

Acoustic Associates Sussex Ltd

Planning Change of Use – Noise Assessment.

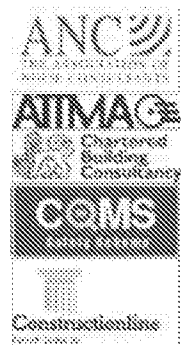
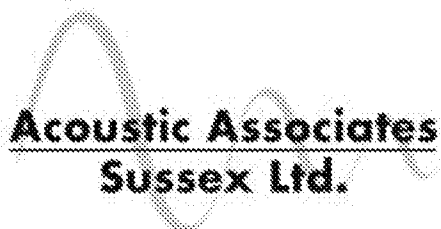
Site: **Former Barclays Bank, 71 High Street, Littlehampton.**
Client: **Sussex Property Partnership**

Report by: **Scott Castle BSc (Hons) CEnvH, MCIEH PGDip: Acoustics MIOA**

Date: **11/11/2021**

Project: **J3270**

Issue **1**



Sound Insulation Testing - Acoustic Design of Buildings - BS4142 - PPG24 - Schools Acoustics B893 -
Vibration - Expert Witness Testimony - Noise at Work - Air Tightness Testing - Auditorium Acoustics

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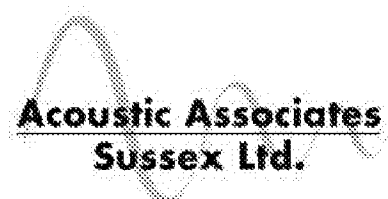
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1 Introduction

Acoustic Associates have been appointed to undertake an acoustic assessment to support an extension of the building and a part change of use planning application. Specifically, the ground floor of the former Barclays Bank will be four separate commercial units with a HMO (House in Multiple Occupation) above.

Standards and guidance referenced for this assessment include:

- World Health Organisation (WHO) - Guidelines for Community Noise 1999
- BS8233 (Sound insulation and noise reduction for buildings) 2014
- ISO9613 (Attenuation of sound during propagation outdoors) 1996
- ProPG2017: Planning & Noise – New Residential Development.
- Acoustics Ventilation and Overheating Guidance, January 2020
- Sussex Planning Noise Advice Document dated March 2021
- Building Regulations Approved Document E (ADE)

Two long term unattended class 1 sound level meters were used to measure the soundscape to the front and rear of the former Barclays bank between 4th to 9th November 2021. The dates deliberately included a weekend to ensure that any change in the soundscape was properly assessed.

The noisier façade is the East Street facade which overlooks the B2140 (61dB $L_{Aeq,16 \text{ hour}}$ for daytime and 55dB $L_{Aeq, 8 \text{ hour}}$ for night time). The quieter High Street façade looks to the South and measured 58dB $L_{Aeq,16 \text{ hour}}$ for the daytime period and 53dB $L_{Aeq, 8 \text{ hour}}$ for the night time period.

In line with ProPG2017, an initial site risk assessment has been undertaken detailing a low to medium risk for the development of the site

The proposed change of use and extension makes the site three storeys throughout. This includes four commercial units at the ground floor and a HMO above with bedrooms overlooking the East Street and High Street Facades. Three kitchen and dining areas (A-C) are located to the rear and will be sheltered from road traffic noise. A communal terrace for the residents is situated at the first-floor rear area which due to the shape of the building is also sheltered.

Noise modelling predicts a sound pressure level of 39dB $L_{Aeq, 16 \text{ hour}}$ for the communal terrace which is comfortably below the requirements for external amenity areas in both the WHO Guidelines for Community Noise (1999) as well as BS8233:2014.

Noise modelling software was used to predict the sound pressure levels of the different facades of the development. For the majority of the development standard thermal double glazing will be sufficient, when used in conjunction with an acoustic ventilator. However, there are two units (8 and 20) which have more than one window and which by default will allow a greater amount of sound energy into the unit. For Units 8 and 20, enhanced glazing is recommended.

It is discussed within the report that the local planning authority may condition that the sound insulation between the ground floor commercial units and first floor residential units is upgraded to achieve 5dB(A) better than Building Regulations Approved Document E.

Sufficient data has been presented within the report to demonstrate that the change of use to flats/HMO is capable of being done on acoustic grounds with future occupants protected against road traffic and commercial sound sources. Planning permission should not therefore be withheld on noise grounds.

2 Context, Noise Criteria & Noise Assessment Methodology

2.1 Context and Location

The site footprint concerns the former Barclays Bank at 71 High Street, Littlehampton, BN17 5AE. The bank has now closed and it is proposed that the ground floor of the premises is given over to commercial premises (shell and core) with residential rooms above on the first and second floors. For the purposes of planning, the following description has been applied:

"Refurbish and renew the first and second floors of the existing building to the southern side of the site, with a new build proposal to the northern half of the site, creating a new entrance and entrance stairwell with bicycle and bin storage to the existing ground floor area and a new two storey (1st and 2nd floor) build co-living, HMO scheme above together with the change of the use to the bank (Use Class E) to four commercial units (Use Class E)"

The report therefore provides a scheme of glazing and/or ventilation to allow planning permission to be granted.

With the planned extension the former bank footprint will effectively all become three storeys in height. The site is seen in Figure 1 below and will have bedrooms which overlook both the East Street and High Street facades.

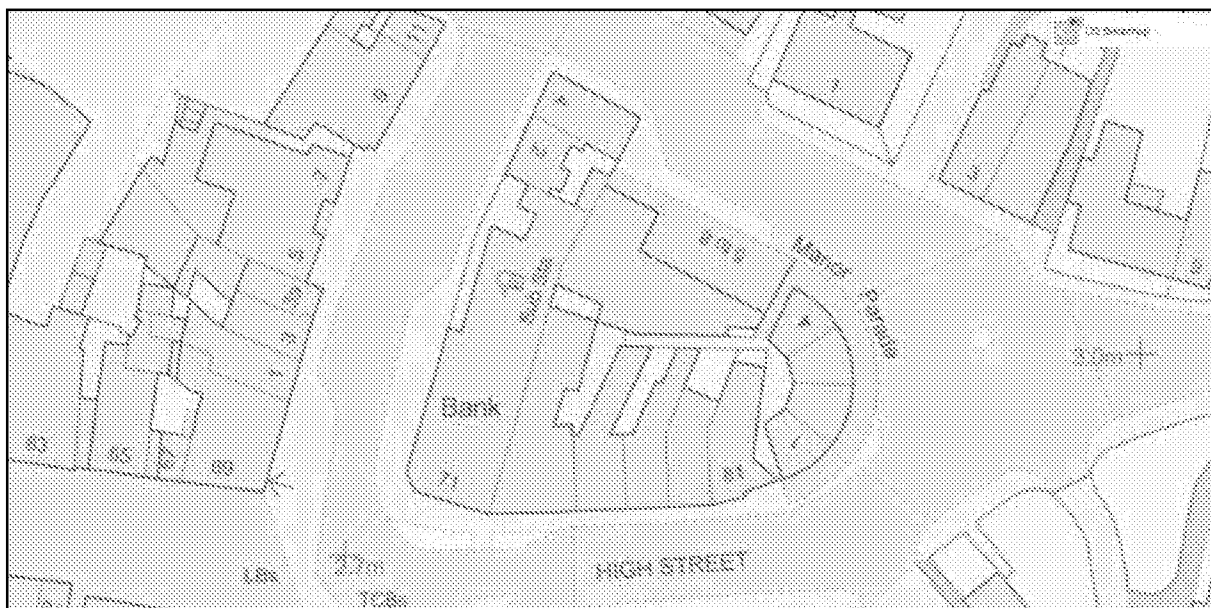


Figure 1. Site Location Plan

East Street is a one-way traffic route, which travels North to South. The road has taxi ranks on both sides which were noted to be well used throughout the daytime period, with the taxi office being immediately adjacent to the site footprint. East street commercial premises at

ground floor are restaurants with these being an Indian takeaway (Shahan), The Fish Factory, chicken cottage and Bethel Fish and Chips, as well as a tattooist. There are no apparent third-party external noise sources such as plant obvious at the rear of the bank area which required assessment.

At the High Street façade, the site is bordered by additional commercial ground floor premises such as estate agents.

Residential accommodation is apparent behind the former bank premises (see Figure 2 below) and above the commercial units which effectively form a small island.



Figure 2. Residential Accommodation behind/adjacent to the former bank

2.2 Proposed Floor Plans

The proposed floorplans are detailed below.





Figure 6. Elevational Drawing Showing changed East Street Facade

There are no habitable rooms located to the rear with only the communal terrace for consideration in terms of acoustics and subsequent assessment against external amenity area criterion. The bedrooms all face either the High Street or East Street facades. Due to the internal layout at first and second floors, there are no windows on the Northern most façade.

2.3 Soundscape

The soundscape was dominated by passing road traffic, pedestrians and the audible warning signal for the road crossing located adjacent to the bank entrance and joining the pedestrianised High street to the West.

2.4 ProPG2017

Planning guidance (ProPG2017) relates to new residential development and airborne transportation noise, which includes exposure to road traffic, railway and aviation noise. Whilst ProPG, 2017 generally mirrors the requirements of BS8233:2014 and the World Health Organisation Guidelines, 1999, it goes further in setting a limit for inside bedrooms for L_{Amax} events and specifically, no more than 10 L_{Amax} events per night time period above 45dB(A).

The internal bedroom L_{Amax} values will be used in accordance with ProPG2017, and an initial site risk assessment has been created to inform decision makers of the risk/s associated with developing the site on noise grounds.

2.5 BS8233:2014 Noise Criteria

Table 4 of BS8233:2014 provides the following guideline values:

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

Table 1. BS8233:2014 Criteria

2.6 Sussex Planning Noise Advice Document, March 2021

In line with the Sussex Planning Noise Advice document, which Arun have signed up to, it is recognised that the L_{Amax} values are an important driver for the site soundscape, and in particular how these influence the bedroom environment during the night time period. The survey equipment has therefore applied a very stringent 1minute L_{Amax} period for the assessment.

2.7 Approach Methodology

A number of external sound level meters are proposed to characterise the site soundscape where bedrooms and/or habitable rooms are proposed.

To ensure that a sensible estimation can be made of the communal terrace area it is proposed to use a noise model to construct the building shape and assign the measured values to the roadside traffic. This is due to the fact that the communal terrace is currently open to the environment, however this would not be the case post construction. The noise modelling software can also be used to predict the likely noise impacts at the receptor windows.

Given the commercial ground floor and residential demise above, it will also be necessary to carry out sound insulation testing in line with Building Regulations Approved Document E (ADE) to assess the performance of the existing separating floor between ground floor and first floor areas.

3 Sound Survey Baseline Conditions & Results

A sound survey was carried out between Thursday 4th November 2021 and Tuesday 9th November 2021. The duration of the survey deliberately covered a weekend to ensure that the soundscape was properly understood. Sound level meters were used to measure both the High Street and East Street Facades. The High Street façade survey location was protruded out of a first-floor window (façade measurement) and the East Street location used a flat roof close to the taxi rank to ensure that any vehicle idling, door slams, taxi office, and/or late-night refreshment venues were captured.

For the purposes of the report, all data has been converted to freefield conditions, with a subtraction of 3dB(A). All sound level meters used were calibrated before and after the survey without any significant drift having occurred. All external sound pressure level data presented is freefield, A weighted and Fast time weighted with a minimum averaging period of 1-minute, used to ensure that the night time L_{Amax} values could be accurately assessed.

The survey equipment is listed in Table 2 and Figures 7-8 it is detailed where the equipment was located.

3.1 Sound Survey Details

Survey(s) carried out by	Scott Castle BSc(Hons) Env Health, MCIEH CEnvH PGDip Acoustics MIOA
Equipment Used	LT1 – Castle/Svantek Mirus – Class 1 Sound Level Meter. Serial No. 96147
Equipment Used	LT2 – 01dB SIP95, Class 1 Sound Level Meter, Serial No. 31540
Location	LT1 – 2 nd Floor Window- High Street Façade. 4.4m above ground level LT2 – Flat Roof, East Street Façade. 1.9 m above flat roof level
Duration	4 th November 2021 to 9 th November 2021

Table 2. Survey Equipment

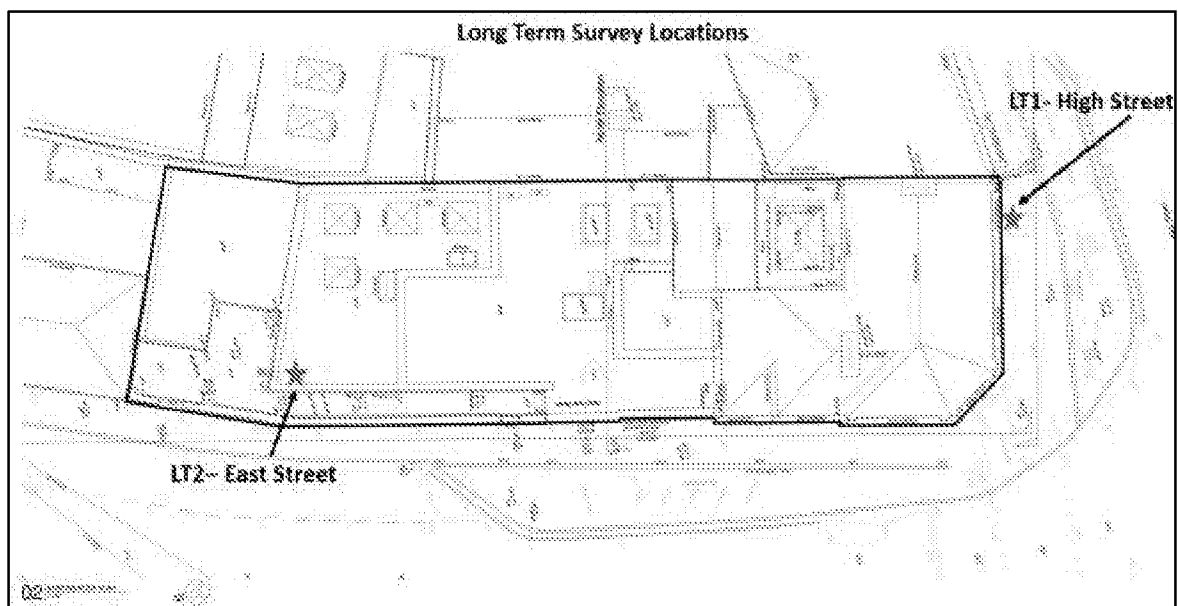


Figure 7. Site Plan of Long-Term Survey Locations



Figure 8. Images of Long-Term Survey Locations

3.2 Short Term Measured Data

A simultaneous measurement was made on the High Street façade with two sound level meters. This included the survey location LT1 at first floor level (see Figure 8 above) as well as an internal sound level meter at the second storey, same window element. This was to calculate the performance sound reduction index of the façade (SRI) for outside to inside. The current windows are single glazed sash windows which have deteriorated and not all catchments close properly.

The measurement duration was 15 minutes and the time clocks of the sound level meters were synchronised to allow a like for like comparison.

3.3 Sound Insulation Performance – Ground to First Floor Separating Floor

Given the commercial ground floor and residential demise above, a Building Regulations Approved Document (Part E) sound insulation test was carried out between ground and first floor to assess the performance of the separating floor. This was carried out on 4th November 2021. This was a vertical airborne test which used two tripod mounted speakers to excite the ground floor open area of the bank with subsequent receiving room and background tests made in defined first floor areas.

4 Measured External Sound Pressure Levels

As stated, the sound pressure levels measured are presented in dB(A), Freefield and Fast time weighted.

4.1.1 Position LT1-High Street Facade

LT1- High Street Façade			
Logarithmically Averaged Day and Night time Periods (External - Freefield)-dB(A)			
L _{Aeq} , 16 hour- 07:00-23:00		L _{Aeq} , 8 hour 23:00-07:00	
Day 1	57.7	Night 1	56.3
Day 2	58.0	Night 2	51.5
Day 3	57.4	Night 3	52.0
Day 4	57.4	Night 4	51.6
Day 5	58.7	Night 5	53.0
Arithmetic Average	57.8	Arithmetic Average	52.9

Figure 9. Measured Data for LT1- High Street Facade

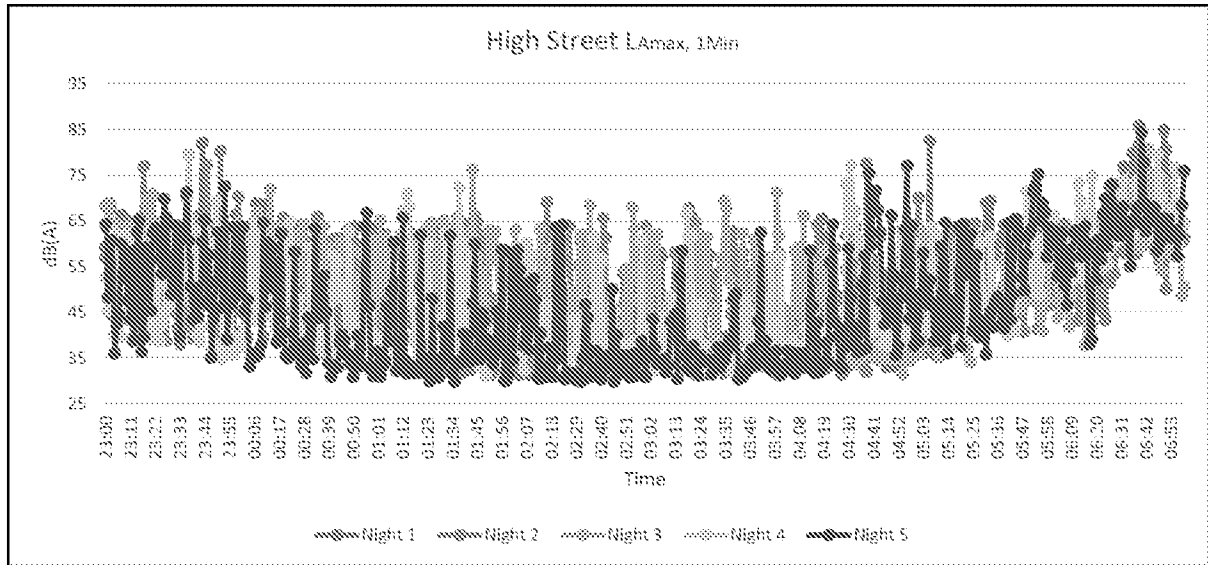


Figure 10. L_{max} Data for LT1-High Street

4.1.2 Position LT2-East Street Façade

LT2 - East Street Façade			
Logarithmically Averaged Day and Night time Periods (External - Freefield)-dB(A)			
	$L_{Aeq, 16 \text{ hour } 07:00-23:00}$		$L_{Aeq, 8 \text{ hour } 23:00-07:00}$
Day 1	60.7	Night 1	60.4
Day 2	61.6	Night 2	54.6
Day 3	59.5	Night 3	53.5
Day 4	60.4	Night 4	53.6
Day 5	60.9	Night 5	53.6
Arithmetic Average	60.6	Arithmetic Average	55.2

Figure 11. Measured Data for LT2- East Street Façade

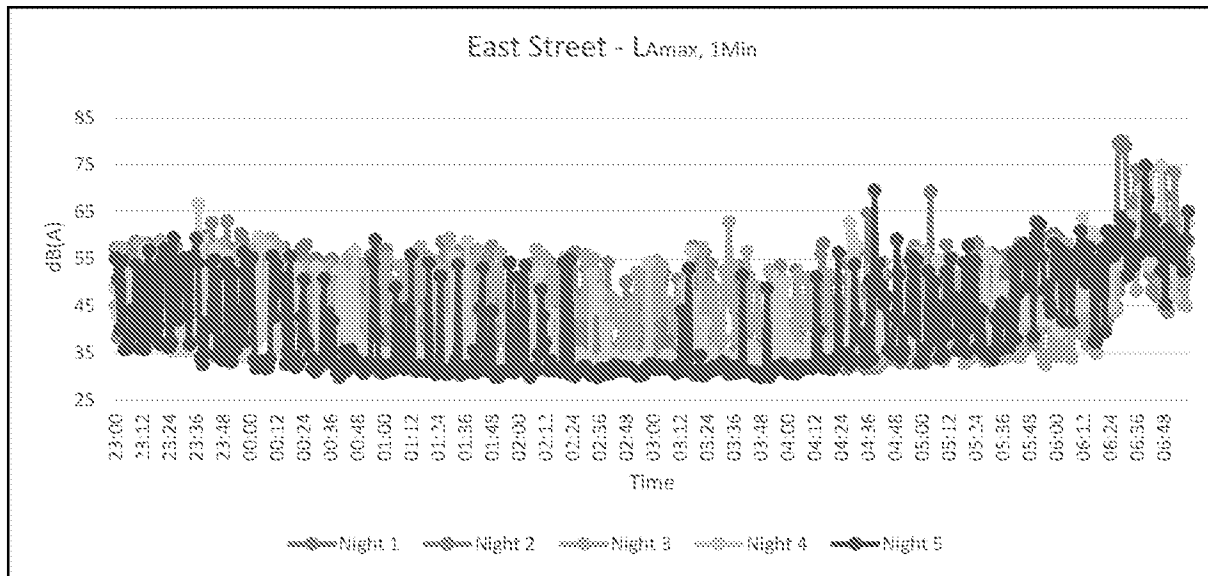


Figure 12. L_{Amax} Data for LT2-East Street

4.1.3 Outside to Inside Sound Reduction Index

As stated, a 15-minute measurement was made from outside to inside with the following results indicating the approximate performance of the current façade.

Inside to Outside Measurement	dB- $L_{Aeq,15minutes}$
Outdoor Measurement - Level 1 - External (Façade)	60.5
Internal Measurement - Level 2- windows closed	40.7
Approximate Sound Reduction Index	19.8

Figure 13. Outside to Inside Sound Reduction Index of Façade

It should be noted that the above results are only an approximation as the external measurements were made at 1st floor level and the internal measurements made at 2nd floor level.

4.1.4 Approved Document E- Vertical Airborne Sound Insulation Test

The results of the sound insulation testing carried out was as follows:

Ground Floor to First Floor Area – $50dB D_{nTw}-8dB(C_{tr}) = 42dB$.

Ground Floor to First Floor Server Room - $57dB D_{nTw}-6dB(C_{tr})=41 dB$

These results fall below the requirements of Approved Document E for a conversion which is $43dB D_{nTw}+C_{tr}$.

As a commercial premises with residential properties above, it is normal to consider a higher sound insulation performance requirement of 5dB above approved document E, this being a minimum requirement of $48dB D_{nTw}+C_{tr}$.

There would therefore be a requirement to upgrade the current ceiling/flooring partition between the ground floor and first floor.

4.1.5 Data Summary

Figure 14 details the rounded, logarithmically averaged freefield sound pressure levels as a result of the two survey positions.

Data Summary -dB(A)		
Location	Daytime- $L_{Aeq, 16 \text{ hour}}$	Night Time- $L_{Aeq, 8 \text{ hour}}$
LT1 High Street Façade	58	53
LT2 East Street Façade	61	55

Figure 14. Data Summary

5 Discussion

5.1 Data and General

The measured data at the two long term positions remained relatively consistent with only a 2dB variation in the daytime results for both LT1 and LT2 and between 4-6dB in the night time measured data. The noisier façade was that of East Street, which may relate to the taxi ranks and taxi office and/or the presence of late-night food venues where individuals may be loitering. East Street was noted to have a more continual flow of traffic before it slowed down to turn left into the High Street.

Given the location of LT2 on a secure rooftop area, it is relevant that as the residential demises move closer to the road and the road traffic noise (line source) that the expected façade noise levels may increase. Given the creation of a noise model for assessing the communal terrace area at the first floor, the same model can be used to predict façade noise levels for residential windows at first floor (4.9m above ground level) and second floor windows (7.9m above ground level) around the proposed development.

5.2 Noise Modelling Approach

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 area have been used to complete the noise models and the topography of the location recreated. IMMI faithfully implements the propagation method of ISO-9613:1996; Acoustics – Attenuation of sound during propagation outdoors.

IMMI Noise modelling was used to both construct a current site layout and then subsequently calibrated to the sound pressure levels measured from the two long term survey positions (see Figure 14 above). With the noise model constructed, the proposed new storeys were added and receptor positions placed as stated in 5.1 above to replicate the residential windows.

The architect drawings were used to scale the model as well as laser measurements taken on site.

An assortment of first and second floor properties were selected with different window sizes and exposures and worst-case flats with either large amounts of exposed façade or double windows (units 8 and 20)

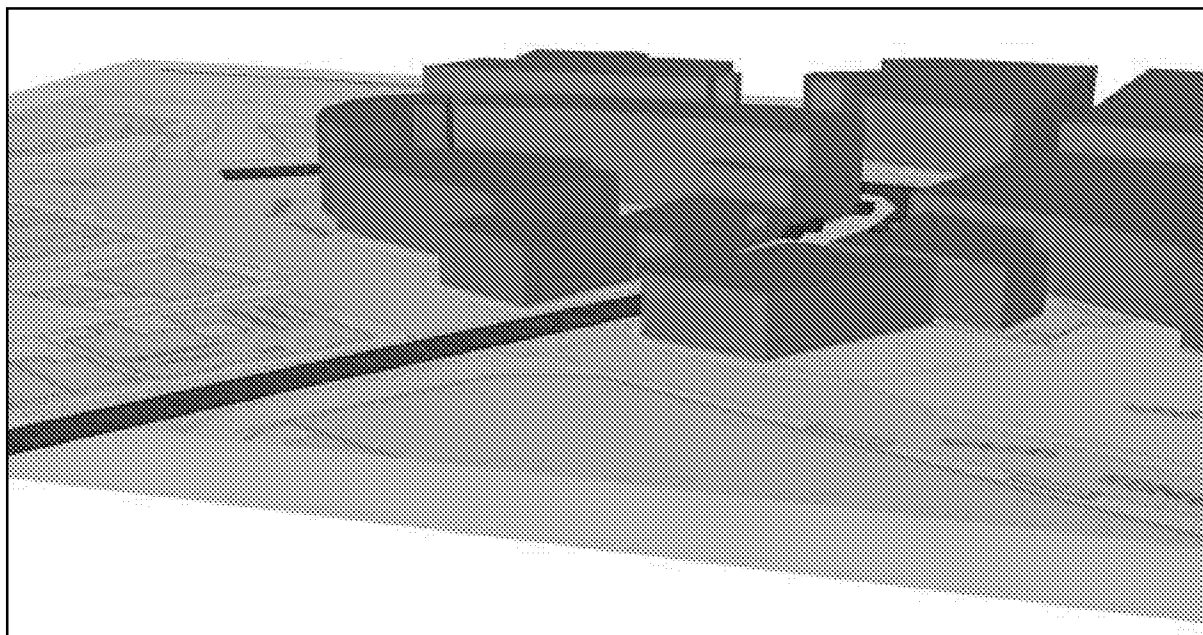


Figure 15. Calibration Model of Current Site

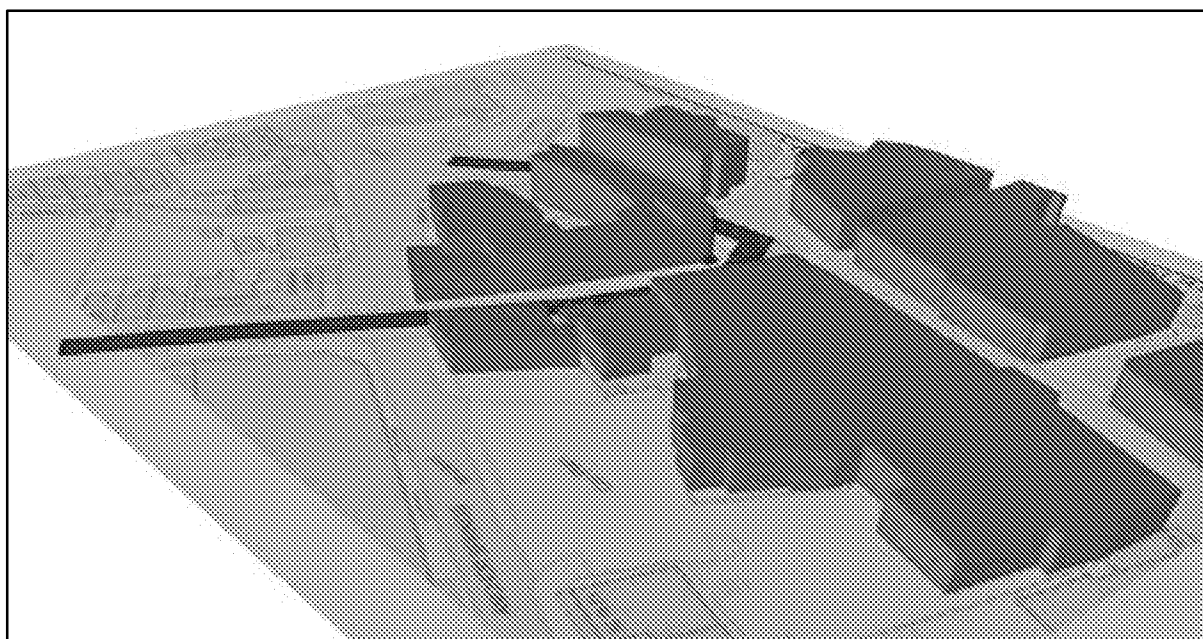


Figure 16. Newly Constructed Noise Model

5.3 Noise Model Outputs and Predicted External Sound Pressure Levels

The IMMI noise modelling process predicts A weighted and freefield values at the receptor locations. The daytime and night time predictions are shown in Figures 17 and 18 below. It must be noted that this represents only the continuous daytime and night time sound pressure levels, L_{Amax} events are further considered in section 5.4. It is also noted that the legend can be difficult to read and has been replicated below in section 5.4 for transparency.

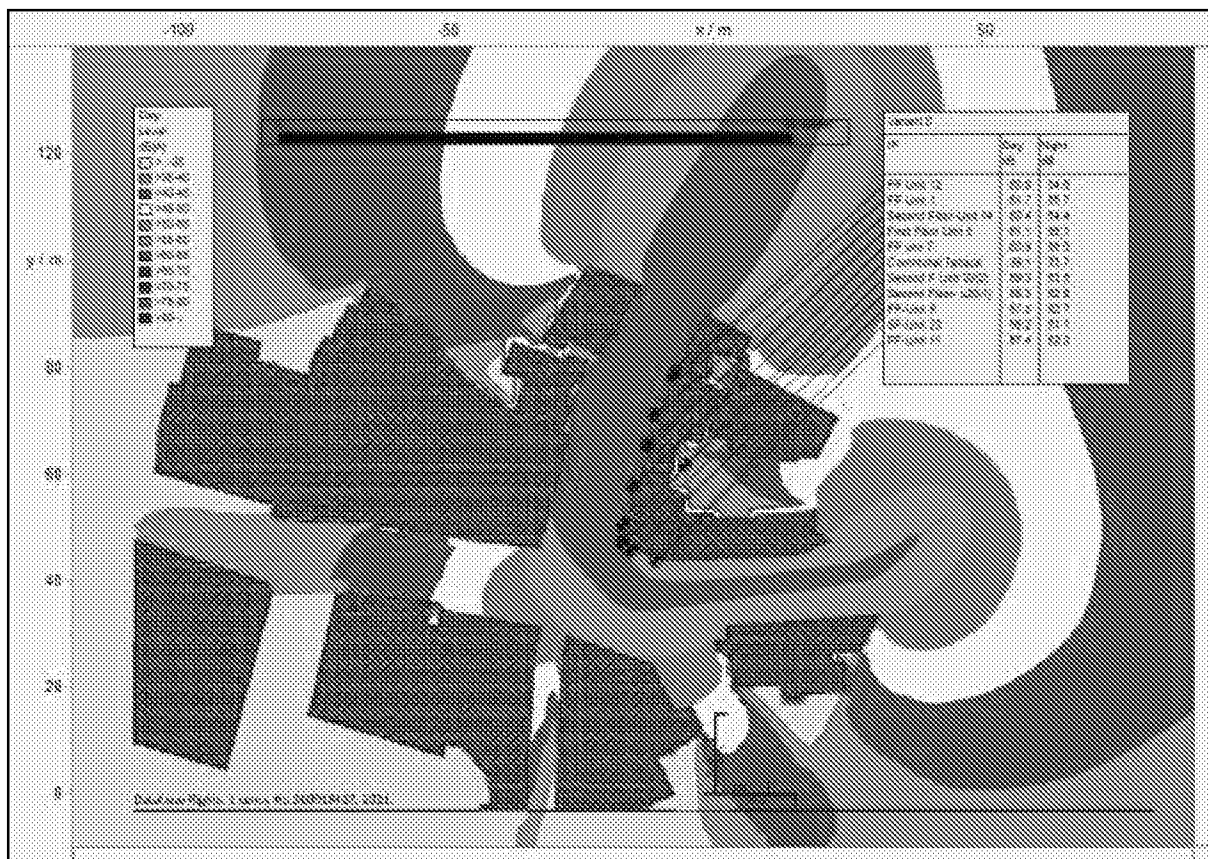


Figure 17. 2D Noise Contours- Daytime

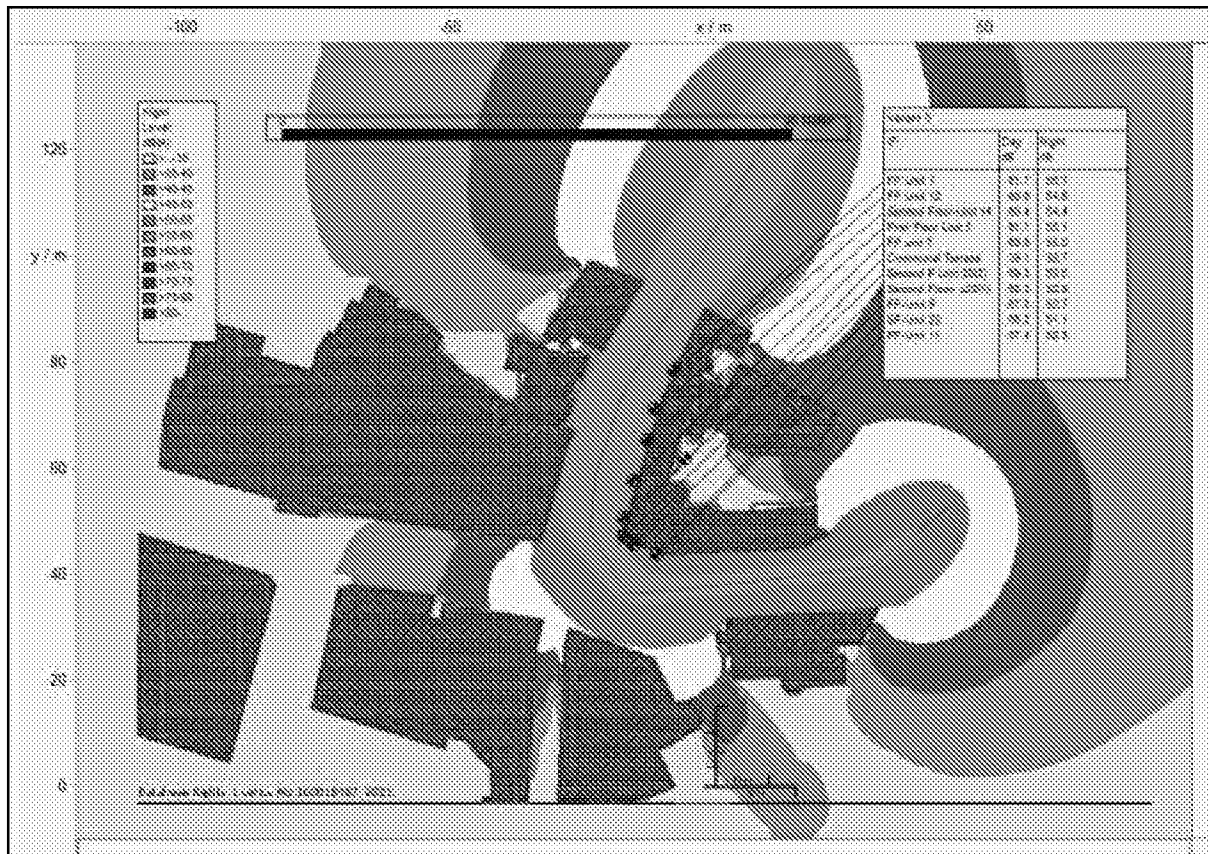


Figure 18. 2D Noise Contours - Night Time

5.4 Required Sound Reduction Index

There are three drivers which impact the façade sound reduction index or SRI. These are the daytime continuous noise levels measured over 16 hours in $L_{Aeq,T}$ and the night time continuous noise levels over 8 hours, also measured in $L_{Aeq,T}$. Additionally, ProPG2017 requires a consideration of the number of L_{Amax} events which will occur in a bedroom during the night time period. Specifically, ProPG2017 requires no more than ten events exceeding 45dB L_{Amax} measured internally. Whichever of the drivers is highest is applied to ensure that the residents are protected from each criterion.

An assessment has been made below of the predicted external noise levels around the proposed property at first and second floors with a view to providing receptor locations on both East Street and High Street facades.

The daytime SRI is the predicted external freefield sound pressure level minus 35dB as per the Table 4 values in BS8233:2014 and the same for the night time values (albeit minus 30dB).

The L_{Amax} SRI is achieved by using the predicted night time external sound pressure level and comparing this with the measured night time survey noise level. The SRI figure is then adjusted to prevent no more than 10 L_{Amax} events per night inside the bedroom environment above 45dB L_{Amax} . The adjustment process takes account of each of the 5 measured night time periods to ensure that no individual night exceeds 10 events of 45dB L_{Amax} inside the bedroom.

It should be noted that the more accurate 1-minute survey periods were used on both sound level meters to ensure that the Sussex Planning Noise Guidance was adhered to.

In reviewing the required SRI it is noted that for East Street, the SRI is dominated by the daytime continuous noise level over the 16 hour period, yet for the High Street façade, this is very much dominated by the L_{Amax} SRI during the night time period as the driver. This is reinforced by comparing Figures 10 and 12 above showing the incidence of L_{Amax} events during the night time period. The SRI requirements are detailed in Figure 19 below.

Assessment of SRI							
Location	Façade	Unit Number	Predicted Daytime $L_{Aeq, 16 \text{ hour}}$	Predicted Night Time $L_{Aeq, 8 \text{ hour}}$	Day SRI	Night SRI	L_{Amax} SRI
First Floor	East Street	1	62	56	27	26	23
Second Floor	East Street	12	61	55	26	25	22
First Floor	East Street	5	61	55	26	25	22
Second Floor	East Street	14	60	54	25	24	21
First Floor	East Street	7	61	55	26	25	22
Second Floor	East Street/High Street	20	58	53	23	23	32
Second Floor	East Street/High Street	20	59	53	24	23	32
Second Floor	High Street	23	56	51	21	21	30
First Floor	High Street	11	57	52	22	22	31
First Floor	High Street	9	58	53	23	23	31

Figure 19. Required Sound Reduction Index (SRI)

It is relevant to note that the existing single glazed timber sash windows would not meet the required Sound Reduction Index if left in situ as these were noted to be approaching the end of their functional life with fixtures and fittings failing.

5.5 Predicted Internal Sound Pressure Levels

Using the predicted freefield sound pressure levels from Figure 19 above, it is possible to use a rigorous calculation as per Annex G.2 of BS8233:2014. The calculation takes into account how the glazing size and façade size, and indeed any other transmission routes such as through ceilings to identify the likely internal sound pressure levels. Whilst Figure 20 below is a summary, the worked examples are detailed in the Appendix. Figure 20 also details the required sound reduction index vs the achieved sound reduction index and internal sound pressure level.

As all rooms are bedrooms, a through the wall vent with a free space of 2500mm² has been applied.

Only bedrooms have been assessed.

The kitchen and dining room areas (A-C), based on the predicted results of the noise modelling for the communal terrace will not require any enhanced glazing.

Room Type	Total Window Size (m ²)	Façade Size (m ²)	Remaining Façade (m ²)	Ceiling (m ²)	External Freefield SPL(dB-L _{Aeq,16 hour})	Glazing Applied	Vent Applied	Required SRI	Internal SPL	SRI Achieved
First Floor										
First Floor - Unit 11 (High Street Façade)	2.04	6.25	4.21	N/A	57	4\12\4	MA3015	31	24	33
First Floor - Unit 5 East Street Façade)	2.4	6.75	4.35	N/A	61	4\12\4	MA3015	26	29	32
First Floor Unit 1 (East Street Façade)	2.4	7.5	5.1	N/A	62	4\12\4	MA3015	27	30	32
First Floor Unit 9 (High Street Façade)	1.7	6.25	4.55	N/A	58	4\12\4	MA3015	31	25	34
Second Floor										
Second Floor - Unit 12 (East Street Façade)	2.4	25.6	23.2	14.5	61	4\12\4	MA3015	26	29	32
Second Floor-Unit 14 (East Street Façade)	2.04	9.6	7.56	15	60	4\12\4	MA3015	25	27	33
Second Floor - Unit 20 (Dual Outlook)	3.74	24.5	20.76	11.7	58/59	10\12\4	MA3015	32	26	33
Second Floor -Unit 23 (High Street)	1.87	8	6.13	12.7	56	4\12\4	MA3015	30	23	33

Figure 20. Rigorous Calculation Process

It is noted that standard thermal 4/12/4 double glazing with an R_w+C_{tr} ($R_{traffic}$) of 25dB(A) has been used predominantly throughout with a Greenwood acoustic ventilator with a $D_{n,e,w}+C_{tr}$ of 52dB(A). The only exception to this is unit 8 on the first floor and unit 20 on the second floor, which are above one another. This is due to the double windows within the unit allowing more sound energy into the space. For Units 8 and 20, as per Figure 20 above, the glazing has used 10/12/4 with an R_w+C_{tr} ($R_{traffic}$) of 29dB(A) and used in conjunction with the same Greenwood passive ventilator.

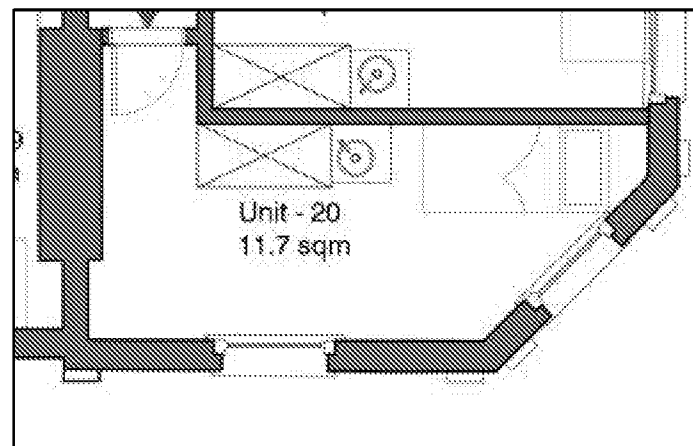


Figure 21. Units 8 and 20

5.6 Predicted External Communal Terrace

A computer noise model was constructed in IMMI noise modelling software with a receive position or receptor position plotted at 5m in height in the centre of the proposed terrace area.

The noise modelling detailed that the predicted daytime sound pressure level for the communal terrace is 39dB $L_{Aeq, 16 \text{ hour}}$, which is significantly below the amenity area levels described in both WHO Guidelines for Community Noise dated 1999 and BS8233:2014. The noise contours are detailed in Figure 22 below which illustrates the positioning of the terrace.

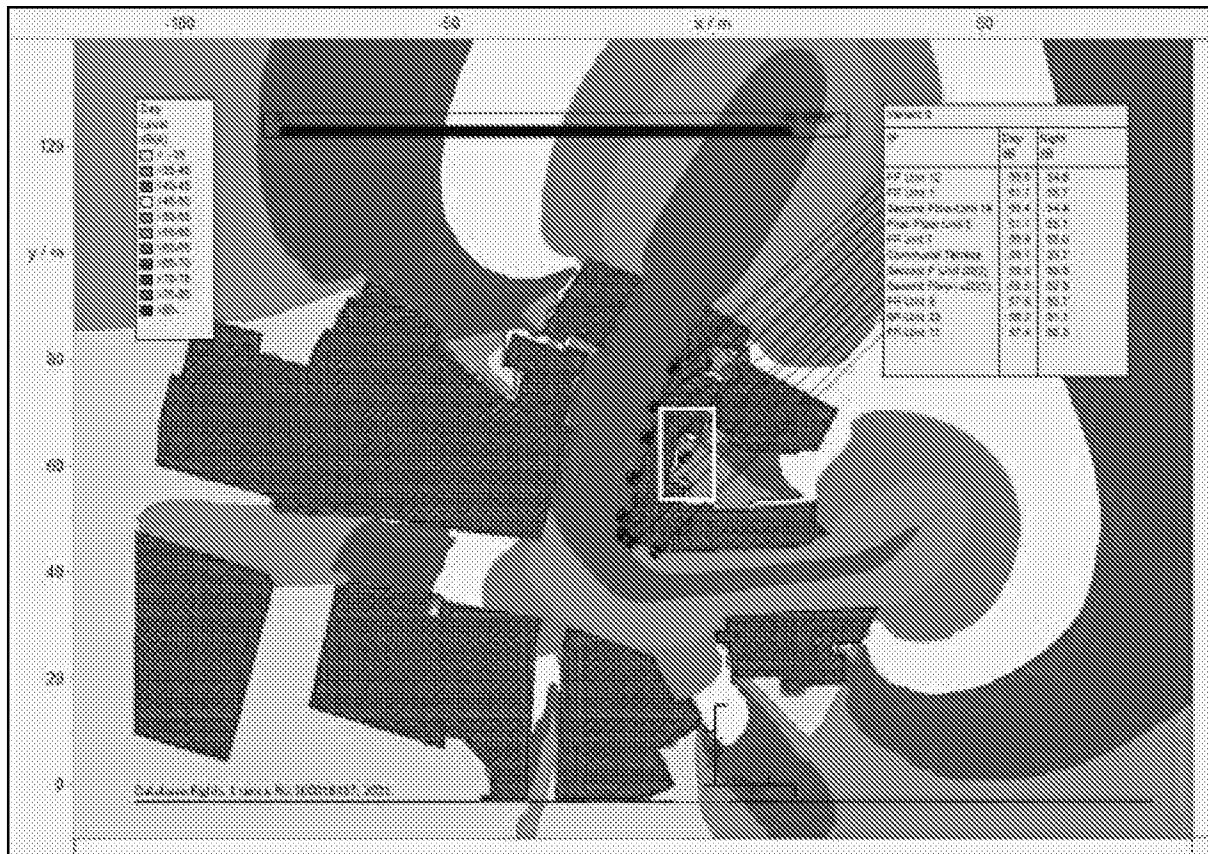


Figure 22. IMMI 2D Daytime Noise Model with Rear Communal Terrace Highlighted

5.7 Assessment of Open Windows for Background Ventilation

Using the Acoustics Ventilation and Overheating Guidance (Jan 2020), a 13dB subtraction has been made from the external freefield sound pressure level predicted in the noise model to represent sound passing through an open window.

Figure 23 below shows that open windows may not be entirely relied upon to provide background ventilation to the flats. Whilst it is a future occupant's choice to open windows, the practice of opening the windows on both the East Street and High Street facades will cause the internal Table 4 values in BS8233:2014 to be exceeded.

In the calculations shown in figure 20 an acoustic through the wall vent was included to provide background ventilation. The client's M+E consultant should be asked to review the assumptions made and consider air changes etc. It may well be that either larger through the wall ventilators or mechanical extract ventilation (MEV) are required to provide the required number of air changes to satisfy Building Regulations Approved Document F.

It should be noted that the final ventilation solution decided upon by the client must achieve the required SRI detailed in the report.

Assessment of whether windows may be opened for background ventilation								
Location	Description and Room (Area)	Unit Number	Highest Predicted Daytime External Sound Pressure Level ($L_{Aeq, 16 \text{ hour}}$)	Open Window (-13dB)	Closed Window (-30dB)	BS8233:2014 Daytime Criterion	Openable Windows (Yes/No)	Rigorous Calculation Required - Yes/No
First Floor	East Street	1	62	49	32	35 dB $L_{Aeq, 16 \text{ hour}}$	No	Yes
Second Floor	East Street	12	61	48	31	35dB $L_{Aeq, 16 \text{ hour}}$	No	Yes
First Floor	East Street	5	61	48	31	35 dB $L_{Aeq, 16 \text{ hour}}$	No	Yes
Second Floor	East Street	14	60	47	30	35 dB $L_{Aeq, 16 \text{ hour}}$	No	Yes
First Floor	East Street	7	61	48	31	35 dB $L_{Aeq, 16 \text{ hour}}$	No	Yes
Second Floor	East Street/High Street	20	58	45	28	35dB $L_{Aeq, 16 \text{ hour}}$	No	Yes
Second Floor	East Street/High Street	20	59	46	29	35 dB $L_{Aeq, 16 \text{ hour}}$	No	Yes
Second Floor	High Street	23	56	43	26	35 dB $L_{Aeq, 16 \text{ hour}}$	No	Yes
First Floor	High Street	11	57	44	27	35 dB $L_{Aeq, 16 \text{ hour}}$	No	Yes
First Floor	High Street	9	58	45	28	35 dB $L_{Aeq, 16 \text{ hour}}$	No	Yes
Location	Description and Room (Area)		Highest Predicted Night Time External Sound Pressure Level $L_{Aeq, 8 \text{ hour}}$	Open Window (-13dB)	Closed Window (-30dB)	BS8233:2014 Night Time Criterion	Openable Windows (Yes/No)	Rigorous Calculation Required - Yes/No
First Floor	East Street	1	56	43	26	30 dB $L_{Aeq, 8 \text{ hour}}$	No	Yes
Second Floor	East Street	12	55	42	25	30 dB $L_{Aeq, 8 \text{ hour}}$	No	Yes
First Floor	East Street	5	55	42	25	30 dB $L_{Aeq, 8 \text{ hour}}$	No	Yes
Second Floor	East Street	14	54	41	24	30 dB $L_{Aeq, 8 \text{ hour}}$	No	Yes
First Floor	East Street	7	55	42	25	30 dB $L_{Aeq, 8 \text{ hour}}$	No	Yes
Second Floor	East Street/High Street	20	53	40	23	30 dB $L_{Aeq, 8 \text{ hour}}$	No	Yes
Second Floor	East Street/High Street	20	53	40	23	30 dB $L_{Aeq, 8 \text{ hour}}$	No	Yes
Second Floor	High Street	23	51	38	21	30 dB $L_{Aeq, 8 \text{ hour}}$	No	Yes
First Floor	High Street	11	52	39	22	30 dB $L_{Aeq, 8 \text{ hour}}$	No	Yes
First Floor	High Street	9	53	40	23	30 dB $L_{Aeq, 8 \text{ hour}}$	No	Yes

All predicted External data presented is dB(A) and Freefield

Figure 23. Assessment of Open Windows

5.8 ProPG2017 Initial Site Risk Assessment

In line with ProPG2017 an initial site risk assessment is provided to stakeholders and decision makers to determine the level of risk associated with developing the site and more specifically, what mitigation measures may be needed to safeguard the development.

The assessment indicates a low to medium risk with both East Street and High Street facades presented for clarity. The assessment also uses the predicted worst case residential rooms from the IMMI noise modelling software.

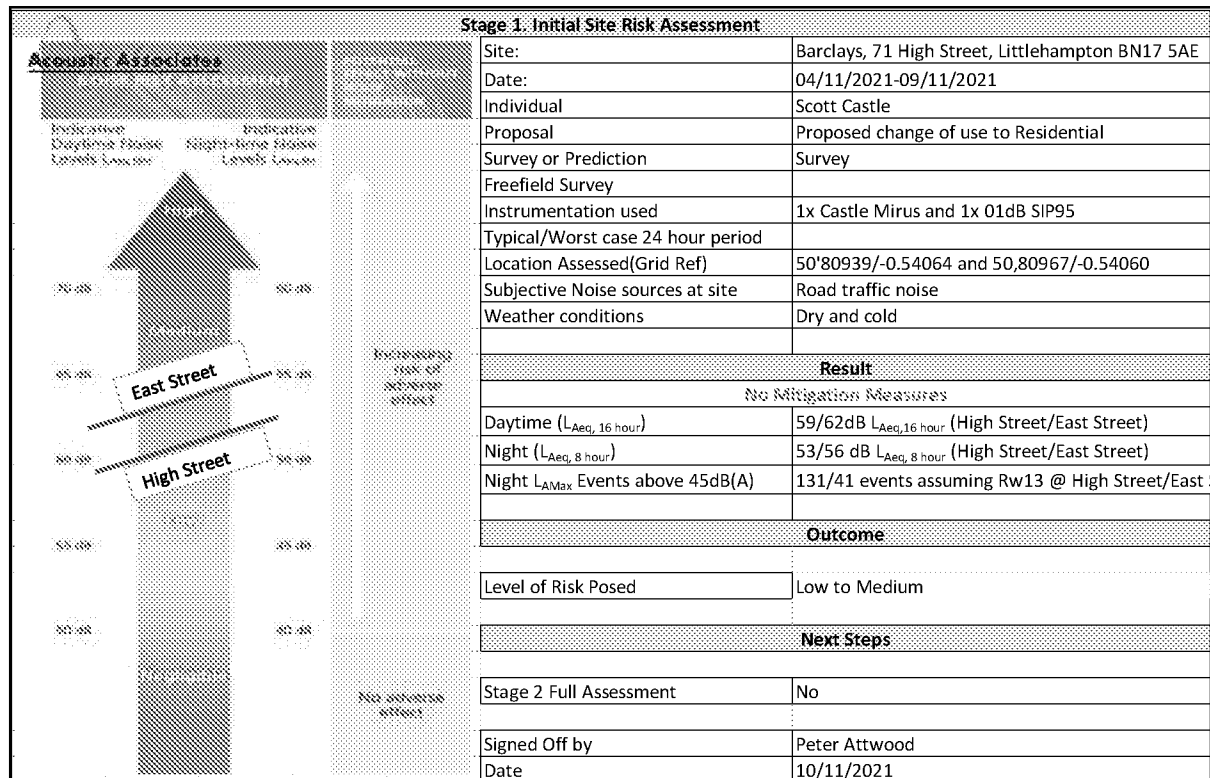


Figure 24. ProPG2017 Initial Site Risk Assessment

5.9 Measured Sound Insulation Testing and Separation Requirements

As stated in 4.1.4, the sound insulation performance of the current ceiling partition between ground and first floor does not achieve the required criterion above Building Regulations Approved Document E. Given the proposed shell and core arrangement, it is possible that the local planning authority may condition the sound insulation requirements between the proposed commercial and residential demises to reduce the likelihood of any sound transfer and subsequent complaints being received.

The Sussex Planning Noise Advice Document dated March 2021 states as follows in 3.3.1:

“3.3.1. Building Regulation, Approved Document E, Section 0.8 states “a higher standard of sound insulation may be required between spaces used for normal domestic purposes and communal or non-domestic purposes. In these situations, the appropriate level of sound insulation will depend on the noise generated in the communal or non-domestic space. Specialist advice may be needed to establish if a higher standard of sound insulation is required and, if so, to determine the appropriate level”.

In the experience of the report author, it is normal to consider 5dB better than Approved Document E values, which for a conversion property would be 48dB $D_{nTw} + C_{tr}$. As stated, this may be positively conditioned by the Local Planning Authority.

6 Uncertainty

It is key to report where areas of uncertainty may arise in the reporting and assessment and what measures have been taken to minimise uncertainty to ensure that the report remains as robust as possible.

Given the shape of the building and the outlook of the facades, two sound level meters were carefully placed to capture the soundscape as representatively as possible, whilst still being secure, weather proof and utilising open rooms and windows within the former bank.

The sound level meters used in the site survey were calibrated before and after the survey in situ, without any significant drift having occurred, to ensure that the information and data being obtained was representative and that the sound level meters were operating correctly.

Given the requirement to also consider the first-floor communal terrace, a noise model was constructed to determine the predicted sound pressure levels, post construction.

The survey data has only used whole data periods, ie whole days or nights and the weather for the survey duration was also ideal for environmental monitoring.

Whilst a weekend was deliberately included into the dataset period, it was noted that the weekend may have experienced fireworks. These are prohibited by law from being set off post 23:00 hours and would not have impacted the night time L_{Amax} events.

It was noted that residential rooms will overlook the pedestrian crossing which when activated has a signature audible signal that is noticeable, for the purposes of allowing waiting pedestrians to cross. Some liaison with the County Council is suggested to determine if it is possible to reduce the audibility of the alarm.

External plant and wall mounted condensers were not assessed as these belonged to the bank and would be removed as part of the development.

The assessment has only considered the residential aspects of the development and whilst it is clear that there is a need to improve the separation between ground and first floor units, recommendations have not been made in respect of the commercial ground floor units. Future occupants of the commercial units would be responsible for any new external plant which would require separate planning applications to be made. Any new planning applications would have to take into account the newly created residential demises above.

7 Conclusion

Two long term unattended class 1 sound level meters were used to measure the soundscape to the front and rear of the former Barclays bank between 4th to 9th November 2021. The dates deliberately included a weekend to ensure that any change in the soundscape was properly assessed.

The noisier façade is the East Street facade which overlooks the B2140 (61dB $L_{Aeq,16\text{ hour}}$ for daytime and 55dB $L_{Aeq, 8\text{ hour}}$ for night time). The quieter High Street façade looks to the South and measured 58dB $L_{Aeq,16\text{ hour}}$ for the daytime period and 53dB $L_{Aeq, 8\text{ hour}}$ for the night time period.

In line with ProPG2017, an initial site risk assessment has been undertaken detailing a low to medium risk for the development of the site

The proposed change of use and extension makes the site three storeys throughout. This includes four commercial units at the ground floor and a HMO above with bedrooms overlooking the East Street and High Street Facades. Three kitchen and dining areas (A-C) are located to the rear and will be sheltered from road traffic noise. A communal terrace for the residents is situated at the first-floor rear area which due to the shape of the building is also sheltered.

Noise modelling predicts a sound pressure level of 39dB $L_{Aeq, 16 \text{ hour}}$ for the communal terrace which is comfortably below the requirements for external amenity areas in both the WHO Guidelines for Community Noise (1999) as well as BS8233:2014.

Noise modelling software was used to predict the sound pressure levels of the different facades of the development. For the majority of the development standard thermal double glazing will be sufficient, when used in conjunction with an acoustic ventilator. However, there are two units (8 and 20) which have more than one window and which by default will allow a greater amount of sound energy into the unit. For Units 8 and 20, enhanced glazing is recommended.

It is discussed within the report that the local planning authority may condition that the sound insulation between the ground floor commercial units and first floor residential units is upgraded to achieve 5dB(A) better than Building Regulations Approved Document E.

Sufficient data has been presented within the report to demonstrate that the change of use to flats/HMO is capable of being done on acoustic grounds with future occupants protected against road traffic and commercial sound sources. Planning permission should not therefore be withheld on noise grounds.

8 Appendix A – Rigorous Calculations

8.1 Unit 11

Non Frequency Dependent Variables			Key for Table Below					
Term	Derivation	Value	R _{wi}	Sound Reduction of Window (Octave)				
A ₀	Given in BS EN 20140-10 = 10 (m²)	10	R _{ew}	Sound Reduction Index of External Wall (Octave)				
S _t	Total Facade Area (m²)	6.25	R _{rc}	Sound Reduction Index of Roof/Ceiling (Octave)				
S _{wi}	Window Area (m²)	2.04	A	Equivalent Absorption Area of Rx Room				
S _{ew}	External Wall Area (m²)	4.21	D _{tr}	Insulation of Trickle Vent (BS EN 20140-10)				
S _{rc}	Ceiling Area (m²)	0.0001						
S	Total Area sound enters the room (m²)	6.25						

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}	Free-Field External Noise Level	59	55	53	53	50	43
D _{tr}	MA3015	46.7	46.3	49	55.7	66.3	69.3
R _{wi}	4 12 4	24	20	25	35	38	35
R _{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R _{rc}	No Roof	100	100	100	100	100	100
A	Equivalent Absorption Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details							
Term From Equation Below	Octave Band Centre Frequency						
	125	250	500	1000	2000	4000	
L _{eq,ff}	59	55	53	53	50	43	
A ₀ /S · 10 ⁴ · (-D _{tr} /e/10)	3.42E-05	3.75E-05	2.01E-05	4.31E-06	3.75E-07	1.88E-07	
S _{wi} /S · 10 ⁴ · (-R _{wi} /10)	0.001299	0.003264	0.001032	0.000103	5.17E-05	0.000103	
S _{ew} /S · 10 ⁴ · (-R _{ew} /10)	5.35E-05	8.48E-05	2.68E-05	4.25E-06	6.74E-07	2.13E-07	
S _{rc} /S · 10 ⁴ · (-R _{rc} /10)	1.6E-15	1.6E-15	1.6E-15	1.6E-15	1.6E-15	1.6E-15	
10log10(S/A)+3	0.544873	-0.50248	-1.0824	-1.0824	-0.80211	-0.80211	
L _{eq,2}	30.96606	29.79479	22.24832	12.40098	6.422548	2.352229	
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1	
A-Weighted L _{eq}	14.86606	21.19479	19.04832	12.40098	7.622548	3.352229	

A-Weighted Level Outside	57
BS8233 Predicted Internal A-Weighted Level	24
Predicted Building Envelope SRI	33

Unit 11

BS8233 Calculation can be seen below:							
$L_{eq,2} = L_{eq,ff} + 10 \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{tr}}{10}} + \frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}} + \frac{S_{rc}}{S} 10^{\frac{-R_{rc}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$							

8.2 Unit 5

Non-Frequency Dependent Variables			Key for Table Below	
Term	Derivation	Value	R_{w1}	Sound Reduction of Window (Octave)
A_0	Given in BS EN 20140-10 = 10 (m ²)	10	R_{w2}	Sound Reduction Index of External Wall (Octave)
S_1	Total Facade Area (m ²)	6.75	R_{r1}	Sound Reduction Index of Roof/Ceiling (Octave)
S_{w1}	Window Area (m ²)	2.4	A	Equivalent Absorption Area of Rx Room
S_{w2}	External Wall Area (m ²)	4.35	D_{trv}	Insulation of Trickle Vent (BS EN 20140-10)
S_c	Ceiling Area (m ²)	0.0001		
S	Total Area sound enters the room (m ²)	6.75		

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
$L_{eq,ff}$	Free-Field External Noise Level	63	59	57	57	54	47
$D_{n,f}$	MA3015	46.7	46.3	49	55.7	66.3	69.3
R_{w1}	A 12.4	24	20	25	35	38	35
R_{w2}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{r1}	No Roof	100	100	100	100	100	100
A	Equivalent Absorption Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details							
Term From Equation Below		Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
$L_{eq,ff}$		63	59	57	57	54	47
$A_0/S \cdot 10^{(D_{n,f}-R_{w1})/10}$		3.17E-05	3.47E-05	1.87E-05	3.99E-06	3.47E-07	1.74E-07
$S_{w1}/S \cdot 10^{(A-R_{w1})/10}$		0.001415	0.003556	0.001124	0.000112	5.64E-05	0.000112
$S_{w2}/S \cdot 10^{(A-R_{w2})/10}$		5.12E-05	8.11E-05	2.57E-05	4.07E-06	6.44E-07	2.04E-07
$S_{r1}/S \cdot 10^{(A-R_{r1})/10}$		1.48E-15	1.48E-15	1.48E-15	1.48E-15	1.48E-15	1.48E-15
$10 \log_{10}(S/A) + 3$		0.879111	-0.16824	-0.74816	-0.74816	-0.46787	-0.46787
$L_{eq,2}$		35.63526	34.48009	26.92876	17.06135	11.11697	7.05577
A-Weighting		-16.1	-8.6	-3.2	0	1.2	1
A-Weighted L_{eq}		19.53526	25.88009	23.72876	17.06135	12.31697	8.05577

A-Weighted Level Outside	61
BS8233 Predicted Internal A-Weighted Level	29
Predicted Building Envelope SRI	32

Unit 5

BS8233 Calculation can be seen below:							
$L_{int,2} = L_{eq,ff} + 10 \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{n,f}}{10}} + \frac{S_{w1}}{S} 10^{\frac{-R_{w1}}{10}} + \frac{S_{w2}}{S} 10^{\frac{-R_{w2}}{10}} + \frac{S_{r1}}{S} 10^{\frac{-R_{r1}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$							

8.3 Unit 1

Non Frequency Dependent Variables			Key for Table Below					
Term	Derivation	Value	R _w	Sound Reduction of Window (Octave)				
A _o	Given in BS EN 20140-10 = 10 (m ²)	10	R _{ew}	Sound Reduction Index of External Wall (Octave)				
S _t	Total Facade Area (m ²)	7.5	R _r	Sound Reduction Index of Roof/Ceiling (Octave)				
S _w	Window Area (m ²)	2.4	A	Equivalent Absorption Area of Rx Room				
S _{ew}	External Wall Area (m ²)	5.1	D _{tr}	Insulation of Trickle Vent (BS EN 20140-10)				
S _c	Ceiling Area (m ²)	0.0001						
S	Total Area sound enters the room (m ²)	7.5						

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}	Free-Field External Noise Level	64	60	58	58	55	48
D _{tr,e}	MA3015	46.7	46.3	49	55.7	66.3	69.3
R _w	4, 12, 4	24	20	25	35	38	35
R _{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R _r	No Roof	100	100	100	100	100	100
A	Equivalent Absorption Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details							
Term From Equation Below		Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}		64	60	58	58	55	48
A _o /S . 10 ⁴ (-D _{tr,e} /10)		2.85E-05	3.13E-05	1.68E-05	3.59E-06	3.13E-07	1.57E-07
S _w /S . 10 ⁴ (-R _w /10)		0.001274	0.0032	0.001012	0.000101	5.07E-05	0.000101
S _{ew} /S . 10 ⁴ (-R _{ew} /10)		5.4E-05	8.56E-05	2.71E-05	4.29E-06	6.8E-07	2.15E-07
S _{rr} /S . 10 ⁴ (-R _{rr} /10)		1.33E-15	1.33E-15	1.33E-15	1.33E-15	1.33E-15	1.33E-15
10log10(S/A)+3		1.336686	0.289332	-0.29059	-0.29059	-0.0103	-0.0103
L _{eq,2}		36.66077	35.49661	27.94517	18.08655	12.12537	8.057123
A-Weighting		-16.1	-8.6	-3.2	0	1.2	1
A-Weighted L _{eq}		20.56077	26.89661	24.74517	18.08655	13.32537	9.057123

A-Weighted Level Outside	62
BS8233 Predicted Internal A-Weighted Level	30
Predicted Building Envelope SRI	32

Unit 1

BS8233 Calculation can be seen below:							
$L_{eq,2} = L_{eq,R} + 10 \log_{10} \left(\frac{A_o}{S} 10^{\frac{-D_{tr,e}}{10}} + \frac{S_{w1}}{S} 10^{\frac{-R_{w1}}{10}} + \frac{S_{w2}}{S} 10^{\frac{-R_{w2}}{10}} + \frac{S_{w3}}{S} 10^{\frac{-R_{w3}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$							

8.4 Unit 9

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
$L_{eq,ff}$	Free-Field External Noise Level	60	56	54	54	51	44
$D_{n,e}$	MA3015	46.7	46.3	49	55.7	66.3	69.3
R_{wi}	4, 12, 4	24	20	25	35	38	35
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{rr}	No Roof	100	100	100	100	100	100
A	Equivalent Absorption Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
Term From Equation Below	Octave Band Centre Frequency					
	125	250	500	1000	2000	4000
$L_{eq,ff}$	60	56	54	54	51	44
$A_0/S \cdot 10^{(-D_{n,e}/10)}$	3.42E-05	3.75E-05	2.01E-05	4.31E-06	3.75E-07	1.88E-07
$Swi/S \cdot 10^{(-R_{wi}/10)}$	0.001083	0.00272	0.00086	8.6E-05	4.31E-05	8.6E-05
$S_{ew}/S \cdot 10^{(-R_{ew}/10)}$	5.78E-05	9.16E-05	2.9E-05	4.59E-06	7.28E-07	2.3E-07
$S_{rr}/S \cdot 10^{(-R_{rr}/10)}$	1.6E-15	1.6E-15	1.6E-15	1.6E-15	1.6E-15	1.6E-15
$10 \log_{10}(S/A)+3$	0.544873	-0.50248	-1.0824	-1.0824	-0.80211	-0.80211
$L_{eq,2}$	31.24483	30.04468	22.5045	12.69089	6.653306	2.564641
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted L_{eq}	15.14483	21.44468	19.3045	12.69089	7.853306	3.564641

A-Weighted Level Outside	58
BS8233 Predicted Internal A-Weighted Level	25
Predicted Building Envelope SRI	34

Unit 9

BS8233 Calculation can be seen below:						
$L_{eq,2} = L_{eq,ff} + 10 \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$						

8.5 Unit 12

Non Frequency Dependent Variables			Key for Table Below	
Term	Derivation	Value	R _w	Sound Reduction of Window (Octave)
A _o	Given in BS EN 20140-10 = 10 (m²)	10	R _{ew}	Sound Reduction Index of External Wall (Octave)
S _t	Total Facade Area (m²)	25.6	R _r	Sound Reduction Index of Roof/Ceiling (Octave)
S _w	Window Area (m²)	2.4	A	Equivalent Absorption Area of Rx Room
S _{ew}	External Wall Area (m²)	23.2	D _{tr}	Insulation of Trickle Vent (BS EN 20140-10)
S _r	Ceiling Area (m²)	14.5		
S	Total Area sound enters the room (m²)	39.6		

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}	Free-Field External Noise Level	63	59	57	57	54	47
D _{tr,e}	MA3015	46.7	46.3	49	55.7	66.3	69.3
R _{wi}	4, 12, 4	24	20	25	35	38	35
R _{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R _r	100mm flat concrete roof (230 kg/m²)	52	52	52	52	52	52
A	Equivalent Absorption Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details							
Term From Equation Below		Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}		63	59	57	57	54	47
A _o /S · 10 ⁴ · (-D _{tr,e} /10)		5.4E-06	5.92E-06	3.18E-06	6.8E-07	5.92E-08	2.97E-08
S _{wi} /S · 10 ⁴ · (-R _{wi} /10)		0.000241	0.000606	0.000192	1.92E-05	9.61E-06	1.92E-05
S _{ew} /S · 10 ⁴ · (-R _{ew} /10)		4.65E-05	7.38E-05	2.33E-05	3.7E-06	5.86E-07	1.85E-07
S _{rr} /S · 10 ⁴ · (-R _{rr} /10)		2.31E-06	2.31E-06	2.31E-06	2.31E-06	2.31E-06	2.31E-06
10log10(S/A)+2		8.563025	7.515672	6.935752	6.935752	7.216039	7.216039
L _{eq,2}		36.26893	34.89185	27.36917	18.06067	12.20621	7.57875
A-Weighting		-16.1	-8.6	-3.2	0	1.2	1
A-Weighted L _{eq}		20.16893	26.29185	24.16917	18.06067	13.40621	8.57875

A-Weighted Level Outside	61
BS8233 Predicted Internal A-Weighted Level	29
Predicted Building Envelope SRI	32

BS8233 Calculation can be seen below:							
$L_{eq,2} = L_{eq,ff} + 10 \log_{10} \left(\frac{A_o}{S} 10^{\frac{-D_{tr,e}}{10}} + \frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 2$							

Unit 12

8.6 Unit 14

Non Frequency Dependent Variables			Key for Table Below						
Term	Derivation	Value	R _w	Sound Reduction of Window (Octave)					
A ₀	Given in BS EN 20140-10 = 10 (m ²)	10	R _{ew}	Sound Reduction Index of External Wall (Octave)					
S ₀	Total Facade Area (m ²)	9.6	R _c	Sound Reduction Index of Roof/Ceiling (Octave)					
S _{wi}	Window Area (m ²)	2.04	A	Equivalent Absorption Area of Rx Room					
S _{ew}	External Wall Area (m ²)	7.56	D ₀₁	Insulation of Trickle Vent (BS EN 20140-10)					
S _c	Ceiling Area (m ²)	15							
S	Total Area sound enters the room (m ²)	24.6							

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}	Free-Field External Noise Level	62	58	56	56	53	46
D _{01p}	MA3015	46.7	46.3	49	55.7	66.3	69.3
R _{0w}	4 12 4	24	20	25	35	38	35
R _{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R _c	100mm flat concrete roof (230 kg/m ²)	52	52	52	52	52	52
A	Equivalent Absorption Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details							
Term From Equation Below		Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}		62	58	56	56	53	46
A ₀ /S . 10 [^] (-D _{01,e} /10)		8.69E-06	9.53E-06	5.12E-06	1.09E-06	9.53E-08	4.78E-08
S _{wi} /S . 10 [^] (-R _{wi} /10)		0.00033	0.000829	0.000262	2.62E-05	1.31E-05	2.62E-05
S _{ew} /S . 10 [^] (-R _{ew} /10)		2.44E-05	3.87E-05	1.22E-05	1.94E-06	3.07E-07	9.72E-08
S _{rr} /S . 10 [^] (-R _{rr} /10)		3.85E-06	3.85E-06	3.85E-06	3.85E-06	3.85E-06	3.85E-06
10log ₁₀ (S/A)+3		6.495424	5.448071	4.868151	4.868151	5.148438	5.148438
L _{eq,2}		34.14311	32.89948	25.39272	16.06699	10.55217	5.95081
A-Weighting		-16.1	-8.6	-3.2	0	1.2	1
A-Weighted L _{eq}		18.04311	24.29948	22.19272	16.06699	11.75217	6.95081

A-Weighted Level Outside	60
BS8233 Predicted Internal A-Weighted Level	27
Predicted Building Envelope SRI	33

Unit 14

BS8233 Calculation can be seen below:							
$L_{eq,2} = L_{eq,ff} + 10 \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{01,e}}{10}} + \frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$							

8.7 Unit 20

Non Frequency Dependent Variables			Key for Table Below						
Term	Derivation	Value	R _w	Sound Reduction of Window (Octave)					
A ₀	Given in BS EN 20140-10 = 10 (m ²)	10	R _{ew}	Sound Reduction Index of External Wall (Octave)					
S ₀	Total Facade Area (m ²)	24.5	R _c	Sound Reduction Index of Roof/Ceiling (Octave)					
S _{wi}	Window Area (m ²)	3.74	A	Equivalent Absorption Area of Rx Room					
S _{ew}	External Wall Area (m ²)	20.76	D _{tr}	Insulation of Trickle Vent (BS EN 20140-10)					
S _c	Ceiling Area (m ²)	11.7							
S	Total Area sound enters the room (m ²)	36.1							

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}	Free-Field External Noise Level	61	57	55	55	52	45
D _{10,p}	MA3015	46.7	46.3	49	55.7	66.3	69.3
R _{ww}	10 12 4	25	22	33	40	43	44
R _{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R _c	100mm flat concrete roof (230 kg/m ²)	52	52	52	52	52	52
A	Equivalent Absorption Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details							
Term From Equation Below		Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}		61	57	55	55	52	45
A ₀ /S . 10 ⁴ (-D _{tr,e} /10)		5.92E-06	6.49E-06	3.49E-06	7.46E-07	6.49E-08	3.25E-08
S _{wi} /S . 10 ⁴ (-R _{wi} /10)		0.000328	0.000654	5.19E-05	1.04E-05	5.19E-06	4.12E-06
S _{ew} /S . 10 ⁴ (-R _{ew} /10)		4.57E-05	7.24E-05	2.29E-05	3.63E-06	5.75E-07	1.82E-07
S _{rr} /S . 10 ⁴ (-R _{rr} /10)		2.04E-06	2.04E-06	2.04E-06	2.04E-06	2.04E-06	2.04E-06
10log ₁₀ (S/A)+3		8.161145	7.113792	6.533872	6.533872	6.814159	6.814159
Leq,2		34.97338	32.77439	20.58372	13.78155	7.777929	-0.13507
A-Weighting		-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq		18.87338	24.17439	17.38372	13.78155	8.977929	0.864928

A-Weighted Level Outside	59
BS8233 Predicted Internal A-Weighted Level	26
Predicted Building Envelope SRI	33

Unit 20

BS8233 Calculation can be seen below:							
$L_{eq,2} = L_{eq,ff} + 10 \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{tr,e}}{10}} + \frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$							

8.8 Unit 23

Non Frequency Dependent Variables			Key for Table Below						
Term	Derivation	Value	R _w	Sound Reduction of Window (Octave)					
A ₀	Given in BS EN 20140-10 = 10 (m ²)	10	R _{ew}	Sound Reduction Index of External Wall (Octave)					
S ₀	Total Facade Area (m ²)	8	R _c	Sound Reduction Index of Roof/Ceiling (Octave)					
S _{wi}	Window Area (m ²)	1.87	A	Equivalent Absorption Area of Rx Room					
S _{ew}	External Wall Area (m ²)	6.13	D _{tr}	Insulation of Trickle Vent (BS EN 20140-10)					
S _c	Ceiling Area (m ²)	12.7							
S	Total Area sound enters the room (m ²)	20.7							

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}	Free-Field External Noise Level	58	54	52	52	49	42
D _{10,p}	MA3015	46.7	46.3	49	55.7	66.3	69.3
R _{wi}	4 12 4	24	20	25	35	38	35
R _{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R _c	100mm flat concrete roof (230 kg/m ²)	52	52	52	52	52	52
A	Equivalent Absorption Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details							
Term From Equation Below		Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}		58	54	52	52	49	42
A ₀ /S · 10 ⁴ · (-D _{10,e} /10)		1.03E-05	1.13E-05	6.08E-06	1.3E-06	1.13E-07	5.68E-08
S _{wi} /S · 10 ⁴ · (-R _{wi} /10)		0.00036	0.000903	0.000286	2.86E-05	1.43E-05	2.86E-05
S _{ew} /S · 10 ⁴ · (-R _{ew} /10)		2.35E-05	3.73E-05	1.18E-05	1.87E-06	2.96E-07	9.36E-08
S _{rr} /S · 10 ⁴ · (-R _{rr} /10)		3.87E-06	3.87E-06	3.87E-06	3.87E-06	3.87E-06	3.87E-06
10log ₁₀ (S/A)+3		5.745777	4.698423	4.118504	4.118504	4.398791	4.398791
L _{eq,2}		29.73767	28.50236	20.99578	11.63389	6.093479	1.529492
A-Weighting		-16.1	-8.6	-3.2	0	1.2	1
A-Weighted L _{eq}		13.63767	19.90236	17.79578	11.63389	7.293479	2.529492

A-Weighted Level Outside	56
BS8233 Predicted Internal A-Weighted Level	23
Predicted Building Envelope SRI	33

Unit 23

BS8233 Calculation can be seen below:							
$L_{eq,2} = L_{eq,ff} + 10 \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{10,e}}{10}} + \frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$							