Parker Acoustics Ltd

Proposed Mixed Use Development
Noise Impact Assessment

Site:

58 Main Road

Pinhoe

Exeter

EX4 9EY

For:

Zenel Management Ltd

30 March 2023

Ref: PAL-NIA-23010-1-v1

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Issue: Draft

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1 Introduction

1.1 Overview

Parker Acoustics Ltd (PAL) has been commissioned by Zenel Management Ltd to undertake a noise impact assessment for a proposed mixed-use development at 58 Main Road, Pinhoe, Exeter, EX4 9EY (hereafter referred to as 'the site').

The assessment has been requested to inform a planning application for the proposal.

This report has been prepared for Zenel Management Ltd for the sole purpose described above and no extended duty of care to any third party is implied or offered. Third parties referring to the report should consult Zenel Management Ltd and PAL as to the extent to which the findings may be appropriate for their use.

A glossary of acoustic terms used in the main body of the text is contained in Appendix A.

1.2 Site Location

The site is located to the south-east of Main Road in Pinhoe, Exeter, as shown in Figure 1.1.

Figure 1.1: Site Location

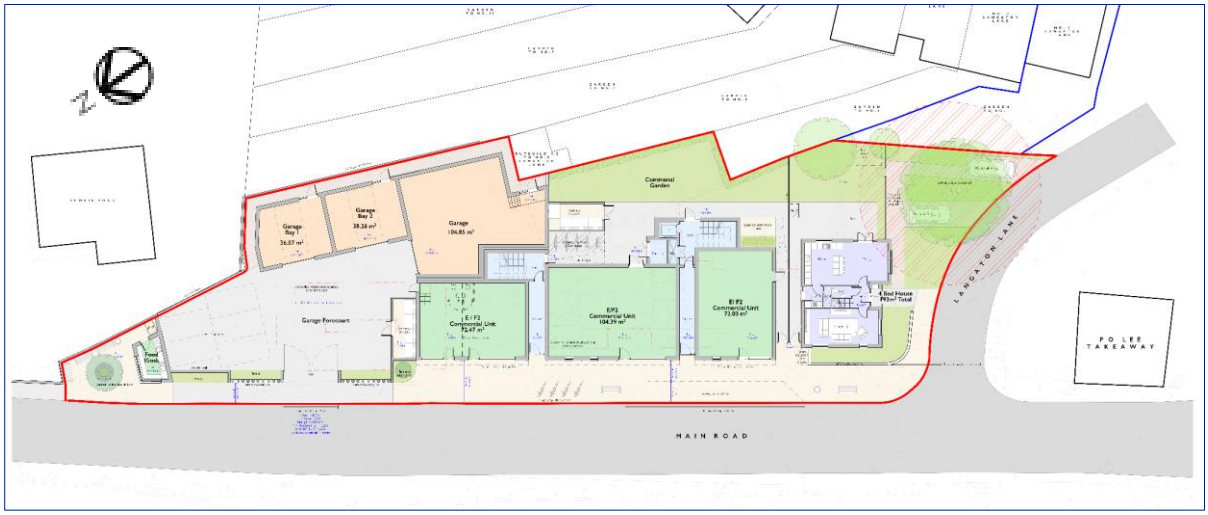
The site is bound by:

- Main Road to the north-west
- Dwellings to the north-east and south-east
- Dwellings to the south-east
- Langaton Lane to the south-west

1.3 Proposal

The proposal includes the replacement of an existing garage, forecourt and retail units with a mixed-use development comprising residential and commercial units (including a new car garage in the same location plus 2 no. additional bays), as shown in Figure 1.2.

Figure 1.2: Proposed Layout



The nearest noise sensitive receptors to the commercial part of the proposed development area:

- Apartments proposed above the commercial units (NSR1)
- No. 66 Main Road to the north-east of the site (NSR2)
- Dwellings at Langaton Lane to the south-east of the site (NSR3)

2 Noise Criteria and Assessment Guidance

2.1 Planning Policy

National Planning Policy Framework

The National Planning Policy Framework (NPPF)[1] sets out the Government's planning policies for England and how these are expected to be applied.

Where issues of noise impact are concerned the NPPF provides brief guidance in paragraph 174 where it states that 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…..noise pollution'.

Paragraph 185 advises that:

'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'.

The NPPF also refers to the 2010 DEFRA publication, the Noise Policy Statement for England (NPSE) which reinforces and supplements the NPPF.

Noise Policy Statement for England

The Noise Policy Statement for England[2] (NPSE) sets out the long-term vision of promoting good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development. This long-term vision is supported by the following aims:

- Avoid significant adverse impacts on health and quality of life
- Mitigate and minimise adverse impacts on health and quality of life
- Where possible, contribute to the improvement of health and quality of life

The NPSE describes the following levels at which noise impacts may be identified:

- 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
- SOAEL – Significant Observed Adverse Effect Level. This is the level above which significant adverse effects on health and quality of life occur

According to the explanatory notes in the statement, where a noise level falls between the lowest observable adverse effect level (LOAEL) and a level which represents a significant observable adverse effect level (SOAEL):

[1] National Planning Policy Framework. Ministry of Housing, Communities and Local Government (2021)
[2] Noise Policy Statement for England. Government Department for Environment, Food and Rural Affairs (2010)

'....all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life whilst also taking into consideration the guiding principles of sustainable development. This does not mean that such effects cannot occur.'

Planning Practice Guidance on Noise

Planning Practice Guidance[3] (PPG) is an online resource providing additional guidance and elaboration on the NPPF. It advises that:

'Plan making and decision making need to take into account the acoustic environment and in doing so consider:

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

In line with the Explanatory Note of the NPSE, the PPG references the LOAEL and SOAEL in relation to noise impact. It also provides examples of outcomes that could be expected for a given perception level of noise, plus actions that may be required to bring about a desired outcome. However, in line with the NPSE, no objective noise levels are provided for LOAEL or SOAEL although the PPG acknowledges that:

'…the subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation'.

The PPG also provides general advice on the typical options available for mitigating noise, suggesting that Local Plans may include noise standards applicable to proposed developments within the Local Authority's administrative boundary, although it states that:

'Care should be taken, however, to avoid these being implemented as fixed thresholds as specific circumstances may justify some variation being allowed'.

With regard to the mitigation of extant environmental noise at a proposed residential development, the guidance states that:

'… consideration should also be given to whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time. In both cases a suitable alternative means of ventilation is likely to be necessary. Further information on ventilation can be found in the Building Regulations'.

The subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation. The following guidance documents provide some meaningful context.

2.2 Assessment Guidance

British Standard 4142

BS 4142[4] presents methods for rating and assessing the potential impact of commercial and industrial sound upon noise sensitive receptors.

[3] Planning Practice Guidance on Noise (http://planningguidance.planningportal.gov.uk/blog/guidance/noise/). Ministry of Housing, Communities and Local Government (2019)
[4] British Standard 4142:2014+A1:2019 'Methods for Rating and Assessing Industrial and Commercial Sound'. British Standards Institution (2019)

In order to assess noise impact using BS 4142, the 'Rating level' of the new noise source is compared with the existing 'Background level' and the following analysis made:

- Typically, the greater this difference, the greater the magnitude of the impact
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact.
- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context

In order to establish the 'rating level':

- The 'specific level' of the industrial / commercial noise source is determined by measurement or calculation with regard to the appropriate reference time interval (for day or night periods).
- Where appropriate, a rating penalty can then be applied to the specific noise level to account for the character of the noise (namely tonality, impulsivity and intermittency). Such 'acoustic feature corrections' can be added together in linear fashion where appropriate.

Tonality can be determined objectively (using adjacent third octave band analysis / the Joint Nordic method) or subjectively as listed below:

- +2 dB penalty: Just perceptible
- +4 dB penalty: Clearly perceptible
- +6 dB penalty: Highly perceptible

Impulsivity (the rapidity of the change in sound level) can be determined objectively (using Fast Fourier Transform analysis) or subjectively as listed below:

- +3 dB penalty: Just perceptible
- +6 dB penalty: Clearly perceptible
- +9 dB penalty: Highly perceptible

Where intermittency is present (i.e. when the specific noise has identifiable on/off conditions) a +3 dB penalty can be applied.

Where the acoustic feature characteristics are neither tonal nor impulsive, but are clearly distinguishable against the residual noise, a +3 dB penalty can be applied.

BS 4142 requires separate analysis for day and night time periods, evaluating the Rating level over an appropriate reference time interval (T_r) of:

- 1 hr during the day (between 07:00 - 23:00 hrs)
- 15 min during the night (between 23:00 - 07:00 hrs)

Section 11 of BS 4142 introduces the concept of 'context' to the process of identifying noise impact and explains that:

'The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs. An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context.'

For the introduction of a new noise sensitive receptor to extant industrial and/or commercial sound, BS 4142 advises that:

'it ought to be recognized that the industrial and/or commercial sound forms a component of the acoustic environment. In such circumstances other guidance and criteria in addition to or alternative to this standard can also inform the appropriateness of both introducing a new noise-sensitive receptor and the extent of required noise mitigation.'

British Standard 8233

British Standard 8233:2014 '*Guidance on Sound Insulation and Noise Reduction for Buildings*' (BS8233)[5] provides recommendations for the control of noise both in and around buildings and suggests criteria and limits appropriate to their function. For dwellings, the main considerations are:

- Bedrooms - the effect of noise upon sleep
- Other habitable rooms - the effect of noise upon resting, listening and communicating

It is desirable that the internal ambient noise level does not exceed the guideline values as replicated in Table 2.1.

Table 2.1: Indoor Ambient Noise Levels for Dwellings – BS 8233:2014

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

BS 8233 states:

'If relying on closed windows to meet the guide values, there needs to be appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level. If applicable, any room should have adequate ventilation (e.g. trickle ventilators should be open) during assessment.'

For external areas that are used for amenity space, BS 8233 states that:

'……it is desirable that the external noise level does not exceed 50 dB LAeq,T, with an upper guideline value of 55 dB LAeq,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.'

[5] British Standard 8233:2014 Guidance on sound insulation and noise reduction for buildings. BSI

ProPG Planning and Noise: New Residential Development

ProPG Planning and Noise: New Residential Development (ProPG)[6] recommends compliance with indoor noise level targets in residential dwellings based on the guidance contained in BS 8233 (see Table 2.1). However, it is noted that:

'Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved. The more often internal L_{Aeq} levels start to exceed the internal L_{Aeq} target levels by more than 5 dB, the more that most people are likely to regard them as "unreasonable".....Once internal L_{Aeq} levels exceed the target levels by more than 10 dB, they are highly likely to be regarded as "unacceptable" by most people, particularly if such levels occur more than occasionally'.

Additionally, with regard to individual noise events, ProPG states:

'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. In most circumstances in noise sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night.'

ProPG acknowledges that the internal target noise levels may only be practically achieved with windows closed in certain areas (e.g. in urban areas or sites adjacent to transportation noise sources) and states that:

'In such circumstances, internal noise levels can be assessed with windows closed but with any façade openings used to provide 'whole dwelling ventilation' in accordance with Building Regulations Approved Document F (e.g. trickle ventilators in the open position).

It should also be noted that the internal noise level guidelines are generally not applicable under 'purge ventilation' conditions as defined by Building Regulations Approved Document F, as this should only occur occasionally (e.g. to remove odour from painting and decorating or from burnt food).'

ProPG also considers compliance with ambient noise level targets for external amenity areas in line with the recommendation of BS 8233. On this issue, ProPG states that:

'Where, despite following a good acoustic design process, significant adverse noise impacts remain on any private external amenity space (e.g. garden or balcony) then that impact may be partially off-set if the residents are provided, through the design of the development or the planning process, with access to:

- *a relatively quiet facade (containing openable windows to habitable rooms) or a relatively quiet externally ventilated space (i.e. an enclosed balcony) as part of their dwelling; and/or*
- *a relatively quiet alternative or additional external amenity space for sole use by a household, (e.g. a garden, roof garden or large open balcony in a different, protected, location); and/or*
- *a relatively quiet, protected, nearby, external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings; and/or*
- *a relatively quiet, protected, publicly accessible, external amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5 minutes walking distance). The local planning authority could link such provision to the definition and management of Quiet Areas under the Environmental Noise Regulations.'*

[6] 'ProPG Planning and Noise: New Residential Development (ProPG)', 2017. Association of Noise Consultants (ANC), Institute of Acoustics (IOA) and the Chartered Institute of Environmental Health (CIEH)

Building Regulations - Approved Document O (Overheating)

Requirement O1(2)(a)[7] of Schedule 1 to the Building Regulations 2010 states:

'(1) Reasonable provision must be made in respect of a dwelling, institution or any other building containing one or more rooms for residential purposes, other than a room in a hotel ("residences") to –

…..

*(b) provide an **adequate means to remove heat** from the indoor environment.*

(2) In meeting the obligations in paragraph (1) –

*(a) account must be taken of the **safety of any occupant, and their reasonable enjoyment** of the residence; and*

(b) mechanical cooling may only be used where insufficient heat is capable of being removed from the indoor environment without it.

…..

*In the Secretary of State's view, requirement **O1(2)(a) is met** in a new residential building if the building's **overheating mitigation strategy** for use by occupants **takes account of** all of the following.*

*a. **Noise at night**……..'*

Section 3 of ADO address noise at night as follows:

'In locations where external noise may be an issue (for example, where the local planning authority considered external noise to be an issue at the planning stage), the overheating mitigation strategy should take account of the likelihood that windows will be closed during sleeping hours (11pm to 7am)….

Windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits.

a. 40dB $L_{Aeq,T}$, averaged over 8 hours (between 11pm and 7am).

b. 55dB L_{AFmax}, more than 10 times a night (between 11pm and 7am).'

[7] The Building Regulations 2010 Approved Document O 'Overheating' (2021) (ADO)

3 Noise Survey

3.1 Methodology

In order to establish existing external noise levels affecting the proposed residential development and nearest noise sensitive receptors (NSRs) to the proposal, noise monitoring was carried out at the site between Tuesday 14th and Wednesday 15th March 2023.

The adopted noise monitoring positions (shown in Appendix B) were as follows:

- 1 – north-east boundary of the site, representing NSR2
- 2 – north-western boundary of the site, representing the elevations of the proposed dwellings most exposed to road traffic noise on Main Road, at circa 5 metres from the kerb
- 3 – south-east boundary of the site, representing NSR3
- 4 – long-term 'anchor' position at the existing garage forecourt, circa 6 metres from the kerb of Main Road

Measurements were acquired at ground floor level, circa 1.7 metres above ground level.

Noise measurements were undertaken using a Norsonic Nor 140 Type 1 integrating sound level meter[8] connected to a windshield covered microphone. The measurement system calibration was verified immediately before and after the survey period using a Norsonic Nor 1255 portable calibrator[9]. No significant drift (0.2 dB in this instance) in calibration level was noted.

Measurements consisted of A–weighted broadband parameters including L_{Aeq}, L_{A90} and L_{AFmax} together with linear octave band data.

3.2 Meteorology

Weather conditions[10] during the survey were:

- 14/03/2023: Dry, sunny / partially cloudy (45 - 75% cover), cool (~ 8^0C) and calm (wind speeds ~ 3 m/s)
- 15/03/2023: Damp, cloudy (100% cover), cold (~3^0C) and calm (wind speeds ≤ 1 m/s)

Reference has been made to online meteorological data measured at a nearby weather station to identify periods of adverse weather (i.e. precipitation or wind speeds > 5 m/s). Where appropriate, these periods have been identified and the corresponding noise data excluded from analysis, as detailed further in Sections 3.4 and 3.5.

3.3 Summary of Measured Noise Data

Table 3.1 presents a summary of the measured external noise data at each position, for each measurement session, rounded to the nearest decibel.

[8] Serial number 1404079; UKAS calibration certificate number U37864/U37865 valid until May 2023
[9] Serial number 125525543; UKAS calibration certificate number U41915 until September 2023
[10] Quantifiable parameters determined using a Hold Peak 866B Portable Digital Anemometer

Table 3.1: Summary of Measured External Noise Data – Attended (14/03/2023)

Position	Time (hh:mm)	Noise Level (dB)			Notes / Noise Source(s)
		$L_{Aeq, T}$	L_{AFmax}	$L_{A90,15min}$ (Range)	
1	10:00 – 10:15	68	83	57	Road traffic noise from Main Road dominant; other sources included vehicles entering / leaving site, jet washing at the site car wash, occasional nut gun use emanating from site MOT / repair garage
	11:09 – 11:24	68	83	53	
	12:20 – 12:35	68	78	59	
	13:30 – 13:45	70	89	59	
	14:44 – 14:59	70	93	58	
2	10:19 – 10:34	68	81	53	Road traffic noise from Main Road dominant; occasional impulsive noise emanating from rear of site MOT / repair garage also audible in lulls of road traffic noise
	11:25 – 11:40	68	81	56	
	12:37 – 12:52	67	82	52	
	13:46 – 14:01	68	87	51	
	15:00 – 15:15	72	96	58	
3	10:34 – 10:49	58	77	50	Road traffic noise from Main Road dominant; other sources included occasional overhead aircraft, occasional contributions from rear of MOT / repair garage including compressor and birdsong
	11:41 – 11:56	58	72	47	
	12:52 – 13:07	57	66	49	
	14:02 – 14:17	58	76	50	
	15:16 – 15:31	57	70	49	
4	10:50 – 11:05	69	96	53	Road traffic noise from Main Road dominant; other sources included vehicles entering / leaving site, jet washing at the site car wash, occasional nut gun use emanating from site MOT / repair garage
	11:56 – 12:11	68	80	55	
	13:12 – 13:27	69	88	57	
	14:18 – 14:33	69	84	56	

Table 3.2: Summary of Measured External Noise Data - Unattended

Position	Date	Time (hh:mm)	Noise Level (dB)			Weather Conditions
			$L_{Aeq, T}$	L_{AFmax}	$L_{A90,15min}$ (Range)	
4	14/03/2023	16:45 – 23:00	69	90	39 – 65	Showers between 21:20 – 21:20 hrs, wind speeds 1 – 7 m/s
	14/03/2023 - 15/03/2023	23:00 – 07:00	62	91	32 – 57	Dry, wind speeds 1 – 3 m/s
	15/03/2023	07:00 – 09:00	72	96	59 – 66	Showers from 07:00 hrs, wind speed 1 m/s

3.4 Analysis

Position 1 – NSR2

Measured daytime ambient noise levels at this location were around 68 – 70 dB $L_{Aeq, 15min}$.

Daytime background noise levels were between 53 – 59 dB $L_{A90, 15min}$ with the typical[11] value determined at 57 dB $L_{A90 (15min)}$.

Position 2 – Proposed House

Measured daytime ambient noise levels at this location were around 67 – 72 dB $L_{Aeq, 15min}$.

Daytime background noise levels were between 51 – 58 dB $L_{A90, 15min}$ with the typical value determined at 54 dB $L_{A90 (15min)}$.

[11] The 'typical' value is taken to be either the most occurring (i.e. 'modal') value or the mean value, whichever is the lower of the two averaging data sets

Position 3 – NSR3

Measured daytime ambient noise levels at this location were around 57 – 58 dB $L_{Aeq, 15min}$.

Daytime background noise levels were between 47 – 50 dB $L_{A90, 15min}$ with the typical value determined at 49 dB $L_{A90 (15min)}$.

Position 4 – Anchor Position (Overnight)

Adverse weather conditions (i.e. precipitation and excessive wind speed) affected the site at certain times during the survey; therefore, all data measured during these periods have been excluded from analysis – the periods of concern are as follows:

- 16:50 – 17:50 hrs on Tuesday 14th March 2023
- 07:00 – 09:00 hrs on Wednesday 15th March 2023

Of the remaining available data, the following has been determined:

- Ambient noise levels were around 68 dB $L_{Aeq,T}$ during the day and 62 dB $L_{Aeq,T}$ at night
- Background noise levels were between 39 – 59 dB $L_{A90,15min}$ during the day and 32 – 57 dB $L_{A90, 15min}$ at night
- Typical background noise levels were 47 dB $L_{A90,15min}$ during the day and 36 dB $L_{A90, 15min}$ at night
- Maximum noise levels were attributed to vehicle movements on Main Road and measured at ≤ 91 dB L_{AFmax} at night. The assessed value (i.e. the 10th highest value per night[12]) was 81 dB L_{AFmax}.

Comparison of NSR Positions with Anchor Position

Average (logarithmic) daytime noise levels at Positions 2 and 4 were both 69 dB $L_{Aeq,T}$ during the manned survey. It follows that the noise levels measured at the long-term (anchor) position were also representative of those affecting the west elevations of the proposed dwellings in terms of ambient noise levels and night maxima.

[12] The assessed L_{AFmax} should be such that internal noise levels do not exceed 45 dB L_{AFmax} more than 10 times per night as per ProPG guidance; since the sampling period was a full 8 hrs (between 23:00 hrs on Tuesday 14/03/2023 and 07:00 hrs on Wednesday 15/03/2023, the 10th highest $L_{AFmax,1min}$ measured during this period has been considered

4 Commercial Noise

4.1 Overview

The proposed site layout drawing[13] shows the following:

- The replacement of an existing garage with a new garage on the same footprint
- 2 no. additional garage bays to the north of the existing / replaced garage
- 3 no. commercial units (Use Class E/F2) roughly central to the site
- Food kiosk at the northern end of the site

In terms of commercial noise impact, it is considered that the primary areas of concern would be:

- Noise break-out from the replacement garage and additional garage bays affecting the proposed residential use (NSR1)
- Noise break-out from the additional 2 no. garage bays affecting the existing dwellings in the vicinity (NSR2 and NSR2)[14]
- Noise from plant, associated with the 3 no. commercial units and food kiosk, affecting all NSRs

The above noise sources are considered in further detail below.

4.2 MOT / Repair Garage

Source Noise Levels

On the morning of Wednesday 15th March 2023, a number of sample measurements were acquired within the existing MOT / Repair Garage to determine typical indoor ambient noise levels that would assist with noise break-out calculations from this unit and the additional bays proposed to the immediate north.

Measurements were acquired using the same equipment detailed in Section 3.1, positioned at height of 1.5 metres above ground and at ≥ 2 metres distance from repair works performed on a car, as shown in Figure 4.1.

[13] Drawing Ref: 20.94_PL_07 Rev B 'Proposed Site Plan' issued by PMR Architecture
[14] It is not considered necessary to assess the noise impact of the existing garage; since the replacement garage is expected to be like-for-like in terms of noise emission to the existing dwellings, noise impact from the replacement garage to existing receptors has been scoped out of the assessment

Figure 4.1: Existing MOT / Repair Garage

Table 4.1 summarises the indoor ambient noise measurements acquired within the existing MOT / Repair Garage on Wednesday 15th March 2023.

Table 4.1: Summary of Indoor Noise Data within Existing MOT / Repair Garage – 15/03/2023

Time (hh:mm)	Indoor Ambient Noise Level (dB $L_{Aeq,T}$)	Notes / Observations
09:45 – 10:00	70	Conversation; engine idling; repair noise such as: Sporadic nut-gun use, compressor, horn beeps, ramp being elevated / lowered, sporadic metallic clanks
10:00 – 10:15	64	
10:15 – 10:30	69	
10:30 – 10:45	69	

Using the above data, an indoor reverberant ambient noise level of 69 dB $L_{Aeq,1hr}$ has been determined via logarithmic average of the four samples.

Propagation (Garage to Proposed Dwellings)

Given the proximity of the nearest proposed residential window (NSR1) to the existing / replacement garage, noise propagation between the two locations has been calculated using the following near-field equation:

$SPL_2 = SPL_1 - R - 6$

Where:

SPL2 = Sound pressure level at the NSR (near field), dB(A)
SPL1 = Assumed internal reverberant sound pressure level within the unit, dB(A)
R = Composite sound reduction performance of nearest façade / roof, dB R_w

For the purpose of the preliminary calculations, the sound reduction performance of the building envelope is assumed to be as follows:

- External wall: Elevation drawings show brick construction; therefore ≥ 44 dB R_w sound insulation
- Roof: Elevation drawings show metal profile roof, assumed to be basic single-skin insulated metal cladding; therefore ≥ 25 dB R_w sound insulation
- Roller shutter door: Elevation drawings show metal garage door; therefore ≥ 15 dB R_w sound insulation when closed

Calculations assume that the sound insulation of the unit will not be compromised by weaker elements (e.g. rooflights) or penetrations such as louvres or access doors. Where any louvres, roof lights or doors are proposed for the garage, they should therefore be designed with a sound insulation performance of ≥ 25 dB R_w.

The weakest (acoustically) point of the unit will be the roller shutter door (RSD) when open on the northern elevation, with a total surface area of circa 9m². For the purpose of calculation, it is assumed that an open RSD offers a sound reduction of 0 dB R_w.

Where appropriate (i.e. where there is a break in the line of propagation between the garage façade / roof element and NSR position) calculations also incorporate a barrier attenuation correction.

The calculated garage noise break-out levels to the nearest proposed dwelling (NSR1) are presented in Table 4.2.

Table 4.2: Calculated Garage Break-Out Levels at NSR1

Source	MOT / Repair Garage Noise Break-Out Level (dB $L_{Aeq,1hr}$) at NSR1	
	North Elevation	East Elevation
Open RSD (North Elevation) of Garage	63	53
Garage Roof	28	38
Total (Cumulative)	**63**	**53**

Propagation (Additional Bays to Existing and Proposed Dwellings)

Noise propagation, from the nearest façade / roof element of the additional bays, has been calculated at all NSRs using the following equation:

$SPL_2 = SPL_1 - R + 10 \log S - 20 \log r - 14$

Where:

SPL2 = Sound pressure level at the NSR, dB(A)
SPL1 = Assumed internal reverberant sound pressure level within the unit, dB(A)
R = Composite sound reduction performance of nearest façade / roof, dB R_w
S = Surface area of nearest façade / roof, m²
r = Distance from NSR to nearest façade / roof, m

Where a NSR is exposed to more than one façade, noise break-out from both façades has been calculated in addition to noise break-out contributions via the roof.

With regard to building element surface area, dimensions have been determined using the aforementioned plan drawing. The building height has been determined from the proposed elevation drawing[15].

The weakest point of the bays (acoustically) will be the 2 no. roller shutter doors (RSD) when open on the north-western elevation, with a surface area of circa 9m² each. For the purpose of calculation, it is assumed that an open RSD offers a sound reduction of 0 dB R_w.

Where appropriate (i.e. where there is a break in the line of propagation between the unit façade / roof element and NSR position) calculations also incorporate a barrier attenuation correction.

The calculated workshop noise break-out levels are presented in Table 4.3.

Table 4.3: Calculated Break-Out Levels from Additional Bays to NSRs

Source	MOT / Repair Bay Noise Break-Out Level (dB $L_{Aeq,1hr}$) to Receptor		
	NSR1	NSR2	NSR3
Bay 1 North Elevation	< 5	5	< 5
Bay 1 East Elevation	< 5	< 5	< 5
Bay 1 Open RSD (West Elevation)	43	32	21
Bay 1 Roof	24	24	13
Bay 2 East Elevation	< 5	< 5	< 5
Bay 2 Open RSD (West Elevation)	49	28	23
Bay 2 Roof	28	20	15
Total (Cumulative)	**50**	**34**	**26**

Impact Assessment

In terms of impact due to garage noise break-out to the proposed dwellings (NSR1), the specific level is taken to be the cumulative (i.e. logarithmic sum) of contributions from the replacement garage and additional bays.

With regard to impact due to garage noise break-out to the existing dwellings (NSR2 and NSR3); it is considered that only noise from the additional bays would require assessment since NSR2 and NSR3 are already experiencing contributions from the existing garage. The replacement garage is expected to be like-for-like in terms of noise emission to the existing dwellings as there would be no changes to the relative positioning and magnitude of the primary noise source (i.e. the open RSD on the northern elevation).

With regard to 'acoustic feature' corrections, the following is considered (based on observations at the existing site):

- Some activities were observed to be sporadic and 'intermittent' in nature; therefore, a + 3 dB correction for intermittent operation would be appropriate
- Some activities were observed to be 'clearly impulsive' in nature; therefore, a + 6 dB correction for impulsivity is considered appropriate

Based on the above, a total acoustic feature correction of + 9 dB has been applied.

The results of the BS 4142 assessment are presented in Table 4.4. Since operating hours are expected to be during the day only; no night-time assessment (i.e. 23:00 – 07:00 hrs) is required in this instance.

[15] Drawing ref: 20.94_PL_204 Rev A 'Proposed Garage Elevations' issued by PMR Architecture

Table 4.4: BS 4142 Assessment of MOT / Repair Garage Noise Break Out

Parameter	Level at Receptor		
	NSR1	NSR2	NSR3
Typical daytime background sound level (See Section 3.4)	54 dB $L_{A90,15min}$	53 dB $L_{A90,15min}$ *	49 dB $L_{A90,15min}$
Specific noise level (See Tables 4.2 and 4.3 – no corrections for % on time deemed necessary)	63 dB $L_{Aeq,1hr}$	34 dB $L_{Aeq,1hr}$	26 dB $L_{Aeq,1hr}$
Acoustic feature correction (See above)	+ 9 dB	+ 9 dB	+ 9 dB
Rating level	72 dB $L_{Ar,1hr}$	43 dB $L_{Ar,1hr}$	35 dB $L_{Ar,1hr}$
Excess of rating level over background sound level	+ 18 dB	- 10 dB	- 14 dB
Assessment, depending on the context	Significant adverse impact	Low impact	Low impact
* *The lowest background noise level measured at Position 1 has been used to avoid a potential unrepresentative baseline due to influence of occasional contributions from the nearby jet wash on the site*			

The BS 4142 assessment of noise break-out from the relocated MOT / Repair Garage and additional bays indicates that:

- Significant adverse impacts would be expected at the nearest proposed dwelling (NSR1)
- Low impacts would be expected at the nearest existing dwellings (NSR2 and NSR3)

The context is as follows:

- Subjectively, the magnitude of noise break-out from the Garage was not considered to be overly intrusive on site due to the high levels of masking noise provided by the road traffic on Main Road
- There would be no contributions from the Garage beyond typical daytime business hours; therefore there would be no associated adverse impacts in the evening or at night with no risk of sleep disturbance during these periods
- Noise impact can be minimised if appropriate mitigation measures are incorporated into the design of the scheme, as detailed in Section 5 of this report
- BS 4142 advises that, for the introduction of a new noise sensitive receptor to extant industrial and/or commercial sound, it should be recognized that the industrial and/or commercial sound forms a component of the acoustic environment and that, in such circumstances other guidance and criteria can be used to inform the extent of required noise mitigation. In this instance, the use of BS 8233:2014 and ProPG design targets are considered appropriate, as detailed in Section 2 of this report, provided that the external noise levels used in the mitigation calculations factor in the aforementioned 'acoustic feature' corrections, where appropriate

4.3 Plant

Detailed information regarding any proposed item(s) of external plant was not available at the time of writing. However, this section has been included to aid in the specification of any external plant associated with the proposed commercial units and food kiosk.

Proposed external plant should be designed so that rating levels (as determined using the guidance of BS 4142) do not exceed the existing background noise level at the nearest NSRs in order to avoid an adverse impact.

Table 4.5 provides the highest permissible free-field rating noise levels from external plant when measured at the nearest NSRs. These are based on the background noise levels measured at the overnight 'anchor' position, presented in Section 3.

Table 4.5: Limiting Rating Noise Levels from External Plant at Site

Limiting Plant Rating Noise Level at NSRs	
Day (07:00 – 23:00 hrs)	**Night (23:00 – 07:00 hrs)**
47 dB $L_{Ar,1hr}$	36 dB $L_{Ar,15min}$

It should be noted that the limits presented in Table 4.5 are rating levels i.e. plant noise levels when appropriate acoustic feature corrections have been applied, in accordance with the penalties described in Section 2 of this report.

It should also be noted that the plant noise limits shown in Table 4.5 are the highest allowable noise levels from all proposed fixed plant. Care should be taken to see that these limits are met with all proposed plant in operation simultaneously.

5 Noise Mitigation Strategy – Residential Use

5.1 External Noise Levels

North-West Elevations (Detached House and Apartments) – Facing Main Road

Average (logarithmic) daytime noise levels at Positions 2 and 4 were both 69 dB $L_{Aeq,T}$ during the manned survey. It follows that the noise levels measured at the long-term (anchor) position were also representative of proposed residential elevations facing Main Road.

Based on the above, the following external design levels have been determined for the north-west elevations of the proposed house and apartments:

- Daytime (07:00 – 23:00 hrs) ambient noise levels of 68 dB $L_{Aeq,T}$
- Night (07:00 – 23:00 hrs) ambient noise levels of 62 dB $L_{Aeq,T}$
- 10th highest maximum noise level of 81 dB L_{AFmax} at night

South-East Elevation (Detached House) – Shielded from Main Road

Increased distance from the dominant noise source (i.e. Main Road) and screening offered by the built form of the development will reduce external noise levels by around:

- 4 dB due to distance attenuation
- 10 dB due to barrier attenuation

Processing the above, the following external noise levels have been determined for the south-east (shielded) elevation of the proposed detached house:

- Daytime (07:00 – 23:00 hrs) ambient noise levels of 54 dB $L_{Aeq,T}$
- Night (07:00 – 23:00 hrs) ambient noise levels of 48 dB $L_{Aeq,T}$
- 10th highest maximum noise level of 67 dB L_{AFmax} at night

North-East Elevation (Apartments) – Overlooking Main Road, Garage and Bays

During the day, these elevations will be affected by commercial noise (from the garage and additional bays) and similar levels of road traffic noise as the detached house; however, there would be a reduced angle of exposure to road traffic from Main Road; a reduction of 180° to 90° results in circa 3 dB reduction in ambient noise levels from road traffic.

Processing the above, the following external noise levels have been determined for the north-east elevation of the apartment block:

- Daytime (07:00 – 23:00 hrs) ambient noise levels of 72 dB $L_{Ar,Tr}$ due to commercial noise and 65 dB $L_{Aeq,T}$ road traffic noise resulting in a cumulative daytime design level of 73 dB $L_{Aeq,T}$
- Night (07:00 – 23:00 hrs) ambient noise levels of 59 dB $L_{Aeq,T}$
- 10th highest maximum noise level of 81 dB L_{AFmax} at night

South-East Elevation (Apartments) – Overlooking Garage and Bays

During the day, this elevation will be affected by relatively shielded from road traffic noise but will be exposed to commercial noise (from the garage and additional bays).

At night, this elevation will be exposed to similar levels of road traffic noise for the rear (shielded) elevation of the proposed detached house.

Processing the above, the following external noise levels have been determined for the south-east elevation of the apartment block:

- Daytime (07:00 – 23:00 hrs) ambient noise levels of 72 dB $L_{Ar,Tr}$ due to commercial noise and 55 dB $L_{Aeq,T}$ road traffic noise resulting in a cumulative daytime design level of 72 dB $L_{Aeq,T}$
- Night (07:00 – 23:00 hrs) ambient noise levels of 48 dB $L_{Aeq,T}$
- 10th highest maximum noise level of 67 dB L_{AFmax} at night

South-West Elevations (Apartments and Detached House)

These elevations will be affected by similar levels road traffic noise as the north-west elevations however, there would be a reduced angle of exposure to road traffic from Main Road; a reduction of 180° to 90° results in circa 3 dB reduction in ambient noise levels from road traffic.

Processing the above, the following external noise levels have been determined for the south-west elevations of the apartment block and detached house:

- Daytime (07:00 – 23:00 hrs) ambient noise levels of 65 dB $L_{Aeq,T}$ due to road traffic noise
- Night (07:00 – 23:00 hrs) ambient noise levels of 59 dB $L_{Aeq,T}$
- 10th highest maximum noise level of 81 dB L_{AFmax} at night

5.2 Feasibility of Open Windows

With regard to internal noise levels when windows are open, the WHO Guidelines[16] states:

'the noise reduction from outside to inside with the window partly open is 15 decibels'

Further to the above, a publication by the Institute of Acoustics (IOA) and Association of Noise Consultants (ANC) '*Guide to Demonstrating Compliance with the Noise Requirements of Approved Document O*' suggests that, in order to provide enough free area to satisfy the requirements of Approved Document O of the Building Regulations, a greater degree of window opening may be required (than that previously assumed and defined as 'partly open') which is estimated to reduce noise from outside to inside by circa 9 dB.

Processing the above, it would seem reasonable to deduce that an open window could offer between 9 – 15 dB sound reduction, depending on the degree by which the window is 'partly open'. On this basis, internal ambient noise levels with windows open have been calculated, as shown in Table 5.1.

[16] Guidelines for Community Noise. World Health Organisation (1999)

Table 5.1: Internal Ambient Noise Levels (Windows Open)

Unit	Elevation	Period	External Noise Levels (dB)		Internal Noise Levels (dB)*	
			Ambient (L_{Aeq})	Max (L_{AFmax})	Ambient (L_{Aeq})	Max (L_{AFmax})
Detached Dwelling	North-West	Day (07:00–23:00)	68	N/A	53 – 59	N/A
		Night (23:00–07:00)	62	81	47 – 53	66 – 72
	South-East	Day (07:00–23:00)	54	N/A	39 – 45	N/A
		Night (23:00–07:00)	48	67	33 – 39	52 – 58
	South-West	Day (07:00–23:00)	65	N/A	50 – 56	N/A
		Night (23:00–07:00)	59	81	44 – 50	66 – 72
Apartment Block	North-West	Day (07:00–23:00)	68	N/A	53 – 59	N/A
		Night (23:00–07:00)	62	81	47 – 53	66 – 72
	South-East	Day (07:00–23:00)	72	N/A	57 – 63	N/A
		Night (23:00–07:00)	48	67	33 – 39	52 – 58
	North-East	Day (07:00–23:00)	73	N/A	58 – 64	N/A
		Night (23:00–07:00)	59	81	44 – 50	66 – 72
	South-West	Day (07:00–23:00)	65	N/A	50 – 56	N/A
		Night (23:00–07:00)	59	81	44 – 50	66 – 72
** A range of values has been presented as the level of attenuation offered can vary depending on the degree by which the window is 'partly open' as discussed above*						

It can be seen that internal noise levels are expected be above the thresholds[17] for which '*windows are likely to be closed during sleeping hours*' (according to ADO); therefore, the overheating mitigation strategy should take account of the likelihood that windows are likely to be closed during sleeping hours (23:00 – 07:00 hrs) in the proposed dwellings.

Purge Ventilation

There is no requirement to comply with internal noise guidelines when windows are opened for temporary purge ventilation (to enable discretionary rapid air changing). In such instances, resultant internal levels would exceed the internal noise guidelines but this would normally be on a brief, temporary basis.

5.3 Glazing / Ventilation Specification

Based on the nature and level of noise at the site, it is considered that the most appropriate ventilation strategy to be employed at the site will be:

- Background ventilators and intermittent extract fans (typically the most cost effective) in areas with relatively low noise exposure; and
- Continuous Mechanical Extract Ventilation (MEV) or Positive Input Ventilation (PIV) in the areas with relative high noise exposure

Calculations incorporate the above assumptions; however, where a fully ducted Mechanical Ventilation with Heat Recovery (MVHR) system is preferred throughout, alternative (typically lower specification) sound reduction performances may be appropriate for glazing.

[17] > 40 dB $L_{Aeq,8hr}$ and > 55 dB L_{AFmax}

In order to determine sound reduction requirements for the glazing and ventilation, noise ingress calculations have been performed using:

- The measured/calculated external noise level data on site
  The calculation methodology outlined in BS8233:2014
- Room dimensions and façade element surface areas determined from layout and elevation drawings supplied by PMR Architecture[18]
- Typical masonry external wall construction
- Tiled/slate roof construction with 25mm plasterboard ceiling and mineral wool insulation in the void
- Assumed room reverberation time of 0.5 seconds

In order to satisfy the internal noise criteria detailed in Section 2 of this report, it is necessary to incorporate mitigation measures in the form of appropriate glazing and ventilation with the minimum specifications presented in Tables 5.2 and 5.3.

Table 5.2: Ventilation and Glazing Recommendations – Detached Dwelling

Elevation	Room	Element	Required Sound Reduction	Indicative Specification [A]
North-West	Living Room	Glazing [B]	29 dB $R_w + C_{tr}$	'6 (12) 4' Double Glazing
		Ventilation [C]	42 dB $D_{n,e,w} + C_{tr}$	Greenwood EAR 42W (or equivalent) Window Trickle Vent [D]
	Bedroom	Glazing [B]	37 dB $R_w + C_{tr}$	'10 (12) 8.8' Acoustic Laminate Double Glazing
		Ventilation [C]	42 dB $D_{n,e,w} + C_{tr}$	Greenwood EAR 42W (or equivalent) Window Trickle Vent [D]
South-East	Dining Room	Glazing [B]	25 dB $R_w + C_{tr}$	'4 (12) 4' Double Glazing
		Ventilation [C]	14 dB $D_{n,e,w} + C_{tr}$	Greenwood 8000HD (or equivalent) Window Trickle Vent [E]
	Bedroom	Glazing [B]	25 dB $R_w + C_{tr}$	'4 (12) 4' Double Glazing
		Ventilation [C]	27 dB $D_{n,e,w} + C_{tr}$	Greenwood 8000HD (or equivalent) Window Trickle Vent [E]
South-West	Living Room	Glazing [B]	25 dB $R_w + C_{tr}$	'4 (12) 4' Double Glazing
		Ventilation [C]	35 dB $D_{n,e,w} + C_{tr}$	Greenwood 5000EAW.AC1 (or equivalent) Window Trickle Vent [E]
	Bedroom	Glazing [B]	40 dB $R_w + C_{tr}$	'10 (12) 12.4' Acoustic Laminate Double Glazing
		Ventilation [C]	42 dB $D_{n,e,w} + C_{tr}$	Greenwood EAR 42W (or equivalent) Window Trickle Vent [D]

Notes:

[A] *For more information, Appendix C and Appendix D present lists of various commercially available glazing and ventilation units along with associated sound reduction performances*

[B] *Requirements also apply to glazing for roof lights and patio doors*

[C] *Requirements apply to trickle vents per habitable room (i.e. living room / bedroom) in open position*

[D] *2500mm² equivalent area; therefore, will require mechanical assistance via MEV or PIV*

[E] *5000mm² equivalent area; therefore, can operate as part of a passive ventilation system*

[18] Drawing ref:
- 20.94_PL_102 'Proposed First Floor Plan'
- 20.94_PL_103 'Proposed Second Floor Plan'
- 20.94_PL_104 'Proposed House Plans'
- 20.94_PL_200 'Proposed Apartments Front Elevation'
- 20.94_PL_201 'Proposed Apartments Rear Elevation'
- 20.94_PL_202 'Proposed Apartments Side Elevations'
- 20.94_PL_203 'Proposed House Elevations'

Table 5.3: Ventilation and Glazing Recommendations – Apartment Block

Elevation	Room	Element	Required Sound Reduction	Indicative Specification [A]
North-West	Living Room	Glazing [B]	35 dB $R_w + C_{tr}$	'10 (6) 8.8' Acoustic Laminate Double Glazing
		Ventilation [C]	42 dB $D_{n,e,w} + C_{tr}$	Greenwood EAR 42W (or equivalent) Window Trickle Vent [D]
	Bedroom	Glazing [B]	39 dB $R_w + C_{tr}$	'12 (15) 8.8' Acoustic Laminate Double Glazing
		Ventilation [C]	42 dB $D_{n,e,w} + C_{tr}$	Greenwood EAR 42W (or equivalent) Window Trickle Vent [D]
South-East	Bedroom	Glazing [B]	40 dB $R_w + C_{tr}$	'10 (12) 12.4' Acoustic Laminate Double Glazing
		Ventilation [C]	42 dB $D_{n,e,w} + C_{tr}$	Greenwood EAR 42W (or equivalent) Window Trickle Vent [D]
North-East	Living Room	Glazing [B]	32 dB $R_w + C_{tr}$	'4 (12) 10' Double Glazing
		Ventilation [C]	42 dB $D_{n,e,w} + C_{tr}$	Greenwood 5000EAW.AC1 (or equivalent) Window Trickle Vent [E]
	Bedroom	Glazing [B]	40 dB $R_w + C_{tr}$	'10 (12) 12.4' Acoustic Laminate Double Glazing
		Ventilation [C]	42 dB $D_{n,e,w} + C_{tr}$	Greenwood EAR 42W (or equivalent) Window Trickle Vent [D]
South-West	Living Room	Glazing [B]	27 dB $R_w + C_{tr}$	'6 (12) 4' Double Glazing
		Ventilation [C]	42 dB $D_{n,e,w} + C_{tr}$	Greenwood EAR 42W (or equivalent) Window Trickle Vent [D]

Notes:

[A] *For more information, Appendix C and Appendix D present lists of various commercially available glazing and ventilation units along with associated sound reduction performances*

[B] *Requirements also apply to glazing for roof lights and patio doors*

[C] *Requirements apply to trickle vents per habitable room (i.e. living room / bedroom) in open position*

[D] *2500mm² equivalent area; therefore, will require mechanical assistance via MEV or PIV*

[E] *5000mm² equivalent area; therefore, can operate as part of a passive ventilation system*

The opening and free area of the ventilation unit should be checked by a mechanical service engineer before designs are finalised. Should the equivalent open area be insufficient to meet the minimum requirements of Part F of the Building Regulations, it may be necessary to increase the number of units per habitable room. Where this applies, the required sound reduction of the ventilation units should be increased accordingly (3 dB per doubling of required no. of vent units).

Where mechanical ventilation is provided, the system should be designed such that internal ambient noise levels from mechanical services do not exceed 30 dB $L_{Aeq,T}$ in living rooms and 26 dB $L_{Aeq,T}$ in bedrooms.

5.4 External Amenity

The proposed site plan shows a communal garden proposed to the south-east of the apartments and a private garden proposed to the south-east of the detached house.

In Section 4.1, it was established that daytime ambient noise levels of circa 54 dB $L_{Aeq,T}$ would be expected at the eastern elevations of the detached house due to distance from the road and screening from the built form of the development; therefore, external noise levels would be expected to be below (thus satisfying) the ≤ 55 dB L_{Aeq} upper limit for external amenity areas[19].

Based on the above, additional mitigation measures are not considered necessary to protect external amenity.

[19] As recommended by BS 8233 / Pro PG guidance

6 Vertical Noise Transfer Between Proposed Commercial Use and Residential Use

6.1 Criteria

For new build apartments, the performance requirements of the Building Regulations Approved Document E 'Resistance to the Passage of Sound' (2003) as amended (ADE) include an airborne sound insulation ≥ 45 dB $D_{nT,w} + C_{tr}$ for separating floors.

It should be noted that the above is a minimum requirement to mitigate against a 'reasonable degree of domestic noise'. In order to protect first floor residents against potential disturbance from noise generated in the ground floor commercial units, it is recommended that, in addition to the above ADE requirements, an airborne sound insulation performance target of ≥ 65 dB $D_{nT,w}$ is adopted.

The above criterion is often adopted by some hotel chains to avoid potential disturbance in circumstances where rooms for residential purposes are proposed immediately above or below third-party commercial units for which the hotel chain has no control over the source noise levels generated within those spaces. This level of sound insulation performance is considered to be a useful starting point given the limited information available at this stage with regard to potential tenants and the associated reverberant noise levels anticipated within those spaces.

6.2 Recommendations

It is understood that the separating floor / ceiling design is yet to be determined. In order to provide the required level of airborne sound insulation performance in the separating floors between apartments and commercial units, it is recommended that the separating floor / ceiling design should incorporate significant mass and isolation.

Appropriate mass can be achieved by using dense material in the floor with as much thickness that can be accommodated (e.g. ≥ 200 mm concrete with density ≥ 2300 kg/m^3).

Appropriate isolation can be achieved by using an independent ceiling (or suspended ceiling system utilising acoustic hangers) in the commercial units to create a void as large as possible (minimum depth 150mm). The ceiling system should be lined with at least 2 no. layers of 15mm dense plasterboard (e.g. Gyproc SoundBloc or equivalent). The ceiling should not be penetrated by M&E services. Where proposed M&E services are to be located above or through a ceiling, this should occur within a sacrificial ceiling (e.g. Armstrong lightweight tile system or similar) positioned below the acoustic ceiling detailed above. The cavity between the floor and ceiling should be lined with ≥ 100 mm mineral wool insulation (e.g. Rockwool with density ≥ 45 kg/m^3).

The above separating floor construction is expected[20] to offer around 74 dB R_w (as shown in Appendix E, Figure E.1) – this would typically equate to an on-site performance of around 65 – 69 dB $D_{nT,w}$ which would satisfy the adopted criteria set out in the foregoing Section 6.1.

6.3 Additional Considerations

Isolated inner wall linings should be applied to the inner leaves of external / structural walls in the commercial units in order to minimise airborne noise transfer to the apartments via the external / structural walls (flanking routes).

[20] As determined via the proprietary sound insulation calculation software, Insul 9.0 by Marshall Day Acoustics

Appropriate isolation can be achieved by using an independent wall lining such as 2 no. layers of 15mm dense plasterboard (e.g. Gyproc SoundBloc or equivalent) on independent studs (≥ 75 mm thickness set ≥ 20mm from the inner leaf of the external/structural wall). The cavity between the inner leaf of the external/structural wall and the independent panel should be lined with ≥ 50 mm mineral wool insulation (e.g. Rockwool with density ≥ 45 kg/m^3).

Audio transducers such as loudspeakers (or televisions) should not be directly fixed to structural elements such as soffits of separating floors or external / structural walls.

Resilient isolation (e.g. neoprene) fixings / pads should be used to mount loudspeakers to avoid direct transmission of energy between rigid surfaces.

7 Summary and Conclusions

A noise survey and assessment has been performed for a proposed mixed-use development at 58 Main Road, Pinhoe, Exeter, EX4 9EY

Noise monitoring was carried out between Tuesday 14th and Wednesday 15th March 2023 to establish external noise levels affecting the proposed development and nearest noise sensitive receptors (NSRs) to the proposal.

Section 4 provides an assessment of the commercial noise at the site using the guidance set out in BS 4142. Noise limits are also recommended to avoid adverse impacts due to external plant associated with the commercial units.

Section 5 provides recommendations to mitigate noise (commercial and road traffic) as far as is reasonably practicable, with regard to relevant guidance including BS 4142, BS 8233 and ProPG.

Section 6 considers vertical noise transfer between the commercial use and the residential use above.

In order to avoid adverse impacts to future occupants or nearby noise sensitive receptors, a number of mitigation measures have been recommended including the specification of appropriate configurations of glazing and ventilation for various elevations (detailed in Section 5.3) and the specification of a separating floor build-up to minimise the potential for noise disturbance from the proposed ground floor commercial use to the proposed residential use immediately above (as detailed in Sections 6.2 and 6.3).

Appendix A – Abbreviations and Definitions

Sound Pressure Level (L_p)
The basic unit of sound measurement is the sound pressure level. As the pressures to which the human ear responds can range from 20 µPa to 200 Pa, a linear measurement of sound levels would involve many orders of magnitude. Consequently, the pressures are converted to a logarithmic scale and expressed in decibels (dB) as follows:

$L_p = 20 \log_{10}(p/p_0)$

Where L_p = sound pressure level in dB; p = rms sound pressure in Pa; and p_0 = reference sound pressure (20 µPa).

A-weighting
A frequency filtering system in a sound level meter, which approximates under defined conditions the frequency response of the human ear. The A-weighted sound pressure level, expressed in dB(A), has been shown to correlate well with subjective response to noise.

Human Perception of Sound
Audibility of sound covers a range of approximately 0 to 140 dB. The human ear system does not respond uniformly to sound across the detectable frequency range and consequently instrumentation used to measure noise is weighted to represent the performance of the ear, using the 'A weighting' [dB (A)]. Table A1 lists the sound pressure level in dB (A) for common situations:

Table A.1: Noise levels for Common Situations

Typical Noise Level dB(A)	Example
0	Threshold of hearing
30	Rural area at night, still air
40	Public library, refrigerator humming at 2m
50	Quiet office, no machinery Boiling kettle at 0.5m
60	Normal conversation
70	Telephone ringing at 2m Vacuum cleaner at 3m
80	General factory noise level Heavy goods vehicle from pavement
90	Powered lawn motor at operator's ear
100	Pneumatic drill at 5m
120	Discotheque – 1m in front of loudspeaker
140	Threshold of pain

Human Perception of Loudness
Because of the logarithmic nature of the decibel scale, it should be borne in mind that noise levels in dB(A) do not have a simple linear relationship. For example, 100dB(A) is not twice as loud as 50 dB(A) sound level. It has been found experimentally that changes in the average level of fluctuating sound, such as traffic noise, need to be of the order of 3 dB(A) before becoming definitely perceptible to the human ear. Data from other experiments have indicated that a change in sound level of 10 dB(A) is perceived by the average listener as a doubling or halving of loudness.

Equivalent Continuous A-weighted Sound Pressure Level ($L_{Aeq, T}$)
The value of the A-weighted sound pressure level in decibels of continuous steady sound that within a specified time interval, T, has the same mean-square sound pressure as a sound that varies with time. $L_{Aeq, 16h}$ (07:00 to 23:00 hours) and $L_{Aeq, 8h}$ (23:00 to 07:00 hours) are used to qualify daytime and night time noise levels.

$L_{A10, T}$

The A-weighted sound pressure level in decibels exceeded for 10% of the measurement period, T. $L_{A10,\,18h}$ is the arithmetic mean of the 18 hourly values from 06:00 to 24:00 hours.

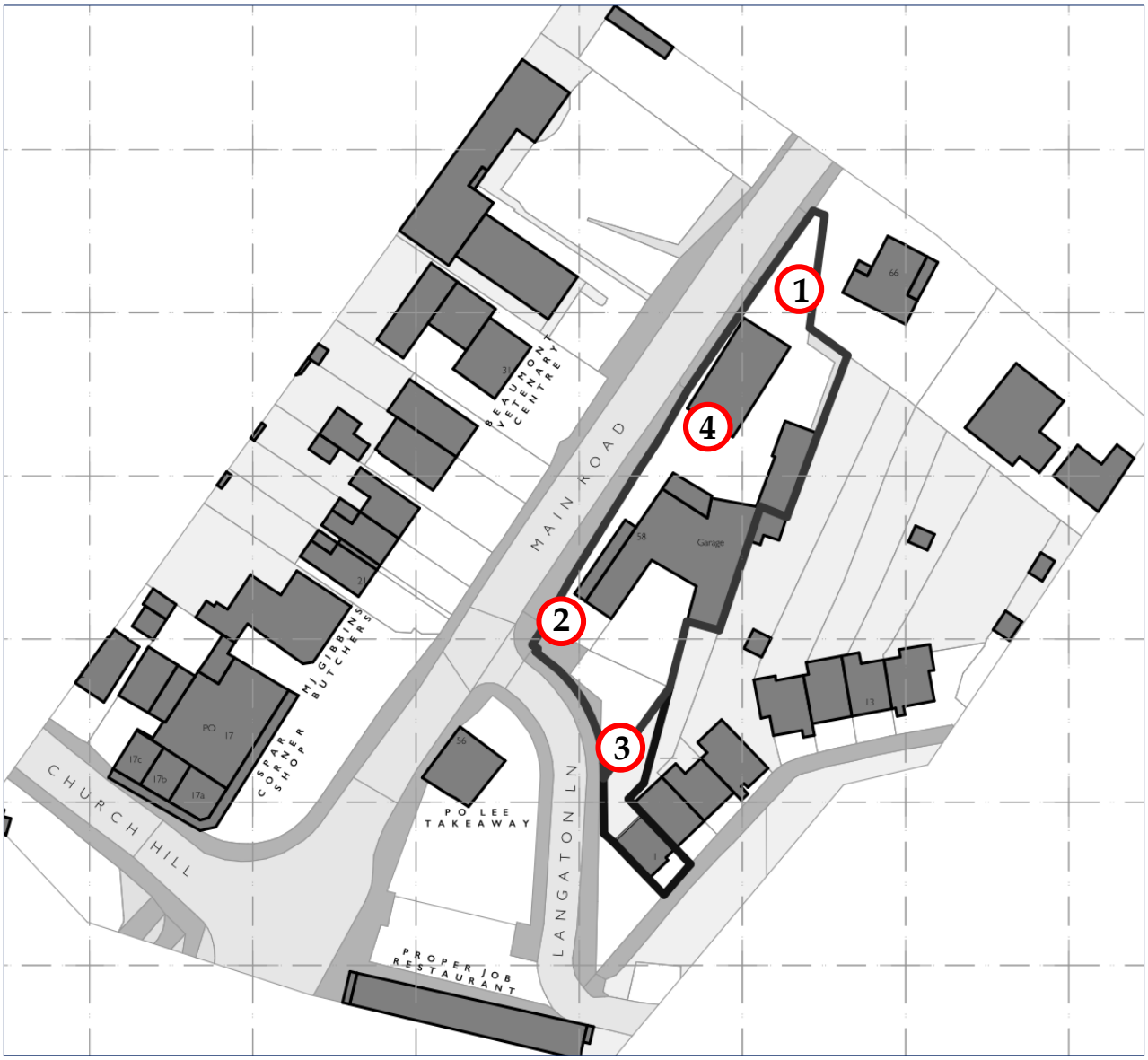
$L_{A90,\,T}$
The A-weighted sound pressure level of the residual noise in decibels exceeded 90% of a given time interval, T. L_{A90} is typically taken as representative of background noise.

$L_{AF\,max}$
The maximum A-weighted noise level recorded during the measurement period. The subscript 'F' denotes fast time weighting, slow time weighting 'S' is also used.

Single Event Level / Sound Exposure Level (SEL or L_{AE})
The energy produced by a discrete noise event averaged over one second, regardless of event duration. This allows for comparison between different noise events which occur over different lengths of time.

Weighted Sound Reduction Index (R_W)
Single number quantity which characterises the airborne sound insulation properties of a material or building element over a defined range of frequencies (R_W is used to characterise the insulation of a material or product that has been measured in a laboratory).

Appendix B – Noise Monitoring Positions



Appendix C – Example Glazing Units

Table C.1 presents a range of example glazing configurations along with their associated sound reduction performance. The following should be noted:

- Data is as per manufacturers publications; therefore, it is the responsibility of the manufacturer in ensuring the product achieves the specified performance
- These are example solutions only, alternative solutions are available and may be considered; however, where alternatives are sourced, the sound reduction data should be obtained from the manufacturer to ensure the required sound reduction performance is satisfied
- The stated dimensions are in millimetres with the void size indicated in brackets e.g. '4 (16) 6' refers to a double-glazed unit comprising a 4mm glass pane and a 6mm glass pane separated by a 16mm air void
- The use of letters (beside the dimensions) denotes laminated or acoustic glass, see notes at the bottom of the table

Table C.1: Example Glazing Units and Associated Sound Reduction Performances

Configuration	Manufacturer	Sound Reduction (dB)	
		R_w	$R_w + C_{tr}$
4 (16) 4	Saint Gobain	30	26
6 (12) 4	Saint Gobain	32	29
6 (15) 4	Saint Gobain	33	29
6 (25) 4	Saint Gobain	34	30
4 (16) 8	Saint Gobain	35	30
4 (6) 10	Saint Gobain	36	33
4 (12) 6.8P	Pilkington	36	30
6 (12)10	Saint Gobain	37	33
10 (6) 8.8S	Saint Gobain	38	35
6 (12) 6.8P	Pilkington	38	33
6 (15) 8.8A	Saint Gobain	39	33
5 (16) 8.8P	Pilkington	39	33
6 (27) 10	Saint Gobain	40	36
10.8L (12) 6.8P	Pilkington	40	34
8 (15) 8.8A	Saint Gobain	41	35
6 (16) 8.8P	Pilkington	41	34
10 (12) 8.8A	Saint Gobain	42	37
8 (16) 8.8P	Pilkington	42	34
12 (15) 8.8A	Saint Gobain	43	39
8 (16) 10.8P	Pilkington	43	36
8.4A (16) 10.4A	Saint Gobain	44	38
10 (16) 8.8P	Pilkington	44	37
10 (16) 12.4A	Saint Gobain	45	40
10 (16) 9.1P	Pilkington	45	39
8.8S (20) 10.8A	Saint Gobain	46	40
9.1P (12) 4 (12) 10	Pilkington	46	40
12.8A (15) 12.8A	Saint Gobain	47	41
8.8P (16) 12.8P	Pilkington	47	39
16.8A (15) 16.8A	Saint Gobain	48	44
9.1P (20) 13.1P	Pilkington	49	42
14.8A (24) 12.8A	Saint Gobain	50	46
9.1P (20) 17.1P	Pilkington	50	43
11.1P (20) 17.1P	Pilkington	51	46
9.1P (20 Arg) 17.1P	Pilkington	52	44
A = 'Stadip Silence' (Saint Gobain); S = 'Stadip' (Saint Gobain); P = 'Optiphon' (Pilkington); L = 'Optilam' (Pilkington); Arg = Argon Filled Cavity			

Appendix D – Example Ventilation Units

Table D.1 presents a range of example ventilators, including trickle vents and acoustic air bricks, along with their associated sound reduction performance. The following should be noted:

- Data is as per manufacturers publications; therefore, it is the responsibility of the manufacturer in ensuring the product achieves the specified performance
- These are example solutions only, alternative solutions are available and may be considered; however, where alternatives are sourced, the sound reduction data should be obtained from the manufacturer to ensure the required sound reduction performance is satisfied
- The units listed may not always provide the required free area through one ventilator alone; for each additional ventilator, the required $D_{n,e,w}$ should be increased by 10 log (n), where 'n' is the number of ventilators

Table D.1: Example Ventilation Units and Associated Sound Reduction Performances

Manufacturer	Model	Type	Equivalent Area (mm^2)	Sound Reduction (dB)	
				$D_{n,e,w}$	$D_{n,e,w} + C_{tr}$
Greenwood	8000HD	Window Vent	6400	30	31
Titon	Trimvent Select Xtra S16	Window Vent	4600	31	31
Greenwood	6000S	Window Vent	4200	32	31
Titon	SF Xtra	Window Vent	4000	32	32
Titon	Trimvent Select Xtra S13	Window Vent	5000	32	33
Greenwood	5000EA	Window Vent	5300	33	33
Greenwood	2500F	Window Vent	2500	33	34
Greenwood	4000L	Window Vent	3200	34	33
Greenwood	3000S	Window Vent	2500	35	34
Greenwood	2500EA	Window Vent	2723	36	36
Ryton	TAL9H&M	Thru-Wall Vent	12800	38	35
Ryton	TAL4H&M	Thru-Wall Vent	6300	38	37
Airvent	SM Ultima 5000	Window Vent	5000	39	37
Greenwood	5000EAW.AC1	Window Vent	5713	39	37
Greenwood	AWV39	Thru-Wall Vent	2500	39	37
Ryton	TALH&M	Thru-Wall Vent	10500	39	37
Ryton	TAL4HMCWL	Thru-Wall Vent	6300	39	38
Ryton	TAL9HMCWL	Thru-Wall Vent	12700	40	37
Greenwood	5000EAW.AC2	Window Vent	5493	42	38
Ryton	TALHMCWL	Thru-Wall Vent	9800	42	39
Greenwood	2500EAW.AC1	Window Vent	2749	42	40
Greenwood	EAR 42W	Window Vent	3325	42	42
Ryton	AAC125HP	Thru-Wall Vent	8500	43	41
Ryton	AAH125HP	Thru-Wall Vent	7700	44	42
Greenwood	AAB4000	Thru-Wall Vent	2500	44	44
Greenwood	2500EAW.AC2	Window Vent	2736	45	42
Ryton	AAC125HPCWL	Thru-Wall Vent	8400	45	42
Airvent	SM Ultima 2960	Window Vent	2960	47	45
Greenwood	MA3051	Thru-Wall Vent	2500	55	52

Appendix E – Separating Floor Sound Insulation

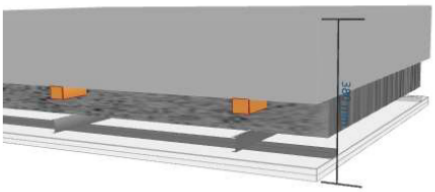
Figure E.1: Recommended Separating Floor Construction between Commercial and Residential Use

Sound Insulation Prediction (v9.0.23)

INSUL

Program copyright Marshall Day Acoustics 2017
Margin of error is generally within Rw ±3 dB
- Key No. 6559
Job Name:
Job No.: Initials:parks
Date:25/01/2023
File Name:Separating Floors.ixl

Notes:



Rw 74 dB
C -1 dB
Ctr -4 dB

Mass-air-mass resonant frequency = =27 Hz

Panel Size = 2.7 m x 4.0 m

Partition surface mass = 497 kg/m²

System description

Panel 1 : 1 x 200 mm Concrete

Frame: Solid Joist with Gyproc acoustic hanger (37 mm x 45 mm), Stud spacing 600 mm ; Cavity Width 150 mm , 1 x Rockwool (40kg/m3) Thickness 100 mm ...
Panel 2 : 2 x 15 mm Gyproc SoundBloc 15mm

freq.(Hz)	R(dB)	R(dB)
50	50	
63	56	53
80	61	
100	65	
125	67	62
160	59	
200	60	
250	63	62
315	65	
400	68	
500	70	70
630	73	
800	75	
1000	77	77
1250	79	
1600	81	
2000	80	81
2500	81	
3150	102	
4000	106	105
5000	110