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Noise and Vibration Report for Proposed Residential Development at Leslie Road Kendray, Barnsley

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On behalf of:
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1.0 INTRODUCTION

1.1 Blue Tree Acoustics was commissioned by Keepmoat Homes Ltd to carry out an assessment of the potential impact of rail noise and rail generated vibration on a proposed residential development at Leslie Road Kendray, Barnsley.

1.2 The site was given planning permission on 12th August 2009 ref 2009/0657.

1.3 The development site is in Kendray, to the west of the railway line from Barnsley to Sheffield and to the south of the A635 – Doncaster Road. The site is bounded by the railway embankment to the east, with railway elevated by 5-6m above adjacent site, by Raymond Road and Reginald Road to the West and by a children's play area to the South.

1.4 It is understood that the site was until recently covered with housing in a similar manner to the existing housing to the west of the site. The housing which was on this site has been demolished and the site is currently undeveloped and has a small amount of rubble and vegetation across the whole site. The surrounding area is solely residential in nature. There are no industrial or other commercial premises in the immediate vicinity.

1.5 The proposed development comprises approximately one hundred residential units. The proposed scheme is not fixed at the time of writing. Figure 1 represents the current proposal and possible layout.

1.6 The noise impact assessment has included:

i) Inspection of the site and surroundings and study of the plans provided by Keepmoat Homes Ltd

ii) Daytime and night time noise and vibration monitoring surveys.

iii) Evaluation of the site in accordance with Planning policy guidance note 24 'Planning and Noise' issued by the Department of the Environment, HMSO, 1994 (PPG24)

iv) Consideration of noise control measures required to maintain acceptable noise levels within the proposed bedrooms and living rooms in accordance with British Standard 8233: 1999, 'Code of practice for Sound insulation and noise reduction for buildings'.

v) Evaluation of the site in accordance with British Standard 6472, 2008 'Guide to the evaluation of human exposure to vibration in buildings'.

2.0 EXISTING NOISE SOURCES

Road

2.1 Raymond Road and Reginald Road are lightly trafficked throughout the day and at night with occasional passing vehicles. Road traffic noise levels are very low across the site.

Rail

2.2 The railway line is in close proximity to the site and there are two distinct types of passenger train using the line between approximately 5am and midnight. It is understood that the railway line does not support scheduled freight use.

2.3 Noise from passing trains is clearly audible across the development site and is the dominant noise source affecting the site.

3.0 NOISE SURVEY

Daytime Survey

3.1 A daytime noise survey was undertaken on 24th February 2009.

3.2 Noise levels were measured at the following locations, as shown on Figure 1.

i) Southeast side of development (free-field)

ii) Central site location (free-field)

iii) West side of development (free-field)

iv) North side of development (free-field)

3.3 Noise measurements were carried out using a Rion NA28 Type 1, Class 1 Integrating Sound Level Meter(s). Noise was measured in terms of broadband A-weighted indices and at 1/3 octave bands from 50Hz to 10kHz. The sound level meter was mounted on a tripod at approximately 1.5m from local ground level and the proprietary windshield was fitted to the microphone. Calibration checks were carried out both before and after the measurements with no variance observed.

3.4 Two distinctly different types of measurement were made: measurement of ambient noise levels over a 15 minute period, (including noise from any trains passing during the measurement period) and short period measurement of a train pass-by only.

3.5 Weather conditions were good, being dry and still with wind speeds <5m/s.

Table 1: Location 1 Daytime Noise Levels – Free field at approx 20m from track

Time	Time Period	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
1312	15 min	53.4	81.7	50.4	40.3	Ambient
1316	6 seconds	69.4	75.1	74.2	56.6	2 Carriage train
1326	9 seconds	65.9	72.8	71.2	51.8	2 Carriage train
1437	15 min	61.2	87.6	47.7	41.8	Ambient

Table 2: Location 2 Daytime Noise Levels – Free field at approx 55m from track

Time	Time Period	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
1308	4 seconds	71.6	77.6	76.0	60.0	2 Carriage train
1328	15 min	58.2	81.4	48.1	40.1	Ambient
1329	8 seconds	77.3	82.1	80.8	68.6	3 Carriage train
1334	4 seconds	71.0	75.6	72.2	61.4	2 Carriage train
1342	16 seconds	67.7	74.4	72.4	57.0	2 Carriage train
1407	7 seconds	69.2	73.5	72.0	62.6	2 Carriage train
1438	15 min	56.9	80.5	46.6	42.0	Ambient

Table 3: Location 3 Daytime Noise Levels – Free field at approx 90m from track

Time	Time Period	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
1346	15 min	52.4	72.6	51.6	40.0	Ambient
1357	11 seconds	68.8	73.5	71.8	61.6	2 Carriage train
1403	12 seconds	68.6	71.7	71.0	61.6	3 Carriage train
1503	6 seconds	66.9	69.5	68.6	64.6	2 Carriage train
1520	15 min	55.9	75.1	53.8	42.6	Ambient
1526	11 seconds	70.0	73.1	72.6	64.0	3 Carriage train
1530	10 seconds	70.4	74.0	72.8	63.0	2 Carriage train

Table 4: Location 4 Daytime Noise Levels – Free field at approx 30m from track

Time	Time Period	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
1412	15 min	60.1	82.5	55.4	44.1	Ambient
1416	9 seconds	72.7	78.0	76.6	62.6	2 Carriage train
1426	9 seconds	70.4	76.1	75.0	61.2	2 Carriage train
1431	5 seconds	75.0	79.2	78.0	66.2	2 Carriage train
1457	8 seconds	74.6	79.8	78.9	64.9	2 Carriage train
1502	15 min	59.5	82.6	55.7	41.9	Ambient
1511	9 seconds	74.7	79.9	79.2	61.2	2 Carriage train
1515	5 seconds	70.7	74.7	74.0	57.8	2 Carriage train

Night-time Survey

3.6 A night-time noise survey was undertaken on 24th February 2009. With measurement locations, equipment and conditions as per the day survey.

Table 5: Location 1 Night-time Noise Levels – Free field at approx 20m from track

Time	Time Period	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
2310	15 min	37.9	50.1	40.3	34.5	Ambient
2330	15 min	49.2	75.8	40.5	32.7	Ambient
2345	15 min	39.1	64.5	40.2	33.0	Ambient
0000	15 min	54.2	81.0	41.1	33.3	Ambient
0015	15 min	37.3	54.0	39.3	32.1	Ambient
0030	15 min	37.2	56.5	38.7	32.7	Ambient
0045	15 min	37.2	65.4	38.0	33.2	Ambient
0100	15 min	33.9	35.5	35.0	33.0	Ambient

Table 6: Location 2 Night-time Noise Levels – Free field at approx 55m from track

Time	Time Period	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
2257	15 min	43.3	62.7	45.0	36.2	Ambient
2317	15 min	37.6	51.3	39.4	34.4	Ambient
0010	15 min	35.8	49.9	37.4	32.6	Ambient

Table 7: Location 3 Night-time Noise Levels – Free field at approx 90m from track

Time	Time Period	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
2333	15 min	49.6	71.1	39.2	31.6	Ambient
0037	15 min	35.0	49.0	36.4	31.6	Ambient

Table 8: Location 4 Night-time Noise Levels – Free field at approx 30m from track

Time	Time Period	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
2351	15 min	51.6	75.0	41.4	31.0	Ambient
0056	15 min	33.2	47.8	35.2	30.0	Ambient

3.7 The last train passing the site was noted just after midnight.

Noise Calculations

3.8 Using the above data, it is possible to calculate the noise levels which would be experienced at any location on the site, assuming a certain number of train movements in a time period.

3.9 It was not possible to measure at height at the nearest noise sensitive location. Therefore noise levels were made at various locations across the site. In order to make best use of the expansive data collected, the pass-by data has been processed to give the noise level which would be experienced at 15m from the railway, 15m has been chosen as this represents the location of the nearest proposed property to the railway line.

Table 9: Calculated Noise Levels for Nearest Property.

Time	Time Period(mins)	dB L_{Aeq}	dB SEL	dB SEL @15m	1 Train in 15 minutes	Comments
1316	6 seconds	69.4	77.2	78.4	48.9	2 Carriage
1326	9 seconds	65.9	75.4	76.6	47.1	2 Carriage
1308	4 seconds	71.6	77.6	83.2	53.7	2 Carriage
1329	8 seconds	77.3	86.3	91.9	62.4	3 Carriage
1334	4 seconds	71.0	77.0	82.6	53.1	2 Carriage
1342	16 seconds	67.7	79.7	85.3	55.8	2 Carriage
1407	7 seconds	69.2	77.7	83.3	53.8	2 Carriage
1357	11 seconds	68.8	79.2	87.0	57.4	2 Carriage
1403	12 seconds	68.6	79.4	87.2	57.6	3 Carriage
1503	6 seconds	66.9	74.7	82.5	52.9	2 Carriage
1526	11 seconds	70.0	80.4	88.2	58.6	3 Carriage
1530	10 seconds	70.4	80.4	88.2	58.6	2 Carriage
1416	9 seconds	72.7	82.2	85.2	55.7	2 Carriage
1426	9 seconds	70.4	79.9	82.9	53.4	2 Carriage
1431	5 seconds	75.0	82.0	85.0	55.5	2 Carriage
1457	8 seconds	74.6	83.6	86.6	57.1	2 Carriage
1511	9 seconds	74.7	84.2	87.2	57.7	2 Carriage
1515	5 seconds	70.7	77.7	80.7	51.2	2 Carriage
Logarithmic Average					56.4 dB(A)	
6 trains in 1 hour					58.2dB(A)	

3.10 During the survey the highest number of trains passing the site within any one hour period was six. The bottom line of the table shows the noise level which would result from 6 average trains in 1 hour. The figure of 58.2dB L_{Aeq} tallies well with the 15 minute ambient measurements made on site. The ambient measurements do not contain 6 trains in an hour measurement, but some do contain 3 trains in 15 minutes.

3.11 The figure of 58.2dB L_{Aeq} can be used as being representative of the most exposed location on the site. As trains operate every hour of the day (0700 hours to 2300 hours) the 58.2dB L_{Aeq} is therefore representative of the 16 hour noise level.

3.12 Although only four trains were witnessed at night, it has been assumed that there can be up to 6 trains an hour for 3 hours and no trains for the remaining 5 hours of the night. 58.2dB L_{Aeq} would therefore occur for 3 hours. The 5 hours with no passing trains have much reduced noise levels. As can be seen from the L_{A10} and L_{A90} figures, when there are no trains passing the site, noise levels are very low and can be as low as 38dB L_{Aeq}, even at 2300 hours. Assuming 38.0dB L_{Aeq} for 5 hours, the night time 8 hour ambient noise level becomes 54.0dB L_{Aeq}.

4.0 PPG24 ASSESSMENT AND BS8233 ASSESSMENT CRITERIA

4.1 Using the lookup table below, the noise exposure categories (NEC) may be established for the development site.

Table 10: PPG24 NEC Categories

Categories For New Dwellings dB $L_{Aeq,T}$				
	Noise Exposure Category			
Noise Source	**A**	**B**	**C**	**D**
Road Traffic				
07.00 - 23.00	<55	55 – 63	63 – 72	>72
23.00 - 07.00	<45	45 – 57	57 – 66	>66
Rail Traffic				
07.00 - 23.00	<55	55 – 66	66 – 74	>74
23.00 - 07.00	<45	45 – 59	59 – 66	>66
Air Traffic				
07.00 - 23.00	<57	57 – 66	66 – 72	>72
23.00 - 07.00	<48	48 – 57	57 – 66	>66
Mixed Sources				
07.00 - 23.00	<55	55 – 63	63 – 72	>72
23.00 - 07.00	<45	45 – 57	57 – 66	>66

4.2 *if maximum noise levels through the night regularly exceed 82dB LAmax(slow) several times in any hour it is considered to be NEC C unless it is already categorised as NEC D.*

4.3 The site is dominated by rail noise. The highest ambient noise levels experienced on this site are those calculated in the previous section. Namely, 58.2dB L_{Aeq} during the 16 hour daytime period and 54.0dB L_{Aeq} during the 8 hour night-time period.

4.4 The highest noise exposure category on the site is therefore NEC B as shown in the above tables.

4.5 PPG24 states that the NEC categories are interpreted as follows:

NEC A

"Noise need not be considered as a determining factor in granting planning permission, although the noise level at the high end of the category should not be regarded as a desirable level."

NEC B

"Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise."

NEC C

"Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise."

NEC D

"Planning permission should normally be refused."

4.6 In order to mitigate noise impact PPG24 states that engineering, lay-out and administrative techniques may be employed.

4.7 Planning permission has been granted and condition 11 considers noise, it states:

"Prior to the commencement of development the applicant shall submit a noise report to the Local Planning Authority for approval prior to any development commencing. The report shall detail noise mitigation measures to ensure that main habitable rooms (living rooms and bedrooms) can meet the good standard recommended for residential properties in BS8233.

"Code of Practice for sound insulation and noise reduction in buildings" as follows: inside bedrooms LAeq (8 hours) 30dB and 45dBmax maximum noise levels, inside living rooms LAeq (16 hours) 30dB maximum noise levels, external areas such as gardens and balconies LAEQ (16 hours) 55dB maximum noise levels (such mitigation measures may include the use of acoustic fencing, double or acoustic glazing and background ventilation e.g. trickle vents, sound insulation in the construction)"

In effect this says:

Inside Bedrooms:	$L_{Aeq(8hour)}$ 30dB (2300 to 0700 hours)
Inside Bedrooms:	$L_{Amax(8hour)}$ 45dB (2300 to 0700 hours)
Inside Living Rooms:	$L_{Aeq(16hour)}$ 30dB (0700 to 2300 hours)
External areas such as Gardens:	$L_{Aeq(16hour)}$ 55dB (0700 to 2300 hours)

4.8 The above criteria are more stringent than agreed with Barnsley MBC in previous discussions about the site.

4.9 Noise ingress calculations have been carried out in accordance with BS8233. Typical daytime and night time BS8233 calculations are presented in the appendices.

5.0 NOISE CONTROL MEASURES

5.1 Based on the BS8233 noise ingress calculations, the following sound insulation measures are required in order to achieve the design criteria stated above.

Glazing

Table 11: Glazing Sound Reduction Indices – Living Room windows within 45m of railway, facing the railway

	Minimum Sound Reduction Indices (dB) at Octave Band Centre Frequency (Hz)						
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**
Glazing	20	25	22	33	40	43	44

5.2 The above performance is achievable with a number of glazing combinations including a double glazed system comprising 10mm glass/12mm cavity/6mm glass in aluminium, timber or uPVC framing. The above system should be provided to all Living Room windows within 45m of the railway line which face the railway line. All other Living Room windows may be standard double glazing.

Table 12: Glazing Sound Reduction Indices – Bedroom windows within 45m of Railway with a view to railway

	Minimum Sound Reduction Indices (dB) at Octave Band Centre Frequency (Hz)						
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**
Glazing	24	26	33	41	52	54	61

5.3 The above performance is achievable with a number of glazing combinations including a double glazed system comprising Saint Goban Glass STADIP SILENCE 8.4mm/16mm cavity/SGGSTADIP SILENCE 10.4mm in aluminium, timber or uPVC framing. The above system should be provided to all Bedroom windows that have a view of the railway line and are within 45m of the railway line. All other bedroom windows may be standard double glazing.

Walls

Table 13: Wall Sound Reduction Indices

	Minimum Sound Reduction Indices (dB) at Octave Band Centre Frequency (Hz)						
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**
Wall	34	40	40	48	60	61	61

5.4 The above performance is achievable with a well sealed cavity masonry construction.

Ventilation

Table 14: Ventilation Sound Reduction Indices – within 45m of Railway

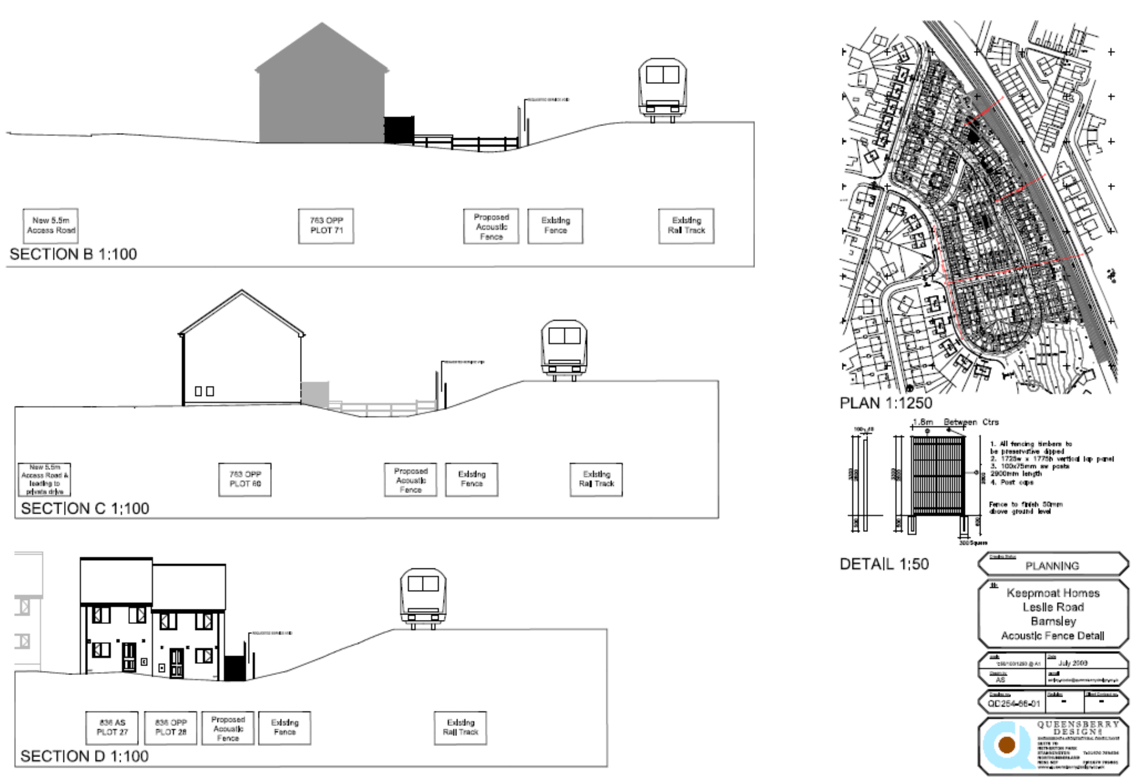
	Minimum Dne (dB) at Octave Band Centre Frequency (Hz)						
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**
Ventilation	29	33	35	44	53	59	60

5.5 The above performance is achievable with a number of ventilation options including the the Silavent Freshflo Permanent Vent Type A. There should be no other ventilators in the rooms other than the acoustic ventilators. This system should be provided for all rooms with elevations facing the railway which are within 45m of the railway. All other rooms may have standard trickle ventilation.

5.6 Any alternative glazing, ventilation, wall systems etc should be checked by a competent acoustic consultant in order to ensure adequate sound insulation performance.

External Areas

5.7 All gardens with a view to the railway line and within 45m of the railway line should be protected with a 2.8m high acoustic fence in order to reduce noise levels. Acoustic fencing should be constructed of weather-treated timber (or ply) of at least 15mm minimum thickness. All joints should be tight-butted with timber cover strips or tongue and groove boards used to ensure there are no air gaps. Gravel boards should be used to fully seal the gap between the fencing and the ground. Alternatively, a solid masonry wall can be constructed to provide the acoustic barrier. The sketch below is taken from drawing QD254-66-01 by Queensberry Design. The drawings show that the 2.8m fence will adequately protect the gardens. In each case the barrier is the left of the two lines and is above the wording "above acoustic fence". In order to meet the 55dB L_{Aeq} criterion applied to the garden areas, the barrier would need to provide 3dB of attenuation. A grazing incidence would give 5dB(A) attenuation, and clearly, the barrier provides more than grazing incidence, i.e. the line of sight is broken between noise source and noise receiver. The 55dBL_{Aeq} garden criterion is therefore satisfied.



6.0 VIBRATION ASSESSMENT

6.1 Measurements of ground vibration from passing trains were carried out at the site at the same times and locations as the noise survey.

6.2 Vibration measurements were carried out for a sample of passing trains using a RION VM 54 vibration meter and VDV transducer.

6.3 There was no perceptible vibration underfoot during the passage of trains. The measured vibration levels were found to be very low. The extrapolated daytime and night-time vibration exposure valves are shown below.

Table 15: Daytime Vibration Levels ms$^{-1.75}$

Time	Time Period(mins)	X VDV	Y VDV	Z VDV	Comments
1318	15	0.001	0.001	0.012	Location 1
1412	15	0.001	0.001	0.005	Location 2
1437	15	0.001	0.001	0.009	Location 3
1457	15	0.000	0.000	0.002	Location 4

Table 16: Night-time Vibration Levels ms$^{-1.75}$

Time	Time Period(mins)	X VDV	Y VDV	Z VDV	Comments
2300	60	0.019	0.019	0.009	Location 1
0000	60	0.001	0.001	0.004	Location 1

6.4 Guidance on assessing the potential annoyance resulting from vibration in buildings is set out in British Standard 6472, 2008 'Guide to the evaluation of human exposure to vibration in buildings'. The standard includes a section on intermittent vibrations which requires the vibration exposure to be determined in terms of a 'vibration dose value', VDV. This takes into account the magnitude of the vibration and the duration of the exposure.

6.5 The vibration dose value for both the day and night-time periods can be calculated using the formula:

$$VDV_{b/d,\,day/night} = \left(\int_0^T a^4(t)\,dt \right)^{0.25}$$

where; $VDV_{b/d,\ day/night}$ is the vibration dose value

a(t) is the frequency weighted acceleration in ms^{-2}

T is the total period of day or night (in seconds) during which vibration can occur

6.6 From the short-term vibration measurements the whole 8 or 16 hour period VDV values can be estimated. Train pass-bys occur regularly through the day. The data collected over the measurement period provides an accurate estimate of the full daytime period $VDV_{(16\ hour)}$ at the site. There is a 5 hour period where trains do not use the line during the night. The calculated night-time $VDV_{(8\ hour)}$ is therefore a worst case assessment of night-time vibration dose levels at the site as they do not take into account the 5 hours with no passing trains.

6.7 Vibration dose values ($ms^{-1.75}$) in residential buildings at which various degrees of adverse comment may be expected are quoted in BS 6472 and are given below.

Vibration dose value ranges which might result in various probabilities of adverse comment within residential buildings

Place and time	Low probability of adverse comment $m \cdot s^{-1.75}$ 1)	Adverse comment possible $m \cdot s^{-1.75}$	Adverse comment probable $m \cdot s^{-1.75}$ 2)
Residential buildings 16 h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

6.8 The calculated vibration dose values at the proposed development site are well below the thresholds for the onset of annoyance that are quoted in BS 6472. All the VDV values are much less than 0.1 $ms^{-1.75}$ which is the bottom end of the range considered in the standard. Consequently, no special vibration isolation measures or exclusion zones are necessary for the proposed development.

7.0 SUMMARY AND CONCLUSIONS

7.1 A noise and vibration assessment has been carried out for the proposed residential development at the site located at Leslie Road, Kendray, Barnsley.

7.2 The site was given planning permission on 12th August 2009 ref 2009/0657.

7.3 The assessment has included measurements of the daytime and night-time ambient noise levels at the site as well as noise from individual passing trains.

7.4 Measurement of ground vibration from passing trains has also been undertaken.

7.5 Noise from passing trains is the dominant noise source affecting the site. Noise control measures have therefore been recommended in order to meet the noise criteria stated in the planning permission for the site.

7.6 Measured vibration levels are low, hence there are no special requirements for mitigation of vibration from passing trains.

FIGURE 1 – POSSIBLE SITE LAYOUT SHOWING NOISE MONITORING LOCATIONS

APPENDIX I – NOISE UNITS AND INDICES

a) Sound Pressure Level and the decibel (dB)

A sound wave is a small fluctuation of pressure in air. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. Due to the wide range of pressure variations detectable by the ear, a logarithmic scale is used to convert the values into manageable numbers. The dB (decibel) is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (threshold of hearing) to 120 dB (threshold of pain).

b) Frequency and Hertz (Hz)

Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or Hertz (Hz). Sometimes large frequencies are often written as kilohertz (kHz), where 1kHz = 1000Hz.

Young people with normal hearing can hear frequencies in the range 20Hz to 20kHz. However, the upper frequency limit gradually reduces as a person gets older.

As the ear hears some frequencies better than others, the A-weighting scale is used to mimic human hearing. A-weighing applies a correction to the sound level at a given frequency depending on how well the ear hears that frequency.

c) Glossary of Terms

In order to describe noise where the level is continuously varying, a number of other indices, including statistical parameters, are used. The indices used in this report are described below.

L_{Aeq} This is the A-weighted equivalent continuous sound level which is an average of the total sound energy measured over a specified time period. In other words, L_{Aeq} is the level of a continuous noise which has the same total (A-weighted) energy as the real fluctuating noise, measured over the same time period.

L_{Amax} This is the maximum A-weighted sound level that was recorded during the monitoring period.

L_{A90} This is the A-weighted sound level exceeded for 90% of the time period. L_{A90} is used as a measure of background noise.

L_{A10} This is the A-weighted sound level exceeded for 10% of the time period and is often used in the assessment of road traffic noise.

SEL This is the Single Event Level which is used to calculate the resultant L_{Aeq} which would be generated by a number of events with a given SEL. The SEL is the total energy measured over the event, compressed into 1 second. SEL= L_{Aeq} +10log(t) there t is time in seconds. Also L_{Aeq} =SEL - 10log(t) + 10log(n) where t is time in seconds and n is the number of events in the time period. SELs are often used for Train noise calculations and other specific events.

APPENDIX II – TYPICAL BS8233 CALCULATION – LIVING ROOM

In order to find the internal noise level which would result from external noise ingress into a room the following equation is used:

$$L_{eq,2} \approx L_{eq,ff} + 10\log\left\{\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S}10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S}10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S}10^{\frac{-R_{rr}}{10}}\right\} + 10\log\left\{\frac{S}{A}\right\} + 3$$

		Octave Band Centre Frequency (Hz)							
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
$L_{eq,ff}$	Sound pressure level outside	65	55	50	53	56	55	46	40
$D_{n,e}$	Insulation of the ventilator	29	33	35	44	53	59	60	60
R_{wi}	Window sound reduction index	20	25	22	33	40	43	44	44
R_{ew}	Wall sound reduction index	34	40	40	48	60	61	61	61
R_{rr}	Roof/ceiling sound reduction index	-	-	-	-	-	-	-	-
A	Absorption area of room	9.3	11.1	12.8	14.1	15.5	15.5	15.5	15.5
S_f	Facade area (including window)	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
S_{wi}	Window area	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
S_{ew}	$S_f - S_{wi}$	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
S_{rr}	Area of Ceiling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S	$S_f + S_{rr}$	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
A_0	Given in BS EN 20140-10	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

White cells denote the information required by BS8223 over the frequency range of 125Hz -2kHz, greyed cells are additional to BS8233 frequency range but are used in the calculation to be more complete.

	Reference Letter	Octave Band Centre Frequency (Hz)							
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
$L_{eq,ff}$	A	**65**	**55**	**50**	**53**	**56**	**55**	**46**	**40**
$D_{n,e}$		29	33	35	44	53	59	60	60
$\frac{A_0}{S} 10^{\frac{-D_{n,e}}{10}}$	B	1.4E-03	5.6E-04	3.5E-04	4.4E-05	5.6E-06	1.4E-06	1.1E-06	1.1E-06
R_{wi}		20	25	22	33	40	43	44	44
$\frac{S_{wi}}{S_f} 10^{\frac{-R_{wi}}{10}}$	C	2.2E-03	7.0E-04	1.4E-03	1.1E-04	2.2E-05	1.1E-05	8.8E-06	8.8E-06
R_{ew}		34	40	40	48	60	61	61	61
$\frac{S_{ew}}{S_f} 10^{\frac{-R_{ew}}{10}}$	D	3.1E-04	7.8E-05	7.8E-05	1.2E-05	7.8E-07	6.2E-07	6.2E-07	6.2E-07
R_{rr}		-	-	-	-	-	-	-	-
$\frac{S_{rr}}{S_f} 10^{\frac{-R_{rr}}{10}}$	E	-	-	-	-	-	-	-	-
$10 \log_{10} (B + C + D + E)$	F	-24	-29	-27	-38	-45	-49	-50	-50
A									
$10 \log \left(\frac{S}{A}\right)$	G	-0.14	-0.91	-1.53	-1.95	-2.36	-2.36	-2.36	-2.36
$L_{eq,2}$	A + F + G + 3	44	28	24	16	12	7	-3	-9
A-weighting dB		-26	-16	-9	-3	0	1	1	-1
$L_{eq,2}$ + A-weighting	$L_{Aeq,freq}$	18	12	15	13	12	8	-2	-10
$L_{eq,2}$ + A-weighting	L_{Aeq}	22							
	NR	15							

White cells denote the information required by BS8223 over the frequency range of 125Hz -2kHz, greyed cells are additional to BS8233 frequency range but are used in the calculation to be more complete.

APPENDIX III – TYPICAL BS8233 CALCULATION – BEDROOM

In order to find the internal noise level which would result from external noise ingress into a room the following equation is used:

$$L_{eq,2} \approx L_{eq,ff} + 10\log\left\{\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S}10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S}10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S}10^{\frac{-R_{rr}}{10}}\right\} + 10\log\left\{\frac{S}{A}\right\} + 3$$

		Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
$L_{eq,ff}$	Sound pressure level outside	69	62	62	67	71	65	58	47
$D_{n,e}$	Insulation of the ventilator	29	33	35	44	53	59	60	60
R_{wi}	Window sound reduction index	24	26	33	41	52	54	61	61
R_{ew}	Wall sound reduction index	34	40	40	48	60	61	61	61
R_{rr}	Roof/ceiling sound reduction index	-	-	-	-	-	-	-	-
A	Absorption area of room	9.3	11.1	12.8	14.1	15.5	15.5	15.5	15.5
S_f	Facade area (including window)	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
S_{wi}	Window area	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
S_{ew}	$S_f - S_{wi}$	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
S_{rr}	Area of Ceiling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S	$S_f + S_{rr}$	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
A_0	Given in BS EN 20140-10	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

White cells denote the information required by BS8223 over the frequency range of 125Hz -2kHz, greyed cells are additional to BS8233 frequency range but are used in the calculation to be more complete.

	Reference Letter	Octave Band Centre Frequency (Hz)							
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
$L_{eq,ff}$	A	69	62	62	67	71	65	58	47
$D_{n,e}$		29	33	35	44	53	59	60	60
$\frac{A_0}{S} 10^{\frac{-D_{n,e}}{10}}$	B	1.4E-03	5.6E-04	3.5E-04	4.4E-05	5.6E-06	1.4E-06	1.1E-06	1.1E-06
R_{wi}		24	26	33	41	52	54	61	61
$\frac{S_{wi}}{S_f} 10^{\frac{-R_{wi}}{10}}$	C	8.8E-04	5.6E-04	1.1E-04	1.8E-05	1.4E-06	8.8E-07	1.8E-07	1.8E-07
R_{ew}		34	40	40	48	60	61	61	61
$\frac{S_{ew}}{S_f} 10^{\frac{-R_{ew}}{10}}$	D	3.1E-04	7.8E-05	7.8E-05	1.2E-05	7.8E-07	6.2E-07	6.2E-07	6.2E-07
R_{rr}		-	-	-	-	-	-	-	-
$\frac{S_{rr}}{S_f} 10^{\frac{-R_{rr}}{10}}$	E	-	-	-	-	-	-	-	-
$10 \log_{10} (B + C + D + E)$	F	-26	-29	-33	-41	-51	-55	-57	-57
A									
$10 \log \left(\frac{S}{A}\right)$	G	-0.14	-0.91	-1.53	-1.95	-2.36	-2.36	-2.36	-2.36
$L_{eq,2}$	A + F + G + 3	46	35	30	27	21	11	2	-9
A-weighting dB		-26	-16	-9	-3	0	1	1	-1
$L_{eq,2}$ + A-weighting	$L_{Aeq,freq}$	20	19	21	24	21	12	3	-10
$L_{eq,2}$ + A-weighting	L_{Aeq}	28							
	NR	25							

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The same calculation carried out for the L_{Amax} parameter yields a result of 41dBL_{Amax}