appendix 15.
noise impact assessment

Noise Impact Assessment

Kilburn Mews, London

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1 Introduction

Sweco UK Ltd has been instructed by Transport for London – Simon Stockley to prepare a noise impact assessment for the proposed renovation of 12 railway arches as well as a construction of a new Use Class E unit, in order to provide a total of 11 Use Class E units, at Kilburn Station, London. The purpose of this assessment is to support a new planning application.

A detailed environmental noise and vibration survey was undertaken at the site and surrounding area, to inform the subsequent assessments.

Based on the measured noise levels affecting the site, this report provides performance recommendations and minimum specification for the building envelope, such that appropriate internal ambient noise levels can be achieved within the proposed uses.

This report sets limits for noise arising from operational activities associated with the use of the retail units, in accordance with BS4142:2014+A1:2019. Based on the proposed uses, a maximum internal ambient noise level has been determined within the retail units, that will comply with the set limit.

This report also sets limits for noise arising from any proposed items of static plant, in accordance with BS4142:2014+A1:2019 along with an outline assessment based on the currently available information. Where necessary, mitigation recommendations have been provided.

An assessment of the impact of vibration from the passage of trains along the overhead lines has been undertaken, in order to determine the levels of vibration affecting the proposed retail units.

Whilst every effort has been made to ensure that this report is easily understood, it is technical in nature; a glossary of terms is included in Appendix A to assist the reader.

2 Policy and Assessment Methodology

2.1 Local Planning Policy and Guidance: London Borough of Camden

2.1.1 London Borough of Camden Local Plan

The Local Plan 2017 was adopted in January 2017 and is the strategy for planning the London Borough of Camden. Policy A4 deals with noise requirements for new development and states as follows:

Policy A4 Noise and vibration

The Council will seek to ensure that noise and vibration is controlled and managed.

Development should have regard to Camden's Noise and Vibration Thresholds (Appendix 3). We will not grant planning permission for:

a. development likely to generate unacceptable noise and vibration impacts; or

b. development sensitive to noise in locations which experience high levels of noise, unless appropriate attenuation measures can be provided and will not harm the continued operation of existing uses.

We will only grant permission for noise generating development, including any plant and machinery, if it can be operated without causing harm to amenity. We will also seek to minimise the impact on local amenity from deliveries and from the demolition and construction phases of development."

There are further details on Noise and Vibration are addressed between section 6.84 and section 6.106 of the Local Plan and are summarised as follows:

Sources and the character of noise in Camden

6.86 The main sources of noise and vibration in Camden are; road traffic, railways, industrial uses, plant and mechanical equipment, food, drink and entertainment uses, and building sites. The top six sources of noise that receive the most complaints in Camden are; music, construction noise, general people noise (e.g. footsteps, gathering), parties, fixed machinery and burglar alarms.

Assessing the impact of noise and vibration

6.89 Where uses sensitive to noise and vibration are proposed close to an existing source of noise or when development is likely to generate noise is proposed, the Council will require an acoustic report to accompany the application. In assessing applications, we will have regard to noise and vibration thresholds, set out in Appendix 3, and other relevant national and regional policy and guidance and British Standards. Further guidance on the application of these standards will be provided in supplementary planning document Camden Planning Guidance on amenity.

*6.90 Noise sensitive development includes **housing**, **schools** and **hospitals** as well as **offices**, **workshops** and **open spaces**. The impacts on external amenity spaces such as gardens and balconies will also be considered. Our supplementary planning document provides further information on how to minimise the impact of*

noise of developments; ways to mitigate noise emitted from developments and further detail on how the Council will assess the impact of noise and vibration.

6.91 Noise generating uses and fixed machinery will likely have a greater impact on amenity when the background noise level is lower or in areas where noise sensitive uses such as residential developments co-exist with other uses. The Council will take into consideration the general character of the noise (whether noise is intermittent, has a distinct screech, bang, hiss) and where appropriate, the cumulative impacts of noise from one or more noise sources and will assess whether tighter noise restrictions, secured by planning condition, should be imposed.

6.92 Planning permission will not normally be granted for development sensitive to noise in locations that have unacceptable levels of noise and vibration. The Council will only grant planning permission for development sensitive to noise and vibration, in locations that experience high levels of noise and for development likely to generate noise impacts, if appropriate attenuation measures can be taken. Such attenuation measures should be included on plans. Planning permission will not be granted in instances where there will be a significant adverse impact on external amenity areas including gardens, balconies and open spaces unless they can be appropriately mitigated.

6.100 Emergency equipment such as generators which are only to be used for short periods of time will be required to meet the noise criteria of no more than 10dB above the background level ($L_{90\ 15\ minutes}$). During standby periods, emergency equipment will be required to meet the usual criteria for plant and machinery. Conditions to this effect may be imposed in instances where emergency equipment forms part of the application.

2.1.2 London Borough of Camden Typical Planning Condition for Industrial and Commercial Noise Emissions

The London Borough of Camden Environmental Health department have been consulted previously in relation to noise from building services systems and fixed mechanical plant. Their typical planning condition in relation to this aspect has previously been provided and is understood to be as follows:

> *"Where appropriate and within the scope of the document it is expected that British Standard 4142:2014 'Methods for rating and assessing industrial and commercial sound' (BS 4142) will be used. For such cases a 'Rating Level' of 10 dB below background (15dB if tonal components are present) should be considered as the design criterion)."*

2.1.3 Adopted Criteria for Noise Emissions

In accordance with the above expected typical criteria, the following criteria has been adopted for the project:

- Cumulative rating level from any proposed items of static plant shall not exceed 10 dB below existing background sound level at surrounding receptors.

- Cumulative rating level from operational noise (primarily internal activity noise break-out) shall not exceed 10 dB below existing background sound level at surrounding receptors.

2.2 BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings

BS 8233:2014 provides guidance on internal acoustic environments in different types of spaces. The Standard advises that, for steady external noise sources, it is desirable for internal ambient noise levels to not exceed the guidance values for non-domestic buildings, as detailed in Table 1 below.

Table 1: BS 8233:2014 Commercial Indoor Ambient Noise Levels (IANL)

Space Type	$L_{Aeq,T\ (Operational\ time)}$, dB
Restaurant	40 – 55
Night club, public house	40 – 45
Open plan office	45 – 50
Meeting Rooms/Training Rooms	35 – 45
Department Store	50 – 55

A target indoor ambient noise level of 45 dBA has been adopted for the proposed gymnasium. This target noise level is based on the sports hall indoor ambient noise limit recommended by BB93 - Acoustic design of schools: performance standards (Sports Hall – Refurbishment limit).

It must be noted that the above criteria applies for closed spaces only.

2.3 British Standard 6472

BS 6472:2008 Guide to evaluation of human exposure to vibration in buildings, Part 1, Vibration sources other than blasting describes how to determine the vibration dose value, VDV, from frequency-weighted vibration measurements.

The vibration dose value is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings. Consideration is given to the time of day and use made of occupied space in buildings, whether residential, office or workshop.

BS 6472 contains a methodology for assessing the human response to vibration in terms of either the vibration dose value, or in terms of the acceleration or the peak velocity of the vibration, which is also referred to as peak particle velocity. The advice contained in BS 6472 states that when the vibration is intermittent, as is the case at this site with the only significant potential source of vibration being the railway lines to the west, the vibration dose value, or VDV, may be used to assess the potential for impacts.

Appropriately-weighted vibration measurements can be aggregated to derive the vibration dose values. The vibration dose value is a single figure descriptor that represents the cumulative dose of transient vibrations, taking into account the frequency spectrum and duration of each event. The vibration dose value is determined over a 16 hour daytime period or eight hour night-time period, and the guidance in BS 6472 is set out as follows, with reference to residential buildings:

Table 2: Vibration Dose Values ($ms^{-1.75}$) Above Which Various Degrees of Adverse Comment May Be Expected in Residential Buildings			
Period	**Low Probability of Adverse Comment**	**Adverse Comment Possible**	**Adverse Comment Probable**
Residential Buildings – 16-hour day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential Buildings – 8-hour night	0.13	0.26	0.51
NOTE For offices and workshops, multiplying factors of 2 and 4 respectively should be applied to the above vibration dose value ranges for a 16 h day			

In this instance, based on the expected uses of the proposals, the above criteria values will be multiplied by a factor of 2, in accordance with the note provided in the Table. For east, the table below presents the vibration dose values limits used in this assessment, when considering an office use.

Table 3: Vibration Dose Values ($ms^{-1.75}$) Above Which Various Degrees of Adverse Comment May Be Expected in Commercial (Office) Buildings			
Period	**Low Probability of Adverse Comment**	**Adverse Comment Possible**	**Adverse Comment Probable**
Offices – 16-hour day	0.4 to 0.8	0.8 to 1.6	1.6 to 3.2

2.4 BS4142:2014+A1:2019

BS 4142 sets out a method to assess the likely effect of sound from factories, industrial premises or fixed installations and sources of an industrial nature in commercial premises, on people who might be inside or outside a dwelling or premises used for residential purposes in the vicinity.

The procedure contained in BS 4142 for assessing the effect of sound is to compare the measured or predicted sound level from the source in question, the $L_{Aeq,T}$ 'specific sound level', with the $L_{A90,T}$ background sound level at the assessment location.

Where the sound contains a tonality, impulsivity, intermittency and other sound characteristics, then a correction depending on the grade of the aforementioned characteristics of the sound is added to the specific sound level to obtain the $L_{Ar,Tr}$ 'rating sound level'. A correction to include consideration of a level of uncertainty in sound measurements, data and calculations can also be applied when necessary.

BS 4142 states: "The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs". An estimation of the impact of the specific sound can be obtained by the difference of the rating sound level and the background sound level and considering the following:

Table 4: Classification of Industrial/Commercial Noise Impacts	
Difference Between Rating Sound Level and Background Sound Level (dB)	**Impact Category (depending on the context)**
+ 10 dB or more	Significant adverse impact
+ 5 dB	Adverse impact
Equal or less than	Low impact

For the daytime, the assessment is typically carried out over a reference time period of one hour, but at night-time it is carried out over a 15-minute period. The periods associated with day or night, for the purposes of the Standard, are 07.00 to 23.00 and 23.00 to 07.00, respectively.

Interpreting the guidance given in BS4142:2014, with consideration of the guidance given in the NPSE and NPPG Noise, an estimation of the impact of the rating sound is summarised in the following text:

- A rating sound level that is +10 dB above the background sound level is likely to be an indication of a Significant Observed Adverse Effect Level.
- A rating sound level that is +5 dB above the background sound level is likely to be an indication of a Lowest Observed Adverse Effect Level.
- The lower the rating sound level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating sound level does not exceed the background sound level, this is an indication of the specific sound source having a low impact and would therefore classify as a No Observed Adverse Effect Level.

In this instance, in order to comply with the Local Authority criteria, the rating level from either static items of plant and operational activities' noise will be limited to 10 dB below background sound level.

3 Proposed Development

3.1 Site Description

The proposed development site is located near Kilburn Station, east of Kilburn High Road and north of Loveridge Road. The current site comprises a number of railway arches, as well as external areas. A number of the existing arches are currently being used. From our observations, some of the existing uses include vehicle repair shops, photography studio and an art / sculpture studio.

The site is located in a relatively busy urban setting, not untypical for the area. The surrounding area is a mixture of urban infrastructure (major road and rail network), commercial elements and residential areas. To the north, east and south-east, the site is predominantly surrounded by residential dwellings and flats. To the west, the site is bound by Kilburn station and Shoot-Up Hill / Kilburn High Road, which is a busy main road. The overhead rail lines include a mixture of overground and underground trains. The northern lines accommodate southbound services, whilst the lines to the south accommodate northbound services. The number of services used on either of these lines is expected to be identical.

The nearest noise-sensitive receptors are outlined below:

- NSR1 – residential dwellings and flats south of Maygrove Road;
- NSR2 – residential dwellings and flats north of Maygrove Road;
- NSR3 – residential flats at 2 to 4 Shoot-Up Hill;
- NSR4 – residential flats at Kilburn High Road;
- NSR5 – residential flats at Loveridge Mews / Loveridge Road;
- NSR6 – residential dwellings and flats along Loveridge Road.

The location of the proposed development site and the nearest noise-sensitive receptors are identified in Figure 1.

Figure 1: Site location (red line), nearest noise-sensitive receptors (NSRs) and surrounding area

3.2 Proposed Development

The development will comprise the renovation of the existing railway arches as well as new-build retail unit, in order to provide a total of 11 no. class E retail units and improvements to the public realm.

There are no allocated tenants at this stage, therefore the applications seeks maximum flexibility within the desired class.

Figure 2 below shows the current layout of the proposals.

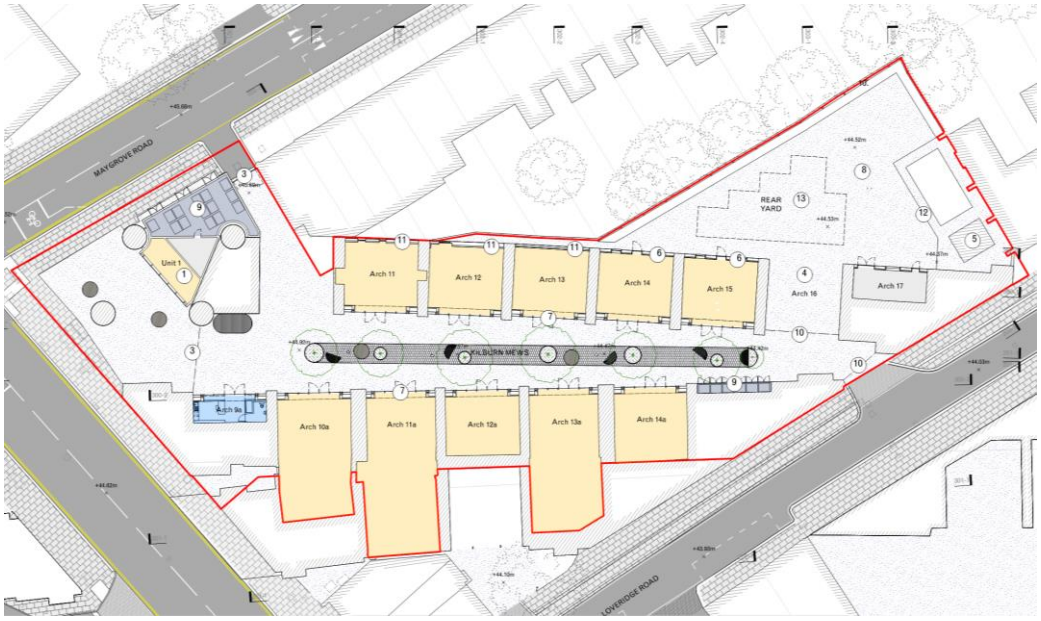

Figure 2: Layout of the proposals

4 Noise and Vibration Survey

4.1 Survey Overview

The prevailing noise and ground-borne vibration conditions in the area have been determined by an environmental noise and vibration survey at a number of external measurement locations at the development site as well as within the existing archway units. The environmental noise and vibration survey was undertaken by Sweco over a period of 48 hours, between Wednesday 20 and Friday 22 July 2022.

The results of the survey are used to:

- Establish the existing noise levels affecting the proposed development site, in order provide a specification for the building envelope (primarily glazing and ventilation strategy).
- Determine the likely effect of the vibration from the overhead railway lines on the proposed development site.
- Establish the existing background noise levels at the surrounding receptors, in order to set a noise limit for any proposed items of static plant, as well as operational activities' noise.

4.2 Methodology

All noise measurements were undertaken by a consultant certified as competent in environmental noise monitoring, and, in accordance with the principles of BS 7445.

All acoustic measurement equipment used during the noise survey conformed to Type 1 Specification of BS 61672. A full inventory of this equipment is shown in Table 5 below:

Table 5: Inventory of Equipment

Item	Make & Model	Serial Number
1 - Sound Level Meter	Rion NA-28	00860027
1 - Preamplifier	Rion NH-23	60027
1 - Microphone	Rion UC-59	10030
2 - Sound Level Meter	01dB Fusion	12089
2 - Preamplifier	01dB PRE-22N°	1805176
2 - Microphone	GRAS 40CE	331995
3 - Vibration Monitoring Station	Svantek SV958A	59194
3 - Accelerometer	Svantek SV84	E4997
Calibrator	B&K 4231	2615249

All noise measurement equipment used during the survey was calibrated at the start and end of the measurement period. The calibrator used had been calibrated by an accredited calibration laboratory within the twelve months preceding the measurements. No significant drift in calibration was found to have occurred on any sound level meter.

The microphones were fitted with protective windshields for the measurements. The sample period was selected following close monitoring of local weather conditions.

During the survey, it was noted that the weather conditions were generally suitable for a noise measurement exercise, it being dry with very light winds.

The measurements are detailed and illustrated on Figure 3 below.

Noise Measurement Position 1 (MP1):

Unattended noise measurement position within the rear yard behind Arch 16. The microphone was located 3 metres above the ground level and approximately 2 metres from the boundary with the rear gardens of Maygrove Road dwellings.

The noise climate at this position was deemed representative of the existing background sound conditions at the nearest noise-sensitive receptors (NSR 1 – rear façades of Maygrove Road and NSR6 – Loveridge Road). Measurements at this position were therefore primarily used to set the relevant noise limits, in accordance with the Local Authority criteria and relevant Guidance.

Since the survey was largely unattended, it is not possible to comment on the precise nature of the noise climate for the entire duration of the survey. However, during our time on site, it was noted that noise levels at this measurement position were dominated by frequent overhead rail traffic movements, consisting of passenger trains. The noise climate was also found to be affected by screened road traffic from the surrounding network, domestic works from an adjacent property to the north and some activities associated with the use of the existing site.

Noise Measurement Position 2 (MP2):

Unattended noise measurement position within the inner courtyard of the Kilburn Mews. The microphone was extended via a partially open window on the first floor of the unit in Arch 12, 4.5 metres above the ground level, and approximately 1 metre from the façade of the unit.

Measurements at this position were deemed representative of the façade-incident noise levels affecting the proposed front façades of future units located within Arches 11 – 15. Measurements at this position also further assist in characterisation of the current background sound conditions in the area and at the nearest noise-sensitive receptors.

Spot Measurement 1 (SM1):

Short-term attended 2 x 15-minute measurements of noise levels along Maygrove Road. Measurements at this location were used to determine the levels of background sound affecting road-facing façades of dwellings along Maygrove Road (NSR1, NSR2 as well as NSR3), by comparing them to measurements from the same periods at MP1.

The noise levels at this measurement position were predominantly affected by road traffic noise arising from Shoot-Up Hill / Kilburn High Road and overhead railway traffic noise.

Spot Measurement 2 (SM2):

Short-term attended 2 x 15-minute measurements of noise levels along Shoot-Up Hill / Kilburn High Road.

Measurements at this location were used to:

- Determine the levels of background sound affecting road-facing façade of 2-4 Shoot-Up Hill (NSR3), by comparing them to measurements from the same periods at MP1.
- Determine the levels of façade-incident sound at the location of the proposed façade of Retail Unit 1.

The noise levels at this measurement position were heavily dominated by road traffic noise arising from Shoot-Up Hill / Kilburn High Road and overhead railway traffic noise.

Spot Measurement 3 (SM3):

Short-term attended 1 x 15-minute measurement of noise levels along Loveridge Road. Measurements at this location were used to determine the levels of background sound affecting eastern façade of residential flats on Kilburn High Road (NSR4) as well as flats on corner of Loveridge Mews / Loveridge Road (NSR5), by comparing them to measurements from the same periods at MP1.

The noise levels at this measurement position were predominantly affected by road traffic noise arising from Kilburn High Road and overhead railway traffic noise.

Vibration Measurement Position 1 (VP1):

Unattended vibration measurement position at the ground floor level within the existing unit in Arch 12A. The accelerometer was mounted on a metal plate, levelled and placed on the base of the existing floor structure, approximately 2 metres set back from the unit's northern façade.

Measurements at this position were deemed representative of the existing VDV levels arising from the overhead rail lines, affecting the proposed units.

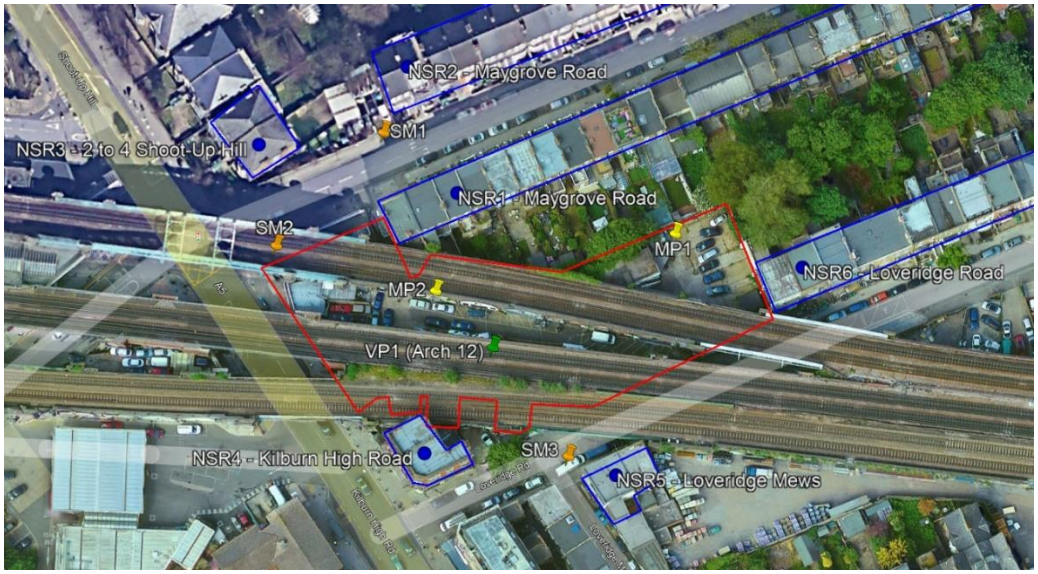

Figure 3: Measurement Locations

4.3 Noise Measurement Results

4.3.1 Unattended Noise Measurements (MP1-2)

A summary of the unattended measured daytime and night-time noise levels at measurement positions MP1 and MP2 are presented in Table 6-7 below. The values are rounded to the nearest whole number. A graphical illustration of the unattended noise measurement data during the full measurement period is presented in Appendix B.

Table 6: Measured Broadband Noise Levels at MP1 (dBA)

Day	Period	$L_{Aeq,T}$ (dB)	$L_{A90,T}$ (dB)*	Maximum L_{AFmax} (dB)
Wednesday 20/07/2022	Daytime (07:00-23:00)	-	-	-
	Night-time (23:00-07:00)	51	34 – 39	91
Thursday 21/07/2022	Daytime (07:00-23:00)	57	44 – 46	91
	Night-time (23:00-07:00)	51	38 – 43	83

*The L_{A90} is estimated as a typical value for periods (T) of 1 hour during the daytime and 15 minutes during the night-time periods

Table 7: Measured Broadband Noise Levels at MP2 (dBA)				
Day	**Period**	**$L_{Aeq,T}$ (dB)**	**$L_{A90,T}$ (dB)***	**Maximum L_{AFmax} (dB)**
Wednesday 20/07/2022	Daytime (07:00-23:00)	-	-	-
	Night-time (23:00-07:00)	57	33 – 42	81
Thursday 21/07/2022	Daytime (07:00-23:00)	62	46 – 48	84
	Night-time (23:00-07:00)	58	34 – 38	85
*The L_{A90} is estimated as a typical value for periods (T) of 1 hour during the daytime and 15 minutes during the night-time periods				

4.3.2 Attended Noise Measurements (SM1-3)

A summary of the attended measured noise levels at SM1-3 are presented in Tables 8-10 below. The values are rounded to the nearest whole number.

Table 8: Measured Noise Levels at Spot Measurement 1 (compared to same period at Measurement Position 1)			
Day	**Period**	**L_{Aeq} (dB)**	**L_{A90} (dB)**
20/07/2022 16:40 – 16:55 (15 min)	Spot Measurement 1	65	54
	Measurement Position 1	55	46
20/07/2022 17:55 – 18:10 (15 min)	Spot Measurement 1	65	55
	Measurement Position 1	46	47
Overall difference*		10	7
*MP1 measurement adjusted for the identified difference to determine background sound levels at NSR2, rear façade of NSR3 and road-fronting façade of NSR1			

Table 9: Measured Noise Levels at Spot Measurement 2 (compared to same period at Measurement Position 1)			
Day	**Period**	**L_{Aeq} (dB)**	**L_{A90} (dB)**
20/07/2022 17:00 – 17:15 (15 min)	Spot Measurement 2	71	62
	Measurement Position 1	53	41
20/07/2022 18:15 – 18:30 (15 min)	Spot Measurement 2	71	62
	Measurement Position 1	56	48
Overall difference*		17	18
*MP1 measurement adjusted for the identified difference to determine background sound levels at front façade of NSR3			

Table 10: Measured Noise Levels at Spot Measurement 3 (compared to same period at Measurement Position 1)			
Day	**Period**	**L_{Aeq} (dB)**	**L_{A90} (dB)**
20/07/2022 17:20 – 17:35 (15 min)	Spot Measurement 3	62	53
	Measurement Position 1	54	46
Overall difference*		8	7
*MP1 measurement adjusted for the identified difference to determine background sound levels at north-eastern façade of NSR4 and northern façade of NSR5			

Using measurements at MP1 and SM1-3, Figure 4 below illustrates the measured and calculated existing background sound levels $L_{A90,T}$ (daytime and night-time) at each of the receptors, which the below assessments consider.

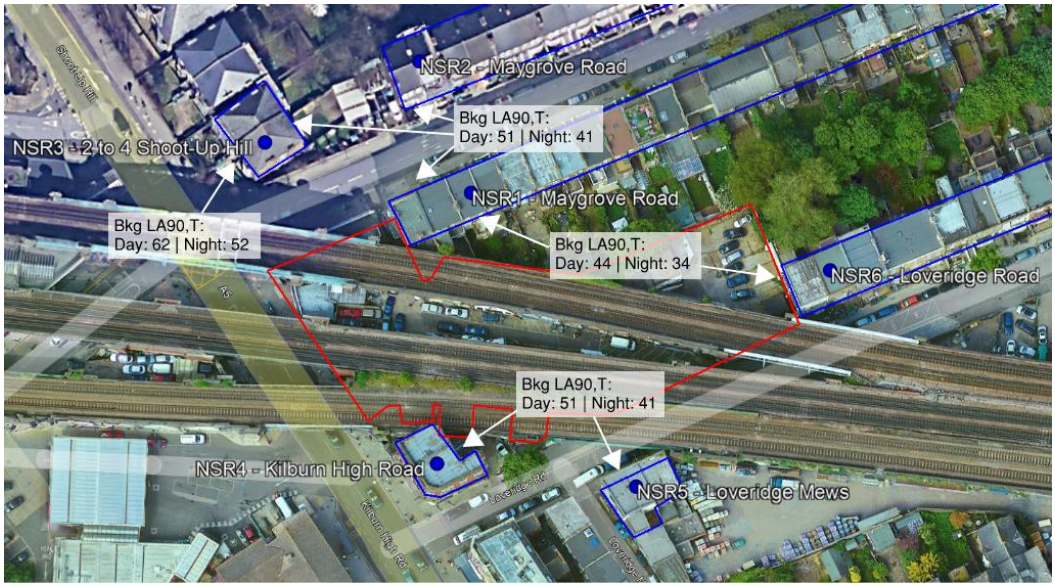

Figure 4: Background $L_{A90,T}$ Sound Levels at each Receptor Considered in the Assessment

4.4 Vibration Measurement Results (VP1)

A summary of the vibration measurements at VP1 are presented in Table 11 below.

Table 11: Measured Vibration Dose Value Levels at VP1 – Arch 12A ($m/s^{-1.75}$)				
Day	**Period**	**Axis**		
		X	**Y**	**Z**
Wednesday 20/07/2022	Daytime (07:00-23:00)	-	-	-
	Night-time (23:00-07:00)	0.005	0.005	0.042
Thursday 21/07/2022	Daytime (07:00-23:00)	0.008	0.007	0.067
	Night-time (23:00-07:00)	0.005	0.005	0.042

5 Building Envelope Assessment

Based on the measured noise levels affecting the site, a detailed assessment has been undertaken to determine the minimum reduction for the building envelope that would be required to ensure that suitable indoor ambient noise levels can be achieved across a variety of class E uses.

The building envelope sound reduction requirement has been provided for each of the variety of uses as listed in Section 2.2. It should be noted that the criteria and assessment has only been applied to spaces where the building envelope is expected to remain closed during normal operations (please see Section 5.2 below).

5.1 Assessment Assumptions

5.1.1 Drawings:

This assessment has been based on the following drawings, supplied to us by DK-CM architects:

- Drawing no. 2018-S3-201-DR2 (date: 07/07/2022)
- Drawing no. 2018-S3-202-DR2 (date: 07/07/2022)
- Drawing no. 2018-S3-203-DR2 (date: 07/07/2022)
- Drawing no. 2018-S3-601-DR2 (date: 07/07/2022)
- Drawing no. 2018-S3-602-DR2 (date: 07/07/2022)
- Drawing no. 2108-S3-100- (date: 21/03/2022)

5.1.2 Other Assumptions

As is necessary at this stage, our assessment has been based on a number of robust assumptions. These are outlined below:

- For the archway units the glazed area and dimensions have been determined from the drawings provided (Section 5.1.1). Any non-glazed façades assumed to be solid. Units are to be open plan internally (i.e. shell only) with typical dimensions of 8.5m wide, 9m deep and 6.5m high;
- It has been assumed as a worst case that the future units will not be acoustically treated for controlling reverberation. Based on this assumption, the reverberation time within the proposed units is expected to be circa 1 second.
- It has been assumed that the proposed retail units will operate during the daytime only (07:00 to 23:00 hours).

5.2 Assessment Exclusions

It is understood that Unit 1(New build) will feature a bi-folding glazed door as the main façade element. It has also been confirmed that the bi-folding doors will generally remain open during the operational hours of the unit. As such, is not considered appropriate (or achievable) to apply an internal ambient noise limit to this unit, which will be fully exposed to the street noise environment. To that end, based on the proposed usage, Unit 1 has been excluded from this assessment.

For guidance purposes, where the façade was to remain closed, Unit 1 (used as a shop) would be expected to require typical thermal façade treatments to achieve appropriate internal ambient noise levels as per the remaining units.

5.3 Building Envelope Sound Reduction Requirements

Table 12 below presents the broadband sound reduction requirements for the building envelope of the existing (and to be retained) railway arches, in order to comply with the proposed internal ambient noise level criteria for each space.

Table 12: Minimum Sound Reduction Performance Requirements for Railway Arches' Units

Example Use	Predicted External Free-field Level $L_{Aeq,16hr}$ (dBA)	Internal Ambient Noise Level Criteria (dB $L_{Aeq,16\ hour}$)	Broadband Sound Reduction Requirement (dB)
Restaurant	62	40 – 55	7 – 22
Meeting Room / Training Room		35 – 45	17 – 27
Open Plan Office		45 – 50	12 – 17
Department Store		50 – 55	7 – 12
Gymnasium		45	22

As may be seen with reference to Table 12, the external noise levels affecting the site are such that for some of the potential uses, it would be possible to adopt a ventilation strategy that relies on the use of opening windows (assuming a loss of 15 dB via a partially open window). However, for the more sensitive uses (where the IANL criteria are lower), the use of this strategy would not be expected to prove possible, so an alternative strategy that does not rely on façade openings would be required. In these cases, windows would need to remain closed and provide a defined sound reduction performance. Our initial assessment has shown that the relevant internal ambient noise levels could generally be achieved with use of standard thermal double glazed units (capable of achieving R_w [C_{tr}] 31 [-4]dB).

It must be noted that where a mechanical ventilation system is provided, the system must be designed so that external noise break-in via the ductwork is negligible. Additionally, noise arising from the operation of the system itself must be appropriately mitigated, so that suitable internal levels are achieved within the units, which will depend on the proposed uses. Accordingly, we would suggest that a detailed building services acoustic design is undertaken during the design stages by a suitable qualified acoustician.

6 Assessment of Transportation Vibration Impacts

6.1 Vibration Dose Value Impact Assessment

6.1.1 Assessment Overview

To assess the impacts from vibration resulting from the passage of trains on the overhead railway lines, measurements were undertaken on the ground floor levels within Arch 11. These measurements were deemed representative of vibration impacts across all units part of the proposed development.

Full details for the vibration survey carried out on site are presented in Section 4 of this report.

6.1.2 Assessment Results and Discussion

The tables below summarize the measured daytime vibration dose values ($ms^{-1.75}$) and provides an indication of the likelihood of compliance, in accordance with the guidance contained in BS6472-1:2008, with reference to commercial buildings. Whilst night-time impacts are not deemed relevant for the proposed development, they have been provided for information.

Table 13: Vibration Dose Values, $ms^{-1.75}$ within Arch 15 (representative of all proposed units)

Parameter	Period	
	Day (07:00 – 23:00)	Night (23:00 – 07:00)
Measured VDV ($ms^{-1.75}$)	0.067	0.042
VDV - Low Probability of Adverse Effect Limit ($ms^{-1.75}$)	0.4 - 0.8	0.26
Probability of Adverse Comment (BS6472-1:2008)	< low	< low

Table 13 identifies that the measured vibration dose values within Arch 11 are well below the level that would result in a 'low possibility of adverse comment', with reference to commercial use, in accordance with the guidance presented in BS 6472.

Accordingly, no mitigation measures are considered necessary to control the impact of vibration from the nearby railway line.

7 Operational Noise Impact

It is understood that all proposed 11 no. retail units are to be used under Class E. This includes shops, offices, cafés, restaurants, light industrial units, gymnasiums and more.

This section presents an outline noise impact assessment of operational noise associated with the expected noise levels within the units, in accordance with BS4142:2014+A1:2019 and the Local Authority criteria.

This should form part of any future tenancy agreements.

7.1 Local Authority Criteria

Operational noise emissions will need to be limited to give a cumulative sound rating level ($L_{Ar,Tr}$) of no greater than 10 dB below the prevailing background sound level ($L_{A90,T}$) at any time at the nearest noise-sensitive receptors.

7.2 Nearest Noise-sensitive Receptors

The nearest noise-sensitive receptors considered in the assessment are as outlined in Section 3.1 above.

7.3 Assessment Exclusions

It has been confirmed to Sweco that Unit 1 will be a flower shop (or similar retail use, with low activity noise). Noise impacts due to the activity of this type of commercial unit are considered negligible. Therefore, Unit 1 has been excluded in the operational noise impact assessment.

7.4 Assessment Assumptions

7.4.1 Internal Noise Levels within Proposed Retail Units

Based on the variety of proposed uses covered under Planning Use Class E, we have assumed a maximum indoor reverberant noise level within each proposed unit.

It is understood that a gymnasium is likely to be located in either Unit 10A, 11A or 13A. For the purposes of the assessment, Unit 10A has been considered as the location of the gymnasium. The reverberant noise levels detailed in Table 14 below, represent typical internal noise level within a gymnasium. Please note that these assumed noise levels are taken from our historic database of noise levels in similar establishments and are considered appropriate in this instance.

Table 14: Assumed Class E Gymnasium Internal Reverberant Levels

Internal Reverberant Levels (dB) at Octave Band Centre Frequency (Hz)									dBA
31.5	63	125	250	500	1k	2k	4k	8k	
93	93	94	84	83	93	86	77	74	95

For all remaining uses, the reverberant noise levels detailed in Table 15 have been assumed. These indoor ambient noise levels, also taken from our historic database, are considered representative of the worst-case activity noise levels for the likely uses.

Table 15: Assumed Non-Gym Class E Space Internal Reverberant Levels									
Internal Reverberant Levels (dB) at Octave Band Centre Frequency (Hz)									dBA
31.5	63	125	250	500	1k	2k	4k	8k	
87	82	77	74	72	70	67	62	62	75

7.4.2 Operation Periods

Based on the proposed use (Class E), it has been assumed that the units will operate during the daytime only (07:00 – 23:00 hours).

7.4.3 Façade Assumptions

Noise break-out via the glazing or ventilation elements will be weakest acoustic link.

It is understood that the units will be ventilated either naturally (using openable windows) or using a Mechanical Ventilation system. To that end, to ensure a worst-case assessment, it has been assumed that units 11, 12, 13, 14, 15, 13A and 14A are to be naturally ventilated and that. Units 10A, 11A and 13A are to be mechanically ventilated.

It is understood that the arches will primarily comprise glazed elements on their fronting façades, as indicated on the elevation plans provided. However, Arches 11, 12, 14 and 15 also comprise glazed elements and openings along their northern (rear) façade, facing NSR1 and NSR6.

7.5 Modelling

To establish the impact of noise arising from the proposed development at the nearest noise-sensitive receptors, predictions have been carried out using the Cadna/A suite of noise modelling software.

The predictions have been carried out using the methodology set out in ISO9613. The model considers the effects of the topographical conditions throughout the area, ground absorption, acoustic reflections, acoustic screening as well as applying a light downwind propagation correction to represent the worst case.

The above assumptions have been incorporated in the noise model, by covering the proposed glazed areas with vertical area sources, which were assigned an internal reverberant level (Table 15 and 16) and a façade reduction.

Where units were assumed to be mechanically ventilated (Unit 10A, 11A and 12A), with windows closed, a reduction for a standard thermal double glazing of $R_w(C_{tr})$ 31(-4) was considered.

Where units were assumed to be ventilated naturally via openable windows (all remaining units), the previously mentioned façade reduction of 15 dB was considered as a worst-case (BS8233).

As an absolute worst-case, all units were assumed to operate simultaneously.

A screenshot from our noise model is presented in Figure 5 below.

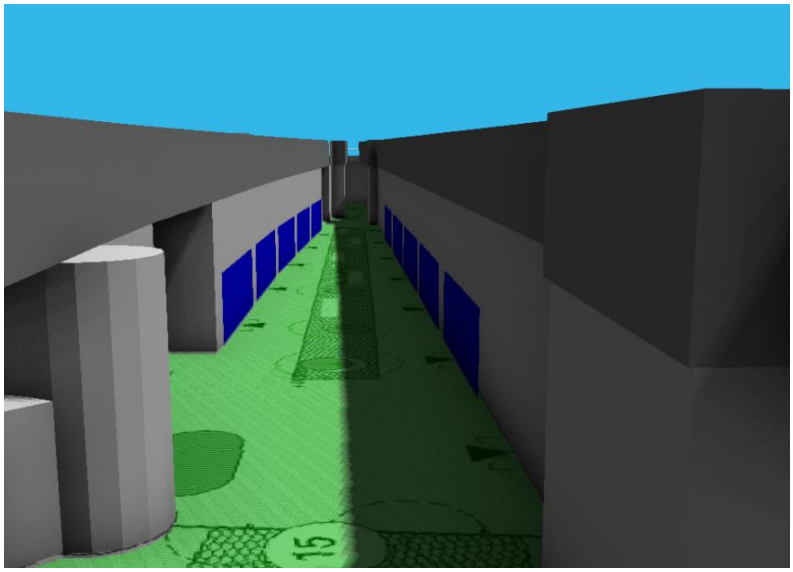

Figure 5: 3D Screenshot of Operational Noise Impacts' Noise Model

7.6 Assessment Results of Operational Noise Impacts

Table 16 below presents the predicted operational noise impacts at the considered receptors, considering daytime (07:00 – 23:00) periods only.

BS4142:2014 advises that when the noise contains a tonal, impulsive, intermittent or other sound characteristic, then a correction depending on the grade of aforementioned characteristics of the sound is added to the specific noise level to obtain the $L_{Ar,Tr}$ rating noise level. As the site's current operations are similar to the proposed ones, no corrections are deemed necessary, as the proposals are not considered to be introducing a new source into the area.

Table 16: Operational Noise Impacts (Daytime only)

Location	Predicted Specific Sound Level (dBA)	Background Sound Level $L_{A90,T}$ (dB)	Assessment Criteria	Excess of Specific over criteria (dB)
NSR1 – 2 Maygrove Road (southern façade)	45	44	34	+11
NSR2 – 1 Maygrove Road (southern façade)	23	51	41	-18
NSR3 – 2 to 4 Shoot-Up Hill (eastern façade)	23	51	41	-18

NSR3 – 2 to 4 Shoot-Up Hill (western façade)	25	62	52	-27
NSR4 – Kilburn High Road	33	51	41	-8
NSR5 (Loveridge Mews / Loveridge Road)	32	51	41	-9
NSR6 (Loveridge Road)	37	44	34	+3

As detailed in the table above, it can be concluded that the predicted operational activities' noise will result in an exceedance of the assessment criteria at the location of the most exposed noise-sensitive receptors, when assessed in accordance with the Local Authority limits and following guidance presented in BS4142:2014+A1:2019.

As such, suitable mitigation measures will need to be incorporated, in order to reduce the predicted operational noise impacts.

7.7 Mitigation Measures and Updated Assessment of Operational Noise Impacts

The above exceedances (Table 16) at NSR1 and NSR6 are dominated by noise break-out via partially open windows of glazed openings along the northern façades of Arches 11, 12, 14 and 15, due to their close proximity to the receptors' façades. As such, the following mitigation measures are recommended:

- Keep all windows and openings along these façades closed and rely on southern-facing windows for ventilation;
- Glazing elements along the northern façade of Arch 14 and 15 should achieve a sound reduction performance of minimum $R_w(C_{tr})$ 31(-4).
- Glazing elements along the northern façade of Arch 11 and 12 should achieve a sound reduction performance of minimum $R_w(C_{tr})$ 35(-4).

Table 17 below presents the predicted operational noise impacts at the considered receptors, with the above outlined mitigation measures, considering daytime (07:00 – 23:00) periods.

Table 17: Mitigated Operational Noise Impacts (Daytime only)

Location	Predicted Specific Sound Level (dBA)	Background Sound Level $L_{A90,T}$ (dB)	Assessment Criteria	Excess of Specific over criteria (dB)
NSR1 – 2 Maygrove Road (southern façade)	34	44	34	0

NSR2 – 1 Maygrove Road (southern façade)	22	51	41	-19
NSR3 – 2 to 4 Shoot-Up Hill (eastern façade)	21	51	41	-20
NSR3 – 2 to 4 Shoot-Up Hill (western façade)	25	62	52	-27
NSR4 – Kilburn High Road	32	51	41	-9
NSR5 (Loveridge Mews / Loveridge Road)	31	51	41	-10
NSR6 (Loveridge Road)	29	44	34	-5

With reference to Table 17 above, it can be concluded that with the implementation of the above mitigation measures, the predicted operational activities' noise will result in compliant noise impacts at the location of the nearest noise-sensitive receptors, when assessed in accordance with the Local Authority limits and following guidance presented in BS4142:2014+A1:2019.

It should be noted that this assessment includes assumptions related to the activity noise levels for the future retail units. A further noise impact assessment should be carried out if the activity noise levels assumed in this assessment are expected to be exceeded to ensure that the proposed noise levels do not have an adverse noise impact effect at the nearby receptors. It should be ensured that any future tenants are aware of the maximum reverberant noise levels used in this assessment and that if their intended operation is expected to exceed these limits, additional mitigation will be required. Similarly, any future tenants should be aware that windows and other openings along the northern façades of Units 11, 12, 14 and 15 should remain closed, in order to control noise break-out.

8 External Plant Noise Impact Assessment

8.1 Currently Proposed Plant Items

It is understood that the proposed development will comprise the following plant items:

- 2 no. External ASHP units on the rooftop of Waste Storage room (facing Maygrove Road);
- 1 x ASHP unit located within a plant room in Arch 17;
- Kitchen extract fans with a flue at roof level (where commercial kitchens are intended);
- Roof mounted exhaust cowl;
- Mechanical Ventilation (atmosphere-side) openings (where units are to be mechanically ventilated).

With exception of the 3 no. ASHP units, the exact location, make, model and source noise data for the above proposed items of static plant are not known at this stage.

8.2 Local Authority Criteria

Any items of static plant and machinery associated with the development will need to be designed to give a cumulative sound rating level ($L_{Ar,Tr}$) of no greater than 10 dB below the prevailing background sound level ($L_{A90,T}$) at any time at the nearest noise-sensitive receptors.

8.3 Nearest Noise-sensitive Receptors

The nearest noise-sensitive receptors considered in the assessment are as outlined in Section 3.1 above.

8.4 Plant Noise Emission Limits

The noise criteria for the cumulative sound rating level ($L_{Ar,Tr}$) is set out in Table 18 below.

Table 18: Proposed Target Sound Criteria for Static Items of Plant and Machinery

Location	Target Sound Criteria, $L_{Ar,Tr}$ (dB)	
	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
NSR 1 - Maygrove Road (southern façades)	34	24
NSR 1 - Maygrove Road (northern façades)	41	31
NSR 2 - Maygrove Road (southern façades)	41	31
NSR3 – 2 to 4 Shoot-Up Hill (eastern façades)	41	31

Table 18: Proposed Target Sound Criteria for Static Items of Plant and Machinery		
Location	**Target Sound Criteria, $L_{Ar,Tr}$ (dB)**	
	Daytime (07:00 – 23:00)	**Night-time (23:00 – 07:00)**
NSR3 – 2 to 4 Shoot-Up Hill (western façades)	52	42
NSR4 – Flats at Kilburn High Road	41	31
NSR5 – Loveridge Mews / Loveridge Road	41	31
NSR6 – Loveridge Road	34	24

The above limits apply to the total noise emission level from all static plant and processes within the proposed development. Individual plant items may need to be designed to a lower limit such that the overall total achieves the stated criteria above. Should the proposed plant items be found to be tonal, or impulsive in nature (so as to attract attention), a penalty should be applied to the above limits.

Compliance with the above limiting noise levels would result in an indication of a low impact in accordance with BS4142:2014+A1:2019 and the expected Local Authority criteria.

8.5 Practical Control Measures

Screening of any external plant as well as provision of noise attenuators and enclosures to items of plant may be necessary to control the transmission of noise and achieve the above criteria as well as to reduce the noise level produced by the plant to a reasonable extent throughout the site itself.

8.6 Outline Plant Noise Assessment

8.6.1 Overview

This section presents an outline assessment of noise from any known mechanical plant items, in accordance with the requirements of BS4142:2014+A1:2019 and the Local Authority criteria.

8.6.2 Methodology

To predict the propagation of noise from outdoor plant areas, the three-dimensional sound propagation model of the Proposed Development has been amended to include the primary known items of mechanical plant that are currently proposed. The model has been used to predict the level of sound that would be associated with the operation of the proposed 3 no. Air Source Heat Pumps (ASHPs).

8.6.3 Proposed Plant

The proposals include the installation of 2 no. ASHP units at the top of the proposed Waste Storage room (facing Maygrove Road) and one ASHP unit within the proposed plant room within Arch no. 17.

The acoustic specifications for the proposed ASHPs are detailed in Table 19 below.

Table 19: ASHP Noise Level Data

Unit	Sound Pressure Level (dB) at 1m at Octave Band Centre Frequency (Hz)								Sound Pressure Level at 1m (dBA)
	63	125	250	500	1k	2k	4k	8k	
Mitsubishi Electric CAHV-P500YB-HPB	66	60	66	60	52	50	56	48	63

It is understood that the proposed ASHPs will operate during the opening times for the retail units only.

BS4142 corrections for sound characteristics are not considered necessary for the proposed units.

8.6.4 Predicted Noise Levels at Nearest Noise-Sensitive Locations

External plant noise predictions have been carried out based on the current plant proposals. The predicted rating sound levels at the worst-receptors are presented in Table 20.

Table 20:Predicted external plant noise levels at the worst affected receptors – Daytime operation

Location	Predicted Rating Sound Level (dBA)	Assessment Criteria	Excess of Specific over criteria (dB)
NSR 1 - Maygrove Road (southern façades)	32	34	-2
NSR 1 - Maygrove Road (northern façades)	39	41	-2
NSR 2 - Maygrove Road (southern façades)	33	41	-8
NSR3 – 2 to 4 Shoot-Up Hill (eastern façades)	33	41	-8
NSR6 – Loveridge Road	34	34	0

The predicted ASHP rating noise levels are compliant with the plant noise limits at the nearest noise sensitive receptors.

It should be noted that the limits apply to the cumulative plant noise emissions arising from the proposed development site. As such, please note that mitigation measures may need to be considered at a later stage.to account for the noise emissions from other (currently unconfirmed) plant serving the development.

9 Conclusion

Sweco UK Ltd has been instructed by Transport for London – Simon Stockley to prepare a noise impact assessment for the proposed renovation of 12 railway arches as well as a construction of a new Use Class E unit, in order to provide a total of 11 Use Class E units, at Kilburn Station, London. The purpose of this assessment is to support a new planning application.

A detailed environmental noise and vibration survey was undertaken at the site and surrounding area, to inform the subsequent assessments.

This report provides performance recommendations and minimum specification for the building envelope, such that appropriate internal ambient noise levels can be achieved within the proposed uses.

This report sets limits for noise arising from operational activities associated with the use of the retail units, in accordance with BS4142:2014+A1:2019. Based on the proposed uses, a maximum internal ambient noise level has been determined within the retail units, that will comply with the set limit, along with performance recommendations for glazing elements, where windows are recommended to be closed for ventilation purposes or to control noise-breakout. It is recommended that appropriate tenancy agreements are put in place to control this.

External plant noise limits have been set out in accordance with the Local Authority criteria. The noise impact due to the operation of the proposed plant units have been predicted. Where necessary, mitigation recommendations have been provided.

An assessment of the impact of vibration from the passage of trains along the overhead lines has been undertaken to determine the levels of vibration affecting the proposed retail units. The measured vibration dose values on site are below the level that would result in a ‘low possibility of adverse comment’, with reference to commercial use, in accordance with the guidance presented in BS 6472. Therefore, no mitigation measures are considered necessary to control the impact of vibration from the nearby railway line.

Based on the findings of this report, the proposed development is considered to be suitable from a noise and vibration perspective and planning should not be refused on the basis of noise and/or vibration impacts, provided that the mitigation measures recommended in this report are implemented into the design.

Appendix A - Glossary of Acoustic Terminology

Wording	Description
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 Pascal's) 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 s1 and s2 is given by 20 log10 (s1 / s2). 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 or 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.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m

Wording	Description
Facade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast Time Weighting	An averaging time used in sound level meters. Defined in BS 5969.
Insertion Loss	The sound level reduction at a given location due to the insertion of a noise control device, expressed in decibels. The difference, in decibels, between the sound pressure level before and after the effect of a sound-attenuating device.
R_w	Sound Reduction Index: laboratory measurement that characterises the sound insulating properties of a material or building element in a stated frequency band. It is calculated through the following formula: R = L1 – L2 + 10 log (S/A), where L1 is the average sound pressure level in the source room, L2 is the average sound pressure level in the receiving room, S is the area of the test specimen in m2 and A is the equivalent sound absorption area of the receiving room). The w weighting is used to provide a single-number quantity for the sound reduction performance of a material or building element, and it is calculated in line with BS EN ISO 717-1.
D_{nTw}	Standardized Level Difference: in-situ sound insulation measurement between two rooms, which includes the effects of flanking transmission, different room sizes and other on-site considerations (differing from a laboratory measurement). This index corrects the measured level difference between rooms to a standardized reverberation time of 0.5 seconds. This RT value is often cited as approximately average for a medium sized, carpeted and furnished living room. The level difference per each frequency band is calculated using the following formula: D_{nT} = D + 10 log (T/T0), where D is the level difference (L1-L2), T is the reverberation time in the receiving room and T0 is the reference reverberation time (0.5 seconds for habitable rooms). The w weighting is used to provide a single-number quantity for the sound reduction performance of a material or building element, and it is calculated in line with BS EN ISO 717-1.
C_{tr}	Spectrum adaption term for an urban traffic noise spectrum, which is usually added to R_w or D_{nTw} values in order to characterise their sound insulation performance taking into account low frequency noise. This Ctr adaption term is calculated using the BS EN ISO 717-1.

Wording	Description
L_i	Impact Sound Pressure Level: average sound pressure level in a one-third octave band in the receiving room when the floor under test is excited by the standardized impact sound source; it is expressed in decibels.
L'_{nTw}	Weighted Standardized Impact Sound Pressure Level: in-situ impact sound pressure level in a stated frequency band, corrected for the standardized reverberation time of 0.5 seconds for a medium sized, carpeted and furnished living room. It is calculated using the following formula: $L_{nT} = L_i - 10 \log (T/T0)$, where Li is the impact sound pressure level, T is the reverberation time in the receiving room and T0 is the reference reverberation time (0.5 seconds for habitable rooms). The w weighting is used to provide a single-number quantity for the impact sound pressure level of a floor, calculated in line with BS EN ISO 717-2. The L_{nTw} is the equivalent index for laboratory measurements.

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.

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 logarithmic 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 generally regarded as the smallest change in broadband continuous noise which the human ear can detect (although in certain controlled circumstances a change of 1 dB(A) is just perceptible). Therefore, a 2 dB(A) increase would not be normally be perceptible. A 10 dB(A) increase in noise represents a subjective doubling of loudness.

A noise impact on a community is deemed to occur when a new noise is introduced that is out of character with the area, or when a significant increase above the pre-existing ambient noise level occurs.

For levels of noise that vary with time, it is necessary to employ a statistical index that allows for this variation. These statistical indices are expressed as the sound

level that is exceeded for a percentage of the time period of interest. In the UK, traffic noise is measured as the L_{A10}, the noise level exceeded for 10% of the measurement period. The L_{A90} is the level exceeded for 90% of the time and has been adopted to represent the background noise level in the absence of discrete events. An alternative way of assessing the time varying noise levels is to use the equivalent continuous sound level, L_{Aeq}.

This is a notional steady level that would, over a given period of time, deliver the same sound energy as the actual fluctuating sound.

Appendix B – Noise and Vibration Measurements

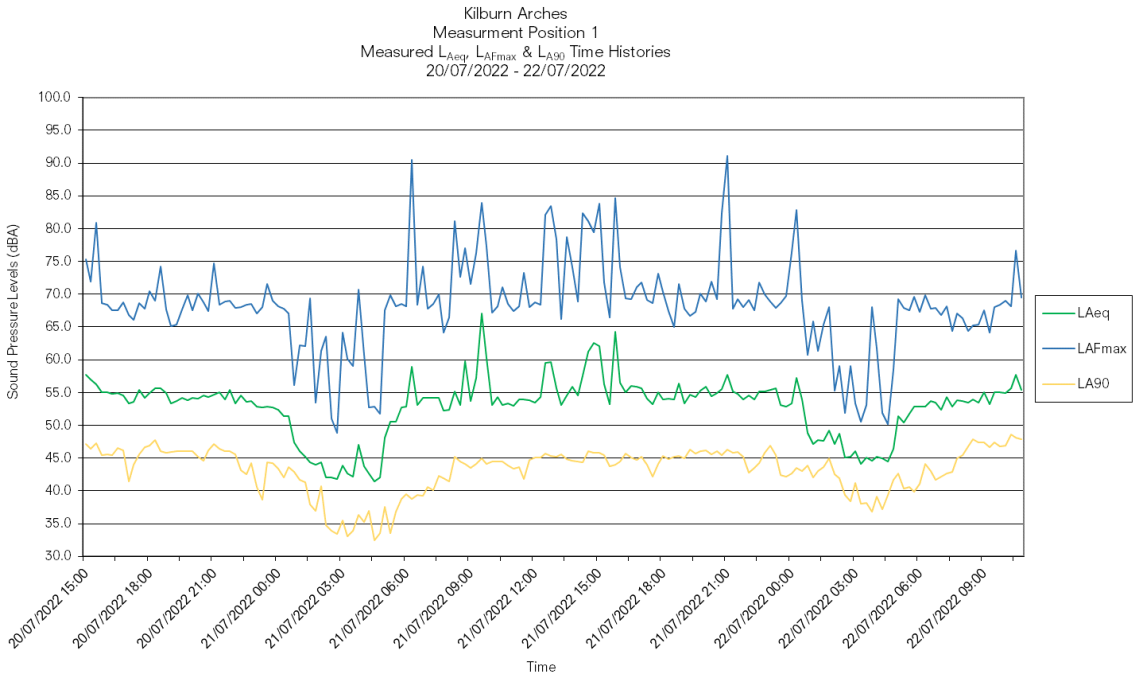

Figure B1: Measurement Position 1 Time History Graph

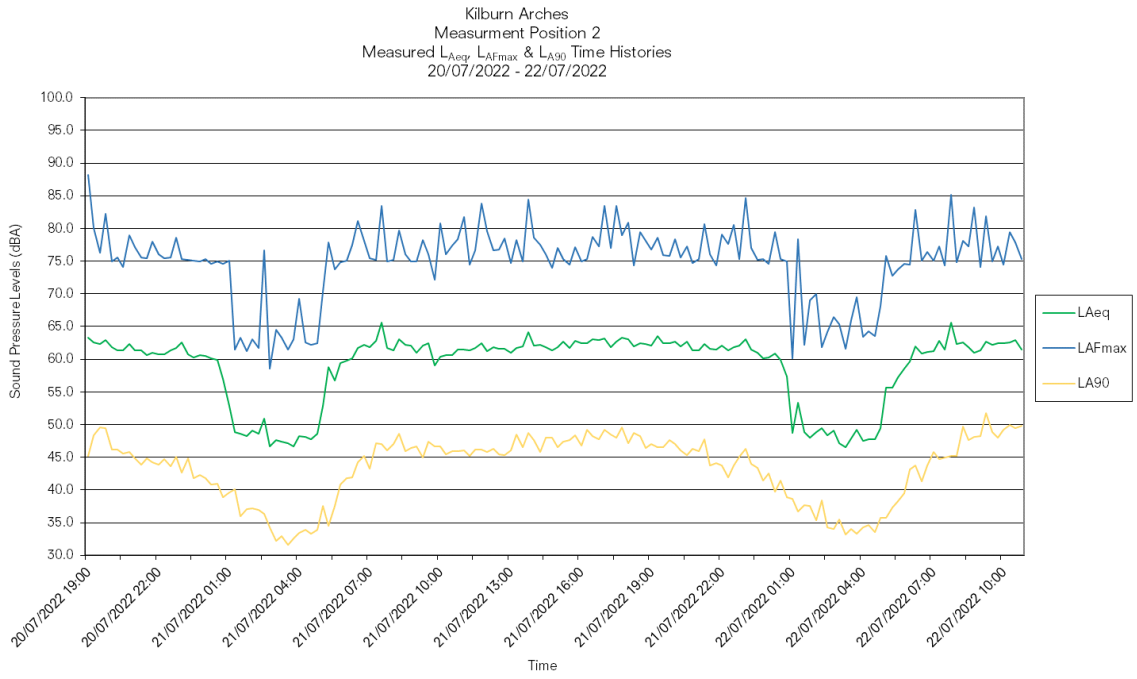

Figure B2: Measurement Position 2 Time History Graph

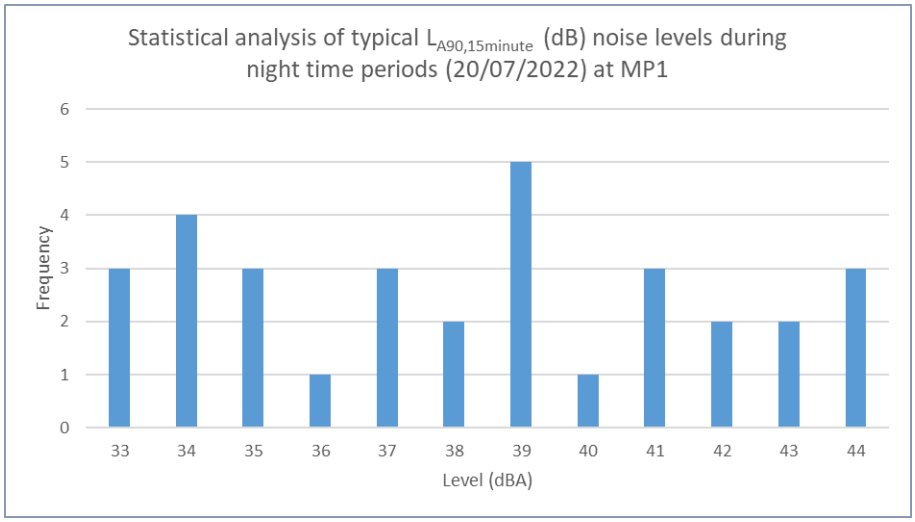

Figure B3: Measurement Position 1 (20/07/2022) Statistical Analysis of L_{A90} Background Noise Levels (night-time)

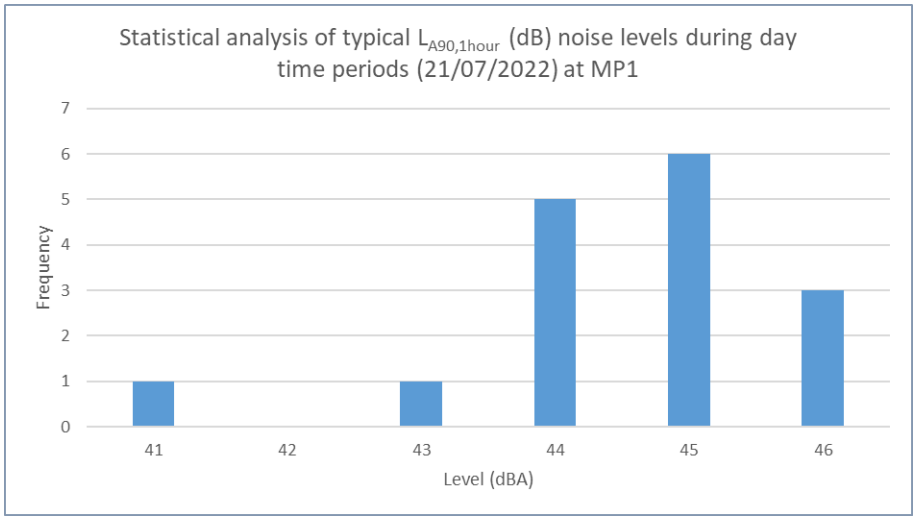

Figure B4: Measurement Position 1 (21/07/2022) Statistical Analysis of L_{A90} Background Noise Levels (daytime)

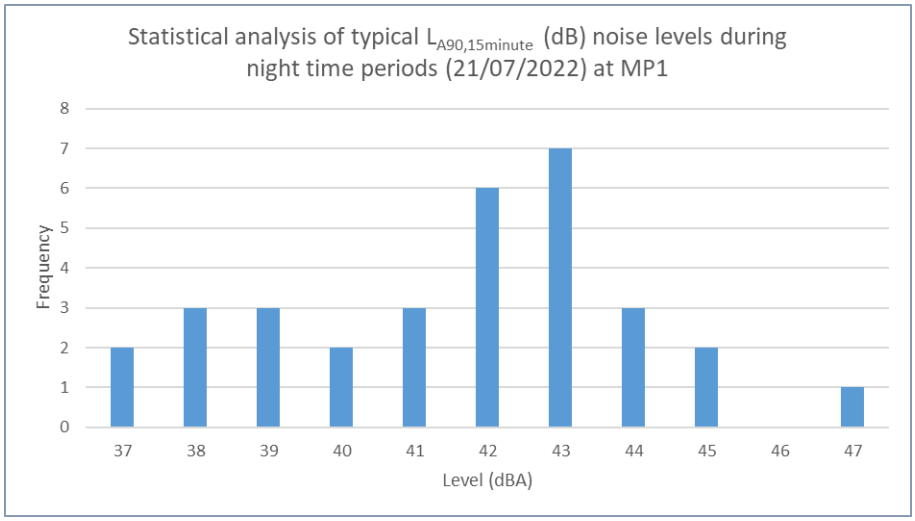

Figure B5: Measurement Position 1 (21/07/2022) Statistical Analysis of L_{A90} Background Noise Levels (night-time

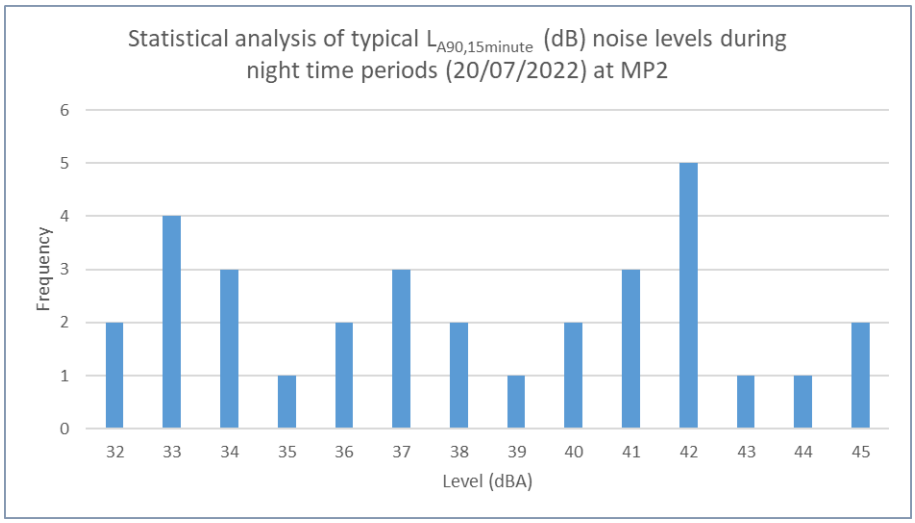

Figure B6: Measurement Position 2 (20/07/2022) Statistical Analysis of L_{A90} Background Noise Levels (night-time)

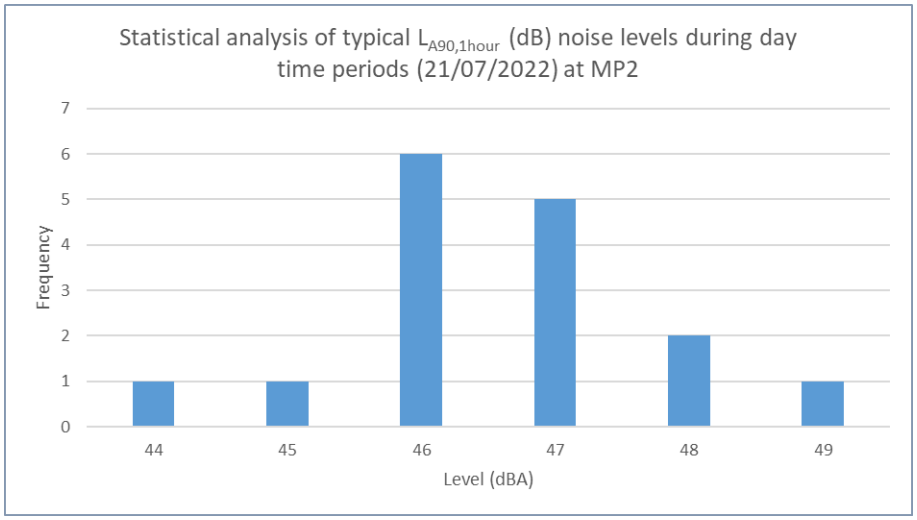

Figure B7: Measurement Position 2 (21/07/2022) Statistical Analysis of L_{A90} Background Noise Levels (daytime)

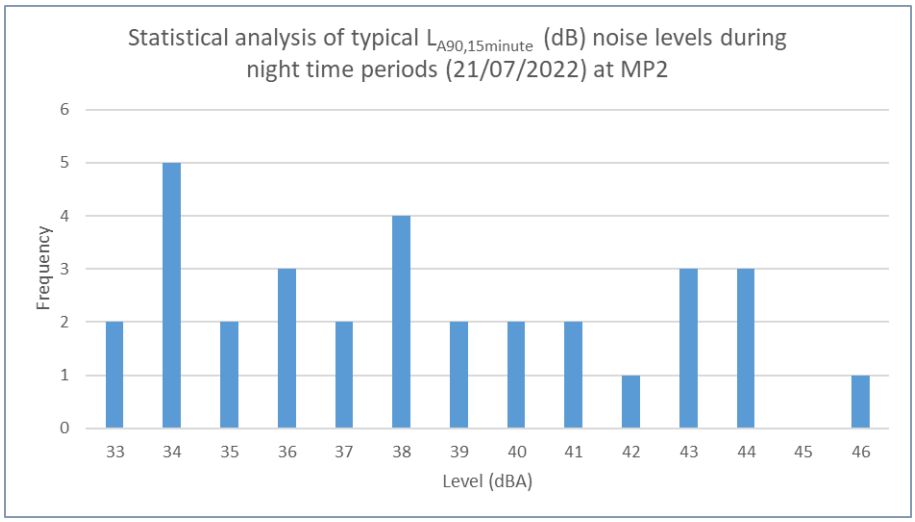

Figure B7: Measurement Position 2 (21/07/2022) Statistical Analysis of L_{A90} Background Noise Levels (night-time)

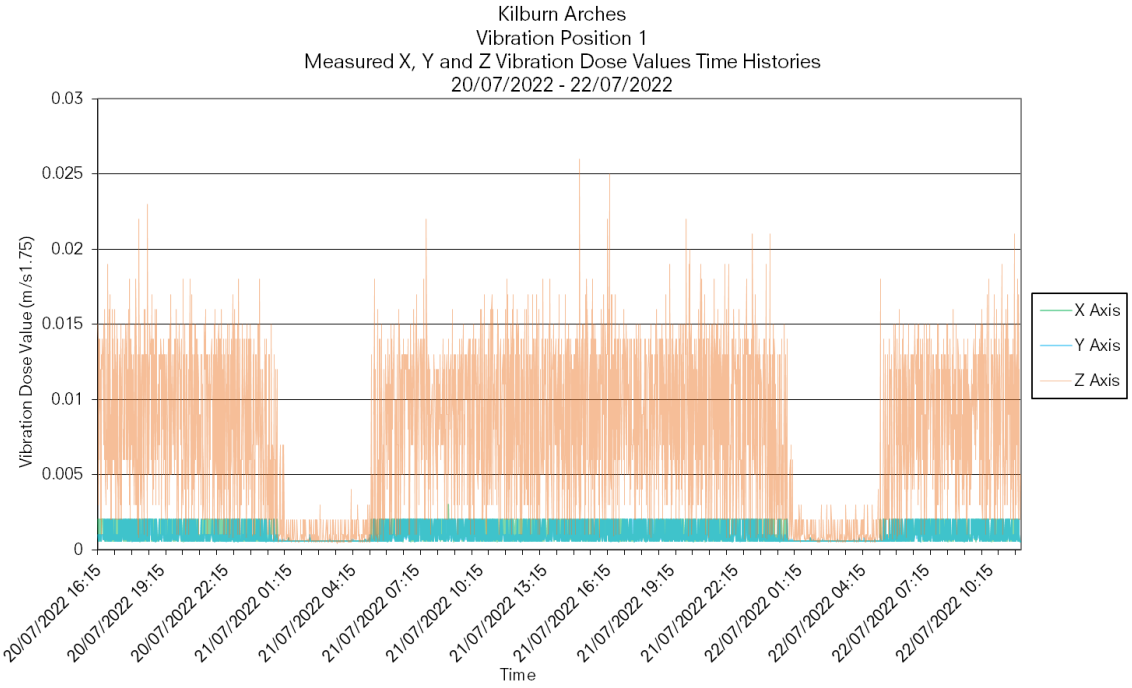

Figure B8: Unit 12A Vibration Position 1 (ground floor) Time History Graph