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ACOUSTIC
CONSULTANTS

Former Kirklees College Site, Huddersfield Mixed Use Development

Noise Impact Assessment

architectural

environmental

occupational

industrial

noise control at source

project management

legal services

expert witness

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1.0 SUMMARY

PDA Ltd was commissioned by Rhodes Asset Management to carry out an environmental noise assessment for the proposed mixed use development of the former Kirklees College site, Huddersfield.

In accordance with the National Planning Policy Framework, a noise measurement survey has been undertaken to be representative of day and night-time periods to quantify the nature and level of incident noise upon the proposed development. The local noise climate is dominated by road traffic on the surrounding road network.

Calculations suggest that the noise level criteria of BS8233:2014 and WHO Guidelines can be achieved within the proposed residential dwellings, and therefore the site may be considered suitable for residential development in line with the NPPF. Recommendations are given for glazing and treatment to meet the noise level requirements of BS 8233:2014 for new residential development.

For the commercial development proposed, suitable limits to the noise egress from external plant and services have been recommended to ensure that unacceptable impact on the existing and proposed residential uses is avoided.

2.0 SITE DESCRIPTION

2.1 Existing site details

The proposed development is located the former Kirklees College Site in Huddersfield. The site currently contains a number of existing buildings which are proposed to be demolished as part of the scheme, with the entrance block to the former Royal Infirmary building proposed to be retained. The site is bounded by Trinity Street, Castlegate, New North Road, Fitzwilliam Street and Portland Street.

2.2 Noise sensitive receivers

The nearest noise sensitive properties to the site have been identified as the residential properties on Portland Street, Trinity Street, Fitzwilliam Street and Saint Patrick's Church Presbytery off New North Road.

The existing site is shown in the figure below;

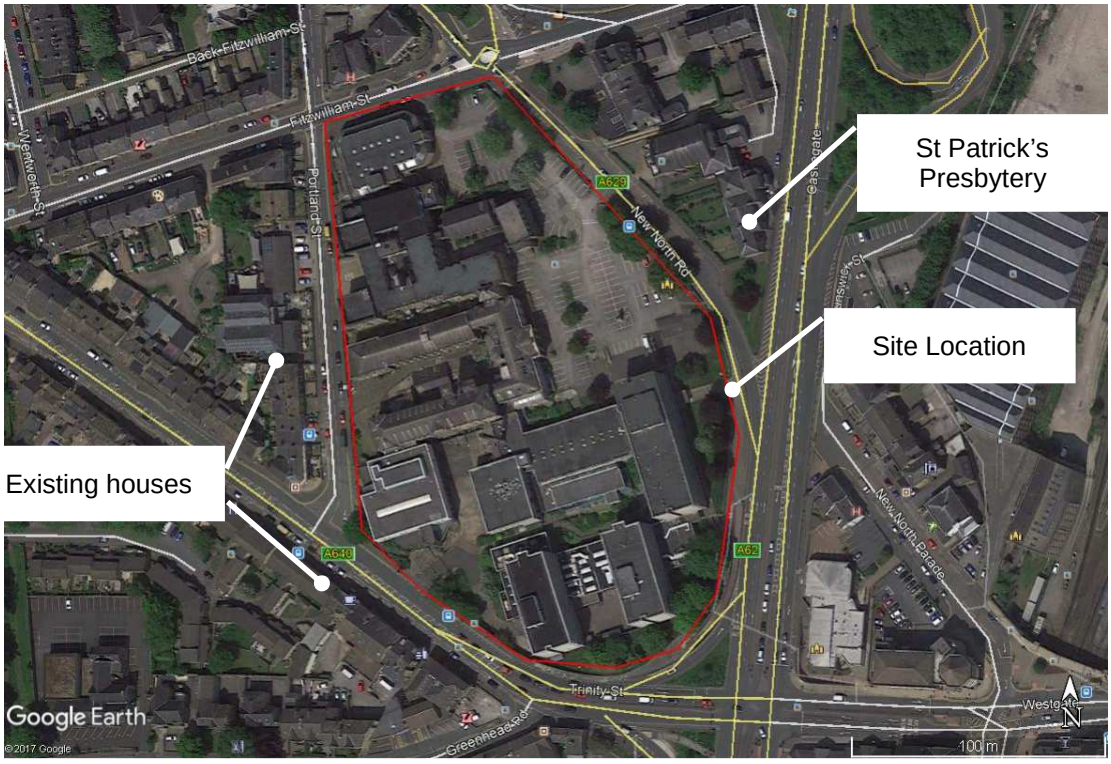

Figure 1 – Site location and existing noise sensitive receivers

2.3 Development Details

The proposed development consists of a retail store to the south-east of the site with a residential development of flats above the retail, an office block to the north-east of the site on New North Road and residential blocks to the south and south-east of the site along Fitzwilliam Street and Portland Street. It is proposed to retain the main entrance block of the classical styled former Royal Infirmary building, developing this as office space, whilst demolishing the side wings and replacing these with separate new-build residential buildings.

The proposed site masterplan is shown in the figure below;

Figure 2 – Proposed site layout

3.0 ASSESSMENT CRITERIA

3.1 National Planning Policy Framework

National Planning Policy is guided by the National Planning Policy Framework. With regard to Noise the Framework states the following;

Planning policies and decisions should aim to:

- *avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;*

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

The terms '*significant adverse impact*' and '*other 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 'other 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.

It should be noted that no noise limits for LOAEL and SOAEL have yet been specifically defined; however, guidance from other acoustic standards may be employed to determine suitable levels within the overall principal of the National Planning Policy Framework.

3.2 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 1 - *BS8233 recommended indoor ambient noise levels*

Activity	***Location***	***07:00 to 23:00***	***23:00 to 07:00***
Resting	Living room	35 $L_{Aeq,16hour}$	–

Dining	Dining room/area	40 $L_{Aeq,16hour}$	–
Sleeping (daytime resting)	Bedrooms	35 $L_{Aeq,16hour}$	30 $L_{Aeq,8hour}$

It should however be noted 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'.*

3.3 WHO Guidelines for Community Noise

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

Table 2 - *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.

The WHO guidelines state that, *"it is recommended that $L_{Aeq,T}$ be used to evaluate more-or-less continuous environmental noises. Where the noise is principally composed of a small number of discrete events, the additional use of L_{Amax} or SEL is recommended."*

3.2 Planning Practice Guidance – Noise

The UK Government Planning Practice Guidance on noise is published on-line at http://planningguidance.planningportal.gov.uk/blog/guidance/noise/ and offers further guidance on the typical levels which constitute the NOEL, LOAEL and SOAEL. The relevant section is reproduced in the table below;

Table 3. Planning Practice noise level guidance

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
		Lowest Observed Adverse Effect Level	
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; 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 perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
		Significant Observed Adverse Effect Level	
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. 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
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

It is notable from the above planning guidance that development should not be above Significant Observed Adverse Effect Levels, and should minimise Other Adverse Effect Levels (below SOAEL but above LOAEL). As such it may be inferred that development is permissible where noise levels, *"can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life."*

3.3 BS4142:2014

The effect of plant noise emissions on the nearest noise sensitive residences can be assessed in accordance with BS4142:2014 – '*Methods for rating and assessing industrial and commercial sound*'.

The standard describes a method of determining the level of a noise of commercial or industrial nature, together with procedures for assessing the impact of such a noise outside nearby noise sensitive areas.

The standard may be thought of as a procedure for comparing the noise from commercial sources with background noise levels in the absence of the commercial noise and determining the likely impact of the noise on noise sensitive areas.

In accordance with BS 4142 the background noise level is the typical A-weighted sound pressure level at the assessment position that is exceeded for 90% of a given time interval (L_{A90}). The specific noise level is the equivalent continuous (L_{Aeq}) sound pressure level at the assessment position produced by the noise source over a given time interval.

Certain acoustic features can increase the impact over that expected from a simple comparison between the specific noise level and the background level. Where such features are present, these are taken into account by adding corrections to the specific noise level.

The corrections are applied based on whether the following features occur, or are expected to be present. The correction values can either be determined subjectively, or by various objective measurement procedures.

- The noise contains a distinguishable, discrete, continuous tone (whine, hiss, screech, hum, etc.). 0 – 6 dB penalty
- The noise contains distinct impulses (bangs, clicks, clatters, or thumps). 0 – 9 dB penalty.
- Other features (including noticeable intermittency if applicable) if neither tones nor impulsive character is present: 0 – 3 dB penalty.

From the application of the above penalties where appropriate the rating level is established, this being the value that is compared with the background noise.

According to BS 4142 an initial estimate of the impact is given for a rating level of:

- 10 dB(A) or more above the background is an indication of significant adverse impact, depending on the context.
- 5 dB(A) above the background is an indication of an adverse impact, depending on the context.
- where the rating level does not exceed the background level, this is an indication of the specific sound source having a low impact, depending on the context.

The above initial assessment may then be modified depending on the context to take into account;

- The absolute level of the sound.
- The character and level of the residual sound compared to the character and level of the specific sound.
- The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions, such as:

    1. Façade insulation treatment
    2. Ventilation and / or cooling that will reduce the need to have windows open so as to provide rapid or purge ventilation; and
    3. Acoustic screening

3.4 Design Manual for Roads and Bridges 2011

For offsite traffic noise we have assessed the noise impact in accordance with the noise and vibration section of the Design Manual for Roads and Bridges Published by the Highways Agency in 2011. This document sets out procedures for undertaking the environmental assessment of new road schemes, including the assessment of noise impacts from road

traffic. Although the DMRB strictly applies to new road schemes, the procedures contained within the document can also be applied to the assessment of noise from road traffic in general.

The DMRB assessment suggests that the magnitude of noise changes from a project should be classified into levels of impact. The impact for short-term events are summarised as follows:

Table 2: Classification of magnitude of noise impacts in the short term

Noise Change [dBA]	Magnitude of Impact
0	No change
0.1 – 0.9	Negligible
1.0 – 2.9	Minor
3.0 – 4.9	Moderate
5 +	Major

4.0 ENVIRONMENTAL NOISE SURVEY

4.1 Southern section of site

The southern part of the site bounded by Trinity Street and Castlegate was surveyed in November 2015 and the results submitted in PDA report 8832/1421/01 in support of Planning Application 2015/62/93827/W. These results have been reproduced in the results section below.

4.2 Northern section of site

The remainder of the site has been surveyed in September 2017.

4.2.1 Suvey Times

The ambient noise measurements were undertaken between 22:30 on 20th September and 13:15 on 21st September 2017.

4.2.2 Weather

During the course of the survey the weather was as follows;

Wind speeds varied between 0 and 2 m/s with variable direction and the temperature was approximately 13°C.

4.2.3 Equipment

The survey was conducted using a RION NL52 and two NTi XL2 sound level meters. The meters are precision grade 1 accuracy as per IEC 61672-1:2002. The meters were set to measure 'A' weighted, broadband and octave band sound pressure levels and the time weighting was set to fast response. The microphones were of the 'free field' type.

The meters were field calibrated before and after the survey during which time no significant calibration drift was observed.

4.2.4 Measurement Procedure

Measurements were made at three positions around the southern part of the site to correspond to the noise levels that are likely to be experienced at the residential receiver locations and close to the surrounding roads. Position 3 was located approximately 1m in front of the entrance of the existing Royal Infirmary building facing New North Road, Position

4 was located approximately 1m from the hoarding around the former Kirklees College building on Fitzwilliam Street and Position 5 was approximately 1m from the hoarding of the former college buildings on Portland Street.

Details of the measurement locations are indicated on the figure below;

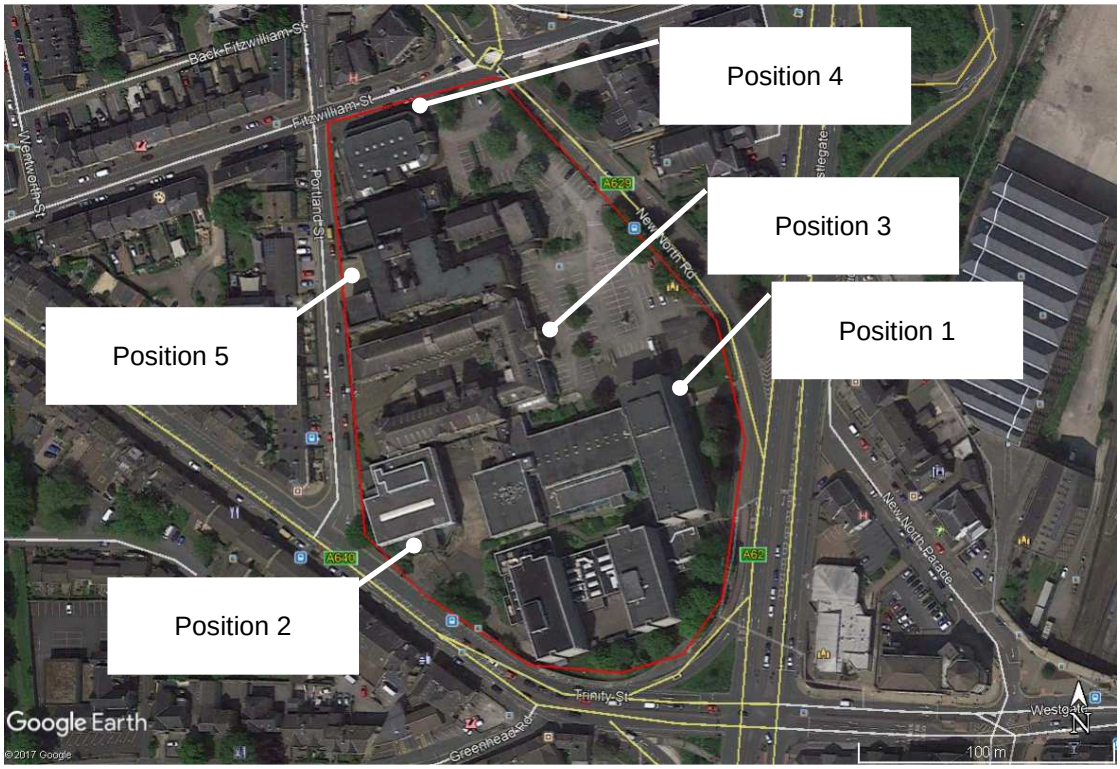

Figure 3 – Survey Measurement Positions

5.0 RESULTS

5.1 Noise sources

The noise sources in the area consisted of road traffic noise on the surrounding roads.

5.2 Measured Noise Results

The measured noise levels from the assessment positions are summarised in Table 4 below. L_{Aeq} levels are the logarithmic average over the measurement period, L_{A90} are the typical (modal) values observed over the measurement period in accordance with the Statistical Analysis example of BS4142:2014.

Table 4 - *Summary of measurements*

Position	Daytime (07:00 – 23:00)		Night-time (23:00 – 07:00)		
	L_{Aeq}	Typical L_{A90} [1]	L_{Aeq}	Typical L_{A90} [1]	Typical L_{Amax} [2]
1	70	63	62	35	77
2	68	61	60	42	76
3	57	51	51	36	68
4	62	55	57	35	58
5	53	44	48	28	55

Notes:

1 The typical L_{A90} is the modal value over the measured time period in accordance with the Statistical Analysis example of BS4142:2014

2 The WHO Guidelines for Community Noise state that sleep disturbance may occur where the specified 45dB L_{Amax} is exceeded 10 to 15 times over the 8-hour night-time period. The L_{Amax} recorded for these positions is the L_{Amax} exceeded no more than 10 times over the full night-time period.

The spectrum of the road traffic noise affecting the site was also measured at positions 4 and 5. The octave band traffic noise spectrum is shown in Table 5 below. Octave band values in L_{Zeq} are given relative to the broadband L_{Aeq} of the measured traffic noise.

Frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Relative L_{Zeq} [dB]	9.5	2.7	-2.4	-6.0	-4.8	-7.8	-11.2	-9.2

Table 5 – Measured traffic noise spectrum (relative to broadband L_{Aeq})

The time histories of the measurements at each position are shown in the following charts.

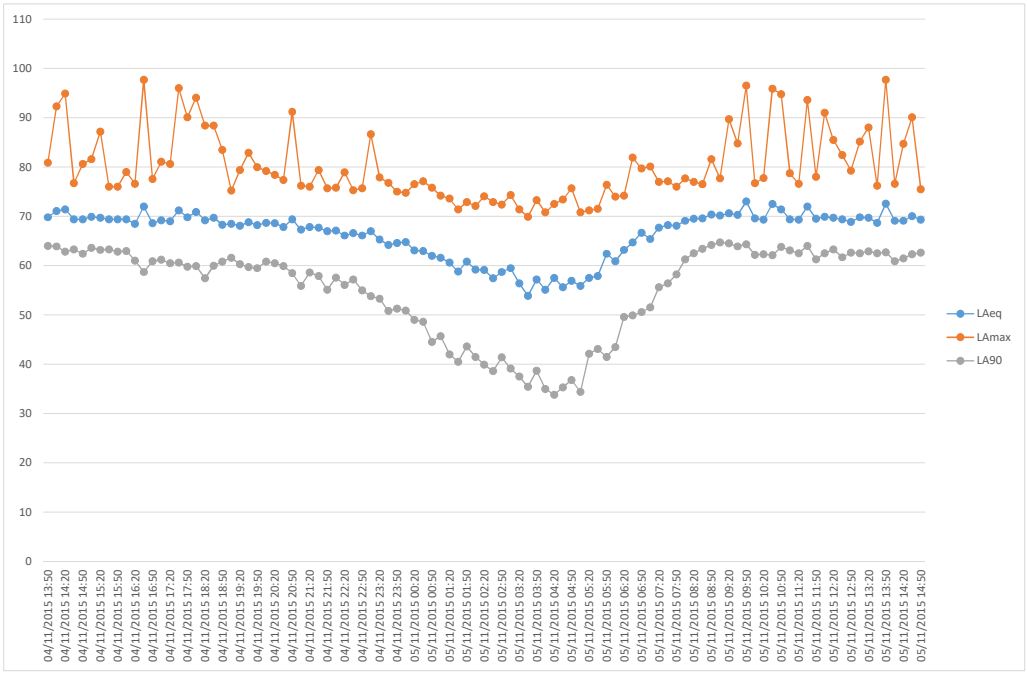

Figure 4 – Time History of Measurement Position 1

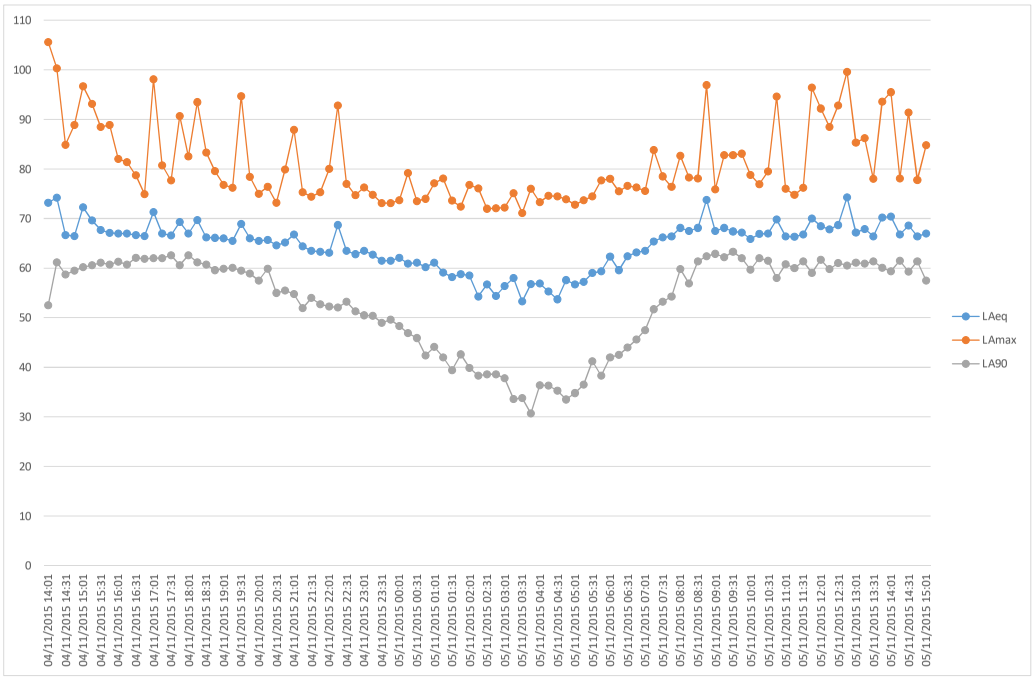

Figure 5 – Time History of Measurement Position 2

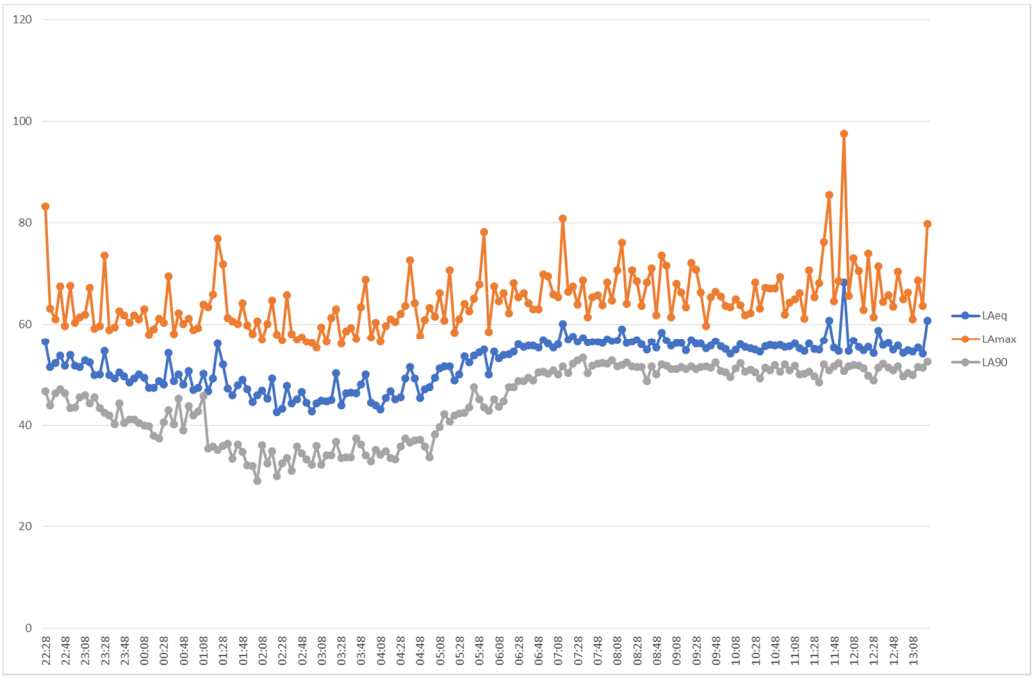

Figure 6 – Time History of Measurement Position 3

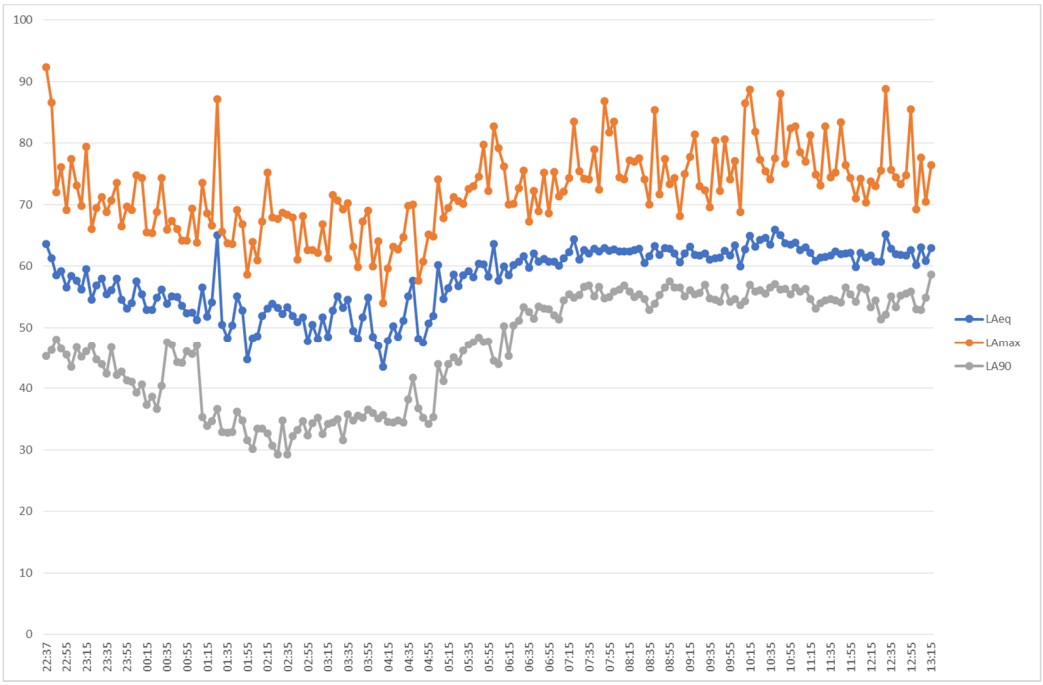

Figure 7 – Time History of Measurement Position 4

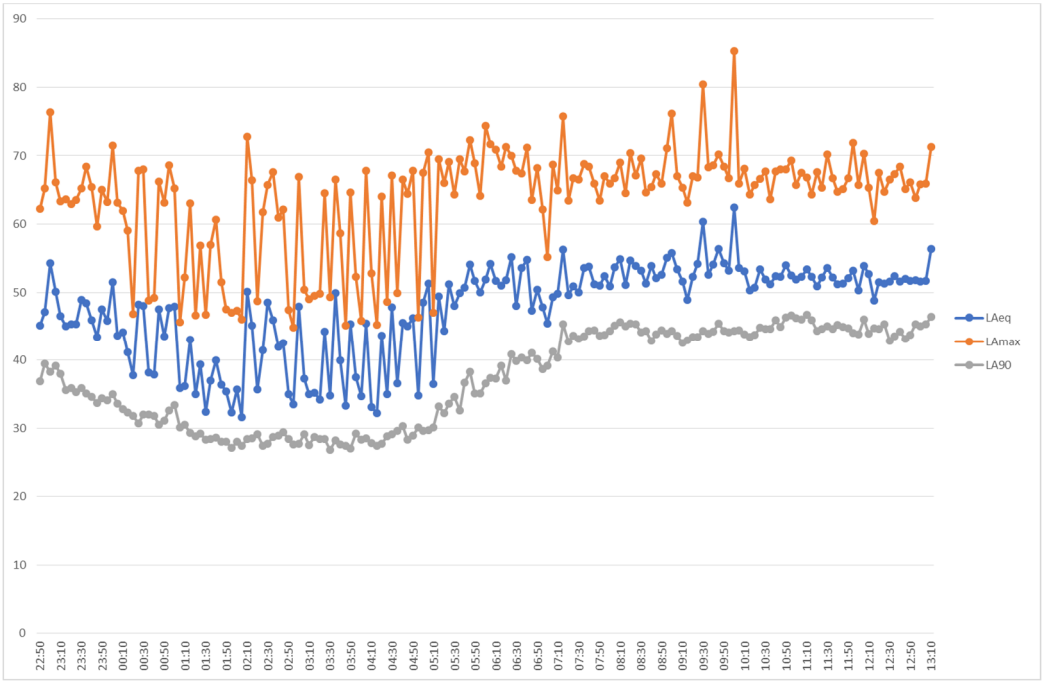

Figure 8 – Time History of Measurement Position 5

6.0 NOISE IMPACT ASSESSMENT

6.1 Residential

In order to calculate the noise propagation around the site the proposed buildings and the surroundings buildings have been modelled using Sound Plan noise propagation software

and the method of ISO 9613:2 “Acoustics – attenuation of sound during propagation outdoors – General Method of Calculation”. The model takes into account the effects of geometric spreading, shielding, ground and air absorption as well as reflections from the surroundings to calculate the noise incident at the proposed building facades. A ground absorption coefficient of 0 has been used representative of the hard surfaces (hard standing, roads and paths). From the calculated external noise levels, the noise break-though the building envelope has been calculated. The results of the sound propagation model are shown in Figure 9 below.

In the noise model the surrounding roads have been treated as line sources. The sound power of the sources have been calibrated with reference to the surveyed noise levels such that the receiver points correlate to the measured sound pressure values.

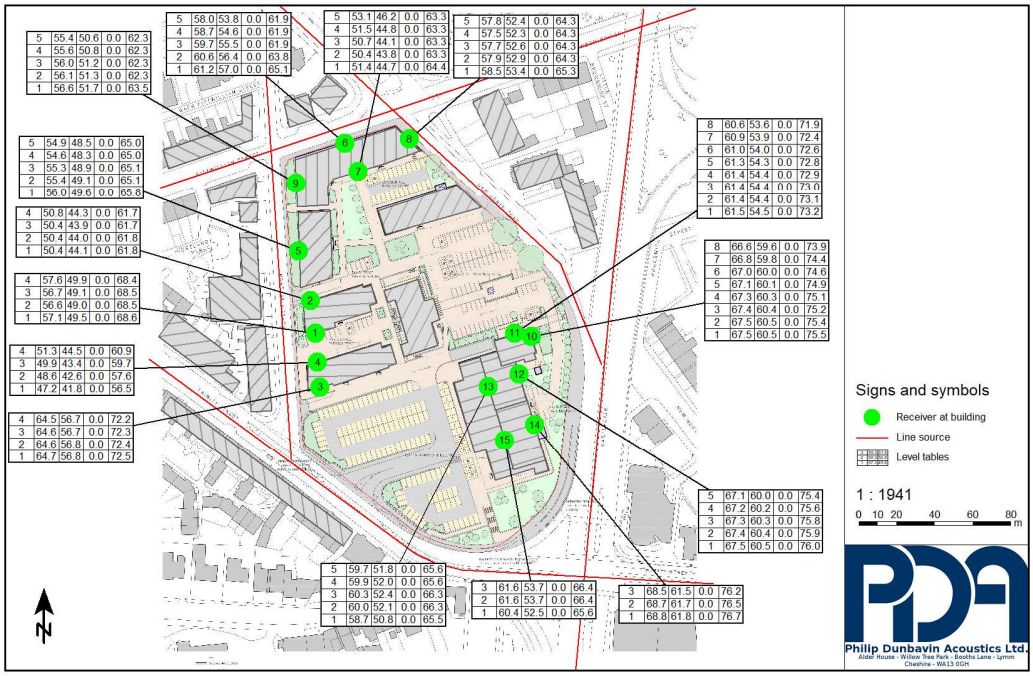

Figure 9 – Sound levels at residential façades [Day, Night, 0, Typical Max]

Note that the tables in the above figure represent noise levels at the façade for each residential floor of the proposed buildings. For building 8 (retail, hotel, residential) the indicated noise levels are for the residential floors only on each indicated facade.

7.0 NOISE BREAK-IN CALCULATIONS AND MITIGATION

Noise break-in to the habitable rooms of the residential buildings have been calculated in octave frequency bands in accordance with the detailed method of BS 8233:2014 from the calculated façade noise levels. Internal noise levels have been compared to the criteria of Section 3.2 and 3.3. The noise levels measured indicate that the site is generally suitable for residential development. Residential rooms will require adequate mitigation to the glazing and ventilation to ensure that suitable noise levels are achieved within the habitable rooms.

Information on the sound insulation properties for specific element details has either been sourced from manufacturer’s literature or from Insul® Sound insulation prediction software. In accordance with the reverberation time standardisation detailed within ISO 140-4 the reverberation time within residential habitable rooms has been assumed as 0.5 seconds.

The proposed mitigation detailed in the sections below is capable of achieving the internal noise criteria of BS 8233:2014 and WHO Guidelines for Community Noise.

7.1 Room Geometry

Habitable room volumes, façade areas and glazing areas have been taken from Enjoy Design 16047 800 series drawings for buildings 2, 3 and 8. We have assumed that similar room geometries will be employed for residential uses in Buildings 4, 5 and 6.

7.2 Building Envelope Elements

The following typical construction elements have been used to model the external building envelope of the proposed development;

7.2.1 Walls

The proposed construction has not been confirmed however our calculations have assumed that the external wall consists of an outer facing of brickwork, cavity partially or fully filled with insulation and a blockwork internal lining, or a lightweight construction of an equivalent acoustic performance. See Table 4 below:

Table 6 - *External Wall Acoustic Properties*

Façade Element	Octave Band (Hz) Sound Insulation, R [dB]							R_w [dB]
	63	125	250	500	1000	2000	4000	
External Wall	29	42	49	54	58	53	57	55

7.2.2 Glazing and Ventilation Inlets

As the glazing and ventilation inlets directly into habitable rooms are the acoustically weak area, the noise level incident on the façade will determine the type of window glazing used. Our calculations have indicated that the minimum requirements for each block are as summarised within the following figure.

Figure 10 – Required treatment for residential façades

Minimum acoustic requirements for glazing and ventilation correlating to the above figure are detailed in Table 7 below.

7.3 Glazing and ventilation

Façade	Room	Glazing		Ventilation	
		Typical build-up	R_w [dB]	Typical Vent	$D_{ne,w}$ [dB]
	All habitable rooms	4/12/4	31	Simon Framevent	31
	Living rooms	4/12/4	31	Simon Framevent	31
	Bedrooms	10/12/6	38	Simon Acoustic EHAS	38
	All habitable rooms	10/12/6	38	Simon Acoustic EHAS	38
	Living rooms	10/12/6	38	Simon Acoustic EHAS	38
	Bedrooms	10/12/6	38	Ducomax Largo 10	51
	Living Rooms (large glazed area)	10/16/12.4 (acoustic)	45	Greenwood MA3051 (wall vent)	55
	Bedrooms	10/12/6.4 (acoustic)	40	Ducomax Largo 10	51
	Living Rooms	10/12/6.4 (acoustic)	40	Ducomax Largo 10	51
	Bedrooms	10/16/12.4 (acoustic)	45	Ducomax Largo 10	51

Table 7 – Required Glazing and Ventilation

With regard to the above specified glazing and ventilation any substitutions must meet the equivalent acoustic performance in octave frequency bands. Full specifications of the performance requirements are given in the tables below;

Typical build-up	R_w [dB]	R (octave bands) [dB]							
		63	125	250	500	1000	2000	4000	8000
4/12/4	31	20	24	20	25	35	38	35	35
10/12/6	38	22	26	27	34	40	38	46	46
10/12/6.4(acoustic)	40	23	27	29	36	41	42	52	52
10/16/12.4(acoustic)	45	25	31	38	45	45	45	58	58

Figure 11 – Glazing octave band performance requirements

Typical vent	$D_{ne,w}$ [dB]	D_{ne} (octave bands) [dB]							
		63	125	250	500	1000	2000	4000	8000
Simon Framevent	31	32	36	33	33	31	29	31	36
Simon Acoustic EHAS	38	36	40	36	34	35	44	40	45
Ducomax Largo 10	51	35	35	40	50	57	52	52	52
Greenwood MA3051	55	40	46	46	49	55	66	69	69

Figure 12 – Vent octave band performance requirements

It must be ensured that the acoustic performance of the window frames matches the performance of the glazing that is fitted within them. Glazing framing systems must be fully sealed with any small gaps (<10mm nominal) around perimeter to be sealed both sides with acoustic non-setting mastic. No gaps should be left unsealed.

It should be noted that the inclusion of ventilators alone does not ensure compliance with Building Regulations requirements for ventilation. The ventilation strategy will need to be checked by others.

8.0 COMMERCIAL USES

Commercial uses proposed for the site include the ground floor retail store proposed in building 8, Offices proposed in Buildings 1 and 7 and ground floor retail or office use proposed as an option for the ground floor of the residential blocks.

None of the above proposed uses are expected to generate significant noise levels in terms of noise break out from the buildings. However, there are likely to be external mechanical services plant associated with the above commercial building types.

Noise from plant associated with commercial uses should be assessed in accordance with the requirements of BS 4142:2014. For the impact of the commercial uses on the existing surrounding residential receivers it is recommended that the noise rating level of the commercial use mechanical services is limited to the pre-existing typical background noise level. Table 4 indicates the typical background noise levels in the vicinity of nearby noise sensitive properties. We would recommend that the total mechanical services rating level due to all the commercial uses is limited to 35 dB(A) at existing noise sensitive properties. We note that during the survey night-time background noise measurements at Position 5 were as low as 28 dB(A). However, a rating level of 35 dB(A), (allowing for 15 dB attenuation due to an open window) would result in an internal level of 20 dB(A) which is not likely to be significantly audible within habitable rooms due to noise from building services and the room occupants breathing etc. Hence we would not expect a lower limit (than a rating level of 35dB(A)) to be justified in terms of reduction of noise impact.

For the noise sensitive properties proposed as part of the development, these will be provided with acoustic glazing and ventilation in order that the noise criteria of BS 8233:2014 / WHO guidelines may be achieved without opening windows. In these cases where the residents do not have a prior experience of background noise levels at the site, and where alternative background ventilation other than opening windows is provided, we would recommend that mechanical services rating noise levels are limited to the outdoor noise criteria given in WHO Guidelines for Community Noise of not greater than 45dB outside residential windows.

Where deliveries are required to commercial and retail uses situated below residential, we would recommend that delivery noise is restricted to no more than 5dB greater than the background noise level. Considering the background noise levels at the site it is likely that deliveries will need to be restricted to occur during the daytime (07:00 – 23:00) only.

APPENDIX

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.