

Acoustic Associates Sussex Ltd

Planning Application Noise & Vibration Assessment

Site: Land West of Toddington Lane Farm Cottages
Client: Helg Properties Ltd

Report by: George Orton BEng(Hons) MIOA

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Project: J2949

Issue 1



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1 Introduction

Acoustic Associates have been appointed to undertake an acoustic assessment of the proposed “Land West of Toddington Lane Farm Cottages, Wick, Littlehampton”.
Development

The development will create two new dwelling houses and the assessment will be submitted as part of a planning application.

The following has been assessed:

- Noise created by the railway line to the south of the proposed development
- Vibration levels created by the railway line to the south of the proposed development

Noise and vibration levels have been measured at one location close to where the proposed re-development will take place. Historic noise and vibration measurements have also been detailed in the report.

The noise & vibration levels for the day and the night time period have been assessed in terms of and following the guidelines of the documents listed below:

- Calculation of Rail Noise (CRN) 1995.
- World Health Organisation (WHO): Guidelines for Community Noise (1999)
- BS8233: Sound insulation and noise reduction for buildings (2014)
- ProPG: Planning & Noise (Professional Practice Guidance on Planning & Noise) 2017
- BS 6472-1: Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting (2008)

Measured vibration levels are at worst in the “low probability of adverse comment” range as defined by BS6472.

Noise mitigation measures have been recommended so the ProPG, WHO and BS8233 noise criteria can be achieved.

Achieving these criteria will result in a good acoustic environment inside the proposed dwellings. For the reasons above it is considered that planning permission would not be refused on noise grounds albeit with possible planning conditions relating to noise.

2 Context, Noise Criteria & Noise Assessment Methodology

2.1 Site Description

The proposed development involves the clearance of the site to allow the construction of a pair of semidetached dwellings. This will result in a gain of 2 dwellings on the site.

- To the south of the site is the railway line that runs (east to west) between Angmering Station and either Littlehampton or Ford station (line splits approximately 2Km to the west of the site).
- To the north of the site is another empty site that has planning granted to build residential dwellings
- To the west of the site is a commercial development that has gained planning approval to re-develop the site and create new residential dwellings
- To the east of the site are Toddington Lane farm cottages (existing residential dwellings)

2.2 National Planning Policy Framework 2019

The National Planning Policy Framework (2019) defines the Government's planning policies for England and how these are expected to be applied. It sets out the Government's requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so.

The document recommends: preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability.

Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

- *Mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;*
- *Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason;*

Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed.

The Framework states that the planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of noise pollution. It does not, however, provide any specific formal guidelines.

2.3 Noise and Vibration Criteria

It is recommended in this case that appropriate criteria are provided by:

- BS8233 (Sound insulation and noise reduction for buildings) 2014
- World Health Organisation (WHO) - Guidelines for Community Noise 1999
- ProPG: Planning & Noise (Professional Practice Guidance on Planning & Noise) 2017 (would apply only to transport sources).
- BS 6472-1: Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting (2008)

Assessment methodology, predictions of building envelope sound insulation and calculations of noise propagation will follow the principles detailed within:

- Calculation of Rail Noise (CRN) 1995.
- ISO9613 (1996) Attenuation of sound during propagation outdoors
- BS EN 12354-3 Building acoustics. Estimation of acoustic performance in buildings from the performance of elements. Airborne sound insulation against outdoor sound

2.4 WHO Internal Noise Criteria

The target internal levels are based on guidelines laid out by the World Health Organisation (WHO) and are as follows:

Room Type Target Maximum Internal Level - L_{Aeq} dB (A)

Living rooms	35 (Daytime only)
Bedrooms	30 (Night)

Room Type Maximum Internal Level – L_{Amax} dB(A)

Bedrooms	45 (not more than 10-15 times per Night)
----------	--

The target maximum internal noise level for a bedroom during the night time corresponds to the threshold of sleep disturbance. WHO state that the noise level outside a bedroom window would be less than 45dB(A) this assumes that an open window provides 15dB attenuation.

2.5 WHO External Noise Criteria

With regard to outdoor amenity areas WHO states the following:

To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55dB(A) on balconies, terraces and in outdoor living areas.

To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 50dB(A) on balconies, terraces and in outdoor living areas.

2.6 BS8233 Noise Criteria

Table 5 of BS8233 provides the following guideline values:

Activity	Location	Time period of day	
		07:00-23:00	23:00-07:00
Resting	Living Rooms	35dB LAeq,16hour	-
Dining	Dining Room/Area	40dB LAeq,16hour	-
Sleeping (daytime resting)	Bedroom	35dB LAeq,16hour	30dB LAeq,8hour

Table 1: BS8233 Criteria

With regard to external amenity areas BS8233 (7.7.3.2 Design criteria for external noise) states the following:

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

2.7 BS 6472-1 Vibration Criteria

Part 1 of BS 6472 provides guidance on predicting human response to vibration in buildings over the frequency range 0.5 Hz to 80 Hz. Methods of assessing continuous, intermittent and impulsive vibration are presented. This part of BS 6472 describes how to determine the vibration dose value, VDV, from frequency-weighted vibration measurements.

The vibration dose value is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings. Consideration is given to the time of day and use made of occupied space in buildings, whether residential, office or workshop.

In homes, adverse comment about building vibrations is likely when the vibration levels to which occupants are exposed are only slightly above thresholds of perception. When the appropriately-weighted vibration measurements have been used to calculate the VDV (day/night) at the relevant places of interest, their significance in terms of human response for people in those places can be derived from the table below which has been taken from BS6472:

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

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

Figure 1: BS6472 Criteria

2.8 Rail Noise Measurement and Prediction Methodology

The noise levels for the day and night time periods have been predicted, using on site measurements, rather than measuring constantly for 24hrs or more. The predictions have been made using the following information:

- 2020 usual time table data which details the number of passenger trains that pass by the site (between Angmering and the Ford/Barnham junction). *The standard timetable information was used as opposed to the actual timetable for June. At the time of the on-site survey the train timetable was reduced due to Covid19 Lockdown restrictions.*
- Train Sound Exposure levels were measured on site during the day time. These individual measurements were then grouped into train types based on train length. As a precaution the train noise measurements were compared to measurements completed historically (2013) at a site only 100m to the west. On average the historic measurements were marginally higher. As such the historic sound readings have been used to form the basis of this noise assessment
- The individual measurements have been averaged for each train type in order to create a “typical” sound exposure level for each train type.

The above is in accordance with Calculation of Rail Noise 1995 which states the following in section 43 paragraph 2 and 3.

“In order to determine the $L_{Aeq,16h}$ or $L_{Aeq,8h}$ noise level it may be necessary to carry out SEL noise measurements of each train pass-by over the full time period of interest. Exceptions to this may occur when the train mix and speed of individual train types remain reasonably constant over the relevant time period. For this situation, it is acceptable to measure a representative sample of individual train pass bys of each train type running on each track and determine an arithmetic mean value for the SEL for each case.”

In paragraph 3 CRN goes on to say that having established by measurement the mean values for the SELs of each train type operating on the railway, the day and the night time noise levels ($L_{Aeq,16hr}$ and $L_{Aeq,8h}$) should be calculated using a formula that is also stated in CRN. The SEL to $L_{Aeq,day/night}$ formula is detailed below and implemented in section 4.

For each train type: $L_{Aeq} = SEL - 10\log T + 10\log N$

- $N =$ no. of events in period (For each train type based upon timetable information)
- $T =$ no. of seconds in period (57600 seconds for the day and 28800 for the night)

It should be noted that a train SEL measured in the daytime is likely to be marginally higher than if an identical train SEL was measured at night time. This is due to the fact that in the daytime the background noise levels are generally higher than at night time and during the train SEL measurement background noise will be “captured” as well as the train noise.

The predicted day and night time noise levels at the survey position have been used to calibrate a noise model which predicts noise levels around the whole of the proposed development

2.9 Non Passenger Train Activity

The effect of noise from night time freight train activity is sometimes difficult to assess due to irregularity of freight operations and the non-existence of any useful timetable information. However reference can be made to the Network Rail Business Plan for Brighton & Sussex which does not state that there would be freight traffic on the south coast line between Brighton and Portsmouth (There is likely to be some freight traffic on the Brighton to London mainline and between London and the channel tunnel)

In the past several freight train operators were contacted who confirmed that freight trains on this railway line would be very unlikely.

There may well be occasional leaf clearing or maintenance trains that operate during the day or night-time period. These trains will be seasonal/infrequent and it is very unlikely that there would be several in a week let alone more than one in any night time hour.

Because of infrequency of such events, it has not been possible to carry out measurements of the rail traffic noise associated with them

It should be borne in mind that such trains pass the site only on an occasional basis, as the need arises. Therefore, it would not normally be the case that Planning Decisions would hinge upon such irregular events.

2.10 ProPG –Planning and Noise: new residential development

The following extract has been taken (Figure 2, Page 13) from the ProPG document:

ACTIVITY	LOCATION	07:00 – 23:00 HRS	23:00 – 07:00 HRS
Resting	Living room	35 dB $L_{Aeq,10hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,10hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,10hr}$	30 dB $L_{Aeq,10hr}$ 45 dB $L_{Amax,10min}$

NOTE 1 The Table provides recommended internal L_{Aeq} target levels for overall noise in the design of a building. These are the sum total of structure-borne and airborne noise sources. Ground-borne noise is assessed separately and is not included as part of these targets, as human response to ground-borne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity.

NOTE 2 The internal L_{Aeq} target levels shown in the Table are based on the existing guidelines issued by the WHO and assume normal diurnal fluctuations in internal noise. In cases where local conditions do not follow a typical diurnal pattern, for example on a road serving a port with high levels of traffic at certain times of the night, an appropriate alternative period, e.g. 1 hour, may be used, but the level should be selected to ensure consistency with the internal L_{Aeq} target levels recommended in the Table.

NOTE 3 These internal L_{Aeq} target levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events, such as fireworks night or New Year's Eve.

NOTE 4 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 $L_{Amax,10min}$, depending on the character and number of events per night. Sporadic noise events could require separate values. In most circumstances in noise-sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB $L_{Amax,10min}$ more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events (see Appendix A).

NOTE 5 Designing the site layout and the dwellings so that the internal target levels can be achieved with open windows in as many properties as possible demonstrates good acoustic design. Where it is not possible to meet internal target levels with windows open, internal noise levels can be assessed with windows closed, however any façade openings used to provide whole dwelling ventilation (e.g. trickle ventilators) should be assessed in the "open" position and, in this scenario, the internal L_{Aeq} target levels should not normally be exceeded, subject to the further advice in Note 7.

Figure 2: ProPG Guidance

3 Noise Survey Baseline Conditions & Results

A noise survey was carried out on the 11/06/2020 to assess the existing noise levels affecting the proposed development.

3.1 Noise Survey Details

- Survey carried out by: George Orton BEng (Hons) MIOA
- Equipment used: Norsonic NOR140 Type 1 Sound Level Meter
- Weather conditions: Dry with slight breeze

The meter was calibrated before commencing the noise measurements (@94dB). The calibration was re-checked at the end of the measurements to ensure that no calibration drift had occurred. After survey the calibration showed no significant drift (94dB)

3.2 Noise Survey Location

The measurement position (shown below along with layout of the proposed development) was on the empty site where noise levels would be defined as free-field. All noise levels in this report will be free-field noise levels unless stated otherwise (including noise levels predicted by the model):

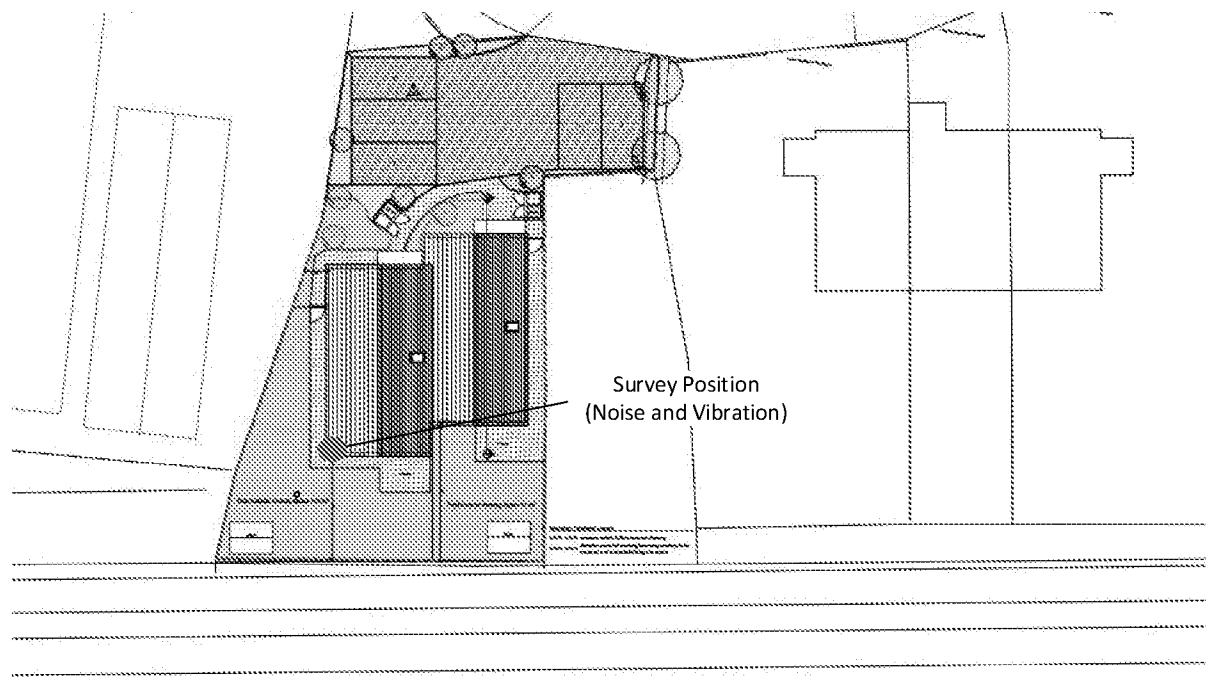


Figure 3: Survey Location Drawing

3.3 Noise Survey Results Summary

A summary of the noise measurements can be seen below:

- Westbound Trains – Average Sound Exposure Level = 79dBA
- Eastbound Trains – Average Sound Exposure Level = 84dBA
- No train(same duration as train pass by) – Average Sound Exposure Level = 58dBA

The ambient (no train) measurements were well below the train noise measurements. Therefore no corrections would be required.

4 Rail Noise Prediction

As stated previously the train timetable was reduced due to Covid19 Lockdown restrictions. However the usual (non-lockdown) timetable for 2020 was still available

4.1 Noise Level comparison

As a precaution the train noise measurements were compared to measurements completed historically (2013) at a site only 100m to the west.

On average the historic measurements (adjusted for distance (-1.5dB) to enable a like for like comparison) were marginally higher as detailed below:

- Westbound Trains – Average L_{Ae} – 2020 = 79dBA
- Westbound Trains – Average L_{Ae} – 2013 = 84dBA
- Eastbound Trains – Average L_{Ae} – 2020 = 84dBA
- Westbound Trains – Average L_{Ae} – 2013 = 87dBA

It is possible that the lighter weight (less passengers) trains create lower noise levels as they pass by. Another reason for the difference is that the 2013 site had a clearer view of the railway line. With the clear view the trains could be seen and heard sooner than was possible on the proposed (2020 survey) site which had a limited field of view. This may have resulted in the 2020 measurements being slightly shorter in duration which will have reduced the overall sound exposure level.

To err on the side of caution historic sound readings have been used to form the basis of this noise assessment.

4.2 Timetable Information

The usual (non-lockdown) 2020 timetable was reviewed and found to be very similar to the 2013 timetable:

Train Type	2020 (pre Covid)		2013	
	Day	Night	Day	Night
East	71	11	70	11
East GW	2	0	2	0
West	73	7	73	8
West GW	2	0	2	0
Total	148	18	147	19

Table 2: Train Timetable Data

The difference in train numbers would translate to a difference in noise level of no more than 0.2dB

4.3 Total Noise Level at Measurement Position

The total noise levels at the 2013 measurement position for all trains in both directions is detailed below:

Train Type	$L_{Aeq, day/night}$ – dB(A)	
	Day	Night
All Passenger Trains	62	56

Table 3: Noise Level at 2013 Position

The full calculation can be found in the appendix

5 Computer Noise Model

In order to see how noise varies at different positions around the proposed development it is possible to produce a noise contour map. A computer noise model has been completed using the computer package IMMI. Drawings of the proposed development have been used to complete the noise models. IMMI faithfully implements the propagation method of ISO-9613:1996; Acoustics – Attenuation of sound during propagation outdoors.

5.1 Survey Noise Model Methodology

The surrounding buildings were added to the model along with a survey position reception point (RP) for the 2013 survey position. The RPs predict the noise level at a discrete position within the noise model.

The railway was added to the model as two line sources (Separate for east and west directions)

Initially westbound sound power was adjusted until the day and night time levels equaled the westbound noise levels detailed in the appendix.

The westbound source was switched off and then the eastbound train source was added and calibrated as above.

5.2 Main Noise Model Methodology

The proposed development building was added to the model along with reception points corresponding with habitable room windows. Both railway (East & West) noise sources were switched on. The day time model can be seen below (other models can be found in the appendix of the report):

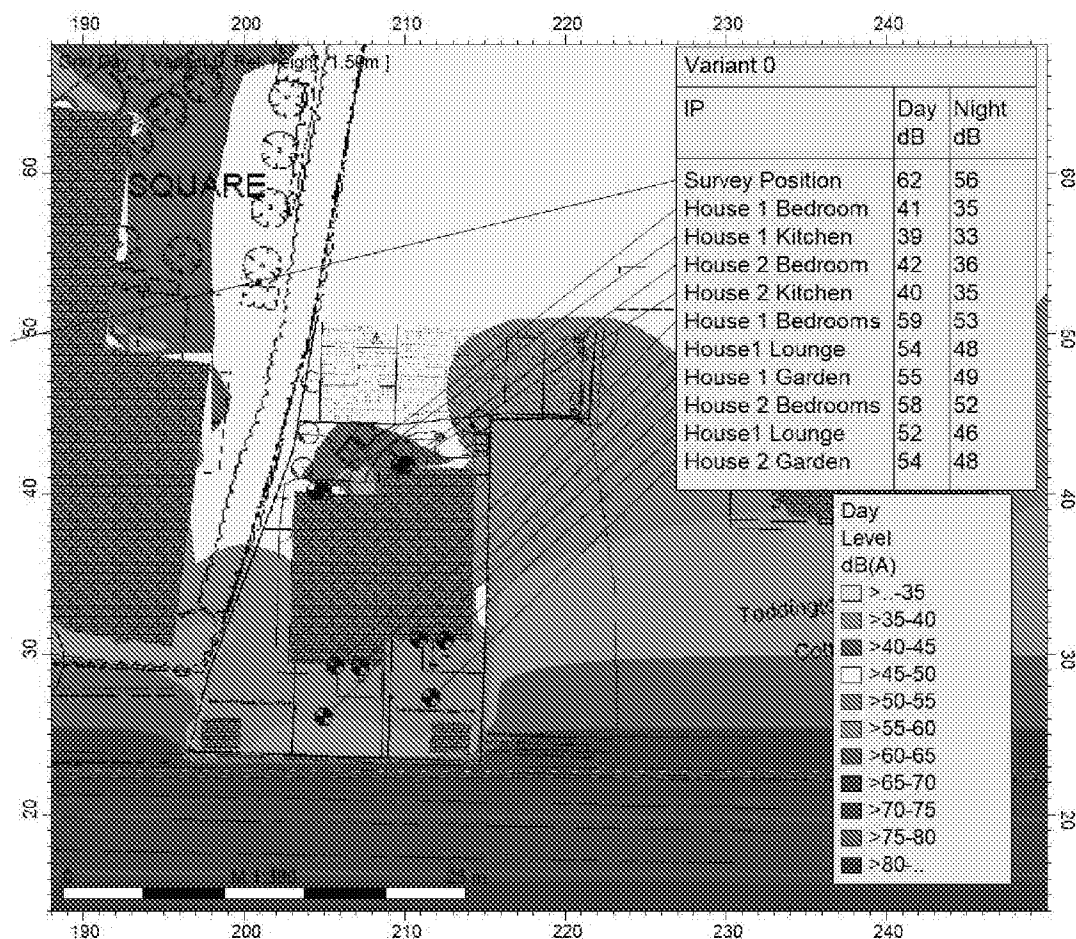


Figure 4: Day Time Gnd Floor Model

6 Required Sound Insulation of Building Envelope

6.1 Noise Criteria

6.1.1 Continuous Noise Levels

The BS8233 2014 and WHO noise criteria will be used to specify the noise mitigation measures for all habitable rooms. The maximum internal noise level for each area is as follows:

- Bedrooms 30dBA Night
- Lounges 35dBA Day
- Kitchens 40dBA Day

6.1.2 Maximum Noise Levels

For L_{Amax} events the ProPG noise L_{Amax} criterion will be used to specify the noise mitigation measures for bedrooms only:

For a reasonable standard in noise sensitive rooms at night (e.g. bedrooms) individual noise events should not normally exceed 45dB LAFmax more than 10 times a night.

The above is similar to guidance in the WHO Guidelines for Community Noise 1999 document. However the ProPG criteria suggests limiting the number of L_{Amax} events (over 45dBA) to less than 10 times a night as opposed to less than 10-15 times a night as stipulated by the WHO

6.2 Location Specific Sound Reduction (SRI)

The sound reduction of the building envelope (SRI) quantifies how well the building fabric will attenuate noise created outside of the building. The required sound reduction (SRI) has initially been calculated so that the continuous noise level; criteria can be achieved within the development.

For bedrooms the L_{Amax} survey data has also been used to predict the SRI required to limit L_{Amax} events to an average of no more than 10 per night.

This was completed by using the survey data with a correction factor relating to the difference in noise level between survey location and receptor location. The SRI was adjusted until the average number of L_{Amax} events per night was less than or equal to 10.

The calculations show that Bedrooms require a higher SRI for L_{Amax} events than for the SRI required to achieve the L_{Aeq,8hr} night time period noise criteria. As the 2020 data was used the L_{Amax} events have been limited to lower than the usual requirement of no more than 10 events (to allow for a small amount of uncertainty).

A summary of the required sound reduction to be provided by the building envelope can be seen below:

Area	Lounge/Kitchen		Bedrooms			L _{Amax} >45
	RP	SRI	RP	SRI	SRI L _{Amax}	
Rear	54	19	53	23	30	8 (if SRI is 30)
Front	40	0	36	6	13	8 (if SRI is 13)

Figure 5: Sound Reduction Summary

7 Mitigation Measures

7.1 Building Fabric and Noise Ingress

Usually the weakest part, in terms of noise ingress, of a building's façade are the windows and trickle ventilators.

7.1.1 Glazing

From a calculation detailed in the appendix basic glazing and trickle ventilators should achieve a sound reduction of approximately 24dB (for worst case lounge with larger window).

For the basic mitigation measures calculation the glazing R_w+C_{tr} was 25dB (As detailed in a test result for Pilkington 4mm/12mm/4mm glazing) and the ventilator $D_{n,e,w}$ was 29 (Velfac test result for standard non-acoustic vent is 31dB for worst case assumed there are 2 vents I.E. performance of both vents together is 29dB)

At the most affected façade the building envelope sound reduction will have to be 30dB which demonstrates that enhanced glazing will be required.

7.1.2 Ventilation Strategy

It is understood that either intermittent or continuous extract fans will be installed. Therefore there will be the need for trickle ventilators to allow the ingress of fresh air. As with the glazing an enhanced specification would be required for bedrooms overlooking the railway.

7.1.3 Acoustic Design Strategy

A calculation was completed to show that the 30dB sound reduction would be relatively easy to achieve.

Windows (performance for glazing and frame) achieving at least $R_w+C_{tr} = 26dB$.

The total performance for all trickle ventilators, in the room, will have to achieve a minimum element normalised sound reduction of $D_{n,e,w} = 36dB$.*

** For one trickle vent $D_{n,e,w} = 36dB$. For two trickle vents $D_{n,e,w} = 39dB$. (I.E Required performance $+10\log N$ where N = number of trickle vents in room).*

The table below shows the recommended glazing and trickle ventilator specifications for each habitable room:

Room	Window R_w+C_{tr}	Trickle Vent $D_{n,e,w}$		
		1 Vent	2 Vents	3 Vents
Enhanced Specification (30dB sound reduction)				
Bedrooms overlooking railway	26	36	39	42
Standard Specification (at least 24dB sound reduction)				
All other rooms	Standard glazing and vents			

Table 4: Room Specific Mitigation Measures

7.2 Noise Barrier

To reduce the noise level in the gardens to below 55dBA (WHO/BS8233 upper limit) a 2.2m high noise barrier will be required (barrier was detailed in the noise model calculations)

7.2.1 Location

The location (Blue) of the barrier is shown below (also shown on planning drawings):

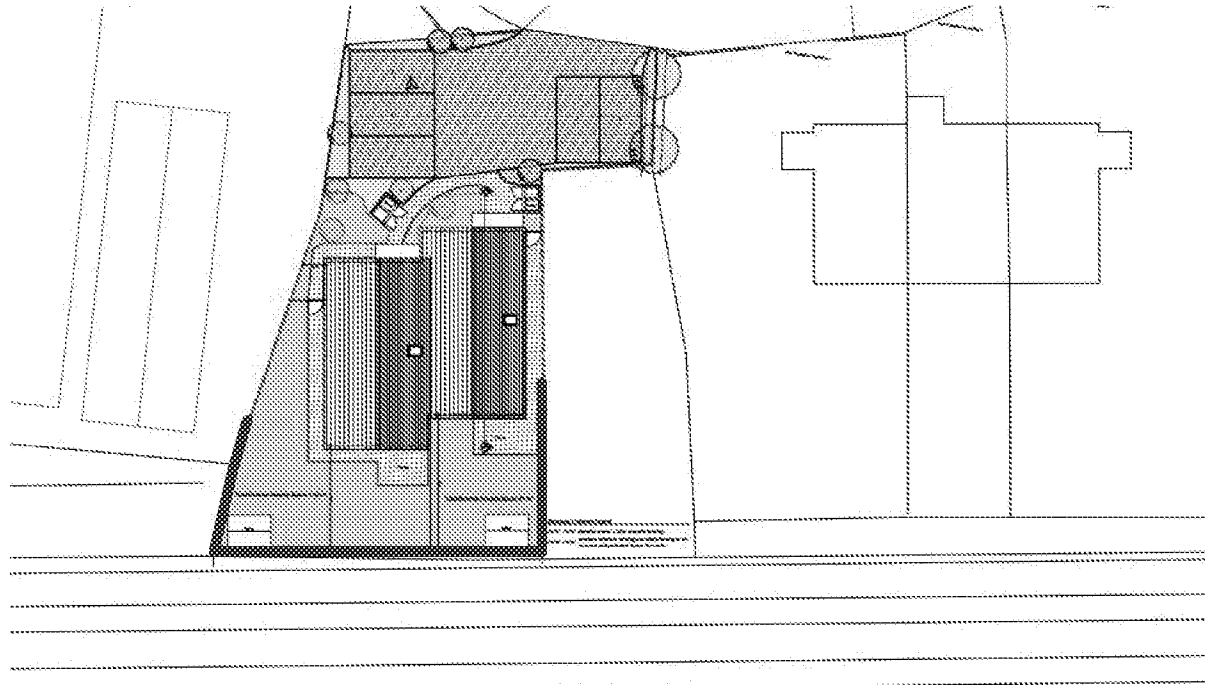


Figure 6: Noise Barrier Location

7.2.2 Construction

If a timber fence is to be built the specification should be as follows:

Spruce:

- Abutting panels not less than 30 mm thick, with joints sealed by cover strips not less than 30 mm thick, and the strip extending not less than 25 % over adjacent panels.
- Tongued and grooved panels to be not less than 35mm.

Douglas Fir

- Abutting panels not less than 22 mm thick, with joints sealed by cover strips not less than 22 mm thick, and the strip extending not less than 25 % over adjacent panels.
- Tongued and grooved panels to be not less than 27mm.

Alternatively proprietary acoustic fencing could be used such as Jackson's "Jakoustic" system:

<http://www.jacksons-fencing.co.uk/fencing/fencing/acoustic-barriers/fencing-acoustic-barriers.aspx?pg=5>

8 Vibration Survey Baseline Conditions & Results

A vibration survey was carried out on the 11/06/2020 in order to measure ground-borne vibration levels associated with the nearby railway.

8.1 Survey Details

8.1.1 Equipment

- Omnidots Swarm vibration monitor
- Spiked Mounting Plate

8.1.2 Personnel

Survey carried out by: George Orton BEng(Hons) MIOA

8.1.3 Location

The transducer was located at the same position at the noise survey (see Figure 3)

The tri-axial transducer was fixed to a mounting plate (with spiked feet) that was placed on the ground (area of soil amongst the crushed concrete spread over the site)

8.2 Frequency Weighting

BS6472 states which frequency weightings should be used for each axis. The weighting curve modulus for vertical acceleration (z-axis) is *Wb*; and *Wd* for horizontal acceleration (x- and y-axis). The Omnidots Swarm was set up so that the correct frequency weightings were applied to the measurements.

8.3 VDV Results

Vibration from passing trains was measured continuously for 2 hours:

Position	Measured VDV $ms^{-1.75}$		
	X-axis	Y-axis	Z-axis
1 (2hrs)	0.030	0.04	0.14

Table 5: Measured Vibration Levels

8.4 Prediction of Day and Night VDV levels

Measurements lasted for 2hrs during the daytime. During the day the trains operate for the whole period (16hrs). The standard timetables show that trains will pass the site for approximately 3 hours of the 8hr night time period.

The equation, from BS6472 as detailed below, will be used to predict the VDV_{day} and VDV_{night} values:

Where the vibration conditions are constant or repeated regularly, only one representative sample, of duration τ seconds, needs to be measured. If the vibration dose value determined is $VDV_{b/d,r}$ then the total vibration dose value for the day, $VDV_{b/d,day}$ will be given by equation 2.

$$(2) \quad VDV_{b/d,day} = \left(\frac{t_{day}}{t_r} \right)^{0.25} \times VDV_{b/d,r}$$

Where: t_{day} is the duration of exposure per day (s).

To err on the side of caution (as reduced timetable was operating) it is assumed that the number of trains during lockdown was 25% lower. Therefore the above equation will be modified to:

$$VDV_{Day} = \left(\frac{16}{2} \times 1.25 \right)^{0.25} \quad VDV_{Night} = \left(\frac{3}{2} \times 1.25 \right)^{0.25}$$

8.5 Vibration Assessment

8.5.1 Predicted Levels Uncorrected

The predicted vibration levels are detailed below:

Period	Predicted VDV $ms^{-1.75}$		
	X-axis	Y-axis	Z-axis
Day 07:00-23:00Hrs	0.05	0.07	0.26
Night 07:00-23:00Hrs	0.04	0.05	0.17

8.5.2 Corrections

BS6472 states that when vibration transfers from one medium to another, a transfer function should be applied to the measured levels to indicate the factor of change created by the change in medium. This is important as the measurements of vibration need to be assessed for the point where vibration enters the human body, in this case, the building where a person is located.

As the measurements were taken in what would effectively be free-field conditions (within the soil) a transfer function to convert the vibration to how it would be felt within a building will need to be applied.

The ANC Guidelines for the Measurement and Assessment of Groundborne Noise and Vibration provides a table (table 14.3 on page 121 of the document). This has been repeated below for completeness:

Ground Surface to building slab (in contact with the ground)	Ground surface to foundation	Floor to Floor	Floor Resonance
0 dB at low frequencies	woodframe: -5dB 1-2 storey commercial: -7dB 2-4 storey masonry: -10dB	1 – 5 floors: -2dB/floor	= 5 to 15dB over 16-80 Hz= 6dB

Table 6: ANC Guidelines - Groundbourne Vibration Transfer Functions

In summary, as the vibration enters the foundation from the ground surface, there will be a large reduction in the vibration level, followed by a smaller reduction per storey that the vibration travels through. This will be offset by the resonance of each floor (which will increase the vibration magnitude).

This ultimately means that the vibration reduction due to building structure will be more or less cancelled out by mid-floor resonances and thus there will be no change in vibration level to be applied.

8.5.3 Assessment

At worst the most affected Z axis VDV level is within the “Low Probability of Adverse Comment” range. The VDV levels for other axis are lower than “Low Probability of Adverse Comment” range.

The predictions are marginally higher than for a (non-lockdown) assessment carried out at a site to the east of the development on the other side of the level crossing.

9 Conclusion

9.1 Summary

The following has been assessed:

- Noise created by the railway line to the south of the proposed development
- Vibration levels created by the railway line to the south of the proposed development

The noise & vibration levels for the day and the night time period have been assessed in terms of and following the guidelines of the documents listed below:

- Calculation of Rail Noise (CRN) 1995.
- World Health Organisation (WHO): Guidelines for Community Noise (1999)
- BS8233: Sound insulation and noise reduction for buildings (2014)
- ProPG: Planning & Noise (Professional Practice Guidance on Planning & Noise) 2017
- BS 6472-1: Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting (2008)

9.2 Assessments

9.2.1 Internal Noise Criteria

The model has been used to predict that, for the worst case areas, an SRI of 30dB will be required if the internal noise criteria are to be achieved (WHO/BS8233 and ProPg for L_{Amax}).

Acoustic performance specifications have been provided, for glazing and trickle vents, so the 30dB sound reduction can be achieved.

With an open window (reducing external sound level by around 13dB) the majority of rooms will have a noise level defined as at least reasonable by BS8233 (40/35dBA at day/night).

9.2.2 External Noise Criteria

To reduce the noise level in the gardens to below 55dBA (WHO/BS8233 upper limit) a 2.2m high noise barrier will be required

9.2.3 Vibration

Measured vibration levels are at worst in the “low probability of adverse comment” range as defined by BS6472.

9.3 Conclusion

No specific vibration mitigation measures would be required.

Noise mitigation measures have been recommended so the ProPG, WHO and BS8233 noise criteria can be achieved.

Achieving these criteria will result in a good acoustic environment inside the proposed dwellings. For the reasons above it is considered that planning permission would not be refused on noise grounds albeit with possible planning conditions relating to noise.

Achieving these criteria will result in a good acoustic environment inside the proposed dwellings. For the reasons above it is considered that planning permission would not be refused on noise grounds albeit with possible planning conditions relating to noise.

10 Appendix A

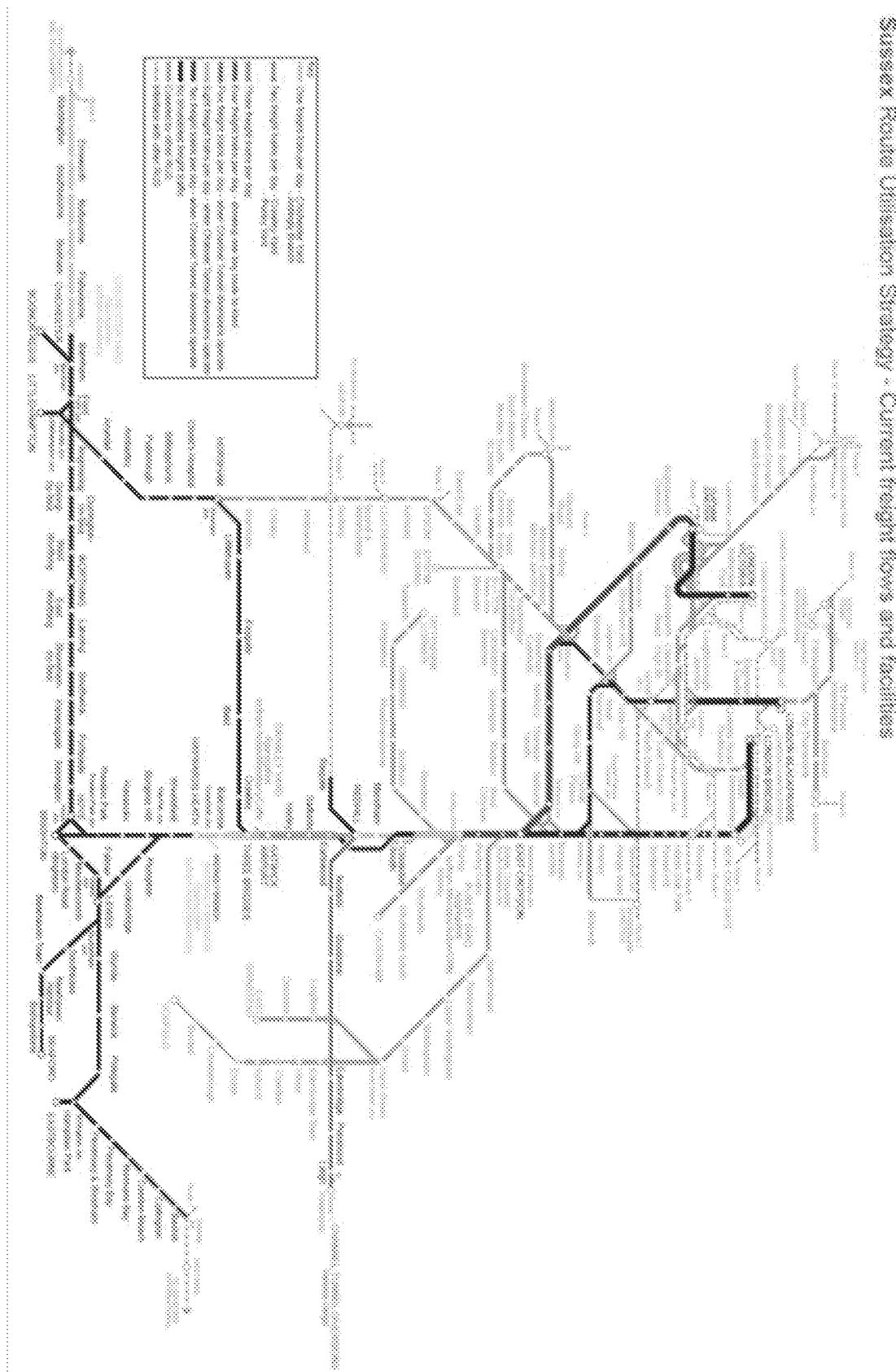


Figure 7: RUS Freight Train Map

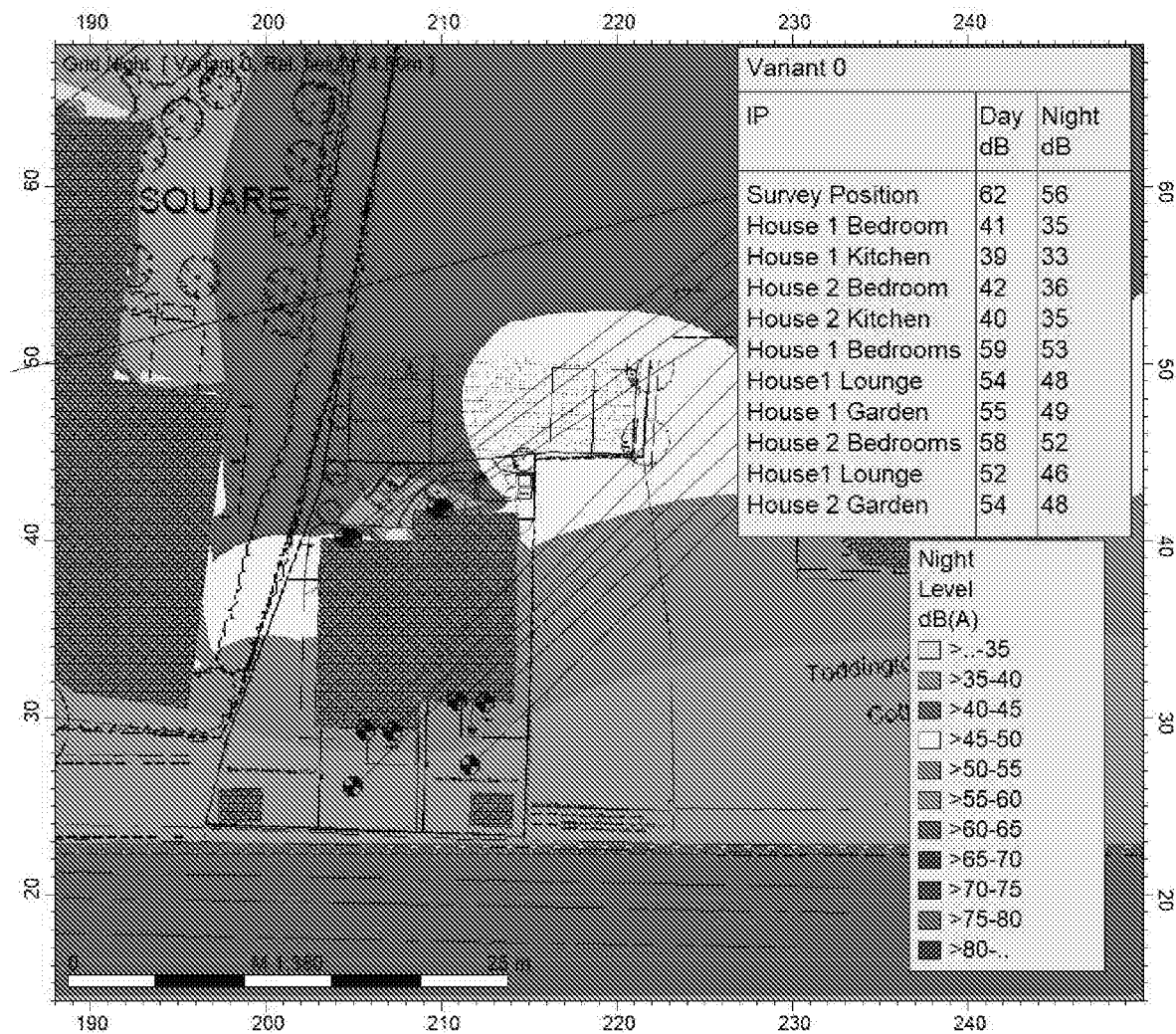


Figure 8: Night Time Noise Model

Status	LAeq	LAE	LAFmax
8 e	74	84.5	78
8 w	74.7	83.7	78.4
3 w	72.8	83.7	79.2
4 e	70.6	82.1	78
4 w	70.7	78.7	78.1
4 e	72.3	82.1	79.2
8 e	76.9	86.1	81.2
4w	57.5	64.9	65.8
4e	73.6	81.5	80
4 w	63.1	70.5	67.5
3 w	75.3	83.5	
4 e	71.9	81.9	80
8 e	76.8	88.3	78
8 w	75.8	87.2	82.2

Table 7: 2020 Train Noise Measurements

Octave Band Centre Frequency (Hz)								Overall dBA
Source	63	125	250	500	1k	2k	4k	
Incident sound level (freefield)	50	46	41	46	48	43	33	51
Path								
Element 1 ,Rw +Ctr25 STL	-16	-19	-16	-27	-40	-46	-44	19
Facade Shape Level diff.	0	0	0	0	0	0	0	
Area (+10Log A) [5.0 m2]	7	7	7	7	7	7	7	
Element sound level contribution	33	26	24	18	6.9	-4.1	-12	
Element 2 ,Dnew 29 STL	-30	-30	-28	-22	-27	-27	-33	21
Facade Shape Level diff.	0	0	0	0	0	0	0	
Area (+10Log A) [10 m2]	10	10	10	10	10	10	10	
Element sound level contribution	35	28	26	20	9.3	-2.5	-10	
Receiver								
Room volume (-10Log V) [40 m3]	-16	-16	-16	-16	-16	-16	-16	27
Reverberation time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
RT (+10Log T)	-3	-3	-3	-3	-3	-3	-3	
Equation Constant	11	11	11	11	11	11	11	
Room sound level	33	27	24	27	23	18	2.1	

Figure 9: SRI 24dB Calculation

Octave Band Centre Frequency (Hz)								Overall dBA
Source	63	125	250	500	1k	2k	4k	
Incident sound level (freefield)	50	46	41	46	48	43	33	51
Path								
Element 1 ,Rw +Ctr 26 STL	-20	-21	-17	-35	-44	-47	-50	13
Facade Shape Level diff.	0	0	0	0	0	0	0	
Area (+10Log A) [1.5 m2]	2	2	2	2	2	2	2	
Element sound level contribution	26	20	20	6.7	-0.2	-8.4	-21	
Element 2 ,Dnew 36 STL	-40	-40	-36	-35	-33	-37	-37	20
Facade Shape Level diff.	0	0	0	0	0	0	0	
Area (+10Log A) [10 m2]	10	10	10	10	10	10	10	
Element sound level contribution	14	9.5	9.2	15	19	9.8	0.34	
Receiver								
Room volume (-10Log V) [20 m3]	-13	-13	-13	-13	-13	-13	-13	21
Reverberation time (s)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	
RT (+10Log T)	-4	-4	-4	-4	-4	-4	-4	
Equation Constant	11	11	11	11	11	11	11	
Room sound level	26	21	20	16	19	9.9	0.37	

Figure 10: SRI 30dB Calculation

11 Appendix B Calculation of Railway Noise Level at 2013 Position

This section gives details of the 2013 noise survey measurements and details of how the day and night time period noise levels have been calculated.

11.1 Noise Survey Results

During the survey 24 measurements were taken (Sound Exposure Level (SEL)) of the train pass-by events. Ambient noise measurements were also taken. As the train noise measurements were at least 10dB greater than the ambient noise level, no correction has been applied. Taking the (arithmetic) averages of the SEL values for each train type (and direction) gave the following results:

Quantity		Operator	Train Notes	Average SEL - dB(A)	
East	West			East	West
7	8	Southern	4 Carriage Train	88	86
4	4	Southern	3 Carriage Train	90	87
1	-	Great Western	3 Carriage Train	82	80 ¹

Table 8: Survey Noise Levels

11.2 Train Timetable

Train timetable information for trains operating between Angmering and the Ford/Barnham junction was viewed online (Southern Trains timetable was used which also includes Great Western train). Below is a summary of the timetable information (including trains which do not stop at Angmering station):

Train Type	Number of trains			
	East		West	
	Day	Night	Day	Night
Southern	37	6	37	5
Southern S/P ²	33	5	36	3
Great Western	2	0	2	0
Total	72	11	75	8

Table 9: Train timetable info.

11.3 Converting Sound Exposure Levels (SEL) to L_{Aeq} Levels (measurement position)

In paragraph 3 CRN states that having established, by measurement, the mean values for the SELs of each train type operating on the railway, the day and the night time noise levels (L_{Aeq,16hr} and L_{Aeq,8h}) can be calculated.

The day and the night time period noise level relating to each train type can be calculated using the following formula

$$\text{Train Type } L_{Aeq, \text{ day/night}} = \text{SEL} - 10\log T + 10\log N$$

- N = no. of events in period (For each train type based upon timetable information)
- Day = 07:00-:23:00hrs & Night = 23:00-07:00hrs
- T = no. of seconds in period (57600 seconds for the day and 28800 for the night)

¹ Great Western westbound predicted as none were measured:

GW West = GW east train noise level minus east/west noise level difference

² The 3 carriage "Southern" trains travel to and from Southampton/Portsmouth (S/P)

11.4 Train Type Day/Night Noise Levels

The table below shows the calculated results of the train type noise levels:

Train Type	L _{Aeq,day/night} – dB(A)			
	East		West	
	Day	Night	Day	Night
Southern	56	51	54	48
Southern S/P	58	52	55	47
Great Western	38	0	35	0
Total	60	55	58	51

Table 10: Train Type Day/Night Noise levels

11.5 Total Noise Level at 2013 Measurement Position

The total noise levels detailed above can be added together to show the total day and night time noise level at the measurement position for all trains in both directions

Train Type	L _{Aeq,day/night} – dB(A)	
	Day	Night
All Passenger Trains	62.1	56.3

Table 11: Total Noise Level Day/Night at 2013 measurement Position