

5.3.33. The predicted noise level at the worst-affected property (i.e. the north façade of the independent living facility located to the south) from noise at the Ageas Bowl is 62 dB. The predicted residual level (i.e. ambient noise level from the M27 in the absence of noise from the Ageas Bowl) at this location is 58 dB. Therefore, the noise from the Ageas Bowl is predicted to exceed the residual noise level by 5 dB at the façade and in the balcony spaces, albeit only for the few hours when the events take place. It should be noted that predicted noise from the Ageas Bowl includes for a 6 dB correction for the prevalence of acoustic features, which is considered to represent a robust assessment case.

5.3.34. In terms of internal habitable noise levels, sufficient ventilation is provided at this property through the proposed ventilation strategy (see Tables 5-2, 5-3 and Figures H-1 to H5 in Appendix H) such that windows do not need to be opened for ventilation. Furthermore, as this façade is north-facing, the requirement for windows to be open to provide thermal comfort is reduced. Therefore, with windows closed, the glazing performance which has been recommended would be sufficient to maintain habitable internal noise levels.

5.3.35. It is also important to note that events at the Ageas Bowl take place during daytime hours, without the risk to sleep disturbance during the more sensitive night-time hours (23:00 to 07:00). Furthermore, as stated in paragraph 5.3.28, events at the Ageas Bowl which are likely to result in

noise levels similar to those assumed in this assessment are likely to be very limited over the course of the year.

- 5.3.36. Therefore, given the limited time for which an event takes place (generally a few hours in the afternoon/evening), the limited number of occasions where noise from the Ageas Bowl is predicted to exceed the residual noise level, and given the option available to manage noise levels with closed windows, it is suggested that the likelihood of complaint from occupiers is low.

NOISE FROM PITTER COMMERCIALS

- 5.3.37. The predicted noise level at the façade of the worst-affected properties (i.e. those nearest to the southern boundary of Pitter Commercials) is 47 dB. The predicted residual level (i.e. ambient noise level from the David Lloyd car park and the M27 in the absence of noise from Pitter Commercials) at these properties is 50 dB. Therefore, the noise from Pitter Commercials is predicted to fall below the residual noise level by 3 dB at the façade and in the garden spaces. Therefore, it is suggested that the likelihood of complaint from occupiers as a result of noise in garden spaces from Pitter Commercials is low.
- 5.3.38. In terms of internal habitable noise levels, the predicted noise level from Pitter Commercials is below 50 dB $L_{Aeq,1h}$ and is therefore not likely to result in internal noise levels which would be cause complaint during the daytime if windows are opened. Between 06:00 and 07:00 (i.e. during the night-time), the predicted noise level from Pitter Commercials is in excess of 45 dB $L_{Aeq,1h}$ by 2 dB and may therefore be noticeable in bedrooms with windows open, albeit only for the hour of 06:00 to 07:00 (i.e. the only night-time hour when the premises is open). During this hour, sufficient ventilation is provided though the proposed ventilation strategy (see Tables 5-2, 5-3 and Figures H-1 to H5 in Appendix H), such that windows do not need to be opened for ventilation. Furthermore, as this façade is north-facing, the requirement for windows to be open to provide thermal comfort is considered to be low. Therefore, with windows closed, the glazing performance which has been recommended would be comfortably sufficient to maintain habitable internal noise levels during the only affected hour of the night (i.e. Between 06:00 and 07:00). Consequently, it is suggested that the likelihood of complaint from occupiers is low.

NOISE FROM THE DAVID LLOYD CAR PARK

- 5.3.39. The predicted noise level at the façade of the worst-affected properties (i.e. those nearest to the southern boundary of the car park) is 50 dB. The predicted residual level (i.e. ambient noise level from Pitter Commercials and the M27 in the absence of noise from the car park) at these properties is 52 dB. Therefore, the noise from the car park is predicted to fall below the residual noise level by 2 dB at the façade and in the garden spaces. Therefore, it is suggested that the likelihood of complaint from occupiers as a result of noise in garden spaces from the David Lloyd car park is low.
- 5.3.40. In terms of internal habitable noise levels, the predicted noise level from the car park is equal to 50 dB $L_{Aeq,1h}$ and is therefore not likely to result in internal noise levels which would be cause complaint during the daytime if windows are opened. During the night-time, the predicted noise level from the car park is in excess of 45 dB $L_{Aeq,1h}$ by 2 dB and may therefore be noticeable in bedrooms with windows open. However, sufficient ventilation is provided at this property through the proposed ventilation strategy (see Tables 5-2, 5-3 and Figures H-1 to H5 in Appendix H), such that windows do not need to be opened for ventilation. Furthermore, as this façade is north-east-facing, the requirement for windows to be open to provide thermal comfort is reduced. Therefore, with windows closed, the glazing performance which has been recommended would be comfortably sufficient to



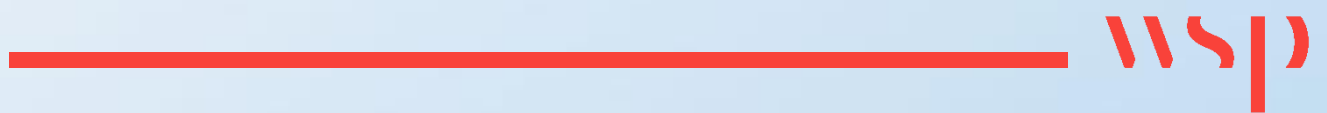
maintain habitable internal noise levels during the daytime and night-time. Consequently, it is suggested that the likelihood of complaint from occupiers is low.

6 CONCLUSION

- 6.1.1. WSP UK Ltd (WSP) has been commissioned by Land & Development Advisory Ltd to provide noise services for the development at the Ageas Bowl, Southampton.
- 6.1.2. Consideration is given in this report to relevant national and local planning policy, appropriate professional guidance and the specific assessment requirements of Eastleigh Borough Council (EBC). Details are provided in Section 2 of this report.
- 6.1.3. Baseline conditions have been quantified through a combination of attended and unattended noise measurements and through the use of traffic data which has been used to inform a 3D acoustic model of the site and surrounding area.
- 6.1.4. An assessment of the suitability of the site for residential use (i.e. assessment of internal noise conditions and noise across external amenity) has been undertaken, where it is predicted that internal habitable noise levels can be achieved across a significant proportion of spaces within dwellings of the Proposed Development with openable windows for ventilation and thermal comfort. Noise levels are likely to be exceeded within properties located towards the extremities of the Proposed Development during brief periods when windows may be opened to manage thermal comfort. Given that the majority of these properties have facades which are exposed to more elevated noise levels on north or north-eastern facades, it is likely that periods where windows may be opened to manage thermal comfort will be limited.
- 6.1.5. Noise levels across the majority of external amenity spaces are predicted to fall below the upper guideline noise limit of 55 dB set out in BS 8233, with the exception of 9 garden spaces (out of 102) where a minor exceedance is predicted. Across balcony spaces located in proximity to the Ageas Bowl, noise levels are predicted to exceed the upper guideline limit of 55 dB, however, this would only be for a few hours on a very limited number of event days (anticipated to be in the region of 21 across the year). The guidance in BS 8233 also suggests that imposing noise limits in balconies is not necessarily appropriate, given limited space constraints.
- 6.1.6. In accordance with the 'agent of change' principle set out in NPPF, the likelihood of complaint from occupants of the Proposed Development regarding noise from the Ageas Bowl; noise from the David Lloyd car park; and noise generated by operational activity at Pitter Commercials has been assessed. It is anticipated that the likelihood of complaint is low and does not require further consideration.

Appendix A

GLOSSARY OF TERMS



NOISE

Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 20 Hz (deep bass) to 20,000 Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold 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 mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. 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 or impulsiveness 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.

The most widely used 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_{A90} etc., according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

An indication of the range of sound levels commonly found in the environment is given in the table below.

Table A-1: Range of sound levels commonly found in the environment

Sound pressure level (dBA)	Location
0	Threshold of hearing
20 to 30	Quiet bedroom at night
30 to 40	Living room during the day
40 to 50	Typical office
50 to 60	Inside a car
60 to 70	Typical high street
70 to 90	Inside factory

Sound pressure level (dBA)	Location
100 to 110	Burglar alarm at 1 m away
110 to 130	Jet aircraft on take off
140	Threshold of pain

Table A-2: Noise terminology

Terminology	Description
A-weighting, dB(A)	A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' - weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
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 Pa.
Façade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast Time Weighting (F)	Averaging time used in sound level meters and commonly used in the measurement of environmental noise. Equivalent to 1/8 of second, or 125 milliseconds.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m away.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period, T. L_{10} may be thought of as the "average maximum" noise level. Generally used to describe road traffic noise.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period, T. L_{90} may be thought of as the "average minimum" noise level. Generally used to describe background noise.
$L_{eq,T}$	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.

Terminology	Description
$L_{max,T}$	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.
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.
Sound Power	The sound energy radiated per unit time by a sound source. Measured in watts (W).
Sound Power Level, L_w	Sound power measured on a decibel scale, relative to a reference value of 10^{-12} W.
Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure. Measured in pascals (Pa).
Sound Pressure Level (Sound Level), L_p	The sound level is the sound pressure on a decibel scale, relative to a reference value of 20×10^{-6} Pascals.

Appendix B

SITE LAYOUT PLAN





Appendix C

POLICY AND GUIDANCE



Professional Practice Guidance on Planning & Noise: New Residential Development (ProPG), 2017

The 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), together with practitioners from a planning and local authority background, to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England.

The scope of the ProPG is limited to the consideration of new residential development that will be exposed predominantly to airborne noise from transport sources.

The ProPG aims to complement Government planning and noise policy and guidance, and in particular it strives 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;*
- *improve understanding of how to determine the extent of potential noise impact and effect; and assist the delivery of sustainable development.”*

The ProPG recommends that the assessment of noise for new residential development is undertaken in the following two stages:

- **Stage 1**, which provides an Initial Site Noise Risk Assessment (ISNRA), based on the predicted levels from the model across the undeveloped site; and
- **Stage 2**, which provides an assessment of the developed site, comprising the following four elements:
 - good acoustic design;
 - internal noise levels;
 - external noise levels; and
 - any other relevant issues.

The ProPG provides the following figure to assist with the undertaking of ISNRAs for new residential development. The figure provides a scale of daytime and night-time noise levels for negligible, low, medium and high risk categories for application sites with guidance as to how noise levels may need to be mitigated.

Figure C-1: Stage 1 – Initial Site Noise Risk Assessment (ISNRA) (from ProPG, Figure 1, page 09)

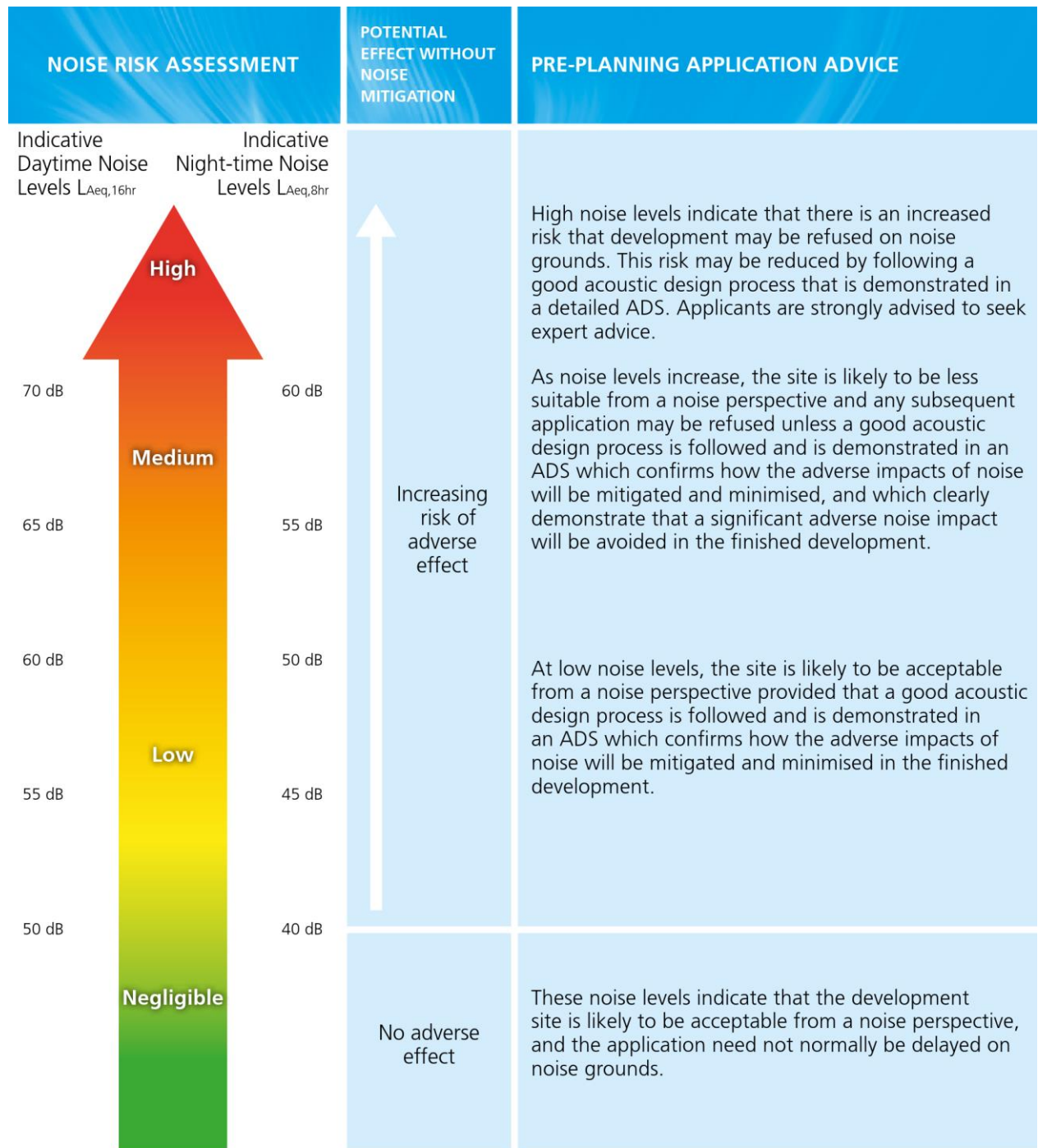


Figure 1 Notes:

- Indicative noise levels should be assessed without inclusion of the acoustic effect of any scheme specific noise mitigation measures.
- Indicative noise levels are the combined free-field noise level from all sources of transport noise and may also include industrial/commercial noise where this is present but is "not dominant".
- $L_{Aeq,16hr}$ is for daytime 0700 – 2300, $L_{Aeq,8hr}$ is for night-time 2300 – 0700.
- An indication that there may be more than 10 noise events at night (2300 – 0700) with $L_{Amax,F} > 60$ dB means the site should not be regarded as negligible risk.

Internal Spaces (habitable rooms)

In terms of noise criteria, the document references, and builds upon, those contained in British Standard (BS) 8233. Figure 2 in the ProPG presents the internal noise level guidelines as set-out in Section 7.7.2 of BS 8233, but with elaborated guidance in the accompanying notes. The additional guidance from Note 4, Note 5 and Note 7 is provided below.

Note 4 proposes the WHO-based limit of 45 dB L_{AFmax} , with the following accompanying text:

“In most circumstances in noise-sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events (see Appendix A).”

Note 5 from BS 8233 has been rewritten in the ProPG as follows:

“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 L_{Aeq} target levels should not normally be exceeded, subject to the further advice in Note 7.”

The following is added to Note 7:

“The more often internal L_{Aeq} levels start to exceed the internal L_{Aeq} target levels by more than 5 dB, the more that most people are likely to regard them as “unreasonable”. Where such exceedances are predicted, applicants should be required to show how the relevant number of rooms affected has been kept to a minimum. Once internal L_{Aeq} levels exceed the target levels by more than 10 dB, they are highly likely to be regarded as “unacceptable” by most people, particularly if such levels occur more than occasionally. Every effort should be made to avoid relevant rooms experiencing “unacceptable” noise levels at all and where such levels are likely to occur frequently, the development should be prevented in its proposed form (see Section 3.D).”

Key to note from the above, therefore, is that:

- the use of a limit of 45 dB L_{AFmax} (not to be exceeded by more than 10 individual events per night) is further supported;
- where there is a need to assess with windows closed, any façade openings used to provide whole dwelling ventilation should be assumed open; and
- where levels exceed the targets by more than 5 dB, they are likely to be regarded as “unreasonable”, and “unacceptable” when more than 10 dB above.

Where industrial and/or commercial noise is dominant, the ProPG states that regard should be had to the guidance in BS 4142.

External Areas (amenity space)

The ProPG recommended assessment methodology reflects and extends the advice contained in BS 8233. In particular, the ProPG suggests that consideration of the need to provide access to a quiet or relatively quiet external amenity space forms part of a good acoustic design process. If noise levels

are relatively high on any private external amenity space, the effect may be mitigated through the provision of an alternative such as:

- a relatively quiet façade (with openable windows) or externally ventilated space (i.e. enclosed balcony);
- a relatively quiet additional external amenity space for sole use by a household in a different location (e.g. roof garden);
- a relatively quiet external amenity space for sole use by a limited group of residents (e.g. communal garden);
- a relatively quiet, protected, publicly accessible external amenity space (e.g. a public park).

In terms of criteria, the ProPG mentions the same values as BS 8233, with the ProPG including a quote from the British Standard, which states that “...noise levels should ideally not be above the range 50 – 55 dB $L_{Aeq,16hr}$.”

BS 8233:2014 Guidance on sound insulation and noise reduction for buildings (BS 8233), 2014

The scope of BS 8233 is the provision of guidance for the control of noise in and around buildings. It suggests appropriate criteria for different situations, which primarily are intended to guide the design of new buildings, or refurbished buildings undergoing a change of use. The noise level criteria recommended in BS 8233 for residential spaces are based on the World Health Organisation Guidelines for Community Noise and are summarised in the table below.

Table D-1: Indoor ambient noise levels for dwellings (BS 8233 Table 4)

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

Note 7 to the above table states:

“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.”

On design criteria for external noise, BS 8233 states that:

“For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external 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 recognised that these guideline values are not achievable in all circumstances where development might also 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”.

World Health Organisation (WHO) Guidelines for Community Noise, 1999

The WHO guidelines consolidate scientific knowledge on the health effects of community noise and provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments. The main sources of community noise are identified as road, rail and air traffic, industries, construction and public work and neighbours.

A wide range of specific effects and environments are considered in the guidelines but a few that relate to this study are described below.

With regard to community noise, the guidelines state (in section 4.2.7) that annoyance “*varies with the type of activity producing the noise.....During the daytime, few people are seriously annoyed by activities with L_{Aeq} levels below 55 dB; or moderately annoyed with L_{Aeq} levels below 50 dB.*” The time base for these values, which relate to the daytime period, is 16 hours.

In dwellings, the critical effects of noise are on sleep, annoyance and speech interference. To avoid sleep disturbance “*indoor guideline values for bedrooms are 30 dB L_{Aeq} for continuous noise and 45 dB L_{Amax} for single sound events*”.

Acoustics, Ventilation and Overheating: Residential Design Guide (AVOG), 2020

The Acoustics, Ventilation and Overheating Guide (AVOG) (2020) recommends an approach to acoustic assessments for new residential development that takes due regard of the interdependence of provisions for acoustics, ventilation and overheating.

The AVOG provides a two-level noise assessment procedure to estimate the potential impact on occupants in the case of the overheating condition. The overheating condition, is where excessive or prolonged high-temperatures in homes, resulting from internal or external heat gains, may have adverse effects on the comfort, health or productivity of the occupants.

The AVOG includes a number of useful design principles, such as the following:

- ‘good acoustic design’ must include consideration of appropriate solutions to overheating conditions for new-build residential property;
- increasing levels of noise outside a proposed residential building will generally demand a greater level of assessment for noise effects during overheating conditions;
- consideration of noise inside a building during overheating conditions should include consideration for both noise generated outside the building, and by the ventilation solution itself (e.g. mechanical noise); and
- it is appropriate to apply higher noise criteria to habitable rooms during overheating conditions than for normal/typical conditions.

Calculation of Road Traffic Noise (CRTN), 1988

CRTN provides a calculation methodology for using road traffic flow data to calculate road traffic noise levels. This methodology produces noise levels in terms of L_{A10} , either over a 1-hour or an 18-hour period.

The factors which may influence road traffic noise levels at source can be divided into two groups:

- road related factors - gradient and surface type; and
- traffic related factors - flow, speed and the proportion of heavy-duty vehicles.

The propagation of noise is also covered in CRTN and can influence the noise levels at receptor locations.

Converting the UK traffic noise index $L_{A10,18h}$ to EU noise indices for noise mapping (TRL Project Report PR/SE/451/02), 2002

The *Calculation of Road Traffic Noise* prediction method produces noise levels in terms of L_{A10} , either over a 1-hour or an 18-hour period.

The European-wide noise mapping exercise required by EU Directive 2002/49/EC relating to the assessment and management of environmental noise (known as the Environmental Noise Directive or END), requires outputs in terms of L_{den} and L_{night} , both of which are based on the equivalent continuous noise level L_{Aeq} .

The Transport Research Laboratory (TRL) published a report in 2002, which provided a 'back-end' correction for converting the UK traffic noise index $L_{A10,18h}$ to the noise indices required for EU noise mapping.

The TRL report presented equations for three potential methods of conversion, depending on the quantity and quality of traffic data available.

- **Method 1** is the most detailed and can be used when the assessor has available hourly traffic data. Equations are provided for motorway and non-motorway roads to convert $L_{A10,1h}$ to $L_{Aeq,1h}$, with the generated $L_{Aeq,1h}$ values subsequently being used to derive values of L_{den} and L_{night} as required by the END.
- **Method 2** can be used where traffic data are known or can be estimated for the relevant time periods specified in the END (i.e. 12-hour day, 4-hour evening and 8-hour night) as well as the 18-hour period, with the generated L_{day} , $L_{evening}$ and L_{night} values subsequently being used to derive values of L_{den} as required by the END.
- **Method 3** is the least detailed and can be used when only $L_{A10,18h}$ traffic data are available. Equations are provided for motorway and non-motorway roads to convert $L_{A10,18h}$ directly to the L_{den} and L_{night} values as required by the END.

BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound (BS 4142), 2019

BS 4142 describes methods for rating and assessing the following:

- sound from industrial and manufacturing processes;
- sound from fixed installations which comprise mechanical and electrical plant and equipment;
- sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and
- sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train movements on or around an industrial and/or commercial site.

The methods use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes and upon which sound is incident.

The Standard effectively compares and rates the difference between the specific sound level of the source ($L_{Aeq,T}$) and the typical background sound level ($L_{A90,T}$) in the absence of the specific sound. If appropriate, the specific sound level is corrected, by the application of one or more corrections for acoustic features such as tonal qualities and/or distinct impulses, to give a 'rating' level ($L_{Ar,Tr}$).

The Standard allows the following additive corrections for character: 0 dB to +6 dB for tonality and 0 dB to +9 dB for impulsivity. Where the specific sound features characteristics that are neither tonal nor impulsive, but otherwise are readily distinctive, a penalty of +3 dB can be applied. Finally, should the specific sound contain identifiable on/off conditions and so be readily distinctive, a penalty of +3 dB can be applied.

The Standard advises that the time interval of the background sound measurement should be sufficient to obtain a representative or typical value of the background sound level at the time(s) the source in question operates or is proposed to operate in the future. The specific sound level should be evaluated over a one hour period during the day and over a 15 minute period during the night.

Comparing the rating level with the background sound level, the Standard states:

“Typically, the greater this difference, the greater the magnitude of impact.

A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.

A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.”

Appendix D

NOISE SURVEY EQUIPMENT

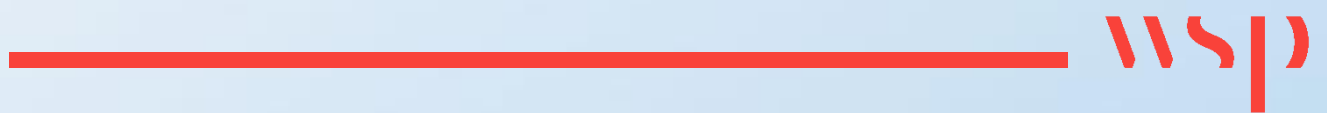


Table D-1: Noise survey measurement

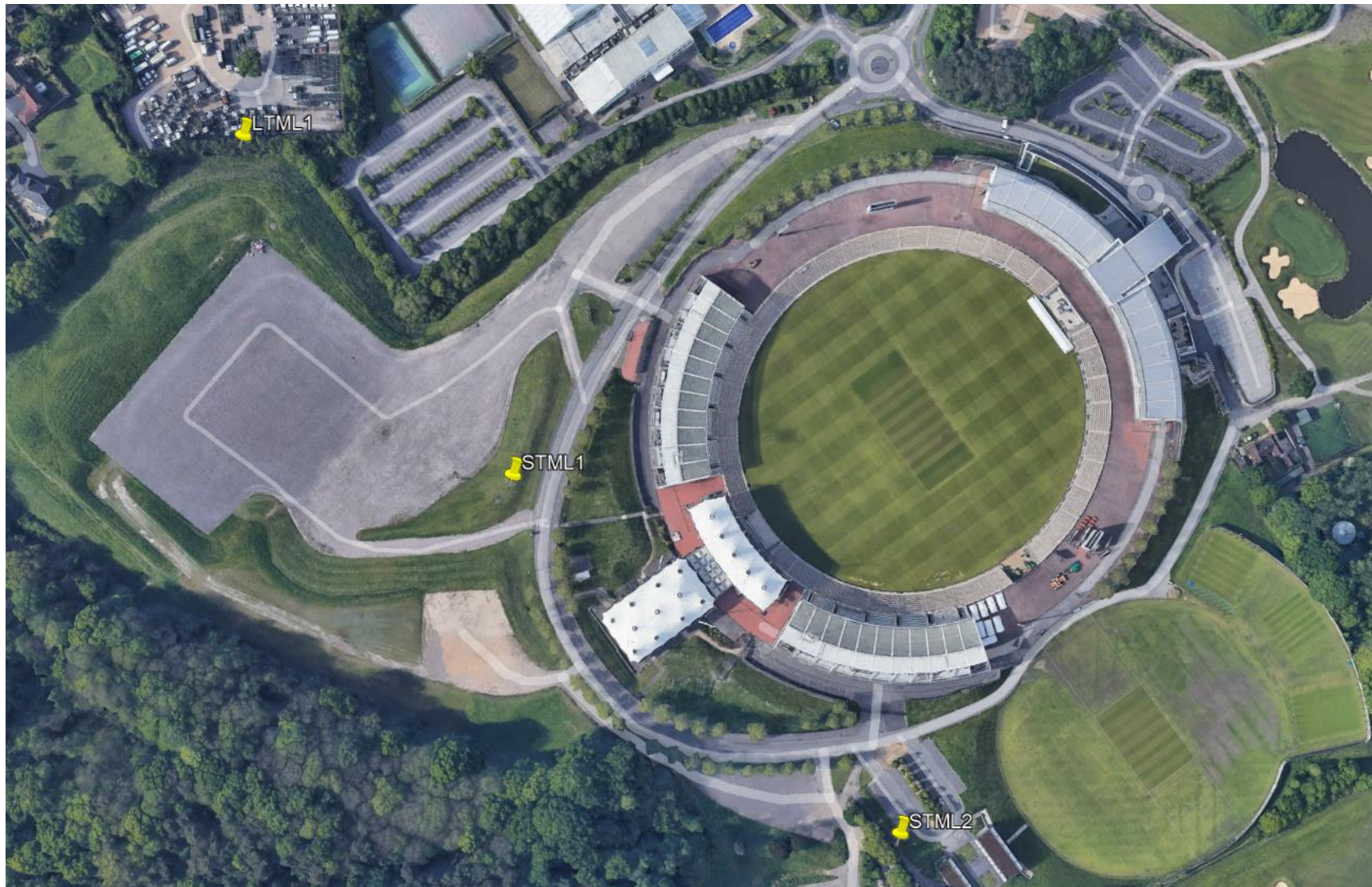
Location	Equipment Description	Manufacturer & Type No.	Serial No.
LTML1	Sound Level Meter	01dB-Stell Duo 'Datalogging Integrating Sound Level Meter'	10616
	Pre-amplifier	01dB-Stell PRE 21 S Preamplifier	10180
	Microphone	G.R.A.S Type 40CD Condenser Microphone	154423
	Calibrator	01dB Cal 21	34924053
STML1	Sound Level Meter	01dB-Stell Duo 'Datalogging Integrating Sound Level Meter'	10618
	Pre-amplifier	01dB-Stell PRE 21 S Preamplifier	10627
	Microphone	G.R.A.S Type 40CD Condenser Microphone	331635
	Calibrator	01dB Cal 21	34924047
STML2	Sound Level Meter	01dB-Stell Duo 'Datalogging Integrating Sound Level Meter'	10617
	Pre-amplifier	01dB-Stell PRE 21 S Preamplifier	10324
	Microphone	G.R.A.S Type 40CD Condenser Microphone	162071
	Calibrator	01dB Cal 21	34924010

Appendix E

NOISE MEASUREMENT LOCATIONS

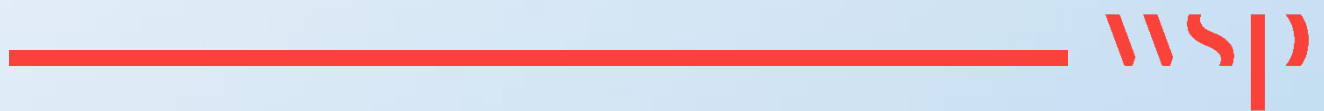


Figure E-1: Noise measurement locations



Appendix F

NOISE MEASUREMENT DATA



Period start	LAeq	LA90	LAFmax
12/01/2022 15:00	46.8	41.4	78.7
12/01/2022 16:00	47.7	43.5	66.7
12/01/2022 17:00	51	46.9	66.8
12/01/2022 18:00	51.2	49.2	68.1
12/01/2022 19:00	49.2	47.4	57.6
12/01/2022 20:00	47.6	45.8	58.4
12/01/2022 21:00	50	45.8	71.8
12/01/2022 22:00	44.9	42.3	58.1
12/01/2022 23:00	46.5	41.4	72.2
13/01/2022 00:00	42.8	39.5	52.2
13/01/2022 01:00	42.4	40.8	48.6
13/01/2022 02:00	42.2	40.2	49.5
13/01/2022 03:00	42.2	37.4	55.7
13/01/2022 04:00	46.1	40.1	64.5
13/01/2022 05:00	49.3	44.5	74.5
13/01/2022 06:00	57.6	52.1	82.7
13/01/2022 07:00	59.4	57.1	73.9
13/01/2022 08:00	60	58.5	73.8
13/01/2022 09:00	58.9	57	68.8
13/01/2022 10:00	55.4	51.5	70.4
13/01/2022 11:00	53.6	46.8	75.2
13/01/2022 12:00	51.7	43.6	72.6
13/01/2022 13:00	48.7	40.6	70
13/01/2022 14:00	51.7	41.3	82.5
13/01/2022 15:00	48.1	42.3	72.4
13/01/2022 16:00	48.3	43.9	76
13/01/2022 17:00	52.1	47.3	74.3
13/01/2022 18:00	52.6	50.6	65
13/01/2022 19:00	50.7	48.7	54.1
13/01/2022 20:00	49.8	46.7	59.4

13/01/2022 21:00	50	47.3	58
13/01/2022 22:00	50.3	47.4	71.4
13/01/2022 23:00	51.6	45.5	80.4
14/01/2022 00:00	47.1	39.8	70.1
14/01/2022 01:00	43	41.1	58.2
14/01/2022 02:00	43.2	40.8	59.7
14/01/2022 03:00	43.1	39	52
14/01/2022 04:00	46.4	41	56.3
14/01/2022 05:00	47.6	42.5	59.2
14/01/2022 06:00	54.4	49.6	73.1
14/01/2022 07:00	57.4	53.9	63.6
14/01/2022 08:00	60	56.9	67.8
14/01/2022 09:00	59.4	54.9	87.1
14/01/2022 10:00	59.7	55.3	74.1
14/01/2022 11:00	54.6	50.1	78.2
14/01/2022 12:00	53.8	43.1	87.4
14/01/2022 13:00	53.6	42.3	84.9
14/01/2022 14:00	51.6	42.3	85.3
14/01/2022 15:00	51.6	43.9	81.6
14/01/2022 16:00	48.8	45.8	71.8
14/01/2022 17:00	51.7	48.4	74.8
14/01/2022 18:00	53.7	51.6	66.4
14/01/2022 19:00	54.1	52.1	71.4
14/01/2022 20:00	51.7	49.9	67.5
14/01/2022 21:00	51.7	48.9	64.3
14/01/2022 22:00	49.8	46.1	62.5
14/01/2022 23:00	50.9	47	71.1
15/01/2022 00:00	47	43	65.7
15/01/2022 01:00	46.8	44	57.3
15/01/2022 02:00	46.5	43.4	57.2
15/01/2022 03:00	44.7	39.3	58.2

15/01/2022 04:00	43.4	39.6	52.9
15/01/2022 05:00	46.7	41	63.1
15/01/2022 06:00	50.6	44.5	64.1
15/01/2022 07:00	49.6	44.7	64.6
15/01/2022 08:00	54	43.4	82.5
15/01/2022 09:00	51.5	40.8	66.8
15/01/2022 10:00	51.4	40.6	65.8
15/01/2022 11:00	55.9	45.2	80.6
15/01/2022 12:00	45.5	39.5	62.4
15/01/2022 13:00	42.4	38.8	59
15/01/2022 14:00	43.7	37.9	62.4
15/01/2022 15:00	45.2	36	66.6
15/01/2022 16:00	44.5	38.4	60.9
15/01/2022 17:00	50.9	46.8	67.5
15/01/2022 18:00	48	44.9	63.6
15/01/2022 19:00	45.4	43.8	55.2
15/01/2022 20:00	46.3	44.6	59.4
15/01/2022 21:00	44.3	40.8	56.8
15/01/2022 22:00	43.2	40.7	60.6
15/01/2022 23:00	46	43.6	55.2
16/01/2022 00:00	42	38.8	59.2
16/01/2022 01:00	41.3	39.2	56
16/01/2022 02:00	42.4	32.9	83.3
16/01/2022 03:00	33.1	31.3	47.2
16/01/2022 04:00	31.9	30.2	42.1
16/01/2022 05:00	45.5	31	66.2
16/01/2022 06:00	47.2	32.8	64.6
16/01/2022 07:00	51.1	38.4	65.6
16/01/2022 08:00	53	40.9	71.6
16/01/2022 09:00	51.5	40.5	67.3
16/01/2022 10:00	48.4	40.3	67.3

16/01/2022 11:00	47.9	41	66.3
16/01/2022 12:00	51.4	40.1	85.6
16/01/2022 13:00	43.4	37.9	66.8
16/01/2022 14:00	44.9	38.5	68.2
16/01/2022 15:00	43.6	40.4	66.9
16/01/2022 16:00	42.4	39.5	60.7
16/01/2022 17:00	45.9	38.6	66.1
16/01/2022 18:00	42.6	36.9	66.8
16/01/2022 19:00	37.7	35	52.9
16/01/2022 20:00	36.9	34	58.4
16/01/2022 21:00	38.6	35.5	57.6
16/01/2022 22:00	36.8	35	46
16/01/2022 23:00	37.7	34	56.5
17/01/2022 00:00	34.9	32.3	53.1
17/01/2022 01:00	37.8	35.1	54.4
17/01/2022 02:00	34.7	32.7	41
17/01/2022 03:00	32.2	30	46.8
17/01/2022 04:00	35.6	30.5	60.1
17/01/2022 05:00	45.3	40.1	65.9
17/01/2022 06:00	51.2	40.2	77.4
17/01/2022 07:00	53.3	45.3	85.8
17/01/2022 08:00	55.7	47.6	86.5
17/01/2022 09:00	53.1	49	73.7
17/01/2022 10:00	50.1	45.8	70.2
17/01/2022 11:00	51.7	43.3	79.4
17/01/2022 12:00	47.1	41.1	71.8
17/01/2022 13:00	43.6	40.8	59.3
17/01/2022 14:00	50.1	39.4	74.4
17/01/2022 15:00	46.4	39.2	68.4
17/01/2022 16:00	48.5	41	69.7
17/01/2022 17:00	51	45.1	77.3

17/01/2022 18:00	50.1	47.3	75.3
17/01/2022 19:00	48.1	45.8	59
17/01/2022 20:00	47.1	45.2	55.2
17/01/2022 21:00	47.2	45.1	66.4
17/01/2022 22:00	45	41.9	64.5
17/01/2022 23:00	45	42.1	64
18/01/2022 00:00	44.7	40.4	61.9
18/01/2022 01:00	44.5	41.9	55.1
18/01/2022 02:00	44.1	41.2	52.5
18/01/2022 03:00	45	41	55.7
18/01/2022 04:00	46.7	42.4	57.3
18/01/2022 05:00	50.1	45.3	68.3
18/01/2022 06:00	55	51.7	78.3
18/01/2022 07:00	54.9	51.8	76.6
18/01/2022 08:00	56.7	54.1	70.9
18/01/2022 09:00	57.8	54.5	76.3
18/01/2022 10:00	53.7	49	79.9
18/01/2022 11:00	53.4	50.6	70.5
18/01/2022 12:00	52.1	44.7	72.1
18/01/2022 13:00	51.4	44.9	83

Appendix G

NOISE MODELLING CONTOUR PLOTS

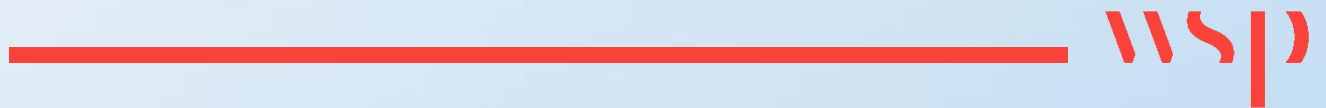


Figure G1: Predicted noise across the undeveloped site during the daytime at ground floor level

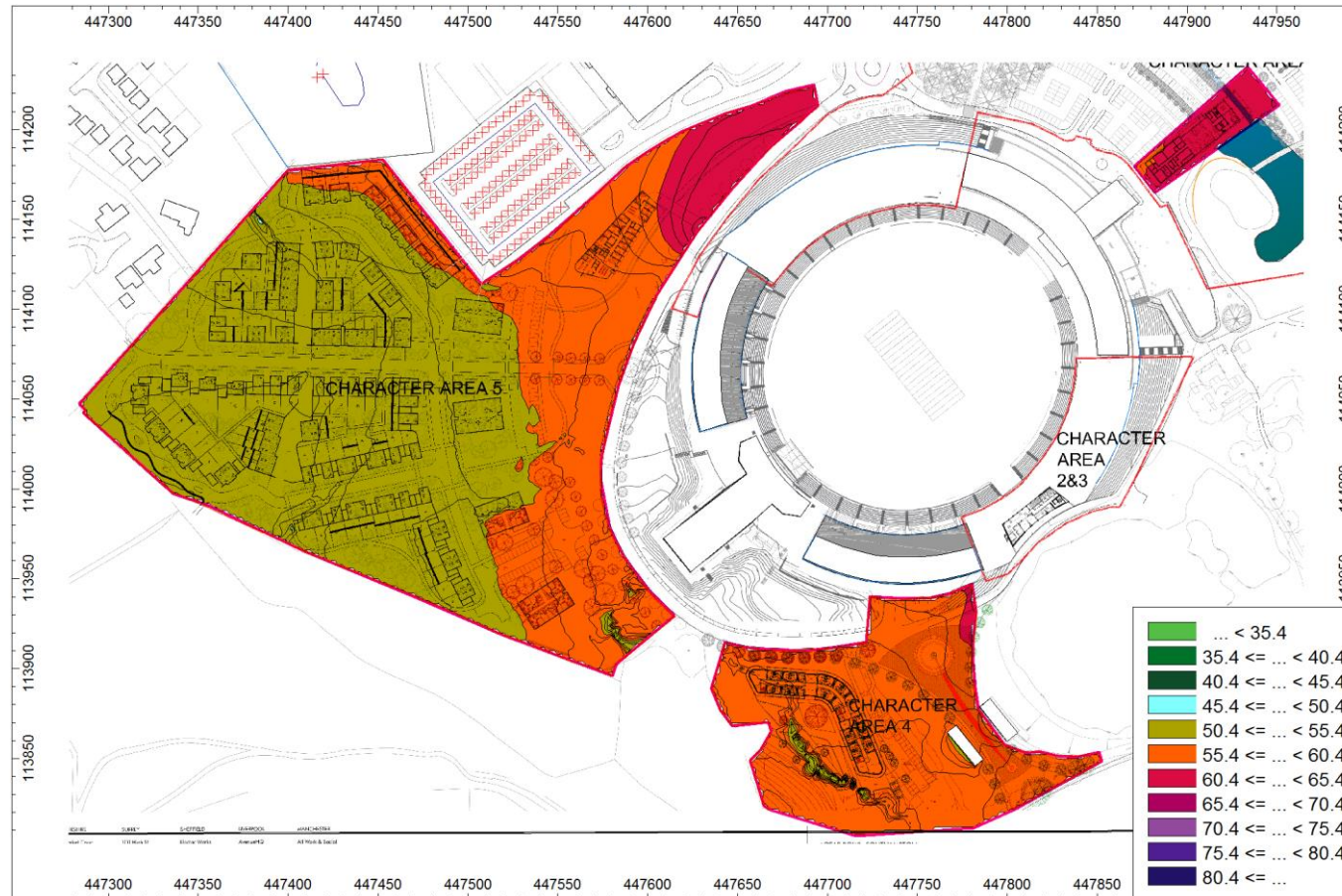


Figure G2: Predicted noise across the undeveloped site during the night-time at ground floor level

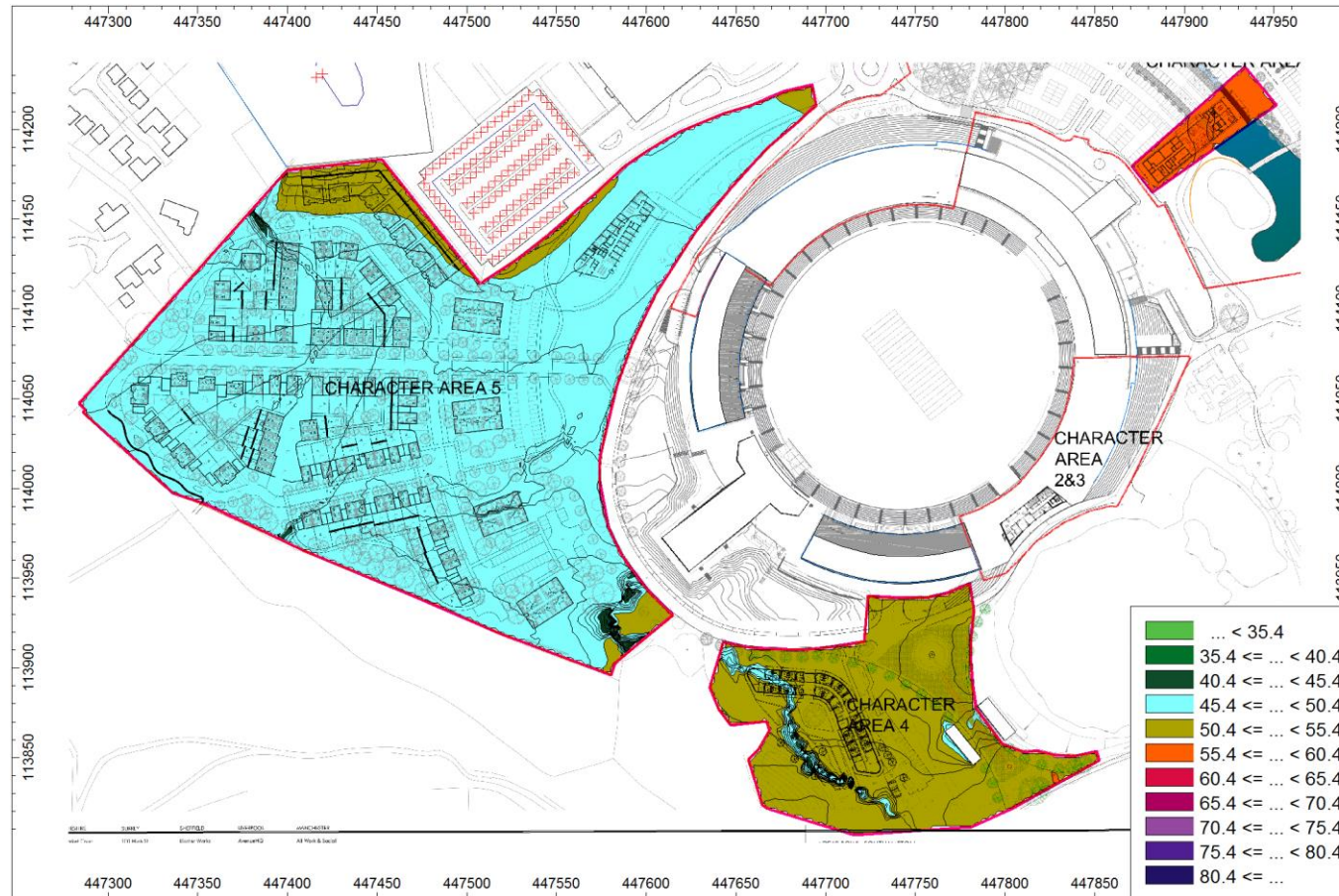


Figure G3: Predicted noise across the developed site during the daytime at ground floor level

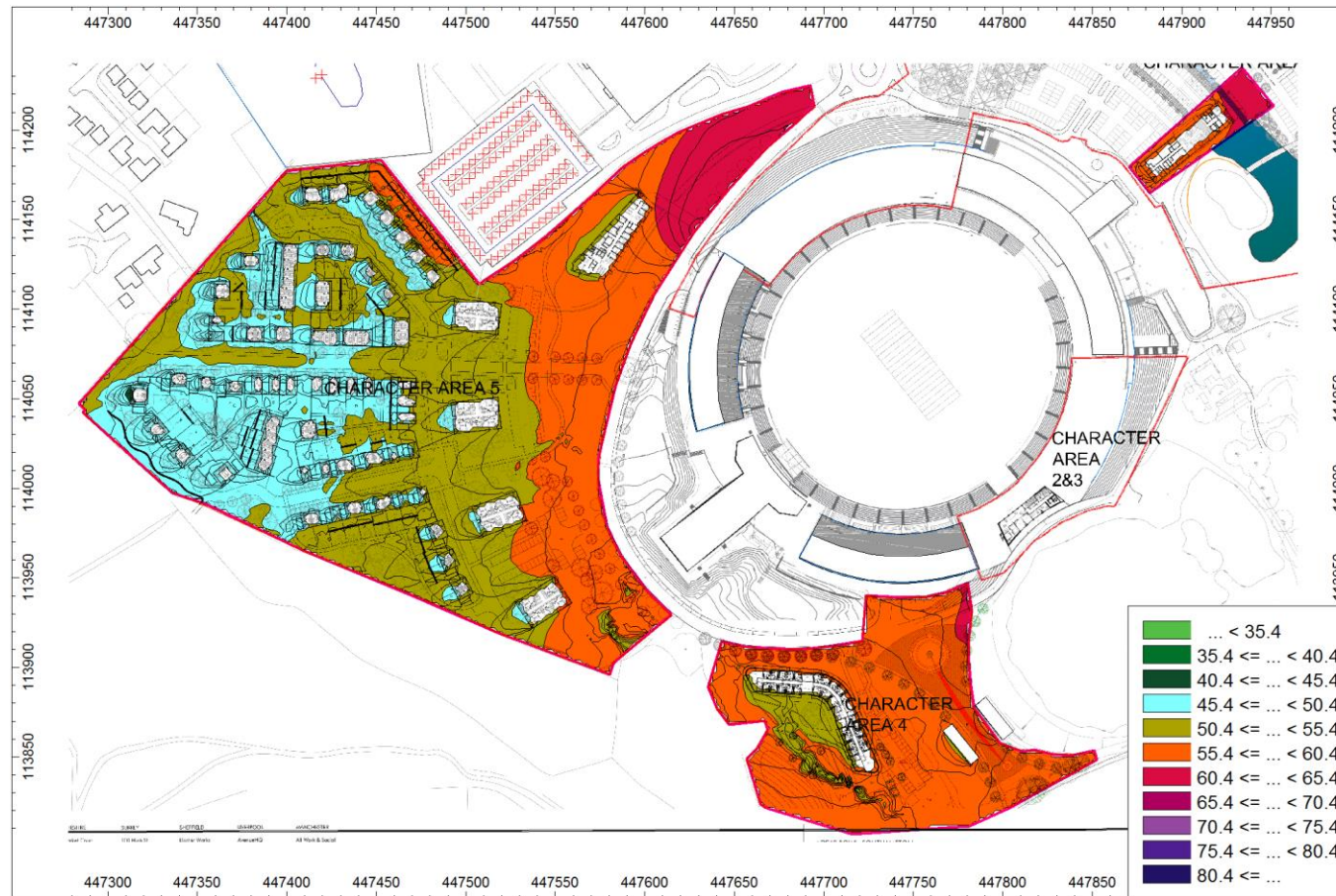


Figure G4: Predicted noise across the developed site during the daytime at first floor level

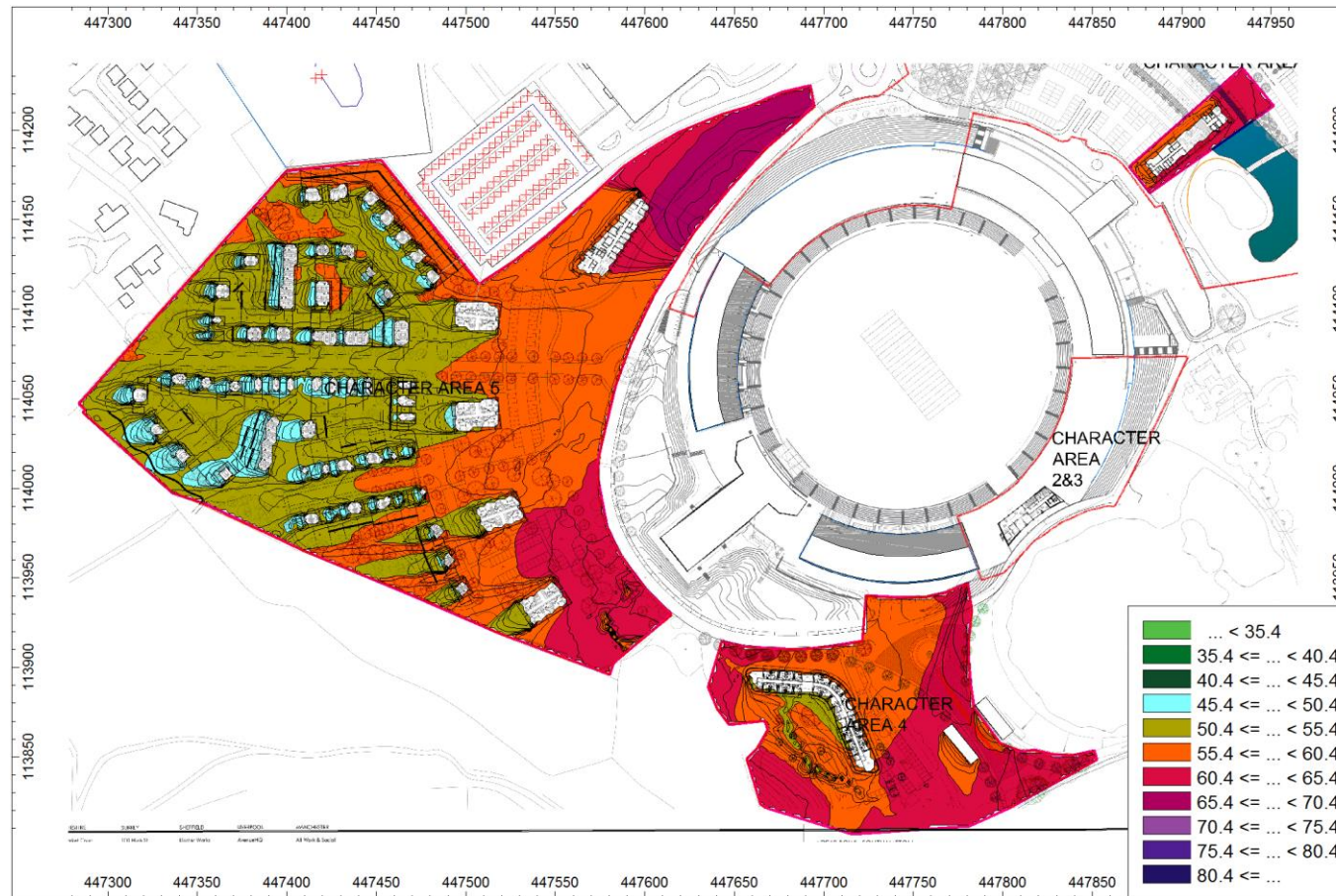


Figure G5: Predicted noise across the developed site during the daytime at second floor level

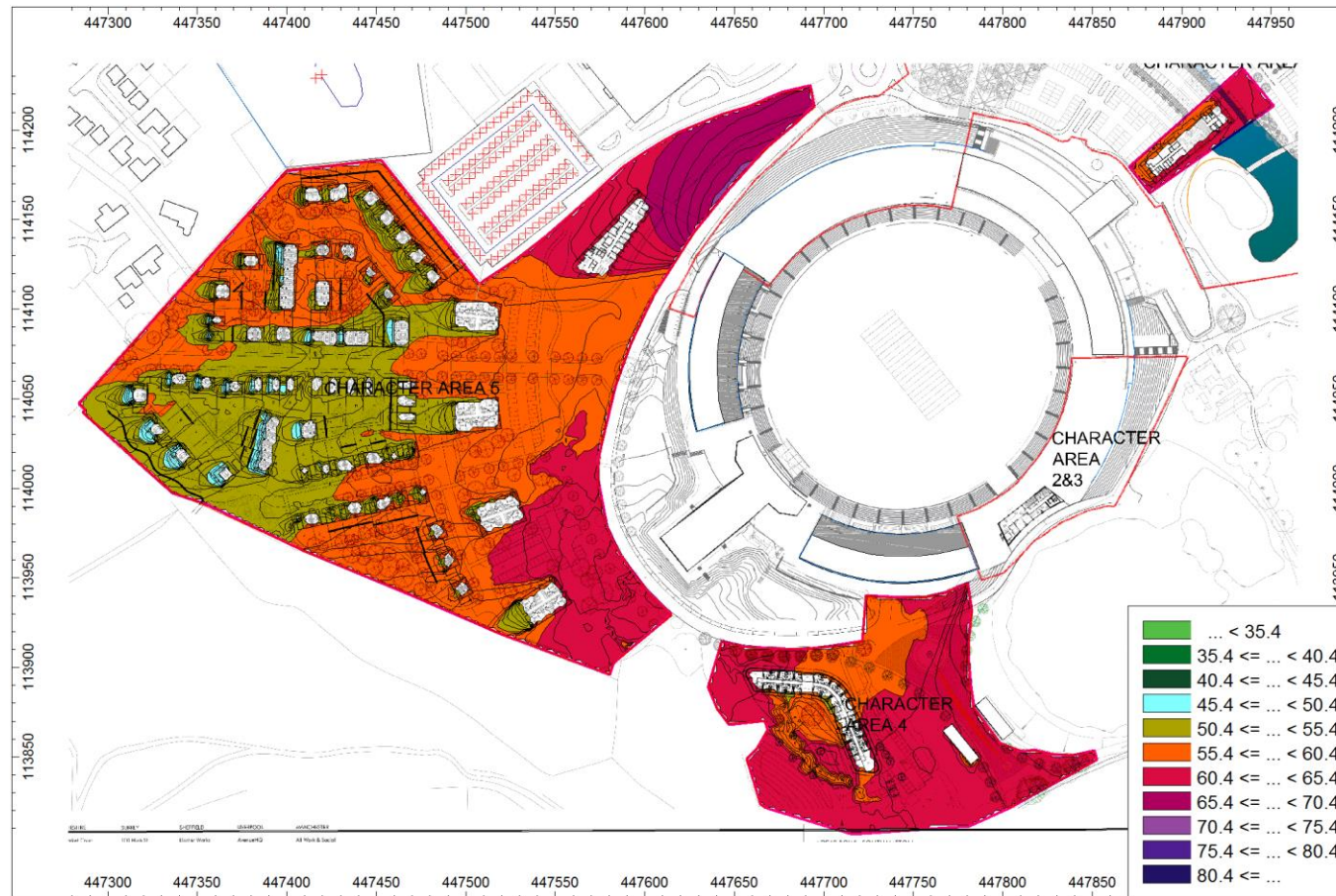


Figure G6: Predicted noise across the developed site during the daytime at third floor level (apartment blocks and independent living facility only)

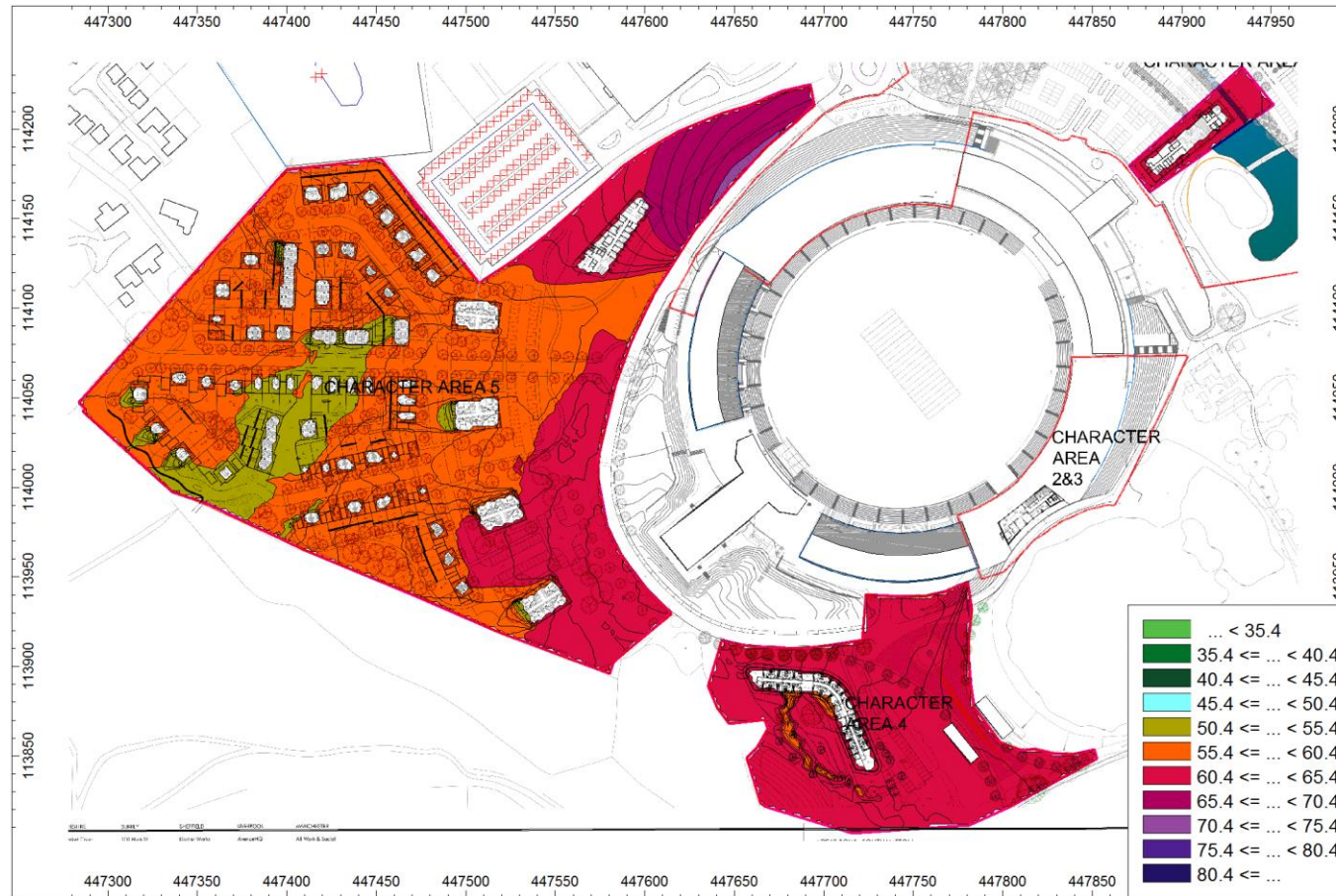


Figure G7: Predicted noise across the developed site during the daytime at fourth floor level (apartment blocks and independent living facility only)

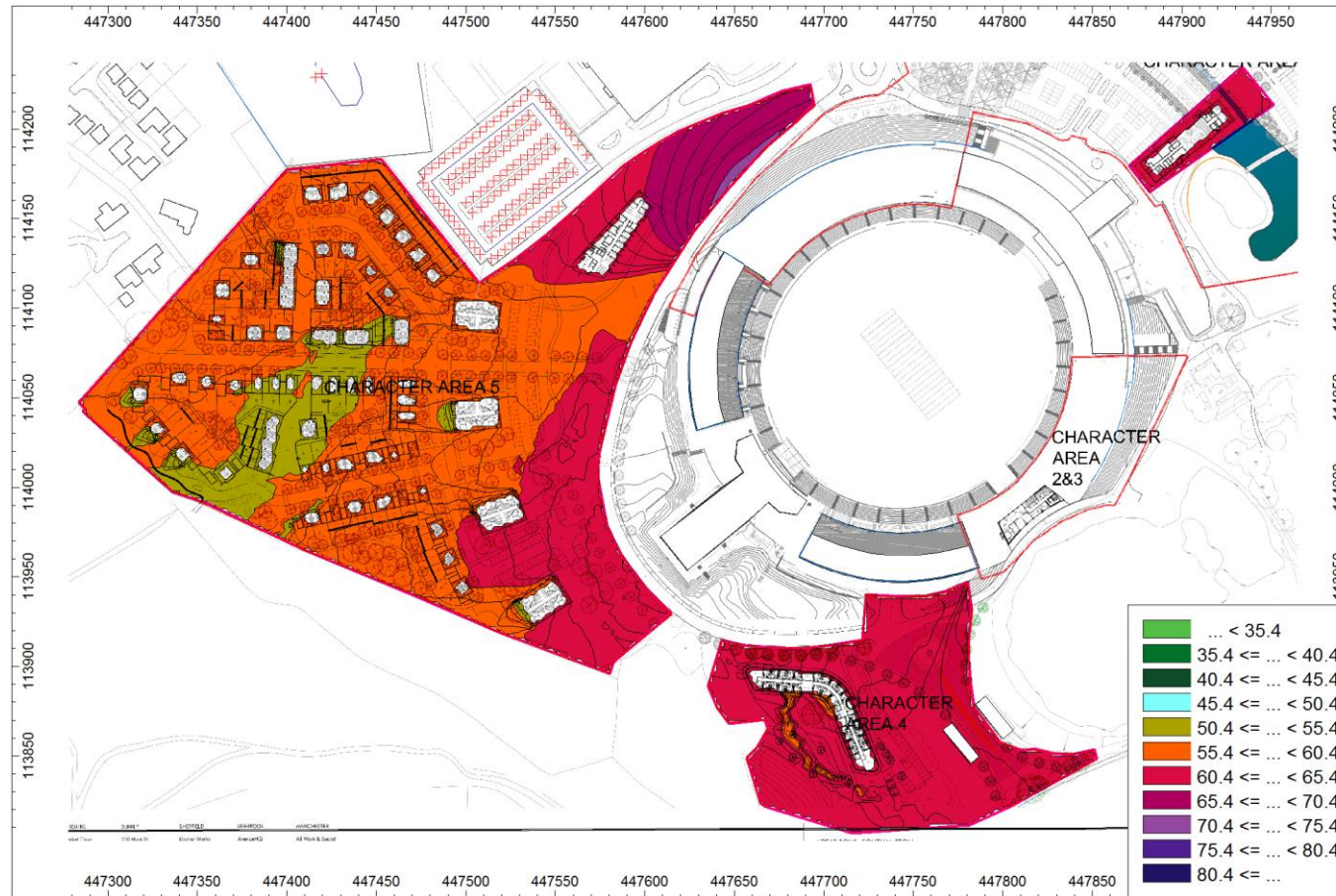


Figure G8: Predicted noise across the developed site during the night-time at ground floor level

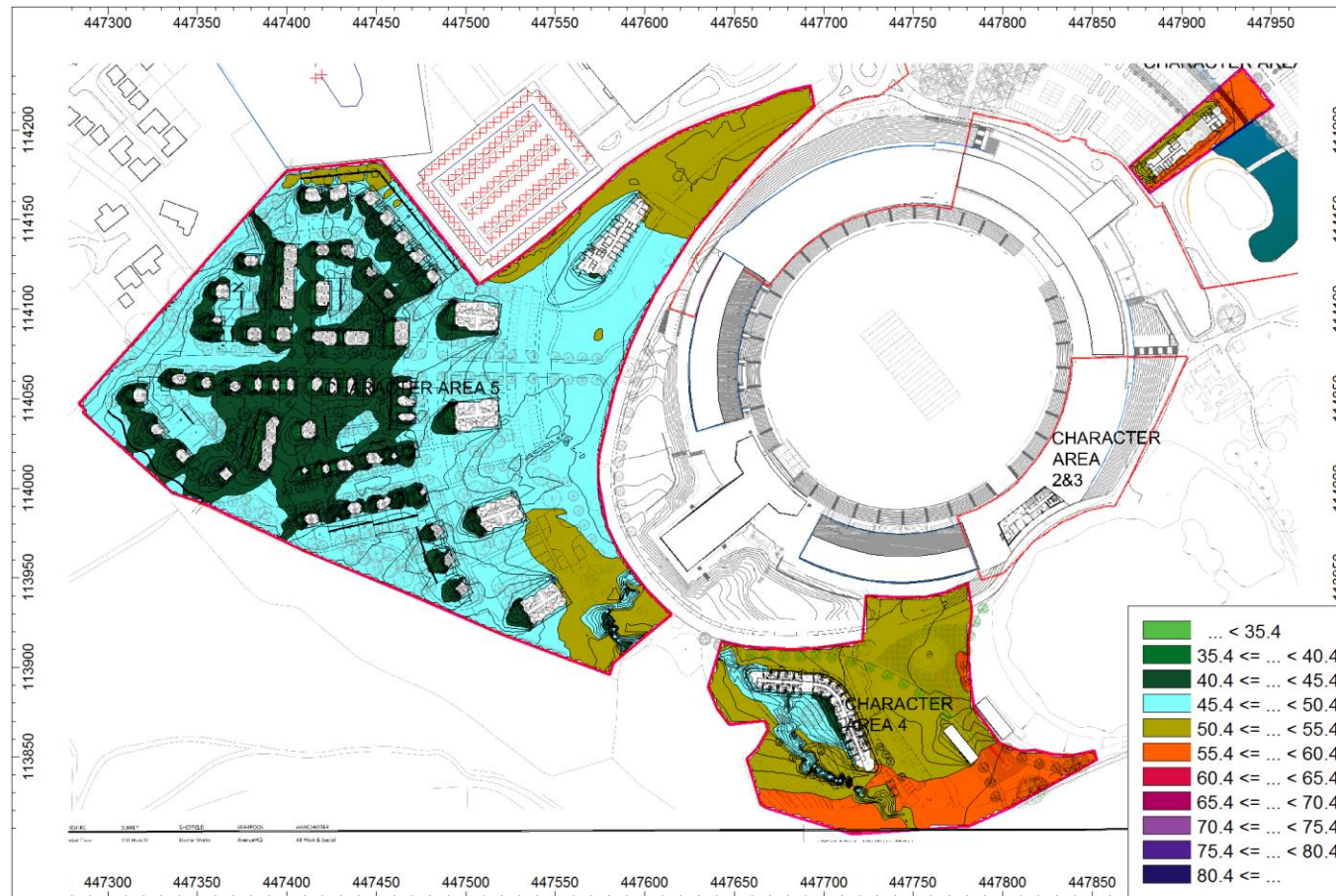


Figure G9: Predicted noise across the developed site during the night-time at first floor level

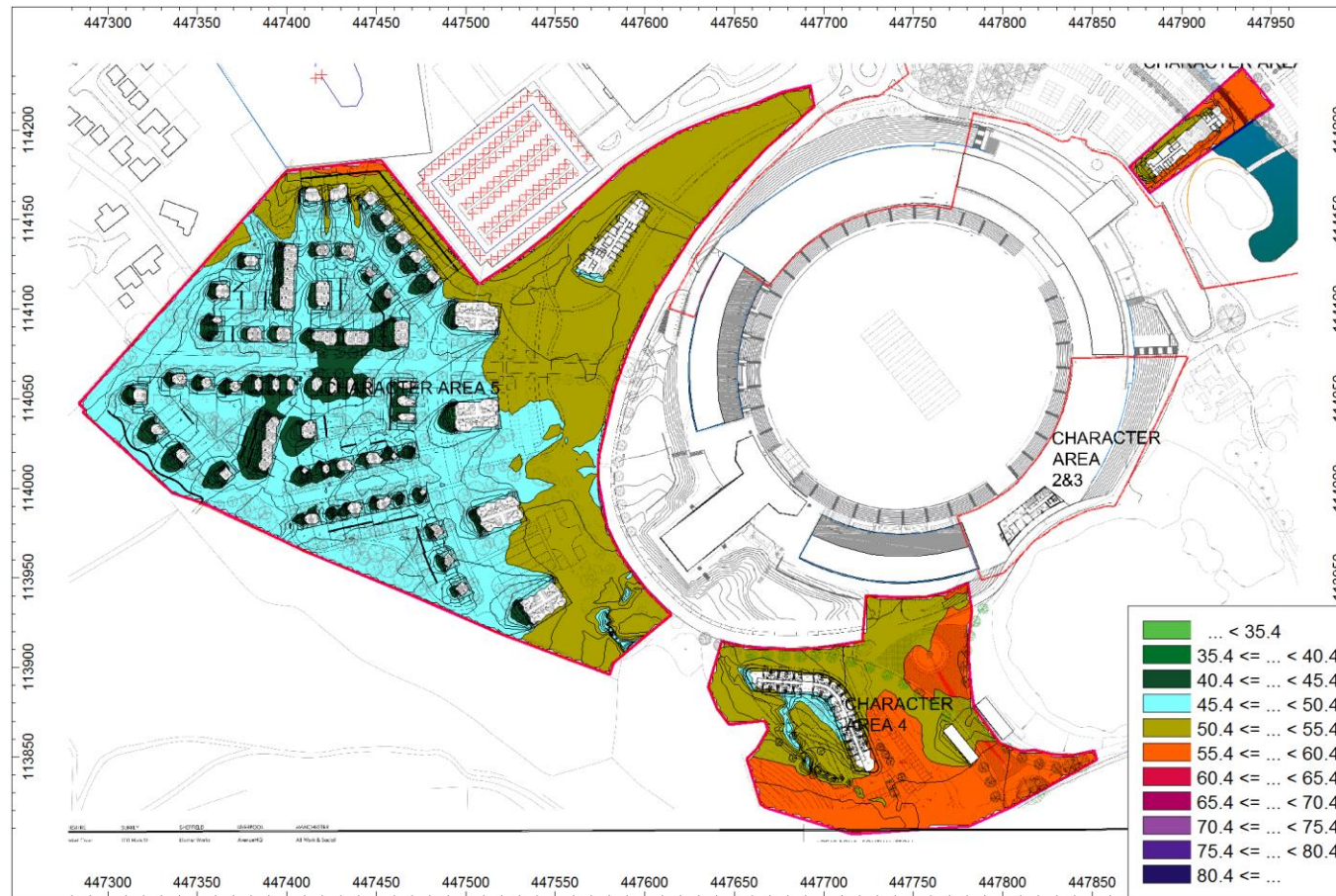


Figure G10: Predicted noise across the developed site during the night-time at second floor level

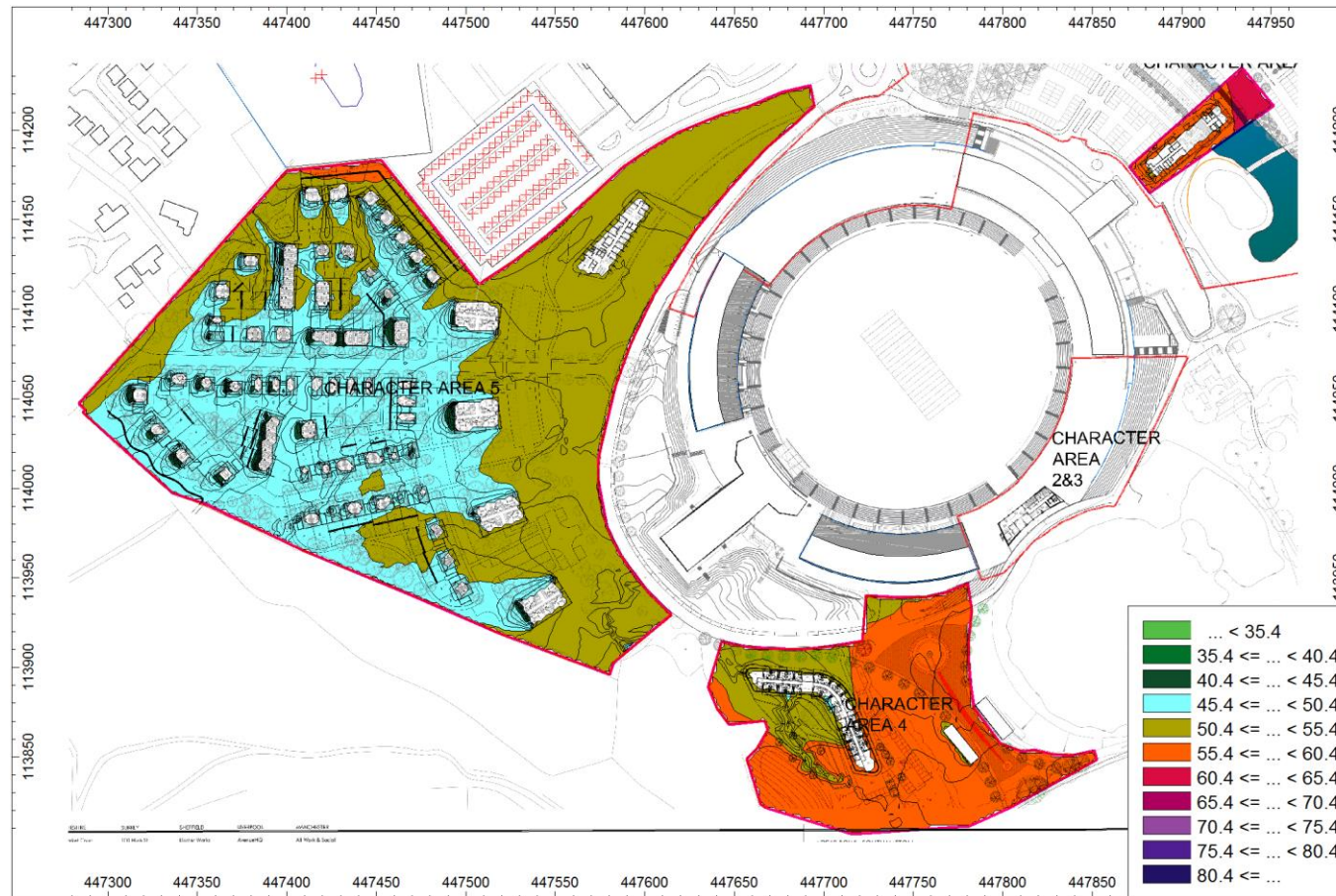


Figure G11: Predicted noise across the developed site during the night-time at third floor level (apartment blocks and independent living facility only)

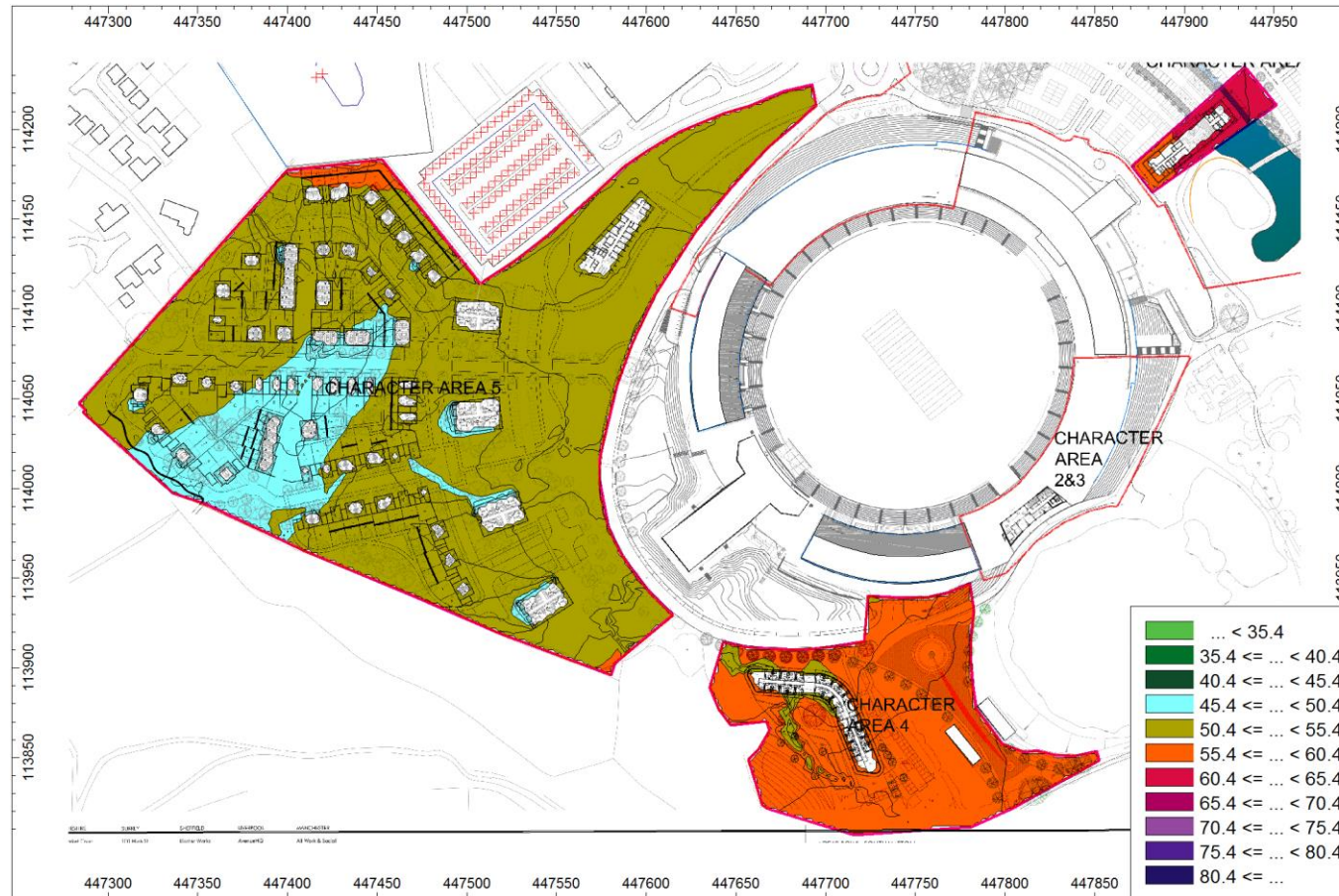
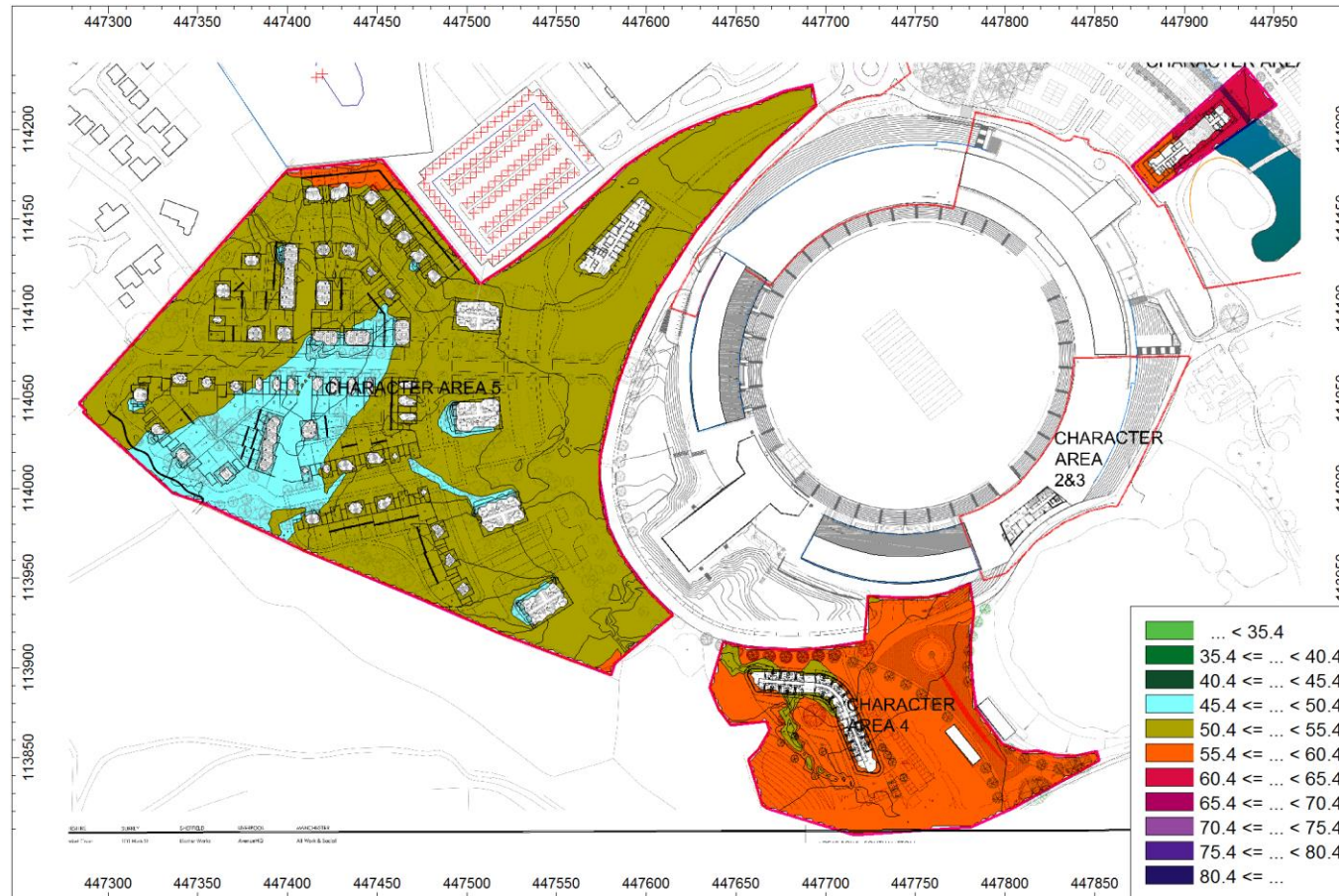


Figure G12: Predicted noise across the developed site during the night-time at fourth floor level (apartment blocks and independent living facility only)



Appendix H

PROPOSED GLAZING AND VENTILATION REQUIREMENTS

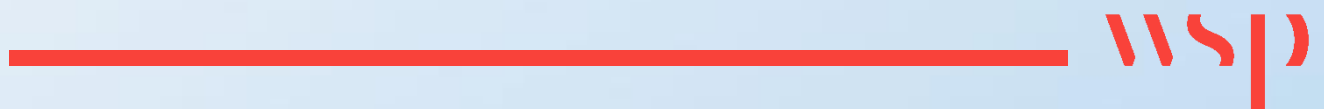


Figure H-1: Proposed glazing and ventilation performance requirements (ground floor level) (to be read in conjunction with Table 5-2 of the report)

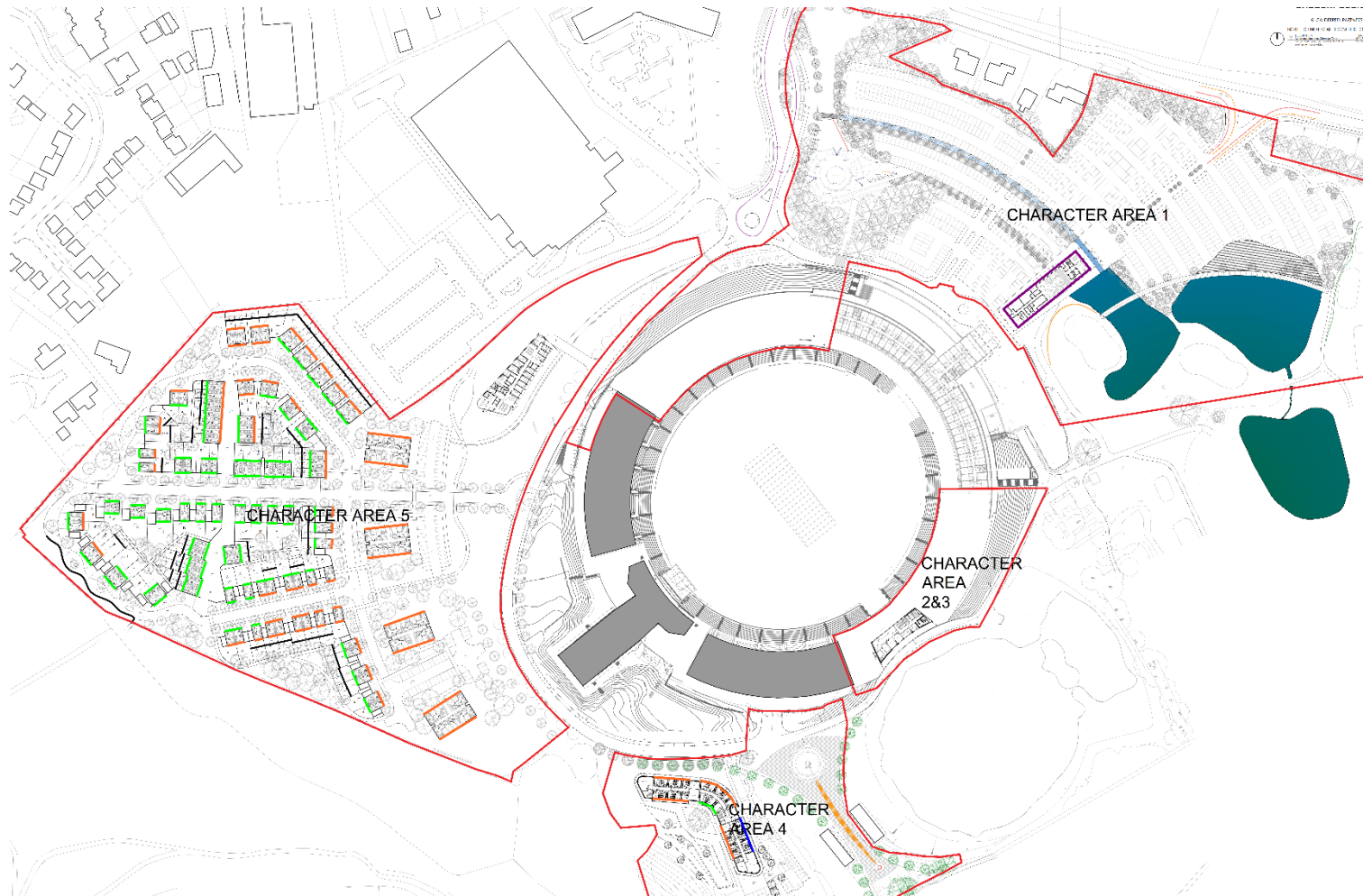


Figure H-2: Proposed glazing and ventilation performance requirements (first floor level) (to be read in conjunction with Table 5-2 of the report)

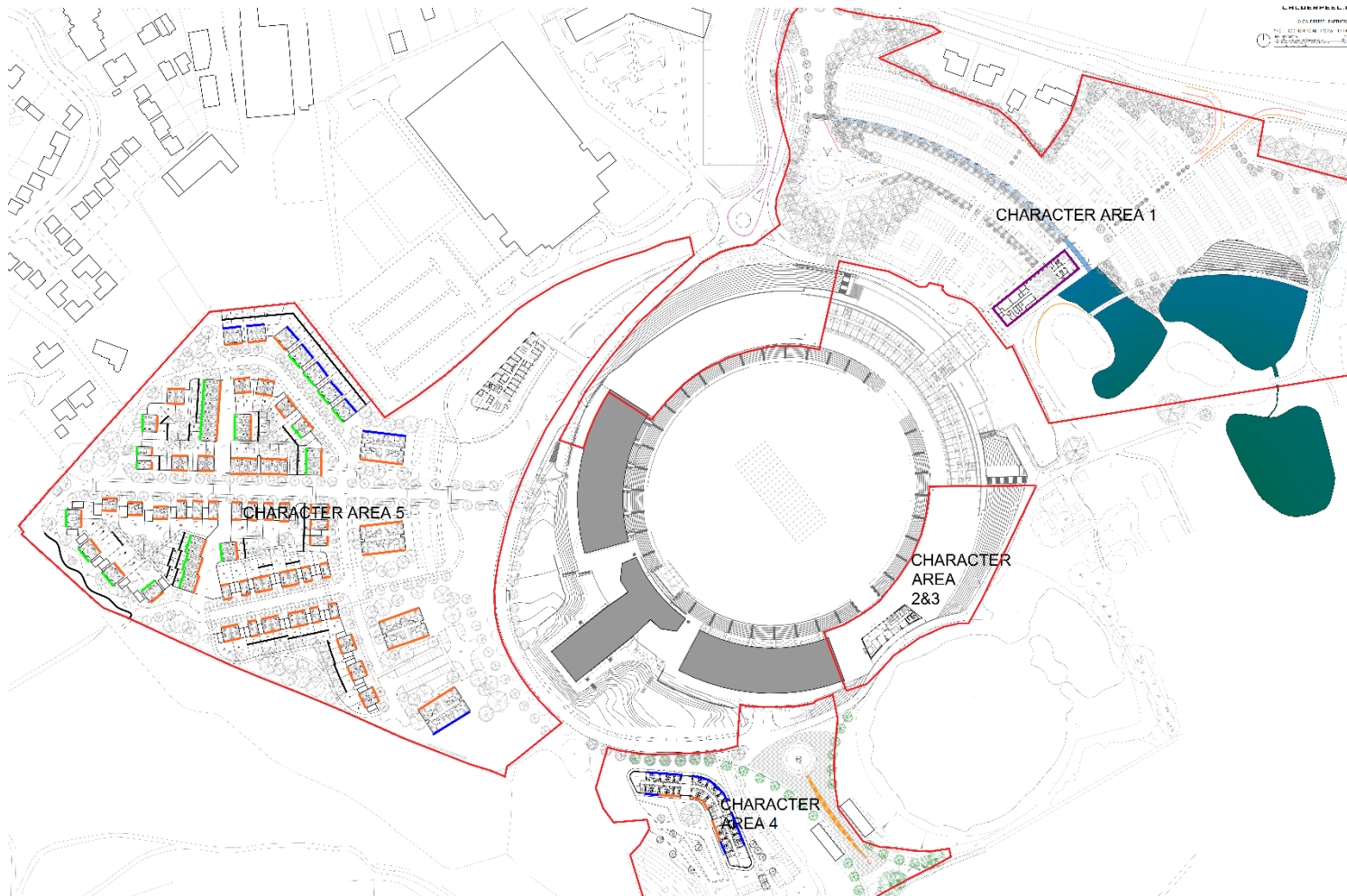


Figure H-3: Proposed glazing and ventilation performance requirements (second floor level) (to be read in conjunction with Table 5-2 of the report)

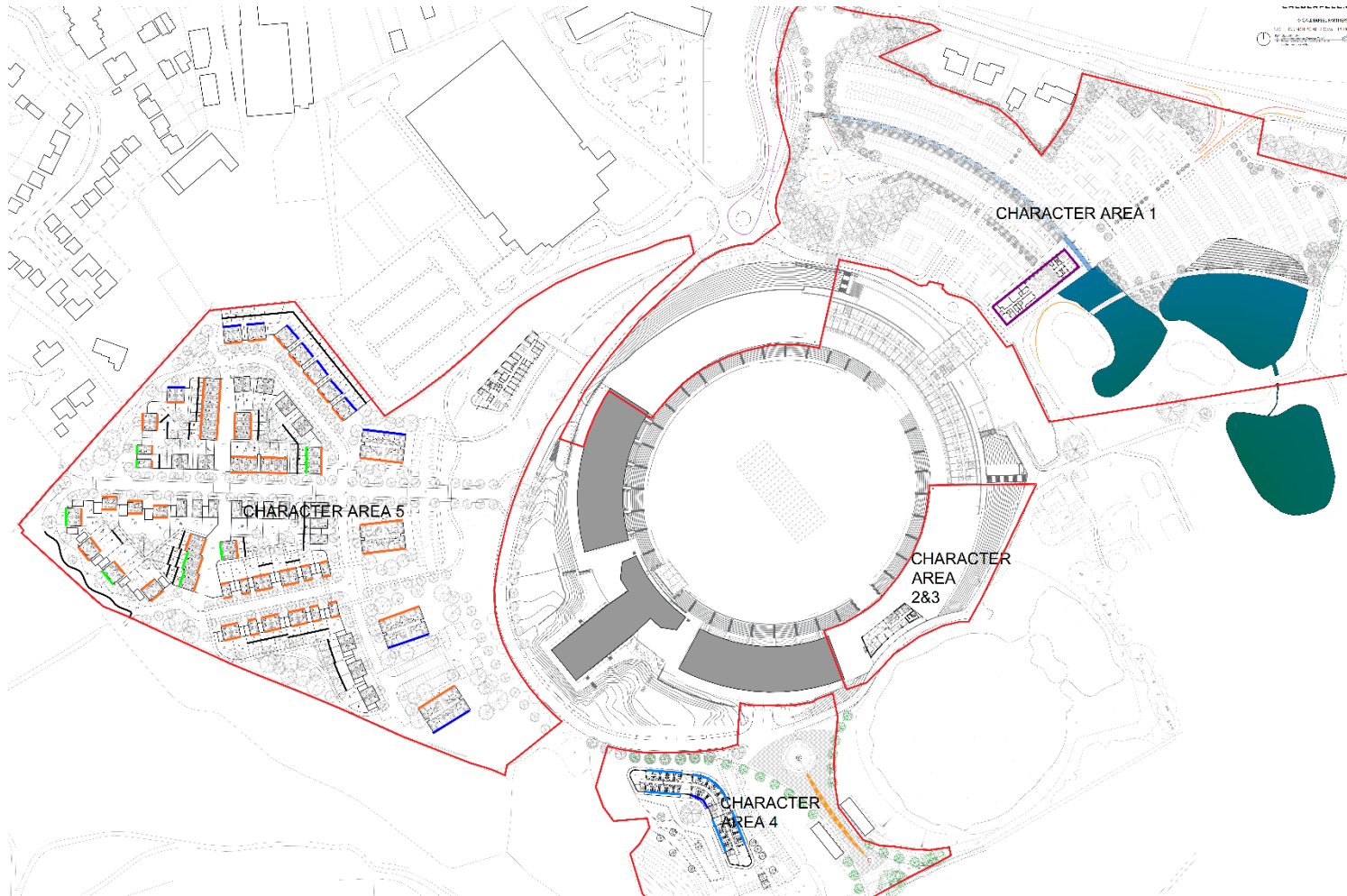


Figure H-4: Proposed glazing and ventilation performance requirements (third floor level) (to be read in conjunction with Table 5-2 of the report)

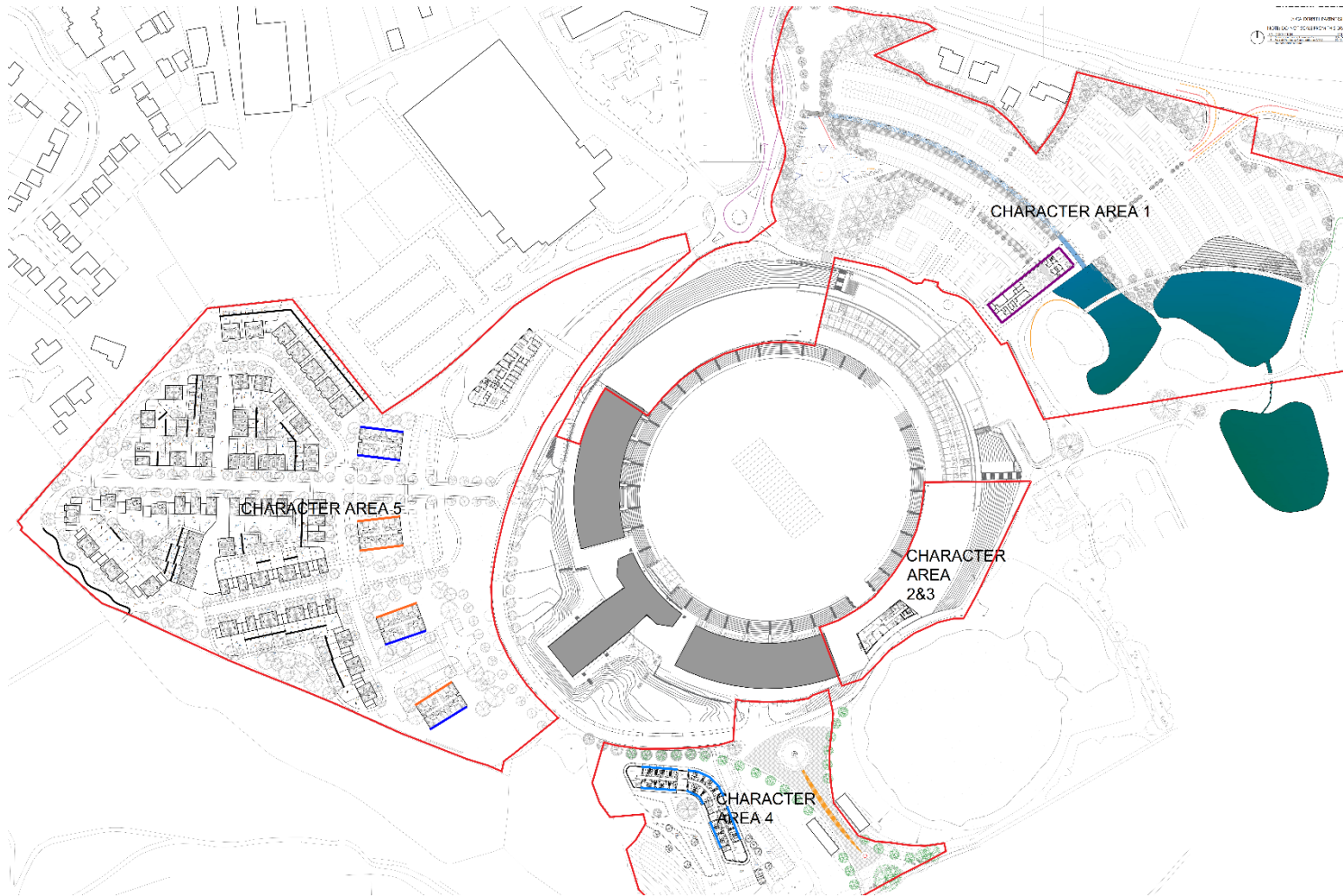
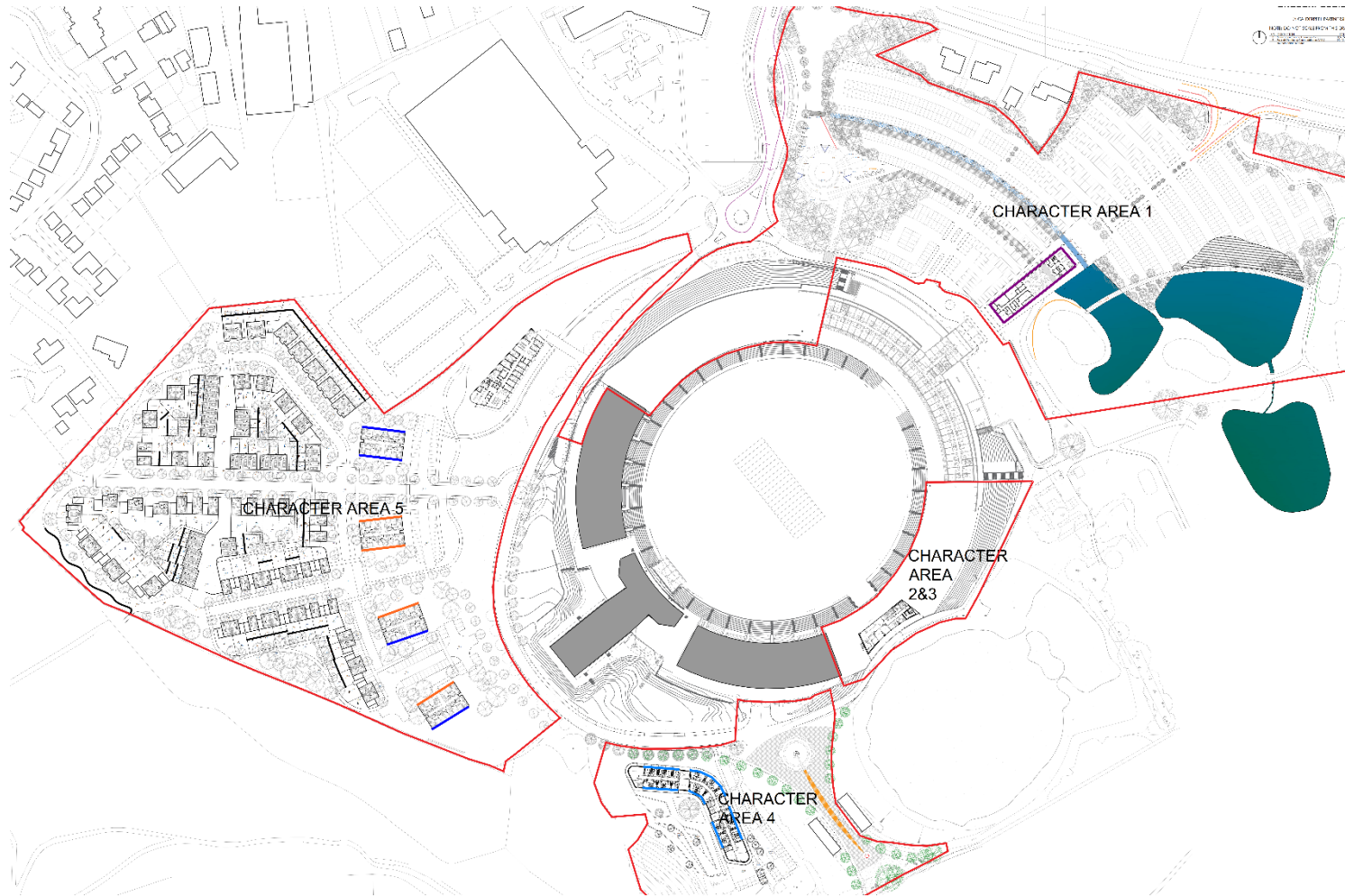


Figure H-5: Proposed glazing and ventilation performance requirements (fourth floor level) (to be read in conjunction with Table 5-2 of the report)





4th Floor
6 Devonshire Square
London
EC2M 4YE

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