

ENVIRONMENTAL NOISE ASSESSMENT

GREAT DUCIE STREET, MANCHESTER

REPORT REFERENCE NO. J003897-5694-DH-01

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This report has been prepared based upon a scope of works and associated resources agreed between the client and Philip Dunbavin Acoustics Ltd (PDA). This report has been prepared with all reasonable skill, care and diligence and has been based upon the interpretation of data collected. This has been accepted in good faith as being accurate and valid at the time of the collection. This report has been based solely on the specific design assumptions and criteria stated herein.



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1.0 SUMMARY

PDA Ltd was commissioned by One Heritage to carry out an environmental noise and vibration assessment report for the proposed new residential accommodation development at Great Ducie Street, Manchester. The proposed development consists of two 9 to 13 storey blocks comprising 129 no. residential apartments and 2 no. commercial units with a shared rooftop amenity space located upon the Great Ducie Street elevation block. The proposal for the ground floor commercial units incorporates A1/ A2 (retail) as well as A3 (entertainment) uses.

A noise level survey has been undertaken at the site representative of daytime and night-time hours. The local noise climate is dominated by road traffic from Great Ducie Street and to a lesser extent Mirabel and Breslyn Street. Rail noise is more dominant to the south of site emanating from the raised viaduct. During evening periods noise is also present from the AO Arena during events.

Based upon the measured and predicted noise levels, supplemented with Azimuth Acoustics UK survey data, calculations have been undertaken for the Bedrooms and Kitchen/Living Rooms to evaluate the internal noise levels. Recommendations are given for glazing and building façade elements to meet the internal noise level requirements of good practice guidance given in BS8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings. Calculations suggest that the noise level criteria of BS8233:2014 can be achieved within the proposed accommodation. Calculations have also been carried out to assess the external amenity spaces where it is noted these areas will fall within the desired levels set out in BS8233:2014. Further to this, calculations suggest that the proposed development can achieve the low frequency music noise level criteria as set out within the Planning and Noise – Technical Guidance 2022 by Manchester City Council.

In addition a vibration survey has been undertaken running concurrently with the noise measurements. The measured and predicted vibration levels are well below the '*Low probability of adverse comment*' criterion of BS 6472 for both day and night time periods and as such, BS 6472 would suggest that for levels below the ranges, adverse comment is not expected.

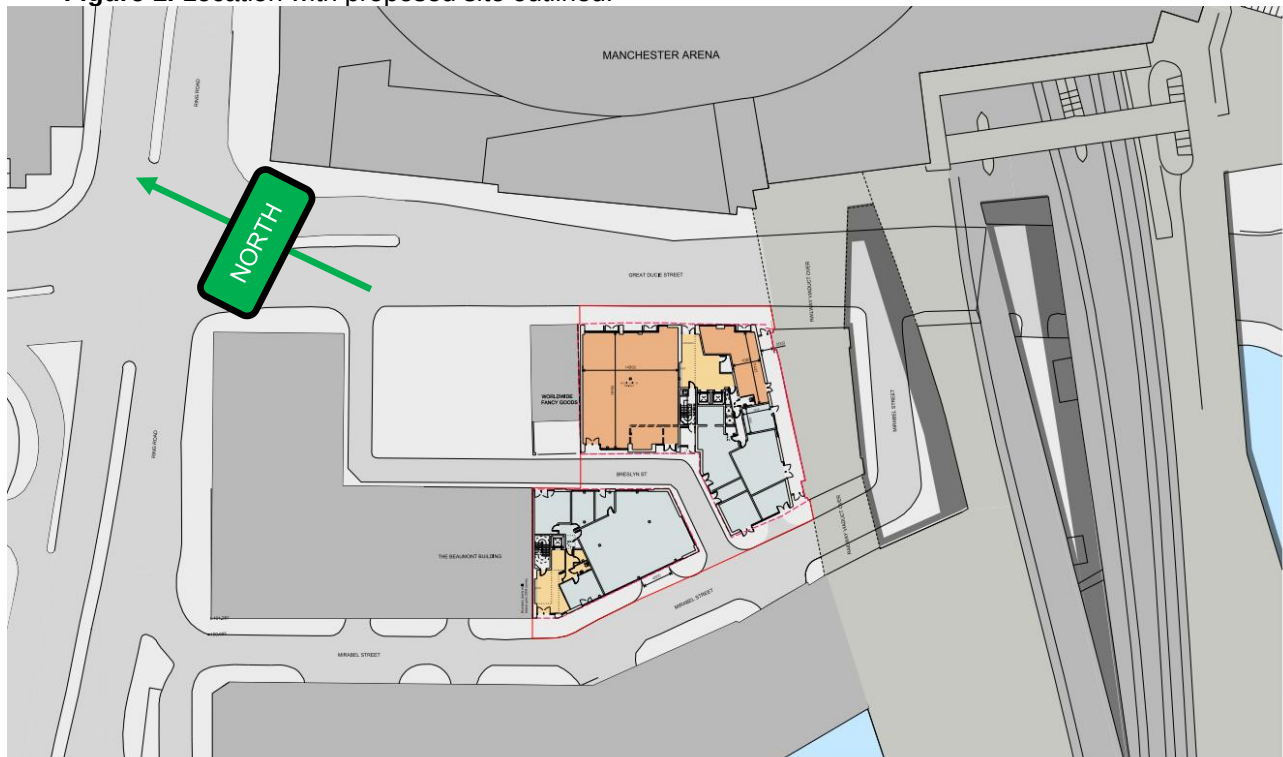
2.0 SITE DESCRIPTION

The proposed development consists of two 9 to 13 storey blocks comprising 129 no. residential apartments and 2 no. commercial units with a shared rooftop amenity space located upon the Great Ducie Street elevation block. The proposal for the ground floor commercial units incorporates A1/ A2 (retail) as well as A3 (entertainment) uses.

The development site is immediately bordered by Great Ducie Street to the east with the AO Arena approximately 35m from the eastern boundary. Immediately to the west of site is Mirabel Street and Breslyn Street which runs between the two proposed blocks. To the south of site are four separate trainlines which feed into Manchester Victoria station which are on a raised viaduct.

A site plan showing the location of the site and surrounding local area is shown in Figure 1 below.

Figure 1. Location with proposed site outlined.



3.0 NOISE ASSESSMENT CRITERIA

3.1 National Planning Policy Framework

National Planning Policy is guided by the National Planning Policy Framework (NPPF) updated in July 2021. With regard to Noise the Framework states the following;

Planning policies and decisions should contribute to and enhance the natural and local environment by:

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

Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

- *mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;*
- *identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.*

The terms 'significant adverse' and 'adverse' impacts are defined in the explanatory notes of the 'Noise Policy Statement for England (NPSE)' which states;

There are two established concepts from toxicology that are currently being applied to noise impacts, for example, by the World Health Organisation. They are:

NOEL – No Observed Effect Level

This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

LOAEL – Lowest Observed Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected.

Extending these concepts for the purpose of this NPSE leads to the concept of a significant observed adverse effect level.

SOAEL – Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur.

The notes also offer an explanation of the term 'adverse impacts' as follows;

... refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development (paragraph 1.8). This does not mean that such adverse effects cannot occur.

Although no specific noise limits for LOAEL and SOAEL have been defined, in 2014 the UK Government published a planning practice guidance document for noise which indicates where these limits fall with relation to the perception of noise, updated in July 2019. A summary is reproduced in Section 4.2 below, and the full document is published at <https://www.gov.uk/guidance/noise--2>. It is considered that guidance from other acoustic standards may be employed to determine suitable levels within the overall principal of the National Planning Policy Framework.

3.2 Planning Practice Guidance – Noise

The UK Planning Practice Guidance on noise offers further guidance on the typical levels which constitute the NOEL, LOAEL and SOAEL, reproduced in the table below.

Table 1. Planning Practice noise level guidance

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

3.3 BS8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings

Dwelling houses, flats and rooms in residential use

British Standard 8233:2014, *Guidance on Sound Insulation and noise reduction for buildings*, gives guidance on internal noise levels within dwellings, flats and rooms in residential use when unoccupied. The following criteria are for Living and Dining Rooms for daytime use and Bedrooms for night time.

Table 2. BS8233 recommended indoor ambient noise levels

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

It should however be stressed that the above criterion relates to steady noise, in this case from road traffic etc., excluding unusual noise events departing from the typical noise character of the area.

In addition BS 8233 suggests, '*regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$, depending on the character and number of events per night. Sporadic noise events could require separate values*'.

With regard to external areas of residential developments BS8233:2014 states the following;

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.

3.4 WHO Guidelines for Community Noise

In 1999, the WHO (World Health Organisation) published Guidelines for Community Noise, stating the following internal noise levels are applicable within dwellings.

Table 3. WHO Guidelines for Community Noise criteria

Specific Environment	Critical Health Effect(s)	L_{Aeq} dB	Time Base (hours)*
Dwelling, indoors	Speech intelligibility & moderate annoyance, daytime & evening	35	16
Inside bedrooms	Sleep disturbance, night time	30	8

* Typically taken to be daytime/evening - 07:00 – 23:00 hours and night time 23:00 – 07:00 hours.

In addition to the above continuous equivalent noise levels, WHO guidelines indicates that exceedances of 45 dB L_{Amax} for single sound events should be limited to no more than 10 – 15 times per night, when measured with a 'fast' time weighting.

3.5 BS6472:2008 Guide to Evaluation of human exposure to vibration in buildings

BS6472:2008 develops guideline limiting vibration criteria for residential and other premises. BS6472 uses the Vibration Dose Value (VDV) parameter to assess the probability of adverse comments when human subjects are exposed to vibration from typical environmental sources of vibration (e.g. rail traffic). BS6472 gives the following envelope limiting values to describe varying degrees of perception:

Table 4. BS6472 Guideline Vibration Limiting Criteria for residential use

VDV Period	VDV ms ^{-1.75}		
	Low Probability of Adverse Comment	Adverse Comment Possible	Adverse Comment Probable
Residential Buildings 16hr day 07:00 – 23:00 hours	0.2 – 0.4	0.4 – 0.8	0.8 – 1.6
Residential Buildings 8hr night 07:00 – 23:00 hours	0.1 – 0.2	0.2 – 0.4	0.4 – 0.8

BS6472 states that for levels below the ranges in the table above adverse comment is not expected.

3.6 Re-radiated Structure Borne Noise

Re-radiated structure borne noise has the potential to cause disturbance if it is generated at a sufficiently loud level. In the absence of any local or national government guidance with regards to structure-borne noise due to subterranean rail movements, appropriate design criteria for structure-borne noise in this case would be that given in the American Public Transit Association (APTA) Guideline for Design of Rapid Transit Facilities, Section 2.7, Noise and Vibration, 1981. The guidelines are reproduced in the Table below:

Table 5: APTA Guidelines for Acceptable Ground-Borne Noise Within Residential Dwellings

Community Area	Maximum A-weighted Sound Pressure Level dB L _{ASMAX}	
	Single Family Dwelling	Multi-Family Dwelling
Low Density Residential	30	35
Average Density Residential	35	40
High Density Residential	35	40
Commercial	40	45
Industrial / Highway	40	45

3.7 Manchester City Council – Planning and Noise – Technical Guidance 2022

The Planning and Noise – Technical Guidance 2022 document sets out Manchester City Council's noise design criteria to meet requirements of the NPPF for various types of developments.

3.7.1 Entertainment Venues

'Entertainment Venues' are not strictly defined within the technical guidance, however it is inferred that venues including for the playing of recorded music should be considered as an Entertainment Venue. Further to this the guidance specifies that applicants and consultants in respect of the noise impact assessment for a new venue, should consider noise levels that are 'typical' for the type of venue to be constructed, in anticipation that future owners of the venue may wish to provide some level of entertainment even if previously there was none.

The guidance considers that with regards to music, noise in the 63Hz & 125Hz bands may be particularly disturbing to local residents exposed to it. Therefore the assessment of the noise from entertainment venues should consider the overall noise (L_{Aeq}) and the 63 Hz and 125 Hz octave band noise levels (L_{Zeq}).

The following design criteria is given for new residential developments that are structurally connected to the entertainment venue (or vice versa) .

'Music noise levels in the 63Hz and 125Hz octave centre frequency bands (L_{eq}) should be controlled so as not to exceed (in habitable rooms) 47dB and 41dB (L_{eq}), respectively'

The guidance notes that the above criteria may also be applicable to new residential developments that are structurally separated from an existing entertainment venue.

In regards to a new entertainment venue that is structurally detached from other buildings, the following criteria is specified.

'Entertainment noise ($L_{Aeq,5min}$) should be controlled to 5dB below the typical background noise level (L_{A90}) in each octave band at the nearest noise sensitive location'

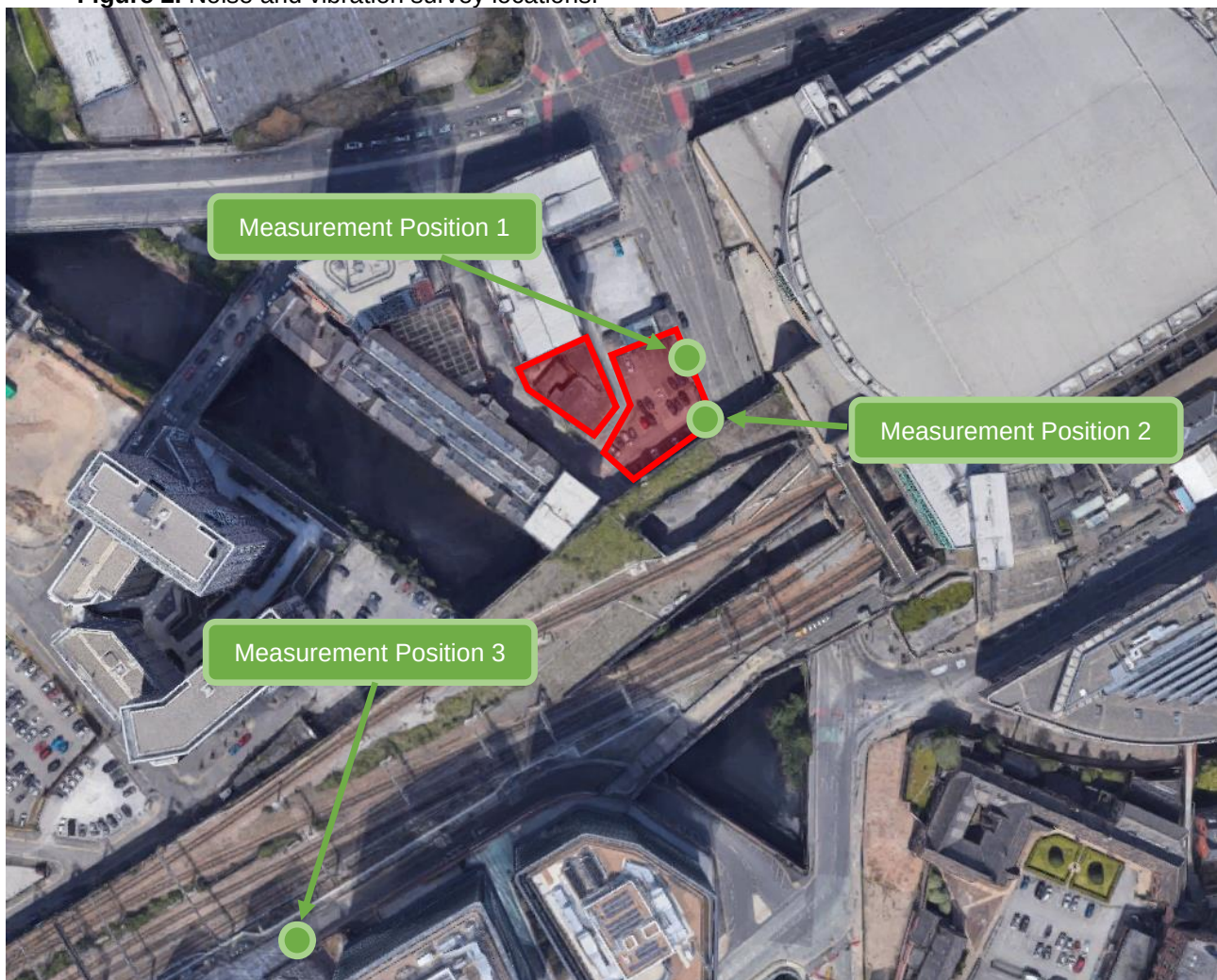
4.0 SURVEY DETAILS AND RESULTS

4.1 Environmental Noise and Vibration Survey

A noise level survey was undertaken at the site between 21:20 hours on Tuesday 5th July and 01:00 hours on Wednesday 6th July 2022. In addition a second noise and vibration level survey was carried out between 06:05 hours and 12:47 hours on Wednesday 13th July 2022. The periods measured were deemed to be representative of day and night-time hours.

Noise measurements were taken along the eastern boundary of site (measurement position 1) with additional noise measurements being carried out in close proximity to the rail line (measurement position 3) as can be seen within Figure 2. A vibration survey was also carried out at to the southern boundary edge of site (measurement position 2) closest to the rail line viaduct.

Figure 2. Noise and vibration survey locations.



The measurement positions are detailed as follows:

- Measurement Position 1 – microphone located on a mast approximately 4m above ground level at the eastern boundary. This was deemed to have no reflective surfaces affecting the noise level measurements.
- Measurement Position 2 – vibration transducer located on ground level at southern boundary. This was deemed to be level and on hard ground.
- Measurement Position 3 – microphone located on a tripod approximately 1.5m above ground level and approximately 16m from the most southernly rail line. This was deemed to have no reflective surfaces affecting the noise level measurements.

All measurements were made and attended by Mr David Hible of PDA Ltd. Measurements were of continuous 5 minute samples. The survey was conducted using 1x NTi XL2. Calibration certificates for the sound level meters are held.

The NTi meters are Class 1 frequency response as per BS EN 61672-1:2003. For both surveys the sound level meters were field calibrated both before and after the measurement period, during which time no significant deviation from the calibrated level was observed. The sound level meters were fitted with a microphone windshield at all times.

The microphone of the sound level meter at each position was mounted on a mast/tripod at least 3m from surrounding structures and can be assumed to be a free field measurement. All measurements were undertaken with a fast time-weighting and broadband statistics were measured throughout. In addition, octave band frequency spectra were recorded.

The weather during the noise survey on the 5th to 6th July was dry, with wind speeds reported at 1-2m/s in a West-North-Westerly direction. Temperatures were between 14-16 degrees celsius with mainly clear skies at approximately 10% coverage.

The weather during the noise and vibration survey on 13th July was dry, with wind speeds at 1-2m/s in a West-North-Westerly direction. Temperatures were between 15-20 degrees celsius with mainly clear skies and approximately 5% cloud coverage.

Noise Sources

The local noise climate is dominated by road traffic from Great Ducie Street which is a busy throughfare and to a lesser extent Mirabel and Breslyn street. Contributions from surrounding local roads include cars, buses, lorries and motorbikes. Frequent rail noise is also present to the south of site with regular pass-bys in the day and less so in the night.

Measurements were made during which time an event was taking place at AO arena. During the hours of the performance mostly low frequency noise can be noticed along with extraction fans running from the lower roof level of the arena.

4.1.1 Vibration

The vibration survey was conducted using a Svan 958 vibration analyser. The Svan 958 vibration analyser is a continuous monitoring vibration analyser with a tri-axial geophone sensor. The Svan 958 was set-up at Measurement Position 2 on an area of concrete ground surface at the closest point to the existing railway line. The location was judged to be representative of the proposed buildings. Vibration data was recorded between 06:15 hours and 11:00 hours on Wednesday 13th July. The vibration analyser was set to measure continuously and calculate VDV values over 5-minute periods throughout the measurement periods.

4.2 Measurement Results

4.2.1 Environmental Noise

Measurement positions on site are shown on Figure 2 Section 4.1 of this report. A summary of the results is given below:

Table 6. Summary of environmental noise measurements – Measurement Position 1

Position	Time Period (hh:mm)	Duration (hh:mm)	L _{Aeq,T} (dB)	Typical Night-time L _{Amax,5mins} (dB) ¹
1	Day 5/7/2022 21:20 – 23:00 13/7/2022 07:00 – 11:00	05:40	66.1*	N/A
	Night 5/7/2022 23:00 – 01:00 Night 13/7/2022 06:05 – 07:00	02:55	63.4*	78.7

Notes:

¹ Typical L_{Amax} noise levels are those which have been calculated as the upper tenth percentile of L_{Amax}'s

* Periods removed where a street drummer was playing which is considered to not be typical of the environmental noise at site. This is shown within Appendix A Figure 5.

4.2.2 Rail Noise

From the measurements taken at position 3, specific rail line noise calculations have been undertaken by utilising 1-second logging and taking only the periods where a train is passing and audible. Any measurements which are compromised by other noise sources such as construction or local car pass-bys have been disregarded. A summary of which can be seen in Table 7 below. From this, the sound exposure level (SEL) has been calculated using the $L_{Aeq,T}$ with a distance correction and then converted using the duration of measurement.

Table 7. Summary of specific rail noise measurements – Measurement Position 3

Trainline	Distance from Measurement Position 3 (meters)	Measurement Duration (seconds)	$L_{Aeq,T}$ (dB)	SEL ⁺	Highest L_{Amax} (dB)
1	16	18	59	84	69
2	21	60	64	95	70
3	26	18	60	87	67
4	35	23	61	90	65
5	42	25	62	91	67

+ Distance correction applied to SEL

For the noise break-in assessment, it is necessary to calculate the $L_{Aeq,18h}$ and $L_{Aeq,6h}$ for day time and night-time periods respectively. CRN (Calculation of Railway Noise) gives the following formula to convert from the SEL to the equivalent noise level over the desired period:

$$L_{Aeq,18h} = SEL - 48.1 + 10\log_{10}Q_{DAY}$$

$$L_{Aeq,6h} = SEL - 43.3 + 10\log_{10}Q_{NIGHT}$$

Where Q is equal to the number of trains passing during each period, we have obtained the working timetable from Network Rail, as provided by the www.realtimetetrains.co.uk site, in order to provide an accurate quantity for Q. The derived equivalent noise levels for each train line is as follows.

Table 8. Summary of calculated $L_{Aeq,18h}$ and $L_{Aeq,6h}$ per train line

Trainline	$L_{Aeq,18h}$ (dB)	$L_{Aeq,6h}$ (dB)	Highest L_{Amax} (dB) ⁺
1	56	51	86
2	67	62	89
3	58	53	86
4	62	57	85
5	62	57	88

+ Distance correction applied to L_{Amax}

4.3 Vibration Results

A summary of the vibration measurements in terms of VDV $\text{ms}^{-1.75}$ is given in the Table below. Note that the measurements are split into daytime [07:00 – 11:00] and night-time [06:15 – 07:00] periods. The 5 minute measurements were combined to calculate the overall VDV for both the daytime and the night-time periods.

$$VDV(T) = \sqrt[4]{\sum (VDV(dT))^4}$$

Table 9. Summary of Vibration Measurements VDV $\text{ms}^{-1.75}$

Measurement Location	Period	VDV $\text{m/s}^{1.75}$		
		X axis (horizontal)	Y axis (horizontal)	Z axis (vertical)
3	Day 13/7/2022 07:00 – 11:00	0.011	0.005	0.028
	Night 13/7/2022 06:15 – 07:00	0.005	0.003	0.017

4.4 Mirabel and Breslyn Street Noise Data

In order to assess noise from Mirabel Streets and Breslyn Street, data has been taken from a previous environmental report specific to the development carried out by Azimuth Acoustics UK titled '12280_FO_2019_ENVIRONMENTAL_NOISE_REPORT-1070250'. Data is provided for L_{Aeq} and L_{Amax} (worst 5%) for measurements taken at the boundaries of Mirabel Street and Breslyn Street. A summary of the data can be seen in Table 10. This data has been taken and used to normalise a typical road traffic noise spectrum from within the PDA database.

Table 10. Previous on-site measurement data

Location	Time Period	L_{Aeq}	L_{Amax}^*
Mirabel Street	Day	60	77
	Night	55	75
Breslyn Street	Day	59	75
	Night	57	72

Notes:

* Typical L_{Amax} noise levels are those which have been calculated as the upper tenth percentile L_{Amax} .

Measurement data has also been utilised from the Azimuth Acoustic UK report to assess the noise break-out from within the platform opening of Manchester Victoria train station. The details of which are summarised in Table 11. These levels will then be used to model the area source opening of the train station within the assessment in Section 5.

Table 11. Summary of measurements taken by Azimuth Acoustics UK from within Manchester Victoria train station

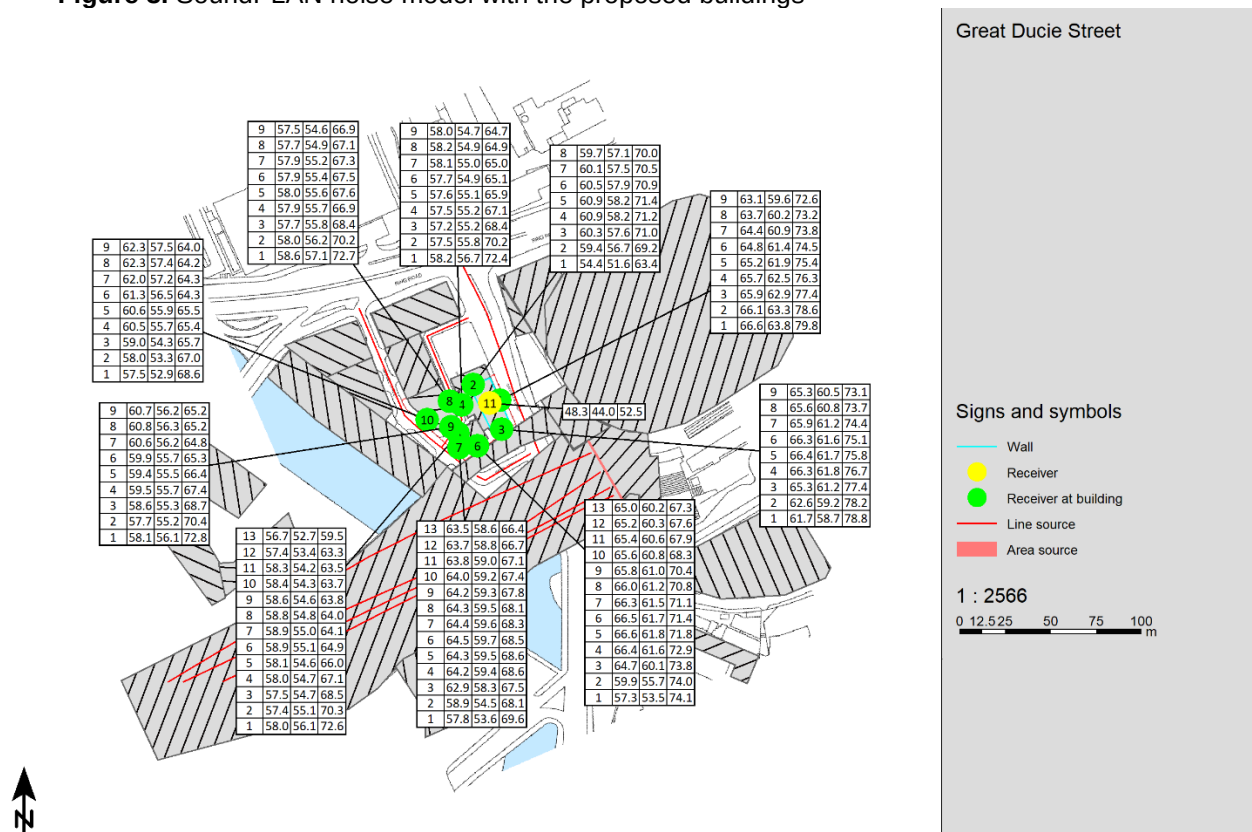
Octave Band Noise Level Data (dB)								Noise Level L_{Aeq} (dB[A])
63	125	250	500	1k	2k	4k	8k	
92	83	83	80	78	75	73	72	81

5.0 NOISE PROPAGTION AND IMPACT ASSESSMENT

Using the measured and predicted noise level data above, a 3-dimensional computer noise model has been constructed using SoundPLAN noise modelling software to determine the noise level impact upon the proposed development. All calculations have followed the methodology contained within ISO 9613-2:1996 *Attenuation of sound during propagation outdoors - Part 2: General method of calculation*. The topographical data for the site and surrounding area is taken from Google Maps Terrain height data.

The model has been calibrated to the noise levels measured on-site and the predicted railway line noise levels. A ground absorption coefficient of 0 has been used to take into account the predominantly hard surfaces of roads, hard standing, etc. From this, the proposed layout of the new buildings has been added. Noise level incident upon the proposed building are calculated at 5m above ground level and 2.8m for each additional floor for the 9-13 storey accommodation. The SoundPLAN model would suggest the following noise levels calculated at the façade of the proposed buildings.

Figure 3. SoundPLAN noise model with the proposed buildings



5.1 Discussion

It is PDA's experience that developments with the measured noise levels above are suitable for residential development provided that adequate acoustic attenuation is provided to habitable areas. Considering the acoustic weak points of a building façade, typically the glazing and the ventilation elements, calculations have been undertaken to determine specifications for these building elements and the internal noise levels. These levels are compared with the criteria detailed in Table 12 below, derived from the guidance in Section 4.

Table 12. Proposed internal noise level criteria

Space	L _{Aeq,T} dB	Time Base (hours)
Living Rooms/Bedrooms, Daytime	35	16 (07:00 – 23:00 hours)
Bedrooms, Night time	30	8 (23:00 – 07:00 hours)

In addition for bedrooms at night time (23:00 – 07:00 hours) individual noise events should not normally exceed 45 dB L_{Amax}, when limited to no more than 10 – 15 times per night.

6.0 NOISE LEVEL PREDICTIONS

Based upon the measured noise levels in Section 4, calculations have been undertaken to determine internal noise levels for the proposed residential accommodation. The proposed site and internal layouts are derived from the received Hodder+partners drawings, ref. 'Typical_Floor_Layout_Level_x-x_-1070295' dated October 2016 which encompasses all floors and rooms across each block.

In addition, calculations for noise break in have been carried out based upon the façade details given in Hodder+partners drawings, ref. 'Façade_Detail_X_2-1114976'. It is understood that the ceiling height is of 2.5m

6.1 Glazing and Ventilation Attenuation Requirements

The dominant paths for noise transfer to the interior of buildings are generally the glazing and ventilation elements of the façade constructions. It is PDA's understanding that the ventilation strategy for the proposed development is Mechanically Ventilated Heat Recovery (MVHR) across site. Due to loss through the louvre opening, duct system and heating system, we consider the external noise ingress via this path negligible in comparison to the rest of the façade. Based on this premise, to achieve the required internal noise levels from Table 6 would require the following glazing specifications.

The calculation of noise break-in to the residential rooms has been undertaken in accordance with the calculation methods of BS EN 12354-3:2000 *Building Acoustics – Estimation of acoustic performance of buildings from the performance of elements. Part 3: Airborne sound insulation against outdoor sound*, in octave bands. Reverberation time is taken as 0.5 seconds as per the BS EN 12354-3 reference time for dwellings.

Figure 4. Site layout for the proposed accommodation

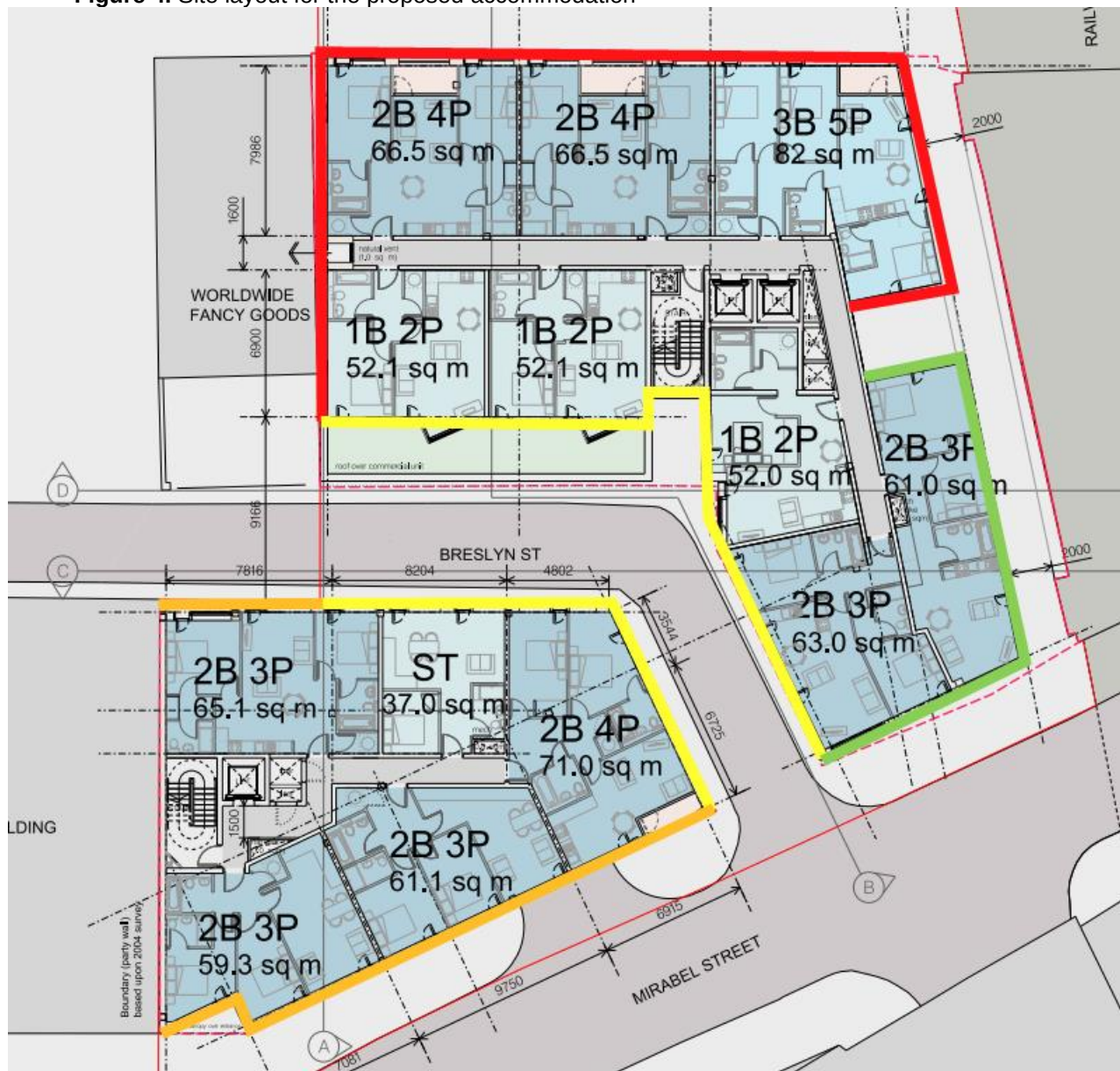


Table 13. Glazing Schedule

Colour	Floor	Room	Minimum Glazing Rating R_w dB	Internal Noise Level Target	Calculated Internal Noise Level	
				$L_{Aeq,T}$ dB Day/Night	$L_{Aeq,T}$ dB Day/Night	L_{Amax} Night
Red	All	Bedroom	42	35/30	28/25	41
		Kitchen/Living	36	35/-	33/-	-
Green	All	Bedroom	40	35/30	32/28	37
		Kitchen/Living	38	35/-	33/-	-

Colour	Floor	Room	Minimum Glazing Rating R_w dB	Internal Noise Level Target	Calculated Internal Noise Level	
				$L_{Aeq,T}$ dB Day/Night	$L_{Aeq,T}$ dB Day/Night	L_{Amax} Night
Yellow	All	Bedroom	33	35/30	32/28	44
		Kitchen/Living	29	35/-	33/-	-
Orange	All	Bedroom	36	35/30	32/28	38
		Kitchen/Living	36	35/-	33/-	-

With the glazing specifications proposed in Table 13 above, calculations suggest that the internal Day and Night time BS8233:2014/WHO noise level requirements can be achieved. Calculated internal noise levels are given on the worst-case internal receivers. Calculations have been undertaken to determine L_{Amax} noise levels within the bedrooms at night time. Using the full night time L_{Amax} noise levels measured across site and previous rail measurements, with the glazing and ventilation specifications above, the calculated L_{Amax} values will not normally exceed 45 dB L_{Amax} .

6.1.1 Entertainment Venue Noise

In addition to the above break-in calculations, an assessment has been made upon low frequency noise specifically from the AO Arena within habitable rooms. A summary of the 'worst-case' receiver on the eastern façade facing the AO Arena is presented in Table 14 below.

Table 14. Calculated internal noise levels within eastern elevation rooms.

Room	Octave Band Noise Level Data (dB)								Noise Level (dB[A])
	63	125	250	500	1k	2k	4k	8k	
Bedroom	46	39	31	21	17	13	-6	-15	28
Kitchen/Living	46	36	37	28	20	12	-1	-10	33

In regards to the *Planning and Noise – Technical Guidance 2022* as published by Manchester City Council, it can be seen how the noise levels at 63 and 125Hz fall below the guidance of 47dB and 41dB respectively as discussed within Section 3.7. Thus, we would consider this to meet the condition of being understood to be 'inaudible'/'virtually inaudible'.

6.1.2 Glazing Specification and Installation Notes

Notes on Glazing Installation

For the glazing specifications in Table 14, all sound insulation values quoted must be achieved by the overall combination of frame and glazing, and not just by the glazing alone. The frame should not reduce the performance of the system overall. Glazing framing systems must be fully sealed with any small gaps (<10mm nominal) around the perimeter to be stuffed with dense mineral wool to full frame depth and sealed both sides with acoustic non-setting mastic, with additional weathering protection to be applied additionally externally to this. No gaps should be left unsealed.

Minimum performance requirements for the combination of glazing and framing recommended in the above tables are as follows:

Table 15. Required Minimum Sound insulation of Combined Glazing and Framing

Typical Product	Minimum Sound Reduction Index R (dB) at Octave Band Centre Frequency (Hz)								R _w dB
	63	125	250	500	1k	2k	4k	8k	
8/20/12.8lam	28	26	32	41	45	43	54	54*	42
4/12/8	23	26	24	30	39	41	45	45	36
8/12/8.8lam	23	28	27	35	45	46	52	52	40
6/12/6	18*	20	19	29	38	36	45	45*	33
10/12/6	20*	26	27	34	40	38	46	46*	38
4/12/4	22	21	17	25	37	42	37	37	29

*Assumed sound reduction value as not stated in manufacturers literature.

Figures stated in the table above are based on Saint Gobain manufacturer quoted data. Acoustic ratings should be checked with the manufacturer and supported by laboratory test reports where necessary. Any areas of aluminium panelling (if proposed) adjacent to the window glass should meet the same minimum specification as the glass to which they are adjacent.

6.2 External Walls

It is assumed that the external wall will be a brick cavity construction. Within our calculations it has been determined that the sound insulation performance of the façade should be no less than 54 dB R_w. Manufacturer's test data has been used based upon the example build-up below:

- 100mm brick, 75mm cavity filled with rockwool (33kg/m³) and an inner plasterboard frame with 2x 15mm SoundBloc.

From the façade detail drawings noted in Section 6.0, it is understood that areas of the façade are of a lightweight aluminium construction which border with the glazing. Sound insulation prediction software, Insul, has been used to determine the sound insulation performance of these areas which should be no less than 59 dB R_w. The construction of which is as below:

- 1mm Aluminium, 200mm cavity with wall ties and 180mm (33kg/m³) rockwool, 2x 12mm cement particle board, steel stud with 100mm cavity filled with rockwool (33kg/m³) and 2x 15mm SoundBloc.

It is PDA's understanding that sections of the lightweight aluminium construction contain openable panels for ventilation purposes. It must be ensured that the sound insulation performance of these areas also meets no less than 59 dB R_w when closed.

6.3 Roof

Within the calculations the roof has been assumed to be a concrete slab roof construction with insulation and plasterboard ceiling within the top floor rooms. It is considered that this is likely to be acceptable.

Insul sound prediction software would suggest the a typical minimum 150mm concrete slab structure has a laboratory sound insulation of at least 54 dB R_w, which is considered to be acceptable.

6.4 Ground Floor Spaces

It is proposed that there will be ancillary spaces on the ground floor of the building including Commercial, Laundry and Amenity areas. The required sound insulation performance of separating elements in residential buildings is governed by the Building Regulations Approved Document E, which sets out minimum sound reduction performance criteria that should be achieved between the spaces.

Clause 0.8 of Approved Document E would suggest that, *‘the performance standards set out in Tables 1a and 1b (of the document) are appropriate for walls, floors and stairs that separate spaces used for normal domestic purposes. A higher standard of sound insulation may be required between spaces used for normal domestic purposes and communal or non-domestic purposes. In these situations the appropriate level of sound insulation will depend on the noise generated in the communal or non-domestic space. Specialist advice may be needed to establish if a higher standard of sound insulation is required and, if so, to determine the appropriate level.’*

Where the proposed use is to be low noise generation, e.g. offices, it is considered that meeting the minimum sound insulation criteria of Approved Document E for the separating walls/floors is likely to be sufficient. Where the use is likely to generate greater noise than that experienced in normal domestic uses then uprating works to the building structure may be required using enhanced ceilings or improved wall constructions/linings, etc. Assessment will be undertaken at detailed design stage to control internal noise levels to bedrooms to meet the requirements of BS8233:2014.

6.5 External Amenity Spaces

Using the 3-dimensional noise model created within SoundPLAN, as discussed within Section 5.0, noise level predictions have been made for the external rooftop amenity area. This has been modelled as a receiver located 1.5m from the top of the building. It is assumed that a 2m solid wall will also be present around the boundary of the rooftop area.

The predicted level is 48 dB(A) during day-time hours. Within Section 3.3, it is discussed how an external noise level of 50 dB L_{Aeq} is desirable within amenity areas with an upper limit of 55 dB L_{Aeq} in noisier environments. We would therefore regard the predicted level to be within the desirable limit as stated within BS8233:2014.

7.0 VIBRATION ASSESSMENT

Vibration was measured at position 2 on an area of concrete ground surface at the closest point to the existing railway line. The location was judged to be representative of the proposed buildings. No amplification has been applied to the x and y axes. These amplification factors are in accordance with Association of Noise Consultants guidelines for the assessment of ground-borne vibration.

The measured and predicted vibration levels are compared to the criteria of BS 6472 in Table 16 below.

Table 16. Comparison of measured vibration with BS 6472 criteria

Measurement	Period	BS 6472 ‘Low probability of adverse comment’ criterion [VDV]	Maximum predicted vibration [VDV] $ms^{-1.75}$		
			X	Y	Z
Day 13/7/2022 07:00 – 11:00	Residential Buildings 16hr day 07:00 – 23:00 hours	0.2 – 0.4	0.011	0.005	0.028
Night 13/7/2022 06:15 – 07:00	Residential Buildings 8hr night 07:00 – 23:00 hours	0.1 – 0.2	0.005	0.003	0.017

The measured and predicted vibration levels are well below the ‘Low probability of adverse comment’ criterion of BS 6472 for both day and night time periods and as such, BS 6472 would suggest that for levels below the ranges in the table, adverse comment is not expected.

7.1 Re-Radiated Noise Assessment

The ANC Guidelines describe various corrections and transfer functions with regards to propagation of structure borne vibration in buildings. These include but are not limited to attenuation/amplification within different foundation types, slab resonance and attenuation from floor to floor. The most onerous structural coupling and correction factors have been assumed such that our assessment is conservative. The corrections are as summarised below:

- Coupling attenuation (large masonry on piled foundations) = 5 – 10 dB
- Floor-to-Floor attenuation = 1 - 2 dB / 31 – 125 Hz
- Slab resonance = +6 dB / 20 – 30 Hz

Having accounted for the corrections above, the following equation was used to predict the re-radiated noise in 1/3 octave bands into the 1st floor dwellings:

$$L_p = L_v - 32 \text{ dB}$$

Where:

L_p = The $L_{\text{max slow}}$ sound pressure level during a train pass event

L_v = The $L_{\text{max slow}}$ vibration velocity level in dB re: $1 \times 10^{-9} \text{ ms}^{-1}$

The re-radiated noise have been predicted utilising the 10 highest measured L_{ASMax} velocity levels, the results suggest that the noise levels will be between 20 – 36dB L_{ASMax} on piled foundations. The calculated levels are below the maximum A-weighted sound pressure level dB L_{ASmax} as stated in Table 5 within Section 3.6 for multi-family dwellings in a high density residential area. Therefore we would consider that no adverse comment is expected.

8.0 CONCLUSIONS

PDA Ltd was commissioned by One Heritage to carry out an environmental noise and vibration assessment report for the proposed new residential accommodation development at Great Ducie Street, Manchester. The proposed development consists of two 9 to 13 storey blocks comprising 129 no. residential apartments and 2 no. commercial units with a shared rooftop amenity space located upon the Great Ducie Street elevation block. The proposal for the ground floor commercial units incorporates A1/ A2 (retail) as well as A3 (entertainment) uses

A noise level survey has been undertaken at the site representative of daytime and night-time hours. The local noise climate is dominated by road traffic from Great Ducie Street and to a lesser extent Mirabel and Breslyn Street. Rail noise is more dominant to the south of site emanating from the raised viaduct. During evening periods noise is also present from the AO Arena during events.

Based upon the measured and predicted noise levels, supplemented with Azimuth Acoustics UK survey data, calculations have been undertaken for the Bedrooms and Kitchen/Living Rooms to evaluate the internal noise levels. Recommendations are given for glazing and building façade elements to meet the internal noise level requirements of good practice guidance given in BS8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings. Calculations suggest that the noise level criteria of BS8233:2014 can be achieved within the proposed accommodation. Calculations have also been carried out to assess the external amenity spaces where it is noted these areas will fall within the desired levels set out in BS8233:2014. Further to this, calculations suggest that the proposed development can achieve the low frequency music noise level criteria as set out within the Planning and Noise – Technical Guidance 2022 by Manchester City Council.

In addition a vibration survey has been undertaken running concurrently with the noise measurements. The measured and predicted vibration levels are well below the '*Low probability of adverse comment*' criterion of BS 6472 for both day and night time periods and as such, BS 6472 would suggest that for levels below the ranges, adverse comment is not expected.

APPENDIX A – SURVEY DATA

Figure 5. Ambient Noise Level Survey – Measurement Position 1

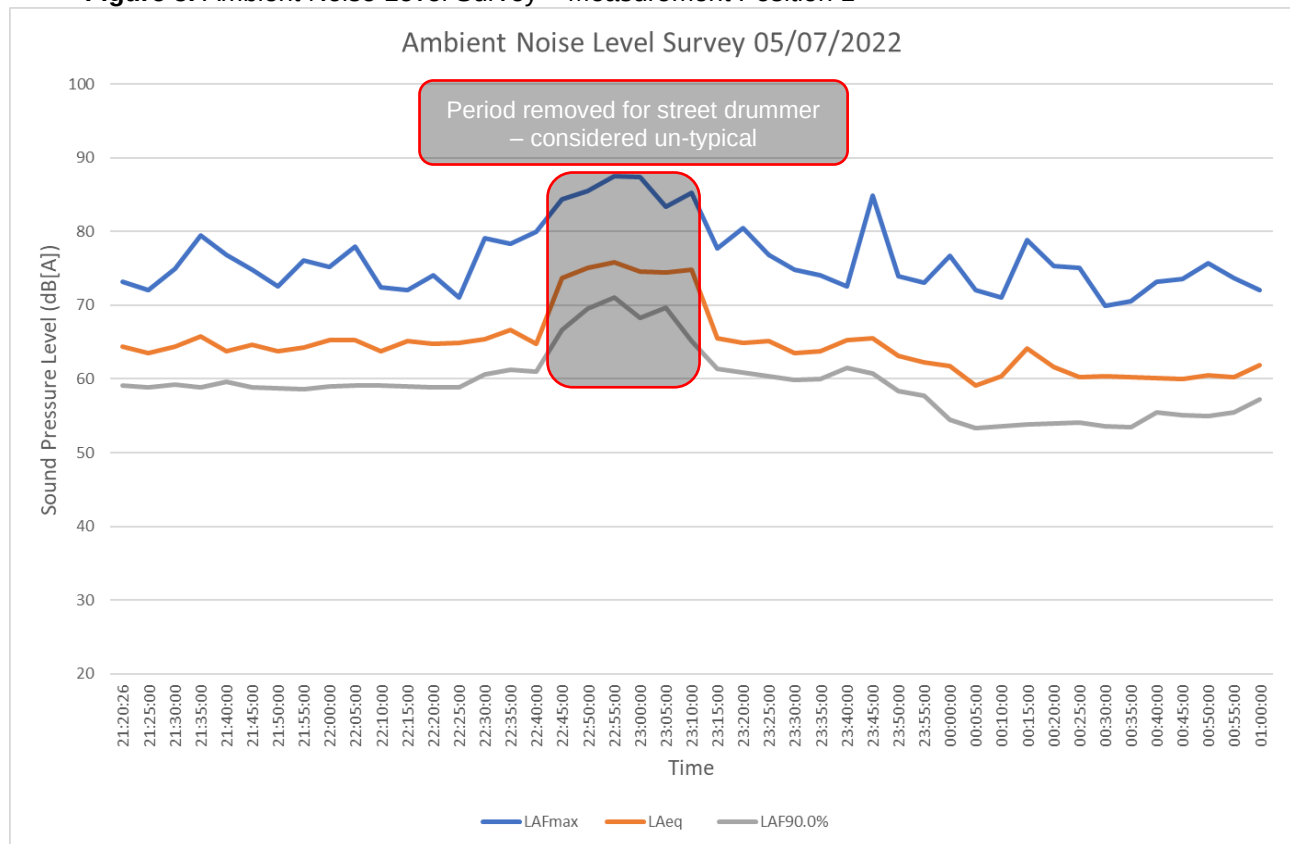


Figure 6. Ambient Noise Level Survey – Measurement Position 1

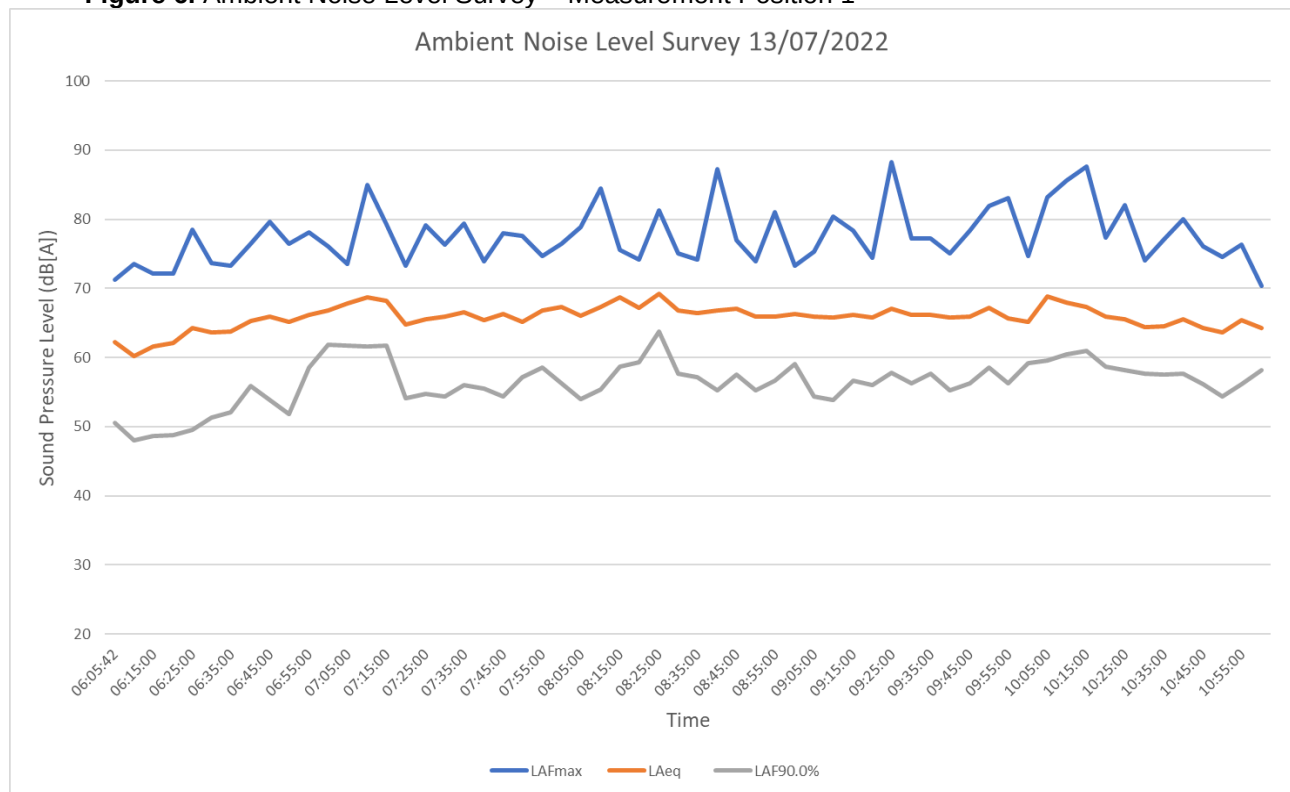


Table 17. Vibration Survey – Measurement Position 2

				CH1 (VLM)	CH2 (VLM)	CH3 (VLM)
				P1 (WD, LIN)	P1 (WD, LIN)	P1 (WB, LIN)
		FILENAME	ELAPSED TIME	VDV [M/S ^{1.75}]	VDV [M/S ^{1.75}]	VDV [M/S ^{1.75}]
NO.	DATE & TIME		[HH:MM:SS]			
1	13/07/2022 06:15	@NG198	00:05:00	0.002	0.002	0.006
2	13/07/2022 06:20	@NG199	00:05:00	0.002	0.001	0.012
3	13/07/2022 06:25	@NG200	00:05:00	0.002	0.001	0.011
4	13/07/2022 06:30	@NG201	00:05:00	0.002	0.001	0.008
5	13/07/2022 06:35	@NG202	00:05:00	0.003	0.002	0.012
6	13/07/2022 06:40	@NG203	00:05:00	0.003	0.002	0.009
7	13/07/2022 06:45	@NG204	00:05:00	0.003	0.002	0.008
8	13/07/2022 06:50	@NG205	00:05:00	0.003	0.002	0.009
9	13/07/2022 06:55	@NG206	00:05:00	0.003	0.002	0.01
10	13/07/2022 07:00	@NG207	00:05:00	0.002	0.001	0.008
11	13/07/2022 07:05	@NG208	00:05:00	0.003	0.002	0.01
12	13/07/2022 07:10	@NG209	00:05:00	0.003	0.002	0.007



13	13/07/2022 07:15	@NG210	00:05:00	0.003	0.002	0.014
14	13/07/2022 07:20	@NG211	00:05:00	0.003	0.002	0.008
15	13/07/2022 07:25	@NG212	00:05:00	0.003	0.002	0.008
16	13/07/2022 07:30	@NG213	00:05:00	0.004	0.002	0.01
17	13/07/2022 07:35	@NG214	00:05:00	0.003	0.002	0.008
18	13/07/2022 07:40	@NG215	00:05:00	0.004	0.002	0.013
19	13/07/2022 07:45	@NG216	00:05:00	0.003	0.002	0.014
20	13/07/2022 07:50	@NG217	00:05:00	0.003	0.002	0.006
21	13/07/2022 07:55	@NG218	00:05:00	0.005	0.002	0.011
22	13/07/2022 08:00	@NG219	00:05:00	0.003	0.002	0.011
23	13/07/2022 08:05	@NG220	00:05:00	0.003	0.002	0.007
24	13/07/2022 08:10	@NG221	00:05:00	0.003	0.002	0.007
25	13/07/2022 08:15	@NG222	00:05:00	0.003	0.002	0.008
26	13/07/2022 08:20	@NG223	00:05:00	0.003	0.002	0.007
27	13/07/2022 08:25	@NG224	00:05:00	0.004	0.002	0.012
28	13/07/2022 08:30	@NG225	00:05:00	0.003	0.002	0.007
29	13/07/2022 08:35	@NG226	00:05:00	0.004	0.002	0.017
30	13/07/2022 08:40	@NG227	00:05:00	0.003	0.002	0.007
31	13/07/2022 08:45	@NG228	00:05:00	0.003	0.002	0.011
32	13/07/2022 08:50	@NG229	00:05:00	0.003	0.002	0.007
33	13/07/2022 08:55	@NG230	00:05:00	0.003	0.002	0.01
34	13/07/2022 09:00	@NG231	00:05:00	0.004	0.002	0.011
35	13/07/2022 09:05	@NG232	00:05:00	0.007	0.002	0.008
36	13/07/2022 09:10	@NG233	00:05:00	0.005	0.002	0.006
37	13/07/2022 09:15	@NG234	00:05:00	0.006	0.002	0.01
38	13/07/2022 09:20	@NG235	00:05:00	0.006	0.002	0.015
39	13/07/2022 09:25	@NG236	00:05:00	0.006	0.002	0.011
40	13/07/2022 09:30	@NG237	00:05:00	0.004	0.002	0.011
41	13/07/2022 09:35	@NG238	00:05:00	0.004	0.002	0.015
42	13/07/2022 09:40	@NG239	00:05:00	0.005	0.002	0.014
43	13/07/2022 09:45	@NG240	00:05:00	0.005	0.002	0.012

44	13/07/2022 09:50	@NG241	00:05:00	0.003	0.002	0.009
45	13/07/2022 09:55	@NG242	00:05:00	0.003	0.002	0.009
46	13/07/2022 10:00	@NG243	00:05:00	0.003	0.001	0.006
47	13/07/2022 10:05	@NG244	00:05:00	0.003	0.002	0.01
48	13/07/2022 10:10	@NG245	00:05:00	0.003	0.002	0.012
49	13/07/2022 10:15	@NG246	00:05:00	0.004	0.002	0.01
50	13/07/2022 10:20	@NG247	00:05:00	0.003	0.002	0.007
51	13/07/2022 10:25	@NG248	00:05:00	0.003	0.002	0.009
52	13/07/2022 10:30	@NG249	00:05:00	0.003	0.002	0.007
53	13/07/2022 10:35	@NG250	00:05:00	0.003	0.002	0.007
54	13/07/2022 10:40	@NG251	00:05:00	0.003	0.002	0.009
55	13/07/2022 10:45	@NG252	00:05:00	0.003	0.002	0.007
56	13/07/2022 10:50	@NG253	00:05:00	0.003	0.002	0.008
57	13/07/2022 10:55	@NG254	00:05:00	0.004	0.002	0.01

APPENDIX B – NOTES FOR QUALITY CONTROL

1. Blockwork

All blockwork is to be mortared to an almost fair faced standard both horizontally and vertically. Only perfect blocks may be used with no pitting or cracks. The blockwork must seal effectively to the underside of the soffit.

Where blockwork walls form a cavity wall, care should be taken to avoid rubble and snots from bridging the cavity. This is especially important where one or more of the leaves is floating.

2. Plasterboard

All plasterboard joints are to be butted tight. The rule of thumb is that the joint should be tight enough over its entire length to prevent a normal business card from being inserted. Multiple layers should be fitted with staggered joints.

Base details and deflection heads are to be as per the British Gypsum White Book unless otherwise stated, and copious amounts of mastic to be used when fitting to the walls, floor and ceiling respectively.

3. Mineral Fibre

Mineral fibre slabs are to be butted tightly together and to boundary structures, to form a homogeneous layer.

4. Windows

All window frames are to be a good tight fit into the building structure with any gaps to be filled both internally and externally with a non-setting mastic in addition to the usual weather proofing seal to the exterior. Any gaps between the frame and building that are greater than 5 mm are to be packed with a dense mineral fibre prior to mastic sealing.

5. Electrical Sockets

Electrical sockets must not be fitted back to back and removed areas of blockwork and plasterboard should be kept to an absolute minimum.

6. Water Pipes

All water pipes (and any other pipework) are to be resiliently mounted to avoid "water hammer". This is particularly important for plasterboard walls.

7. Penetrations

Penetrations are to be dealt with as described in this report. Details for specific services penetrations may be supplied upon request.

8. Approved Samples and Inspections

Samples of each individual acoustic element should be provided for inspection at the beginning of its installation. Once approved, the Clerk of Works must ensure that the same level of quality continues throughout construction.

APPENDIX C – DEFINITION OF ACOUSTIC TERMS

The decibel

This is the basic unit of noise, denoted dB.

A Weighting

This is a weighting process which simulates the human ear's different sensitivity at different frequencies. A weighting can be shown two typical ways, 50 dB(A) L_{eq} or 50 dB L_{Aeq} . Both mean the same thing. (See below for a definition of L_{eq}). The dB(A) level can be regarded as the overall level perceived by human beings.

L_{eq} and $L_{eq(s)}$

This is the equivalent continuous noise level which contains the same acoustic energy as the actual time-varying sound. In other words it is a kind of average noise level. It is denoted dB L_{eq} or, for A-weighted figures dB(A) L_{eq} or dB L_{Aeq} . It can also be expressed in terms of frequency analysis (see later). $L_{eq(s)}$ is the sample L_{eq} level.

L_n

This is the level exceeded for n% of the time. It is denoted dB L_n or, for A-weighted figures dB(A) L_n or dB L_{An} . It can be expressed in terms of frequency analysis (see later). L_{90} is the level exceeded for 90% of the time and is a measure of the lowest level typically reached. L_{10} is the level exceeded for 10% of the time and is the highest level typically reached. L_{50} is the level exceeded for 50% of the time and, mathematically, it is the median.

L_{max}

This is the maximum level reached during a measurement period. The "time constant", or the ability of the equipment to respond to impulses is usually expressed along with it, e.g. "Fast", "Slow", etc. It is denoted dB L_{max} or, for A-weighted figures dB(A) L_{max} , dB L_{Amax} , etc. It can also be expressed in terms of frequency analysis.

Frequency Analysis

Whereas dB(A) gives a very useful overall figure, it has its limitations in that it cannot be used to model or predict the effect of noise control and mitigation as this nearly always has radically different performance at different frequencies.

Frequency analysis expresses an overall noise level at each frequency or band of frequencies in the audible range. Octave band analysis divides the audible range into 10 bands from 31.5 Hz to 16 kHz and the noise level in each band can be expressed in any form e.g. L_{eq} , L_{90} , L_{max} etc. One third octave band analysis uses 30 bands.

Narrow band analysis takes the process to resolutions of less than 1 Hz. This is useful for identifying the existence of tones (whines, hums, etc.) and in pin-pointing the sources.