HOARE LEA

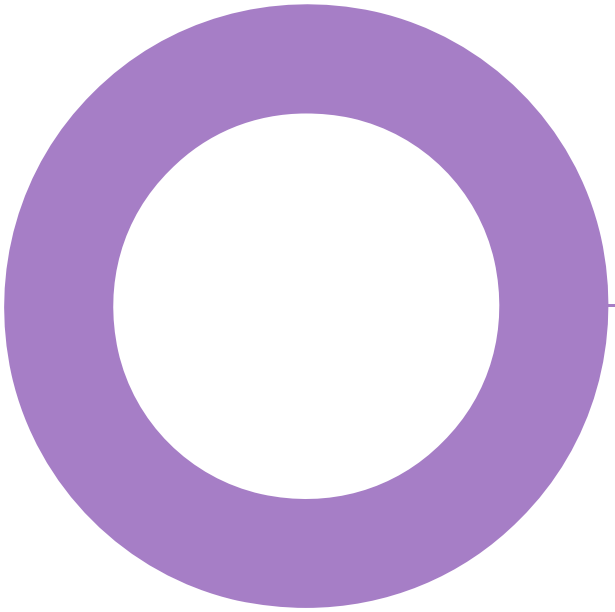
Tavistock House – Workstream 2. London.

British Medical Association.

ACOUSTICS

NOISE CONTROL STRATEGY

REVISION 01 – 31 MARCH 2023



Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
00	31/03/2023	First issue	CS	DF	BJ
01	31/03/2023	Updated plant layout image	CS	DF	BJ

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Contents.

Executive summary.

There are proposals to refurbish the British Medical Association's head office building at Tavistock House, Tavistock Place, London, WC1H 9JP. Tavistock House is a grade II listed building within the Bloomsbury conservation area. A number of workstreams are underway to refurbish different parts of the building, as well as the whole site. Workstream 2, to which this report pertains, relates to levels 3 and 4 of blocks E and F, and level 3 of block G, which are to be refurbished into Cat A office spaces. As part of these works, new building services plant is to be installed in a number of locations on the roof of blocks F, G and H.

An environmental sound survey was undertaken at the site to establish the baseline sound levels. The results of the survey have been used to derive plant noise emission limits in line with London Borough of Camden criteria at the nearest noise sensitive receivers. These comprise offices along Tavistock Square and the residences on Woburn Walk and Burton Street. The office receptors at Lynton House, 9 Tavistock Square, WC1H 9BQ are considered to be the most affected noise sensitive receivers by future plant noise emissions at the site.

An assessment of the key items of landlord plant has been undertaken to Lynton House, based on preliminary plant selections. These include:

- Variable Refrigerant Flow (VRF) units on the rooves of blocks G & H,
- Direct Exchange (DX) units on the ledge above the courtyard entrance,
- Air Handling Units (AHUs) in the Block F attic,
- Provision has also been made for future tenant plant to be installed.

To meet the plant noise emission limits at the most affected noise sensitive receiver, provision has been made for the following measures:

- VRF units to run in low noise mode,
- Attenuation kits to be installed on all VRFs,
- Inline ductwork attenuators to be installed on the AHU intake and exhaust ducts.

As Lynton House overlooks the proposed plant locations, the plant noise limits at this receiver were found to be onerous and require the installation of large attenuation kits to the VRF units, forcing them to run harder and less efficiently. Relaxed plant noise emission limits have been proposed to facilitate a more efficient and sustainable design. These would allow the removal of the attenuation kits to the VRF units, therefore also reducing the visual impact of the units. However, confirmation of acceptance of the proposed approach is yet to be received from the local authority and as such the plant has been designed in line with Camden's standard criteria.

On the basis of the above, plant noise emissions should not pose an obstacle to the granting of planning permission for the proposed works.

1. Introduction.

There are proposals to refurbish the British Medical Association's head office building at Tavistock House, Tavistock Place, London, WC1H 9JP. Tavistock House is a grade II listed building within the Bloomsbury conservation area. A number of workstreams are underway to refurbish different parts of the building, as well as the whole site. Workstream 2, to which this report pertains, relates to levels 3 and 4 of blocks E and F, and level 3 of block G, which are to be refurbished into Cat A office spaces. As part of these works, new building services plant is to be installed in a number of locations on the roof of blocks F, G and H.

An environmental sound survey has been undertaken to establish the existing sound levels around the site and nearby noise sensitive receivers.

This survey has been used to establish plant noise limits to protect neighbours in line with the local authority planning policy. Early assessments of noise emissions from the proposed plant items have also been carried out. The survey and assessments have been undertaken in accordance with the relevant British Standards and local authority's requirements.

This report summarises the results of the survey and assessments and is intended to support the planning application for the works to the London Borough of Camden. A glossary of technical terms used within the report is provided in Appendix A.

2. Site description.

2.1 Existing site.

Tavistock House is located in the London Borough of Camden. The site is bordered to the northwest and southeast by residential buildings and the southwest façade overlooks Tavistock Square which is subject to heavy road traffic noise.

The northeast façade overlooks Burton Street which is predominantly residential. Prevalent noise sources here are occasional motor vehicles, building services plant, and distant road traffic from Tavistock Square and other main roads.

The site itself is separated by three courtyards. The northernmost courtyard serves as a car park and accommodates several items of building services plant, predominantly at ground level.

The middle courtyard has direct line of sight to Tavistock Square and is thus subject to higher levels of road traffic noise than the other courtyards. There are also ground level intake / exhaust louvres for building services plant and occasional cars passing in and out of the car park which contribute to the overall sound level.

The southernmost courtyard is a garden area with a water fountain. Along with the fountain and distant road traffic noise, the sound level is controlled by building services plant located on level 3 of Block H. For reference, a drawing of the site with each block labelled is given in Figure 1.

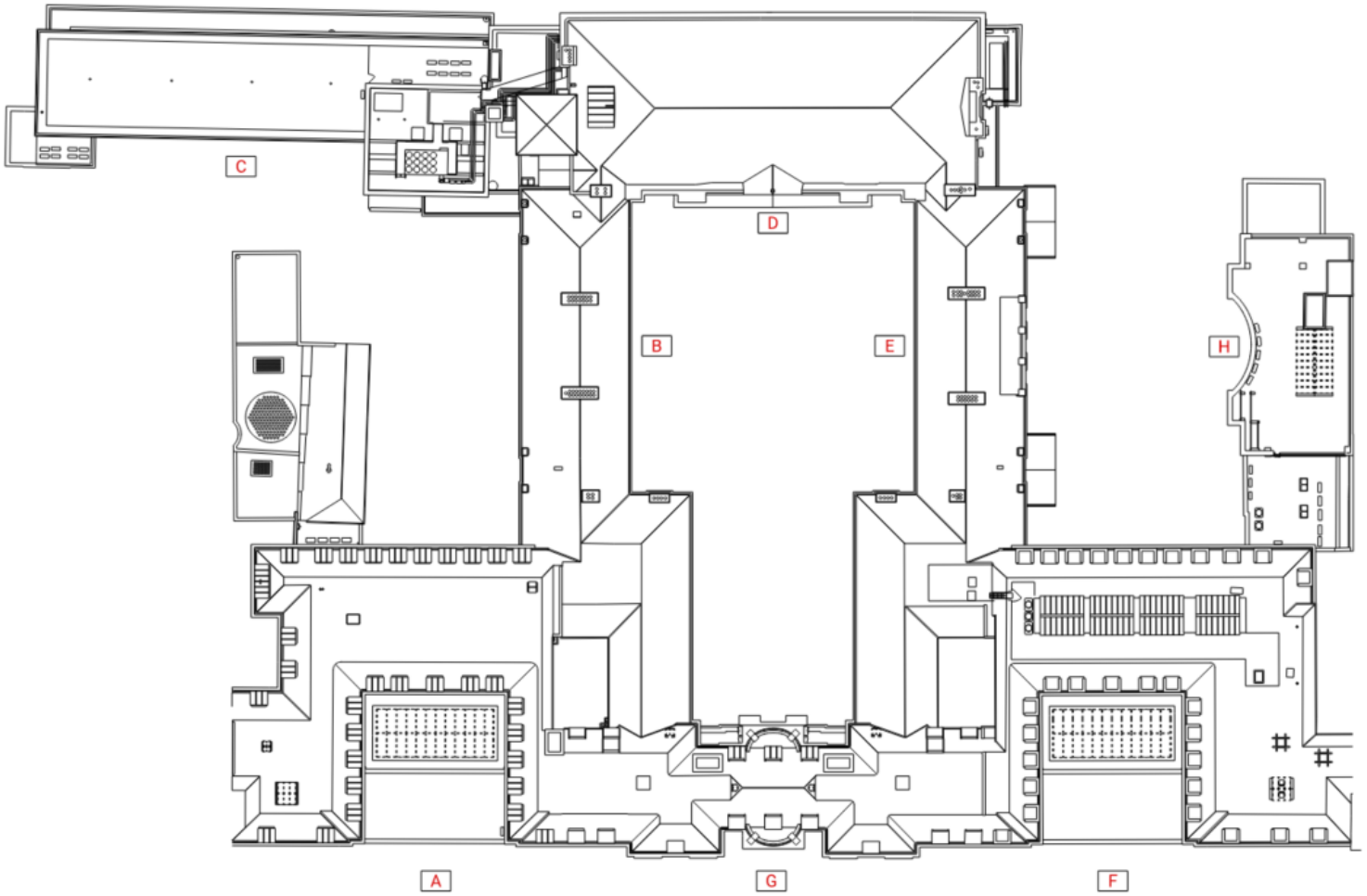


Figure 1 Layout of blocks across site.

2.2 Environmental sound survey,

The environmental sound survey comprised long-term, unattended measurements between 28th January – 3rd February 2022, as well as short-term, attended measurements on 3rd February 2022.The long-term measurements were taken at four positions, each representative of a different area and noise sensitive receiver around the site:

1. Overlooking Tavistock Square at third floor roof level – free-field level,
2. Overlooking Burton Street at fourth floor roof level – façade level,
3. Overlooking the car park to the north of site at first floor roof level – free-field level,
4. Overlooking the garden to the south of site at third floor roof level – free-field level.

These measurement locations are displayed in Figure 2 along with a summary of the recorded sound levels.

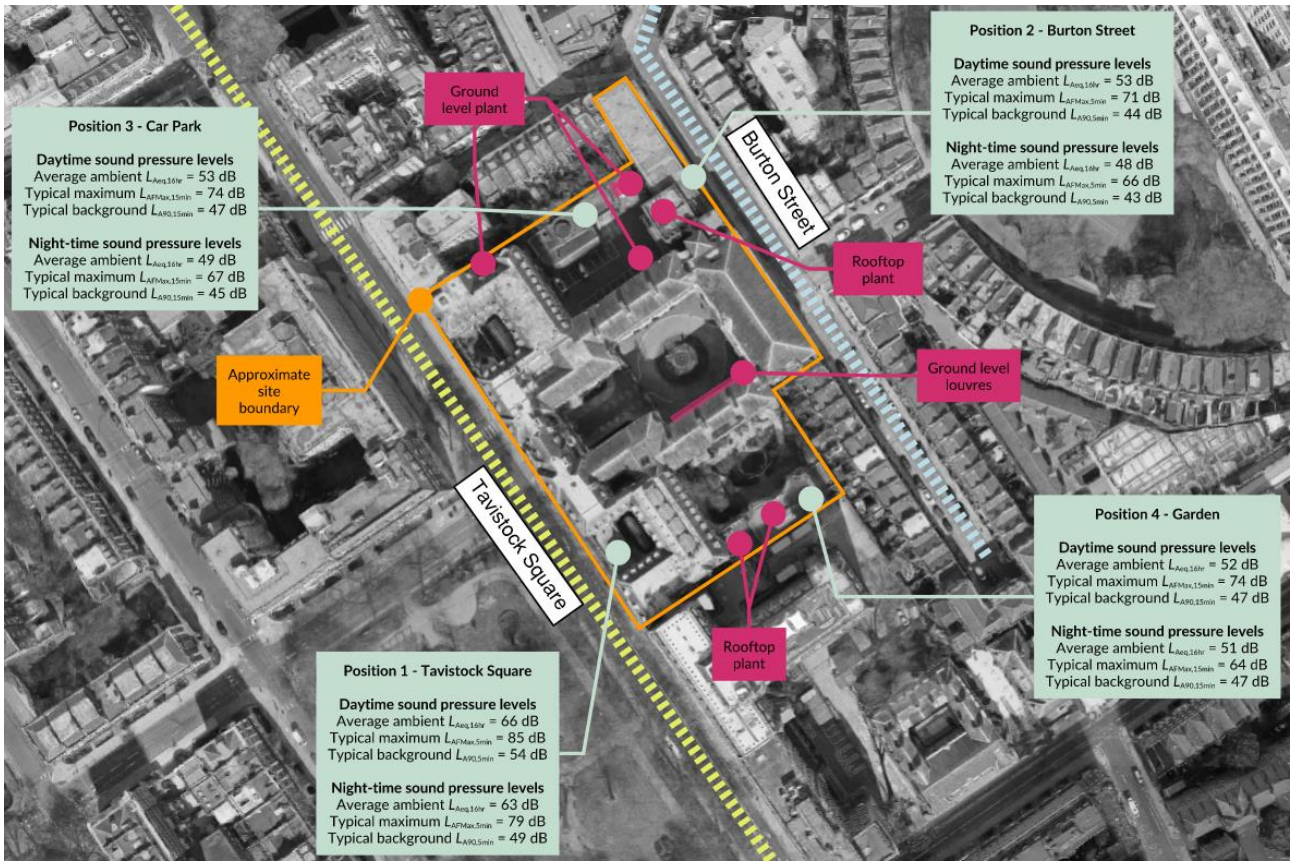


Figure 2 Summary of long-term measurement positions and results (Image from Google Maps).

Additional short-term measurements were taken at various positions around the site to complement the long-term measurements, and to capture the specific sound levels at 1 meter from existing items of building services plant. A summary of these measurements is given in Appendix B.

3. Basis of assessment.

3.1 Standard guidance documents.

Appropriate, well-established guidance on the assessment of noise and acoustic design relevant to the development is available from several references including, but not limited to, the following:

- Camden Local Plan: adopted 2017.
- National Planning Policy Framework (NPPF), 2021
- British Standard 4142: 2014 + A1 2019 *"Methods for rating and assessing industrial and commercial sound"*.

3.1.1 Local policy.

Policy A4 of Camden's Local Plan states:

"The Council will seek to ensure that noise and vibration is controlled and managed. Development should have regard to Camden's Noise and Vibration Thresholds (Appendix 3). We will not grant planning permission for:

a. *development likely to generate unacceptable noise and vibration impacts; or*

b. *development sensitive to noise in locations which experience high levels of noise, unless appropriate attenuation measures can be provided and will not harm the continued operation of existing uses.*

We will only grant permission for noise generating development, including any plant and machinery, if it can be operated without causing harm to amenity. We will also seek to minimise the impact on local amenity from deliveries and from the demolition and construction phases of development."

Appendix 3 of the Camden Local Plan further states:

"A relevant standard or guidance document should be referenced when determining values for LOAEL and SOAEL for non-anonymous noise. Where appropriate and within the scope of the document it is expected that British Standard 4142:2014 'Methods for rating and assessing industrial and commercial sound' (BS 4142) will be used. For such cases a 'Rating Level' of 10 dB below background (15dB if tonal components are present) should be considered as the design criterion)."

3.1.2 BS 4142:2014 + A1:2019 Methods for rating and assessing industrial and commercial sound.

The BS 4142:2014 method for assessing noise emissions from new building services plant can be summarised as follows:

- Establish the typical background sound levels of the local acoustic environment over the relevant period;
- Determine the rating levels of plant noise emissions. These include specific noise emissions plus corrections that ought to be applied where noise emissions can be perceived as tonal, impulsive and / or intermittent. If a new type of noise source is to be introduce in a local acoustic environment, a further correction of +3 dB may be applied due to the change in the pre-existing environment;
- Subtract the typical background noise levels from the estimated rating levels, as measured / calculated at the nearest noise sensitive receivers;
- Based on the above levels difference, evaluate the impact of the new building services plant on the nearest noise sensitive receivers considering that:
  - A difference of at least +10 dB is likely to be an indication of a significant adverse impact, depending on the context;
  - A difference of around +5 dB is likely to be an indication of adverse impact, depending on the context.
  - Where the rating level does not exceed the background noise level, this is an indication of low impact, depending on context.

4. Plant noise assessment.

4.1 Plant noise emissions to atmosphere.

Noise from new building services plant connected to atmosphere will need to be controlled to limiting noise levels in line with Camden Council policy as outlined in section 3.1.1.

Plant noise emission limits were derived based upon the environmental sound survey results and in line with the local policy and guidance of new plant needing to be designed to at least 10 dB below the typical background sound levels at the nearby noise sensitive receivers. The daytime (07:00 – 23:00) limits are summarised in Figure 3 and are presented as specific levels as defined within BS 4142. As the scheme is for office use, it is not intended to be used during the night-time (23:00 – 07:00). Therefore, only the daytime limits are presented i.e., when plant will be operating.

The limits apply at 1 m from the windows of the nearest noise sensitive receivers. Should the plant exhibit tonal, intermittent, or impulsive characteristics, the limits given in Figure 3 should become 5 dB more onerous, as per the local authority requirements.

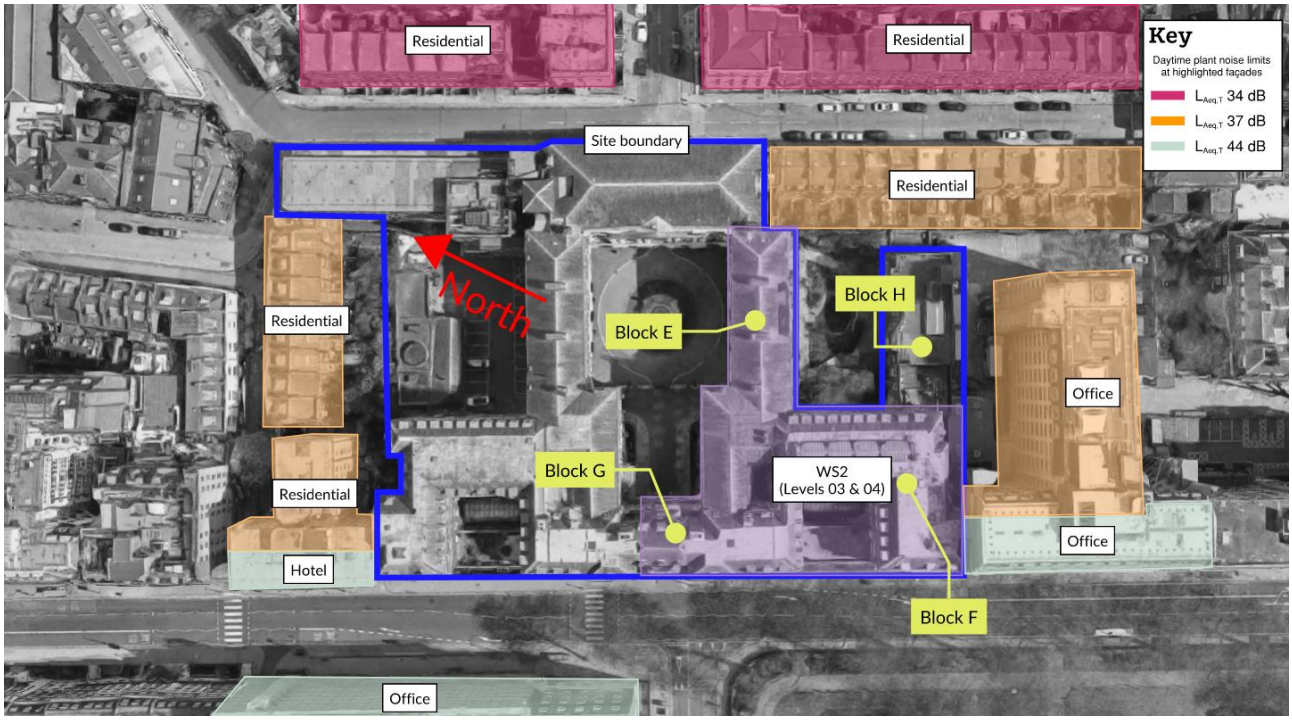


Figure 3 Daytime (07:00 – 23:00) plant noise emission limits.

4.1.1 Proposal for relaxed plant noise limits at the offices.

Given the location of the new plant in relation to the nearby noise sensitive receivers, the plant noise limits based upon Camden's policy are low and will place onerous requirements on the building services plant. Early assessments have identified the worst-affected receiver to be the office building at Lynton House, 9 Tavistock Square, WC1H 9BQ, due to its proximity and direct line of sight to the plant area on block H. Camden's Environment Health Officer (EHO) has been engaged to negotiate relaxed plant noise limits at this receiver. However, at the time of writing, it has not been possible to agree on an approach for noise limits at the offices.

Section 11 of BS 4142:2014 states that assessments of sound of an industrial or commercial nature should be considered in the context within which the sounds will occur, and that *"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."* The assessment of context requires evaluation of several factors including the level and character of both the specific and background noises, as well as any mitigation measures proposed.

It is proposed that the daytime plant noise limit at Lynton House is relaxed such that it is 5 dB below the typical background sound levels, i.e. 42 dB $L_{Ar,Tr}$. Assuming that the Lynton House offices rely upon open windows for ventilation and cooling, and considering that the noise reduction through a partially open window is typically taken to be approximately 13 dB, plant noise levels in the offices would be approximately 29 dB(A), or ~NR 24. This level will be even lower when the windows are closed, i.e. during cold weather or if the building is fully mechanically ventilated and cooled.

British Council for Offices guidelines state that typical internal sound levels in meeting rooms, the most sensitive spaces in office buildings, should be NR 35. The specific noise level from the proposed plant, as derived above, would be at least 10 dB below this limit and the plant noise is therefore unlikely to be perceptible over typical ambient sound levels within the office / meeting room from occupant activity and internal building services.

Therefore, relaxing the plant noise limits at the Lynton House offices as described above would still allow Tavistock House and Lynton House to operate without negatively affecting each other.

The assessment that follows, however, is based on achieving compliance with the limits in Figure 3, i.e., without the relaxation as this is yet to be agreed with the EHO. Should the proposed approach given above be approved for the less sensitive office receivers, the required mitigation measures could be reduced and, in some instances, removed altogether. This would reduce the visual impact from the plant and allow a more sustainable building services strategy.

4.2 Plant proposals.

Several items of building services plant are proposed for workstream 2 of the scheme. These items are summarised in Table 1. The approximate proposed positions of the plant items are illustrated in Figure 4.

Allowance is also being made for future tenant plant which is likely to comprise 5no. DX condensers. These will need to be designed to achieve a sound power level of 50 dB(A) each. These limits will be included in the future tenants' leases.

Table 1 Schedule of proposed plant.

Location	Unit type	Quantity	Manufacturer / Model	Broadband sound level
Block G ledge facing courtyard	DX unit	2no.	Daikin RXM71R	48 dB L_{pA} at 1 m
Block G roof	VRF unit	2no.	Daikin REYQ16U	70 dB L_{wA}[1]
		1no.	Daikin REYQ34U	73 dB L_{wA}[1]
Block H roof	VRF unit	1no.	Daikin REYQ50U	74 dB L_{wA}[1]
Block F lightwell	Air handling unit	-	No selection	

[1] Unit running in low noise mode as specified by the manufacturer.

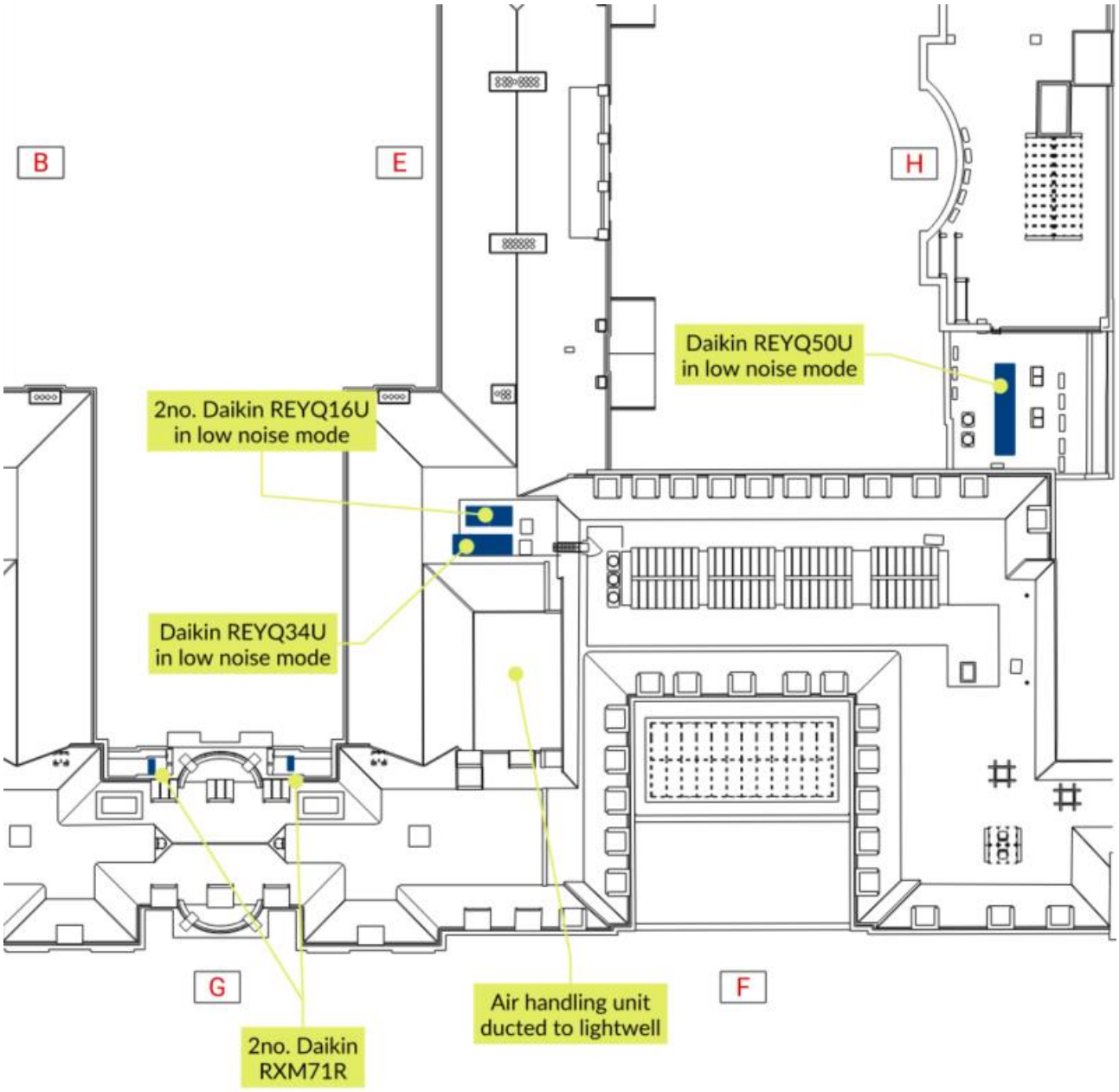


Figure 4 Proposed roof plant layout.

4.3 Mitigation measures.

An early assessment of the plant proposals identified the need for mitigation. Below are the measures required for each type of plant item. These mitigation measures are based on achieving compliance with the plant noise limits set out in Figure 3.

4.3.1 Condenser units.

With the current design, the VRF units will be the most challenging items of plant to control. Attenuation kits capable of reducing the noise levels from the VRF units by at least 7 dB have been allowed for all VRF units. An example of a suitable system is provided in Figure 5.

Figure 5 Indicative image of attenuator kit on VRF.

In addition to this, the VRF units will be required to run in “low noise mode” as specified by the manufacturer. These units will also need to be turned off at night-time (23:00 – 07:00).

The DX units are positioned within a courtyard and with no direct line of sight to any noise sensitive receivers. They are therefore not expected to require specific mitigation measures.

4.3.2 Air handling units.

Air handling units (AHUs) will be located internally within the building and will be ducted to atmosphere on level 5 of block F.

Selections have not been made for AHUs at this early stage of the design. Provision, however, has been made for induct attenuators to control noise from the intake and exhaust ducts.

Since the AHU ducts will terminate within the lightwell, there will be a high degree of screening to the receivers provided by the mass of the building. The AHUs are therefore not expected to contribute significantly to the specific plant noise level at the receiver, particularly with induct attenuation.

The induct attenuation will be developed so as to ensure that noise emissions from the AHUs will allow compliance with the local authority’s plant noise requirements at all times.

4.4 Assessment.

An assessment has been undertaken to determine whether the noise emissions from the proposed plant at the nearest noise sensitive receivers can be achieved with the current proposals. The calculations consider the following:

- Manufacturer's sound data for the units including a +3 dB tolerance applied for uncertainty,
- No corrections for intermittency or tonality; the plant will run continuously, and the current manufacturer data does not exhibit potential signs of tonality.
- Corrections for distance and directivity assuming hemispherical point source propagation,
- Losses from proposed mitigation measures set out in section 0.

Early assessments indicated that the noise sensitive receiver likely to be most affected by the plant is the office building at Lynton House to the south.

A broadband summary of the calculations for the VRF units is given in Table 2. However, calculations were performed based upon spectral characteristics of the noise and details of this can be made available upon request. Only the VRF condensers have been presented as the noise levels from other items of plant are significantly lower than these and will not contribute to the overall plant noise levels at the most affected receivers.

Table 2 Summary of VRF unit noise assessment calculation to the most affected noise sensitive receiver.

Calculation step	Summary of plant noise assessment at Lynton House		
	2no. VRFs on block G	1no. VRF on block G	1no. VRF on block H
Sound power level of 1no. VRF, dB(A)	70	73	74
Correction for no. units, dB	+3	+0	+0
Tolerance, dB	+3	+3	+3
Distance, m	55	55	20
Distance attenuation, dB	-43	-43	-34
Reduction from attenuation kits*, dB	-7	-7	-7
Resultant sound pressure level at 1 m from window of receiver, dB(A)	26	26	36
Combined sound pressure level, dB(A)	37		
Plant noise emission limit (no tonal characteristics), dB(A)	37		
Difference between level at receiver and limit, dB	+0		
Assessment	Achieves limit		

*Broadband approximation based upon detailed spectral calculations.

Based upon the assessment presented in Table 2, the local authority's plant noise emission limits can be achieved with the provision of attenuation kits to the VRF units and operation of the units in low noise mode. Therefore, noise should not pose an obstacle regarding granting planning permission.

Should the proposed relaxation in noise limits set out in section 4.1.1 be accepted by the local authority, the attenuation kits to the VRF units on block G could be removed, reducing the visual impact of the units and allowing them to operate more efficiently.

Appendix A – Glossary of acoustic terminology.

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

Sound pressure
Sound Pressure is the force (N) of sound on a surface area (m^2) perpendicular to the direction of the sound. The SI-units for 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.

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, the threshold of audibility) and the highest is approximately 200 Pa (threshold of pain).

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} = 2×10^{-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 the 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.

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 an 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 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 provide a fine resolution by dividing each octave band into three bands. For example, third-octave bands would be 160 Hz, 250 Hz and 315 Hz for the same 250 Hz octave band.

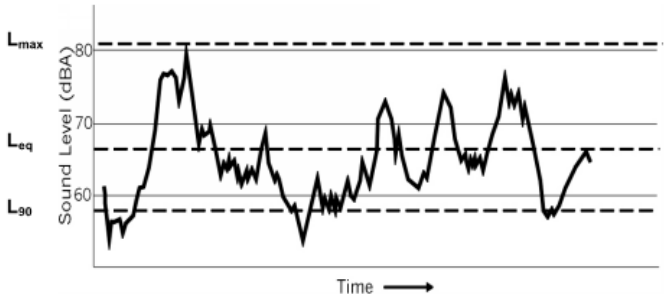
A-Weighting
The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high frequency than to low frequencies within the range. This is the basis of the A-weighting. This is a correction term applied to the frequency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

$L_{90,T}$

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, $L_{Aeq,Tr}$

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 m from reflecting vertical surfaces and 1.2 m from the ground.

Appendix B – Environmental sound survey.

Methodology.

Measurements were undertaken in accordance with BS 7445:2003 *Description and measurement of environmental noise*.

The weather conditions during the long-term measurements were appropriate for environment sound measurements, with no significant precipitation or strong winds.

Measurement equipment details.

All measurement equipment was calibrated before and after the survey. No significant calibration drift was observed. Details of the equipment used for the survey has been provided in Table 3.

Table 3 Details of survey equipment.

Position	Manufacturer	Description	Model	Serial no.	Calibration date / Certificate reference
1	Rion	Sound Level Meter	NL-52	00810564	14/01/2022 CONF012203
		Microphone	UC-59	19955	
		Pre-amp	NH-25	11107	
		Acoustic Calibrator	NC - 74	34557134	10/11/2021 UCRT21/2390
2	Rion	Sound Level Meter	NL-52	00342839	09/07/2020 UCRT20/1612
		Microphone	UC-59	06360	
		Pre-amp	NH-25	42867	
		Acoustic Calibrator	NC - 74	34557134	10/11/2021 UCRT21/2390
3	Rion	Sound Level Meter	NL-52	00331821	27/04/2021 UCRT21/1545
		Microphone	UC-59	18642	
		Pre-amp	NH-25	21772	
		Acoustic Calibrator	NC - 74	34557134	10/11/2021 UCRT21/2390
4	Rion	Sound Level Meter	NL-52	00331820	19/07/2017 UCRT17/1602
		Microphone	UC-59	04886	
		Pre-amp	NH-25	21771	
		Acoustic Calibrator	NC - 74	34557134	10/11/2021 UCRT21/2390
5 - 13	Brüel & Kjær	Sound Level Meter	2250	3004050	04/11/2021 UCRT21/2363
		Microphone	4189	3245822	
		Pre-amp	ZC0032	29334	
		Acoustic Calibrator	4231	2445715	28/09/2021 UCRT21/2185

Long-term measurements results.

Unattended, long-term measurements were taken from 28th January – 3rd February 2022. Measurements at positions 1 and 2 were taken in 5-minute contiguous periods to provide a higher resolution of the sound levels incident on the main façades, while measurements at positions 3 and 4 were taken in 15-minute contiguous periods in line with the guidance of BS 4142 for plant noise emissions.

Position 1 – Tavistock Square.

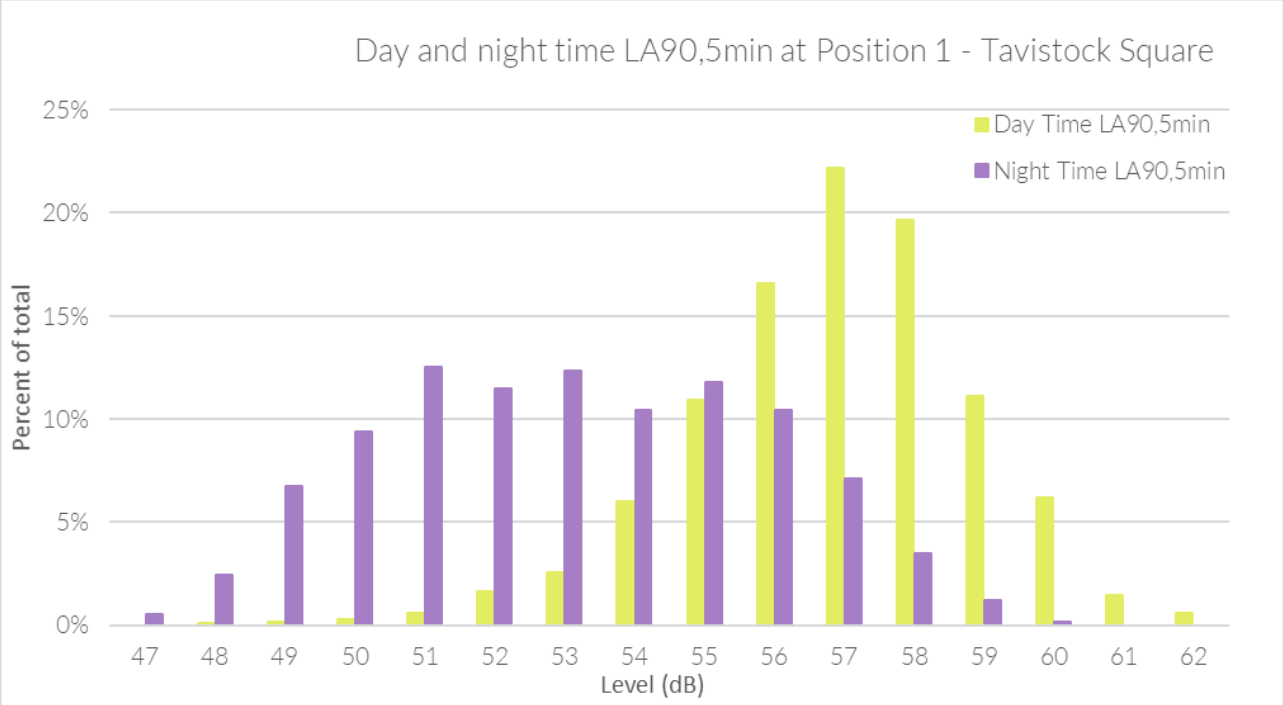
Table 4 Ambient sound pressure levels at position 1.

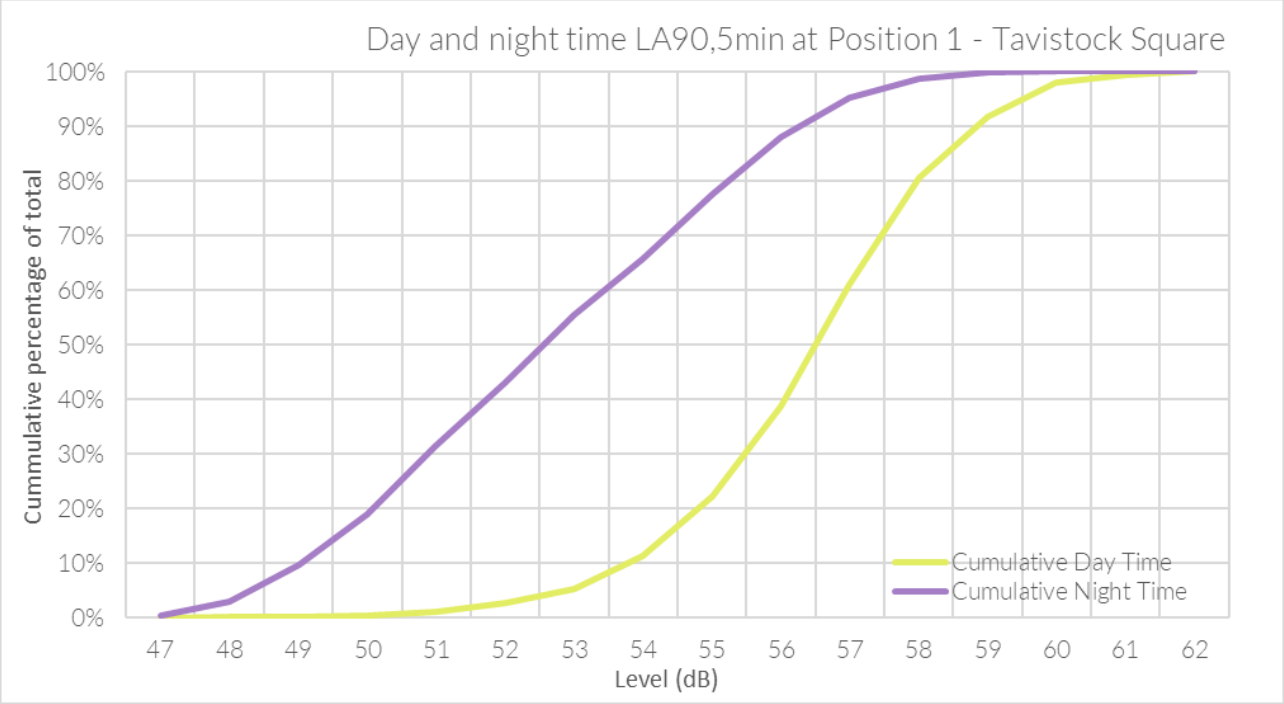
Date	Ambient sound pressure levels, dB	
	Daytime (07:00 – 23:00) $L_{Aeq,16hr}$	Night-time (23:00 – 07:00) $L_{Aeq,8hr}$
28/01/2022	68*	63
29/01/2022	64	64
30/01/2022	63	64
31/01/2022	66	63
01/02/2022	66	63
02/02/2022	66	62
03/02/2022	66*	-

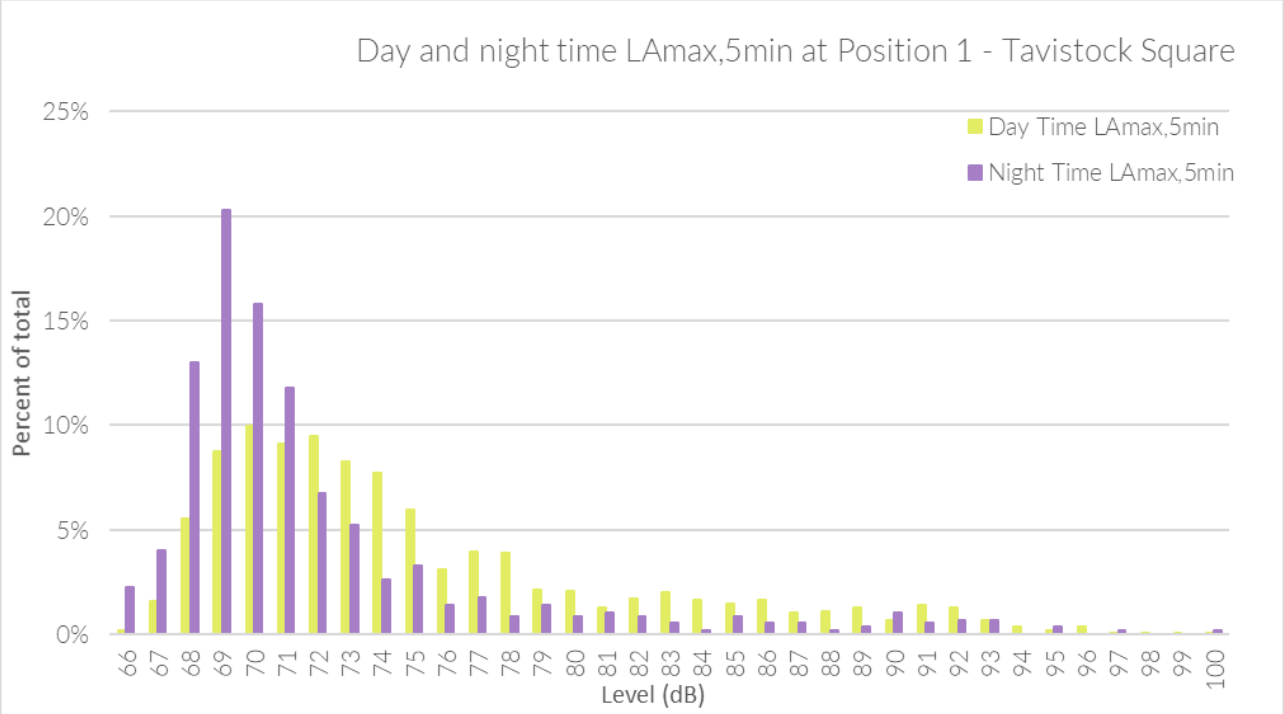
*Incomplete measurement period.

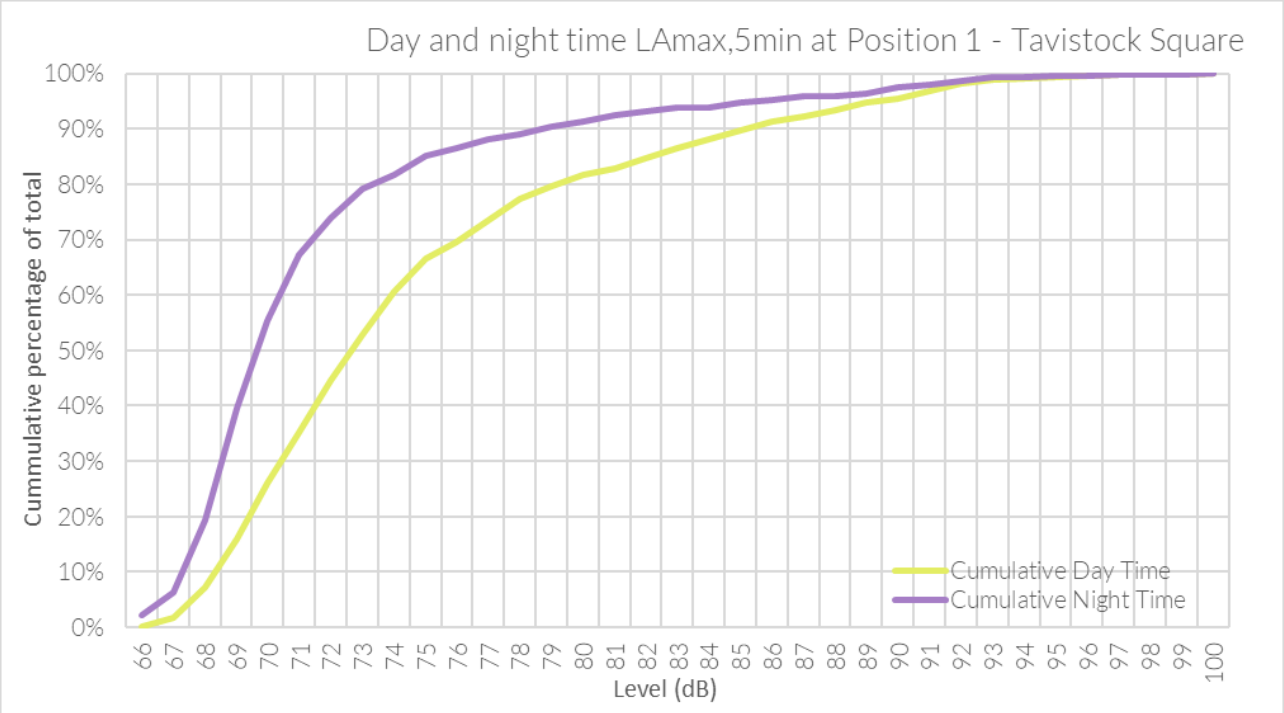
Table 5 Background sound pressure levels at position 1.

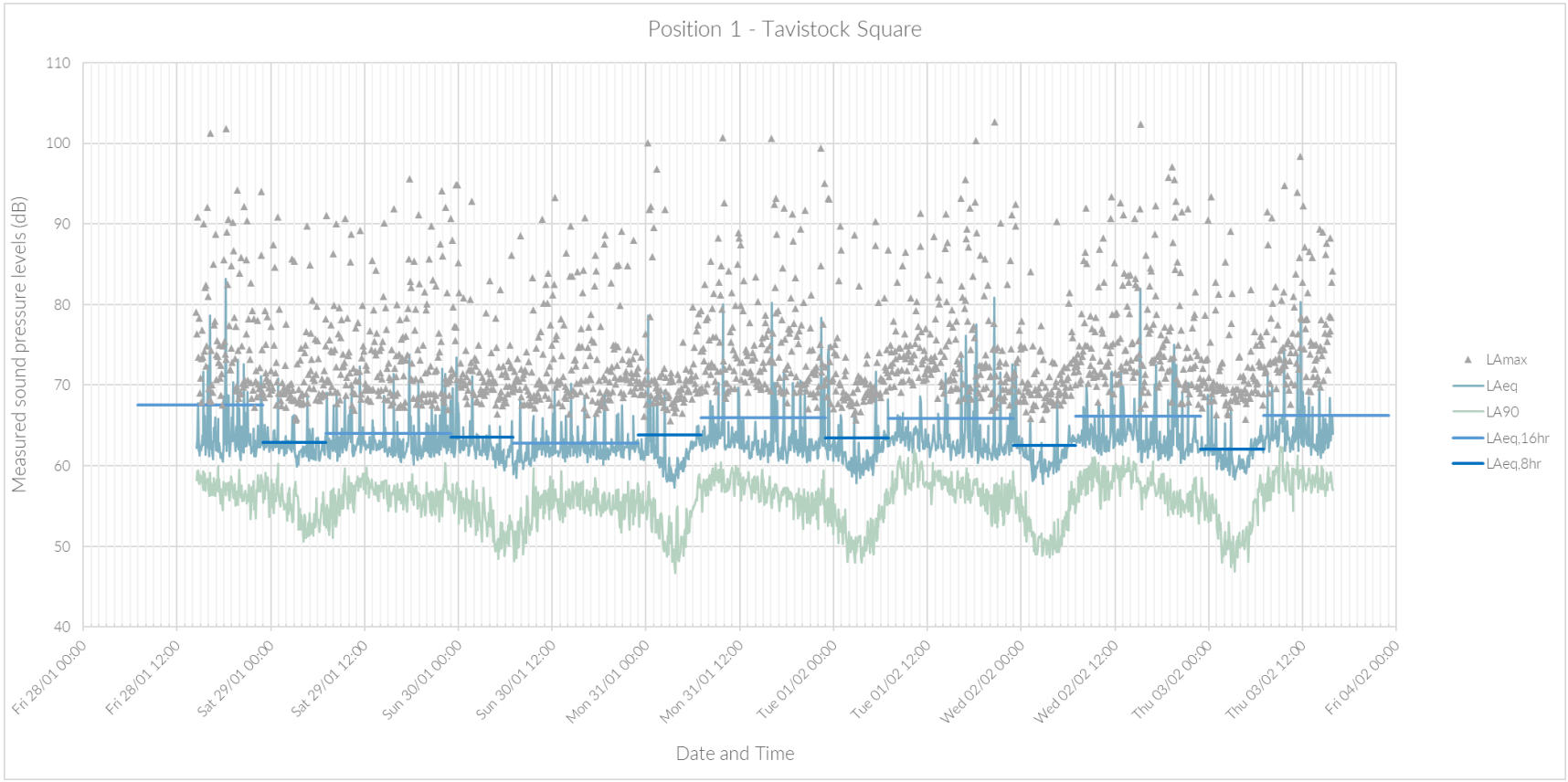
Date	Lowest background sound pressure levels, dB	
	Daytime (07:00 – 23:00) $L_{A90,5min}$	Night-time (23:00 – 07:00) $L_{A90,5min}$
28/01/2022	53	51
29/01/2022	51	48
30/01/2022	48	47
31/01/2022	52	48
01/02/2022	52	49
02/02/2022	53	47
03/02/2022	54	-


Day and night time LA90,5min at Position 1 - Tavistock Square
Day Time LA90,5min
Night Time LA90,5min
Percent of total
25%
20%
15%
10%
5%
0%
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62
Level (dB)


Day and night time LA90,5min at Position 1 - Tavistock Square
Cummulative percentage of total
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62
Level (dB)
Cumulative Day Time
Cumulative Night Time


Day and night time LAmax,5min at Position 1 - Tavistock Square
Day Time LAmax,5min
Night Time LAmax,5min
Percent of total
25%
20%
15%
10%
5%
0%
66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100
Level (dB)


Day and night time LAmax,5min at Position 1 - Tavistock Square
Cummulative percentage of total
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Cumulative Day Time
Cumulative Night Time
66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100
Level (dB)


Position 1 - Tavistock Square
Measured sound pressure levels (dB)
110
100
90
80
70
60
50
40
Fri 28/01 00:00
Fri 28/01 12:00
Sat 29/01 00:00
Sat 29/01 12:00
Sun 30/01 00:00
Sun 30/01 12:00
Mon 31/01 00:00
Mon 31/01 12:00
Tue 01/02 00:00
Tue 01/02 12:00
Wed 02/02 00:00
Wed 02/02 12:00
Thu 03/02 00:00
Thu 03/02 12:00
Fri 04/02 00:00
Date and Time
LAmax
LAeq
LA90
LAeq,16hr
LAeq,8hr

Position 2 – Burton Street.

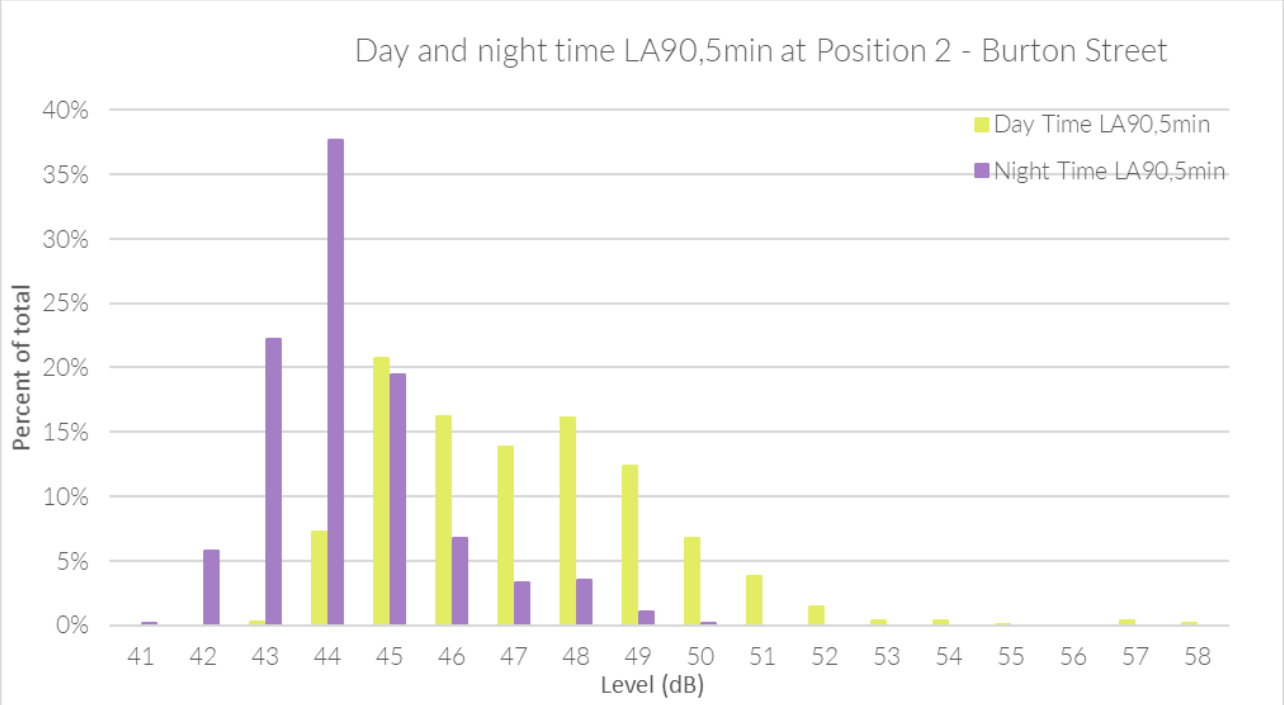
Table 6 Ambient sound pressure levels at position 2.

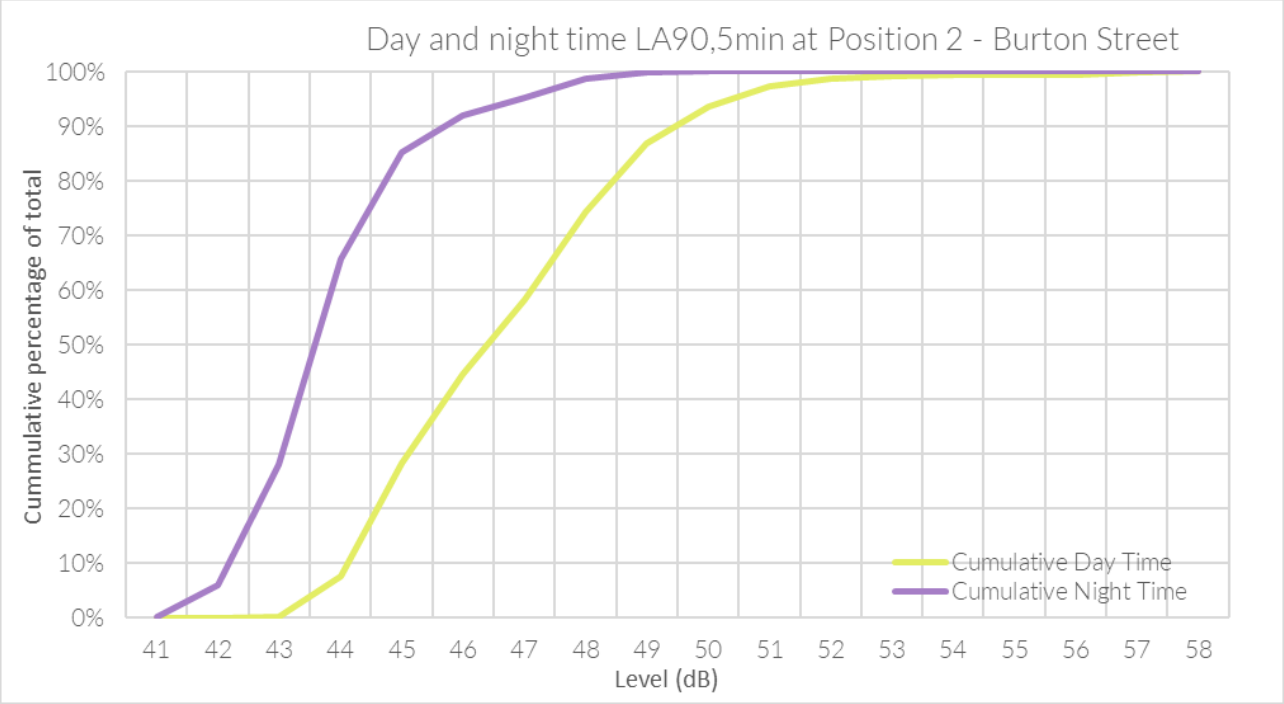
Date	Ambient sound pressure levels, dB	
	Daytime (07:00 – 23:00) $L_{Aeq,16hr}$	Night-time (23:00 – 07:00) $L_{Aeq,8hr}$
28/01/2022	52*	48
29/01/2022	53	48
30/01/2022	51	48
31/01/2022	54	48
01/02/2022	53	49
02/02/2022	53	47
03/02/2022	53*	-

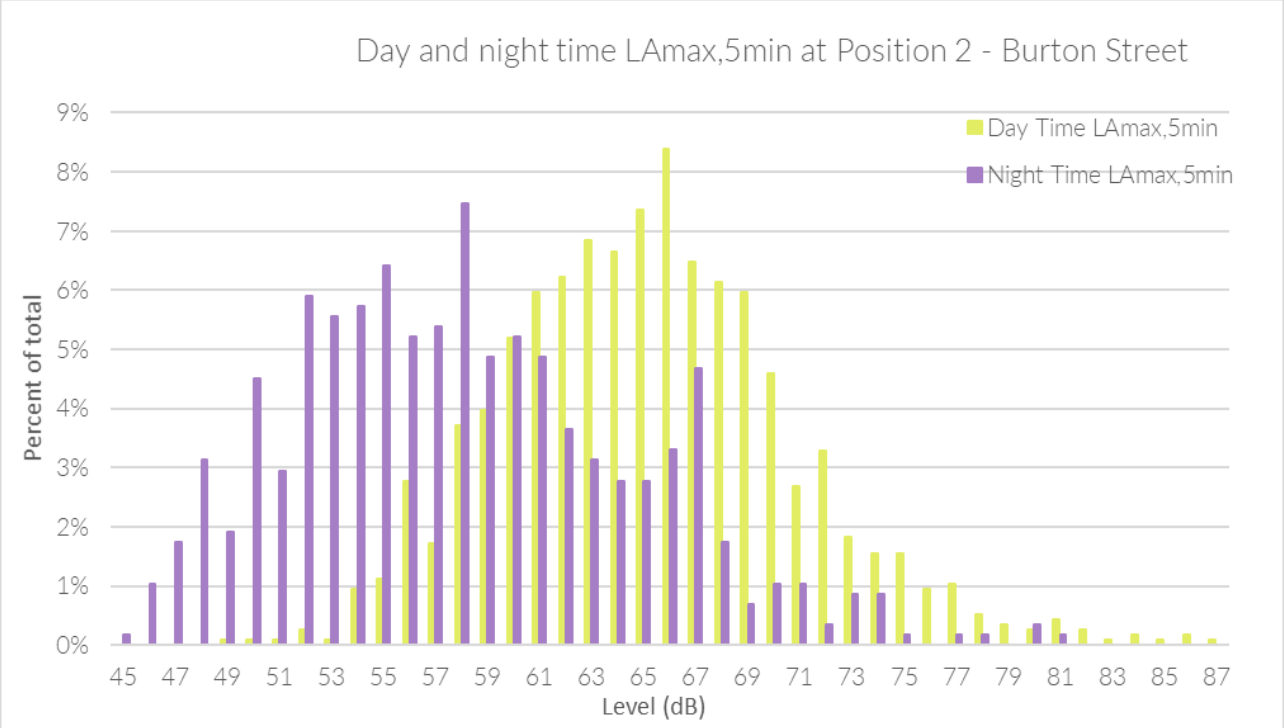
*Incomplete measurement period.

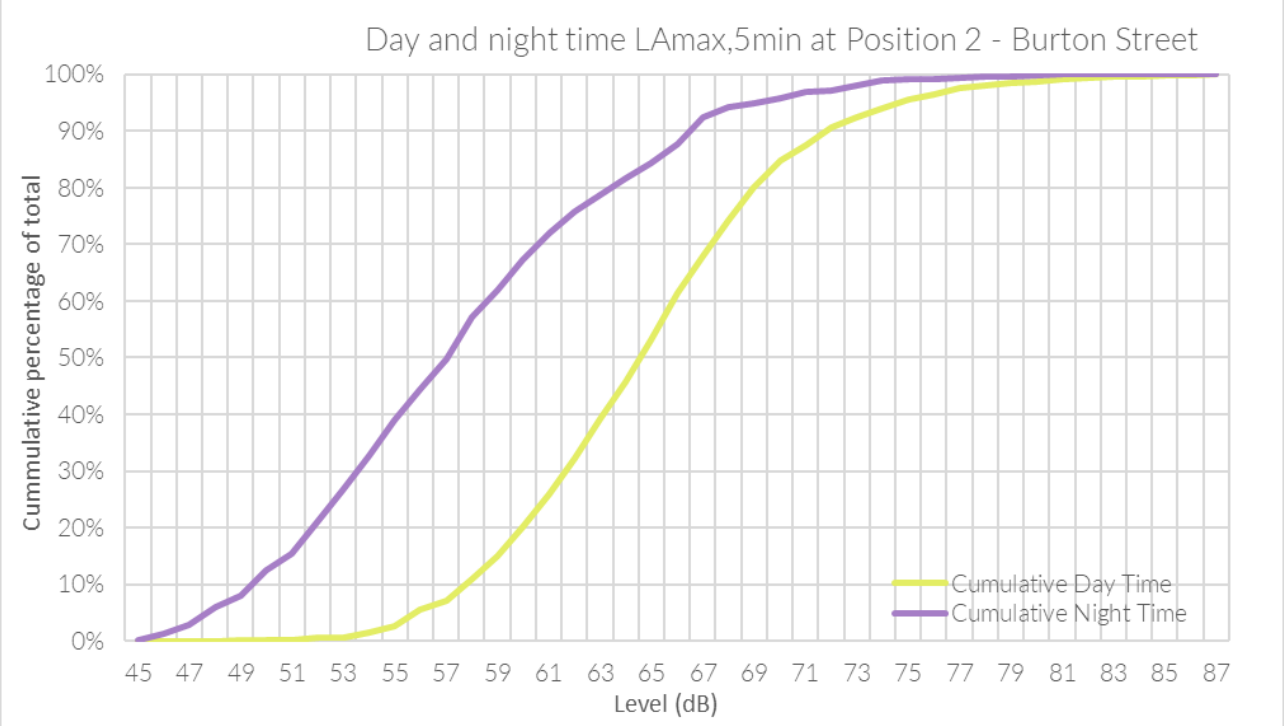
Table 7 Background sound pressure levels at position 2.

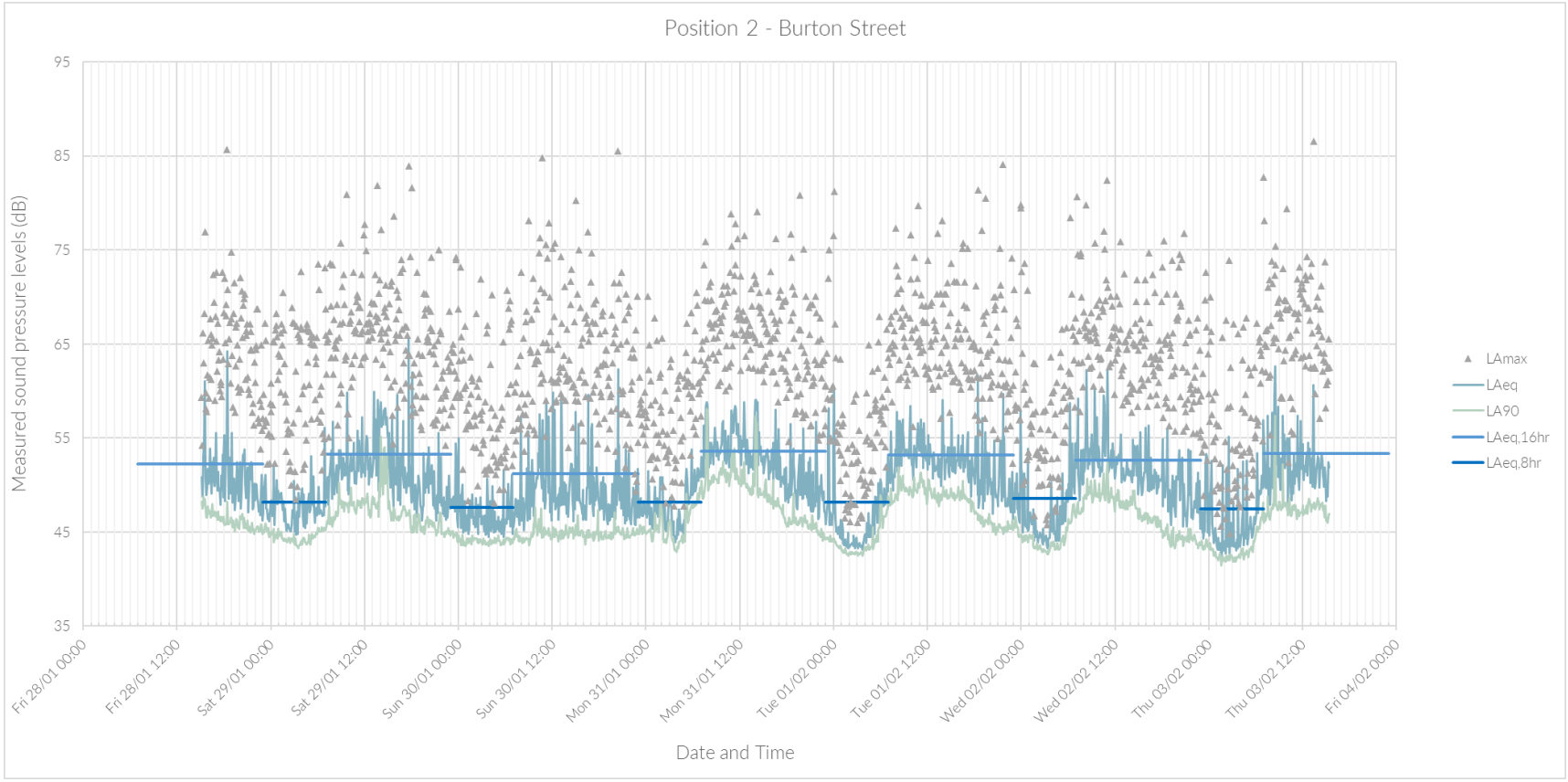
Date	Lowest background sound pressure levels, dB	
	Daytime (07:00 – 23:00) $L_{A90,5min}$	Night-time (23:00 – 07:00) $L_{A90,5min}$
28/01/2022	45	43
29/01/2022	45	44
30/01/2022	44	43
31/01/2022	44	43
01/02/2022	45	43
02/02/2022	43	41
03/02/2022	46	-


Day and night time LA90,5min at Position 2 - Burton Street
Day Time LA90,5min
Night Time LA90,5min
Percent of total
40%
35%
30%
25%
20%
15%
10%
5%
0%
41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58
Level (dB)


Day and night time LA90,5min at Position 2 - Burton Street
Cummulative percentage of total
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58
Level (dB)
Cumulative Day Time
Cumulative Night Time


Day and night time LAmax,5min at Position 2 - Burton Street
Day Time LAmax,5min
Night Time LAmax,5min
Percent of total
9%
8%
7%
6%
5%
4%
3%
2%
1%
0%
45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87
Level (dB)


Day and night time LAmax,5min at Position 2 - Burton Street
Cummulative percentage of total
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Cumulative Day Time
Cumulative Night Time
45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87
Level (dB)


Position 2 - Burton Street
Measured sound pressure levels (dB)
95
85
75
65
55
45
35
Fri 28/01 00:00
Fri 28/01 12:00
Sat 29/01 00:00
Sat 29/01 12:00
Sun 30/01 00:00
Sun 30/01 12:00
Mon 31/01 00:00
Mon 31/01 12:00
Tue 01/02 00:00
Tue 01/02 12:00
Wed 02/02 00:00
Wed 02/02 12:00
Thu 03/02 00:00
Thu 03/02 12:00
Fri 04/02 00:00
Date and Time
LAmax
LAeq
LA90
LAeq,16hr
LAeq,8hr

Position 3 – Car park.

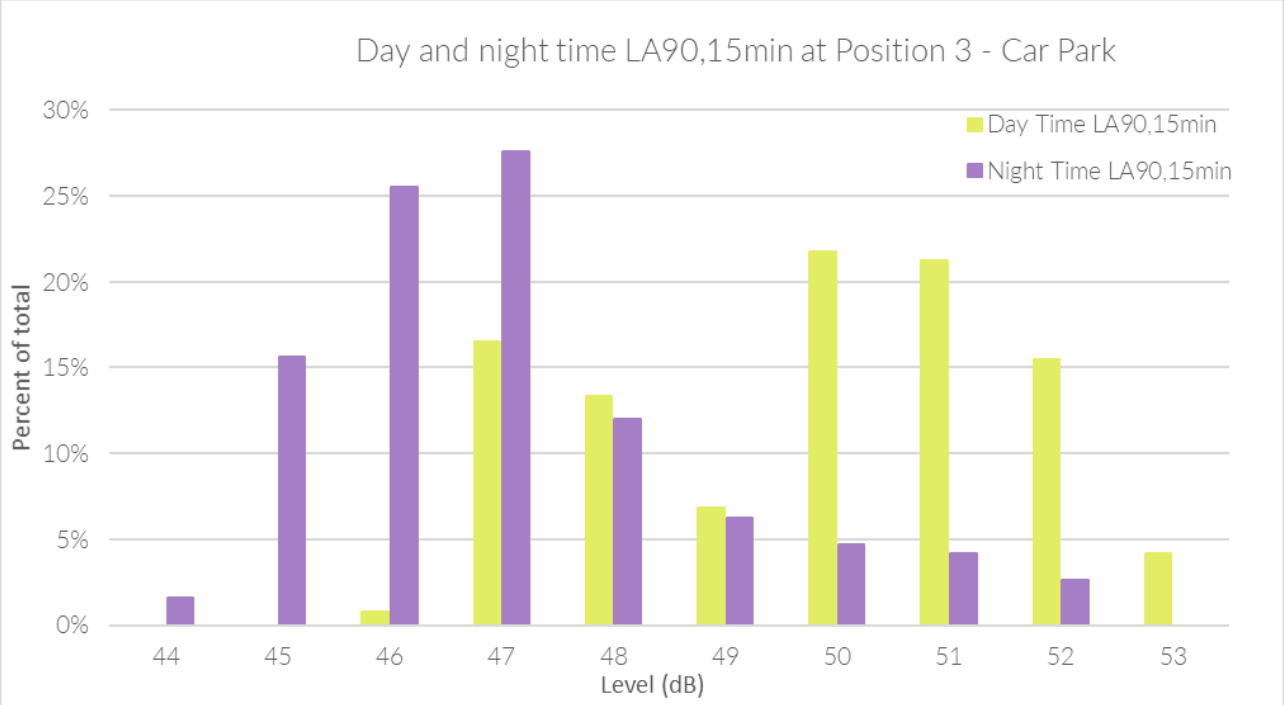
Table 8 Ambient sound pressure levels at position 3.

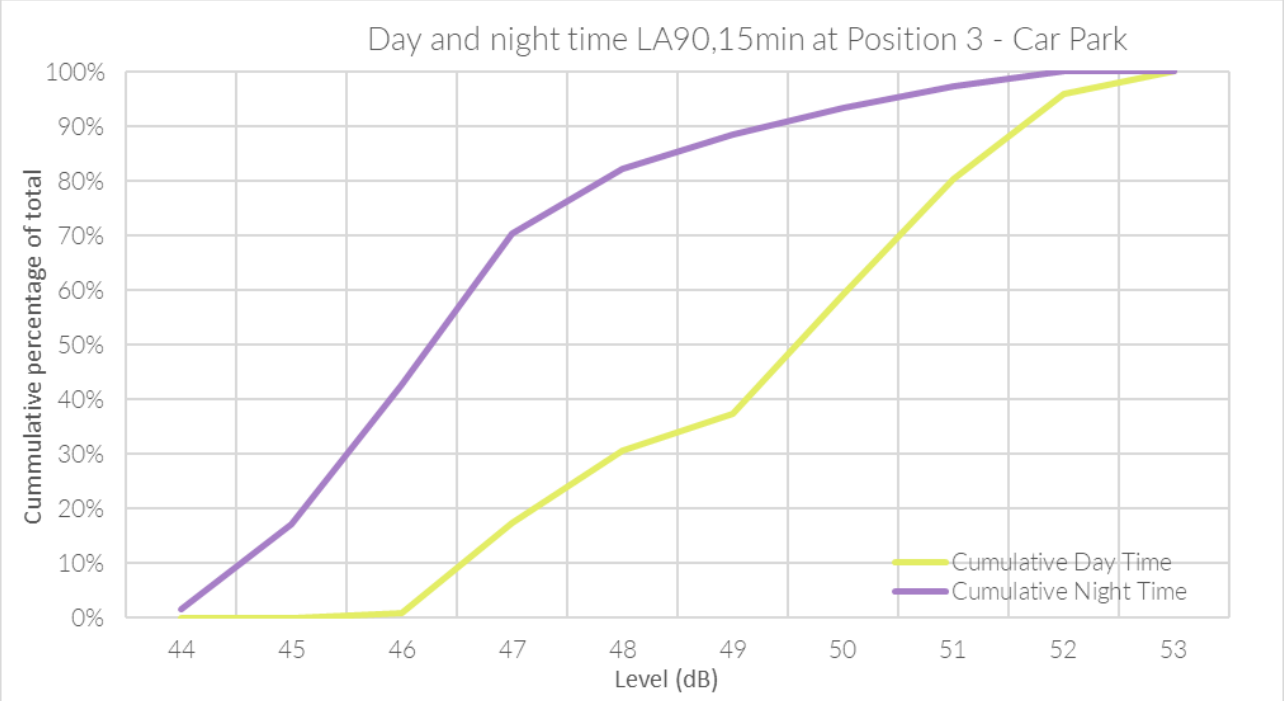
Date	Ambient sound pressure levels, dB	
	Daytime (07:00 – 23:00) $L_{Aeq,16hr}$	Night-time (23:00 – 07:00) $L_{Aeq,8hr}$
28/01/2022	53*	49
29/01/2022	52	49
30/01/2022	52	50
31/01/2022	55	50
01/02/2022	53	50
02/02/2022	53	49
03/02/2022	54*	-

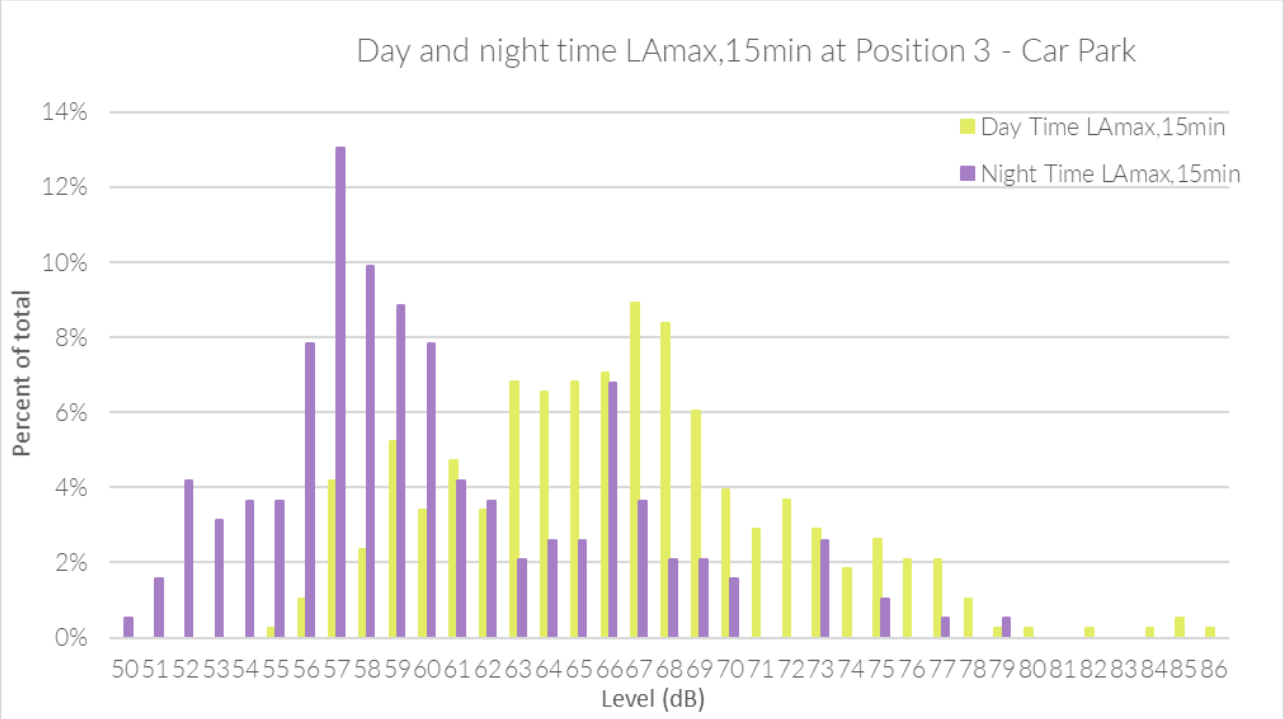
*Incomplete measurement period.

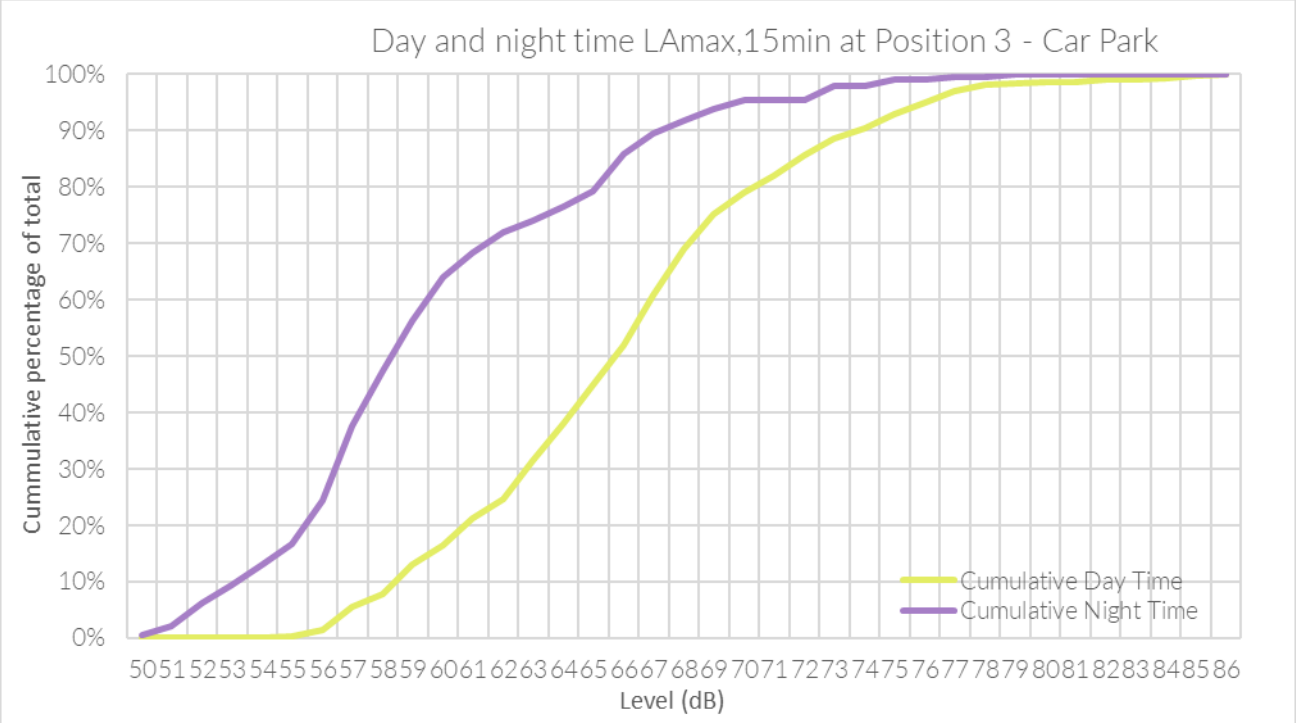
Table 9 Background sound pressure levels at position 3.

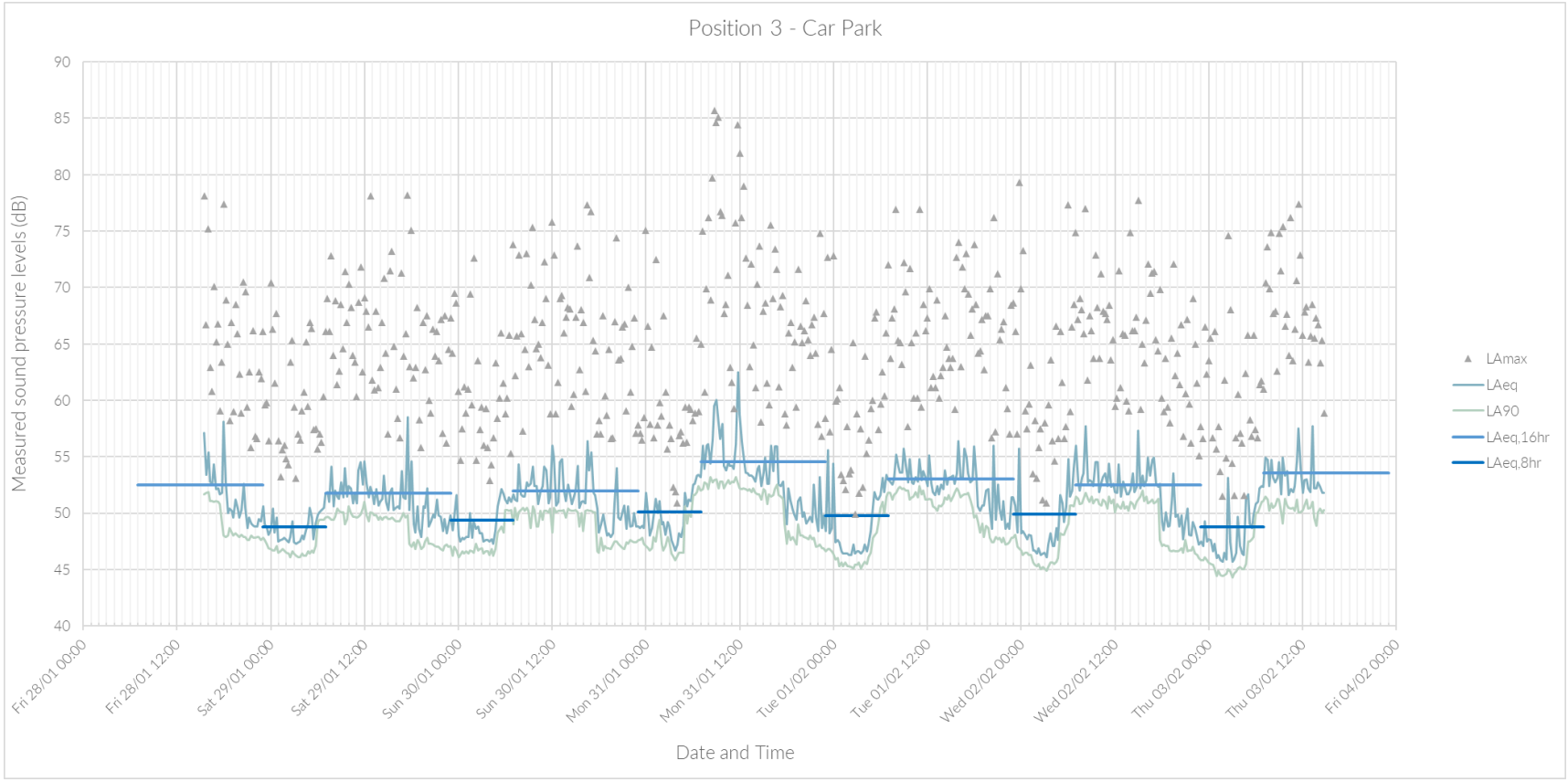
Date	Lowest background sound pressure levels, dB	
	Daytime (07:00 – 23:00) $L_{A90,15min}$	Night-time (23:00 – 07:00) $L_{A90,15min}$
28/01/2022	48	46
29/01/2022	47	46
30/01/2022	47	46
31/01/2022	47	45
01/02/2022	47	45
02/02/2022	46	44
03/02/2022	49	-


Day and night time LA90,15min at Position 3 - Car Park
Day Time LA90,15min
Night Time LA90,15min
Percent of total
30%
25%
20%
15%
10%
5%
0%
44
45
46
47
48
49
50
51
52
53
Level (dB)


Day and night time LA90,15min at Position 3 - Car Park
Cummulative percentage of total
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Cumulative Day Time
Cumulative Night Time
44
45
46
47
48
49
50
51
52
53
Level (dB)


Day and night time LAmax,15min at Position 3 - Car Park
Day Time LAmax,15min
Night Time LAmax,15min
Percent of total
14%
12%
10%
8%
6%
4%
2%
0%
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
Level (dB)


Day and night time LAmax,15min at Position 3 - Car Park
Cummulative percentage of total
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Cumulative Day Time
Cumulative Night Time
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
Level (dB)


Position 3 - Car Park
Measured sound pressure levels (dB)
90
85
80
75
70
65
60
55
50
45
40
Fri 28/01 00:00
Fri 28/01 12:00
Sat 29/01 00:00
Sat 29/01 12:00
Sun 30/01 00:00
Sun 30/01 12:00
Mon 31/01 00:00
Mon 31/01 12:00
Tue 01/02 00:00
Tue 01/02 12:00
Wed 02/02 00:00
Wed 02/02 12:00
Thu 03/02 00:00
Thu 03/02 12:00
Fri 04/02 00:00
Date and Time
LAmax
LAeq
LA90
LAeq,16hr
LAeq,8hr

Position 4 – South garden.

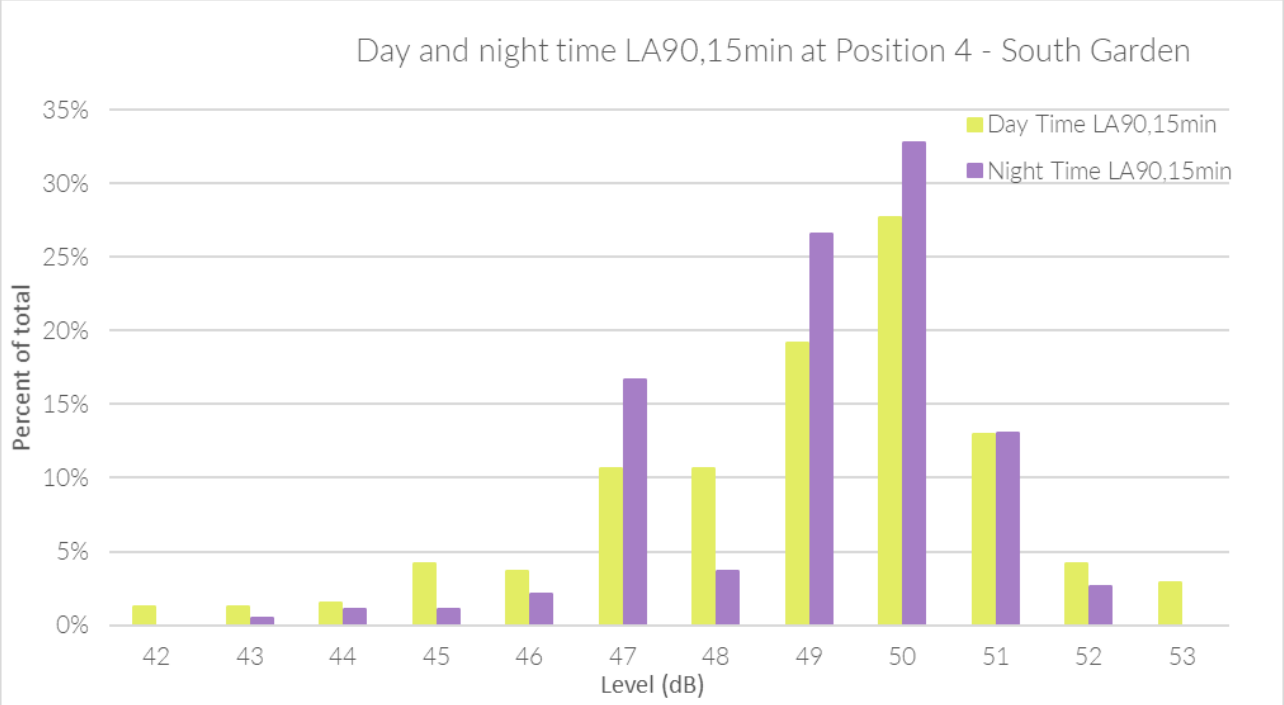
Table 10 Ambient sound pressure levels at position 4.

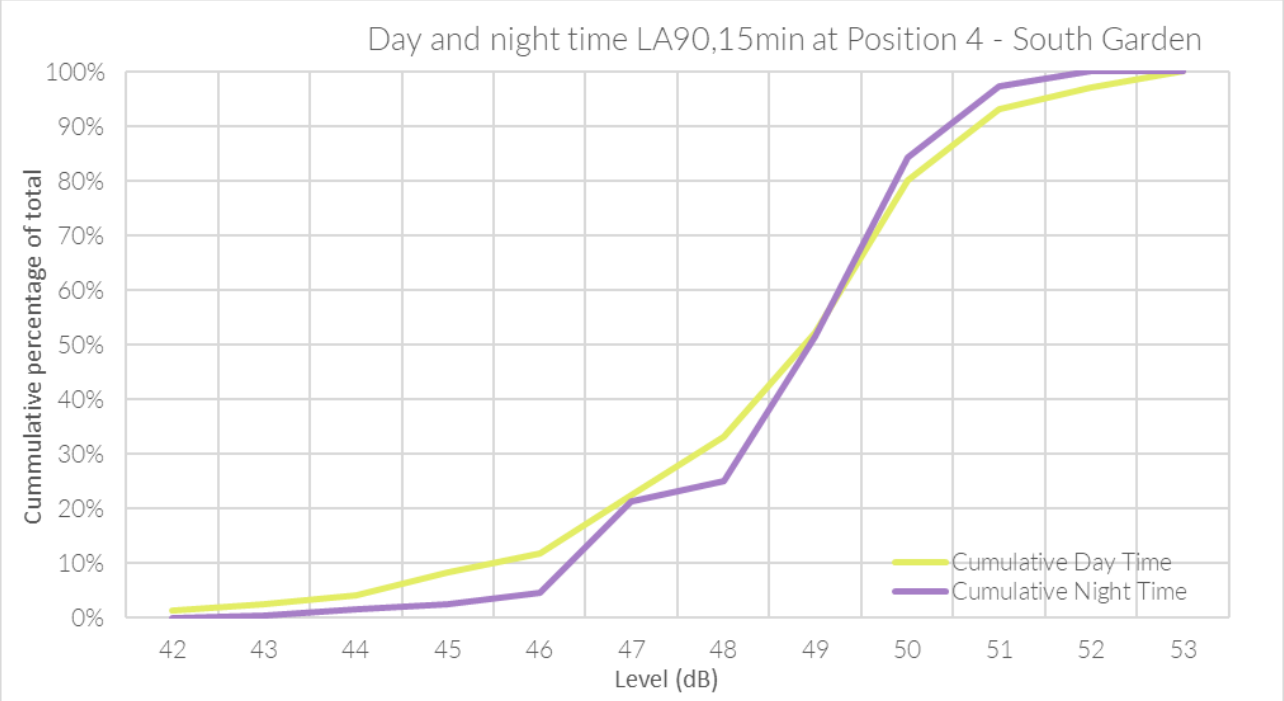
Date	Ambient sound pressure levels, dB	
	Daytime (07:00 – 23:00) $L_{Aeq,16hr}$	Night-time (23:00 – 07:00) $L_{Aeq,8hr}$
28/01/2022	52*	50
29/01/2022	52	51
30/01/2022	53	51
31/01/2022	53	51
01/02/2022	52	50
02/02/2022	51	48
03/02/2022	50*	-

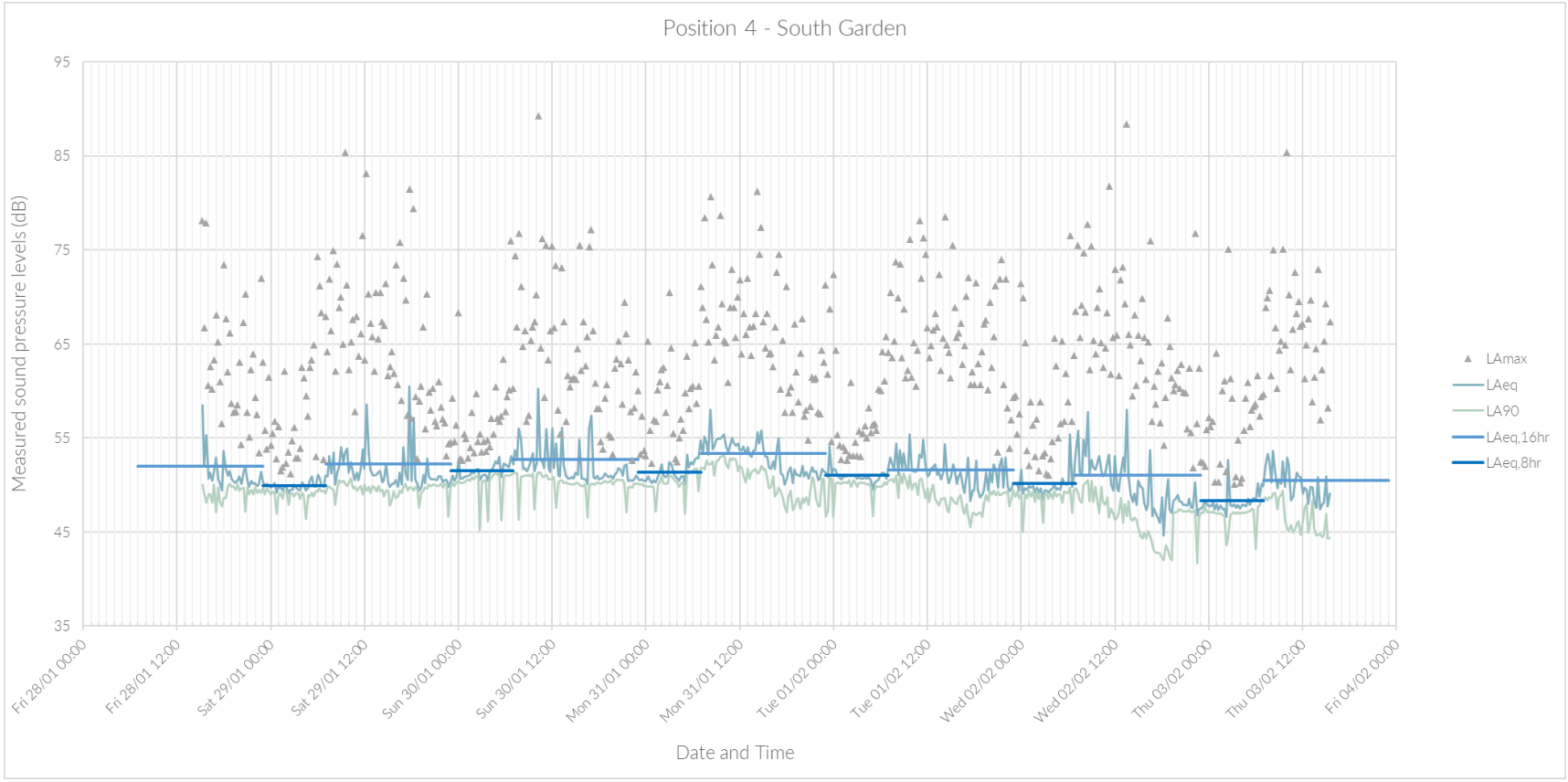
*Incomplete measurement period.

Table 11 Background sound pressure levels at position 4.

Date	Lowest background sound pressure levels, dB	
	Daytime (07:00 – 23:00) $L_{A90,15min}$	Night-time (23:00 – 07:00) $L_{A90,15min}$
28/01/2022	47	46
29/01/2022	47	45
30/01/2022	46	47
31/01/2022	47	47
01/02/2022	46	45
02/02/2022	42	43
03/02/2022	44	-


Day and night time LA90,15min at Position 4 - South Garden
Day Time LA90,15min
Night Time LA90,15min
Percent of total
35%
30%
25%
20%
15%
10%
5%
0%
42
43
44
45
46
47
48
49
50
51
52
53
Level (dB)


Day and night time LA90,15min at Position 4 - South Garden
Cummulative percentage of total
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
42
43
44
45
46
47
48
49
50
51
52
53
Level (dB)
Cumulative Day Time
Cumulative Night Time


Position 4 - South Garden
Measured sound pressure levels (dB)
95
85
75
65
55
45
35
Fri 28/01 00:00
Fri 28/01 12:00
Sat 29/01 00:00
Sat 29/01 12:00
Sun 30/01 00:00
Sun 30/01 12:00
Mon 31/01 00:00
Mon 31/01 12:00
Tue 01/02 00:00
Tue 01/02 12:00
Wed 02/02 00:00
Wed 02/02 12:00
Thu 03/02 00:00
Thu 03/02 12:00
Fri 04/02 00:00
Date and Time
LAmax
LAeq
LA90
LAeq,16hr
LAeq,8hr

Short-term measurements.

Attended, short-term measurements were taken on 3rd February 2022. Results are summarised in … and the corresponding positions are shown in ….

Table 12 Short-term measurement results.

Position	Start time	Duration, min:sec	Ambient sound pressure level, dB $L_{Aeq,T}$	Background sound pressure level, dB $L_{A90,T}$	Maximum sound pressure level, dB L_{AFMax}
5	13:20	04:59	69	61	80
	13:25	04:54	69	61	82
	13:30	04:58	68	62	78
6a	13:40	05:00	52	49	64
6b	13:45	04:32	53	51	67
6c	13:50	04:51	56	49	73
7	14:15	04:56	44	42	56
	14:20	05:00	43	42	55
8a	14:30	04:59	52	48	68
8b	14:35	04:47	53	52	68
8c	14:41	05:00	57	49	68
9a	14:50	05:00	52	51	59
9b	14:55	04:15	53	52	62
9c	15:00	05:00	49	48	62
10	15:09	00:16	66	66	67
	15:10	00:26	67	66	68
11	15:14	00:30	57	57	61
	15:14	00:30	57	57	58
12	15:27	00:30	55	54	56
	15:28	00:30	58	57	59
13	15:44	00:30	66	66	67
	15:45	00:30	70	69	71

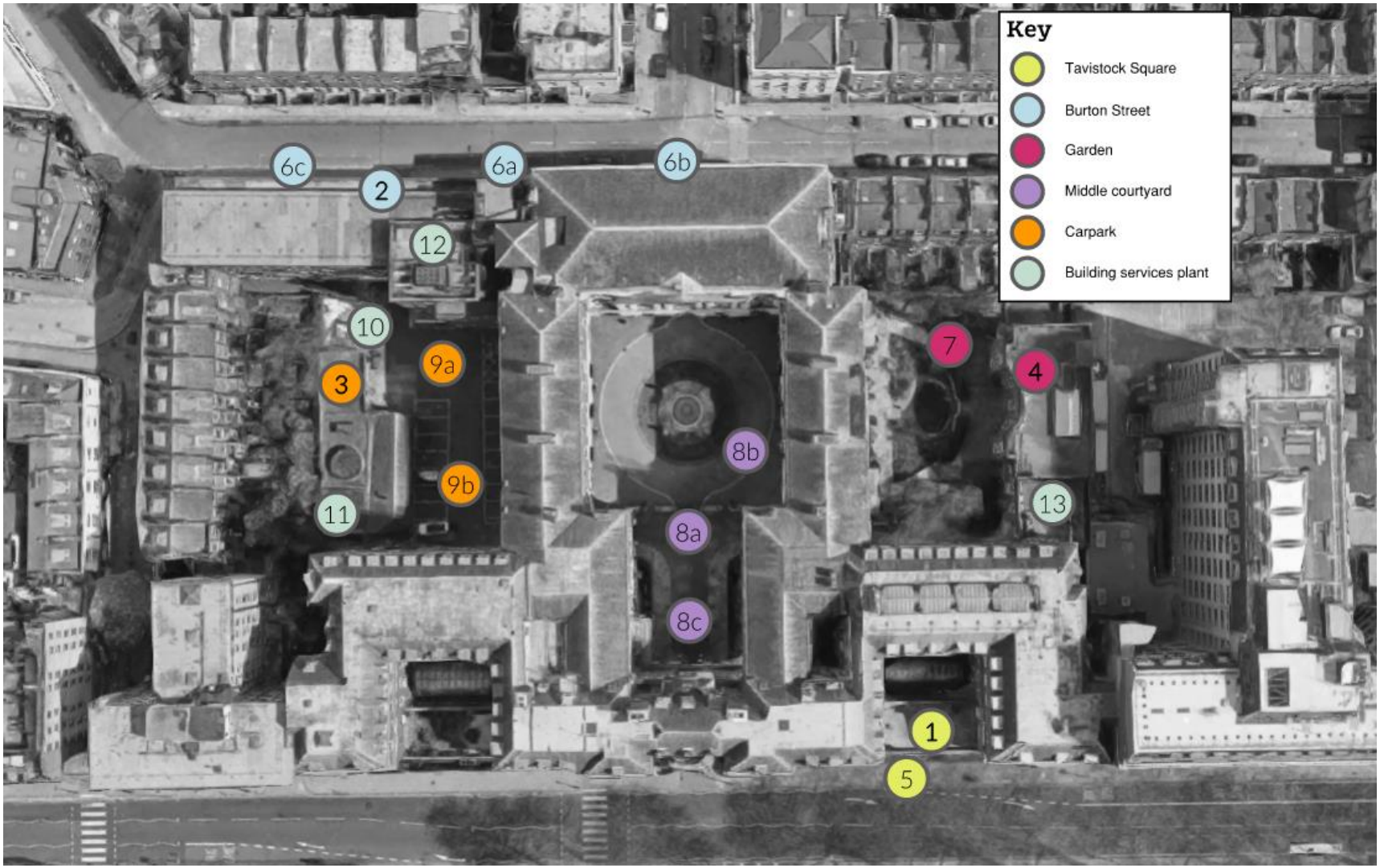


Figure 6 Measurement positions (image from Google Maps).

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