CHAPTER 15: NOISE AND VIBRATION

Introduction

15.1 This chapter assesses the likely noise and vibration impacts of the proposed development on the local noise and vibration environment and assesses the suitability of the site's existing noise environment for the proposed development. In particular, it considers the potential effects of noise and vibration during both the construction and operational phases.

15.2 The chapter describes the methods used to assess the impacts, the baseline conditions for the site and surroundings, the potential impacts of the development arising from construction activities, development generated road traffic and noise generative items of fixed plant, the potential impacts on the proposed development arising from existing baseline noise levels, the mitigation measures required to prevent, reduce, or offset the impacts and the residual impacts. It has been written by WSP│Parsons Brinckerhoff.

15.3 This chapter is necessarily technical in nature so to assist the reader, a glossary of terminology relating to noise and vibration is provided within Appendix 15.1.

Planning Policy Context

15.4 A summary of pertinent planning policy is presented below with a summary of other relevant guidance and British Standards etc., as adopted as part of the completed assessment work, presented within Appendix 15.2.

National Planning Policy

National Planning Policy Framework[i]

15.5 Published in March 2012, this document sets out the Government's planning policies for England and supersedes a number of previous Planning Policy Guidance Notes and Planning Policy Statements (amongst other documents), including Planning Policy Guidance Note 24: *Planning and noise* (PPG24)[ii]. In contrast to PPG 24, reference to noise is scant within the new NPPF. However it does make the following reference to noise in the section entitled Conserving and enhancing the natural environment:

> *"The planning system should contribute to and enhance the natural and local environment by… [a number of points including]…preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability".*

15.6 The NPPF also references noise in paragraph 123:

"*123. Planning policies and decisions should aim to:*

- *avoid noise from giving rise to significant adverse impacts[27] on health and quality of life as a result of new development;*
- *mitigate and reduce to a minimum other adverse impacts[27] 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;[28] 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."*

15.7 The reference numbers 27 and 28 point respectively to the Explanatory Note to the NPSE and the provisions of the Environmental Protection Act 1990 and other relevant law.

15.8 On 6th March 2014, the Department for Communities and Local Government (DCLG) launched a national planning practice guidance web-based resource (PPG). It is stated that this guidance is provided to complement the NPPF and provide advice on how to deliver its policies. This document is discussed further within Paragraphs 15.15 and 15.16.

Noise Policy Statement for England (NPSE)[iii]

15.9 The Noise Policy Statement for England was published in March 2010. The NPSE is the overarching statement of noise policy for England and applies to all forms of noise other than occupational noise, setting out the long term vision of Government noise policy which is to:

> "*Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development."*

15.10 That vision is supported by the following aims:

> "*Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:*
>
> - *avoid significant adverse impacts on health and quality of life;*
> - *mitigate and minimise adverse impacts on health and quality of life; and*
> - *where possible, contribute to the improvement of health and quality of life."*

15.11 The Explanatory Note to the NPSE has introduced three concepts to the assessment of noise in this country:

- *NOEL – No Observed Effect Level*

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

- *LOAEL – Lowest Observable 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.

15.12 None of these three levels are defined numerically and for the SOAEL the NPSE makes it clear that the noise level is likely to vary depending upon the noise source, the receptor and the time of day/day of the week, etc. The need for more research to investigate what may represent an SOAEL for noise is acknowledged in the NPSE and the NPSE asserts that not stating specific SOAEL levels provides policy flexibility in the period until there is further evidence and guidance.

15.13 The NPSE concludes by explaining in a little more detail how the LOAEL and SOAEL relate to the three aims listed in paragraph 15.10 above. It starts with the aim of avoiding significant adverse effects on health and quality of life, then addresses the situation where the noise impact falls between the LOAEL and the SOAEL when "*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*." The final aim envisages pro-active management of noise to improve health and quality of life, again taking into account the guiding principles of sustainable development.

Planning Practice Guidance[iv]

15.14 Last updated on the 24th December 2014, the Department for Communities and Local Government (DCLG) has issued a national planning practice guidance web-based resource (PPG). It is stated that the guidance is to complement the NPPF and provide advice on how to deliver its policies. The PPG replaced the former "*in beta*" version which was launched on the 14 October 2013 for testing and comment under the title "*National Planning Practice Guidance*".

15.15 The PPG section on noise includes a table that summarises "*the noise exposure hierarchy, based on the likely average response*". This table offers "*examples of outcomes*" relevant to the NOEL, LOAEL and SOAEL effect levels described in the NPSE and is reproduced below:

Table 15.1 Noise exposure hierarchy, based on the likely average response.

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum

Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

15.16 These outcomes are in descriptive form and the guidance offers no numerical definition of the NOEL, LOAEL and SOAEL, or detailed advice regarding methodologies for their determination. There is also no reference to the further research that was identified as necessary in the NPSE in 2010 to assist in the determining of NOEL, LOAEL and SOAEL.

Local Planning Policy

Staffordshire Moorlands Core Strategy [v]

15.17 With specific reference to noise, Policy SD4 – Pollution and Flood Risk, within the Staffordshire Moorlands Core Strategy states:

> *"The Council will ensure that the effects of pollution (air, land, noise, water, light) are avoided or mitigated by refusing schemes which are deemed to be (individually or cumulatively) environmentally unacceptable and by avoiding unacceptable amenity impacts by refusing schemes which are pollution-sensitive adjacent to polluting developments, or polluting schemes adjacent to pollution sensitive areas, in accordance with national guidance."*

15.18 Further reference to noise is given in Policy C1 – *Creating Sustainable Communities* where it is stated:

"In order to create sustainable communities at a local level the council will:

5. Support the relocation of uses which are no longer compatible with their surroundings due to negative amenity issues such as noise or accessibility where an alternative suitable site can be secured, subject to the requirements set out in Policy E2 in order to facilitate regeneration."

15.19 With respect to noise, Policy R1 – *Rural Diversification* states:

> *"Appropriate development should not harm the rural character and environmental quality of the area or any sites designated for their nature conservation, or historical interest by virtue of the scale, nature and level of activity involved and the type and amount of traffic generated or by other effects such as noise and pollution."*

Churnet Valley Masterplan SPD[vi]

15.20 The development of the Churnet Valley Masterplan has been informed by the identification of a number of strengths, weaknesses, opportunities and threats. Noise is specifically mentioned under the heading of "Threats" where it is stated:

> *"Impact of potential future development on local residents and existing visitors. Additional visitors may result in increased noise and increased number of vehicles on the roads. This could threaten quiet enjoyment of the countryside."*

Approach

Assessment Methodology

Scope of the Assessment

15.21 This chapter considers the effects of noise and vibration that will occur during both the construction phase and the operational phase of the Proposed Development. The following potential effects are considered:

Construction Phase

- Noise from construction activities on nearby noise-sensitive receptors; and
- Vibration from construction activities on surrounding sensitive receptors.

Operational Phase

- Noise from development generated road traffic on surrounding existing receptors;
- Noise from fixed plant items proposed as part of the development on surrounding existing and proposed new noise sensitive receptors; and
- The impact of existing baseline noise levels on proposed sensitive aspects of the development (new holiday cottages and lodges).

Extent of the Study Area

15.22 The study area considered for the purpose of the noise and vibration assessment consists of the Site itself (within the red line boundary), noise sensitive receptors immediately surrounding the Site and proposed as part of the development (i.e. holiday lodges and cottages), and residential dwellings located in the vicinity of the site and those adjacent to the local road traffic network immediately surrounding the Site (i.e. the route network adopted within the Transport Assessment).In consideration of the study area, a desktop review of the site and its environs was undertaken, including consideration to detailed aerial photography and Ordnance Survey mapping of the site and surrounding area. All residential receptors within approximately 500m of the site boundary were identified, which encompassed the closest existing residential dwellings in all directions from the site. These dwellings range from being within approximately 70m of the site boundary and approximately

500m of the site boundary, depending upon the direction considered. The identified dwellings are presented on Figure 15.1.

Consultation

15.23 At the outset of the assessment for the 2014 application, consultation discussions were held with the dealing Environmental Health Officer at SMDC (Mr Denis Colgan). The scope and duration of the baseline noise survey was discussed and agreed as was the scope and assessment methodology to be adopted within the assessment.

Method of Baseline Data Collation

15.24 At the outset of the assessment and prior to undertaking the baseline noise survey, a desk based review of online mapping was undertaken in order to determine the potential dominant noise sources present on site, and identify local noise sensitive receptors. This approach allowed appropriate targeting of the baseline noise measurement locations.

15.25 In order to determine the baseline noise levels present at the Site and at locations representative of a sample of local receptors, an environmental noise survey was conducted on and within the vicinity of the Site. This survey was undertaken over the course of an approximate 4 day period. Noise monitoring locations were selected such that the dominant noise sources and a sample of existing and proposed noise sensitive receptors were represented. The noise measurement locations are illustrated in **Figure 15.1**.

15.26 The survey commenced at approximately 11:00 on Thursday 4th September 2014 concluding at approximately 12:00 on Monday 8th September 2014.

15.27 Details of the Type 1 sound level monitoring equipment used during the survey are presented within Table 15.2. All sound level meters had been calibrated to traceable standards within the preceding two years and the hand held calibrators within the previous 12 months.

Table 15.2: Noise Measurement Equipment

Equipment	Make & Model	Serial Number
Sound Level Meter	01dB Solo	10717
Preamplifier	01dB PRE 21 S	11139
Microphone	Microtech Gefell MCE212	93763
Calibrator	01dB-STELL Cal 21	35293348
Sound Level Meter	01dB Solo	10966
Preamplifier	01dB PRE 21 S	13150
Microphone	Microtech Gefell MCE212	65593
Calibrator	01dB-STELL Cal 21	35293349
Sound Level Meter	01dB Solo	65804
Preamplifier	01dB PRE 21 S	16471
Microphone	Microtech Gefell MCE212	175391
Calibrator	01dB-STELL Cal 21	34323996
Sound Level Meter	01dB Solo	65806
Preamplifier	01dB PRE 21 S	16461
Microphone	Microtech Gefell MCE212	166412
Calibrator	01dB-STELL Cal 21	34323904
Sound Level Meter	01dB Solo	65811
Preamplifier	01dB PRE 21 S	16485
Microphone	Microtech Gefell MCE212	166394
Calibrator	01dB-STELL Cal 21	34634224

15.28 Weather conditions present during the noise measurement period were conducive to obtaining accurate and reliable measurements, being dry and calm (wind speeds below 5 m/s). Meteorological data were obtained from the archived meteorological records on the Weather Underground, Inc. web site (www.wunderground.com) for Cheddleton (ISTAFFOR6), approximately 9 km to the north west of the Site for the period of the survey. A summary of the prevailing conditions on each day of the survey is set out in the following table:

Table 15.3 Summary of Meteorological Conditions During the Survey

Date	Wind direction		Average wind speed ($m.s^{-1}$)		Rainfall periods	
	Day	Night	Day	Night	Day	Night
04/09/14	Variable	N/A	0.8	0.0	N/A	N/A
05/09/14	WSW	N/A	0.2	0.0	N/A	N/A
06/09/14	Variable	N/A	0.4	0.0	N/A	N/A
07/09/14	Variable	N/A	0.4	0.0	N/A	N/A
08/09/14	Variable	N/A	0.4	0.0	N/A	N/A

15.29 The measurement locations used during the noise survey are presented within **Figure 15.1** and are described within Table 15.4 below.

Table 15.4 Measurement Locations

Location	Description
1	Located to the south west of the site adjacent to Little Eaves Farm adjacent to the track leading to the farm at a height of approximately 1.5 metres above ground level. Baseline noise levels consist of general noise from farm operations, natural sources including bird song and moving vegetation, and distant road traffic noise. Noise levels generated by on site activities within the quarry were present during short term daytime periods on Thursday 4th and Friday 5th September, however such sources were generally of a low level and were intermittent in nature.
2	Located to the south of Eaves Lane adjacent to Cottage Farm at a distance of approximately 2.5 metres from the nearside kerb edge of Eaves Lane. The microphone was positioned at a height of approximately 1.5 metres above ground level within free-field conditions. Baseline noise levels consist of natural sources including bird song and moving vegetation, distant road traffic noise and intermittent road traffic noise from Eaves Lane. Noise levels generated by on site activities within the quarry were generally infrequent and insignificant at this location.
3	Located to the east of the site adjacent to Blakeley Lane at a distance of approximately 2.5 metres from the nearside kerb edge. The microphone was positioned at a height of approximately 1.5 metres above ground level and on top of an embankment of approximately 1.5 metres in height within free-field conditions. Baseline noise levels consist of natural sources including bird song and moving vegetation, distant road traffic noise and intermittent road traffic noise from Blakeley Lane. Noise levels generated by on site activities within the quarry were not observed to be present.

4	Located to the east of the site adjacent to Crowtrees Farm entrance track at a height of approximately 1.5 metres above ground level. Baseline noise levels consist of general noise from farm activity, natural sources including bird song and moving vegetation, distant road traffic noise and noise from intermittent traffic on Eaves Lane. Noise levels generated by on site activities within the quarry were present during short term day time periods on Thursday 4th and Friday 5th September, however such sources were generally of a low level and were intermittent in nature.
5	Located towards the centre of the site adjacent to the quarry access road at a height of approximately 1.5 metres above ground level and in free field conditions. Baseline noise levels consist of quarry vehicles accessing the site, natural sources including bird song and moving vegetation, distant road traffic noise and noise from intermittent traffic on Eaves Lane. Noise levels generated by on site activities within the quarry were present during short term daytime periods on Thursday 4th and Friday 5th September, however such sources were generally of a low level and were intermittent in nature.
6	Located towards the south of the site adjacent to the quarry – railway access track at a height of approximately 1.5 metres above local ground level and in free-field conditions. Noise levels present at this location consisted of noise from quarry vehicles on the access track (mid-week only), natural sources including birdsong and moving vegetation, and distant road traffic noise. Noise levels generated by on site activities within the quarry were present during short term daytime periods on Thursday 4th and Friday 5th September, however such sources were generally of a low level and were intermittent in nature.

Identification of Sensitive Receptors

15.30 For the purpose of the noise and vibration assessment relating to on-site construction activities, a sample of noise and vibration sensitive receptors located close to the Site have been considered. Such sensitive receptors include residential dwellings located to the north-east of the site adjacent to Blakeley Lane, High Trees to the east of the site, residential dwellings to the south-east of the site adjacent to Eaves Lane (to the north of Oakmoor), Little Eaves Farm and Dustystile located to the south-west of the site, and residential dwellings located to the north east of the site adjacent to Eaves Lane. Other receptors who could be affected by construction noise are the users of Public Rights of Way (PROW)_and local employees. However, given the associated transient nature of PROW users, and that dwellings are considered of higher sensitivity than work places, it is considered that the adopted approach represents a worst case scenario.

15.31 For the assessment of noise effects relating to road traffic generation arising from the Proposed Development, it has been considered appropriate that the impact magnitude should be determined at noise sensitive receptors located along the local road network surrounding the Site. It is anticipated that the greatest effects will arise on the routes close to the Site before the traffic generated by the Proposed Development is dispersed across the wider network. Accordingly, noise sensitive receptors adjacent to the local road network have also been considered.

Significance Criteria

15.32 The significance level attributed to each effect has been assessed based on the impact magnitude due to the development proposals, and the sensitivity of the affected receptor / receiving environment to change / effect. The following terms have been used to define the impact magnitude identified:

- Major Beneficial: where the Proposed Development could be expected to have a very significant beneficial effect on existing and proposed noise and vibration sensitive receptors;
- Moderate Beneficial: where the Proposed Development could be expected to have a noticeable beneficial effect on existing and proposed noise and vibration sensitive receptors;
- Minor Beneficial: where the Proposed Development could be expected to result in a small, barely noticeable beneficial effect on existing and proposed noise and vibration sensitive receptors;
- Negligible; where no discernible effect is expected as a result of the Proposed Development on existing and proposed noise and vibration sensitive receptors.
- Minor Adverse: where the Proposed Development could be expected to result in a small, barely noticeable adverse effect on existing and proposed noise and vibration sensitive receptors;
- Moderate Adverse: where the Proposed Development could be expected to have a noticeable adverse effect on existing and proposed noise and vibration sensitive receptors; and
- Major Adverse: where the Proposed Development could be expected to have a very significant adverse effect on existing and proposed noise and vibration sensitive receptors.

15.33 Impact Magnitude and the sensitivity of the affected receptor / receiving environment are both assessed on a scale of high, medium, low and negligible. Receptors such as residential dwellings are considered to be of high sensitivity, whereas receptors such as industrial premises are considered to be of lesser sensitivity. Receptors such as offices and medical facilities are considered to be of medium to low sensitivity.

The determined Impact Magnitude and receptor sensitivities have been used to determine significance of effects using the following significance matrix:

Table 15.5: Matrix for Determining Significance of Effects

		Sensitivity of Receptor/Receiving Environment to the Impact			
		High	**Medium**	**Low**	**Negligible**
Impact Magnitude	**High**	Major	Moderate to Major	Minor to Moderate	Negligible
	Medium	Moderate to Major	Moderate	Minor	Negligible
	Low	Minor to Moderate	Minor	Negligible to Minor	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

15.34 The Impact Magnitude has been determined drawing upon the applicable guidance in each case. A summary of the approach to the determination of Impact Magnitude is presented below.

Construction Noise

15.35 For on-site construction, following the advice provided within BS5228-1:2009 +A1 2014 [vii] and given the measured ambient noise levels in the area it is considered that for the most-sensitive receptors, the following Impact Magnitude criteria can be applied to the assessment of construction noise, measured or predicted as a façade level:

Table 15.6: Scale for Assessment of Façade Noise Levels (Excluding Existing Ambient Noise) on Humans in Rural and Suburban Areas during Construction Works

Absolute Noise Level, dB $L_{Aeq, 10h}$	Impact Magnitude
> 70	High
65 – 70	Medium
60 – 65	Low
< 60	Negligible

Construction Vibration

15.36 The assessment of ground-borne vibration associated with typical on-site construction activities has been undertaken drawing upon the guidance presented within BS 5228-2:2009 +A1 2014[viii]. The Impact Magnitude associated with construction vibration has been assessed drawing upon the guidance criteria presented within BS5228-2:2009 +A1 2014, in this regard the following criteria have been adopted:

Table 15.7: Impact Magnitude Applicable to Construction Vibration – Applicable to Human Perception

Vibration Level	Effect	Impact Magnitude
<0.3 mms^{-1}	Unlikely to be perceptible in residential environments	Negligible
0.3>1.0 mms^{-1}	Onset of perceptibility in residential environments.	Low
1.0>10.0 mms^{-1}	Onset of complaints in residential environments	Medium
>10 mms^{-1}	Vibration is likely to be intolerable for any more than a very brief exposure to this level.	High

15.37 Table 15.7 has been generated based upon the guidance concerned with human perception as presented within BS5228-2:2009+A1. The corresponding vibration ranges and associated impact magnitude ratings adopted for the purpose of this assessment have also been included within the Table.

15.38 Human perception is more sensitive than the point at which cosmetic damage occurs (above 10 to 15mm/s) and structural damage (above 30mm/s). Therefore, mitigating the effect on human perception will also ensure building damage is not incurred.

Development Generated Road Traffic Noise on Existing Receptors

15.39 The assessment of noise effects due to changes in road traffic noise has been undertaken drawing upon the suggested classification provided within the DMRB, 2011[ix]. The DMRB classification has been adapted to produce a set of Impact Magnitude criteria applicable to residential properties ranging from None to High as presented within Tables 15.8 and 15.9 below.

Table 15.8: Impact Magnitude Scale for Comparison of Future Road Traffic Noise against Existing Road Traffic Noise in the Short Term

Change in Noise Level (dBA)	Magnitude of effect
0	None
0 – 0.9	Negligible
1 – 2.9	Low
3 – 4.9	Medium
5+	High

Table 15.9: Impact Magnitude Scale for Comparison of Future Road Traffic Noise against Existing Road Traffic Noise in the Long Term

Change in Noise Level (dBA)	Magnitude of effect
0	None
0.1 to 2.9	Negligible
3.0 to 4.9	Low
5.0 to 9.9	Medium
10.0+	High

Noise from Proposed Mechanical and Electrical Plant Items

15.40 It is anticipated that there will be mechanical and electrical plant items associated with the new development. These plant items will have the potential to generate noise. However, at this stage, details of the proposed type, number and location of any such plant or the detailed nature of their operation are not available. Therefore, it is appropriate to specify suitable mechanical and electrical plant item noise limits in accordance with the criteria specified by Staffordshire Moorlands District Council (SMDC) making reference to the guidance provided within BS4142.

15.41 Staffordshire Moorlands District Council stated that a noise rating level limit of 5dB above the existing background noise level may be considered. However this was advised prior to the publication of the now latest version of BS4142. BS4142:2014: *Method for rating and assessing industrial and commercial sound*, the latest version, details an updated approach to both determining and assessing plant rating levels, including revised guidance on the application of acoustic character corrections and the determination of impact significance.

15.42 This version advises that, as a guideline:

- "*A difference (between the background and rating level) of around +10 dB or more is likely to be indicative of significant adverse impact, depending on context.*
- *A difference (between the background and rating level) of around +5 dB or more is likely to be indicative of adverse impact, depending on context.*
- *The lower the rating level relative to the background level, the less likely it is that the specific sound will have an adverse impact, depending on context.*
- *Where the rating level does not exceed the background level, this in an indication that the specific sound will have a low impact, depending on context.*"

15.43 The advice is that significance of impact is highly context specific and it goes on to provide advice on particular points to be taken into consideration. These points include the absolute sound levels, including the background sound level. It is stated that "*Where the background sound levels and rating levels are low, absolute levels*

might e as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."

15.44 As there is no reference to what might be considered to constitute a 'low background sound level', consideration has been given to the previous, 1997 version of BS4142, which stated that:

"For the purposes of this standard, background noise levels below 30 dB and rating levels below about 35 dB are considered to be very low".

15.45 The impact magnitude scale detailed in Table 15.10 has therefore been developed by WSP|Parsons Brinckerhoff based on the above guidance, including consideration to low background sound level conditions. This impact scale also reflects the detail of the draft proposed fixed and mechanical plant noise planning conditions as put forward by SMBC for the 2014 outline application.

Table 15.10: Impact Magnitude Scale Fixed Mechanical / Electrical Plant Noise

Difference Between Rating Level $L_{Ar,Tr}$ and Background Sound Level $L_{A90,T}$ (dB)[1]	**Commentry**	**Impact Magnitude**
≥+10[1]	Likely to be an indication of a "*significant adverse impact*" in accordance with the BS 4142 assessment methodology.	High
+5 to +9[1]	A difference of around +5dB is likely to be an indication of an "*adverse impact*" in accordance with the BS 4142 assessment methodology.	Medium
0 to +4[1]	An indication of the specific sound having a "*low impact*" in accordance with the BS 4142 assessment methodology.	Low
-5 to -1[1]	An indication of the specific sound having a negligible impact in general accordance with the BS 4142 assessment methodology.	Negligible
[1] A rating level of 35dB $L_{Ar,Tr}$ is considered to give rise to a Negligible impact magnitude at worst, regardless of background sound level		

Existing baseline noise levels on proposed noise sensitive receptors

15.46 As agreed during consultation with SMDC and in accordance with the guidance contained within BS8233: 2014[x], the daytime design target for internal habitable areas such as living rooms is 35 dB $L_{Aeq,16hr}$. During the night-time 8 hour period, the design target applicable to bedrooms is 30 dB $L_{Aeq,\ 8hr}$. In addition, a design target for typical maximum noise levels inside bedrooms at night of 45 dB L_{AFmax} has been adopted in accordance with the WHO Guidelines[xi]. A design target of 55 dB $L_{Aeq,\ 16hr}$ applicable within principal outdoor amenity areas during the day has also been adopted.

15.47 Where it is identified that the residential (i.e. holiday lodge) elements of the proposed development can be designed such that the adopted assessment criteria can be achieved, the Impact Magnitude is categorised as being minor to negligible.

Assumptions/Limitations

15.48 At this outline planning application stage, detailed information on construction techniques and equipment is not available. Consequently it has not been possible to precisely calculate the noise and vibration associated with construction works. The approach has therefore been to consider the potential effects based on a number of appropriately robust assumptions of typical and likely on site operations / works based on experience gained from other similar sites and information provided by the project team.

15.49 The assessment of vibration from construction activities on nearby vibration-sensitive receptors has been undertaken based on vibration levels associated with a small range of groundborne vibration generative construction activities. It is possible that activities other than those presented may take place, similarly some of those presented may not be applicable to the activities specific to the Site at the time of construction. The conclusions drawn from this assessment provide an indication of the likely effects which may arise based upon activities similar to those proposed on-site. Such conclusions should therefore be used for indicative purposes.

15.50 The completed glazing and ventilation specifications/calculations are of sufficient detail to demonstrate how these measures would work in principle. The final glazing and ventilation requirements will depend upon the detailed design, including the final scheme layout, elevations and internal floor plans and façade building materials.

15.51 The results of the Transport Assessment have been used as the basis for the assessment of changes in noise level associated with traffic from the Proposed Development. In applying these traffic figures a number of assumptions have been incorporated, these assumptions are presented within the Transport Assessment. A 20 percent contingency has been applied onto the development traffic flows to provide a robust assessment. Furthermore, traffic generation during the peak August month (2016 surveyed flows factored by 1.5 to reflect August peak holiday Saturday in 2016) has been used to provide a robust assessment.

Baseline Conditions

15.52 The noise environment present within the vicinity of the Site predominantly consists of distant road traffic noise from the A52, intermittent road traffic noise from Eaves Lane and Blakely Lane, natural noise sources such as bird song and moving vegetation, and noise from onsite short-term crushing activity (mid-week only).

15.53 Given that noise levels currently present across the site predominantly consist of local and distant road traffic noise and natural noise sources, it is not expected that the current baseline noise environment will significantly change following restoration of the site.

15.54 A summary of the measured Daytime $L_{Aeq,T}$ and night-time $L_{Aeq,T}$ and L_{AFmax} noise levels recorded during the baseline noise survey is presented within Tables 15.11 and 15.12. It should be noted that, wherever possible, noise from onsite crushing activity has been removed from the data obtained at Locations 1, 4 and 5 through interrogation of the 1 second profile data.

Table 15.11: Summary of Daytime Baseline $L_{Aeq,T}$ Noise Measurement Results, Free Field, dBA

Location	Date	Period	$L_{Aeq,T}$
1	04/09/2014	11:00 – 23:00	46.0
	05/09/2014	07:00 – 23:00	44.3
	06/09/2014	07:00 – 23:00	43.6
	07/09/2014	07:00 – 23:00	40.4
	08/09/2014	07:00 – 13:00	47.5
2	04/09/2014	15:00 – 23:00	47.9
	05/09/2014	07:00 – 23:00	44.3
	06/09/2014	07:00 – 23:00	44.1
	07/09/2014	07:00 – 23:00	43.3
	08/09/2014	07:00 – 12:00	45.1
3	04/09/2014	14:00 – 23:00	45.5
	05/09/2014	07:00 – 23:00	45.9
	06/09/2014	07:00 – 23:00	45.5
	07/09/2014	07:00 – 20:00	41.1
4	04/09/2014	12:00 – 23:00	40.9
	05/09/2014	07:00 – 23:00	44.9
	06/09/2014	07:00 – 23:00	43.5
	07/09/2014	07:00 – 23:00	40.9
	08/09/2014	07:00 – 12:00	46.3
5	04/09/14 - 05/09/14	07:00 – 23:00	44.1
6	05/09/2014	07:00 – 23:00	41.6
	06/09/2014	07:00 – 23:00	35.3
	07/09/2014	07:00 – 23:00	38.1
	08/09/2014	07:00 – 12:00	47.1

Table 15.12: Summary of Night-time Baseline $L_{Aeq,T}$ and L_{AFmax} Noise Measurement Results, Free Field, dB(A)

Location	Date	Period	$L_{Aeq,T}$	Typical L_{AFmax}
1	04/09/2014	23:00 – 07:00	34.9	63.0
	05/09/2014	23:00 – 07:00	33.6	61.0
	06/09/2014	23:00 – 07:00	39.2	59.0
	07/09/2014	23:00 – 07:00	33.1	57.0
2	04/09/2014	23:00 – 07:00	35.9	63.0
	05/09/2014	23:00 – 07:00	36.3	62.0

	06/09/2014	23:00 – 07:00	34.0	62.0
	07/09/2014	23:00 – 07:00	34.5	63.0
3	04/09/2014	23:00 – 07:00	40.2	69.0
	05/09/2014	23:00 – 07:00	33.8	60.0
	06/09/2014	23:00 – 07:00	30.1	51.0
4	04/09/2014	23:00 – 07:00	37.3	62.0
	05/09/2014	23:00 – 07:00	36.5	63.0
	06/09/2014	23:00 – 07:00	41.8	69.0
	07/09/2014	23:00 – 07:00	40.6	69.0
5	04/09/2014	23:00 – 07:00	35.1	59.0
6	05/09/2014	23:00 – 07:00	35.4	63.0
	06/09/2014	23:00 – 07:00	35.9	66.0
	07/09/2014	23:00 – 07:00	31.5	58.0

15.55 A detailed analysis of the measured $L_{A90,15\ minute}$ background noise levels obtained over the course of the survey has been undertaken in accordance with BS4142:2014. The results of this assessment can be found in Appendix 15.3, with a summary of the determined background sound levels presented in Table 15.13 below.

Table 15.13: Summary of Daytime and Night-time Background Sound Levels $L_{A90,T}$, Free Field, dBA

Measurement Location	Period	Background Sound Level, $L_{A90,T}$
1	Daytime	28
	Night-time	21
2	Daytime	25
	Night-time	19
3	Daytime	23
	Night-time	17
4	Daytime	27
	Night-time	21
5	Daytime	27
	Night-time	18
6	Daytime	25
	Night-time	21

15.56 It is evident from the baseline noise measurements that current baseline noise levels within the locality of the site are low, generally consisting of natural noise sources, distant road traffic noise and intermittent road traffic noise from the local road network. Following full restoration of the site, it is not expected that the existing baseline noise environment will significantly change from that which is currently present.

Potential Impacts

Construction

Construction Noise Levels at Nearby Noise-Sensitive Receptors

15.57 For the purpose of the assessment of noise from the construction phase, the main noise generating activities to be undertaken during this phase are anticipated to include the following activities and it is assumed that these activities will be undertaken in broadly the following order; however, there is likely to be overlap between each stage, and different working areas:

- Bulk earthworks to ground formation levels;
- Installation of temporary and permanent infrastructure, roads and haul routes;
- Building foundation works; and
- Construction of proposed buildings.

15.58 Detailed information regarding construction techniques, phasing, the expected numbers, types and locations of plant and operational durations are not yet known. Therefore, in undertaking the following assessment it has been necessary to make a number of broad assumptions with respect to plant type, numbers, locations and operational characteristics likely to be applicable. These assumptions have been based on professional experience of working on similar sites.

15.59 The works have been split down into the following key stages for noise prediction purposes.

- Stage 1 – Earth works;
- Stage 2 – Road works;
- Stage 3a – Foundation works (no piling);
- Stage 3b – Foundation works (piling);and
- Stage 4 – Building construction works.

15.60 Although there are techniques available to predict the likely effect of noise from site works, such as those contained within BS 5228-1:2009+A1 2014, they are necessarily based on quite detailed information on the type and number of plant being used, their location and the length of time they are in operation.

15.61 An estimate of the likely effects of noise from the construction activities has been made for a sample of local receptors in the vicinity of the Site. The predictions are based on the methodology contained within BS 5228-1:2009+A1 2014 and are in terms of the Equivalent Continuous Sound Level, $L_{Aeq,T}$ over the core working day, which is assumed to be 08:00 to 18:00 hours Monday to Friday, 08:00-13:00 on Saturdays with no working on Sundays or Bank Holidays. The predictions are worst case in that it is assumed that any mitigation measures (such as those identified later in this Chapter) have not been implemented.

15.62 Predictions have been undertaken for each of the five stages presented above. Table 15.14 sets out the typical plant types, numbers and utilisation (the percentage of time plant is actually operating during the working day – the 'on-time') which have used in the noise level predictions. Confirmation of the need or otherwise for piled foundations within the vicinity of the Q3 slopes to the north western section of the site cannot at this stage be made. As a worst case, an option allowing for piled foundations using rotary bored piling has been assessed (see Stage 3b in Table 15.14 below).

Table 15.14: Assumed Site Preparation, Earthworks and Construction Phase Plant Details

Stage	Plant Type	Sound Power Level Lw_A dB	No. of Plant	Assumed Percentage On-time
Stage 1 - Earthworks	Diesel Generator	88	1	90
	Tracked Excavator	102	2	50
	Dump Truck	106	2	40
	Lorry pulling up	98	1	10
	Lorry unloading	112	1	10
	Concrete Breaker	111	1	20
	Vibratory Compactor	106	1	30
Stage 2 – Road Works	Asphalt spreader with support lorry	108	1	60
	Road Roller	108	1	30
	Tracked excavator	102	1	50
Stage 3a - Building Foundation Works (no piling)	Excavator	101	1	50
	Truck mixer with pump	103	1	30
	Compressor	100	1	60
	Poker vibrator	97	2	30
	Dump truck	106	1	40
	Concrete Breaker	111	1	20
	Vibratory Compactor	106	1	30
Stage 3b - Building Foundation Works (piling)	Rotary Bored Piling	111	1	50
	Tracked Crane	98	1	40
	Truck mixer	108	1	15
	Concrete pump	103	1	10
	Compressor	100	1	75
	Concrete Breaker	111	1	20
	Vibratory Compactor	106	1	30
Stage 4 - Building Construction	Hammering	103	2	20
	Lorry Pulling Up	98	1	10
	Lorry Unloading	112	1	10
	Dump truck	106	1	40
	Compressor	100	1	75
	Fork lift truck	104	1	60
	Scaffolding	100	1	10
	Concrete pump	103	1	10

Stage	Plant Type	Sound Power Level Lw_A dB	No. of Plant	Assumed Percentage On-time
	Tracked Crane	98	1	40
	Wheeled Loader	109	1	40

15.63 Noise predictions have been carried out for each of the above stages. For the purpose of these predictions, it is robustly assumed that the intervening ground between the noise sources and the receivers will be acoustically hard such that there will be no attenuation of sound due to ground absorption. Given the restored nature of the Site it is however evident that this is unlikely for the majority of the construction phase. Calculations have also not included for acoustic screening, which, in some cases will be significant due to the quarry faces. Calculations have therefore been undertaken on a worst case basis.

15.64 The worst case and the average case scenarios have been considered. The worst case assumes that the noisiest plant item within each stage is at the closest point of the relevant Site area to the receptor under consideration and that the remaining plant items are located in the approximate centre of the closest site region. The average case considers the works at the approximate mid-point of the closest site region.

15.65 The predictions have been undertaken for four worst case assessment locations as described below. These Assessment Locations are depicted in **Figure 15.1**.

- Assessment Location A – Little Eaves Farm to the south-west of the Site;
- Assessment Location B – Cottage Farm to the north-west of the Site;
- Assessment Location C – Representative of dwellings on Blakeley Lane to the north-east of the Site; and
- Assessment Location D – Crowtrees Farm to the east of the site.

15.66 Table 15.15 sets out the range of predicted unmitigated construction noise levels for each assessment location identified above. The range extends from the average to the worst case scenarios as described above. Stage 3b works including piled foundations have been considered for Assessment Location B only. It is not expected that piled foundations will be required in close proximity to any other receptor.

Table 15.15: Predicted Unmitigated 'Average' and 'Worst' Case Site Preparation, Earthworks and Construction Works Noise Levels – façade $L_{Aeq,10hours}$ dB

Assessment Locations (see Figure 15.1)	Average - Worst Case Site Preparation, Demolition, Earthworks and Construction Noise Levels, $L_{Aeq,10hour}$ dB				
	Stage 1	Stage 2	Stage 3a	Stage 3b	Stage 4
A	56-61	54-61	55-60	-	56-59
B	58-64	56-64	57-63	59-67	58-62
C	50-54	48-54	48-53	-	50-53
D	54-63	52-63	53-62	-	54-60

15.67 It is evident from Table 15.15, that even without mitigation, average case construction works noise levels at the identified receptors will be below a 60 dBA criterion. It is evident therefore, that for the large majority of the construction phase, Impact Magnitudes of Negligible will occur at all local receptors.

15.68 Without mitigation, when worst case operations occur at the closest boundary of the development to Assessment Location B, the 65 dBA noise criterion above which an impact magnitude of Medium arises is exceeded, but only during Stage 3b (foundation works including the assumed worst case of rotary bored piling[1]). It should be noted however, in the event that piling is not required, noise levels below 65 dBA are predicted such that impact magnitudes of Negligible to Low will occur.

15.69 Drawing upon the criteria presented in Table 15.6, the sensitivity of the existing local residential dwellings (as depicted in assessment locations A-D) is High, and considering an average case, the impact magnitude is Negligible. Therefore, there is likely to be a direct, temporary, short-term, effect on existing local dwellings of **Negligible** significance for the majority of the construction phase. Intermittently, and assuming that piled foundations are required in Q3 to the north-west of the site, due to the nature and location of activities during this phase, the impact magnitude has the potential to rise to Medium at Assessment Location B, resulting in potential effects of **Moderate adverse** significance during worst case operations, prior to the implementation of mitigation measures. Such impacts would remain short term and temporary. A number of noise mitigation measures are available including the use of noise management plans and the selection of appropriate working methods etc. Such measures could be applied to reduce the impacts that may arise, even though only anticipated over short periods. Further consideration is given to mitigation in the corresponding section below.

Construction Vibration Levels at Nearby Vibration-Sensitive Receptors

15.70 Groundborne vibration calculations have been performed for typical site preparation, demolition, earthworks and construction activities / machinery based on the empirical prediction procedures presented within BS 5228-2:2009, TRL RR 246: *Traffic induced vibration in buildings*: 1990[xii] (applicable to Heavy Goods Vehicle (HGV) induced vibration), and TRL Report 429: *Groundborne vibration caused by mechanical construction works*: 2000 (applicable to vibratory rollers)[xiii].

15.71 Such predictions have been performed in order to determine the possible distances at which the adopted Impact Magnitude criteria may be registered based on a specified confidence limit (where applicable). In this regard, groundborne vibration levels and associated distances have been identified for a sample of typical vibration sources which may be associated with this phase.

Table 15.16: Predicted Groundborne Vibration Levels Applicable to Typical Vibration Generating Site Preparation, Earthworks and Remediation / Construction Activities

Operation	Confidence Limit	Distance (m)	PPV mm/s
Vibratory Rollers – start & end	95	60	0.3
	95	23	1.0
Vibratory Rollers – steady state[1]	95	3.3	10
Piling – Driven cast in place	95	215	0.3
	95	85	1.0
	95	15	10
HGV's[2]	N/A	50	0.3[3]
	N/A	17	1.0[3]

[1] It is anticipated that piling may be required on the slopes of Quarry Q3 to support the proposed lodges and also in the area of the proposed hub should a single completion level be required for foundations. The detail of the preferred method of construction would be submitted at the reserved matters stage, so for the purpose of the outline application, the need for piling has been accounted for, albeit it would only constitute a limited proportion of the construction period.

	N/A	2.5	10[3]
Rotary Bored Piling - Augering	N/A	20	0.3
	N/A	6	1.0
	N/A	0.6	10
Rotary Bored Piling – Auger hitting base	N/A	45	0.3
	N/A	14	1.0
	N/A	1.4	10
Rotary Bored Piling – Driving casing	N/A	75	0.3
	N/A	23	1.0
	N/A	2.3	10

[1] Assumes 2 rollers, 0.4mm amplitude, drum width of 1.3m, e.g. heavy duty ride on roller

[2] Assumes max height / depth of surface defect of 50 mm, max speed of 30 km/h, and that surface defect occurs at both wheels.

[3] Where alluvium soils are present, higher vibration levels can be expected.

15.72 It should be noted that the data presented within Table 15.16 is general in nature and is not specific to any one site, furthermore, there may be a variety of different potential vibration generating activities employed other than those listed, however the vibration levels provided, and associated distances, can be used to determine the typical distances at which specific impacts are likely to be registered.

15.73 It is evident from the masterplan (**Figure 15.1**) that, at worst there is potential for significant construction activities to take place at distances of approximately 70 metres from the closest existing vibration sensitive receptors to the Site. Piling activities are expected to be confined to Q3 towards the west of the site, as such, piling activities are expected to take place at distances of no less than 90 metres from existing vibration sensitive receptors (i.e. Cottage Farm). In this regard, Table 15.17 presents the predicted Impact Magnitudes at such properties.

15.74 It should be noted that the impact magnitude ratings presented within Table 15.17, in some cases, have been generated based on a 95 per cent confidence limit, in reality it is likely that much lower vibration levels will prevail for the majority of activities and the majority of the time.

Table 15.17: Predicted Impact Magnitude at Closest Sensitive Receptors from Activities – Groundborne Vibration

Activity	Impact Magnitude
Vibratory Rollers	Negligible (<0.3 mm s^{-1})
Piling – driven cast in place	Medium (1.0>10.0 mm s^{-1})
HGVs	Negligible (<0.3 mm s^{-1})
Rotary Bored Piling	Negligible (<0.3 mm s^{-1})

15.75 Comparing the assessment results presented in Table 15.17, with the impact matrix presented in Table 15.5, the sensitivity of the existing local dwellings is High, and the impact magnitude of predicted vibration levels is Medium at worst. Therefore, there is likely to be a direct, temporary, short-term effect on existing local dwellings of **Moderate adverse** significance, prior to the implementation of mitigation measures. In the event that driven piling techniques can be avoided, effects of **Negligible** significance are expected.

15.76 It should be noted that this is a worse-case assessment based on the shortest possible distances to the closest existing receptors to the Site. In reality, for the large majority of the works associated with this phase, it is expected that activities will take place at greater distances from such properties thus leading to effects of lesser significance. Furthermore, it is possible that heavy activities involving the use of vibratory rollers, piling activities and HGVs in proximity to existing vibration sensitive receptors may not be required, but have been appraised within the

completed assessment. The detail of the preferred method of construction would be submitted at the reserved matters stage. Consideration to available vibration mitigation measures is presented within the corresponding section below.

15.77 It should also be noted that significantly higher levels of vibration than those presented are required to cause any sort of damage to buildings than those representing human perception. Consequently, considering the sources of vibration listed above, even cosmetic damage (such as hair line plaster cracks) to existing dwellings due to vibration is highly unlikely. It should be noted that driven piling has not been included as part of this assessment, it is assumed that such methods will not be employed.

Completed Development

Development Generated Road Traffic Noise on Existing Receptors

15.78 Upon completion of the Proposed Development, it is possible that local road traffic noise levels may change as a result of traffic generated by the Proposed Development. Therefore, it is appropriate to consider the impact magnitude and significance of effect from any associated changes that might arise.

15.79 The results of the Transport Assessment and more specifically, the road traffic flow data, have been used as the basis for determining the change in road traffic noise levels on road traffic routes local to the Proposed Development.

15.80 Road traffic noise calculations have been carried out in accordance with CRTN, being undertaken for a notional receptor location 10m from the edge of the carriageway of each road considered, and 1.5m above ground level. A notional receptor has been used because the change in traffic noise level adjacent to any given road will be the same at all distances where noise from that route is dominant. Traffic noise calculations have been undertaken to establish the change in the daytime $L_{A10,18hour}$ noise level.

15.81 It should be noted that the CRTN methodology is strictly only valid for traffic flows of greater than 1000 vehicles per day, defined in CRTN as the 18 hours between 06:00 and 00:00 hours. Where traffic flows are between 1000 and 4000, CRTN employs a 'low flow' correction in the calculation procedure.

15.82 In accordance with the above, the following noise calculation method has been adopted for routes with flow rates below this volume. This methodology is hereafter referred to as the 'L_{eq} method' and has only been used for links 3, 4, 6, 8, 9 and 10 as presented within the link reference plan presented within Appendix 15.4 and described within Table 15.18 below.

15.83 The 'L_{eq} method' is based on the guidance contained within the Noise Advisory Council (ANC) guidance document '*A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level Leq*'[xiv]. The report provides a method for calculating the L_{eq} noise level from the combined effect of a number of events (e.g. vehicle pass-bys) with their own single event noise exposure level (L_{AX}, commonly referred to as the SEL). In addition, the report presents a method for determining the L_{AX} at a distance of 10m from the nearside edge of the road, for heavy and light vehicles travelling at different speeds. These L_{AX} values can then be used to calculate the associated L_{eq} at 10m from the nearside edge.

15.84 Although this method calculates the L_{eq} associated with a series of moving vehicles and not the L_{A10}, the outcome of such calculations can be used to predict noise level changes when comparing a number of scenarios. The calculations undertaken for

links 3, 4, 6, 8, 9 and 10 have therefore been presented as noise level changes only.

15.85 Predictions have been undertaken for the following scenarios:

- 2020 Year of completion without scheme flows;
- 2020 Year of completion with scheme flows;
- 2035 (year of completion + 15 years) without scheme flows; and
- 2035 (Year of completion + 15 years) with scheme flows.

15.86 Consideration to potential cumulative impacts associated with the simultaneous operation of the proposed development and the proposed Bolton Copper Works development is presented within Chapter 17- Cumulative Impacts.

15.87 It should be noted that, in undertaking these calculations, for links 3 and 8, other than the road speed limits, traffic speed data has not been provided, it has therefore been assumed that the speeds applicable to links 4 and 9 would reasonably apply to links 3 and 8 respectively.

15.88 The predicted changes in road traffic noise are shown in Table 15.18 for each considered link. Table 15.18 shows the noise level changes for the following comparisons:

- 2020 (year of completion) with scheme flows minus 2020 year of completion without scheme flows;
- 2035 (year of completion + 15 years) without scheme flows minus 2020 (year of completion) without scheme flows; and
- 2035 (year of completion + 15 years) with scheme flows minus 2020 (year of completion) without scheme flows.

Table 15.18: Predicted Changes in Road Traffic Noise Levels Resulting from Operation of the Development, Free-field, dB, $L_{A10,18hour}$

Link	Road Section	2020		2035		Change in Noise levels (B-A), (C-A), (D-A)
		Baseline (A)	With Development (B)	Baseline (C)	With Development (D)	
1	A52 west of Eaves Lane	61.5	62.2	62.4	63.0	0.7, 0.9, 1.5
2	A52 east of Eaves Lane	61.5	62.0	62.5	62.8	0.5, 1.0, 1.3
3	Eaves Lane east of site access	-	-	-	-	0.8, 0.8, 1.5
4	Carr Bank south of Blakeley Lane	-	-	-	-	0.6, 0.8, 1.3
5	B5417(West)	60.6	60.6	61.7	61.7	0.0, 1.1, 1.1
6	Carr Bank north of B5417	-	-	-	-	0.2, 0.8, 1.0
7	B5417 (East)	60.2	60.4	61.3	61.4	0.2, 1.1, 1.2
8	Eaves Lane north of site access	-	-	-	-	5.5, 0.8, 5.8
9	Eaves Lane south of the A52	-	-	-	-	2.4, 0.8, 2.9
10	Blakeley Lane	-	-	-	-	0.0, 0.8, 0.8

15.89 It can be seen from Table 15.18 that for all routes, with the exception of links 8 and 9, noise level changes of between 0 and 1dB are predicted to arise as a result of the Proposed Development alone in the year of completion. For links 8 and 9 increases of 5.5 and 2.4 dB(A) are predicted respectively.

15.90 When comparing the year of completion +15 years with development against the year of completion without development it is evident that, with the exception of links 8 and 9, increases of between 0.8 and 1.5 dB are predicted. Furthermore, a significant proportion of such increases (between 0.8 and 1.1 dB) are as a result of natural traffic growth alone. For links 8 and 9, increases of 5.8 and 2.9 dB are predicted respectively, of which 0.8 dB is due to natural traffic growth alone.

15.91 Drawing upon the criteria presented in Table 15.8 for the year of completion, for links 1, 2, 3, 4, 5, 6, 7 and 10 the sensitivity of dwellings fronting these local road traffic routes is High and the impact magnitude associated with the predicted noise level increases in the short term are None or Negligible. Therefore, there is likely to be a direct, permanent short-term effect on dwellings fronting such local road traffic routes of **None** or **Negligible** significance. For link 9, the predicted noise level increase in the short term is Low. Therefore, there is likely to be a direct, permanent effect on dwellings fronting this route of **Minor adverse** significance.

15.92 For dwellings fronting link 8, the predicted noise level change is categorised as being High impact magnitude. However, it is important to note that this is a comparative assessment and it is important to place that change into context by considering the noise levels that would arise at any affected properties in absolute terms. Firstly, it is of note that the 'with development' the flows on this route are below 1000 per daytime 18 hour period, and therefore below the threshold of validity for CRTN road traffic noise level predictions. This indicates that the resulting noise levels will be low in absolute terms, regardless of the degree of change that may arise; indeed it is the very low base flows which give rise to a comparatively high degree of change, even though the resultant flows remain below the 1000 threshold of traffic movements per day. In addition, the only receptor in the vicinity of this route section is Cottage Farm, which is set well back from this road, and would therefore benefit from additional attenuation due to distance. After accounting for the resulting noise levels in absolute terms, it is anticipated that the overall impact magnitude would be Medium at worst. In accordance with Table 15.5, for High sensitivity receptors, this corresponds to an effect of **Moderate adverse** significance at worst in the short term.

15.93 Drawing upon the criteria presented in Table 15.9 for the year of completion + 15 years, for links 1, 2, 3, 4, 5, 6, 7, 9 and 10 the sensitivity of dwellings fronting these local road traffic routes is High and the impact magnitude associated with the predicted noise level increases in the long term are Negligible. Therefore, there is likely to be a direct, permanent long-term effect on dwellings fronting such local road traffic routes of **Negligible** significance. For link 8, predicted noise level increases in the long term are Moderate. However, accounting for the resulting noise levels in absolute terms, in the same way as above, an overall impact magnitude of Minor to Moderate is anticipated. Therefore, there is likely to be a direct, permanent effect on dwellings fronting this route of **Minor to Moderate adverse** significance in the long term.

Noise from Proposed Mechanical and Electrical Plant Items

15.94 The Proposed Development incorporates a number of ancillary commercial uses including an admin/business centre, a hub building containing leisure and restaurant uses, a water sports centre and a visitor's centre. Such uses are

generally to be located within the central southern section of the site such that they are located at significant distance from existing noise sensitive receptors.

15.95 It is anticipated that there may be activities or equipment associated with such uses (e.g. any fixed plant items that may be installed), that have the potential to generate noise. However at this stage, the proposed type, number and precise location of any such plant or the nature of any such operations are not available. In the absence of detailed information it is appropriate to specify suitable noise control limits to which any plant / operations should conform. These limits should be specified so that any applicable corrections for acoustic characteristics are appropriately accounted for.

15.96 Table 15.13 presents a summary of the background sound levels determined at each adopted measurement location during both daytime and night-time periods. It can be seen that daytime levels range between 23 and 28 dB(A), whilst night-time levels range between 17 and 21 dB(A). These background noise levels are low and therefore, under which conditions, BS4142 advises that "…*absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."*

15.97 Therefore in accordance with BS41242 and the content of Table 15.10, it is considered appropriate to set a rating level limit for proposed fixed and mechanical plant of 35dB $L_{Ar,Tr}$. This is detailed further in Table 15.19 which considers the closest existing receptors to the site

Table 15.19 Proposed Noise Limits for Future Plant Noise, Rating Levels, $L_{Ar,Tr}$ dB

Measurement Location	Receptor	Period	Background Sound Level, $L_{A90,T}$	Proposed Rating Level Limits $L_{Ar,Tr}$
1	Little Eaves Farm	Daytime	28	35
		Night-time	21	35
2	Cottage Farm	Daytime	25	35
		Night-time	19	35
4	Crowtrees Farm	Daytime	27	35
		Night-time	21	35
5	Holiday Lodges	Daytime	27	35
		Night-time	18	35

15.98 The above rating level limits apply at 3.5m from the façade of any residential property (Free-Field) or at the closest point of any open area proposed for noise sensitive development.

15.99 In accordance with BS 4142:2014, assessments of plant noise emissions should include any applicable acoustic character corrections (e.g. for tonality, irregularity, intermittency or other acoustic feature etc.), before comparison with the above limits.

15.100 Provided that the above plant noise limits are complied with, it is considered that the sensitivity of both existing and proposed new noise sensitive receptors is High and the Impact Magnitude will be Negligible. Therefore, the impact on existing and proposed residential receptors is therefore identified to be of **Negligible** significance.

Existing baseline noise levels on proposed noise sensitive receptors

15.101 During attendance on site it was noted that, in the absence of onsite activities, distant road traffic noise and natural noise sources were the predominant noise sources.

15.102 In order to establish the suitability of the future on-site noise environment for the residential aspects of the Proposed Development, it is necessary to establish the noise levels present across the Site. The Site has been assessed based on the noise survey measurement results obtained at Measurement Locations 1 – 5 (See **Figure 15.1**).

15.103 Tables 15.11 and 15.12 present the daytime ($L_{Aeq, 16hour}$) and night-time ($L_{Aeq, 8hour}$) noise levels applicable at the Site. It is evident that, during the day, noise levels no greater than 47.9 dB L_{Aeq} have been measured. This noise level was measured at Location 2 adjacent to Eaves Lane. At night, it is evident that noise levels no greater than 41.8 dB L_{Aeq} have been measured. This noise level was measured at Location 4 adjacent to Crowtrees Farm / Eaves Lane.

15.104 Based upon the L_{AFmax} noise measurements recorded at Measurement Locations 1 - 5, it is evident that L_{AFmax} noise levels typically no greater than 69 dB will be present.

15.105 A summary of the internal noise criteria (taken from BS8233), the worst case measured noise levels and the required noise level reductions is set out in Table 15.20.

Table 15.20: Baseline Noise Levels and Required Sound Level Reduction for Holiday Cottages, dB(A)

Time Period	Noise Level, dB(A)	Internal Target Noise Levels	Required Noise Level Reduction
Day ($L_{Aeq, 16hour}$)	48	35	13
Night ($L_{Aeq, 8hour}$)	42	30	12
Night (L_{AFmax})	69	45	24

15.106 It is evident that existing noise levels present within and surrounding the site (even when considering worst case days / nights and locations) are relatively low. Furthermore, it is expected that the corresponding required noise level reductions can be achieved by adopting relatively standard façade construction components.

15.107 Considering the measured noise levels presented within Tables 15.11 and 15.12 and the adopted assessment criteria presented within referenced guidance documents including the WHO guidelines and BS8233, the sensitivity of proposed Holiday Lodges is High, and the impact magnitude has the potential to be Low. Therefore, it is possible that a direct, permanent, long-term effect on proposed sensitive receptors of **Minor adverse** significance may arise prior to the implementation of mitigation.

Mitigation Measures

Construction

Construction Noise Levels at Nearby Noise-Sensitive Receptors

15.108 Generic safeguards exist to minimise the effects of construction noise, these include:

- The various EC Directives and UK Statutory Instruments that limit noise emissions of a variety of construction plant;
- Guidance set out in BS 5228: Part 1: A1 2014, which covers noise control on construction sites; and
- The powers that exist for local authorities under Sections 60 and 61 of the Control of Pollution Act 1974 to control noise from construction sites.

15.109 The adoption of Best Practicable Means, as defined in Section 72 of the Control of Pollution Act 1974 is usually the most effective means of controlling noise from construction sites. Such measures will be included within a Construction Environmental Management Plan (CEMP), where appropriate, and may include the following:

- Any compressors brought onto the Site to be silenced or sound reduced models fitted with acoustic enclosures;
- All pneumatic tools to be fitted with silencers or mufflers;
- Care to be taken when erecting or striking scaffolds to avoid impact noise from banging steel. All operatives undertaking such activities to be instructed on the importance of handling the scaffolds to reduce noise to a minimum;
- The majority of deliveries to be programmed to arrive during normal working hours only. Care to be taken when unloading vehicles to minimise noise. Delivery vehicles to be routed so as to minimise disturbance to local residents. Delivery vehicles to be prohibited from waiting within or in the vicinity of the Site with their engines running;
- All plant items to be properly maintained and operated according to manufacturers' recommendations in such a manner as to avoid causing excessive noise;
- All plant to be sited so that the effect of noise at nearby noise-sensitive properties is minimised;
- Local hoarding, screens or barriers to be erected as necessary to shield particularly noisy activities; and
- Problems concerning noise from construction works can often be avoided by taking a considerate and neighbourly approach to relations with the local residents. Works should only normally take place during given periods (e.g. during normal construction hours) and not at night.

15.110 In addition to the above measures, the development will be registered to the Considerate Constructors Scheme (CCS) to further ensure that any potential adverse effects are minimised.

15.111 Through the provisions of the Section 60 and 61 of the Control of Pollution Act 1974, the Local Authority have means of controlling construction noise where they consider than an unacceptable noise nuisance is being generated, or could be generated by the works.

15.112 In general terms, it is anticipated that the proposed good practice noise mitigation measures will typically afford 5 to 10 dB noise attenuation

Construction Vibration Levels at Nearby Vibration-Sensitive Receptors

15.113 It is possible to employ a number of physical and operational measures in order to reduce the potential effects resulting from construction generated vibration, these measures may include:

- Adoption of low vibration working methods. Consideration should be given to use of the most suitable plant;
- Where processes could potentially give rise to significant levels of vibration, on-site vibration levels should be monitored regularly by a suitably qualified person; and
- The provision of cut-off trenches in order to interrupt the direct transmission path of vibrations;

15.114 It is expected that mitigation measures and operational considerations such as these would be incorporated within the CEMP in order that the effects of groundborne construction vibration can be controlled wherever practically possible.

Completed Development

Development Generated Road Traffic Noise on Existing Receptors

15.115 The assessment of development generated road traffic noise level increases (including those associated with natural traffic growth), has identified that for the vast majority of the study area, the significance of effects is predicted to be Minor at worst when considering noise level changes that could arise in both the short and long term. The only exception is Link 8, for which a Medium impact has been identified in the short term. In the long term a Minor to Medium impact is again identified to result. It should however be noted that the completed assessment is based on worst case summer trip generation, for the majority of the year, road traffic noise level increases will be less than predicted.

15.116 Notwithstanding this it should be noted that there is only one property adjacent to Link 8 which could potentially be affected. That property is Cottage Farm, which is located at a distance of approximately 50m from this route. At such distances, it is expected that noise sources other than road traffic on Eaves Lane will contribute to the noise environment experienced at this property. It is therefore likely that development generated road traffic noise level increases experienced at this receptor may be less than that predicted.

15.117 In addition, at such distances, it is also appropriate to consider the noise levels in absolute terms, as well as the associated noise level change which has been assessed. Based on measured noise levels at Measurement Location 2 (adjacent to Cottage Farm) and predicted noise level increases of no greater than 5.8 dB, it is evident that absolute noise levels at Cottage Farm following completion of the Proposed Development (+ 15 years) are expected to be in the region of 50 dBA. Such noise levels are described within BS8233: 2014 as being 'desirable' within external areas used for amenity space. Consequently, it is considered that mitigation is not warranted.

Noise from Proposed Mechanical and Electrical Plant Items

15.118 It is assumed that the specification and location of any plant is sufficiently flexible to ensure suitably quiet plant can be procured, and/or mitigation options can be investigated, to ensure compliance with the proposed noise limits.

15.119 The assessment of noise impacts has been based on assumptions in relation to maximum noise limits on the site. These noise levels should be incorporated into the planning conditions with respect to fixed plant items associated with the Proposed Development to ensure consistency with this assessment and to maintain acceptable noise levels.

15.120 Once the detailed nature of such future uses are confirmed, if considered necessary, noise from any related operations can be reconsidered and an appropriate noise mitigation scheme devised and incorporated into the Proposed Development design to ensure that the above limits can be complied with. It is anticipated that this may require consideration to the location of noise generating activities, and the selection of appropriate plant.

15.121 It should be noted that the noise emission limits specified within Table 15.19 would be applicable to the total noise from the simultaneous operation of all external plant serving the Proposed Development. As such, noise emissions from individual items of plant will need to be lower than the given limit, although the exact limit for each individual item of plant will be dependent upon its type, noise characteristics, location etc.

Existing baseline noise levels on proposed noise sensitive receptors

15.122 Based upon the worst case measured $L_{Aeq,T}$ and L_{AFmax} noise levels, consideration has been given to the noise attenuation that will be required to ensure a commensurate level of protection against noise for future occupants residing both within the proposed holiday lodges and in associated external living areas.

15.123 Consideration has been given to appropriate acoustic attenuation measures, to provide a commensurate level of protection against noise for future occupants of proposed holiday lodges which may experience worst case measured noise levels.

15.124 Given that worst case noise levels are likely to be significantly influenced by natural noise sources, it is not appropriate to consider mitigation in terms of development layout and setback distances, such provisions are unlikely to significantly affect noise levels experienced by future occupants. An assessment has therefore been undertaken in order to determine the acoustic properties of façade components which are expected to be required in order to achieve the adopted internal noise criteria within worst affected lodges. It is assumed that the glazing will be the acoustic weak link in the sound reduction performance of the façade.

15.125 At this early stage it has been considered appropriate to apply the 'simple calculation' method given in BS8233, with single figure values being used in lieu of a full spectral noise break-in analysis. This provides adequate information regarding the suitability of the design at the planning application stage. The initial calculations have been undertaken in order to determine the possible glazing and ventilation components which may be required to ensure that the adopted internal noise level criteria can be achieved within bedrooms and living rooms of the worst affected lodges.

15.126A summary of the internal noise criteria (taken from BS8233), the worst case measured noise levels and the required sound insulation values is set out in Table 15.21.

Table 15.21: Required Sound Insulation Performance for Holiday Lodges, dB(A)

Time Period	Measured Noise Level, dB(A)	Internal Target Noise Levels	Required Sound Insulation Performance (R_w)[1]
Day ($L_{Aeq, 16hour}$)	48	35	18
Night ($L_{Aeq, 8hour}$)	42	30	17
Night (L_{AFmax})	69	45	29
[1]Includes +5dB allowance in line with BS8233 simple calculation method			

15.127British Standard 12354-3:2000 *Building Acoustics – Estimation of acoustic performance of buildings from the performance of elements* – Part 3: *Airborne sound insulation against outdoor sound* (BS12354-3) [xv]sets out data relating to the typical noise reduction performance of different glazing systems. A selection of these performances is set out in Table 15.22.

Table 15.22: Typical Sound Reduction Properties of Insulating Glass Units

Glass / Cavity Width / Glass (mm)	Sound reduction (R_w – C dB)
4/12/4	28
6/12/4	30
6/12/6	30
10/12/4	33
10/12/6	36
10/12/6.4	34

15.128Comparing the sound insulation performance requirements in Table 15.21 with the typical sound insulation performance values of those different glazing systems presented in Table 15.22, it can be seen that standard double glazing systems, such as 6/12/4 (glazing (mm) / air gap (mm) / glazing (mm)), would be sufficient in order to achieve the internal noise criteria within the building with windows closed.

15.129The above calculations do not make any allowance for the incorporation of permanent ventilation to the dwellings. On ventilation, BS 8233 advises that:

> *"The Building Regulations on ventilation recommend that habitable rooms in dwellings have background ventilation. Trickle ventilators can provide this, and sound attenuating types are available. Where sound insulation requirements preclude opening windows for rapid ventilation and cooling, acoustic ventilation units incorporating fans are available for insertion in external walls; these can provide sound reduction comparable with domestic secondary glazing."*

15.130Where appropriate, the preferred choice of ventilation is through the use of natural ventilation openings such as trickle vents, air-bricks and passive ventilation devices. Such ventilators can be used to meet the requirements of the Building Regulations Approved Document F for background ventilation. The future occupants would then have the option of keeping windows closed for most of the time and opening windows for rapid ventilation and summer cooling.

15.131 The Building Research Establishment (BRE) has published an Information Paper on the acoustic performance of such passive ventilation systems. IP4/99: 1999: *Ventilators: Ventilation and Acoustic Effectiveness* details a study into the sound reduction performance of fourteen different window mounted trickle ventilators and seven different through-wall passive ventilators. The measured sound reduction performance, after taking into account flanking sound paths (i.e. sound paths that do not travel directly through the vent) and the effective area of the ventilator were as follows.

Table 15.23: Range of Measured Sound Reduction Performance of Passive Ventilators, with Vents Open, dB(A)

Window Mounted Trickle Vents (open)	**Passive Through-Wall Ventilators (open)**
From 14 to 40 (depending on model)	From 30 to 46 (depending on model)
Figures corrected for effective area of ventilator	

15.132 It can be seen from the above figures that passive through wall ventilators are available that meet the requirements of the Building Regulations Approved Document F for background ventilation and also provide a sound insulation performance that meets or exceeds that required from the glazing elements.

15.133 With regards to external daytime noise levels, it is evident that the Site will experience noise levels below the adopted 50 dB(A) criterion. Mitigation for external living areas is therefore not required.

Residual Impacts

Construction

Construction Noise Levels at Nearby Noise-Sensitive Receptors

15.134 With the anticipated 5 to 10 dB noise attenuation associated with the recommended mitigation, it is expected that construction noise levels will generally not exceed 65 dB $L_{Aeq,\ 10h}$ at the closest existing noise sensitive receptors to the site. Given that the construction noise level predictions were based on a number of broad assumptions, there is however potential for isolated exceedances to occur during worst case works. It should be noted that any such exceedances are expected to be of extremely short duration when considering the construction phase as a whole.

15.135 Based upon the impact matrix presented in Table 15.5, and accounting for mitigation, the sensitivity of the existing local dwellings is High, and when considering both an average and worst case, the impact magnitude is Negligible. Therefore, there is likely to be a direct, temporary, short-term, residual effect on existing local dwellings of **Negligible** significance following the implementation of mitigation measures.

Construction Vibration Levels at Nearby Vibration-Sensitive Receptors

15.136 Where appropriate mitigation measures are adopted and included within the Proposed Development construction methodologies, it is expected that the impact magnitude can be controlled to be Low at worst. The sensitivity of existing local dwellings is High, therefore, there is likely to be direct, temporary, short-term residual effect on existing local dwellings of **Negligible** to **Minor adverse** significance, following the implementation of mitigation measures.

Completed Development

Development Generated Road Traffic Noise on Existing Receptors

15.137As the implementation of noise mitigation measures is not considered necessary, it is considered that permanent, short term / long term, direct effects of **Negligible adverse** significance will remain for the vast majority for the area studied. For the one dwelling located adjacent to Link 8 (Eaves Lane) predicted effects of **Moderate adverse** significance at worst will remain.

Noise from Proposed Mechanical and Electrical Plant Items

15.138Appropriate fixed mechanical and electrical plant rating level limits have been specified in accordance with BS4142:2014. The derived noise level limits have been specified accounting for the context of the local area, in particular the low prevailing background sound levels. These limits have been set such that compliance would ensure an impact magnitude of Negligible at worst. Existing and proposed receptors are of High sensitivity. Therefore, there is likely to be a direct, permanent, long-term residual effect on existing and proposed receptors of **Negligible** significance.

Existing baseline noise levels on proposed noise sensitive receptors

15.139It has been identified that, with due consideration to appropriate sound insulation (building fabric specification), a commensurate level of protection can be afforded to future residents of the proposed holiday lodges.

15.140The sensitivity of the proposed holiday lodges is considered to be High, however, it is anticipated that with due consideration to appropriate sound insulation, the impact magnitude will be negligible. Therefore, there is likely to be a direct, permanent, long-term, local residual effect on the noise sensitive aspects of the Proposed Development of **Negligible** significance following the implementation of appropriate mitigation.

Conclusions

15.141The baseline noise environment present within the vicinity of the Site is relatively low and predominantly consists of distant and local road traffic noise, noise from farming activity and natural noise sources. There are a number of noise sensitive receptors located within the vicinity of the Site, the closest being residential farms to the north, east, south and west of the Site boundary.

15.142An assessment has been undertaken to determine the potential noise and vibration effects associated with construction and operational phases of the Proposed Development on existing and proposed noise and vibration sensitive receptors.

15.143With respect to noise generated during the construction phase of the Proposed Development it has been identified that significant effects have the potential to occur should piling activities be necessary at the closest site boundaries to existing noise sensitive receptors. A number of mitigation measures have been identified with a view to minimising the effects of any such works. Following implementation of the proposed mitigation measures residual noise effects are predicted to be of negligible significance.

15.144For groundborne vibration associated with site construction activities it has been identified that negligible to moderate adverse effects may arise in the absence of mitigation measures. However, following the implementation of appropriate control measures it is expected that residual effects of negligible to minor adverse

significance would occur. Such effects will also be temporary in nature and will be dependent upon the precise operations undertaken at such locations. Vibration levels would be significantly below those required to generate even cosmetic building damage.

15.145An assessment of potential road traffic noise level changes from the Proposed Development on the local road network has identified that, for the majority of routes residual effects of negligible to minor adverse significance can be expected. The only exception is for residential receptors to the north of the site access on Eaves Lane for which an effect of Moderate significance at worst has been identified. However, when considering noise levels in absolute terms it is evident that measured / predicted noise levels are expected to be in the region of 50 dBA or less described within BS8233: 2014 as being 'desirable'.

15.146To reflect the application stage of this project, the assessment of noise from any proposed fixed and mechanical plant items has focussed on the determination of appropriate rating level limits for subsequent compliance with (which could be ensured through the use of appropriate planning conditions). Drawing on the results of the baseline noise survey, and the guidance contained within BS4142:2014, rating level limits have been specified, compliance with which would ensure a residual effect of **Negligible** significance.

15.147An assessment of noise effects during the operational phase has considered the impact of current ambient noise levels upon the noise sensitive aspects of the Proposed Development (holiday lodges). It has been identified that the prevailing noise environment across the proposed development site is generally low and therefore, noise levels can be appropriately controlled with the use of building fabric design. With such measures, internal noise levels can be controlled to within recognised criteria applicable to internal residential occupation. It has also been identified that external noise levels fall below those appropriate for the occupation of external living spaces, without need for further mitigation. Residual effects associated with the impact on the proposed development during the operational phase are therefore predicted to be Negligible.

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[ii] The Department of the Environment and the Welsh Office, Planning Policy Guidance Noise 24: 1994: Planning and noise.
[iii] Department for Environment, Food and Rural Affairs (DEFRA), (March, 2010). Noise Policy Statement for England, (March 2010).
[iv] Department for Communities and Local Government national planning practice guidance, (6th March 2014)
[v] Staffordshire Moorlands Local Development Framework – A local plan for the future of Staffordshire Moorlands –Core Strategy Development Plan Document – Adopted Version (March 2014)
[vi] Staffordshire Moorlands Local Development Framework – Churnet Valley Masterplan supplementary planning document (March 2014)
[vii] Subcommittee B/564/1. (2009). BS 5228-1:2009 + A1 2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise. London: BSi.
[viii] Subcommittee B/564/1. (2009). BS 5228-2:2009 +A1 2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration. London: BSi.
[ix] Department of Transport. (1993 and subsequent amendment). Design Manual for Roads and Bridges, Volume 11, Environmental Assessment. London: HMSO
[x] Technical Committee B/209/18. (1999). BS 8233:1999 Code of practice for sound insulation and noise reduction for buildings. London: BSI.
[xi] World Health Organisation (WHO) (1999). Guidelines for Community Noise
[xii] Transport and Road Research Laboratory, G R Watts, (1990). Research report 246: Traffic Induced Vibrations in Buildings: 1990.
[xiii] Transport and Research Laboratory, DM Hiller and G I Crabb, (2000). Report 429: Groundborne vibration caused by mechanical construction works: 2000.
[xiv] Noise Advisory Council, A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level L_{eq}, Report by a Working Party for the Technical Sub-Committee of the Council (1978)
[xv] British Standard 12354-3:2000 Building Acoustics – Estimation of acoustic performance of buildings from the performance of elements – Part 3: Airborne sound insulation against outdoor sound