Bickerdike
Allen
Partners
Architecture
Acoustics
Technology

845-847 HARROW ROAD

NOISE AND VIBRATION REPORT

REF 2015/01063/FUL

Report to

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25 Lonsdale Road
London
NW6 6RA

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Bickerdike Allen Partners is an integrated practice of Architects, Acousticians, and Construction Technologists, celebrating over 50 years of continuous practice.

Architects: Design and project management services which cover all stages of design, from feasibility and planning through to construction on site and completion.

Acoustic Consultants: Expertise in planning and noise, the control of noise and vibration and the sound insulation and acoustic treatment of buildings.

Construction Technology Consultants: Expertise in building cladding, technical appraisals and defect investigation and provision of construction expert witness services.

Sustainability Consultants: Energy Conservation and Environmental Specialists and registered assessors for the Code for Sustainable Homes.

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1.0 INTRODUCTION

Bickerdike Allen partners (BAP) have been retained by Cottage Linnen Hire and instructed by Robert O'Hara Architects (ROH) to provide acoustic consultancy services relating to the redevelopment of 845-847 Harrow Road. The proposed redevelopment involves converting the currently unoccupied commercial building into a mixed use development comprising nine residential units and three commercial units.

The site is described in section 2.0. Planning conditions relating to noise and vibration, and relevant acoustic design criteria are covered in section 3.0. The noise and vibration survey conducted by BAP is described in section 4.0. Section 5.0 contains recommendations for wall and floor details to comply with the relevant planning conditions and section 6.0 details the vibration assessment. The report is summarised in section 7.0.

Acoustic terminology is provided in Appendix 1. Appendix 2 contains graphical data from the survey.

2.0 THE SITE

Figure 1 shows a map of the site. 845 – 847 Harrow Road is marked in red. The site is located within the London Borough of Hammersmith and Fulham. The site is exposed to moderately high levels of road traffic noise from the heavily trafficked Harrow Road to the north of the site. Further north (at least 50m) is the North London/London Overground railway. This is regularly used by Class 378 EMU 5 carriage electric passenger trains. Intermittent freight also uses this line. The narrow road to the south of the site is Letchford Mews (incorrectly labelled as Harrow Road in the ordnance survey map below). Though a narrow mews road, frequent vehicle movements were observed, suggesting that it may be used as a “rat run” between Scrubbs Lane and Harrow Road. Attended noise measurement positions are labelled 1 and 2.

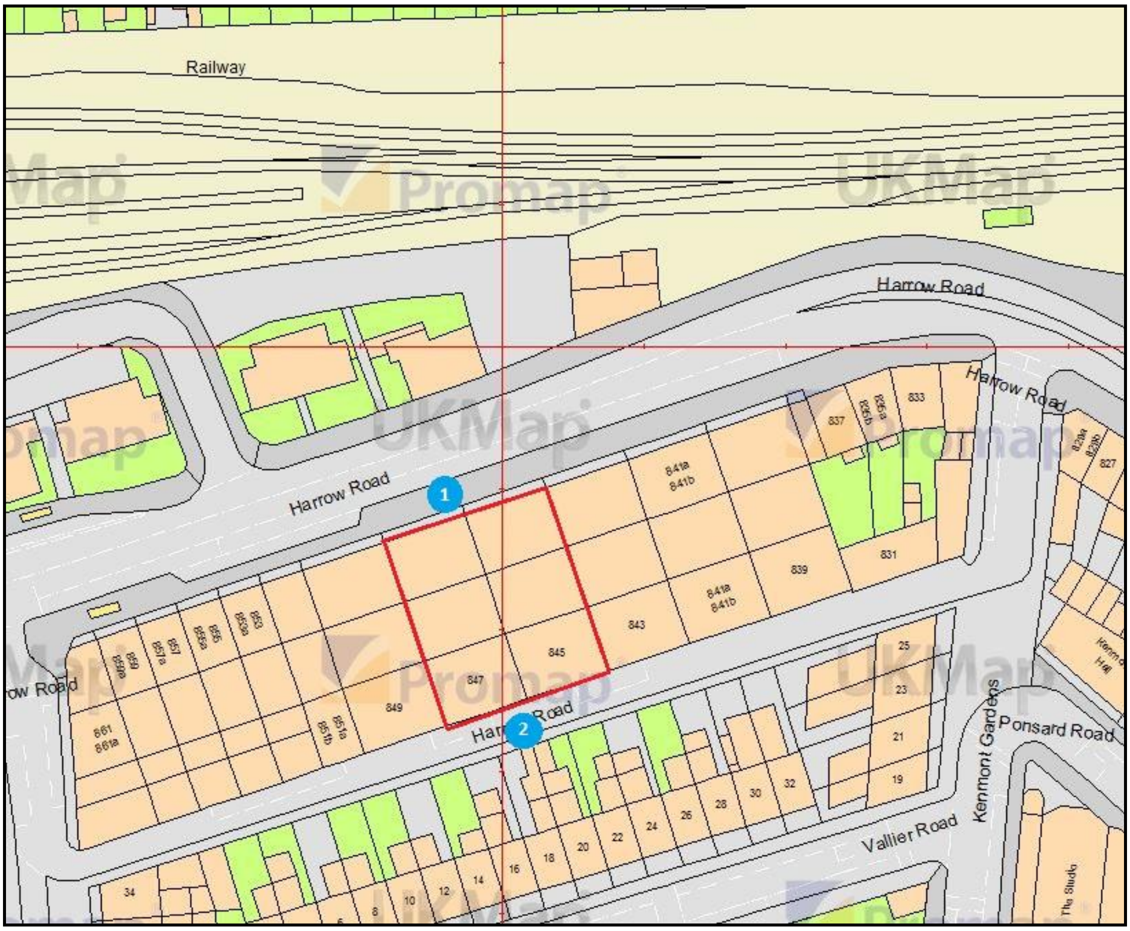

Figure 1: Site layout and measurement positions

3.0 ASSESSMENT CRITERIA

3.1 Planning conditions

The development has been granted planning consent (local authority reference 2015/01063/FUL). This includes four noise and vibration related planning conditions reproduced below.

"29) Prior to commencement of the development, a noise assessment shall be submitted and approved by the Council demonstrating external noise levels and details of the sound insulation of the building envelope, orientation of habitable rooms away from major noise sources and of silenced mechanical ventilation, as necessary, to achieve 'Good' internal room- and external amenity noise standards in accordance with the criteria of BS8233:1999. Approved details shall be implemented prior to occupation of the development and thereafter be permanently retained."

"30) Prior to commencement of the development, details shall be submitted to and approved in writing by the Council, of an enhanced sound insulation value $D_{nT,w}$ and L_{nTw} of at least 5dB above the Building Regulations value, for the floor/ceiling/wall structures separating different types of rooms/ uses in adjoining dwellings. Approved details shall be implemented prior to occupation of the development and thereafter be permanently retained.

31) Prior to commencement of the development, details shall be submitted to and approved in writing by the Council, of the sound insulation of the floor/ ceiling/ walls separating the commercial part(s) of the premises from dwellings. Details shall demonstrate that the sound insulation value $D_{nT,w}$ is enhanced by at least 10dB above the Building Regulations value and, where necessary, additional mitigation measures are implemented to contain commercial noise within the commercial premises and to achieve the criteria of BS8233:2014 within the dwellings/ noise sensitive premises. Approved details shall be implemented prior to occupation of the development and thereafter be permanently retained.

32). Prior to commencement of the development, details shall be submitted to and approved in writing by the Council, of building vibration levels and with appropriate mitigation measures where necessary. Details shall demonstrate that vibration will meet a level that has low probability of adverse impact and the assessment method shall be as specified in BS 6472:2008. No part of the development shall be occupied until the approved details have been implemented. Approved details shall thereafter be permanently retained"

3.2 BS 8233: 1999

The above conditions refer to both the current British Standard BS 8233:2014 and the recently withdrawn 1999 version of the standard.

'Good' and 'reasonable' levels for internal sound in residential spaces as defined by BS 8233:1999 are outlined in Table 1:

Scenario	Type of room	Design range $L_{Aeq,T}$ (dB)	
		Good	Reasonable
Reasonable resting/sleeping conditions	Living Rooms	30	40
	Bedrooms	30	35

Table 1: Criteria for internal sound levels in residential spaces according to BS 8233: 1999

With regards to gardens and amenity spaces the document advises "*As well as protection for the building, barriers or bunds should be considered to protect the gardens. In gardens and balconies etc. it is desirable that the steady noise level does not exceed 50 $L_{Aeq,T}$ dB and 55 $L_{Aeq,T}$ dB should be regarded as the upper limit*."

3.3 BS 8233: 2014

For internal ambient noise criteria in dwellings, the updated BS 8233: 2014 states that in general, for steady external noise sources, it is desirable that the internal ambient noise level does not exceed the guideline values given in Table 2:

Activity	Location	07:00 – 23:00 dB $L_{Aeq,\ 16\ hour}$	23:00 – 07:00 dB $L_{Aeq,\ 8\ hour}$
Resting	Living room	35	-
Dining	Dining room/area	40	-
Sleeping (daytime resting)	Bedroom	35	30

Table 2: Criteria for internal sound levels in residential spaces according to BS 8233: 2014

The current BS8233 also includes the following guidance with respect to gardens and amenity spaces,

"*For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a* *situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.*"

There are no specific standards for commercial spaces. A design range of 45-55 dB L_{Aeq} is provided for speech or telephone communication in concourses, corridors and circulation spaces. BAP have adopted a performance specification of 45 dB L_{Aeq}.

3.4 Summary of environmental noise criteria for condition 29

Based on the standards above BAP have adopted the following performance standards to be achieved inside spaces with windows closed and adequate ventilation provided.

- Bedrooms at night – 30 dB $L_{Aeq,8h}$ with noise maxima to not regularly exceed 45 dB $L_{AF,max}$
- Bedrooms during the day - 35 dB $L_{Aeq,16h}$
- Living and dining rooms during the day - 35 dB $L_{Aeq,16h}$
- Amenity spaces – ideally 50-55 dB $L_{Aeq,16h}$ if practicable
- Commercial premises – 45 dB $L_{Aeq,16h}$

3.5 Approved Document E: 2003

The planning conditions refer to standards of internal sound insulation higher than current Building Regulations performance standards. Current Building Regulations performance standards are presented in Approved Document E 2003 (incorporating 2004, 2010, 2013 and 2014 amendments).

Approved Document E compliance standards for walls and floors with a separating function between dwellings formed by a material change of use are reproduced in Table 3, along with the 5dB betterment standard specified in planning Condition 30.

Type of partition	Document E Airborne sound insulation minimum value $D_{nT,w + Ctr}$ (dB)	Condition 30 Airborne sound insulation minimum value $D_{nT,w + Ctr}$ (dB)	Document E Impact sound insulation maximum value $L_{nT,w}$ (dB)	Condition 30 Impact sound insulation maximum value $L_{nT,w}$ (dB)
Walls	43	48	-	-
Floors and stairs	43	48	64	59

Table 3: Compliance standards for airborne and impact sound transmission

The compliance standard specified by Condition 31 for separating walls between dwellings and commercial premises is given in Table 4:

Type of partition	Document E Airborne sound insulation minimum value $D_{nT,w + Ctr}$ (dB)	Condition 31 Airborne sound insulation minimum value $D_{nT,w + Ctr}$ (dB)	Document E Impact sound insulation maximum value $L_{nT,w}$ (dB)	Condition 31 Impact sound insulation maximum value $L_{nT,w}$ (dB)
Floors and stairs	43	53	N/A[1]	N/A[1]

Table 4: Compliance standards for separating floors between dwellings and commercial premises

[1] Approved Document E does not set impact sound insulation performance standards applicable between the ground floor commercial premises and the flats below. The standards are set to protect the occupants of the flats.

3.6 BS 6472: 2008

Planning condition 32 requires an assessment of vibration dose values using BS6472:2008. For the assessment of building vibration with respect to human response, BS 6472: 2008 states the following:

"When the appropriately weighted vibration measurements or predictions have been used to derive the VDV (Vibration dose value) for either 16h (daytime) or 8h (night-time) at the relevant places of interest, their significance in terms of human response for people in those places can be derived from Table 1. The judgement made is of the probability that the determined vibration dose might result in adverse comment by those who experience it."

The VDV ranges which might result in various probabilities of adverse comment within residential buildings are outlined below in Table 5.

Place and time	Probability of adverse comment		
	Low $m.s^{-1.75}$ (1)	**Possible** $m.s^{-1.75}$	**Probable** $m.s^{-1.75}$ (2)
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 0.16
Residential buildings 8h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Table 5: BS 6472: 2008 VDV ranges for assessing vibration impact

[1] Below these ranges adverse comment is not expected.

[2] Above these ranges adverse comment is very likely.

4.0 SURVEYS

4.1 Noise surveys

A long term unattended noise survey and a short term attended noise survey were conducted by BAP from Wednesday 09th December to Thursday 10th December 2015. This was to investigate prevailing noise conditions at the site. The weather during the survey period was generally dry with light winds estimated not to exceed 5 m/s

4.1.1 Unattended survey

The long-term measurements were carried out using a Norsonic type 118 sound level meter with a Norsonic type 1251 calibrator. The equipment was checked for calibration both prior to and after the survey and no significant drift was observed. Continuous samples of 15-minute duration with a one second resolution were made. The long term measurement position is indicated in Figure 2. The microphone was mounted outside a first floor window projecting 1 m from the façade of the building.

Figure 2: Long term measurement position

4.1.2 Attended survey

The attended measurements were made using a Norsonic type 140 sound level meter with a Norsonic type 1251 calibrator. The equipment's calibration was checked both before and after the measurements and no significant drift was observed. Short term measurement positions are shown in Figures 3 and 4. Their relative location on site is shown in Figure 1. Continuous samples of 15-minute duration with a one second resolution were made over a period of 45 minutes at each measurement location.

Figure 3: Measurement position 1, Harrow Road

Figure 4: Measurement position 2, Letchford Mews

4.2 Vibration survey

A vibration survey was carried out by BAP to measure the prevailing VDV at the site from Wednesday 09th December to Thursday 10th December 2015. The measurements were made using a Rion VM-54 Tri-axial vibration meter and a PV-83CW Tri-axial accelerometer. Consecutive samples with a 1 minute resolution were made continuously for the duration of the measurement period. The accelerometer was set up on the ground floor slab at a location close to the Harrow Road façade.

4.3 Results

4.3.1 Long term noise survey

Detailed graphical data from the unattended survey is presented in Appendix 2. The $L_{Aeq,T}$, $L_{Amax,T}$, and L_{A90} are reported in Table 6.

Period	$L_{Aeq,T}$ (dB)	$L_{Amax,T}$ (dB)	Representative L_{A90} (dB)$^{(1)}$	Minimum L_{A90} (dB)
Daytime	73	88	65	55
Night time	70	85	48	45

Table 6: Summary of unattended survey results

(1) Arithmetic mean average

Figure 5 shows the frequency with which noise events of different $L_{max,15min}$ levels occurred during the night time period.

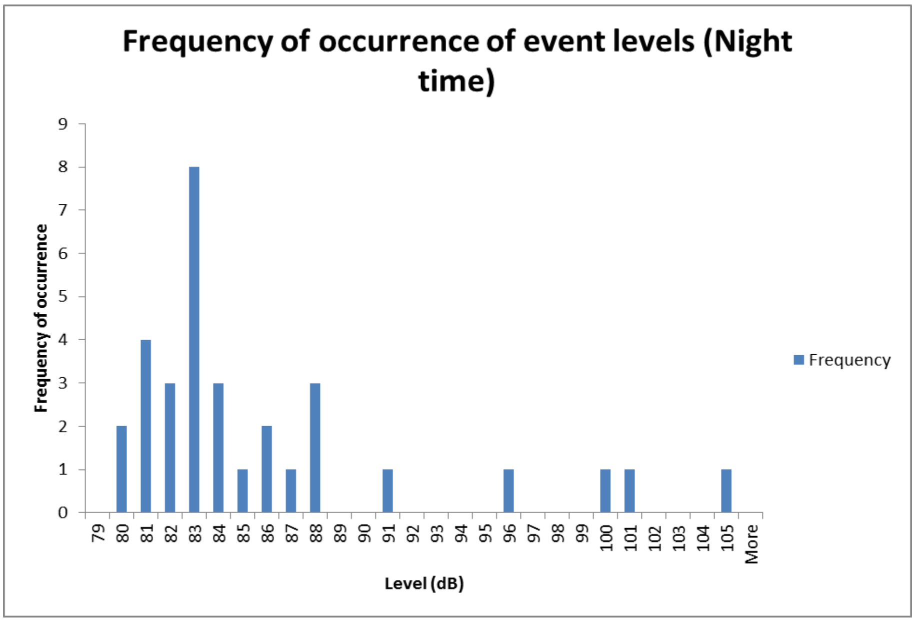

Figure 5: Frequency of occurrence of event levels in the night time period, Harrow Road

An external design level is needed for night time noise maxima. Based on the above data BAP have adopted a design level of 88 dB $L_{AF,max}$ for the front facade. This level is not regularly exceeded. Table 7 gives a typical spectrum.

Octave band centre frequency (Hz)								
63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**A**
94	89	87	84	83	81	78	70	88

Table 7: Typical spectrum of an event at 88 dB

4.3.2 Attended noise survey

Detailed graphical data from the daytime attended survey is presented in Appendix 2. The $L_{Aeq\ 15min}$, is reported in Table 8.

Measurement position	Octave band centre frequency (Hz) (logarithmic average of $L_{Aeq\ 15\ m}$)								A
	63	125	250	500	1000	2000	4000	8000	
1, Harrow Road	81	72	69	67	68	64	57	52	72
2, Letchford Mews	70	62	57	56	55	51	47	42	59

Table 8: $L_{Aeq\ 15m}$ of attended measurements

Figure 6 shows the frequency with which noise events of different $L_{A,max,30sec}$ levels occurred at attended measurement position 2.

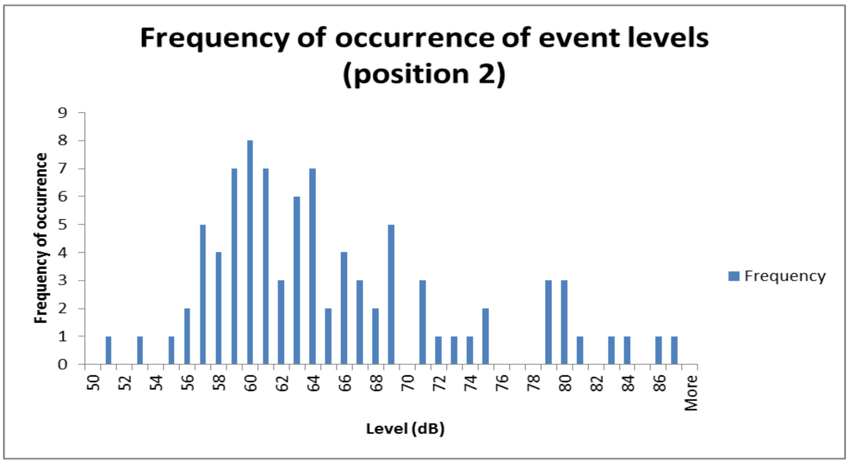

Figure 6: Frequency of occurrence of event levels at measurement position 2.

Cars and vans driving down Letchford Mews at the rear of the site are responsible for noise maxima at position 2. As the proposed development includes bedrooms facing Letchford Mews BAP have adopted a design target of 81 dB $L_{AF,max}$ for the rear façade. Table 9 gives a typical spectrum for events measured at this level.

Octave band centre frequency (Hz)								
63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**A**
91	84	78	77	75	76	70	62	81

Table 9: Typical spectrum of an event at 81 dB

4.3.3 Vibration survey and assessment

Detailed graphical data from the vibration survey is presented in Appendix 2. The results of the measured VDV for the 18 hour day and 8 hour night are summarised in Table 10.

Period	VDV	BS6472 rating
Daytime (07:00-233:00)	0.05	Adverse comment not expected
Night-time (23:00-07:00)	0.04	Adverse comment not expected

Table 10: Summary of measured VDV values

Vibration dose values are well below BS 6472:2008 guidelines for adverse comment. As a result, no vibration mitigation measures are necessary to comply with the planning condition.

5.0 ACOUSTIC ASSESSMENT

5.1 Façade elements

In order to ensure that the noise levels experienced in habitable rooms meet the requirements outlined in Section 3.4, the façade, glazing and ventilation elements of the building envelope will have to be specified accordingly.

5.1.1 Assumptions

The area of glazing and method of ventilation in any particular room, along with the room size and room acoustic conditions, affects the degree of reduction in noise transmission from outside to inside. BAP have carried out an initial assessment using some drawings E-100, E101, P-101B, P-102C, P-103A, and P-104 (rev B). This assessment may require reviewing during design development. The following assumptions have been used for the assessment of the sound insulation requirements of the building envelope:

- Predictions are made using the general method set out in BS EN 12354-3:2000;
- Sound insulation data based on both BAP library data and specific manufacturers' data.
- It has been assumed that the on-site performance will be comparable with manufacturers' claimed performance;
- The predictions assume good quality workmanship, for example that windows, doors and opening lights are well sealed. Poor workmanship or low quality seals may result in predicted internal noise levels being exceeded.

Design levels used in the calculations for the assumed external levels at the proposed building façades are shown below in Table 11.

Facade	Design level	Octave band centre frequency (Hz)						A
		125	250	500	1000	2000	4000	
Front (Harrow Road) – Daytime	$L_{Aeq,16,h}$	69	68	67	70	67	60	73
Front (Harrow Road) – Night	L_{Amax}	89	87	84	83	81	78	88
Front (Harrow Road) – Night	$L_{Aeq,8h}$	66	65	64	67	64	55	70
Rear (Letchworth Mews) – Day	$L_{Aeq,16h}$	62	56	55	54	50	45	58
Rear (Letchworth Mews) – Night	L_{Amax}	84	78	77	75	76	70	81
Rear (Letchworth Mews) – Night	$L_{Aeq,8h}$	59	53	52	51	47	42	55

Table 11: Design levels for front and rear facades

5.1.2 Recommended performance standards

This section provides glazing sound insulation performance requirements for the living room and bedrooms, which with careful detailing are expected to provide the necessary performance requirements to meet the relevant criteria. The glazing requirements are applicable to the window system as a whole including frames, and any mullions and panels. When selecting window glazing products, acoustic performances must be verified by test data from an independent testing facility. Table 12 provides a summary of the minimum sound insulation requirements for façade elements. The specified sound reduction indices, R_w and $R_{w + Ctr}$, should be met, as a minimum in each case.

The window suppliers will be required to submit laboratory spectral sound reduction index data to demonstrate compliance with the performance requirements. The performance requirements may need review following design development.

Facade	Room type	Façade element	
		Window	Ventilator[1]
Front (Harrow Road)	Living room	37 R_w 32 R_{w+Ctr}	50 dB $D_{n,e,w}$
	Bedroom	49 R_w 45 R_{w+Ctr}	50 dB $D_{n,e,w}$
Front (Harrow Road)	Commercial	31 R_w 27 R_{w+Ctr}	N/A
Rear (Letchworth Mews)	Living room	31 R_w 27 R_{w+Ctr}	50 dB $D_{n,e,w}$
	Bedroom	35 R_w 30 R_{w+Ctr}	50 dB $D_{n,e,w}$

Table 12: Minimum sound insulation requirements for windows and vents

[1] Assumes one in-wall unit ventilator per room. If additional ventilators are required, the performance specification is increased by 10 x Log(N) where N is the number of ventilators. If a whole house system is used this will require attenuators within the atmosphere side ductwork to ensure that the planning noise standards are achieved.

To achieve the performance standard for the front façade living room, high acoustic performance double glazed units will be required (for example 6.4mm(acoustic laminate)/12/6mm or similar).

It is not feasible to achieve the required performance standard for the bedrooms facing Harrow Road with replacement double glazed windows. The standard for front façade bedrooms can be achieved with a secondary glazing system with a 200mm air gap and 8mm acoustic laminated glass. The existing primary windows could be retained or replaced with any conventional (i.e. 4/12/4mm) double glazed units. The rear façade's performance standard for living rooms and bedrooms is likely to be achieved with a 812/6mm double glazed units.

The planning condition explicitly refers to silenced mechanical ventilation. It is therefore recommended that either of the following systems are used,

- In-wall mechanical acoustic ventilators such as Siegenia Aeropac or Titon Sonair (or similar approved) with a minimum acoustic performance of 50 dB $D_{n,e,w}$ or,
- Whole house mechanical ventilation system with heat recover (MVHR). This should include summer bypass and boost settings in the habitable rooms. The system will need to incorporate atmosphere side attenuators (likely to be at least 900mm) to ensure that the required noise standards are achieved for the Harrow Road façade. Atmosphere side supply ductwork should not pass over bedrooms.

The sound transmission through the external (assumed monolithic brickwork) walls is not expected to be significant.

The inclusion of living rooms within the roof will require detailing to ensure that the sound insulation performance of the roof is at least 61 dB R_w and 52 dB R_w+C_{tr}. This can be achieved using,

- Inner plasterboard lining within the living room comprising 2 layers of 12.5mm plasterboard of combined minimum mass 20 kg/m^2 (e.g. 2x12.5mm Soundbloc or similar) supported on timber or independent steel frame,
- an air gap of at least 140mm with 50mm of mineral wool absorption (minimum density 10kg/m^3)
- outer boarding material to form a solid barrier of boarding of combined minimum mass 20 kg/m^2.

The design of this will need to be developed during detailed design to comply with all relevant thermal and ventilation requirements.

5.2 Amenity spaces

The development contains a communal courtyard which is enclosed on all four sides. The measured noise level at the rear of the property was 58 dB L_{Aeq} façade. This was a façade level and it follows that the free field level at this position would be approximately 55 dB. As the courtyard is enclosed it is expected that levels will be lower than this. These levels are below the maximum guidelines of 50-55 dB $L_{Aeq\ 16h}$ for amenity spaces recommended by BS 8233: 2014

5.3 Separating walls

Planning conditions 30 and 31 specify that the performance of separating walls between dwellings must exceed building regulations by 5 dB and the performance of separating walls between dwellings and commercial units must exceed building regulations by 10 dB.

There are many different wall systems capable of achieving the required performance standard. The following options are available,

To achieve 48 dB $D_{nt,w+Ctr}$ Option 1 (preferred) – 200 mm Quiet IWL

The wall should comprise two layers of board minimum combined mass 25 kg/m^2 (i.e. 2x15mm Soundbloc) fixed to the outside faces of two Gypframe 48 I 50 ‘I’ stud frameworks with studs at 600mm centres. 50 mm of mineral wool absorption minimum density 10 kg/m^3 (i.e. APR1200 or similar approved) in the cavity (cavity width 140mm). Back to back sockets should be avoided and any sockets within the wall should be suitably detailed with either the plasterboard manufacturers recommend back-box detail or proprietary “putty pads” such as Hilti CP617 (or similar approved)

To achieve 48 dB $D_{nt,w+Ctr}$ Option 2 – 208 mm Staggered Stud

This wall should comprise two rows of Gypframe 92 I 90 ‘I’ studs in Gypframe 148 DC 60 deep flange floor and ceiling channel. Gypframe SC2 spacer clips and alternate studs staggered in the channel at 300 mm centres. There should be two layers of board either side of this (minimum combined mass 25 kg/m^2, i.e. 2x15mm Soundbloc) and 50 mm of mineral wool absorption (APR1200 or similar approved) in the cavity. Back to back sockets should be avoided and any sockets within the wall should be suitably detailed with either the plasterboard manufacturers recommend back-box detail or proprietary “putty pads” such as Hilti CP617 (or similar approved)

To achieve 48 dB $D_{nt,w+Ctr}$ Option 3 – 137 mm Quiet SF single stud with resilient bars

This wall should comprise two layers of board (minimum combined mass 25 kg/m^2, i.e. 2x15mm Soundbloc) each side of Gypframe ‘C’ studs at 600 mm centres with Gypframe RB1 resilient bars at 600mm centres to one side 50mm of mineral wool absorption (APR1200 or similar approved) in the cavity. Back to back sockets should be avoided and any sockets within the wall should be suitably detailed with either the plasterboard manufacturers recommend back-box detail or proprietary “putty pads” such as Hilti CP617 (or similar approved)

As noted above BAP’s preferred wall system is the twin frame wall construction option 1. The acoustic performance of this wall system will be higher than the other two systems. The wall is less prone to workmanship errors and this wall system has the additional benefit of providing a much higher level of protection against structure borne noise.

There are two walls on the ground floor that separate residential units from commercial units. These need to be designed to achieve a minimum acoustic performance standard of 53 dB $D_{nT,w}$+C_{tr}. The following wall type is recommended to achieve this high performance standard.

To achieve 53 dB $D_{nt,w+Ctr}$ 310mm twin independent frame with masonry core

Approved Document E 'type 3' masonry wall with a rendered 140mm 1350-21650kg/m^3 core (or alternatively "paint grade 140mm blocks) with twin independent panels with absorbent material either side. The plasterboard leaves should have a mass greater than 20 kg/m2 (i.e. 2x12.5mm Soundbloc) and there is should be cavity of 10mm between the frame and the independent core. The absorbent material should be at least 50mm thick with a density in excess of 10kg/m^3 (i.e. APR 1200 or similar approved).

5.4 Separating floors

Planning conditions 30 and 31 specify that the airborne and impact sound insulation performance of separating floors between dwellings must exceed building regulations by 5 dB and the airborne sound insulation performance of separating floors between dwellings and commercial units by 10 dB.

BAP understand that the existing separating floors use a beam and block construction. BAP recommend the following upgrades will be necessary.

Ceiling – domestic – 48 dB $D_{nT,w+Ctr}$

One sheet of 12.5mm plasterboard with minimum mass 10 kg/m^2 (e.g. 12.5mm Soundbloc or similar approved) suspended on a metal frame system with a cavity at least 100 mm. This cavity should contain at least 50mm of mineral wool acoustic absorption minimum density 10 kg/m^2 (e.g. APR 1200 or similar approved).

Ceiling – ground floor commercial - 53 dB $D_{nT,w+Ctr}$

Two sheets of minimum 15mm plasterboard with combined minimum mass 25 kg/m^2 (e.g. 2 x 15mm Soundbloc or similar approved) suspended on a metal frame system with a cavity at least 200 mm. This cavity should contain at least 50mm of mineral wool acoustic absorption minimum density 10 kg/m^2 (e.g. APR 1200 or similar approved).

Acoustic floors 48 dB $D_{nT,w+Ctr}$ and 53 dB $D_{nT,w+Ctr}$

Either of the following acoustic floor systems to the existing beam and block floor would be required in addition to the ceiling treatments above:

- Sand and cement screed of at least 65mm, or proprietary screed of at least 40mm (minimum mass 80 kg/m^2) floating on a resilient layer (e.g 8mm Regupol E48 or similar approved)
- Levelling screed of at least 20 mm with a "FFT3" resilient composite acoustic batten system with battens of a minimum thickness of 45 mm such as Cellecta Deckfon Batten 45 ot similar approved. There should be a layer of at least 18mm t&g boarding on top of the acoustic battens.

Note on beam and block floors

Existing beam and block floors are susceptible to poor acoustic performance. There can be air-paths and gaps between individual blocks or even blocks missing. The junction between the beam and block floor and external and internal flanking walls must be inspected as this is another potential significant sound path. The quality of the structural floor will need to be inspected and any defects remedied to ensure that the performance of the floor is not compromised. The junction between the floor slab and flanking walls needs to be inspected to ensure that the edges have been built into the flanking walls.

Wall linings to control flanking transmission – ground floor

To achieve the 10 dB betterment performance standards for floors between commercial and residential uses any masonry flanking walls and the masonry external wall will need an acoustic lining comprising at least 2 sheets of plasterboard (minimum combined mass 20 kg/m^2) on a wall lining system (such as Gyplyner or similar) to provide a minimum cavity of 35 mm with 25mm acoustic absorption (such as APR 1200 or rockwool) within the cavity.

Wall linings to control flanking transmission – 1st floor

It has been assumed that the external flanking walls are monolithic masonry. If there are any cavity masonry external walls the detail design of these, particularly the interface with the beam and block floor will need to be assessed and detailed to ensure the acoustic performance is not compromised. These walls may require acoustic linings (i.e. minimum 2x12.5mm boards on gypliner (or similar) wall lining system with a minimum cavity of 35mm and 25mm acoustic absorption (i.e. APR1200 or similar) within the cavity.

Flanking elements & junction details

The above recommendations all need to be built correctly to a high standard of workmanship to achieve the required acoustic performance standards.

All proprietary products such as floating screeds and/or timber floating floors must be installed in strict accordance with manufacturers' recommendations including all applicable edge or flanking strip details.

In addition to this all junction and flanking details must be appropriately assessed and detailed to ensure the acoustic performance is not compromised.

Figure 7 shows a sketch of the junction between a separating wall and a lined external wall

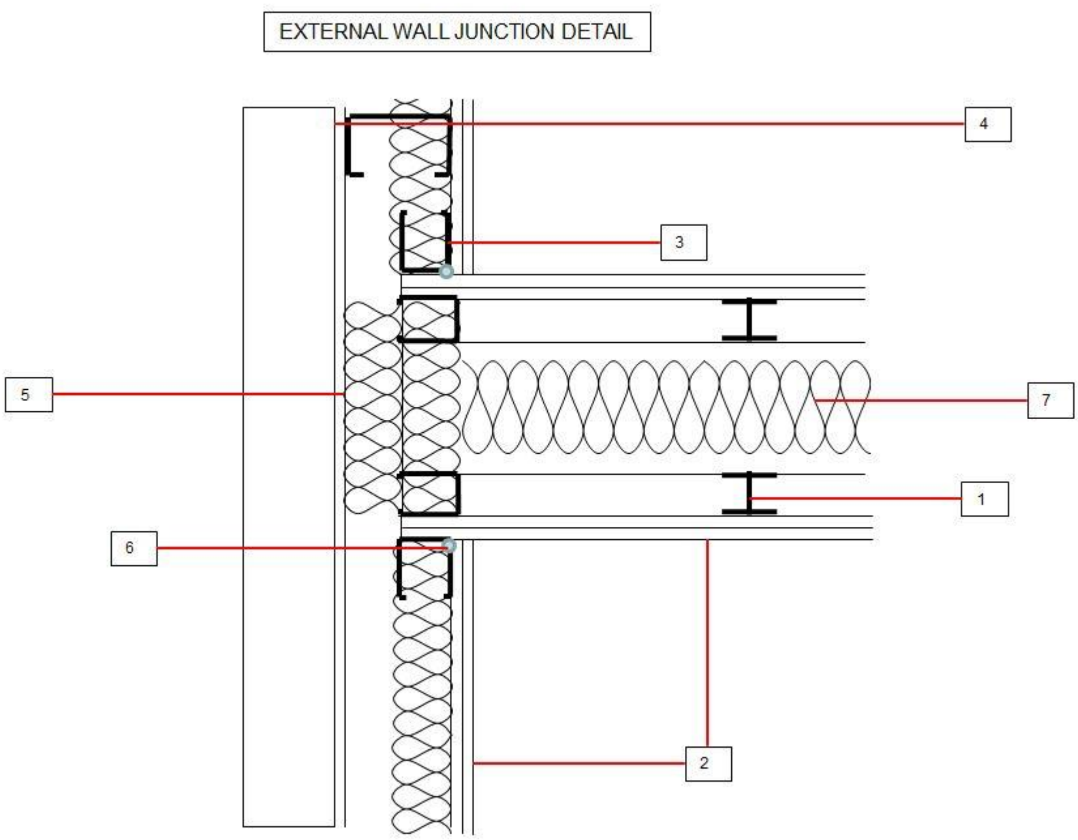

Figure 7: Separating wall/external wall junction

1. Gypframe 'I' stud.
2. Plasterboard layers
3. Gypframe 'C' stud

4. External masonry
5. Cavity barrier (subject to regulatory requirements)
6. Gyproc sealant
7. Acoustic insulation

Figure 8 shows a sketch of a junction with a 25mm deflection head.

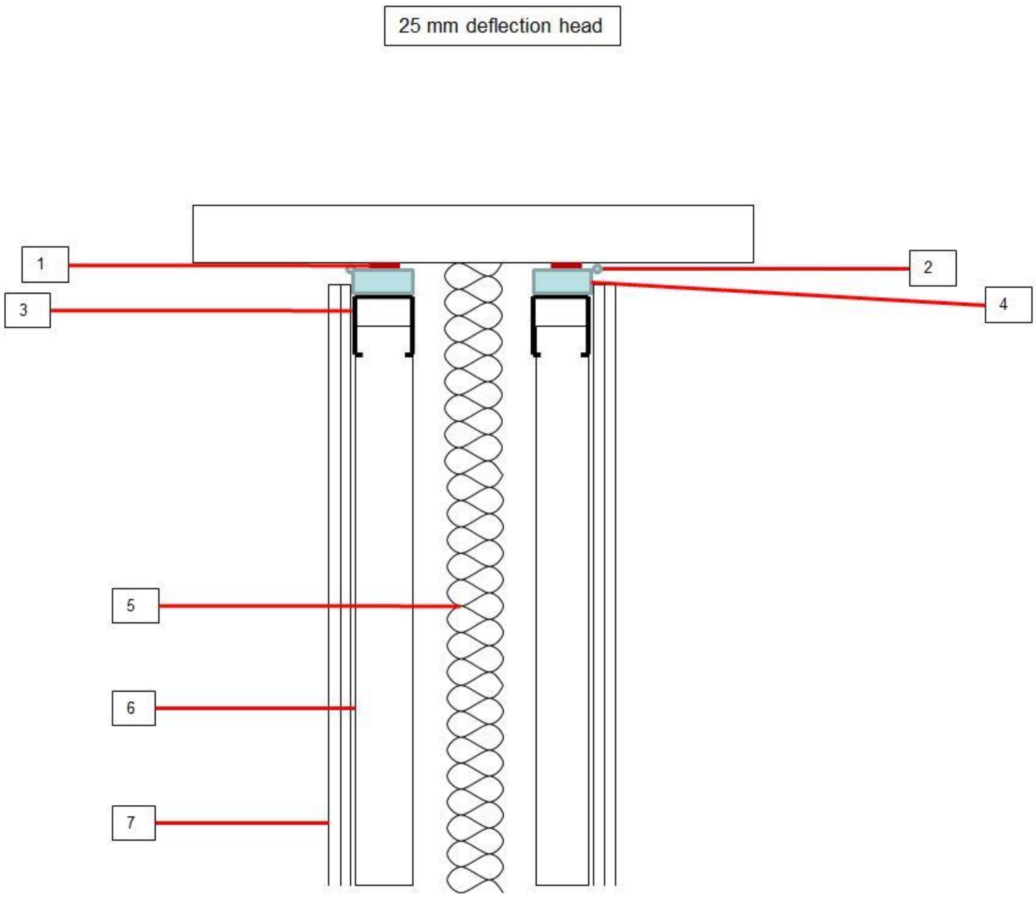

Figure 8: Deflection head junction

1. Gyproc firestrip
2. Gyproc sealant
3. Gypframe deep flange floor and ceiling channel
4. Gyproc coreboard
5. Acoustic insulation
6. Gypframe 'I' stud
7. Plasterboard layers

6.0 SUMMARY

Bickerdike Allen Partners (BAP) have been retained by ROH architects to provide acoustic consultancy services relating to a proposed mixed use development at 847 Harrow Road. This development has been granted planning consent subject to four conditions, which specify performance targets for façade elements and partitions and require that a vibration survey is undertaken, and if necessary appropriate vibration mitigation measures are specified.

This report records the results of noise and vibration surveys conducted to establish prevailing conditions on site and BAP's recommended performance specifications for façade elements and separating walls and floors based on this data in order to satisfy the site's planning conditions. From the results of the vibration survey it can be concluded that groundborne vibration is unlikely to adversely affect the development.

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APPENDIX 1

GLOSSARY OF ACOUSTIC TERMINOLOGY

The Decibel, dB

The unit used to describe the magnitude of sound is the decibel (dB) and the quantity measured is the sound pressure level. The decibel scale is logarithmic and it ascribes equal values to proportional changes in sound pressure, which is a characteristic of the ear. Use of a logarithmic scale has the added advantage that it compresses the very wide range of sound pressures to which the ear may typically be exposed to a more manageable range of numbers. The threshold of hearing occurs at approximately 0 dB (which corresponds to a reference sound pressure of 2 x 10^{-5} Pascals) and the threshold of pain is around 120 dB.

The sound energy radiated by a source can also be expressed in decibels. The sound power is a measure of the total sound energy radiated by a source per second, in watts. The sound power level, L_w is expressed in decibels, referenced to 10^{-12} watts.

Frequency, Hz

Frequency is analogous to musical pitch. It depends upon the rate of vibration of the air molecules that transmit the sound and is measure as the number of cycles per second or Hertz (Hz). The human ear is sensitive to sound in the range 20 Hz to 20,000 Hz (20 kHz). For acoustic engineering purposes, the frequency range is normally divided up into discrete bands. The most commonly used bands are octave bands, in which the upper limiting frequency for any band is twice the lower limiting frequency, and one-third octave bands, in which each octave band is divided into three. The bands are described by their centre frequency value and the ranges which are typically used for building acoustics purposes are 63 Hz to 4 kHz (octave bands) and 100 Hz to 3150 Hz (one-third octave bands).

A-weighting

The sensitivity of the ear is frequency dependent. Sound level meters are fitted with a weighting network which approximates to this response and allows sound levels to be expressed as an overall single figure value, in dB(A).

Environmental Noise Descriptors

Where noise levels vary with time, it is necessary to express the results of a measurement over a period of time in statistical terms. Some commonly used descriptors follow.

Statistical Term	Description
$L_{Aeq, T}$	The most widely applicable unit is the equivalent continuous A-weighted sound pressure level (LAeq, T). It is an energy average and is defined as the level of a notional sound which (over a defined period of time, T) would deliver the same A-weighted sound energy as the actual fluctuating sound.
L_{A90}	The level exceeded for 90% of the time is normally used to describe background noise.
$L_{Amax,T}$	The maximum A-weighted sound pressure level, normally associated with a time weighting, F (fast), or S (slow)

Sound Transmission in the Open Air

Most sources of sound can be characterised as a single point in space. The sound energy radiated is proportional to the surface area of a sphere centred on the point. The area of a sphere is proportional to the square of the radius, so the sound energy is inversely proportional to the square of the radius. This is the inverse square law. In decibel terms, every time the distance from a point source is doubled, the sound pressure level is reduced by 6 dB.

Road traffic noise is a notable exception to this rule, as it approximates to a line source, which is represented by the line of the road. The sound energy radiated is inversely proportional to the area of a cylinder centred on the line. In decibel terms, every time the distance from a line source is doubled, the sound pressure level is reduced by 3 dB.

Factors Affecting Sound Transmission in the Open Air

Reflection

When sound waves encounter a hard surface, such as concrete, brickwork, glass, timber or plasterboard, it is reflected from it. As a result, the sound pressure level measured immediately in front of a building façade is approximately 3 dB higher than it would be in the absence of the façade.

Screening and Diffraction

If a solid screen is introduced between a source and receiver, interrupting the sound path, a reduction in sound level is experienced. This reduction is limited, however, by diffraction of the sound energy at the edges of the screen. Screens can provide valuable noise attenuation, however. For example, a timber boarded fence built next to a motorway can reduce noise levels on the land beyond, typically by around 10 dB(A). The best results are obtained when a screen is situated close to the source or close to the receiver.

Meteorological Effects

Temperature and wind gradients affect noise transmission, especially over large distances. The wind effects range from increasing the level by typically 2 dB downwind, to reducing it by typically 10 dB upwind – or even more in extreme conditions. Temperature and wind gradients are variable and difficult to predict.

Airborne Sound Insulation

Voices, hi-fi systems, television and radio sound and musical instruments are all sources of airborne sound. They excite the air around them and the vibration in the air is transmitted to surrounding surfaces, such as walls, ceilings and floors. This sets these constructions into vibration and this vibration is radiated in neighbouring rooms as sound. Energy is lost in the transmission path and this is referred to as transmission loss or, more generally, sound insulation. The most simple measure of sound insulation is the sound level difference, D, which is the arithmetic difference between the sound level, in dB, in the source room and the sound level in the receiving room.

Other measures of sound insulation include the sound reduction index, R, which is a measure of the acoustical performance of a partition, obtained in a laboratory, and the standardised level difference, D_{nT}, which is used mainly in the sound insulation of domestic separating walls and separating floors. The relevant test procedures are laid down in BS EN ISO 140-4. A single figure “weighted” result can be obtained from one-third octave band test results by using a curve-fitting procedure laid down in BS EN ISO 717. The subscript “w” is added to the relevant descriptor (eg $D_{nT,w}$).

The standardised sound level difference, D_{nT} (dB), was obtained in each one third octave band, according to the following formula:

$$D_{nT} = L_1 - L_2 + 10\log_{10}\left(T/0.5\right)$$

where L_1 is the average level in the source room
L_2 is the average level in the receiving room

T is the reverberation time in the receiving room (in seconds)
0.5 is the reference reverberation time (in seconds)

The weighted standardised sound level difference, $D_{nT,w}$ was obtained using the curve-fitting procedure given in BS EN ISO 717-1. The standardised level difference values are plotted on a graph and compared with a reference curve. The reference curve is moved up and/or down until the sum of the unfavourable deviations is as large as possible, without exceeding 32.0 dB. The standard reference curve is shown on the graphs in Appendix C.

Impact Sound Insulation

In the case of impact sound, the building construction is caused to vibrate as a result of a physical impact. Footsteps on floors are the most obvious example. The vibration is radiated as sound in neighbouring rooms. Impact insulation is measured using a standard tapping machine, which drops weights cyclically onto a floor. The sound pressure level is measured in the receiving room below and the result is known as the impact level, L_i for laboratory tests and L'_I for field tests. The test procedures are set out in BS EN ISI 140-7 and the single figure weighting is described BS EN ISO 717-2.

The standardised impact level, L'_{nT} (dB), was obtained in each one third octave band, according to the following formula:

$$L'_{nT} = L_1 - 10\log_{10}\left(T/_{0.5}\right)$$

where L_i is the average impact sound pressure level
T is the reverberation time in the receiving room (in seconds)
0.5 is the reference reverberation time (in seconds)

The weighted standardised impact sound pressure level, $L'_{nT,w}$ was obtained using the curve-fitting procedure given in BS EN ISO 717-2. The standardised level difference values are plotted on a graph and compared with a reference curve. The reference curve is moved up and/or down until the sum of the unfavourable deviations is as large as possible, without exceeding 32.0 dB. The standard reference curve is shown on the graphs in Appendix C.

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APPENDIX 2

DETAILED SURVEY RESULTS

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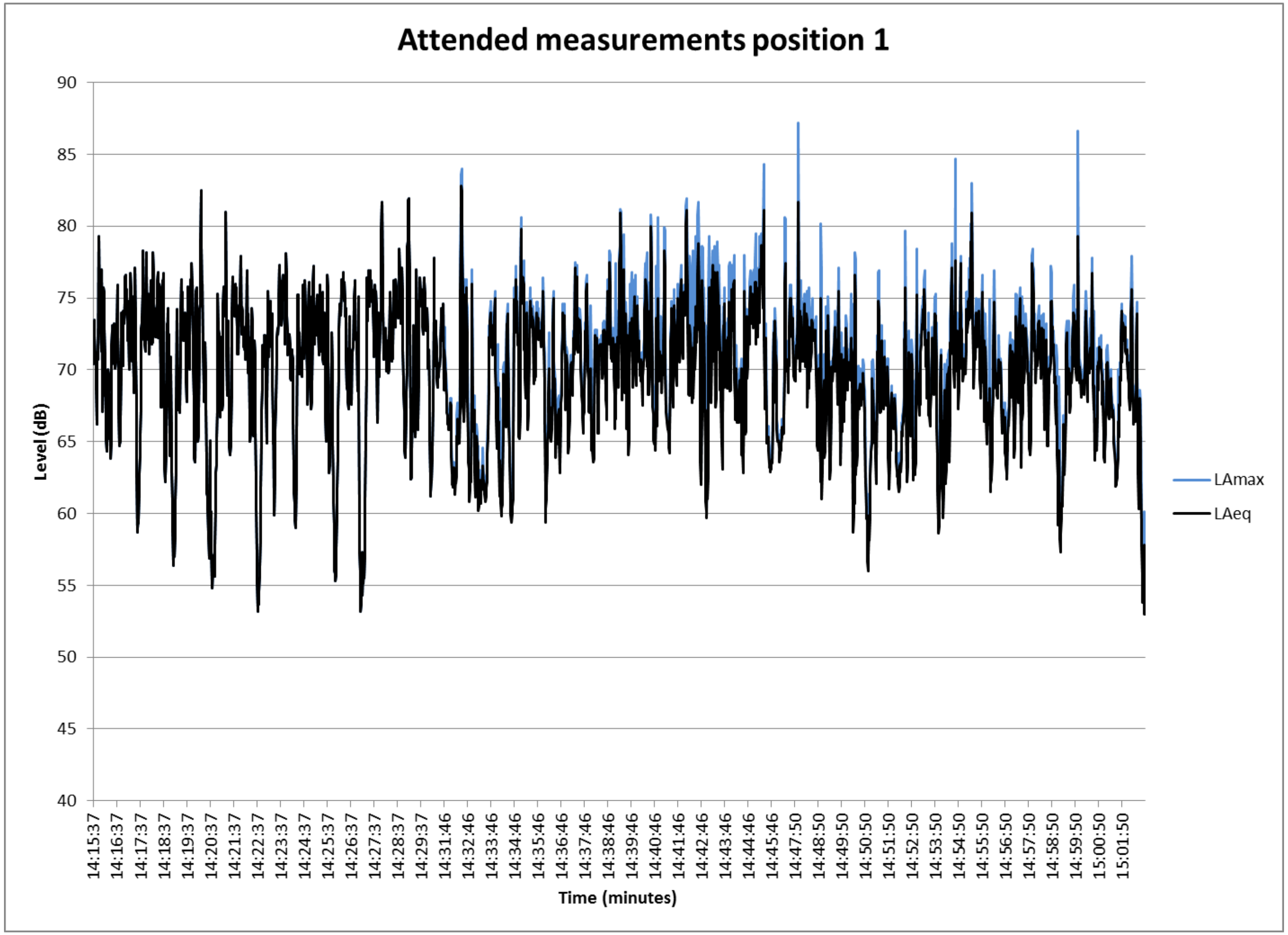

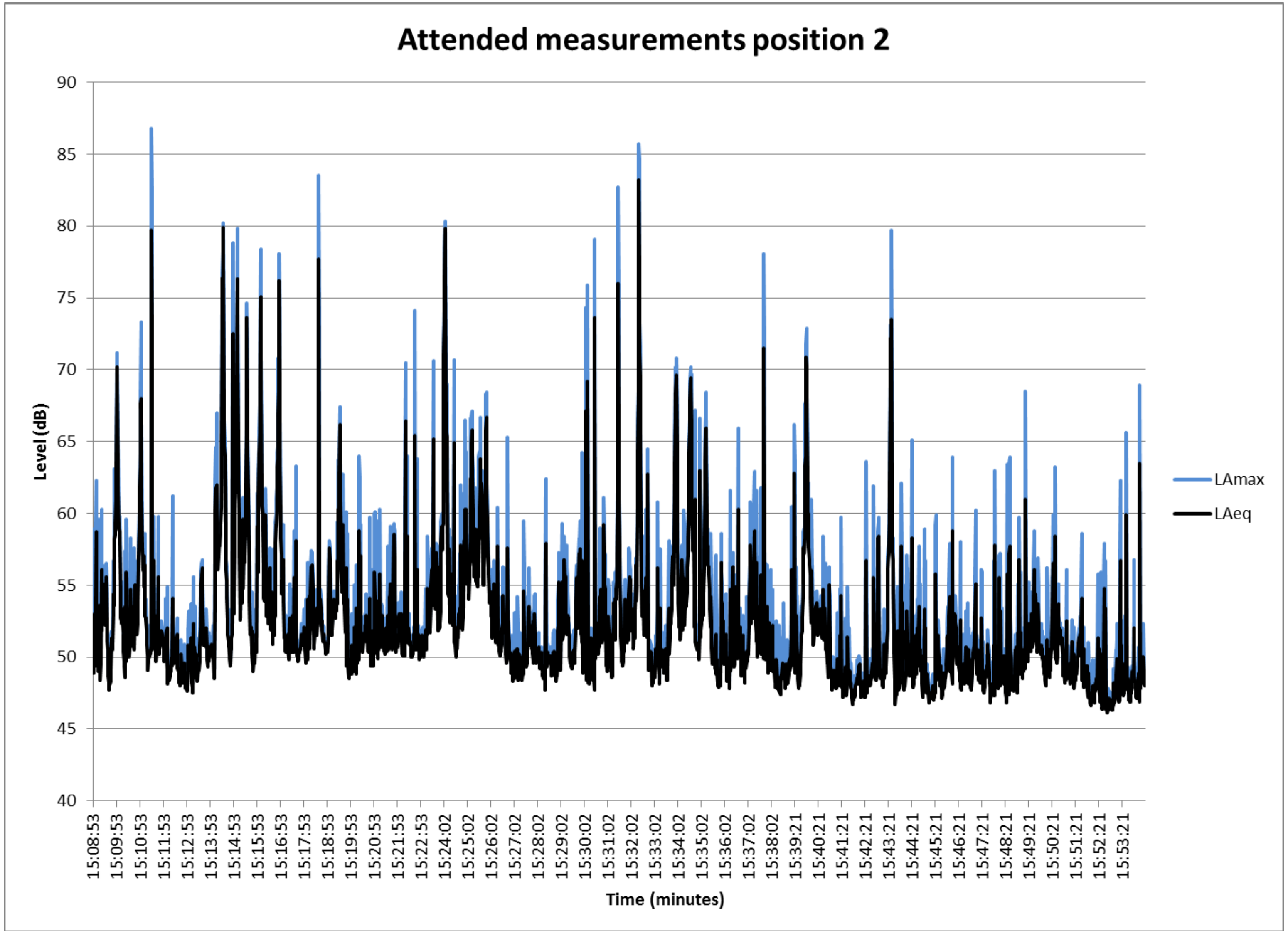
Attended measurements position 2
Level (dB)
90
85
80
75
70
65
60
55
50
45
40
Time (minutes)
15:08:53
15:09:53
15:10:53
15:11:53
15:12:53
15:13:53
15:14:53
15:15:53
15:16:53
15:17:53
15:18:53
15:19:53
15:20:53
15:21:53
15:22:53
15:24:02
15:25:02
15:26:02
15:27:02
15:28:02
15:29:02
15:30:02
15:31:02
15:32:02
15:33:02
15:34:02
15:35:02
15:36:02
15:37:02
15:38:02
15:39:21
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15:46:21
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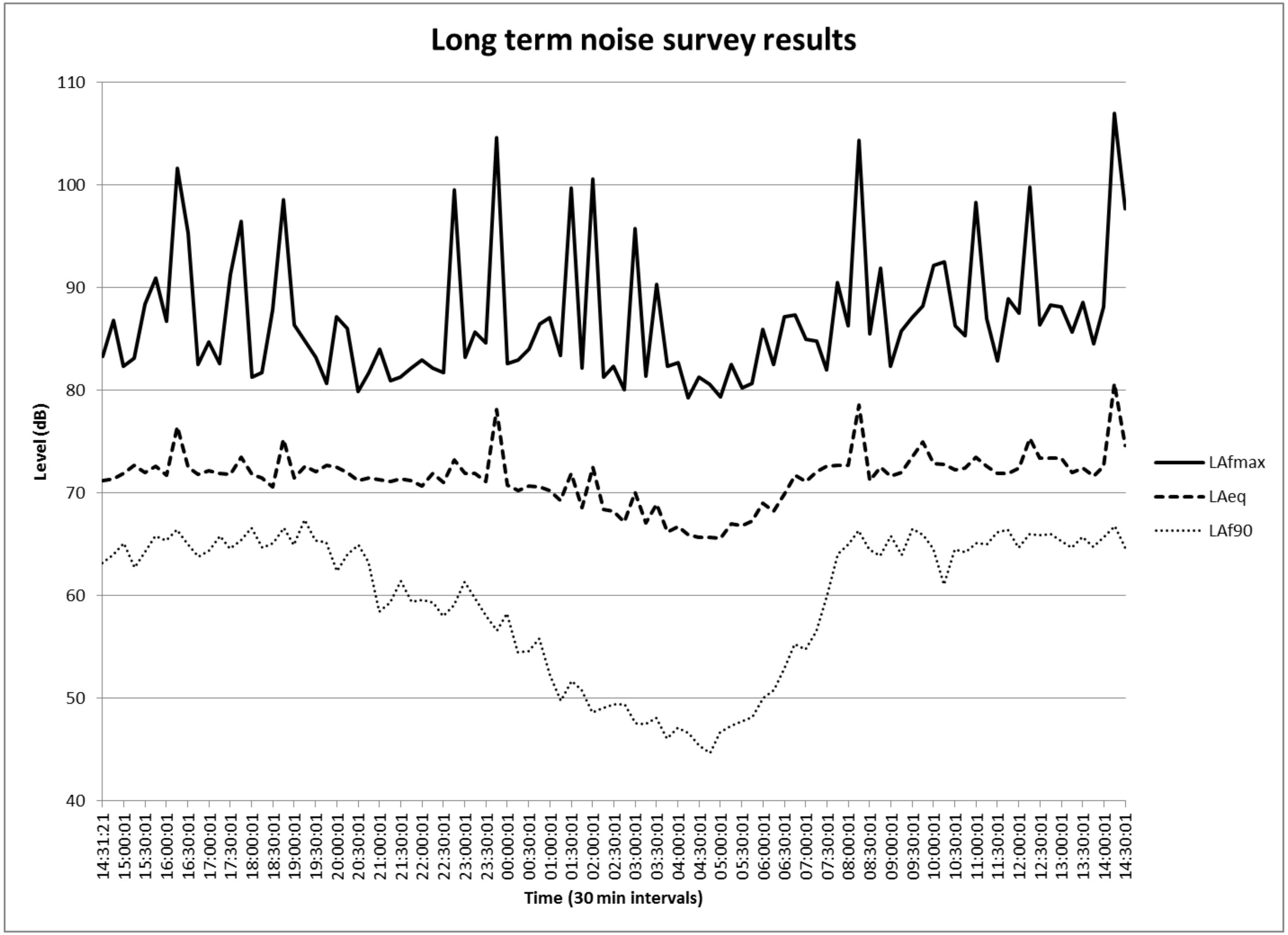
15:53:21
LAmax
LAeq


Long term noise survey results
110
100
90
80
70
60
50
40
Level (dB)
LAfmax
LAeq
LAf90
14:31:21
15:00:01
15:30:01
16:00:01
16:30:01
17:00:01
17:30:01
18:00:01
18:30:01
19:00:01
19:30:01
20:00:01
20:30:01
21:00:01
21:30:01
22:00:01
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11:00:01
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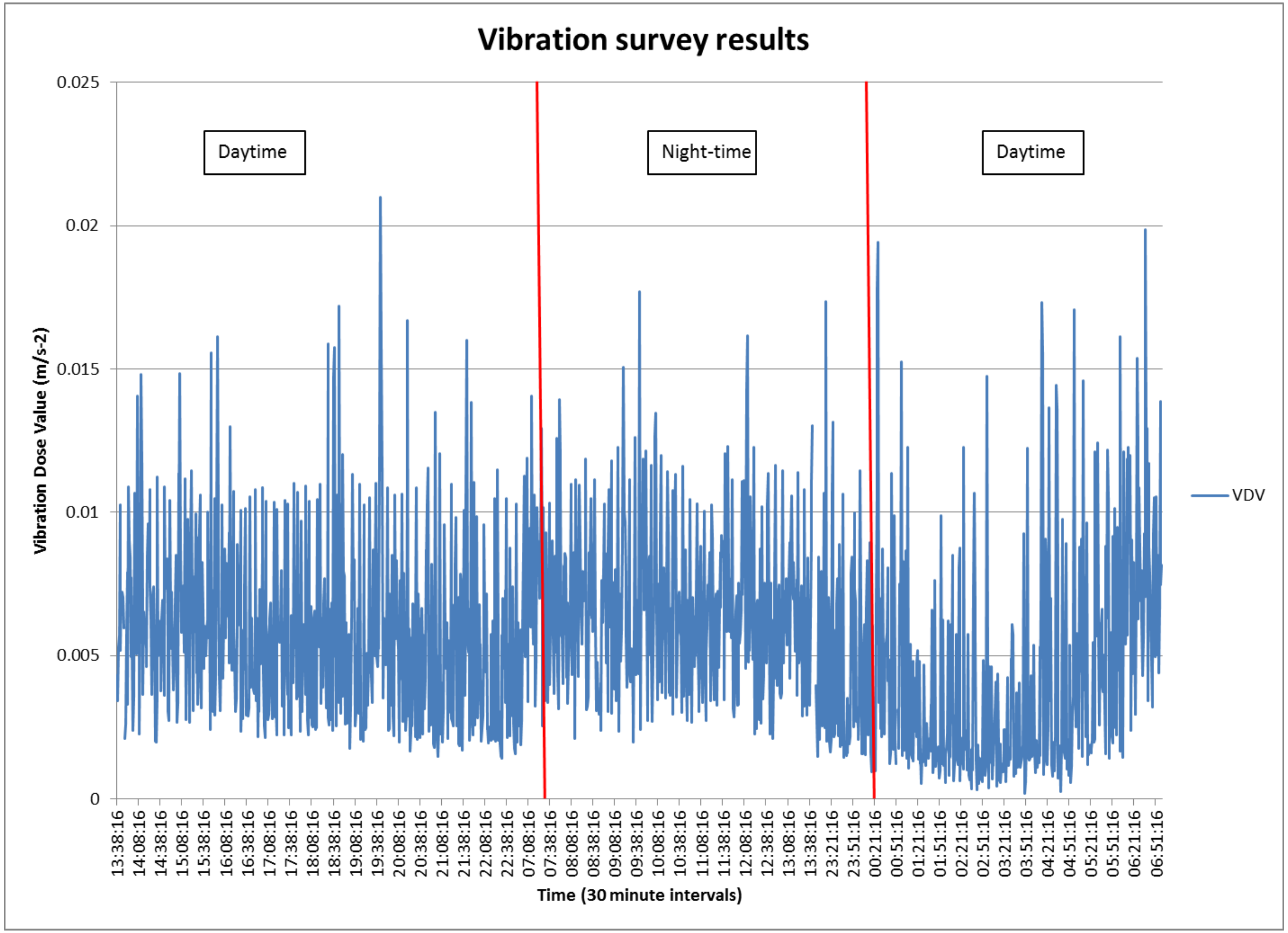
13:00:01
13:30:01
14:00:01
14:30:01
Time (30 min intervals)


Vibration survey results
0.025
0.02
0.015
0.01
0.005
0
Vibration Dose Value (m/s-2)
Daytime
Night-time
Daytime
VDV
13:38:16
14:08:16
14:38:16
15:08:16
15:38:16
16:08:16
16:38:16
17:08:16
17:38:16
18:08:16
18:38:16
19:08:16
19:38:16
20:08:16
20:38:16
21:08:16
21:38:16
22:08:16
22:38:16
07:08:16
07:38:16
08:08:16
08:38:16
09:08:16
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10:08:16
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23:21:16
23:51:16
00:21:16
00:51:16
01:21:16
01:51:16
02:21:16
02:51:16
03:21:16
03:51:16
04:21:16
04:51:16
05:21:16
05:51:16
06:21:16
06:51:16
Time (30 minute intervals)

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