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CHANDOS ROAD LHR11 & LHR12
NOISE AND VIBRATION ASSESSMENT

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NOISE AND VIBRATION ASSESSMENT

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Prepared by	**JHOWS**
Checked by	**CBARS**
Approved by	**CBARS**

Ramboll
Cornerblock
Two Cornwall Street
Birmingham
West Midlands B3 2DX
United Kingdom

T +44 121 230 1650
https://uk.ramboll.com

Ramboll UK Limited
Registered in England & Wales
Company No: 03659970
Registered office:
240 Blackfriars Road
London
SE1 8NW

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APPENDICES

1. INTRODUCTION

1.0 BACKGROUND

1.0.1 This noise assessment has been prepared by Ramboll UK Limited ('Ramboll') on behalf of Vantage Data Centres Ltd in support of a Permitting Application for Phases 1 and 2 (LHR11 and LHR12) of the redevelopment of the Chandos Road Trading Estate, Chandos Road, Park Royal, NW10 6NF ('the Site').

1.1 THE PROPOSAL

1.1.1 The site is located along the east side of Chandos Road, 40m north of A4000 Victoria Road and Bashley Road along the northern boundary. A freight rail line runs along the east side of the site. The general context of the area surrounding the site is industrial and commercial and there are other data centres nearby, including one closer to the Bashley Road receivers than the application site, built since the noise surveys were done. Figure 1.1 shows the proposed development.

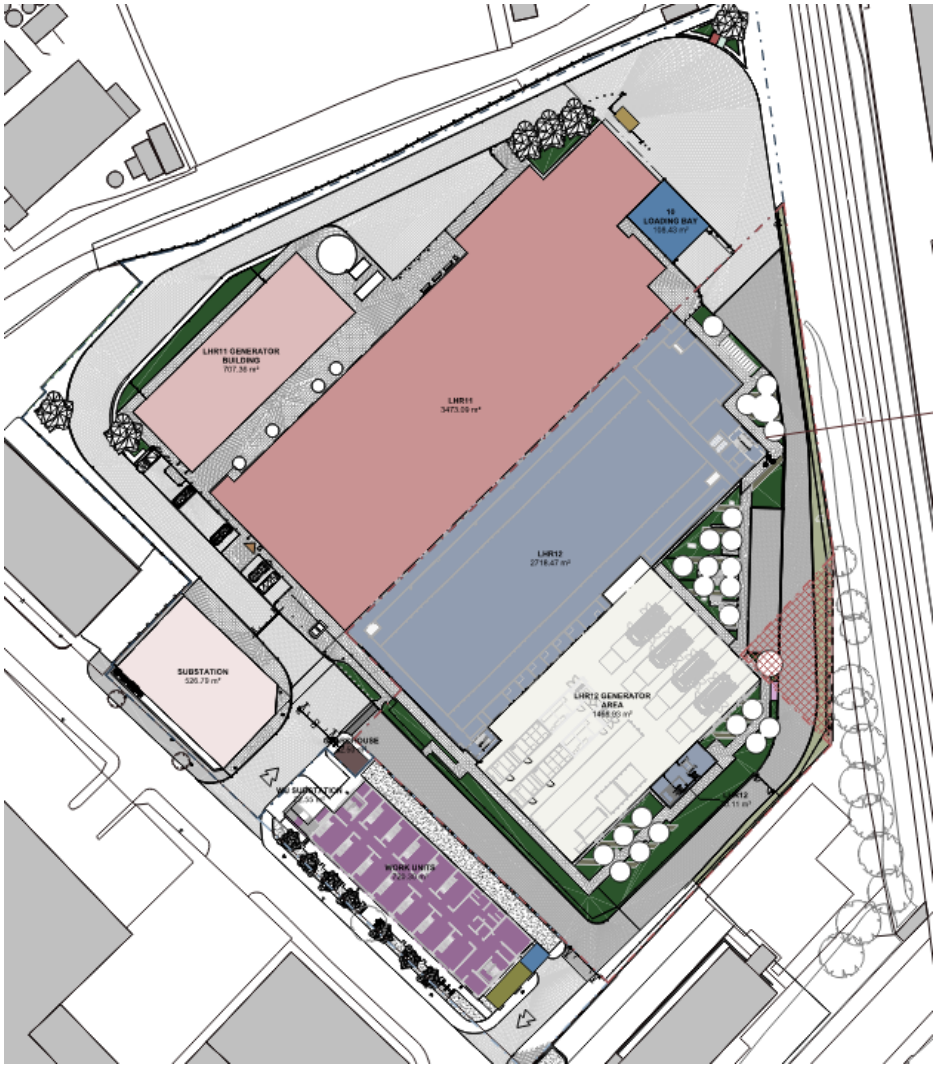

Figure 1.1 General arrangement plan

1.2 PURPOSE AND STRUCTURE

1.2.1 This report provides an assessment of the impact of operational and plant noise.

1.2.2 Noise emissions from operation of the facility have been calculated using proprietary modelling software. The impact of proposed operations has been assessed in accordance with BS4142:2014+ A1 2019 and compared to background noise levels measured at the nearest properties.

1.2.3 This report is prepared in support of the permitting application for the scheme. It is not intended to represent a full acoustic design of the facility. Specifications for plant and other noise sources used in this assessment are for the purpose of assessing the noise impact of the scheme.

2. POLICY & GUIDANCE

2.0 NOISE EFFECT LEVELS - PLANNING PRACTICE GUIDANCE

2.0.1 Planning Practice Guidance[1] (PPG) is a web-based resource, which includes a section on noise. This resource provides guidance on how to determine the noise impact in terms of whether a significant adverse effect is likely to occur and/or whether a good standard of amenity can be achieved.

2.0.2 In line with the Noise Policy Statement for England, Planning Practice Guidance introduces the following concepts:

i. Significant observed adverse effect level (SOAEL): This is the level of noise exposure above which significant adverse effects on health and quality of life occur;
ii. Lowest observed adverse effect level (LOAEL): this is the level of noise exposure above which adverse effects on health and quality of life can be detected;
iii. No observed adverse effect level (NOAEL): this is the level of noise exposure where noise can be heard, but does not cause any change in behaviour, attitude or other physiological response; and
iv. No observed effect level (NOEL): this is the level of noise exposure below which no effect at all on health or quality of life can be detected.

2.0.3 Table 2.1 summarises the noise exposure hierarchy, based on the likely average response.

Table 2.1 Noise exposure hierarchy

Perception	Examples of outcome	Increasing effect level	Action
Not noticeable	No effect	No Observed Effect	No specific measures
No Observed Adverse Effect Level			
Noticeable and not intrusive	Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			

[1] GOV.UK. 2018. Noise. [ONLINE] Available at: https://www.gov.uk/guidance/noise--2. [Accessed 12 May 2020].

Perception	Examples of outcome	Increasing effect level	Action
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

London Borough of Ealing Supplementary Planning Guidance SPG 10 '*Noise And Vibration'*

2.0.4 The application site falls under the jurisdiction of Old Oak and Park Royal Development Corporation (OPDC). However, OPDC have advised that they do not have any of their own guidance specific to noise and they refer to the planning guidance produced by the particular borough, in this case the London Borough of Ealing's SPG 10.

2.0.5 Table 3A3 of SPG10 details that the rating level of noise emitted from the proposed development shall be at least 5 dBA below the background noise level $L_{A90,1hr}$, measured at 3.5m from ground floor façades (i.e. free field), and 1m from upper floor façades at the nearest affected premises, following the procedure set out in BS 4142:1997 (superseded).

2.0.6 SPG 10 is retained as Interim Guidance pending publication of replacement Supplementary Planning documents. The plant noise criterion from SPG 10 has been used in the plant noise assessment and the design of the scheme.

British Standard 4142:2014+A1:2019 Method for rating and assessing industrial and commercial sound

2.0.7 British Standard 4142:2014[2] provides a method for rating industrial and commercial sound and assessing resulting impacts upon people. The method is applicable to fixed plant installations, sound from industrial and manufacturing process and other associated activities.

2.0.8 The basis of BS4142 is a comparison between the background noise level in the vicinity of residential locations and the rating level of the noise source under consideration. The relevant parameters in this instance are as follows:

[2] British Standards Institute, 2014. British Standard BS 4142:2014 +A1:2019 Methods for rating and assessing industrial and commercial sound. BSI.

i. Background Level, $L_{A90,T}$: defined in the Standard as the 'A' weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, and quoted to the nearest whole number of decibels;
ii. Specific Level, $L_{Aeq,T}$: the equivalent continuous 'A' weighted sound pressure level at the assessment location in the absence of the specific sound source under consideration, over a given time interval, T; and
iii. Rating Level, $L_{Ar,T}$: the specific sound level plus any adjustment made for the characteristic features of the noise.

2.0.9 Potential impacts are predicted from the difference between the representative background level at a noise sensitive receptor and the rating level from the noise source considered. The standard suggests that the greater the difference, the greater the magnitude of impact.

2.0.10 Section 11 of BS 4142 gives guidance for significance of impacts in reference to comparing rating noise levels against existing background noise levels:

i. Typically, the greater this difference, the greater the magnitude of the impact;
ii. A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context;
iii. A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context; and
iv. The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

2.0.11 In determining the significance of the impact, BS 4142 requires a consideration of the context of the assessment i.e. the nature of the existing acoustic environment and the new noise source, and the sensitivity of the affected receptors.

Noise Characteristics and Penalties

2.0.12 BS4142 applies different penalties for noise sources that have an acoustic feature. These penalties are applied to the plant noise level where such features increase attention to the noise, such as tonality and intermittent operation.

2.0.13 BS 4142 gives a guide to the level of penalty that should be applied using the subjective method. This is summarised below.

Tonality

- *Tone just perceptible at the receptor: +2dB*
- *Tone clearly perceptible at the receptor: +4dB*
- *Tone highly perceptible at the receptor: +6dB*

Impulsivity

- *Sound that is highly impulsive just perceptible at the noise receptor: +3dB*

- *Sound that is highly impulsive clearly perceptible at the receptor: +6dB*
- *Sound that is highly impulsive highly perceptible at the receptor: +9dB*

Intermittency

- *Identifiable on/off conditions, readily distinctive against the residual acoustic environment: +3dB*

3. METHODOLOGY

3.0.1 The following section outlines the methodology applied to identify and assess the potential noise impacts likely to result from the proposed development.

3.1 RECEPTOR LOCATIONS

3.1.1 The receptors considered in this assessment are detailed in Table 3.1 and Figure 3.1.

Table 3.1 Receptor locations

Location	Description	Distance from site (m) at closest point
R1	Bashley Road Traveller's Site	19
R2	Residential dwellings along Midland Terrace	75
R3	Residential dwellings along Midland Terrace	95
R4	Residential dwellings along Shaftesbury Gardens	105

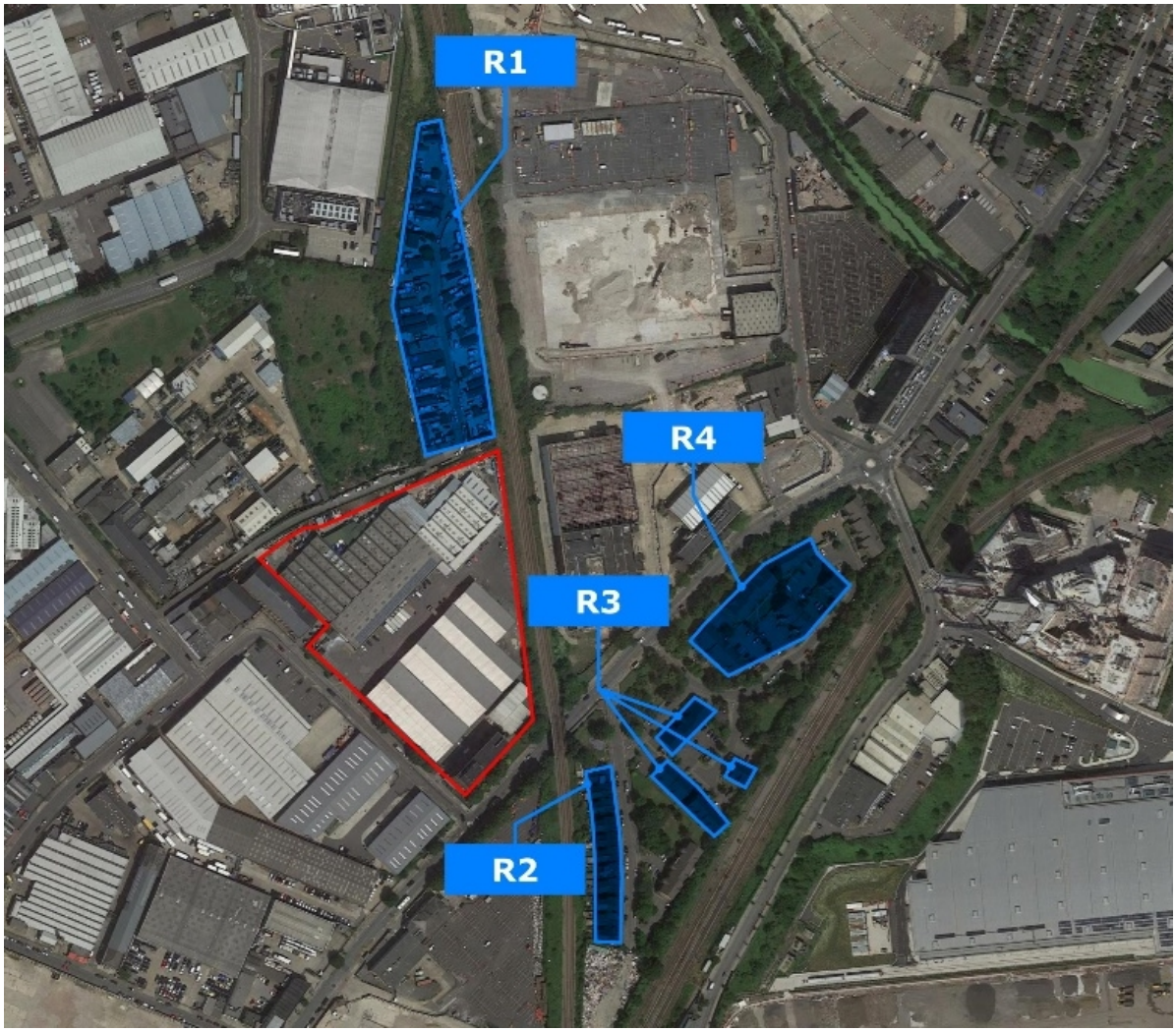

Figure 3.1 Receptor locations in relation to Chandos Park site

3.1.2 Residential receptors to the north west are over 400m away from the site boundary, and have closer proximity to an existing data centre, so have not been considered for this assessment.

3.2 BASELINE CHARACTERISATION

3.2.1 A baseline noise survey was carried out at the nearest noise sensitive receptors (NSRs) and across the application site, to quantify the prevailing ambient and background noise levels during daytime and night-time periods. The purpose of the baseline survey was to establish the ambient noise level to inform the assessment criteria for construction noise effects and operational plant noise effects. Details are given in Section 5.

3.2.2 Plant noise limits have been set in line with Local Authority requirements based on prevailing background noise levels at noise sensitive receptor locations.

3.3 OPERATIONAL NOISE ASSESSMENT

3.3.1 The operational noise assessment will involve setting noise limits from fixed plant and site processes, using the methodology of BS 4142:2014+A1:2019.

Operational noise limits

3.3.2 Operational noise will be assessed based on the background noise levels measured during the baseline survey. In accordance with the Local Authority guidance and BS 4142:2014+A1:2019, the rating noise level limits will be set as per Table 3.2, allowing for any penalties for acoustic characteristics of the noise.

Table 3.2 Operational plant rating noise limits

Conditions	Plant Rating Noise Limit
Normal	-5 dB below the typical background noise level (L_{A90})
Emergency and testing/maintenance of standby generators	+5 dB over the typical background noise level (L_{A90})

4. SIGNIFICANCE CRITERIA

4.0.1 Significance criteria have been defined for the different sources of noise in accordance with the principles in Planning Practice Guidance (PPG). Effects that are described as Significant Observed Adverse Effect Level (SOAEL) are considered to be significant effects requiring further action or mitigation.

4.1 OPERATIONAL NOISE

4.1.1 Table 4.1 details the significance of effects for operational noise based on the numerical difference between predicted rating level and the prevailing background level at a receptor and the criteria from BS 4142:2014+A1:2019. These are based on the principles in PPG given in Table 2.1.

Table 4.1 Operational noise significance criteria (non-emergency)

Description	Effect level	Magnitude of Impact
Predicted Rating Level is more than 5dB below the prevailing Background Level at the receptor.	NOEL	Negligible
Predicted Rating Level is between 5 dB and 0.1 dB below the prevailing Background Level at the receptor.	NOAEL	Minor
Predicted Rating Level is between 0 dB and 4.9 dB above the prevailing Background Level at the receptor.	LOAEL	Moderate
Predicted Rating Level is between 5 dB and 9.9 dB above the prevailing Background Level at the receptor.	SOAEL	Major
Predicted Rating Level is ≥10 dB or more above the prevailing Background Level at the receptor.	SOAEL	Major

4.2 CHANGES IN ROAD TRAFFIC NOISE

4.2.1 Traffic data is not available at this stage in design. A 25% change in road traffic is required for a 1 dB change in noise level. This level of change is unlikely to be realised as a result of the development, therefore any changes in road traffic noise level would be considered negligible.

4.3 ASSUMPTIONS AND LIMITATIONS

4.3.1 All reasonable measures have been undertaken to reduce uncertainty in the baseline noise survey data and the calculations detailed in this report.

4.3.2 Uncertainty has been minimised by completing unattended noise measurements over daytime, evening, weekend and night-time periods. Attended noise measurements were completed (where possible) at the nearest receptor locations to support the unattended measurements. Attended vibration measurements have been completed on site to measure vibration levels on site.

4.3.3 It should be noted that on Thursday 05/11/2020, national lockdown restrictions were put into place by the UK Government in reaction to COVID-19. However, where possible, attended measurements were completed on Wednesday 04/11/2020, outside of lockdown measures. These further restrictions are not expected to significantly affect site noise levels due to reductions in road traffic flows/noise levels, as the site noise climate is dominated by industrial noise from adjacent uses and the adjacent railway line at the eastern boundary.

4.3.4 Results have been rounded to the nearest A-weighted decibel.

4.3.5 Receptors at R1 are part of a traveller's site. This site could not be accessed in order to assess the current representative noise level, however, LT1 is considered representative of noise levels at the traveller's site.

4.3.6 The assessments and calculations undertaken in this report are based on the development parameters provided by the client. Should any of this change, the results of the assessments may not be valid and would need to be updated.

5. BASELINE NOISE AND VIBRATION SURVEY

5.1 SURVEY METHODOLOGY

5.1.1 Unattended noise monitors were installed at LT1 and LT2 (as shown on Figure 4.1) between Wednesday 04/11/2020 and Tuesday 10/11/2020.

5.1.2 Noise monitor LT1 was installed at a height of 3m above local ground level so that it was not affected by on site screening. Noise monitor LT2 was installed at a height of 1.5m above local ground level. Both monitoring positions were deemed to be installed under free-field conditions.

5.1.3 Noise levels were monitored continuously over the survey period and averaged over 15-minute intervals.

5.1.4 The sound level meter calibration was checked upon installation and upon completion of the surveys. No significant drift in calibration was recorded.

5.1.5 Attended measurements of 15 minutes in duration were taken at two positions (as shown on Figure 4.1) on 04/11/2020:

i. ST1: representative of noise levels affecting the nearest noise sensitive receptors on Midland Terrace.
i. ST2: representative of noise levels at noise sensitive receivers along Shaftesbury Gardens;
ii. ST3: representative of noise levels at the entrance to Chandos Park Industrial Estate; and
iii. ST4: representative of noise levels emanating from Victoria Road.

5.1.6 Each measurement was taken at a height of 1.5m above local ground level and under free-field conditions.

5.1.7 Attended vibration measurements were carried out at Position V2, but these are not used in this assessment.

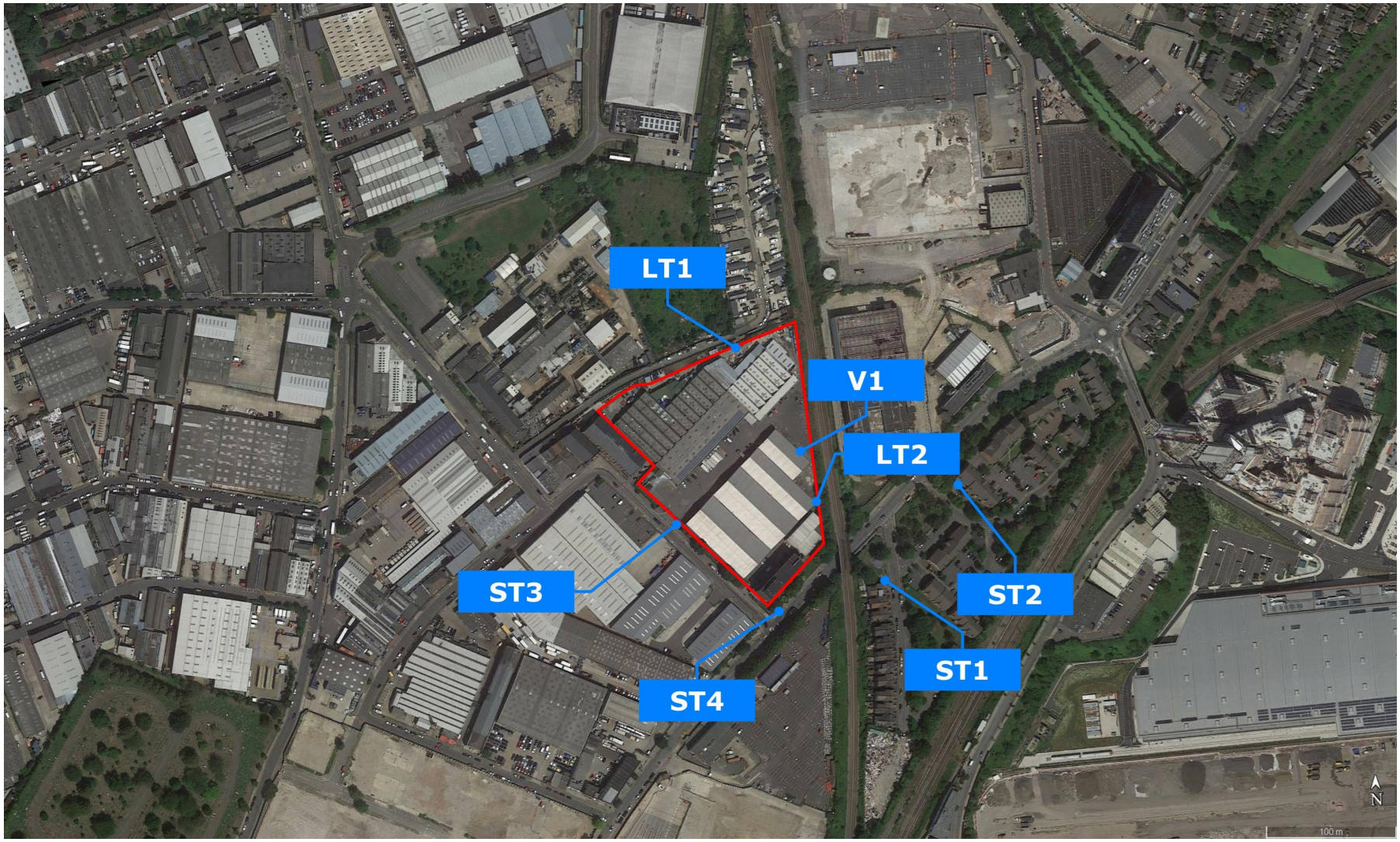

Figure 5.1 **Baseline monitoring locations**

5.2 WEATHER

5.2.1 Start of unattended survey:
Wednesday 04/11/2020
Dry, sunny, ~8°C, wind speed (average) 2 m/s in south to westerly direction, no precipitations.

Unattended survey:
Temperatures generally in the range of 0-13°C.
Wind speeds were below 5 m/s throughout the survey. Winds were in variable directions.
Some periods of fog occurred on each day, but no rainfall was recorded.

End of unattended survey:
Wednesday 04/11/2020
Dry, mostly cloudy, ~15°C, wind speed (average) 3 m/s in general northerly direction, no precipitations.

Attended surveys:
Wednesday 04/11/2020
Dry, sunny, ~8°C, wind speed (average) 2 m/s in south to westerly direction, no precipitations.
Monday 09/11/2020
Dry, mostly cloudy, ~15°C, wind speed (average) 3m/s in a general northerly direction, no precipitations.

5.3 EQUIPMENT

5.3.1 The following measurement equipment was used:

Unattended survey:

i. 01dB FUSION Class 1 Sound Level Meter (serial no. 12081) with 01dB CAL31 Sound Calibrator (serial no. 86020).
ii. Norsonic Class 1 Sound Analyser Nor140 (serial no. 1403396) and associated microphone Nor1225 (serial no. 112825).
iii. Norsonic Class 1 Field Calibrator type 1251 (serial no. 32853).

Attended survey

i. Norsonic Class 1 Sound Analyser Nor140 (serial no. 1403396) and associated microphone Nor1225 (serial no. 112825).
ii. Norsonic Class 1 Field Calibrator type 1251 (serial no. 32853).

5.3.2 Calibration and certificates are available upon request.

5.4 ATTENDED NOISE SURVEY RESULTS

5.4.1 A summary of the attended survey results is shown in

5.4.2 Table 5.1. A summary of the results of attended and unattended measurements is provided in Appendix 2.

Table 5.1 Summary of attended noise survey results

Measurement position	Representative $L_{Aeq,T}$ (dB)	Highest L_{Afmax} (dB)	Lowest $L_{A90,15mins}$ (dB)
ST1 (Midland Terrace)	59	75	51
ST2 (Shaftesbury Gardens)	61	86	54
ST3 (Front Gates of Chandos Park Industrial Estate)	60	80	48
ST4 (Victoria Road)	69	93	58

5.4.3 The noise climate at ST1 and ST2 was dominated by traffic noise from A4000 Victoria Road. An active building site on the other site of A4000 Victoria Road was also a contributing noise source throughout the measuring period.

5.4.4 The noise climate at ST3 was dominated by traffic movements along Chandos Road. Traffic along Victoria Road also contributed to the noise levels.

5.4.5 The noise climate at ST4 was dominated by traffic movements along Victoria Road

5.5 UNATTENDED NOISE SURVEY RESULTS

5.5.1 The unattended survey results are shown in Figure 4.2 and Figure 4.3. A summary of the results of attended and unattended measurements is provided in Appendix 2.

5.5.2 The noise climate at LT1 was dominated by on site movements from the existing ToughGlaze unit. Freight train movements were also audible from the railway line to the east.

5.5.3 Typical daytime average noise levels ranged from 53-62 dB $L_{Aeq,16hour.}$ Daytime background noise levels ranged from 43-51 dB $L_{A90,\ 16hour.}$

5.5.4 Night-time average noise levels ranged from 46-66 dB $L_{Aeq,8hour}$. Night-time background noise levels ranged from 40-56 dB $L_{A90,8hour}$. The typical background noise level in the absence of existing site noise was 41 dB $L_{A90,15mins}$ during night-time periods. The typical L_{A90} has been calculated using statistical analysis as set out in BS 4142:2014+A1:2019 *'Methods for rating and assessing industrial and commercial sound'*.

5.5.5 The noise climate LT2 was dominated by freight rail passbys and site movements from the industrial park.

5.5.6 Typical daytime average noise levels ranged from 51-61 dB $L_{Aeq,16hour}$. Daytime background noise levels ranged from 41-49 dB $L_{A90,16hour}$.

5.5.7 Night-time average noise levels ranged from 45-55 dB $L_{Aeq,8hour}$. Night-time background noise levels ranged from 38-43 dB $L_{A90,8hour}$. The typical background noise level in the absence of existing site noise was 41 dB $L_{A90,15mins}$ during night-time periods.

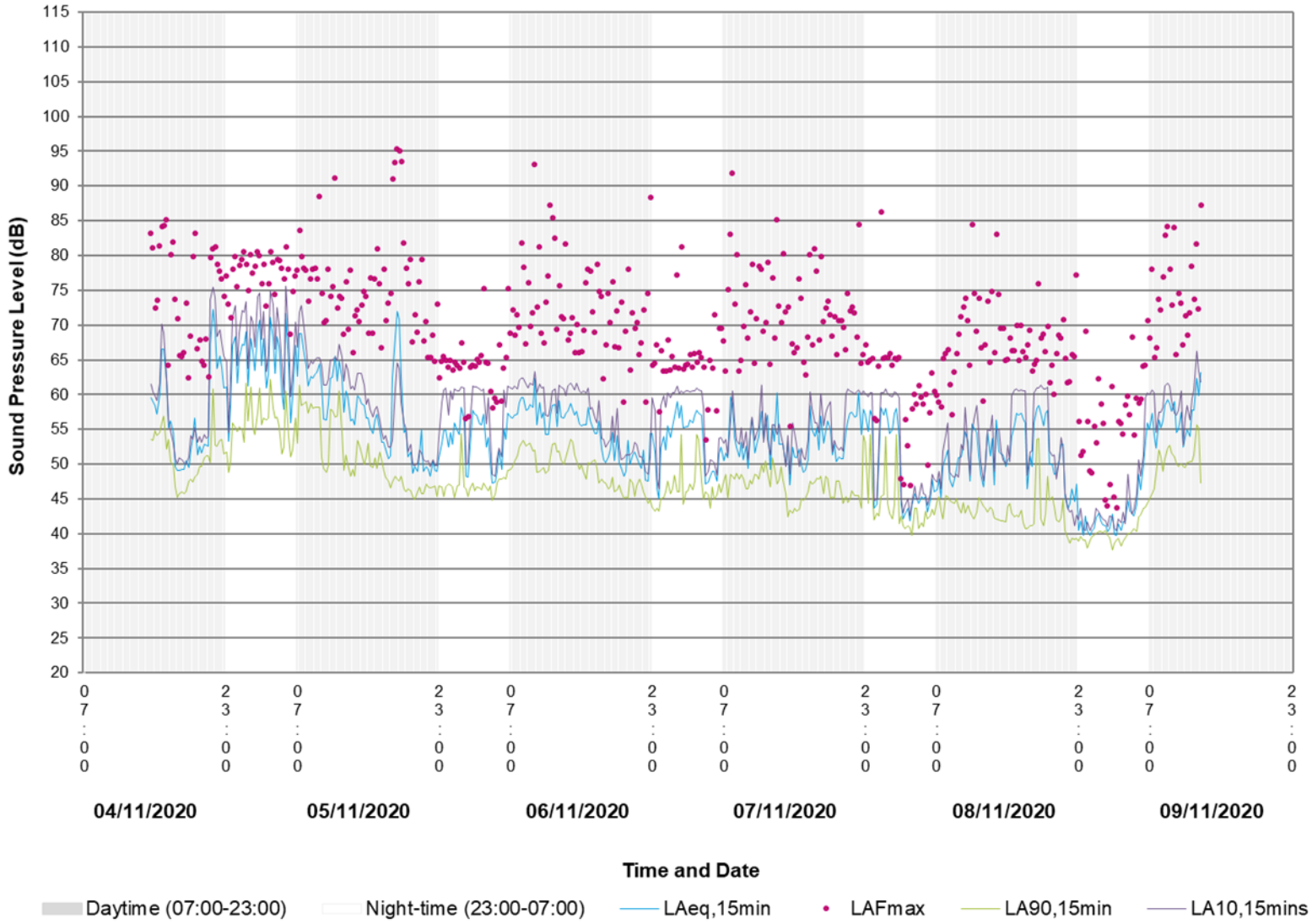

Figure 5.2 **Unattended survey results at LT1**

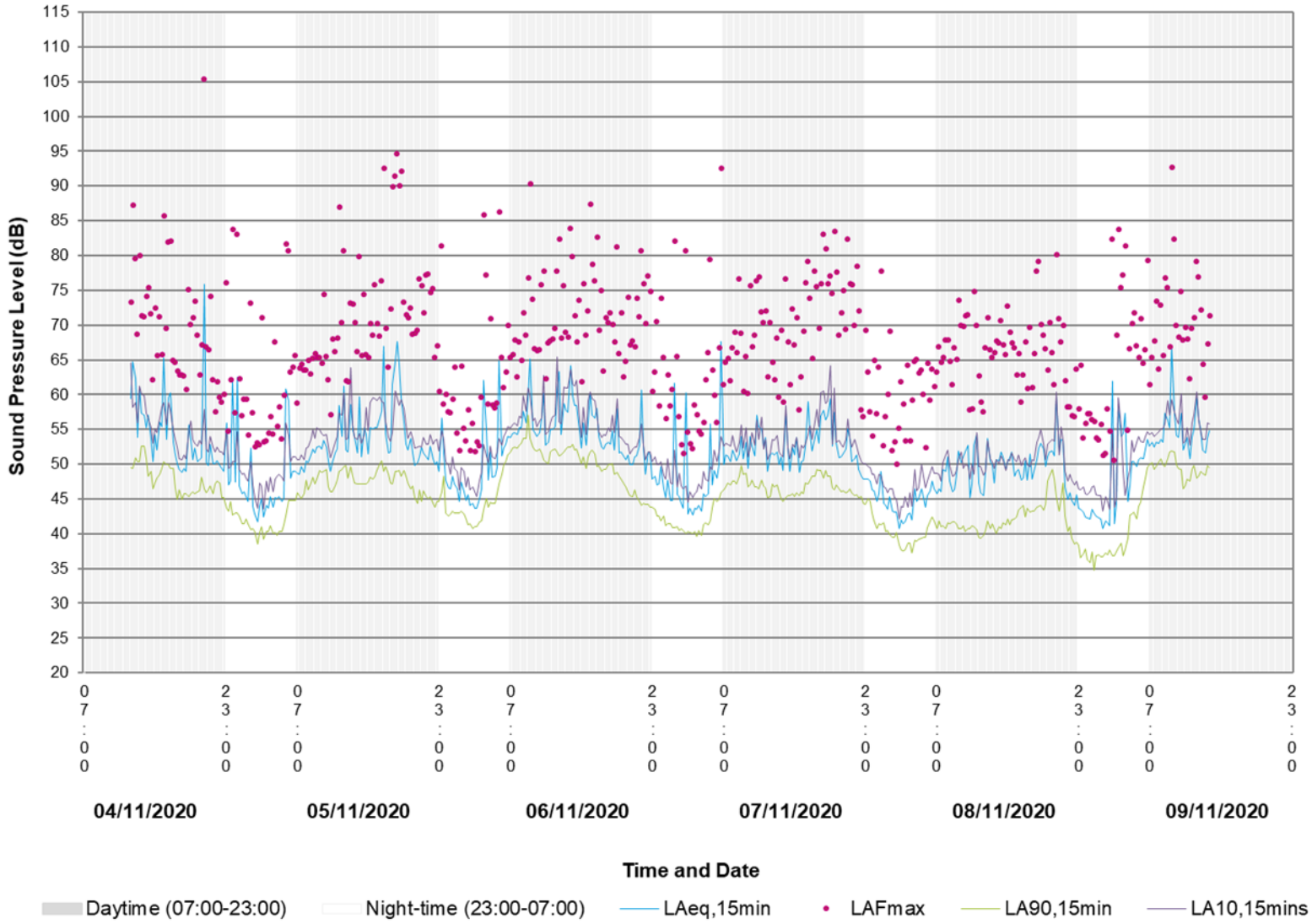

Figure 5.3 **Unattended survey results at LT2**

6. OPERATIONAL NOISE ASSESSMENT

6.0 PLANT NOISE

6.0.1 The data centre will include chiller equipment, generators and substation transformers. The chillers would be required to operate continuously during daytime and night-time periods. Generators would only be required to be operational during power failures and for testing and maintenance.

6.1 PLANT NOISE LIMITS AT ALL RECEPTORS

6.1.1 In line with Local Authority requirements, the rating sound level from fixed plant installations has been set 5 dB below the representative background noise level (L_{A90}) during the quieter hours of the night-time periods. During emergency operation, it is appropriate for standby equipment to be designed to a relaxed criterion. Therefore, the rating level during emergency operation has been set at 5 dB above background noise levels.

6.1.2 Based on the noise survey results, and statistical analysis of the measured background noise levels in accordance with guidance set out in BS 4142:2014+A1:2019, a noise level of 41 dB $L_{A90,15mins}$ is deemed to be the typical background noise level to be used at the northern and south-eastern site boundaries.

6.1.3 The proposed plant noise limits are set out in Table 6.1. The rating level should include any penalties to the methodology of BS 4142:2014+A1:2019. The sum of all fixed plant installations associated with the site as a whole (LHR11 and LHR12) has been designed to meet the total plant noise rating levels of Table 6.1.

Table 6.1 Plant noise rating levels

Time	Representative background noise level dB L_{A90}	Plant noise rating level dB L_{Ar} at sensitive receptors
24 hour normal operation[1]	41	**36**
Emergency operation[1]	41	**46**
Testing of emergency plant (daytime only)	43	**48**

[1] Limit based on typical night time (23:00-07:00) background level

In accordance with Table 4.1, achieving these limits is expected to result in No Observed Adverse Effect Level and a Negligible to Minor impact on nearby receptors during normal operation and a Lowest Observed Adverse Effect Level during temporary emergency conditions, with a Moderate impact.

6.2 CALCULATED PLANT NOISE LEVELS

6.2.1 Noise levels from operational and emergency plant have been calculated using proprietary modelling software (CadnaA), based on manufacturers noise data for each item of plant. A summary of the plant is given below.

The following scenario relating to the main chillers has been modelled:

LHR11: Engie A1700 chillers, output reduced at night to lower sound power level by 1dB + Allaway AA304SX-P enclosures.
LHR12: Schneider BCEF1604A chillers + Allaway AA304SX-P enclosures.

Table 6.2 Summary of plant items

Type of plant	Description	Location	Sound power level, dB L_{wA}
16no. Chillers (+1 redundant not in operation)	Engie A1700	LHR11 roof	102 (before attenuation)
20no. Chillers (+1 redundant not in operation)	Schneider BCEF1604A	LHR12 roof	97 (before attenuation)
AHU 'DOAS DM01'	Trox X-Cube 4025	LHR11 DOAS roof	Fai: 57 Exh: 65 Cas: 60[1]
AHU 'DOAS DM02'	Trox X-Cube 4025	LHR11 DOAS roof	Fai: 57 Exh: 65 Cas: 60[1]
AHU 'DOAS ADM01'	Trox X-Cube 3010	LHR11 DOAS roof	Fai: 61 Exh: 52 Cas: 64[1]
AHU 'DOAS ADM02'	Trox X-Cube 3010	LHR11 DOAS roof	Fai: 61 Exh: 64 Cas: 65[1]
Admin Chiller	Ciat LD0600R	LHR11 Chiller platform	89.5
Air source heat pump	Ciat ILD2000R	LHR11/LHR12 Chiller platform	95
2no. VRV Condensers	Mitsubishi PUHYP1000YSNW-A	LHR12 roof	88.5
Emergency Plant			
17no. emergency generators	Kohler KD3500E diesel gen set	LHR11 Generator building	General: 123.8
17no. exhausts in 5no. generator exhaust stacks	Kohler KD3500E diesel gen set	Exhaust stacks, 50m height, LHR11	Exhaust: 128.4
20no. emergency generators	Kohler KD3500E diesel gen set in acoustic pack	LHR12 Generator gantry	Pack rated at 65dB(A)@1m
20no. generator exhaust stacks	Kohler KD3500E diesel gen set in acoustic pack	Exhaust stacks, 50m height, LHR12	Pack rated at 65dB(A)@1m
Emergency smoke extract fan (2 fans in tandem assumed)	Typical 630mm smoke extract fan 3.05m/s	LHR11/LHR12 roof	83

Type of plant	Description	Location	Sound power level, dB L_{wA}
Substation	Data unavailable	External substation compound	106dB L_w assumed

[1] Fai = fresh air intake, Exh = extract exhaust, Cas = Casing radiated noise

6.3 KEY DATA USED IN MODELLING

6.3.1 Spectral sound emission and attenuator insertion loss data used for the key items of plant are summarised below.

6.3.2 Chillers

Table 6.3 Engie chiller sound power levels, dB Lw

	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Engie A1700	99.2	105.1	103.6	99.2	93.0	88.8	91.0	93.1

Table 6.4 Schneider chiller sound power levels, dB Lw

	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Schneider BCEF1604A[1]	99.0	99.0	95.0	94.0	93.0	87.0	82.0	77.0

[1] data provided by Vantage from BER14 project.

6.3.3 It is necessary to reduce the sound power level of the LHR11 Engie A1700 chillers (in addition to the attenuation packs) when running at night when background levels are lowest. A night set back mode that can achieve a 1dB reduction in overall sound power has been confirmed by Engie and is summarised in the table below.

Table 6.5 Engie chiller reduced night time operating mode

Operating Point	CHWR °C	CHWS °C	EP kPa	OAT °C	Cooling Capacity kW	Chiller Unit power kWe	Pump power kWe	Total power kWe	Sound power level dB(A)	Air flowrate m³/h	exit air temperature °C
With corrosion resistant coils											
Normal	24,40	16,70	300	35,8	1822	433	34,6	467,6	94	534200	48,9
26 (90% fan speed)	24,40	16,70	300	36	1900	478,0	36,6	514,6	93	470100	52,0
27 (100% FC)	24,40	16,70	300	0,5	1900	49,6	53,1	102,7	92	500000	11,0

35 Pa external air pressure drop (customer requirement) included and
35 Pa external air pressure drop (acoustical package) included
sound power levels as shown only possible with acoustical package
ambient temperatures > 40 °C -> impermissible temperature ranges (theoretical values, temperature ranges out of operational limits) -> chiller derating or chiller cutt-off possible

6.3.4 The following minimum insertion loss performance is proposed for the proposed chiller acoustic packages (both Engie and Schneider), which apply to both the horizontal and top attenuation of the unit:

Table 6.6 Chiller attenuation package specification, dB insertion loss

	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Allaway AA304SX-P	1	2	5	10	12	10	9	7

6.3.5 Attenuation packages are required on all of the main chillers on both LHR11 and LHR12. Drip trays must be provided underneath all chillers that are large enough or adapted to sufficiently enclose the underside of the chiller such that noise emissions from the underside are mitigated. The acoustic pack provider can advise on suitable solutions.

6.3.6 Screening around the main chillers includes a 6m high solid barrier, the top of which is at the same height as the top of the chiller acoustic packages, the bottom of which is in line with the top of the roof parapet (see Figure 7.1). The extent of the solid barrier is shown in Figure 7.2, with the remaining perimeter screened with a non-acoustic weather louvre. A 2.5m high solid parapet is included around the perimeter of the roof.

LHR11 Generator Building

6.3.7 Façade specification - the following performance has been used in the noise model (some variation at different frequencies is likely to be acceptable):

Table 6.7 Generator building façade outline specification

	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	Rw
External façade & roof sound insulation, dB	35	41	53	69	74	74	74	74	63

6.3.8 Generator Air Intake & Exhaust - attenuators on the Exhaust-air side of the building (facing away from the data centre) and on the Intake side of the building (facing the data centre) should allow the following specification to be achieved at 1m from the Exhaust and Intake of each generator (in isolation):

Table 6.8 Generator air intake and exhaust noise level specification

Exhaust (facing away from data centre)	65dB(A) @1m
Intake (facing towards data centre)	65dB(A) @1m

6.3.9 Attenuators on air inlet and air exhausts have been given the following minimum insertion loss performance in the model:

Table 6.9 Generator air intake and exhaust outline attenuator specification, dB insertion loss

	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Air inlet & extract attenuator	12	23	40	55	55	55	55	47

6.3.10 Generator Engine Exhaust Attenuators - attenuators on the engine exhausts should have the following minimum insertion loss performance:

Table 6.10 Engine exhaust outline attenuator specification, dB insertion loss

	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Exhaust silencer (primary + secondary system)	31	41	51	50	51	54	50	42

6.3.11 This assumes additional losses from ducts and bends based on the current flue layout.

6.3.12 The sound power of the basic genset itself and the exhaust is shown in Table 7.11. This has been used to calculate the reverberant level in the generator building and sound passing through the air intake/exhaust attenuators.

LHR12 Generator Gantry

6.3.13 The manufacturer's sound spectrum for the Kohler KD3500 diesel gen set has been used (Table 7.11) and adjusted such that the overall LwA produces a level of 65dB(A) at 1m from each face of the generator, and the exhaust flue outlet. This has been calibrated at a 1m distance using the modelling software.

6.3.14 In the absence of information on the specific measurement conditions of the sound power level of the generators (an overall figure averaged from measurements all around the generator is provided) and the performance at different frequencies of the provided acoustic package, the modelling software has been used to first calibrate to a level of 85dB(A)@1m from all faces of the generator using the overall spectrum provided. Reductions to the overall sound power level for each side of the generator and the exhaust are as follows - Top: -20dB, Long sides: -22dB, Ends: -26dB, Exhaust flue: -39dB.
Then the level has been further reduced by different amounts in each octave band, with less of a reduction at low frequencies as the difference at low frequencies between an 85dB(A) enclosure and a 65dB(A) enclosure is not expected to be a full 20dB reduction.
Reductions to the sound power level (of an 85dB(A)@1m enclosure) in each octave band are as follows – 63Hz: -5dB, 125Hz, -10dB, 250Hz: -10dB, 500-8kHz: -20dB, to estimate a 65dB(A)@1m enclosure.

6.3.15 This is an estimate, in the absence of sound pressure or sound power level data for the generator in the specific enclosure, however for estimating the level (in terms of dBA) at the nearest houses during temporary emergency use, the level of accuracy is expected to be adequate.

6.3.16 Note that it is not possible to model the intermediate floors between generators in the modelling software, therefore the LHR12 generators have been modelled stacked above each other as shown in Figure 7.3. This is not expected to make a significant difference to the calculation of generator sound level emitted from the building overall.

Table 6.11 Kohler KD3500 genset sound power levels (before attenuation package), dB Lw

	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
KD3500 generating set	119.4	126.3	125.6	118.7	117.7	116.9	114.6	114.7
KD3500 exhaust	129.9	142.9	135.2	129.3	125.4	123.8	125.6	124.2

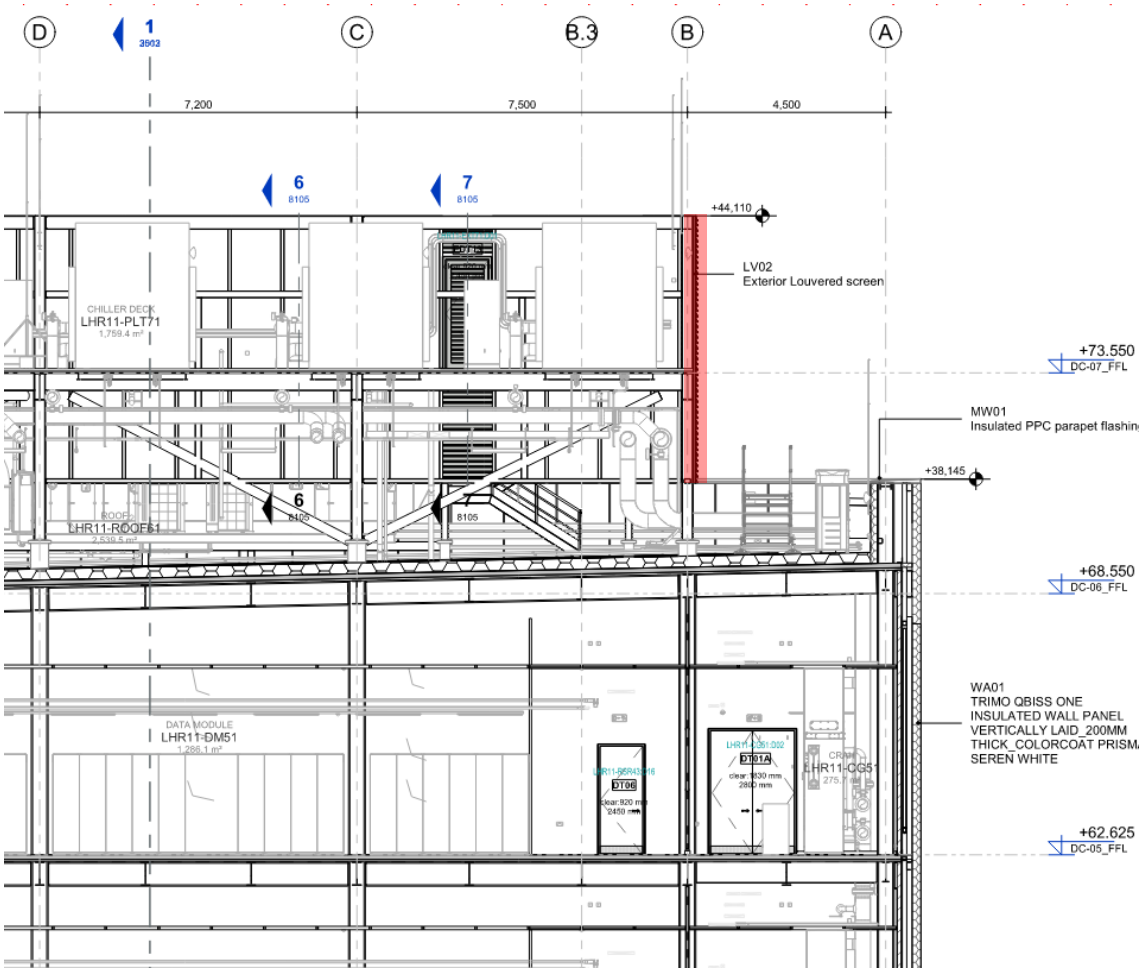

Figure 6.1 Section image of solid and louvred chiller screening

Figure 6.2 Extent of solid and louvred screening

6.3.17 An image from the modelling software is given below, showing the locations of the plant listed in Table 7.2.

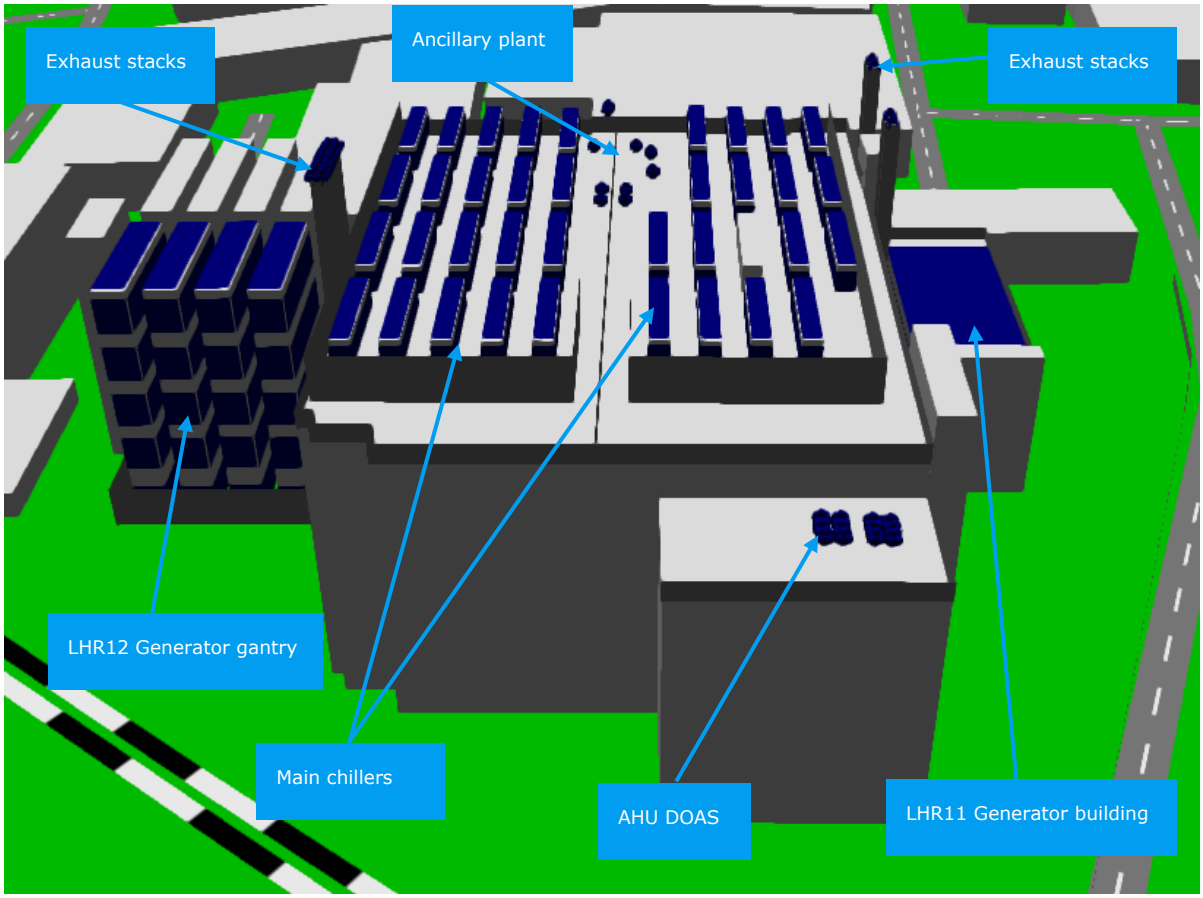

Figure 6.3 Excerpt of noise prediction model (site viewed from the north)

6.4 ASSUMPTIONS AND LIMITATIONS

1. The sound power level for the Engie A1700 and the Schneider BCEF1604 has been provided by the manufacturer/Vantage as a single overall figure per octave band from all of the surfaces measured. We have assumed that the majority of noise is emitted from the top surface of the chiller, with lower contributions from the sides, with proportions approximately as follows - Top: -3dB, Long sides: -7dB, Ends: -14dB.
   This is based on our experience and datasheets for similar units from other manufacturers.

2. One chiller on each plant deck has been chosen as the redundant unit, however the redundant unit will be varied regularly to distribute wear on the units evenly. This is not expected to result in any increase in the noise levels predicted.

3. Noise data for the chillers has been provided by Engie as sound power levels in each octave frequency band for the overall unit, equating to an overall sound power level of 102dB L_{wA}. We have validated our representation of the chillers in

our model by calibrating to a free-field level of 57dB(A) at 50m (without mitigation), calculated from the provided sound power level. If the SPL differs from this assumption, our assessment would need to be updated accordingly.

4. The Allaway AA304SX-P package has an increase over chiller height of 925mm and this has been included in the modelling.

5. No attenuation packages are provided on the Admin Chiller, VRVs or Air Source Heat Pumps.

6. All exhaust stack heights are modelled at 50m.

7. In the absence of information on the specific measurement conditions of the sound power level of the generators (an overall figure averaged from measurements all around the generator is provided) it is assumed that the generator radiates equal sound levels from all faces.

8. For LHR11 the Exhaust air attenuator is ducted up to the radiator of the generator and it is assumed that a proportion of the reverberant sound in the room is also able to pass through the radiator to outside.

9. Generators will be for standby/testing use only.

10. Noise from the generators (when passed through the attenuators) is not expected to be tonal or intermittent. The spectral sound power data does not indicate any strong tonal properties to the noise.

11. Modelling predictions use the following settings and conditions:
    - Sound propagation calculated according to ISO9613-2:1996
    - 2 orders of reflection
    - General ground absorption hard ground (0.3)
    - Temp: 20°C, RH: 70%
    - All receivers are free-field

12. The details used in the modelling presented in this report have been provided by Vantage and the design team and have been implemented by Ramboll based on the assumptions above. This report does not represent an acoustic design for the scheme and is not intended to provide Employer's Requirements or commissioning noise levels for contractors or designers.

7. CALCULATED NOISE LEVELS

7.0 NORMAL OPERATION

7.0.1 Noise from all chillers and ancillary equipment (per datacentre building) running together is predicted to be **36 dB $L_{Aeq,T}$** or lower within the traveller's site (R1) and **36 dB $L_{Aeq,T}$** or lower at Midland Terrace/Shaftsbury Gardens (R2-R4). This is 5dB below the typical background noise level at night and meets the guideline criterion of ≤36 dB $L_{Aeq,T}$.

7.0.2 Noise from the chillers is very low and the cumulative noise is not expected to contain any tonality or intermittency that would be noticeable over the general background levels and no correction has been added to the Rating Level. The ambient noise level at the nearest properties is above 50dB L_{Aeq} for most of the time and chiller noise would be at least 14dB lower than this. Chillers would be operating at different duties and therefore not necessarily all producing the same noise spectrum. Any cycling of their operation is unlikely to be distinguishable within the general steady noise from them operating together.

7.0.3 Additional attenuation is not required on the AHUs (which already have integral attenuators) or smoke extract fans (expected to be used during emergency or testing only). This is based on the specifications given in Table 6.2.

7.1 EMERGENCY STANDBY OPERATION

7.1.1 Noise from all generators of both datacentres running together is predicted to be **46 dB $L_{Aeq,T}$** at the entrance of the traveller's site (R1) and **43-46 dB $L_{Aeq,T}$** at Midland Terrace/Shaftsbury Gardens (R2-R4). This is no more than 5dB above the typical night time background noise level and meets the guideline criterion of ≤46 dB $L_{Aeq,T}$.

7.1.2 This is based on the worst case of all generators from both buildings in operation (as well as both data centres and associated chillers, AHUs and smoke extract fans).

7.2 SINGLE GENERATOR OPERATION

7.2.1 With one generator running for testing (plus the main chillers and other plant on the roof of the data centre) the noise level at the nearest properties is predicted to be around 40 dB $L_{Aeq,T}$. This achieves a level lower than the daytime background level and is likely to be acceptable for short term running or testing.

7.3 SUMMARY OF PREDICTED PLANT NOISE LEVELS

7.3.1 The noise levels calculated at the nearest noise sensitive receptors, and discussed above, are summarised in the table below.

Table 7.1 Summary of calculated plant noise levels

Operating condition	Receptor	Calculated noise level dB(A)	Rating Noise limit dB(A)
24 hour normal operation	Bashley Rd Travellers Site (to north)	36	36
	Midland Terrace (to south)	36	
Emergency operation	Bashley Rd Travellers Site (to north)	46	46
	Midland Terrace (to south)	46	
Testing of emergency plant (single generator)	Bashley Rd Travellers Site (to north)	40	48[1]
	Midland Terrace (to south)	≤40	

[1]daytime operation only

7.3.2 In all cases the proposed plant selections and attenuation set out in this report can achieve the noise level limits set at the nearest sensitive properties.

7.3.3 In accordance with Table 4.1, the levels predicted are expected to result in No Observed Adverse Effect Level and a Negligible to Minor impact on nearby receptors during normal operation and a Lowest Observed Adverse Effect Level during temporary emergency conditions, with a Moderate impact.

7.4 ROAD TRAFFIC NOISE LEVELS

7.4.1 Road traffic flow data is not available for assessment at the time of writing this report. However, road traffic flows would need to change by 25% for the resultant noise level to change by 1 dB. A change in noise level of 1 dB would be considered to be negligible. On this basis, it is expected that a data centre usage on this site would provide negligible changes in road traffic noise levels.

8. CONCLUSIONS

8.0.1 Calculations of plant noise during normal and emergency conditions indicate that plant noise limits which have been set based on the typical background noise levels at the nearest sensitive receptors, can be met with the proposed plant selections and scheme of attenuation given in this report. During normal operation, plant noise is expected to have no adverse effect (NOAEL) and during an emergency situation or when testing emergency equipment, a low effect is expected (LOAEL).

8.0.2 Changes in road traffic noise levels are not expected to give rise to any significant effects.

APPENDIX 1
ACOUSTIC TERMINOLOGY

Term	Definition
$L_{eq,T}$ or Ambient noise	A noise level index called the equivalent continuous noise level over the time period T. Often described as the average.
$L_{90,T}$ or Background Noise Level	A noise level index defined as the noise level exceeded for 90% of the time over the time period T. L_{90} is used to describe the background noise.
Vibration	The periodic movements of structures transferred by ground and parts of the building, due to events such as train pass-by, piling, blasting or use of heavy machinery.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1/s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20μPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
BNL	The Basic Noise Level is the road traffic noise at a reference distance of 10 m from the road edge, expressed in terms of the L_{A10} statistical level (18-hour or 1-hour), and calculated according by Calculation of Road Traffic Noise (CRTN) based on the traffic flow.
AAWT	Annual Average Weekday Traffic is the total number of vehicles annually (on Monday – Fridays) divided by the total number of weekdays in this period.
Rating Level ($L_{Ar,Tr}$)	To BS 4142:2014+A1:2019, the rating level is defined as the equivalent continuous A-weighted sound pressure level produced by the specific sound source over a given reference time interval, Tr plus any adjustment for the characteristic features of the sound (tonality, impulsivity, etc.).
NSR	A Noise Sensitive Receiver is any receiver that is classed as being sensitive to noise sources, (residential properties, churches, music studios etc.)

APPENDIX 2
BASELINE NOISE SURVEY RESULTS

The results of the baseline attended measurements are shown in the table below:

Location of measurement	Start time	$L_{AFmax,15mins}$ (dB)	$L_{Aeq,15mins}$ (dB)	$L_{A90,15mins}$ (dB)
ST1 – Midland Terrace	04/11/2020 11:56	75	59	51
	04/11/2020 12:44	75	60	54
	04/11/2020 13:42	74	59	54
ST2 – Shaftesbury Gardens	04/11/2020 12:15	86	62	54
	04/11/2020 13:12	73	60	55
ST3 – Front gates of Chandos Park Industrial Estate	09/11/2020 13:22	78	59	48
	09/11/2020 14:38	80	61	51
ST4 – Victoria Road	09/11/2020 13:45	93	71	59
	09/11/2020 15:04	89	68	58

A summary of the baseline unattended measurements are shown in the tables below:

Summary of Survey Results from LT1

Date	Period	$L_{Aeq,T}$ dB	Highest L_{AFmax} dB	Typical $L_{A10,T}$ dB	Typical $L_{A90,T}$ dB
Wed 04/11/2020	14:30-23:00	62	85	59	51
	23:00-07:00	66	81	68	56
Thu 05/11/2020	07:00-23:00	62	95	59	51
	23:00-07:00	54	75	57	47
Fri 06/11/2020	07:00-23:00	56	93	57	49
	23:00-07:00	55	81	57	46
Sat 07/11/2020	07:00-23:00	55	92	55	47
	23:00-07:00	53	86	52	44
Sun 08/11/2020	07:00-23:00	53	84	53	43
	23:00-07:00	46	71	44	40
Mon 09/11/2020	07:00-13:00	58	87	59	50

Summary of Survey Results from LT2					
Date	**Period**	**$L_{Aeq,T}$ dB**	**Highest L_{AFmax} dB**	**$L_{A10,T}$ dB**	**Typical $L_{A90,T}$ dB**
Wed 04/11/2020	12:15-23:00	61	105	56	47
	23:00-07:00	53	84	49	41
Thu 05/11/2020	07:00-23:00	57	95	55	47
	23:00-07:00	54	86	52	43
Fri 06/11/2020	07:00-23:00	57	90	58	48
	23:00-07:00	55	93	49	41
Sat 07/11/2020	07:00-23:00	53	84	54	46
	23:00-07:00	45	78	48	39
Sun 08/11/2020	07:00-23:00	51	80	51	41
	23:00-07:00	52	84	51	38
Mon 09/11/2020	07:00-14:00	57	93	56	49