150 Holborn

London EC1

PPG24 Acoustic assessment

August 2011

WSP

QM

Issue/revision	Issue 1	Rev 01	Rev 02
Remarks	For Review	Issue 2	Issue 3
Date	1 June 2011	10 June 2011	13 June 2011
Prepared by	Ellen Harrison	Ellen Harrison	Ellen Harrison
Signature			
Checked by	A Jarvis	A Jarvis	A Jarvis
Signature			
Authorised by	Martin Raisborough	Martin Raisborough	Martin Raisborough
Signature			
Project number	21629	21629	21629
File reference	150 Holborn Acoustic Planning Report	150 Holborn Acoustic Planning Report	150 Holborn Acoustic Planning Report

WSP Acoustics
WSP House
70 Chancery Lane
London
WC2A 1AF

Tel: +44 (0)20 7314 5000
Fax: +44 (0)20 7314 5111
http://www.wspacoustics.com

Contents

1 Introduction

1.1 WSP Acoustics has been commissioned by Laffly LLP to undertake an environmental noise survey and carry out a planning assessment of the acoustic considerations affecting the proposed development at 150 Holborn. The development is proposed to include residential and office uses.

1.2 The purpose of the environmental noise survey is to establish the prevailing ambient noise levels at the proposed site during the day time and night-time periods.

1.3 An assessment of the proposed residential element of the development has been undertaken in accordance with national guidance, as set out in Planning Policy Guidance Note 24: Planning and Noise (PPG 24).

1.4 On the basis of the measured noise levels, outline advice has been provided on the required sound insulation performance of the external building fabric elements to ensure that noise break-in is controlled to acceptable levels.

1.5 The criteria for external noise break-in, on which the outline sound insulation requirements for the building fabric are based, are in accordance with the latest standard guidance documents, referred to in this report.

1.6 Environmental noise emission limits for building services plant have been proposed based on the existing measured background noise and guidance provided by Camden Council.

1.7 This report is necessarily technical in nature and to assist the reader, a glossary of acoustic terminology is contained within Appendix A.

2 Site Description

2.1 The site at 150 Holborn is occupied by a seven storey building surrounding a service yard. The site will be refurbished and extended to accommodate offices with a section developed to include residential properties along Brooke Street. At ground floor, the units facing out onto High Holborn and Gray's Inn Road will continue to be of retail use, typically containing shops or café/food outlet units.

2.2 The site is located at the junction of High Holborn and Gray's Inn Road within close proximity to Chancery Lane Tube Station. The site is bounded by Brooke Street to the east and Fox Court, an office building at 14 Gray's Inn Road to the north. The closest residential properties are to the east of 150 Holborn, on the upper levels of 1-23 Gray's Inn Road.

2.3 The dominant source of noise at the exposed (eastern, southern and western) façades of the building on the site is noted to be due to road traffic. This noise source is considered to be dominant during both day time and night-time periods. Noise at the elevations facing onto the service yard is significantly lower due to the acoustic screening of road traffic by the building itself.

2.4 A plan of the existing site can be seen in Appendix B.

3 Noise Survey

3.1 An environmental noise survey was undertaken over a three day period to establish the prevailing noise levels at the site.

3.2 It was noted, during the time spent on site, that the noise climate was dominated by road traffic movements on High Holborn, Gray's Inn Road and Brooke Street.

3.3 Measurements were undertaken at six positions on the site, namely:

- Position 1: free-field measurements taken at roof level on the south-west corner of the building roof (see photo in Appendix B). This position did not have a direct line of site to High Holborn or Gray's Inn Road, but it is considered indicative of the ambient noise climate in this area;
- Position 2: free-field measurements four storeys up on the north-east corner of the building roof (see photo in Appendix B). This location is considered representative of general ambient noise levels in the service yard;
- Position 3: a façade measurement 1.5m above the ground, 1m from the west-facing façade and 4m from the kerb of Gray's Inn Road;
- Position 4: a façade measurement 1.5m above the ground, 1m from the south-facing façade and 10m from the kerb of High Holborn;
- Position 5: a façade measurement at 1.5m above the ground, 1m from the east facing façade and 1m from the kerb of Brooke Street;
- Position 6: a free-field measurement 1.5m above the ground, in the service yard.

3.4 The measurement positions are indicated on the site map in Appendix B.

3.5 Un-attended long-term measurements taken at positions 1 and 2 began at approximately 10:00 hrs on Friday 15 April 2011, and continued for 3 days. Attended sample measurements were taken at positions 3 to 6 in the morning rush hour of Tuesday 19 April 2011 from 08:00-10:00 hrs.

3.6 Further attended noise measurements were made between 06:10 – 09:30 hrs on 20 May 2011.

3.7 Weather conditions during the measurement period were bright and dry, and would not have had a significant effect on the noise measurements taken.

3.8 The equipment items used during the surveys are listed below in Table 3-1.

Table 3-1 Noise measurement equipment used during the survey

Equipment Description	Manufacturer & Type No.	Serial Number	Calibration Due Date
Sound Level Meter	01dB-Stell Solo	10705	16 March 2012
Pre-amplifier	01dB-Stell PRE 21 S	11464	
Microphone	01dB – Condenser Mic MCE212	59725	
Sound Level Meter	01dB-Stell Solo	11750	25 May 2012
Pre-amplifier	01dB-Stell PRE 21 S	13150	
Microphone	01dB – Condenser Mic MCE212	61802	
Sound Level Meter	Brüel & Kjær Type 2250	2463189	31 January 2013
Pre-amplifier	Brüel & Kjær Type ZC	0026	
Microphone	Brüel & Kjær 4189	24577838	

3.9 The measurement systems were calibrated at the beginning and end of the survey using a 01dB-Stell Cal 21 Sound Calibrator, which had itself been calibrated within the preceding twelve months by a UKAS accredited calibration laboratory. No significant drift in calibration levels occurred during the survey. All noise instruments had been calibrated to traceable standards within the preceding two years and the acoustic calibrator within the preceding 12 months.

3.10 The results of the environmental noise survey can be found in Appendix C, in tabular and graphical form, and are referred to the following assessments.

4 Building Services Noise Emission Criteria

4.1 The nearest noise sensitive properties to 150 Holborn are identified in the site plan and photos in Appendix B, and are described below:

- The residential development at the upper floors of 1-23 Gray's Inn Road, to the west of 150 Holborn.
- The offices at Fox Court, which face onto the service yard of 150 Holborn.

NOISE EMISSION LIMIT AT RESIDENCES – UPPER FLOORS OF 1-23 GRAY'S INN ROAD

4.2 The noise emission criteria in relation to the residential development on the upper floors of 1-23 Gray's Inn Road are based on achieving a BREEAM credit and criterion set by Camden Local Authority.

4.3 The BREEAM credit awarded for noise attenuation in relation to new plant is based on the following conditions:

'One credit where evidence provided demonstrates that new sources of noise from the development do not give rise to the likelihood of complaints from existing noise-sensitive premises and amenity or wildlife areas that are within the locality of the site.

Where the rating level of the noise source(s) from the site/building is equivalent to or less than the background noise level, the credit can be awarded.'

4.4 This credit can be achieved by meeting the relevant plant noise emission criterion set by Camden Local Authority in the 'Camden Development Policies: Adoption Version 1, November 2010' document, which provides restricting noise levels from new plant and machinery to prevent an adverse impact upon the nearby noise sensitive properties.

4.5 This document sets out guidance in Development Policy 28: Noise and vibration (DP28) to ensure that noise and vibration is controlled and managed and will not grant permission for:

> *"a) development likely to generate noise pollution; or*
>
> *b) development sensitive to noise in locations with noise pollution, unless appropriate attenuation measures are provided."*

4.6 With regard to plant noise, the document states

> *"The Council will only grant permission for plant or machinery if it can be operated without cause harm to amenity and does not exceed noise thresholds."*

4.7 The limits on noise levels from plant and machinery are set out in Table 4-1.

Table 4-1 Noise limits above which planning permission will not be granted at 1m from the sensitive façade

Recommended building services plant noise limits (dB re 20μPa)		
Noise description	**Period**	**Noise Limit**
General Noise	Day, evening and night (00:00-24:00 hrs)	L_{A90} -5 dB
Noise with distinguishable discrete continuous note (whine, hiss, screech, hum)		L_{A90} -10 dB
Noise with distinct impulses (bangs, clicks, clatters, thumps)		L_{A90} -10 dB
Noise where L_{A90} > 60dB		55dB L_{Aeq}

4.8 At this stage, it is recommended the rating noise level ($L_{Ar,Tr}$) of the plant should be 10 dB below the minimum background noise level (L_{A90}). This allows for the use of building services plant which may exhibit tonal characteristics (i.e. whine, hiss, screech or hum) where otherwise unavoidable.

4.9 Position 1 is representative of the noise levels at the set-back residential windows on the upper floors of 1-23 Gray's Inn Road. Therefore, it is proposed that noise measurements taken at this location be used for reference when assessing compliance with Camden Council's noise criteria.

4.10 The lowest background noise levels measured at position 1 are presented in Appendix C, Table C-5. Based on these levels and the guidance outlined above, the following plant noise emission limits (in terms of the rating noise level, $L_{Ar,Tr}$) are proposed in Table 4-2 below.

Table 4-2 Plant noise emission limits for building services plant at 1m from the nearest residential properties

Period	Recommended building services plant noise limit at nearest sensitive receptor
Day time (07:00-19:00 hrs)	41 dB $L_{Ar,1hr}$
Evening (19:00-23:00 hrs)	42 dB $L_{Ar,1hr}$
Night-time (23:00-07:00 hrs)	37 dB $L_{Ar,5min}$

4.11 It must be noted that the specified limits apply to total noise emissions from any new plant. Individual plant items must be designed to lower levels than stated above (where more than one plant item contributes to noise emission to a particular area). This issue must be addressed during the detailed design development.

NOISE EMISSION LIMIT AT OFFICES – FOX COURT

4.12 The following guidance regarding suitable internal ambient noise criteria is taken from BREEAM for Offices 2008 and is referred to here in the assessment of building services noise emissions potentially affecting the nearby office building.

- ≤ 40 dB $L_{Aeq,T}$ in single occupancy offices
- 40-50 dB $L_{Aeq,T}$ in multiple occupancy offices
- ≤ 40 dB $L_{Aeq,T}$ general spaces (staffrooms, restrooms)
- ≤ 35 dB $L_{Aeq,T}$ in spaces designed for speech e.g. seminar/lecture rooms

4.13 Partially open windows typically provide around 10 – 15 dB of attenuation. Taking the most sensitive type of office space identified above as the design case, and considering the relatively low noise levels existing in the service yard during the day, it is proposed that a noise level limit at the nearest office window be set as follows:

'Building services noise emissions must not exceed a cumulative noise level of 45 dB when measured at 1m from the nearest office window'.

4.14 The above noise limit would achieve a noise level of around 30 – 35 dB L_{Aeq} internally, even with a partially open window.

5 Residential Planning Assessment

CRITERIA - PLANNING POLICY GUIDANCE NOTE 24: PLANNING AND NOISE

5.1 Planning Policy Guidance Note (PPG) 24, published in September 1994, sets out the Government's policies on noise related planning guidance. It outlines the considerations to be taken into account when determining planning applications for both noise-sensitive developments and for those activities which will generate noise.

5.2 PPG 24 recommends the use of four Noise Exposure Category (NEC) bands, designed to assist local planning authorities in evaluating applications for residential development in noisy areas. PPG 24 provides a table showing each NEC band, defined by a range of 'free-field' noise levels into which development land falls, together with relevant planning advice to the local authority. The definition of each NEC band is dependent on the noise source in question.

5.3 Table 5-1 below presents the definitions of the NEC bands relating to a noise climate dominated by road traffic, which is considered most relevant to this assessment.

Table 5-1 Recommended NECs for new dwellings affected by road traffic noise

NEC	Day time (07:00–23:00 hrs) $L_{Aeq,16hr}$ (dB)	Night-time (23:00–07:00 hrs) $L_{Aeq,8hr}$ (dB)	Planning Advice
A	<55	<45	Noise need not be considered as a determining factor in granting planning permission, although noise at the high end of the category should not be regarded as a desirable level.
B	55-63	45-57	Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise.
C	63-72	57-66	Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise.
D	>72	>66	Planning permission should normally be refused.

5.4 In addition to the above, PPG 24 also states that during the night, (23:00-07:00 hrs): 'Sites where individual noise events regularly exceed 82 dB L_{Amax} (slow time weighting) several times in any hour should be treated as being in NEC C, regardless of the $L_{Aeq,8hr}$, except where the $L_{Aeq,8hr}$ already puts the site into NEC D.'

5.5 Where PPG 24 advises that conditions should be imposed to ensure a commensurate level of protection against noise, reference is made to other standards that establish suitable internal noise levels within homes, such as BS 8233:1999: Sound Insulation and Noise Reduction for Buildings – Code of Practice.

ASSESSMENT – PPG 24

5.6 The proposed residential units are on the north-east end of the building, shown on the site map in Appendix B. Façades of the residential development will face onto Brooke Street and the newly developed courtyard, with higher noise levels on the Brooke Street façade as a result of road traffic movements.

5.7 For the purposes of the PPG 24 assessment, the measured levels at position 5 have been corrected by -3dB to predict the equivalent free-field levels at the proposed residential façade fronting Brooke Street. Results are shown in Table 5-2 below.

Table 5-2 Corrected environmental levels at Brooke Street façade for PPG 24 Assessment

Period	Noise Level		Applicable NEC
	Measured level	Corrected free-field level at proposed façades	
Day $L_{Aeq,16hr}$ (07:00 – 23:00 hrs)[1]	68 dB	65 dB	NEC C
Night $L_{Aeq,8hr}$ (23:00 – 07:00 hrs)[2]	66 dB	63 dB	NEC C

Notes
1) Taken from an energy average of attended sample noise measurements at position 5, results shown in Appendix C, Tables C-6 and C-7.
2) Taken from attended measurements at position 5, results shown in Appendix C, Table C-7.

5.8 The night-time measured level in Table 5-2 is taken from the noise survey on 20 May 2011 between 06:10-07:00 hrs (50 minute period). This period is representative of the worst-case levels during the night due to early morning HGV deliveries on Brooke Street and the beginning of the rush hour traffic.

5.9 To predict the free-field noise levels at the residential façades facing the service yard, the attended sample day time measurements in the service yard at position 6 and the un-attended night-time measurements at position 2 are used. The attended sample measurements made in the service yard were found to closely match the un-attended long-term measurements made on the roof. Results are shown in Table 5-3 below.

Table 5-3 Environmental Noise Levels at the façade facing onto the Service yard for PPG 24 Assessment

Period	Free-field Measured Noise Level ($L_{Aeq,T}$)	Applicable NEC
Day $L_{Aeq,16hr}$ (07:00–23:00 hrs)[1]	56 dB	NEC B
Night $L_{Aeq,8hr}$ (23:00–07:00 hrs)[2]	50 dB	NEC B

Notes
1) Taken from an average of attended sample noise measurements at position 6, results shown in Appendix C, Table C-6.
2) Taken from un-attended long-term noise measurements at position 2, results shown in Appendix C, Table C-2, and Table C-4.

5.10 A comparison of the equivalent free-field noise levels in Table 5-2 and 5-3 with the Noise Exposure Categories for road traffic noise, shows that the noise levels incident upon residential façades facing Brooke Street fall within NEC C during the day time and night-time periods. However, noise levels incident upon the residential façades facing onto the service yard fall into NEC B during the day and the night-time periods.

From Table 5-1, PPG 24 states the following advice for sites falling into NEC B and NEC C:

B: *"Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise."*

C: *"Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise."*

5.11 The following section, therefore, considers sound insulation requirements that should be included in the design of the residential façades, such that suitable internal noise levels as defined in BS 8233:1999 are achieved.

6 Noise Break-In Assessment - Residential

CRITERIA – BS 8233: 1999: SOUND INSULATION AND NOISE REDUCTION FOR BUILDINGS – CODE OF PRACTICE

6.1 The scope of this Standard is the provision of recommendations for the control of noise in and around buildings.

6.2 The Standard suggests suitable internal noise levels within different types of buildings, including residential dwellings, as shown in Table 6-1. BS 8233:1999 states that the given internal noise level criteria are based on anonymous noise sources such as road traffic or mechanical service noise, the criteria do not apply to noise from neighbours, which 'may trigger complex emotional reactions that are disproportionate to the noise level.' As the predominant noise source at the site is traffic noise, these criteria levels are considered appropriate to this assessment.

Table 6-1 Suitable internal ambient noise levels in spaces when they are unoccupied

Criterion	Typical Situations	Design Range $L_{Aeq,T}$	
		Good	Reasonable
Reasonable resting/sleeping conditions	Living rooms	30 dB	40 dB
	Bedrooms*	30 dB	35 dB
* For a reasonable standard in bedrooms at night, individual noise events (measured with fast time-weighting) should not normally exceed 45 dB L_{Amax}.			

BUILDING ENVELOPE SOUND INSULATION ASSESSMENT - RESIDENTIAL

6.3 The assessment below is based on achieving the BS 8233:1999 "Reasonable" criteria in bedrooms and living rooms.

Brooke Street façade

6.4 The predicted noise levels incident upon the windows of the habitable spaces on the Brooke Street side of 150 Holborn is shown below in Table 6-2. The following elements of the façade have been taken into consideration:

- All windows of habitable spaces are set back from the façade facing onto Brooke Street by a common balcony; this area provides acoustic screening from traffic noise on Brooke Street. The attenuation is accounted for in the calculation, which is in accordance with the procedure stated in BS 12354-3:2000 *Building acoustics. Estimation of acoustic performance in buildings from the performance of elements. Airborne sound insulation against outdoor sound.*
- The day time assessment is based on achieving the BS 8233:1999 criterion for living rooms in the first floor kitchen/diners. These are the closest habitable

rooms to road traffic noise on Brooke Street, and are therefore the most exposed. The calculation includes a line source distance correction of -1 dB from the ground floor measurement position to the first floor level.

- The night-time assessment is based on achieving the BS 8233:1999 criterion for bedrooms in the second floor bedrooms. These rooms are considered a worst case scenario as they are the closest bedrooms to road traffic noise on Brooke Street. The calculation includes a line source distance correction of -2.5 dB from the ground floor measurement position to the second floor level.
- Night-time maximum noise events are considered as point sources and are attributed a distance attenuation of -5 dB.

6.5 An energy average of the measured levels at position 5 is used, and are shown in Appendix C, Tables C-6 and C-7. Note that in accordance with BS 8233:1999, maximum noise levels are not considered during the day period.

Table 6-2 Equivalent Free-Field Levels at the Residential Windows affected by traffic on Brooke Street

Period	Noise sensitive window nominated for calculation (worst case)	Predicted Incident Free-Field Noise Level at Window	Internal Criteria Level
Day (07:00-23:00 hrs)	Kitchen / Diner	62 dB L_{Aeq}	40 dB L_{Aeq}
Night (23:00-07:00 hrs)	Bedroom	58 dB L_{Aeq} 77 dB $L_{AF,max}$	35 dB L_{Aeq} 45 dB $L_{AF,max}$
Note The measured levels can be found in Appendix C, Tables C-6 and C-7.			

6.6 The glazed elements and ventilation systems are expected to be the controlling factor in the sound reduction performance of the façade.

6.7 The minimum glazing sound insulation performance on all bedroom windows that face onto the common balcony overlooking Brooke Street must be at least 36 dB $R_w + C_{tr}$ (provided by the glazing and frame element). This can be achieved with an acoustic double glazing unit, i.e. 8mm glass / 10mm gap / 10.8mm glass.

6.8 It should be noted that when bedroom windows facing onto the common balcony area overlooking Brooke Street are open, the level in BS 8233:1999 will be exceeded at night-time. However, windows would only be open temporarily as all apartments will have background MHRV systems for cooling.

Service yard Façade

6.9 The following noise levels incident upon the residential windows facing onto the service yard are shown below in Table 6-3. The day time façade noise level is taken from the attended sample measurements at position 6 shown in Appendix C, Table C-5, and is assumed to be representative of the ambient noise level at this façade. The night-time façade noise levels are taken from the un-attended long-term measurements taken at position 2 shown in Appendix C, Table C-2 and Table C-4, which are also considered to be representative of the ambient noise level at this façade.

Table 6-3 Equivalent Free-Field Levels at the Service yard Facing Residential Windows

Period	Noise sensitive window nominated for calculation (worst case scenario)	Incident Free-Field Noise Level	Internal Criteria Level
Day (07:00-23:00 hrs)	Living Room	56 dB L_{Aeq} [1]	40 dB L_{Aeq}
Night (23:00-07:00 hrs)	Bedroom	50 dB L_{Aeq} [2] 64 dB $L_{AF,\,max}$ [2]	35 dB L_{Aeq} 45 dB $L_{AF,\,max}$

Notes
1) Taken from attended sample measurements at position 5, found in Appendix C, Table C-5.
2) Taken from un-attended long-term noise measurements at position 2, found in Appendix C, Table C-2 and Appendix C, Table C-4.

6.10 As for the Brooke Street façade, the glazed elements and ventilation systems are expected to be the controlling factor in the sound reduction performance of the façade.

6.11 As noise levels in the service yard area are much lower, standard double glazed units and non-acoustic background vents would provide sufficient sound insulation to achieve the requirements of BS8233:1999 in all habitable rooms.

6.12 It should be noted that when bedroom windows facing onto the service yard are open, the BS 8233:1999 criteria regarding internal night-time maximum noise levels would be exceeded on a few occasions during the night. However, windows would only be open temporarily when purge ventilation is required or during the hottest periods of the year to provide cooling as needed.

6.13 A further, more detailed façade assessment will be necessary during the later design stages.

SOUND INSULATION BETWEEN RETAIL AND RESIDENTIAL AREAS

6.14 A party floor separates the residential properties from ground floor retail space, and party walls are proposed to separate the residential from the office space.

6.15 It is proposed that the architectural design allows for at least a 5 dB increase in the airborne sound insulation relative to the minimum requirements of Approved Document E for both the party walls and floors separating the residential spaces from adjacent retail spaces. In addition to this, it is recommended that the tenant agreement includes limiting noise criteria to prevent noise inside the retail units from potentially disturbing the adjacent residences.

7 Noise Break-In Assessment - Office

CRITERIA - BREEAM FOR OFFICES 2008

7.1 The following guidance in BREEAM for Offices 2008 is referred to in the assessment of environmental noise at the proposed office development.

7.2 Internal acoustic performance criteria are provided under section HEA 13 'Acoustic Performance'. Minimum sound insulation requirements between 'acoustically sensitive areas' and other occupied areas are provided, which will be considered during the detailed design of the internal architecture between office spaces.

7.3 Also provided in the document are internal ambient noise criteria which are summarised below:

- ≤ 40 dB $L_{Aeq,T}$ in single occupancy offices
- 40-50 dB $L_{Aeq,T}$ in multiple occupancy offices
- ≤ 40 dB $L_{Aeq,T}$ general spaces (staffrooms, restrooms)
- ≤ 35 dB $L_{Aeq,T}$ in spaces designed for speech e.g. seminar/lecture rooms

7.4 The following assessment considers suitable mitigation measures to be applied to the building façade such that suitable internal levels are achieved in the offices. For the purpose of the assessment, it is assumed that 'spaces designed for speech' i.e. the most noise sensitive type of space, would be located away from the noisiest façades.

7.5 This assessment is therefore based on achieving 37 dB $L_{Aeq,T}$ in areas close to the façade, which would be compatible with achieving a cumulative internal noise level of 40 dB $L_{Aeq,T}$ when combined with an assumed equal contribution of noise due to building services.

BUILDING ENVELOPE SOUND INSULATION ASSESSMENT - OFFICE

7.6 The worst affected office façades are anticipated to be those fronting High Holborn and Gray's Inn Road. Noise levels will be lower on façades facing the service yard due acoustic screening of the road by the building, and the enclosed service yard.

7.7 The attended sample noise measurements taken at positions 3 to 6 during the weekday rush hour are considered worst-case, and have been used to calculate the minimum required façade performance. The free-field levels at the office façades are shown below in Table 7-1. The measured levels at the High Holborn façade are similar to those measured at Gray's Inn Road façade, and therefore these two façades are considered as one.

Table 7-1 Equivalent Free-Field Levels at the Office Façades

Location of Façade	Free-Field Incident Noise Level	Internal Criterion
Gray's Inn Road and High Holborn (Positions 3 and 4)	68 dB $L_{Aeq,T}$	37 dB $L_{Aeq,T}$
Brooke Street (Position 5)	65 dB $L_{Aeq,T}$	37 dB $L_{Aeq,T}$
Service yard (Position 6)	55 dB $L_{Aeq,T}$	37 dB $L_{Aeq,T}$
Note Full measurement results found in Appendix C, Tables C-6 and C-7.		

7.8 The environmental noise levels at the Grays Inn Road, High Holborn and Brooke Street facades preclude the use of open windows without significantly exceeding recommended internal noise levels. Typically the internal noise levels with open windows would be around 53 – 58 dB L_{Aeq}.

7.9 Office windows on façades which face Gray's Inn Road, High Holborn and Brooke Street must provide at least 31 dB $R_w + C_{tr}$ (provided by the glazing and frame element). This can be achieved with an acoustic laminate double glazed unit. Ventilation elements required in these facades would need to be acoustically treated.

7.10 Noise levels to the rear of the building are significantly lower. The internal criteria in these offices can be achieved with a standard double glazed unit.

7.11 A further, more detailed façade assessment will be necessary during the later design stages.

8 Conclusions

8.1 WSP Acoustics has undertaken a survey of the prevailing noise climate affecting the site at 150 Holborn, which is proposed for a refurbishment and extension of the office and residential accommodation.

8.2 Continuous unattended noise measurements were undertaken over 3 days at two locations on the roof of the existing building. In addition to this, sample measurements were made at ground level at three positions surrounding the building, and another position in the service yard.

8.3 Building services environmental noise emission limits have been defined based on the background noise measurements taken on site and relevant guidance, to achieve the requirements of Camden Council.

8.4 An assessment of the proposed residential part of the development has been undertaken in accordance with national guidance, as set out in Planning Policy Guidance Note 24: Planning and Noise (PPG 24).

8.5 This has shown that noise levels across the Brooke Street façade fall into NEC C during the day, evening and night-time periods as a result of road traffic movements. All other residential façades fall into NEC B.

8.6 Accordingly, recommendations have been provided regarding the sound insulation of the building envelope elements for the residential façades to achieve suitable internal noise levels according to the guidance contained in BS 8233:1999.

8.7 A similar exercise has been undertaken for the office elements of the development, to achieve suitable internal noise levels referenced to the guidance contained in BREEAM for Offices 2008, BS 8233:1999 and CIBSE Guide A.

8.8 This report fully complies with the local planning policy in ‘Camden Development Policies: Adoption Version 1, November 2010’, with specific reference to development policy DP28: Noise and vibration.

8.9 The limitations to this report can be found in Appendix D.

APPENDIX A - ACOUSTIC TERMINOLOGY

Term	Definition
Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of 20μPa ($20x10^{-6}$ Pascals) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by $20 \log_{10} (s_1 / s_2)$. The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20μPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging of statistics are carried out.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
Free-field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Time Weighting	An averaging time used in sound level meters which may be classified as either ‘fast’ or ‘slow’.
Ambient Noise Level	The totally encompassing sound in a given situation at a given time, usually composed of a sound from many sources both distant and near ($L_{Aeq,T}$).

In order to assist the understanding of acoustic terminology and the relative change in noise, the following background information is provided.

The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale is used. The decibel scale typically ranges from 0 dB (the threshold of hearing) to over 120 dB. An indication of the range of sound levels commonly found in the environment is given in the following table.

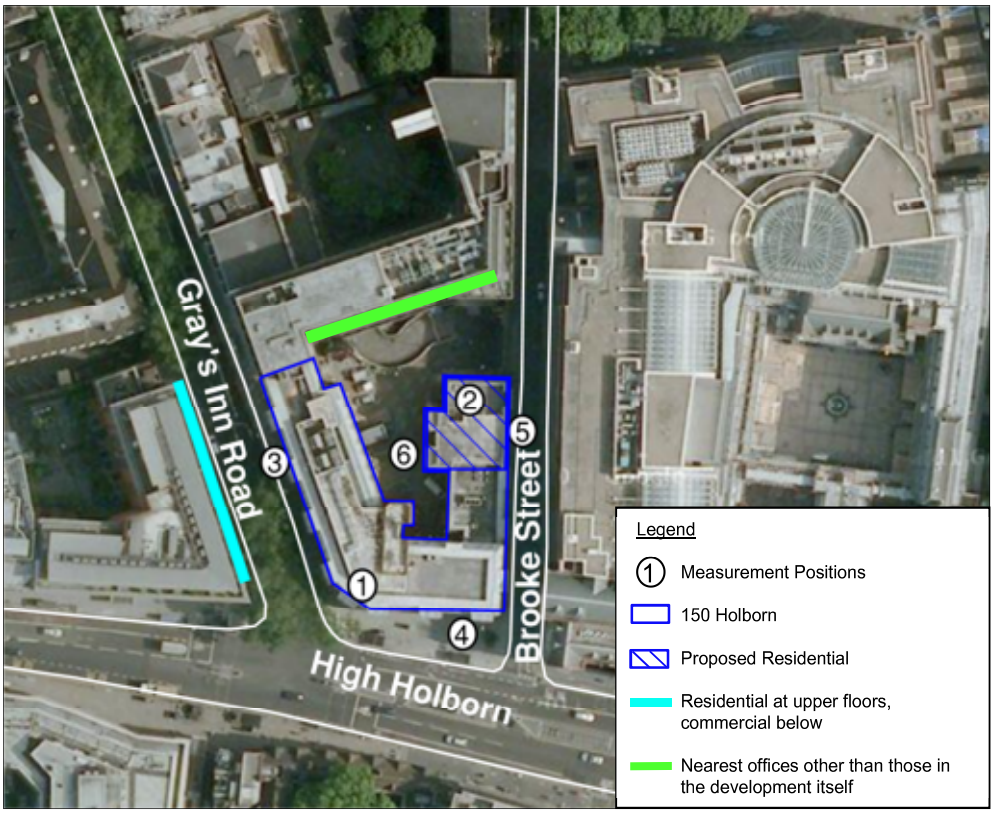
Sound Level	Description
0 dB(A)	Threshold of hearing
20 to 30 dB(A)	Quiet bedroom at night
30 to 40 dB(A)	Living room during the day
40 to 50 dB(A)	Typical office
50 to 60 dB(A)	Inside a car
60 to 70 dB(A)	Typical high street
70 to 90 dB(A)	Inside factory
100 to 110 dB(A)	Burglar alarm at 1m away
110 to 130 dB(A)	Jet aircraft on take off
140 dB(A)	Threshold of pain

The ear is less sensitive to some frequencies than to others. The A-weighting scale is used to approximate the frequency response of the ear. Levels weighted using this scale are commonly identified by the notation dB(A).

In accordance with energy addition, combining two sources with equal noise levels would result in an increase of 3 dB(A) in the noise level from a single source.

A change of 3 dB(A) is regarded as the smallest change in broadband continuous noise which the human ear can usually detect. A 2 dB(A) increase would not be perceptible. A 10 dB(A) increase in noise represents a subjective doubling of loudness.

APPENDIX B - SITE PLAN AND SURVEY PHOTOS



Position 1

At the south-east corner of 150 Holborn roof, looking north across Gray's Inn Road to the nearby residential properties at 1-23 Gray's Inn Road.

Position 2

At the north-east corner of 150 Holborn roof, looking east across Brooke Street.

APPENDIX C - RESULTS

UN-ATTENDED LONG-TERM MEASUREMENTS – EQUIVALENT CONTINUOUS NOISE LEVEL

The results of the un-attended long-term noise measurements are presented graphically at the end of Appendix C. The day, evening and night average noise levels at position 1 are presented below in Table C-1, and of position 2 in Table C-2. Differences in the battery life of the two noise logging sound level meters caused the meter at position 1 to stop logging noise data earlier than the meter at position 2.

Table C-1 Day (12 hour), evening (4 hour) and night (8 hour) average noise levels measured at the un-attended long-term noise monitoring position 1 (Equivalent Free-field)

Date	Equivalent Continuous Noise Level ($L_{Aeq,T}$)		
	Day time (07:00-19:00hrs)	Evening (19:00-23:00hrs)	Night-time (23:00-07:00hrs)
Friday 15 April	Incomplete Period	59 dB	58 dB
Saturday 16 April	59 dB	57 dB	56 dB
Sunday 17 April	Incomplete Period	No Data	No Data
Energy Average	**59 dB**	**58 dB**	**57 dB**

Table C-2 Day (16 hour), evening (4 hour) and night (8 hour) average noise levels measured at the un-attended long-term noise monitoring position 2 (Equivalent Free-field)

Date	Equivalent Continuous Noise Level ($L_{Aeq,T}$)		
	Day time (07:00-19:00hrs)	Evening (19:00-23:00hrs)	Night-time (23:00-07:00hrs)
Friday 15 April	Incomplete Period	56 dB	50 dB
Saturday 16 April	53 dB	51 dB	49 dB
Sunday 17 April	55 dB	50 dB	50 dB
Monday 18 April	56 dB	Incomplete Period	No Data
Energy Average	**55 dB**	**53 dB**	**50 dB**

UN-ATTENDED LONG-TERM MEASUREMENTS – MAXIMUM EVENT NOISE LEVELS

To allow an assessment of maximum noise levels potentially affecting bedrooms at night and offices during the day, the normal maximum event is calculated by taking the 90th percentile of the maximum noise event, based on five minute periods at night-time, and hourly periods during the day and evening. This approach allows an assessment based on the guidance provided in BS 8233:1999, and provides a reasonable level to design for removing the extreme maximum noise levels. The calculated normal maximum noise event level for each day, evening and night at position 1 is below in Table C-3, and for position 2 in Table C-4.

Table C-3 Assumed typical maximum noise event levels at position 1 (90th percentile) (Equivalent Free-field)

Date	Typical Maximum Noise Level ($L_{AFmax,T}$)		
	Day time (07:00-19:00 hrs)	Evening (19:00-23:00 hrs)	Night-time (23:00-07:00 hrs)
Friday 15 April	Incomplete Period	74 dB	72 dB
Saturday 16 April	72 dB	70 dB	70 dB
Sunday 17 April	Incomplete Period	No Data	No Data
Arithmetic Average	**72 dB**	**72 dB**	**71 dB**

Table C-4 Assumed typical maximum noise event levels at position 2 (90th percentile) (Equivalent Free-field)

Date	Maximum Noise Level ($L_{AFmax,T}$)		
	Day time (07:00-19:00 hrs)	Evening (19:00-23:00 hrs)	Night-time (23:00-07:00 hrs)
Friday 15 April	Incomplete Period	70 dB	66 dB
Saturday 16 April	70 dB	68 dB	63 dB
Sunday 17 April	73 dB	65 dB	64 dB
Monday 18 April	74 dB	Incomplete Data	No Data
Arithmetic Average	**72 dB**	**68 dB**	**64 dB**

UN-ATTENDED LONG-TERM MEASUREMENTS - LOWEST MEASURED BACKGROUND NOISE LEVELS

The lowest measured background noise levels are used for the assessment of plant noise emission limits discussed in Section 4. The lowest minimum background noise level measured at positions 1 and 2 are shown below in Table C-5, the day and night time levels represent the lowest hour period and the night time level presents the lowest 5 minute period.

Table C-5 Lowest measured background noise level at positions 1 and 2

Date	Position 1		Position 2	
	Noise Level ($L_{A90,T}$)	Date and Time of Occurrence	Noise Level ($L_{A90,T}$)	Time of Occurrence
Day time (07:00-19:00 hrs)	51 dB	17/04/2011 08:00 hrs	45 dB	17/04/2011 07:00 hrs
Evening (19:00-23:00 hrs)	52 dB	16/04/2011 21:00 hrs	43 dB	16/04/2011 22:00 hrs
Night-time (23:00-07:00 hrs)	47 dB	17/04/2011 04:25 hrs	39 dB	17/04/2011 03:10 hrs

ATTENDED SAMPLE MEASUREMENTS

The results of the attended sample measurements taken on 19 May 2011 at positions 3 to 6 are presented below in Table C-6. The normal maximum event was calculated by taking the 90th percentile of the maximum noise event, based on five minute periods.

Table C-6 Attended sample measurements at positions 3 to 6

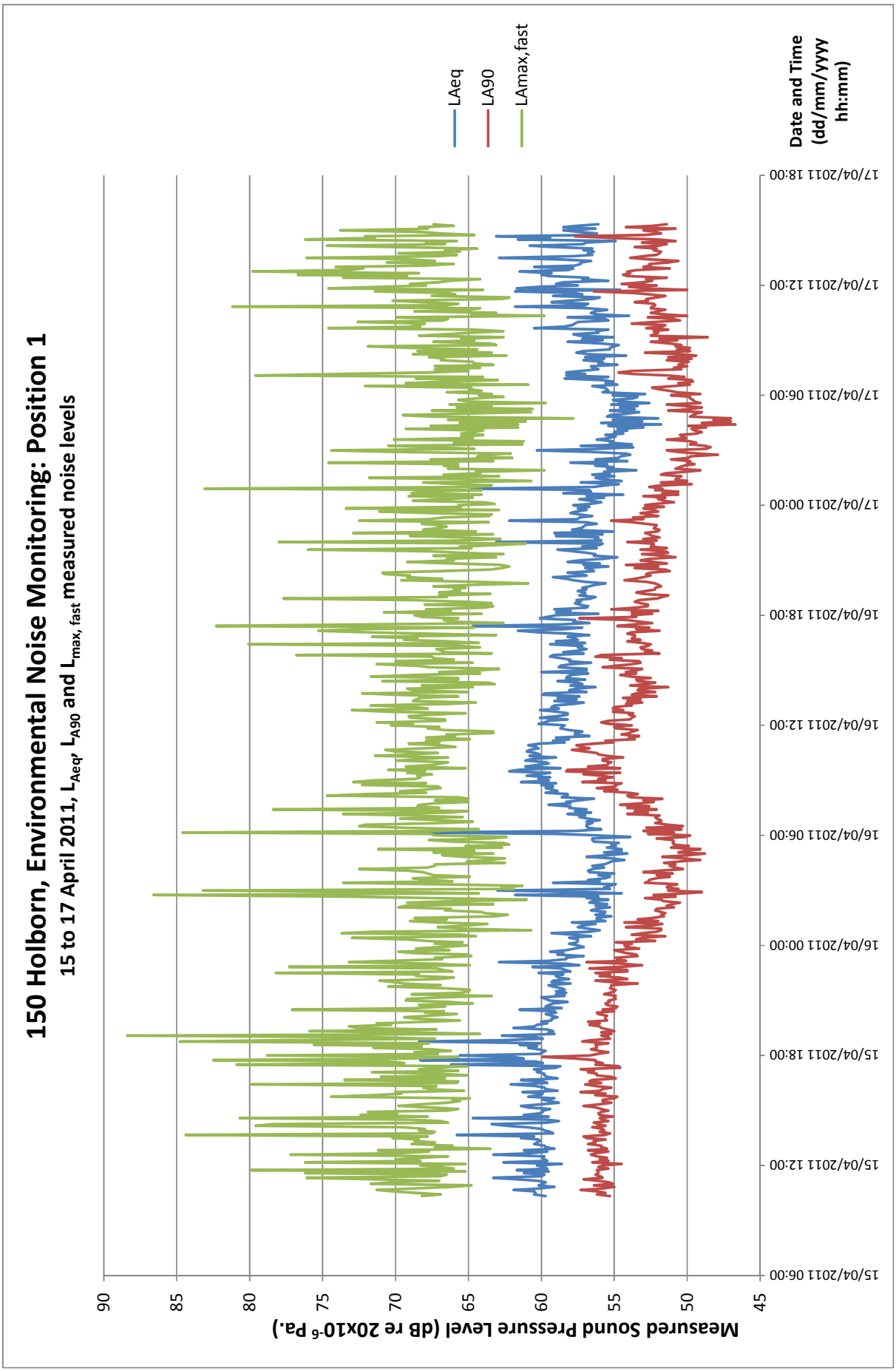
Position	Start Time (hrs:mins)	Measurement Period (hrs:mins)	Noise Level (dB)	
			$L_{Aeq,\ T}$	$L_{AF,\ max}$
3	08:00	00:10	72	83
3	09:00	00:10	71	86
4	08:15	00:10	70	87
4	09:15	00:10	70	84
5	08:30	00:10	67	87
5	09:30	00:10	71	95
6	08:45	00:10	55	74
6	09:47	00:10	56	82

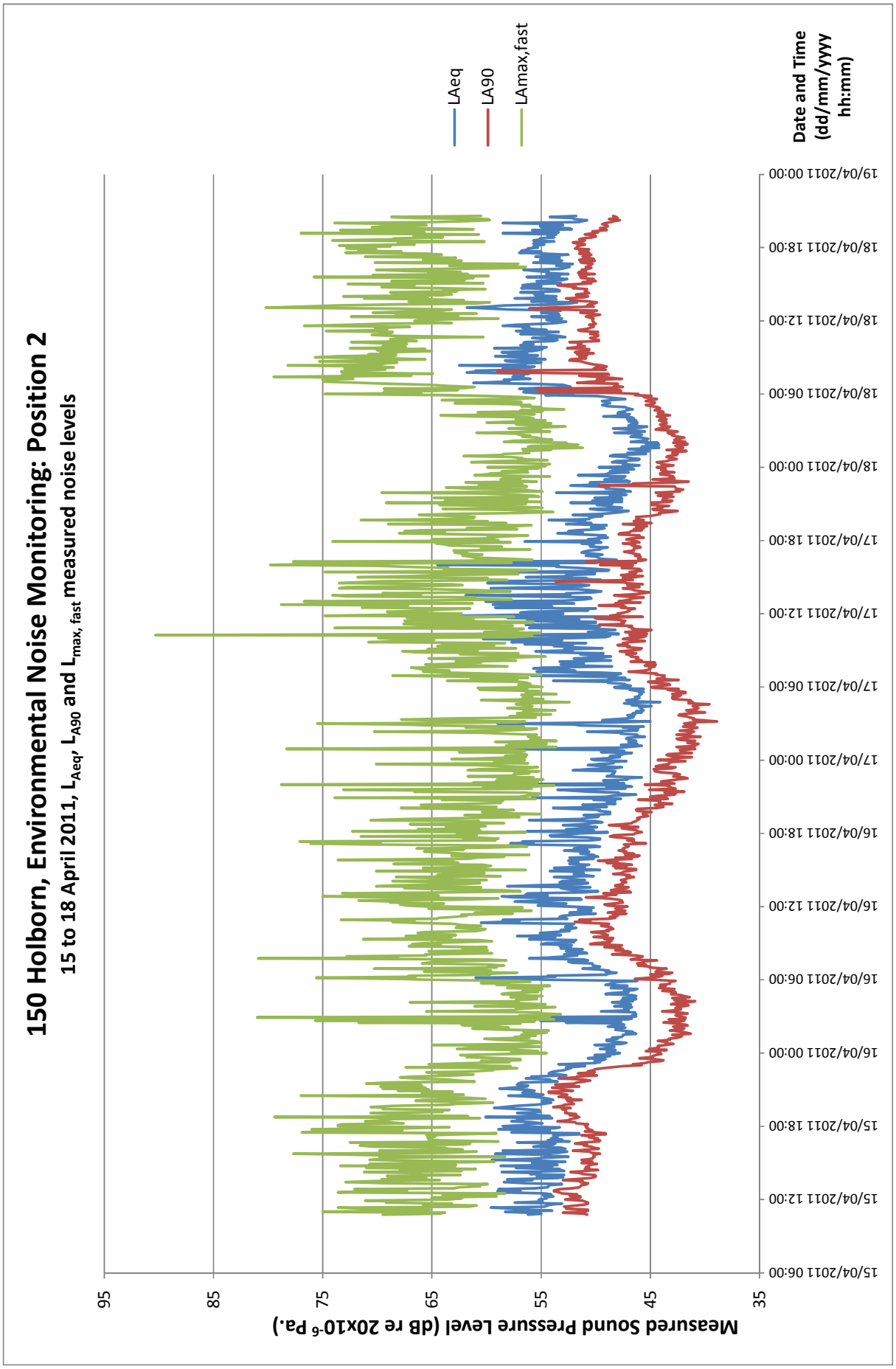
The measurement taken at position 5 at 09:30 hrs was found to be unusually high. This was due to noise from a nearby construction site. Several more attended sample measurements were taken on the early morning of 20 May 2011 at position 5; results are shown below in Table C-7. During this further measurement survey the weather was also clear and bright and would not have significantly affected the measurement results.

Representative Period	Start Time (hrs:mins)	Measurement Period (hrs:mins)	Noise Level (dB)	
			$L_{Aeq, T}$	$L_{AF, max}$
Night-time	06:10	00:50	66	87
Day time	08:30	01:00	68	90

Table C-7 Additional attended sample measurements at position 5.

UN-ATTENDED LONG-TERM NOISE MEASUREMENT RESULTS




150 Holborn, Environmental Noise Monitoring: Position 2
15 to 18 April 2011, L_{Aeq}, L_{A90} and $L_{max, fast}$ measured noise levels
LAeq
LA90
LAmax,fast
Date and Time (dd/mm/yyyy hh:mm)
19/04/2011 00:00
18/04/2011 18:00
18/04/2011 12:00
18/04/2011 06:00
18/04/2011 00:00
17/04/2011 18:00
17/04/2011 12:00
17/04/2011 06:00
17/04/2011 00:00
16/04/2011 18:00
16/04/2011 12:00
16/04/2011 06:00
16/04/2011 00:00
15/04/2011 18:00
15/04/2011 12:00
15/04/2011 06:00
95
85
75
65
55
45
35
Measured Sound Pressure Level (dB re 20x10-6 Pa.)

APPENDIX D - LIMITATIONS TO THIS REPORT

This report has been prepared for the titled project or named part thereof and should not be used in whole or part and relied upon for any other project without the written authorisation of WSP Environmental Limited. WSP Environmental Limited accept no responsibility or liability for the consequences of this document if it is used for a purpose other than that for which it was commissioned. Persons wishing to use or rely upon this report for other purposes must seek written authority to do so from the owner of this report and/ or WSP Environmental Limited and agree to indemnify WSP Environmental Limited for any and all loss or damage resulting therefrom. WSP Environmental Limited accepts no responsibility or liability for this document to any other party other than the person by whom it was commissioned.

The findings and opinions expressed are relevant to the dates of the site works and should not be relied upon to represent conditions at substantially later dates. Opinions included therein are based on information gathered during the study and from our experience. If additional information becomes available which may affect our comments, conclusions or recommendations WSP Environmental Limited reserve the right to review the information, reassess any new potential concerns and modify our opinion.