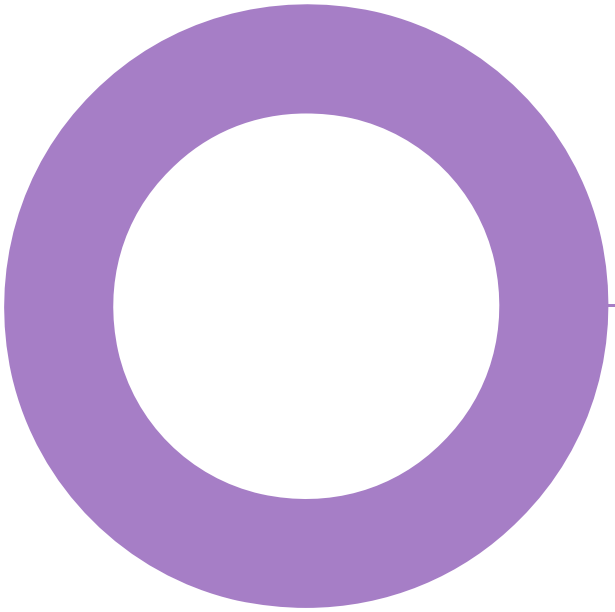
HOARE LEA

Waterhouse Square. London.
Prudential Assurance Company Limited.

ACOUSTICS
NOISE IMPACT ASSESSMENT

REVISION 02 – 21 JULY 2023



Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
00	26/06/2023	Initial issue for comment.	KJ	AH	BJ
01	27/06/2023	Second issue.	KJ	AH	BJ
02	21/07/2023	Final draft.	KJ	AH	BJ

Project number: 10/14413
Document reference: REP-1014413-5A-KJ-20230721-Noise Impact Assessment-Rev02.docx

Contents.

Executive summary

This report has been prepared on behalf of Prudential Assurance Company Limited in support of the redevelopment of 2 Waterhouse Square, EC1N 7RA. Proposals include the refurbishment and extension of the existing building at 2 Waterhouse Square comprising the delivery of Class E (commercial) floorspace and a flexible commercial (Class E) and bar (sui generis) unit, external alterations, reconfiguration of entrances and servicing arrangements, new hard and soft landscaping, provision of cycle parking and other ancillary works.

It is recognised that external noise ingress into the offices and commercial spaces and external noise emissions from new plant will need to be controlled so as to protect the amenity of future users of the development and existing noise-sensitive uses nearby. This report serves to present an acoustic assessment of the façade and plant proposals and demonstrate that the objective requirements of the London Borough of Camden can be achieved.

Baseline sound survey.
An environmental sound survey has been undertaken at the proposed development site to establish the baseline acoustic environment. Unattended measurements were captured across the site over a period of 6 days, inclusive of a weekend, to establish long-term trends in the local sound climate. Further attended measurements were captured on Leather Lane to gain an understanding of how the local food market affects the sound climate to the east.

Prevailing sound levels across the site are predominantly influenced by road and pedestrian traffic on the local road network. Following a typical daily cycle driven by activity in the local area, reaching a peak during the day before receding into the early hours of the morning. Patron noise associated with the food market on Leather Lane has been found to contribute to elevated noise levels during lunchtime.

The measurement data from the survey have been used to inform the assessment of external noise ingress and the façade sound insulation recommendations, and the assessment of external noise emission from building services plant.

Assessment of noise ingress.
Desirable internal sound levels for the proposed development have been adopted from available good practice guidance. The minimum sound insulation performances for new façade elements to achieve these internal sound levels have been recommended based on the latest architectural drawings and environmental sound survey data.

It is anticipated that external noise ingress can be readily controlled with standard façade constructions and double-glazing window configurations. Ventilation, heating, and cooling demands are to be supplied mechanically and so users will not be reliant upon façade openings.

Assessment of noise emissions.
External plant associated with the development is anticipated to comprise multiple air source heat pumps, chillers and an emergency backup generator. External noise limits for new equipment have been established at the nearest noise-sensitive receivers in accordance with the London Borough of Camden's planning guidance and good practice.

The assessment of the proposals indicates that plant noise levels are expected to range from 0 – 6 dB below prevailing background sound levels when assessed the nearest noise-sensitive receivers. This aligns with the "Amber" noise thresholds as set out within Camden Local Plan and would be considered indicative of low impact in the context of BS 4142.

The proposals are therefore considered compliant with the strategic objectives of Camden's Policy A4 which seeks to prevent "*development likely to generate unacceptable noise and vibration impacts".*

1. Introduction.

Proposals are being brought forward for the refurbishment and extension of 2 Waterhouse Square, EC1N 7RA. Works will include to the refurbishment and extension of the existing building at 2 Waterhouse Square comprising the delivery of Class E (commercial) floorspace and a flexible commercial (Class E) and bar (sui generis) unit, external alterations, reconfiguration of entrances and servicing arrangements, new hard and soft landscaping, provision of cycle parking and other ancillary works.

External noise ingress into the development and external noise emissions from new plant will need to be controlled so as to protect the amenity of future users of the development and existing noise-sensitive uses nearby. This report serves to present an assessment of the façade and plant proposals and demonstrate that the objective requirements of the London Borough of Camden, in terms of noise, can be achieved.

As this report contains technical terminology, a glossary of terms is provided in Appendix A.

2. Basis of assessments.

The assessments of the building envelope and external plant have been carried out in accordance with the following policy and guidance:

- Camden Local Plan (The London Borough of Camden, 2017);
- British Council for Offices' Guide to Specification (2019) and Guide to Fit Out (2011);
- British Standard 8233:2014 Guidance on sound insulation and noise reduction for buildings (2014);
- British Standard 4142:2014 + A1:2019 Methods for rating and assessing industrial and commercial sound (2014 & 2019).

Further discussion on the design criteria for external noise ingress and noise emissions are provided within each assessment.

3. Site context.

3.1 Site description.

The Waterhouse Square estate is located within the London Borough of Camden, on the busy Holborn Road (A40). 2 Waterhouse Square is a seven-story office building located to the north of the site and fronts onto Brookes Market which is a minor one-way road, providing access to surrounding buildings. The street also provides pedestrian access to Leather Lane and Hatton Garden which are popular commercial districts and subject to high levels of footfall throughout the week.

3 Waterhouse square, which will house plant serving the proposed development, lies to the south and occupies the western half of the estate. Planning permission is currently being sought for a new plant screen at roof level (Planning reference: 2023/1376/P & 2023/1807/L) to control noise emissions from the proposed equipment

The noise sensitive receiver to the noise generating elements of the development has been identified as 150 Holborn to the west. The building is a mixed-use development comprising 9-storeys of commercial office space to the south and 7-storeys of residential units to the north.

3.2 Existing acoustic climate.

An environmental sound survey has been undertaken to establish baseline acoustic conditions across the proposed development site.

Long term measurements (Positions L1 and L2) were captured across a 6-day period, inclusive of a weekend to establish trends in the local sound climate.

Further attended measurements (Position S1) were taken on Leather Lane to gain an understanding of how noise levels towards the east of the site change when the local food market is in operation.

Details of the survey methodology, equipment details and measurement data can be found within Appendix B. All measurement data can be provided in digital format upon request.

A summary overview of the measurement positions and the pertinent statistical free-field sound level data is provided in Figure 1. Ambient sound levels are presented as the worst-case 8-hour working day (09:00-17:00) in accordance with BCO guidance. The representative L_{A01} values have been derived as the 90th percentiles from the dataset respectively.

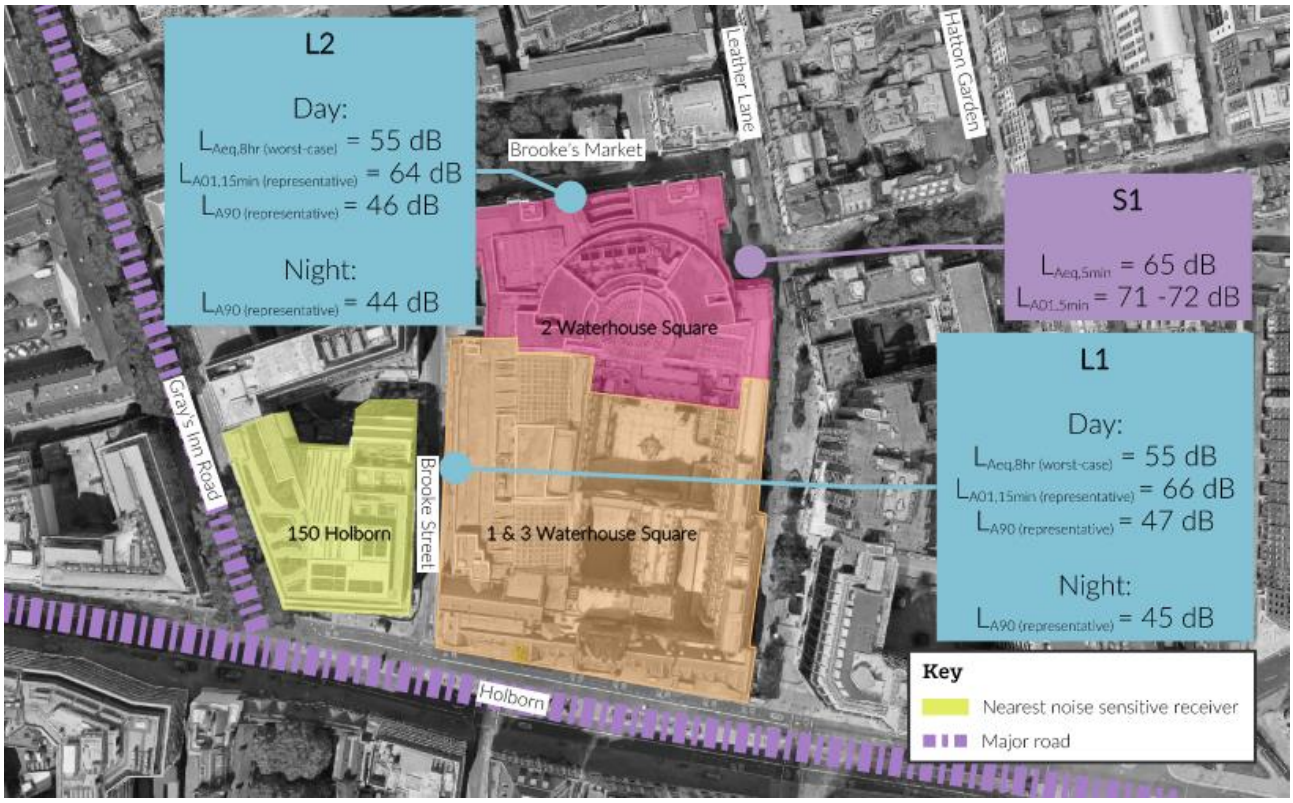


Figure 1 Site and survey overview.

4. Assessment of noise ingress.

4.1 Internal sound criteria.

The London Borough of Camden identify offices as noise sensitive development within the current Camden Local Plan 2017. Retail uses are not considered noise-sensitive therefore the commercial space (Class E) are not included within the scope of this assessment.

Objective thresholds for external noise ingress are provided within Table B of Appendix 3, however, it is stated that these levels are only applicable for dwellings. Camden acknowledge that thresholds of acceptability are use specific and consideration should be given to the likely times of occupation.

In the absence of specific guidance relating to offices, desirable internal sound levels have instead been adopted from BS 8233 and the British Council for Office's (BCO) *Guide to Specification 2019*. BS 8233 offers design ranges in terms of an $L_{Aeq,T}$ whereas BCO guidance recommends limits in terms of a Noise Rating level assessed over a typical 8-hour working day (09:00 – 17:00). Noise Rating levels are typically 6 dB lower than an L_{Aeq} and compliance with the BCO standards can usually be expected to satisfy BS 8233 guidance. A summary of the recommended design limits for the proposed development are presented in Table 1.

Table 1 Recommended internal sound levels.

Location	BS 8233 recommended design range (dB $L_{Aeq,T}$)	Recommended internal noise limit ($L_{eq,8hr}$)
Cellular office / meeting room	35 – 45	NR 35
Offices (Cat A)	45 - 50	NR 38

In addition to controlling ambient noise levels, BCO recommends that individual noise events should not normally exceed 55 dB $L_{A01,1hr}$ and 50 dB $L_{A01,1hr}$ within open-plan and cellular offices, respectively.

4.2 Recommended sound insulation performance.

The minimum sound insulation performances recommended for new façade elements are based on the latest architectural drawings and the survey sound level data. Calculations have anticipated the future fit out designs of incoming tenants and seek to enable the most onerous internal sound level criteria across the floor plates.

The minimum sound reduction indices for solid and glazed elements are presented in Table 2. Slight deviations may be acceptable if a shortfall at one frequency is compensated for by a sufficient overperformance at another.

Table 2 Minimum recommended sound insulation performances for façade elements.

Element	Sound reduction indices (R dB) at octave band centre frequency (Hz)								$R_w + C_{tr}$
	63	125	250	500	1000	2000	4000	8000*	
Solid elements (walls)	13	27	42	50	55	45	47	47	41
Glazing (windows)	15	24	22	29	38	33	38	38	29

*Test data is not typically available at this frequency and so the performance at 4000 Hz has been adopted.

The sound insulation requirements are not considered particularly onerous and should be readily achievable with conventional masonry or lightweight façade systems. Standard double glazing or heritage style slim-double glazing can be expected to achieve the performance requirements for windows.

4.3 Ventilation and cooling.

It is understood that ventilation, heating and cooling requirements throughout the building will be supplied mechanically. Façade openings have therefore been excluded from the scope of the façade assessment.

5. Assessment of noise emissions.

5.1 External noise criteria.

5.1.1 Operational plant.

The London Borough of Camden have established a series of noise thresholds with which to assess external noise emissions from new building services plant. These are defined within Appendix 3 of the Local Plan and apply to the cumulative rating level, established in accordance with BS 4142: 2014, when assessed at the nearest noise sensitive façade and compared to prevailing background sound levels.

These thresholds are re-presented in Table 3 alongside project specific design limits derived from the survey data.

Table 3 Camden's noise thresholds

Category	Description	Threshold	Project specific limits.
Green	where noise is considered to be at an acceptable level.	Rating level 10 dB below background.	Day: 37 dB $L_{Ar,Tr}$ Night: 35 dB $L_{Ar,Tr}$
Amber	where noise is observed to have an adverse effect level, but which may be considered acceptable when assessed in the context of other merits of the development.	Rating level between 9 dB below and 5 dB above background.	Day:38 – 52 dB $L_{Ar,Tr}$ Night: 36 – 50 dB $L_{Ar,Tr}$
Red	where noise is observed to have a significant adverse effect.	Rating level greater than 5 dB above background.	Day: 53 dB $L_{Ar,Tr}$ Night: 51 dB $L_{Ar,Tr}$

Separate to Camden's planning guidance, the assessment methodology of British Standard 4142: 2014 offers the following conclusions when the rating level is compared to background sound levels:

- A difference of around + 10 dB or more is likely to be an indication of a significant adverse impact, depending upon the context;
- A difference of around + 5 dB is likely to be an indication of an adverse impact, depending upon the context; and
- When the rating level does not exceed background sound levels, this is indication of a low impact, depending upon the context.

While Camden's green category is considered the ideal target for plant noise, the limits are not always practical to achieve with large plant installations. Designing to the amber thresholds is considered acceptable if steps to reduce noise as much as practicable have been taken.

Ensuring that plant noise does not normally exceed background sound levels would further reduce the risk of noise complaints as this would be a likely indication of a low impact when assessed in accordance with BS 4142.

5.1.2 Emergency plant.

The London Borough of Camden do not offer specific objective limits for emergency plant and so it is proposed that noise from this equipment should be controlled to a level no more than 10 dB above prevailing background sound levels to control noise during periods of testing. This is a common approach adopted for developments across London.

The proposed limits for life-safety and business critical plant, subject to approval, are presented in Table 4.

Table 4 Design limits for emergency life-saving plant.

Period	Adopted criterion	Typical background sound level (dB $L_{A90,15min}$)	Plant noise emissions limit (dB $L_{Aeq,T}$)
Day (07:00 – 23:00)	*10 dB above typically occurring background sound levels*	47	57

The testing of emergency plant should also be limited to less noise sensitive hours of 09:00 -17:00 Monday to Friday.

5.2 Discussion of plant proposals.

5.2.1 Operational plant.

External building services plant associated with the development is expected to comprise 4 No. Air source heat pumps (ASHP)and 2 No. Chillers which will be located at roof level on 3 and 2 Waterhouse Square, as shown in Figure 2.

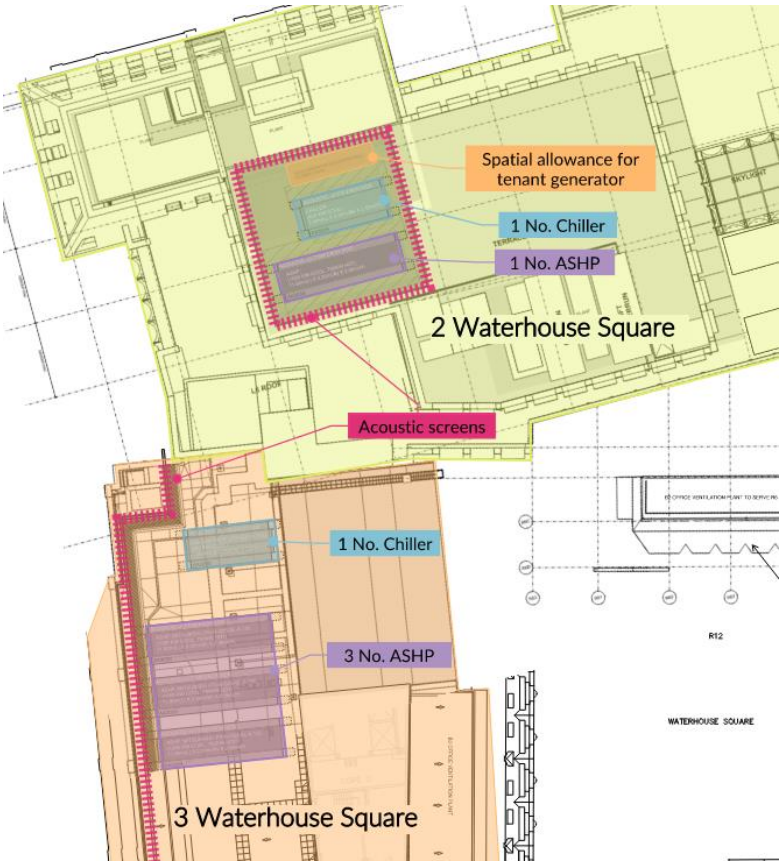


Figure 2 Proposed plant layout (not to scale).

A preliminary plant schedule, and sound power levels for indicative equipment selections, are set out in Table 5.

Table 5 Preliminary plant schedule and sound power levels

Equipment	No.	Sound power level (dB L_{wA})
Air source heat pump (ASHP)	4	97
Chiller	2	101
Life-safety generator	2	110

It is understood that plant has the potential to operate at any time of day and night. A conservative approach has been taken for the purposes of this assessment and it has been assumed that all plant will remain operating at its maximum design duty for a full 24-hour cycle.

In practice, this is only likely to occur during the hottest and coldest days of the year. The noise output from the proposed equipment is directly linked to the heating and cooling demands placed upon the system and this would usually be expected to reduce overnight as the building occupancy decreases.

5.2.2 Emergency plant

Emergency plant is to comprise a single diesel generator for life-safety functions located within the loading bay at ground floor level and ducted to atmosphere through the northern façade. Spatial allowance has been made for an additional generator on the roof of 3 Waterhouse Square however the installation of this unit will be deferred to a future tenant's fit out.

Any testing and maintenance of the generator should also be limited to brief periods during less sensitive daytime hours (09:00 - 17:00).

5.3 Noise control strategy.

5.3.1 Acoustic enclosures.

Spatial allowance has been made to fit the ASHPs and Chillers with full acoustic enclosures, such as Allaway Acoustic's AA303S shown in Figure 3, to reduce noise at source as much as is practicable.

It is recommended that the enclosures achieve the minimum dynamic insertion losses in Table 6 which can be expected to reduce the overall broadband noise output of the ASHPs and chiller by 18 to 21 dB respectively.

Table 6 Minimum dynamic insertion losses for localised acoustic enclosures.

	Dynamic insertion loss (dB) at octave band centre frequency (Hz)							
Element	63	125	250	500	1000	2000	4000	8000
Acoustic enclosure	4	8	13	22	24	21	18	14

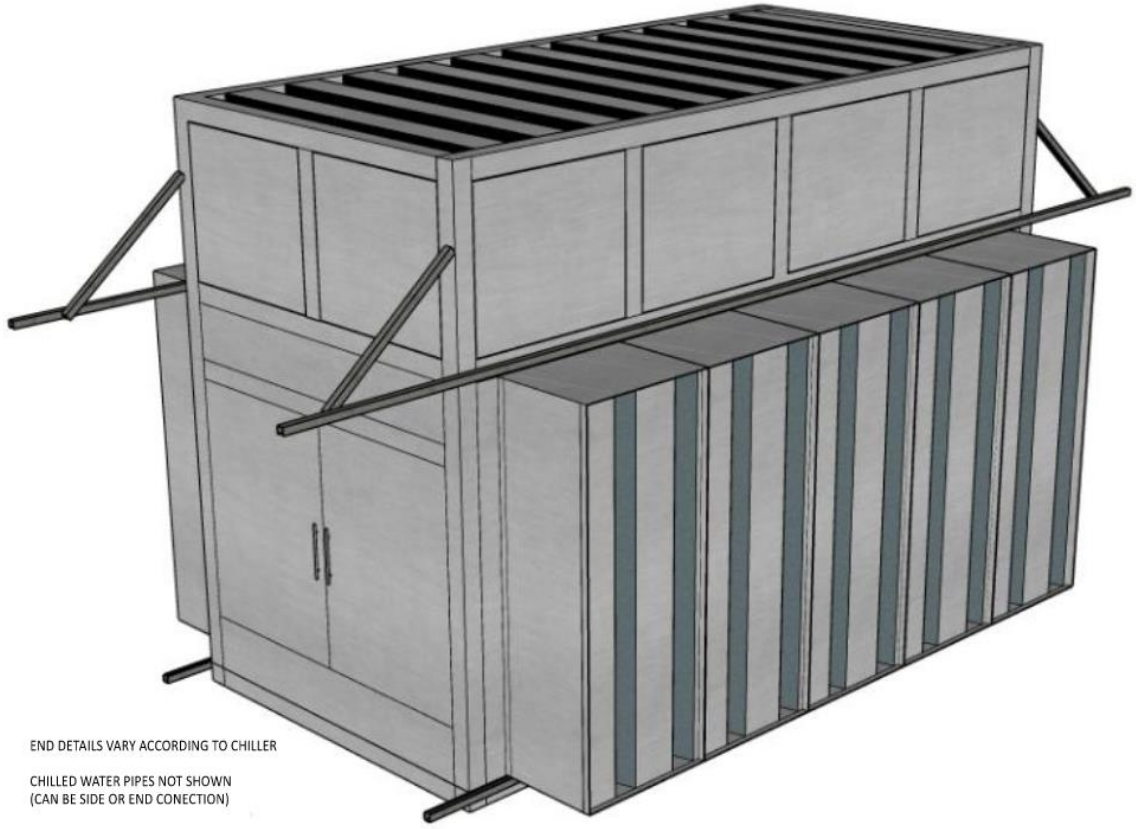


Figure 3 Example acoustic package, Allaway Acoustic's AA303S

5.3.2 Plant screen.

It is proposed that the units on 3 Waterhouse Square will be installed behind the permitted louvred plant screen, with a similar screen to be erected around the equipment on 2 Waterhouse Square.

The screens should terminate at the installed height of the equipment and be predominantly formed with acoustically rated louvres to allow airflow through the plant area and support the efficient operation of the equipment. Any areas not required for airflow should be blanked out to create a solid screen achieving a minimum surface density of 10kg/m^2,

It is recommended that louvres are selected on the basis that they achieve the minimum sound reduction indices in Table 7.

Table 7 Minimum sound insulation requirements of the plant screen louvres.

	Sound reduction indices (R dB) at octave band centre frequency (Hz)								
Element	63	125	250	500	1000	2000	4000	8000	R_w
300 mm deep louvre	7	7	10	17	29	30	27	21	21

This performance is equivalent to a 300 mm deep louvre and represents a balance between the sound insulation performance and spatial requirements. Enhancing the sound insulation performance further would require a reduction of the free area, which can be expected to negatively impact upon the equipment's operating efficiency.

5.3.3 Emergency generator.

The design of the generators will need to ensure compliance with the limits in Table 4. This could be achieved with acoustic packages and in-duct attenuation limiting the noise output from each generator to 75 dB $L_{Aeq,T}$ at a distance of 1 metre.

5.4 Assessment of plant noise.

Noise emissions from operational plant has been calculated based on the proposals and noise control strategy presented in Sections 5.2 and 5.3 at the following facades of 150 Holborn:

- Level 08 offices which overlook the plant compound;
- Level 07 offices which are directly level with the plant compound and will be acoustically screened;
- Level 06 residences which sit below the plant compound and will be acoustically screened.

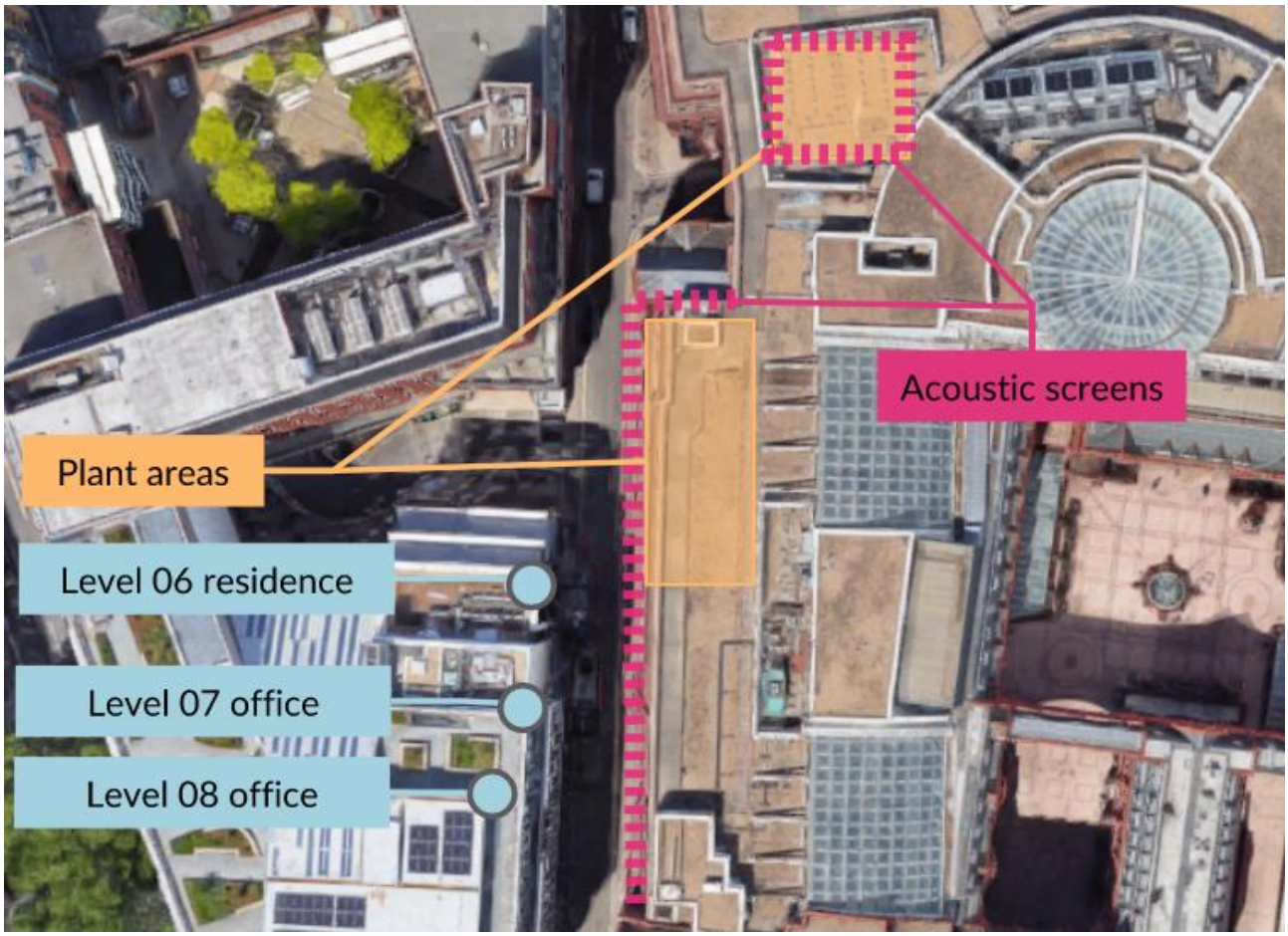


Figure 4 Assessment locations.

The lower levels of 150 Holborn and other surrounding buildings can be expected to benefit from greater attenuation from distance propagation and screening by the roof edge and have therefore been excluded from the scope of this study.

The noise output from the packaged equipment is assumed to be free from any perceptible tonal or impulsive qualities and soft-start up modes are expected to remove any obvious on-off conditions.

The local sound climate, particularly at night, is already heavily influenced by surrounding building services plant and noise from new building services equipment is therefore unlikely to be readily identifiable or change the prevailing environmental sound character. Consequently, no penalty corrections to the rating levels are anticipated.

Table 8 presents a summary of the predicted plant noise levels. The calculations for each receiver have also been provided in Appendix C.

Table 8 Predicted plant noise emissions at neighbouring noise sensitive receptors

Operating scenario	Background sound level (dB L_{A90})	Predicted rating level (dB $L_{Ar,Tr}$)		
		Offices (L08)	Offices (L07)	Residences (L06)
Daytime (07:00 -23:00)	47	45	41	45
Night-time (23:00 – 07:00)	45			

With plant noise ranging between 0 to 6 dB below background sound levels, the proposals comply with Camden's Amber noise thresholds. They also have a low impact in the context of a BS 4142 assessment which is the most favourable outcome.

As discussed previously, this represents a conservative assessment and noise levels overnight are likely to be lower than those predicted in Table 8, further reducing the risk of an adverse impact.

The proposals are therefore considered compliant with the strategic objectives of Camden's Policy A4 which seeks to prevent "*development likely to generate unacceptable noise and vibration impacts".*

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.

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 x 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 x 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.

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.

A-Weighting.

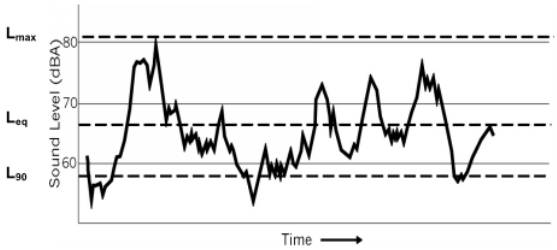
The A-weighting is a correction term applied to the frequency range in order to mimic the sensitivity of the human ear to noise. It is generally used to obtain an overall noise level from octave or third octave band frequencies.

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'. Fast and slow time constant are usually employed for airborne and structure-borne noise, respectively.

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 3.5m 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 – Environmental sound survey details.

Measurement equipment details.

Table 9 details the equipment used during the long-term measurements. All equipment used was within their respective dates of calibration and calibration certificates are available upon request. All sound level meters and microphones were calibrated before and after the measurements and no significant calibration drift was observed.

Table 9: Measurement equipment details.

Position	Equipment	Model	Serial number	Date of last calibration
L1 (West)	Class 1 sound level meter	Rion NL-52	00810564	14/01/2022
	Preamplifier	Rion NH-25	19955	14/01/2022
	Microphone	Rion UC-59	11107	14/01/2022
L2 (North)	Class 1 sound level meter	Rion NL-52	00710469	14/01/2022
	Preamplifier	Rion NH-25	19733	14/01/2022
	Microphone	Rion UC-59	11012	14/01/2022
S1	Class 1 sound level meter	Rion NL-52	00810564	14/01/2022
	Preamplifier	Rion NH-25	11107	14/01/2022
	Microphone	Rion UC-59	19955	14/01/2022
All	Portable sound calibrator	NC-74	34172704	10/08/2022

Methodology.

Continuous, unattended sound level measurements were recorded at two locations over a period of 6 days inclusive of a weekend.

Details of the measurement positions and periods are provided below. Statistical and spectral noise level data were recorded in 15-minute samples for the long-term measurements and 5-minute samples during the short-term measurements. Data are considered representative of the typical sound climate.

Position L1 (15:45 Friday 18th November – 13:00 Wednesday 23rd October 2022):
The sound level meter and associated microphone were installed on the western perimeter of the seventh-floor roof, overlooking Brooke Street below.

The microphone was in free-field conditions and sound level data measured at this position are considered representative of those typically experienced at the residences.

Position L2 (15:45 Friday 18th November – 12:45 Wednesday 23rd October 2022):
The sound level meter and associated microphone were installed on the northern perimeter of the seventh-floor roof, overlooking Brookes Market below.

The microphone was in free-field conditions and sound level data from this position are considered representative of those typically experienced towards the north of the site.

Position S1 (12:51 – 13:21 Thursday 23rd March 2023):
Handheld attended measurements undertaken at street level on Leather Lane.

The microphone was in free-field conditions and sound level data from this position are considered representative of those typically experienced towards the north-east of the site when the local food market is in operation.

Weather conditions.

Weather data during the survey has been taken from a measurement position approximately 1.1 km to the south-west of the site[1]. Conditions throughout the survey were generally calm and dry, however periods of adverse weather conditions were recorded during the following periods:

- 06:00 – 08:00 Sunday 20th November (wind speeds above 5 m/s and rainfall)
- 12:00 – 18:00 Monday 21st November (wind speeds above 5 m/s and rainfall)
- 08:00 – 11:00 Wednesday 23rd November (wind speeds above 5 m/s and rainfall)

A review of the data does not suggest that weather conditions led to a sustained and significant uplift in sound levels recorded during these periods. Consequently, the weather is not believed to have adversely affected the findings of the survey.

Results.

Summaries of the long-term and short-term measurement data are presented in Table 10, Table 11 and Table 12. Full time level history graphs are presented in Figure 5 and Figure 6.

Table 10 Summary measurement data, Position L1.

Date	Ambient sound pressure levels measured (dB) at Position 1, West Roof	
	Day Time (07:00 - 23:00) $L_{Aeq,\ 16hr}$	Night Time (23:00 - 07:00) $L_{Aeq,\ 8hr}$
18/11/2022	53	51
19/11/2022	52	50
20/11/2022	52	50
21/11/2022	54	50
22/11/2022	54	50
23/11/2022	56	-

Table 11 Summary measurement data, Position L2.

Date	Ambient sound pressure levels measured (dB) at Position 2, North Roof	
	Day Time (07:00 - 23:00) $L_{Aeq,\ 16hr}$	Night Time (23:00 - 07:00) $L_{Aeq,\ 8hr}$
18/11/2022	52	47
19/11/2022	51	48
20/11/2022	51	47
21/11/2022	53	47
22/11/2022	53	47
23/11/2022	55	-

[1] Weather Station: ILONDO533 [Accessed via: www.wunderground.com, 01 December 2022]

Table 12 Summary measurement data, Position S1.

Time start	Duration (T)	Ambient sound level (dB $L_{Aeq,T}$)	Noise events (dB $L_{A01,T}$)
12:51	00:05:00	65	71
13:04	00:05:00	65	72
13:16	00:05:00	65	72

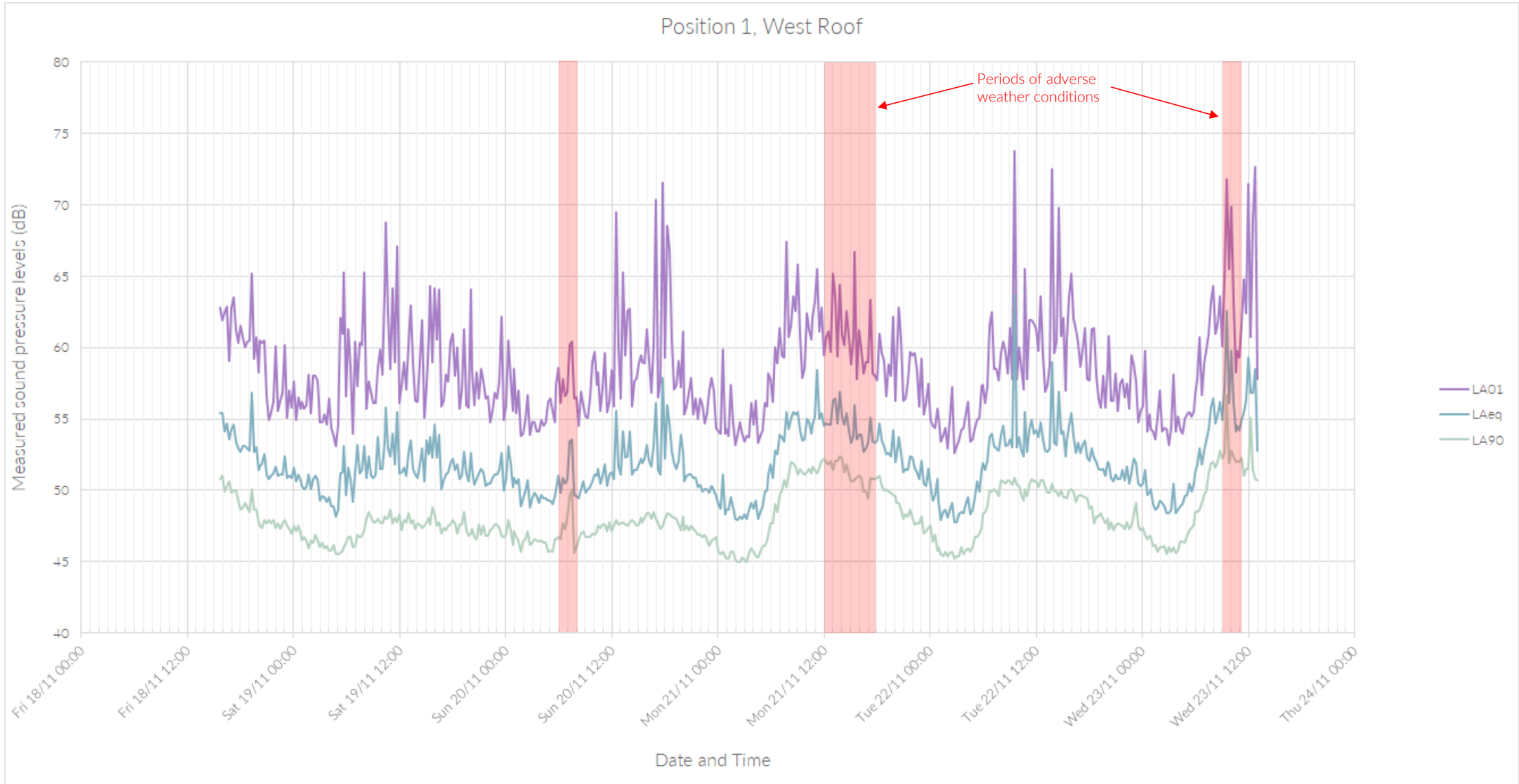


Figure 5 Time history graph, Position L1.

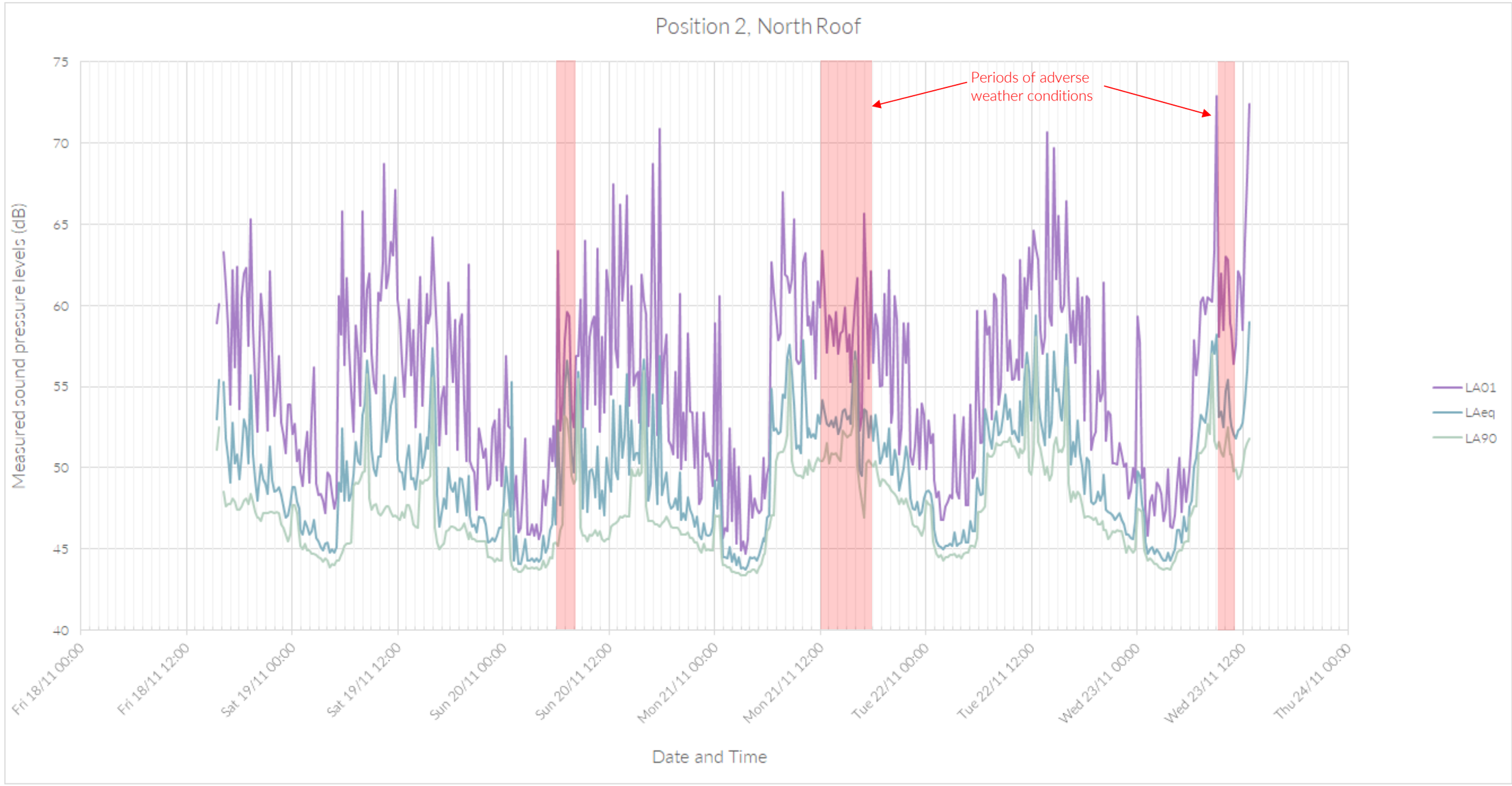


Figure 6 Time history graph, Position L2.

Statistical analysis of the L_{A90}.

Figure 7 and Figure 8 present a statistical overview of the background sound levels measured during the day and night, exclusive of the measurements identified during periods of adverse weather conditions.

Representative background sound levels have been taken as the 10th percentile values:

- Position 1:
  - 47 dB $L_{A90,15mins}$ during the day.
  - 45 dB $L_{A90,15mins}$ during the night.
- Position 2
  - 46 dB $L_{A90,15mins}$ during the day
  - 44 dB $L_{A90,15mins}$ during the night

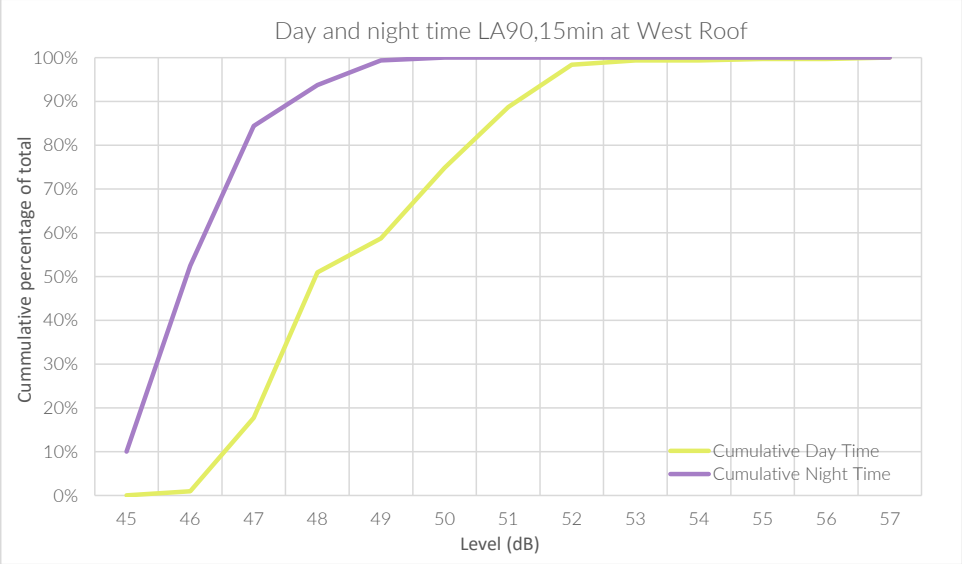


Figure 7 Statistical spread of background sound levels measured at Position 1 during the day and night.

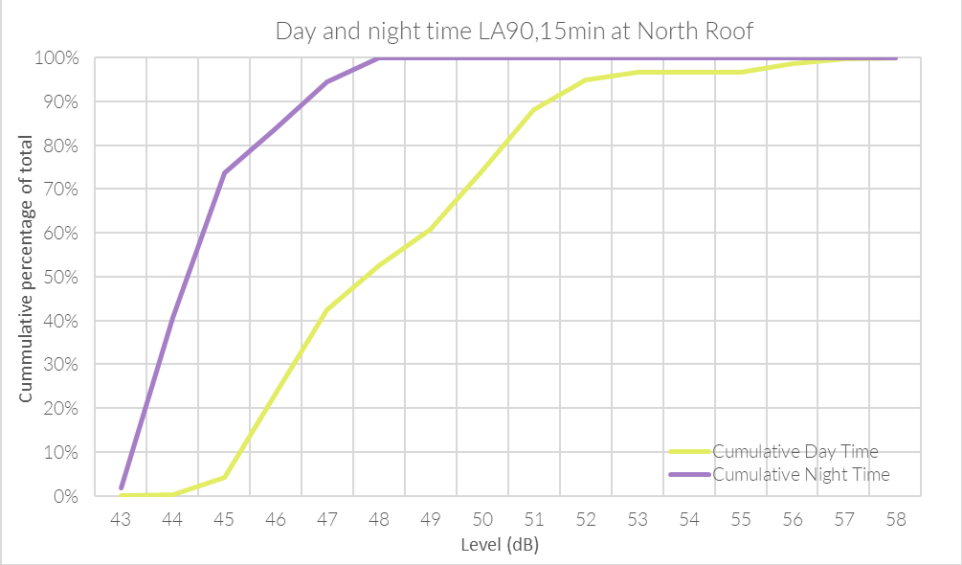


Figure 8 Statistical spread of background sound levels measured at Position 2 during the day and night.

Appendix C - Noise calculations.

For the purposes of the calculations, plant items have been grouped by type and location as shown in Figure 9. The closest point between the equipment and the receivers has been used to derive the attenuation owing to distance propagation so as to provide a conservative assessment.

Table 13, Table 14, and Table 15 overpage provide an summary calculations for each receiver. Full spectral data can be provided upon request.

Figure 9 Grouping of plant calculations.

Table 13 Summary calculation of plant noise at Level 08 office.

Calculation group (see Figure 9)	Item	Note	
1	ASHP	Sound power level (dB L_{wA})	97
	Number of units correction	3	+5
	Geometric spreading	34m (Hemispherical propagation)	-39
	Attenuation pack	Allaway Acoustic's AA303S	-21
	Acoustic screen	Receiver overlooks plant	0
	Total noise level	Sound pressure level (dB L_{pA})	42
2	Chiller	Sound power level (dB L_{wA})	101
	Number of units correction	1	+0
	Geometric spreading	50m (Hemispherical propagation)	-42
	Attenuation pack	Allaway Acoustic's AA303S	-18
	Acoustic screen	Receiver overlooks plant	0
	Total noise level	Sound pressure level (dB L_{pA})	41
3	ASHP	Sound power level (dB L_{wA})	97
	Number of units correction	1	+0
	Geometric spreading	80m (Hemispherical propagation)	-46
	Attenuation pack	Allaway Acoustic's AA303S	-21
	Acoustic screen	Receiver overlooks plant	0
	Total noise level	Sound pressure level (dB L_{pA})	30
4	Chiller	Sound power level (dB L_{wA})	101
	Number of units correction	1	0
	Geometric spreading	80m (Hemispherical propagation)	-46
	Attenuation pack	Allaway Acoustic's AA303S	-18
	Acoustic screen	Receiver overlooks plant	0
	Total sound pressure level		37
	Combined noise level	**Sound pressure level (dB L_{pA})**	**45**
	Rating level correction	**dB**	**0**
	Rating level at receiver	**dB $L_{Ar,Tr}$**	**45**

Table 14 Summary calculation of plant noise at Level 07 offices.

Calculation group (see Figure 9)	Item	Note	
1	ASHP	Sound power level (dB L_{wA})	97
	Number of units correction	3	+5
	Geometric spreading	27m (Hemispherical propagation)	-37
	Attenuation pack	Allaway Acoustic's AA303S	-21
	Acoustic screen	As per details in Section 5.3.2	-7
	Total noise level	Sound pressure level (dB L_{pA})	37
2	Chiller	Sound power level (dB L_{wA})	101
	Number of units correction	1	+0
	Geometric spreading	39m (Hemispherical propagation)	-40
	Attenuation pack	Allaway Acoustic's AA303S	-18
	Acoustic screen	As per details in Section 5.3.2	-6
	Total noise level	Sound pressure level (dB L_{pA})	37
3	ASHP	Sound power level (dB L_{wA})	97
	Number of units correction	1	+0
	Geometric spreading	70m (Hemispherical propagation)	-45
	Attenuation pack	Allaway Acoustic's AA303S	-21
	Acoustic screen	As per details in Section 5.3.2	-7
	Total noise level	Sound pressure level (dB L_{pA})	24
4	Chiller	Sound power level (dB L_{wA})	101
	Number of units correction	1	0
	Geometric spreading	33m (Hemispherical propagation)	-45
	Attenuation pack	Allaway Acoustic's AA303S	-18
	Acoustic screen	As per details in Section 5.3.2	-6
	Total noise level	Sound pressure level (dB L_{pA})	32
	Combined noise level	**Sound pressure level (dB L_{pA})**	**41**
	Rating level correction	**dB**	**0**
	Rating level at receiver	**dB $L_{Ar,Tr}$**	**41**

Table 15 Summary calculation of plant noise at Level 06 residence

Calculation group (see Figure 9)	Item	Note	
1	ASHP	Sound power level (dB L_{wA})	97
	Number of units correction	3	+5
	Geometric spreading	14m (Hemispherical propagation)	-31
	Attenuation pack	Allaway Acoustic's AA303S	-21
	Acoustic screen	As per details in Section 5.3.2	-11
	Total noise level	Sound pressure level (dB L_{pA})	39
2	Chiller	Sound power level (dB L_{wA})	101
	Number of units correction	1	+0
	Geometric spreading	22m (Hemispherical propagation)	-35
	Attenuation pack	Allaway Acoustic's AA303S	-18
	Acoustic screen	As per details in Section 5.3.2	-7
	Total noise level	Sound pressure level (dB L_{pA})	41
3	ASHP	Sound power level (dB L_{wA})	97
	Number of units correction	1	+0
	Geometric spreading	33m (Hemispherical propagation)	-38
	Attenuation pack	Allaway Acoustic's AA303S	-21
	Acoustic screen	As per details in Section 5.3.2	-8
	Total noise level	Sound pressure level (dB L_{pA})	30
4	Chiller	Sound power level (dB L_{wA})	101
	Number of units correction	1	0
	Geometric spreading	33m (Hemispherical propagation)	-38
	Attenuation pack	Allaway Acoustic's AA303S	-18
	Acoustic screen	As per details in Section 5.3.2	-7
	Total noise level	Sound pressure level (dB L_{pA})	38
	Combined noise level	**Sound pressure level (dB L_{pA})**	**45**
	Rating level correction	**dB**	**0**
	Rating level at receiver	**dB $L_{Ar,Tr}$**	**45**

HOARE LEA

JACKSON, KIAL
PRINCIPAL ACOUSTICS ENGINEER

+44 20 3668 7276
kialjackson@hoarelea.com

HOARELEA.COM

Western Transit Shed
12-13 Stable Street
London
N1C 4AB
England