

Appendix: Noise and Vibration

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Annex 1. Glossary.

Table 1 – Glossary of terms

Term	Description
A-weighting	a filter that down-weights low frequency and high frequency sound to better represent the frequency response of the human ear when assessing the likely effects of noise on humans
acoustic character	one or more distinctive features of a sound (e.g. tones, whines, whistles, impulses) that set it apart from the background noise against which it is being judged, possibly leading to a greater subjective effect than the level of the sound alone might suggest
acoustic screening	the presence of a solid barrier (natural landform or manmade) between a source of sound and a receiver that interrupts the direct line of sight between the two, thus reducing the sound level at the receiver compared to that in the absence of the barrier
ambient noise	All-encompassing noise associated with a given environment, usually a composite of sounds from many sources both far and near, often with no particular sound being dominant
annoyance	a feeling of displeasure in this case evoked by noise
attenuation	the reduction in level of a sound between the source and a receiver due to any combination of effects including: distance, atmospheric absorption, acoustic screening, the presence of a building façade, etc.
audible sound	a sound that can be heard above all other ambient sounds
background noise	the noise level rarely fallen below in any given location over any given time period, often classed according to day-time, evening or night-time periods (for the majority of the population of the UK the lower limiting noise level is usually controlled by noise emanating from distant road, rail or air traffic)
dB	abbreviation for ‘decibel’
dB(A)	abbreviation for the decibel level of a sound that has been A-weighted
decibel	the unit normally employed to measure the magnitude of sound
directivity	the property of a sound source that causes more sound to be radiated in one direction than another
equivalent continuous sound pressure level	the steady sound level which has the same energy as a time varying sound signal when averaged over the same time interval, T, denoted by $L_{Aeq,T}$
external noise level	the noise level, in decibels, measured outside a building
frequency	the number of acoustic pressure fluctuations per second occurring about the atmospheric mean pressure (also known as the ‘pitch’ of a sound)
frequency analysis	the analysis of a sound into its frequency components

Term	Description
hertz	the unit normally employed to measure the frequency of a sound, equal to cycles per second of acoustic pressure fluctuations about the atmospheric mean pressure
instantaneous sound pressure	at a given point in space and at a given instant in time, the difference between the instantaneous pressure and the mean atmospheric pressure
internal noise level	the noise level, in decibels, measured inside a building
L_{Aeq}	the abbreviation of the A-weighted equivalent continuous sound pressure level
L_{A10}	the abbreviation of the 10 percentile noise indicator, often used for the measurement of road traffic noise
L_{A90}	the abbreviation of the 90 percentile noise indicator, often used for the measurement of background noise
level	the general term used to describe a sound once it has been converted into decibels
loudness	the attribute of human auditory response in which sound may be ordered on a subjective scale that typically extends from barely audible to painfully loud
masking	the effect whereby an otherwise audible sound is made inaudible by the presence of other sounds
noise	physically: a regular and ordered oscillation of air molecules that travels away from the source of vibration and creates fluctuating positive and negative acoustic pressure above and below atmospheric pressure. Subjectively: sound that evokes a feeling of displeasure in the environment in which it is heard, and is therefore unwelcomed by the receiver
noise emission	the noise emitted by a source of sound
noise immission	the noise to which a receiver is exposed
octave band frequency analysis	a frequency analysis using a filter that is an octave wide (the upper limit of the filter’s frequency band is exactly twice that of its lower frequency limit)
percentile exceeded sound level	the noise level exceeded for n% of the time over a given time period, T, denoted by $L_{An,T}$
receiver	a person or property exposed to the noise being considered
residual noise	the ambient noise that remains in the absence of the specific noise whose effects are being assessed
sound	physically: a regular and ordered oscillation of air molecules that travels away from the source of vibration and creates fluctuating positive and negative acoustic pressure above and below atmospheric pressure subjectively: the sensation of hearing excited by the acoustic oscillations described above (see also ‘noise’)
sound level meter	an instrument for measuring sound pressure level

Term	Description
sound pressure amplitude	the root mean square of the amplitude of the acoustic pressure fluctuations in a sound wave around the atmospheric mean pressure, usually measured in Pascals (Pa)
sound pressure level	a measure of the sound pressure at a point, in decibels
sound power level	the total sound power radiated by a source, in decibels
spectrum	a description of the amplitude of a sound as a function of frequency
third-octave band frequency analysis	a frequency analysis using frequency bands one third of an octave wide
threshold of hearing	the lowest amplitude sound capable of evoking the sensation of hearing in the average healthy human ear (0.00002 Pa)
tone	the concentration of acoustic energy into a very narrow frequency range

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Annex 2. Legislative, Policy and Guidance Documents.

1. Key Legislation.

In England there are two legislative instruments that address noise and vibration: the Environmental Protection Act 1990 (EPA); and the Control of Pollution Act (1974) (CoPA).

1.1 Environmental Protection Act, 1990.

The EPA provides powers to control noise where a statutory noise nuisance exists. Section 80 describes the powers of the Local Authority to serve a notice requiring the abatement of a nuisance or prohibition of its occurrence/reoccurrence. Section 82 gives individuals subject to a statutory nuisance the right to make representations to the courts and for the courts to take such action.

1.2 Control of Pollution Act, 1974.

The CoPA requires that 'Best Practicable Means' (as defined in section 72 of CoPA) are adopted to control construction noise on any given site. The CoPA refers to BS 5228 as best practicable means.

2. Key National Planning Policy.

2.1 Noise Policy Statement for England.

Noise Policy Statement for England (NPSE) advises that noise impacts should be assessed on the basis of adverse and significant adverse effect. The NPSE does not provide any specific guidance on assessment methods or noise limits. However, the concepts summarised in Table 1 are introduced and can be applied when considering the significance of noise impacts.

Table 1 – Observed Effect Levels

Effect Level	Description
No Observed Effect Level (NOEL)	This is the noise level below which no effect can be detected. In simple terms, below this level of noise, there is no detectable effect on health and quality of life due to the noise being assessed.
Lowest Observed Adverse Effect Level (LOAEL)	This is the level of noise above which adverse effects on health and quality of life can be detected.
Significant Observed Adverse Effect Level (SOAEL)	This is the level of noise above which significant adverse effects on health and quality of life occur.

2.2 National Planning Policy Framework.

National Planning Policy Framework (NPPF) sets out the Government's planning policies and how these are expected to be applied. In relation to noise and vibration, NPPF section 11 Paragraph 109 states:

'The planning system should contribute to and enhance the natural and local environment by:

- preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability'*

Whilst Paragraph 123 states:

'Planning policies and decisions should aim to:

- avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;*
- mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;*
- recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put upon them because of changes in nearby land uses since they were established; and*
- identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.'*

2.3 Planning Practice Guidance.

Online Planning Practice Guidance (PPG) has been published to provide greater details in relation to the relevance of noise to the planning process following the introduction of the NPPF and NPSE.

This guidance states, under the heading 'How to Determine the Noise Impact', that the following should be considered by local authorities:

- whether or not a significant adverse effect is occurring or likely to occur;
- whether or not an adverse effect is occurring or likely to occur; and
- whether or not a good standard of amenity can be achieved.

In line with NPSE, this includes identifying where noise exposure is above or below the significant observed adverse effect level and the lowest observed adverse effect level for a given situation, during both construction and operation of the Revised Scheme.

Further guidance on each of the various observed effect levels set out in the NPSE is provided in the table detailed in the section headed 'How to Recognise when Noise could be a concern?' which is reproduced below.

Table 2 – Observed Effects

Perception	Examples of outcomes	Increasing effect level	Action
Not noticeable	No Effect	No Observed Effect	No Specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.		No Specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; closing windows for some of the time because of the noise. Potential for non-awakening sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. having to keep windows closed most of the time, avoiding certain activities during periods of intrusion. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and disruptive	Extensive and regular changes in behaviour and/or inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

It is important to note that no specific noise parameters are defined in the text or target noise levels provided.

Under the heading 'What factors influence whether noise could be a Concern?', the subjective nature of noise is discussed. It is stated that there is no simple relationship between noise levels and the impact on those affected. This depends on how various factors combine in particular situations, these include:

- ‘the source and absolute level of the noise together with the time of day it occurs. Some types and level of noise will cause a greater adverse effect at night than if they occurred during the day - this is because people tend to be more sensitive to noise at night as they are trying to sleep. The adverse effect can also be greater simply because there is less background noise at night;*
- for non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise;*
- the spectral content of the noise (i.e. whether or not the noise contained particular high or low frequency content) and the general character of the noise (i.e. whether or not the noise contains particular tonal characteristics or other particular features). The local topology and topography should*

also be taken into account along with the existing and, where appropriate, the planned character of the area.’

More specific factors to consider when relevant:

- ‘Consideration should also be given to whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time. In both cases a suitable alternative means of ventilation can be found in the Building Regulations.*
- In cases where existing noise sensitive locations already experience high noise levels, a development that is expected to cause even a small increase in noise may result in a significant adverse effect occurring even though little to no change in behaviour would be likely to occur.*
- If external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended.*
- Some commercial developments including fast food restaurants, night clubs and public houses can have particular impacts, not least because activities are often at their peak in the evening and late at night. Local planning authorities will wish to bear in mind not only the noise that is generated within the premises but also the noise that may be made by customers in the vicinity.’*

3. Key Local Planning Policy.

3.1 Local Plan.

A new Local Plan has been approved by Reading Council for on 4 November 2019, containing the proposed policies to guide development up to 2036. This document consolidates previously adopted guidance as presented above and introduces new policies to be adopted. Although this document is currently undergoing consultation, draft policy EN 17 is understood to form the basis of currently enforced planning conditions, and is presented below:

‘Where noise generating equipment is proposed, the noise source rating level (plant noise level) should be at least 10dBA below the existing background level as measured at the nearest noise sensitive receptor’.

4. Other Relevant Standards & Guidance.

4.1 British Standard (BS) 5228 Parts 1 and 2.

British Standard 5228-1: 2009 ‘Code of practice for noise and vibration control on construction and open sites - Part 1: noise’ (BS 5228-1) provides guidance on a range of considerations relating to construction noise including the legislative framework, general control measures, example methods for estimating construction noise levels and example criteria which may be considered when assessing the significance of any effects.

British Standard 5228-2: 2009 ‘Code of practice for noise and vibration control on construction and open sites - Part 2: noise’ also provides general guidance relating to construction vibration, including the legislative framework, prediction methods, control measures and assessment criteria.

4.2 British Standard (BS) 8233.

BS 8233: 2014 provides guidance for the control of noise in and around buildings, and suggests appropriate criteria and limits for different situations. The criteria and limits are primarily intended to guide the design of new or refurbished buildings undergoing a change of use.

Table 4 within BS 8233 provides desirable internal ambient noise levels for spaces in residential dwellings when they are unoccupied. This is reproduced below in Table 3.

Table 3 – Indoor Ambient Noise Levels in Spaces for Dwellings

Activity	Location	Day (07.00 to 23.00)	Night (23.00 to 07.00)
Resting	Living room	35 dB LAeq, 16hour	-
Dining	Dining room / area	40 dB LAeq, 16hour	-
Sleeping (daytime resting)	Bedroom	35 dB LAeq, 16hour	30 dB LAeq, 8hour

Supplementary Note 2 and 4 to Table 4 within BS 8233 are copied below for reference:

‘NOTE 2 - the levels shown in Table 4 are based on the existing guidelines issued by the WHO...

NOTE 4 - regular individual noise events (for example, schedule aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or LAmax,T depending on the character and number of events per night.’

4.3 British Standard (BS) 4142.

Current Government advice to Local Planning Authorities in both England and Wales makes reference to BS 4142 as being the appropriate guidance for assessing commercial operations and fixed building services plant noise. This British Standard provides an objective method for rating the likelihood of complaint from industrial and commercial operations. It also describes means of determining noise levels from fixed plant installations and determining the background noise levels that prevail on a site.

The assessment of impacts is based on the subtraction of the measured background noise level from the rating level determined. The rating level is the source noise level (either measured or predicted) corrected for tone or character (if necessary). The difference is compared to the following criteria to evaluate the impact:

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB indicates is likely to be an indication of an adverse impact, depending on the context.
- Where the rating level does not exceed the background noise level, this is an indication of the specific sound source having a low impact, depending on the context.

This method is only applicable for external noise levels.

4.4 World Health Organisation Guidelines (2000 and 2009).

The World Health Organisation (WHO) has published a series of guidelines that relate to acceptable levels of noise from a health perspective. These are detailed in two separate documents, the WHO ‘Guidelines for Community Noise’, 2000 and the WHO ‘Night Noise Guidelines for Europe’, 2009. The ‘Guidelines for Community Noise’ set out criteria that should be achieved in order to avoid sleep disturbance in dwellings, as set out in Table 4.

Table 4 – Guideline Values for Noise Levels During the Night

Specific Environment	Health Effect	Guideline Values	
		dB LAeq, 8hour	dB LAfmax
Dwelling, inside bedrooms	Sleep disturbance, night	30	45
Dwelling, external noise level, windows open	Sleep disturbance, night	45	60

The WHO Guidelines also give criteria that relate to noise levels experienced in outdoor living areas (e.g. gardens) during the daytime and evening periods. A level of 50 dB LAeq, 16 hour is described to be of moderate annoyance and a level of 55 dB LAeq, 16 hour to be of serious annoyance.

The WHO ‘Night Noise Guidelines for Europe’ provide further criteria that relate external noise levels at dwellings to specific health effects. These criteria were produced with the intention of supplementing the criteria that were given in the ‘Guidelines for Community Noise’. The ‘Night Noise Guidelines’ are, however, set in terms of the Lnight, outside, which is the average night time noise level experienced outside the building over a year. It therefore does not take into account mitigation measures that may be designed into the building envelope and requires knowledge of the noise levels experienced at the development site over the course of a full year. As such, the Lnight, outside measurement descriptor is not appropriate for assessing the acceptability of noise affecting the Proposed Development and will therefore not be considered further in this assessment.

4.5 Possible Options for SOAEL and LOAEL.

In the absence of any specific guidance in the NPSE relating to the levels of noise from different sources to effect levels, DEFRA commissioned AECOM to carry out research to identify the potential threshold levels for LOAEL and SOAEL for residential receptors affected by different sources of noise. A summary of AECOM’s findings were published in the report entitled ‘Possible Options for the Identification of SOAEL and LOAEL in Support of the NPSE’, dated 2014. A summary of the recommendations of the report are contained within

Table 1.1 of the report, reproduced in Table 5 for road traffic noise. Note: numbers shown in parentheses indicate mid points of the range.

Table 5 – Summary of Outcomes of the AECOM Report – Road Traffic Noise

Annoyance / Stress dB L _{Aeq, 16hour}		Sleep disturbance dB L _{night}		Cardiovascular disease dB L _{Aeq, 16hour}	
LOAEL	SOAEL	LOAEL	SOAEL	LOAEL	SOAEL
53 – 59 (56)	64 – 68 (66)	43 – 52 (46)	51 – 54 (56)	58	67

4.6 ProPG Professional Practice Guidance on Planning and Noise.

ProPG Planning & Noise is a document aimed at providing practitioners guidance on a recommended approach to the management of noise in the context of the planning system. The document was published jointly by the three professional bodies in the acoustics industry: Acoustics and Noise Consultants (ANC); the Institute of Acoustics (IOA); and the Chartered Institute of Environmental Health (CIEH).

The guide is focussed on new residential development being affected by transport noise. Its primary goal is to assist in the delivery of sustainable development by promoting good health and wellbeing through the effective management of noise. It seeks to do this by encouraging good acoustic design processes in and around proposed new residential development, having particular regard to national policy on planning and noise.

One consideration of the ProPG is that of access to space providing some respite from noise during those times when homes may be noise affected. This may include at least one façade of a home being exposed to lower noise levels, thus allowing windows to be opened on that façade for ventilation purposes in situations where occupants may choose to close windows on a more noise exposed façade. Alternatively, where external amenity directly associated with a property is noise affected, easy access to external amenity space on an acoustically screened side of the property, or indeed to nearby public open space where the noise levels are lower, may both reasonably be considered as contributory mitigating factors.

4.7 Calculation of Road Traffic Noise.

In England and Wales, the standard method for predicting road traffic noise levels is given in the Calculation of Road Traffic Noise 1988 (CRTN). This methodology utilises a number of input parameters (e.g. road traffic flow, composition, speed, gradient road, road surface, distance of receptor from road etc.) to enable predictions of noise levels due to road traffic to be produced. This method enables the calculation of average levels over a period of either 18 hours or 1 hour. Predictions are produced in terms of L_{A10}, as this is considered the measurement descriptor that best describes road traffic noise.

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Annex 3. Noise survey data.

1. Location L1 – North west of site

Noise Monitoring Information Sheet						
Name	Location L1					
Description	Location L1 was located on the north-western boundary of the site approximately 12m above ground overlooking Oxford Road. Consistently high volumes of road traffic were noted on Oxford Road, which was the dominant source of noise.					
Equipment		Type	Serial Number	Last Calibrated		
Sound Level Meter		NL-52	00832246	10/10/2017		
Pre-amplifier		NH-25	05473	10/10/2017		
Microphone		UC-59	32274	10/10/2017		
Calibrator		B&K 4231	3014189	11/10/2017		
SLM Range		20 – 120 dB(A)				
Data Collected						
Time Start		Time End	Cal. Start	Cal. End	Drift	Notes
12:30 13/06/2018		13:00 18/06/2018	93.9	93.9	0	

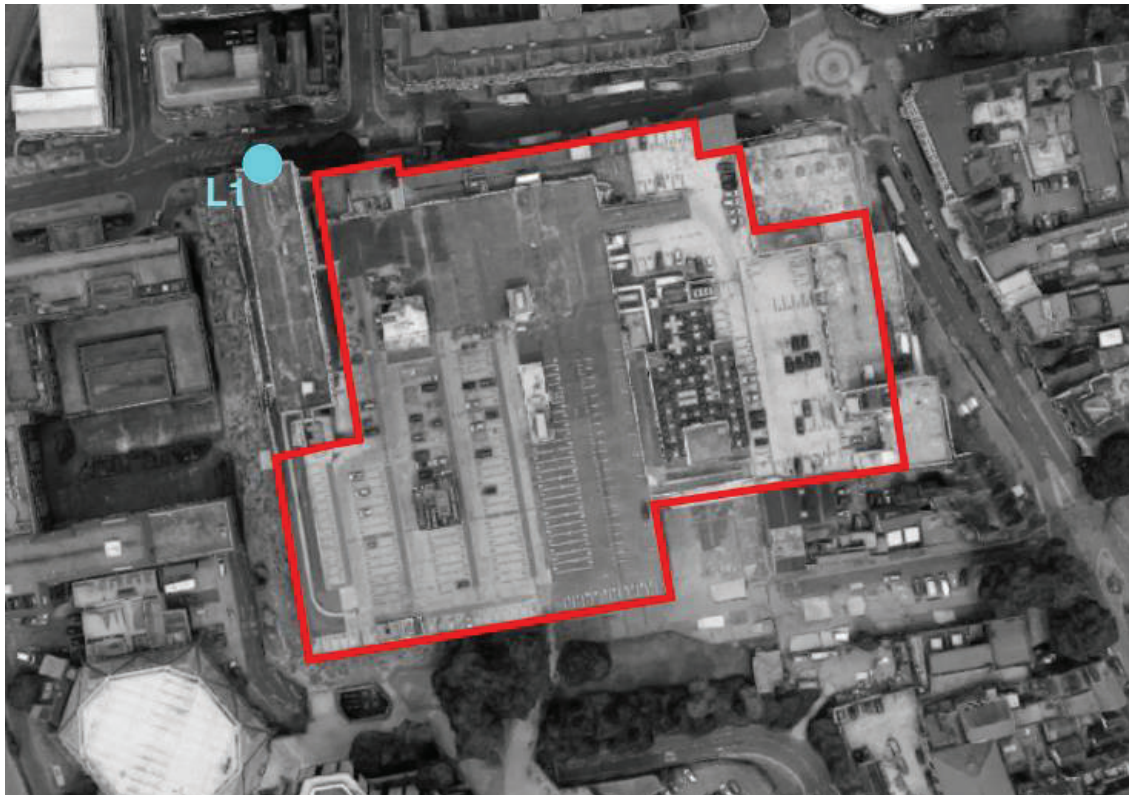


Figure 1 - Satellite image of survey location L1



Figure 2 - Photograph of logger at location L1 overlooking Oxford Road

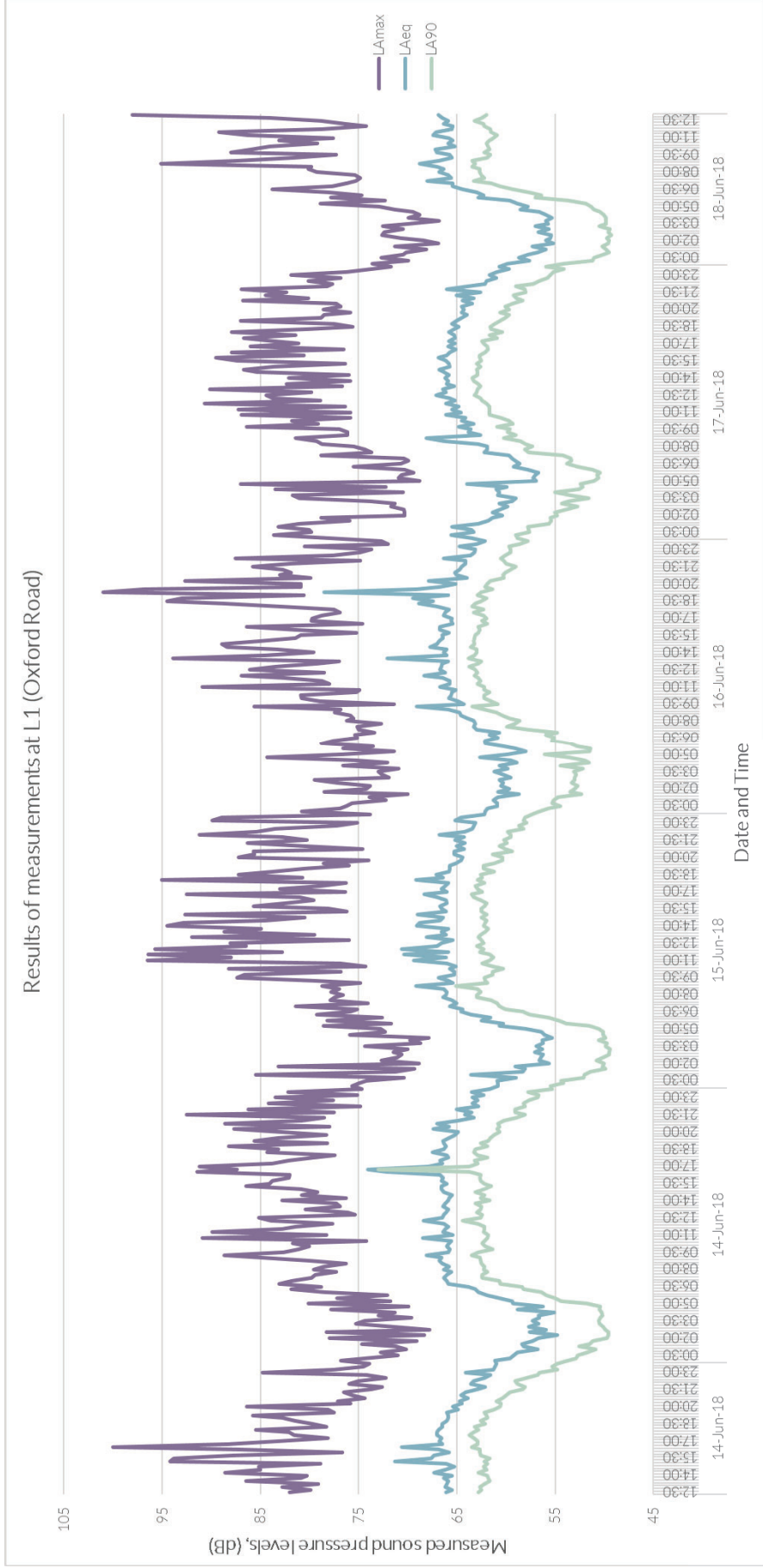


Figure 3 - Time history of noise levels measured at location L1

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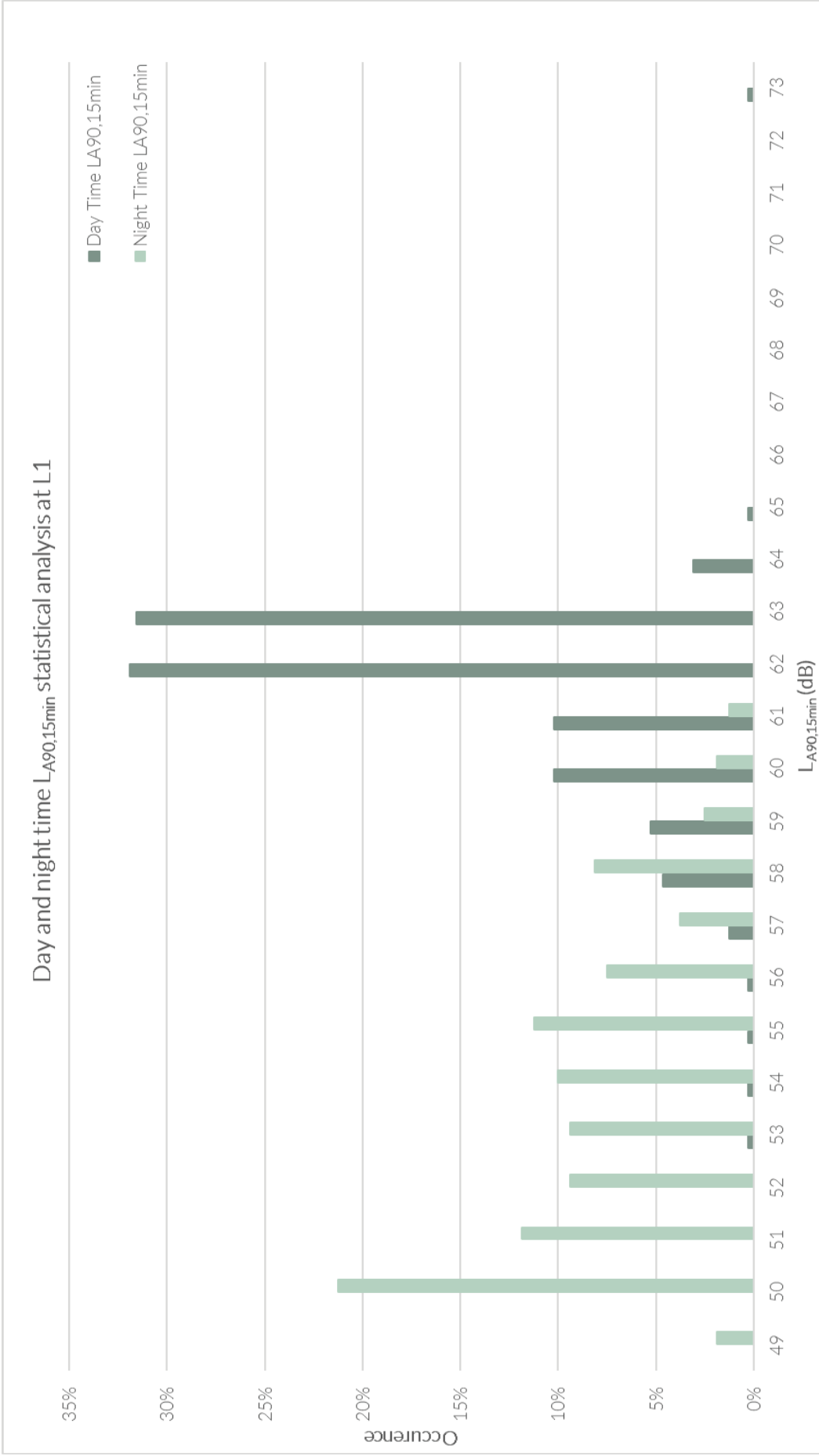


Figure 4 - Histogram of background levels measured at location L1

2. Location L2 – East of site

Noise Monitoring Information Sheet						
Name	Location L2					
Description	Location L2 was located on the eastern boundary of the site approximately 7m above ground overlooking St Mary's Butts. Consistently high volumes of road traffic were noted on St Mary's Butts, which was the dominant source of noise.					
Equipment		Type	Serial Number	Last Calibrated		
Sound Level Meter		NA-28	01260203	24/07/2017		
Pre-amplifier		NH-23	60106	24/07/2017		
Microphone		UC-59	00286	24/07/2017		
Calibrator		B&K 4231	3014189	11/10/2017		
SLM Range		20 – 120 dB(A)				
Data Collected						
Time Start		Time End	Cal. Start	Cal. End	Drift	Notes
13:14 13/06/2018		12:13 18/06/2018	94.0	94.0	0	

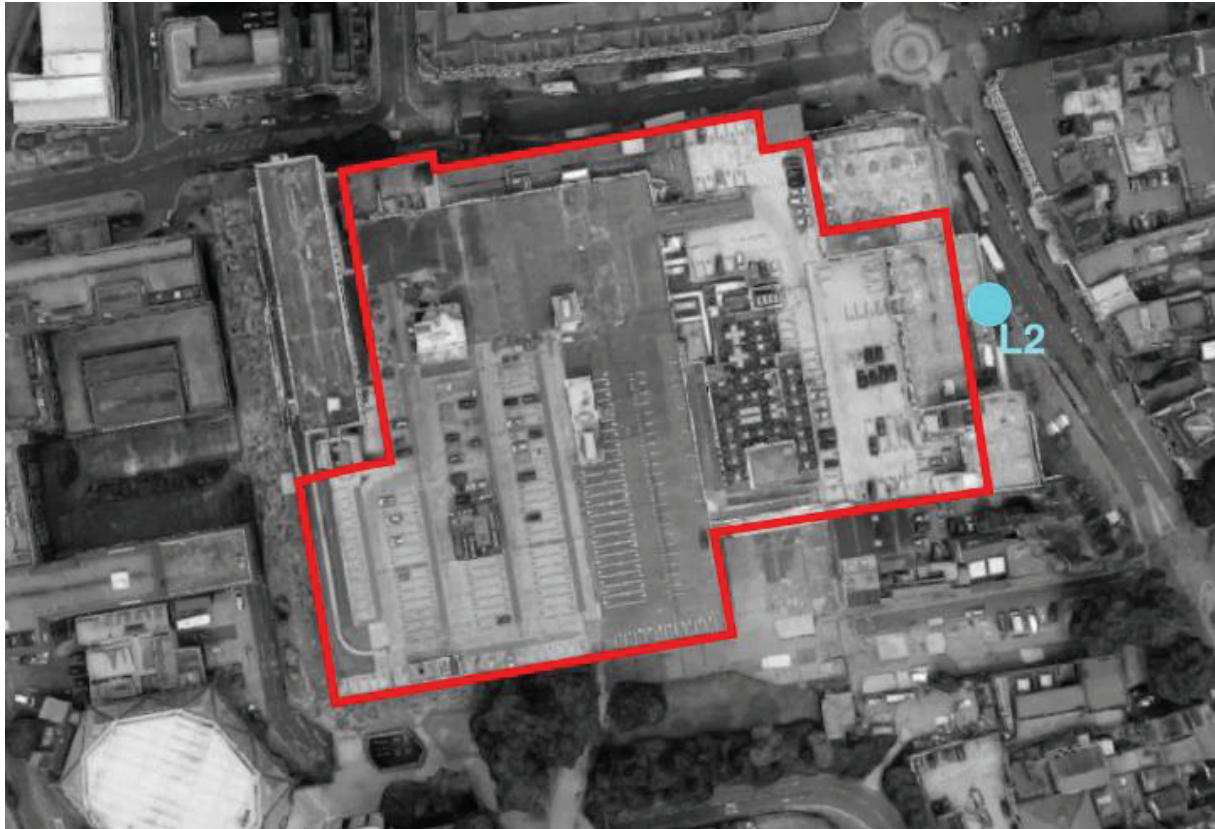


Figure 5 - Satellite image of survey location L2



Figure 6 – Photograph of logger at location L2 overlooking St Mary's Butts

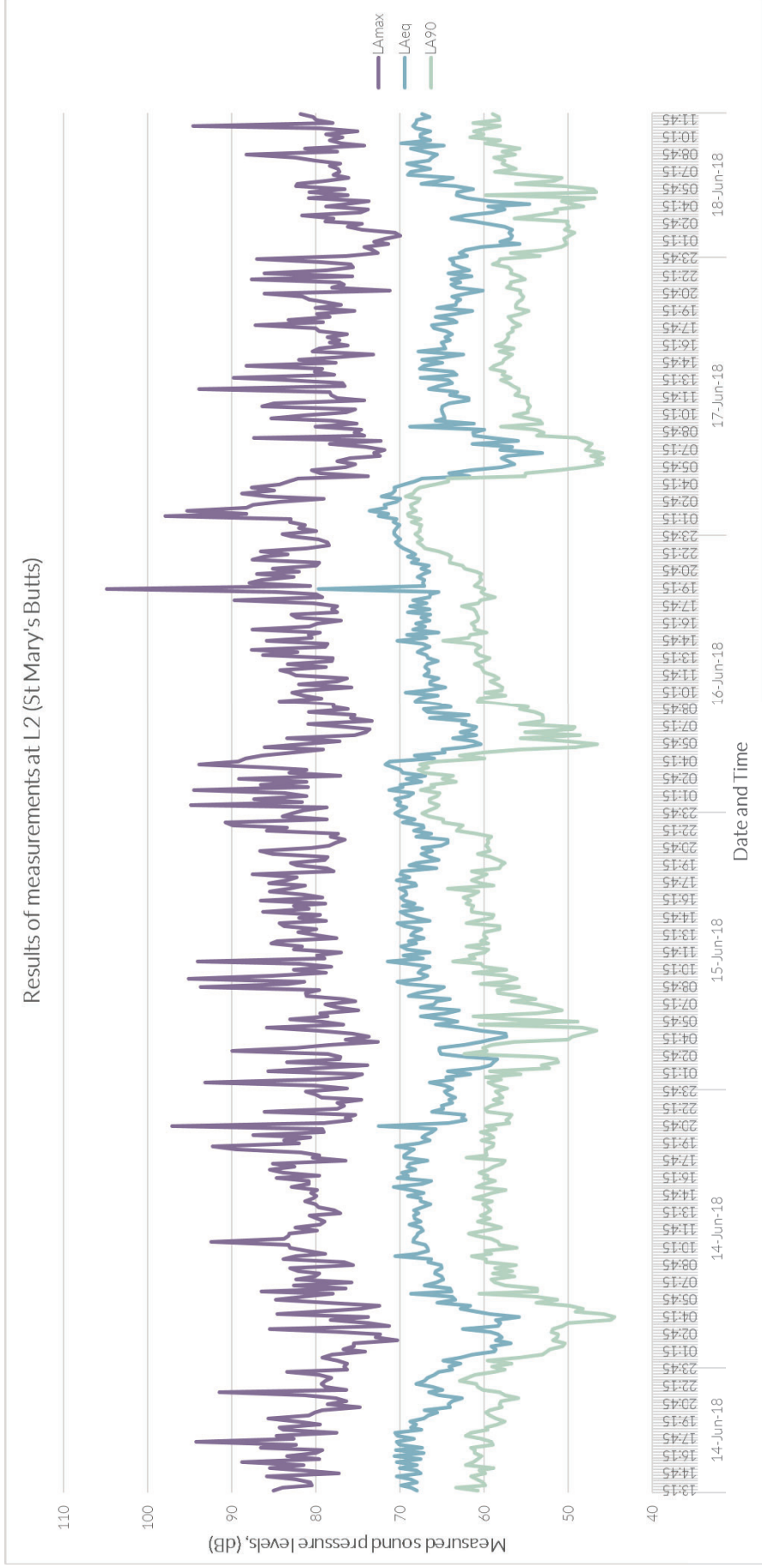


Figure 7 - Time history of noise levels measured at location L2

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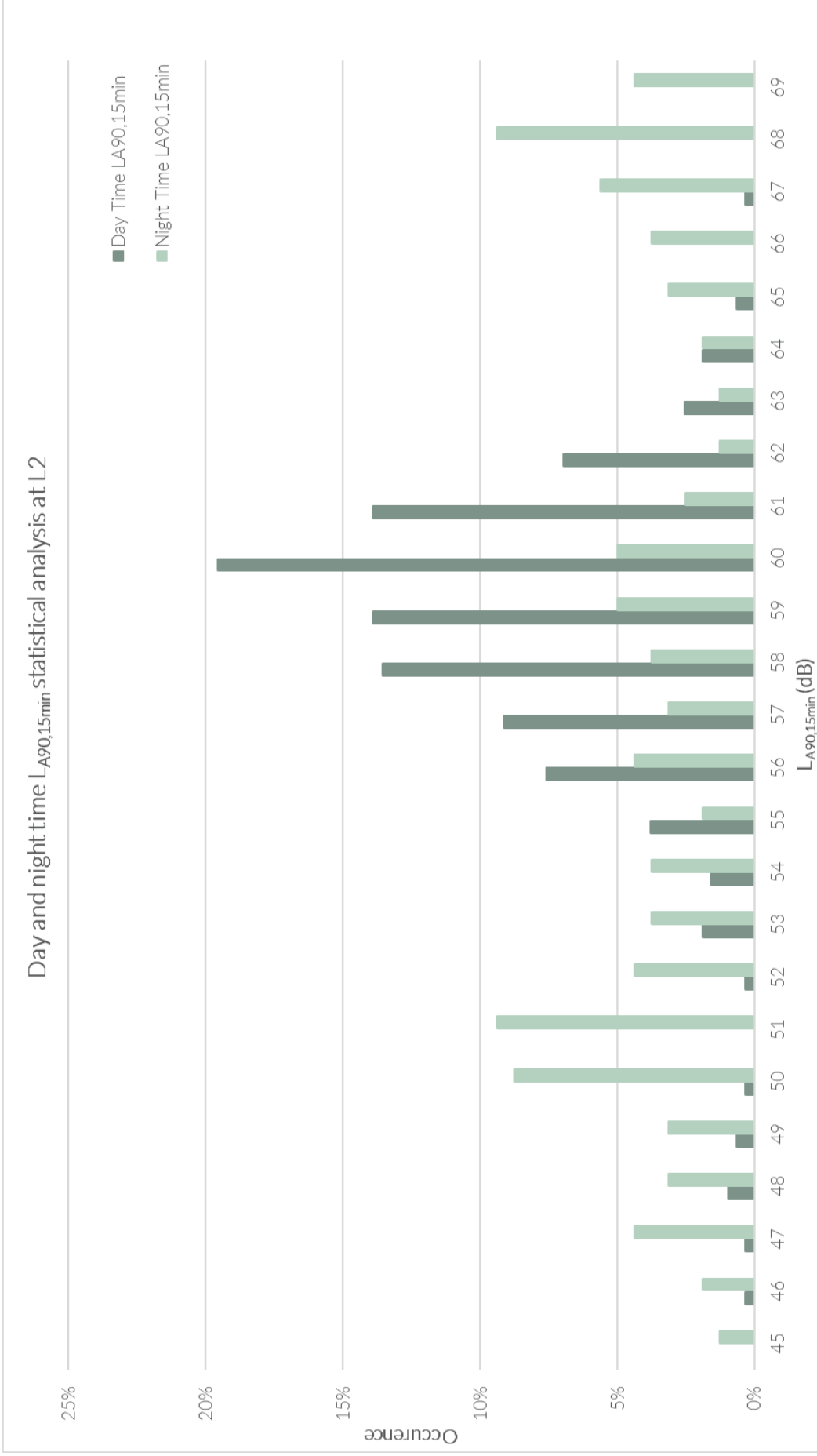


Figure 8 - Histogram of background levels measured at location L2

3. Location L3 – East of site

Noise Monitoring Information Sheet						
Name	Location L3					
Description	Location L3 was located on the southern boundary of the site approximately 7m above ground overlooking Dusseldorf Way. High volumes of road traffic along the A329 as well as St Mary's Butts was the dominant source of noise.					
Equipment		Type	Serial Number	Last Calibrated		
Sound Level Meter		NL-52	00832244	11/10/2017		
Pre-amplifier		NH-25	32272	11/10/2017		
Microphone		UC-59	05471	11/10/2017		
Calibrator		B&K 4231	3014189	11/10/2017		
SLM Range		20 – 120 dB(A)				
Data Collected						
Time Start		Time End	Cal. Start	Cal. End	Drift	Notes
12:15 13/06/2018		12:30 18/06/2018	93.8	94.0	0.2	Not significant

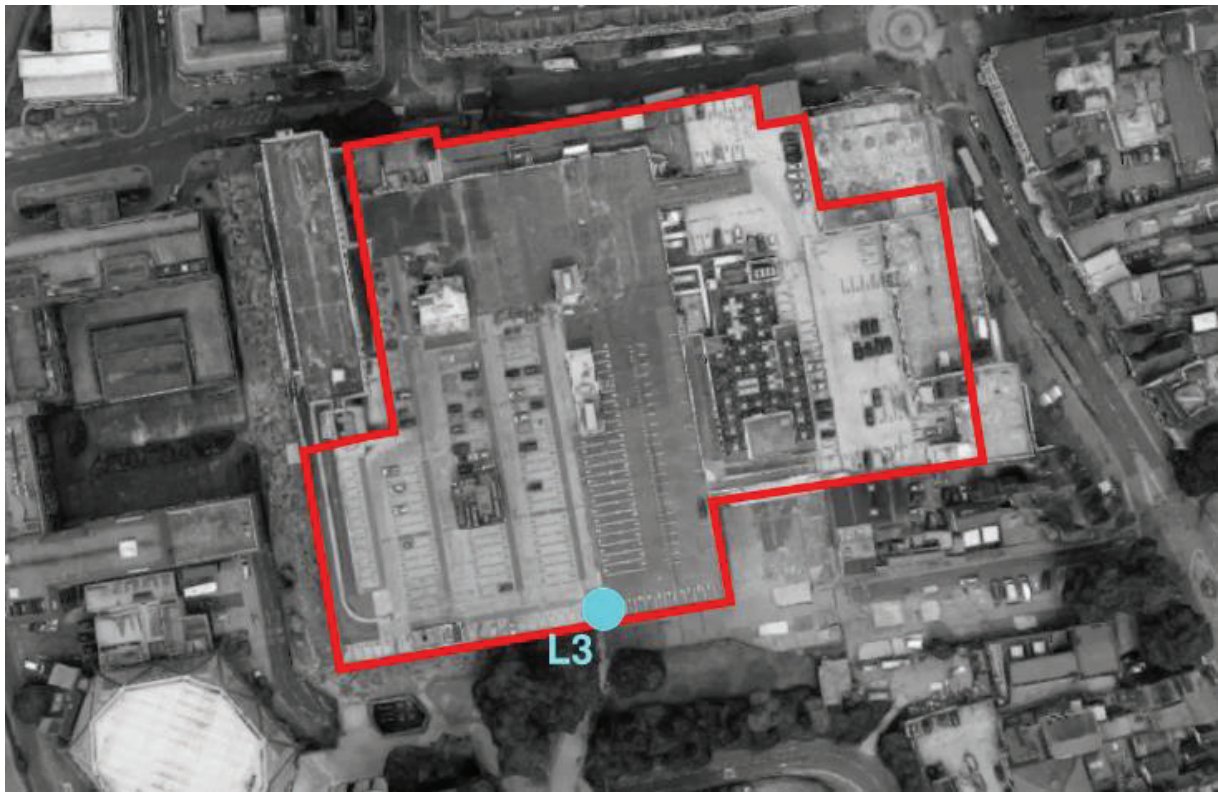


Figure 9 - Satellite image of survey location L3



Figure 10 - Photograph of logger at location L3 overlooking Dusseldorf Way

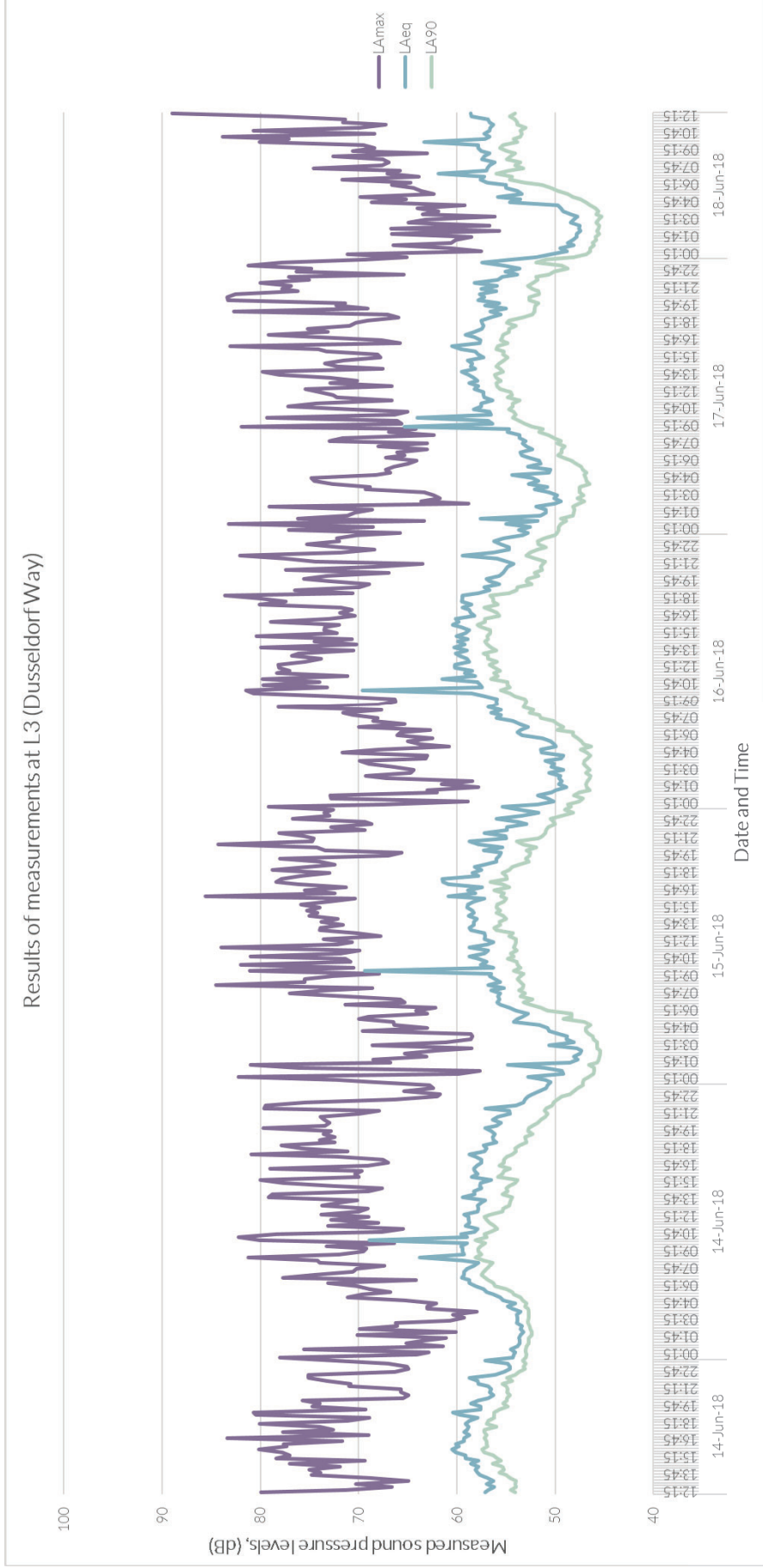


Figure 11 - Time history of noise levels measured at location L3

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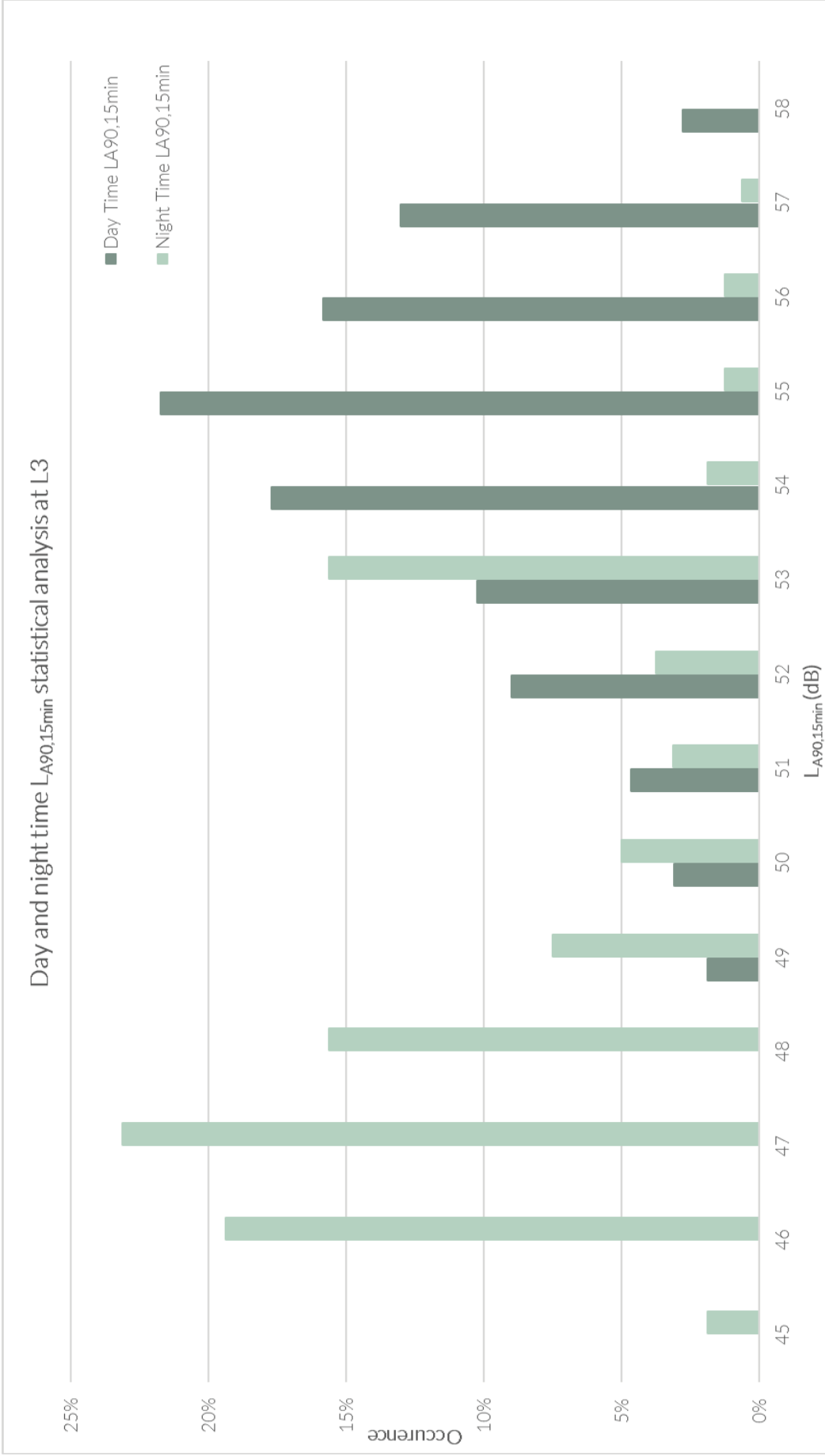


Figure 12 – Histogram of background levels measured at location L3

4. Location L4 – West of site

Noise Monitoring Information Sheet						
Name	Location L4					
Description	Location L4 was located on the western boundary of the site approximately 18m above ground overlooking Queen's Walk. Consistently high volumes of road traffic along the A329 to the west was the dominant noise source with some contribution from Oxford Road to the north and intermittent car park traffic directly below.					
Equipment		Type	Serial Number		Last Calibrated	
Sound Level Meter		NL-52	00632045		15/08/2017	
Pre-amplifier		NH-25	32073		15/08/2017	
Microphone		UC-59	05212		15/08/2017	
Calibrator		B&K 4231	3014189		11/10/2017	
SLM Range		20 – 120 dB(A)				
Data Collected						
Time Start		Time End	Cal. Start	Cal. End	Drift	Notes
13:00 13/06/2018		12:45 18/06/2018	93.9	93.9	0	

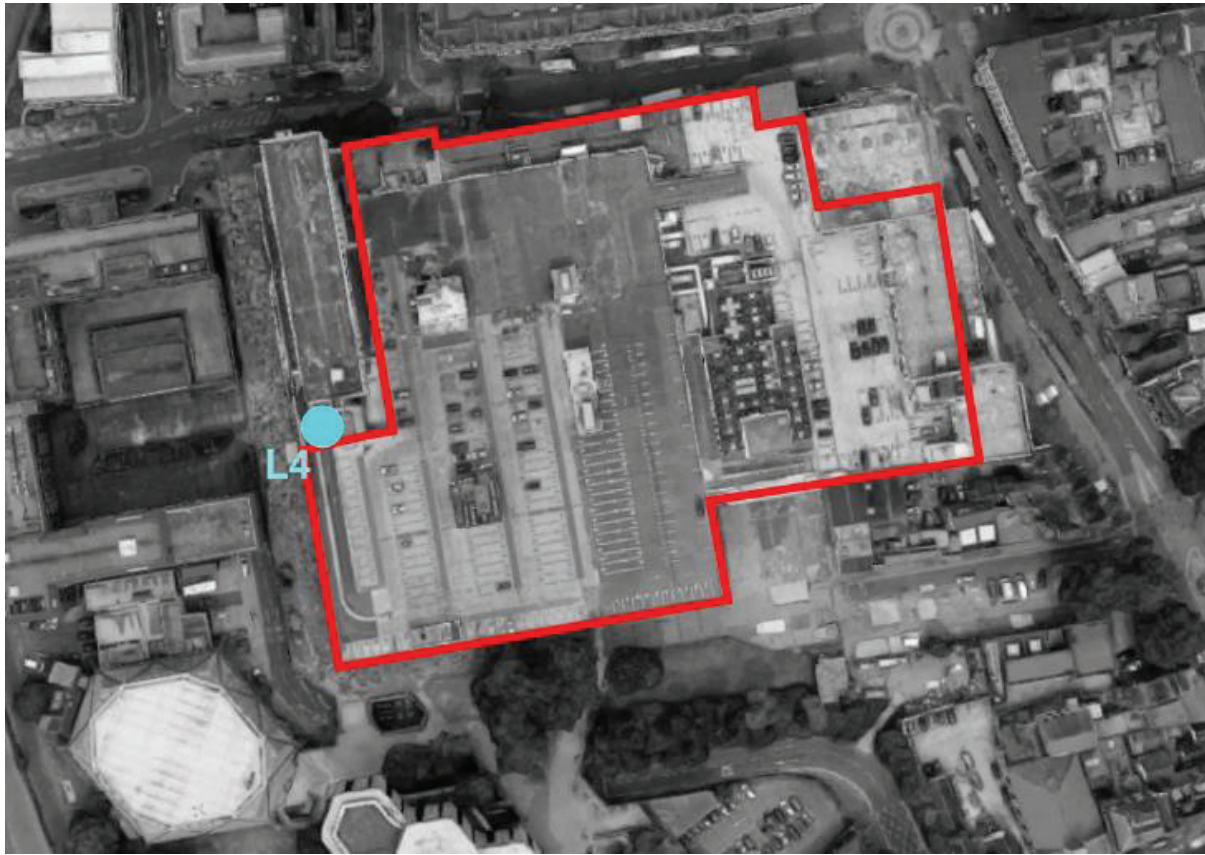


Figure 13 - Satellite image of survey location L4



Figure 14 - Photograph of logger at location L4 overlooking Queen's Walk

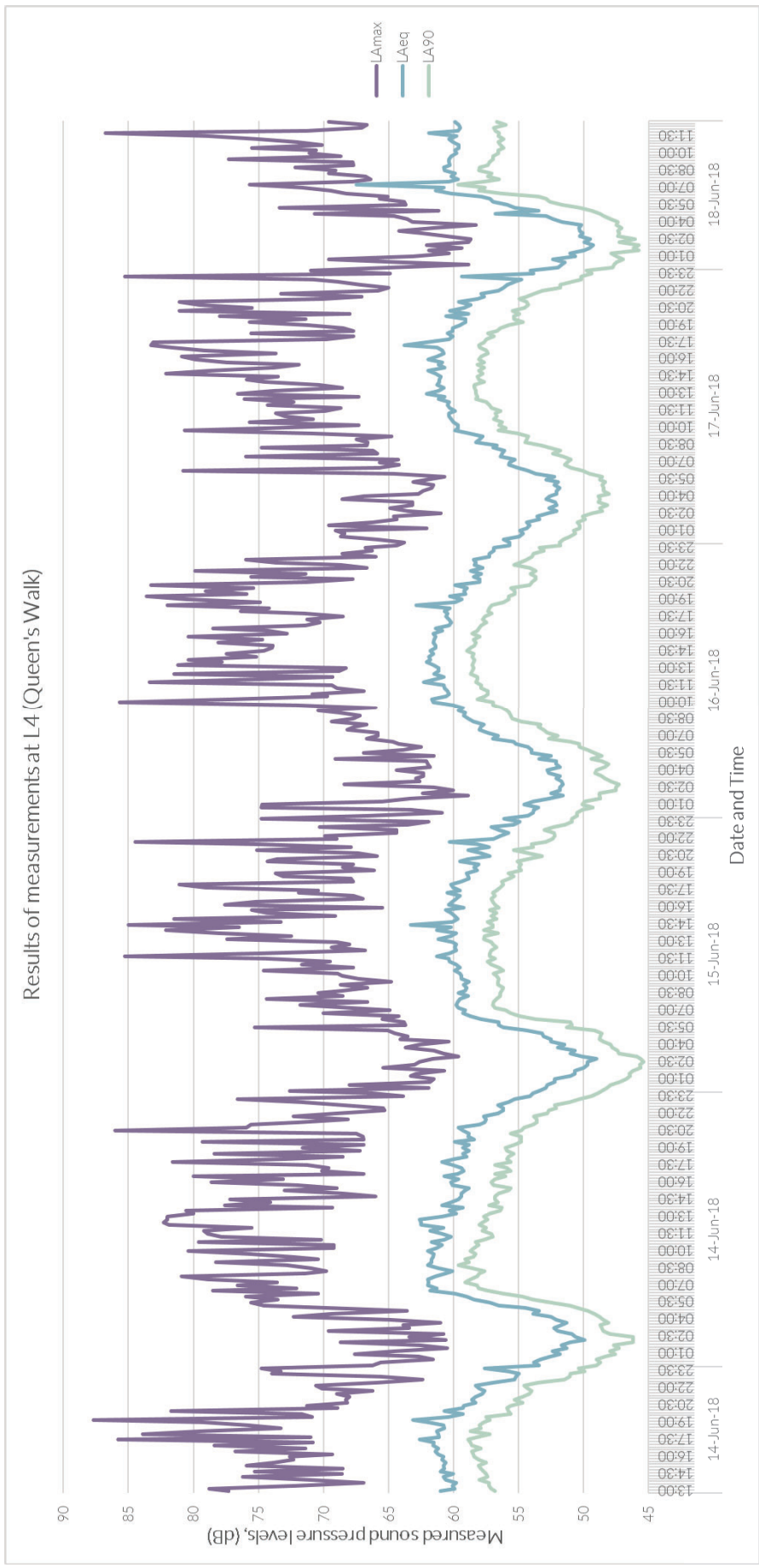


Figure 15 - Time history of noise levels measured at location L4

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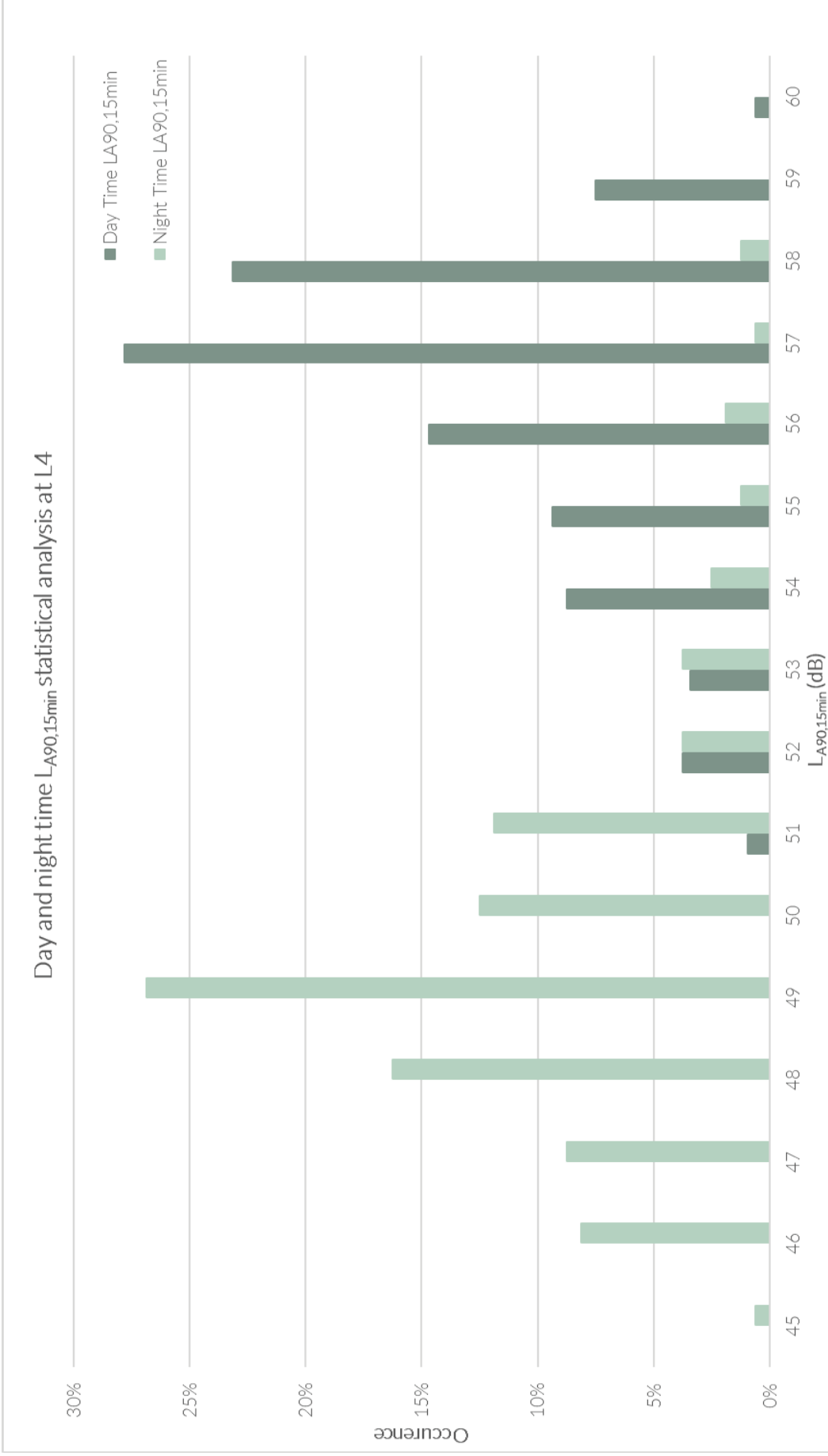


Figure 16 - Histogram of background levels measured at location L4