Raag St Pancras Ltd
Proposed Hotel and Residential Development
Britannia Street
Kings Cross
London

Local Authority Planning Requirements: Environmental Noise Survey

prepared for

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Proposed Tune Hotel and Housing, Britannia Street
Acoustic Survey and Design Report

Summary
A 24 hour noise survey has been carried out on the site of the proposed development. Between the hours of 06.00 and 24.00 there are movements of Underground trains on the tracks adjacent to the site at a frequency of about one per minute, creating noise levels of about 65dBA close to ground level and about 75dBA at more elevated positions. Noise levels are much lower when the Underground closes down for the night, from about 00.45 to 05.30.

The housing section of the proposed development will be more affected by railway noise than the hotel, and the proposed environmental control strategy for the housing is to provide ventilation by a near-silent fan system. This will be under the control of occupiers who will have the option to override the system and open the windows instead.

The hotel elevations will be screened from the railway noise by intervening structures, and ventilation by means of trickle vents will be employed.

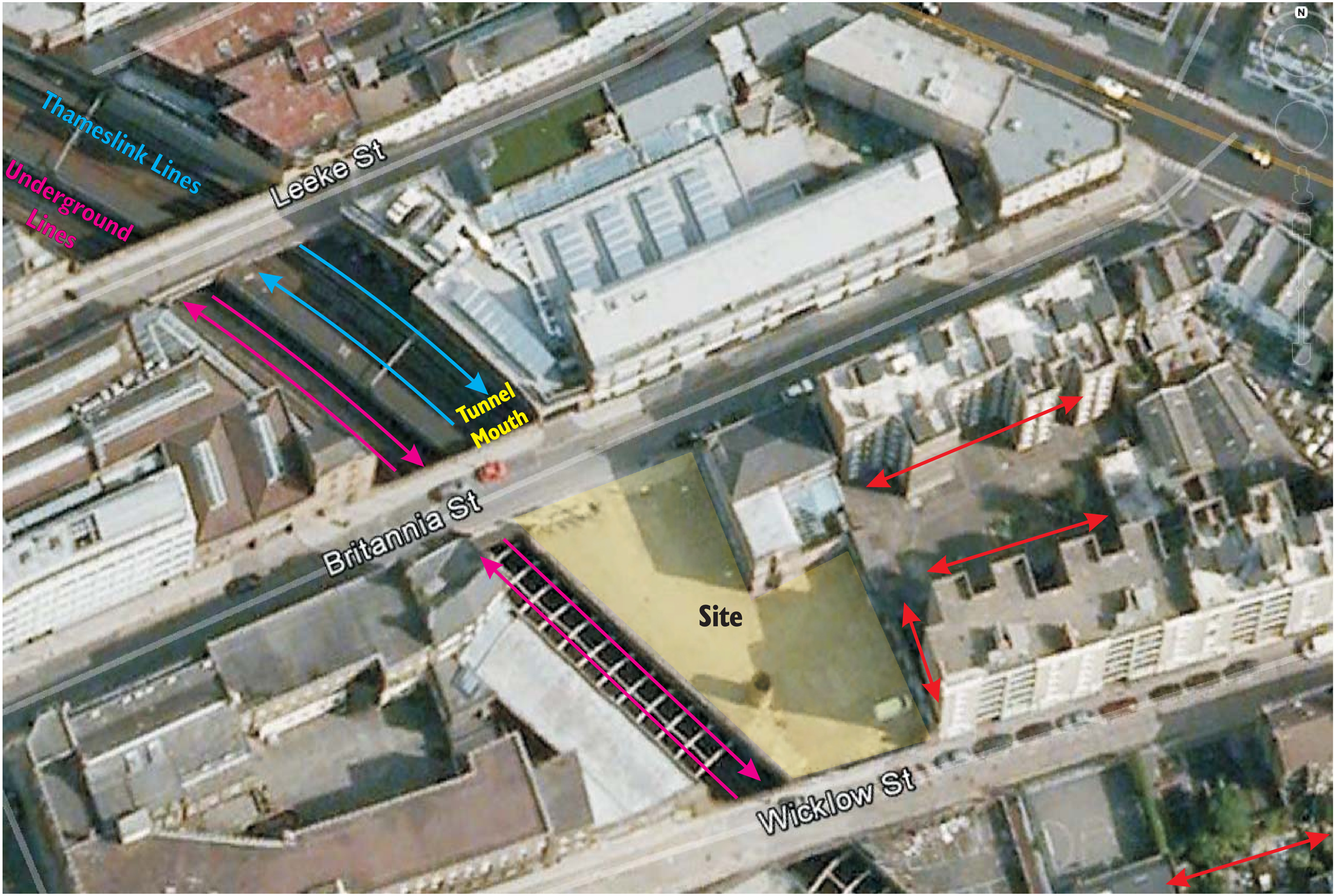
The lowest ambient noise levels measured on the site were L_{AF90} 42.5dBA. To protect noise sensitive elevations on neighbouring properties and in the new development itself, the cumulative level of fixed services noise emitted from the new development will not exceed L_{AF90} 32.5dBA at any noise sensitive elevation.

1 Introduction
This report describes the ambient noise background of the site for the proposed mixed development at Britannia Street, and proposes a design strategy which would provide a suitable acoustic environment for occupiers of the site, and protect the occupiers of nearby premises from potential sources of noise disturbance arising from activities associated with the proposed development.

2 Methodology
A fully-observed 24 hour noise survey was carried out on and around the site. Day-time and night-time surveys were carried out on successive weekdays, and an additional survey was carried on a Sunday to provide information on quieter conditions which had been anticipated at weekends.

3 General Description of the Site
The proposed development incorporates housing and hotel accommodation on the site of an existing open-air car park.

The site and surrounding area are shown in the annotated aerial view on page 2.



The Site and Surrounding Area

Noise Sensitive Facades

4 Summary of Design Proposals for the Site

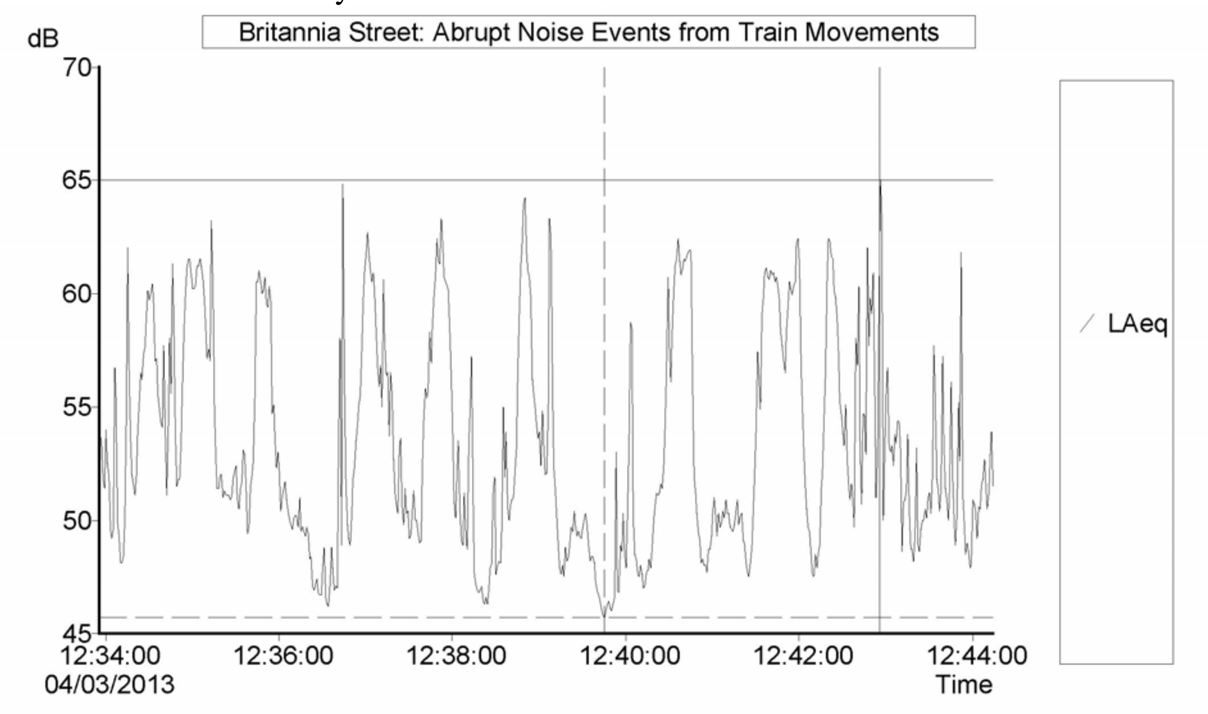
The section below shows the proposed layout of the site incorporating the two components, housing and hotel accommodation.

5 Summary of Main Findings and Design Proposals

The detailed results of the noise survey are shown in section 7 (page 13). This section presents the main findings and puts them in the context of the design proposals for the site.

5.1 Ambient Background Levels Around the Site

The character of the noise environment of the site can be summarised very simply; a reasonably quiet and neutral background level, punctuated abruptly by nearby train movements approximately every minute. There is a quiet period from about 12.30am to 5.30am, at which time train services resume. This pattern prevails throughout the week, with just a slightly reduced service on Sundays.



Noise Profile Over 10 Minute Period

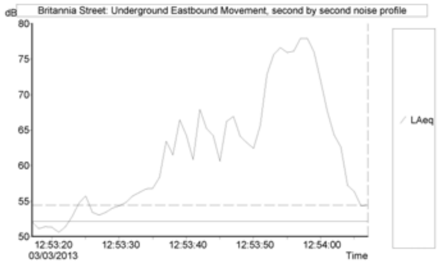
5.1.1 Railway Noise

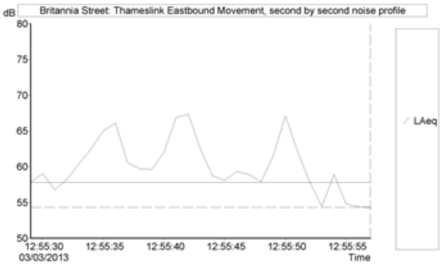
The main noise impact on the site is created by railway movements on two separate sets of tracks. A pair of London Underground tracks lies immediately beyond the south-east boundary of the site in an open cutting with a depth of approximately 7m. Running approximately parallel to the Underground tracks, and at the same level, is a pair of Thameslink tracks which pass directly under the site in a cut and cover tunnel.

Thameslink Tunnel Opening Under Site

Circle Line Train in Cutting: site railings to the left

The subjective noise impact from the Underground lines is greater than that of the Thameslink lines, mainly for the obvious reason that the cutting is open-topped, giving the noise a more open pathway to the site. There is however another significant factor which makes Thameslink movements less intrusive; the tracks appear to be continuously welded and do not create the type of clattering noise which arises from the segmented Underground tracks. The two detailed noise profile traces below, which are to the same vertical scale, show a clear difference in the noise impact of the two sets of lines.





During the day there are frequent movements on the Underground lines; the pair of lines carry services on a number of different routes, with intervals between movements often less than 60 seconds. The interval between services increases significantly during the late evening, and scheduled services stop shortly before 1am, resuming again at around 5am. A small number of train movements continues during the night-time hours. The sound levels created are usually significantly lower than those which occur during the day - visibility of the tracks is almost zero, but it is believed that the sound levels may be lower because some movements are not of complete trains, and also because rolling stock is much lighter because it is running empty.

As well as generating lower noise levels, the frequency of movements is significantly lower on the Thameslink lines, and the potential for disturbance is accordingly much less.

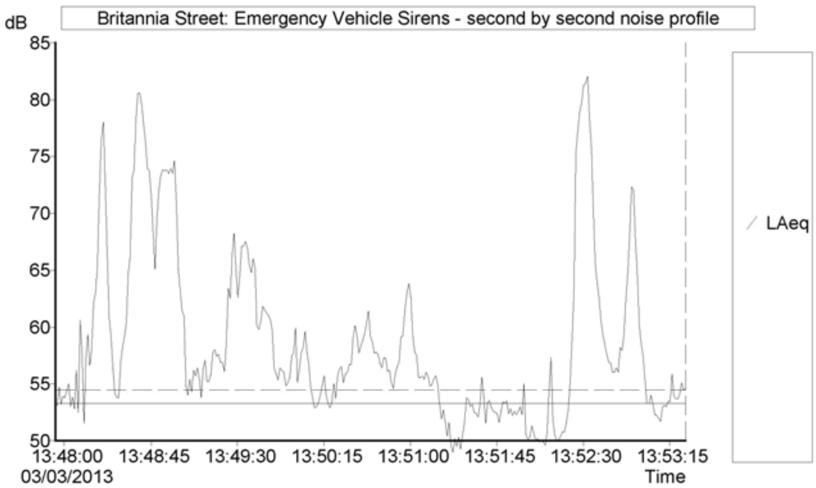
5.1.2 Road Traffic Noise

The roads in the immediate vicinity of the site carry only small amounts of traffic, most of it light. There are occasional movements by heavier vehicles, sometimes with a more protracted noise impact, for example refuse and recycling collections. At the time of the survey there was occasional noise from vehicles associated with construction activities in the large courtyard area to the west of the site, across the Underground cutting.

There are several roads at a somewhat greater distance from the site which carry heavier traffic flows, notably those which form a clockwise one way ring road system. These roads, and the wider general urban background, create a diffuse and distant noise background which does not appear to fall below 40dBA on the site.

One Way Road System Wrapping Round the Site

The most intrusive traffic-related noises affecting the site are emergency sirens, almost invariably from vehicles on the one-way system. Some emergency vehicles travel most or all of the way around the route, and may create a noise event lasting several minutes, as the following noise profile trace shows:



There is nosatisfactory way in which the sound of emergency sirens can be rendered inaudible inside residential buildings; an overriding need for audibility is inherent in the design of the sound emitters.

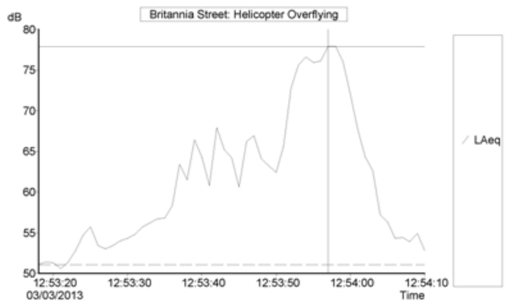
5.1.3 Aircraft Noise

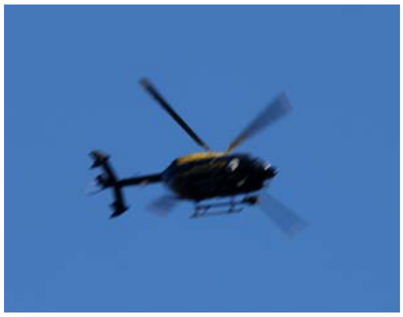
There is relatively little disturbance on the site from fixed wing aircraft, and what disturbance there is depends on prevailing wind conditions. At times of westerly wind there is occasional overflying by aircraft apparently on approach to Heathrow, but noise levels were not observed to rise much above the urban background affecting the site.

At times of easterly wind the site is affected by somewhat higher noise levels arising from aircraft on approach to London City Airport:

Easterly movements account for only about 20% of landings at London City Airport, but when they do occur there could be upwards of 30 landings per hour at peak times, and some degree of noise disturbance should be anticipated. There are no night flights at the airport and only limited activity at weekends.

Helicopter movements are much less predictable than fixed wing movements, and the noise levels can be significantly higher:



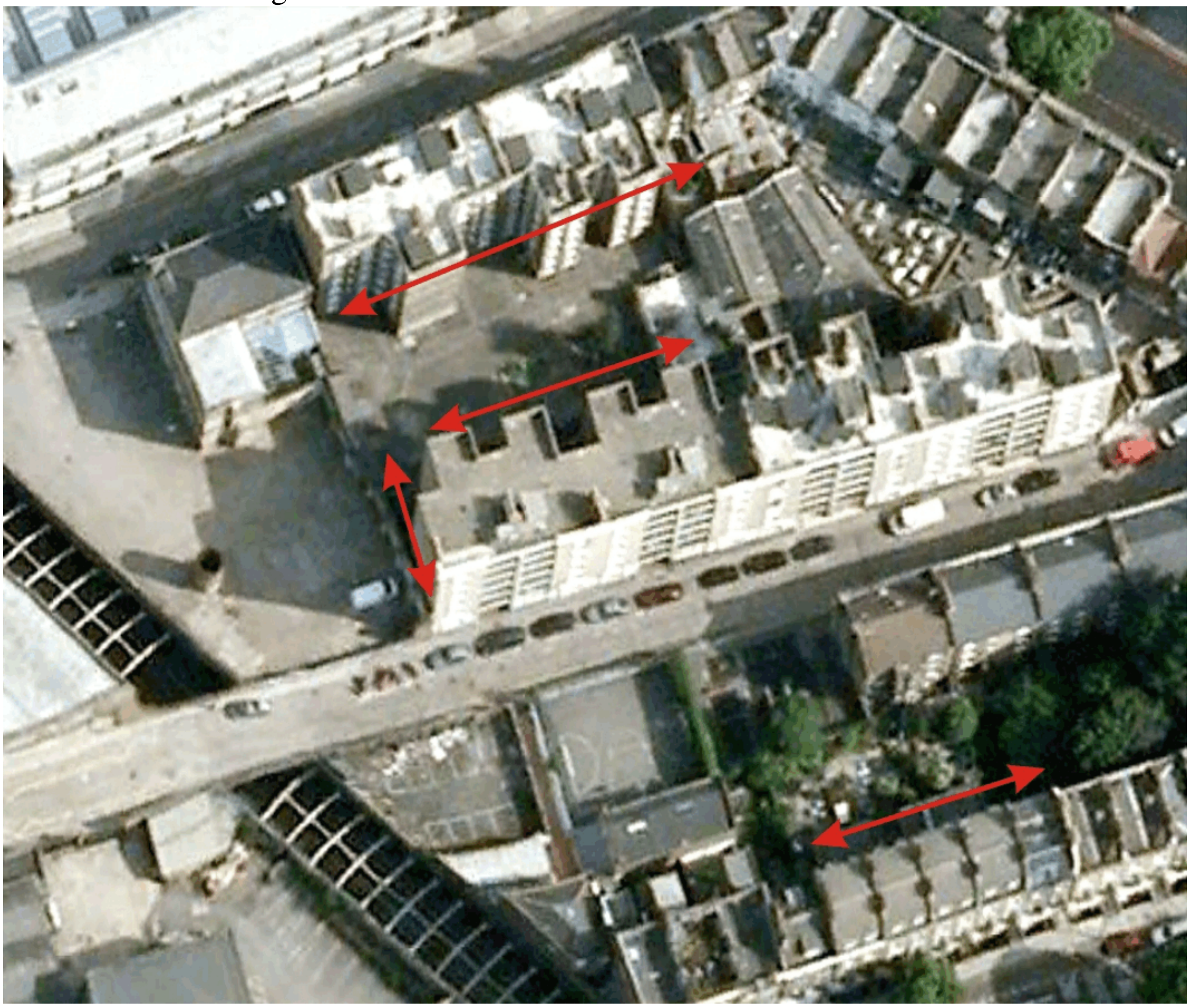


As a result of the intrusive pulsating nature of the sound, the perceived noise of helicopter movements is even higher than the measured sound levels would suggest, and significant noise disturbance should be anticipated when helicopter movements occur. The frequency of direct overflying is, however, likely to be relatively low; routine helicopter movements are not allowed in the area and only emergency and strategic flights are to be expected.

5.2 Acoustic Control Strategy Proposed for the Development

5.2.1 Limitations on Noise Emissions from Fixed Plant

The hotel development will have fixed plant installations to provide servicing to the bedrooms and public spaces. Existing night-time minimum noise levels have been measured in order to provide reference levels for the design of noise attenuation systems to protect nearby noise sensitive locations from disturbance, in accordance with good practice and the requirements likely to be imposed by the local authority. The existing facades identified as noise sensitive are shown in the image below:



Noise sensitive Facades of Nearby Residential Properties

It is recognised that the same protection must be provided for noise sensitive locations within the site - in this case hotel bedrooms and habitable rooms within the housing development, as for those associated with neighbouring properties.

It is expected that the local authority's requirements for protection of noise sensitive locations will be related to the existing ambient background noise level, L_{AF90}. The lowest value of L_{AF90} recorded was 42.5dBA, measured at three different times during the night. For the purposes of compliance, the services installation will be designed such that the sound level at any noise sensitive facade, including habitable rooms in the new development, will not exceed a level of 32.5dBA. This margin of 10dBA below the ambient L_{AF90} will ensure that services noise from the development will be inaudible at a position 1m away from any residential facade.

5.2.2 Control of Noise from Fixed Plant Installed in the Buildings

At the current stage of design it is not possible to specify the precise details of the services installation, but the strategy to be adopted for environmental control is given below.

Environmental control of the hotel section of the development will be provided by two major items of installed plant; air-source heat pumps and air handlers. There will, in addition, be provision for an ambient energy installation. Details of that installation will be subject to discussions with the local authority, but the same limitations on noise emissions will be applied to its design. The acoustic design will take account of the additive effects of multiple units, to ensure that the limiting noise output conditions will be met when all units are operating simultaneously.

Air-source heat pumps require a continuous free flow of outside air, and the principal means of noise control will be to surround the units with open-topped, acoustically optimised screens. The screening systems will be specified to ensure compliance with the stipulations of the local authority in relation to noise sensitive locations both outside the development site and within it.

Additional protection will be provided for nearby residents by the use of the latest generation of inverter-driven heat pumps. The inverter drive provides soft starting, avoiding the abrupt start-up noise characteristic of older units, and also gives the capability of running continuously on low load (and very low noise) instead of repeated cycling between off and full-on which can create a very disturbing noise environment.

Air handling plant is used to supply and extract air from the buildings. All necessary noise control will be achieved internally within the units; acoustic attenuators are required to control noise in the ducting system, and the same attenuators also act to limit the noise emissions to the atmosphere. The attenuators will be sized to achieve the necessary levels of sound reduction both internally and externally.

5.2.3 Internal Noise Levels and Ventilation Strategy

5.2.3.1 Habitable Rooms in the Residential Development

The ground floor level of the residential development will be screened from direct sound from the railway cutting, and the predicted values for external L_{Aeq} and L_{ASmx} at a position 1m from the facade are:

Daytime hours (07.00 - 23.00)	L_{Aeq} 54dBA	L_{ASmx} 73dBA
Night-time hours (23.00 - 07.00)	L_{Aeq} 47dBA	L_{ASmx} 66dBA

The upper levels of the residential development will be more exposed to railway noise, and the predicted values for external L_{Aeq} and L_{ASmx} are:

Daytime hours (07.00 - 23.00)	L_{Aeq} 63dBA	L_{ASmx} 80dBA
Night-time hours (23.00 - 07.00)	L_{Aeq} 55dBA	L_{ASmx} 73dBA

The parameter L_{Aeq} measures, effectively, the dose of sound energy received in a given period of time, and L_{ASmx} gives an indication of the maximum sound level perceived during that time. Taken together, the parameters allow an assessment to be made of the need or otherwise for protection against environmental noise in habitable rooms. Such assessments are necessarily subjective, not least because the sensitivity of individuals to noise varies very widely.

The internal noise levels in rooms facing towards the railway will clearly be lower than the external figures quoted above - by about 10 - 15dBA if the room has partially open windows, and by about 30dBA if ventilation is provided by acoustically-lined trickle vents.

The trickle vent option would result in night-time internal levels on the top floor of the housing of approximately:

Night-time hours (23.00 - 07.00) L_{Aeq} 25dBA L_{ASmx} 43dBA

The value of L_{Aeq} (25dBA) would generally be regarded as satisfactory, but the value of (43dBA) is somewhat high for reasonably assured sleeping conditions, and the design proposal is therefore to provide a low-power background ventilation system to the residential accommodation. This will provide a sound reduction of 35 - 38dBA, bringing the internal L_{ASmx} down to between 35dBA and 38dBA - a much more equable value for sleeping. The option will remain, for those who wish, to turn off of the powered ventilation and use partially open windows instead. which will allow individuals who so desire to keep the windows open for ventilation.

5.2.3.2 Bedrooms Within the Hotel

The section through the proposed development (page 3) shows that there will be no direct sound path between trains in the cutting and the elevations of the hotel. It was not possible to obtain sound level measurements at the position of the upper elevations, but based on the low level measurements made during the survey, it is calculated that upper bedroom facades will be exposed to the following external noise levels:

Daytime hours (07.00 - 23.00) L_{Aeq} 50dBA L_{ASmx} 61dBA
Night-time hours (23.00 - 07.00) L_{Aeq} 43dBA L_{ASmx} 54dBA

The noise levels at the lower bedroom facades will be significantly lower.

This calculation cannot be very precise, particularly at the upper levels of the hotel, because the greater height will increase the exposure to more distant noise sources, such as traffic on the one-way ring road. Nonetheless, there is little doubt that perfectly acceptable sleeping conditions could be created in the hotel using acoustically-lined trickle vents installed within the building cladding. The windows themselves will be openable, with the usual mechanical limiters fitted for reasons of safety and security.

5.2.2.3 Protection Against Aircraft Noise

In order to protect against the ingress of aircraft noise though the ductwork, the sizing of the attenuators in the air handling units will be checked and increased if necessary to ensure adequate control of internal noise levels.

6 Acoustic Survey Procedures

Noise level measurements were made on:

Sunday 3 March, 11.00 - 16.00: measurements of ambient noise and detailed assessment of railway noise during the quieter weekend period

Monday 4 March, 07.00 - 23.00: daytime survey

Tuesday 5 March to Wednesday 6 March, 23.00 - 07.00: night-time survey

6.1 Equipment Used

CEL Precision Sound Level Meter type 480C1, serial number 089663, fitted with integral octave and third-octave filters and statistical analysis processor, pre-amplifier type 496 and half-inch electret microphone type 250, serial number 1886. Used in this configuration, this meter conforms to Type 1 specification of IEC 804-1985 and type S(1) specification of ANSI S1.4:1983.

CEL Acoustical Calibrator type 284/2, serial number 4/12023512 which conforms to IEC 942:1988 Class 1L and ANSI S1.4:1984.

Tripod, Windshield

6.2 Configuration of the Sound Level Meter

The sound level meter operates under the control of an internal computer and is capable of automatic recording and storing of data over extended periods. For most measurements the meter was operated in broad-band mode, in which the meter responds to all frequencies in the audible range, recording and storing 11 different acoustic parameters simultaneously. Broad band mode also provides the facility to record detailed second by second noise profiles.

6.3 Calibration

Calibration was carried out before each survey started. Subsequent calibrations were carried out at intervals during the survey, and minor corrections were made as necessary.

6.4 Broad Band Measurements

The meter was set to fast time response and to A-weighting, with the exception of L_{Zpk} values which were recorded as linear dB. Statistical percentile levels were to set to L_5, L_{10}, L_{50}, L_{90} and L_{95}.

A separate set of measurements was carried in conformity with BS8233:1999 in order to provide information relevant to the assessment of sleeping conditions (see page 9). For those measurements the meter was set to slow time response as required under the standard.

Noise profiles were recorded throughout the course of each broadband survey. These provided a second by second record of the values of two parameters at one time. For the purposes of this survey combinations of L_{AFmn}, L_{AFmx}, L_{ASmn}, L_{ASmx}, and L_{Aeq} were used at different times.

6.4 Measurement Positions

Noise level measurements were made at the two locations shown in the annotated aerial view below.

Point A: the microphone was at a height of 1.4m above ground level.

Point B: the sound level meter was on the wall between the site and pavement in the north-west corner of the site at a height of 2.2m above ground level, with the microphone pointed downward at 30 degrees, directed into the railway cutting. This location gave a direct sight and sound line to the railway tracks and the trains, allowing noise from the train movements to be directly measured.

7 Results of Noise Surveys

Graphical details from the survey results have been shown in previous sections. The full tabulated results are shown on page 14; owing to the very large number of data points the detailed second by second noise profiles have been omitted, but are retained for future use if needed. A description of the parameters used in the survey is provided on pages 15 to 16. For the purposes of this study the most relevant parameters are $L_{AF90,}$ the background level against which services noise is measured, L_{AFmn}, which records the lowest noise level recorded in any one second interval during the measurement period, and L_{Aeq}, which effectively provides a measure of the time-averaged exposure to sound energy.

Sound Pressure Levels (dB)

Position A

Date	Hour Start	LAFmx	LAFmn	LAeq	LZpk	LTm3	LTm5	LAF5.0	LAF10.0	LAF50.0	LAF90.0	LAF95.0
4 March 2013	7.00	74.8	45.6	55.8	108.7	59.6	60.6	61.5	60.0	51.5	48.0	47.5
	8.00	82.9	44.6	58.0	113.2	64.0	65.5	63.5	61.5	52.0	47.5	47.0
	9.00	81.4	45.3	59.3	111.3	65.8	66.8	63.5	61.5	53.5	47.5	47.0
	10.00	69.8	46.7	58.6	107.9	62.2	63.4	63.0	62.0	56.0	49.0	48.0
	11.00	73.3	44.3	56.9	112.4	61.2	62.0	62.0	60.5	54.5	48.5	47.0
	12.00	73.3	44.9	57.7	101.1	61.2	62.1	63.0	60.5	51.0	47.0	46.0
	13.00	74.0	46.3	59.5	104.9	64.5	65.7	65.0	62.5	55.5	48.5	48.0
	14.00	73.4	46.0	56.5	108.8	62.1	63.2	62.0	60.5	53.0	49.0	48.0
	15.00	69.0	45.3	56.0	107.0	59.5	60.5	61.5	60.5	51.5	48.0	47.0
	16.00	67.9	45.1	56.4	104.6	60.5	61.2	62.5	61.5	51.5	47.5	47.0
	17.00	69.5	45.2	55.9	101.1	59.6	60.7	62.5	60.5	52.5	47.5	47.0
	18.00	77.0	45.9	56.7	108.3	63.3	64.1	62.0	60.0	51.5	48.5	47.5
	19.00	74.3	44.9	57.4	108.1	62.5	63.2	62.5	60.5	54.0	48.0	46.5
	20.00	66.6	44.7	54.0	103.8	57.0	57.9	61.0	59.0	49.5	46.5	46.0
	21.00	77.2	44.5	57.9	110.4	62.4	63.6	63.0	61.0	52.0	47.0	46.5
	22.00	72.0	44.6	55.6	105.4	59.8	61.0	61.5	60.0	51.5	47.5	46.5
Date												
5 March 2013	23.00	68.6	42.4	52.8	97.3	55.2	56.3	59.0	53.0	45.5	44.0	43.5
6 March 2013	0.00	66.6	41.7	50.3	94.6	51.9	52.6	58.0	51.5	46.0	43.5	43.0
	1.00	68.9	41.7	46.4	93.0	50.9	52.4	50.0	48.5	44.5	43.0	43.0
	2.00	71.0	41.0	46.7	93.5	51.5	53.1	50.5	49.0	44.5	42.5	42.5
	3.00	62.6	41.1	45.8	96.3	48.7	49.7	49.5	48.0	44.0	42.5	42.0
	4.00	66.3	41.2	48.4	89.3	50.9	52.0	51.5	48.5	44.0	42.5	42.5
	5.00	63.7	41.5	48.9	88.0	51.7	52.9	54.5	49.0	45.0	43.0	42.5
	6.00	82.1	45.7	61.3	106.3	68.6	69.3	66.0	64.0	56.5	50.0	49.0

Position B

Date	Start time	LAFmx	LAFmn	LAeq	LZpk	LTm3	LTm5	LAF5.0	LAF10.0	LAF50.0	LAF90.0	LAF95.0
3 March 2013	12.45	80.3	46.2	65.7	111.1	68.8	69.6	74.0	68.0	55.0	50.5	49.5
	13.00	83.8	47.8	66.3	110.5	69.3	70.1	72.5	68.5	55.5	51.0	50.0
	13.15	82.4	46.2	66.2	113.5	69.1	70.4	74.5	68.0	54.0	50.0	49.0
	13.30	83.6	46.5	67.1	109.1	70.0	70.8	74.5	69.0	54.5	51.0	50.0
	13.45	84.2	48.2	66.7	114.6	69.9	71.0	74.5	70.0	56.0	52.0	51.0

Position B

Note: Measurement to BS8233:1999 using slow sound level meter response for evaluation of potential sleep disturbance

Date	Start time	LASmx	LSmn	LAeq	LZpk	LTm3	LTm5	LAS5.0	LAS10.0	LAS50.0	LAS90.0	LAS95.0
4 March 2013	13.28	82.2	49.1	67.5	107.1	69.2	69.9	72.0	56.5	52.0	51.5	50.0

7 Glossary of Acoustic Parameters

7.1 Noise Exposure Parameters

L_{eq}: Equivalent Noise Level
This parameter is regarded as a crucial indicator in many environmental noise assessments. It records the average noise level during the assessment period, but the average is calculated, effectively, in terms of the amount of sound power received. Depending on the nature of the noise source, this can give a result which may be very different from the arithmetic average of the decibel values. It is used widely as an indicator of exposure to sound energy in the environment, because it accounts fully for the large amount of sound energy delivered by relatively short periods of high noise level.

L_{eq} is often written in the form L_{Aeq}, which indicates that A-weighted decibels are used in the measurement.

7.2 Statistical Parameters

These parameters are indicated by abbreviations such as L_{10}, L_{50} and L_{90}. They express statistical exceedance levels; L_{10}, for example, indicates the noise level exceeded for 10% of the total measurement time. Any number of exceedance levels may be derived from the raw data; if one were so inclined it would be possible to calculate the noise level exceeded for 37% of the time, but in practice a relatively small number of values are in common use. In this survey the meter was set up to calculate L_5, L_{10}, L_{50}, L_{90} and L_{95}.

The abbreviation may often be seen in its expanded form, which indicates the decibel weighting and meter response settings employed. L_{AF10}, for example, shows fast meter response and A-weighting.

L_{10}: Sound Level exceeded for 10% of the time
L_{10} gives a reasonable correlation with a subjective assessment of peak noise level - in the ten minute measurement period generally used in this study, L_{10} indicates the noise level which was exceeded for one minute. In assessing the annoyance of noises, most individuals will discount loud sounds which do not persist for long, and L_{10} generally gives a good correlation with perceived noisiness.

L_{50}: Sound Level exceeded for 50% of the time
This parameter provides an estimate of the mid value of the range of noise levels. On its own, it is of limited significance - it must be viewed in the light of the accompanying L_{10} and L_{90} values.

L_{90}: Sound Level exceeded for 90% of the time
This parameter provides a reasonable correlation with a subjective evaluation of the background noise level - in a ten minute measurement period the noise level would only fall below the L_{90} value for a total of one minute.

7.3 Maximum and Minimum Values

The definition of a maximum sound level is much more complicated than might be thought - the definition of maximum depends crucially on how sharp the response of the measuring system is. With a slow response, a very abrupt burst of sound could be averaged out and appear as a longer, less intense peak than it really was. Sound level meters are built to very exacting standards, and are capable of recording maximum levels in a number of different ways, each suitable for a particular type of measurement.

L_{Zpk}: Maximum Peak Level during the measurement period

This parameter reports the highest peak of sound pressure level detected at any time during the measurement period, measured in unweighted decibels (Z-weighting). The recorded value may often appear to be very high - this is due to the very fast response of the meter to an abrupt sound, and the effect of removing the usual A-weighting bias. The value shown for L_{Zpk} will nearly always arise from a very short-lived event, usually a sudden mechanical impact. Because the sound is very short-lived, the subjectively perceived noise level may be quite low. This issue is very significant in terms of occupational health and hearing damage, because short-lived impulse noises can damage hearing even if there is little perceived auditory discomfort.

L_{AFmx}: Maximum Continuous Level during the measurement period

This parameter reports the highest continuous sound level detected in the measurement period. It differs from L_{Zpk} in that the peak sound is averaged over one or more complete cycles, and the usual A-weighting bias is applied. In contrast to L_{Zpeak}, the measured value of L_{AFmax} will usually show a good correlation with a subjective assessment of the highest sound level in the measurement period. The subscript F in L_{AFmax} indicates that the meter is set to fast response.

L_{Tm5}: Five Second Cumulative Average Peak

This useful **DIN** parameter measures the peak level recorded in every five second interval throughout the whole measurement period, and expresses the result as the cumulative average over the whole measurement period. Its usefulness lies in the fact that it can give a picture of peak levels which is less prone to distortion by random events. There is a related **DIN** parameter L_{Tm3} which records peak levels at three second intervals. The differences between the two results are subtle, and of little significance in this study.

L_{AFmn}: Minimum Continuous Level during the measurement period

L_{AFmin} records the quietest period of about one second in a defined measurement period. For the purposes of this survey the standard measurement period used was 15 minutes, as specified in a number of standards relating to background noise levels. In real terms, L_{AFmin} effectively reports the lowest noise level during the measurement period.