

11.5

**DESIGN NOTE BY HOARE LEA, DOCUMENT
REFERENCE**

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HILL, PHASE 1 PLOTS E&F DATED 1ST
FEBRUARY 2019**

Design Note

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Station Hill, Phase 1 – Plots E & F.

Noise intrusion.

Planning Conditions.

As part of the granted planning permission for Station Hill, Reading, two planning conditions have been issued specifically relating to noise intrusion within residential dwellings of Plots E and F, as follows:

Planning Condition 42 (Application No. 151426) – Plot E.

“No commencement (other than demolition) shall take place for any building within a Plot containing residential dwellings before details of a sound attenuation scheme has been submitted to and approved in writing by the Local Planning Authority. The scheme shall be informed by an assessment of the current noise environment and seek to ensure that noise levels within residential properties within a relevant Plot do not exceed 30-40 dB $L_{Aeq,16hr}$ for living rooms within residential properties within a relevant Plot during the day, and 30-35 dB $L_{Aeq,8hr}$ and 45 dB L_{Amax} for bedrooms within residential properties within a relevant Plot at night (in accordance with BS 8233: 2014). Such measures as may be approved shall be implemented within a relevant Plot and a sample unit tested before any of the approved residential units within a relevant Plot are occupied. The scheme shall thereafter be retained for the lifetime of the residential uses hereby permitted.”

Planning Condition 42 (Application No. 151427) – Plot F.

“No Plot containing residential units shall be first Occupied before details of a sound attenuation scheme has been submitted to and approved in writing by the Local Planning Authority. The scheme shall be informed by an assessment of the current noise environment and seek to ensure that noise levels within residential properties within a relevant Plot do not exceed 30-40 dB $L_{Aeq,16hr}$ for living rooms within residential properties within a relevant Plot during the day, and 30-35 dB $L_{Aeq,8hr}$ and 45 dB L_{Amax} for bedrooms within residential properties within a relevant Plot at night (in accordance with BS 8233: 1999). Such measures as may be approved shall be implemented within a relevant Plot and a sample unit tested before any of the approved residential units within a relevant Plot are occupied. The scheme shall thereafter be retained for the lifetime of the residential uses hereby permitted.”

On the basis of the above Planning Conditions, internal noise levels within residential properties of Plot E and F shall be designed to achieve the criteria of BS 8233: 2014 and detailed overleaf in Table 1.

Location	Daytime (0700 to 2300)	Night-Time (2300 to 0700)
Living room	35 dB $L_{Aeq,16hr}$	-
Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$ & 45 dB $L_{Amax,T}$

Table 1: External noise intrusion criteria.

Environmental noise survey.

An acoustic survey has been carried out at the proposed development site to establish the prevailing noise conditions local to the site. The survey included the installation of three noise monitors across a fourteen-day period, in addition to attended noise measurements during the daytime and night-time.

Noise prediction model.

The results of the environmental noise survey have been used to predict the external noise levels at each façade of Plots E and F using Cadna/A environmental noise prediction and mapping software, which implements the environmental noise propagation prediction methodology set out in ISO 9613-2.

The noise model of the site was constructed and validated against the measured baseline conditions before modelling the proposed development in order to demonstrate how the proposed built form will influence noise conditions across the site. Figures 1 to 4 attached display a three-dimensional representation of the noise map prediction for each of the development façades.

Building envelope.

On the basis of the results of the noise model, calculations have been undertaken to determine the sound reduction requirements of the building envelope to ensure achievement of the internal noise criteria detailed in Table 1 above.

The calculations indicate that the non-glazed element on all façades is required to achieve a sound reduction of 46 dB $R_w + C_{tr}$. The required acoustic performance ($R_w + C_{tr}$) of all glazed elements (windows and doors including glass, frame, seals, mullions and transoms) on each façade, as identified in Figure 5, is provided in Table 2 below.

Façade	Minimum required $R_w + C_{tr}$ (dB)	
	Living room	Bedroom
Friar Street	31	44
Block E Courtyard South	12	26
Block E East	17	30
Block E Courtyard North	14	19
Garrard Street	33	31
Block E West	20	25
Block F West	21	28
Block F East	10	19
Garrard Street South	26	22

Table 2: Minimum required $R_w + C_{tr}$ of glazed elements.

Examples of primary glazing configurations capable of achieving the minimum required $R_w + C_{tr}$ detailed above are provided below.

- $R_w + C_{tr}$ 25 dB – 4mm glass, 16mm air gap, 4mm glass.
- $R_w + C_{tr}$ 29 dB – 10mm glass, 16mm air gap, 4mm glass.
- $R_w + C_{tr}$ 31 dB – 10mm glass, 16mm air gap, 6mm glass.
- $R_w + C_{tr}$ 33 dB – 6mm glass, 16mm air gap, 8.8mm acoustic glass.
- $R_w + C_{tr}$ 44 dB – 10.8mm acoustic glass, 24mm air gap, 14.8mm acoustic glass.

It should be noted that the above glazing configurations are for illustrative purposes only. Final glazing configurations will be selected by the applicant that comply with the above acoustic requirements while considering all requirements (i.e. thermal, aesthetic etc.).

It should be noted that the above is based on a Stage 3 level design and further calculations will be required to be undertaken to determine refined octave band glazing requirements during subsequent design phases.

Conclusions.

On the basis of the guidance provided above, adoption of the sound attenuation scheme will enable achievement of the internal noise levels stated within BS 8233: 2014 and therefore the requirements of Planning Condition 42 for both applications.

Final details of the sound attenuation scheme will be submitted to RBC for approval pursuant to the planning conditions at the appropriate time.

Building services plant.

Planning Conditions.

As part of the granted planning permission for Station Hill, Reading, two planning conditions have been issued specifically relating to noise from building services plant associated with Plots E and F, as follows:

Planning Condition 48 (Application No. 151426) – Plot E.

"No installation of any noise generating plant on (a) relevant building(s) within a Plot shall take place before a noise assessment of equipment has been first submitted to and approved in writing by the Local Planning Authority. The assessment shall be carried out in accordance with BS 4142: 2014 methodology. The predicted rating level, $L_{A,T,r}$ (specific sound level plus any adjustment for the characteristic of the sound) as measured at a point 1 metre external to sensitive façades at the nearest noise sensitive premises (i.e. the nearest residential property window) and shall be at least 10 dB below the existing background sound level, $LA_{90,T}$, when all plant / equipment (or any part of it) is in operation. The plant shall thereafter only be installed and maintained to the same approved standard.

Planning Condition 48 (Application No. 151427) – Plot F.

"No Plot shall be first Occupied until details of any noise-generating plant in relation to the building(s) in the relevant Plot has / have been first submitted to and approved in writing by the Local Planning Authority. The details shall include an acoustic assessment which shall demonstrate that the plant noise rating level will not cause an increase in the existing background noise level when measured / predicted in accordance with the methodology in BS 4142: 1997. For the avoidance of doubt, the noise levels shall be determined at the nearest noise-sensitive premises (i.e. the nearest residential property window). The plant shall thereafter only be installed and operated as approved in accordance with the assessment."

Building services plant noise emission limits.

On the basis of the results of the acoustic survey undertaken at the proposed development and in accordance with the requirements of Planning Conditions 48, noise due to building services plant serving the proposed development shall achieve the following limits These are based on the lowest background noise levels measured.

Period	Lowest prevailing background noise level $L_{A90,T}$ dB	Noise Emission Limit Calculation $L_{A,T,r}$ dB
Daytime (0700 to 2300)	43	33
Night-Time (2300 to 0700)	36	26

Table 3: Building services noise emission limits.

Each of the limits stated above are the combined operational noise levels of plant at 1m from the nearest noise sensitive façade.

Whilst finalised details of the proposed plant are not known at this stage, all plant shall be designed, selected and provided with suitable attenuation and / or screening methods so that the criteria detailed in Table 3 are achieved with due consideration to the characteristic / tonality of the proposed plant.

Conclusions.

On the basis of the guidance provided above, building services plant shall be designed to achieve the requirements of Planning Condition 48 for both applications.

Final details of the building services plant and acoustic mitigation will be submitted to RBC for approval pursuant to the planning conditions at the appropriate time.

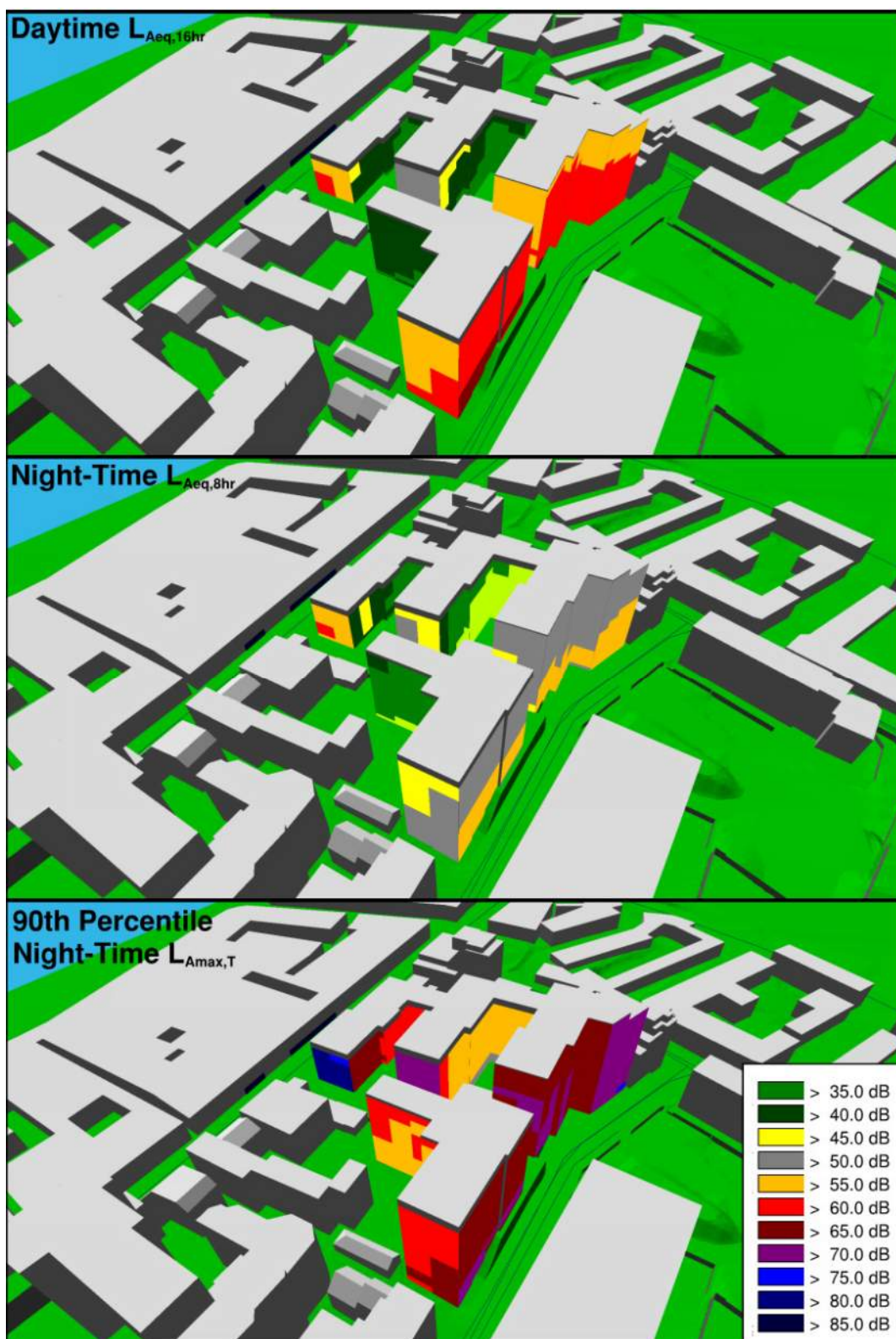


Figure 1: 3D noise map of proposed development from the north east (design development ongoing).

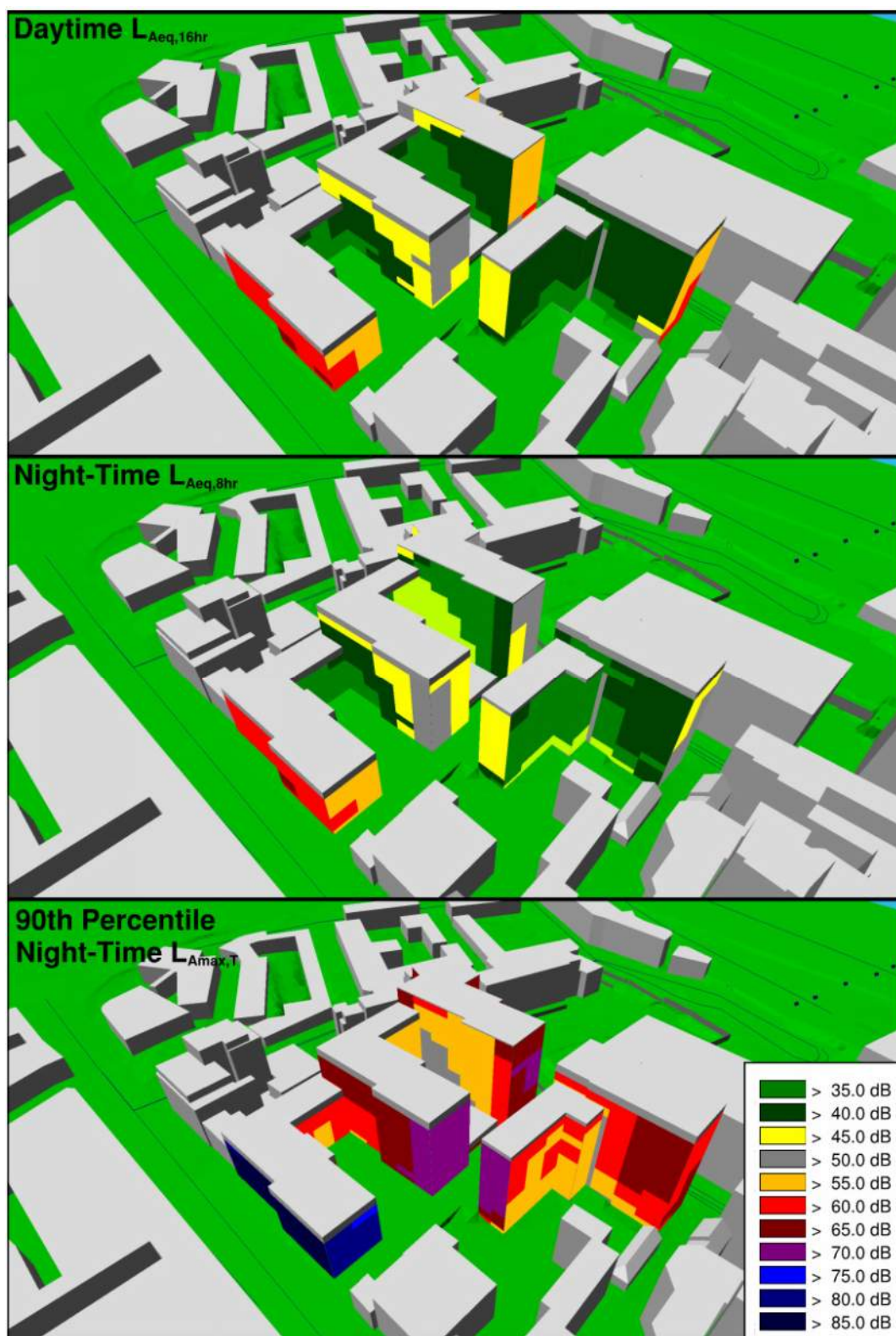


Figure 2: 3D noise map of proposed development from the south east (design development ongoing).

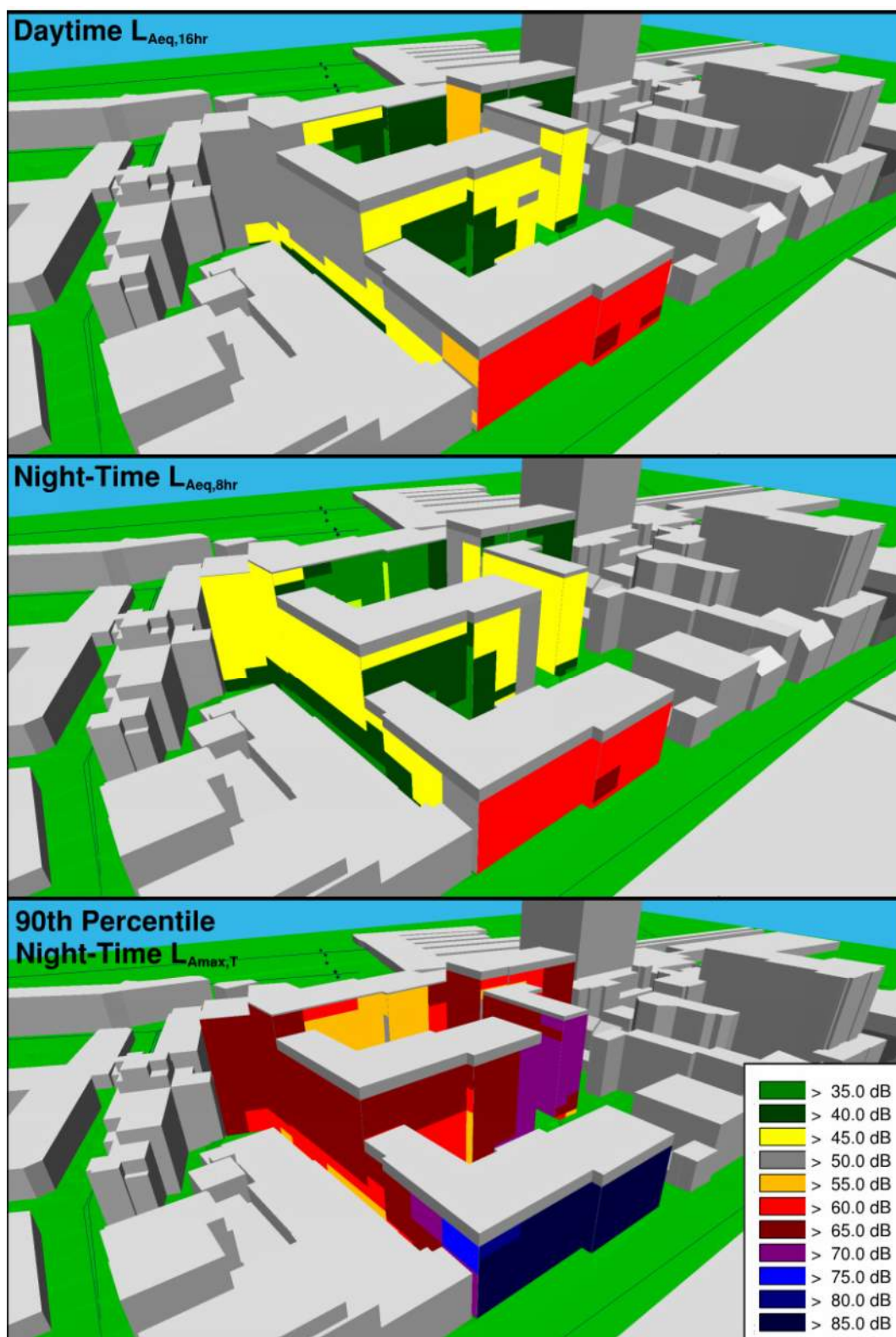


Figure 3: 3D noise map of proposed development from the south west (design development ongoing).

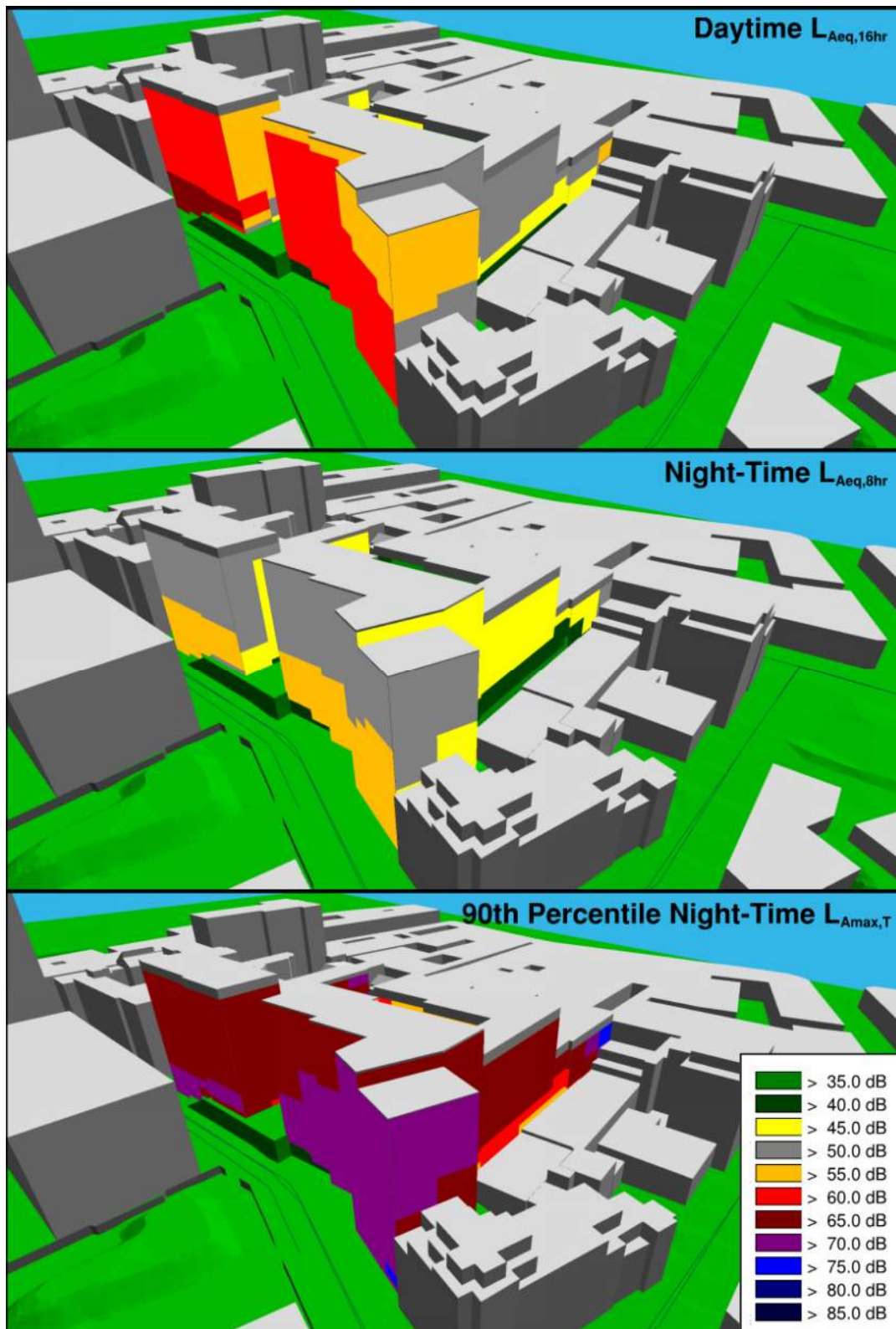


Figure 4: 3D noise map of proposed development from the north west (design development ongoing).



Figure 5: Façade locations (design development ongoing).

11.6

**STATION HILL NORTH, READING -
ENVIRONMENTAL NOISE SURVEY
PHASE 2 DETAILED PLANNING
APPLICATION, REV 1-OCTOBER 2019**

STATION HILL NORTH

READING

ENVIRONMENTAL NOISE SURVEY
PHASE 2 DETAILED PLANNING APPLICATION

DECEMBER 2019

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Executive summary.

Hoare Lea has conducted an environmental noise survey for the proposed development at One Station Hill, Reading.

The following summarises the assessment procedure and findings contained within this report:

- Environmental noise monitoring was undertaken at the proposed development site over a typical fourteen-day period between Monday 17th September 2018 and Monday 1st October 2018.
- Background noise levels typical of the daytime and night-time have been measured and used to defined building services plant noise emission limits at the nearest noise sensitive receptors.
- The nearest receptors have been identified as existing residential dwellings along Merchant Place to the south and also future residential dwellings proposed as part of the Phase 1 development for the Station Hill site.
- During the daytime and night-time, the combined building services plant noise emission contribution limit advised is 33 dB(A) and 26 dB(A) respectively, one metre from the nearest residential façade.
- The total building services noise emissions shall also not exceed 45 dB(A) at one metre from an office façade with opening windows and 60 dB(A) with a sealed façade. This assumes a partially opened window provides a 10 dB(A) noise reduction and a sealed façade will provide a minimum noise reduction of 25 dB(A).
- An assessment of the building envelope acoustic performance is provided and indicates that the ventilation strategy should allow for full mechanical ventilation of all spaces as the level differences required are above those achievable by simple means of natural ventilation. Windows may be openable for purge ventilation.
- Glazing requirements and indicative primary glazing configurations have been provided for guidance purposes only.

1. Introduction.

Hoare Lea has been appointed by SH Reading Master LLP to conduct an environmental noise survey in support of the hybrid planning application for the North Site. The hybrid planning application comprises a detailed application (Plot G / One Station Hill, Podium and Landscape) and an outline application (Plots A, B, C and D). This report considers One Station Hill / Plot G (detailed application).

The detailed application for the redevelopment of the site comprises a commercial development containing a range of co-working and office spaces including retail and related uses (Use Class A1-15), associated infrastructure and public realm works. The proposal will also include the installation of new mechanical services plant.

An environmental noise survey is required to quantify the existing ambient and background noise levels at the site in order to establish the design constraints on noise emissions from the operation of plant. The noise survey will also provide information required to establish the acoustic performance of the building façade and ventilation strategy to ensure that the office accommodation is in accordance with the Local Authority requirements and current guidance.

This report provides a description of the results from the noise survey undertaken, an assessment to determine the external noise limits for building services plant required to meet the Local Authority's general noise emission limits and advice regarding the building envelope and ventilation strategy.

To aid in the understanding of the assessment, definitions of technical terms used have been included in Appendix B.

2. Site description.

2.1 Existing site.

The existing site is formed of a disused and dilapidated office building and an existing NCP car park, and is located between Garrard Street, Station Hill and Reading train station within Reading.

The surrounding buildings are generally commercial in nature, including offices within Thames Tower to the west. There are also several residential dwellings in close proximity of the site, including residential dwellings along Merchants Place, Garrard Street, as well as the Novotel and Ibis Hotels which are located to the south of the site. It is also noted that the future residential dwellings will be introduced to the south of Garrard Street as part of the Phase 1 development for Station Hill.

The proposed site (indicative only) and neighbouring commercial units are identified in Figure 1 overleaf.

2.2 Local noise environment.

The surrounding noise climate is predominantly formed of road traffic noise from the immediate road network around the site, in particular also vehicles (including taxis and buses) using Greyfriars Road, Garrard Street and Station Hill.

Daytime noise activities within the vicinity of the proposed development were observed to include the following:

- Vehicles serving Reading Station and the drop-off point on Station Hill;
- Idling taxis (with engines running) queuing along Garrard Street as they approach the Reading Station taxi rank on Station Road;
- Trains serving Reading Station to the north of the site. Train movements were observed to be frequent, although slow moving as trains approached / left Reading Station; and
- PA announcements associated with trains serving Reading Station.

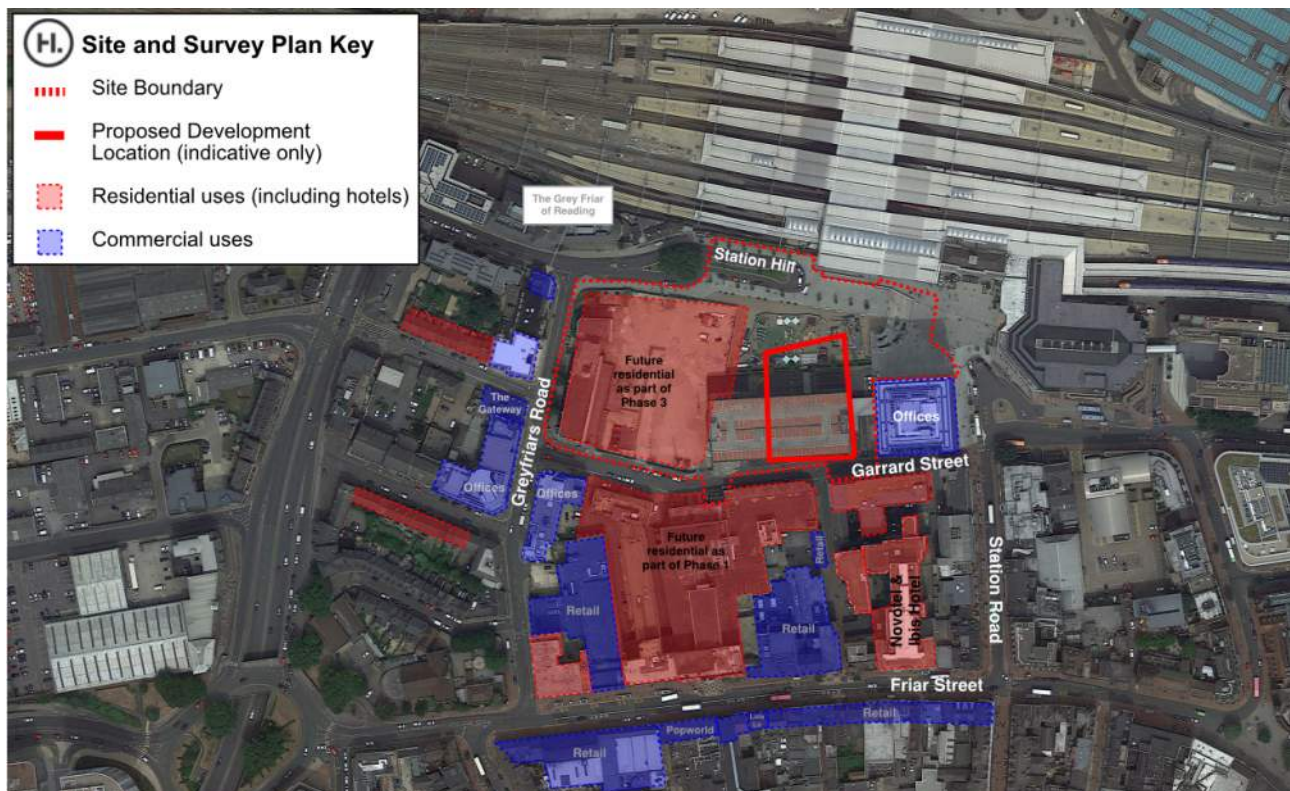


Figure 1: Existing site (indicative only).

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3. Basis of assessment.

3.1 National planning policy framework (NPPF).

The revised National Planning Policy Framework (1) published in July 2018 and updated in February and June 2019 sets out the Government's current planning policies for England and how these are expected to be applied. The NPPF supersedes the previous NPPF published in March 2012.

With regards to local noise and vibration, paragraph 180 states:

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

- a. Mitigate and reduce to a minimum potential adverse impact resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;*
- b. Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and*
- c. Limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation."*

Reference is made to the DEFRA Noise Policy Statement for England 2010 (NPSfE). This latter document is intended to apply to all forms of noise other than that which occurs in the workplace and includes environmental noise and neighbourhood noise in all forms.

The NPSfE advises that the impact of noise should be assessed on the basis of adverse and significant effect but does not provide any specific guidance on assessment methods or limit sound levels. Moreover, the document advises that it is not possible to have 'a single objective noise-based measure...that is applicable to all sources of noise in all situations'. It further advises that the sound level at which an adverse effect occurs is 'likely to be different for different noise sources, for different receptors and at different times'.

In the absence of specific guidance for assessment of environmental noise within the NPPF and the NPSfE, it is considered appropriate to base assessment on current British Standards and national guidance. These are considered to be Local Authority guidance, BS 4142 (2), BS 8233 (3) and the World Health Organisations (4) (WHO) guidelines.

3.2 BS 4142: 2014.

Current Government advice to Local Planning Authorities in both England and Wales makes reference to BS 4142 as being the appropriate guidance for assessing commercial operations and fixed building services plant noise. This British Standard provides an objective method for rating the likelihood of complaint from industrial and commercial operations. It also describes means of determining noise levels from fixed plant installations and determining the background noise levels that prevail on a site.

The assessment of impacts is based on the subtraction of the measured background noise level from the rating level determined. The rating level is the source noise level (either measured or predicted) corrected for tone or character (if necessary). The difference is compared to the following criteria to evaluate the impact.

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact.
- A difference of around +5 dB indicates is likely to be an indication of an adverse impact.
- Where the rating level does not exceed the background noise level, this is an indication of the specific sound source having a low impact.

This method is only applicable for external noise levels.

3.3 BS 8233: 2014 – Sound insulation and noise reduction for buildings.

BS 8233: 2014 provides guidance for control of noise in and around buildings, and suggests appropriate criteria and limits for different situations. The criteria and limits are primarily intended to guide the design of new or refurbished buildings undergoing a change of use.

Table 4 within BS 8233 provides desirable internal ambient noise levels for spaces in residential dwellings when they are unoccupied.

Activity	Location	Daytime (0700 to 2300)	Night-Time (2300 to 0700)
Resting	Living Room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining Room / Area	40 dB $L_{Aeq,16hr}$	-
Sleeping (Daytime Resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$

Table 1: Indoor ambient noise levels in spaces for dwellings.

Supplementary Note 2 and 4 to Table 4 within BS 8233 are copied below for reference:

'NOTE 2 – the levels shown in Table 4 are based on the existing guidelines issued by the WHO...'

'NOTE 4 – regular individual noise events (for example, schedule aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$ depending on the character and number of events per night.'

Guidance provided within the superseded BS 8233: 1999 (5) stated that *'for a reasonable standard in bedrooms at night, individual noise events (measured with F-time weighting) should not normally exceed 45 dB L_{Amax} '*. This follows current guidelines issued by the WHO.

3.4 The British Council for Offices (BCO) guide to specification 2014.

The British Council for Offices Guide provides guidance on sustainability, cost and value, building form, engineering systems and finishes within commercial offices. In particular, the BCO Guide provides advice within Section 8 regarding the acoustic environment within an office building, as summarised below.

External noise intrusion levels should not be more than the following ratings when measured in terms of $L_{eq,T}$.

- Open plan offices: NR 40 ($L_{eq,T}$)
- Speculative offices: NR 38 ($L_{eq,T}$)
- Cellular offices / meeting rooms NR 35 ($L_{eq,T}$)

In addition, $L_{Amax,F}$ noise intrusion levels should not normally be more than 55 dB in open plan / speculative offices or 50 dB in cellular offices.

Flanking transmission horizontally across cladding mullions should be capable of demonstrating a weighted normalised flanking level difference of at least $D_{nF,w}$ 45 dB when tested in accordance with BS EN ISO 10848-2: 2006 (6) and rated in accordance with BS EN ISO 717-1: 2013 (7). Flanking constructions should be capable of being upgraded in the fit out up to at least $D_{nF,w}$ 53 dB without affecting warranties.

3.5 Local planning policy.

3.5.1 Reading Borough Local Development Framework, Core Strategy, January 2008 (updated 2015).

The Reading Borough Local Development Framework Core Strategy adopted in January 2008 (with alteration adopted 27th January 2015) is the key spatial planning document and seeks to set out the key elements of the planning framework for the Reading area.

In respect of noise, the Core Strategy contains a single relevant policy, this is *Policy CS34*.

3.5.1.1 Policy CS34: Pollution and water resources.

Policy CS34 states the following:

"Development will only be permitted where it would not be damaging to the environment through air, land, noise or light pollution; where it would preserve or ideally enhance ground and surface water quality; and where existing water resources, sewerage and wastewater treatment infrastructure are adequate to support the proposed development.

Proposals for development that are sensitive to the effects of air, noise or light pollution will only be permitted in areas where they will not be subject to high levels of such pollution, unless adequate mitigation measures are provided to minimise the impact of such pollution."

3.5.2 Reading Borough Local Development Framework, Sites and Detailed Policies Document, October 2012 (updated 2015).

The Reading Borough Local Development Framework Sites and Detailed Policies Document adopted in October 2012 (with alteration adopted 27th January 2015) is intrinsically linked to the Core Strategy. The Document provides detailed planning policies in order to deliver the Core Strategy.

In respect of noise, the Sites and Detailed Policies Document contains a single relevant policy, this is *Policy DM4*.

3.5.2.1 Policy DM4: Safeguarding amenity.

Policy DM4 states the following:

"Development will not cause a significant detrimental impact to the living environment of existing or new residential properties, in terms of:

- *Privacy and overlooking;*
- *Access to sunlight and daylight;*
- *Visual dominance and overbearing effects of a development;*
- *Noise and disturbance;*
- *Artificial lighting;*
- *Vibration;*
- *Dust and fumes;*
- *Smell; or*
- *Crime and safety."*

3.5.3 Reading Borough Local Development Framework, Reading Central Area Action Plan, January 2009.

The Reading Borough Local Development Framework Central Area Action Plan adopted in January 2009 forms part of the Local Development Framework for the Borough and establishes planning framework for specific areas within Reading where significant change or conservation has been identified as being required.

In respect of noise, the Area Action Plan contains a single relevant policy, this is *Policy RC9*.

3.5.3.1 Policy RC9: Living in the centre.

Policy RC9 states the following:

"Proposals for residential development within the central area will be assessed against the following criteria:

ii. Proposals for new residential development within the central area will be required to demonstrate how the issue of potential noise disturbance from neighbouring land uses and other sources, and air quality implications of residential development, have been considered and if necessary, mitigated. New residential development should not be located next to existing town centre uses where those uses would give rise to unacceptable levels of noise and disturbance to the occupiers of the new scheme, unless this can be mitigated. "

3.5.4 Reading Borough Local Plan, November 2019.

The Reading Borough Local Plan adopted in November 2019 contains policies for how Reading will develop up to 2036.

In respect of noise, the Local Plan contains four relevant policies, these are *Policies CC8, N16, EN17 and CR6*.

3.5.4.1 Policy CC8: Safeguarding amenity.

Policy CC8 states the following:

"Development will not cause a detrimental impact on the living environment of existing residential properties or unacceptable living conditions for new residential properties, in terms of:

- *Privacy and overlooking;*
- *Access to sunlight and daylight;*
- *Visual dominance and overbearing effects of a development;*
- *Harm to outlook;*
- *Noise and disturbance;*
- *Artificial lighting;*
- *Vibration;*
- *Dust and fumes;*
- *Smell;*
- *Crime and safety; or*
- *Wind, where the proposals involve new development of more than 8 storeys."*

3.5.4.2 Policy EN16: Pollution and water resources.

Policy EN16 states the following:

"Development will only be permitted where it would not be damaging to the environment and sensitive receptors through land, noise or light pollution ...

Proposals for development that are sensitive to the effects of noise or light pollution will only be permitted in areas where they will not be subject to high levels of such pollution unless adequate mitigation measures are provided to minimise the impact of such pollution."

3.5.4.3 Policy EN17: Noise generating equipment.

Policy EN17 states the following:

"Where noise generating equipment is proposed, the noise source specific level (plant noise level) should be at least 10 dBA below the existing background level as measured at the nearest noise sensitive receptor."

3.5.4.4 Policy CR6: Living in Central Reading.

Policy CR6 states the following:

"Proposals for residential development within the central area will be assessed against the following criteria:

- ii) *Proposals for new residential development within the central area will be required to demonstrate how the issue of potential noise disturbance from neighbouring land uses and other sources, and air quality implications of residential development, have been considered and if necessary, mitigated. New residential development should not be located next to existing town centre uses where those uses would give rise to unacceptable levels of noise and disturbance to the occupiers of the new scheme, unless this can be mitigated."*

3.6 Proposed standards.

Given the lack of specific guidance within Reading Borough Council's planning policy in relation to internal noise levels, it is deemed appropriate to base assessment on current guidance and British Standards. This is considered to be BS 8233: 2014.

3.6.1 Building services – noise.

On the basis of guidance contained within Reading Borough Council's Draft Local Plan and based on previous conditions imposed by Reading Borough Council, all building services plant shall be designed to achieve the following noise emission limits.

Description of noise source	Noise emission limit
Building services plant	$L_{Ar,Tr} = L_{A90,T} - 10 \text{ dB}$

Table 2: Noise emission limits for building services.

Additionally, for plant noise that is tonal, contains a specific character or is intermittent, the limits of Table 2 above need to include a character correction as defined within BS 4142: 2014.

3.6.2 Environmental noise – internal noise levels.

On the basis of guidance provided by Reading Borough Council, the development will be designed to enable achievement of the internal noise levels contained within BS 8233 and the BCO Guide to Specification.

Location	Daytime (0700 to 2300)		
Restaurant / café / retail unit	40 dB $L_{Aeq,T}$		
Open-plan office	40 dB $L_{Aeq,T}$	55 dB $L_{Amax,F}$	NR 38
Cellular space (meeting room, office etc.)	35 dB $L_{Aeq,T}$	50 dB $L_{Amax,F}$	NR 35

Table 3: Proposed internal noise level criteria.

4. Environmental noise survey.

An acoustic survey has been carried out at the site to establish the prevailing environmental noise conditions local to the site, so as to determine building services plant noise emission limits and to advise upon the building envelope and ventilation strategy.

4.1 Methodology

The survey comprised fourteen days of unattended automatic noise measurements at three locations by three noise monitors. The position of these monitors is shown as positions L1, L2 and L3 in Figure 2 below. The measurements at positions L1 and L3 were façade measurements, approximately 1m from the façade at second floor level, whilst the measurements at position L2 were located above the site hoarding at a height of approximately 2.5m above ground floor level.

Measurements recorded consisted of fifteen-minute samples of ambient noise levels ($L_{Aeq,15min}$ in dB), maximum noise levels ($L_{Amax,15min}$ in dB) and background noise levels ($L_{A90,15min}$ in dB) between Monday 17th September 2018 and Monday 1st October 2018.

Sample octave band measurements have also been conducted at nine positions at ground floor level during the daytime and night-time. The position of these measurements is shown within Figure 2 and were hand-held samples at a height of 1.2m above ground floor level and considered “free-field”. These measurement positions were selected to quantify noise levels associated with various sources around the site (road traffic, bus and taxi movements, noise from *Popworld* etc.).

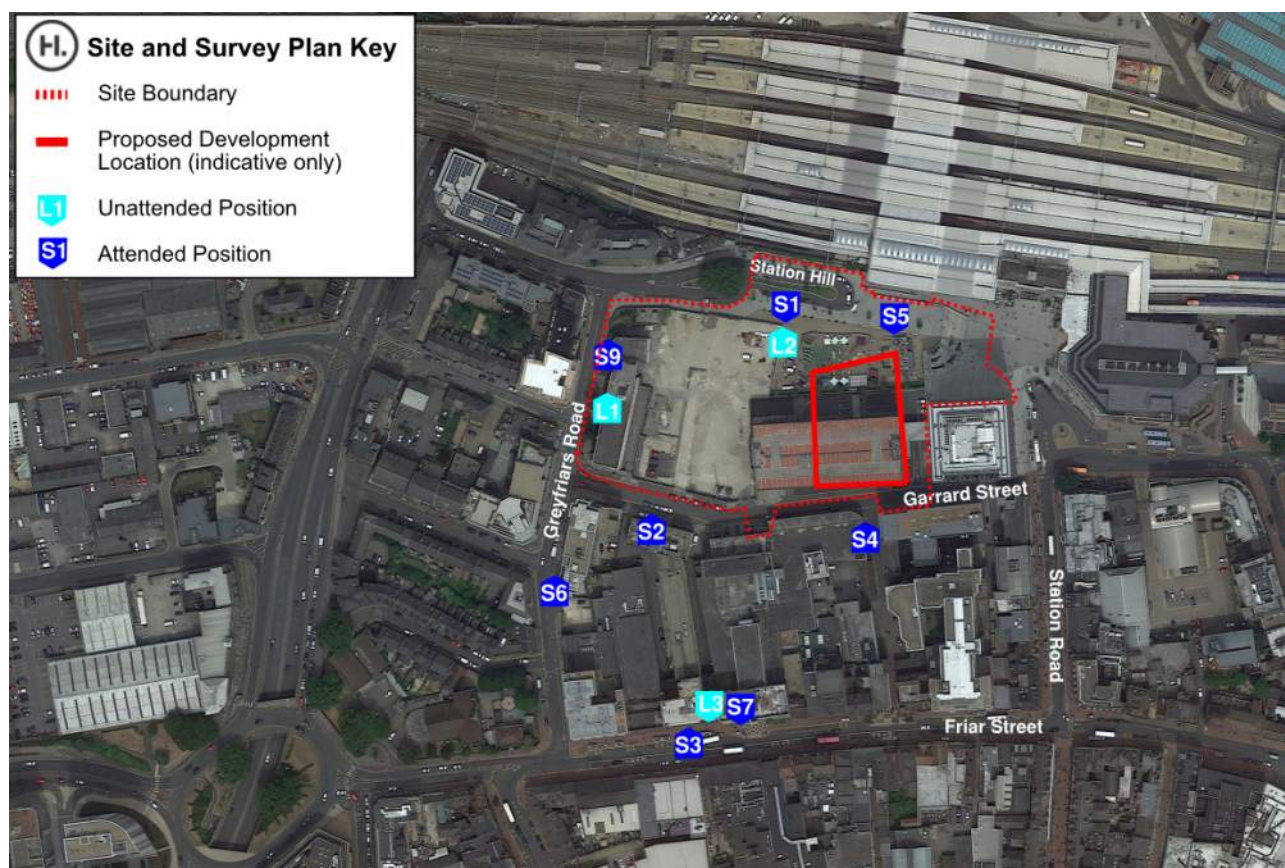


Figure 2: Measurement locations.

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The measurement instrumentation used is listed in Appendix B attached and a general acoustic terminology is provided in Appendix A.

During the measurement period, weather conditions were variable but were generally suitable for environmental noise measurements. Poor weather conditions were encountered between Monday 17th September and Saturday 22nd September with wind speeds regularly above 5m/s. As such, this data has been removed from the subsequent analysis.

4.2 Results summary.

A time history of the L_{Aeq} , L_{A90} and L_{Amax} from the unattended measurements recorded at positions L1, L2 and L3 is shown in Appendix C attached.

The results of the unattended measurements at positions L1, L2 and L3 have been calculated into daytime ($L_{Aeq,16hr}$) and night-time ($L_{Aeq,8hr}$) equivalent levels, and are shown with the associated measured minimum background noise level ($L_{A90,T}$) and maximum instantaneous measured noise level ($L_{Amax,T}$) in Table 5 overleaf.

It should be noted that the minimum daytime ($L_{A90,1hr}$) background noise level shown overleaf is the lowest arithmetic average of the measured background noise levels ($L_{A90,15min}$) in an hourly period. Similarly, the maximum events shown in Table 5 are the maximum measured in each corresponding period.

As shown in Table 5, noise levels measured by the unattended noise logger at position L2 and position L1 indicate that the lowest background noise level was $L_{A90,1hr}$ 43 dB during the daytime and $L_{A90,15min}$ 36 dB during the night-time.

A summary of the attended measurements conducted at positions the attended measurement positions is provided in Table 4 below.

Measurement Position	Typical $L_{Aeq,T}$ dB	Ninetieth Percentile $L_{Amax,T}$ dB
Daytime		
S1	58	71
S2	60	76
S3	65	77
S4	62	78
S5	56	74
S6	63	76
Night-time		
S1	58	67
S2	63	81
S7 (<i>Popworld & Lola Lo</i>)	71	81
S9	65	77

Table 4: Measured noise levels at attended positions.

Full details of the hand-held octave band measurements at all positions during the daytime are shown in the tables within Appendix D attached.

Measurement Date	Time	Position L1						Position L2						Position L3					
		Daytime			Night-Time			Daytime			Night-Time			Daytime			Night-Time		
		L _{Aeq,16hr} dB	Min L _{A90,1hr} dB	Max L _{Amax,T} dB	L _{Aeq,8hr} dB	Min L _{A90,15min} dB	Max L _{Amax,T} dB	L _{Aeq,16hr} dB	Min L _{A90,1hr} dB	Max L _{Amax,T} dB	L _{Aeq,8hr} dB	Min L _{A90,15min} dB	Max L _{Amax,T} dB	L _{Aeq,16hr} dB	Min L _{A90,1hr} dB	Max L _{Amax,T} dB	L _{Aeq,8hr} dB	Min L _{A90,15min} dB	Max L _{Amax,T} dB
Monday 17 th September 2018	1230 – 2300	64*	48*	95*	-	-	-	56**	51**	86**	-	-	-	67**	52**	106**	-	-	-
17 th / 18 th September 2018	2300 – 0700	-	-	-	58*	41*	93*	-	-	-	55**	41**	78**	-	-	-	61**	46**	86**
Tuesday 18 th September 2018	0700 – 2300	67*	50*	101*	-	-	-	58**	52**	94**	-	-	-	67**	53**	95**	-	-	-
18 th / 19 th September 2018	2300 – 0700	-	-	-	58*	38*	84*	-	-	-	53**	38**	78**	-	-	-	62**	47**	90**
Wednesday 19 th September 2018	0700 – 2300	69**	52**	88**	-	-	-	58**	52**	85**	-	-	-	67**	54**	99**	-	-	-
19 th / 20 th September 2018	2300 – 0700	-	-	-	59**	40**	82**	-	-	-	53**	40**	79**	-	-	-	63**	48**	92**
Thursday 20 th September 2018	0700 – 2300	65**	55**	96**	-	-	-	59**	54**	85**	-	-	-	67**	57**	94**	-	-	-
20 th / 21 st September 2018	2300 – 0700	-	-	-	63**	46**	88**	-	-	-	56**	44**	77**	-	-	-	64**	48**	86**
Friday 21 st September 2018	0700 – 2300	66**	53**	96**	-	-	-	58**	54**	88**	-	-	-	66**	55**	98**	-	-	-
21 st / 22 nd September 2018	2300 – 0700	-	-	-	59**	42**	86**	-	-	-	54**	40**	88**	-	-	-	69**	48**	95**
Saturday 22 nd September 2018	0700 – 2300	65	48	88	-	-	-	58	50	84	-	-	-	67	51	94	-	-	-
22 nd / 23 rd September 2018	2300 – 0700	-	-	-	61	40	87	-	-	-	52	38	82	-	-	-	69	48	93
Sunday 23 rd September 2018	0700 – 2300	65	50	85	-	-	-	57	48	80	-	-	-	65	51	94	-	-	-
23 rd / 24 th September 2018	2300 – 0700	-	-	-	-	-	-	-	-	-	50	37	69	-	-	-	64	47	90
Monday 24 th September 2018	0700 – 2300	64	50	86	-	-	-	57	52	90	-	-	-	66	53	95	-	-	-
24 th / 25 th September 2018	2300 – 0700	-	-	-	57	37	84	-	-	-	50	37	77	-	-	-	63	47	87
Tuesday 25 th September 2018	0700 – 2300	65	50	92	-	-	-	57	51	91	-	-	-	66	55	88	-	-	-
25 th / 26 th September 2018	2300 – 0700	-	-	-	58	38	85	-	-	-	51	38	78	-	-	-	67	47	92
Wednesday 26 th September 2018	0700 – 2300	68	51	93	-	-	-	57	51	88	-	-	-	67	54	103	-	-	-
26 th / 27 th September 2018	2300 – 0700	-	-	-	59	37	85	-	-	-	52	37	72	-	-	-	66	47	87
Thursday 27 th September 2018	0700 – 2300	68	51	88	-	-	-	58	52	95	-	-	-	66	53	96	-	-	-
27 th / 28 th September 2018	2300 – 0700	-	-	-	59	37	81	-	-	-	52	37	72	-	-	-	66	45	100
Friday 28 th September 2018	0700 – 2300	67	53	89	-	-	-	58	52	94	-	-	-	66	53	93	-	-	-
28 th / 29 th September 2018	2300 – 0700	-	-	-	61	39	87	-	-	-	52	40	80	-	-	-	68	47	93
Saturday 29 th September 2018	0700 – 2300	62	50	91	-	-	-	57	52	94	-	-	-	66	51	103	-	-	-
29 th / 30 th September 2018	2300 – 0700	-	-	-	61	38	83	-	-	-	52	38	75	-	-	-	68	46	91
Sunday 30 th September 2018	0700 – 2300	62	44	89	-	-	-	59	43	93	-	-	-	63	47	93	-	-	-
30 th September / 1 st October 2018	2300 – 0700	-	-	-	59	36	89	-	-	-	54	37	76	-	-	-	61	43	88
Monday 1 st October 2018	0700 – 1245	68	54	94	-	-	-	57	53	81	-	-	-	66	55	93	-	-	-

Table 5: Measured noise levels at position L1, L2 and L3.

Note *: Greyfriars Road was closed on Monday 17th and Tuesday 18th September and therefore impacted the measured values at position L1. This data has therefore been removed from the analysis.

Note **: Poor weather conditions were encountered with wind speeds regularly above 5 m/s. This data has therefore been removed from the analysis.

5. Noise sensitive areas.

A noise sensitive area is defined as landscapes or buildings where the occupiers are likely to be sensitive to noise created by plant installed in the proposed development, including residential areas. Noise sensitive receptors around the site have been identified and are shown in Figure 3 below.

Of the noise sensitive receptors identified in Figure 3, the nearest noise sensitive receptors to the proposed development have been identified as existing residential dwellings along Merchant Place to the south and also future residential dwellings proposed as part of the Phase 1 development for the Station Hill site.



Figure 3: Nearest noise sensitive receptors.

© Google Earth.

6. Noise emissions of fixed plant.

Noise levels due to building services serving the proposed development are advised to meet the following noise level criteria shown below in Table 6 one metre from the nearest noise sensitive area as identified in Section 6. These are based on the lowest background noise levels measured at the unattended loggers which are deemed representative of the nearest noise sensitive receptors.

Period	Lowest Prevailing Background Noise Level $L_{A90,T}$ dB	Noise Emission Limit Calculation $L_{A_{r,Tr}}$ dB
Daytime (0700 to 2300)	43	33
Night-Time (2300 to 0700)	36	26

Table 6: Building services noise emission limits.

It should be noted that each of the limits stated above are the combined operational noise levels of plant at the nearest noise sensitive façade. As such, the combined operational noise levels of all plant are required to achieve the noise limits defined above.

For plant noise that is tonal, contains a specific character or is intermittent, the limits of Table 6 above need to include character correction in accordance with BS 4142: 2014.

Consideration could be given to a slightly higher noise emission limit during the night-time, as this is a very low level and may not be achievable.

Noise levels outside commercial buildings should be acceptable at marginally higher levels than those proposed outside noise sensitive residential façades. Based on the level of noise that should be acceptable inside an office (35 to 40 dB in accordance with BS 8233: 2014) from external noise sources, the proposed plant could produce a noise level of 45-50 dB L_{Aeq} at one metre from commercial units with opening windows. This is determined on the basis that the internal noise level would not exceed 35 dB L_{Aeq} when a window is partially opened.

Similarly, for an office with a sealed façade, the proposed plant could produce a level of 60-65 dB L_{Aeq} at one metre, assuming that a sealed façade will provide a minimum noise reduction of 25 dB(A).

7. Noise prediction model.

In order to predict the external noise levels present at each façade of the proposed development and to determine a suitable ventilation strategy, a noise map has been created using CADNA environmental noise prediction and mapping software.

A baseline noise map was generated of the existing site using the results of the environmental noise survey and calibrated for daytime equivalent noise levels ($L_{Aeq,T}$) and the ninetieth percentile daytime $L_{Amax,T}$. The noise map was calibrated for each of the noise sources discussed in Section 2.2. The noise map for the existing site during the daytime ($L_{Aeq,T}$ and $L_{Amax,T}$) at a height of 1.5m above ground floor level is shown in Appendix E attached. A height of 1.5m was chosen as this is the preferred measurement height for environmental noise measurement and thus appropriate for noise prediction.

Subsequently, a noise map was generated of the site with the proposed development in-situ. Appendix F attached displays the noise level map of the proposed development during the daytime ($L_{Aeq,T}$ and $L_{Amax,T}$) at a height of 1.5m above ground floor level for each of the various noise sources individually as well as a combined noise map.

Additionally, Appendix G attached displays a three-dimensional representation of the noise map prediction for each of the proposed development façades. It should be noted that the noise mapping exercise takes into consideration all noise reflections that may occur off the proposed development and adjacent buildings.

It should also be noted that for the purposes of the noise modelling exercise, it is assumed that the buildings associated with the Phase 1 development are complete, but the Phase 3 works have not commenced (albeit the existing building has been demolished).

8. Building envelope & ventilation strategy.

The sound insulation properties of the building envelope depend upon the external noise levels present at the façade and the proposed design criteria for the internal noise levels of specific rooms, dependant on their use. Table 7 overleaf assumes compliance with the internal noise levels stated in Table 3 and shows the level differences for varying spaces within the proposed development.

The examples shown represent the highest level differences required for each façade as identified in Figure 4 below, based on the predicted data from the noise maps.



Figure 4: Façade locations.

It should be noted that the highest level difference (D) shown for hotel bedrooms within Table 7 takes precedence.

Façade	Room Use	Noise Levels (dB)		
		Measured External	Proposed Internal (Maximum)	Minimum Level Difference D
Station Side	Open-plan office	60	40	20
	Open-plan office (L_{Amax})	75	55	20
	Cellular space	60	35	25
	Cellular space (L_{Amax})	75	50	25
Garrard Street	Open-plan office	67	40	27
	Open-plan office (L_{Amax})	77	55	22
	Cellular space	67	35	32
	Cellular space (L_{Amax})	77	50	27

Table 7: Notional sound insulation values of proposed façade construction.

Simple natural ventilation through the use of opening windows will provide a level difference (D) in the order of 10 dB. It can be seen from Table 7 above that all internal spaces require greater levels of sound insulation based on the measured external noise levels.

As such, although windows may be openable for purge ventilation, provision for alternative forms of ventilation will need to be made such that windows are not required to be opened for ventilation purposes.

Calculations have been undertaken to determine the sound insulation requirements of the building envelope across all floors to achieve the internal noise criteria. Table 8 below details the minimum acoustic performance requirements of all glazed elements as a whole unit (glazing, seals, frames etc.) on each façade. Achievement of the octave band requirements is necessary, although overall values are also provided for guidance purposes only.

Façade	Internal space	Sound insulation values per octave band frequency (Hz) dB						Guidance $R_w + C_{tr}$ dB
		125	250	500	1000	2000	4000	
Station Side	Open-plan	24	21	32	37	42	43	29
	Cellular	24	26	40	48	46	54	34
Garrard Street	Open-plan	21	17	25	35	37	31	25
	Cellular	24	24	32	37	37	44	31

Table 8: Minimum sound insulation requirements of glazed elements.

Examples of primary glazing configurations capable of achieving the minimum required $R_w + C_{tr}$ detailed within Table 8 are provided below:

- $R_w + C_{tr}$ 25 dB – 4mm glass, 16mm air gap, 4mm glass.
- $R_w + C_{tr}$ 29 dB – 10mm glass, 16mm air gap, 4mm glass.
- $R_w + C_{tr}$ 31 dB – 10mm glass, 16mm air gap, 6mm glass.
- $R_w + C_{tr}$ 34 dB – 6mm glass, 16mm air gap, 8.8mm acoustic glass.

On the basis of the proposed façade and that mechanical ventilation is to be provided, it is confirmed that suitable internal noise levels will be achieved.

8.1 Compliance

In order to confirm the suitability of the proposed glazed and non-glazed elements, evidence of the laboratory sound insulation performance will be required for the entire unit as it will be installed (including glass, frame, seals, mullions and transoms). All acoustic testing shall be undertaken in controlled laboratory conditions in accordance with ISO 10140-2: 2010 – *“Acoustics – Laboratory measurement of sound insulation of building elements. Part 2: Measurement of airborne sound Insulation”*. (8)

9. Summary & conclusions.

Hoare Lea has conducted an environmental noise survey for the proposed commercial development at Station Hill in Reading. Unattended noise monitoring throughout a typical fourteen-day period and sample octave band measurements were conducted.

Background noise levels typical of the daytime and night-time have been measured and used to define building services plant noise emission limits at the nearest noise sensitive receptors. The nearest receptors have been identified as existing residential dwellings along Merchant Place to the south and also future residential dwellings proposed as part of the Phase 1 development for the Station Hill site.

During the daytime the combined building services plant noise emission contribution limit advised is 33 dB(A) and during the night-time the combined building services plant noise emission contribution limit advised is 26 dB(A), one metre from the nearest residential façade.

Additionally, the total building services noise emissions shall not exceed 45 dB(A) at one metre from an office façade with opening windows and 60 dB(A) with a closed façade. This assumes a partially opened window provides a 10 dB(A) noise reduction and a closed façade will provide a minimum noise reduction of 25 dB(A).

An assessment of the building envelope acoustic performance is provided with the minimum level difference (D) in accordance with the internal noise criterion of BS 8233: 2014 and the BCO Guide. The ventilation strategy should allow for full mechanical ventilation of all spaces as the level differences required are above those achievable by simple means of natural ventilation.

Detailed glazing requirements for varying internal spaces and indicative primary glazing configurations have been provided.

On the basis of the proposed façade and that mechanical ventilation is to be provided, it is confirmed that suitable internal noise levels will be achieved.

The guidance provided within this report is sufficient to satisfy the requirements of Reading Borough Council, in our opinion and confirms that the Site is considered suitable for development in terms of noise.

10. References.

1. *National Planning Policy Framework, Department for Communities and Local Government, February & June 2019.*
2. *BS 4142: 2014: 'Method for rating industrial and commercial sound'.*
3. *BS 8233: 2014, "Guidance on Sound Insulation and Noise Reduction for Buildings", BSI.*
4. *World Health Organisation (WHO) - Environmental Noise Guidelines for the European Region, 2018.*
5. *BS 8233: 1999, 'Sound Insulation and Noise Reduction for Buildings - Code of Practice'.*
6. *BS EN ISO 10848-2: 2006: 'Application to Light Elements when the Junction has a Small Influence'.*
7. *BS EN ISO 717-1: 2013. "Acoustics - Rating of Sound Insulation in Buildings and of Building Elements. Part 1: Airborne Sound Insulation."*
8. *ISO 10140-2: 2010, "Acoustics - Laboratory Measurement of Sound Insulation of Building Elements. Part 2: Measurement of Airborne Sound Insulation."*

Appendix A – List of measurement equipment.

Environmental Noise Survey

Sound Level Meter (Position L1 – Unattended)

- Rion NL-52 Sound Level Meter (Serial Number 00832246)
- Rion NH-25 Pre-Amplifier (Serial Number 32274)
- Rion UC-59 Microphone (Serial Number 05473)

Sound Level Meter (Position L2 – Unattended)

- Rion NL-31 Sound Level Meter (Serial Number 00910453)
- Rion NH-21 Pre-Amplifier (Serial Number 02294)
- Rion NC-74 Sound Calibrator (Serial Number 34172705)
- Rion UC-53A Microphone (Serial Number 101799)

Sound Level Meter (Position L3 – Unattended)

- Rion NL-31 Sound Level Meter (Serial Number 00110032)
- Rion NH-21 Pre-Amplifier (Serial Number 00134)
- Rion NC-74 Sound Calibrator (Serial Number 34551669)
- Rion UC-53A Microphone (Serial Number 102143)

Noise Spectral Analyser (Octave Band Measurements at all Positions)

- Brüel and Kjær 2250 Sound Level Meter (Serial Number 3002554)
- Brüel and Kjær ZC 0032 Pre-Amplifier (Serial Number 19475)
- Brüel and Kjær 4231 Sound Calibrator (Serial Number 3017591)
- Brüel and Kjær 4189 Microphone (Serial Number 2887250)

Sound level meters were field calibrated before and after noise survey and no discernible variations occurred.

Appendix B – Acoustic terminology.

Sound

Sound is produced by mechanical vibration of a surface, which sets up rapid pressure fluctuations in the surrounding air.

The Sound Pressure

The Sound Pressure is the force (N) of sound on a surface area (m²) perpendicular to the direction of the sound. The SI-units for the Sound Pressure are Nm⁻² or Pa (Pascal).

Sound is measured with microphones responding proportionally to the sound pressure – p. The power is proportional to the square of the sound pressure.

The Sound Pressure Level

The human ear has an approximately logarithmic response to sound pressure over a very large dynamic range. The lowest audible sound pressure approximately 2×10^{-5} Pa (2 ten billionths of an atmosphere) and the highest is approximately 100 Pa.

It is therefore convenient to express the sound pressure as a logarithmic decibel scale related to this lowest human audible sound, where:

$$L_p = 10 \log \left(\frac{p^2}{p_{ref}^2} \right) = 10 \log \left(\frac{p}{p_{ref}} \right)^2 = 20 \log \left(\frac{p}{p_{ref}} \right)$$

Where:

L_p = sound pressure level (dB)

p = sound pressure (Pa)

$p_{ref} = 2 \times 10^{-5}$ – reference sound pressure (Pa)

In accordance with the logarithmic scale, doubling the sound pressure level gives an increase of 6 dB.

Decibel (dB)

The decibel is the unit used to quantify sound pressure levels as well as sound intensity and power levels.

In accordance with the logarithmic scale, an increase of 10 dB in sound pressure level is equivalent to an increase by a factor of 10 in the sound pressure level (measured in Pa). Subjectively, this increase would correspond to a doubling of the perceived loudness of the sound.

Sound Pressure Level of Some Common Sources

An indication of the range of sound levels commonly found in the environment is given in the following Table.

Source	Sound Pressure Level dB
Threshold of Hearing	0
Rustling Leaves	20
Quiet Whisper	30
Home	40
Quiet Street	50
Conversation	60
Inside a Car	70
Loud Singing	80
Motorcycle (10m)	90
Lawn Mower (1m)	100
Diesel Truck (1m)	110
Amplified Music (1m)	120
Jet Plane (1m)	130

Frequency

The rate at which the pressure fluctuations occur determines the pitch or frequency of the sound. The frequency is expressed in Hertz (Hz) or cycles per second.

Octave and Third Octave Bands

An octave is the interval between two points where the frequency at the second point is twice the frequency of the first.

There are many methods of describing the frequency content of a noise. The most common methods split the frequency range into defined bands, in which the mid-frequency is used as the band descriptor and in the case of octave bands is double that of the band lower. For example, two adjacent octave bands are 250 Hz and 500 Hz.

Third octave bands provided a fine resolution by dividing each octave band into three bands. For examples, third octave bands would be 160 Hz, 250 Hz and 315 Hz for the same 250 Hz octave band.

The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high frequency than to low frequencies within the range. This is the basis of the A-weighting.

A-Weighting

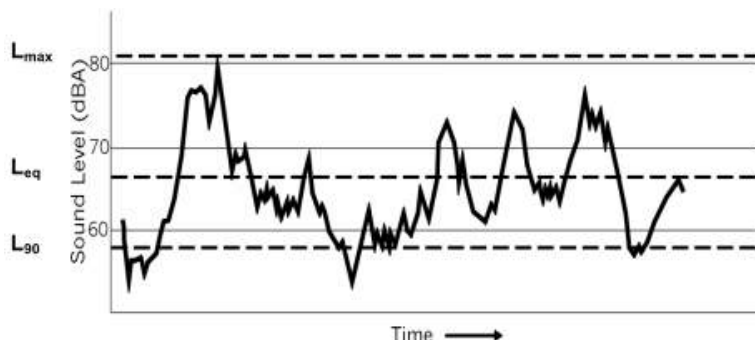
The A-weighting is a correction term applied to the frequency range in order to mimic the sensitivity of the human ear to noise. It is generally used to obtain an overall noise level from octave or third octave band frequencies.

An A weighted value would be written as dB(A), or including A within the parameter term.

Noise Units

In order to assess environmental noise, measurements are carried out by sampling over specific periods of time, such as five minutes, the statistically determined results being used to quantify various aspects of the noise.

The figure below shows an example of sound level varying with time. Because of this time variation the same period of noise can be described by several different levels. The most common of these are described below.



$L_{eq,T}$

The $L_{eq,T}$ is a parameter defined as the equivalent continuous sound pressure level over a defined time period 'T'. It is the sound pressure level equivalent to the acoustic energy of the fluctuating sound signal.

The $L_{eq,T}$ can be thought of as an 'average' sound pressure level over a given time period (although it is not an arithmetic average). Typically the $L_{eq,T}$ will be an A-weighted noise level in dB(A) and is commonly used to describe all types of environmental noise sources.

$L_{01,T}$

The $L_{01,T}$ is a parameter defined as the sound pressure level exceeded for 1% of the measurement period 'T'. It is a statistical parameter and cannot be directly combined to other acoustic parameter.

$L_{10,T}$

The $L_{10,T}$ is a parameter defined as the sound pressure level exceeded for 10% of the measurement period 'T'. It is a statistical parameter and cannot be directly combined to other acoustic parameter and is generally used to describe road traffic noise.

$L_{90,T}$

The $L_{90,T}$ is a parameter defined as the sound pressure level exceeded for 90% of the measurement period 'T'. It is a statistical parameter and cannot be directly combined to other acoustic parameter and is generally used to describe the prevailing background noise level.

$L_{max,T}$

The $L_{max,T}$ is a parameter defined as the maximum noise level measured during the specified period 'T'.

Specific Noise Level, $L_{Aeq,T,r}$

This is the equivalent continuous A-weighted sound pressure level at the assessment position due to a specific noise source operating over a given time interval.

Free Field

A measurement taken in the free field is at least 3.5m from reflecting vertical surfaces and 1.2m from the ground.

Façade

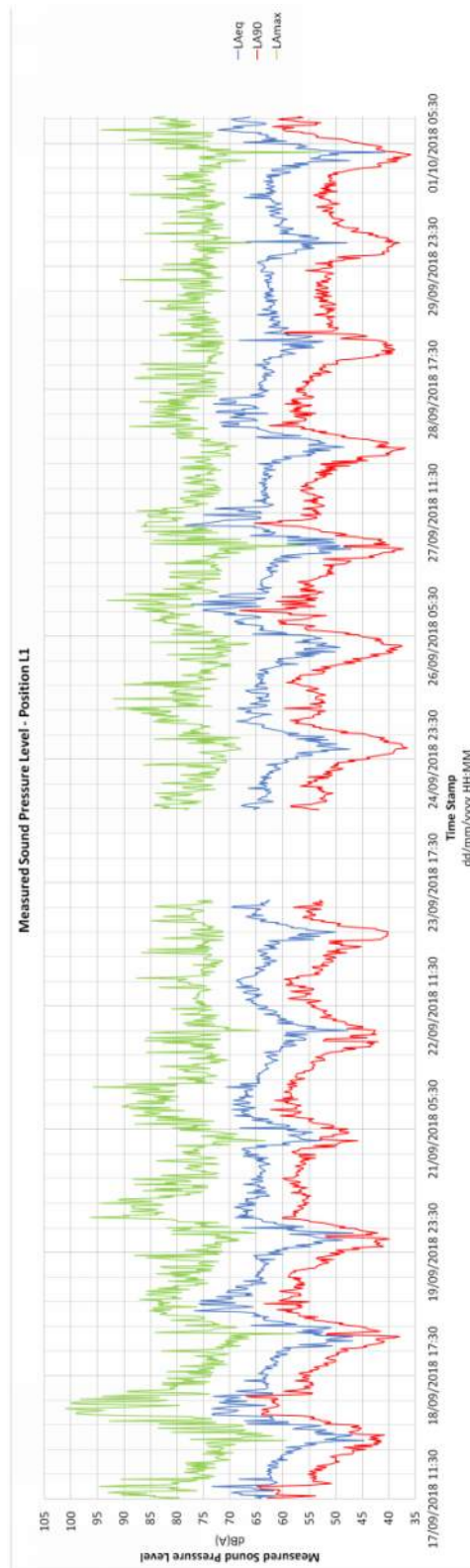
A measurement is influenced by the reflection of sound from the façade of a building within 3.5m. A façade measurement is made 1m in front of the vertical building surface.

R_w

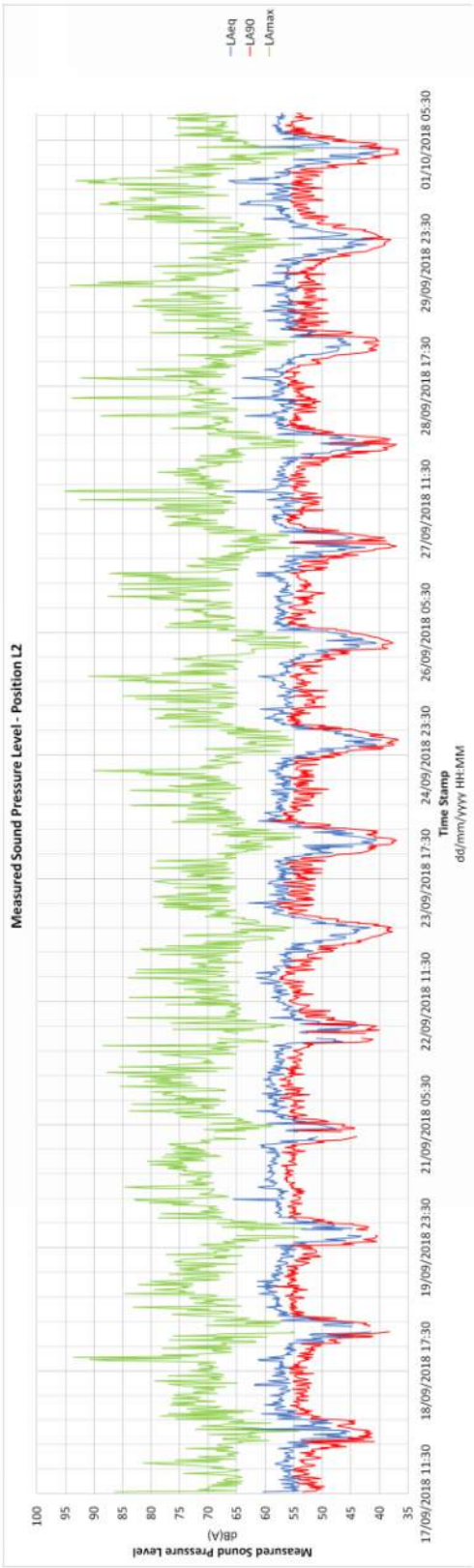
A single-number quantity which characterizes the airborne sound insulation of a material or building element in the laboratory. See BS EN ISO 717-1: 1997.

Appendix C – Time history of unattended measurements.

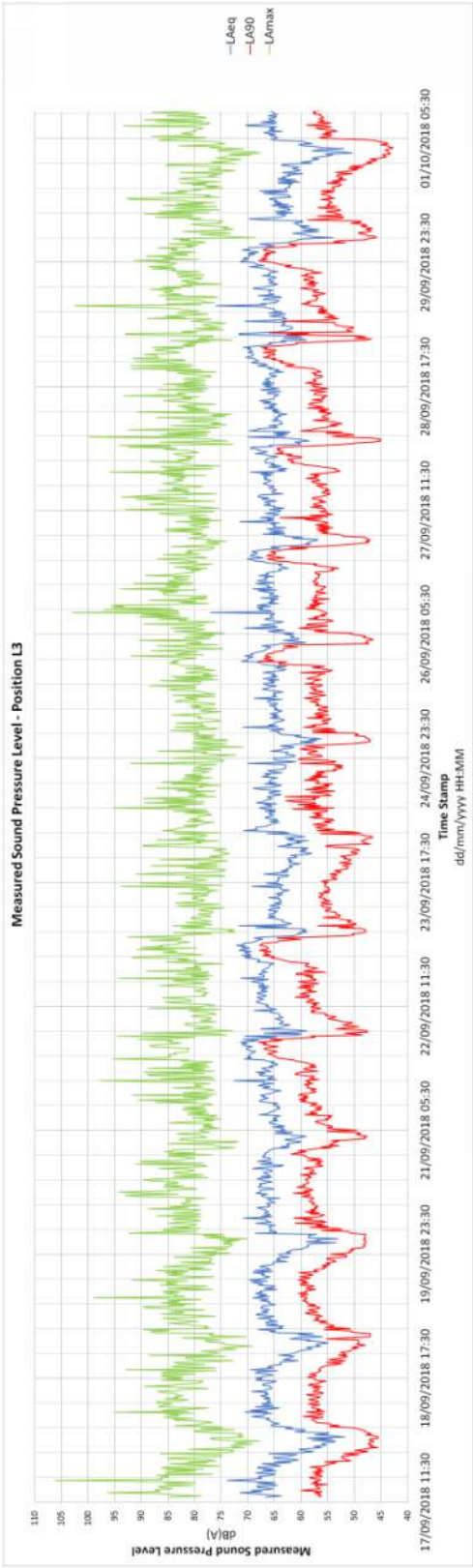
Position L1



Position L2



Position L3



Appendix D – Octave band levels at measurement positions.

Position	Measurement Period	Duration	Sound Pressure Level per Octave Band Frequency in dB										L _{Aeq,T} dB
			16Hz	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
S1	17/09/2018 13:00	00:05:00	63.8	71.7	66.2	59.2	57.2	52.2	49.3	45.7	43.1	37.6	55.2
	17/09/2018 13:05	00:05:00	64.9	79.1	69.9	63.8	59.7	54.0	55.9	51.1	44.4	37.9	59.6
	17/09/2018 13:11	00:05:00	65.7	77.5	70.8	65.0	61.6	53.9	55.2	50.4	43.9	37.8	59.5
	24/09/2018 13:16	00:05:00	64.7	74.3	67.5	60.3	57.2	54.9	53.9	50.7	44.7	36.0	58.4
	24/09/2018 13:21	00:05:00	66.6	70.2	67.5	63.7	58.5	54.1	52.3	48.9	44.4	35.3	57.9
	30/09/2018 00:16	00:05:00	64.8	75.7	68.8	61.7	56.9	53.6	54.6	49.1	42.8	35.1	58.1
S10	30/09/2018 00:29	00:05:00	58.4	66.7	70.3	65.7	59.5	59.2	57.6	56.1	52.3	45.9	63.0
S2	17/09/2018 13:25	00:05:00	64.6	68.0	69.1	63.1	56.7	55.7	56.0	51.1	45.0	37.6	59.5
	17/09/2018 13:30	00:05:00	61.6	64.4	64.8	61.1	56.4	54.7	54.9	48.3	41.1	34.4	58.0
	17/09/2018 13:35	00:05:00	63.5	72.1	66.8	61.0	55.2	54.4	53.0	48.4	47.6	35.7	57.5
	24/09/2018 13:01	00:05:00	68.8	68.3	66.3	62.3	55.7	54.3	55.8	51.4	45.8	37.8	59.2
	24/09/2018 13:07	00:05:00	71.5	71.3	69.3	67.9	61.7	58.0	59.1	53.5	47.2	39.8	62.6
S3	17/09/2018 13:50	00:05:00	77.7	79.5	72.3	66.6	63.6	62.0	58.9	55.4	48.9	42.0	64.0
	17/09/2018 13:55	00:05:00	76.2	79.7	74.3	66.4	63.7	61.7	58.2	55.5	49.0	42.6	63.8
	17/09/2018 14:09	00:05:00	75.9	75.6	72.6	65.3	63.9	61.9	58.0	55.3	53.0	48.8	63.9
	24/09/2018 12:35	00:05:00	76.3	76.7	70.6	65.9	63.5	62.7	59.2	56.3	50.8	41.7	64.6
	24/09/2018 12:40	00:05:00	76.6	77.1	73.6	67.0	66.6	64.0	60.7	56.5	50.1	40.9	65.8
S4	17/09/2018 14:25	00:05:00	67.8	71.6	69.9	60.5	58.5	56.6	56.4	52.4	46.4	39.6	60.3
	17/09/2018 14:30	00:05:00	68.0	70.4	68.9	61.3	59.4	57.1	57.6	54.1	47.8	39.8	61.4
	17/09/2018 14:35	00:05:00	74.1	72.8	70.7	62.6	59.3	57.5	57.4	55.2	49.3	42.0	61.9
	24/09/2018 12:50	00:05:00	66.7	72.7	71.9	63.2	59.4	58.2	58.3	54.7	48.7	40.0	62.2
	24/09/2018 12:55	00:05:00	71.5	72.7	70.9	66.2	58.3	57.6	57.2	55.7	52.3	40.5	62.3
S5	17/09/2018 14:45	00:05:00	66.8	65.5	64.0	56.3	54.4	51.5	49.7	46.2	48.0	47.0	55.8
	17/09/2018 14:50	00:05:00	65.9	74.9	73.0	58.7	55.3	51.9	50.5	46.4	39.8	32.2	55.4
S6	24/09/2018 12:05	00:05:00	73.4	69.6	68.4	61.8	59.0	58.3	58.7	54.7	47.2	39.0	62.2
	24/09/2018 12:11	00:05:00	70.5	68.1	71.3	64.8	60.9	58.8	59.0	55.1	48.1	39.1	62.8
	24/09/2018 12:16	00:05:00	68.7	67.9	69.3	62.2	60.7	59.2	60.8	56.4	48.3	40.5	63.9
S7	29/09/2018 23:52	00:05:00	73.9	78.1	74.8	74.7	69.3	71.2	67.1	62.8	55.4	43.4	72.1
	29/09/2018 23:59	00:05:00	73.3	75.4	75.7	75.1	68.5	70.6	66.3	61.6	54.3	44.6	71.3
	30/09/2018 00:40	00:05:00	65.6	71.8	75.8	73.4	67.6	69.8	66.8	61.7	54.7	45.5	71.2
	30/09/2018 00:47	00:05:00	71.0	76.7	77.7	73.0	67.8	68.6	64.6	60.0	54.5	44.0	69.8
S9	30/09/2018 00:23	00:05:00	62.5	70.3	74.4	68.9	64.0	61.1	61.1	56.5	51.1	44.8	65.0

Table 9: Ambient levels measured at attended measurement positions.

Position	Measurement Period	Duration	Sound Pressure Level per Octave Band Frequency in dB										L _{Amax,T} dB
			16Hz	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
S1	17/09/2018 13:00	00:05:00	74.9	81.5	78.2	72.6	71.7	67.4	63.5	61.3	68.3	63.6	70.8
	17/09/2018 13:05	00:05:00	77.2	84.8	78.1	77.9	71.6	65.4	67.9	68.5	58.9	53.3	70.6
	17/09/2018 13:11	00:05:00	78.2	84.3	82.2	83.8	79.8	66.3	63.6	64.6	57.2	54.6	70.5
	24/09/2018 13:16	00:05:00	80.1	84.2	78.9	77.2	73.3	70.8	66.5	69.3	63.6	57.2	71.0
	24/09/2018 13:21	00:05:00	81.5	82.0	81.5	85.5	77.6	72.1	68.3	65.8	61.9	55.9	71.8
S10	30/09/2018 00:16	00:05:00	75.2	83.3	79.0	77.8	69.2	65.9	62.0	57.7	55.1	52.0	65.9
	30/09/2018 00:29	00:05:00	73.1	78.5	89.7	85.1	76.9	78.7	73.6	76.2	72.9	67.0	80.9
S2	17/09/2018 13:25	00:05:00	78.7	79.2	81.8	75.8	69.8	68.7	68.4	65.3	66.5	57.9	69.7
	17/09/2018 13:30	00:05:00	73.1	77.6	80.4	73.6	68.8	67.7	67.9	63.2	59.1	58.3	70.4
	17/09/2018 13:35	00:05:00	76.6	79.7	83.5	74.4	69.2	67.6	64.9	65.3	74.0	56.6	75.2
	24/09/2018 13:01	00:05:00	79.3	81.6	78.7	77.3	69.9	69.2	69.7	69.7	67.3	57.7	71.2
	24/09/2018 13:07	00:05:00	83.6	84.6	82.8	85.1	77.1	71.8	75.8	69.6	72.2	62.1	77.4
S3	17/09/2018 13:50	00:05:00	92.3	96.0	88.2	82.6	76.5	76.7	72.4	69.9	65.5	57.4	75.4
	17/09/2018 13:55	00:05:00	93.8	90.8	85.8	83.2	79.9	76.3	74.0	72.7	64.7	63.2	75.4
	17/09/2018 14:09	00:05:00	90.7	92.4	84.8	79.4	75.6	75.0	70.7	69.1	69.6	66.6	74.2
	24/09/2018 12:35	00:05:00	91.1	92.2	85.1	81.8	77.6	80.2	76.2	72.1	67.5	58.7	77.1
	24/09/2018 12:40	00:05:00	91.1	91.2	86.9	83.9	84.4	81.6	75.7	74.6	67.3	55.6	79.5
S4	17/09/2018 14:25	00:05:00	82.0	83.1	85.3	75.1	71.5	70.3	72.0	63.8	61.4	58.4	73.8
	17/09/2018 14:30	00:05:00	82.1	86.7	86.6	75.8	73.4	73.7	72.8	72.3	66.2	59.0	75.8
	17/09/2018 14:35	00:05:00	85.5	83.1	86.9	82.3	74.3	74.0	73.3	72.5	67.2	60.5	77.7
	24/09/2018 12:50	00:05:00	79.3	88.8	88.0	81.1	73.0	72.8	72.8	72.3	66.0	58.3	76.6
	24/09/2018 12:55	00:05:00	89.2	87.3	90.3	89.3	77.6	77.5	71.3	68.5	67.0	55.2	77.3
S5	17/09/2018 14:45	00:05:00	79.1	74.3	77.8	69.6	64.7	70.9	68.8	64.3	73.2	71.9	75.3
	17/09/2018 14:50	00:05:00	73.7	79.6	80.2	69.8	64.0	63.5	59.7	57.8	52.2	50.9	61.3
S6	24/09/2018 12:05	00:05:00	84.4	83.0	84.8	76.5	71.7	76.6	71.9	73.8	63.3	57.4	74.2
	24/09/2018 12:11	00:05:00	82.4	80.5	91.5	82.2	77.9	73.3	71.7	68.2	63.1	56.5	74.4
	24/09/2018 12:16	00:05:00	80.4	79.5	87.8	77.4	73.9	73.6	75.6	70.4	64.0	60.7	77.1
S7	29/09/2018 23:52	00:05:00	93.6	95.7	85.5	86.7	78.9	83.0	80.6	74.5	69.1	59.8	79.6
	29/09/2018 23:59	00:05:00	93.9	90.5	88.6	87.3	81.7	81.4	78.9	75.2	69.4	66.0	79.6
	30/09/2018 00:40	00:05:00	81.2	80.8	92.3	84.8	76.3	82.8	81.5	74.0	73.3	68.4	80.9
	30/09/2018 00:47	00:05:00	85.3	93.6	90.9	84.0	77.6	81.1	76.1	71.9	79.1	65.4	80.7
S9	30/09/2018 00:23	00:05:00	72.4	81.8	91.5	84.5	76.8	75.4	74.5	71.5	68.8	66.3	76.9

Table 10: Maximum levels measured at attended measurement positions.

Position	Measurement Period	Duration	Sound Pressure Level per Octave Band Frequency in dB										L _{A90,T} dB
			16Hz	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
S1	17/09/2018 13:00	00:05:00	59.4	62.2	58.6	52.5	49.6	46.6	45.0	41.0	35.7	28.1	51.0
	17/09/2018 13:05	00:05:00	60.8	73.4	63.7	55.4	52.2	50.4	52.7	48.3	41.9	34.3	56.8
	17/09/2018 13:11	00:05:00	60.8	65.8	61.7	57.1	54.0	48.5	47.3	43.7	37.1	28.9	54.2
	24/09/2018 13:16	00:05:00	57.5	61.8	60.4	53.7	50.0	49.2	47.5	45.1	38.1	28.0	53.1
	24/09/2018 13:21	00:05:00	59.2	66.5	59.3	52.7	51.4	49.2	47.7	43.7	39.4	29.3	52.7
	30/09/2018 00:16	00:05:00	62.8	71.6	65.3	58.0	53.0	49.3	52.8	46.8	40.2	30.3	56.3
S10	30/09/2018 00:29	00:05:00	50.7	56.4	59.6	58.1	44.4	42.5	42.1	37.4	28.8	17.1	47.4
S2	17/09/2018 13:25	00:05:00	56.2	61.2	60.5	57.8	50.3	49.9	48.4	43.9	35.9	25.0	53.2
	17/09/2018 13:30	00:05:00	56.2	58.8	58.0	56.5	48.2	47.1	45.0	40.1	33.9	22.9	50.2
	17/09/2018 13:35	00:05:00	57.7	65.6	60.4	57.9	48.6	48.3	46.6	42.2	35.3	26.3	52.0
	24/09/2018 13:01	00:05:00	58.1	63.3	61.4	58.3	48.9	47.4	47.1	42.0	34.2	22.8	51.7
	24/09/2018 13:07	00:05:00	60.5	65.4	62.9	59.6	50.5	48.9	48.0	43.5	34.9	23.7	52.7
S3	17/09/2018 13:50	00:05:00	60.5	65.4	62.2	56.0	54.8	53.7	51.5	47.2	40.9	32.8	56.8
	17/09/2018 13:55	00:05:00	60.0	63.1	62.1	56.9	53.8	52.6	50.1	45.5	39.0	31.9	55.4
	17/09/2018 14:09	00:05:00	61.6	63.2	62.3	56.4	54.9	53.3	50.1	46.4	41.4	32.9	56.5
	24/09/2018 12:35	00:05:00	59.2	64.0	61.3	57.1	54.6	53.1	50.5	47.0	40.2	31.6	56.1
	24/09/2018 12:40	00:05:00	62.1	64.2	61.5	57.0	55.9	54.4	51.1	46.5	40.1	32.0	57.2
S4	17/09/2018 14:25	00:05:00	61.0	65.2	60.6	53.4	52.8	50.3	49.8	46.1	38.9	25.8	54.2
	17/09/2018 14:30	00:05:00	61.3	64.3	61.0	52.7	52.1	49.9	49.5	45.5	37.8	23.7	53.9
	17/09/2018 14:35	00:05:00	63.2	66.0	62.7	53.8	53.7	51.6	51.4	47.5	40.2	28.5	56.1
	24/09/2018 12:50	00:05:00	60.5	66.5	61.4	53.6	51.4	50.0	48.9	45.4	39.3	25.7	53.9
	24/09/2018 12:55	00:05:00	61.5	67.2	61.3	54.8	50.9	50.3	49.2	46.4	40.0	26.9	54.1
S5	17/09/2018 14:45	00:05:00	61.5	61.6	59.1	51.3	50.6	47.5	46.4	41.6	35.3	25.8	51.4
	17/09/2018 14:50	00:05:00	61.6	69.8	63.4	53.6	51.5	48.8	48.0	43.3	36.2	25.8	53.1
S6	24/09/2018 12:05	00:05:00	64.7	62.6	61.2	55.2	52.0	51.0	50.8	47.0	38.5	27.1	55.2
	24/09/2018 12:11	00:05:00	63.5	61.8	61.9	55.1	52.4	50.6	50.2	46.8	37.3	25.8	55.0
	24/09/2018 12:16	00:05:00	60.9	62.1	61.5	55.4	54.3	51.9	51.7	48.4	39.7	28.5	56.2
S7	29/09/2018 23:52	00:05:00	56.6	66.2	68.5	67.0	65.5	67.1	63.0	58.6	51.2	38.6	69.2
	29/09/2018 23:59	00:05:00	56.8	67.3	70.6	68.8	64.7	66.7	61.9	57.4	50.2	38.1	68.3
	30/09/2018 00:40	00:05:00	56.2	62.9	64.9	65.6	63.4	65.6	61.9	57.2	49.6	37.1	67.9
	30/09/2018 00:47	00:05:00	57.3	65.1	72.2	67.2	63.8	64.9	60.7	55.9	48.1	36.7	67.3
S9	30/09/2018 00:23	00:05:00	57.1	72.2	63.2	55.8	51.1	49.1	49.5	43.4	35.3	23.3	53.6
S9	30/09/2018 00:23	00:05:01	54.2	60.0	62.4	58.4	53.5	51.6	49.6	43.8	35.3	24.1	55.2

Table 11: Background levels measured at attended measurement positions.

Appendix E – Noise map of existing site at 1.5m above ground floor level.

Daytime $L_{Aeq,T}$



Daytime ninetieth percentile $L_{Amax,T}$



Appendix F – Noise map of proposed site at 1.5m above ground floor level.

Daytime $L_{Aeq,T}$

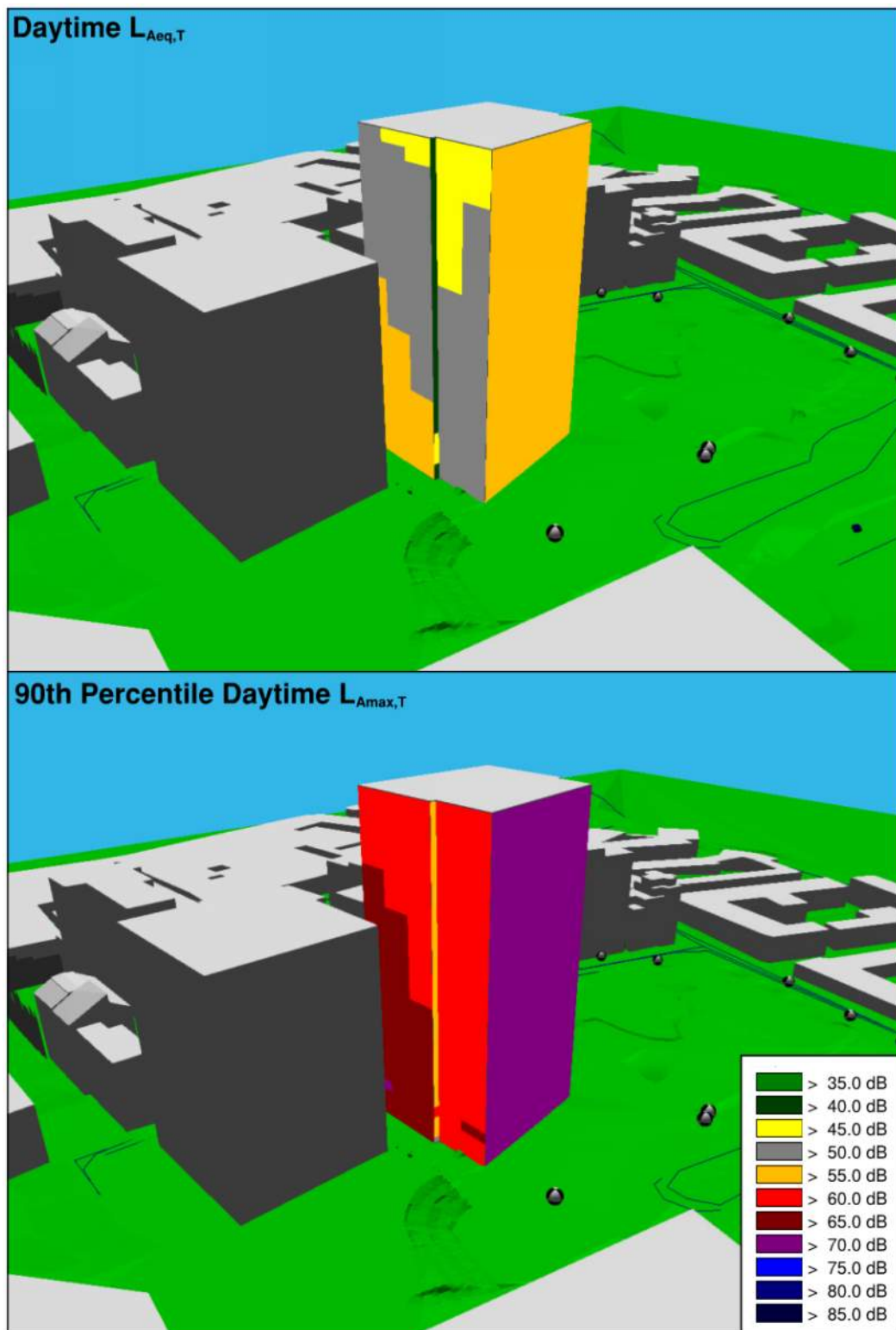


Daytime ninetieth percentile $L_{Amax,T}$

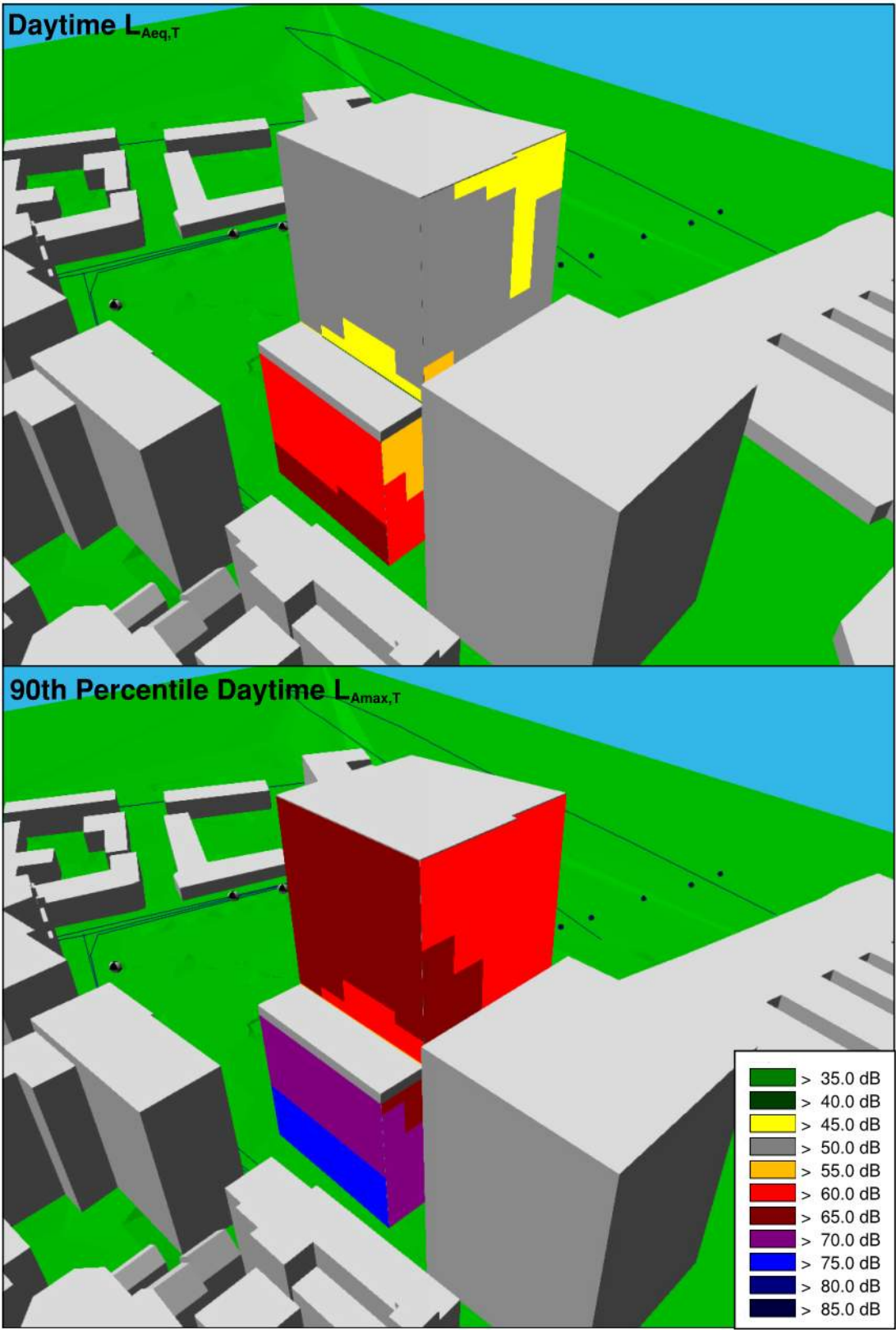


Appendix G – Three-dimensional noise map of proposed site.

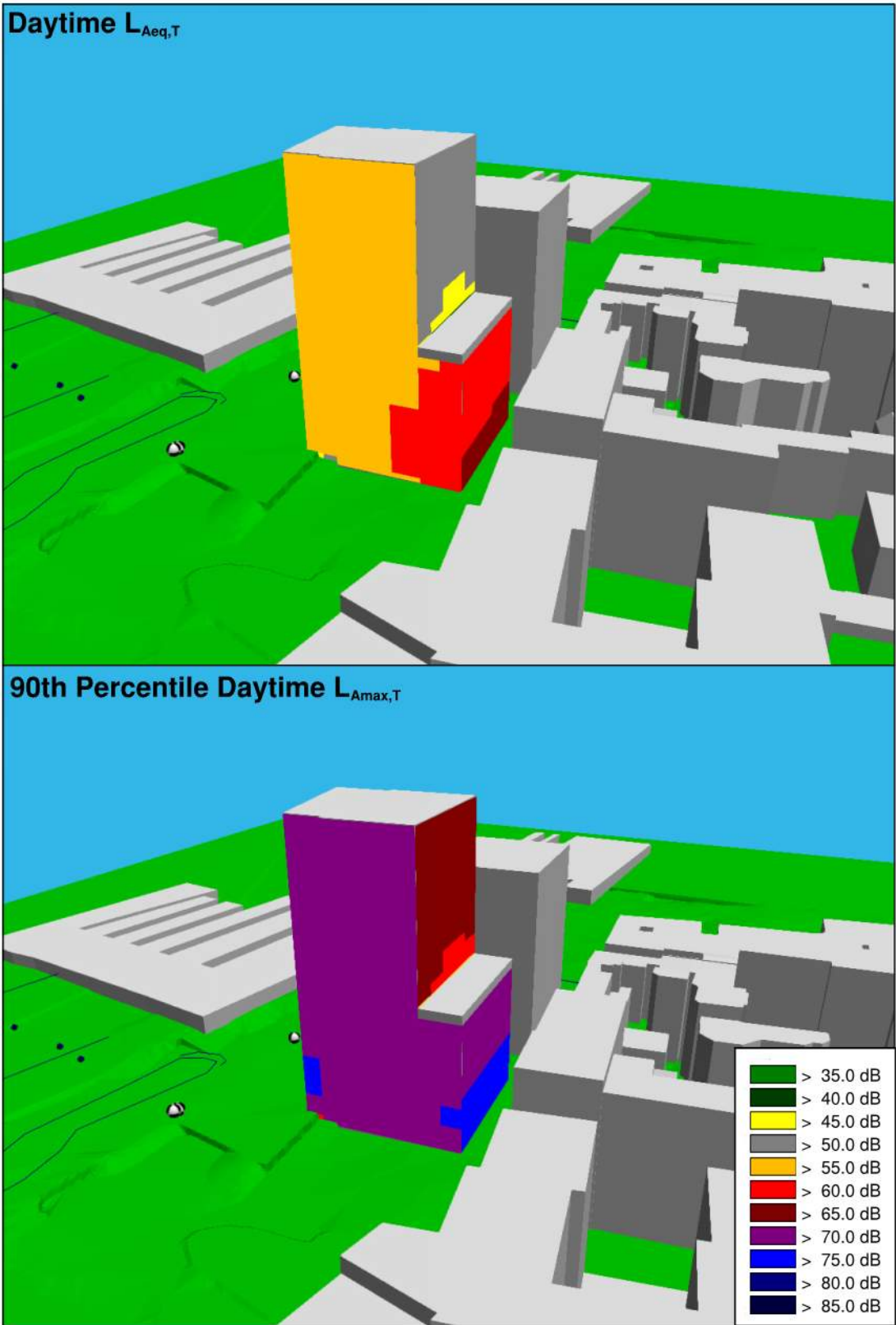
From the north east.



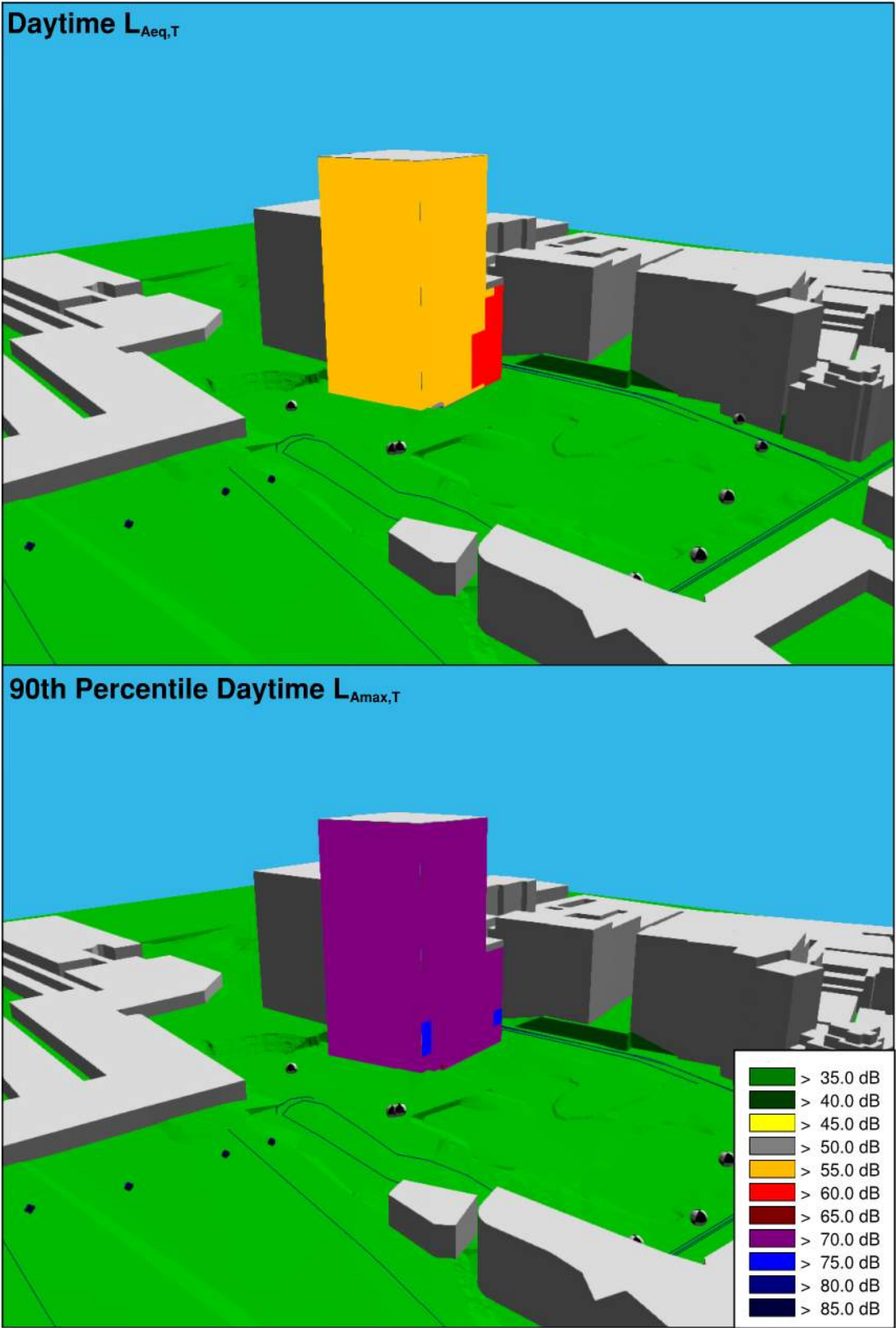
From the south east.



From the south west.



From the north west.





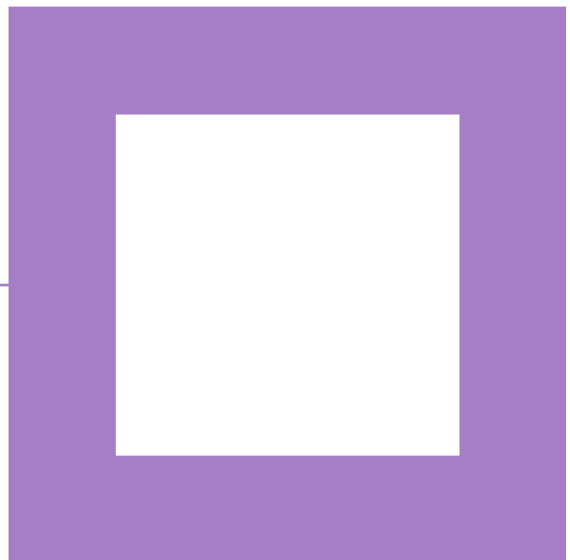
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11.7

**STATION HILL NORTH, READING -
ENVIRONMENTAL NOISE SURVEY PHASE
3 OUTLINE PLANNING APPLICATION, REV
1 - OCTOBER 2019**

STATION HILL NORTH

READING

ENVIRONMENTAL NOISE SURVEY
PHASE 3 OUTLINE PLANNING APPLICATION

DECEMBER 2019

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Executive summary.

Hoare Lea has conducted an environmental noise survey for the proposed commercial and residential development at Station Hill North, Reading.

The following summarises the assessment procedure and findings contained within this report:

- Environmental noise monitoring was undertaken at the proposed development site over a typical fourteen-day period between Monday 17th September 2018 and Monday 1st October 2018.
- Background noise levels typical of the daytime and night-time have been measured and used to defined building services plant noise emission limits at the nearest noise sensitive receptors.
- The nearest receptors have been identified as existing residential dwellings above The Greyfriars and Gateway public houses on Greyfriars Road and future residential dwellings proposed as part of the Phase 1 development for the Station Hill site.
- During the daytime and night-time, the combined building services plant noise emission contribution limit advised is 33 dB(A) and 26 dB(A) respectively, one metre from the nearest residential façade.
- The total building services noise emissions shall also not exceed 45 dB(A) at one metre from an office façade with opening windows and 60 dB(A) with a sealed façade. This assumes a partially opened window provides a 10 dB(A) noise reduction and a sealed façade will provide a minimum noise reduction of 25 dB(A).
- A high-level assessment of the building envelope acoustic performance is provided and indicates that the ventilation strategy should allow for full mechanical ventilation of all spaces as the level differences required are above those achievable by simple means of natural ventilation. Windows may be openable for purge ventilation.
- Notional glazing requirements and indicative primary glazing configurations have been provided for guidance purposes only. Detailed analysis and modelling will be required to be undertaken to determine refined glazing requirements once finalised plan and elevation drawings are achievable.
- It is confirmed that suitable internal noise levels are achievable, thereby confirming that the site is suitable for the proposed residential and commercial development.

1. Introduction.

Hoare Lea has been appointed by SH Reading Master LLP to conduct an environmental noise survey in support of the hybrid planning application for the North Site. The hybrid planning application comprises a detailed application (Plot G, Podium and Landscape) and an outline application (Plots A, B, C and D). This report considers Plots A, B, C and D (outline application).

The outline application for the redevelopment of the site comprises four buildings, known as Blocks A, B, C and D, comprising a range of office (Use Class B1), flexible retail and leisure (Use Class A1-A5 and D2) and residential uses (Use Class C1 / C2 / C3). The proposal will also include the installation of new mechanical services plant.

An environmental noise survey is required to quantify the existing ambient and background noise levels at the site in order to establish the design constraints on noise emissions from the operation of plant. The noise survey will also provide information required to establish the acoustic performance of the building façade and ventilation strategy to ensure that the accommodation is in accordance with the Local Authority requirements and current guidance.

This report provides a description of the results from the noise survey undertaken, an assessment to determine the external noise limits for building services plant required to meet the Local Authority's general noise emission limits and advice regarding the building envelope and ventilation strategy.

The report is necessarily technical in nature, but to aid in the understanding of the assessment, definitions of technical terms used have been included in Appendix A.

2. Site description.

2.1 Existing site.

The existing site is formed of a disused and dilapidated office building and an existing NCP car park, and is located between Garrard Street, Station Hill and Reading train station within Reading.

The surrounding buildings are generally commercial in nature, including offices within Thames Tower to the east. There are also several residential dwellings in close proximity of the site, including residential dwellings along Merchants Place, Garrard Street, as well as the Novotel and Ibis Hotels which are located to the south east of the site. It is also noted that the future residential dwellings will be introduced to the south of Garrard Street as part of the Phase 1 development for Station Hill.

The proposed site (indicative only) and neighbouring commercial units are identified in Figure 1 below.

2.2 Local noise environment.

The surrounding noise climate is predominantly formed of road traffic noise from the immediate road network around the site, in particular also vehicles (including taxis and buses) using Greyfriars Road, Garrard Street and Station Hill.

Daytime noise activities within the vicinity of the proposed development were observed to include the following:

- Vehicles serving Reading Station and the drop-off point on Station Hill;
- Idling taxis (with engines running) queuing along Garrard Street as they approach the Reading Station taxi rank on Station Road;
- Trains serving Reading Station to the north of the site. Train movements were observed to be frequent, although slow moving as trains approached / left Reading Station; and
- PA announcements associated with trains serving Reading Station.

Night-time noise activities within the vicinity of the proposed development were observed to include the following:

- Taxis were observed to travel a circular route from Friar Street, to Station Hill before returning to Station Road via Garrard Street; and
- Trains serving Reading Station to the north of the site, including PA announcements.

It is also noted that night-time activities were influenced by pedestrians serving the nearby clubs *Popworld* and *Lola Lo*, which are located on Friar Street. *Popworld's* typical opening hours are understood to be 2200 to 0200 on Thursdays, 2100 to 0400 on Fridays and 2000 to 0400 on Saturdays, whilst opening hours at *Lola Lo* are understood to be 2000 to 0300 on Tuesdays and Thursdays and 2100 to 0400 on Fridays and Saturdays.



Figure 1: Existing site (indicative only).

© Google Earth.

3. Basis of assessment.

3.1 National Planning Policy Framework (NPPF).

The revised National Planning Policy Framework (1) published in July 2018 and updated in February and June 2019 sets out the Government's current planning policies for England and how these are expected to be applied. The NPPF supersedes the previous NPPF published in March 2012.

With regards to local noise and vibration, paragraph 180 states:

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

- a. Mitigate and reduce to a minimum potential adverse impact resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;*
- b. Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and*
- c. Limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation."*

Reference is made to the DEFRA Noise Policy Statement for England 2010 (NPSfE). This latter document is intended to apply to all forms of noise other than that which occurs in the workplace and includes environmental noise and neighbourhood noise in all forms.

The NPSfE advises that the impact of noise should be assessed on the basis of adverse and significant effect but does not provide any specific guidance on assessment methods or limit sound levels. Moreover, the document advises that it is not possible to have 'a single objective noise-based measure...that is applicable to all sources of noise in all situations'. It further advises that the sound level at which an adverse effect occurs is 'likely to be different for different noise sources, for different receptors and at different times'.

In the absence of specific guidance for assessment of environmental noise within the NPPF and the NPSfE, it is considered appropriate to base assessment on current British Standards and national guidance. These are considered to be Local Authority guidance, BS 4142 (2), BS 8233 (3) and the World Health Organisations (4) (WHO) guidelines.

3.2 BS 4142: 2014.

Current Government advice to Local Planning Authorities in both England and Wales makes reference to BS 4142 as being the appropriate guidance for assessing commercial operations and fixed building services plant noise. This British Standard provides an objective method for rating the likelihood of complaint from industrial and commercial operations. It also describes means of determining noise levels from fixed plant installations and determining the background noise levels that prevail on a site.

The assessment of impacts is based on the subtraction of the measured background noise level from the rating level determined. The rating level is the source noise level (either measured or predicted) corrected for tone or character (if necessary). The difference is compared to the following criteria to evaluate the impact.

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact.
- A difference of around +5 dB indicates is likely to be an indication of an adverse impact.
- Where the rating level does not exceed the background noise level, this is an indication of the specific sound source having a low impact.

This method is only applicable for external noise levels.

3.3 BS 8233: 2014 – Sound insulation and noise reduction for buildings.

BS 8233: 2014 provides guidance for control of noise in and around buildings, and suggests appropriate criteria and limits for different situations. The criteria and limits are primarily intended to guide the design of new or refurbished buildings undergoing a change of use.

Table 4 within BS 8233 provides desirable internal ambient noise levels for spaces in residential dwellings when they are unoccupied.

Activity	Location	Daytime (0700 to 2300)	Night-Time (2300 to 0700)
Resting	Living Room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining Room / Area	40 dB $L_{Aeq,16hr}$	-
Sleeping (Daytime Resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$

Table 1: Indoor ambient noise levels in spaces for dwellings.

Supplementary Note 2 and 4 to Table 4 within BS 8233 are copied below for reference:

'NOTE 2 – the levels shown in Table 4 are based on the existing guidelines issued by the WHO...'

'NOTE 4 – regular individual noise events (for example, schedule aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$ depending on the character and number of events per night.'

Guidance provided within the superseded BS 8233: 1999 (5) stated that *'for a reasonable standard in bedrooms at night, individual noise events (measured with F-time weighting) should not normally exceed 45 dB L_{Amax} '*. This follows current guidelines issued by the WHO.

3.4 The British Council for Offices (BCO) guide to specification 2019.

The British Council for Offices Guide provides guidance on sustainability, cost and value, building form, engineering systems and finishes within commercial offices. In particular, the BCO Guide provides advice within Section 11 regarding the acoustic environment within an office building, as summarised below.

External noise intrusion levels should not be more than the following ratings when measured in terms of $L_{eq,T}$.

- Open plan offices: NR 40 ($L_{eq,T}$)
- Speculative offices: NR 38 ($L_{eq,T}$)
- Cellular offices / meeting rooms NR 35 ($L_{eq,T}$)

In addition, $L_{A01,1hr}$ noise intrusion levels should not normally be more than 55 dB in open plan / speculative offices or 50 dB in cellular offices.

Flanking transmission horizontally across cladding mullions should be capable of demonstrating a weighted normalised flanking level difference of at least $D_{nF,w}$ 45 dB when tested in accordance with BS EN ISO 10848-2: 2006 (6) and rated in accordance with BS EN ISO 717-1: 2013 (7). Flanking constructions should be capable of being upgraded in the fit out up to at least $D_{nF,w}$ 53 dB without affecting warranties.

3.5 Local planning policy.

3.5.1 Reading Borough Local Development Framework, Core Strategy, January 2008 (updated 2015).

The Reading Borough Local Development Framework Core Strategy adopted in January 2008 (with alteration adopted 27th January 2015) is the key spatial planning document and seeks to set out the key elements of the planning framework for the Reading area.

In respect of noise, the Core Strategy contains a single relevant policy, this is *Policy CS34*.

3.5.1.1 Policy CS34: Pollution and water resources.

Policy CS34 states the following:

"Development will only be permitted where it would not be damaging to the environment through air, land, noise or light pollution; where it would preserve or ideally enhance ground and surface water quality; and where existing water resources, sewerage and wastewater treatment infrastructure are adequate to support the proposed development.

Proposals for development that are sensitive to the effects of air, noise or light pollution will only be permitted in areas where they will not be subject to high levels of such pollution, unless adequate mitigation measures are provided to minimise the impact of such pollution."

3.5.2 Reading Borough Local Development Framework, Sites and Detailed Policies Document, October 2012 (updated 2015).

The Reading Borough Local Development Framework Sites and Detailed Policies Document adopted in October 2012 (with alteration adopted 27th January 2015) is intrinsically linked to the Core Strategy. The Document provides detailed planning policies in order to deliver the Core Strategy.

In respect of noise, the Sites and Detailed Policies Document contains a single relevant policy, this is *Policy DM4*.

3.5.2.1 Policy DM4: Safeguarding amenity.

Policy DM4 states the following:

"Development will not cause a significant detrimental impact to the living environment of existing or new residential properties, in terms of:

- *Privacy and overlooking;*
- *Access to sunlight and daylight;*
- *Visual dominance and overbearing effects of a development;*
- *Noise and disturbance;*
- *Artificial lighting;*
- *Vibration;*
- *Dust and fumes;*
- *Smell; or*
- *Crime and safety."*

3.5.3 Reading Borough Local Development Framework, Reading Central Area Action Plan, January 2009.

The Reading Borough Local Development Framework Central Area Action Plan adopted in January 2009 forms part of the Local Development Framework for the Borough and establishes planning framework for specific areas within Reading where significant change or conservation has been identified as being required.

In respect of noise, the Area Action Plan contains a single relevant policy, this is *Policy RC9*.

3.5.3.1 Policy RC9: Living in the centre.

Policy RC9 states the following:

"Proposals for residential development within the central area will be assessed against the following criteria:

ii. Proposals for new residential development within the central area will be required to demonstrate how the issue of potential noise disturbance from neighbouring land uses and other sources, and air quality implications of residential development, have been considered and if necessary, mitigated. New residential development should not be located next to existing town centre uses where those uses would give rise to unacceptable levels of noise and disturbance to the occupiers of the new scheme, unless this can be mitigated. "

3.5.4 Reading Borough Local Plan, November 2019.

The Reading Borough Local Plan adopted in November 2019 contains policies for how Reading will develop up to 2036.

In respect of noise, the Local Plan contains four relevant policies, these are *Policies CC8, N16, EN17 and CR6*.

3.5.4.1 Policy CC8: Safeguarding amenity.

Policy CC8 states the following:

"Development will not cause a detrimental impact on the living environment of existing residential properties or unacceptable living conditions for new residential properties, in terms of:

- *Privacy and overlooking;*
- *Access to sunlight and daylight;*
- *Visual dominance and overbearing effects of a development;*
- *Harm to outlook;*
- *Noise and disturbance;*
- *Artificial lighting;*
- *Vibration;*
- *Dust and fumes;*
- *Smell;*
- *Crime and safety; or*
- *Wind, where the proposals involve new development of more than 8 storeys."*

3.5.4.2 Policy EN16: Pollution and water resources.

Policy EN16 states the following:

"Development will only be permitted where it would not be damaging to the environment and sensitive receptors through land, noise or light pollution ...

Proposals for development that are sensitive to the effects of noise or light pollution will only be permitted in areas where they will not be subject to high levels of such pollution unless adequate mitigation measures are provided to minimise the impact of such pollution."

3.5.4.3 Policy EN17: Noise generating equipment.

Policy EN17 states the following:

"Where noise generating equipment is proposed, the noise source specific level (plant noise level) should be at least 10 dBA below the existing background level as measured at the nearest noise sensitive receptor."

3.5.4.4 Policy CR6: Living in Central Reading.

Policy CR6 states the following:

"Proposals for residential development within the central area will be assessed against the following criteria:

- ii) *Proposals for new residential development within the central area will be required to demonstrate how the issue of potential noise disturbance from neighbouring land uses and other sources, and air quality implications of residential development, have been considered and if necessary, mitigated. New residential development should not be located next to existing town centre uses where those uses would give rise to unacceptable levels of noise and disturbance to the occupiers of the new scheme, unless this can be mitigated."*

3.6 Proposed standards.

Given the lack of specific guidance within Reading Borough Council's planning policy in relation to internal noise levels, it is deemed appropriate to base assessment on current guidance and British Standards. This is considered to be BS 8233: 2014.

3.6.1 Building services – noise.

On the basis of guidance contained within Reading Borough Council's Draft Local Plan and based on previous conditions imposed by Reading Borough Council, all building services plant shall be designed to achieve the following noise emission limits.

Description of noise source	Noise emission limit
Building services plant	$L_{Ar,Tr} = L_{A90,T} - 10 \text{ dB}$

Table 2: Noise emission limits for building services.

Additionally, for plant noise that is tonal, contains a specific character or is intermittent, the limits of Table 2 above need to include a character correction as defined within BS 4142: 2014.

3.6.2 Environmental noise – internal noise levels.

On the basis of guidance provided by Reading Borough Council, the development will be designed to enable achievement of the internal noise levels contained within BS 8233 and the BCO Guide to Specification.

Location	Daytime (0700 to 2300)			Night-time (2300 to 0700)
Residential				
Living Room	35 dB L _{Aeq,16hr}			-
Bedroom	35 dB L _{Aeq,16hr}			30 dB L _{Aeq,8hr} & 45 dB L _{Amax,T}
Commercial				
Restaurant / café / retail unit	40 dB L _{Aeq,T}			-
Open-plan office	40 dB L _{Aeq,T}	55 dB L _{Amax,F}	NR 38	-
Cellular space (meeting room, office etc.)	35 dB L _{Aeq,T}	50 dB L _{Amax,F}	NR 35	-

Table 3: Proposed internal noise level criteria.

4. Environmental noise survey.

An acoustic survey has been carried out at the site to establish the prevailing environmental noise conditions local to the site, so as to determine building services plant noise emission limits and to advise upon the building envelope and ventilation strategy.

4.1 Methodology

The survey comprised fourteen days of unattended automatic noise measurements at three locations by three noise monitors. The position of these monitors is shown as positions L1, L2 and L3 in Figure 2 below. The measurements at positions L1 and L3 were façade measurements, approximately 1m from the façade at second floor level, whilst the measurements at position L2 were located above the site hoarding at a height of approximately 2.5m above ground floor level.

Measurements recorded consisted of fifteen-minute samples of ambient noise levels ($L_{Aeq,15min}$ in dB), maximum noise levels ($L_{Amax,15min}$ in dB) and background noise levels ($L_{A90,15min}$ in dB) between Monday 17th September 2018 and Monday 1st October 2018.

Sample octave band measurements have also been conducted at nine positions at ground floor level during the daytime and night-time. The position of these measurements is shown within Figure 2 and were hand-held samples at a height of 1.2m above ground floor level and considered “free-field”. These measurement positions were selected to quantify noise levels associated with various sources around the site (road traffic, bus and taxi movements, noise from *Popworld* etc.).



Figure 2: Measurement locations.

© Google Earth.

The measurement instrumentation used is listed in Appendix B attached and a general acoustic terminology is provided in Appendix A.

During the measurement period, weather conditions were variable but were generally suitable for environmental noise measurements. Poor weather conditions were encountered between Monday 17th

September and Saturday 22nd September with wind speeds regularly above 5m/s. As such, this data has been removed from the subsequent analysis.

4.2 Results summary.

A time history of the L_{Aeq} , L_{A90} and L_{Amax} from the unattended measurements recorded at positions L1, L2 and L3 is shown in Appendix C attached.

The results of the unattended measurements at positions L1, L2 and L3 have been calculated into daytime ($L_{Aeq,16hr}$) and night-time ($L_{Aeq,8hr}$) equivalent levels, and are shown with the associated measured minimum background noise level ($L_{A90,T}$) and maximum instantaneous measured noise level ($L_{Amax,T}$) in Table 5 overleaf.

It should be noted that the minimum daytime ($L_{A90,1hr}$) background noise level shown overleaf is the lowest arithmetic average of the measured background noise levels ($L_{A90,15min}$) in an hourly period. Similarly, the maximum events shown in Table 5 are the maximum measured in each corresponding period.

As shown in Table 5, noise levels measured by the unattended noise logger at position L2 and position L1 indicate that the lowest background noise level was $L_{A90,1hr}$ 43 dB during the daytime and $L_{A90,15min}$ 36 dB during the night-time.

A summary of the attended measurements conducted at positions the attended measurement positions is provided in Table 4 below.

Measurement Position	Typical $L_{Aeq,T}$ dB	Ninetieth Percentile $L_{Amax,T}$ dB
Daytime		
S1	58	71
S2	60	76
S3	65	77
S4	62	78
S5	56	74
S6	63	76
Night-time		
S1	58	67
S2	63	81
S7 (<i>Popworld & Lola Lo</i>)	71	81
S9	65	77

Table 4: Measured noise levels at attended positions.

Full details of the hand-held octave band measurements at all positions during the daytime are shown in the tables within Appendix D attached.

Measurement Date	Time	Position L1						Position L2						Position L3					
		Daytime			Night-Time			Daytime			Night-Time			Daytime			Night-Time		
		L _{Aeq,16hr} dB	Min L _{A90,1hr} dB	Max L _{Amax,T} dB	L _{Aeq,8hr} dB	Min L _{A90,15min} dB	Max L _{Amax,T} dB	L _{Aeq,16hr} dB	Min L _{A90,1hr} dB	Max L _{Amax,T} dB	L _{Aeq,8hr} dB	Min L _{A90,15min} dB	Max L _{Amax,T} dB	L _{Aeq,16hr} dB	Min L _{A90,1hr} dB	Max L _{Amax,T} dB	L _{Aeq,8hr} dB	Min L _{A90,15min} dB	Max L _{Amax,T} dB
Monday 17 th September 2018	1230 – 2300	64*	48*	95*	-	-	-	56**	51**	86**	-	-	-	67**	52**	106**	-	-	-
17 th / 18 th September 2018	2300 – 0700	-	-	-	58*	41*	93*	-	-	-	55**	41**	78**	-	-	-	61**	46**	86**
Tuesday 18 th September 2018	0700 – 2300	67*	50*	101*	-	-	-	58**	52**	94**	-	-	-	67**	53**	95**	-	-	-
18 th / 19 th September 2018	2300 – 0700	-	-	-	58*	38*	84*	-	-	-	53**	38**	78**	-	-	-	62**	47**	90**
Wednesday 19 th September 2018	0700 – 2300	69**	52**	88**	-	-	-	58**	52**	85**	-	-	-	67**	54**	99**	-	-	-
19 th / 20 th September 2018	2300 – 0700	-	-	-	59**	40**	82**	-	-	-	53**	40**	79**	-	-	-	63**	48**	92**
Thursday 20 th September 2018	0700 – 2300	65**	55**	96**	-	-	-	59**	54**	85**	-	-	-	67**	57**	94**	-	-	-
20 th / 21 st September 2018	2300 – 0700	-	-	-	63**	46**	88**	-	-	-	56**	44**	77**	-	-	-	64**	48**	86**
Friday 21 st September 2018	0700 – 2300	66**	53**	96**	-	-	-	58**	54**	88**	-	-	-	66**	55**	98**	-	-	-
21 st / 22 nd September 2018	2300 – 0700	-	-	-	59**	42**	86**	-	-	-	54**	40**	88**	-	-	-	69**	48**	95**
Saturday 22 nd September 2018	0700 – 2300	65	48	88	-	-	-	58	50	84	-	-	-	67	51	94	-	-	-
22 nd / 23 rd September 2018	2300 – 0700	-	-	-	61	40	87	-	-	-	52	38	82	-	-	-	69	48	93
Sunday 23 rd September 2018	0700 – 2300	65	50	85	-	-	-	57	48	80	-	-	-	65	51	94	-	-	-
23 rd / 24 th September 2018	2300 – 0700	-	-	-	-	-	-	-	-	-	50	37	69	-	-	-	64	47	90
Monday 24 th September 2018	0700 – 2300	64	50	86	-	-	-	57	52	90	-	-	-	66	53	95	-	-	-
24 th / 25 th September 2018	2300 – 0700	-	-	-	57	37	84	-	-	-	50	37	77	-	-	-	63	47	87
Tuesday 25 th September 2018	0700 – 2300	65	50	92	-	-	-	57	51	91	-	-	-	66	55	88	-	-	-
25 th / 26 th September 2018	2300 – 0700	-	-	-	58	38	85	-	-	-	51	38	78	-	-	-	67	47	92
Wednesday 26 th September 2018	0700 – 2300	68	51	93	-	-	-	57	51	88	-	-	-	67	54	103	-	-	-
26 th / 27 th September 2018	2300 – 0700	-	-	-	59	37	85	-	-	-	52	37	72	-	-	-	66	47	87
Thursday 27 th September 2018	0700 – 2300	68	51	88	-	-	-	58	52	95	-	-	-	66	53	96	-	-	-
27 th / 28 th September 2018	2300 – 0700	-	-	-	59	37	81	-	-	-	52	37	72	-	-	-	66	45	100
Friday 28 th September 2018	0700 – 2300	67	53	89	-	-	-	58	52	94	-	-	-	66	53	93	-	-	-
28 th / 29 th September 2018	2300 – 0700	-	-	-	61	39	87	-	-	-	52	40	80	-	-	-	68	47	93
Saturday 29 th September 2018	0700 – 2300	62	50	91	-	-	-	57	52	94	-	-	-	66	51	103	-	-	-
29 th / 30 th September 2018	2300 – 0700	-	-	-	61	38	83	-	-	-	52	38	75	-	-	-	68	46	91
Sunday 30 th September 2018	0700 – 2300	62	44	89	-	-	-	59	43	93	-	-	-	63	47	93	-	-	-
30 th September / 1 st October 2018	2300 – 0700	-	-	-	59	36	89	-	-	-	54	37	76	-	-	-	61	43	88
Monday 1 st October 2018	0700 – 1245	68	54	94	-	-	-	57	53	81	-	-	-	66	55	93	-	-	-

Table 5: Measured noise levels at position L1, L2 and L3.

Note *: Greyfriars Road was closed on Monday 17th and Tuesday 18th September and therefore impacted the measured values at position L1. This data has therefore been removed from the analysis.

Note **: Poor weather conditions were encountered with wind speeds regularly above 5 m/s. This data has therefore been removed from the analysis.

5. Noise sensitive areas.

A noise sensitive area is defined as landscapes or buildings where the occupiers are likely to be sensitive to noise created by plant installed in the proposed development, including residential areas. Noise sensitive receptors around the site have been identified and are shown in Figure 3 below.

Of the noise sensitive receptors identified in Figure 3, the nearest noise sensitive receptors to the proposed development have been identified as existing residential dwellings above The Greyfriars and Gateway public houses on Greyfriars Road and also future residential dwellings proposed as part of the Phase 1 development for the Station Hill site.



Figure 3: Nearest noise sensitive receptors.

© Google Earth.

6. Noise emissions of fixed plant.

Noise levels due to building services serving the proposed development are advised to meet the following noise level criteria shown below in Table 6 one metre from the nearest noise sensitive area as identified in Section 6. These are based on the lowest background noise levels measured at the unattended loggers which are deemed representative of the nearest noise sensitive receptors.

Period	Lowest Prevailing Background Noise Level $L_{A90,T}$ dB	Noise Emission Limit Calculation $L_{A_{r,Tr}}$ dB
Daytime (0700 to 2300)	43	33
Night-Time (2300 to 0700)	36	26

Table 6: Building services noise emission limits.

It should be noted that each of the limits stated above are the combined operational noise levels of plant at the nearest noise sensitive façade. As such, the combined operational noise levels of all plant are required to achieve the noise limits defined above.

For plant noise that is tonal, contains a specific character or is intermittent, the limits of Table 6 above need to include character correction in accordance with BS 4142: 2014.

Consideration could be given to a slightly higher noise emission limit during the night-time, as this is a very low level and may not be achievable.

Noise levels outside commercial buildings should be acceptable at marginally higher levels than those proposed outside noise sensitive residential façades. Based on the level of noise that should be acceptable inside an office (35 to 40 dB in accordance with BS 8233: 2014) from external noise sources, the proposed plant could produce a noise level of 45-50 dB L_{Aeq} at one metre from commercial units with opening windows. This is determined on the basis that the internal noise level would not exceed 35 dB L_{Aeq} when a window is partially opened.

Similarly, for an office with a sealed façade, the proposed plant could produce a level of 60-65 dB L_{Aeq} at one metre, assuming that a sealed façade will provide a minimum noise reduction of 25 dB(A).

7. Noise prediction model.

In order to predict the external noise levels across the proposed development site and to determine a suitable ventilation strategy, a noise map has been created using CADNA environmental noise prediction and mapping software.

A baseline noise map was generated of the existing site using the results of the environmental noise survey and calibrated for daytime equivalent noise levels ($L_{Aeq,T}$), night-time equivalent noise levels ($L_{Aeq,8hr}$) and the maximum ninetieth percentile daytime and night-time $L_{Amax,T}$. The noise map was calibrated for each of the noise sources discussed in Section 2.2.

The noise map for the existing site during the daytime ($L_{Aeq,T}$ and $L_{Amax,T}$) and night-time ($L_{Aeq,8hr}$ and $L_{Amax,T}$) at a height of 1.5m above ground floor level is shown in Appendix E attached. A height of 1.5m was chosen as this is the preferred measurement height for environmental noise measurement and thus appropriate for noise prediction.

Detailed plan and elevation drawings are not available for the outline element of the Proposed Development at this stage. As such, it has not been possible to produce a noise map of the site with the proposed development in-situ. This exercise will be undertaken as part of the future detailed application; however, a noise map for the detailed proposals in-situ has been produced and is shown in Appendix F.

8. Building envelope & ventilation strategy.

The sound insulation properties of the building envelope depend upon the external noise levels present at the façade and the proposed design criteria for the internal noise levels of specific rooms, dependant on their use. As the proposals are outline at this stage and as noted above, it has not been possible to produce a noise map of the site with the proposed development in-situ, the baseline noise map of the site with the detailed proposals has been used to enable a high-level assessment of the proposed development.

Table 7 below assumes compliance with the internal noise levels stated in Table 3 and shows the highest level differences for each of the spaces within the proposed development based on the highest noise level predicted at the building façades.

It should be noted that the highest level difference (D) shown for bedrooms within Table 7 takes precedence.

Building	Room Use	Noise Levels (dB)		
		Predicted External	Proposed Internal (Maximum)	Minimum Level Difference D
Block A	Living room ¹	70	35	35
	Bedroom ¹	65	30	35
	Bedroom (L_{Amax}) ²	85	45	40
Block B / D	Living room ¹	65	35	30
	Bedroom ¹	60	30	30
	Bedroom (L_{Amax}) ²	83	45	38
Block C	Open-plan office	63	40	23
	Open-plan office (L_{Amax})	81	55	26
	Cellular space	63	35	28
	Cellular space (L_{Amax})	81	50	31

Table 7: Notional sound insulation values of proposed façade construction.

Note 1: Bedroom (day) $L_{Aeq,16hr}$ (0700 to 2300) and bedroom (night) $L_{Aeq,8hr}$ (2300 to 0700).

Note 2: Bedroom $L_{Amax,T}$ (2300 to 0700).

Simple natural ventilation through the use of opening windows will provide a level difference (D) in the order of 10 dB. It can be seen from Table 7 above that all internal spaces require greater levels of sound insulation based on the measured external noise levels.

As such, although windows may be openable for purge ventilation, provision for alternative forms of ventilation will need to be made such that windows are not required to be opened for ventilation purposes.

Table 8 overleaf details the minimum required $R_w + C_{tr}$ of all window elements (glazing, seals, frames etc.) to each building

Façade	Minimum required $R_w + C_{tr}$ (dB)			
	Open-plan office	Cellular office	Living room	Bedroom
Block A	-	-	35	40
Block B / D	-	-	30*	38
Block C	26*	31*	-	-

Table 8: Minimum required $R_w + C_{tr}$ of glazed elements.

Note *: Achievable with a standard thermal double-glazed unit.

It should be noted that at this stage it is assumed that the non-glazed element on all façades will be capable of achieving a sound reduction of 46 dB $R_w + C_{tr}$. An example of an external wall capable of achieving this requirement is a 100mm cavity wall construction.

Examples of primary glazing configurations capable of achieving the minimum required $R_w + C_{tr}$ detailed within Table 8 are provided below:

- $R_w + C_{tr}$ 26 dB – 6mm glass, 16mm air gap, 6mm glass.
- $R_w + C_{tr}$ 31 dB – 10mm glass, 16mm air gap, 6mm glass.
- $R_w + C_{tr}$ 35 dB – 6mm glass, 16mm air gap, 10.8mm acoustic glass.
- $R_w + C_{tr}$ 40 dB – 8.8mm acoustic glass, 16mm air gap, 12.8mm acoustic glass.

It should be noted that at this stage the required glazing sound insulation values are notional. Further detailed analysis and modelling will be required to be undertaken once finalised proposals are available. The sound insulation values stated within Table 8 are therefore indicative and for guidance purposes only, however these confirm that suitable internal noise levels are achievable, thereby confirming that the site is suitable for the proposed residential and commercial development.

It should also be noted that the sound insulation values represent the highest performances required. It is expected that façades on the rear (internal facing) elevations will be exposed to lower levels of noise, due to the screening provided by the built form of the development, and will therefore require lower sound insulation values than those stated in Table 8. This can be confirmed with further analysis and modelling once the finalised proposals are available.

8.1 Compliance.

In order to confirm the suitability of the proposed glazed and non-glazed elements, evidence of the laboratory sound insulation performance will be required for the entire unit as it will be installed (including glass, frame, seals, mullions and transoms). All acoustic testing shall be undertaken in controlled laboratory conditions in accordance with ISO 10140-2: 2010 – “Acoustics – Laboratory measurement of sound insulation of building elements. Part 2: Measurement of airborne sound insulation”. (8)

9. Summary & conclusions.

Hoare Lea has conducted an environmental noise survey for the proposed commercial and residential development at Station Hill North in Reading. Unattended noise monitoring throughout a typical fourteen-day period and sample octave band measurements were conducted.

Background noise levels typical of the daytime and night-time have been measured and used to define building services plant noise emission limits at the nearest noise sensitive receptors. The nearest receptors have been identified as existing residential dwellings above The Greyfriars and Gateway public houses on Greyfriars Road and also future residential dwellings proposed as part of the Phase 1 development.

During the daytime the combined building services plant noise emission contribution limit advised is 33 dB(A) and during the night-time the combined building services plant noise emission contribution limit advised is 26 dB(A), one metre from the nearest residential façade.

Additionally, the total building services noise emissions shall not exceed 45 dB(A) at one metre from an office façade with opening windows and 60 dB(A) with a closed façade. This assumes a partially opened window provides a 10 dB(A) noise reduction and a closed façade will provide a minimum noise reduction of 25 dB(A).

A high-level assessment of the building envelope acoustic performance based on indicative noise modelling is provided with the minimum level difference (D) in accordance with the internal noise criterion of BS 8233: 2014 and the BCO Guide. The ventilation strategy should allow for full mechanical ventilation of all spaces as the level differences required are above those achievable by simple means of natural ventilation.

Notional glazing requirements for varying internal spaces and indicative primary glazing configurations have been provided however, it should be noted that these performances are for guidance purposes only. Detailed analysis and modelling will be required to be undertaken to determine refined glazing requirements once finalised plan and elevation drawings are available. However, it is confirmed that suitable internal noise levels are achievable, thereby confirming that the site is suitable for the proposed residential and commercial development.

The guidance provided within this report is sufficient to satisfy the requirements of Reading Borough Council and the emerging policy, in our opinion.

10. References

1. *National Planning Policy Framework, Department for Communities and Local Government, February & June 2019.*
2. *BS 4142: 2014: 'Method for rating industrial and commercial sound'.*
3. *BS 8233: 2014, "Guidance on Sound Insulation and Noise Reduction for Buildings", BSI.*
4. *World Health Organisation (WHO) - Environmental Noise Guidelines for the European Region, 2018.*
5. *BS 8233: 1999, 'Sound Insulation and Noise Reduction for Buildings - Code of Practice'.*
6. *BS EN ISO 10848-2: 2006: 'Application to Light Elements when the Junction has a Small Influence'.*
7. *BS EN ISO 717-1: 2013. "Acoustics - Rating of Sound Insulation in Buildings and of Building Elements. Part 1: Airborne Sound Insulation."*
8. *ISO 10140-2: 2010, "Acoustics - Laboratory Measurement of Sound Insulation of Building Elements. Part 2: Measurement of Airborne Sound Insulation."*
9. *National Planning Policy Framework, Department for Communities and Local Government, February 2019.*

Appendix A – Acoustic terminology.

Sound

Sound is produced by mechanical vibration of a surface, which sets up rapid pressure fluctuations in the surrounding air.

The Sound Pressure

The Sound Pressure is the force (N) of sound on a surface area (m²) perpendicular to the direction of the sound. The SI-units for the Sound Pressure are Nm⁻² or Pa (Pascal).

Sound is measured with microphones responding proportionally to the sound pressure – p. The power is proportional to the square of the sound pressure.

The Sound Pressure Level

The human ear has an approximately logarithmic response to sound pressure over a very large dynamic range. The lowest audible sound pressure approximately 2×10^{-5} Pa (2 ten billionths of an atmosphere) and the highest is approximately 100 Pa.

It is therefore convenient to express the sound pressure as a logarithmic decibel scale related to this lowest human audible sound, where:

$$L_p = 10 \log \left(\frac{p^2}{p_{ref}^2} \right) = 10 \log \left(\frac{p}{p_{ref}} \right)^2 = 20 \log \left(\frac{p}{p_{ref}} \right)$$

Where:

L_p = sound pressure level (dB)

p = sound pressure (Pa)

$p_{ref} = 2 \times 10^{-5}$ – reference sound pressure (Pa)

In accordance with the logarithmic scale, doubling the sound pressure level gives an increase of 6 dB.

Decibel (dB)

The decibel is the unit used to quantify sound pressure levels as well as sound intensity and power levels.

In accordance with the logarithmic scale, an increase of 10 dB in sound pressure level is equivalent to an increase by a factor of 10 in the sound pressure level (measured in Pa). Subjectively, this increase would correspond to a doubling of the perceived loudness of the sound.

Sound Pressure Level of Some Common Sources

An indication of the range of sound levels commonly found in the environment is given in the following Table.

Source	Sound Pressure Level dB
Threshold of Hearing	0
Rustling Leaves	20
Quiet Whisper	30
Home	40
Quiet Street	50
Conversation	60
Inside a Car	70
Loud Singing	80
Motorcycle (10m)	90
Lawn Mower (1m)	100
Diesel Truck (1m)	110
Amplified Music (1m)	120
Jet Plane (1m)	130

Frequency

The rate at which the pressure fluctuations occur determines the pitch or frequency of the sound. The frequency is expressed in Hertz (Hz) or cycles per second.

Octave and Third Octave Bands

An octave is the interval between two points where the frequency at the second point is twice the frequency of the first.

There are many methods of describing the frequency content of a noise. The most common methods split the frequency range into defined bands, in which the mid-frequency is used as the band descriptor and in the case of octave bands is double that of the band lower. For example, two adjacent octave bands are 250 Hz and 500 Hz.

Third octave bands provided a fine resolution by dividing each octave band into three bands. For examples, third octave bands would be 160 Hz, 250 Hz and 315 Hz for the same 250 Hz octave band.

The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high frequency than to low frequencies within the range. This is the basis of the A-weighting.

A-Weighting

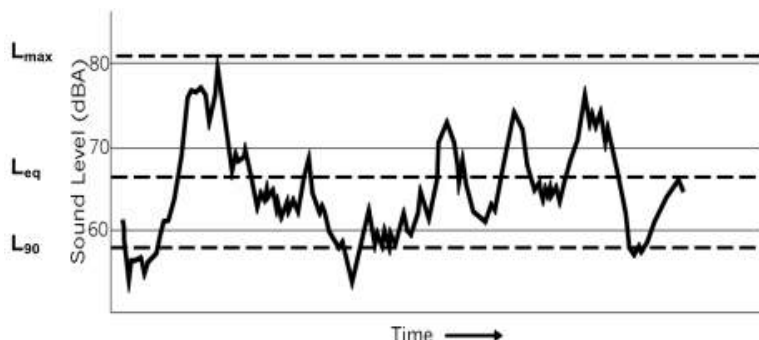
The A-weighting is a correction term applied to the frequency range in order to mimic the sensitivity of the human ear to noise. It is generally used to obtain an overall noise level from octave or third octave band frequencies.

An A weighted value would be written as dB(A), or including A within the parameter term.

Noise Units

In order to assess environmental noise, measurements are carried out by sampling over specific periods of time, such as five minutes, the statistically determined results being used to quantify various aspects of the noise.

The figure below shows an example of sound level varying with time. Because of this time variation the same period of noise can be described by several different levels. The most common of these are described below.



$L_{eq,T}$

The $L_{eq,T}$ is a parameter defined as the equivalent continuous sound pressure level over a defined time period 'T'. It is the sound pressure level equivalent to the acoustic energy of the fluctuating sound signal.

The $L_{eq,T}$ can be thought of as an 'average' sound pressure level over a given time period (although it is not an arithmetic average). Typically the $L_{eq,T}$ will be an A-weighted noise level in dB(A) and is commonly used to describe all types of environmental noise sources.

$L_{01,T}$

The $L_{01,T}$ is a parameter defined as the sound pressure level exceeded for 1% of the measurement period 'T'. It is a statistical parameter and cannot be directly combined to other acoustic parameter.

$L_{10,T}$

The $L_{10,T}$ is a parameter defined as the sound pressure level exceeded for 10% of the measurement period 'T'. It is a statistical parameter and cannot be directly combined to other acoustic parameter and is generally used to describe road traffic noise.

$L_{90,T}$

The $L_{90,T}$ is a parameter defined as the sound pressure level exceeded for 90% of the measurement period 'T'. It is a statistical parameter and cannot be directly combined to other acoustic parameter and is generally used to describe the prevailing background noise level.

$L_{max,T}$

The $L_{max,T}$ is a parameter defined as the maximum noise level measured during the specified period 'T'.

Specific Noise Level, $L_{Aeq,T,r}$

This is the equivalent continuous A-weighted sound pressure level at the assessment position due to a specific noise source operating over a given time interval.

Free Field

A measurement taken in the free field is at least 3.5m from reflecting vertical surfaces and 1.2m from the ground.

Façade

A measurement is influenced by the reflection of sound from the façade of a building within 3.5m. A façade measurement is made 1m in front of the vertical building surface.

R_w

A single-number quantity which characterizes the airborne sound insulation of a material or building element in the laboratory. See BS EN ISO 717-1: 1997.

Appendix B – List of measurement equipment.

Environmental Noise Survey

Sound Level Meter (Position L1 – Unattended)

- Rion NL-52 Sound Level Meter (Serial Number 00832246)
- Rion NH-25 Pre-Amplifier (Serial Number 32274)
- Rion UC-59 Microphone (Serial Number 05473)

Sound Level Meter (Position L2 – Unattended)

- Rion NL-31 Sound Level Meter (Serial Number 00910453)
- Rion NH-21 Pre-Amplifier (Serial Number 02294)
- Rion NC-74 Sound Calibrator (Serial Number 34172705)
- Rion UC-53A Microphone (Serial Number 101799)

Sound Level Meter (Position L3 – Unattended)

- Rion NL-31 Sound Level Meter (Serial Number 00110032)
- Rion NH-21 Pre-Amplifier (Serial Number 00134)
- Rion NC-74 Sound Calibrator (Serial Number 34551669)
- Rion UC-53A Microphone (Serial Number 102143)

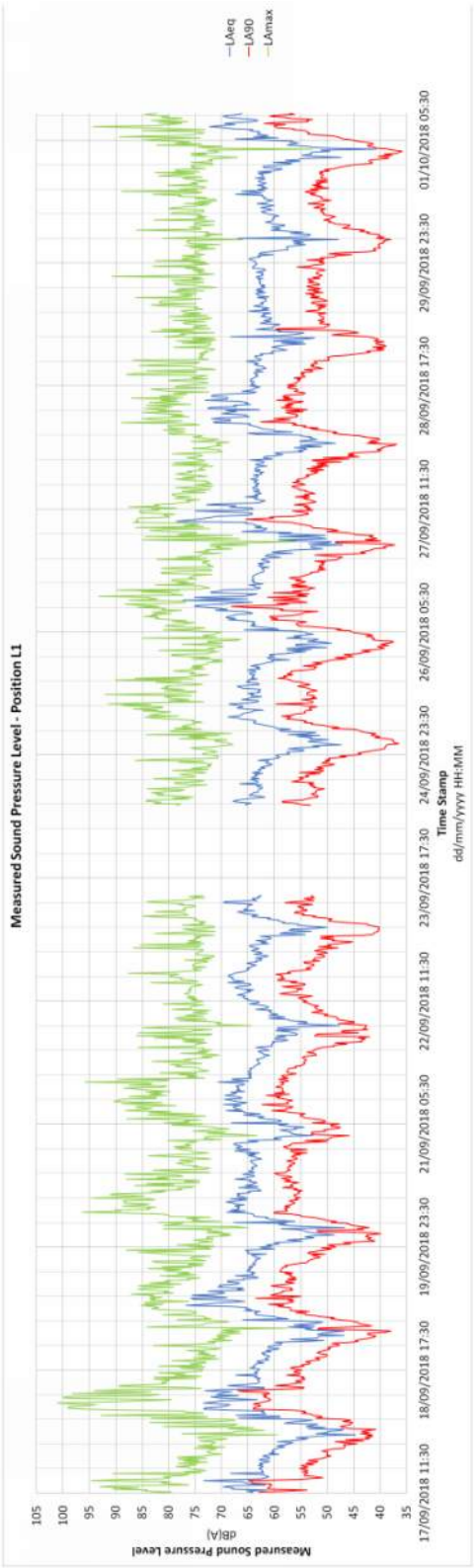
Noise Spectral Analyser (Octave Band Measurements at all Positions)

- Brüel and Kjær 2250 Sound Level Meter (Serial Number 3002554)
- Brüel and Kjær ZC 0032 Pre-Amplifier (Serial Number 19475)
- Brüel and Kjær 4231 Sound Calibrator (Serial Number 3017591)
- Brüel and Kjær 4189 Microphone (Serial Number 2887250)

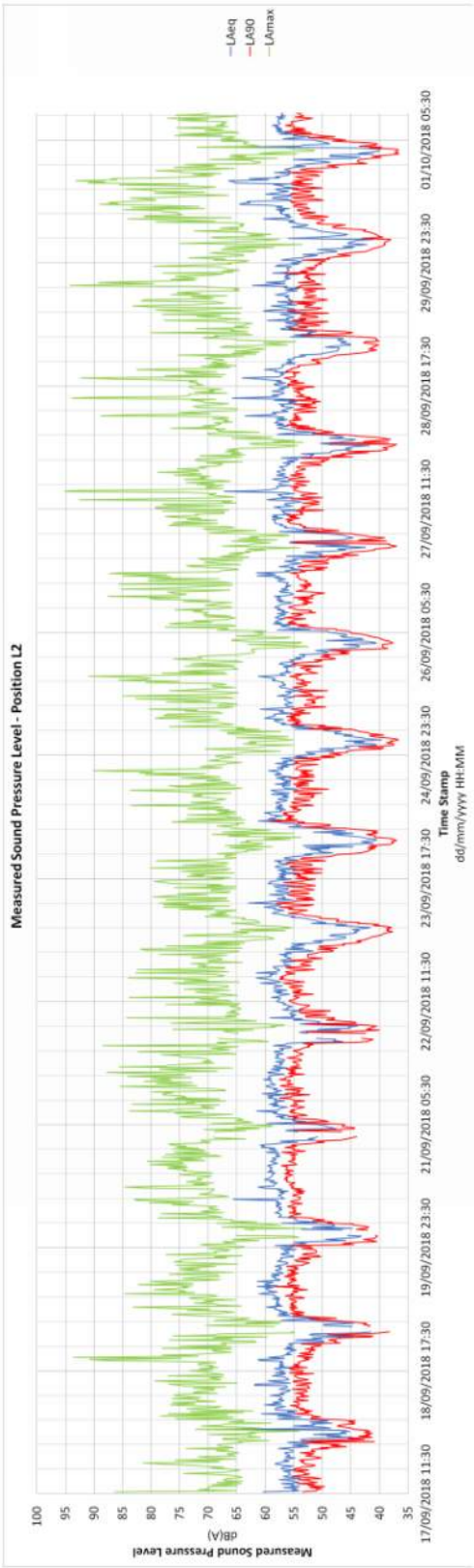
Sound level meters were field calibrated before and after noise survey and no discernible variations occurred.

Appendix C – Time history of unattended measurements.

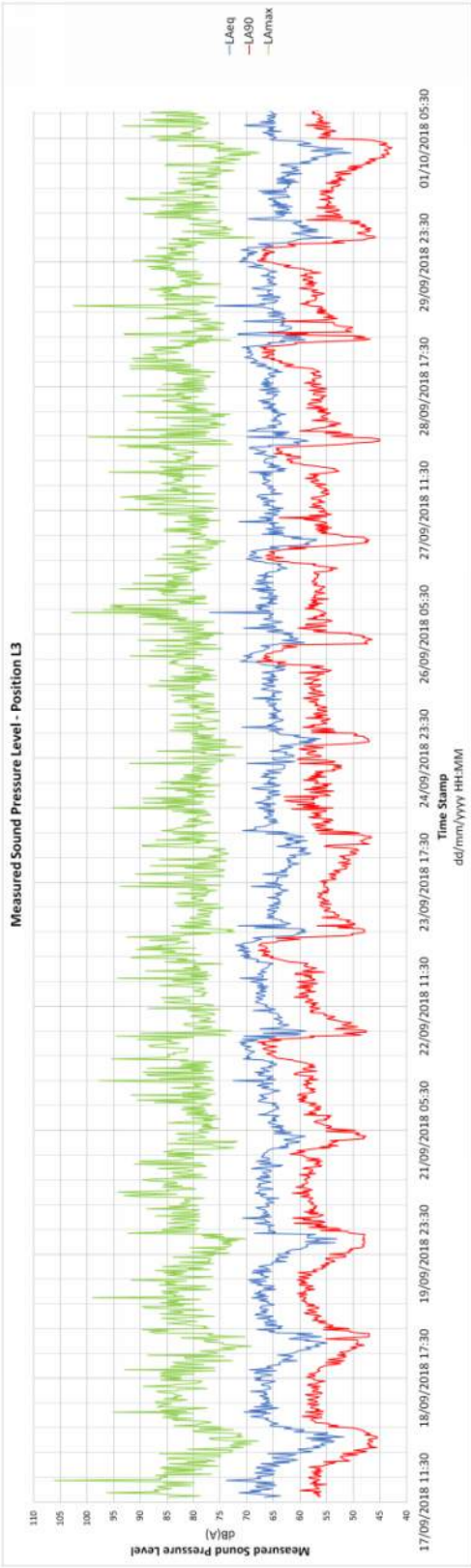
Position L1



Position L2



Position L3



Appendix D – Octave band levels at measurement positions.

Position	Measurement Period	Duration	Sound Pressure Level per Octave Band Frequency in dB										L _{Aeq,T} dB
			16Hz	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
S1	17/09/2018 13:00	00:05:00	63.8	71.7	66.2	59.2	57.2	52.2	49.3	45.7	43.1	37.6	55.2
	17/09/2018 13:05	00:05:00	64.9	79.1	69.9	63.8	59.7	54.0	55.9	51.1	44.4	37.9	59.6
	17/09/2018 13:11	00:05:00	65.7	77.5	70.8	65.0	61.6	53.9	55.2	50.4	43.9	37.8	59.5
	24/09/2018 13:16	00:05:00	64.7	74.3	67.5	60.3	57.2	54.9	53.9	50.7	44.7	36.0	58.4
	24/09/2018 13:21	00:05:00	66.6	70.2	67.5	63.7	58.5	54.1	52.3	48.9	44.4	35.3	57.9
	30/09/2018 00:16	00:05:00	64.8	75.7	68.8	61.7	56.9	53.6	54.6	49.1	42.8	35.1	58.1
S10	30/09/2018 00:29	00:05:00	58.4	66.7	70.3	65.7	59.5	59.2	57.6	56.1	52.3	45.9	63.0
S2	17/09/2018 13:25	00:05:00	64.6	68.0	69.1	63.1	56.7	55.7	56.0	51.1	45.0	37.6	59.5
	17/09/2018 13:30	00:05:00	61.6	64.4	64.8	61.1	56.4	54.7	54.9	48.3	41.1	34.4	58.0
	17/09/2018 13:35	00:05:00	63.5	72.1	66.8	61.0	55.2	54.4	53.0	48.4	47.6	35.7	57.5
	24/09/2018 13:01	00:05:00	68.8	68.3	66.3	62.3	55.7	54.3	55.8	51.4	45.8	37.8	59.2
	24/09/2018 13:07	00:05:00	71.5	71.3	69.3	67.9	61.7	58.0	59.1	53.5	47.2	39.8	62.6
S3	17/09/2018 13:50	00:05:00	77.7	79.5	72.3	66.6	63.6	62.0	58.9	55.4	48.9	42.0	64.0
	17/09/2018 13:55	00:05:00	76.2	79.7	74.3	66.4	63.7	61.7	58.2	55.5	49.0	42.6	63.8
	17/09/2018 14:09	00:05:00	75.9	75.6	72.6	65.3	63.9	61.9	58.0	55.3	53.0	48.8	63.9
	24/09/2018 12:35	00:05:00	76.3	76.7	70.6	65.9	63.5	62.7	59.2	56.3	50.8	41.7	64.6
	24/09/2018 12:40	00:05:00	76.6	77.1	73.6	67.0	66.6	64.0	60.7	56.5	50.1	40.9	65.8
S4	17/09/2018 14:25	00:05:00	67.8	71.6	69.9	60.5	58.5	56.6	56.4	52.4	46.4	39.6	60.3
	17/09/2018 14:30	00:05:00	68.0	70.4	68.9	61.3	59.4	57.1	57.6	54.1	47.8	39.8	61.4
	17/09/2018 14:35	00:05:00	74.1	72.8	70.7	62.6	59.3	57.5	57.4	55.2	49.3	42.0	61.9
	24/09/2018 12:50	00:05:00	66.7	72.7	71.9	63.2	59.4	58.2	58.3	54.7	48.7	40.0	62.2
	24/09/2018 12:55	00:05:00	71.5	72.7	70.9	66.2	58.3	57.6	57.2	55.7	52.3	40.5	62.3
S5	17/09/2018 14:45	00:05:00	66.8	65.5	64.0	56.3	54.4	51.5	49.7	46.2	48.0	47.0	55.8
	17/09/2018 14:50	00:05:00	65.9	74.9	73.0	58.7	55.3	51.9	50.5	46.4	39.8	32.2	55.4
S6	24/09/2018 12:05	00:05:00	73.4	69.6	68.4	61.8	59.0	58.3	58.7	54.7	47.2	39.0	62.2
	24/09/2018 12:11	00:05:00	70.5	68.1	71.3	64.8	60.9	58.8	59.0	55.1	48.1	39.1	62.8
	24/09/2018 12:16	00:05:00	68.7	67.9	69.3	62.2	60.7	59.2	60.8	56.4	48.3	40.5	63.9
S7	29/09/2018 23:52	00:05:00	73.9	78.1	74.8	74.7	69.3	71.2	67.1	62.8	55.4	43.4	72.1
	29/09/2018 23:59	00:05:00	73.3	75.4	75.7	75.1	68.5	70.6	66.3	61.6	54.3	44.6	71.3
	30/09/2018 00:40	00:05:00	65.6	71.8	75.8	73.4	67.6	69.8	66.8	61.7	54.7	45.5	71.2
	30/09/2018 00:47	00:05:00	71.0	76.7	77.7	73.0	67.8	68.6	64.6	60.0	54.5	44.0	69.8
S9	30/09/2018 00:23	00:05:00	62.5	70.3	74.4	68.9	64.0	61.1	61.1	56.5	51.1	44.8	65.0

Table 9: Ambient levels measured at attended measurement positions.

Position	Measurement Period	Duration	Sound Pressure Level per Octave Band Frequency in dB										L _{Amax,T} dB
			16Hz	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
S1	17/09/2018 13:00	00:05:00	74.9	81.5	78.2	72.6	71.7	67.4	63.5	61.3	68.3	63.6	70.8
	17/09/2018 13:05	00:05:00	77.2	84.8	78.1	77.9	71.6	65.4	67.9	68.5	58.9	53.3	70.6
	17/09/2018 13:11	00:05:00	78.2	84.3	82.2	83.8	79.8	66.3	63.6	64.6	57.2	54.6	70.5
	24/09/2018 13:16	00:05:00	80.1	84.2	78.9	77.2	73.3	70.8	66.5	69.3	63.6	57.2	71.0
	24/09/2018 13:21	00:05:00	81.5	82.0	81.5	85.5	77.6	72.1	68.3	65.8	61.9	55.9	71.8
S10	30/09/2018 00:16	00:05:00	75.2	83.3	79.0	77.8	69.2	65.9	62.0	57.7	55.1	52.0	65.9
	30/09/2018 00:29	00:05:00	73.1	78.5	89.7	85.1	76.9	78.7	73.6	76.2	72.9	67.0	80.9
S2	17/09/2018 13:25	00:05:00	78.7	79.2	81.8	75.8	69.8	68.7	68.4	65.3	66.5	57.9	69.7
	17/09/2018 13:30	00:05:00	73.1	77.6	80.4	73.6	68.8	67.7	67.9	63.2	59.1	58.3	70.4
	17/09/2018 13:35	00:05:00	76.6	79.7	83.5	74.4	69.2	67.6	64.9	65.3	74.0	56.6	75.2
	24/09/2018 13:01	00:05:00	79.3	81.6	78.7	77.3	69.9	69.2	69.7	69.7	67.3	57.7	71.2
	24/09/2018 13:07	00:05:00	83.6	84.6	82.8	85.1	77.1	71.8	75.8	69.6	72.2	62.1	77.4
S3	17/09/2018 13:50	00:05:00	92.3	96.0	88.2	82.6	76.5	76.7	72.4	69.9	65.5	57.4	75.4
	17/09/2018 13:55	00:05:00	93.8	90.8	85.8	83.2	79.9	76.3	74.0	72.7	64.7	63.2	75.4
	17/09/2018 14:09	00:05:00	90.7	92.4	84.8	79.4	75.6	75.0	70.7	69.1	69.6	66.6	74.2
	24/09/2018 12:35	00:05:00	91.1	92.2	85.1	81.8	77.6	80.2	76.2	72.1	67.5	58.7	77.1
	24/09/2018 12:40	00:05:00	91.1	91.2	86.9	83.9	84.4	81.6	75.7	74.6	67.3	55.6	79.5
S4	17/09/2018 14:25	00:05:00	82.0	83.1	85.3	75.1	71.5	70.3	72.0	63.8	61.4	58.4	73.8
	17/09/2018 14:30	00:05:00	82.1	86.7	86.6	75.8	73.4	73.7	72.8	72.3	66.2	59.0	75.8
	17/09/2018 14:35	00:05:00	85.5	83.1	86.9	82.3	74.3	74.0	73.3	72.5	67.2	60.5	77.7
	24/09/2018 12:50	00:05:00	79.3	88.8	88.0	81.1	73.0	72.8	72.8	72.3	66.0	58.3	76.6
	24/09/2018 12:55	00:05:00	89.2	87.3	90.3	89.3	77.6	77.5	71.3	68.5	67.0	55.2	77.3
S5	17/09/2018 14:45	00:05:00	79.1	74.3	77.8	69.6	64.7	70.9	68.8	64.3	73.2	71.9	75.3
	17/09/2018 14:50	00:05:00	73.7	79.6	80.2	69.8	64.0	63.5	59.7	57.8	52.2	50.9	61.3
S6	24/09/2018 12:05	00:05:00	84.4	83.0	84.8	76.5	71.7	76.6	71.9	73.8	63.3	57.4	74.2
	24/09/2018 12:11	00:05:00	82.4	80.5	91.5	82.2	77.9	73.3	71.7	68.2	63.1	56.5	74.4
	24/09/2018 12:16	00:05:00	80.4	79.5	87.8	77.4	73.9	73.6	75.6	70.4	64.0	60.7	77.1
S7	29/09/2018 23:52	00:05:00	93.6	95.7	85.5	86.7	78.9	83.0	80.6	74.5	69.1	59.8	79.6
	29/09/2018 23:59	00:05:00	93.9	90.5	88.6	87.3	81.7	81.4	78.9	75.2	69.4	66.0	79.6
	30/09/2018 00:40	00:05:00	81.2	80.8	92.3	84.8	76.3	82.8	81.5	74.0	73.3	68.4	80.9
	30/09/2018 00:47	00:05:00	85.3	93.6	90.9	84.0	77.6	81.1	76.1	71.9	79.1	65.4	80.7
S9	30/09/2018 00:23	00:05:00	72.4	81.8	91.5	84.5	76.8	75.4	74.5	71.5	68.8	66.3	76.9

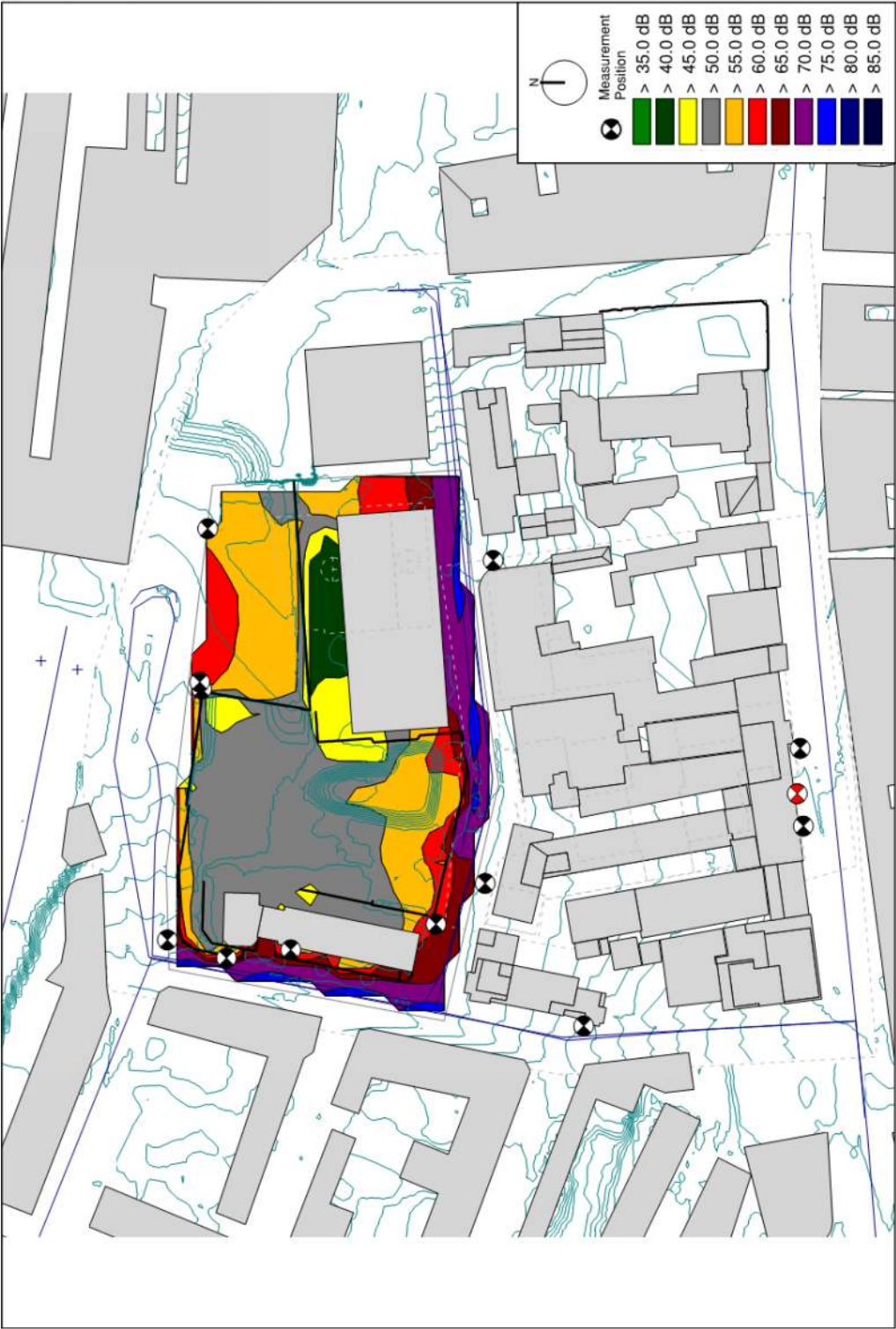
Table 10: Maximum levels measured at attended measurement positions.

Position	Measurement Period	Duration	Sound Pressure Level per Octave Band Frequency in dB										L _{A90,T} dB
			16Hz	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	
S1	17/09/2018 13:00	00:05:00	59.4	62.2	58.6	52.5	49.6	46.6	45.0	41.0	35.7	28.1	51.0
	17/09/2018 13:05	00:05:00	60.8	73.4	63.7	55.4	52.2	50.4	52.7	48.3	41.9	34.3	56.8
	17/09/2018 13:11	00:05:00	60.8	65.8	61.7	57.1	54.0	48.5	47.3	43.7	37.1	28.9	54.2
	24/09/2018 13:16	00:05:00	57.5	61.8	60.4	53.7	50.0	49.2	47.5	45.1	38.1	28.0	53.1
	24/09/2018 13:21	00:05:00	59.2	66.5	59.3	52.7	51.4	49.2	47.7	43.7	39.4	29.3	52.7
S10	30/09/2018 00:16	00:05:00	62.8	71.6	65.3	58.0	53.0	49.3	52.8	46.8	40.2	30.3	56.3
	30/09/2018 00:29	00:05:00	50.7	56.4	59.6	58.1	44.4	42.5	42.1	37.4	28.8	17.1	47.4
S2	17/09/2018 13:25	00:05:00	56.2	61.2	60.5	57.8	50.3	49.9	48.4	43.9	35.9	25.0	53.2
	17/09/2018 13:30	00:05:00	56.2	58.8	58.0	56.5	48.2	47.1	45.0	40.1	33.9	22.9	50.2
	17/09/2018 13:35	00:05:00	57.7	65.6	60.4	57.9	48.6	48.3	46.6	42.2	35.3	26.3	52.0
	24/09/2018 13:01	00:05:00	58.1	63.3	61.4	58.3	48.9	47.4	47.1	42.0	34.2	22.8	51.7
	24/09/2018 13:07	00:05:00	60.5	65.4	62.9	59.6	50.5	48.9	48.0	43.5	34.9	23.7	52.7
S3	17/09/2018 13:50	00:05:00	60.5	65.4	62.2	56.0	54.8	53.7	51.5	47.2	40.9	32.8	56.8
	17/09/2018 13:55	00:05:00	60.0	63.1	62.1	56.9	53.8	52.6	50.1	45.5	39.0	31.9	55.4
	17/09/2018 14:09	00:05:00	61.6	63.2	62.3	56.4	54.9	53.3	50.1	46.4	41.4	32.9	56.5
	24/09/2018 12:35	00:05:00	59.2	64.0	61.3	57.1	54.6	53.1	50.5	47.0	40.2	31.6	56.1
	24/09/2018 12:40	00:05:00	62.1	64.2	61.5	57.0	55.9	54.4	51.1	46.5	40.1	32.0	57.2
S4	17/09/2018 14:25	00:05:00	61.0	65.2	60.6	53.4	52.8	50.3	49.8	46.1	38.9	25.8	54.2
	17/09/2018 14:30	00:05:00	61.3	64.3	61.0	52.7	52.1	49.9	49.5	45.5	37.8	23.7	53.9
	17/09/2018 14:35	00:05:00	63.2	66.0	62.7	53.8	53.7	51.6	51.4	47.5	40.2	28.5	56.1
	24/09/2018 12:50	00:05:00	60.5	66.5	61.4	53.6	51.4	50.0	48.9	45.4	39.3	25.7	53.9
	24/09/2018 12:55	00:05:00	61.5	67.2	61.3	54.8	50.9	50.3	49.2	46.4	40.0	26.9	54.1
S5	17/09/2018 14:45	00:05:00	61.5	61.6	59.1	51.3	50.6	47.5	46.4	41.6	35.3	25.8	51.4
	17/09/2018 14:50	00:05:00	61.6	69.8	63.4	53.6	51.5	48.8	48.0	43.3	36.2	25.8	53.1
S6	24/09/2018 12:05	00:05:00	64.7	62.6	61.2	55.2	52.0	51.0	50.8	47.0	38.5	27.1	55.2
	24/09/2018 12:11	00:05:00	63.5	61.8	61.9	55.1	52.4	50.6	50.2	46.8	37.3	25.8	55.0
	24/09/2018 12:16	00:05:00	60.9	62.1	61.5	55.4	54.3	51.9	51.7	48.4	39.7	28.5	56.2
S7	29/09/2018 23:52	00:05:00	56.6	66.2	68.5	67.0	65.5	67.1	63.0	58.6	51.2	38.6	69.2
	29/09/2018 23:59	00:05:00	56.8	67.3	70.6	68.8	64.7	66.7	61.9	57.4	50.2	38.1	68.3
	30/09/2018 00:40	00:05:00	56.2	62.9	64.9	65.6	63.4	65.6	61.9	57.2	49.6	37.1	67.9
	30/09/2018 00:47	00:05:00	57.3	65.1	72.2	67.2	63.8	64.9	60.7	55.9	48.1	36.7	67.3
S9	30/09/2018 00:23	00:05:00	57.1	72.2	63.2	55.8	51.1	49.1	49.5	43.4	35.3	23.3	53.6
S9	30/09/2018 00:23	00:05:01	54.2	60.0	62.4	58.4	53.5	51.6	49.6	43.8	35.3	24.1	55.2

Table 11: Background levels measured at attended measurement positions.

Appendix E – Noise map of existing site at 1.5m above ground floor level.

Daytime $L_{Aeq,T}$



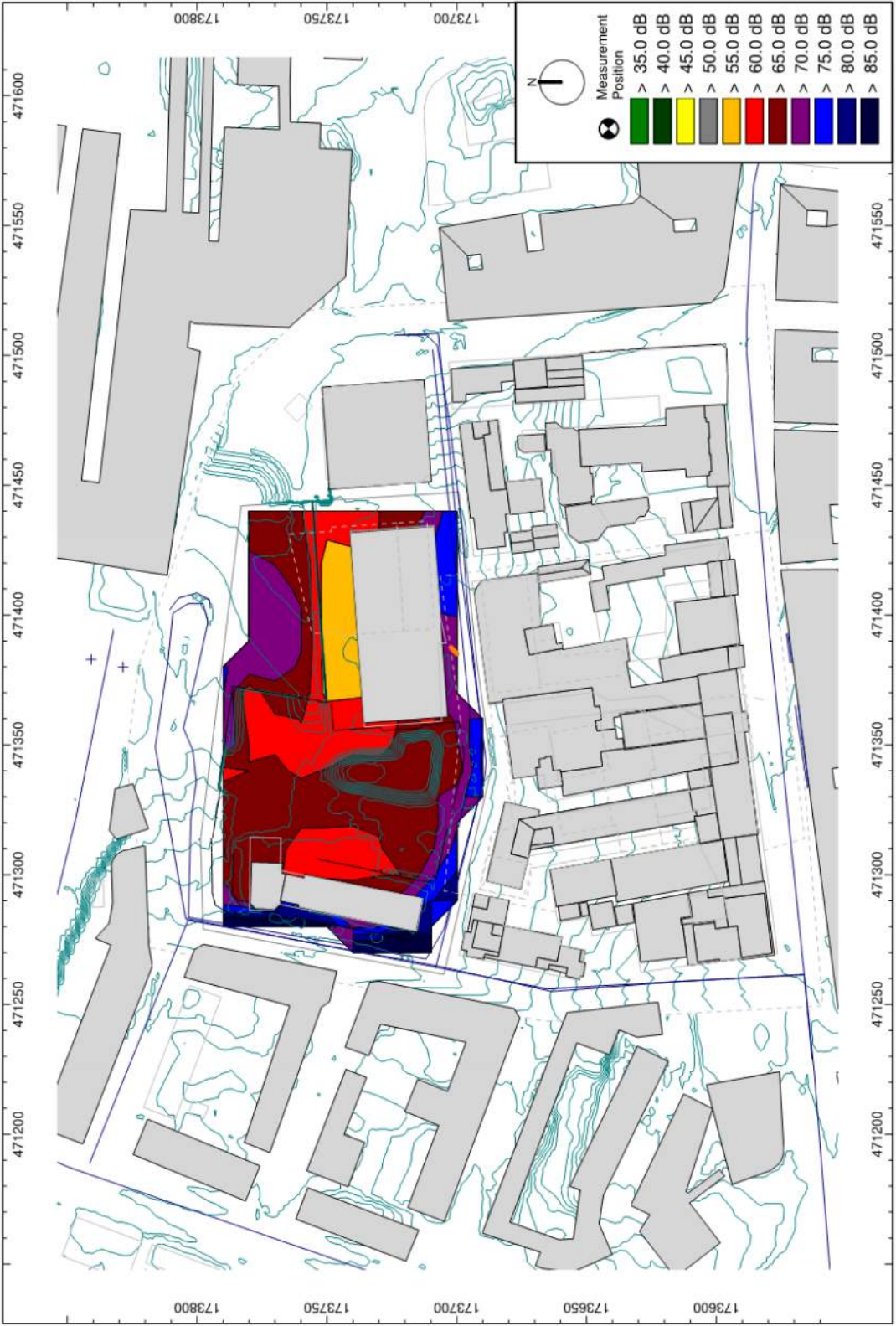
Daytime ninetieth percentile $L_{Amax,T}$



Night-time $L_{Aeq,T}$



Night-time $L_{Amax,T}$



Appendix F – Noise map of proposed site at 1.5m above ground floor level with Phase 1 & 2 development.

Daytime $L_{Aeq,T}$



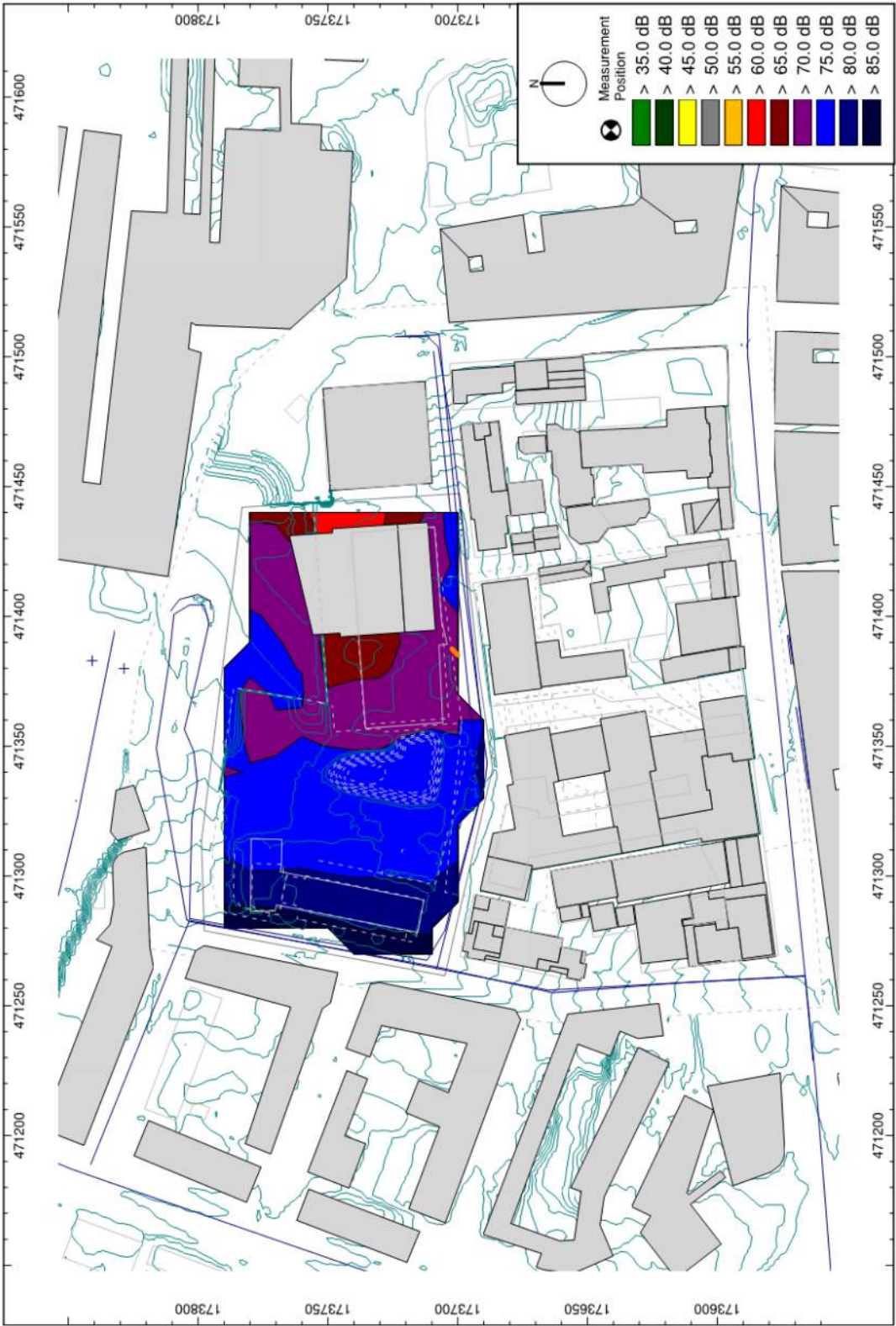
Daytime ninetieth percentile $L_{Amax,T}$



Night-time $L_{Aeq,T}$



Night-time $L_{Amax,T}$





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