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Dear Mr Butler

NOISE IMPACT ASSESSMENT FOR PROPOSED RESIDENTIAL DEVELOPMENT LAND TO THE NORTH OF KERESFORTH HILL ROAD, DODWORTH, BARNSLEY

1.00 INTRODUCTION

1.01 Environmental Noise Solutions Ltd (ENS) has been instructed by PB Planning to undertake a noise impact assessment for the proposed residential development of a parcel of land to the north of Keresforth Hill Road, Dodworth (hereafter referred to as the application site).

1.02 The objectives of the noise impact assessment were to:

- Determine the existing ambient noise climate at the application site during representative periods of the daytime (with pertinent calculation methods used to calculate night time noise levels).
- Assess the potential noise impact of the ambient noise climate at the application site with reference to the National Planning Policy Framework (NPPF) and other pertinent guidelines (including BS 8233:2014).
- Provide recommendations for a scheme of sound attenuation works, such that the future occupants of the proposed residential development do not experience any unacceptable loss of amenity due to noise.

1.03 This report details the methodology and results of the assessment and provides recommendations for the building envelope (fenestration and ventilation) and boundary screening. It has been prepared to accompany a planning application to be submitted to the Local Planning Authority (LPA) for the proposed residential development of the application site.

1.04 This report has been prepared for PB Planning for the sole purpose described above and no extended duty of care to any third party is implied or offered. Third parties making reference to the report should consult PB Planning and ENS as to the extent to which the findings may be appropriate for their use.

1.05 A glossary of acoustic terms used in the main body of the text is contained in Appendix 1.

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2.00 SITE SETTING AND PROPOSED DEVELOPMENT

2.01 The application site is located in a predominantly residential environment. An annotated aerial image of the site, including an overlay of the proposed development, is contained in Appendix 2.1. Approximately rectangular is shape, the site is bound by:

- A wooded area to the north.
- A wooded embankment to the east, leading down to the M1 motorway which runs north-south adjacent to the site.
- Keresforth Hill Road to the south.
- Existing dwellings to the west.

2.02 Adjacent to the site, the M1 runs in a cutting, with a grassed, tree lined, embankment leading up to the eastern site boundary. The edge of the nearside carriageway of the M1 is approximately 30 metres to the eastern site boundary. The eastern area of the site appears to be circa 4+ metres above the road surface.

2.03 Keresforth Hill Road was noted to have a 30 mph speed restriction adjacent to the site and was moderately heavily trafficked (circa 450 vehicles per hour during the daytime period based on a manual traffic count).

2.04 During the survey, road traffic noise was noted to be the main contribution to the ambient noise climate, with no other significant noise sources noted.

2.05 The development proposals consist of five detached dwellings with associated gardens and parking areas/garages. A proposed layout plan is contained in Appendix 2.2. With reference to the layout plan, the gardens of Units 3 – 5 extend to the eastern site boundary, with the dwellings set back at least 15 metres from the boundary (circa 45 metres from the edge of the nearside carriageway of the M1). The dwellings on the southern frontage are set back circa 10 metres from the nearside kerb of Keresforth Hill Road.

3.00 BASELINE NOISE SURVEY

3.01 In order to determine the ambient noise climate at the application site, a baseline noise survey was undertaken on Wednesday 4th April 2018.

3.02 For the purpose of the noise impact assessment, the following noise monitoring positions (MPs) were adopted (the approximate locations are identified on the annotated plan in Appendix 2.1):

- MP1 was located in a free field environment on the eastern site boundary, at 4.0 metres above local ground level (mAGL), approximately 30 metres from the edge of the nearside carriageway of the M1. Measurements were also made at 40 metres from the M1 at 4.0 mAGL (MP1A) and 1.5 mAGL (MP1B), 50 metres from the M1 at 4.0 mAGL (MP1C) and 1.5 mAGL (MP1D) and 70 from the M1 at 4.0 mAGL (MP1E) and 1.5 mAGL (MP1F).

- MP2 was located in a free field environment, at 4.0 mAGL, mid-way along the southern site boundary, at 10 metres to the kerb of Keresforth Hill Road. Measurements were also made at 23 metres to the kerb of Keresforth Hill Road at 4.0 mAGL (MP2A) and 1.5 mAGL (MP2B).

- MP3 was located in a free field environment, at 4.0 mAGL, at the western end of the southern site boundary, at 10 metres to the kerb of Keresforth Hill Road. Measurements were also made at 23 metres to the kerb of Keresforth Hill Road at 4.0 mAGL (MP3A) and at 45 metres to the kerb of Keresforth Hill Road at 4.0 mAGL (MP3B) and 1.5 mAGL (MP3C).

3.03 Noise measurements were undertaken using two Bruel & Kjaer 2250 Type 1 integrating sound level meters. Measurements consisted of logged A–weighted broadband parameters (with a 5 second logging interval), together with linear, octave band L_{eq} levels.

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3.04 The measurement systems calibration was verified immediately before the commencement of the measurement sessions and again at the end, using a Bruel & Kjaer Type 4231 calibrator. No drift in calibration level was noted. Weather conditions throughout the survey were appropriate for monitoring, with an average wind speed of < 2 m/s. A windshield was fitted for all measurements.

3.05 The following table contains a summary of the measurement data for each measurement session, at each measurement position, rounded to the nearest decibel.

Table 3.1 – Summary of noise measurement data

Position	Date	Time	$L_{Aeq,T}$ (dB)	L_{AFmax} (dB)	$L_{A10,T}$ (dB)	$L_{A90,T}$ (dB)	Comment
MP1	4/4/18	11:12-14:12	79	84	80	76	4.0 mAGL, 30 m from M1. Noise climate dominated by M1. Typical L_{AFmax} ≤ 82 dB.
MP1A	4/4/18	11:42-11:52	71	74	72	69	4.0 mAGL, 40 m from M1. Noise climate dominated by M1. Typical L_{AFmax} ≤ 73 dB.
MP1B	4/4/18	11:53-12:03	68	72	70	66	1.5 mAGL, 40 m from M1. Noise climate dominated by M1. Typical L_{AFmax} ≤ 71 dB.
MP1C	4/4/18	12:06-12:16	68	71	69	66	4.0 mAGL, 50 m from M1. Noise climate dominated by M1, but Keresforth Hill Road traffic audible. Typical L_{AFmax} ≤ 70 dB.
MP1D	4/4/18	12:17-12:27	67	70	68	65	1.5 mAGL, 50 m from M1. Noise climate dominated by M1, but Keresforth Hill Road traffic audible. Typical L_{AFmax} ≤ 69 dB.
MP1E	4/4/18	12:42-12:47	64	69	67	62	4.0 mAGL, 70 m from M1. Noise climate consisting of M1 and Keresforth Hill Road traffic. Typical L_{AFmax} ≤ 68 dB.
MP1F	4/4/18	12:48-12:53	64	70	67	62	1.5 mAGL, 70 m from M1. Noise climate consisting of M1 and Keresforth Hill Road traffic. Typical L_{AFmax} ≤ 68 dB.
MP2	4/4/18	13:06-14:11	67	76	71	62	4.0 mAGL, 10 m from Keresforth Hill Road. Noise climate dominated by Keresforth Hill Road. Typical L_{AFmax} ≤ 74 dB.
MP2A	4/4/18	14:19-14:24	66	71	68	63	4.0 mAGL, 23 m from Keresforth Hill Road. Noise climate consisting of M1 and Keresforth Hill Road traffic. Typical L_{AFmax} ≤ 70 dB.
MP2B	4/4/18	14:26-14:34	65	70	67	62	1.5 mAGL, 23 m from Keresforth Hill Road. Noise climate consisting of M1 and Keresforth Hill Road traffic. Typical L_{AFmax} ≤ 69 dB.
MP3	4/4/18	14:41-14:46	66	75	70	59	4.0 mAGL, 10 m from Keresforth Hill Road. Noise climate dominated by Keresforth Hill Road. Typical L_{AFmax} ≤ 74 dB.
MP3A	4/4/18	14:48-14:53	65	71	67	60	4.0 mAGL, 23 m from Keresforth Hill Road. Noise climate consisting of M1 and Keresforth Hill Road traffic. Typical L_{AFmax} ≤ 70 dB.
MP3B	4/4/18	15:07-15:17	64	69	66	62	4.0 mAGL, 45 m from Keresforth Hill Road. Noise climate consisting predominantly of M1 traffic. Typical L_{AFmax} ≤ 67 dB.
MP3C	4/4/18	15:17-15:27	62	67	64	59	1.5 mAGL, 45 m from Keresforth Hill Road. Noise climate consisting predominantly of M1 traffic. Typical L_{AFmax} ≤ 66 dB.

3.06 As stated previously, the ambient noise climate across the site is dominated by road traffic noise. Measurements were made in the vicinity of the eastern and southern site boundaries and then at increasing distances from the boundaries into the body of the site.

3.07 The measurement results adjacent to the M1 (including at different heights and distances from the road) are consistent with a noise propagation model whereby the M1 is acting as a line source (3 dB attenuation per doubling of distance from source), with increased screening with distance from the road afforded by the circa. 4 metre high embankment adjacent to the nearside carriageway. MP1 had a line of sight to the road surface, whilst MP1A (set back a further 10 metres) was screened. The ambient noise levels decreased with increasing distance from the M1, before plateauing at circa 64 dB $L_{Aeq,T}$ mid-way across the site. With increasing distance from the M1, Keresforth Hill Road became more audible.

3.08 A study prepared by TRL Limited on behalf of the Department for Environment, Food and Rural Affairs (DEFRA) entitled 'Converting the UK Traffic Noise Index $L_{A10\ (18\ hour)}$ to EU Noise Indices for Noise Mapping' presents a methodology for calculating night time road traffic noise levels based on daytime road traffic noise level based on the following formulae:

(iv) $L_{Aeq\ (23:00–07:00)} \approx 0.90 * L_{A10,\ 18\ hour} – 3.77$ (for non-motorways)

and

(v) $L_{Aeq\ (23:00–07:00)} \approx 0.87 * L_{A10,\ 18\ hour} + 4.24$ (for motorways)

3.09 Note: based on the Department of Transport's Memorandum on the Calculation of Road Traffic Noise (CRTN) the $L_{A10\ (18\ hour)}$ approximates to the $L_{A10\ (3\ hour)}$ – 1 dB.

3.10 Based on the above and utilizing the motorway formula as representative of the M1, a predicted noise level of **73 dB $L_{Aeq\ (2300-0700)}$** is calculated at MP1 (at 4.0 mAGL). This is circa 6 dB lower than the measured daytime ambient noise level in this location. Typical L_{AFmax} levels in this location during the daytime (and also considered representative of the night time) were ≤ 82 dB.

3.11 Based on the above and utilizing the non-motorway formula as representative of Keresforth Hill Road, a predicted noise level of **58-59 dB $L_{Aeq\ (2300-0700)}$** is calculated at MP2/MP3 (at 4.0 mAGL). This is circa 8 dB lower than the measured daytime ambient noise level in these locations. Typical L_{AFmax} levels in these location during the daytime (and also considered representative of the night time) were ≤ 74 dB.

4.00 NOISE IMPACT ASSESSMENT CRITERIA

4.01 The National Planning Policy Framework (NPPF) is a material consideration in planning decisions. At the heart of the NPPF is a presumption in favour of sustainable development, and the policies in Paragraphs 18 to 219 of the NPPF, taken as a whole, constitute the Government's view on what sustainable development in England means in practice for the planning system.

4.02 The NPPF states that there are three dimensions to sustainable development, which include an economic role (contributing to building a strong, responsive and competitive economy), a social role (providing the supply of housing required to meet the needs of present and future generations) and an environmental role (which includes minimising waste and pollution).

4.03 The main policy statement in relation to noise is Paragraph 123 of the NPPF, which states

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.*

4.04 In relation to 'adverse impacts', the NPPF refers to the Explanatory Note to the Noise Policy Statement for England (NPSE) for guidance.

4.05 The Noise Policy Statement for England (NPSE) and associated Explanatory Note were published by DEFRA in 2010 and set out the Government's noise management strategy to enable noise management decisions to be made within the wider context (i.e. guiding principles of sustainable development), in a cost-effective manner and in a timely fashion.

4.06 Fundamental to this approach is '*there is a need to integrate consideration of the economic and social benefit of the activity or policy under examination with proper consideration of the adverse environmental effects, including the impact of noise on health and quality of life. This should avoid noise being treated in isolation in any particular situation, i.e. not focussing solely on the noise impact without taking into account other related factors'*.

4.07 The noise policy aims of NPSE are to (i) avoid significant adverse impact on health and quality of life, (ii) mitigate and minimise adverse impacts on health and quality of life, and (iii) where possible, contribute to the improvement of health and quality of life. The policy aims are always to be considered within the context of the Government's policy on sustainable development.

4.08 In relation to the mitigation and minimisation of adverse impacts, NPSE considers that '*in reality, although not always stated, the aim has tended to be to minimise noise 'as far as is reasonably practical'*. This is reinforced in Paragraph 2.24 of the Explanatory Note, which 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. This does not mean that such adverse effects cannot occur'*.

4.09 In relation to explaining the 'significant adverse' and 'adverse' effects quoted in the NPPF, NPSE uses the two established concepts from toxicology that are currently being applied to noise impacts, for example by the World Health Organisation (WHO), these 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 noise.

- LOAEL – Lowest Observed Adverse Effect Level. This is the level above which adverse effects on health and quality of life can be detected.

4.10 The NPSE then extends these concepts to lead to a SOAEL – Significant Observed Adverse Effect Level. This is the level above which significant adverse effects on health and quality of life occur.

4.11 No specific criteria are presented in the NPSE, to provide the necessary policy flexibility until further evidence and suitable guidance is available. In lieu of specific criteria, for this assessment, ENS makes reference to existing guideline documents, which are summarised in the following paragraph(s).

4.12 BS 8233:2014 'Guidance on sound insulation and noise reduction for buildings' (BS 8233) sets guideline indoor ambient noise levels for dwellings, for steady external noise sources, which it is desirable are not exceeded. These levels are reproduced in Table 4.1 and are based on guidelines issued by the World Health Organisation (WHO). The Standard also states 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 Standard considers that for regular individual noise events, a guideline value may be set in terms of SEL or L_{AFmax} depending on the character and number of events per night. The WHO Guidelines on Community Noise (1999) considers that if negative effects on sleep are to be avoided, noise events exceeding 45 dB L_{Amax} should be limited.

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Table 4.1 – Indoor Ambient Noise Levels in Dwellings (as recommended in BS 8233:2014)

Activity	Location	07:00 – 23:00	23:00 – 07:00
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 $L_{Aeq,8hour}$

4.13 In relation to the internal design criteria detailed above, 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*.'

4.14 For traditional external areas that are used for amenity space, such as gardens and patios, BS 8233 considers that it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. BS 8233 also states '*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'.*

4.15 With reference to the BS 8233 guidelines, by definition, 'reasonable internal conditions' cannot represent a significant adverse impact (the prevention of which is the 1st aim of NPSE). With cognisance to the 2nd aim of NPSE (to minimise noise impact), the internal ambient noise levels detailed in Table 4.1 are considered appropriate.

4.16 Likewise, for external amenity space, a design range of 50 to 55 dB $L_{Aeq,T}$ is considered appropriate to comply with the requirements of the NPPF. Furthermore, the BS 8233 guidance that in certain circumstance '*development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited',* is considered to be in keeping with the NPSE Explanatory Note, which 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. This does not mean that such adverse effects cannot occur'*.

4.17 On the basis of the above, for residential development of the application site, the following criteria are considered to be in keeping with the aims of the NPPF:

- 35 dB $L_{Aeq(0700-2300)}$ in living rooms and bedrooms during the daytime.
- 30 dB $L_{Aeq(2300-0700)}$ in bedrooms at night.
- 45 dB L_{AFmax} not normally exceeded in bedrooms at night.
- Guideline range of 50 - 55 dB $L_{Aeq(0700-2300)}$ in gardens during the daytime and where this is not achievable, design to achieve the lowest practicable levels.

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5.00 SOUND ATTENUATION SCHEME PROPOSALS

Introduction

5.01 As part of the development proposals, a timber reflective barrier is to be installed along the eastern boundary of the application site adjacent to the M1. In order to assess the performance of the barrier, standard sound wall diffraction mathematics has been used. A number of theoretical formulae have been developed to determine the insertion loss (IL) of a barrier (i.e. the change in sound pressure level at a given position when the barrier is 'inserted'). One of the most frequently used methods of predicting the IL of a uniform barrier is Kurze's empirical formula (based on work by Maekawa). This is the formula which has been used for the assessment.

5.02 It is noteworthy that the barrier will also benefit the existing dwellings to the west of the application site. Noise measurements adjacent to the boundary recorded levels of 62 – 64 dB $L_{Aeq,T}$ (MP3B and MP3C).

5.03 As an initial step, the existing scenario was modelled and calibrated using the measurement data. With a 3.0 metre high barrier along the eastern boundary, the calculated IL of the barrier is 11 dB to the nearest decibel. The barrier could take the form of a full height timber construction or a combination of bund and timber barrier. For a timber barrier, the barrier should have a minimum mass per unit area of 10 kg/m^2, the panels should be rigidly mounted and there should be no gaps between adjacent panels or the barrier and the ground. The barrier should be designed (e.g. through the use of cover strips) so that gaps do not develop between abutting panels through warping or shrinking). An indicative section, elevation and plan view of the barrier are contained in Appendix 3 (based on a 0.6 metre bund with 2.4 metre high timber barrier). The proposed location of the barrier is identified on the annotated aerial image contained in Appendix 2.1.

5.04 With the barrier in place, the predicted noise levels adjacent to the eastern site boundary are as follows:

- MP1A (4.0 mAGL): 60 dB $L_{Aeq,(07:00-23:00)}$, 54 dB $L_{Aeq,(23:00-07:00)}$ and ≤ 62 dB L_{AFmax}.
- MP1B (1.5 mAGL): 57 dB $L_{Aeq,(07:00-23:00)}$, 51 dB $L_{Aeq,(23:00-07:00)}$ and ≤ 60 dB L_{AFmax}.
- MP1C (4.0 mAGL): 57 dB $L_{Aeq,(07:00-23:00)}$, 51 dB $L_{Aeq,(23:00-07:00)}$ and ≤ 59 dB L_{AFmax}.
- MP1D (1.5 mAGL): 56 dB $L_{Aeq,(07:00-23:00)}$, 50 dB $L_{Aeq,(23:00-07:00)}$ and ≤ 58 dB L_{AFmax}.

5.05 In order to calculate the sound insulation requirements of the building envelope for habitable rooms in the development, the Building Research Establishment (BRE) building envelope insulation calculation spreadsheet was used. This spreadsheet is based on the calculation methodology advocated in BS 8233. The spreadsheet allows input of external noise levels, room dimensions and reverberation time together with parameters for the various elements of the building envelope and calculates the internal noise level in terms of the external noise level metric (L_{Aeq} and L_{AFmax} in this case). Calculations were based on a standard living room of 50 m^3 and a standard bedroom of 25 m^3 and standard masonry construction. Living room windows are assumed to be 2m^2, whilst bedroom windows are assumed to be 1.5 m^2.

5.06 The ventilation recommendations below relate to the sound insulation scheme only and the developer should ensure compliance with the ventilation requirements of the Building Regulations.

5.07 The sound attenuation scheme proposals below are identified on the annotated aerial image contained in Appendix 2.1.

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Glazing and Ventilation

5.08 It is recommended that all dwellings are provided with a System 3 mechanical extract ventilation (MEV) system with boost facility to allow for whole house ventilation without the need to open windows (the decision to open windows or not would then be at the occupiers discretion).

5.09 Based on the measured/predicted external noise levels with the barrier in place, standard thermal glazing and trickle vents are considered appropriate for habitable rooms in Unit 2, Unit 3 and Unit 4.

5.10 Based on the measured/predicted external noise levels, it is recommended that habitable rooms on the southern façades of Unit 1 and Unit 5 are fitted with glazing rated at ≥ 32 dB R_w+C_{tr} such as a generic 10 mm float glass (16 mm air) 6 mm float glass double glazing system. Habitable rooms on the eastern and western façades of Unit 1 and Unit 5 should be fitted with glazing rated at $\geq$ 29 dB R_w+C_{tr}, such as a generic 8 mm float glass (16 mm air) 4 mm float glass double glazing system. Standard glazing is considered appropriate for the northern façades of Unit 1 and Unit 5. Where an enhanced glazing specification is required, acoustic trickle vents should be used, which have a vent open $D_{n,e,w} + C_{tr}$ (per 2500 mm^2 EA) of ≥ 35 dB (e.g. Greenwood 2500EAW.AC2 or equivalent).

Gardens

5.11 Based on the measured/predicted external noise levels with the barrier in place, the main garden areas of Units 1 – 4 are considered to comply with the garden criteria detailed in Section 4.

5.12 To protect the main garden area of Unit 5 from traffic noise associated with Keresforth Hill Road, it is recommended that a 2.0 metre high timber barrier (to the same specification as detailed in Para 5.03) is constructed along the southern garden boundary. The proposed location is identified in Appendix 2.1. The fence line should be set so that the barrier does not obstruct the visibility splays from the development access road junction.

6.00 CONCLUSIONS

6.01 A noise impact assessment has been undertaken for a proposed residential development of land to the north of Keresforth Hill Road, Dodworth.

6.02 The ambient noise climate across the application site is associated with road traffic.

6.03 Recommendations for a scheme of sound attenuation works have been developed to protect the proposed residential development from the ambient noise climate in accordance with the requirements of the National Planning Policy Framework. On this basis and with the attenuation works in place, the ambient noise climate is not considered to represent a constraint to the proposed residential development of the application site.

I trust the foregoing is sufficient for your needs. Should you have any queries regarding the above, please do not hesitate to contact me.

Yours sincerely,



Richard Pennell
For Environmental Noise Solutions Limited

cc File

Appendix 1
Glossary of Acoustic Terms

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 Network

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.

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.

Sound Exposure Level (SEL or L_{AE})

The energy produced by a discrete noise event averaged over one second, no matter how long the event actually took. 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).

Weighted Airborne Sound Insulation ($D_{nT,w}$)

Single number quantity which characterises the airborne sound insulation between rooms.

Appendix 2.1: Annotated aerial site image indicating the approximate noise monitoring positions (MPs)



Appendix 2.2: Proposed site layout



Appendix 3: illustrative acoustic barrier

