



HOXTON HOLBORN EXTENSION

NOISE AND VIBRATION IMPACT ASSESSMENT

THE HOXTON (HOLBORN) LIMITED

OCTOBER 2017

REVISION 03

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Revision History		Date	Prepared by	Checked by
R01	Initial issue	9 th Dec 2016	Jacob Perry BMus AMIOA	John Lloyd BEng MSc CEng MIOA MCIBSE
R02	Planning issue	14 th Dec 2016	Jacob Perry BMus AMIOA	John Lloyd BEng MSc CEng MIOA MCIBSE
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- 1.1 Proposals are in place for the extension of the existing Hoxton Holborn hotel, located on the corner of High Holborn and Newton Street. The extension will comprise a new wing extending into the courtyard, and an extra floor added to the Newton Street wing.
- 1.2 The local planning authority for this development is Camden Council, who have criteria relating to the acoustic performance of the proposed development. The recently adopted Camden Local Plan (June 2017) contains the following policy:

Policy A4 Noise and vibration

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. 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.

- 1.3 This report presents a noise and vibration emission assessment for noise associated with the new building services plant, as part of the planning application for this proposal.
- 1.4 Disturbance to hotel guests owing to noise and vibration intrusion is usually a consideration for the hotel operator rather than the local authority. Appropriate glazing and façade constructions will be selected so as to control noise intrusion to meet the Hoxton Hotels brand standards, which are in-line with the recommendations in BS 8233:2014. Vibration intrusion from nearby underground train services will be controlled by floating the super-structure of the new extension and the individual guestrooms of the roof floor; the intention is to reduce vibration intrusion by as much as is practically possible.
- 1.5 An external noise survey has been undertaken in support of the noise emission assessment. Chapter 2 of this report describes the external noise survey, and the measured statistical data from the survey is included in Appendix A.
- 1.6 The proposed plant items are to be located on the roof, as such the nearest receivers of vibration emission would be expected to be hotel guests. It is in the hotels best interest to protect guests from vibration and associated structure-borne noise associated with new plant items. All plant will be mounted on suitable anti-vibration mounts, which can be expected to reduce vibration emission. A detailed vibration assessment is therefore not considered necessary.
- 1.7 A glossary of some of the terminology used in this report is included in Appendix B.

2.1 SITE DESCRIPTION

- 2.1.1 The new extension will overlook Newton Street and the courtyard area to the rear of the existing hotel. Noise levels on Newton Street are predominantly influenced by traffic along High Holborn, in addition to occasional vehicles and pedestrians using the road. Noise levels within the courtyard are mostly influenced by hotel deliveries and external condensers serving the existing hotel.
- 2.1.2 There are a number of noise-sensitive receivers local to the site, those believed to be most likely to be affected by the new building services plant are as follows:
- The residents of 8 Newton Street, to the south of the site. Some residents will overlook the rooftop plant location
 - Residents across Newton Street to the east of the site
 - Residents overlooking the existing hotel courtyard, west of the site

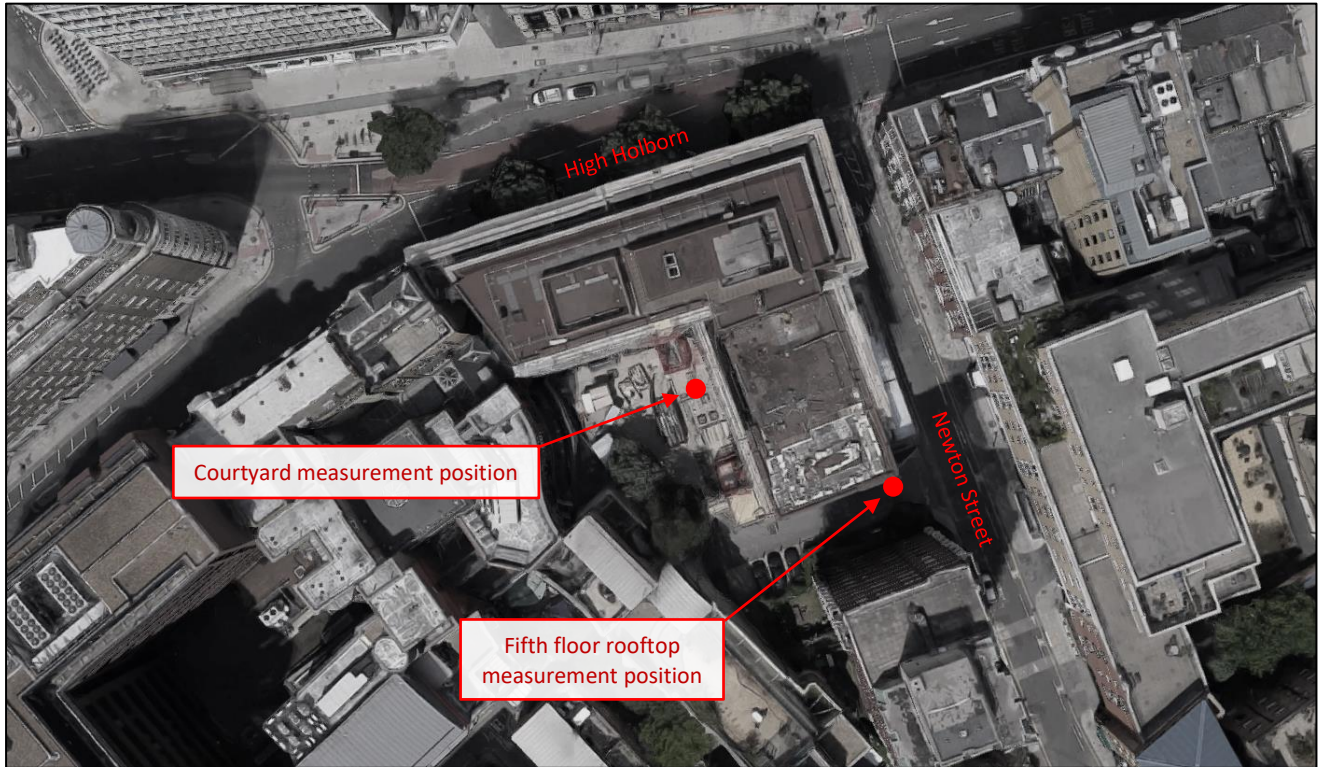
2.2 MEASUREMENT METHODOLOGY

- 2.2.1 Continuous unattended noise level measurements were conducted at two different locations over one weekend. These locations are as follows:
- At the current fifth floor roof level, on the side nearest to 8 Newton Street.
 - Measurements at this location are thought to be representative of noise levels experienced by noise-sensitive receivers facing Newton Street.
 - Statistical and spectral data were recorded between 13:20 on 22/10/2016 and 10:25 on 24/10/2016 in 5 minute samples.
 - The microphone was less than 3.5m from a reflecting surface, but a correction for reflections has not been applied due to the location of the dominant noise sources
 - On the rooftop of the restaurant/bar area of the existing hotel, at first floor level.
 - Measurements at this location are thought to be representative of noise levels at receivers overlooking the hotel courtyard
 - Statistical and spectral data were recorded between 13:40 on 21/10/2016 and 10:45 on 24/10/2016 in 5 minute samples
 - The microphone was less than 3.5m from a reflecting surface, but a correction for reflections has not been applied due to the location of the dominant noise sources
- 2.2.2 The following equipment was used for the noise survey:

Equipment	Type	Serial No.	Measurement location
Norsonic 131	Precision sound analyser	1313605	5 th floor rooftop
Norsonic 1218	Microphone protection kit	12182561	
Norsonic 139	Precision sound analyser	1392774	Courtyard
Norsonic 1218	Microphone protection kit	12182559	
Brüel & Kjær 4231	Calibrator	2291098	Both

Table 2.1 Noise survey equipment

- 2.2.3 The calibration of the sound level meter and associated microphone were checked prior to and on completion of the measurement period in accordance with recommended practice. No significant drift in calibration occurred during the measurement period. The accuracy of the calibrator can be traced to National Physical Laboratory Standards.
- 2.2.4 The weather conditions were generally dry with windspeeds not in excess of 5 ms⁻¹, and are therefore not expected to have affected the findings of the assessment.
- 2.2.5 The measurement locations are shown in Figure 2.1 and Figure 2.2.



Satellite image provided by Google

Figure 2.1 Measurement locations superimposed on satellite image

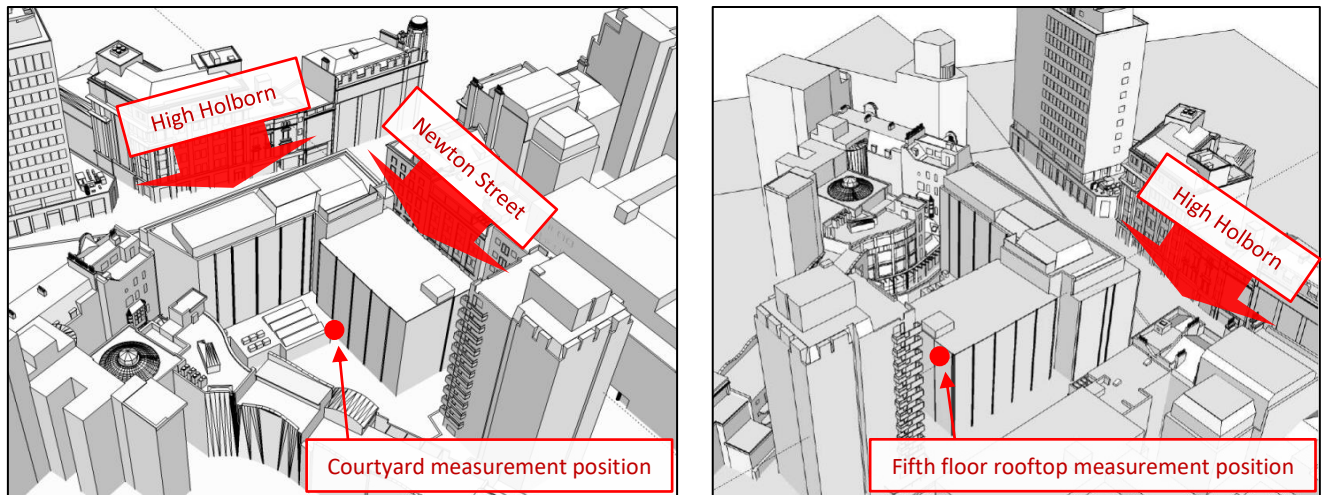


Figure 2.2 Measurement locations superimposed on rendered aerial views

2.3 MEASUREMENT RESULTS

2.3.1 The measurement results are presented in Appendix A. Graphs showing the level-history for both sets of measurements are presented in Figure 2.3 and Figure 2.4.

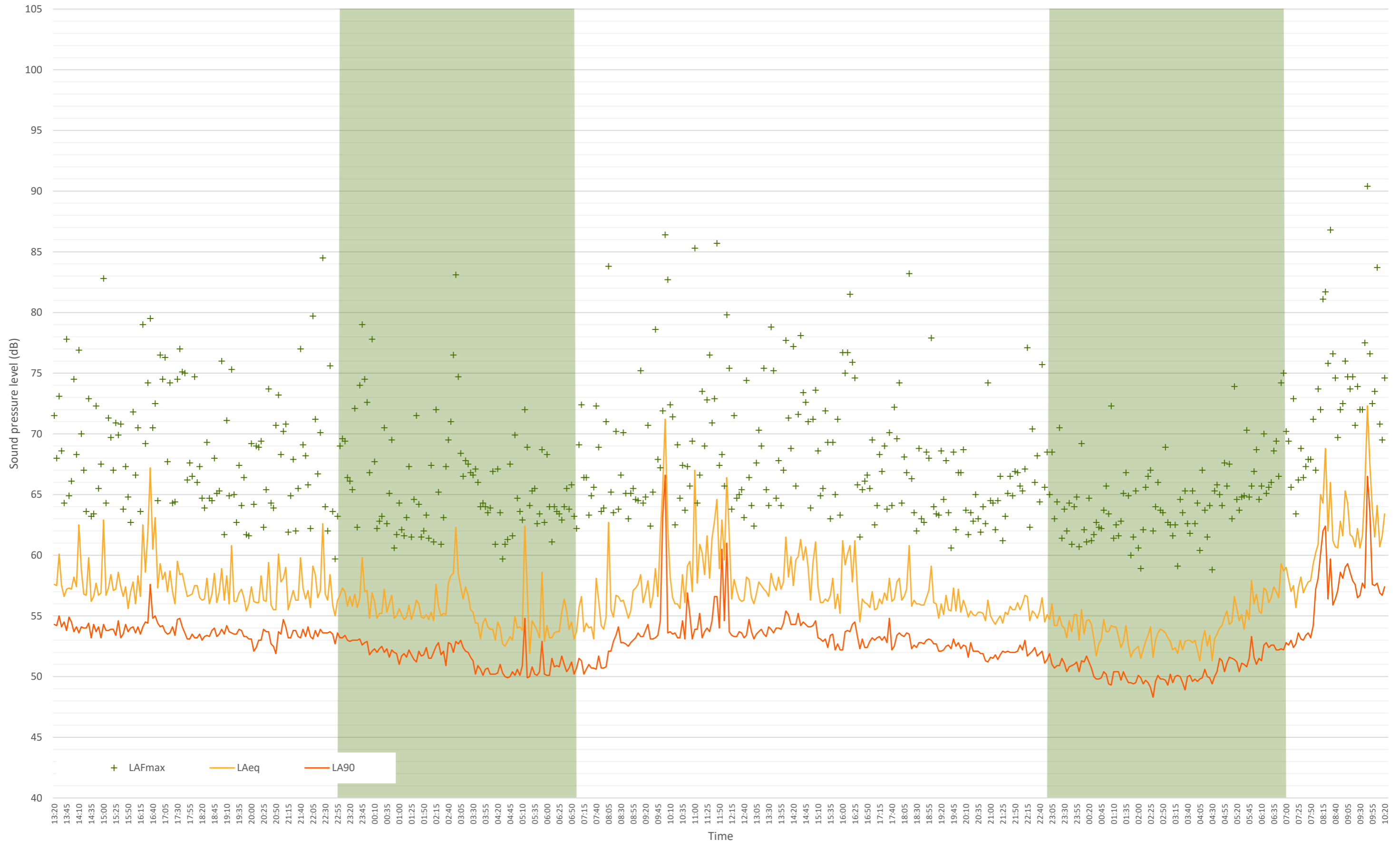


Figure 2.3 Measurements results for the fifth floor rooftop location, 22/10/2016 to 24/10/2016

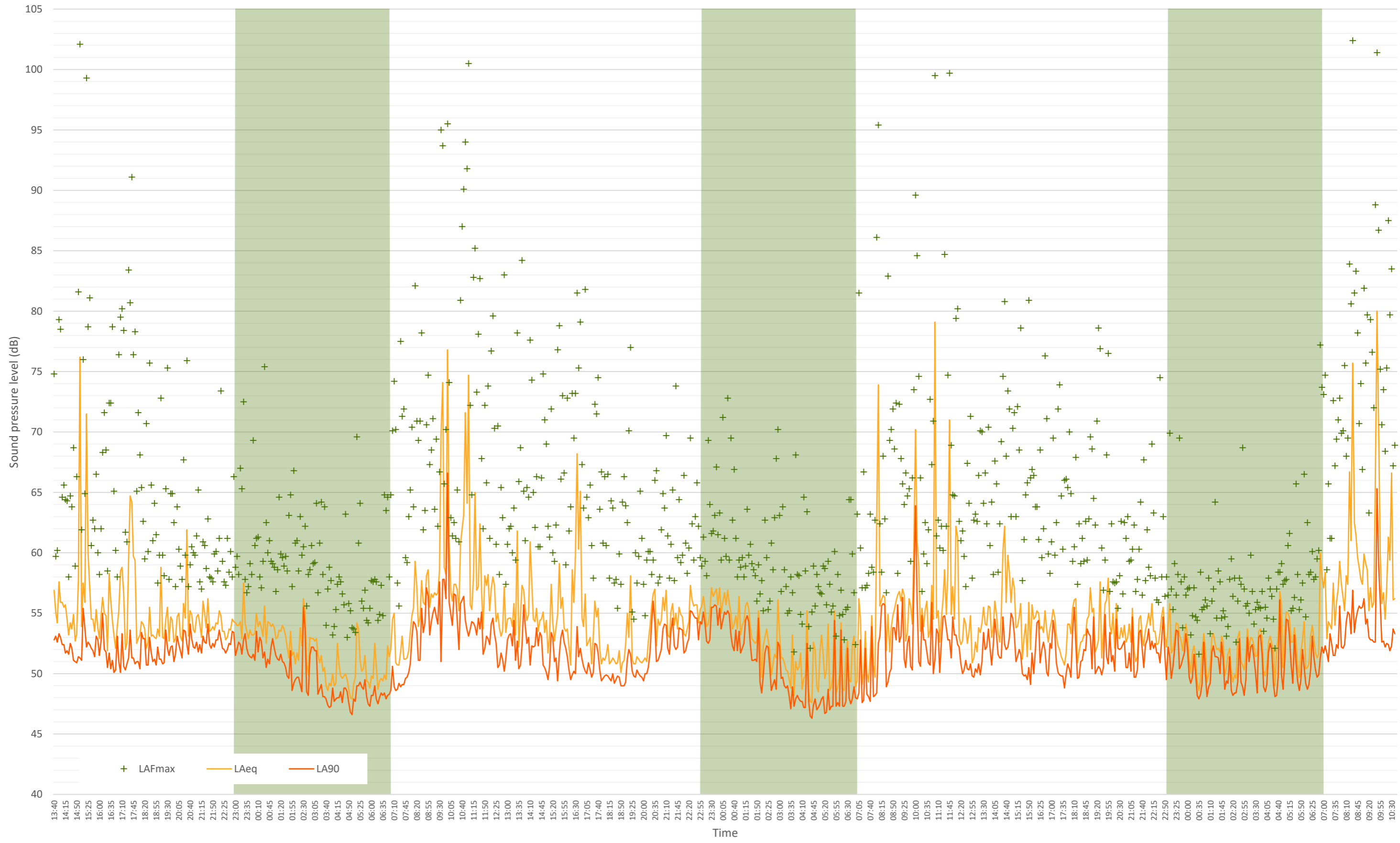


Figure 2.4 Measurement results for the first floor courtyard location, 21/10/2016 to 24/10/2016

2.4 ANALYSIS OF RESULTS

- 2.4.1 Measurements taken on the fifth floor rooftop showed a slight increase in level between 09:00 and 12:00 on both mornings, which is believed to have been caused by deliveries to the existing hotel. Measured noise levels overnight were generally slightly lower than during the day, but will still have been affected by residual traffic noise and a number of mechanical plant items on nearby rooftops.
- 2.4.2 The measurement results taken within the courtyard showed this area to generally be slightly quieter than the rooftop location, owing to increased screening to road traffic. This location also recorded the loudest maxima during the survey; analysis of automatically triggered audio files made during the survey revealed that these events were caused by the emptying of glass recycle bins, which were in close proximity to the measurement location.
- 2.4.3 Amplified music was known to be played in the restaurant/bar area on both the Friday and Saturday nights, which has resulted in slightly increased noise levels in the late evening and night-time periods.

3.1 CRITERIA

3.1.1 The *Noise and Vibration Thresholds* for industrial/commercial plant and machinery in the Camden local plan are presented in Table 3.1, representative of 24 hours a day for existing noise sensitive receptors.

“LOAEL” (green)	“LOAEL-SOAE” (amber)	“SOAEL” (red)
‘Rating level’ 10 dB below background and no events exceeding 57 dB L_{Amax}	‘Rating level’ between 9 dB below and 5 dB above background or noise events between 57 dB and 88 dB L_{Amax}	‘Rating level’ greater than 5 dB above background

Table 3.1 External noise emission limits from Camden Local Plan

- 3.1.2 Corrections for tonality will be considered as part of the BS 4142:2014 assessment methodology, as such the limit of *10 dB below background* has been targeted.
- 3.1.3 The equipment will operate at a continuous, steady noise level and so the criteria regarding L_{Amax} events has not been considered.
- 3.1.4 BS 4142:2014 contains a methodology for assessing the impact of a noise source by calculating the *rating level*. The *rating level* consists of the *specific noise level* (the total level of noise emission experienced by the receiver) with some corrections to account for perceptually intrusive noise characteristics (eg tonality, impulsivity etc).
- 3.1.5 BS 4142:2014 states the following in regard to the assessment of impact using the *rating level* and the *background sound level* at the receiver.

Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level (see Clause 8) from the rating level (see Clause 9), and consider the following.

NOTE 1 More than one assessment might be appropriate.

- a) Typically, the greater this difference, the greater the magnitude of the impact.*
- b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*
- c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.*
- d) 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.*

NOTE 2 Adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact.

3.2 PLANT PROPOSALS

3.2.1 The noisiest items of proposed building services plant are as follows:

- 6 external condenser/heat pump units, located at roof level in a louvred, but not lidded enclosure
- An externally mounted Air Handling Unit (AHU) at roof level, which will have intake and extract atmosphere terminations

3.2.2 The noise emitted from the condensers are based on the load requirements of the hotel, which are themselves determined by the number of guests requesting heating or cooling at any given time. Each unit can be expected to emit noise at a level of 57 dB L_{pA} at 1m when operating at full duty. It should be noted that it is likely that most of the units will be operating at a quieter noise level than this overnight, but as this assessment assumes all units running at full duty overnight it is considered representative of a worst-case scenario.

3.2.3 The enclosure housing the 6 external condenser/heat pump units shall be formed from an acoustic louvred screen with the following sound reduction indices as a minimum.

	Frequency (Hz)						
	63	125	250	500	1000	2000	4000
150mm thick louvred screen (sound reduction indices in dB)	4	4	5	8	12	16	15

Table 3.2 Minimum sound reduction indices for louvred screens

3.2.4 An indicative selection for the AHU has been made, and the acoustic data for this selection is shown in Table 3.3.

	Frequency (Hz)						
	63	125	250	500	1000	2000	4000
Inlet: open duct sound power level (dB L_w)	80	87	88	93	91	89	81
Outlet: open duct sound power level (dB L_w)	79	86	88	92	90	89	81
Casing (steel & 50mm mineral wool): Sound reduction indices (dB)	17	20	25	25	31	33	37
Inlet side: static insertion losses (dB)	7	12	22	28	31	29	24
Outlet side: static insertion losses (dB)	7	12	22	28	31	29	24
Inlet: calculated sound pressure level 1m from termination (dB L_{pA})	62	64	55	54	49	49	46
Outlet: calculated sound pressure level 1m from termination (dB L_{pA})	61	63	55	53	48	49	46
Calculated total casing breakout from air handling unit (dB L_w)	66	70	66	71	63	59	47

Table 3.3 Acoustic data for indicative air handling unit selection

3.2.5 A drawing showing the locations of the proposed plant items is shown in Figure 3.1.

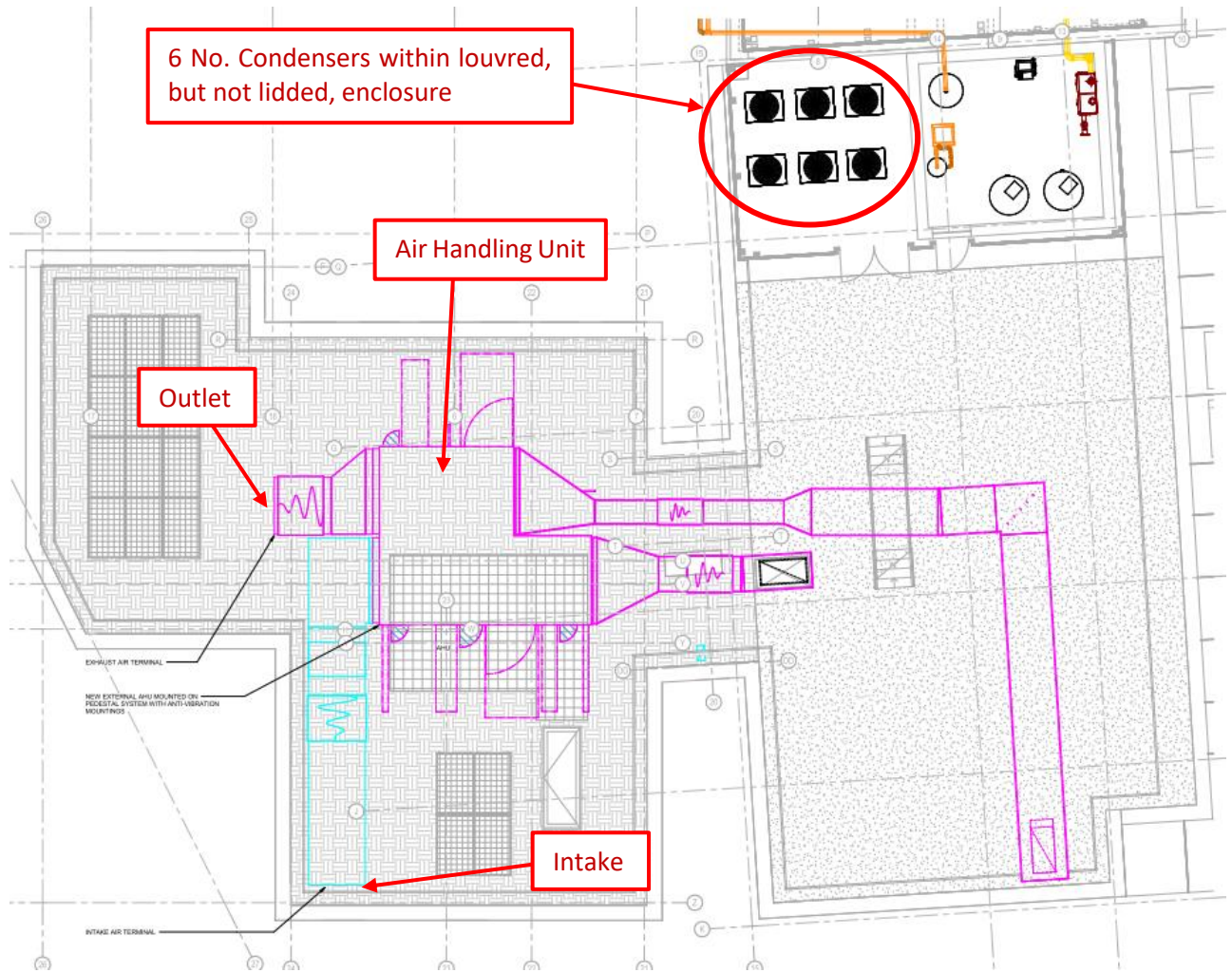


Figure 3.1 Location of proposed plant items

3.3 NEAREST NOISE-SENSITIVE RECEIVERS

3.3.1 The nearest noise-sensitive receivers to the proposed plant items are shown in Figure 3.2. Other nearby noise-sensitive properties are better screened and further away from the proposed plant, as such the noise impact to them could be expected to be less.

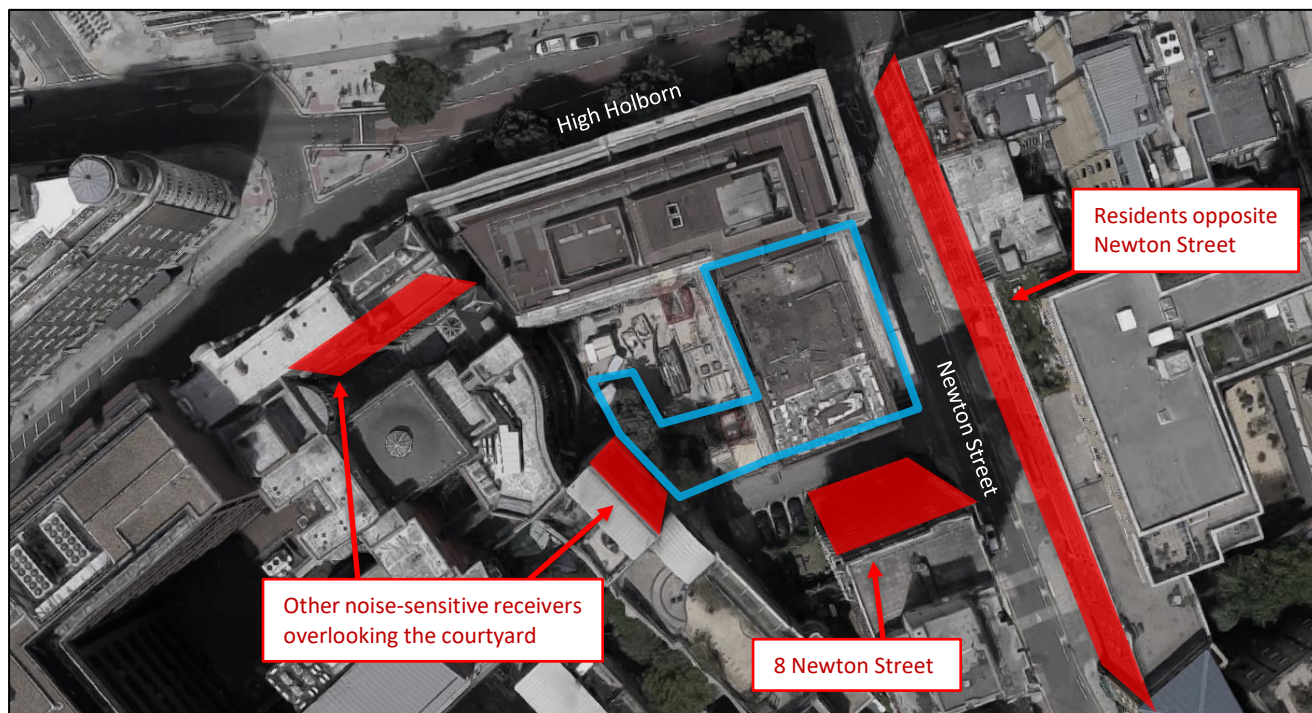


Figure 3.2 Satellite image (courtesy of Google) with nearest noise-sensitive receivers highlighted

3.3.2 The background noise levels for each receiver have been estimated based on the overnight external noise measurements as follows.

- The residents of 8 Newton Street: 50 dB L_{A90}
- Residents across Newton Street to the east of the site: 50 dB L_{A90}
- Residents overlooking the existing hotel courtyard, west of the site: 46 dB L_{A90}

3.4 PREDICTED RATING LEVELS

3.4.1 Noise emission levels to each noise-sensitive receiver detailed in Section 3.4 have been calculated in general accordance with the methodology presented in ISO 9613-2, and taking account of the following.

- All plant operating at the maximum allowable duty simultaneously
- The attenuation of sound over distance as a result of geometric spreading
- The additional attenuation effects of screening wherever the receiver does not have line-of-sight to the plant item
- The additional attenuation effects of the louvred screen wherever the receiver does not have line-of-sight over the top of the enclosure.

3.4.2 The noise emitted from the plant as a group would not be expected to have any perceptible tonal or impulsive qualities, but there may be a slightly perceptible tonal element present in the condenser units in isolation. A precautionary correction of +2 dB has therefore been applied to the condenser noise.

3.4.3 The condensers have a soft stop/start, and will adjust their duty depending on the load requirements of the hotel. As such, a correction of + 3dB has been applied to the condenser noise to account for any perceptible intermittency.

- 3.4.4 Well maintained condensing units will not have an impulsive noise character and so no correction for impulsivity has been applied
- 3.4.5 There are other items of building services plant within earshot of the development, and so noise of this type is not considered to be out of character for the area. Therefore, no other corrections have been applied.
- 3.4.6 The rating levels to each noise-sensitive receiver have been established as follows:
- The residents of 8 Newton Street with no line of sight to condensers: **≤ 42 dB L_{Aeq}**
 - Therefore noise levels from new building services plant would be expected to be at least 8 dB below the background noise level of 50 dB L_{A90} for these receivers
 - Noise emission to these receivers decreases with decreasing height
 - The residents of 8 Newton Street with line of sight to condensers: **≤ 46 dB L_{Aeq}**
 - Therefore noise levels from new building services plant would be expected to be at least 4 dB below the background noise level of 50 dB L_{A90} for these receivers
 - Noise emission to these receiver decreases with increasing height
 - Residents across Newton Street to the east of the site: **≤ 38 dB L_{Aeq}**
 - Therefore noise levels from new building services plant would be expected to be at least 12 dB below the background noise level of 50 dB L_{A90} for these receivers
 - Noise emission to these receivers decreases with decreasing height
 - Residents overlooking the existing hotel courtyard, west of the site: **34 dB L_{Aeq}**
 - Therefore noise levels from new building services plant would be expected to be at least 12 dB below the background noise level of 46 dB L_{pA} for these receivers

3.5 ASSESSMENT OF IMPACT

3.5.1 Comparing the established BS 4142:2014 rating levels to the criteria yields the following assessment findings:

Noise-sensitive receiver	Assessment according to BS 4142:2014	Camden Council noise threshold
8 Newton Street	Indicative of a low impact	“LOAEL to SOAEL” (amber)
Opposite Newton Street	Indicative of a low impact	“LOAEL” (green)
Overlooking the courtyard	Indicative of a low impact	“LOAEL” (green)

Table 3.4 Assessment of noise emission impact

3.5.2 Attempts have been made to revise the design so that the “green” threshold is met for 8 Newton Street. However, this will not be possible without the use of a lidded enclosure, which has been ruled out due to the increased height this will add to the plant enclosure. The design at present is therefore believed to represent the best practical solution given the constraints.

3.5.3 When considering this assessment, Scotch would like to point out the following:

- The noise emission to 8 Newton Street has been assessed as a low impact according to BS 4142:2014.
- The assessment has assumed all equipment operating simultaneously during the quietest period of night, a scenario that is highly unlikely to ever occur. During the quietest periods at least a 6 dB reduction in noise levels could be expected, which will bring the proposals in-line with the “green” noise threshold.
- The predicted noise emission levels are so low that it is unlikely that they will be directly measurable at the noise-sensitive receivers, due to the influence of louder noise sources (eg traffic from Holborn).
- Even though this assessment is considered representative of a worst-case scenario, the result is on the lower end of the “amber” threshold.

APPENDIX A – NOISE LEVEL DATA

A selection of the measured noise level data are presented in the tables in this appendix. The full set of data are available in electronic form on request.

All values are sound pressure levels in dB re: 2×10^{-5} Pa.

Date	Time	L _{AFmax}	L _{A10}	L _{Aeq}	L _{A90}	L _{AFmin}	Date	Time	L _{AFmax}	L _{A10}	L _{Aeq}	L _{A90}	L _{AFmin}
24/10/2016	03:50	61.8	56.2	53.0	50.1	49.3	24/10/2016	10:15	70.8	62.9	60.7	56.9	55.3
24/10/2016	03:55	65.3	55.4	52.8	49.6	48.2	24/10/2016	10:20	69.5	63.9	61.6	56.7	53.9
24/10/2016	04:00	62.6	56.0	53.0	49.8	48.8	24/10/2016	10:25	74.6	66.6	63.4	57.4	54.5
24/10/2016	04:05	64.3	54.6	52.2	49.6	48.4							
24/10/2016	04:10	60.4	52.0	51.3	49.8	48.7							
24/10/2016	04:15	67.0	55.5	52.9	49.9	49.0							
24/10/2016	04:20	63.7	56.6	53.8	50.6	49.2							
24/10/2016	04:25	61.5	55.2	52.5	50.0	49.1							
24/10/2016	04:30	64.1	56.4	53.4	49.9	48.9							
24/10/2016	04:35	58.8	53.6	51.3	49.4	48.4							
24/10/2016	04:40	65.3	55.5	53.1	50.0	48.6							
24/10/2016	04:45	65.8	56.6	53.5	50.4	49.6							
24/10/2016	04:50	65.0	56.4	54.0	51.5	50.5							
24/10/2016	04:55	64.1	57.1	54.2	51.3	49.7							
24/10/2016	05:00	67.6	58.1	54.9	50.4	49.4							
24/10/2016	05:05	65.7	58.3	55.4	51.1	50.0							
24/10/2016	05:10	67.5	56.7	54.3	51.6	50.4							
24/10/2016	05:15	63.0	57.9	54.5	51.5	50.4							
24/10/2016	05:20	73.9	59.0	56.6	51.4	50.4							
24/10/2016	05:25	64.6	59.0	55.6	51.2	50.4							
24/10/2016	05:30	63.7	58.3	54.6	50.4	49.5							
24/10/2016	05:35	64.8	58.8	55.1	51.1	49.9							
24/10/2016	05:40	64.9	57.1	53.9	51.0	49.6							
24/10/2016	05:45	70.3	58.2	55.5	50.8	49.6							
24/10/2016	05:50	64.8	57.7	54.7	51.5	50.5							
24/10/2016	05:55	65.7	60.3	57.9	53.3	51.6							
24/10/2016	06:00	66.9	58.9	56.0	51.6	50.3							
24/10/2016	06:05	68.7	59.9	56.8	51.0	49.8							
24/10/2016	06:10	64.6	58.6	55.4	51.5	50.2							
24/10/2016	06:15	65.7	58.5	55.2	51.3	49.9							
24/10/2016	06:20	70.0	59.6	57.3	52.6	50.9							
24/10/2016	06:25	65.1	59.7	57.1	52.8	51.8							
24/10/2016	06:30	65.6	59.3	56.1	52.4	51.5							
24/10/2016	06:35	66.0	59.6	56.5	52.6	51.5							
24/10/2016	06:40	68.6	60.4	57.4	52.6	51.1							
24/10/2016	06:45	69.4	60.3	57.0	52.2	51.2							
24/10/2016	06:50	66.5	59.3	56.5	52.2	50.9							
24/10/2016	06:55	74.2	61.0	59.3	52.3	51.2							
24/10/2016	07:00	75.0	61.3	58.7	52.2	50.9							
24/10/2016	07:05	70.2	63.0	59.0	52.8	50.9							
24/10/2016	07:10	69.4	62.2	58.0	52.6	51.2							
24/10/2016	07:15	65.6	59.2	57.0	53.0	51.4							
24/10/2016	07:20	72.9	59.0	57.5	52.4	51.2							
24/10/2016	07:25	63.4	58.3	55.7	52.7	51.6							
24/10/2016	07:30	66.2	59.8	57.3	53.6	52.1							
24/10/2016	07:35	68.8	61.6	58.2	53.1	51.6							
24/10/2016	07:40	66.4	59.3	56.9	53.0	51.7							
24/10/2016	07:45	67.3	60.0	57.4	53.4	51.6							
24/10/2016	07:50	67.9	60.3	57.8	53.6	52.1							
24/10/2016	07:55	67.9	61.0	57.9	53.2	51.8							
24/10/2016	08:00	71.2	62.0	59.3	54.2	52.6							
24/10/2016	08:05	67.0	62.0	60.2	57.2	52.6							
24/10/2016	08:10	73.7	62.4	60.9	58.1	55.6							
24/10/2016	08:15	72.0	68.2	65.0	60.1	58.3							
24/10/2016	08:20	81.1	65.8	64.3	62.0	61.0							
24/10/2016	08:25	81.7	72.4	68.8	62.4	61.4							
24/10/2016	08:30	75.8	65.2	62.0	56.4	53.8							
24/10/2016	08:35	86.8	67.5	66.0	59.7	56.5							
24/10/2016	08:40	76.6	63.4	61.2	55.9	54.0							
24/10/2016	08:45	74.6	63.0	60.7	56.4	53.8							
24/10/2016	08:50	69.7	63.3	60.6	57.1	54.1							
24/10/2016	08:55	72.0	65.3	62.8	58.6	55.7							
24/10/2016	09:00	72.5	64.2	61.6	58.1	55.1							
24/10/2016	09:05	76.0	68.2	65.3	59.0	55.8							
24/10/2016	09:10	74.7	66.9	64.3	59.3	57.0							
24/10/2016	09:15	73.7	63.6	61.7	58.6	56.4							
24/10/2016	09:20	74.7	63.6	61.5	57.9	55.9							
24/10/2016	09:25	70.7	63.2	60.7	57.6	55.0							
24/10/2016	09:30	73.9	65.3	62.2	56.5	54.6							
24/10/2016	09:35	72.0	63.6	60.6	56.7	54.6							
24/10/2016	09:40	72.0	64.3	61.6	57.7	54.1							
24/10/2016	09:45	77.5	68.9	65.5	57.3	55.2							
24/10/2016	09:50	90.4	72.9	72.3	66.5	61.1							
24/10/2016	09:55	76.6	69.5	67.5	63.6	61.4							
24/10/2016	10:00	72.5	67.3	63.8	57.6	54.0							
24/10/2016	10:05	73.5	63.9	61.5	57.5	55.0							
24/10/2016	10:10	83.7	64.8	64.1	57.7	55.1							

Table A1d: Statistical measurement data from the fifth floor location, 24/10/2016

Date	Time	L _{AFmax}	L _{A10}	L _{Aeq}	L _{A90}	L _{AFmin}
24/10/2016	05:50	55.3	50.9	49.7	48.6	47.1
24/10/2016	05:55	56.1	53.1	51.7	49.4	47.4
24/10/2016	06:00	57.5	53.6	52.8	52.0	51.0
24/10/2016	06:05	66.5	55.3	54.3	50.5	49.5
24/10/2016	06:10	54.7	51.6	50.4	49.2	48.1
24/10/2016	06:15	62.5	51.6	50.5	48.7	47.5
24/10/2016	06:20	58.2	52.1	50.8	49.1	48.0
24/10/2016	06:25	58.4	54.4	53.1	50.3	48.5
24/10/2016	06:30	60.1	55.3	54.0	53.1	52.1
24/10/2016	06:35	57.8	54.2	52.9	51.4	50.3
24/10/2016	06:40	58.0	53.0	51.7	50.3	49.3
24/10/2016	06:45	59.5	52.8	51.3	49.7	48.6
24/10/2016	06:50	60.2	53.1	51.6	49.9	48.4
24/10/2016	06:55	77.2	59.6	60.0	51.3	50.1
24/10/2016	07:00	73.7	56.9	58.0	52.2	51.3
24/10/2016	07:05	73.1	58.2	57.1	51.7	50.1
24/10/2016	07:10	74.7	58.9	58.4	52.3	51.4
24/10/2016	07:15	58.6	53.9	52.9	51.7	50.4
24/10/2016	07:20	65.7	55.1	54.3	51.0	49.9
24/10/2016	07:25	61.2	54.6	54.0	53.3	52.5
24/10/2016	07:30	61.2	54.9	53.7	52.5	51.3
24/10/2016	07:35	72.6	56.9	57.5	51.5	50.3
24/10/2016	07:40	67.2	54.6	54.0	51.5	50.3
24/10/2016	07:45	69.4	57.7	55.9	52.4	51.2
24/10/2016	07:50	71.0	58.3	57.0	52.1	50.3
24/10/2016	07:55	72.8	59.5	59.3	55.6	54.8
24/10/2016	08:00	69.9	59.0	57.4	52.2	51.1
24/10/2016	08:05	70.1	57.0	56.3	52.1	50.2
24/10/2016	08:10	75.5	56.4	55.2	52.4	51.1
24/10/2016	08:15	68.0	59.9	58.1	54.3	53.1
24/10/2016	08:20	69.5	59.2	57.4	55.1	53.5
24/10/2016	08:25	83.9	70.0	66.7	54.9	53.6
24/10/2016	08:30	80.6	63.5	61.0	53.3	50.8
24/10/2016	08:35	102.4	64.8	75.7	56.9	52.4
24/10/2016	08:40	81.5	65.4	62.5	53.4	50.9
24/10/2016	08:45	83.3	63.9	61.5	54.5	52.2
24/10/2016	08:50	78.2	60.9	59.6	55.2	53.6
24/10/2016	08:55	70.7	60.7	58.8	55.6	54.4
24/10/2016	09:00	74.0	59.4	57.8	55.4	54.4
24/10/2016	09:05	66.9	59.0	57.4	55.5	54.2
24/10/2016	09:10	81.9	59.4	59.9	56.2	55.0
24/10/2016	09:15	75.7	61.4	59.1	54.1	52.4
24/10/2016	09:20	79.7	59.3	58.6	54.5	52.7
24/10/2016	09:25	63.3	57.2	55.2	53.0	51.3
24/10/2016	09:30	79.3	57.9	57.1	52.8	51.8
24/10/2016	09:35	76.6	56.4	55.5	52.8	51.7
24/10/2016	09:40	72.0	59.1	55.9	52.6	50.1
24/10/2016	09:45	88.8	68.4	66.1	52.6	51.4
24/10/2016	09:50	101.4	78.2	80.0	65.3	60.8
24/10/2016	09:55	86.7	73.3	70.7	59.1	56.6
24/10/2016	10:00	75.2	62.8	59.9	55.9	52.6
24/10/2016	10:05	70.6	57.7	55.8	52.6	50.7
24/10/2016	10:10	73.5	59.1	56.7	52.7	50.9
24/10/2016	10:15	68.4	56.1	54.5	52.2	50.6
24/10/2016	10:20	75.3	57.9	57.1	52.5	50.3
24/10/2016	10:25	87.5	61.9	61.3	52.4	50.4
24/10/2016	10:30	79.7	58.5	59.4	51.9	50.0
24/10/2016	10:35	83.5	64.2	66.6	52.3	50.5
24/10/2016	10:40	67.2	58.0	56.1	53.7	52.3
24/10/2016	10:45	68.9	58.0	56.2	53.3	52.2

Table A2f: Statistical measurement data from the first floor courtyard location, 24/10/2016

This appendix provides an explanation of some of the acoustics terms used in this report.

	The human ear does not sense all frequencies of sound equally. Our sensitivity is at a maximum at around 2 kHz and steadily decreases above and below. Below 20 Hz and above about 20 kHz we can't hear at all.
A-weighting L_A or L_{pA} , L_{WA} ,	Within its operating limits a precision measurement microphone measures all frequencies the same so the output it produces does not reflect what we would actually hear. The A-weighting is an electronic filter that matches the response of a sound level meter to that of the human ear. When A-weighted the Sound Pressure Level L_p becomes L_{pA} (or L_A) and the Sound Power Level L_W becomes L_{WA} .
L_p	<i>The instantaneous sound pressure level (L_p)</i>
L_{pA} (or L_A)	<i>The A-weighted instantaneous sound pressure level (L_{pA} or L_A)</i>
	This is the root mean square size of the pressure fluctuations in the air. This level can fluctuate wildly even for seemingly steady sounds. To make sound level meters easier to read the values on the display are smoothed or damped out. This is effectively done by taking a rolling average of the previous 0.125 s (FAST time constant) or the previous 1 s (SLOW time constant).
L_{AF} , L_{AS}	The letters F or S are added to the subscripts in the notation to indicate when the FAST or SLOW time constant has been used. These are often omitted but it is good practice to include them.
L_{max}	<i>The maximum instantaneous sound pressure level (L_{max}),</i>
L_{Amax}	<i>The A-weighted maximum instantaneous sound pressure level (L_{Amax})</i>
L_{AFmax}	<i>The A-weighted maximum instantaneous sound pressure level with a FAST time constant (L_{AFmax}).</i>
L_{min} , L_{Fmin}	The opposite of the L_{max} is the <i>minimum instantaneous sound pressure level</i> or L_{min} etc. It is good practice to include the letter which identifies the time constant used as this can make a significant difference to the value.
$L_{N,T}$	<i>The percentage exceedence sound pressure level ($L_{N,T}$),</i>
$L_{AN,T}$, $L_{AFN,T}$ N = %age value, 0-100 T = measurement time eg. L_{A90} , L_{A10} , $L_{AF90, 5 min}$	<i>The A-weighted percentage exceedence sound pressure level ($L_{AN,T}$), the A-weighted percentage exceedence sound pressure level with a FAST time constant ($L_{AFN,T}$).</i> This is the sound pressure level exceeded for $N\%$ of time period T . eg. If an A-weighted level of x dB is exceeded for a total of 6 minutes within one hour, the level will have been above x dB for 10% of the measurement period. This is written as $L_{A10,1hr} = x$ dB. L_{A0} (the level exceeded for 0 % of the time) is equivalent to the L_{Amax} and L_{A100} (the level exceeded for 100 % of the time) is equivalent to the L_{Amin} . It is good practice to include the letter which identifies the time constant used as this can make a significant difference to the value.
$L_{eq,T}$	<i>The equivalent continuous sound pressure level over period T ($L_{eq,T}$),</i>
$L_{Aeq,T}$ T = measurement time eg. $L_{Aeq,5min}$	<i>The A-weighted equivalent continuous sound pressure level over period T ($L_{Aeq,T}$).</i> This is effectively the average sound pressure level over a given period. As the decibel is a logarithmic quantity the L_{eq} is not a simple arithmetic mean value. The L_{eq} is calculated from the raw sound pressure data. It is not appropriate to include a reference to the FAST and SLOW time constants in the notation



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