New Oxford Street Ltd

21 -31 New Oxford Street

Planning: Acoustics

RP/230602/004

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Contents

Appendices

Executive Summary

Arup has undertaken an assessment of environmental noise, groundborne noise, and vibration for the planning application for 21 -31 New Oxford Street, based upon London Borough of Camden (LBC) planning requirements. The assessment has reached the following conclusions:

Environmental noise

- Noise along High Holborn satisfies LBC's residential planning policy requirements during the day and evening subject to mitigation being provided.
- Noise along High Holborn marginally exceeds LBC's residential planning policy requirements during the night.
- However, the premise of government National Planning Policy Framework (NPPF) planning guidance is to allow local authorities to grant planning permission to developments that create a sustainable legacy for the local community. With careful acoustic design of the façade and using mechanical ventilation, British Standard BS8233 standards for intrusive environmental background noise could be achieved.
- Given the intent of the NPPF planning guidance, and that the affordable housing component will provide a sustainable legacy for the development, it could be considered appropriate to grant planning permission.
- Winter gardens have been designed to minimise environmental noise within external residential amenity space. It is likely that BS8233 standards for external amenity will be exceeded from mezzanine up to fifth floor level. However, BS8233 recognises that where residential development is required in urban areas a compromise needs to be struck between the traits of an urban setting and realistic environmental noise conditions within the external amenity.

Groundborne noise and vibration

- Residential suitability - the results from the study indicate that groundborne noise and vibration at the proposed locations of residential dwellings (from mezzanine to 7th floor) satisfies London Borough of Camden (LBC) planning requirements.
- Commercial suitability - the results from the study indicate that vibration at the proposed locations for commercial offices satisfy LBC planning requirements.

1 Introduction

This report covers the acoustics planning submission for 21-31 New Oxford Street and includes the following main topics:

- summary of the environmental noise survey
- summary of the groundborne noise and vibration survey
- Relevant London Borough Camden (LBC) planning requirements
- Assessment of the prevailing environmental and groundborne noise, and vibration climates in light of LBC's requirements

Appendix A includes a glossary of the technical terms used in this report.

2 Environmental noise

2.1 Noise survey

A long-term noise survey has been undertaken to verify the prevailing noise climate at the site. Measurements have been made at grade and at different heights up the building to determine attenuation due to distance and any screening caused by the building setback at Level 4. Attended spot measurements and long-term unattended monitoring (5-minute sampling) has been undertaken between 7/06/13 and 20/06/13.

The noise climate is dominated by traffic noise along New Oxford Street and High Holborn. During the day, intermittent noise from a construction site directly opposite the proposed site along New Oxford Street interfered with measurements on this side of the building. The evening and night-time noise data was not affected by construction noise.

Table 1 and Table 2 below list the results from the noise loggers and Table 3 a summary of results from the spot measurements. Figure 1 shows the approximate measurement locations. To avoid façade effects the logger microphones were all located at least 1m from any façade. The results are the level averaged over the prescribed / defined periods along with the range (maximum and minimum measured level) in brackets.

In dense urban environments it is common for traffic noise levels to remain relatively constant with little fluctuation throughout the day and evening. The noise climate measured along High Holborn documented in Table 1 substantiates this. To allow the data measured at Location C to inform the planning assessment, the daytime noise data has been averaged over 0700 to 0800 and 1700 to 1900 to reduce the likelihood of it being contaminated by construction noise. Data obtained at location D was at the 5th floor level and recessed from the building edge. Consequently data obtained at this location was much lower in level, and less affected by the construction activity. The measured data has therefore been included.

Logger location	Approx. height above grade	Average ambient noise level, $dBL_{Aeq,T}$		
		0700-1900	1900-2300	2300-0700
Location A (Museum Street)	22m (third floor)	62 (+2, -1)	63 (0, -1)	60 (+1, -1)
Location B (High Holborn)	9m (first floor)	69 (+1, -2)	69 (+2, -1)	67 (+1, -1)
Location C (New Oxford Street)	9m (first floor)	73[1]	72 (+1, -1)	70 (+1, 0)
Location D (New Oxford Street)	31m (fifth floor)	63 (+2, -4)	59 (+1, -1)	56 (+2, -1)
Location E (High Holborn)	31m (fifth floor)	61 (+1, -2)	60 (+2, -2)	58 (0, -1)
Location F (Eastern light well)	20m (third floor)	59 (+1, -1)	55 (0, -1)	54 (+2, -2)

Table 1: Noise survey results – ambient noise

Notes [1]
Noise data averaged over the period 0700 to 0800 and 1700 to 1900 to reduce the likelihood of the data being contaminated by construction noise.

Logger location	Approx. height above grade	Lowest background noise level, $dBL_{A90,5min}$		
		0700-1900	1900-2300	2300-0700
Location A (Museum Street)	22m (third floor)	50	52	48
Location B (High Holborn)	9m (first floor)	52	53	59
Location C (New Oxford Street)	9m (first floor)	62	63	60
Location D (New Oxford Street)	31m (fifth floor)	54	55	50
Location E (High Holborn)	31m (fifth floor)	56	55	54
Location F (Eastern light well)	20m (third floor)	53	51	49

Table 2: Noise survey results - background noise

Location	Measurement period	Average ambient noise level, $dBL_{Aeq,5min}$	Average background noise level, $dBL_{A90,5min}$	Average peak noise level, $dBL_{A10,5min}$
Location 1 (High Holborn)	1145 – 1248	69 (+2, 0)	65 (+2, -1)	72 (+3, -1)
Location 2 (Museum Street)	1126 – 1250	65 (+2, -1)	60 (+1, -1)[1]	68 (+2, -2)[1]
Location 3 (New Oxford Street)	1126 – 1159	70 (+1, -1)	64 (+1, -2)	73 (+0, -1)

Table 3: Attended daytime noise data taken at grade around the site perimeter

Notes
[1] Due to instrumentation error the measurements made at Museum Street on 7th June 2013 recorded $L_{A95,5min}$ and $L_{A05,5min}$ in place of the L_{A90} and L_{A10}. The latter have been included in the analysis.

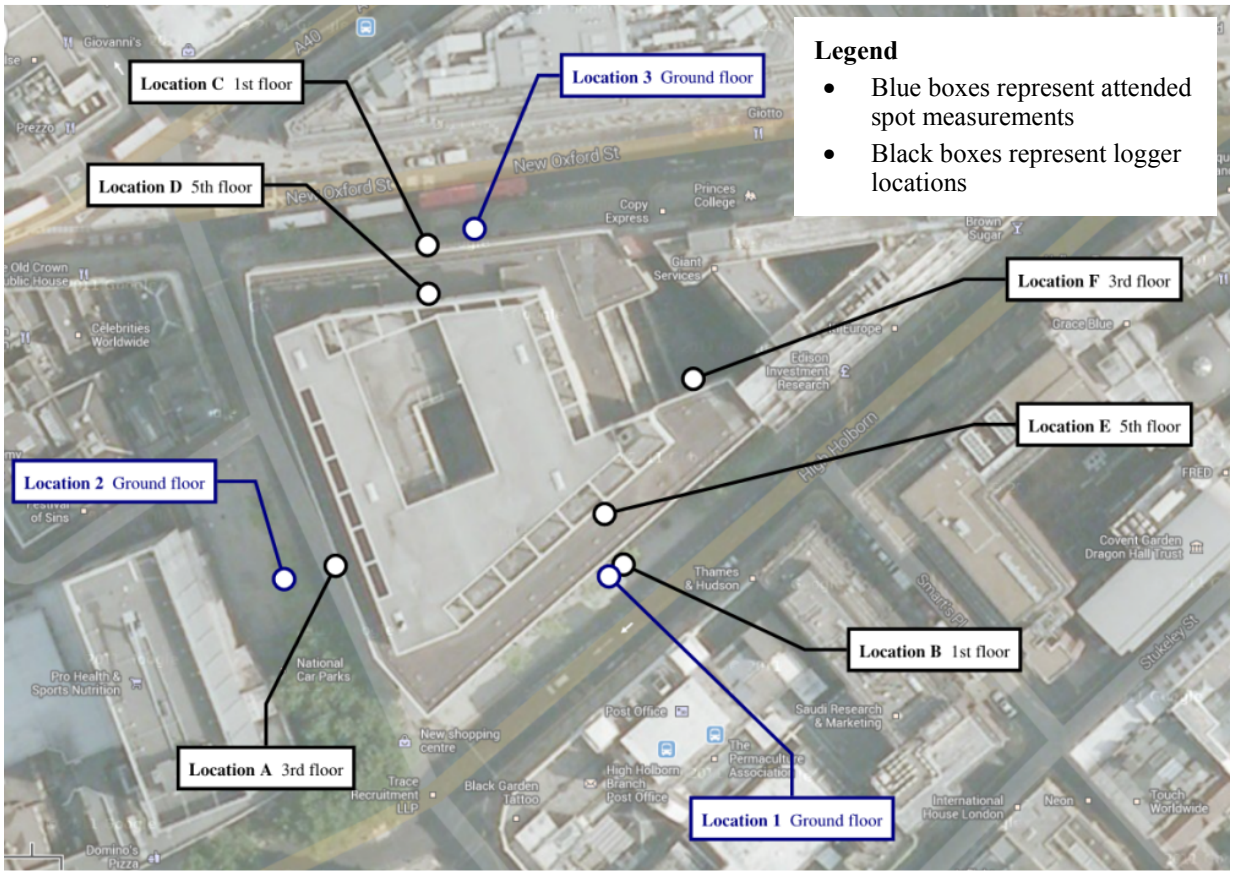

Figure 1: Noise survey locations

Appendix B includes more detail regarding the noise survey including 24-hour time histories from the logger locations.

2.2 LBC residential requirements

2.2.1 Planning

Table 4 below lists LBC's environmental noise planning requirements for sites adjacent to roads.

LBC requirements	**Permissible limit, $dBL_{eq,T}$**		
	0700-1900	**1900-2300**	**2300-0700**
Where mitigation is required	62	57	52
Where planning permission will not be granted	72	72	66

Table 4: LBC's environmental noise planning requirements for sites adjacent to roads

The results from the noise survey indicate the following:

- Noise along High Holborn satisfies the requirements for planning approval during the day and evening provided mitigation is provided.
- Noise along High Holborn exceeds the requirements for planning approval during the night.
- Noise along New Oxford Street exceeds the requirements during the day, evening and night.

2.2.2 Noise intrusion

LBC planning requirements do not include permissible limits for noise intrusion to residential dwellings or external amenity such as winter gardens. Arup spoke with the EHO from LBC to agree in principle these limits.

LBC has requested that the development target the standards provided in BS8233:2014[1] for noise intrusion within the dwellings and the winter gardens. Table 5 lists these standards.

Activity	**Location**	**Time period**	
		0700 – 2300	**2300 – 0700**
Resting	Living room[1]	35dB$L_{Aeq,\ 16hr}$	-
Dining	Dining room / area[1]	40dB$L_{Aeq,\ 16hr}$	-
Sleeping (day resting)	Bedroom[1]	35dB$L_{Aeq,\ 16hr}$	30dB$L_{Aeq,\ 16hr}$
N/a	Winter gardens[2]	55dB$L_{Aeq,16hr}$	-

Table 5: BS8233 noise intrusion limits for residential dwellings

Notes

[1] BS8233 states the following regarding relaxing internal noise levels where development is considered necessary in high noise environments:

> *"Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved."*

[2] BS8233 states the following regarding noise to external amenity space in high noise environments:

> *"…it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport*

[1] BS8233:2014 *Guidance on sound insulation and noise reduction for buildings*

network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited."

The following section considers mitigation measures for the residential dwellings.

2.2.3 Mitigation

Noise intrusion to residential dwellings

NPPF published by the government does not measure whether a site is suitable based upon prescriptive standards for noise. Instead, it was developed to allow planners to grant planning permission based upon a balanced need for sustainable development. However, it does not prevent planning departments from establishing prescriptive standards.

A key principle of NPPF is to support developments that create a sustainable legacy for the local community.

The proposed development at 21-31 New Oxford Street will bring affordable housing to a central London location in a high quality development. With an appropriately designed façade including mechanical ventilation, it will be possible to satisfy background noise levels within the dwellings in accordance with BS8233. Designing to this standard will provide dwellings that achieve national standards for noise ingress to habitable spaces.

Note – if designing to the BS8233 standards in Table 5 result in impractical constructions (such as secondary glazing or glazing that does not fit within a standard frame) the development will target the "reasonable standards" as defined in the standard.

Given the intent of the NPPF planning guidance, and that the affordable housing component will provide a sustainable legacy for the development, it can be considered appropriate to grant planning permission.

Noise intrusion to winter gardens

Winter gardens have been designed to reduce the impact of the prevailing noise climate on the external amenity. The gardens will be recessed into the building and be partially enclosed using glazing.

In light of the desire by the Greater London Authority to provide apartment block residents with external space and that the development is following the design intent of BS8233 to achieve the lowest practical levels in the gardens, this should not preclude planning permission being granted.

2.3 Building services noise

LBC planning requirements include permissible limits of noise from plant and machinery. Table 6 lists these limits and Table 7 sets out the limits that apply to sensitive facades near the development, based on the lowest measured background noise shown in Table 2.

Table 7 shows limits for Museum Street (represented by Logger A), High Holborn (represented by Logger B and E), New Oxford Street (represented by Logger C and D) and in the eastern light well (represented by Logger F). Where sensitive receivers are represented by two logger locations the limit is determined by the lower measurement.

Noise description and location of measurement	**Period**	**Time**	**Noise level**
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000 - 2400	5dB(A) < L_{A90}
Noise that has a distinguishable continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade			10dB(A) < L_{A90}
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade			10dB(A) < L_{A90}
Noise at 1 metre external to a sensitive façade where L_{A90} > 60dB			55dBL_{Aeq}

Table 6: LBC permissible limits of noise from plant and machinery

Sensitive façade location	**Building services noise emission limit at 1m external to sensitive façade, dB$L_{Ar, Tr}$**			
	Type	**0700-1900**	**1900-2300**	**2300-0700**
Museum Street	Noise from plant	45	47	43
	Noise from plant that has a distinguishable continuous note or distinct impulses	40	42	38
High Holborn	Noise from plant	47	48	49
	Noise from plant that has a distinguishable continuous note or distinct impulses	42	43	44
New Oxford Street	Noise from plant	49	50	45
	Noise that from plant has a distinguishable continuous note or distinct impulses	44	45	40
Eastern light well	Noise from plant	48	46	44
	Noise from plant that has a distinguishable continuous note or distinct impulses	43	41	39

Table 7: Limits of noise from plant at sensitive receivers near to the site

3 Groundborne noise

3.1 Vibration survey

Arup visited the site on 12 and 18 July 2013 to undertake vibration measurements in the existing building. Measurements were taken on the basement, ground, first, second, and third floor slabs. Measurements were taken at approximately the same location on each floor. Figure 2 shows a typical measurement location plan and Table 8 lists a selection of results.

Location	Predicted groundborne noise level, $dBL_{Amax, S}$	Vibration dose value (VDV), $ms^{-1.75}$
Basement, Loc A	50	0.006
Basement, Loc B	47	0.006
Basement, Loc C	30	0.001
Basement, Loc D	36	0.001
Ground Floor Loc A	48	0.009
Ground Floor Loc B	37	0.007
Ground Floor Loc C	34	0.005
Ground Floor Loc D	35	0.004
1st floor Loc A	45	0.010
2nd floor Loc A	43	0.017
Second floor mezzanine	33	0.003
Third Floor Loc A	33	0.014

Table 8: Groundborne noise and vibration results

Note: the tabulated groundborne noise results are predictions of noise in a sample fitted-out room based upon the data from the field measurements, calculation methodology included in the Transportation Noise Reference Book[2], and our experience of similar projects. The levels are the mean plus one standard deviation. The tolerance of the predicted groundborne noise levels is approximately ±3dB. The vibration dose values are also the mean plus one standard deviation, are calculated from the raw survey data, and represent the amplitudes in the existing structure.

The groundborne noise results listed above have been quantified using slow time weighting. This is identified in the parameter by the letter S. Acoustic signals can either be measured with a fast or slow time weighting. Different weightings are used based upon the type of noise being measured / quantified. A noise that is transient in nature, such as a horn or car alarm, would be measured using fast weighting to ensure the event is captured. A noise that is deterministic / periodic, such as a train pass-by, would be measured using a slow time weighting.

[2] Nelson, P. M., *Transportation Noise Reference Book*, Butterworth & Co Ltd., 1987

Figure 2: Groundborne noise measurement locations

3.2 LBC groundborne noise and vibration planning requirements

LBC planning requirements include permissible limits for both groundborne noise and vibration (i.e. movement) in residential dwellings. A vibration limit is also provided for commercial office buildings. Table 9 below lists the vibration limits that apply to the development.

Location	Period	Time	Permissible vibration limit, $ms^{-1.75}$
Residential – day	Day and evening	0700 - 2300	0.2 to 0.4
Residential - night	Night	2300 - 0700	0.13
Office	Day, evening and night	0000 - 2400	0.4

Table 9: London Borough Camden planning department permissible vibration limits

The permissible groundborne noise limit for residential dwellings is 35dBL_{Amax} (Fast or Slow time weighting not stipulated).

LBC does not provide groundborne noise limits for commercial offices or retail uses, or vibration limits for retail use.

3.3 Discussions

3.3.1 Commercial and residential uses

In light of LBC's planning requirements, the results from the groundborne noise and vibration survey indicate the following:

- Commercial suitability - the results from the study indicate that vibration at the proposed locations for commercial offices satisfy LBC planning requirements.
- Residential suitability - the results from the study indicate that groundborne noise and vibration at the proposed locations of residential dwellings (from mezzanine to 7th floor) satisfies London Borough of Camden (LBC) planning requirements.

4 Conclusions

Arup has undertaken environmental noise and vibration surveys at 21-31 New Oxford Street. An assessment of the results from the surveys has been undertaken in light of London Borough of Camden's planning requirements. The assessment indicates that it is considered appropriate to grant planning permission in the presence of the prevailing noise and vibration climate in light of relevant UK planning guidance and British Standards.

Appendix A

Glossary

dBA

The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dBA. An A-weighting network can be built into a sound level measuring instrument such that sound levels in dBA can be read directly from a meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. It is worth noting that an increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise, and a change of 2 to 3 dB is subjectively barely perceptible.

Equivalent continuous sound level

Another index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq}. This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

Frequency

The rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the Hertz (Hz), which is identical to cycles per second. A thousand hertz is often denoted kHz, eg 2 kHz = 2000 Hz. Human hearing ranges approximately from 20 Hz to 20 kHz. For design purposes, the octave bands between 63 Hz to 8 kHz are generally used. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For more detailed analysis, each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.

Maximum noise levels

The maximum noise level identified during a measurement period. Experimented data has shown that the human ear does not generally register the full loudness of transient sound events of less than 125 ms. Fast time weighting has an exponential time constant of 125 ms which reflects the ear's response. The maximum level measured with fast time weighting is denoted as $L_{AMax, f}$. Slow time weighting (S) with an exponential time constant of 1s is used to allow more accurate estimation of the average sound level on a visual display.

Impulse (I) time weighting has a fast rise (35 ms) and a slow decay and is intended to mimic the ear's response to impulsive sounds.

Statistical noise levels

For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index which allows for this variation. The L_{10}, the level exceeded for ten per cent of the time period under consideration, has been adopted in this country for the assessment of road traffic noise. The L_{90}, the level exceeded for ninety per cent of the time, has been adopted to represent the background noise level. The L_1, the level exceeded for one per cent of the time, is representative of the maximum levels recorded during the sample period. A weighted statistical noise levels are denoted L_{A10}, dBL_{A90} etc. The reference time period (T) is normally included, eg $dBL_{A10,\ 5min}$ or $dBL_{A90,\ 8hr}$.

Structureborne noise

The transmission of noise energy as vibration of building elements. The energy may then be re-radiated as airborne noise. Structureborne noise is controlled by structural discontinuities, ie expansion joints and floating floors.

Vibration Dose Values (VDV)

This is a complex metric that has been identified as being the best objective measure of human disturbance from intermittent/transient vibration. The VDV is the fourth root of the time integral of the fourth power of the weighted acceleration. VDV are measured in units of $m/s^{1.75}$. The frequency weightings are defined in BS 6472: 1992 and in BS 6841: 1987.

The VDV doubles in magnitude with a doubling of vibration amplitude. However, a 16 fold increase in the duration of exposure to the vibration is required to double the VDV (without any change in amplitude).

Typical noise levels

Some typical noise levels are given below:

Noise level dB(A)	Example
130	Threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside disco
90	Heavy lorries at 5 m
80	Kerbside of busy street
70	Loud radio (in typical domestic room)
60	Office or restaurant
50	Domestic fan heater at 1m

Noise level dB(A)	Example
40	Living room
30	Theatre
20	Remote countryside on still night
10	Sound insulated test chamber
0	Threshold of hearing

Appendix B

Noise survey

B1 Dates, times and personnel

Ed Elbourne and Jay Reilly of Arup made attended noise measurements between:

- 11:50 and 13:00 on Friday 7th June 2013,
- 11:20 and 12:10 on Tuesday 11th June 2013, and
- 19:00 and 19:40 on Thursday 13th June 2013.

They also installed noise logging equipment around the façade. These measured between 7th June 2013 and 20th June 2013, as described in Section 2.1.

During the measurements the weather was generally dry with a low wind speed.

Measurement locations are shown in Figure 1 in Section 2.1

B1.1 Equipment and procedures

For all measurement locations, statistical levels were recorded, storing L_{Aeq}, L_{A10}, L_{A90} and $L_{Amax,f}$ indices. Attended measurements made on Museum Street on 7th June stored L_{A05} and L_{A95} indices instead of L_{A10} and L_{A95}. Octave band frequency spectra were also recorded.

Measurements were made over 5 minute intervals.

For all attended measurements, the microphone was located approximately 1.2m – 1.5m above the ground. Measurements at Location 1 (High Holborn) and Location 2 (Museum Street) were free field, being more than 3m from any vertical noise reflecting surface. Measurements at Location 3 (New Oxford Street) were approximately 1m from the building wall.

Table 10 details the equipment used for measurements. The sound level meters and microphones are Type 1 conforming to BS 61672-1:2003. The survey staff carried out a check of the calibration of the sound level meter and microphone before and after use, to confirm that there was no significant drift in meter response at the calibrator frequency and level. This verification indicated that there was no more than a 0.1dB variation between checks.

Each SLM kit used by Arup has a full traceable calibration carried out in a UKAS accredited laboratory on an annual basis. All measurements were made with a fast (0.125s) time constant.

Manufacturer	Type number	Description	Arup reference	Serial number
Brüel & Kjær	2260	Investigator	Kit A	1772228
	4189	½" Polarised Microphone		2620934
	4231	Sound Pressure Level Calibrator		2094627
Brüel & Kjær	2260	Investigator	Kit H	2370442
	4189	½" Polarised Microphone		1903808
	4231	Sound Pressure Level Calibrator		2402714

Manufacturer	Type number	Description	Arup reference	Serial number
Norsonic	Nor140	Sound Level Meter	Kit D	1405203
	1251	Sound Pressure Level Calibrator		33555
	1225	½" Microphone		151246
	1209	Preamplifier		15390
Rion	NL52	Sound Level Meter	Kit A	00120480
	UC-59	½" Microphone		03152
	NH-25	Preamplifier		10479
	NC-74	Sound Pressure Level Calibrator		35015346
Rion	NL52	Sound Level Meter	Kit B	00620958
	UC-59	½" Microphone		03876
	NH-25	Preamplifier		20999
	NC-74	Sound Pressure Level Calibrator		35015347

Table 10: Measurement equipment

4.1 Results

Tabulated below are results from the attended spot measurements.

Date	Start Time	$L_{Aeq,5min}$	$L_{Afmax,5min}$	$L_{A10,5min}$	$L_{A90,5min}$
07/06/2013	11:54	71	87	75	65
	12:05	69	85	72	65
	12:48	69	92	71	65
11/06/2013	11:36	69	79	71	64
	11:45	69	76	72	64
	12:01	69	79	71	67

Table 11: Results at Location 1 (High Holborn)

Date	Start Time	$L_{Aeq,5min}$	$L_{Afmax,5min}$	$L_{A10,5min}$	$L_{A90,5min}$
07/06/2013	11:54	65	81	69*	60*
	12:07	64	75	68*	60*
	12:50	64	80	66*	59*
11/06/2013	11:26	66	76	69	61
	11:42	65	77	68	60
	11:53	66	77	69	60
	12:04	67	78	70	61

Table 12: Results at Location 2 (Museum Street). Results marked with an asterix are L_{A05} and L_{A95}

Date	Start Time	$L_{Aeq,5min}$	$L_{AFmax,5min}$	$L_{A10,5min}$	$L_{A90,5min}$
11/06/2013	11:26	69	86	72	62
	11:34	70	81	73	63
	11:50	70	83	73	65
	11:59	71	83	73	65
13/06/2013	19:03	67	82	70	60
	19:12	68	87	69	59
	19:17	67	85	70	58
	19:23	68	79	71	61
	19:29	67	84	69	59

Table 13: Measurement results at Location 3 (New Oxford Street)

The following graphs are 24-hour time-histories from the noise loggers.

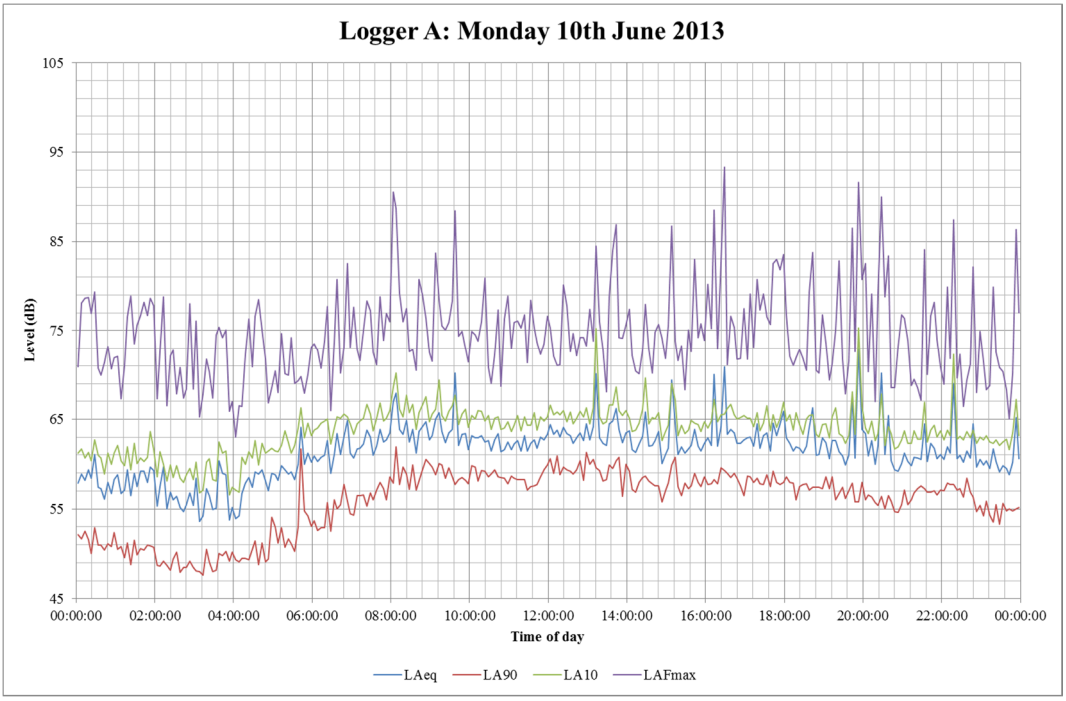

Figure 3: Typical 24-hour profile for Logger A (Museum Street 3F)

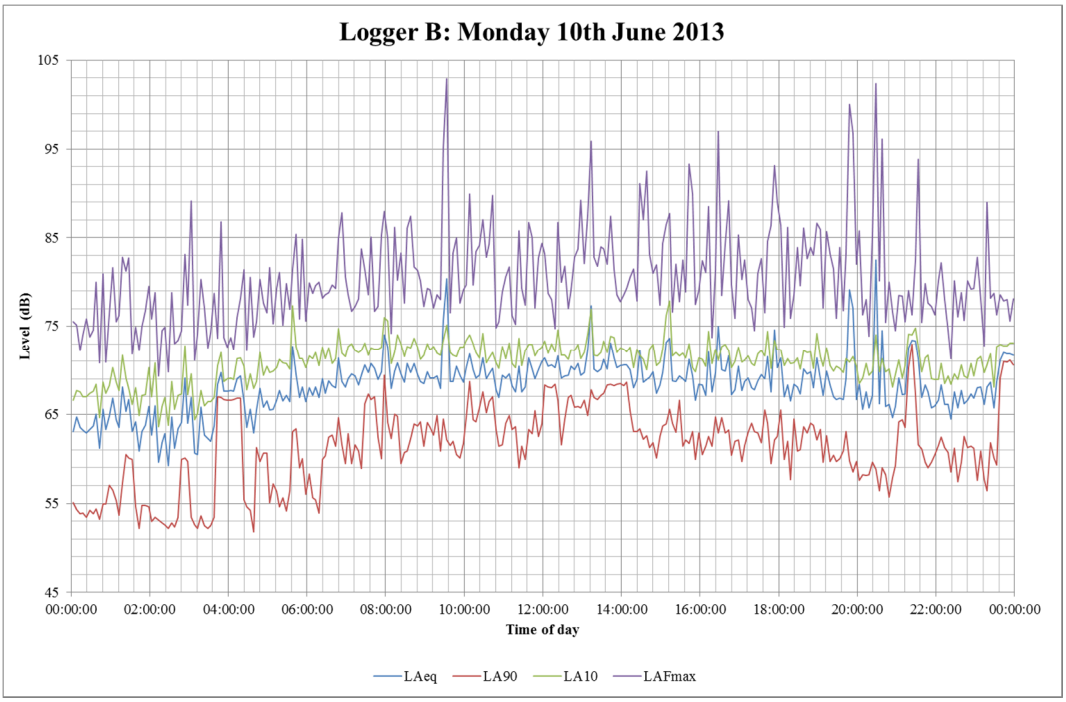

Figure 4: Typical 24-hour profile for Logger B (High Holborn 1F)

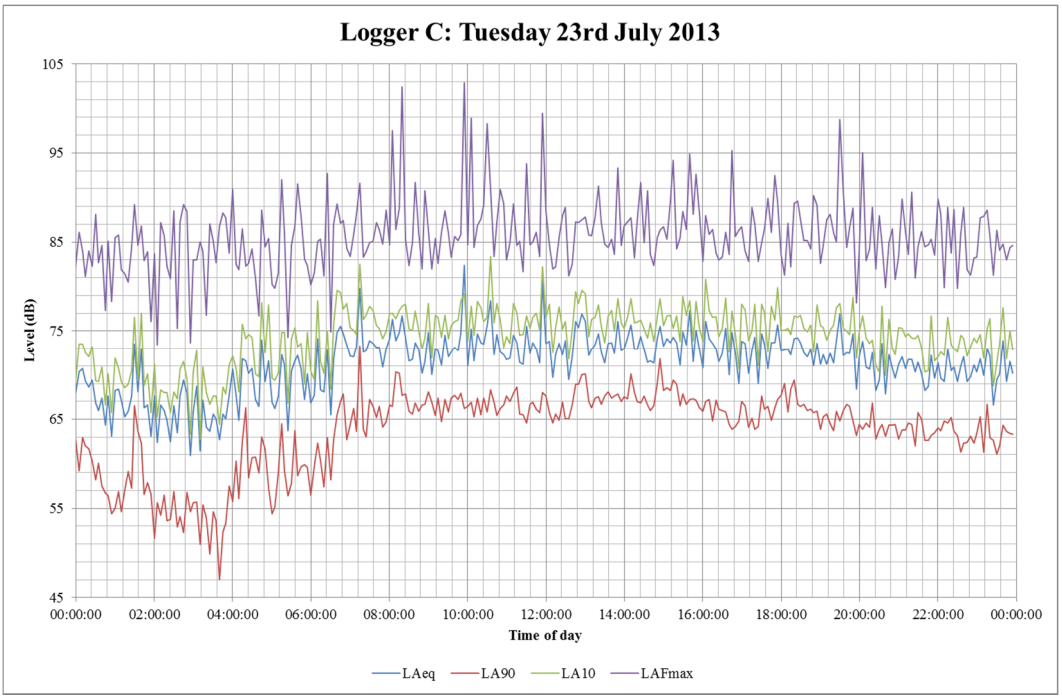

Figure 5: Typical 24-hour profile for Logger C (New Oxford Street 1F)

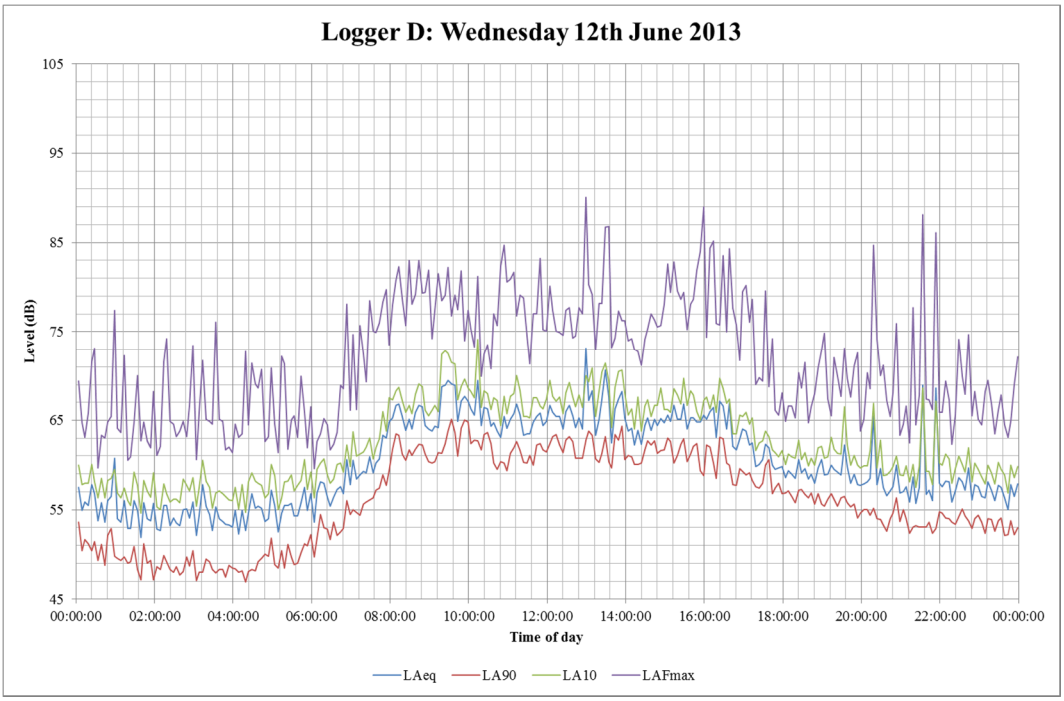

Figure 6: Typical 24-hour profile for Logger D (New Oxford Street 5F)

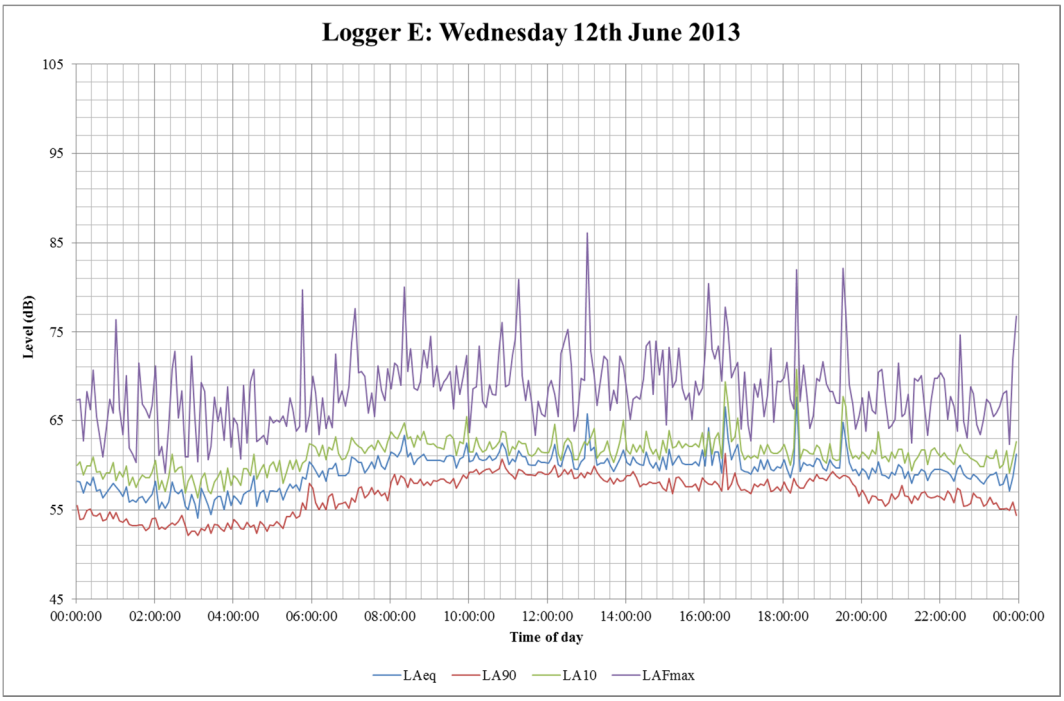

Figure 7: Typical 24-hour profile for Logger E (High Holborn 5F)

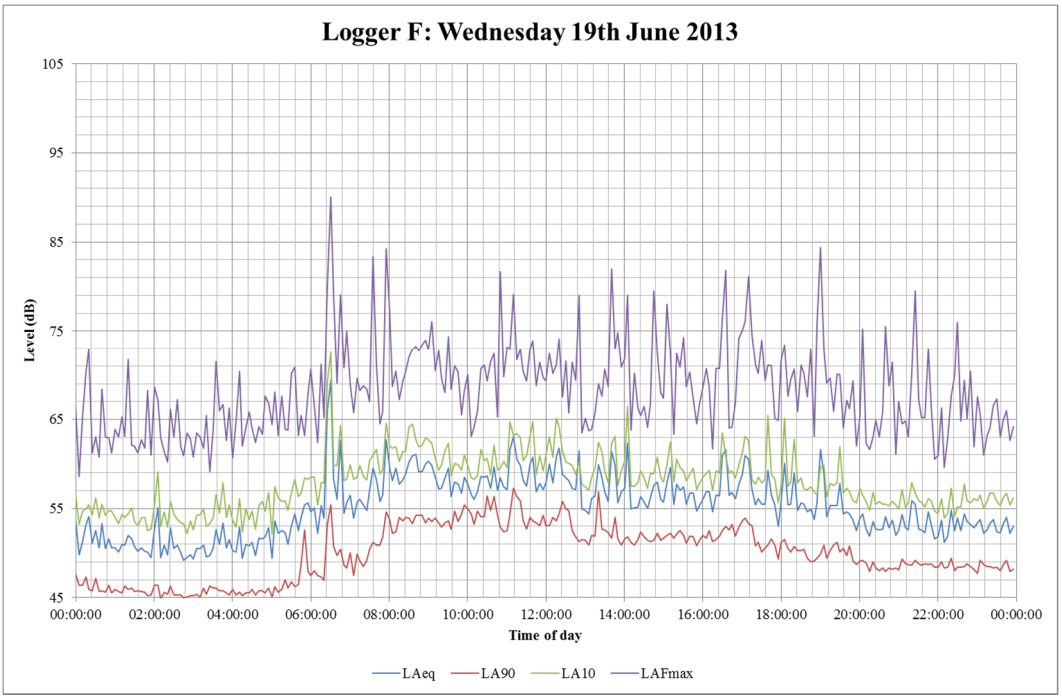

Figure 8: Typical 24 hour profile for Logger F (Eastern light well 3F)