Noise Impact Assessment for Planning Purposes

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Prepared for:	*Stone Property Services* *35 Winnipeg Drive* *Cardiff* *CF23 6ET*
Site address:	*Rosemount Funeral Home* *30 North Road* *Cardiff* *CF10 3DY*

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BRIEF FOR CONSULTANCY:

This report has been prepared by Acoustics & Noise Limited, Newport, South Wales, for Stone Property Services, 35 Winnipeg Drive, Cardiff, CF23 6ET under the instruction of Philippa Cole.

Purchase Order No:

OBJECTIVES:

To investigate the sound levels being experienced at Rosemount Funeral Home, 30 North Road, Cardiff, CF10 3DY and to carry out an assessment of the potential for adverse impact on a proposed residential development.

To investigate and report on potential solutions to mitigating the sound levels, if required.

NON-TECHNICAL SUMMARY:

The development proposal seeks planning permission for the redevelopment of the site for residential purposes comprising 19 apartments accommodated within two purpose-built buildings and the redevelopment of the existing Grade II listed Villa.

The significant source of environmental noise is associated with road traffic on the adjacent North Road at the western boundary to the site. To determine the acoustic conditions across the proposed development site a 24-hour road traffic noise survey was conducted at the position of the most exposed façade of the proposed scheme.

The results of the survey were used to inform a 3D acoustic model to calculate the road traffic noise propagation across the site. This model was developed to predict the external noise levels at each façade of every proposed dwelling to enable the calculation of the relevant internal noise levels.

The results of this assessment indicate that for a relatively small number of habitable rooms within the proposed development, desirable internal ambient noise levels are achievable whilst using an open window ventilation strategy. No additional mitigation is required for these rooms. Furthermore, the results indicate that all habitable rooms within Plots 3, 6 and 9 of the proposed northern block will achieve the desirable internal ambient noise levels whilst using an open window ventilation strategy and no further mitigation is required for these plots.

For the remaining habitable rooms, a scheme of sound insulation is required to control the noise ingress. The recommended scheme requires that the glazing is in the closed position. This report provides recommendations for the minimum sound reduction performance required from the glazing units so that desirable internal noise levels are achievable at all times.

Manufacturers' data should be used to confirm the minimum sound reduction performance requirements recommended in this report are achievable from any specified glazing units, including any provision for background ventilation if applicable.

To realize the full sound insulation potential of the glazing, the glazed unit should be installed into a frame with good seals. It is assumed that the glazing solutions are in the closed position to control the noise ingress. The decision on whether the glazing should be permanently closed is outside the scope of this assessment and our technical expertise. However, where windows are exposed to anonymous noise sources such as road traffic, there is normally no requirement for these windows to be permanently sealed.

All habitable rooms subject to sound mitigation measures will require an alternative, effective means of ventilation. Any ventilation scheme should satisfy the requirements of Approved Document F and provide the required ventilation rates. It is important that any scheme is approved by Building Control and does not compromise the internal noise levels. Recommendations for suitable ventilation are outside the scope of this assessment and technical expertise and independent specialist advice should be obtained to ensure that any ventilation scheme is suitable for purpose.

With reference to the proposed development layout, there are no defined external amenity areas provided for the flats. However, the results of this assessment indicate that around 50% of the external area is exposed to road traffic noise of less than the external criteria limit which may be suitable for use as a community amenity space if required.

Any noise impact may be partially offset if the residents are provided with access to a relatively quiet, protected, publicly accessible, external amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5 minutes walking distance). In this case, the development site is located 30m from Bute Park and Blackweir Fields which is a significant area of publicly accessible recreational parkland and therefore, the absence of defined amenity space within the development site need not be considered a

determining factor when considering the application in accordance with national planning policy guidance.

1.0 DESCRIPTION OF SITE

1.1 The application site is located within the Blackweir area of Cardiff and comprises a roughly rectangular-shaped parcel of land positioned on the eastern side of North Road (A470). It comprises a two storey building finished in white render with a pitched and tiled roof; a redundant funeral home which was previously occupied by Co-op Funeralcare Care Centre until June 2020. A single storey outbuilding finished in white render with a dormer window and flat roof is positioned to the north (rear) of the two storey building and was previously used for the garaging of vehicles associated with the funeral business.

1.2 The main building was designated as a Grade II Listed Building in 1975 for its architectural interest as one of the few county villas that survived the urban expansion of Cardiff, retaining a particularly fine cast iron balcony.

1.3 Generally, the site can be described as being within a residential area, with the addition of a place of worship (Christian Science Centre) to the direct south and a nursing/care home (Nazareth House) to the north. The properties to the east and south are principally semi-detached and detached properties of the Victorian era with villa-style architecture.

1.4 The site lies within Cathays Park Conservation Area and is relatively flat in nature. Blackweir Fields and Bute Park are located on the opposite side of North Road to the west.

1.5 The acoustic climate at the site is characterised by road traffic travelling along North Road.

1.6 A satellite view of the site is presented in Appendix 2.

2.0 DISCUSSION

2.1 In response to a preliminary enquiry for the proposed development, ref: PA/22/00040/MJR, Cardiff City Council provided the following comments with regards to noise:

'PPW11 states at paragraph 6.7.1 that "clean air and appropriate soundscape contribute to a positive experience of place as well as being necessary for public health, amenity and well-being".

Problematic forms of sound are generally experienced as noise pollution, and therefore if a planning application were to be submitted, it is likely that a Noise Impact Assessment would be required to ascertain the existing levels of noise and the impact of the proposed development on future occupiers of the proposed residential/student units. Any future application should be accompanied with mitigation measures which reduce overall exposure to air and noise pollution and create appropriate soundscapes. Any mitigation measures should be carefully considered and should not harm the Listed Building at the site'.

2.2 Acoustics and Noise Ltd were engaged by Stone Property Services to undertake a noise impact assessment for the above proposal to satisfy the requirements of the local authority, as detailed above.

2.3 DESCRIPTION OF PROPOSED DEVELOPMENT

2.3.1 The development proposal seeks planning permission for the redevelopment of the site for residential purposes comprising 19 apartments accommodated within two purpose built buildings and the redevelopment of the existing Villa.

2.3.2 The significant source of noise at the site is associated with road traffic to the west.

2.3.3 The proposed development layout is presented in Appendix 4.

3.0 DETERMINATION OF NOISE LEVELS

3.1 ROAD TRAFFIC NOISE

3.1.1 To determine the acoustic conditions across the proposed development site a 24-hour road traffic noise survey was conducted at the position of the most exposed façade of the proposed scheme. This location enjoyed an uninterrupted view of the road traffic travelling along North Road.

3.1.2 Details of the survey are presented in Appendix 1 with the results detailed in Appendix 3.

3.1.3 The procedures detailed in TAN 11 refer to free-field noise levels. However, the survey results detailed in this report represent the façade noise level, 1m from the façade.

3.1.4 Paragraph A9 of TAN 11 [1] states that "*Levels of noise from road and rail traffic are often specified at one metre from the façade, and these façade levels should be assumed to be 3dB(A) higher than levels measured away from any buildings…*".

3.1.5 In this case, therefore, the calculated daytime and night time façade noise levels are assumed to be 3dB higher than the equivalent free-field levels and should be reduced accordingly as detailed in Table 1.

Table 1 – Equivalent Free-field Road Traffic Noise Levels

Period	Measured Façade Level (dB)	Façade Correction (dB)	Equivalent Free-field Level (dB)
Daytime, $L_{Aeq,16hrs}$	71	-3	68
Night time, $L_{Aeq,8hrs}$	62	-3	59
Night time L_{ASmax}	83	-3	80

3.1.6 The equivalent free-field road traffic noise levels at the site can now be compared with the NEC detailed in TAN 11 [1] to determine the suitability of the site for residential purposes.

3.1.7 The corrected free field noise levels place the most exposed extent of the site within NEC 'C'. During the night time period, there were no instances of L_{ASmax} (free-

field) exceeding 82 dB and therefore, there is no requirement to further amend the NEC.

3.1.8 For sites categorised as NEC 'C', TAN11 [1] states:

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

3.1.9 It should be noted that the above NEC relates to the most exposed area of the site adjacent to North Road and is not necessarily reflective of the acoustic conditions further into the site.

3.1.10 In this case, it is anticipated that a '*commensurate level of protection against noise*' will be attainable following the consideration of good acoustic design principles.

3.2 **Good Acoustic Design**

3.2.1 Planning Policy Wales [2] recommends that the good acoustic design principles put forward in ProPG, Supplementary Document 2 [4] may also be adopted in Wales.

3.2.2 The principles of good acoustic design follow a hierarchy of noise management measures that Local Planning Authorities should encourage, including the following, in descending order of preference:

- *Maximising the spatial separation of noise source(s) and receptor(s).*
- *Investigating the necessity and feasibility of reducing existing noise levels and relocating existing noise sources.*
- *Using existing topography and existing structures (that are likely to last the expected life of the noise-sensitive scheme) to screen the proposed development site from significant sources of noise.*
- *Incorporating noise barriers as part of the scheme to screen the proposed development site from significant sources of noise.*
- *Using the layout of the scheme to reduce noise propagation across the site.*
- *Using the orientation of buildings to reduce the noise exposure of noise-sensitive rooms.*

- *Using the building envelope to mitigate noise to acceptable levels.*

3.2.3 The above measures are considered in the following sections.

3.2.4 **Maximising the spatial separation of noise source(s) and receptor(s).**

3.2.4.1 Due to the relatively small scale of the development site, there is limited scope to increase the source/receptor distance that would make a material difference to the noise levels across the site.

3.2.5 **Investigating the necessity and feasibility of reducing existing noise levels and relocating existing noise sources.**

3.2.5.1 As the noise source is out of the control of the developer, reducing existing noise levels or relocating existing noise sources is not applicable.

3.2.6 **Using existing topography and existing structures to screen the proposed development site from significant sources of noise.**

3.2.6.1 The existing boundary wall will be retained to provide beneficial acoustic screening to ground floor accommodation within the proposed development.

3.2.6.2 However, it is acknowledged that the boundary wall is of limited benefit for habitable rooms located at first floor level and above.

3.2.7 **Incorporating noise barriers as part of the scheme to screen the proposed development site from significant sources of noise.**

3.2.7.1 As discussed above, there is an existing boundary wall separating the site from the road traffic which provides beneficial acoustic screening to the accommodation on the ground floor.

3.2.7.2 For any noise barrier to be effective it will need to interrupt the source to receptor propagation path (line of site). As the proposed residential development is for up to three storeys, a barrier would be of limited benefit to the majority of habitable rooms at or above the first storey.

3.2.7.3 Any improvement to the acoustic effectiveness of the existing boundary wall for the upper storeys within the development will require the height of the wall to be increased significantly. This would likely be unacceptable to the local authority and

adversely impact on the setting of the Grade II listed building on site. Therefore, this option was not investigated further.

3.2.8 **Using the layout of the scheme to reduce noise propagation across the site.**

3.2.8.1 Due to the relatively compact extent of the site, there is limited scope for alternative layout options that would materially affect the noise propagation to the habitable rooms.

3.2.9 **Using the orientation of buildings to reduce the noise exposure of noise-sensitive rooms.**

3.2.9.1 Due to the relatively compact extent of the site, there is limited scope for alternative orientation options that would materially affect the noise propagation to the habitable rooms.

3.2.9.2 With reference to the development layout drawings presented in Appendix 4, bedrooms are located, where practicable, on the least exposed elevations of each building. Less sensitive rooms such as living/kitchens and bathrooms are typically located at the front of the buildings providing a noise buffer to habitable rooms located at the rear.

3.2.10 **Using the building envelope to mitigate noise to acceptable levels.**

3.2.10.1 Consideration should be given to the sound reduction performance of the proposed building envelope. The overall sound insulation of the building envelope is typically determined by the weakest acoustic element which would normally be the windows.

3.3 Mitigation

3.3.1 Planning Policy Wales [2] states "*The planning system should maximise its contribution to achieving the well-being goals, and in particular a healthier Wales, by aiming to reduce average population exposure to air and noise pollution*".

3.3.2 Proposed development should be designed, wherever possible, to prevent adverse effects to amenity, health and the environment. As a minimum, measures should be implemented to limit or constrain any effects that may occur.

3.3.3 Following consideration of the good acoustic design principles detailed above, this report uses 3D acoustic modelling to determine the additional sound reduction required from the building envelope to ensure that a '*commensurate level of protection against noise*' will be attainable throughout the development.

4.0 IMPACT ASSESSMENT

4.1 RELEVANT GUIDANCE

4.1.1 As a matter of best practice, this assessment has been undertaken with reference to relevant guidance on noise. Summary descriptions of the guidance is presented in Appendix 8.

4.2 Assessment Criteria

4.2.1 There are no objective criteria detailed in the comments from Cardiff City Council.

4.2.2 Suitable guidance on acceptable internal noise levels can be found in BS 8233:2014 [5]. This document suggests that "*in general, for steady external noise sources, it is desirable that the internal ambient noise level does not exceed the guideline values*".

4.2.3 BS 8233 also states "*For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$ with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments*".

4.2.4 For the purposes of this report, internal and external noise levels at the site are assessed against the guideline criteria detailed in Table 2 below.

Table 2 – Assessment Criteria for Internal and External Ambient Noise Levels

Assessment Period	Maximum Internal Ambient Noise Level*	Maximum External Ambient Noise Level
Daytime (07:00 – 23:00)	35 dB $L_{Aeq,16hr}$	55 dB $L_{Aeq,16hr}$
Night Time (23:00 – 07:00)	30 dB $L_{Aeq,8hr}$	--

** within habitable rooms*

4.2.5 Internal Ambient Noise Levels

4.2.5.1 The internal noise level in a room is calculated by subtracting the sound reduction performance of the external façade from the noise level outside the room. In this case, the sound insulation performance of the external façade is assumed to be equivalent to the weakest acoustic element which will be the glazing units.

4.2.5.2 A 3D acoustic model was developed to predict the external noise levels at each façade of every proposed dwelling to enable the calculation of the relevant internal noise levels. The details of the modelling are presented in Appendix 5 with the results presented in Appendix 6.

4.2.6 **Open Window Ventilation Strategy, Front Elevation**

4.2.6.1 Whenever possible, it is desirable to open the windows to provide background ventilation and when partially open windows are relied upon for background ventilation, the sound reduction of the façade is reduced to 15 dB [8].

4.2.6.2 To achieve the internal noise criteria of 35 dB $L_{Aeq,16hrs}$ with an open window during the daytime time period, the external noise level would be required to be below 35 + 15 = 50 dB $L_{Aeq,16hrs}$. To achieve the internal noise criteria of 30 dB $L_{Aeq,8hrs}$ with an open window during the night time period, the external noise level would be required to be below 30 + 15 = 45 dB $L_{Aeq,8hrs}$.

4.2.6.3 Following inspection of the results, this assessment identified the following habitable rooms where the use of a partially open window for ventilation would be suitable during both the daytime and night time periods.

Table 3 – Habitable Rooms where an Open Window Ventilation Strategy is Suitable

Habitable Room	Calculated External Road Traffic Noise Level Daytime (07:00 – 23:00 hrs) $L_{Aeq,16hrs}$ (dB)	Calculated External Road Traffic Noise Level Night Time (23:00 – 08:00 hrs) $L_{Aeq,8hrs}$ (dB)
North Flat 2 Bedroom 2	38	31
North Flat 3 Bedroom 1	38	31
North Flat 3 Bedroom 2	38	31
North Flat 3 Living/Kitchen	38	31
North Flat 5 Bedroom 2	41	34
North Flat 6 Bedroom 1	42	34
North Flat 6 Bedroom 2	42	34

Habitable Room	Calculated External Road Traffic Noise Level Daytime (07:00 – 23:00 hrs) $L_{Aeq,16hrs}$ (dB)	Calculated External Road Traffic Noise Level Night Time (23:00 – 08:00 hrs) $L_{Aeq,8hrs}$ (dB)
North Flat 6 Living/Kitchen	41	34
North Flat 8 Bedroom 2	48	40
North Flat 9 Bedroom 1	49	42
North Flat 9 Bedroom 2	48	41
North Flat 9 Living/Kitchen	48	40
South Flat 1 Bedroom 1	37	31
South Flat 2 Bedroom 1	37	30
South Flat 3 Bedroom 1	41	33
South Flat 4 Bedroom 1	40	33
South Flat 5 Bedroom 1	46	39
South Flat 6 Bedroom 1	46	39
Villa Flat 2 Bedroom 2 Rear	39	32
Villa Flat 2 Bedroom 2 Side	49	41
Villa Flat 4 Living/Kitchen Rear	42	35

4.2.6.4 The remaining habitable rooms are exposed to external road traffic noise levels that would result in the internal ambient noise level criteria being exceeded whilst using a partially open window to provide background ventilation.

4.2.7 **Minimum Façade Sound Insulation Specification**

4.2.7.1 As discussed, an open window ventilation strategy would not be suitable for a number of habitable rooms within the proposed development. To achieve the required internal ambient noise levels within these habitable rooms, the windows will need to be in the closed position to control the noise ingress.

4.2.7.2 This report assesses the minimum sound reduction performance required from the glazing units for each of the habitable rooms exposed to unacceptable levels of external road traffic noise.

4.2.7.3 For housing design purposes, the outdoor to indoor noise level difference can be described in terms of the sound reduction index of appropriate parts of the building envelope calculated from values of R_w.

4.2.7.4 However, as stated in BS EN 12354-3, *"…the indoor A-weighted sound pressure level can be determined directly from the A-weighted outdoor sound pressure level, provided the level difference is expressed in a single number rating for the relevant outdoor sound spectrum"*.

4.2.7.5 The relevant outdoor sound spectrum is defined in BS EN ISO 717-1 [10] as a correction term, C or C_{tr}, to be applied to the level difference.

4.2.7.6 When considering road traffic travelling at low speeds (<80 km/h), as in this case, the appropriate correction term is C_{tr}.

4.2.7.7 Therefore, in this case, the level difference of the elements for the building envelope can be described as the single number rating value, $R_w + C_{tr}$.

4.2.7.8 The results of the minimum sound reduction calculations for the glazing units at each habitable room are detailed in Appendix 7.

4.2.7.9 The results indicate a wide variety in the minimum sound reduction specification requirements depending on location. Therefore, it may be more practical from an on-site logistics perspective, to specify the same performance for all glazing units. This will ensure that appropriate glazing is installed to all rooms, avoiding on-site confusion leading to mistakenly installing glazing to a room that was intended for another location.

4.2.7.10 From the results detailed in Appendix 7, a minimum sound reduction performance specification of 30 dB $R_w + C_{tr}$ would provide the required internal noise levels to all habitable rooms during both the daytime and night time.

4.2.7.11 Manufacturers' data should be used to confirm the above minimum sound reduction performance requirements are achievable from any specified glazing units, including any provision for background ventilation if applicable.

4.2.7.12 The windows are required to be in the closed position to effectively control noise ingress. The decision on whether the windows should be permanently closed is outside the scope of this assessment and our technical expertise. However, where windows are exposed to anonymous noise sources such as road traffic, there is normally no requirement for these windows to be permanently sealed.

4.2.7.13 All rooms subject to sound mitigation measures should be provided with an alternative, effective means of ventilation. Any ventilation scheme should satisfy the requirements of Approved Document F and provide the required ventilation rates. Specialist advice should be obtained to ensure that any ventilation scheme is suitable for purpose. It is important that any scheme is approved by Building Control and does not compromise the internal noise levels.

4.2.7.14 Recommendations for suitable ventilation are outside the scope of this assessment and technical expertise.

4.2.8 **External Noise Levels**

4.2.8.1 With reference to the development layout presented in Appendix 4, there are no defined external amenity areas provided for the flats.

4.2.8.2 However, the results of the modelling detailed in Figure 10, Appendix 6 indicate that around 50% of the external area is exposed to road traffic noise of less than the external criteria limit of 55 dB $L_{Aeq,16hrs}$ which may be suitable for use as a community amenity space if required.

4.2.8.3 Additionally, ProPG [4] states that any impact *'…be partially off-set if the residents are provided…with access to: a relatively quiet, protected, publicly accessible, external amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5 minutes walking distance)*'.

4.2.8.4 PPG-Noise states that the availability of suitably protected quiet and tranquil outdoor places within, or close to, proposed new residential development in noisier

locations may be regarded as a mitigating factor when such applications are determined.

4.2.8.5 In this case, the development site is located 30m from Bute Park and Blackweir Fields which is a significant area of publicly accessible recreational parkland and therefore, the absence of defined amenity space within the development site need not be considered a determining factor when considering the application.

5.0 CONCLUSIONS

5.1 An assessment of the potential noise impact from road traffic was carried out to determine the sites suitability for residential development and the extent of mitigation measures required to achieve the anticipated internal and external noise criteria required by Cardiff City Council.

5.2 **Internal Ambient Noise Levels**

5.2.1 The results of this assessment indicate that for a relatively small number of habitable rooms within the proposed development (see Table 3), desirable internal ambient noise levels are achievable whilst using an open window ventilation strategy. No additional mitigation is required for these rooms.

5.2.2 Furthermore, the results indicate that all habitable rooms within Plots 3, 6 and 9 of the proposed northern block will achieve the desirable internal ambient noise levels whilst using an open window ventilation strategy and no further mitigation is required for these plots.

5.2.3 For the remaining habitable rooms, this report provides recommendations for the minimum sound reduction performance required from the glazing units so that desirable internal noise levels are achievable at all times.

5.3 **External Ambient Noise Levels**

5.3.1 With reference to the proposed development layout, there are no defined external amenity areas provided for the flats.

5.3.2 However, the results of this assessment indicate that around 50% of the external area is exposed to road traffic noise of less than the external criteria limit of 55 dB $L_{Aeq,16hrs}$ which may be suitable for use as a community amenity space if required.

5.3.3 The absence of external amenity space may be partially offset if the residents are provided with access to a relatively quiet, protected, publicly accessible, external amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5 minutes walking distance).

5.3.4 In this case, the development site is located 30m from Bute Park and Blackweir Fields which is a significant area of publicly accessible recreational parkland and therefore, the absence of defined amenity space within the development site need not be considered a determining factor when considering the application in accordance with national planning policy guidance.

6.0 RECOMMENDATIONS

6.1 The results of this assessment indicate a wide variety in the minimum sound reduction specification requirements depending on location. Therefore, it may be more practical from an on-site logistics perspective, to specify the same performance for all glazing units. This will ensure that appropriate glazing is installed to all rooms, avoiding on-site confusion leading to mistakenly installing glazing to a room that was intended for another location.

6.2 A minimum sound reduction performance specification of 30 dB $R_w + C_{tr}$ is required for the glazing units for any habitable room where this report has identified that an open window ventilation strategy is not suitable. This would provide the required internal noise levels to all habitable rooms during both the daytime and night time.

6.3 Manufacturers' data should be used to confirm the above minimum sound reduction performance requirements are achievable from any specified glazing units, including any provision for background ventilation if applicable.

6.4 The windows are required to be in the closed position to effectively control noise ingress. The decision on whether the windows should be permanently closed is outside the scope of this assessment and our technical expertise. This decision should be taken by appropriate authorities.

6.5 All habitable rooms subject to sound mitigation measures should be provided with an alternative, effective means of ventilation. Any ventilation scheme should satisfy the requirements of Approved Document F and provide the required ventilation rates. Specialist advice should be obtained to ensure that any ventilation scheme is suitable for purpose. It is important that any scheme is approved by Building Control and does not compromise the internal noise levels.

6.6 Recommendations for suitable ventilation are outside the scope of this assessment and technical expertise.

P.A.T. 19/09/23
M.Sc., I.Eng., M.I.O.A., M.Inst.SCE., M.A.E.S.

Appendix 1
Survey Details

A1.0 SURVEY DETAILS

A1.1.1 The meter was calibrated at the start of the measurement procedure and checked after each set of measurements. No significant deviation i.e. > 0.5 dB was recorded.

A1.1.2 The survey commenced at 11:05 hours on 23rd August 2023 for a continuous 24-hour period.

A1.1.3 Weather conditions: 40% cloud cover, 18°C, dry, slight intermittent breeze (<5m/s).

A1.2 **Measurement Procedure:**

A1.2.1 The meter was located in a weather-proof container and powered with heavy duty rechargeable batteries. The microphone was located on a bracket extending 1m from the front façade of the existing building at first floor level. The microphone was inside an approved weather-proof microphone housing.

A1.2.2 The meter was adjusted to log and store L_{Aeq}, L_{A90} and L_{AFmax} in 15-minute periods for the duration of the survey (see Table 4).

A1.2.3 On completion of the survey, the data was downloaded to a computer for further analysis.

A1.2.4 The analysis consisted of using B&K 7820 Evaluator software to divide the results into the time periods 07:00-23:00 and 23:00-07:00.

A1.2.5 **Subjective Impressions**

A1.2.6 The acoustic environment during the survey was characterised by road traffic.

A1.3 **Equipment Used:**

Table 4 – Equipment Used

ITEM	Serial No	UKAS Calibration Certificate Date (if applicable)
(ANL-M3) B&K 2250 Handheld Analyser	2559188	Certificate: 16158 Date: 08/03/23
(ANPC3) B&K 4231 Calibrator	2162602	Certificate: 16156 Date: 07/03/23

Table 5 – Meter Details

Instrument:		**2250**
Application:		BZ7224 Version 4.7.6
Start Time:		08/23/2023 11:05:01
End Time:		08/24/2023 12:02:05
Elapsed Time:		1.00:57:04
Bandwidth:		Broadband
Max Input Level:		140.99
	Time	Frequency
Broadband (excl. Peak):	FSI	AZ
Broadband Peak:		A
Instrument Serial Number:		2559188
Microphone Serial Number:		2556132
Input:		Top Socket
Windscreen Correction:		None
Sound Field Correction:		Free-field
Calibration Time:		08/23/2023 10:58:52
Calibration Type:		External reference
Sensitivity:		49.74 mV/Pa

Appendix 2
View of Measurement Position

A2.0 VIEW OF MEASUREMENT POSITION

Figure 1 – Measurement Position

Figure 2 – View of Equipment Location

Appendix 3
Survey Results

A3.0 SURVEY RESULTS

Table 6 – Summary of Survey Results (Façade Noise Levels)

Front Elevation	Period	Duration, t	$L_{Aeq,t}$ (dB)	$L_{AF90,t}$ (dB)	L_{AFmax} (dB)
Daytime	07:00 – 23:00	16:00	71.0	47.3	106.1
Night Time	23:00 – 07:00	08:00	62.0	35.4	88.1

Table 7 – Daytime Façade Noise Levels (07:00 – 23:00)

Start date	Start time	$L_{Aeq,15mins}$ (dB)	$L_{AF90,15mins}$ (dB)	L_{AFmax} (dB)
24/08/2023	07:00:00	71.1	50.9	86.2
24/08/2023	07:15:00	71.6	55.0	84.5
24/08/2023	07:30:00	72.7	55.4	82.2
24/08/2023	07:45:00	72.9	59.7	83.4
24/08/2023	08:00:00	72.4	54.8	84.7
24/08/2023	08:15:00	72.1	54.4	82.3
24/08/2023	08:30:00	72.1	58.1	83.0
24/08/2023	08:45:00	76.7	52.1	106.1
24/08/2023	09:00:00	71.5	54.0	83.0
24/08/2023	09:15:00	71.4	52.7	83.3
24/08/2023	09:30:00	71.2	54.7	85.7
24/08/2023	09:45:00	72.0	55.5	93.8
24/08/2023	10:00:00	71.1	54.6	84.5
24/08/2023	10:15:00	70.7	53.5	84.2
24/08/2023	10:30:00	70.3	50.9	83.7
24/08/2023	10:45:00	70.1	47.8	86.5
24/08/2023	11:00:00	70.9	55.4	81.6
23/08/2023	11:15:00	70.8	53.6	82.8
23/08/2023	11:30:00	71.1	55.8	86.3
23/08/2023	11:45:00	71.3	55.9	90.2

Start date	Start time	$L_{Aeq,15mins}$ (dB)	$L_{AF90,15mins}$ (dB)	L_{AFmax} (dB)
23/08/2023	12:00:00	70.8	53.9	86.7
23/08/2023	12:15:00	70.5	51.9	81.0
23/08/2023	12:30:00	74.2	52.9	101.7
23/08/2023	12:45:00	70.3	53.5	82.0
23/08/2023	13:00:00	70.0	52.1	83.2
23/08/2023	13:15:00	73.2	56.7	95.0
23/08/2023	13:30:00	70.9	55.2	84.6
23/08/2023	13:45:00	70.7	51.6	90.8
23/08/2023	14:00:00	70.1	50.4	84.5
23/08/2023	14:15:00	70.3	54.4	84.4
23/08/2023	14:30:00	76.4	52.0	105.3
23/08/2023	14:45:00	71.2	57.0	95.7
23/08/2023	15:00:00	71.8	51.2	91.8
23/08/2023	15:15:00	70.3	49.0	82.4
23/08/2023	15:30:00	71.0	52.4	82.8
23/08/2023	15:45:00	70.9	54.3	79.6
23/08/2023	16:00:00	71.3	51.7	83.8
23/08/2023	16:15:00	72.5	56.1	94.1
23/08/2023	16:30:00	71.6	57.2	83.0
23/08/2023	16:45:00	72.8	55.9	95.6
23/08/2023	17:00:00	71.5	58.0	82.8
23/08/2023	17:15:00	71.1	57.5	79.8
23/08/2023	17:30:00	70.7	49.9	81.5
23/08/2023	17:45:00	71.2	54.0	83.9
23/08/2023	18:00:00	71.2	51.0	90.4
23/08/2023	18:15:00	71.2	54.8	89.1
23/08/2023	18:30:00	71.3	55.8	89.0

Start date	Start time	$L_{Aeq,15mins}$ (dB)	$L_{AF90,15mins}$ (dB)	L_{AFmax} (dB)
23/08/2023	18:45:00	70.4	49.5	87.4
23/08/2023	19:00:00	68.3	48.0	80.5
23/08/2023	19:15:00	68.5	48.7	82.7
23/08/2023	19:30:00	74.3	50.1	102.4
23/08/2023	19:45:00	68.1	44.0	82.1
23/08/2023	20:00:00	66.4	44.2	84.1
23/08/2023	20:15:00	63.2	42.2	78.2
23/08/2023	20:30:00	64.7	48.7	78.5
23/08/2023	20:45:00	66.1	48.6	90.0
23/08/2023	21:00:00	62.7	42.0	77.9
23/08/2023	21:15:00	62.8	40.8	83.0
23/08/2023	21:30:00	64.8	42.9	79.7
23/08/2023	21:45:00	62.9	42.4	77.0
23/08/2023	22:00:00	62.2	41.7	76.7
23/08/2023	22:15:00	61.7	41.2	78.6
23/08/2023	22:30:00	61.1	40.8	76.9
23/08/2023	22:45:00	61.4	45.1	79.4

Table 8 – Night Time Façade Noise Levels (23:00 – 07:00)

Start date	Start time	$L_{Aeq,15mins}$ (dB)	$L_{AF90,15mins}$ (dB)	L_{AFmax} (dB)
23/08/2023	23:00:00	60.3	45.6	76.9
23/08/2023	23:15:00	63.2	44.6	81.3
23/08/2023	23:30:00	59.3	40.1	77.9
23/08/2023	23:45:00	59.4	42.9	77.9
24/08/2023	00:00:00	59.1	44.1	75.0
24/08/2023	00:15:00	58.9	37.4	80.8
24/08/2023	00:30:00	58.8	42.8	78.3
24/08/2023	00:45:00	57.6	41.2	76.0
24/08/2023	01:00:00	58.8	41.1	79.6
24/08/2023	01:15:00	58.7	40.1	82.9
24/08/2023	01:30:00	56.2	35.6	76.9
24/08/2023	01:45:00	57.1	34.2	83.2
24/08/2023	02:00:00	55.5	36.1	76.0
24/08/2023	02:15:00	60.2	35.4	84.9
24/08/2023	02:30:00	60.0	35.1	81.1
24/08/2023	02:45:00	56.3	33.7	78.2
24/08/2023	03:00:00	55.3	34.4	78.8
24/08/2023	03:15:00	54.9	34.1	76.2
24/08/2023	03:30:00	56.2	34.7	75.9
24/08/2023	03:45:00	54.8	34.3	75.5
24/08/2023	04:00:00	59.1	42.0	79.4
24/08/2023	04:15:00	59.3	41.4	88.1
24/08/2023	04:30:00	59.5	40.9	80.3
24/08/2023	04:45:00	61.2	44.2	80.0
24/08/2023	05:00:00	58.4	43.9	76.8
24/08/2023	05:15:00	62.5	44.2	81.8
24/08/2023	05:30:00	63.0	46.1	81.0

Start date	Start time	$L_{Aeq,15mins}$ (dB)	$L_{AF90,15mins}$ (dB)	L_{AFmax} (dB)
24/08/2023	05:45:00	62.5	45.5	80.8
24/08/2023	06:00:00	66.1	45.9	83.2
24/08/2023	06:15:00	66.1	45.6	82.4
24/08/2023	06:30:00	68.1	45.8	84.9
24/08/2023	06:45:00	70.6	48.9	83.2

Appendix 4
Proposed Development Drawings

A4.0 PROPOSED DEVELOPMENT DRAWINGS

Figure 3 – Proposed Development Layout

Figure 4 – Proposed Ground and First Floor Layout, Northern Block

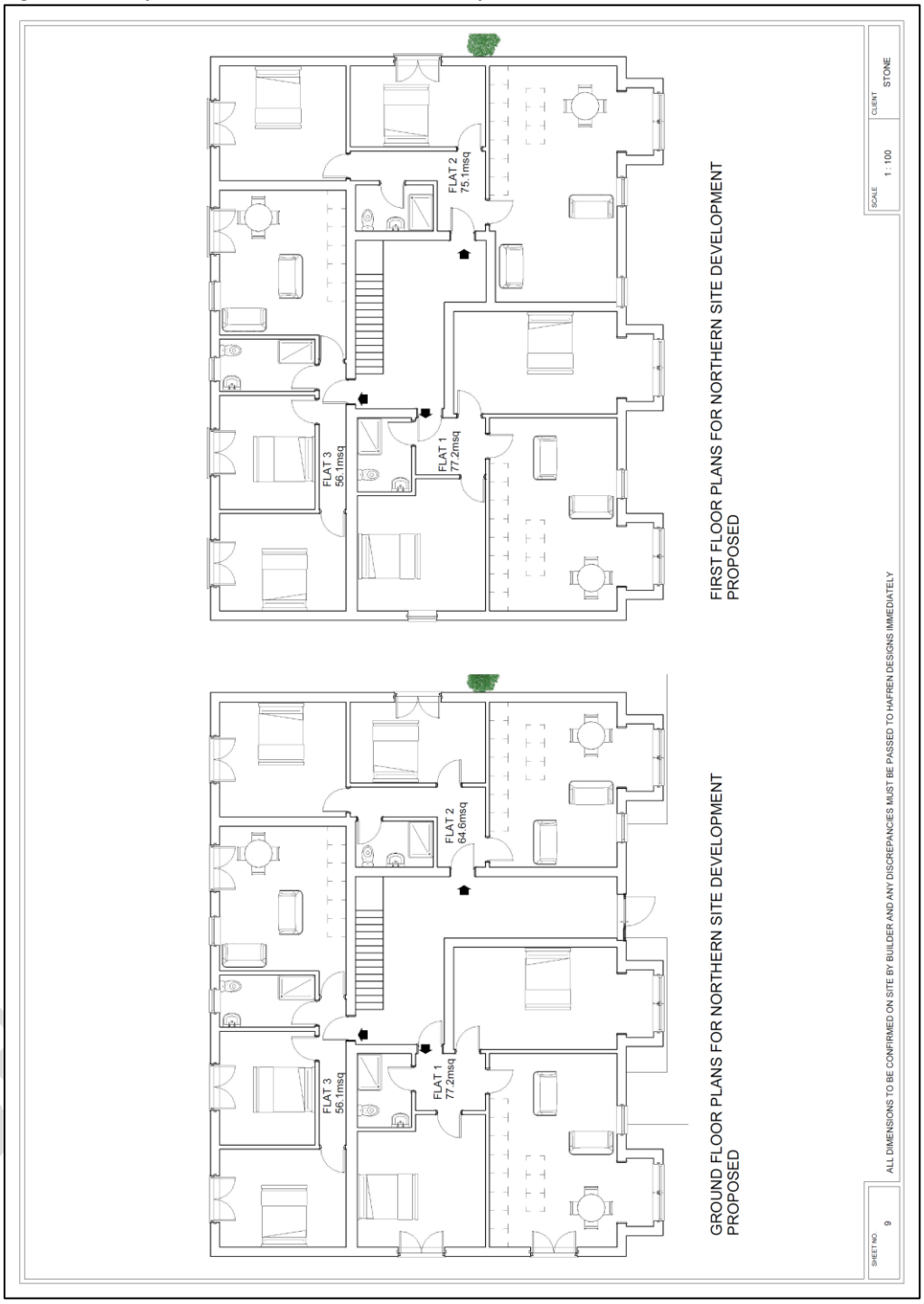


Figure 5 – Proposed Second Floor Layout, Northern Block

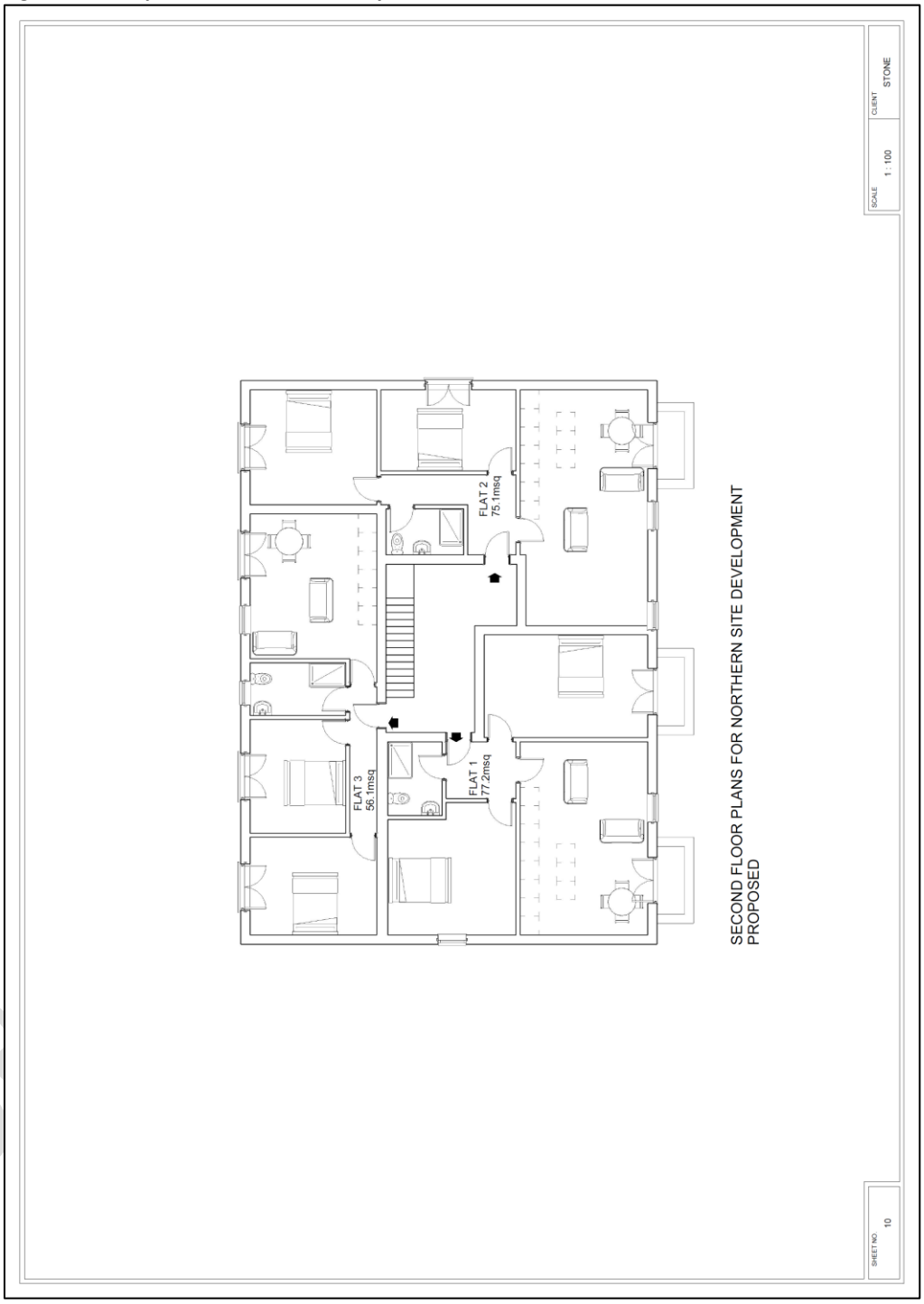
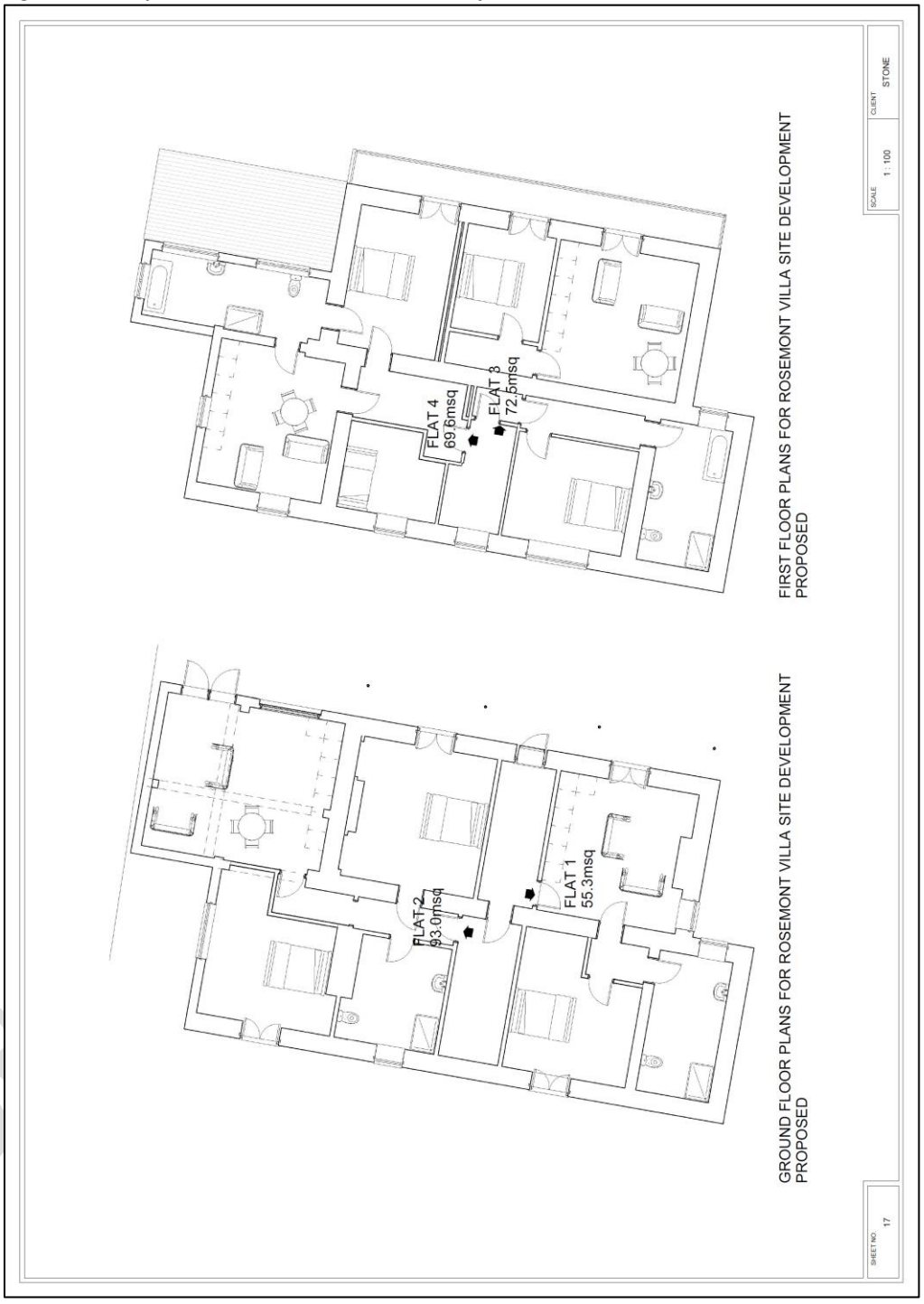


Figure 6 – Proposed Ground and First Floor Layout, Southern Block

Figure 7 – Proposed Ground and First Floor Layout, Southern Block

Figure 8 – Proposed Second Floor Layout, Southern Block

Figure 9 – Proposed Ground and First Floor Layout, Villa Block



Appendix 5
3D Acoustic Model Details

A5.0 3D ACOUSTIC MODEL DETAILS

A5.1 ASSUMPTIONS MADE IN MODEL

A5.1.1 The ground attenuation was modelled as hard/soft/mixed with a ground factor value of 0.0.

A5.1.2 Acoustic barriers were modelled as reflective.

A5.1.3 Atmospheric conditions were modelled as

- *Temperature: 293.15 K*
- *Pressure: 101.33*
- *Air Humidity: 60%*

A5.2 PREDICTION OF NOISE LEVELS ACROSS PROPOSED DEVELOPMENT SITE

A5.2.1 As the site is relatively complex and comprises multiple dwellings, a 3D acoustic CAD model of the proposed development is constructed to aid in the identification of potential areas or plots that may not meet the stated impact criteria. This process minimises unnecessary schemes of mitigation.

A5.2.2 EMS B&K Predictor V2019 Software was utilised to model the road traffic noise levels across the whole of site. This noise prediction software allows for the investigation of noise emissions in complex or large outdoor environments. The software can be used to analyse industrial noise sources and traffic measurements to the latest European and U.K. Standards.

A5.2.3 A major advantage of using this method is the ability to remodel changes and alterations to the site and/or sources.

A5.3 CAD MODEL CONSTRUCTION

A5.3.1 Topographical information for the site was obtained from the online site '*DataMapWales*' in the form of Digital Terrain Model data (2m resolution). The '*DataMapWales*' platform has been developed as a partnership between Welsh Government and Natural Resources Wales. It serves as a hub for data and information covering a wide spectrum of topics, but primarily around the environment.

A5.3.2 The topographical data was imported into the CAD software and used to construct the 3D terrain for the site.

A5.3.3 '*OS Open Zoomstack*' was used as a background image for the model. '*OS Open Zoomstack*' provides a single, customisable basemap of Great Britain made freely available in partnership with the UK government. The data was obtained from '*www.osdatahub.os.uk.co.uk*' under the Open Government Licence (OGL) v3.0 and contains OS data © Crown copyright and database right 2023.

A5.3.4 A proposed site layout drawing, '*8-view-1*', was provided by Hafren Designs to be used as a background for the model to locate proposed development buildings, measurement position and noise sensitive receptors accurately.

A5.3.5 A '*road item*' was positioned centrally along North Road using the basemap as a guide. The modelling software defines a '*road item*' as '*a line source used for modelling the sound level emissions of vehicles on a road*'.

A5.4 CAD MODEL CALIBRATION

A5.4.1 A 24hr noise survey was conducted at the façade of the existing Villa block at a height of 4.5m. The microphone enjoyed an uninterrupted view of the road traffic travelling along North Road.

A5.4.2 A noise receiver was positioned in the model at the position of the actual measurement location used during the 24hr road traffic noise survey.

A5.4.3 The model assumes that the measured noise levels during the 24hr survey are attributable to the road traffic. All other noise sources are assumed to be insignificant when compared to the primary noise source.

A5.4.4 The daytime $L_{Aeq,16hr}$ and night time $L_{Aeq,8hr}$ noise levels at the measurement position are determined from the 24hr survey data using B&K 7820 Evaluator software.

A5.4.5 The vehicle flow was then adjusted until the calculated noise level at the receiver equals the period L_{Aeq} level determined using the procedures detailed above.

A5.4.6 The software calculations for noise propagation follow the procedures set out in CRTN [6] and TRL Method 3 for non-motorway roads [7].

A5.4.7 When the calculated noise level at the receiver equals the level determined from the survey data, the noise emission level for the road has been determined.

A5.4.8 This exercise is conducted for both daytime and night time periods.

A5.5 CAD MODEL PREDICTION

A5.5.1 Once the model calibration exercise is completed, the proposed development buildings are placed into the model using the design drawing as a guide (see Appendix 4).

A5.5.2 All proposed buildings are modelled with a height of 8m.

A5.5.3 Each of the proposed residential properties will have habitable rooms located on both the ground floor level and first floor level (see Appendix 4). The northern and southern block also have habitable rooms located on the second floor level. The height of the ground floor receptor is modelled at 1.5m, the first floor receptor is modelled at a height of 4.5m and the height of the second floor level is modelled at a height of 7.5m.

A5.5.4 Individual receptors are placed 0.1m in front of each habitable room within the development to calculate the external free-field noise levels at each room. A noise contour grid covering the whole site is then constructed to display the external free field noise levels within any proposed amenity areas. This grid is a collection of receivers set 1m apart at a height of 1.5m.

A5.5.5 Using EMS B&K Predictor V2019 software, calculations were made for each receiver using the calibrated noise source emissions as described above. External amenity noise levels were calculated using the 1.5m high grid covering the proposed site.

A5.5.6 Calculations are made for both the daytime and night time periods for all receivers with separate contour maps generated for each assessment period.

A5.5.7 The results of the assessment are presented in the form of easily understood noise contour maps and are shown in Appendix 6.

A5.5.8 These contour maps indicate the free field noise levels across the whole of the proposed development with each contour colour boundary assigned a noise level

so that areas of the proposed development that comply with each of the criteria can be easily identified.

A5.6 NOISE CONTOUR MAPS

A5.6.1 Colour coded noise contour maps are generated by the acoustic model to visually aid identification of the following:

- *External free-field noise levels across the proposed development (including buildings) at a height of 1.5m. Areas where the external amenity criteria are satisfied are indicated in green for ease of identification.*
- *Plots where the internal noise criteria will be satisfied if using an open window ventilation strategy. Noise levels within habitable rooms on any façade located within the green area will satisfy the internal noise criteria with a window partially open for ventilation purposes. Contour maps are generated to represent rooms at ground, first and second floor for both the daytime and night time periods.*

Appendix 6
Modelling Results

A6.0 MODELLING RESULTS

Figure 10 – External Amenity Noise Propagation, Daytime

Figure 11 – Open Window Ventilation Strategy, Ground Floor, Daytime

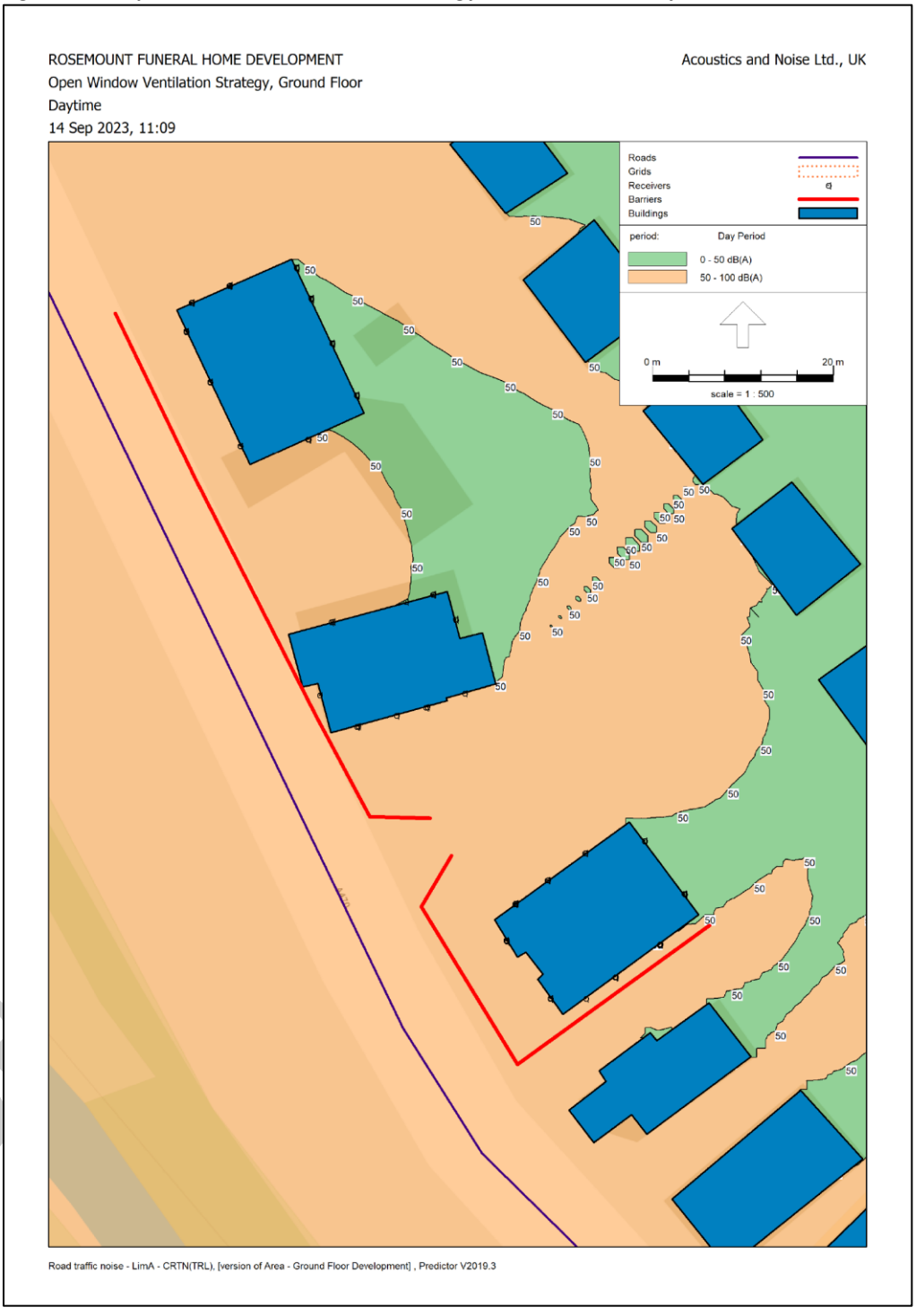


Figure 12 – Open Window Ventilation Strategy, Ground Floor, Night Time

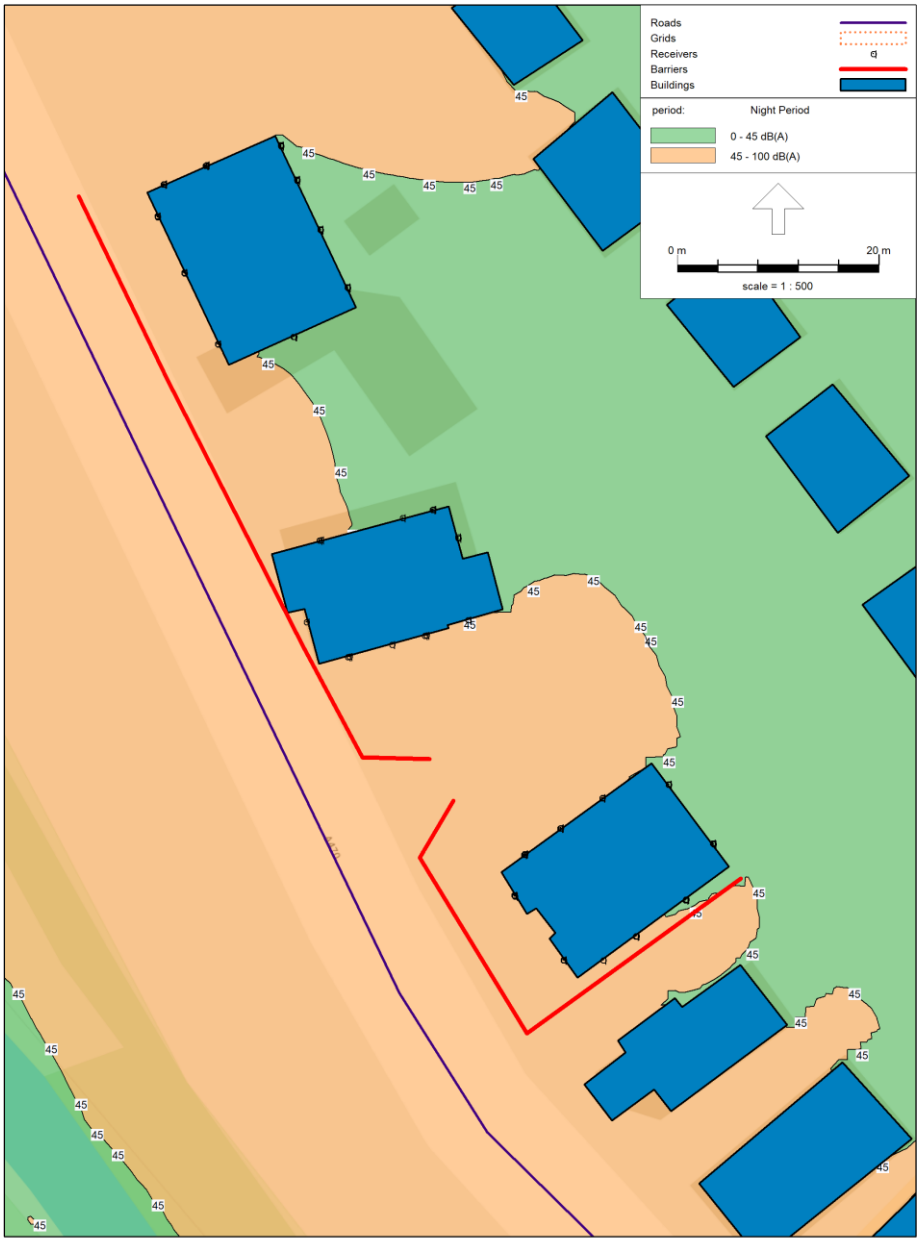


Figure 13 – Open Window Ventilation Strategy, First Floor, Daytime

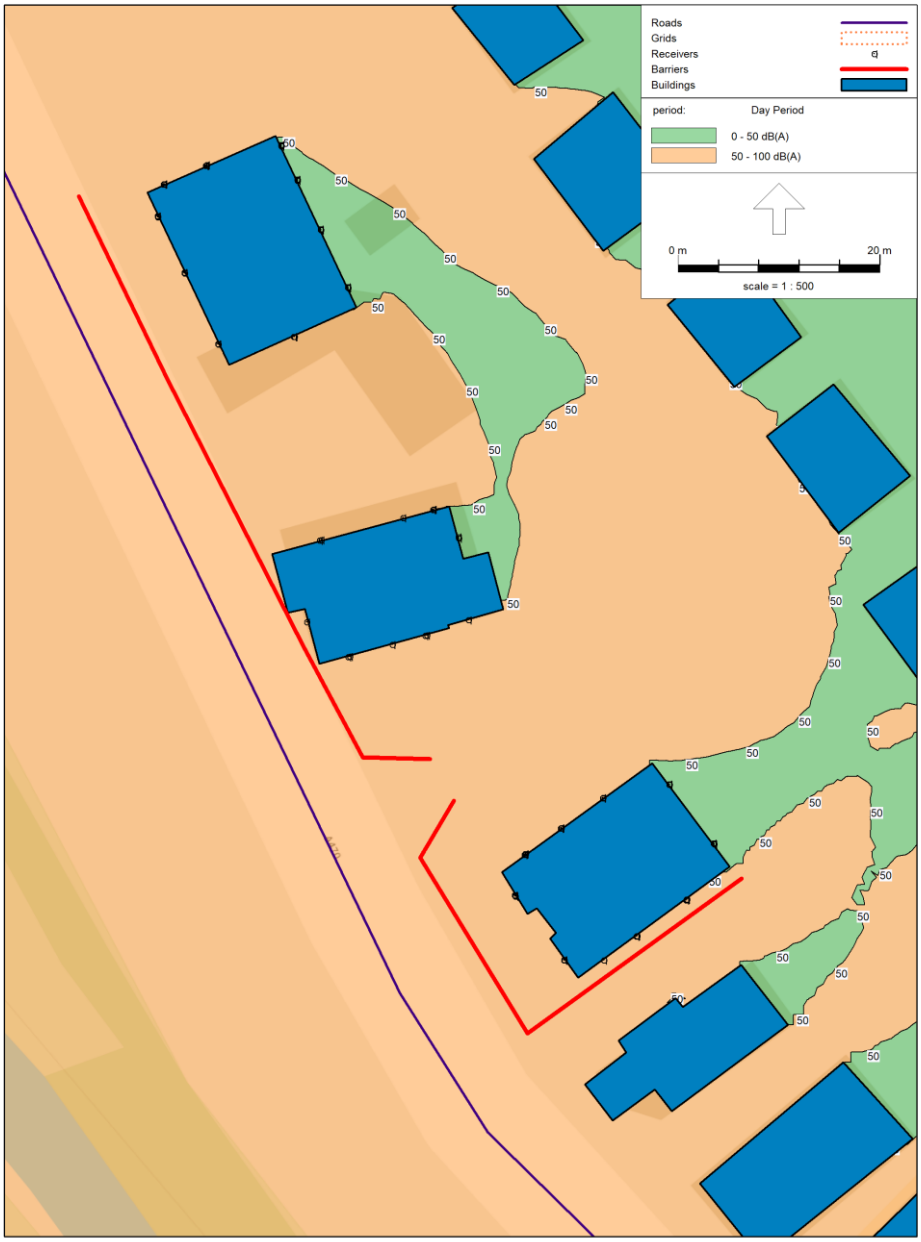


Figure 14 – Open Window Ventilation Strategy, First Floor, Night Time

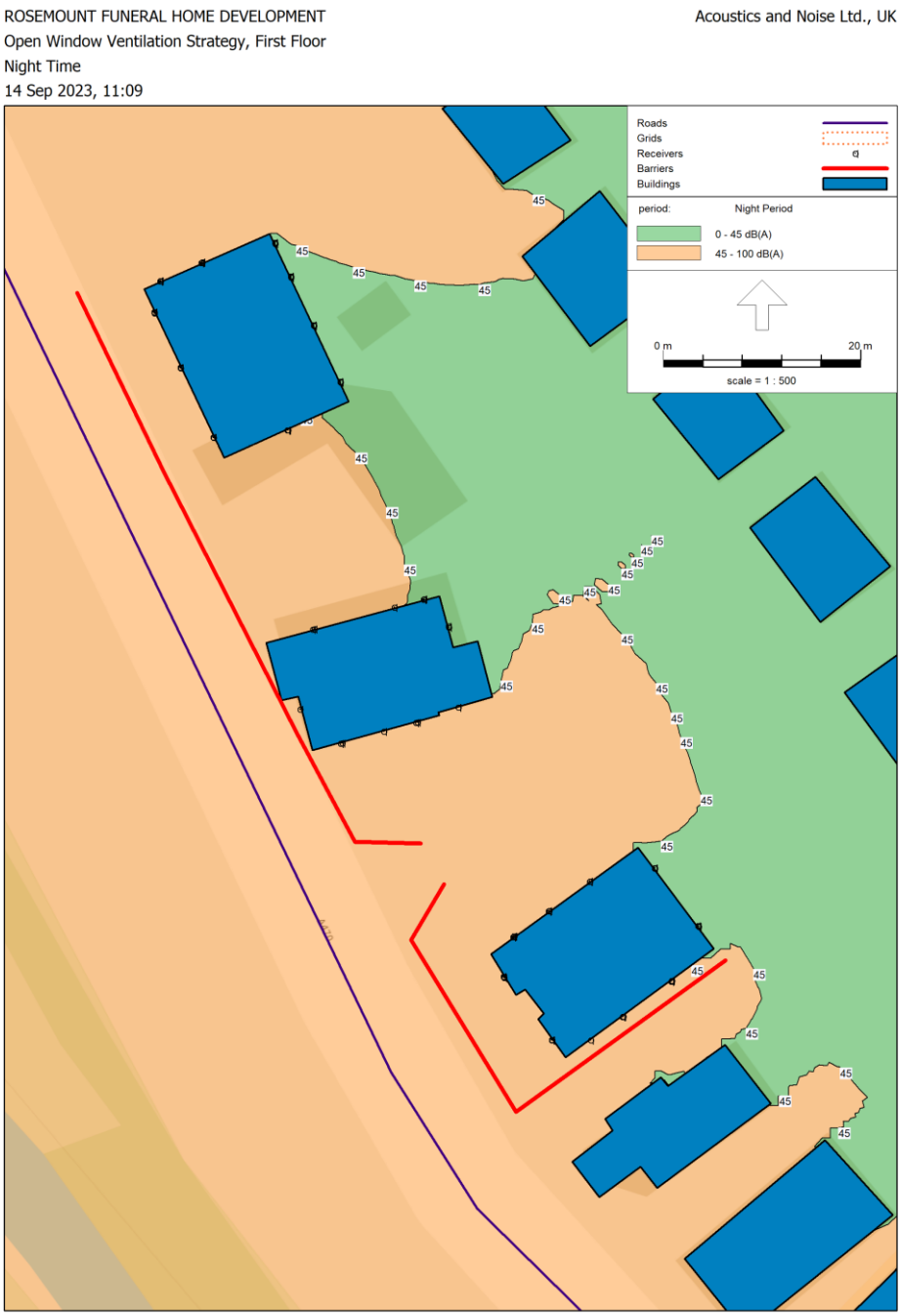


Figure 15 – Open Window Ventilation Strategy, Second Floor, Daytime

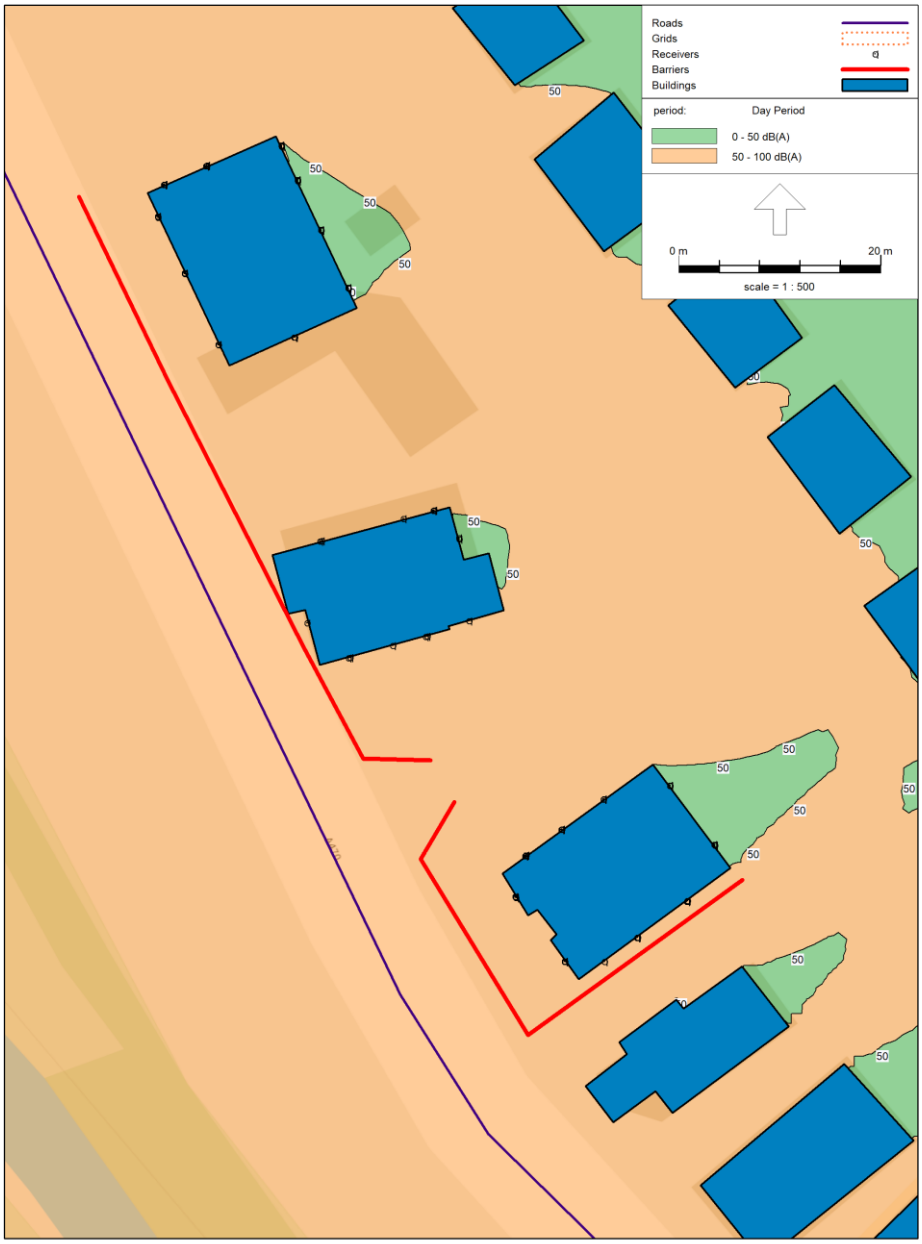


Figure 16 – Open Window Ventilation Strategy, Second Floor, Night Time

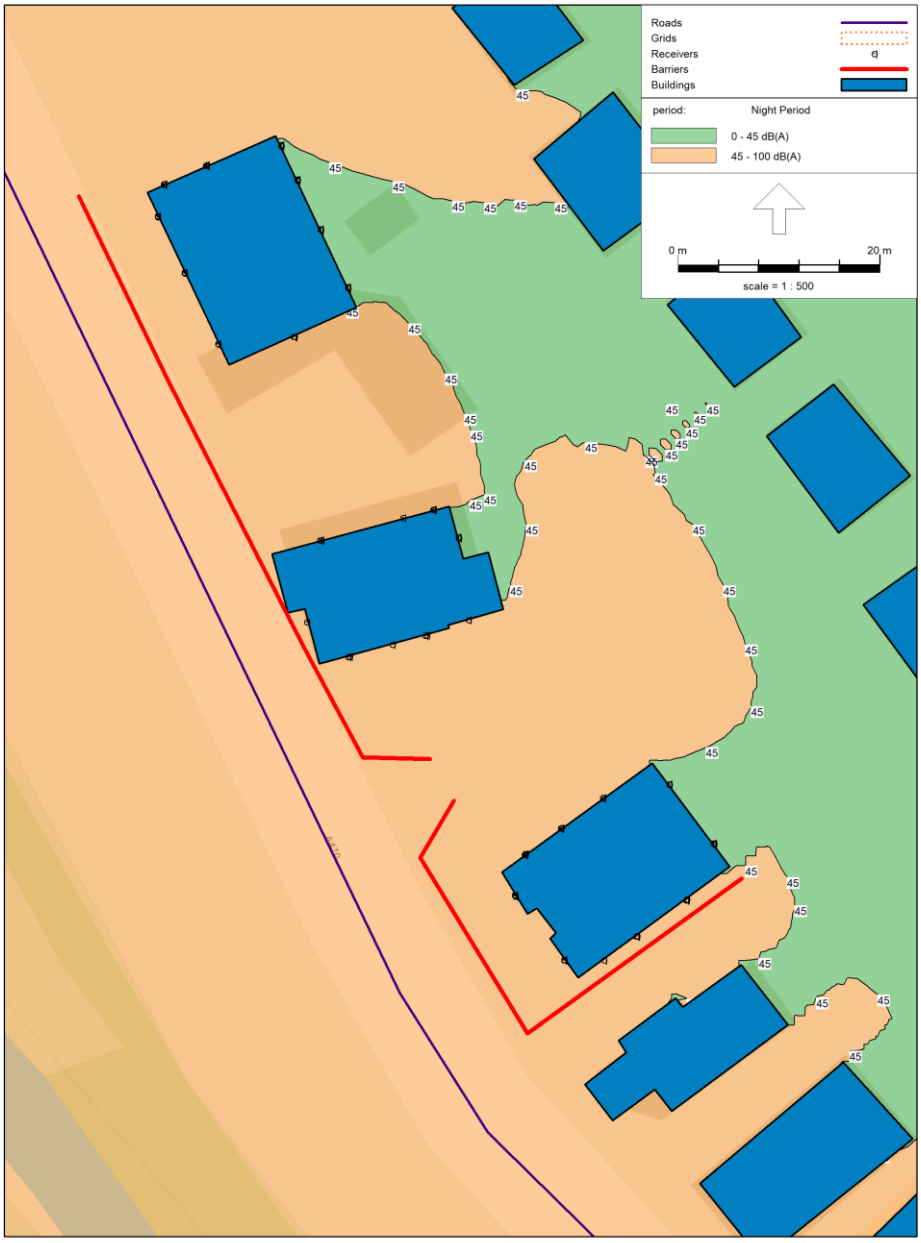


Table 9 – Calculated External Free-Field Noise Level at Sensitive Receptors

Receptor	Receptor Height	Free-Field External Noise Level Daytime $L_{Aeq,16hr}$ (dB)	Free-Field External Noise Level Night Time $L_{Aeq,8hr}$ (dB)
North Flat 1 Bedroom 1	Ground Floor	59.6	51.3
North Flat 1 Bedroom 2	Ground Floor	60.4	52.0
North Flat 1 Living/Kitchen Front	Ground Floor	61.4	53.1
North Flat 1 Living/Kitchen Side	Ground Floor	61.5	53.1
North Flat 2 Bedroom 1	Ground Floor	50.8	43.0
North Flat 2 Bedroom 2	Ground Floor	38.2	31.1
North Flat 2 Living/Kitchen	Ground Floor	58.2	50.0
North Flat 3 Bedroom 1	Ground Floor	38.4	31.3
North Flat 3 Bedroom 2	Ground Floor	38.3	31.2
North Flat 3 Living/Kitchen	Ground Floor	38.3	31.2
North Flat 4 Bedroom 1	First Floor	64.1	55.6
North Flat 4 Bedroom 2	First Floor	60.3	52.0
North Flat 4 Living/Kitchen Front	First Floor	64.3	55.8
North Flat 4 Living/Kitchen Side	First Floor	61.6	53.2
North Flat 5 Bedroom 1	First Floor	55.5	47.4
North Flat 5 Bedroom 2	First Floor	41.2	34.0
North Flat 5 Living/Kitchen	First Floor	63.9	55.4
North Flat 6 Bedroom 1	First Floor	41.5	34.3
North Flat 6 Bedroom 2	First Floor	41.5	34.2
North Flat 6 Living/Kitchen	First Floor	41.4	34.2
North Flat 7 Bedroom 1	Second Floor	65.2	56.7
North Flat 7 Bedroom 2	Second Floor	60.6	52.2
North Flat 7 Living/Kitchen Front	Second Floor	65.3	56.7
North Flat 7 Living/Kitchen Side	Second Floor	62.0	53.6
North Flat 8 Bedroom 1	Second Floor	58.5	50.3
North Flat 8 Bedroom 2	Second Floor	47.5	39.9

Receptor	Receptor Height	Free-Field External Noise Level Daytime $L_{Aeq,16hr}$ (dB)	Free-Field External Noise Level Night Time $L_{Aeq,8hr}$ (dB)
North Flat 8 Living/Kitchen	Second Floor	65.2	56.6
North Flat 9 Bedroom 1	Second Floor	49.2	41.6
North Flat 9 Bedroom 2	Second Floor	48.2	40.6
North Flat 9 Living/Kitchen	Second Floor	47.5	40.0
South Flat 1 Bedroom 1	Ground Floor	37.4	30.5
South Flat 1 Bedroom 2	Ground Floor	54.8	46.8
South Flat 1 Bedroom 3	Ground Floor	55.7	47.6
South Flat 1 Living/Kitchen Front	Ground Floor	60.6	52.5
South Flat 1 Living/Kitchen Side	Ground Floor	56.5	48.4
South Flat 2 Bedroom 1	Ground Floor	37.2	30.4
South Flat 2 Bedroom 2	Ground Floor	51.5	43.8
South Flat 2 Bedroom 3	Ground Floor	53.7	45.9
South Flat 2 Living/Kitchen Front	Ground Floor	60.3	52.3
South Flat 2 Living/Kitchen Side	Ground Floor	56.2	48.3
South Flat 3 Bedroom 1	First Floor	40.5	33.4
South Flat 3 Bedroom 2	First Floor	57.1	48.9
South Flat 3 Bedroom 3	First Floor	59.0	50.8
South Flat 3 Living/Kitchen Front	First Floor	64.8	56.6
South Flat 3 Living/Kitchen Side	First Floor	60.9	52.6
South Flat 4 Bedroom 1	First Floor	40.3	33.3
South Flat 4 Bedroom 2	First Floor	54.6	46.8
South Flat 4 Bedroom 3	First Floor	57.0	49.0
South Flat 4 Living/Kitchen Front	First Floor	64.4	56.1
South Flat 5 Bedroom 1	Second Floor	46.4	39.1
South Flat 5 Bedroom 2	Second Floor	57.9	49.8
South Flat 5 Bedroom 3	Second Floor	59.8	51.6
South Flat 5 Living/Kitchen Front	Second Floor	64.8	56.5

Receptor	Receptor Height	Free-Field External Noise Level Daytime $L_{Aeq,16hr}$ (dB)	Free-Field External Noise Level Night Time $L_{Aeq,8hr}$ (dB)
South Flat 5 Living/Kitchen Side	Second Floor	61.3	53.0
South Flat 6 Bedroom 1	Second Floor	46.0	38.7
South Flat 6 Bedroom 2	Second Floor	55.1	47.2
South Flat 6 Bedroom 3	Second Floor	57.2	49.3
Flat 6 Living/Kitchen Front	Second Floor	64.3	56.0
Villa Flat 1 Bedroom	Ground Floor	54.0	46.0
Villa Flat 1 Living/Kitchen Front	Ground Floor	57.1	49.0
Villa Flat 1 Living/Kitchen Side	Ground Floor	55.5	47.6
Villa Flat 2 Bedroom 1	Ground Floor	53.9	46.2
Villa Flat 2 Bedroom 2 Rear	Ground Floor	38.5	31.5
Villa Flat 2 Bedroom 2 Side	Ground Floor	49.1	41.4
Villa Flat 2 Living/Kitchen	Ground Floor	53.9	46.1
Villa Flat 3 Bedroom 1	First Floor	59.9	51.6
Villa Flat 3 Bedroom 2	First Floor	61.1	52.9
Villa Flat 3 Living/Kitchen	First Floor	64.1	55.7
Villa Flat 4 Bedroom 1	First Floor	59.0	51.0
Villa Flat 4 Bedroom 2	First Floor	53.9	45.9
Villa Flat 4 Living/Kitchen Rear	First Floor	41.6	34.5
Villa Flat 4 Living/Kitchen Side	First Floor	52.4	44.5

Appendix 7
Sound Reduction Calculations for Glazing Units

A7.0 SOUND REDUCTION CALCULATIONS FOR GLAZING UNITS

Table 10 – Minimum Sound Reduction Performance for Glazing, Daytime (07:00 – 23:00 hrs)

Receptor	Height	Calculated External Free-field Noise Level $L_{Aeq,16hrs}$ (dB)	Internal Ambient Noise Level Criteria (07:00 – 23:00 hrs) $L_{Aeq,16hrs}$ (dB)	Minimum Sound Reduction Performance for Glazing $R_w + C_{tr}$ (dB)
North Flat 1 Bedroom 1	Ground Floor	60	35	25
North Flat 1 Bedroom 2	Ground Floor	60	35	25
North Flat 1 Living/Kitchen Front	Ground Floor	61	35	26
North Flat 1 Living/Kitchen Side	Ground Floor	62	35	27
North Flat 2 Bedroom 1	Ground Floor	51	35	16
North Flat 2 Bedroom 2	Ground Floor	38	35	3
North Flat 2 Living/Kitchen	Ground Floor	58	35	23
North Flat 3 Bedroom 1	Ground Floor	38	35	3
North Flat 3 Bedroom 2	Ground Floor	38	35	3
North Flat 3 Living/Kitchen	Ground Floor	38	35	3
North Flat 4 Bedroom 1	First Floor	64	35	29
North Flat 4 Bedroom 2	First Floor	60	35	25
North Flat 4 Living/Kitchen Front	First Floor	64	35	29
North Flat 4 Living/Kitchen Side	First Floor	62	35	27
North Flat 5 Bedroom 1	First Floor	56	35	21
North Flat 5 Bedroom 2	First Floor	41	35	6
North Flat 5 Living/Kitchen	First Floor	64	35	29
North Flat 6 Bedroom 1	First Floor	42	35	7
North Flat 6 Bedroom 2	First Floor	42	35	7
North Flat 6 Living/Kitchen	First Floor	41	35	6
North Flat 7 Bedroom 1	Second Floor	65	35	30
North Flat 7 Bedroom 2	Second Floor	61	35	26
North Flat 7 Living/Kitchen Front	Second Floor	65	35	30

Receptor	Height	Calculated External Free-field Noise Level $L_{Aeq,16hrs}$ (dB)	Internal Ambient Noise Level Criteria (07:00 – 23:00 hrs) $L_{Aeq,16hrs}$ (dB)	Minimum Sound Reduction Performance for Glazing $R_w + C_{tr}$ (dB)
North Flat 7 Living/Kitchen Side	Second Floor	62	35	27
North Flat 8 Bedroom 1	Second Floor	59	35	24
North Flat 8 Bedroom 2	Second Floor	48	35	13
North Flat 8 Living/Kitchen	Second Floor	65	35	30
North Flat 9 Bedroom 1	Second Floor	49	35	14
North Flat 9 Bedroom 2	Second Floor	48	35	13
North Flat 9 Living/Kitchen	Second Floor	48	35	13
South Flat 1 Bedroom 1	Ground Floor	37	35	2
South Flat 1 Bedroom 2	Ground Floor	55	35	20
South Flat 1 Bedroom 3	Ground Floor	56	35	21
South Flat 1 Living/Kitchen Front	Ground Floor	61	35	26
South Flat 1 Living/Kitchen Side	Ground Floor	57	35	22
South Flat 2 Bedroom 1	Ground Floor	37	35	2
South Flat 2 Bedroom 2	Ground Floor	52	35	17
South Flat 2 Bedroom 3	Ground Floor	54	35	19
South Flat 2 Living/Kitchen Front	Ground Floor	60	35	25
South Flat 2 Living/Kitchen Side	Ground Floor	56	35	21
South Flat 3 Bedroom 1	First Floor	41	35	6
South Flat 3 Bedroom 2	First Floor	57	35	22
South Flat 3 Bedroom 3	First Floor	59	35	24
South Flat 3 Living/Kitchen Front	First Floor	65	35	30
South Flat 3 Living/Kitchen Side	First Floor	61	35	26
South Flat 4 Bedroom 1	First Floor	40	35	5
South Flat 4 Bedroom 2	First Floor	55	35	20
South Flat 4 Bedroom 3	First Floor	57	35	22

Receptor	Height	Calculated External Free-field Noise Level $L_{Aeq,16hrs}$ (dB)	Internal Ambient Noise Level Criteria (07:00 – 23:00 hrs) $L_{Aeq,16hrs}$ (dB)	Minimum Sound Reduction Performance for Glazing $R_w + C_{tr}$ (dB)
South Flat 4 Living/Kitchen Front	First Floor	64	35	29
South Flat 5 Bedroom 1	Second Floor	46	35	11
South Flat 5 Bedroom 2	Second Floor	58	35	23
South Flat 5 Bedroom 3	Second Floor	60	35	25
South Flat 5 Living/Kitchen Front	Second Floor	65	35	30
South Flat 5 Living/Kitchen Side	Second Floor	61	35	26
South Flat 6 Bedroom 1	Second Floor	46	35	11
South Flat 6 Bedroom 2	Second Floor	55	35	20
South Flat 6 Bedroom 3	Second Floor	57	35	22
Flat 6 Living/Kitchen Front	Second Floor	64	35	29
Villa Flat 1 Bedroom	Ground Floor	54	35	19
Villa Flat 1 Living/Kitchen Front	Ground Floor	57	35	22
Villa Flat 1 Living/Kitchen Side	Ground Floor	56	35	21
Villa Flat 2 Bedroom 1	Ground Floor	54	35	19
Villa Flat 2 Bedroom 2 Rear	Ground Floor	39	35	4
Villa Flat 2 Bedroom 2 Side	Ground Floor	49	35	14
Villa Flat 2 Living/Kitchen	Ground Floor	54	35	19
Villa Flat 3 Bedroom 1	First Floor	60	35	25
Villa Flat 3 Bedroom 2	First Floor	61	35	26
Villa Flat 3 Living/Kitchen	First Floor	64	35	29
Villa Flat 4 Bedroom 1	First Floor	59	35	24
Villa Flat 4 Bedroom 2	First Floor	54	35	19
Villa Flat 4 Living/Kitchen Rear	First Floor	42	35	7
Villa Flat 4 Living/Kitchen Side	First Floor	52	35	17

Table 11 – Minimum Sound Reduction Performance for Glazing, Night Time (23:00 – 07:00 hrs)

Receptor	Height	Calculated External Free-field Noise Level $L_{Aeq,8hrs}$ (dB)	Internal Ambient Noise Level Criteria (23:00 – 07:00 hrs) $L_{Aeq,8hrs}$ (dB)	Minimum Sound Reduction Performance for Glazing $R_w + C_{tr}$ (dB)
North Flat 1 Bedroom 1	Ground Floor	51	30	21
North Flat 1 Bedroom 2	Ground Floor	52	30	22
North Flat 1 Living/Kitchen Front	Ground Floor	53	30	23
North Flat 1 Living/Kitchen Side	Ground Floor	53	30	23
North Flat 2 Bedroom 1	Ground Floor	43	30	13
North Flat 2 Bedroom 2	Ground Floor	31	30	1
North Flat 2 Living/Kitchen	Ground Floor	50	30	20
North Flat 3 Bedroom 1	Ground Floor	31	30	1
North Flat 3 Bedroom 2	Ground Floor	31	30	1
North Flat 3 Living/Kitchen	Ground Floor	31	30	1
North Flat 4 Bedroom 1	First Floor	56	30	26
North Flat 4 Bedroom 2	First Floor	52	30	22
North Flat 4 Living/Kitchen Front	First Floor	56	30	26
North Flat 4 Living/Kitchen Side	First Floor	53	30	23
North Flat 5 Bedroom 1	First Floor	47	30	17
North Flat 5 Bedroom 2	First Floor	34	30	4
North Flat 5 Living/Kitchen	First Floor	55	30	25
North Flat 6 Bedroom 1	First Floor	34	30	4
North Flat 6 Bedroom 2	First Floor	34	30	4
North Flat 6 Living/Kitchen	First Floor	34	30	4
North Flat 7 Bedroom 1	Second Floor	57	30	27
North Flat 7 Bedroom 2	Second Floor	52	30	22
North Flat 7 Living/Kitchen Front	Second Floor	57	30	27
North Flat 7 Living/Kitchen Side	Second Floor	54	30	24

Receptor	Height	Calculated External Free-field Noise Level $L_{Aeq,8hrs}$ (dB)	Internal Ambient Noise Level Criteria (23:00 – 07:00 hrs) $L_{Aeq,8hrs}$ (dB)	Minimum Sound Reduction Performance for Glazing $R_w + C_{tr}$ (dB)
North Flat 8 Bedroom 1	Second Floor	50	30	20
North Flat 8 Bedroom 2	Second Floor	40	30	10
North Flat 8 Living/Kitchen	Second Floor	57	30	27
North Flat 9 Bedroom 1	Second Floor	42	30	12
North Flat 9 Bedroom 2	Second Floor	41	30	11
North Flat 9 Living/Kitchen	Second Floor	40	30	10
South Flat 1 Bedroom 1	Ground Floor	31	30	1
South Flat 1 Bedroom 2	Ground Floor	47	30	17
South Flat 1 Bedroom 3	Ground Floor	48	30	18
South Flat 1 Living/Kitchen Front	Ground Floor	53	30	23
South Flat 1 Living/Kitchen Side	Ground Floor	48	30	18
South Flat 2 Bedroom 1	Ground Floor	30	30	0
South Flat 2 Bedroom 2	Ground Floor	44	30	14
South Flat 2 Bedroom 3	Ground Floor	46	30	16
South Flat 2 Living/Kitchen Front	Ground Floor	52	30	22
South Flat 2 Living/Kitchen Side	Ground Floor	48	30	18
South Flat 3 Bedroom 1	First Floor	33	30	3
South Flat 3 Bedroom 2	First Floor	49	30	19
South Flat 3 Bedroom 3	First Floor	51	30	21
South Flat 3 Living/Kitchen Front	First Floor	57	30	27
South Flat 3 Living/Kitchen Side	First Floor	53	30	23
South Flat 4 Bedroom 1	First Floor	33	30	3
South Flat 4 Bedroom 2	First Floor	47	30	17
South Flat 4 Bedroom 3	First Floor	49	30	19
South Flat 4 Living/Kitchen Front	First Floor	56	30	26

Receptor	Height	Calculated External Free-field Noise Level $L_{Aeq,8hrs}$ (dB)	Internal Ambient Noise Level Criteria (23:00 – 07:00 hrs) $L_{Aeq,8hrs}$ (dB)	Minimum Sound Reduction Performance for Glazing $R_w + C_{tr}$ (dB)
South Flat 5 Bedroom 1	Second Floor	39	30	9
South Flat 5 Bedroom 2	Second Floor	50	30	20
South Flat 5 Bedroom 3	Second Floor	52	30	22
South Flat 5 Living/Kitchen Front	Second Floor	57	30	27
South Flat 5 Living/Kitchen Side	Second Floor	53	30	23
South Flat 6 Bedroom 1	Second Floor	39	30	9
South Flat 6 Bedroom 2	Second Floor	47	30	17
South Flat 6 Bedroom 3	Second Floor	49	30	19
Flat 6 Living/Kitchen Front	Second Floor	56	30	26
Villa Flat 1 Bedroom	Ground Floor	46	30	16
Villa Flat 1 Living/Kitchen Front	Ground Floor	49	30	19
Villa Flat 1 Living/Kitchen Side	Ground Floor	48	30	18
Villa Flat 2 Bedroom 1	Ground Floor	46	30	16
Villa Flat 2 Bedroom 2 Rear	Ground Floor	32	30	2
Villa Flat 2 Bedroom 2 Side	Ground Floor	41	30	11
Villa Flat 2 Living/Kitchen	Ground Floor	46	30	16
Villa Flat 3 Bedroom 1	First Floor	52	30	22
Villa Flat 3 Bedroom 2	First Floor	53	30	23
Villa Flat 3 Living/Kitchen	First Floor	56	30	26
Villa Flat 4 Bedroom 1	First Floor	51	30	21
Villa Flat 4 Bedroom 2	First Floor	46	30	16
Villa Flat 4 Living/Kitchen Rear	First Floor	35	30	5
Villa Flat 4 Living/Kitchen Side	First Floor	45	30	15

Appendix 8
Relevant Guidance

A8.0 RELEVANT GUIDANCE

A8.1 Technical Advice Note 11 (TAN11) [1]

A8.1.1 The requirements for the assessment of noise impact on a proposed development site are detailed in TAN11 (Noise). This document prescribes the measurement methods and standards to be used for the noise survey. The results of the survey are separated into day and night periods which are compared with four Noise Exposure Categories (NECs).

A8.2 Noise Exposure Categories for Dwellings (NECs)

When assessing a proposal for residential development near a source of noise, local planning authorities should determine into which of the four noise exposure categories the proposed site falls, taking account of both day and night-time noise levels. Local planning authorities should then have regard to the advice in the appropriate NEC, as shown in Table 12.

Table 12 – Planning Advice as per TAN11

NEC	Planning Advice
A	*Noise need not be considered as a determining factor in granting planning permission, although the noise level at the high end of the category should not be regarded as a desirable level.*
B	*Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise.*
C	*Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise.*
D	*Planning permission should normally be refused.*

A8.2.1 The noise exposure category for the site is the measured noise level compared with the range of noise levels as shown in Table 13.

Table 13 – Free-Field Noise Levels Corresponding to the NECs, $L_{Aeq,T}$ dB

Noise source		Noise Exposure Category			
		A	B	C	D
Road traffic	0700-2300	<55	55-63	63-72	>72
	2300-0700	<45	45-57	57-66	>66
Rail traffic	0700-2300	<55	55-66	66-74	>74
	2300-0700	<45	45-59	59-66	>66
Air traffic	0700-2300	<57	57-66	66-72	>72
	2300-0700	<48	48-57	57-66	>66
Mixed Sources	0700-2300	<55	55-63	63-72	>72
	2300-0700	<45	45-57	57-66	>66

A8.2.2 Maximum noise event values L_{ASmax} of 82dB were analysed as per Note 2 [1].

"Note 2: Night-time noise levels 2300-0700): sites where individual noise events regularly exceed 82dBLAmax (S time weighting) several times in any hour should be treated as being in NEC C, regardless of the LAeq,8H (except where the LAeq,8H already puts the site in NEC D)".

A8.2.3 Mixed sources refer to any combination of road, rail, air and industrial noise sources. The '*mixed source*' values detailed in Table 13 are based on the lowest numerical values of the single source limits in the table. The '*mixed source*' NEC should only be used where no individual noise source is dominant.

A8.3 **Planning Policy Wales [2]**

A8.3.1 The foreword to the Planning Policy Wales (PPW) document states that '*PPW will help to ensure that the planning decisions taken in Wales, no matter how big, or how small, are going to improve the lives of both our current and future generations. It will support changing the way we live and work, and the buildings and environment of Wales, today, building a better environment to accommodate current and future needs*'.

A8.3.2 PPW sets out the land use planning policies of the Welsh Government. The primary objective is to ensure that the planning system contributes towards the delivery of sustainable development and improves the social, economic, environmental and cultural well-being of Wales, A well functioning planning system is fundamental for sustainable development and achieving sustainable places.

A8.3.3 The planning system should create sustainable places (Placemaking) which are attractive, sociable, accessible, active, secure, welcoming, healthy and friendly. Development proposals should create the conditions to bring people together, making them want to live, work and play in areas with a sense of place and well-being, creating prosperity for all.

A8.3.4 Placemaking in development decisions happens at all levels and involves considerations at a global scale, including climate change, down to the very local level, such as considering the amenity impact on neighbouring properties and people. Negative environmental impacts should be avoided in the wider public interest.

A8.3.5 The environmental impact relevant to this assessment, will be from noise. PPW refers to the term '*soundscape*' which it describes as '*the acoustic environment as perceived or experienced and/or understood by a person or people, in context (ISO definition)*'.

A8.3.6 An appropriate soundscape contributes to a positive experience of place as well as being necessary for public health, amenity and well-being. Conversely, noise pollution can have negative effects and should be reduced as far as possible.

A8.3.7 Certain sounds, such as those created by trees, birds or water features, can contribute to a sense of tranquillity whilst others can be reassuring as a consequence of their association with the normality of everyday activities. Problematic forms of sound are generally experienced as noise pollution and can affect amenity and be prejudicial to health or a nuisance. Noise action plans drawn up by public bodies aim to prevent and reduce noise levels where necessary and preserve soundscape quality where it is good. Both high and low levels of noise, depending on context, can be annoying or disruptive and impact on amenity, health

and well-being and as such should be protected through the planning process wherever necessary.

A8.3.8 A key planning policy principle is to consider the effects which proposed developments may have on soundscape quality and the effects which existing soundscape quality may have on proposed developments. Soundscape influences the choice of location and distribution of development and it will be important to consider the relationship of proposed development to existing development and its surrounding area and its potential to exacerbate or create poor or inappropriate soundscapes.

A8.3.9 The agent of change principle says that a business or person responsible for introducing a change is responsible for managing that change. In practice, for example, this means a developer would have to ensure that solutions to address noise from nearby pre-existing infrastructure, businesses or venues can be found and implemented as part of ensuring development is acceptable.

A8.3.10 Proposed development should be designed wherever possible to prevent adverse effects to amenity, health and the environment but as a minimum to limit or constrain any effects that do occur.

A8.4 **Noise and Soundscape Action Plan [3]**

A8.4.1 This document sets out action plans for each of the three agglomerations in Wales. These are identified as the Cardiff and Penarth agglomeration, the Newport agglomeration and the Swansea and Neath agglomeration.

A8.5 **ProPG: Planning & Noise [4]**

A8.5.1 Even though ProPG has been written principally to assist with the planning process in England, PPW recommends that the good acoustic design principles put forward in Supplementary Document 2 may also be adopted in Wales.

A8.5.2 A good acoustic design process takes a multi-faceted and integrated approach to achieve optimal acoustic conditions, both internally (inside noise-sensitive parts of the building(s)) and externally (in spaces to be used for amenity purposes).

A8.5.3 Good acoustic design should provide the optimum acoustic outcome, without design compromises that will adversely affect living conditions and the quality of life of the inhabitants or other sustainable design objectives and requirements.

A8.5.4 In requiring good acoustic design, there is a hierarchy of noise management measures that LPAs should encourage, including the following, in descending order of preference:

- *Maximising the spatial separation of noise source(s) and receptor(s).*
- *Investigating the necessity and feasibility of reducing existing noise levels and relocating existing noise sources.*
- *Using existing topography and existing structures (that are likely to last the expected life of the noise-sensitive scheme) to screen the proposed development site from significant sources of noise.*
- *Incorporating noise barriers as part of the scheme to screen the proposed development site from significant sources of noise.*
- *Using the layout of the scheme to reduce noise propagation across the site.*
- *Using the orientation of buildings to reduce the noise exposure of noise-sensitive rooms.*
- *Using the building envelope to mitigate noise to acceptable levels.*

A8.5.5 It is acknowledged that the inherent challenge of introducing noise-sensitive development in noisy locations can limit the extent to which good acoustic design can be achieved in harmony with the other factors that influence the overall quality of a scheme and that compromises may need to be made e.g. accepting that it may not always be possible to achieve acoustic standards with windows open or accepting that noise levels in parts of the outdoor amenity areas may not be optimal.

A8.5.6 Where the scheme relies on windows being closed to achieve good internal noise conditions, details should be provided why this approach has arisen and how the use of layout, orientation, spatial design and non-building envelope mitigation has been considered to minimise the need for reliance upon closed windows.

A8.5.7 Where the LPA accepts that there is a justification that the internal target noise levels can only be practically achieved with windows closed, which may be the case in urban areas and at sites adjacent to transportation noise sources, special care must be taken to design the accommodation so that it provides good standards of acoustics, ventilation and thermal comfort without unduly compromising other aspects of the living environment. Furthermore, in this scenario the internal L_{Aeq} target noise levels should not generally be exceeded.

A8.5.8 A good acoustic design will be one that continues to minimise noise impacts and to avoid significant noise effects for the lifetime of the development or as long as is practicable taking into account other economic, environmental and social impacts. Ideally new development should also help to mitigate any existing adverse impacts elsewhere, for example by acting as a barrier between noisy infrastructure and any existing noise-sensitive uses that do not benefit from incorporated mitigation.

A8.6 **BS 8233 - Guidance on Sound Insulation and Noise Reduction for Buildings [5]**

A8.6.1 For many common situations, BS 8233 suggests criteria, such as suitable sleeping/resting conditions, and proposes noise levels that normally satisfy these criteria for most people.

A8.6.2 The foreword advises that the information detailed in BS 8233 "*…takes the form of guidance and recommendations. It should not be quoted as it were a specification or a code of practice and claims of compliance cannot be made to it.*".

A8.6.3 Section 7.7.2 details the guideline values for desirable internal ambient noise levels within dwelling houses, flats and rooms in residential use (when unoccupied) when such properties are exposed to steady external noise sources.

A8.6.4 These guideline values range from 35 - 40 dB LAeq,16hrs during the daytime period and 30 dB LAeq,8hrs during the night time period as detailed in Table 14 below.

Table 14 – BS 8233 Internal Noise Level Guidelines

Activity	Location	07:00 – 23:00 hrs	23:00 – 07:00 hrs
Resting	Living Room	35 dB $L_{Aeq,16hrs}$	--
Dining	Dining room	40 dB $L_{Aeq,16hrs}$	--
Sleeping (Daytime Resting)	Bedroom	35 dB $L_{Aeq,16hrs}$	30 dB $L_{Aeq,8hrs}$

A8.6.5 The guidelines also provide scope for relaxing these values by up to 5 dB and still achieve reasonable internal conditions.

A8.6.6 The internal noise level in a room is calculated by subtracting the sound reduction performance of the external façade from the noise level outside the room.

A8.6.7 It should be noted that the acoustic performance of the building envelope will be reduced, in the event windows are opened for ventilation or cooling purposes, to no more than 10 to 15 dB(A).

A8.6.8 For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,16hrs}$ with an upper guideline value of 55 dB $L_{Aeq,16hrs}$ which would be acceptable in noisier environments.

A8.6.9 It is recognised that these guideline values may not be achievable in all circumstances where development might be desirable. In higher noise areas, 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.

A8.6.10 The guideline values presented in BS8233, applies to external noise as it affects the internal acoustic environment from sources without a specific character such as road traffic noise.

A8.6.11 BS 8233 provides both simple and detailed calculation methods for determining the internal ambient noise levels attributable to the external noise level. These methods are based on those given in BS EN 12354-3 [9].

A8.6.12 The indoor sound pressure level is estimated from the measured or calculated outdoor sound pressure level by using the sound level difference of the façade.

A8.6.13 The more rigorous calculation method described in BS 8233 uses octave band data to determine the internal noise level and is more appropriate where the external noise may exhibit specific characteristics.

A8.6.14 BS 8233 also states in section 7.7.2 that "*…regular individual noise evets can cause sleep disturbance. A guideline value may be set in terms of SEL of* $L_{Amax,F}$ *depending on the character and number of events per night…*"

A8.6.15 However, BS 8233 does not quantify what the L_{Amax} guideline value should be and therefore this assessment anticipates that any L_{Amax} criteria will make reference to the value presented in the W.H.O. guidelines [8].

A8.7 **Calculation of Road Traffic Noise (CRTN) [6]**

A8.7.1 This memorandum describes the procedures for calculating noise from road traffic. These procedures are necessary to enable entitlement under the Noise Insulation Regulations to be determined but they also provide guidance appropriate to the calculation of traffic noise for more general applications e.g. environmental appraisal of road schemes, highway design and land use planning.

A8.7.2 Road traffic noise levels are expressed in terms of the index, $L_{A10,t}$ dB. The value of $L_{A10,t}$ is the noise level exceed for just 10% of the time over the time period t. For the purposes of CTRN, the time period, t, is 18 hours (06:00 – 00:00 hrs).

A8.7.3 The procedures for calculating traffic noise, as described in the memorandum, comprise five main stages:

- *Division of road into a number of segments;*
- *Calculation of the Basic Noise Level (BNL), at a reference distance of 10m from the nearside carriageway edge, for each road segment using traffic flow data (number of vehicles, speed, %HGV);*

- *For each segment, calculate the noise level at the reception point (1m from exposed façade) by considering the distance to the reception point, ground attenuation and any screening from barriers and or buildings.*
- *Correction to the calculated noise level to account for site layout features including reflections from nearby buildings and facades and the source segment size;*
- *Calculate the total noise level at the reception point by combining the contributions from all road segments.*

A8.7.4 The aim of this memorandum is to enable prediction in as many situations as possible, covering both free and non-free flowing traffic. Prediction is the preferred calculation technique and in complex situations is best carried out using appropriate computer software.

A8.7.5 In addition, CRTN describes a shortened measurement procedure for determining the noise level from the road, $L_{A10,18h}$ dB, based on measurements made over three consecutive hours between 10:00 and 17:00 hours.

A8.7.6 Using $L_{A10,3h}$ as the arithmetic mean of the three consecutive vales of the hourly $L_{A10,1h}$, the value of $L_{A10,18hr}$ can be calculated from the relation:

$$L_{A10,18h} = L_{A10,3h} - 1 \text{ dB}$$

A8.8 **Converting the UK traffic noise index $L_{A10,18h}$ to EU noise indices for noise mapping [7]**

A8.8.1 The UK national method for calculating road traffic noise is described in the document '*Calculation of Road Traffic Noise*' (CRTN) [6]. The noise index derived using these procedures, L_{A10} is however, different from the more commonly used descriptor for environmental noise, $L_{Aeq,T}$.

A8.8.2 Defra therefore commissioned TRL Limited to develop an interim computational method to convert $L_{A10,18hr}$ to $L_{Aeq,t}$ to be used in the UK.

A8.8.3 For UK conditions, TRL recommends that the best interim approach is to adapt CRTN be applying an '*end correction*' to obtain the relevant EU indices from calculated values of L_{A10}.

A8.8.4 Three methods are described dependant on the detail of traffic data available:

- *Method 1: Where the user has available hourly traffic data;*
- *Method 2: Where detailed hourly traffic data is not available, but the user has, or can estimate, traffic data for the relevant day, evening and night time periods;*
- *Method 3: Where detailed hourly or period traffic data is not available, but the user has, or can estimate, traffic data for the full 18hr time period.*

A8.8.5 Each method allows CRTN to calculate the $L_{A10,18hr}$ using the available data and then convert to the relevant period $L_{Aeq,T}$ using defined relationships.

A8.9 **Guidelines for Community Noise, W.H.O. [8]**

A8.9.1 Community noise (also called environmental noise, residential noise or domestic noise) is defined as noise emitted from all sources except noise at the industrial workplace. Main sources of community noise include road, rail and air traffic, industries, construction and public work, and the neighbourhood.

A8.9.2 The objective of the World Health Organization (WHO) is '*the attainment by all peoples of the highest possible level of health*'.

A8.9.3 WHO defines 'health' as '*A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*'. This broad definition of health makes reference to the concept of well-being and thereby includes noise impacts such as annoyance, speech interference, and impaired task performance as 'health' issues.

A8.9.4 The WHO guidelines deal with all aspects of environmental noise impact and provide guideline values for community noise in specific environments. Most of the noise guidelines are given as period L_{Aeq} values. The relevant values for Dwellings are summarized in Table 15 below.

Table 15 – WHO Guideline Noise Levels for Dwellings

Residential Environment	Critical Health Effect(s)	$L_{Aeq,T}$ (dB)	Time Base, T
Outdoor Living Area	Serious Annoyance, daytime and evening	55	07:00 – 23:00 (16 hours)
	Moderate Annoyance, daytime and evening	50	07:00 – 23:00 (16 hours)
Dwelling, indoors	Speech intelligibility & moderate annoyance, daytime & evening	35	07:00 – 23:00 (16 hours)
Inside Bedrooms	Sleep disturbance, night-time	30	23:00 – 07:00 (8 hours)
Outside Bedrooms	Sleep disturbance, window open (outdoor values)	45	23:00 – 07:00 (8 hours)

A8.9.5 These guideline values consider specific environments and identified health effects. Each value is set at the lowest levels that affect health such as annoyance and were derived from annoyance studies.

A8.9.6 The guidelines, whilst not having any legal force in the UK, are commonly used by local authorities when setting environmental noise criteria for proposed developments.

A8.9.7 For a restful sleep, the W.H.O. guidelines further recommend that the indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10 to 15 times per night.

A8.9.8 In addition, the Guidelines also state that *"…at night, sound pressure levels at the outside façades of the living spaces should not exceed 45 dB L_{Aeq} and 60 dB L_{Amax} so that people may sleep with the windows open…the noise reduction from outside to inside with the windows partly open is 15dB"*.

A8.10 **BS EN 12354 Part 3, Airborne Sound Insulation against Outdoor Sound [9]**

A8.10.1 This Standard specifies a calculation model to estimate the sound insulation or the sound pressure level difference of a façade or other external surface of a building. The calculation is based on the sound reduction index of the different elements

from which the façade is constructed. Calculations can be carried out for frequency bands or single number ratings.

A8.10.2 The results of the calculation can be used to determine the indoor sound pressure level due to external sound sources such as road traffic.

A8.10.3 BS EN 12354 states that '*The sound level difference refers to a position 2m in front of the façade. If the calculated or measured outdoor sound pressure level refers to other positions or situations, the level at 2m in front of the façade should be deduced from it. It could, for instance, be deduced from the sound pressure level of the incident sound (without the building) by taking into account the façade reflection. For a plain façade this will result in a 3dB higher level, globally for all frequency bands*'.

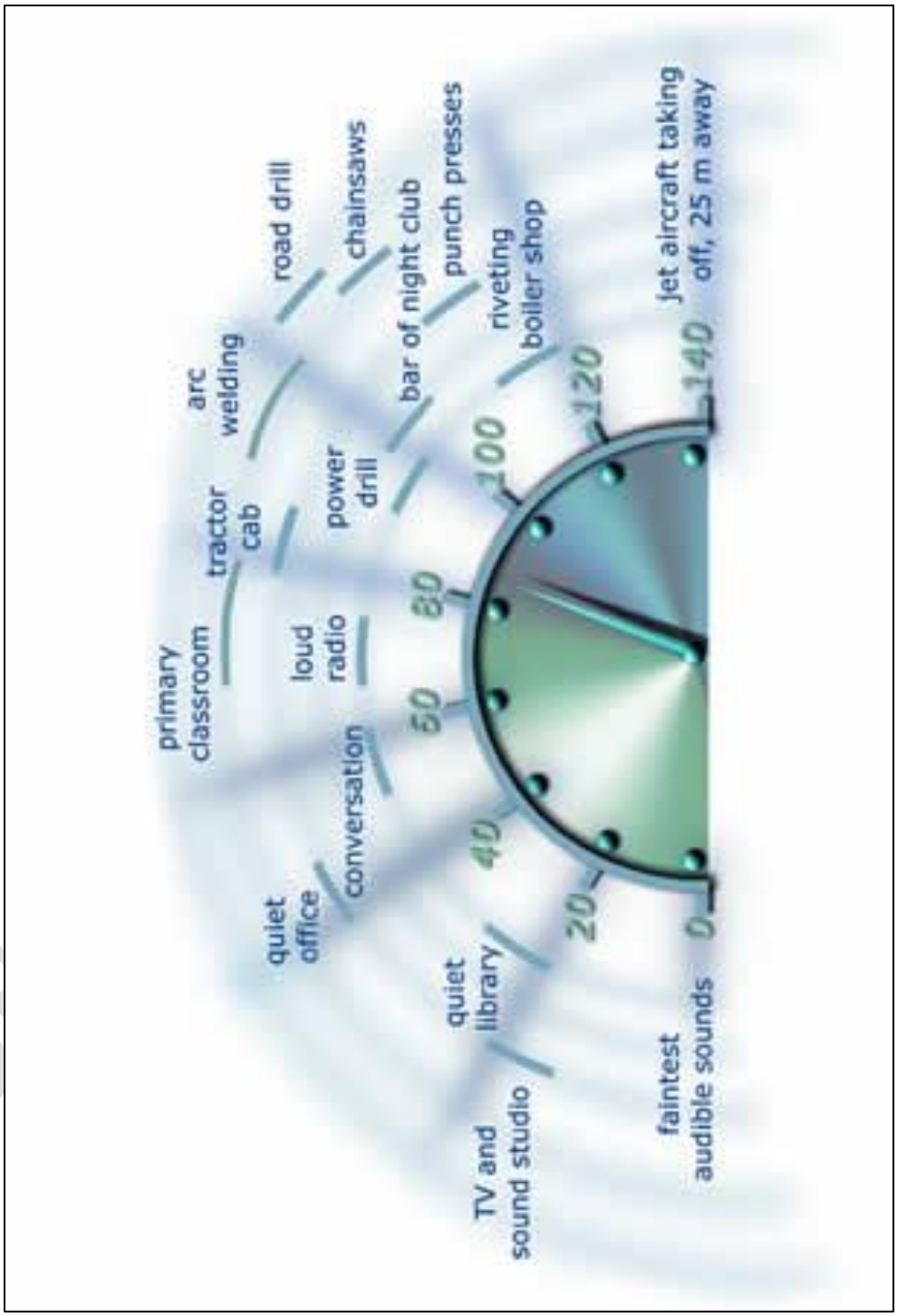
A8.10.4 The indoor A-weighted sound pressure level can be determined from calculation in frequency bands for the appropriate frequency range, applying the A-weighting.

A8.10.5 Alternatively, the indoor A-weighted sound pressure level can be determined directly from the A-weighted outdoor sound pressure level, provided the level difference is expressed in a single number rating for the relevant outdoor sound spectrum in accordance with BS EN ISO 717-1 [10], i.e. applying the spectrum adaptation terms C_{tr} or C to describe the level difference as, for example, $R_w + C_{tr}$ when the outdoor sound is road traffic.

Appendix 9
Range of Typical Sound Levels

A9.0 RANGE OF TYPICAL SOUND LEVELS

Figure 17 – Range of Typical Sound Levels



Appendix 10
Glossary of Acoustic Terms

A10.0 GLOSSARY OF ACOUSTIC TERMS

A10.1 **Acoustic environment:**

Sound from all sound sources as modified by the environment [BS ISO 12913-1:2013]

A10.2 **Ambient sound:**

Totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far

NOTE The ambient sound comprises the residual sound and the specific sound when present.

A10.3 **Ambient sound level, $L_A = L_{Aeq,T}$:**

The equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time, usually from many sources near and far, at the assessment location over a given time interval, T

NOTE the ambient sound level is a measure of the residual sound and the specific sound when present.

A10.4 **Background sound level, $L_{A90,T}$:**

A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels

A10.5 **Equivalent continuous A-weighted sound pressure level, $L_{Aeq,T}$:**

The value of the A-weighted sound pressure level in decibels of continuous steady sound that, within a specified time interval, $T = t_2 - t_1$, has the same mean-squared sound pressure as a sound that varies with time, and is given by the following equation:

$$L_{Aeq,T} = 10lg\left\{\left(\frac{1}{T}\right)\int_{t_1}^{t_2}\left[\frac{p_A(t)^2}{{p_0}^2}\right]dt\right\}$$

where:

p_0 *is the reference sound pressure (20 µPa); and*

$p_A(t)$ *is the instantaneous A-weighted sound pressure (P_A) at time t*

NOTE The equivalent continuous A-weighted sound pressure level is quoted to the nearest whole number of decibels.

A10.6 **Measurement time interval, T_m:**

Total time over which measurements are taken

NOTE This may consist of the sum of a number of non-contiguous, short-term measurement time intervals.

A10.7 **Rating level, $L_{Ar,Tr}$:**

Specific sound level plus any adjustment for the characteristic features of the sound

A10.8 **Reference time interval, T_r:**

Specified interval over which the specific sound level is determined

NOTE this is 1 h during the day from 07:00 h to 23:00 h and a shorter period of 15 min at night from 23:00 h to 07:00 h.

A10.9 **Residual sound:**

Ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound

A10.10 **Residual sound level, $L_r = L_{Aeq,T}$:**

Equivalent continuous A-weighted sound pressure level of the residual sound at the assessment location over a given time interval, T

A10.11 **Specific sound level, $L_s = L_{Aeq,Tr}$:**

Equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T_r

A10.12 **Specific sound source:**

Sound source being assessed

A10.13 **A-weighting:**

Normal hearing covers the frequency (pitch) range from about 20 Hz to 20,000 Hz but sensitivity is greatest between about 500 Hz and 5,000 Hz. The 'A-weighting' is an electrical circuit built into noise meters to approximate this characteristic of human hearing.

A10.14 **Decibel (dB):**

The logarithmic measure of sound level. 0dB (A) is the threshold of normal hearing. 140 dB (A) is the level at which instantaneous damage to hearing is caused. A change of 1 dB is detectible only under laboratory conditions.

A10.15 **dB(A):**

Decibels measured on a sound level meter incorporating a frequency weighting (A-weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with an individual's assessment of loudness. A change of 3 dB (A) is the minimum perceptible under normal conditions and a change of 10 dB(A) corresponds roughly to doubling or halving the loudness of a sound.

A10.16 **Free Field:**

A sound field in which no significant sound reflections occur.

A10.17 **L_{Amax}:**

The maximum 'A-weighted' level of sound recorded during a sound event. The time weighting used (fast or Slow) should be stated.

A10.18 **Tonality:**

The degree to which a sound contains audible pure tones. Broadband sound (across a wider range of frequencies) is generally less annoying than sound with identifiable tones.

A10.19 **Frequency:**

The number of cycles per second of a vibration usually expressed in units of Hertz, Hz

A10.20 **Hertz:**

Unit of frequency, equal to one cycle per second. Frequency determines the pitch of a sound.

Appendix 11
References

A11.0 REFERENCES:

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