Great Stone Road

Acoustic Design Statement, Vibration Assessment and Plant Noise Limits Report

Prepared For: Accrue (Forum) 1 LLP

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Executive Summary

-A noise and vibration assessment has been undertaken for the proposed residential development at the former B&Q site on Great Stone Road, Trafford, Manchester. The noise and vibration affecting the site has been assessed in accordance with ProPG, BS8233:2014, BS6472:2008 and BS4142:4142.

-Noise surveys have been undertaken at the site to determine the noise levels the site is currently subjected to.

-The predominant noise source affecting the site is road traffic noise along Great Stone Road.

-Results of the noise surveys show that the site falls into a Low to Medium noise risk when assessed in accordance with ProPG.

-A computer noise map has been created to predict the noise level at each facade and floor of the proposed development.

-Calculations demonstrate that the internal noise level recommendations in BS8233:2014 can be met via the use of double glazing and acoustically rated trickle vents.

-The results of the noise mapping show that the recommended noise levels for external amenity areas are met with the design with the exception of some of the balconies and a terrace which are discussed in detail in Section 4.3.

-Typical noise from the nearby cricket ground has been measured, assessed and discussed; a noise management plan for the future residents is proposed to address live music noise.

-A vibration survey has been undertaken to measure vibration associated with the tramline on the south eastern boundary of the site.

-Measurements and calculations show that the Vibration Dose Values (VDVs) are significantly below the 'Low Probability of Adverse Comment' levels in BS6472:2008.

-It is not possible to undertake a full plant impact assessment at this stage of the design. Plant noise limits based on the noise survey results have been set in this report.

-A full plant impact assessment should be undertaken as the design information become available.

-Following the guidance of ProPG it is recommended that 'Planning consent may be granted subject to the inclusion of suitable noise conditions'.

1.0 Introduction

1.0.1 Holtz Acoustics has been commissioned to undertake a noise and vibration assessment of the proposed development at Great Stone Road in Trafford.

1.0.2 The proposed development site is located south west of the Old Trafford Cricket Ground. A vacant commercial property (B&Q) is currently located at the site. There are proposals being submitted to replace this with residential buildings with resident's facilities and a small number of commercial and community units.

1.0.3 Great Stone Road is a 30mph road with moderate traffic flow. The Metrolink Altrincham tramline runs along the south eastern border of the site.

1.0.4 An annotated aerial view of the site in included in Appendix A.

1.0.5 The noise surveys, assessments and report have been prepared by James Patterson a Member of the Institute of Acoustics.

2.0 Guidance

2.1 National Planning Guidance

2.1.1 The National Planning Policy Framework[1] (NPPF) states that planning policies and decisions should aim to:

- Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development.

-Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions,

-Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land use since they were established.

-Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

2.1.2 The NPPF refers to an explanatory note, the Noise Policy Statement for England[2] (NPSE). The NPSE sets out a Noise Policy Vision to

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

[1] Department for Communities and Local Government, National Planning Policy Framework 2019
[2] DEFRA, Noise Policy Statement for England, March 2010

2.1.3 The NPSE states the long term vision is supported by the following aims.

-Avoid significant adverse impact on health and quality of life

-Mitigate and minimise adverse impacts on health and quality of life

-Where possible, contribute to the improvement of health and quality of life.

2.1.4 The NPSE does not refer to specific noise criteria but sets out concept of a 'Significant Observed Adverse Effect Level' (SOAEL). This is the level above which significant adverse effects on health and quality of life occur.

2.1.5 The NPSE states '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 receptor 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 provide the necessary policy flexibility until further evidence and suitable guidance is available.'

2.2 Trafford Council Guidance

2.2.1 We have had informal discussions with an Environmental Health Officer (EHO) at Trafford Council regarding the typical requirements for an acoustic report relating to residential development near roads and tram lines.

2.2.2 It was discussed that an assessment in accordance with the new ProPG guidance would be appropriate and should demonstrate that the internal noise level recommendations in BS8233:2014 can be achieved.

2.2.3 Regarding plant noise, an assessment in accordance with BS4142:2014 was recommended.

2.3 Pro PG Guidance

2.3.1 Professional Practice Guidance on Planning & Noise[3] (ProPG) has been produced to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England.

2.3.2 Pro PG recommends that for noise concerning new residential development a two stage assessment approach is used.

-Stage 1 – an initial noise risk assessment of the proposed development site. If the noise risk is above 'negligible' then Stage 2 should be completed and compiled into an Acoustic Design Statement.

[3] Working Group, ProPG: Planning and Noise, May 2017

-Stage 2 – a systematic consideration of four key elements.

-Element 1 – demonstrating a 'Good Acoustic Design Process'

-Element 2 – observing internal 'Noise Level Guidelines'

-Element 3 – undertaking an 'External Amenity Area Noise Assessment'

-Element 4 – consideration of 'Other Relevant Issues'

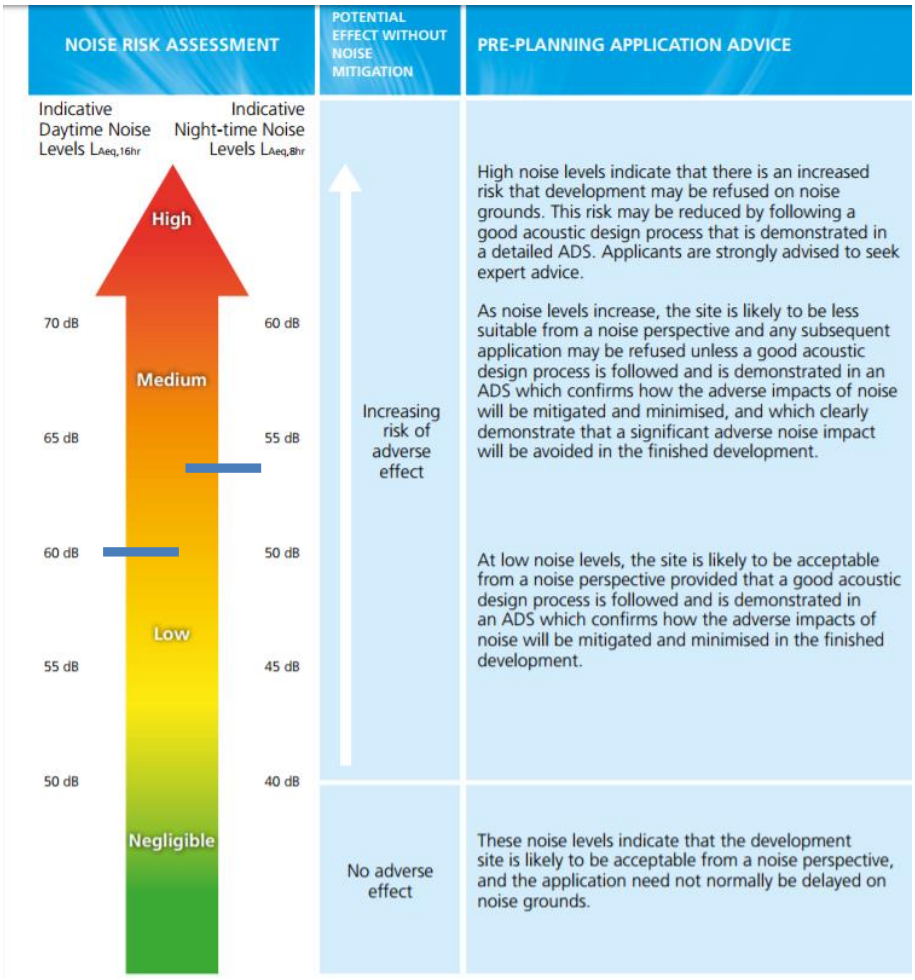
3.0 Stage 1 Initial Site Noise Risk Assessment

3.0.1 Pro PG recommends that an initial site noise risk assessment is undertaken before a planning application is submitted. This should provide an indication of the likely risk of adverse effects from noise.

3.0.2 The risk assessment should indicate whether the proposed site is considered to pose a negligible, low, medium or high risk from a noise perspective.

3.0.3 Figure 1 below (from Pro PG) shows how an initial noise risk assessment is linked with an increasing risk of adverse effect from noise.

Figure 1. Initial Site Noise Assessment taken from Pro PG



3.0.4 In order to determine the noise levels the proposed residential dwellings will be subject to an extensive noise survey and noise mapping procedure has been undertaken, the methodology and results of which are included in the following sections.

3.1 Noise Survey Methodology

3.1.1 Attended and unattended measurements have been taken over an extended period at the existing site. An unattended survey was undertaken between the 7th and 8th of November 2017 and an additional attended survey of cricket noise was undertaken on the 5th of June 2018. Survey times and methodology are included in Appendices B and C.

3.1.2 The 24 hour unattended survey was undertaken at a position on the flat roof of the existing B&Q building. The location was chosen due to good exposure to road traffic noise from Great Stone Road and due security concerns with leaving equipment in an accessible location.

3.1.3 Simultaneous measurements were taken throughout the day at various receiver locations around the site.

3.1.4 Survey equipment and methodology is included in Appendix B.

3.1.5 The survey results have been used to calibrate a noise map and establish the underlying background noise level in the vicinity for used in setting plant noise limits.

3.2 Noise Survey Results

3.2.1 A full schedule of results is included in Appendix C. A summary of results is included in Tables 1 below.

Table 1: Summary of ambient noise survey results, survey position shown in Appendix A.

Daytime L_{Aeq} (dB) (0700hrs-2300hrs)	Night time L_{Aeq} (dB) (2300hrs-0700hrs)
60	54

3.2.2 A noise map has been created to determine the noise levels on each façade and level of the proposed building.

3.2.3 Results from the surveys have been used to calibrate the source noise level from the road and tramline in order that the noise maps accurately predicts the noise levels incident on the proposed building.

3.2.4 The noise map was produced using SoundPlan software, first a map of the existing site was created with the road and tram noise source levels adjusted to match the survey results.

3.2.5 A second map with the proposed building included was then made. This map predicts the noise level at each façade, each level and at external amenity spaces. The procedure was repeated for both the daytime and night-time averages.

3.2.6 A summary of the predicted levels is in included in Table 2 below. Due to the high number of façade and floor combinations highest predicted noise level on each façade has been shown.

Table 2: Summary of predicted ambient noise levels and each façade of the proposed building.

Facade	Highest Predicted Daytime L_{Aeq} (dB) (0700hrs-2300hrs)	Floor where this was predicted	Highest Predicted Night time L_{Aeq} (dB) (2300hrs-0700hrs)	Floor where this was predicted
S-W Elevation Road Side	65	GF	59	GF
S-W Elevation High Level Set Back	59	7th	53	7th
S-E Elevation	61	4th	55	4th
N-W Elevation	63	5th	57	5th
N-E Elevation	56	8th	50	8th

3.2.7 Graphical representations of the noise map are included in Appendix D.

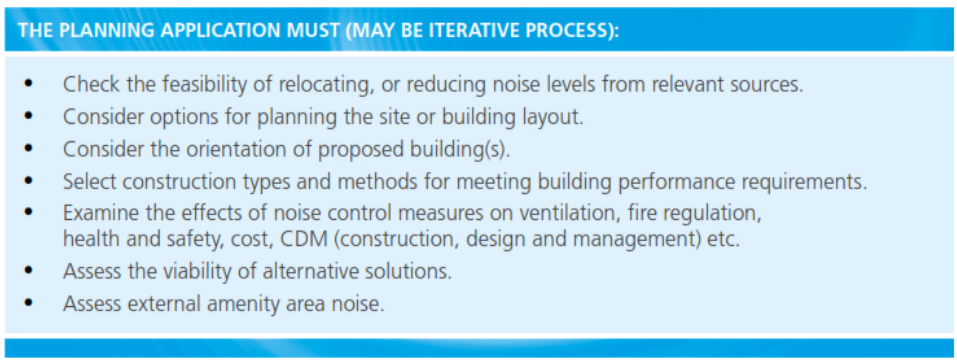
3.2.8 The measured levels from the survey have been marked on Figure 1. As can been seen the noise levels generally fall into the Low to Medium risk category, therefore a Stage 2 assessment has been undertaken.

4.0 Stage 2 Assessment

4.1 Good Acoustic Design Process

4.1.1 ProPG emphasises good acoustic design during the early stages of the scheme design. No specific criteria are given to demonstrate good acoustic design however the following checklist is given in Figure 2.

Figure 2. Good Acoustic Design Checklist, taken from ProPG



4.1.2 The above checklist has been addressed during the design process and the following comments have been made.

-The dominant noise sources are road traffic noise and tram noise, neither of which can be relocated or reduced.

-The building mass has been located as far as possible from the road given the size requirements of the development.

-There are residential flats scheduled for every façade therefore orientation of the building does not affect the number of proposed flats affected by road traffic noise.

-Non-residential spaces are less noise sensitive and have been located on the facade facing the road.

-The building mass is designed around two 'courtyards' which benefit from screening from the Great Stone Road building façade. This will result in quieter facades facing the courtyard and maximises the number of dwellings that can use open windows whilst achieving the recommended internal noise levels.

-The building mass design introduces quieter external amenity spaces inside the two 'courtyard' areas due to the screening offered by the building mass.

4.2 Internal Noise Level Guidelines

4.2.1 British Standard Code of Practice BS8233:2014[4] 'Guidance on sound insulation and noise reduction for buildings' provides recommended internal noise criteria for residential dwellings. The ambient noise levels in domestic building should not normally exceed the design ranges in Table 3 below.

Table 3. Indoor ambient noise levels for dwellings taken from BS8233:2014

Activity	Location	0700hrs-2300hrs	2300hrs-0700hrs
Resting	Living room	35 dB $L_{Aeq,16hour}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hour}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

4.2.2 ProPG states that most residents value the ability to open windows at will and therefore it is suggested that, if possible, the target internal noise levels are met with open windows. ProPG suggests that the insulation through open windows should be no more than 10 to 15dB(A)

4.2.3 ProPG states that where the LPA accepts that there is a justification that the internal target noise levels can only be practically achieved with windows closed, which may be the case in

[4] Guidance on sound insulation and noise reduction for buildings, BSI, 2014

urban areas and at sites adjacent to transportation noise sources internal noise levels can be assessed with closed windows provided that adequate background ventilation is provided.

4.2.4 Internal noise levels have been calculated using the methodology included in BS8233:2014. It has been assumed that the sound insulation of the building fabric is significantly higher than the glazing or ventilation. Therefore the design onus is on the glazing and ventilation. A summary of the calculation results are included in Table 4 below.

Table 4. Summary of internal noise calculations

Façade	Calculated noise level at façade (no façade correction) (Day/Night)	Ventilation	Glazing	Calculated internal level during the Day L_{eq} dB(A)	Calculated internal level at night L_{eq} dB(A)
S-W Elevation Road Side	65/59	Trickle Vents min $D_{ne,w}$ = 34dB	Standard Double Glazing R_w=35dB	35	30
S-W Elevation High Level Set Back	59/53	Trickle Vents min $D_{ne,w}$ = 26dB	Standard Double Glazing R_w=35dB	35	29
S-E Elevation	61/55	Trickle Vents min $D_{ne,w}$ = 30dB	Standard Double Glazing R_w=35dB	34	28
N-W Elevation	63/57	Trickle Vents min $D_{ne,w}$ = 31dB	Standard Double Glazing R_w=35dB	35	29
N-E Elevation	56/50	Trickle Vents min $D_{ne,w}$ = 26dB	Standard Double Glazing R_w=35dB	33	26

4.2.5 An example calculation has been included in Appendix E.

4.2.6 Pro PG and BS8233:2014 recommend that an L_{Amax} level of 45dB from single noisy events is not regularly exceeded in bedrooms at night. Not 'regularly exceeded' is detailed at no more than 10 incursions over a given night.

4.2.7 As trams run past 2300hrs an assessment of L_{Amax} levels from tram passes has been made. Tram passes were measured at the boundary of the site in the same location as the vibration survey. The highest recorded tram pass was 67dB(A), this will be a similar level to tram passes at the façade of the proposed building.

4.2.8 Given the acoustically rated trickle vents detailed in Table 4 the calculated level is well below 45dB(A) for an individual tram pass.

4.2.9 The same procedure was followed for L_{Amax} events from the road affecting the road façade and the results were also well below the 45dB(A) criterion.

4.3 External Amenity Area Noise Assessment

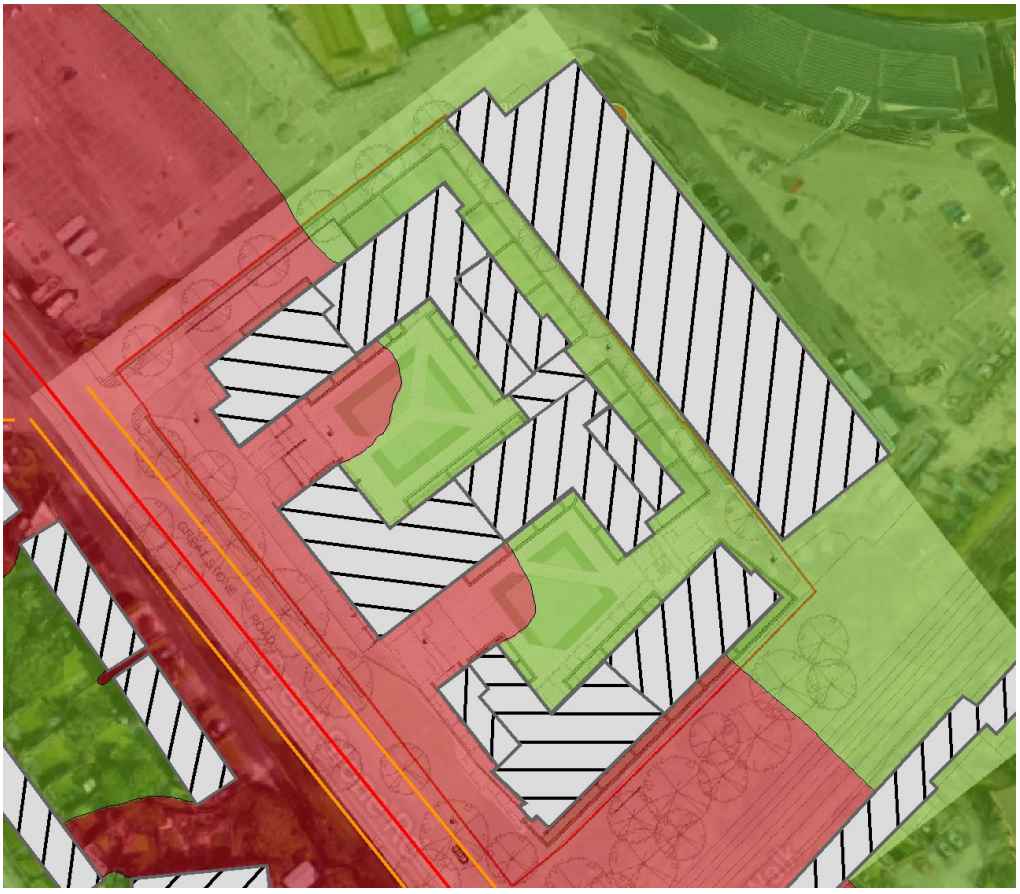
4.3.1 BS8233:2014 states that 'the acoustic environment of external amenity areas that are an intrinsic part of the overall design should always be assessed and noise levels should ideally not be above the range 50-55 dB $L_{Aeq,16hr.}$

4.3.2 There are external amenity areas in the proposed scheme, these are the outdoor spaces located within the courtyard areas at the centre of the proposed building and roof terraces at high level.

4.3.3 The ground floor outdoor areas benefit from partial acoustic screening from the building mass. Figure 3 demonstrates that the vast majority of the courtyard areas will be under 55 dB $L_{Aeq,16hr}$. The green areas shown are below 55 dB and the red areas are above 55dB.

4.3.4 The majority of the roof terraces are set back from the roadside façade, the highest daytime noise level calculated on such a roof terrace was 53 dB $L_{Aeq,16hr}$.

Figure 3. Courtyard noise map



4.3.5 The balconies on the Great Stone Road façade, balconies on part of the north and tramline facades and the smaller roof terrace on the Great Stone Road facade will exceed the 50-55 dB $L_{Aeq,16hr}$ criterion.

4.3.6 ProPG states that if this is the case then the impact may be partially off-set if the residents are provided with access to: 'a relatively quiet, protected, nearby, external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings'.

4.3.7 The aforementioned spaces in 4.3.2 would fit this criterion.

4.4 Assessment of Other Relevant Issues

4.4.1 The proposed development will be within 100m from Old Trafford Cricket Ground. In addition to hosting cricket matches the cricket ground has a license to host live music events.

4.4.2 It is understood from the license agreement that these are limited to 7 a year. However based on previous and upcoming schedules there are typically only 1 or 2 a year.

4.4.3 It will not be possible to fully mitigate live music noise through scheme design and the extent to which residents are disturbed by one off concerts is likely to be linked to their sensitivity to noise.

4.4.4 We have therefore included proposals for a noise management plan for the development, details are to be confirmed but this is likely to take to form of the building management providing early warning of concert dates to residents so they are fully informed.

4.4.5 It should be noted that the building mass of the development will provide acoustic screening to existing properties on the opposite side of the site from the Old Trafford Cricket Ground and thereby reduce the noise levels from concerts in these areas.

4.4.6 A noise survey to determine the noise levels from a typical cricket match has been undertaken. Noise levels were measured at the location shown in Appendix A during a one day match between Lancaster and Yorkshire.

4.4.7 A sample of typical noise levels measured is shown below. These will be similar to the levels experience at the rear façade of the proposed development.

Table 6. Summary of measurements.

Event	$L_{Aeq,10secs}$ (dB)	Comments
Underlying ambient level	43	No audible distinct events
Applause from crowd	48	
Applause and cheering after wicket	53	
PA system	56	Used to announce change of bowler and incoming outgoing batsmen. No music

4.4.8 Noise from these individual events matches that of the predicted road noise on the rear façade, therefore the scheme design recommended in Table 4 has included uprated trickle vents to reduce the cumulative noise exposure to below the BS2833:2014 guidelines.

4.4.9 Depending on the final background noise levels in the apartments individual noise events from the cricket ground may be audible, albeit at a low level, with the windows closed particularly the PA system and visitors in close proximity to the rear façade.

4.4.10 When averaging the measurements taken during the survey over a 8 hour match on a typical 16 hour day the $L_{Aeq,16hour}$ rises to 48dB. This is a marginal increase on the predicted level from road traffic noise alone but the trickle vent and glazing design will ensure there is no additional impact on match days (over the 16 hour daytime period).

5.0 Vibration Assessment Criteria

5.0.1 The Metrolink Altrincham tramline runs along the south eastern border of the proposed site. The Old Trafford tram stop is located approximately 200m to the north east of the site.

5.0.2 Trams run between 0524hrs and 2348hrs Monday to Thursday and 0524 to 0048hrs on Fridays and Saturdays and 0629 to 2348hrs on Sundays and bank holidays, based on a 2018 timetable.

5.0.3 Railway vibration affecting buildings is usually assessed using BS 6472-Part 1:2008[5]. BS 6472 evaluates the disturbance due to vibration by using a vibration dose value (VDV).

5.0.4 The VDV metric uses the duration, total number and the level of vibration events to generate a single figure value for vibration exposure over a set time period. The likelihood of adverse comment as a result of various VDV value ranges is shown below in Table 7.

[5] Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting, BSI, 2008

Table 7. VDV ranges from BS6472

Location and Time Period	Low Probability of Adverse Comment $ms^{-1.75}$	Adverse Comment Possible $ms^{-1.75}$	Adverse Comment Probable $ms^{-1.75}$
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

5.1 Vibration Survey Methodology

5.1.1 A series of manned vibration measurements were undertaken at the boundary of the site. Vibration levels were measured in three orthogonal axes (X,Y,Z) with a tri-axial accelerometer.

5.1.2 The equipment and survey methodology used is shown in Appendix B. VDV measurements were taken over a 1 hour period, the calculation procedures in BS6472 have been used to determine the daytime and night time VDVs in each axis.

5.1.3 The accelerometer was placed in the tarmac of the existing parking area to maximise coupling with the ground. This location was as close to the tram line as possible and would represent the worst case vibration that the site is exposed to.

5.2 Vibration Survey Results

5.2.1 A summary of the VDV results are shown below in Table 8.

Table 8. Summary of Measured VDV Over 1 Hour

Time Period	Horizontal Axis (X) VDV	Horizontal Axis (Y) VDV	Vertical Axis (Z) VDV	Vector Sum
0700hrs-2300hrs	0.004	0.005	0.008	0.047

5.2.2 Vibration from tram passes was subjectively imperceptible during the survey period.

5.2.3 BS6472 states that where the vibration conditions are constant or repeated regularly, only one representative sample, of duration τ seconds, needs to be measured. If the vibration dose value determined is VDVb/d, τ will be given by the following equation.

$$\mathrm{VDV_{b/d,day}} = \left(\frac{t_{\mathrm{day}}}{t_{\tau}}\right)^{0.25} \times \mathrm{VDV_{b/d,\tau}}$$

Where: t_{day} is the duration of exposure per day (s)

5.2.4 The following VDVs over the operation period of the tramline have been calculated using the equation in 5.2.3

Table 9. Summary of Calculated VDV Over Tram Operation Period (0715-1930)

Time Period	Horizontal Axis (X) VDV	Horizontal Axis (Y) VDV	Vertical Axis (Z) VDV	Vector Sum
0700hrs-2300hrs	0.008	0.009	0.014	0.070

5.2.5 All of the calculated VDV results are significantly under the 'Low Probability of Adverse Comment' criteria in BS6472.

6.0 Plant Noise Limits

6.0.1 There will be items of fixed plant associated with development. Currently it is proposed that these are located in the basement level plant room on the N-E side although this may be subject to change as the detailed design progresses.

6.0.2 Plant noise affecting residential premises is usually assessed using BS4142:2014[6] 'Rating and assessing industrial and commercial sound'.

6.0.3 The BS4142:2014 assessment methodology relies on comparing the existing background noise level at the existing receivers with the noise level produced by the new plant. Corrections are also used to account for the natures of the new noise source (tonality, impulsive etc.)

6.0.4 As details of the proposed plant equipment and final locations are not available at this stage of the design, noise limits based on the assessment methodology of BS4142 will be set in this document which should not be exceeded by future plant equipment.

6.0.5 The noise survey detailed in Section 3 will be used to determine the background noise level in the vicinity of the new development.

6.0.6 The representative background noise levels measured of the 24 hours survey period are summarised in Table 10 below. The method of determining the representative levels is detailed in Appendix F.

Table 10. Summary of background noise survey results.

Period	Representative Background Noise Level L_{A90} dB
Daytime (0700-2300hrs)	58
Night-time (2300-0700hrs)	44

[6] Methods for rating and assessing industrial and commercial sound, BSI, 2014

6.0.7 BS4142 assesses the impact of a new plant noise source on existing noise sensitive receivers by subtracting the measured background sound level from the rating level and considering the following.

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

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

-A difference of around +5dB 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 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.

6.0.8 The rating level must take into account the characteristic of the new noise source including tonality, impulsivity, intermittency and other sound characteristics.

6.0.9 It is recommended that the rating level does not exceed the background sound level.

6.0.10 Detailed plant specification are not available at this stage of the design. Once plant details are available these should be assessed to show that they do not exceed the representative background levels.

7.0 Recommendations

7.0.1 Following the ProPG approach will lead to the choice of one of four possible recommendations form the noise practitioner to the decision maker.

A. Planning consent may be granted without any need for noise conditions;

B. Planning consent may be granted subject to the inclusion of suitable noise conditions;

C. Planning consent should be refused on noise grounds in order to avoid significant adverse effects)”avoid”); or

D. Planning consent should be refused on noise grounds in order to prevent unacceptable adverse effects (“prevent”).

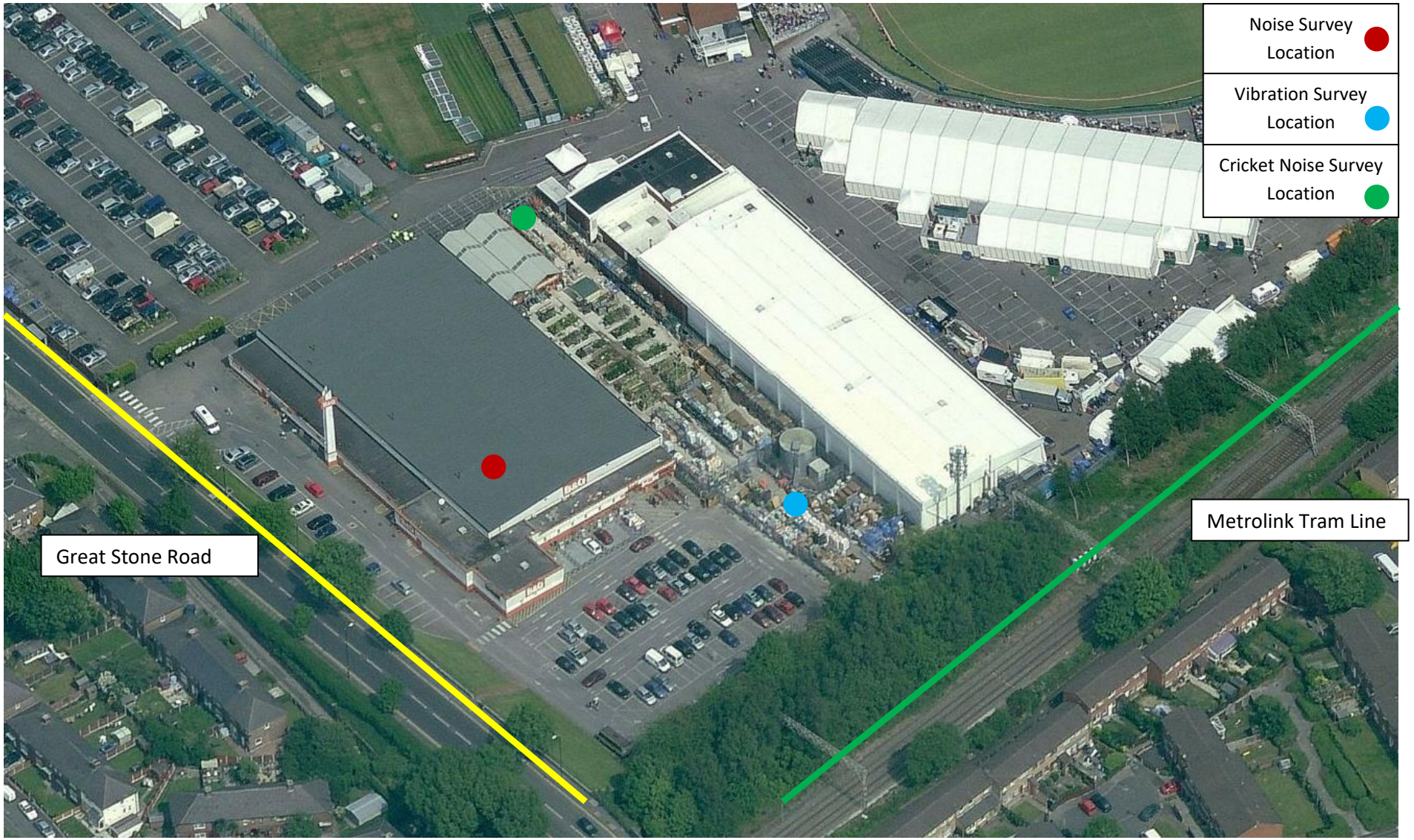
7.0.2 This report demonstrates that the internal noise levels in BS8233:2014 can be comfortably met provided suitable facade ventilation is used.

7.0.3 The report also demonstrates that vibration levels affecting the site are significantly below the recommended levels in BS6472:2008.

7.0.4 The report also sets plant noise limits based on BS4142:2014 guidance, a full assessment should be undertaken once plant details are available.

7.0.5 It is therefore recommended that 'Planning consent may be granted subject to the inclusion of suitable noise conditions'.

Appendix A – Site Plan



Appendix B – Survey Equipment

All equipment was calibrated before and after the survey period and no significant drifts from calibration were recorded.

Item	Manufacturer	Type	Serial Number
Sound Level Meter	Rion	NL-52	00643058
Preamplifier	Rion	NH-25	43086
Microphone	Rion	UC-59	06838
Calibrator	Rion	NC-74	34546657
Windshield	Rion	WS-15	na
Tri-axial Vibration Meter	Rion	XP-2V	na
High Sensitivity Accelerometer x 3	Rion	PV-87	na

Calibration certificates available on request.

The noise survey position was deemed to capture the dominant noise source affecting the development, road traffic noise along great Stone Road.

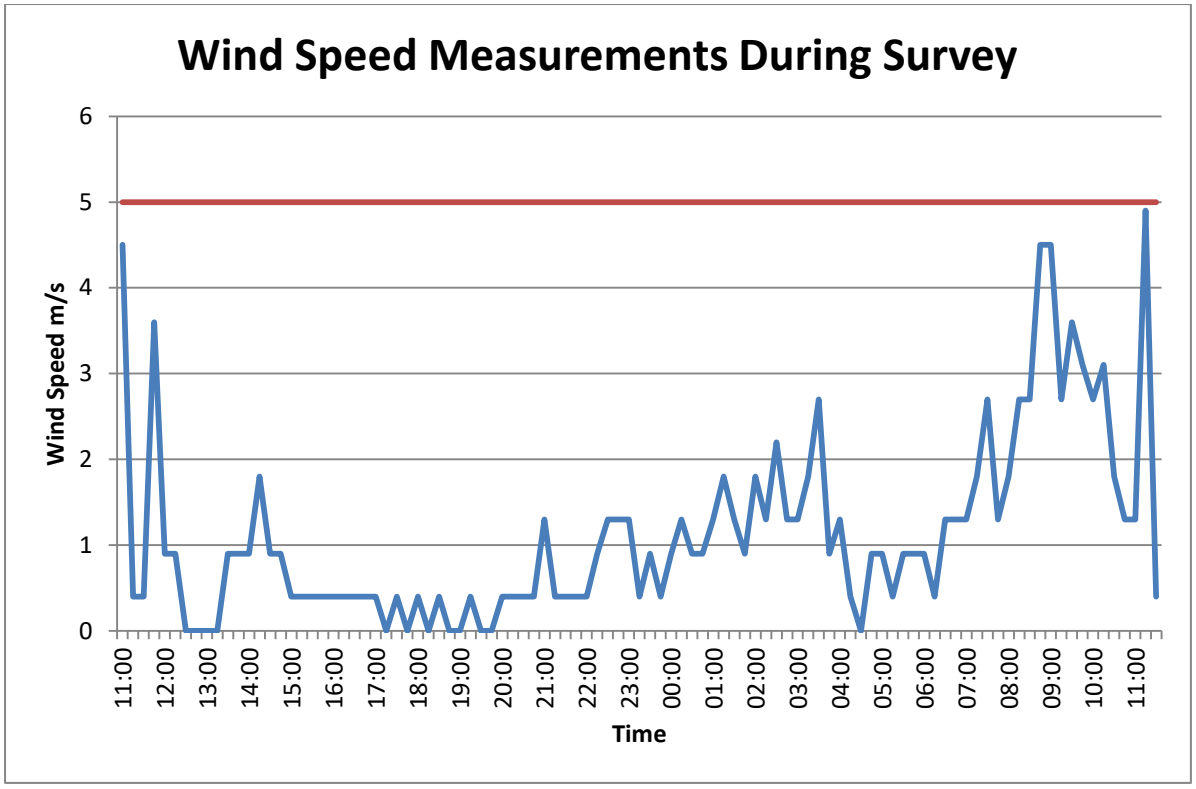
The unmanned measurements were taken at roof level of the existing building (for security reasons). The equipment was set up to integrate noise levels over a 5 minute period and record the L_{Aeq}, L_{A10}, L_{A90} and L_{Amax} levels. The monitoring positions were approximately representative of the 'Free Field' acoustic level at the measurement point.

A weather station was set up to monitor weather during the survey period. A summary of the weather results is shown in the graphs below.

Vibration measurements were taken at the site boundary nearest the tramline.

The survey was undertaken by James Patterson between the 7th and 8th of November 2017.

Weather conditions were generally clear and calm with light winds on the morning of the 8th. There was light rain overnight leading to very light surface water on the roads, rain was not sufficient for the weather station to measure.


Wind Speed Measurements During Survey
Wind Speed m/s
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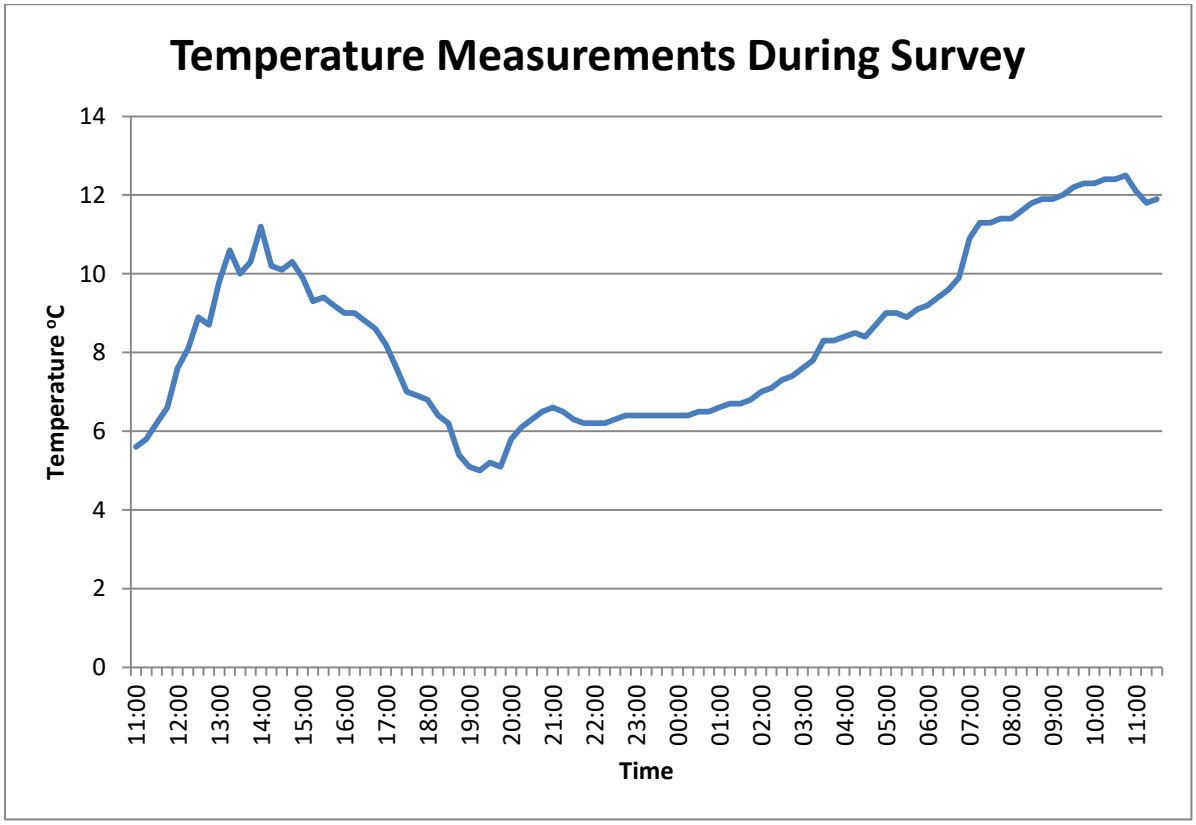
Temperature Measurements During Survey
Temperature °C
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Appendix C – Table of Survey Results

Time	L_{Aeq}	L_{A90}	L_{eq}							
			63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
10:50:00	60	56	62	58	55	53	57	53	45	36
10:55:00	59	49	62	54	53	51	56	53	48	45
11:00:00	59	51	62	59	55	52	56	52	44	38
11:05:00	59	54	62	59	56	52	56	52	44	32
11:10:00	59	51	61	55	53	51	56	53	45	33
11:15:00	58	53	61	57	52	51	55	52	43	31
11:20:00	60	53	62	58	53	53	57	53	45	35
11:25:00	58	48	59	54	52	51	55	52	44	33
11:30:00	59	54	61	57	52	51	57	53	44	32
11:35:00	60	54	61	55	53	52	57	53	45	32
11:40:00	59	52	61	54	52	51	56	53	44	32
11:45:00	60	51	61	55	51	51	57	53	44	32
11:50:00	61	54	65	59	54	54	58	54	46	34
11:55:00	58	53	61	53	51	50	55	51	43	30
12:00:00	60	49	62	54	52	52	57	54	45	33
12:05:00	60	51	62	53	52	51	57	53	44	31
12:10:00	59	53	63	55	52	52	57	53	44	31
12:15:00	59	50	62	53	51	51	56	52	44	32
12:20:00	59	53	61	52	51	51	56	52	43	30
12:25:00	59	54	62	53	52	52	57	53	44	32
12:30:00	59	50	60	52	51	51	56	52	43	31
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12:40:00	61	54	62	59	55	53	58	54	46	35
12:45:00	59	51	61	54	52	51	56	52	44	31
12:50:00	60	51	62	56	53	52	57	53	45	33
12:55:00	59	52	61	55	53	51	56	53	44	31
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13:10:00	59	51	62	54	53	52	56	53	44	32
13:15:00	60	54	61	58	53	53	57	54	45	33
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13:25:00	59	54	62	53	52	51	56	53	44	31
13:30:00	59	54	64	57	54	52	56	52	43	31
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14:00:00	60	55	64	57	56	53	57	54	45	34
14:05:00	60	55	62	52	50	52	57	54	45	38
14:10:00	60	54	60	52	50	52	58	54	44	32

14:15:00	59	52	62	56	49	51	57	53	44	32
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14:25:00	60	53	62	54	50	52	58	54	45	33
14:30:00	59	53	60	52	49	50	56	52	43	31
14:35:00	59	55	60	53	49	51	57	53	44	32
14:40:00	60	55	63	54	50	52	57	54	45	37
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17:20:00	61	58	64	54	52	53	59	55	47	37
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21:25:00	57	50	59	58	49	50	54	50	41	28
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21:35:00	57	49	61	54	51	51	54	50	40	28
21:40:00	58	51	60	54	52	51	56	52	43	30
21:45:00	58	50	62	54	50	51	56	52	42	30
21:50:00	56	48	60	53	49	50	53	49	40	28
21:55:00	57	48	59	52	49	50	54	50	41	29
22:00:00	57	49	61	53	50	50	54	50	42	29
22:05:00	57	49	62	54	50	50	54	50	41	30
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00:40:00	52	44	57	51	46	46	50	46	37	26
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01:00:00	52	44	55	59	45	45	50	45	35	24
01:05:00	50	44	56	56	45	45	46	42	33	22
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01:15:00	49	43	59	53	45	44	45	41	33	21
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01:45:00	51	43	56	51	46	45	48	44	36	26
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02:25:00	51	40	53	48	44	44	48	44	35	24
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02:40:00	43	42	54	48	44	42	37	26	16	14
02:45:00	42	41	54	48	44	42	37	25	15	14
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02:55:00	49	43	56	50	46	44	46	42	34	23
03:00:00	47	43	56	49	45	44	42	39	30	21
03:05:00	48	42	51	47	44	43	44	40	31	21
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04:50:00	49	45	57	50	47	45	46	40	32	23

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05:00:00	51	44	57	50	46	46	48	43	33	22
05:05:00	50	44	56	49	46	45	47	43	36	27
05:10:00	51	45	58	51	47	46	48	44	37	27
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06:20:00	55	49	59	54	50	49	52	47	40	33
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07:25:00	60	52	61	55	52	52	57	53	46	40
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07:40:00	61	55	64	59	53	54	58	54	47	41
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07:55:00	63	59	65	58	54	55	60	56	49	42
08:00:00	61	58	63	56	52	54	59	55	47	40
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08:15:00	61	59	64	57	54	54	58	55	47	40
08:20:00	61	58	65	57	53	54	59	55	47	40
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08:30:00	62	58	64	58	54	55	59	55	47	40

08:35:00	62	58	66	57	54	54	59	56	49	42
08:40:00	61	56	66	57	53	54	59	55	46	38
08:45:00	62	59	66	58	54	55	59	56	48	39
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08:55:00	62	58	65	57	53	54	59	55	47	38
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09:10:00	60	55	65	61	55	54	58	54	45	36
09:15:00	60	55	64	59	53	54	58	54	46	37
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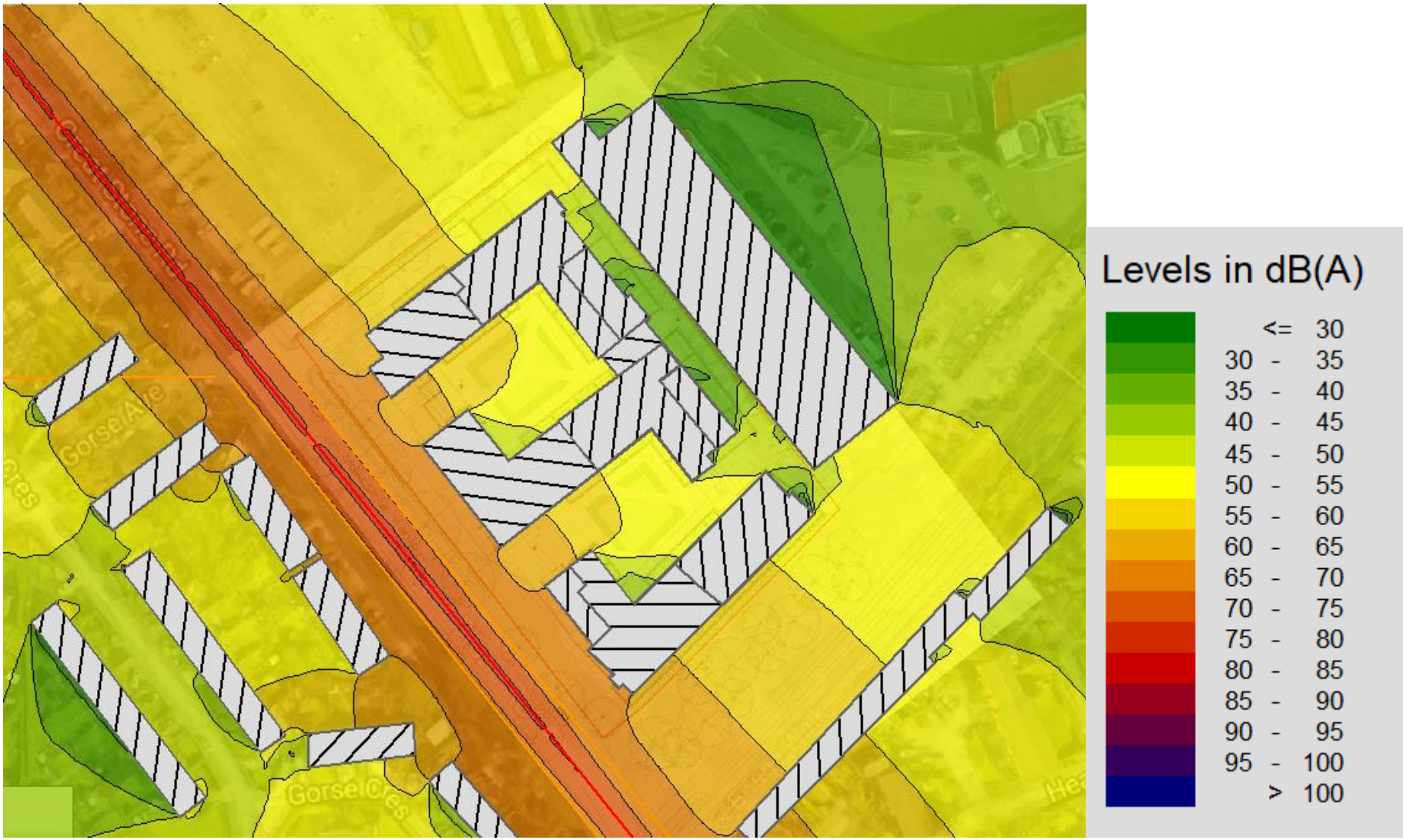
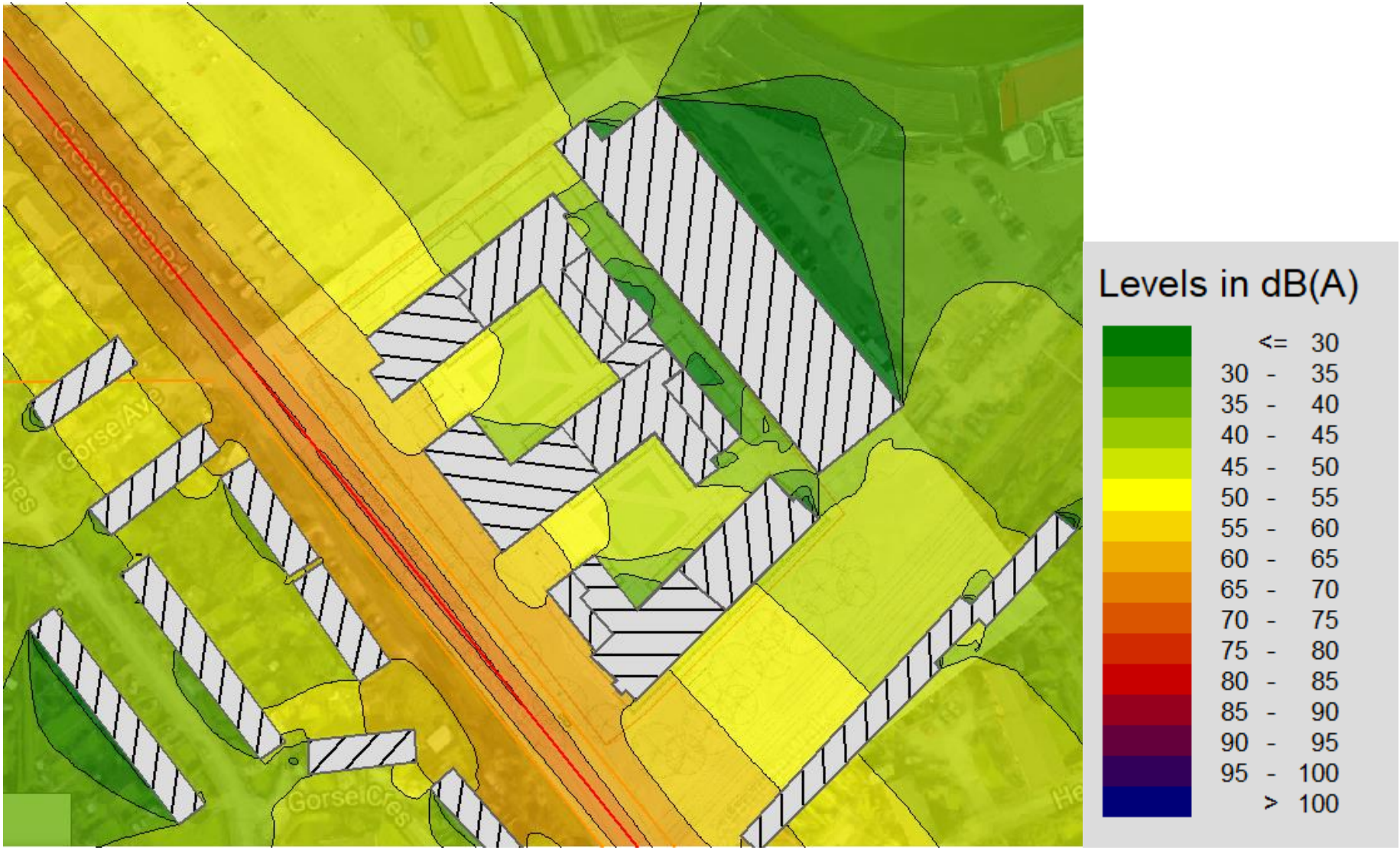
09:25:00	60	57	63	55	51	53	58	54	45	35
09:30:00	60	55	62	56	52	53	58	54	46	36
09:35:00	60	56	62	56	52	53	57	54	45	35
09:40:00	60	53	63	55	51	53	57	53	45	35
09:45:00	60	56	63	55	52	53	57	54	48	43
09:50:00	61	56	63	56	52	53	58	55	50	45
09:55:00	61	56	63	55	53	53	57	54	49	44
10:00:00	60	55	64	56	52	53	57	54	48	43
10:05:00	60	55	64	55	52	52	57	54	48	42
10:10:00	60	56	63	55	52	53	57	54	48	41
10:15:00	60	57	64	58	54	53	56	54	48	41

Appendix D – Graphics From Noise Map

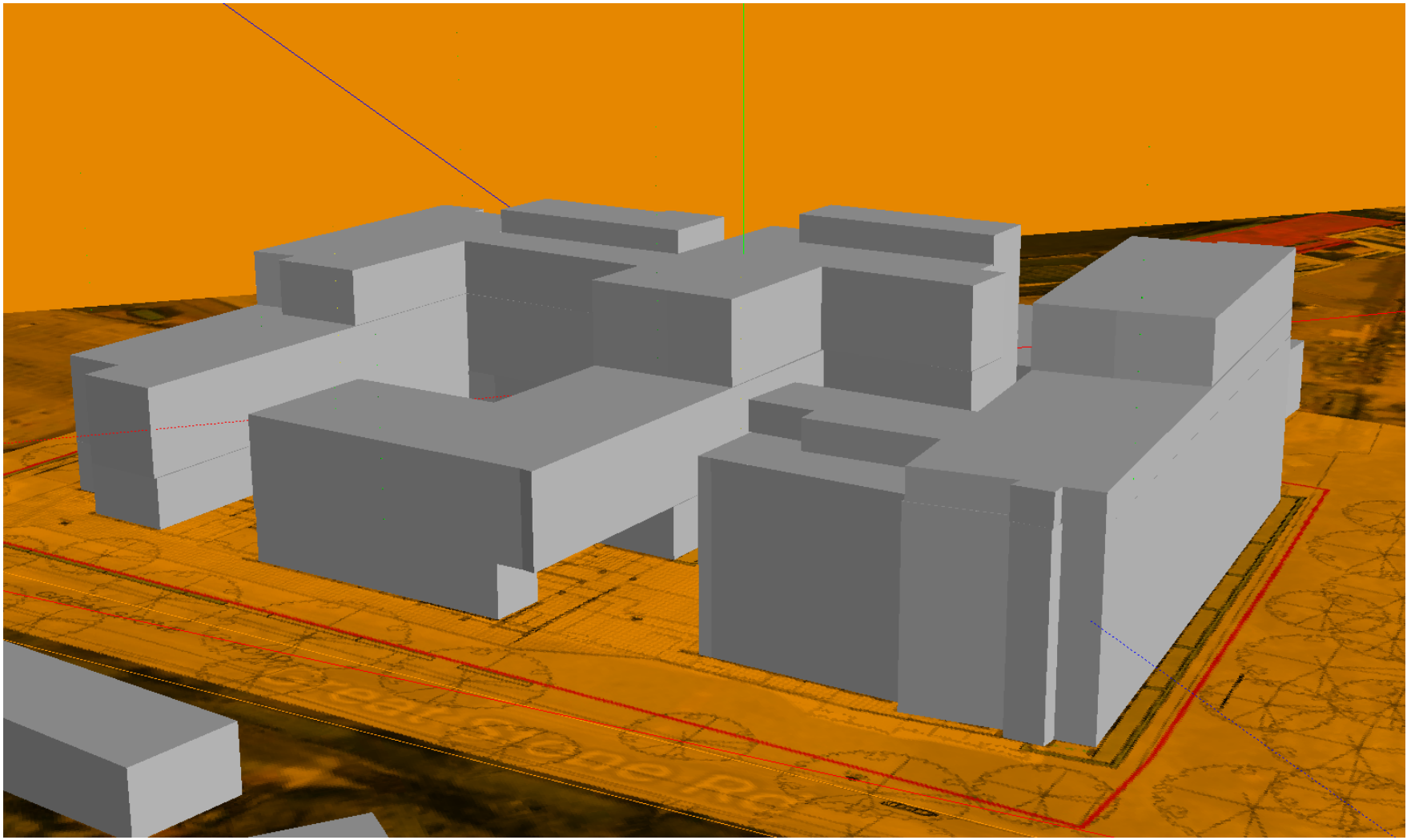
Daytime Noise Map of Proposed Development



Night-time Noise Map of Proposed Development



Building massing used in noise map.



Appendix E – Example Internal Noise Calculation

Data used in the calculation of the noise level inside a room

Terms that are frequency dependent

Term	Description	Single Figure Rating	Octave Band Centre Frequency (Hz)								A-weighted
			63	125	250	500	1000	2000	4000	8000	
$L_{eq,ff}$			60	54	50	50	52	49	40	23	55
$D_{n,e}$	Trickle Vent	30	35	32	31	30	31	29	28	28	30
R_{wi}	Double glazing	34	22	19	19	37	44	44	51	55	34
R_{ew}	Brick wall	49	30	35	40	45	50	55	55	55	49
R_{rr}	Ceiling	0	0	0	0	0	0	0	0	0	0
A			14	14	14	14	14	14	14	14	

Terms that are not frequency dependent

Term	Derivation	Value
S_f	Façade area (including window)	15.00 m2
S_r	Roof area (exposed side)	0.00 m2
S_{wi}	Window area	5.00 m2
S_{ew}	Sf-Swi	10.00 m2
S_{rr}	Area of ceiling	0.00 m2
S	Sf + Srr	15.00 m2
A_0	Given in BS EN 20140-10	10.00 m2

V	45	**T60**	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

$$L_{eq,2} \approx L_{eq,ff} + 10log_{10}\left(\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S}10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S}10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S}10^{\frac{-R_{rr}}{10}}\right) + 10log_{10}\left(\frac{S}{A}\right) + 3 \quad (1)$$

$$L_{Aeq,2} = 10log_{10}\left(10^{\frac{L_{Aeq,125}}{10}} + 10^{\frac{L_{Aeq,250}}{10}} + .. +\right) \quad (2)$$

The calculation

Term from equation (1)	Reference letter of result	Octave band centre frequency (Hz)								
		63	125	250	500	1000	2000	4000	8000	
$L_{eq,ff}$	A	60	54	50	50	52	49	40	23	
$D_{n,e}$		35	32	31	30	31	29	28	28	
$\frac{A_0}{S} 10^{\frac{-D_{n,e}}{10}}$	B	0.00021	0.00042	0.00053	0.00067	0.00053	0.00084	0.00106	0.00106	
R_{wi}		22	19	19	37	44	44	51	55	
$\frac{S_{wi}}{S_f} 10^{\frac{-R_{wi}}{10}}$	C	0.00210	0.00420	0.00420	0.00007	0.00001	0.00001	0.00000	0.00000	
R_{ew}		30	35	40	45	50	55	55	55	
$\frac{S_{ew}}{S_f} 10^{\frac{-R_{ew}}{10}}$	D	0.00067	0.00021	0.00007	0.00002	0.00001	0.00000	0.00000	0.00000	
R_{rr}		0	0	0	0	0	0	0	0	
$\frac{S_{rr}}{S_f} 10^{\frac{-R_{rr}}{10}}$	E	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
10log10 (B+C+D+E)	F	-25	-23	-23	-31	-33	-31	-30	-30	
A (furnished)		14	14	14	14	14	14	14	14	
$10\log\left(\frac{S}{A}\right)$	G	0	0	0	0	0	0	0	0	
$L_{eq,2}$	A+F+G+3	38	34	30	22	23	21	13	-4	
A-weighting dB		-26	-16	-9	-3	0	1	1	-1	
$L_{eq,2}$ + A-weighting	$L_{Aeq,125}$ etc	12	18	21	19	23	23	14	-5	28

$L_{Aeq,2}$ is obtained by combining these values using equation (2)

Appendix F – Noise Survey Histogram