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Noise Assessment Report for Proposed Residential Development, Land West of High Green, Catterick Village

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On behalf of:
Pallett Hill Sand & Gravel Co Ltd

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1.0 INTRODUCTION

1.1 Blue Tree Acoustics has been appointed by Pallett Hill Sand & Gravel Co Ltd to carry out a noise assessment for a proposed residential development at land off High Green in Catterick, North Yorkshire.

1.2 The development site is situated west of High Green and north of Chapmans Court, on the western fringe of Catterick village. The site currently comprises an open field bordered to the east and south by existing residential properties, to the north by agricultural land, woodland and a children's playground, and to the west by woodland, beyond which is a further field and lake. The existing A1 motorway is situated approximately 250m to the west of the development site. The surrounding area is predominantly residential in character.

1.3 The development proposal is to construct new residential houses with access from High Green.

1.4 Blue Tree Acoustics (BTA) has previously undertaken noise assessments for proposed Holiday Lodges on land around the nearby lake to the west (BTA Report ref 1072/1 dated November 2010), and also for residential development on nearby agricultural land to the north (BTA Report ref 1666.11/1 dated February 2013). Both of these assessments identified road traffic noise from the A1 as the dominant noise source in this area.

1.5 At time of writing, works are ongoing to the A1 near Catterick as part of the A1 Leeming to Barton Improvement Scheme. For the section of the A1 near the development site, this involves construction of a new junction, a new motorway to the west of the existing A1, and a new local access road broadly on the line of the current A1 route.

1.6 As construction works are ongoing, prevailing noise levels are not necessarily representative of existing or future conditions when the A1 works are completed (completion due in 2017), and undertaking a site noise survey at present may not provide suitable data. Therefore, it is proposed to base assessment on the previous data gathered at measurement locations in close proximity to the development site, and also on available information in documents pertaining to environmental impact of the A1 improvement scheme.

1.7 This methodology was proposed in discussion with, and by email to, Richmondshire District Council on 16/03/2016 as per the following excerpt:

"As discussed, undertaking noise measurements at present is difficult due to the ongoing A1 Improvement works meaning that traffic movements are not necessarily representative of the final scheme, and also influence of extraneous construction noise from the ongoing works.

One option could be to undertake noise measurements at another location at similar distance from the A1 however, due to the extent of the roadworks it is unlikely that a nearby location of suitably representative topography and environment can easily be found. We have undertaken various surveys around this site in recent years and it would be equally valid to utilise this data, which does reflect the specific topography and environment of the application site, to provide the basis of assessment. Our historic noise data includes source measurements at the previous A1 boundary and also at various locations near the site, which can be used to validate the traffic noise propagation calculations and assessment of noise impact.

Where relevant, we also aim to refer to the available Environmental Assessment documents relating to the A1 works in order to help provide additional information on noise, traffic flows etc and potential noise impact."

1.8 To date, we have received no comment on this email, and therefore assume the proposed methodology is acceptable.

2.0 EXISTING NOISE SOURCES

Road

2.1 The A1 motorway is a primary road with significant flows of traffic at all times. Traffic noise is audible and has been measured at different locations around the site during daytime and nighttime.

Aircraft

2.2 Some contribution to the ambient noise climate at the site from intermittent aircraft activity was noted during the daytime survey period.

Cemex

2.3 We understand the nearby Cemex processing yard operates daytime hours only from 0700 hours. We understand that noise emission from the quarry site is controlled by planning Conditions, as reproduced below:

17. No operations hereby permitted, including the movement of plant and heavy goods vehicles, shall take place except between the hours of:-

    07.00 to 18.00 Monday to Friday
    07.00 to 13.00 Saturdays and
    13.00 to 18.00 Saturdays (plant maintenance operations only)

    No operations shall take place on Sundays, Bank or Public Holidays.

Noise

21. All plant and machinery shall operate only within the permitted hours, except in emergency, and shall be silenced at all times in accordance with the manufacturer's recommendations.

22. Except for temporary operations and except as provided for in Condition 23 below, the free-field Equivalent Continuous Noise Level, LAeq, at the noise sensitive properties adjoining the quarry, due to operations at the quarry, shall not exceed a level of 55 LAeq (one hour). Measurements shall have regard to the effects of extraneous noise and shall be corrected for any such effects.

23. The noise level due to the operation of the fixed plant to the west of Leeming Lane shall not exceed 54 LAeq (one hour) measured at the boundary fence of the adjoining dwellings on Arena View/Pallett Hill Estate. Due allowance shall be made for any effects of extraneous noise from any other source including mobile plant or vehicles using the site. Monitoring of noise levels shall take place at three monthly intervals and results shall be submitted to the County Planning Authority within 28 days.

24. Noise levels to the east of Leeming Lane shall be monitored by the operating Company at three monthly intervals at up to four locations to be agreed in writing with the County Planning Authority. The results shall include the L90 and LAeq noise levels, the weather conditions at the time and comments on the sources of noise which are controlling the noise climate. The survey period shall be for 15 minutes during working periods and the results shall be kept during the life of the site and shall be submitted to the County Planning Authority within 28 days.

25. Unless otherwise agreed in writing with the County Planning Authority any pumps used at the site shall be inaudible at any noise sensitive property.

26. Unless otherwise agreed in writing by the County Planning Authority any reversing warning device fitted to mobile plant operating within the application site shall be inaudible at any noise sensitive property.

2.4 The above Conditions are designed to control noise impact from the quarry at the boundary of the existing residential properties near the site. The proposed development site is further from the quarry site than Arena View/Pallet Hill mentioned in Condition 23, and therefore the measures imposed to control quarry noise impacting on these locations will also suitably protect the proposed new dwellings at the development site.

3.0 NEW NOISE SOURCES

3.1 The new development is residential in nature and will introduce no significant long-term noise sources. There may be potential for noise generation from new M&E equipment, such as ventilation systems, but typical domestic systems for the type of development proposed here do not generate significant external noise. This can usually be adequately addressed at the detailed design stage, or, if needed, by an appropriately worded planning Condition.

3.2 Potentially, there will be noise produced at times during the construction of the development. However, this will be restricted to daytime hours only, and, if needed, can be controlled by an appropriately worded planning Condition.

4.0 AMBIENT NOISE CLIMATE

Existing Noise Surveys

4.1 Noise monitoring was undertaken by Blue Tree Acoustics during site surveys as part of the previous assessments for proposed Holiday Lodges on land to the west of the development site (BTA Report ref 1072/1 dated November 2010), and also for residential development on land to the north of the development site (BTA Report ref 1666.11/1 dated February 2013). The survey data from these assessments is reproduced in Appendix II and Appendix III for reference.

4.2 Both of these assessments identified road traffic noise from the A1 as the dominant noise source.

4.3 The measurement results for the previous survey locations nearest to the development site are summarised in the table below, along with consideration for relative distances to the A1 and the Cemex processing yard, to represent the typical pre-existing daytime and nighttime noise levels expected at the development site.

Table 1: Representative Noise Levels at Development Site

Time Period (hours)	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}
Day (0700-2300)	58	69	60	54
Night (2300-0700)	56	66	58	52

4.4 The measured L_{Aeq} noise levels do not vary greatly between day and night as noise from the A1 traffic flow is the dominant noise source, and this does not reduce significantly during nighttime. It should also be noted that the magnitude of measured noise levels is not considered to be particularly high. For example, daytime noise is only slightly above the desirable upper guideline value of 55dB L_{Aeq} recommended in BS8233:2014 (see Section 5 below).

Future A1 Noise

4.5 We have reviewed available information in the following documents:

A) *Highways Agency A1 Dishforth to Barton Improvement Environmental Statement - Volume 1 March 2006 Ref: D2B/HU/DB/12/15/REP/038/E*

B) *Highways Agency A1 Dishforth to Barton Improvement Environmental Assessment Report Leeming to Barton Section Volume I May 2013 Ref: L2B_12_15_REP_001*

4.6 Document A presents the following table showing predicted traffic noise levels at various receptor locations, including 82 Slessor Road and 10 Yarde Avenue, which are approximately 550m and 800mm southeast of the development site and closer to the A1. Considering these locations, it can be seen that predicted noise levels will reduce by at least 3dB(A), which is primarily due to the increase in distance between the new scheme and pre-existing A1 carriageway.

HIGHWAYS AGENCY d2b

Table 15-5: Predicted Traffic Noise Levels ($L_{10\ 18\ Hour}$/ dB(A)) at selected sensitive receptors

Receptor No.	Address								
		OS location	Base Year 2004	Do min 2010	Do Some 2010	Difference in Noise level	Do min 2025	Do Some 2025	Difference in Noise level
1	York Gate Farm	14929/7559	75.1	76.6	73.4	-3.2	78.1	75	-3.1
2	Leeming Lane	13660/10652	81.4	83.1	76.5	-6.6	86.8	76.7	-10.1
3	Street House Farm	13201/11585	70.4	72	70.6	-1.4	73.4	72.0	-1.4
4	Sunnyside	12128/14117	59.3	60.8	60.5	-0.3	62.6	62.3	-0.3
5	Hopetown House	11927/14411	76.9	78.5	74.4	-4.1	79.9	75.7	-2.2
6	Oak Tree Cottages	11781/14656	66.3	67.9	67.5	-0.4	69.3	68.8	-0.5
7	Theakston Grange	10990/16377	60.7	62.5	63.3	0.8	63.7	64.7	1.0
8	Poplar Farm	10583/17135	74	75.6	68.1	-7.5	77	69.5	-7.5
9	Jalna	9978/17734	63.4	65.2	69.8	4.6	66.5	71.1	4.6
10	Cowfold Grange	9295/18551	69.7	71.3	70.1	-1.2	72.6	71.4	-1.2
11	22 Bedale Road (Leeming Bar)	8364/19689	61.6	63.3	63.6	0.3	64.2	66.0	1.8
12	Leases Farm	8030/21120	56.9	58.5	58.4	-0.1	59.9	59.7	-0.2
13	Leases Hall	7968/21324	66.8	68.4	67.9	-0.5	69.7	69.3	-0.4
14	Angleham House north	6841/23111	67.4	69	68.2	-0.8	70.4	69.5	-0.9
15	10 Yarde Avenue	4202/27270	63.7	65.3	60.7	-4.6	66.6	61.9	-4.7
16	82 Slessor Road	3926/27501	62.0	63.9	60.2	-3.7	65	61.7	-3.3
17	Brookside	3815/27473	54.9	56.6	54.4	-2.2	57.9	55.7	-2.2
18	29 Honey Pot Road	2313/29535	75.1	76.1	69.2	-6.9	77.5	70.5	-7
19	13 Honey Pot Road	2277/29567	72.5	73.5	70.2	-3.3	74.9	71.6	-3.3

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Environmental Statement A1(M) Dishforth to Barton Improvement Volume 1 Amec/McAlpine Joint Venture

4.7 Document B considers potential impact of the new Local Access Roads (LAR) in conjunction with that from the new A1 carriageway, and is focused on the most sensitive new build sections of the LAR between Leeming and Low Street and Scotch Corner and Barton.

4.8 In Section 9 of the document, relating to Noise and Vibration, Document B states:

"Previously, a number of residents gained access to their properties directly from the A1. As part of the upgrade this will no longer be possible and therefore the LAR is a necessity. According to the project transportation consultants, in addition to vehicles using the LAR to gain access to properties, vehicles may also use the LAR to travel between Leeming and Catterick or between Scotch Corner and Barton, rather than using the upgraded A1, hence the relatively high AAWT traffic flow on the LAR. However, as agreed with the transportation consultants, provision of the LAR and upgraded A1 results in no overall increase in traffic flow; rather a proportion of the vehicles that use the existing A1 in the DM scenario will shift to the LAR in the DS scenario, thus slightly reducing the AAWT traffic flow on the upgraded A1."

4.9 Section 9 of Document B states the following summary in relation to noise during the operational phase:

"The assessment of operational effects of the road project has been undertaken in accordance with the requirements of the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 7 (HD 213/11) Scoping Level Assessment. The assessment has focussed on potential effects in the short term (on opening in the baseline year), as, based upon the review of predicted traffic data, effects in the baseline year will be greatest in terms of effect significance and would have the highest possibility of exceeding the DMRB threshold criteria. Predictions have been undertaken for a representative sample of NSR to identify, using a precautionary calculation approach, if the threshold noise criteria will be exceeded.

With respect to noise, it has been concluded that the predicted change in noise level at all NSRs assessed both during the day and night are predicted to be less than the 1dB LA10,18h change required to trigger further assessment, and are therefore of negligible effect magnitude in accordance with DMRB, and of overall Slight adverse significance of

effect. Given the above, it would follow that noise level change in the long term would be significantly less than the 3dB LA10,18h threshold required to trigger further assessment."

4.10 Based on the above, it is concluded that noise levels at the development site once the ongoing A1 improvement works are complete are unlikely to be greater than those presented in Table 1 above, and potentially could reduce by around 3dB, or more.

5.0 NOISE ASSESSMENT

5.1 The National Planning Policy Framework came into force in 2012. This document replaced a great many planning guidance documents that previously informed the planning system in England. The new framework states that:

The planning system should contribute to and enhance the natural and local environment by:

- *protecting and enhancing valued landscapes, geological conservation interests and soils;*
- *recognising the wider benefits of ecosystem services;*
- *minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures;*
- *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;*

  and
- *remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.*

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.*

[27] *See Explanatory Note to the Noise Policy Statement for England (Department for the Environment, Food and Rural Affairs).*

[28] *Subject to the provisions of the Environmental Protection Act 1990 and other relevant law.*

5.2 In addition, the Noise Policy Statement for England (NPSE) states:

Noise Policy Vision

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

Noise Policy 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.**

Guiding principles of sustainable development

Ensuring a Strong Healthy and Just Society – Meeting the diverse needs of all people in existing and future communities, promoting personal wellbeing, social cohesion and inclusion, and creating equal opportunity for all.

Using Sound Science Responsibly – Ensuring policy is developed and implemented on the basis of strong scientific evidence, whilst taking into account scientific uncertainty (through the precautionary principle) as well as public attitudes and values.

Living Within Environmental Limits – Respecting the limits of the planet's environment, resources and biodiversity – to improve our environment and ensure that the natural resources needed for life are unimpaired and remain so for future generations.

Achieving a Sustainable Economy – Building a strong, stable and sustainable economy which provides prosperity and opportunities for all, and in which environmental and social costs fall on those who impose them (polluter pays), and efficient resource use is incentivised.

Promoting Good Governance – Actively promoting effective, participative systems of governance in all levels of society – engaging people's creativity, energy and diversity.

Source: Securing the future – delivering UK sustainable development strategy, HM Government, March 2005.

5.3 The Noise Policy Statement for England Explanatory note states that:

Noise is an inevitable consequence of a mature and vibrant society. For some the noise of city life provides a desirable sense of excitement and exhilaration, but for others noise is an unwanted intrusion that adversely impacts on their quality of life, affecting their health and well being.

The management of noise has developed over many years as the types and character of noise sources have altered and as people's attitude to noise has changed. The Noise Abatement Act came into law in 1960 and the Report from the Committee on the Problem of Noise was published in 1963 (the Wilson report). Since then, examples of noise management can be found in many areas including reducing noise at source; the use of the land use and transport planning systems, compensation measures, the statutory nuisance and licensing regimes and other related legislation.

Furthermore, the broad aim of noise management has been to separate noise sources from sensitive noise receivers and to 'minimise' noise. Of course, taken in isolation and to a literal extreme, noise minimisation would mean no noise at all. In reality, although it has not always been stated, the aim has tended to be to minimise noise as far as reasonably practical. This concept can be found in the Environmental Protection Act 1990, where, in some circumstances, there is a defence of 'best practicable means' in summary statutory nuisance proceedings.

By describing clear policy vision and aims the NPSE provides the necessary clarity and direction to enable decisions to be made regarding what is an acceptable noise burden to place on society.

The intention is that the NPSE should apply to all types of noise apart from noise in the workplace (occupational noise). For the purposes of the NPSE, "noise" includes:

- *"environmental noise" which includes noise from transportation sources;*
- *"neighbour noise" which includes noise from inside and outside people's homes;*

  And
- *"neighbourhood noise" which includes noise arising from within the community such as industrial and entertainment premises, trade and business premises, construction sites and noise in the street.*

The application of the NPSE should mean that noise is properly taken into account at the appropriate time. In the past, the opportunity for the cost effective management of noise has often been missed because the noise implications of a particular policy, development or other activity have not been considered at an early enough stage.

In addition, the application of the NPSE should enable noise to be considered alongside other relevant issues and not to be considered in isolation. In the past, the wider benefits of a particular policy, development or other activity may not have been given adequate weight when assessing the noise implications.

In the longer term, the Government hopes that existing policies could be reviewed (on a prioritised basis), and revised if necessary, so that the policies and any noise management measures being adopted accord with the vision, aims and principles of the NPSE.

Noise management is a complex issue and at times requires complex solutions. Unlike air quality, there are currently no European or national noise limits which have to be met, although there can be specific local limits for specific developments. Furthermore, sound only becomes noise (often defined as 'unwanted sound') when it exists in the wrong place or at the wrong time such that it causes or contributes to some harmful or otherwise unwanted effect, like annoyance or sleep disturbance. Unlike many other pollutants, noise pollution depends not just on the physical aspects of the sound itself, but also the human reaction to it. Consequently, the NPSE provides a clear description of desired outcome from the noise management of a particular situation.

The guiding principles of Government policy on sustainable development should be used to assist in its implementation. The development of further principles specifically to underpin implementation of noise management policy will be kept under review as experience is gained from the application of the NPSE.

There are several key phrases within the NPSE vision and these are discussed below.

Health and quality of life

The World Health Organisation defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity, and recognises the enjoyment of the highest attainable standard of health as one of the fundamental rights of every human being.

It can be argued that quality of life contributes to our standard of health. However, in the NPSE it has been decided to make a distinction between 'quality of life' which is a subjective measure that refers to people's emotional, social and physical well being and 'health' which refers to physical and mental well being.

It is recognised that noise exposure can cause annoyance and sleep disturbance both of which impact on quality of life. It is also agreed by many experts that annoyance and sleep disturbance can give rise to adverse health effects. The distinction that has been made between 'quality of life' effects and 'health' effects recognises that there is emerging evidence that long term exposure to some types of transport noise can additionally cause an increased risk of direct health effects. The Government intends to keep research on the health effects of long term exposure to noise under review in accordance with the principles of the NPSE.

Promote good health and good quality of life

This statement expresses the long term desired policy outcome, but in the use of 'promote' and 'good' recognises that it is not possible to have a single objective noise-based measure that is mandatory and applicable to all sources of noise in all situations.

Effective management of noise

This concept confirms that the policy applies to all types of 'noise' (environmental, neighbour and neighbourhood) and that the solution could be more than simply minimising the noise.

Within the context of Government policy on sustainable development

Sustainable development is a core principle underpinning all government policy. For the UK Government the goal of sustainable development is being pursued in an integrated way through a sustainable, innovative and productive economy that delivers high levels of employment and a just society that promotes social inclusion, sustainable communities and personal wellbeing. The goal is pursued in ways that protect and enhance the physical and natural environment, and that use resources and energy as efficiently as possible.

There is a need to integrate consideration of the economic and social benefit of the activity or policy under examination with proper consideration of the adverse environmental effects, including the impact of noise on health and quality of life. This should avoid noise being treated

in isolation in any particular situation, i.e. not focussing solely on the noise impact without taking into account other related factors.

There are several key phrases within the NPSE aims and these are discussed below.

"Significant adverse" and "adverse"

There are two established concepts from toxicology that are currently being applied to noise impacts, for example, by the World Health Organisation. They are:

NOEL . No Observed Effect Level

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

LOAEL . Lowest Observed Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected.

Extending these concepts for the purpose of this NPSE leads to the concept of a significant observed adverse effect level.

SOAEL . Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur.

It is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

The first aim of the Noise Policy Statement for England

Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

The first aim of the NPSE states that significant adverse effects on health and quality of life should be avoided while also taking into account the guiding principles of sustainable development.

The second aim of the Noise Policy Statement for England

Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

The second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development. This does not mean that such adverse effects cannot occur.

The third aim of the Noise Policy Statement for England

Where possible, contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

This aim seeks, where possible, positively to improve health and quality of life through the pro-active management of noise while also taking into account the guiding principles of sustainable development, recognising that there will be opportunities for such measures to be taken and that they will deliver potential benefits to society. The protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim.

5.4 Unfortunately, the above guidance gives no objective, tangible standards or criteria that enable planning decisions to be made. In the absence of such guidance, quantification of noise impact in terms of guidance such as BS8233, which presents noise limits and criteria based on World Health Organisation recommendations, can be considered as appropriately assessing the potential noise impact with regard to toxicology concepts and hence in line with the principles of

the NPPF and NPSE. Therefore, if a site meets the recommendations of BS8233 and any associated Local Authority noise requirements, it can be considered as being below the level where there is no detectable adverse effect on health and quality of life due to noise, and this meets the NOEL (No Observed Effect Level) set out in the NPSE.

5.5 *British Standard 8233: 2014, 'Guidance on sound insulation and noise reduction for buildings'* (BS8233:2014) provides information on the design of internal acoustics in buildings. It deals with control of noise from outside the building, noise from plant and services within it, and room acoustics for non-critical situations.

5.6 BS8233:2014 provides guidance regarding indoor ambient noise criteria for residential accommodation, as presented below.

Table 2: BS8233:2014 Guidance Criteria for Indoor Ambient Noise Levels

Activity	Location	0700-2300 hours	2300-0700 hours
Resting	Living rooms	35 dB $L_{Aeq\ (16\ hour)}$	-
Dining	Dining room/area	40 dB $L_{Aeq\ (16\ hour)}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq\ (16\ hour)}$	30 dB $L_{Aeq\ (8\ hour)}$,

5.7 BS8233:2014 does not stipulate any criteria for maximum noise levels within rooms in terms of dB L_{Amax}, but does state that, "*Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$, depending on the character and number of events per night. Sporadic noise events could require separate values.*"

5.8 It is noted that BS8233:2014 also states that, where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5dB and reasonable internal conditions still achieved.

5.9 In addition, the BS8233:2014 guidance relating to gardens makes reference to external noise levels in gardens and balconies, etc., as follows:

> *"For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an*

upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.

Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space."

5.10 The following noise mitigation section is based on achieving the BS8233:2014 noise level criteria set out above. Noise ingress calculations have been carried out in accordance with BS8233:2014. It should be noted that calculations to limit noise ingress to 45dB L_{Amax} within bedrooms are based on the typical noise events occurring at the site, in this case being incident noise levels of around 66dB L_{Amax}. However, it must be acknowledged that there will always remain potential for atypical events, such as emergency sirens, police/ambulance helicopter, temporary works, etc., that could result in L_{Amax} noise levels exceeding 45dB within bedrooms.

6.0 NOISE MITIGATION MEASURES

6.1 There are a variety of proportionate and reasonable techniques that could be introduced to mitigate the effects of noise, such as:

- **Engineering:** reduction of noise at source (e.g. use of quiet machinery and working methods), containment of generated noise, and protection of noise-sensitive buildings (e.g. by sound insulation and/or screening them by purpose-built barriers);
- **Layout:** adequate distance between source and noise-sensitive building; screening by natural barriers, other buildings or non-critical rooms in a building;
- **Administrative:** limiting operating time of source, restricting activities on site, specifying an acceptable noise limit.

6.2 An indicative layout for the proposed development is presented in Figure 2. The potential dwelling locations most exposed to traffic noise will be those along the western site boundary, nearest to the A1. The site layout helps reduce noise impact upon these plots by orientating the houses such that gable end walls face toward the A1, thereby reducing the angle of view to the A1 of noise sensitive windows on the front and rear elevations and making them less exposed to incident traffic noise. The plots situated in the eastern section of the development site will benefit from acoustic screening and scattering of the A1 traffic noise provided by the intervening plots situated near the western site boundary.

6.3 The existing daytime noise levels are around 58dB L_{Aeq}, and therefore provision of a suitable acoustic barrier is advisable to reduce noise levels in gardens to the desirable 55dB L_{Aeq} upper guideline value of BS8233:2014. This can be achieved by provision of a close-boarded timber fence of minimum 2m height to gardens along the west/northwest facing site boundary.

6.4 Acoustic fencing should be constructed of solid, weather-treated timber (or ply) of minimum 18mm thickness. All joints should be tight-butted with timber cover strips or tongue and groove boards to ensure that there are no air gaps in the structure or between the base of the fence and the ground beneath. Alternatively, if desired, acoustic barriers can be created from almost any solid material that can be made impermeable to air; for example, the barrier could be constructed from masonry, concrete, plastic, timber panels etc.

6.5 It should also be noted that the predicted noise levels following completion of the A1 improvement works indicate a likely minimum reduction of 3dB(A) in traffic noise, which would reduce daytime

noise levels to be further below the 55dB L_{Aeq} guideline value, and potentially falling below 50dB L_{Aeq} in some areas.

Dwelling Protection

6.6 The design of the building envelope of the new dwellings can incorporate suitable sound insulation to satisfy the internal noise criteria set out above. Noise ingress calculations have been carried out in accordance with BS8233:2014 in order to determine appropriate sound insulation measures to satisfy the acoustic criteria set out above. Based on the noise ingress calculations, the following sound insulation measures are recommended. As there are no detailed plans available at this stage, calculations are based on standard room and window sizes.

6.7 All new housing should be of masonry construction, e.g. external walls comprising insulated cavity with block-work inner leaf and external brick leaf.

6.8 Roof constructions should be tiled, with ceilings to rooms below comprising a minimum of 1 layer of solid gypsum-based board (total minimum mass per unit area 10kg/m^2), overlaid with minimum 100mm insulation wool. Any proposed rooms in the roof-space should be designed to have suitable internal linings to achieve the required sound insulation, e.g. equivalent to the external masonry wall.

6.9 All windows to noise-sensitive habitable rooms should have a minimum double glazing of 4mm glass/12mm airgap/6mm glass (typically minimum sound insulation 33dB R_w). For such acoustically rated windows, the required acoustic performance should be attained by the glazing system as a whole, including frames, opening lights, etc.

6.10 Ground floor living rooms and dining rooms may be provided with standard window trickle ventilators. Bedrooms at first floor and above should be provided with suitable passive acoustic ventilators with minimum sound insulation performance of 41dB $D_{n,e,w}$, such as Greenwood EHA574 or Renson Invisivent AK41. Alternatively, a ducted ventilation system (e.g. whole house type) could be implemented, or it may be possible to design a continuous running MEV/MVHR fan system with no requirement for ventilation openings in window frames or external walls into habitable rooms on building elevations directly exposed to noise sources. It should also be ensured that internally generated noise from new mechanical services are designed to be suitably quiet within the new dwellings. CIBSE guidance suggests Noise Rating (NR) of NR25 is appropriate for bedrooms, and NR30 for living rooms. These criteria can be considered

appropriate for the proposed development and separate to the BS8233 targets stipulated above for external noise sources.

6.11 Glazing and ventilators to non-habitable rooms or spaces do not require special acoustic measures, and these spaces may have standard trickle ventilation. For the purposes of noise assessment, separate kitchens, bathrooms, WCs, etc., are considered as non-habitable spaces.

6.12 The specifications given above are suitable recommendations and should be verified during the detailed building design. Equivalent acoustic performance may be achieved by other materials or products, but acoustic performance data for all proposed systems should be checked by a competent acoustic consultant in order to ensure adequate acoustic performance will be achieved.

6.13 It should be acknowledged that careful design and close attention to detail, along with high standards of site supervision and workmanship, are essential in achieving the required acoustic performance, particularly in relation to controlling flanking sound transmission paths, air gaps, and use of suitable materials. Therefore, effective work management plans will be needed to ensure all contractors and tradesmen are aware of the acoustic performance requirements and details to ensure works are implemented to the necessary standard.

6.14 All recommendations given above are for acoustic purposes only. Any other requirements, such as structural, thermal, fire safety, etc., should be checked by suitably qualified specialists.

7.0 SUMMARY AND CONCLUSIONS

7.1 A noise assessment has been carried out on behalf of Pallett Hill Sand & Gravel Co Ltd for a proposed residential development on land west of High Green and north of Chapmans Court, Catterick Village.

7.2 Construction work for the A1 Leeming to Barton Improvement Scheme is ongoing, and therefore conducting a survey of current noise levels is not necessarily representative of the existing, or future conditions when the A1 works are completed (completion due in 2017). As an alternative, the assessment has considered measurements of the prevailing daytime and nighttime ambient noise levels taken by Blue Tree Acoustics for previous assessments for residential development on neighbouring plots of land. The assessment has also considered available information in documents pertaining to environmental impact of the A1 improvement scheme in order to ascertain potential impact from future road traffic noise once the A1 works are complete. This methodology was proposed to Richmondshire District Council prior to assessment, and we understand is deemed appropriate.

7.3 The A1 road traffic was found to be the dominant noise source impacting upon the site during the day and night.

7.4 The suitability of the noise climate at the site for residential development has been assessed. The assessment has been undertaken in accordance with the National Planning Policy Framework (NPPF) and the Noise Policy Statement for England (NPSE). Noise assessment and design targets for internal and external noise levels recommended in BS8233:2014 have been used to quantify noise impact and determine suitability for residential development with due regard to effects on health and quality of life as set out in the NPSE.

7.5 Outline noise control measures have been recommended in order to meet suitable noise level criteria for the proposed residential development.

7.6 We conclude that the site can be considered suitable for residential development in planning and noise terms, as acceptable noise levels can be achieved following the design and implementation of suitably specified noise mitigation measures. On this basis, we consider that the noise assessment methodology and conclusions meet the principles set out in the NPPF and NPSE.

FIGURE 1 – SITE LOCATION

FIGURE 2 – INDICATIVE SITE DEVELOPMENT PLAN

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.

NR Measured noise levels in each octave band are compared to the NR curve reference values. The overall NR value is the lowest NR curve that has not been exceeded.

$D_{nT,w}$ Weighted standardised level difference, a single figure generated by comparing the D_{nT} with a reference curve. The reference curve is shifted in 1dB steps until the sum of adverse deviation of the test curve, compared to the reference curve, is as large as possible, but no more than 32.0 dB. The value of the shifted reference curve at 500Hz is taken as the $D_{nT,w}$. N.B. As $D_{nT,w}$ for airborne transmission represents a level difference, an improvement generates a larger figure – used in airborne tests.

R_w Similar to the $D_{nT,w}$ term, but a measure of the airborne sound insulation performance of a separating element, when tested in laboratory conditions. As such the build is essentially perfect, and has no flanking noise routes. $D_{nT,w}$ values measured on site will always be of a significantly lower value than the R_w value for a structure.

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APPENDIX II – NOISE SURVEY DATA 2010

BTA Report ref 1072/1 dated November 2010

A noise survey was undertaken on 18th November 2010 during early morning and daytime hours. The early morning survey was undertaken between 0430-0700 hours to determine ambient noise levels during the end of the night-time assessment period. Daytime noise levels were monitored between 1000-1300 hours. The survey results are detailed in Appendix II.

Noise levels were measured on site at the approximate locations of selected holiday lodges, as shown on Figure 1. All measurement positions were on open land, clear of acoustically reflective surfaces, i.e. 'free-field'.

Noise measurements were carried out using a Rion NA28 Type 1, Class 1 Integrating Sound Level Meter. 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.

Weather conditions were calm with wind speeds <5m/s. The wind direction was generally observed as being Southerly.

FIGURE 1 – SITE PLAN & APPROXIMATE MEASUREMENT LOCATIONS

Daytime Noise Levels

The site is subject to road traffic noise from the A1 and has been assessed using the CRTN shortened method. The CRTN shortened measurement method involves measuring the L_{A10} noise level over a representative time period in three consecutive hours between 10:00 and 17:00 hours. The arithmetic mean of these L_{A10} values can then be corrected to give an $L_{Aeq(16\ hour)}$ value. CRTN states that this arithmetic mean minus 1dB gives a value for the $L_{A10\ (18\ hour)}$ level. This $L_{A10\ (18\ hour)}$ value can then be converted to give the equivalent $L_{Aeq\ (16\ hour)}$ value, as PPG24 states that $L_{Aeq(16\ hour)} = L_{A10\ (18\ hour)} - 2dB$. The $L_{Aeq(16\ hour)}$ can then be compared to the noise exposure categories specified in PPG 24.

Table 1: Location 1 Daytime Noise Levels – Free-field

Time	Time Period(mins)	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
10:45	10	58.7	67.8	60.9	55.2	Road traffic noise
11:20	10	60.3	74.9	62.8	54.6	"
12:47	10	59.7	65.3	62.1	54.8	"
Average		**59.6***	**69.3**	**61.9**	**54.9**	
CRTN Shortened method $L_{A10\ (18\ hour)}$				**60.9**	**PPG24 NEC**	
PPG24 correction method				**58.9**		
Free-field $L_{Aeq\ (16\ hour)}$				**59**	NEC B	

*logarithmic average

Table 2: Location 2 Daytime Noise Levels – Free-field

Time	Time Period(mins)	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
10:31	10	59.6	67.1	61.9	56.1	Road traffic noise
11:33	10	58.6	64.0	61.1	54.1	"
12:34	10	59.8	66.7	62.3	56.3	"
Average		**59.4***	**65.9**	**61.8**	**55.5**	
CRTN Shortened method $L_{A10\ (18\ hour)}$				**60.8**	**PPG24 NEC**	
PPG24 correction method				**58.8**		
Free-field $L_{Aeq\ (16\ hour)}$				**59**	NEC B	

*logarithmic average

Table 3: Location 3 Daytime Noise Levels – Free-field

Time	Time Period(mins)	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
10:18	10	57.3	64.1	59.2	54.5	Road traffic noise
11:48	10	57.0	62.9	58.9	54.3	"
12:18	10	56.2	60.6	57.8	54.1	"
Average		**56.9***	**62.5**	**58.6**	**54.3**	
CRTN Shortened method $L_{A10\ (18\ hour)}$				**57.6**	**PPG24 NEC**	
PPG24 correction method				**55.6**		
Free-field $L_{Aeq\ (16\ hour)}$				**56**	NEC B	

*logarithmic average

Table 4: Location 4 Daytime Noise Levels – Free-field

Time	Time Period(mins)	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
08:01	10	57.2	62.7	58.9	55.1	Road traffic noise
10:05	10	56.9	64.8	58.9	54.3	"
12:04	10	57.0	62.8	59.1	53.9	"
Average		**57.0***	**63.4**	**59.0**	**54.4**	
CRTN Shortened method $L_{A10\ (18\ hour)}$				**58.0**	**PPG24 NEC**	
PPG24 correction method				**56.0**		
Free-field $L_{Aeq\ (16\ hour)}$				**56**	NEC B	

*logarithmic average

The site is affected by road traffic noise and the A1 is the dominant noise source. There is little variation in the measured noise levels at each location, which reflects the continuous nature of the A1 traffic flow during the daytime.

During daytime the following sample measurements were also recorded. The locations are indicated on Figure 1.

Table 5: Additional daytime Noise Levels – Free-field

Ref	Location	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}
A1	At top of earth bound, at boundary with A1	77.6	85.4	81.5	65.3
A2	At nearest boundary of Quarry to the development site	54.4	61.3	55.8	52.7
A3	At top of earth bound, at boundary with A1	79.3	89.5	83.1	69.3

Night-time Noise Levels

Night-time L_{Aeq} values have been averaged logarithmically. This value has been taken as being representative of the night-time $L_{Aeq\ (8\ hour)}$ value.

Table 6: Location 1 Night-time Noise Levels – Free-field

Time	Time Period(mins)	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
04:30	10	52.6	61.9	55.0	48.4	Road traffic noise
05:08	10	57.2	65.9	60.0	52.6	"
06:27	10	58.1	66.3	61.0	54.6	"
Average		**56.5***	**64.7**	**58.7**	**51.9**	
			PPG24 NEC			
Free-field $L_{Aeq\ (8\ hour)}$		**56**	NEC B			

*logarithmic average

Table 7: Location 2 Night-time Noise Levels – Free-field

Time	Time Period(mins)	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
04:42	10	53.1	61.9	55.5	49.0	Road traffic noise
05:33	10	55.9	64.7	58.4	51.7	"
06:40	10	58.3	64.6	60.6	54.6	"
Average		**56.3***	**63.7**	**58.2**	**51.8**	
			PPG24 NEC			
Free-field $L_{Aeq\ (8\ hour)}$		**56**	NEC B			

*logarithmic average

Table 8: Location 3 Night-time Noise Levels – Free-field

Time	Time Period(mins)	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}	Comments
04:55	10	52.5	60.1	54.9	48.5	Road traffic noise
05:49	10	53.4	60.8	55.5	49.9	"
06:57	10	56.5	63.3	58.3	54.0	"
Average		**54.5***	**61.4**	**56.2**	**50.8**	
			PPG24 NEC			
Free-field $L_{Aeq\ (8\ hour)}$		**55**	NEC B			

*logarithmic average

During the early morning survey, road traffic noise from the A1 was dominant. As can be seen from the measurements, noise levels gradually increase with time toward the end of the survey period as the A1 traffic flow increased toward daytime levels.

APPENDIX III – NOISE SURVEY DATA 2013

BTA Report ref 1666.11/1 dated February 2013

Noise monitoring was undertaken by Blue Tree Acoustics in order to determine the existing ambient noise climate at the site. Surveys were undertaken during daytime on 15th January 2013 and during daytime and night-time on 1st February 2013 Attended measurements were taken at accessible locations around the site, as indicated in Figure 1. The measurement locations were selected to be representative of the likely positions of the proposed new dwellings near the site boundaries.

Noise measurements were carried out using a Rion NA28 Class 1 Integrating Sound Level Meter and two Rion NL32 Class 1 Integrating Sound Level Meters. Noise was measured in terms of broadband A-weighted indices and at 1/3 octave bands from 50Hz to 10kHz. The measurement microphones were mounted on a tripod at approximately 1.5m height from local ground, with a proprietary environmental windshield fitted to each microphone. Calibration checks were carried out both before and after the measurements with no variance observed. The sound level meters were within a valid period of laboratory calibration.

Weather conditions during the survey periods were suitable. Details are presented in Appendix II alongside the noise survey data.

The primary noise source observed at the development site was the A1 road traffic.

The noise measurement results are detailed in Appendix II and are summarised in the tables below. From the tables below, it can be seen that the measured noise levels are greatest at Locations 3 and 4, which are the most exposed to the A1 traffic noise. Noise levels at other locations are lower, depending on distance, with the lowest noise levels measured at Location 1, at the eastern site boundary furthest from the A1. In addition, from the weather data it can be seen that during the survey on 1st February, there was a consistent westerly wind, i.e. from the A1.

Daytime noise levels have been measured under different weather conditions on different days. The noise levels presented in Table 1 in italics were measured on 15th January and are lower than those measured on 1st February, as the A1 traffic noise was notably reduced at this time due to snowfall and no westerly winds. During this time it was observed that the quarry activities continued, and therefore the measurements provide an indication of the noise emission from the quarry alone. It can be seen that noise levels on the 15th January are generally around 5-6dB(A) lower than those on 1st February, and therefore the A1 traffic noise can be considered as the dominant noise source across the development site.

Table 1: Averaged Daytime Noise Levels

Location	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}
1 - (15/01/13)	*50.4*	*60.9*	*51.7*	*48.0*
1 - (01/02/13)	57.4	72.2	58.7	55.1
2 - (15/01/13)	*53.3*	*59.4*	*54.7*	*51.4*
2 - (01/02/13)	58.1	70.6	59.7	55.6
3 - (15/01/13)	*52.6*	*58.4*	*54.1*	*50.5*
3 - (01/02/13)	58.7	68.9	60.6	56.1
4 - (15/01/13)	*55.3*	*59.4*	*56.8*	*53.3*
4 - (01/02/13)	60.1	65.4	62.2	57.6
5 - (15/01/13)	*54.0*	*63.6*	*55.2*	*51.8*
5 - (01/02/13)	57.7	68.5	59.1	55.5

Table 2: Averaged Night-time Noise Levels

Location	dB L_{Aeq}	dB L_{Amax}	dB L_{A10}	dB L_{A90}
1	55.5	62.3	57.2	52.3
2	56.3	62.7	58.1	53.0
3	57.1	63.2	58.7	54.2
4	57.9	64.0	59.9	54.2
5	56.0	62.3	57.8	52.5

FIGURE 1 – SITE AERIAL PHOTO & APPROXIMATE NOISE MONITORING LOCATIONS

APPENDIX IV – EXAMPLE BS8233 CALCULATIONS

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

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

Representative Noise Break-in Calculation Day-time Living Room

		Octave Band Centre Frequency (Hz)							
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
$L_{eq,ff}$	Sound pressure level outside	40	42	43	51	57	47	33	20
$D_{n,e}$	Insulation of the ventilator	27	27	27	27	27	27	27	27
R_{wi}	Window sound reduction index	18	23	22	27	38	40	41	41
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	6.9	8.3	9.6	10.5	11.6	11.6	11.6	11.6
S_f	Facade area (including window)	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
S_{wi}	Window area	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
S_{ew}	$S_f - S_{wi}$	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
S_{rr}	Area of Ceiling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S	$S_f + S_{rr}$	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
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, grey cells are additional to the 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	**40**	**42**	**43**	**51**	**57**	**47**	**33**	**20**
$D_{n,e}$		27	27	27	27	27	27	27	27
$\frac{A_0}{S} 10^{\frac{-D_{n,e}}{10}}$	B	1.3E-03	1.3E-03	1.3E-03	1.3E-03	1.3E-03	1.3E-03	1.3E-03	1.3E-03
R_{wi}		18	23	22	27	38	40	41	41
$\frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}}$	C	4.2E-03	1.3E-03	1.7E-03	5.3E-04	4.2E-05	2.7E-05	2.1E-05	2.1E-05
R_{ew}		34	40	40	48	60	61	61	61
$\frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}}$	D	2.9E-04	7.3E-05	7.3E-05	1.2E-05	7.3E-07	5.8E-07	5.8E-07	5.8E-07
R_{rr}		-	-	-	-	-	-	-	-
$\frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}}$	E	-	-	-	-	-	-	-	-
$10 \log_{10} (B + C + D + E)$	F	-22	-26	-25	-27	-29	-29	-29	-29
A									
$10 \log \left(\frac{S}{A}\right)$	G	3.37	2.57	1.94	1.55	1.12	1.12	1.12	1.12
$L_{eq,2}$	A + F + G + 3	24	22	23	29	32	22	8	-5
A-weighting dB		-26	-16	-9	-3	0	1	1	-1
$L_{eq,2}$ + A-weighting	$L_{Aeq,freq}$	-2	6	14	26	32	23	9	-6
Totals	**L_{Aeq}**	**33**							
	NR	**32**							

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

Representative Noise Break-in Calculation Nighttime Bedrooms

		Octave Band Centre Frequency (Hz)							
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
$L_{\mathrm{eq,ff}}$	Sound pressure level outside	39	42	40	52	55	45	29	16
$D_{\mathrm{n,e}}$	Insulation of the ventilator	20	34	40	39	42	49	43	45
R_{wi}	Window sound reduction index	18	23	22	27	38	40	41	41
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	5.6	6.7	7.7	8.4	9.3	9.3	9.3	9.3
S_{f}	Facade area (including window)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
S_{wi}	Window area	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
S_{ew}	$S_{\mathrm{f}} - S_{\mathrm{wi}}$	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
S_{rr}	Area of Ceiling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S	$S_{\mathrm{f}} + S_{\mathrm{rr}}$	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
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, grey cells are additional to the 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	**39**	**42**	**40**	**52**	**55**	**45**	**29**	**16**
$D_{n,e}$		20	34	40	39	42	49	43	45
$\frac{A_0}{S} 10^{\frac{-D_{n,e}}{10}}$	B	8.3E-03	3.3E-04	8.3E-05	1.0E-04	5.3E-05	1.0E-05	4.2E-05	2.6E-05
R_{wi}		18	23	22	27	38	40	41	41
$\frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}}$	C	5.3E-03	1.7E-03	2.1E-03	6.7E-04	5.3E-05	3.3E-05	2.6E-05	2.6E-05
R_{ew}		34	40	40	48	60	61	61	61
$\frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}}$	D	2.7E-04	6.7E-05	6.7E-05	1.1E-05	6.7E-07	5.3E-07	5.3E-07	5.3E-07
R_{rr}		-	-	-	-	-	-	-	-
$\frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}}$	E	-	-	-	-	-	-	-	-
$10 \log_{10} (B + C + D + E)$	F	-19	-27	-26	-31	-40	-44	-42	-43
A									
$10 \log \left(\frac{S}{A}\right)$	G	3.31	2.53	1.93	1.55	1.11	1.11	1.11	1.11
$L_{eq,2}$	A + F + G + 3	26	21	19	26	19	5	-9	-23
A-weighting dB		-26	-16	-9	-3	0	1	1	-1
$L_{eq,2}$ + A-weighting	$L_{Aeq,freq}$	0	5	10	23	19	6	-8	-24
Totals	**L_{Aeq}**	**25**							
	NR	**21**							

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