

# Noise & Vibration Planning Report

John Street, Cardiff



Stantec Hydrock Limited

Prepared for:  
Grainger Residential Limited

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# 1 Introduction

Stantec has been appointed to provide acoustic consultancy services in relation to the proposed mixed-use development on John Street, Cardiff. It is understood that the proposed development will comprise 417no. residential apartments, with additional commercial units located at ground floor level and 5no. railway arches to be used as commercial units and amenity space/cycle storage for residents.

A baseline noise survey has been undertaken to assess the existing ambient & background sound climate at the proposed residential site. A vibration survey has also been undertaken to assess rail vibration dose values (VDVs) incident upon the site. Survey results have been used for comparison with current planning guidance.

This report is technical in nature; therefore, a glossary of acoustic terminology is provided in Appendix A.

## 1.1 Outline Description of the Site

The proposed site is bounded by John Street to the southwest, railway lines to the northwest and the east, and a commercial development to the south. The site location is shown in Figure 1 & Figure 2.

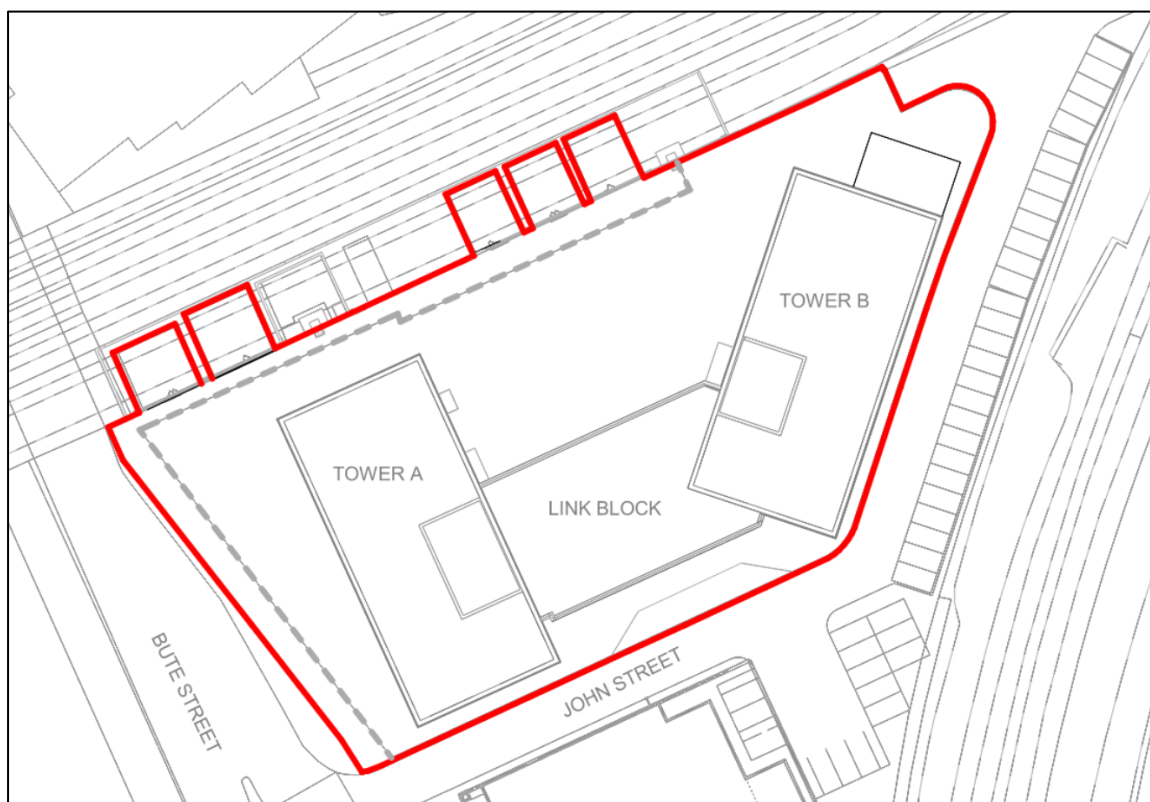
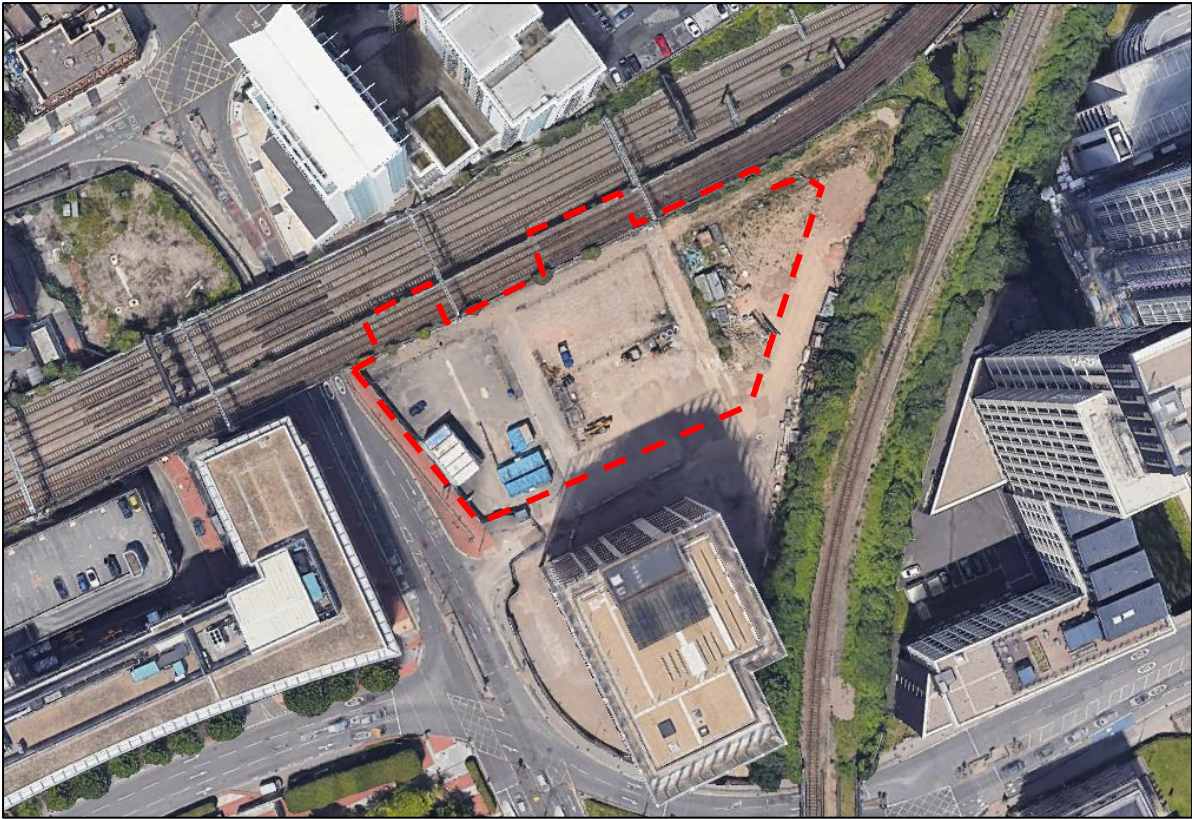


Figure 1: Site Location Plan (Chapman Taylor)





*Figure 2: Site Location Plan (Google Maps)*

## **2 Relevant Guidance & Conditions**

### **2.1 Noise Policy Guidance**

The assessment methodology is based on the following policy and guidance documents:

- Technical Advice Note 11 Wales (hereafter referred to as TAN 11)
- ProPG Supplementary Document 2 (hereafter referred to as ProPG)
- World Health Organisation “Guidelines for Community Noise”, Berglund et. al., 1999 (hereafter referred to as WHO Guidelines)
- British Standard 8233:2014 – “Guidance on sound insulation and noise reduction for buildings” (hereafter referred to as BS8233)
- British Standard 4142:2014 + A1 2019 – “Methods for rating and assessing commercial and industrial sound” (hereafter referred to as BS4142)
- British Standard 6472:2008-1 – “Guide to evaluation of human exposure to vibration in buildings Part 1: vibration sources other than blasting” (hereafter referred to as BS6472)
- Approved Document Part O: Wales 2022 (hereafter referred to as ADO)
- Acoustics Ventilation & Overheating Guide: 2020 (hereafter referred to as AVO Guide)
- ProPG: Gym Acoustics Guidance 2023 (hereafter referred to as GAG)

A review of the relevant planning policy and acoustics guidance is provided in Appendix B.



## 3 Noise & Vibration Survey

### 3.1 Personnel

The noise & vibration survey was undertaken by the following personnel:

Rhodri Owen – Principal Acoustic Consultant:

- BSc (Hons) Sound Technology
- IOA Diploma in Acoustics & Noise Control
- Member of the Institute of Acoustics (MIOA)

Paul Gurney – Senior Acoustic Consultant:

- BSc (Hons) Music, Sound and Technology
- IOA Diploma in Acoustics & Noise Control
- Associate Member of the Institute of Acoustics (AMIOA)

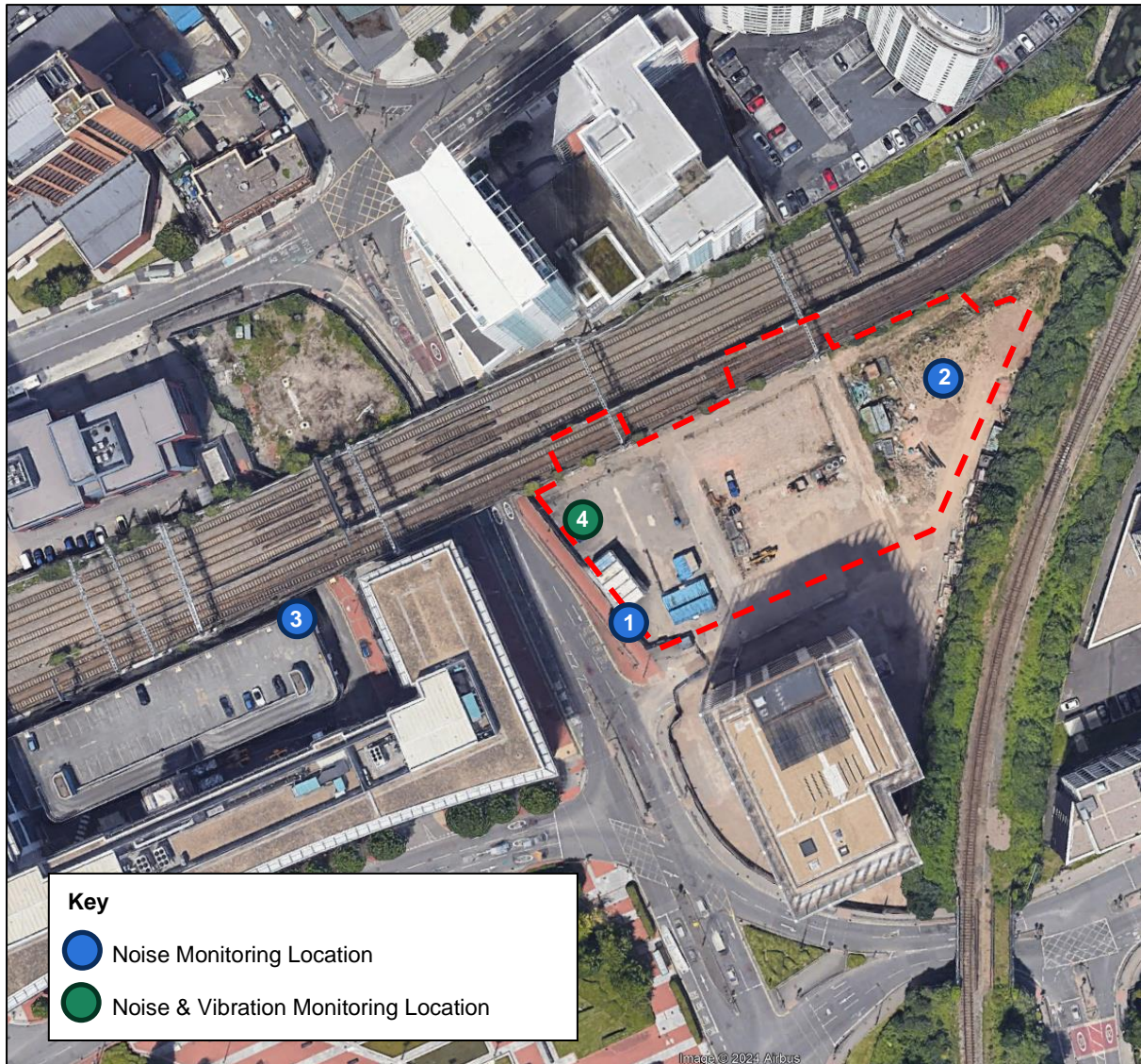
Environmental noise measurements were undertaken between 10:30 on 10/10/2024 and 09:30 on 15/10/2024 by unattended noise monitoring equipment. Vibration measurements were undertaken between 10:00 on 14/10/2024 and 10:00 on 15/10/2024 by unattended vibration monitoring equipment.

The measurement locations and periods are considered to represent typical daytime and night-time noise & vibration levels when the building would be under operation, and typical background noise levels for the nearby noise sensitive receptors during daytime & night-time periods. The noise & vibration monitoring locations are described in Table 1 and shown in Figure 3.

Table 1: Noise & Vibration Monitoring Locations

ID	Description of Monitoring Location
U1	The measurement microphone was installed on a tripod attached to the site hoarding at the southwest façade of the site. The noise climate was dominated by road and railway movements. Measurements were undertaken between 11:00 on 10/10/2024 and 09:30 on 15/10/2024.
U2	The measurement microphone was installed on a tripod attached to a metal post. The noise climate was dominated by road and railway movements. Measurements were undertaken between 11:30 on 11/10/2024 and 09:30 on 15/10/2024.
U3	The measurement microphone was installed on a tripod attached to the metal fencing of the multi-storey car park, overlooking the railway line. The noise climate was dominated by railway movements. Measurements were undertaken between 10:30 on 10/10/2024 and 09:30 on 14/10/2024.
U4	<b>Noise:</b> The measurement microphone was installed on a tripod. The noise climate was dominated by road and railway movements. Measurements were undertaken between 10:30 on 14/10/2024 and 09:30 on 15/10/2024. <b>Vibration:</b> The vibration meter was installed on the ground adjacent to the noise monitoring position. Measurements were undertaken between 10:00 on 14/10/2024 and 10:00 on 15/10/2024.





*Figure 3: Noise & Vibration Monitoring Locations*

The measurement microphones were located at a height of  $\geq 1.5\text{m}$  above local ground at all measurement positions. Measurements were undertaken in accordance with the guidance outlined in the relevant British Standards, BS 4142:2014 and BS 7445-1:2003. The monitoring procedure followed the guidance outlined in BS 7445:2003 Part 1, Section 5.2.3 and section 5.2.2.

Measurements were 'free field', i.e. the microphone was more than 3.5m from reflective elements except the ground. A suitable wind shield was fitted to the monitoring equipment throughout the monitoring period.

Observation and subjective evaluation of noise sources was carried out during the setup and collection of the survey equipment.



## 3.2 Monitoring Equipment List

The equipment list is shown in Table 2.

*Table 2: Equipment List*

Monitoring ID	Equipment	Manufacturer	Instrument	Serial No.	Date of Last Laboratory Calibration
U1	Sound Level Meter	01dB	FUSION	14526	26/04/2024
	Microphone	GRAS	40CD	470800	26/04/2024
	Calibrator	Cirrus	CR:515	96051	19/06/2024
U2	Sound Level Meter	01dB	FUSION	14016	19/02/2024
	Pre-amp	01dB	pre22 n°	2105046	19/02/2024
	Microphone	01dB	40CD	415846	19/02/2024
U3 & U4 (Noise)	Sound Level Meter	NTi Audio	XL2-TA	A2A-20607-E0	03/06/2024
	Pre-amp		MA220	10684	03/06/2024
	Microphone		MC230A	A23089	03/06/2024
	Calibrator	Cirrus	CR:515	95714	19/06/2024
U4 (Vibration)	Vibration Meter	01dB	ORION	10463	22/03/2023

The sound level meters used for the noise survey have been verified as conforming to BS EN 61672-1. The acoustic calibrators used conform to BS EN IEC 60942. Equipment calibration certificates can be provided on request. The sound level meters were calibrated to a reference level of 94 dB at 1kHz both prior to, and on completion of, the noise survey period. No significant drift in calibration was noted during the survey ( $\leq 0.5$  dB).

## 3.3 Weather Conditions

Approximate weather history for Cardiff can be viewed in Appendix C. Weather conditions on each day are summarised as follows:

- Thursday 10<sup>th</sup> October – dry with a light breeze
- Friday 11<sup>th</sup> October – dry with a light breeze
- Saturday 12<sup>th</sup> October – dry with a light breeze
- Sunday 13<sup>th</sup> October – dry with a gentle breeze
- Monday 14<sup>th</sup> October – some rain with a light breeze
- Tuesday 15<sup>th</sup> October – mostly dry with a light breeze



Average recorded wind speeds during the survey period did not exceed 5 m/s. BS 4142:2014 provides the following guidance with regards to the acquisition of environmental noise measurements and weather conditions:

*'An effective windshield should be used to minimize turbulence at the microphone.'*

*'NOTE Windshields are generally effective up to wind speeds of 5 m/s' and. 'exercise caution when making measurements in poor weather conditions such as wind speeds greater than 5 m/s.'*

Weather conditions during the survey period were suitable for the acquisition of noise data. Measurements are therefore considered to adhere to the guidance of the relevant British Standard and no corrections to the measured noise dataset has been applied.

### 3.4 Summary of Noise Survey Results

The following noise level indices are relevant to this assessment:

- $L_{Aeq,T}$  dB ('A' weighted equivalent continuous sound pressure level) - defined as the level of a continuous noise with the same total energy as the actual fluctuating sound over the measurement time periods. It is sometimes referred to as the 'ambient noise level' and can be considered an average.
- $L_{A90,T}$  dB - defined as the 'A' weighted sound pressure level exceeded for 90% of the measurement period 'T'. It is used to describe the prevailing background sound level within BS4142:2014 +A1 2019.

A summary of the ambient noise level measurements is presented in Table 3. The ambient noise levels ( $L_{Aeq}$ ) are logarithmically averaged over each period. The full results are provided graphically in Appendix D.

*Table 3: Summary of Unattended Ambient ( $L_{Aeq,T}$ ) Measured Noise Levels*

Position	Period	Average Ambient Noise Level, dB $L_{Aeq,T}$
U1	Daytime (07:00-23:00)	65
	Night-time (23:00-07:00)	61
U2	Daytime (07:00-23:00)	58
	Night-time (23:00-07:00)	53
U3	Daytime (07:00-23:00)	66
	Night-time (23:00-07:00)	61
U4	Daytime (07:00-23:00)	59
	Night-time (23:00-07:00)	54



**Noise & Vibration Planning Report**  
3 Noise & Vibration Survey

The typical measured daytime & night-time background sound levels are presented in Table 4 and are based on the most-commonly occurring background sound levels measured during the survey period, as shown in the distribution graphs in Appendix E.

*Table 4: Typical Measured Daytime & Night-time Background Sound Levels*

Position	Period	Typical Measured Background Sound Level
U1	Daytime (07:00-23:00)	56dB LA90,1hr
	Night-time (23:00-07:00)	45dB LA90,15mins
U2	Daytime (07:00-23:00)	49dB LA90,1hr
	Night-time (23:00-07:00)	44dB LA90,15mins
U3	Daytime (07:00-23:00)	52dB LA90,1hr
	Night-time (23:00-07:00)	47dB LA90,15mins
U4	Daytime (07:00-23:00)	51dB LA90,1hr
	Night-time (23:00-07:00)	40dB LA90,15mins

The 10<sup>th</sup> highest measured L<sub>Amax</sub> value on each night (23:00 and 07:00) is shown in Table 5 for each monitoring position.

*Table 5: 10th Highest Measured L<sub>Amax</sub> Value on Each Night*

Position	10 <sup>th</sup> Highest L <sub>Amax</sub> Value Measured Between 23:00 and 07:00, dB				
	10 <sup>th</sup> – 11 <sup>th</sup>	11 <sup>th</sup> – 12 <sup>th</sup>	12 <sup>th</sup> – 13 <sup>th</sup>	13 <sup>th</sup> – 14 <sup>th</sup>	14 <sup>th</sup> – 15 <sup>th</sup>
U1	75	78	80	77	77
U2	-	76	74	72	71
U3	83	83	82	81	-
U4	-	-	-	-	70

The existing sound climate at the site is dominated by road traffic noise from Bute Street and railway noise from the adjacent railway line.



### 3.5 Summary of Vibration Survey Results

The following vibration descriptor is relevant to this assessment:

- VDV  $\text{ms}^{-1.75}$  (Vibration Dose Value) – calculated from frequency-weighted vibration measurements to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings.

The measured daytime (07:00 – 23:00) and night-time (23:00 – 07:00) V DVs are shown in Table 6.

Table 6: Summary of Measured Vibration Dose Values (VDVs)

Axis	Measured VDV $\text{ms}^{-1.75}$		Likelihood of Adverse Comment (as per BS6472)
	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)	
Radial (x)	0.012	0.004	Low
Tangential (y)	0.013	0.005	Low
Vertical (z)	0.044	0.017	Low

Based on the measured V DVs at the site, overall vibration levels are indicated to have a low likelihood of adverse comment, as per the guidance values presented in BS6472.



## 4 Noise Map Modelling

### 4.1 Significance Criteria

A description of the impact of predicted facade noise levels is provided in Table 7 with reference to the following guidance:

- British Standard 8233:2014
- World Health Organisation (WHO) Guidelines for Community Noise, 1999
- Professional Practice Guidance – Planning and Noise (ProPG), ANC, IOA and CIEH, May 2017
- Acoustics, Ventilation and Overheating – Residential Design Guide ANC, IOA, Jan 2020.

Table 7: Significance Criteria for Road Traffic and other Anonymous Noise affecting Dwellings

Magnitude of Impact	Daytime External Noise Level, dB LAeq,16hour (07:00 - 23:00 hours)	Night-time External Noise Level, dB LAeq,8hour (23:00 - 07:00 hours)	Description of Effect Without Design Mitigation
High	> 70	> 60	<p>Unacceptable Impact based on advice from ProPG. Significant impact on sleep quality is likely when windows are open and changes in behaviour due to noise are common.</p> <p>High performance acoustic laminated windows may be required (depending on the type of noise sources). Trickle vents may not be an option resulting in a requirement to use Mechanical Ventilation with Heat Recovery (MVHR).</p> <p>The need to open windows to cool overheating rooms should be minimised or avoided at night. This may result in a requirement for mechanical cooling.</p>
Medium	56 – 70	51 – 60	<p>Sleeping with windows open may impact sleep quality and daytime noise in external areas and inside with windows open will impact amenity.</p> <p>Particularly at the upper end of the range, windows and vents with an enhanced acoustic performance may be required. The ventilation system and building design should aim to minimise the need to open windows to control internal temperatures.</p>



Magnitude of Impact	Daytime External Noise Level, dB L <sub>Aeq,16hour</sub> (07:00 - 23:00 hours)	Night-time External Noise Level, dB L <sub>Aeq,8hour</sub> (23:00 - 07:00 hours)	Description of Effect Without Design Mitigation
Low	< 56	< 51	Good internal acoustic conditions will be achieved with windows closed and ventilation provided by a trickle vent. When windows are open slightly, conditions will normally still be reasonable, as defined in BS8233:2014. Windows can normally be opened to cool an overheating room without exceeding reasonable noise limits internally.

## 4.2 Noise Model and Results

To determine the external façade noise levels at the proposed site, a noise model has been created using SoundPLAN v.9.1 environmental noise prediction and mapping software. The noise model has been generated based on the noise survey measurement results outlined in Section 3.4.

Noise map models for the developed site are shown Appendix F. The noise models have been generated to display predicted daytime (07:00 – 23:00) and night-time (23:00 – 07:00) average ambient external noise levels at the façades of the proposed buildings.

During daytime hours, external façade noise levels range from L<sub>Aeq,16-hour</sub> 67dB at the worst affected façade (medium magnitude of impact) to L<sub>Aeq,16hour</sub> 51dB at the least affected façade (low magnitude of impact).

During night-time hours, external façade noise levels range from L<sub>Aeq,8-hour</sub> 62dB at the worst affected façade (high magnitude of impact) to L<sub>Aeq,8hour</sub> 45dB at the least affected façade (low magnitude of impact).

It should be noted that only two building façades are shown to have a high magnitude of impact during night-time hours. The external building fabric will be designed to ensure external noise intrusion is adequately controlled at all building façades during daytime and night-time hours; this is discussed in detail within Section 5.1.



## 5 Noise Impact Assessment

### 5.1 External Building Fabric Assessment

Based on the results of the environmental noise survey and the results of the noise map modelling, sound insulation calculations for habitable rooms within the proposed development have been prepared to determine façade constructions sufficient to control noise intrusion in-line with the internal noise limits recommended in BS8233.

Predicted internal noise levels have been calculated within the worst-affected habitable room types on each façade (i.e. living rooms and bedrooms with small dimensions and a high ratio of glazing to non-glazing) to provide a robust assessment of external noise intrusion to critical areas.

#### 5.1.1 External Wall Construction

Calculations have been undertaken on the basis of the external wall comprising a steel frame system with brickslip cladding which is capable of achieving the minimum insertion loss figures shown in Table 8.

Table 8: External Non-Glazed Wall Specification

Construction	Minimum Sound Reduction Index dB 'R' (BS EN ISO 10140-2:2010) @ Octave Band Centre Frequency (Hz)							R <sub>w</sub> + C <sub>tr</sub>
	63	125	250	500	1k	2k	4k	
Steel Frame System with Brickslip Cladding	31	46	51	55	55	59	60	54

A steel frame system with brickslip cladding is deemed capable of achieving the minimum sound insulation requirements for the external wall, however careful attention should be given to the low frequency performance of the proposed system to check that it is able to sufficiently control road and railway low frequency noise intrusion. At this stage, allowance should be made for two layers of plasterboard to form the internal lining (combined minimum 25kg/m<sup>2</sup> mass per unit area).

#### 5.1.2 Roof Construction



It is understood that the roof of the development will comprise a 225mm in-situ concrete slab (assumed min. density of 1900kg/m<sup>3</sup>). It is assumed that a suspended ceiling will also be included below the concrete slab within top-floor apartments. Therefore, noise intrusion via the roof to top-floor apartments is expected to be negligible compared to noise intrusion via other building elements (i.e. glazing).



### 5.1.3 Preliminary External Glazing Specifications

Based on the results of the external building fabric calculations, the preliminary façade glazing specifications provided within Table 9 are indicated necessary to achieve the internal ambient noise level design criteria within residential apartments. The glazing specifications shown are subject to further development as the external building fabric design progresses and should not be used for tender purposes at this stage.

Table 9: Preliminary Façade Glazing Specifications

Glazing Type	Example Glazing Configuration	Minimum Sound Reduction Index dB 'R' (BS EN ISO 10140-2:2010) @ Octave Band Centre Frequency (Hz)							R <sub>w</sub> + C <sub>tr</sub>
		63	125	250	500	1k	2k	4k	
Type 1 	8.8mm/16as/6.4mm (laminated)	32	26	28	39	48	46	53	<b>35</b>
Type 2 	10mm/16as/4mm	28	25	23	33	40	45	46	<b>32</b>

The glazing types referenced in Based on the results of the external building fabric calculations, the preliminary façade glazing specifications provided within Table 9 are indicated necessary to achieve the internal ambient noise level design criteria within residential apartments. The glazing specifications shown are subject to further development as the external building fabric design progresses and should not be used for tender purposes at this stage.

Table 9 are shown in Figure 4.

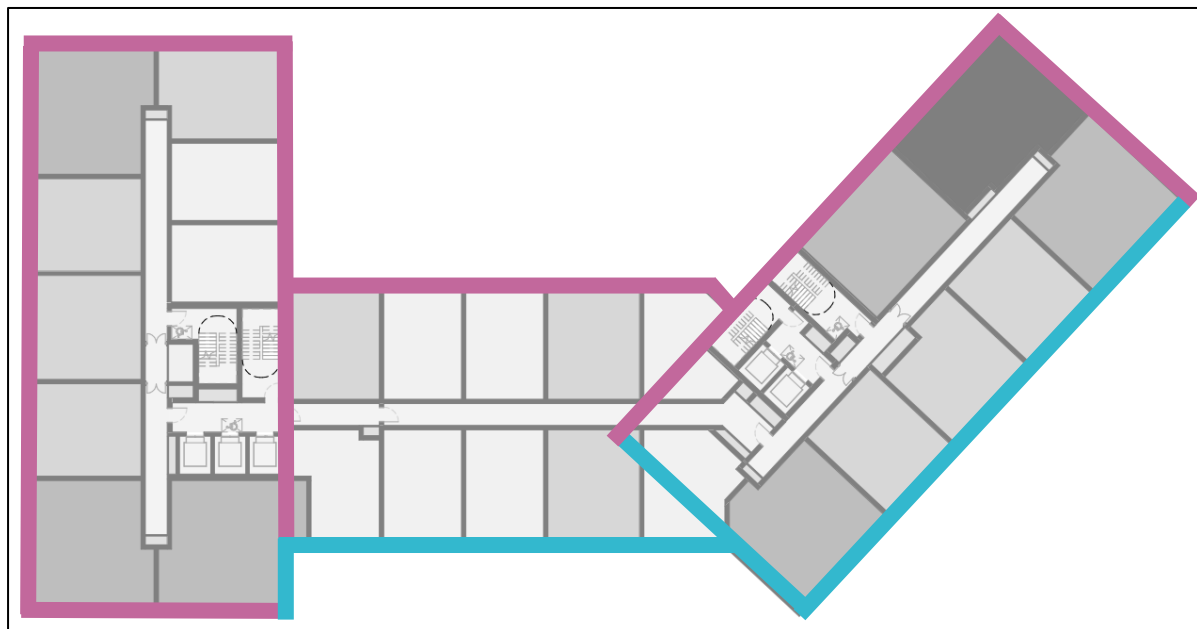


Figure 4: Glazing Types



As the design progresses, qualified comment should be sought on acoustic suitability and evidence of lab performance values should be made available by manufacturers.

**Note:** *The external building fabric assessment is based on controlling existing road and rail transport noise only. Final façade specifications should consider potential noise from the future rooftop plant installation at the adjacent development (located directly to the south of the site). This should be completed at the detailed design stage.*

#### **5.1.4 Background Ventilation Strategy**

It is understood that background ventilation in residential apartments is likely to be provided by mechanical means. Therefore, passive trickle ventilators in the façade (typically within the window frame) have not been included within the calculations. A preliminary assessment indicates any ventilative opening to the most critical façade (in terms of noise intrusion) would require a minimum 56dB  $D_{n,e,w}$  rating; this may necessitate in-duct attenuation. The background ventilation strategy is to be finalised at detailed design stage.

The use of opening windows for rapid purge ventilation (i.e. to expel paint fumes or burnt toast odours as per Approved Document F) is acceptable at all facades. This is on the basis that windows will be opened for short periods and may be closed at occupant discretion once odours are purged.

## **5.2 Internal Sound Insulation Assessment (Commercial to Residential)**

Current proposals for the development show a commercial space, a co-working space, a gym and various back of house areas at ground floor level. Noise & vibration transmission from the ground floor areas to residential apartments above is to be assessed at detailed design stage.

It is likely that separating constructions between typical commercial areas (i.e. commercial space and co-working space) and residential will need to be sufficiently uprated to mitigate noise transfer. A +5dB minimum sound insulation performance above Building Regulations criteria is typically suggested on schemes with commercial and residential adjacencies; however, this would need consideration of how significant noise from commercial activity is likely to be within the building.

Where a gym is proposed directly beneath residential apartments, the separating floor structure and overall development should be designed to achieve the ProPG: Gym Acoustics Guidance (GAG:2020) design criteria within residential apartments when the gym is operational (see Appendix B for further information).



The proposed residential dwellings are to be designed and constructed in accordance with the requirements of the Building Regulations Approved Document Part E (2010). The following aspects are considered:

- Sound insulation of separating walls (airborne)
- Sound insulation of separating floors (airborne and impact)
- Sound insulation of internal walls within a unit
- Sound insulation of entrance doors to each unit
- Sound insulation of enclosures to waste pipes or other penetrating services pipework
- Reverberation time control in common areas
- Flanking sound control across external walls and any internal structure (horizontally and vertically)

Early consultation with the applicable Building Control Authority or Approved Inspector is advised to clearly determine the approach to achieving the requirements of Approved Document E (2010) and the design criteria of the ProPG: Gym Acoustics Guidance (GAG:2023).

### **5.3 Preliminary Overheating Assessment**

It is recommended that the proportion of the year that windows need to be opened to cool overheating rooms is reduced to a minimum through careful consideration of the thermal design, particularly at high noise exposure facades. Options for this include:

- Alternative high-rate ventilation options such as boost fans and/or large acoustically attenuated passive vent louvres
- Smaller windows, particularly on higher noise exposure facades (to reduce thermal gain and noise ingress via windows)
- Solar shading or solar reflective windows
- Exposed thermal mass and enhanced building fabric thermal performance
- Mechanical cooling, although this should be considered a 'last resort' for mitigating overheating condition

The following preliminary assessment has been undertaken to establish the likely measures required to control overheating, noise & ventilation in habitable rooms of the most critical dwellings to satisfy requirements of Building Regulations Part O (Wales).

There are no specific criteria or guidance on internal noise levels within Building Regulations Part O in Wales and therefore guidance is sought from the Acoustics, Ventilation and Overheating Residential Design Guide (AVO Guide): 2020 prepared by the Association of Noise Consultants (ANC) and the Institute of Acoustics (IOA). The AVO Guide and the relevant criteria are summarised in Appendix B.



A 'Level 1 Site Risk Assessment' shows free-field bedroom façades with Glazing Type 1 (see Figure 4) have external noise levels of up to 62dB  $L_{Aeq,8hr}$  and 82dB  $L_{Amax,F}$ . This indicates that bedroom façades with Glazing Type 1 are at a 'High Risk' of adverse effect in periods of overheating at night. Overheating mitigation via openable windows is deemed unlikely to be sufficient.

A 'Level 1 Site Risk Assessment' shows free-field bedroom façades with Glazing Type 2 (see Figure 4) have external noise levels up to 54dB  $L_{Aeq,8hr}$  and 74dB  $L_{Amax,F}$ . This indicates that bedroom façades with Glazing Type 2 are at a 'Medium Risk' of adverse effect in periods of overheating at night.

For design guidance, it is advised that overheating mitigation during night-time periods should not rely on openable windows, therefore a mechanical ventilation means of control (with or without active cooling) is likely to be necessary. This strategy would assist in meeting the upper internal night-time AVO Guide values of 42dB  $L_{Aeq,8hr}$  and 65dB  $L_{Amax,F}$ , during overheating conditions at all façades.

The necessity for an active cooling element as part of the ventilation strategy should be confirmed by the thermal modelling engineer as part of a detailed overheating assessment.

## **5.4 External Amenity Area Assessment**

It is understood that shared external amenity areas are proposed in the form of ground floor amenity areas and an internal courtyard area at fifth floor.

Based on the results of the environmental noise survey and the results of the noise map modelling, it is predicted that the ground floor amenity areas and internal courtyard area at fifth floor may exceed the BS8233 upper guideline limit value of 55dB(A) due to railway and road traffic noise.

Although the amenity areas are predicted to exceed the upper guideline limit, it should be noted that BS8233 acknowledges that this upper guideline limit may not be achievable in all circumstances:

*"However, it is also recognised that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs to 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."*

Considering the proximity of the proposed development to Cardiff Central station, elevated noise levels at the development are noted to be offset by the convenience of living in a location which adjoins the strategic transport network. Additionally, ProPG (2017) provides further guidance on external amenity spaces:

*"Where, despite following a good acoustic design process, significant adverse noise impacts remain on any private external amenity space (e.g. garden or balcony) then that impact may be partially off-set if the residents are provided, through the design of the development or the planning process, with access to:*



*a relatively quiet facade (containing openable windows to habitable rooms) or a relatively quiet externally ventilated space (i.e. an enclosed balcony) as part of their dwelling; and/or*

*a relatively quiet alternative or additional external amenity space for sole use by a household, (e.g. a garden, roof garden or large open balcony in a different, protected, location); and/or*

*a relatively quiet, protected, nearby, external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings; and/or*

*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). The local planning authority could link such provision to the definition and management of Quiet Areas under the Environmental Noise Regulations. "*

Based on the ProPG guidance outlined above, the accessibility of nearby green spaces and external amenity areas to the proposed development (e.g. Craiglee Drive Children's Playground, Silurian Park, Atlantic Wharf, Bute Park etc) is considered to 'off-set' the adverse noise impact at the on-site external amenity areas. Therefore, no further mitigation measures are deemed necessary.



## 6 External Plant Noise Limits

The nearest residential noise sensitive receptors are identified as being the Meridian Plaza & Altolusso residential blocks, and Zenith Student Accommodation, as shown in Figure 5.

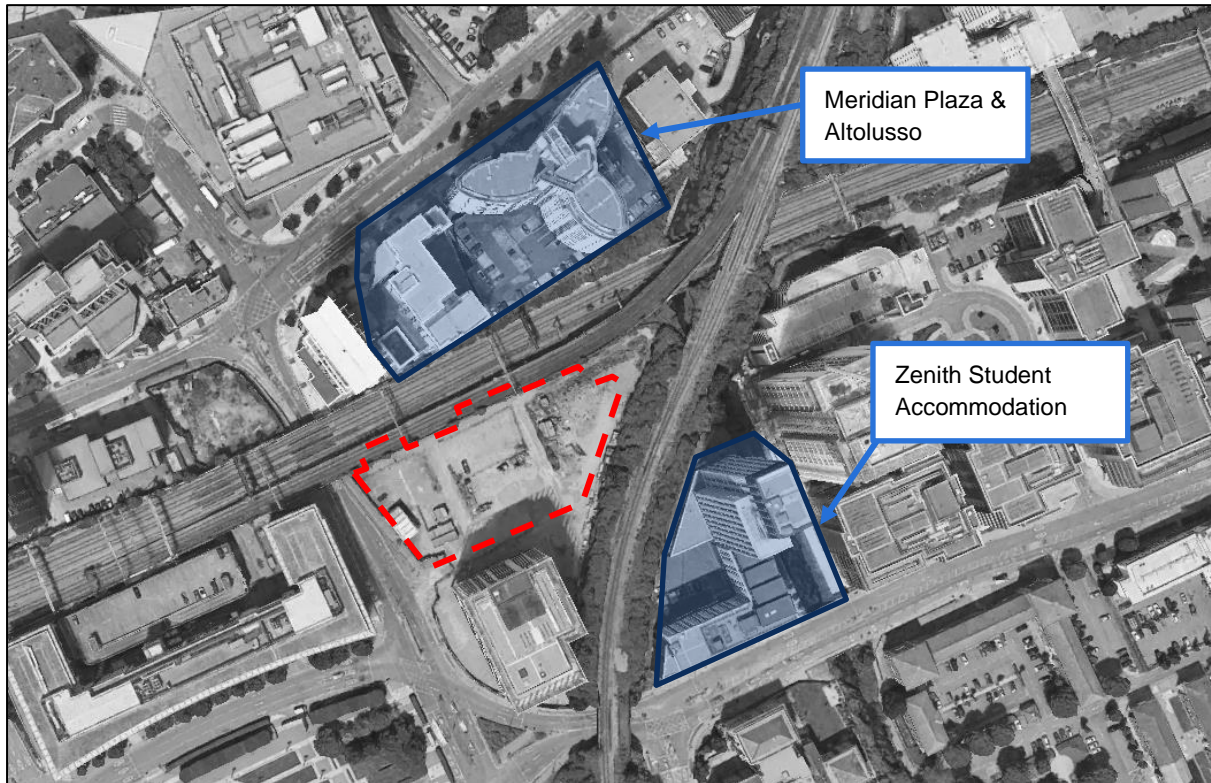


Figure 5: Nearest Noise Sensitive Receptors (NSRs)

Cardiff Council have previously proposed the following fixed plant noise limit planning condition on new mixed-use developments:

*"The rating level of the noise emitted from fixed plant and equipment on the site shall not exceed 10dB below background noise level at the nearest noise sensitive premises, when measured and corrected in accordance with BS 4142: 2014 +A1 2019 (or any British Standard amending or superseding that standard)."*

Rating limits at 10dB below measured background sound level is deemed particularly stringent when relatively low overall background sound levels have been measured. Limiting plant noise levels to  $\leq 34$ dB in a city-centre urban environment (at possibly a considerable expense) is deemed punitive when absolute levels calculated to inside a dwelling through a partially open window fall well-below BS8233 guidelines.



## Noise & Vibration Planning Report

### 6 External Plant Noise Limits

It is therefore recommended that the Local Authority revise their proposed condition to a rating level limit 5dB below measured background sound level. Setting rating limits at 5dB below measured background sound level in this instance would still constitute a low impact at the nearest Noise Sensitive Receptors (NSR), as is targeted within BS 4142:2014+A1:2019 guidance.

Therefore, it is proposed to control building services noise emissions to the limits set out in Table 8 at the nearest noise sensitive receptors (NSRs). Monitoring Position U3 is deemed to be best representative of the typical background sound level at Meridian Plaza and Altolusso. Monitoring position U2 is deemed to be best representative of the typical background sound level at Zenith Student Accommodation.

Table 10: Proposed Plant Noise Limits

Noise Sensitive Receptor	Period	Typical Background Sound Level	Proposed Rating Plant Noise Limit
Meridian Plaza & Altolusso	Daytime (07:00-23:00)	52dB LA90,1hr (U3)	≤ 47dB LA,r,Tr
	Night-time (23:00-07:00)	47dB LA90,15mins (U3)	≤ 42dB LA,r,Tr
Zenith Student Accommodation	Daytime (07:00-23:00)	49dB LA90,1hr (U2)	≤ 44dB LA,r,Tr
	Night-time (23:00-07:00)	44dB LA90,15mins (U2)	≤ 39dB LA,r,Tr

Internal housing of plant will help to reduce noise emissions to the nearest sensitive receptors. If required to comply with the design rating levels, the following additional mitigation measured could also be employed:

- Selection of energy efficient and therefore lower noise emission plant.
- Switching plant off/or operating plant at reduced duty during quieter periods or when demand is lower; via the BMS (building management system).
- Use of in-duct attenuators to reduce noise emissions to atmosphere; and
- Use of acoustically treated louvres to further reduce emissions to atmosphere from plant rooms.

By incorporating the mitigation strategies above (if required and identified during the appropriate design stage) into the detailed design of the proposed development, it is considered that the operational noise from fixed plant installations can be designed to achieve the proposed plant noise limits.



## **7 Conclusion**

Stantec has been appointed to provide acoustic consultancy services in relation to the proposed mixed-use development at John Street, Cardiff. A baseline noise survey has been undertaken to assess the existing noise climate at the proposed site.

A noise model has been generated to predict overall noise levels at all façades of the proposed development during daytime and night-time hours.

An external building fabric assessment has been undertaken based on the predicted external noise levels to verify that internal noise levels within the proposed development are predicted to achieve the BS8233 internal noise criteria and other such relevant planning guidance target levels.

An internal sound insulation assessment has been undertaken to determine the potential impact of noise from commercial units at ground floor level to residential units above. The separating floor construction between ground floor and first floor should be designed appropriately to control noise transfer between commercial and residential areas.

A preliminary noise, overheating and ventilation assessment has been undertaken to determine the feasibility of using an open window strategy as part of the overheating mitigation strategy. It is advised that overheating mitigation during night-time periods should not rely on opened windows.

An assessment of predicted noise levels to the proposed ground floor and fifth floor external amenity areas has been undertaken. Considering the proximity of the proposed development to Cardiff Central station, elevated noise levels at the development are noted to be offset by the convenience of living in a location which adjoins the strategic transport network, as per the guidance presented in BS8233.

External plant noise limits have been proposed based on the typical measured background noise levels at the site. The proposed limits should be agreed acceptable with the Local Planning Authority's Environmental Health department.





# Appendices



## Appendix A Acoustic Terminology

Term	Description
dB (decibel)	The scale on which sound pressure level is expressed. Sound pressure level is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure ( $2 \times 10^{-5} \text{Pa}$ ).
dB(A)	A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' - weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
$L_{Aeq,T}$	$L_{Aeq}$ is defined as the notional steady sound level which, over a stated period of time (T), would contain the same amount of acoustical energy as the A - weighted fluctuating sound measured over that period.
$L_{Amax}$	$L_{AFmax}$ is the maximum A - weighted sound pressure level recorded over the period stated. $L_{AFmax}$ is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the overall $L_{eq}$ noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{10}$ and $L_{90}$	If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The $L_n$ indices are used for this purpose, and the term refers to the level exceeded for n% of the time. Hence $L_{10}$ is the level exceeded for 10% of the time, and the $L_{90}$ is the level exceeded for 90% of the time.
$R_w$	$R_w$ is the single-number quantity which characterizes the sound insulating properties of a given material over a range of frequencies. This is typically measured in a laboratory in accordance with BS EN ISO 717-1.
$D_{n,e,w}$	$D_{n,e,w}$ is the single number quantity which characterizes the airborne sound insulation performance across a given 'element' and is typically used to describe the acoustic performance of trickle ventilators etc.
$C_{tr}$	$C_{tr}$ is a correction term applied to single-number sound insulation values ( $R_w$ , $D_{n,e,w}$ etc.) to afford additional weighting against low frequency performance.
Free-field Level	A sound field determined at a point away from reflective surfaces other than the ground with no significant contributions due to sound from other reflective surfaces. Generally, as measured outside and at least 3m from buildings.



# Appendix B Guidance Documents

## Planning Policy Wales

Welsh Government Planning Policy Wales (Edition 11) dated February 2021 (last updated October 2023), states;

*“6.7.20 Where sensitive developments need to be located close to existing transportation infrastructure for sustainable movement and access they should be designed, as far as practicable, to limit harmful substances and noise levels within and around those developments both now and in the future. This may include employing the principles of good acoustic design and the inclusion of active travel or travel management measures as part of development proposals. Such development, however, should preferably be located away from existing sources of significant noise, which may include aircraft noise or roads, particularly new roads or those with programmed route improvements.”*

The policy document goes on to refer to the ‘Professional Planning Guidance (ProPG) Supplementary Document 2’ produced by the Association of Noise Consultants, the Institute of Acoustics and the Chartered Institute of Environmental Health.

## **ProPG: Planning & Noise - Professional Guidance on Planning & Noise - New Residential Development**

The Professional Practice Guidance on Planning and Noise (May 2017) provides guidance on transportation noise affecting new residential developments. The guidance was prepared by a working group formed from members of the Institute of Acoustics (IoA), the Association of Noise Consultants (ANC) and the Chartered Institute of Environmental Health (CIEH). It is specifically for assessing noise from predominantly transportation sources. The guidance promotes a two stage assessment approach:

- Stage 1 – Initial Site Noise Risk Assessment; and,
- Stage 2 – Full assessment and systematic appraisal of four key elements.

The Stage 1 initial risk assessment provides an indication of the likely risk of adverse effects from noise assuming in the first instance that no mitigation were included within the proposals. The risk assessment is based on measured or predicted noise levels during a “typical worst case” 24-hour period. Figure 1 of the document presents the Stage 1 assessment and indicates that higher noise levels result in increased noise risk without mitigation. This is summarised in Figure A1 below. Figure A1 (Figure 1 of ProPG) does not directly relate noise levels to specific risk categories although a negligible noise risk broadly correlates to noise levels not exceeding 50dB  $L_{Aeq,16hr}$  (daytime) and 40dB  $L_{Aeq,8hr}$  (night).



Day L <sub>Aeq</sub> , 16 Hr	50 dB	55 dB	60 dB	65 dB	70 dB
Night L <sub>Aeq</sub> , 8 Hr	40 dB	45 dB	50 dB	55 dB	60 dB

*ProPG Stage 1 Noise Risk Assessment (adapted from ProPG Figure 1)*

Where the initial noise assessment indicates a higher risk of adverse noise effects, a Stage 2 assessment is required. The Stage 2 assessment is more involved than the Stage 1 and requires systematic consideration of four elements:

Element 1 – Good Acoustic Design Process

The acoustic design of a building and any mitigation should be considered at an early stage of the design process. Following a good acoustic design process is considered a part of achieving a good design as required by the NPSE and NPPF. Guidance on the requirements for providing an Acoustic Design Statement (ADS) is given in Figure 3 of ProPG.

Element 2 – Internal Noise Level Guidelines

The guideline criteria for internal ambient noise levels are consistent with BS8233:2014:

- 35dB L<sub>Aeq,16hr</sub> in living rooms during daytime
- 30dB L<sub>Aeq,8hr</sub> in bedrooms during night-time
- 45dB L<sub>AFmax</sub> should not normally be exceeded 10-15 times a night in bedrooms

Element 3 – External Amenity Area Noise Assessment

The guidance of the ProPG reflects and extends on the advice of BS8233 and PPG Noise. The guidance in the ProPG presents five points for consideration, the first being “If the external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended”.

Element 4 – Assessment of Other Relevant Issues

“Other relevant issues” within the context of the ProPG include relevant national and local policy which may have a bearing on the development.



## Technical Advice Note (Wales) 11

Noise bands defining categories A-D of TAN 11 are set in terms of  $L_{Aeq,16hr}$  daytime and  $L_{Aeq,8hr}$  night time levels for road traffic noise and mixed sources, free field 1.2-1.5m above ground level as follows;

### TAN11 Noise Exposure Categories

Recommended noise exposure categories for new dwellings near existing noise sources (ref Table 2 of TAN 11 (Wales) October 1997)					
Noise Source	Time	Noise Exposure Categories			
		A	B	C	D
Road Traffic	07:00-23:00	<55	55-63	63-72	>72
	23:00-07:00	<45	45-57	57-66	>66
Rail Traffic	07:00-23:00	<55	55-66	66-74	>74
	23:00-07:00	<45	45-59	59-66	>66
Air Traffic	07:00-23:00	<57	57-66	66-72	>72
	23:00-07:00	<48	48-57	57-66	>66
Mixed Sources <sup>(4)</sup>	07:00-23:00	<55	55-63	63-72	>72
	23:00-07:00	<45	45-57	57-66	>66

Note: In addition, sites where individual noise events regularly exceed 82dB(A)  $L_{max(slow)}$ , several times in any night-time hour should be treated as being in NEC C, unless the  $L_{eq(8\ hour)}$  already puts the site in NEC D.

<sup>(4)</sup> Mixed sources: this refers to any combination of road, rail, air and industrial noise sources. The "mixed source" values are based on the lowest numerical values of the single source limits in the table. The "mixed source" NECs should only be used where no individual noise source is dominant.



## **British Standard 4142:2014+A1:2019**

The standard method for assessing noise from commercial and industrial premises is British Standard BS 4142:2014+A1 2019 “Method for rating and assessing industrial and commercial sound”. The standard is applicable for assessing noise affecting “dwellings or premises used for residential purposes”.

A BS 4142 assessment is made by determining the difference between the specific noise under consideration and the background sound level, as represented by the  $L_{A90}$  parameter, determined in the absence of the commercial sound. The  $L_{A90}$  parameter is defined as the level exceeded for 90% of the measurement time. This parameter therefore excludes short duration noise events, such as individual vehicle movements, and represents the underlying continuous noise.

The commercial or industrial sound is assessed in terms of the equivalent continuous noise level,  $L_{Aeq}$ . The equivalent continuous noise level ( $L_{Aeq}$ ) of the commercial or industrial sound, over the applicable assessment period, is known as the specific sound level.

A character correction penalty can be applied to the specific sound level where the commercial noise exhibits distinguishable tones, impulsiveness, intermittency or other characteristics which “are otherwise readily distinctive against the residual acoustic environment”.

The specific noise level with the character correction (if necessary) is known as rating level ( $L_{Ar}$ ) and the difference between the background noise and the rating level is determined to make the BS 4142 assessment. The following is then considered:

- Typically, the greater this difference, the greater the magnitude of the impact.
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

The standard highlights the importance of considering the context in which a sound occurs. Factors including the absolute sound level, the character of the sound, the sensitivity of the receptor and the existing acoustic character of the area should be considered when assessing the noise impact. The use of the proposed premises for short term holiday rentals is also pertinent to the consideration of context.

The standard notes the need to consider absolute sound levels where background sound levels are low:

*“For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level*



*is low. Where the background sound levels and rating level are low, absolute levels might be as, or more, relevant than margin by which the rating level exceeds the background. This is especially true at night."*

## **British Standard 8233:2014**

Appropriate noise limits for internal noise levels within residential premises are recommended in BS 8233:2014. Limits are in terms of the equivalent continuous level ( $L_{Aeq}$ ).

The table below provides the BS 8233:2014 guidance criteria for indoor ambient noise levels in habitable rooms when they are unoccupied.

### *BS 8233 Internal Noise Limits - Residential*

Activity	Location	Daytime (07:00-23:00) $L_{Aeq(16hour)}$ dB	Night-time (23:00-07:00) $L_{Aeq(8hour)}$ dB
Resting	Living room	35	-
Dining	Dining room / area	40	-
Sleeping (daytime resting)	Bedroom	35	30

The indoor ambient noise level guidance of BS 8233:2014 is qualified by various notes, of which applicable ones are given in the table below.

### *BS 8233 Qualifying Notes*

Qualifying Note	Description
Note 2	The levels shown in the table above are based on the existing guidelines issued by the WHO and assume normal diurnal fluctuations in external noise. In cases where local conditions do not follow a typical diurnal pattern, for example on a road serving a port with high levels of traffic at certain times of the night, an appropriate alternative period, e.g. 1 hour, may be used, but the level should be selected to ensure consistency with the levels recommended in the table above.
Note 3	These levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events, such as fireworks night or New Year's Eve.
Note 4	Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$ depending on the character and number of events per night. Sporadic noise events could require separate values.
Note 5	If relying on closed windows to meet the guide values, there needs to be appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level.
Note 7	Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable conditions still achieved.



BS 8233:2014 also provides guidance on external noise levels for protection of private amenity spaces for residential demises. A level of 50dB L<sub>Aeq,T</sub>, is said to be desirable but 55dB L<sub>Aeq,T</sub> should be regarded as the upper guideline value.

### **British Standard 6472:2008**

BS6472 provides the following text regarding vibration measurements at the relevant places of interest, and the significance in terms of human response for people in those places:

*When the appropriately-weighted vibration measurements or predictions have been used to derive the VDV for either 16 h (daytime) or 8 h (night-time) at the relevant places of interest, their significance in terms of human response for people in those places can be derived from Table 1. The judgement made is of the probability that the determined vibration dose might result in adverse comment by those who experience it.*

The table of vibration criteria referenced in the text above is reproduced below:

<b>Place and Time</b>	<b>Low Probability of Adverse Comment</b>	<b>Adverse Comment Possible</b>	<b>Adverse Comment Probable</b>
Residential Buildings 16hr Day (07:00 – 23:00)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential Buildings 8hr Night (23:00 – 07:00)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

### **Approved Document O: Wales 2022**

Approved Document O: Wales 2022 provides the following text with regard to noise during night-time hours (23:00 – 07:00):

*High levels of external noise could limit the use of cross-ventilation to mitigate the risk of summer overheating. External noise is a material consideration considered when applying for Planning permission and mitigating measures may be required in the design in order to obtain Planning permission and controlled through a condition imposed on the consent. In exceptional cases, this could include non-openable windows. More commonly, windows will be openable in order to enable natural ventilation to occur at less sensitive times of day, when there is lower noise, when people are not present in the room, or when they are present but not engaged in noise-sensitive activities. But those windows may need to be kept closed at times to maintain acceptable indoor acoustic conditions, for example when people are using the rooms for sleep or office work. A noise issue may be identified at the Planning stage but rely on occupants to close windows at noise-sensitive times rather than prevent them from ever opening them, and in those cases overheating strategies should assume windows will be closed during noise-sensitive periods even if they are not fixed closed.*

*When the removing excess heat as part of the overheating strategy, noise levels in bedrooms should be kept to a minimum during the sleeping hours of 23:00 – 07:00. Building control bodies may accept as evidence that this requirement is satisfied:*



- a. *documentation to demonstrate that the local planning authority did not consider external noise to be an issue at the site at the planning stage or;*
- b. *if the local planning authority did consider external noise to be an issue that should be controlled through a condition at planning stage, then documentation to demonstrate that the proposals for heat removal (during the sleeping hours of 23.00 – 07.00) are accommodated within or do not conflict with documentation provided to the local planning authority to satisfy any related planning permission condition(s). (For example any expectation that windows on one or more façade, or in certain rooms, will need to be kept closed during noise-sensitive periods.)*

*Where active measures (e.g. mechanical system) are used for removing excess heat within the overheating strategy, the noise generated by these measures, particularly within bedrooms and living rooms should be considered. Noise generated by ventilation/cooling systems (which may travel through ducts) and noise from the fan unit may disturb the occupants of the building and so discourage their use. Therefore, the designer should consider minimising noise by careful design and the specification of quieter products. Further guidance on mechanical ventilation systems can be found in Approved Document F.*

## **Acoustics, Ventilation and Overheating – Residential Design Guide 2020**

The Acoustics, Ventilation and Overheating – Residential Design Guide (AVO Guide) 2020 aims to assist designers to adopt an integrated approach to the acoustic design of residential dwellings within the context of ventilation and thermal comfort requirements.

The guidance outlines a two-level risk assessment procedure for estimating the potential adverse impact on occupants in overheating conditions.

The Level 1 site risk assessment is based on external free-field noise levels and the assumed scenario where a partially open window is used to mitigate overheating. The Level 1 assessment is sufficient for developments on 'Negligible' risk sites. The relevant table outlining guidance for level 1 site risk assessment of noise from transport noise sources (relating to overheating condition) is shown overleaf.

The Level 2 assessment is recommended for 'High' risk sites. For 'Low' and 'Medium' risk sites, a Level 2 assessment can optionally be undertaken to give more confidence regarding the suitability of internal noise conditions. This may be particularly appropriate for sites in the 'Medium' risk category.



**Table 3-2** Guidance for Level 1 site risk assessment of noise from transport noise sources <sup>[Note 1]</sup> relating to overheating condition

Risk category for Level 1 assessment <sup>[Note 5]</sup>	Potential Effect without Mitigation	Recommendation for Level 2 assessment
<p>LAeq, T <sup>[Note 3]</sup> during 07:00 - 23:00</p> <p>LAeq, 8hr during 23:00 - 07:00</p> <p>65 dB</p> <p>High</p> <p>60 dB</p> <p>Medium</p> <p>55 dB</p> <p>Low</p> <p>50 dB</p> <p>Negligible</p> <p>45 dB</p> <p>55 dB</p>	<p>Increasing risk of adverse effect</p> <p>Use of opening windows as primary means of mitigating overheating is not likely to result in adverse effect</p>	<p>Recommended</p> <p>Optional</p> <p>Not required</p>

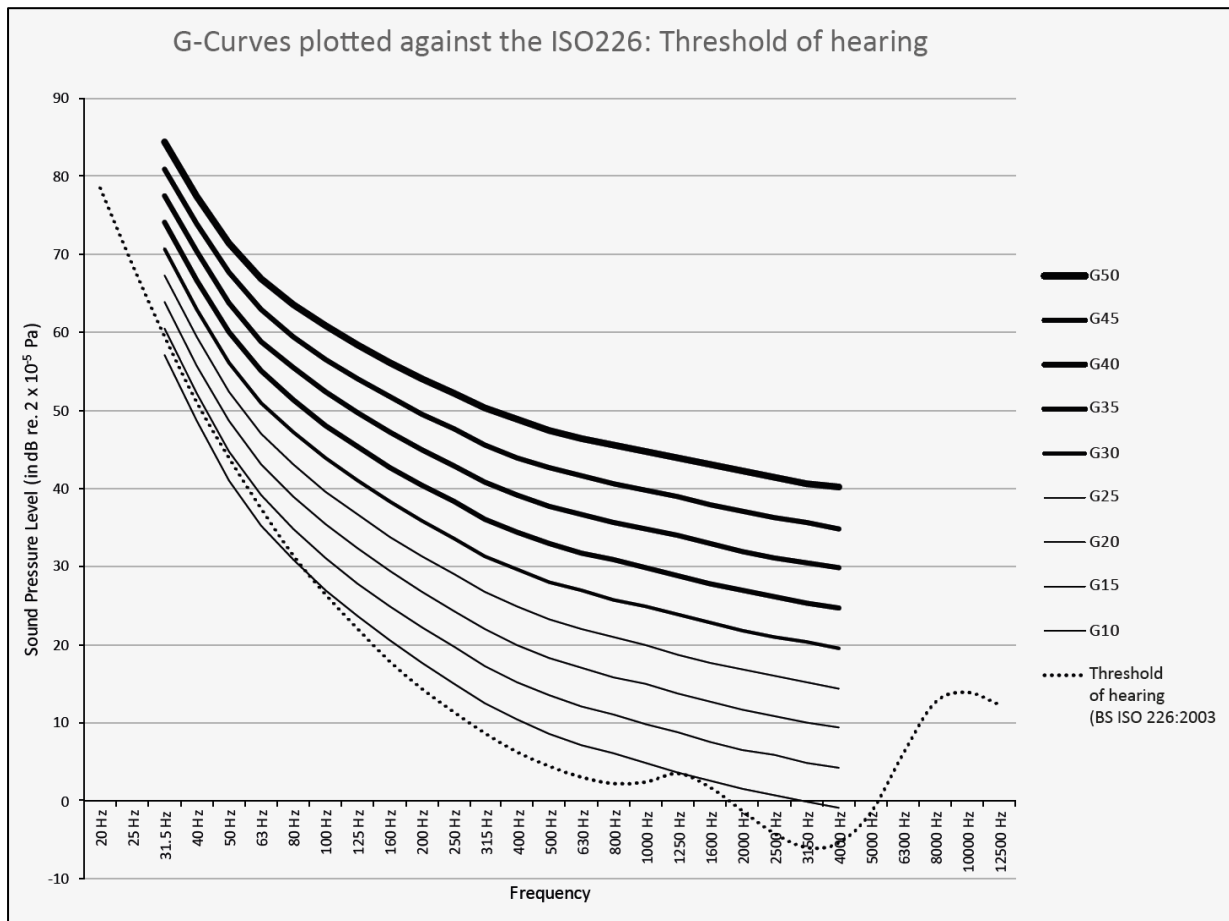
- Note 1** The noise levels suggested assume a steady road traffic noise source but may be adapted for other types of transport. All levels are external free-field noise levels.
- Note 2** The values presented in this table should not be regarded as fixed thresholds and reference can also be made to relevant dose-response relationships, <sup>[15, 17]</sup>.
- Note 3** A decision must be made regarding the appropriate averaging period to use. The averaging period should reflect the nature of the noise source, the occupancy profile and times at which overheating might be likely to occur. Further guidance can be found within the 2014 IEMA Guidelines <sup>[23]</sup>.
- Note 4** Refer also to references <sup>[1, 17, 18, 22]</sup> for further guidance regarding individual noise events. Where 78dB LAFmax is normally exceeded during the night-time period (23:00-07:00), a Level 2 assessment is recommended.
- Note 5** The risk of an adverse effect occurring will also depend on how frequently and for what duration the overheating condition occurs. Refer to Figure 3-2.
- Note 6** To evaluate the risk category for a dwelling, all three aspects of external noise exposure (i.e. daytime, night-time and individual noise events) should be evaluated. The highest risk category for any of the three aspects applies.



## ProPG: Gym Acoustics Guidance (GAG:2023)

The ProPG: Gym Acoustics Guidance 2023 (GAG) provides acoustic design criteria for critical areas potentially exposed to gym noise & vibration, based on NR-curve type targets. The 'G-Curves' provide a way to reference spectral noise data in a single figure, in a similar way to NR, but the reference is in one-third octave bands to provide improved frequency resolution.

It is important to note that a 'G-Curve' is not the same as an NR curve but provides a consistent way to present gym sound data. Furthermore, using a one-third octave band curve as the upper limit for resulting gym noise enables the practitioner to undertake a visual, graphical analysis of the resulting impact noise. Such analysis can be crucial in identifying compliance with the curve at lower frequencies, which is pertinent to identifying excessive impact noise. The 'G-Curve' framework is shown in the figure below.



### ProPG Gym Acoustics Guidance G-Curve Criteria

To avoid a potential noise and vibration disturbance within the first floor residential apartments due to activity within the ground floor gym areas, it is proposed to target the G-curve criteria within residential apartments, as shown in the table overleaf. The relevant G-curves are also shown in the figure above.



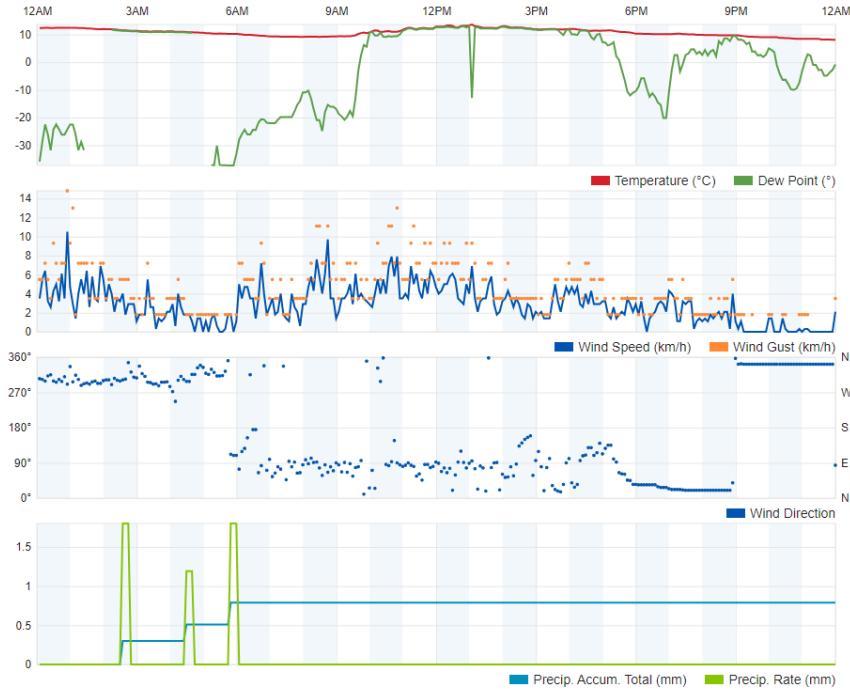
GAG:2023 Acoustic Design Criteria within Residential Apartments

Receptor Type	Guide Design Criteria	
	Airborne Sound (e.g., music) <i>L<sub>eq,T</sub></i> (31.5Hz to 8kHz)	Heavy Impact Sound <i>L<sub>max,F</sub></i> (31.5Hz to 8kHz)
Residential Apartments	G15-G25 (Daytime) G10-G20 (Night-time)	G20-G25 (Daytime) G15-G20 (Night-time)

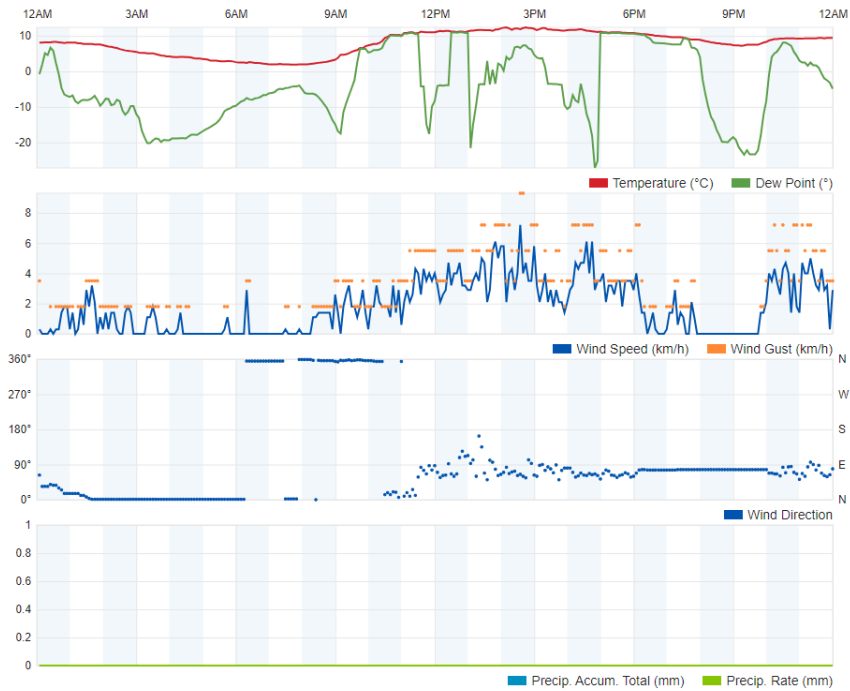


# Appendix C Weather Time History Graphs

October 10, 2024



October 11, 2024



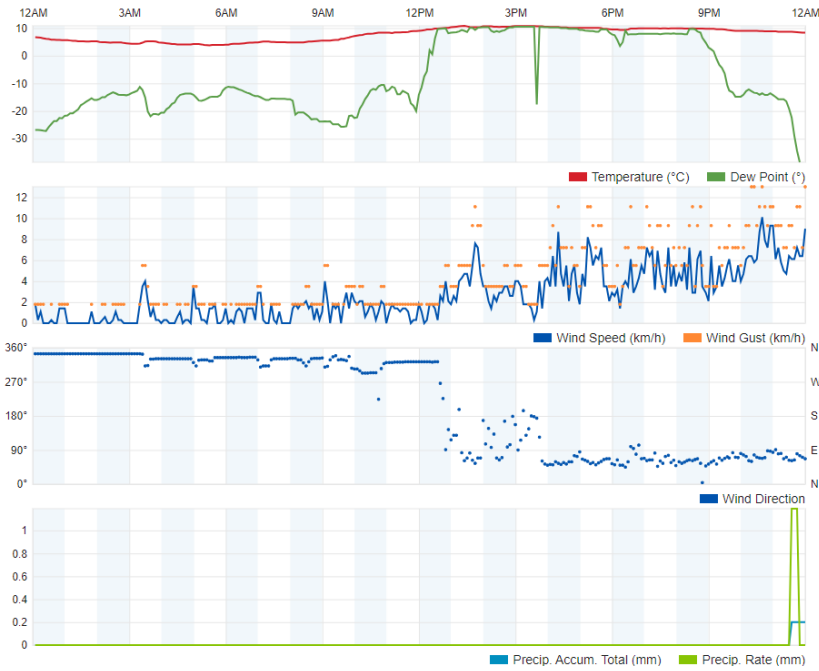
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October 12, 2024



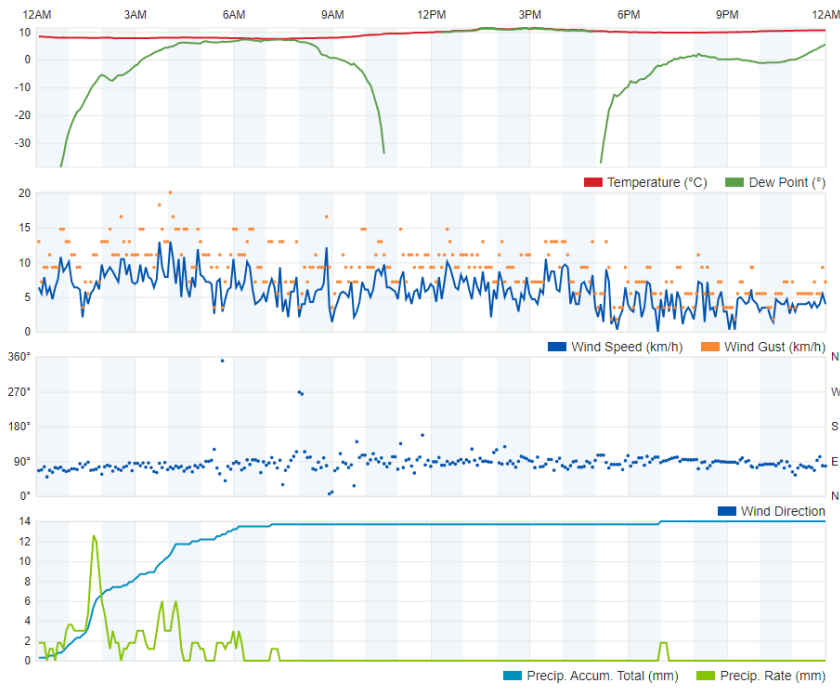
October 13, 2024



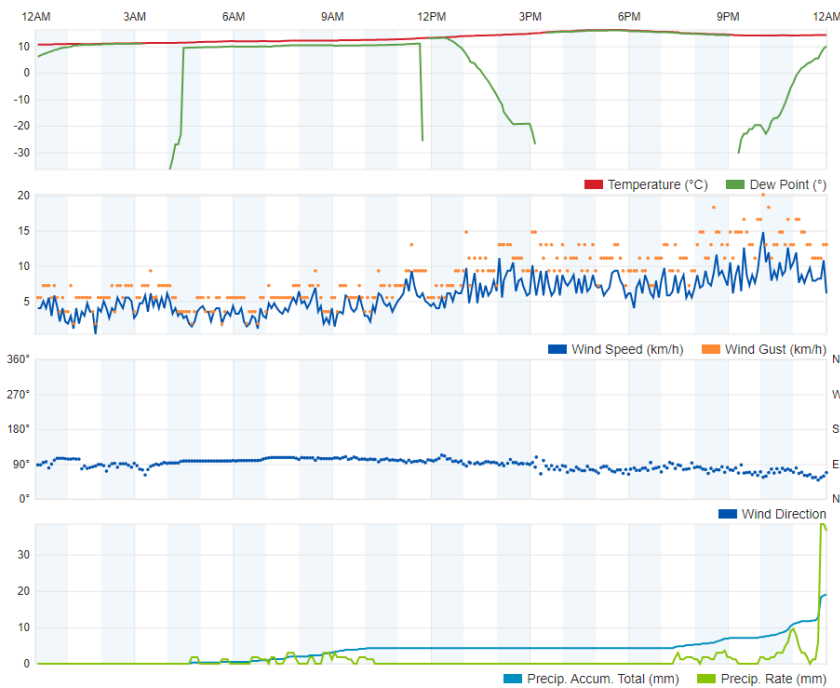
Taken from [www.wunderground.com](http://www.wunderground.com) – weather station 'IWALESCA18' located in Pontcanna, Cardiff



October 14, 2024



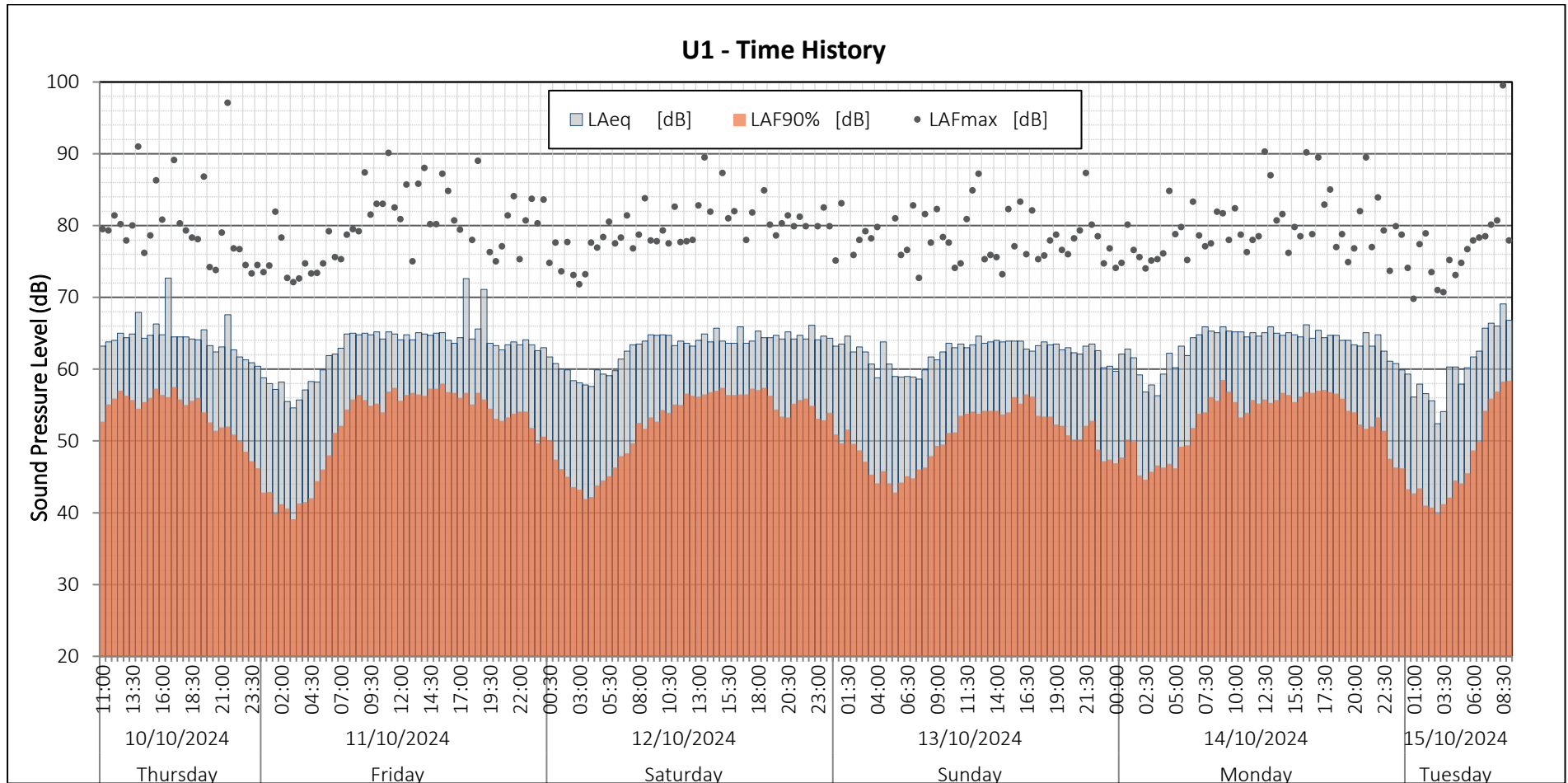
October 15, 2024



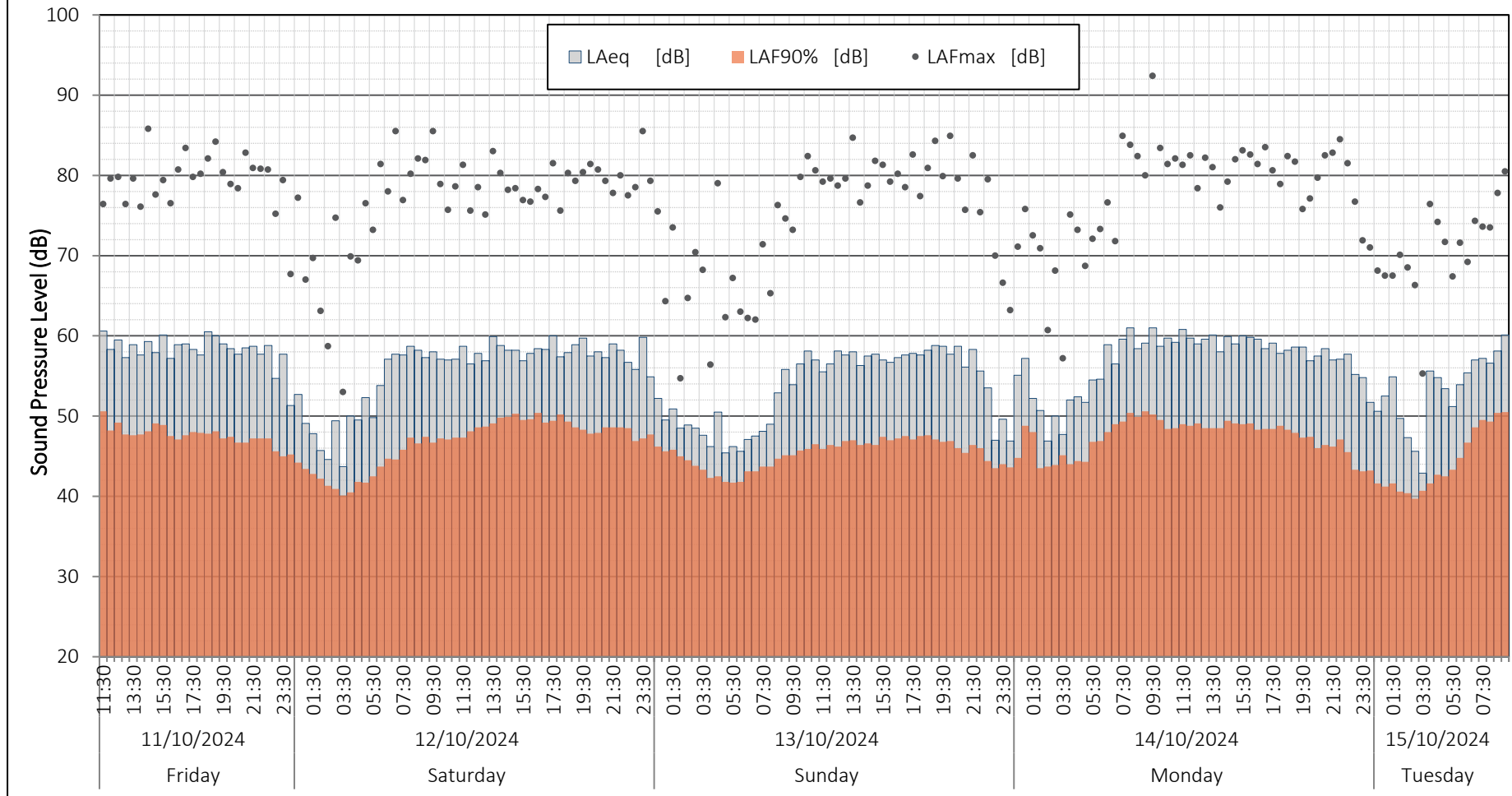
Taken from [www.wunderground.com](http://www.wunderground.com) – weather station 'IWALESCA18' located in Pontcanna, Cardiff



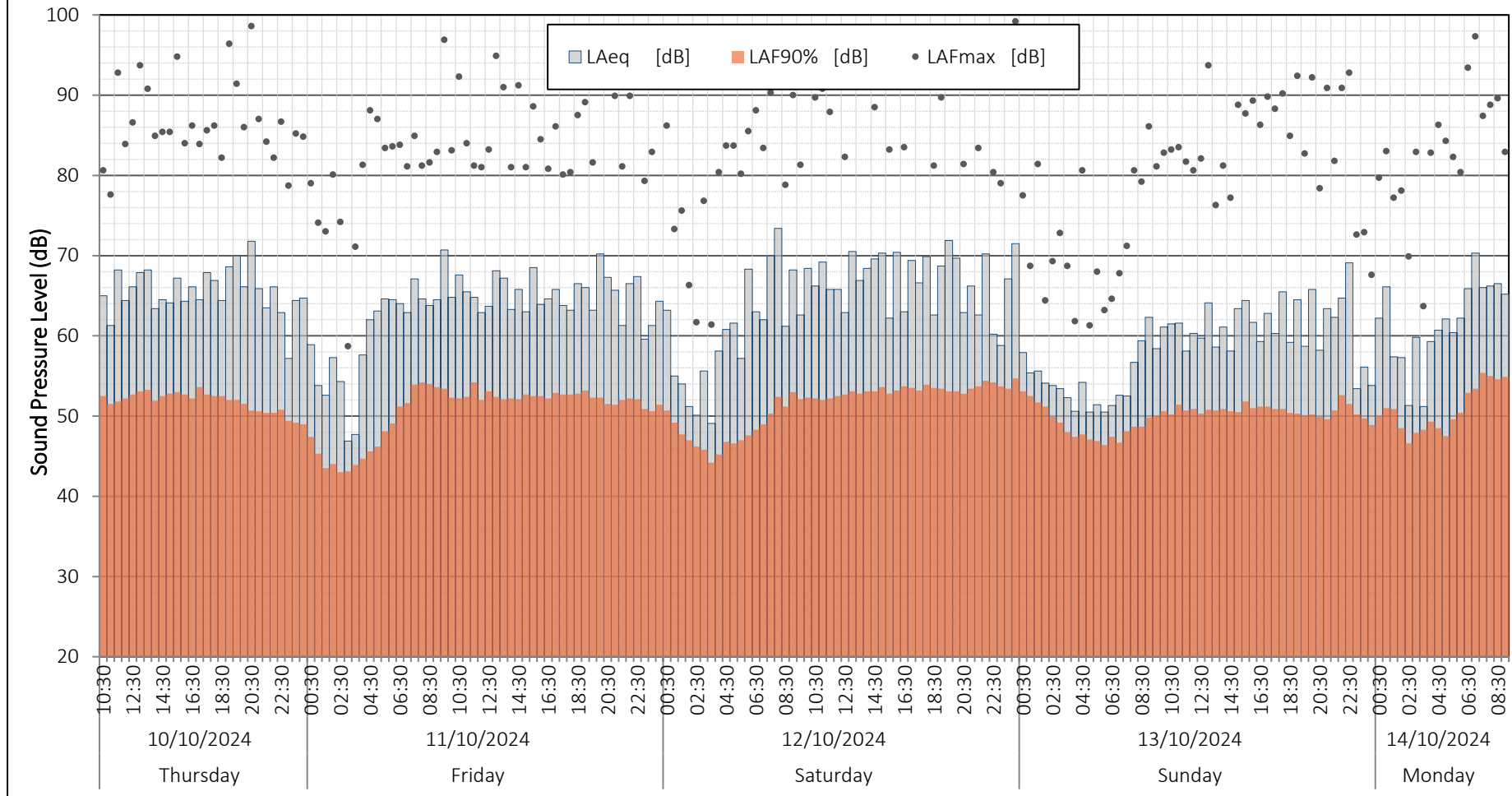
# Appendix D Noise Time History Graphs



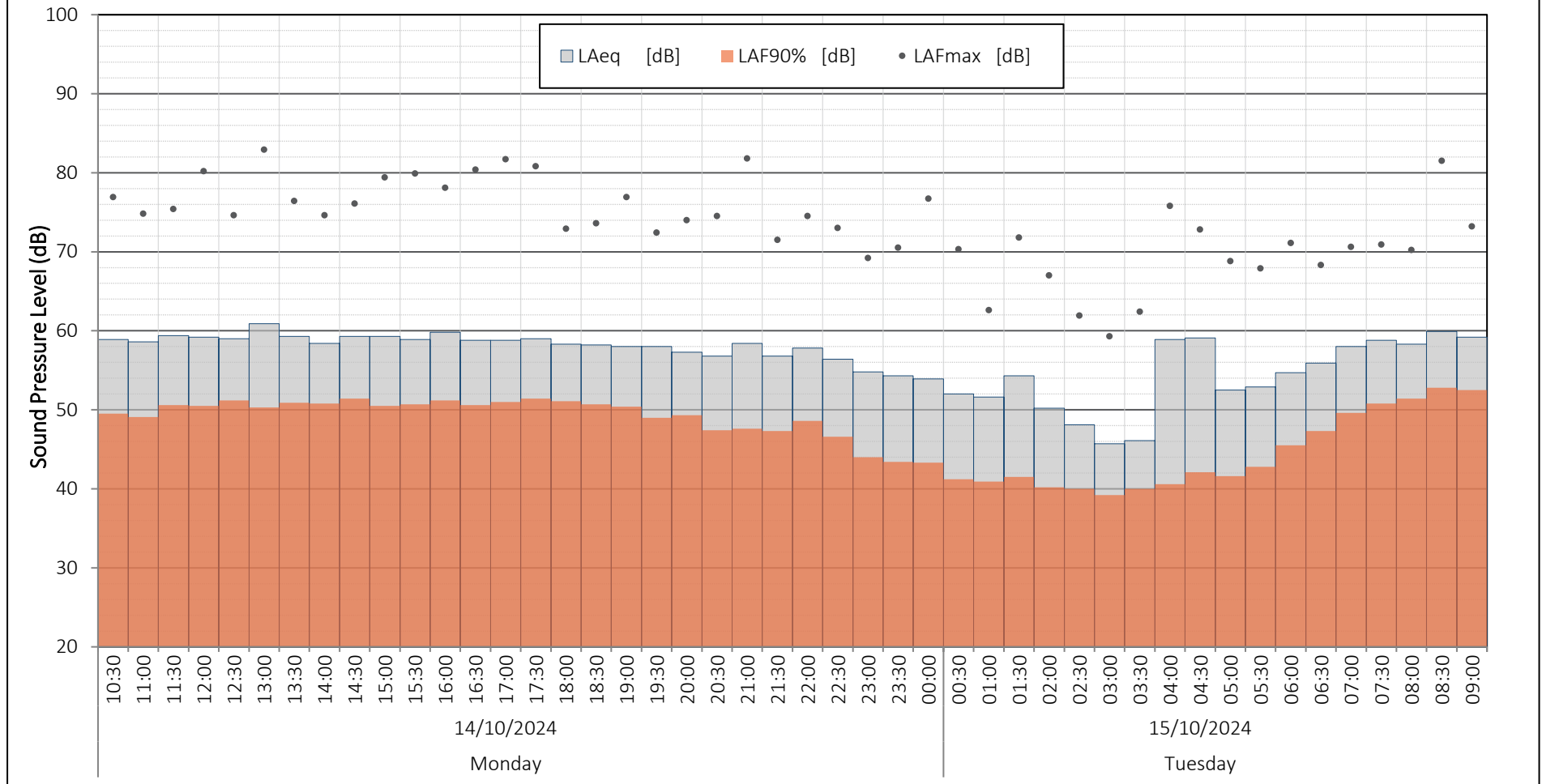
### U2 - Time History



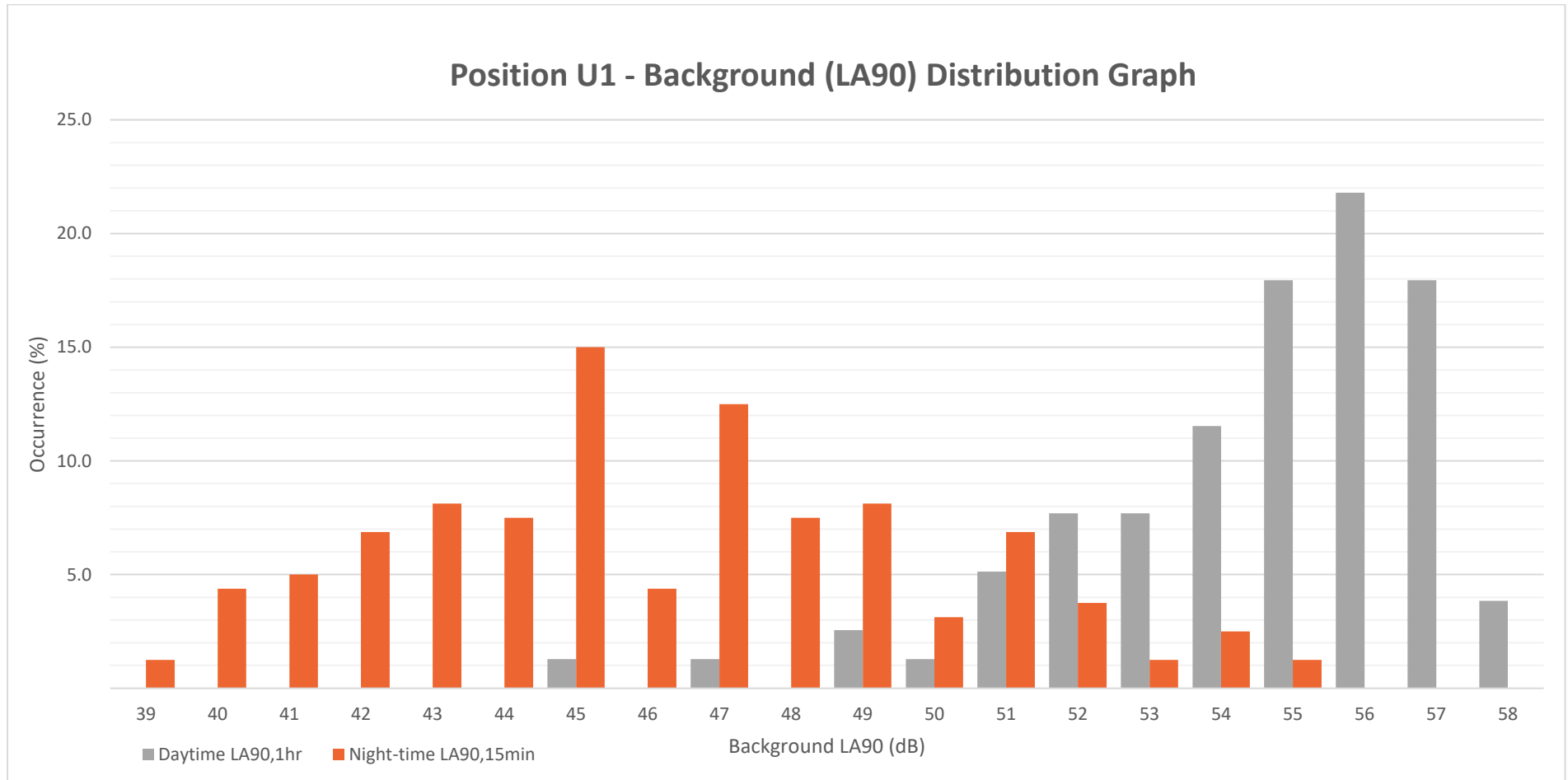
### U3 - Time History



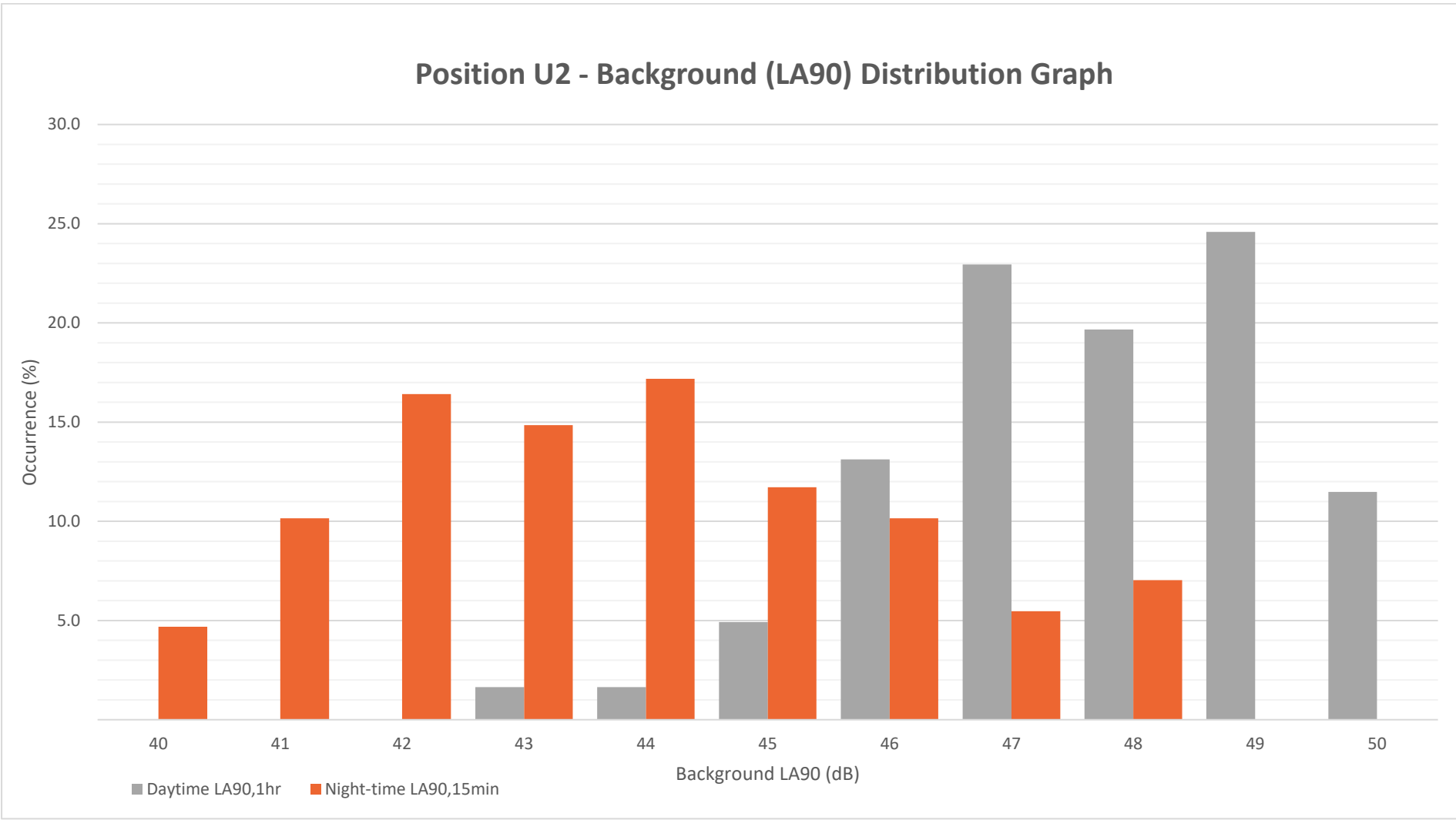
### U4 - Time History



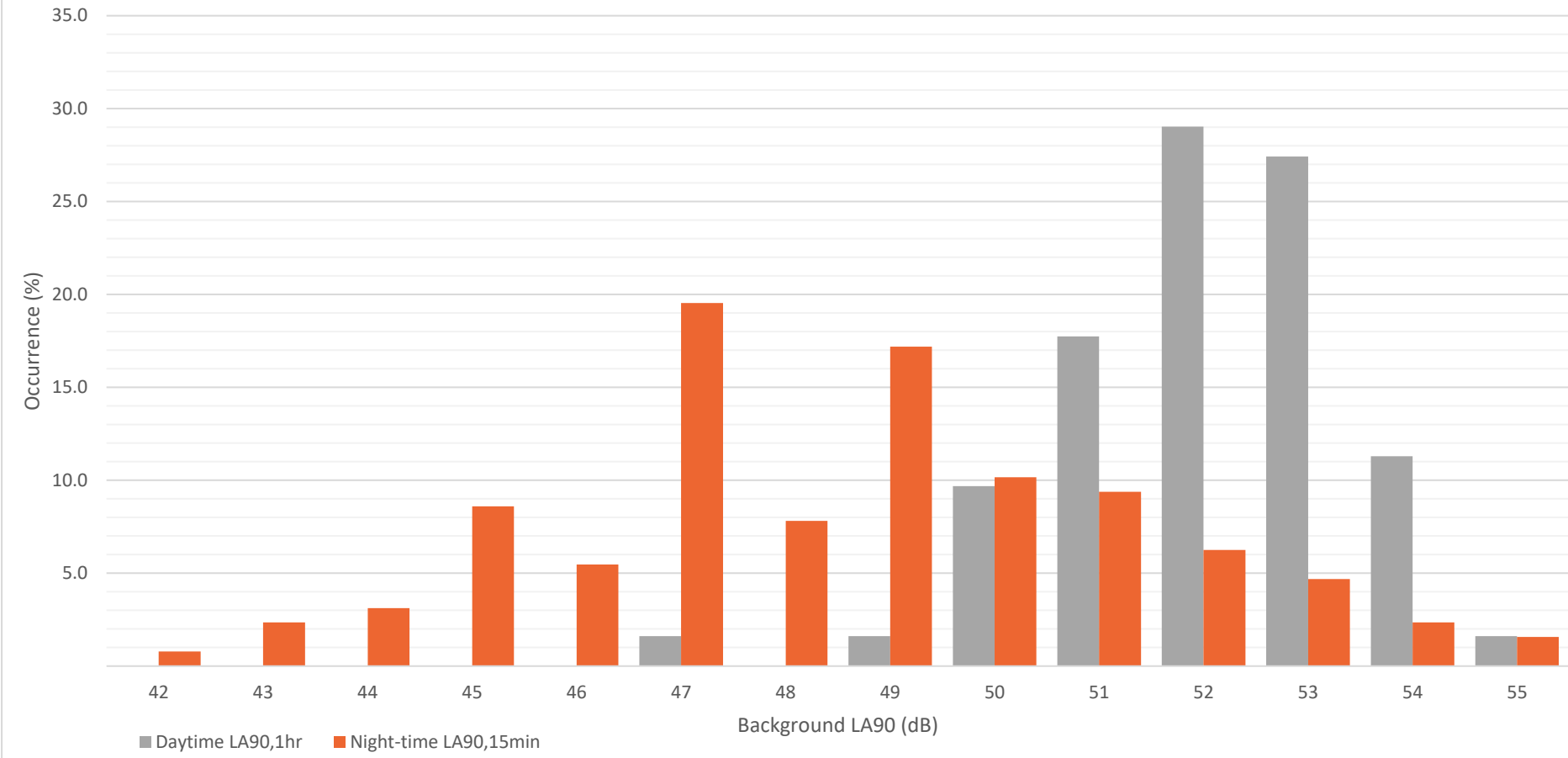
## Appendix E Background LA90 Distribution Graphs



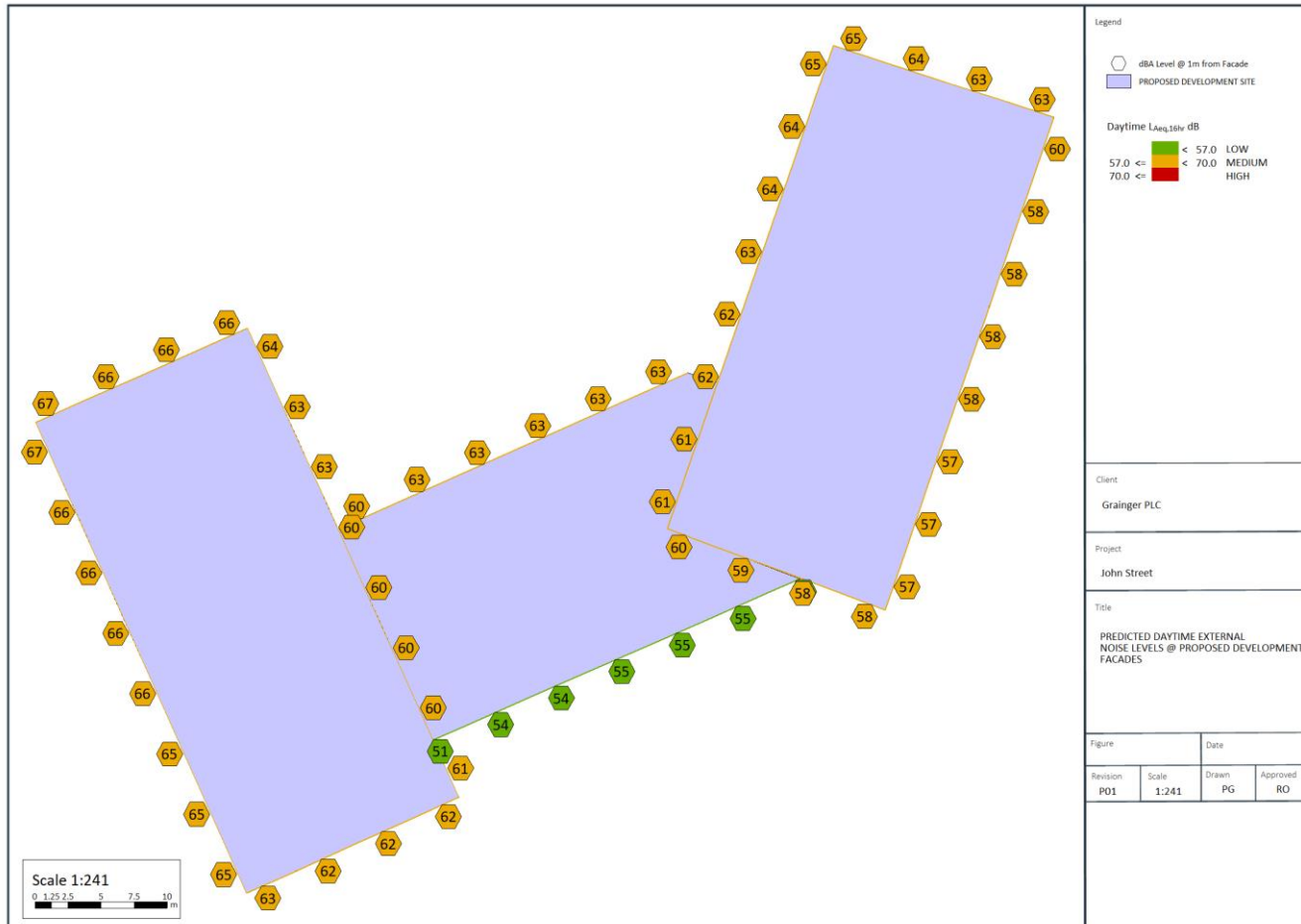
### Position U2 - Background (LA90) Distribution Graph

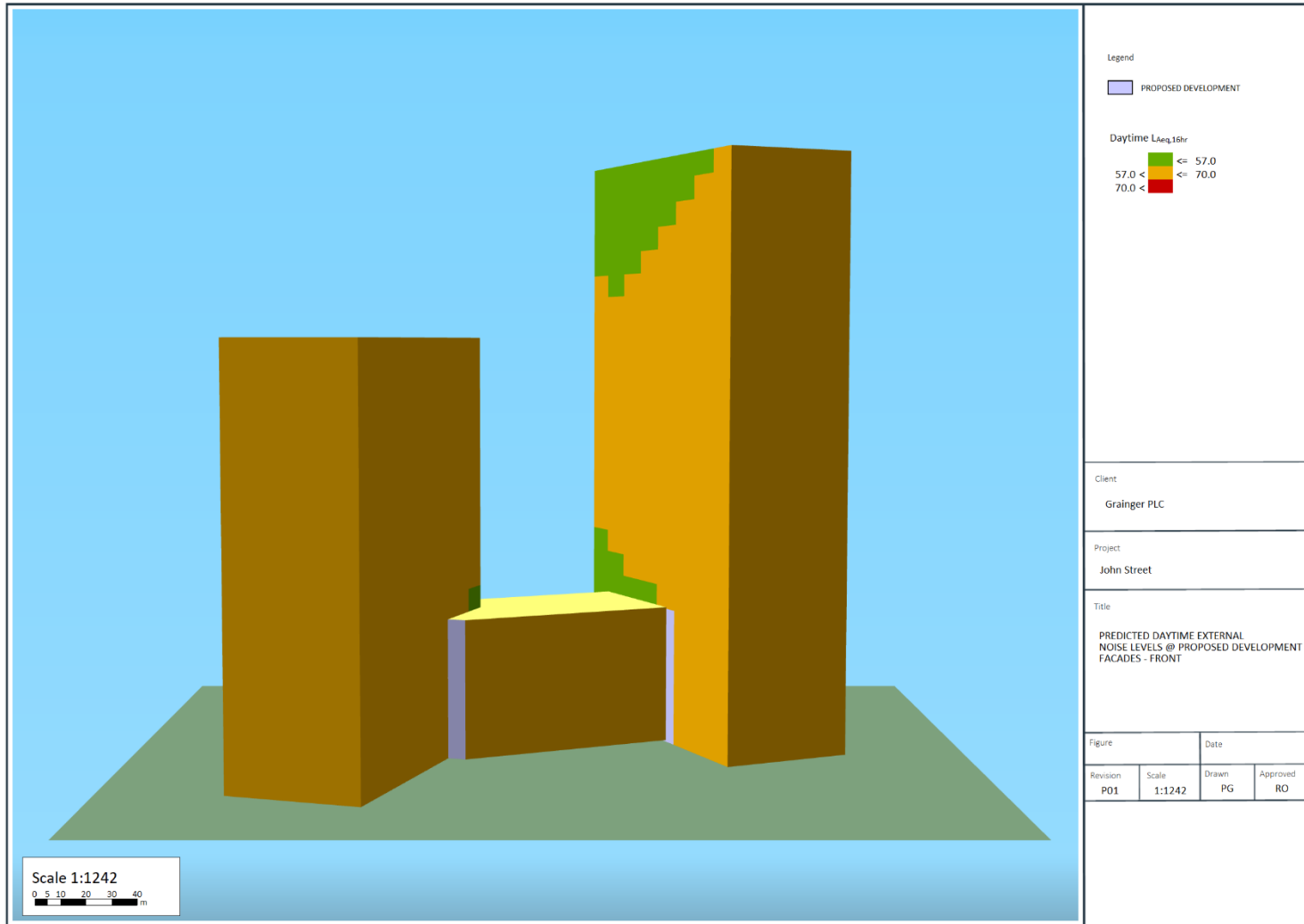


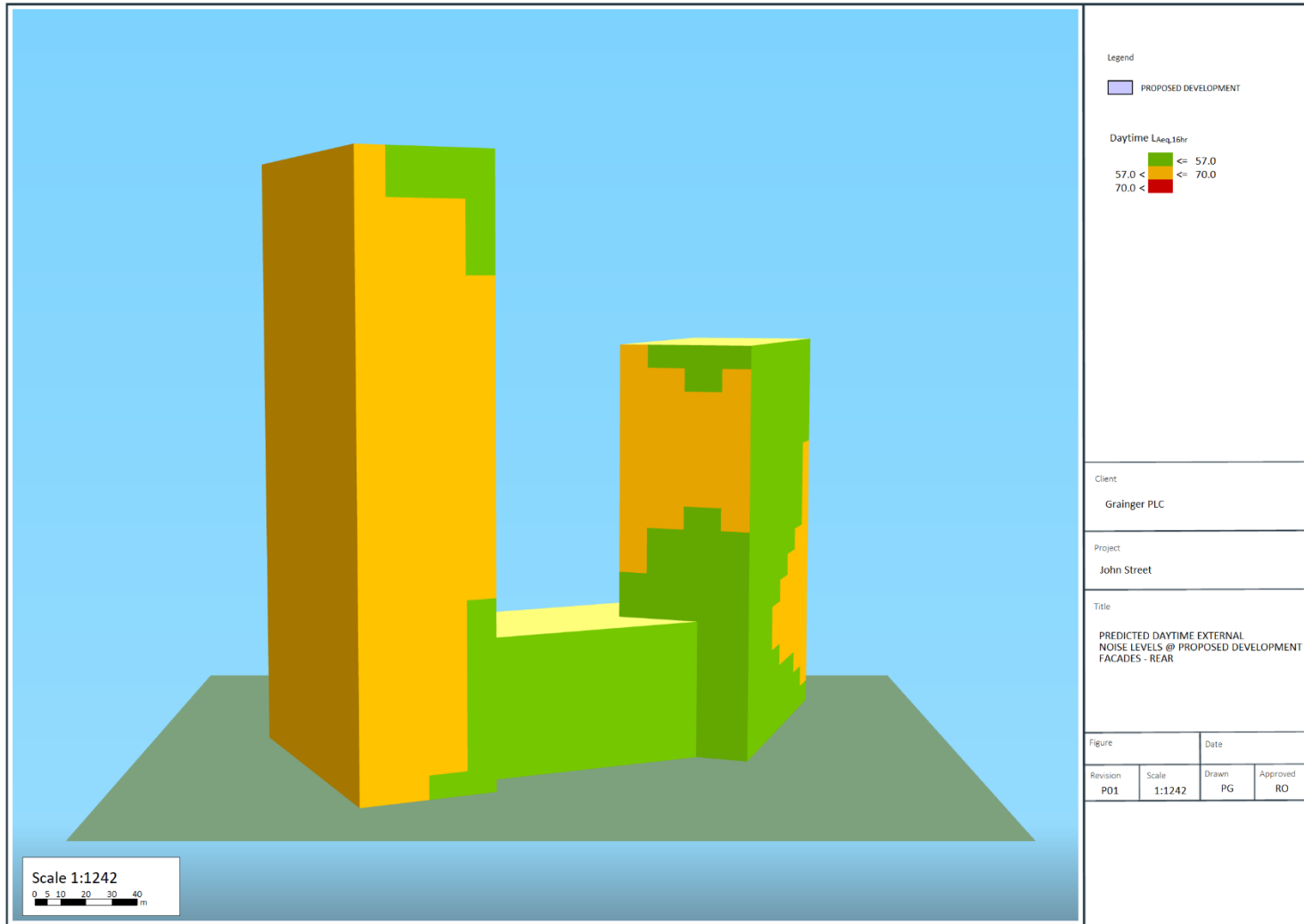
### Position U3 - Background (LA90) Distribution Graph

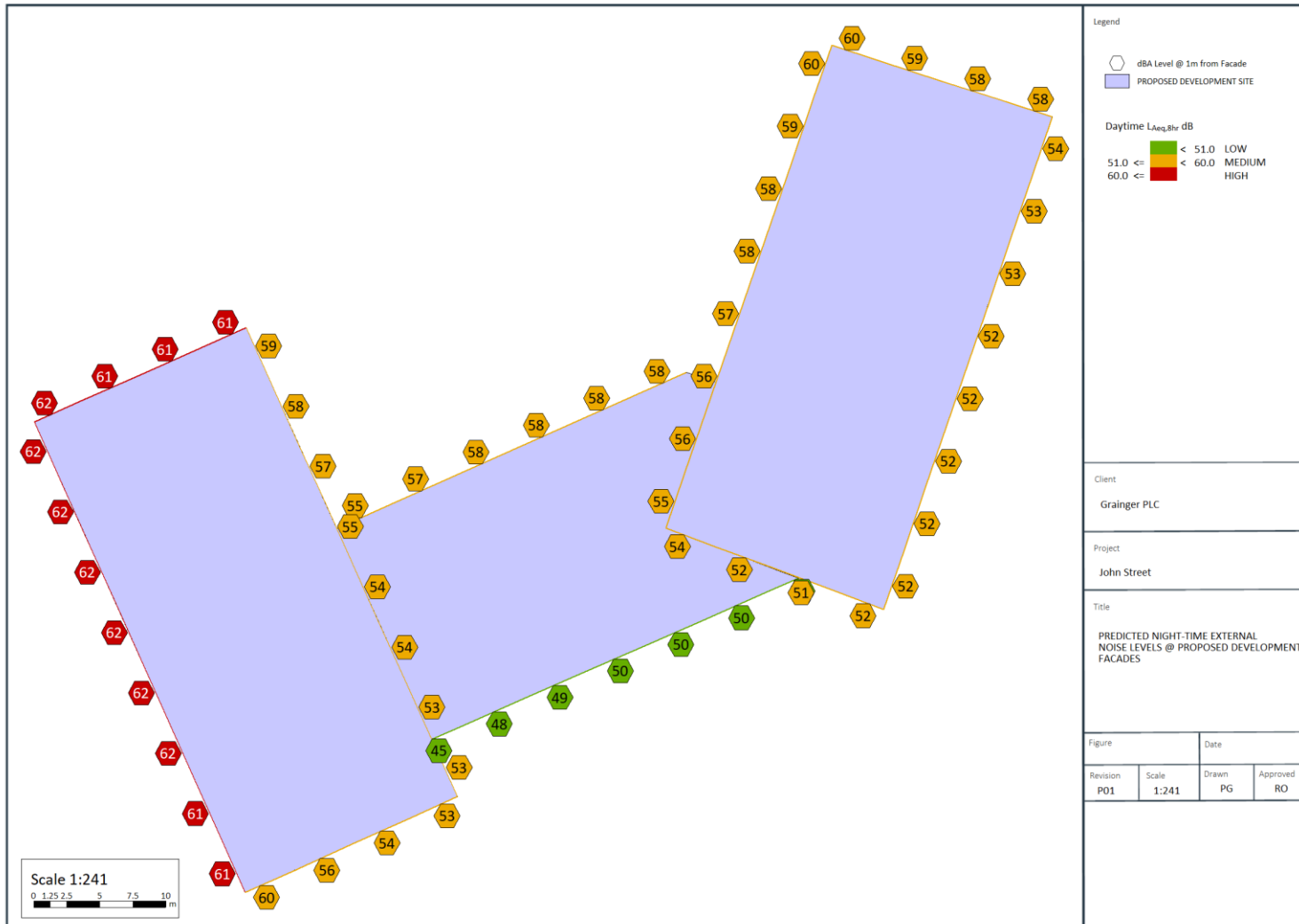


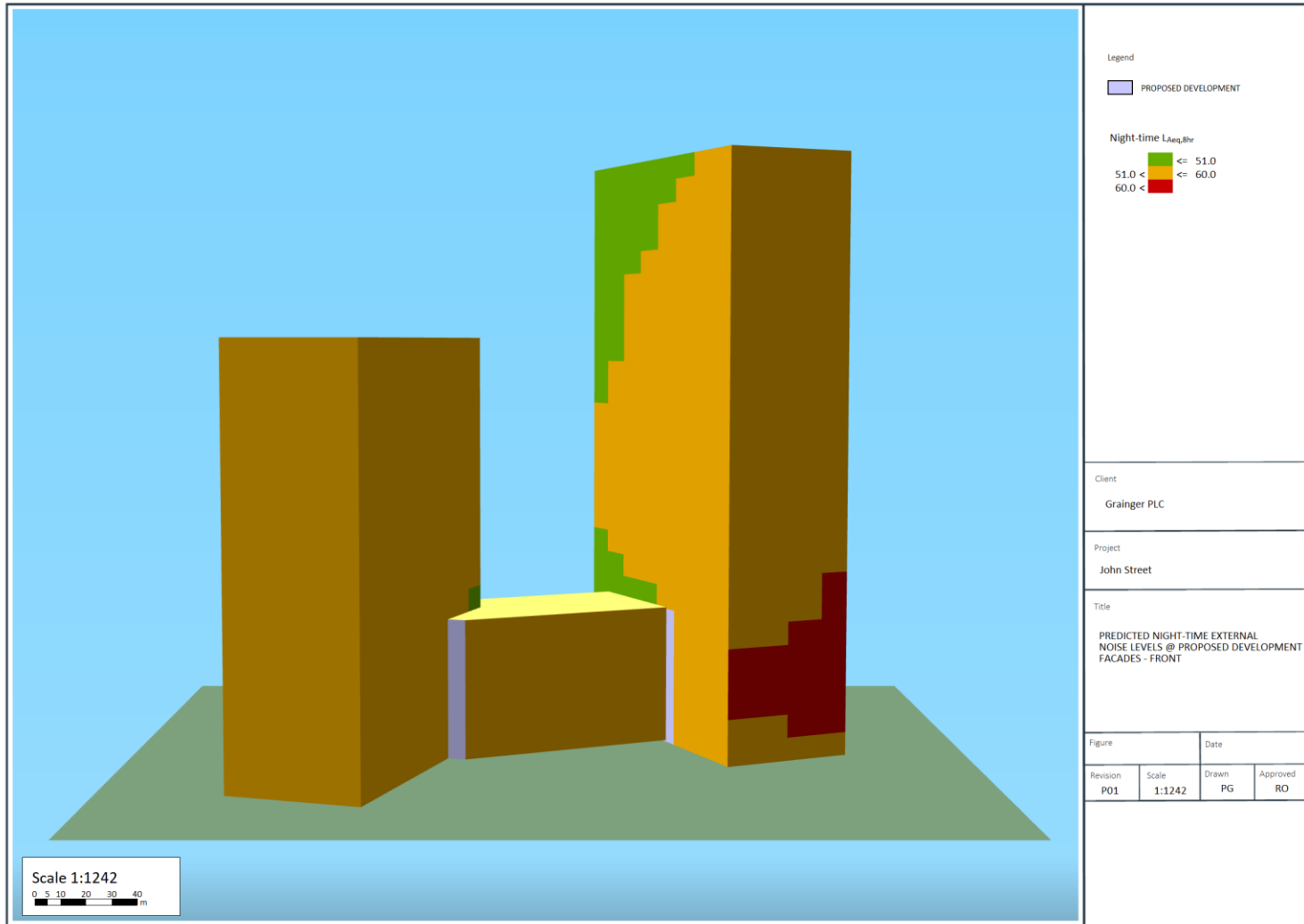
# Appendix F SoundPlan 9.1 Noise Model Figures

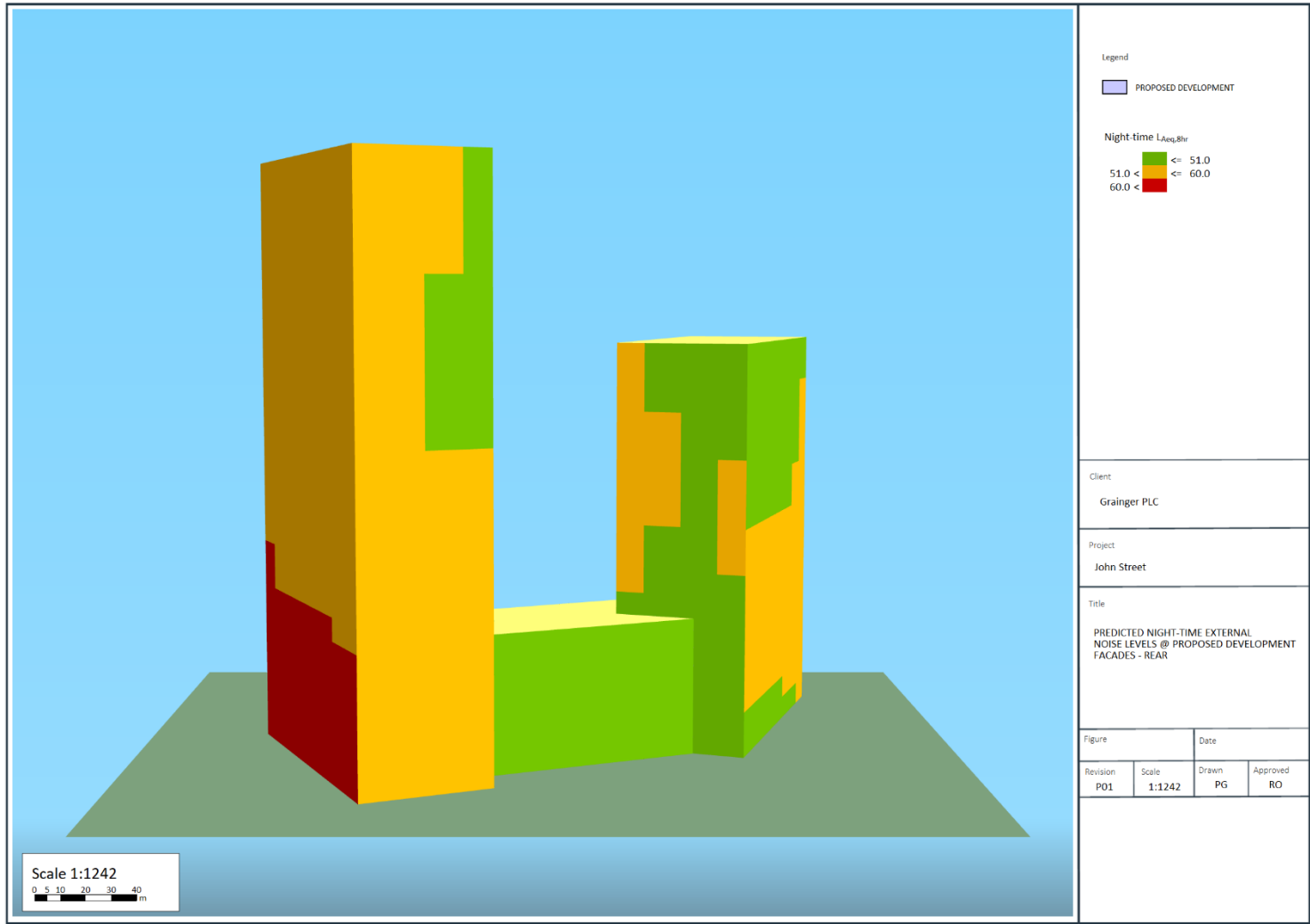












**With every community, we redefine what's possible.**



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