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ST LAURENCE'S PARK, STILLORGAN, DUBLIN

ACOUSTIC REPORT

Technical Report Prepared For

ABK Architects

Technical Report Prepared By

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Our Reference

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EXECUTIVE SUMMARY

AWN Consulting has been commissioned to carry out a study in relation to the potential noise impacts for the proposed mixed use development at St Laurence Park, Stillorgan. The proposed development comprises two blocks of apartments and a library. It is located adjacent to the N11 in Dublin.

A baseline noise survey has been undertaken at the development site and a noise model has been produced to determine the existing environment at the site.

A noise assessment has been undertaken based on the results of the noise model as recommended in the *ProPG: Planning & Noise* guidance document. The assessment concludes that all residents will enjoy a 'Good' internal noise environment when the appropriate enhanced acoustic glazing and mechanical ventilation is employed.

Balconies that have an aspect facing over the N11 will require winter gardens to meet the recommended external noise criteria, however all residents will be able to access an external area to the immediate west of the site that is screened from the N11 and is predicted to achieve the external noise levels recommended in the ProPG document.

Additionally, an inward noise assessment has been conducted for the Library building and a suitable glazing specification has been provided so that the recommended internal noise levels may be achieved.

Outward noise assessments have been undertaken for both vehicular noise and plant noise emissions related to the development. The additional vehicular traffic has been assessed as having impacts ranging from none to negligible.

In terms of plant noise, suitable noise thresholds have been assessed from the measured and calculated prevalent noise levels. During detailed design stage plant and noise mitigation options should be selected so that the noise emissions at local sensitive receptors do not exceed the assessed thresholds.

Construction noise thresholds have been assessed and predictions have been undertaken. The predictions indicate that construction activities can operate within the designated thresholds and that consequently a significant effect is not expected to occur at the local sensitive receptors.

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1.0 INTRODUCTION

AWN Consulting has been commissioned to carry out a study in relation to the potential noise impacts incident to the proposed mixed use development at St Laurence's Park, Stillorgan, Co. Dublin. The development comprises two blocks of apartments and a public library.

Included within this report is an assessment of the impact of inward noise across the development site as per the guidance provided in the *ProPG: Planning & Noise* document. Furthermore, the report assesses the outward noise impact of the construction and operational phases of the development.

The development site is located adjacent to the N11, within land designated for residential use by Dún Laoghaire Rathdown Council. To the west of the site lies a leisure complex, however the land is currently permitted for the development of an apartment block. To the north of the site the area is residential in nature, primarily comprised of two storey terraced houses.

Figure 1 presents the approximate outline of the proposed development site and the surrounding area. Figure 2 presents the First Floor Plan of the proposed development.

Figure 1 Location of proposed development

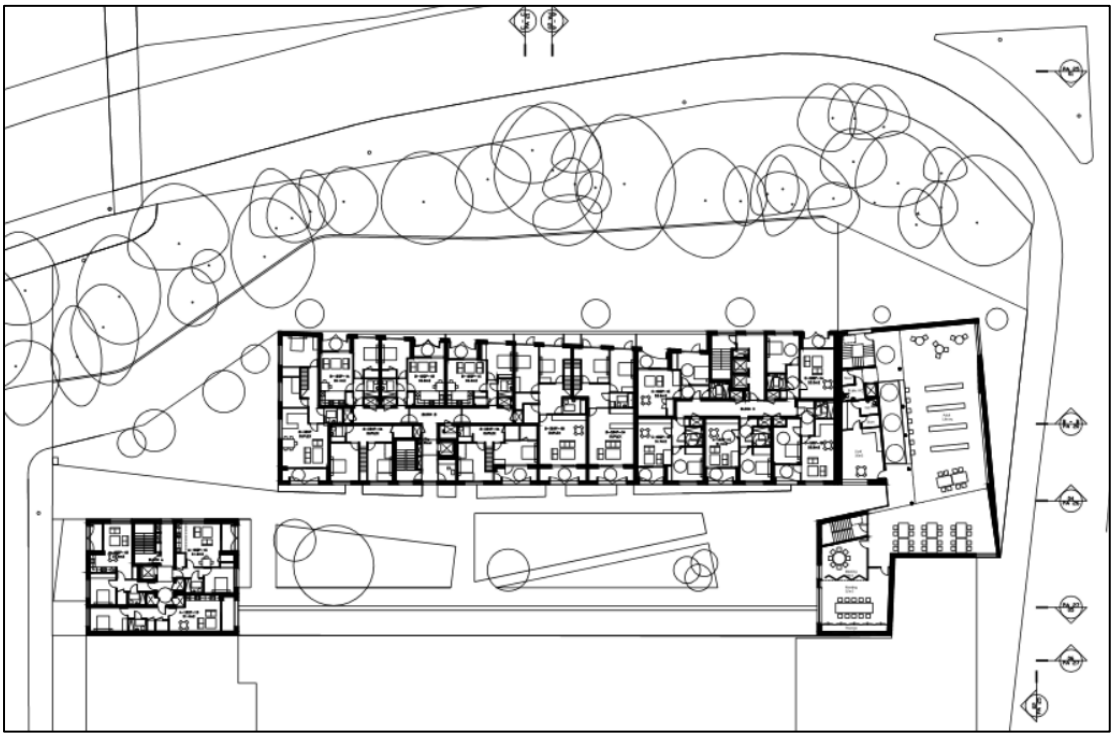

Figure 2 First Floor Plan of Proposed Development

Appendix A presents a glossary of acoustic terminology that is used throughout this report.

In the first instance it is considered appropriate to review relevant noise and vibration criteria being adopted for the assessment and to present a discussion of the site in the context of the existing noise and vibration environment.

2.0 DESIGN CRITERIA

2.1 Inward Noise Assessment

2.1.1 Draft Dún Laoghaire Rathdown Noise Action Plan (NAP)

The Draft Dún Laoghaire Rathdown Noise Action Plan (NAP) 2018 – 2023 was published for review in March 2018. The NAP indicates that guidance within the *ProPG Planning and Noise: Professional Practice Guidance on Planning and Noise* document should be referred to:

> *"In the scenario where new residential development or other noise sensitive development is proposed in an area with an existing climate of environmental noise, there is currently no clear national guidance on appropriate noise exposure levels. The EPA has suggested that in the interim that Action Planning Authorities should examine the planning policy guidance notes issued in England titled, 'ProPG Planning and Noise: Professional Practice Guidance on Planning and Noise'. This has been produced to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England."*

In accordance with this NAP policy, the following Acoustic Report has been prepared to comply with the requirements of this policy.

2.1.2 ProPG: Planning & Noise

The *Professional Guidance on Planning & Noise* (ProPG) document was published in May 2017. The document was prepared by a working group comprising members of the Association of Noise Consultants (ANC), the Institute of Acoustics (IOA) and the Chartered Institute of Environmental Health (CIEH). Although not a government document, since it's adoption it has been generally considered as a best practice guidance.

The ProPG outlines a systematic risk based 2 stage approach for evaluating noise exposure on prospective sites for residential development. The two primary stages of the approach can be summarised as follows:

- Stage 1 - Comprises a high level initial noise risk assessment of the proposed site considering either measured and or predicted noise levels; and,
- Stage 2 – Involves a full detailed appraisal of the proposed development covering four "key elements" that include:
    - Element 1 - Good Acoustic Design Process;
    - Element 2 - Noise Level Guidelines;
    - Element 3 - External Amenity Area Noise Assessment
    - Element 4 - Other Relevant Issues

A key component of the evaluation process is the preparation and delivery of an Acoustic Design Statement (ADS) which is intended for submission to the planning authority. This document is intended to clearly outline the methodology and findings of the Stage 1 and Stage 2 assessments, so as the planning authority can make an informed decision on the permission. ProPG outlines the following possible recommendations in relation to the findings of the ADS:

A. Planning consent may be granted without any need for noise conditions;
B. Planning consent may be granted subject to the inclusion of suitable noise conditions;
C. Planning consent should be refused on noise grounds in order to avoid significant adverse effects ("avoid"); or,
D. Planning consent should be refused on noise grounds in order to prevent unacceptable adverse effects ("prevent").

Section 3.0 of the ProPG provides a more detailed guide on decision making to aid local authority planners on how to interpret the findings of an accompanying Acoustic Design Statement (ADS).

A summary of the ProPG approach is illustrated in Figure 3.

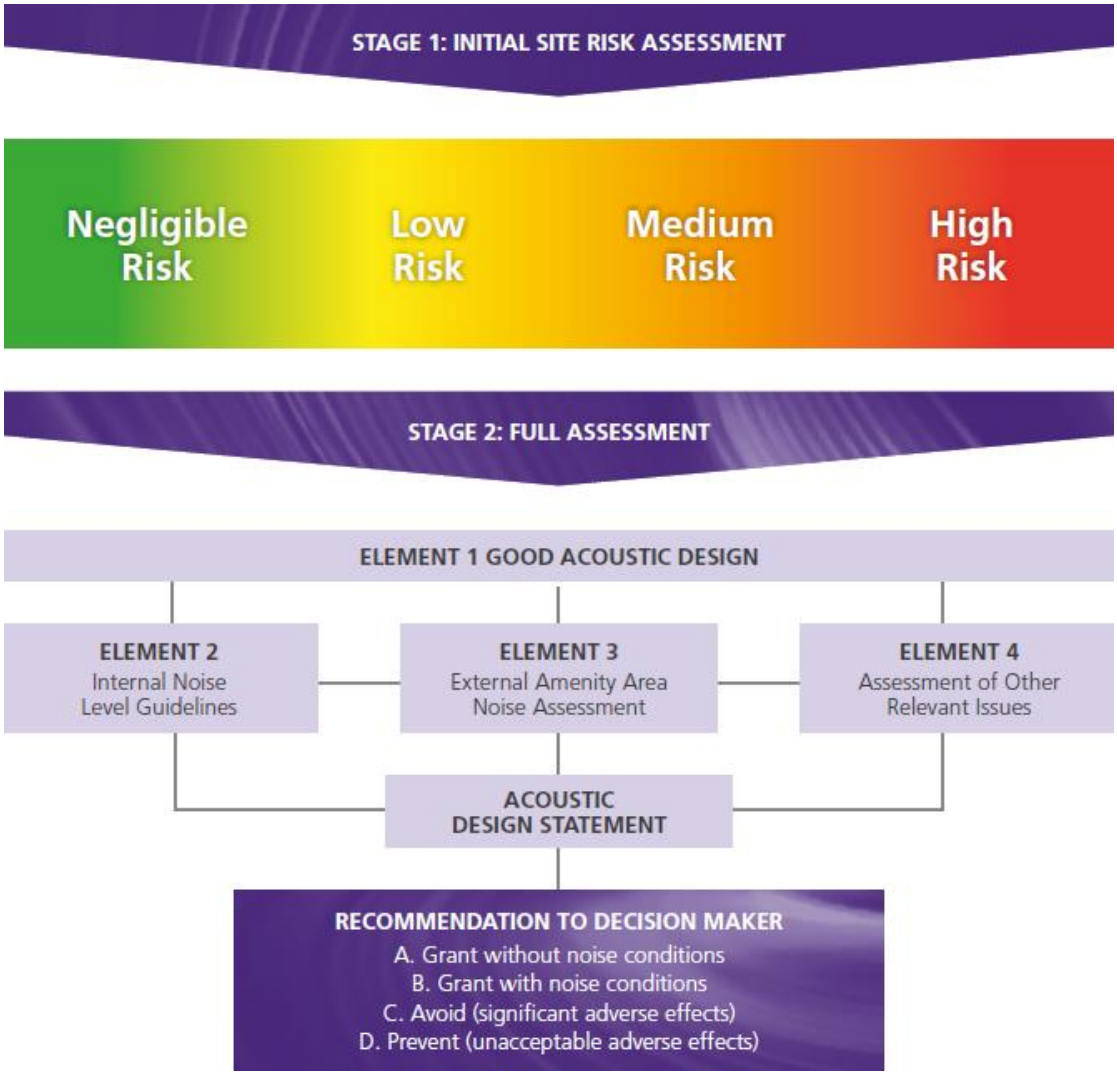

Figure 3 ProPG Approach (Source: ProPG)

2.1.2 BS 8233: Guidance on sound insulation and noise reduction for buildings

There are no statutory guidelines or specific local guidelines relating to appropriate internal noise levels within Libraries. In this instance, reference is made to BS 8233: 2014: *Guidance on sound insulation and noise reduction for buildings.*

BS 8233 sets out recommended internal noise levels for non-domestic buildings from external noise sources such as traffic. The guidance is primarily for use by designers

and hence BS 8233 may be used as the basis for an appropriate schedule of noise control measures. The recommended indoor ambient noise levels for Libraries are set out in Table 1.

Activity	Location	Design Range dB $L_{Aeq,T}$
Study and work requiring concentration	Library, gallery, museum	40 - 50

Table 1 Recommended Internal Noise Levels for Non-Domestic Buildings (ref BS8233)

2.2 Outward Noise Assessment – Construction Phase

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. In lieu of statutory guidance an assessment of significance has been undertaken as per BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Noise.

The approach adopted here calls for the designation of a noise sensitive location into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. This then sets a threshold noise value that, if exceeded at this location, indicates a significant noise impact is associated with the construction activities.

BS 5228-1:2009+A1:2014 sets out guidance on permissible noise levels relative to the existing noise environment. Table 2 sets out the values which, when exceeded, signify a potential significant effect at the facades of residential receptors.

Assessment Category and Threshold Value Period (L_{Aeq})	Threshold Value (dB)		
	Category A [A]	Category B [B]	Category C [C]
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
Evenings and weekends [D]	55	60	65
Night-time (23:00 to 07:00hrs)	45	50	55

Table 2 Example threshold of potential significant effect at dwellings

[A] Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.

[B] Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.

[C] Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.

[D] 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

For the appropriate assessment period (i.e. daytime in this instance) the ambient noise level is determined through a logarithmic averaging of the measurements for each location and then rounded to the nearest 5 dB. If the construction noise exceeds the appropriate category value, then a significant effect is deemed to occur.

In the case of this development the closest sensitive receptor locations have been assigned category B threshold values in-line with the baseline noise levels presented in Section 3.2. The category B threshold for daytime construction noise is 70 dB $L_{Aeq,T}$ (where T is the appropriate threshold value period presented in Table 2). If the construction noise exceeds this category value, then a significant effect is deemed to occur.

Comparison of the proposed plans with the surrounding area indicates that the closest area where significant works are to take place (e.g. the outline of Block A) is

approximately 25m from the nearest residential properties with the remainder of works taking place across the site at varying distances.

In order to assess a worst-case scenario to residential receptors, construction noise levels at distances of 25m have been used although a prediction to 10m distance is also provided as a reference. The calculations also assume that the equipment will operate for 66% of the 12-hour working day (i.e. 8 hours) and that a standard site hoarding, typically 2.4m height, will be erected around the perimeter of the construction site for the duration of works.

2.3 Outward Noise Assessment – Operational Phase

2.3.1 Vehicular Traffic

In order to assist with the interpretation of the noise associated with vehicular traffic on existing public roads, Table 3 offers guidance as to the likely impact associated with any particular change in traffic noise level due to the proposed development (Source DMRB, 2011).

Change in Sound Level (dB L_{A10})	Subjective Reaction	Magnitude of Impact
0	Inaudible	No Change
0.1 – 2.9	Barely Perceptible	Negligible
3 – 4.9	Perceptible	Minor
5 – 9.9	Up to a doubling of loudness	Moderate
10+	Doubling of loudness and above	Major

Table 3 Likely Impact Associated with Change in Traffic Noise Level

2.3.2 Plant Noise Emissions

British Standard 4142: 2014: *Methods for Rating and Assessing Industrial and Commercial Sound* is the industry standard method for analysing building services plant noise emissions to residential receptors.

BS 4142 describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

For an appropriate BS 4142 assessment it is necessary to compare the measured external background noise level (i.e. the $L_{A90,T}$ level measured in the absence of plant items) to the rating level ($L_{Ar,T}$) of the various plant items, when operational. Where noise emissions are found to be tonal, impulsive in nature or irregular enough to attract attention, BS 4142 also advises that a penalty be applied to the specific level to arrive at the rating level.

The subjective method for applying a penalty for tonal noise characteristics outlined in BS 4142 recommends the application of a 2 dB penalty for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible.

The following definitions as discussed in BS 4142 as summarised below:

"ambient noise level, $L_{Aeq,T}$" is the noise level produced by all sources including the sources of concern, i.e. the residual noise level plus the specific noise of

	mechanical plant, in terms of the equivalent continuous A-weighted sound pressure level over the reference time interval [T].
"residual noise level, $L_{Aeq,T}$"	is the noise level produced by all sources excluding the sources of concern, in terms of the equivalent continuous A-weighted sound pressure level over the reference time interval [T].
"specific noise level, $L_{Aeq,T}$"	is the sound level associated with the sources of concern, i.e. noise emissions solely from the mechanical plant, in terms of the equivalent continuous A-weighted sound pressure level over the reference time interval [T].
"rating level, $L_{Ar,T}$"	is the specific sound level plus any adjustments for the characteristic features of the sound (e.g. tonal, impulsive or irregular components);
"background noise level, $L_{A90,T}$"	is the sound pressure level of the residual noise that is exceeded for 90% of the time period T.

If the rated plant noise level is +10 dB or more above the pre-existing background noise level then this indicates that complaints are likely to occur and that there will be a significant adverse impact. 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.

Please refer to Section 7.0 of this document for details in relation to the recommended plant noise criteria for the development.

3.0 ProPG STAGE 1 – NOISE RISK ASSESSMENT

3.1 Methodology

The initial noise risk assessment is intended to provide an early indication of any acoustic issues that may be encountered. It calls for the categorisation of the site as a negligible, low, medium or high risk based on the pre-existing noise environment. Figure 44 presents the basis of the initial noise risk assessment, it provides appropriate risk categories for a range of continuous noise levels either measured and/or predicted on site.

It should be noted that a site should not be considered a negligible risk if more than 10 L_{AFmax} events exceed 60 dB during the night period and the site should be considered a high risk if the L_{AFmax} events exceed 80 dB more than 20 times a night.

Paragraph 2.9 of ProPG states that,

> *"The noise risk assessment may be based on measurements or prediction (or a combination of both) as appropriate and should aim to describe noise levels over a "typical worst case" 24 hour day either now or in the foreseeable future."*

In this instance a 3D computer noise model of the development site has been developed to predict the noise levels across the entire site in order to investigate the initial noise risk. The noise model will use the measured noise levels during the survey, discussed in Section 3.2, to validate the model. Furthermore, the model allows the site to be assessed taking into account the changes in topography that are required to allow development. This is to comply with the requirements of paragraph 2.8 of ProPG which states,

> *"The risk assessment should not include the impact of any new or additional mitigation measures that may subsequently be included in development proposals for the site and proposed as part of a subsequent planning application. In other words, the risk assessment should include the acoustic effect of any existing site features that will remain (e.g. retained buildings, changes in ground level) and exclude the acoustic effect of any site features that will not remain (e.g. buildings to be demolished, fences and barriers to be removed) if development proceeds."*

In this instance the existing low level walls and railings along the boundary of the site will remain.

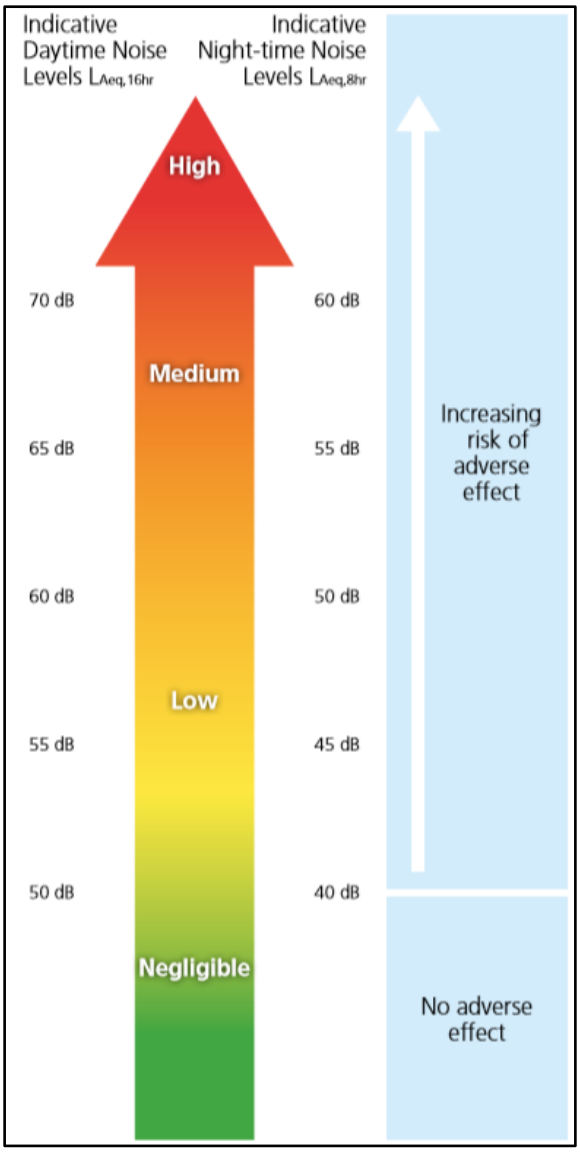

Figure 4 ProPG Stage 1 - Initial Noise Risk Assessment

3.2 Baseline Noise Survey

Environmental noise surveys have been conducted in order to quantify noise emissions across the existing site. The external survey was conducted in general accordance with ISO1996-2:2017 *Acoustics - Description, Measurement and Assessment of Environmental Noise -- Determination of Environmental Noise Levels*. Specific details are set out in the following sections.

3.2.1 Methodology

An unattended environmental noise survey was conducted at the site from the 2nd to the 9th October 2018 by AWN Consulting in order to quantify the existing noise environment. Additional attended 'spot' measurements were undertaken on the 15th of October. The approximate noise measurement locations were selected at the proposed site as shown in Figure 5.

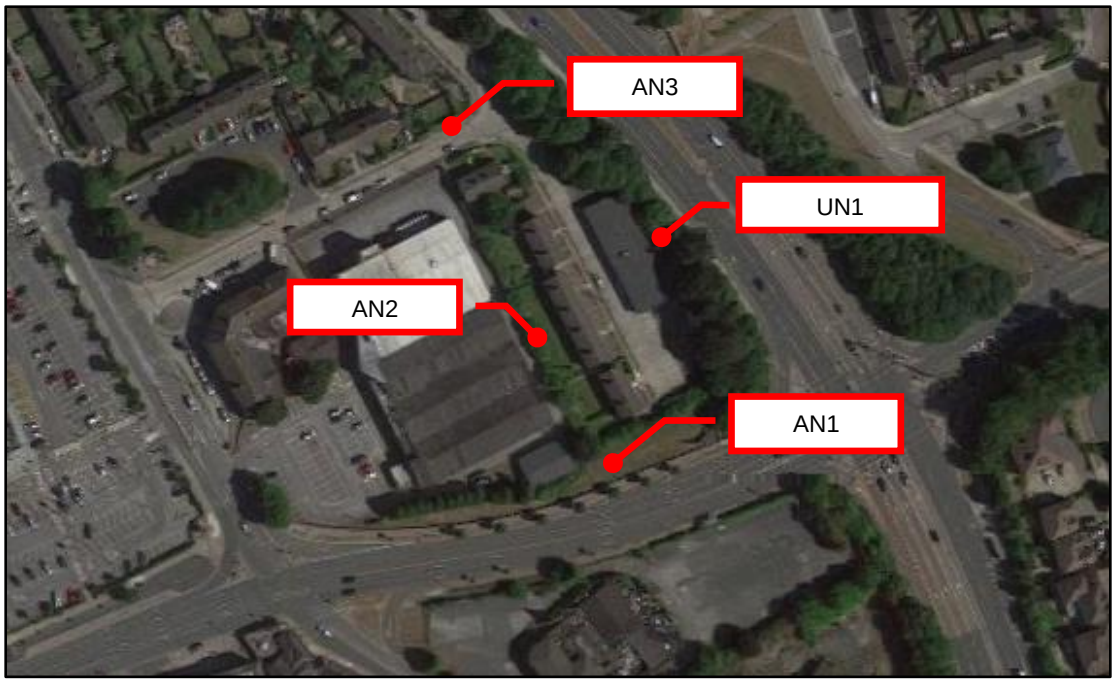

Figure 5 Noise Monitoring Locations

3.2.2 Measurement Parameters

The noise survey results are presented in terms of the following parameters:

L_{Aeq} is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period.

L_{AFMax} is the maximum sound pressure level recorded during the sample period.

L_{AFMin} is the minimum sound pressure level recorded during the sample period.

L_{A10} is the sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for traffic noise.

L_{A90} is the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.

The "A" suffix denotes the fact that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing. All sound levels in this report are expressed in terms of decibels (dB) relative to $2x10^{-5}$ Pa.

3.2.3 Survey Results

Table 4 presents a summary of noise levels measured during the unattended noise survey for both day and night-time periods from 2nd to 9th October 2018.

Date	Period	$L_{Aeq, T}$ dB	Octave Band Centre Frequency (Hz)					
			125	250	500	1k	2k	4k
02/10/18	DAY	71	63	64	65	69	63	53
	NIGHT	67	58	58	61	65	58	47
03/10/18	DAY	72	65	65	66	70	63	51
	NIGHT	67	57	58	61	65	58	46

Date	Period	$L_{Aeq, T}$ dB	Octave Band Centre Frequency (Hz)					
			125	250	500	1k	2k	4k
04/10/18	DAY	72	65	65	66	70	63	52
	NIGHT	68	57	59	62	66	61	54
05/10/18	DAY	72	64	65	66	70	64	52
	NIGHT	67	57	59	61	65	58	46
06/10/18	DAY	72	63	64	66	70	63	50
	NIGHT	68	58	59	61	66	60	47
07/10/18	DAY	71	63	63	65	69	62	51
	NIGHT	68	64	61	62	65	59	53
08/10/18	DAY	71	65	65	66	70	63	52
	NIGHT	66	58	59	61	65	58	47

Table 4 Summary of Unattended Measured Continuous Equivalent Noise Levels

Date	Period	$L_{Aeq, T}$ dB	L_{Amax} dB	L_{Amin} dB	$L_{A10, T}$ dB	$L_{A90, T}$ dB
02/10/18	DAY	71	100	48	76	56
	NIGHT	67	84	35	68	47
03/10/18	DAY	72	101	43	75	57
	NIGHT	67	87	28	69	43
04/10/18	DAY	72	100	42	75	57
	NIGHT	68	92	41	71	51
05/10/18	DAY	72	94	45	76	57
	NIGHT	67	84	37	71	49
06/10/18	DAY	72	96	46	76	57
	NIGHT	68	93	34	72	51
07/10/18	DAY	71	97	43	75	57
	NIGHT	68	90	47	69	56
08/10/18	DAY	71	97	45	75	59
	NIGHT	66	83	33	67	47

Table 5 Summary of Unattended Measured Noise Levels

L_{AFmax} values were measured at 15 minute intervals over the duration of the unattended monitoring survey. Figure 6 presents the number of measured L_{AFmax} events for various decibel levels during the night period.

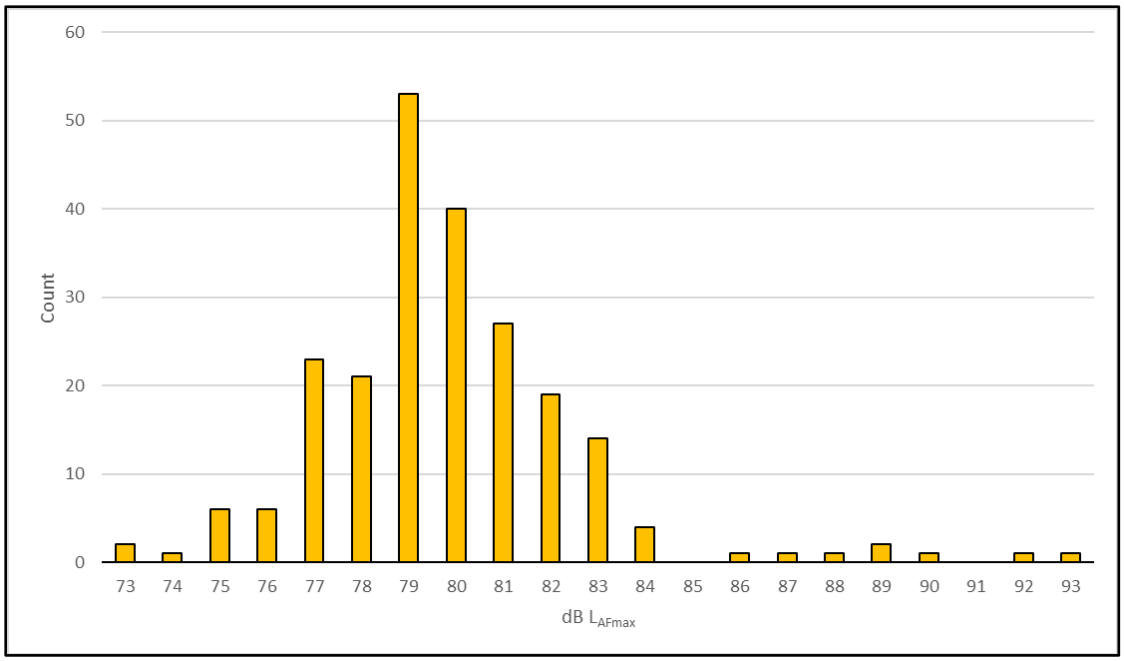

Figure 6 Distribution of the magnitude of L_{AFmax} events

As can be seen the L_{AFmax} values typically range from 77 to 83 dB during the night period.

In addition to the unattended monitor, various attended spot measurements were conducted around the site. The results of these measurements are presented in Table 6.

Location	Time	L_{Aeq} dB	L_{AFmax} dB	L_{AFmin} dB	L_{A10} dB	L_{A90} dB
AN1	11:44 – 12:01	63	76	50	67	54
	12:24 – 12:41	63	83	49	66	54
	13:00 – 13:15	62	70	50	66	55
AN2	11:36 – 12:36	52	70	41	55	47
	12:36 – 13:36	52	67	42	55	47
AN3	12:05 – 12:20	62	83	44	64	52
	12:42 – 12:57	60	73	43	63	51
	13:18 – 13:33	60	78	42	63	50

Table 6 Summary of Attended Measured Noise Levels

It was noted during the noise survey that the primary source of noise was due to traffic on the N11. Pedestrians and traffic on local roads also provided a contribution to the overall noise environment.

3.3 Noise Model of Site

3.3.1 Methodology

Proprietary noise calculation software was used for the purposes of establishing the prevailing noise levels on the proposed site. The selected software, Brüel & Kjær Type 7810 *Predictor*, calculates noise levels in accordance with the *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors*.

The following information was included in the model:

- Site layout drawings of the proposed development;
- OS mapping of the surrounding environment, and
- 3D topographical survey data for the development and adjacent road.

3.3.2 Model Validation

Noise levels recorded during the baseline noise survey were used to calibrate the noise model. It is considered that a strong correlation in respect of predicted noise levels has been achieved.

Noise levels are calculated over daytime periods, i.e. 07:00 to 23:00 hrs and night-time periods, 23:00 to 07:00 hrs. Table 7 details the results of the noise model predictions and compares them to the measured values at each survey location.

Location	Period	Measured (dB L_{Aeq})	Predicted (dB L_{Aeq})
AN1	Daytime	62 - 63	63
	Night-time	-	59
AN2	Daytime	52	52
	Night-time	-	48
AN3	Daytime	60 - 62	60
	Night-time	-	56
UN1	Daytime	71 - 72	72
	Night-time	66 - 68	68

Table 7 Noise Model Validation

3.3.5 Noise Model Output

To assess the initial noise risk assessment across the development site the noise model has been used to prepare noise contour maps for both daytime and night-time periods at heights representative of ground floor, first floor and second floor levels of the proposed development (1.5m, 4.5m, 7.5m, 10.5m, 13.5m and 16.5m above ground). These maps are presented in Figures 6 to 17.

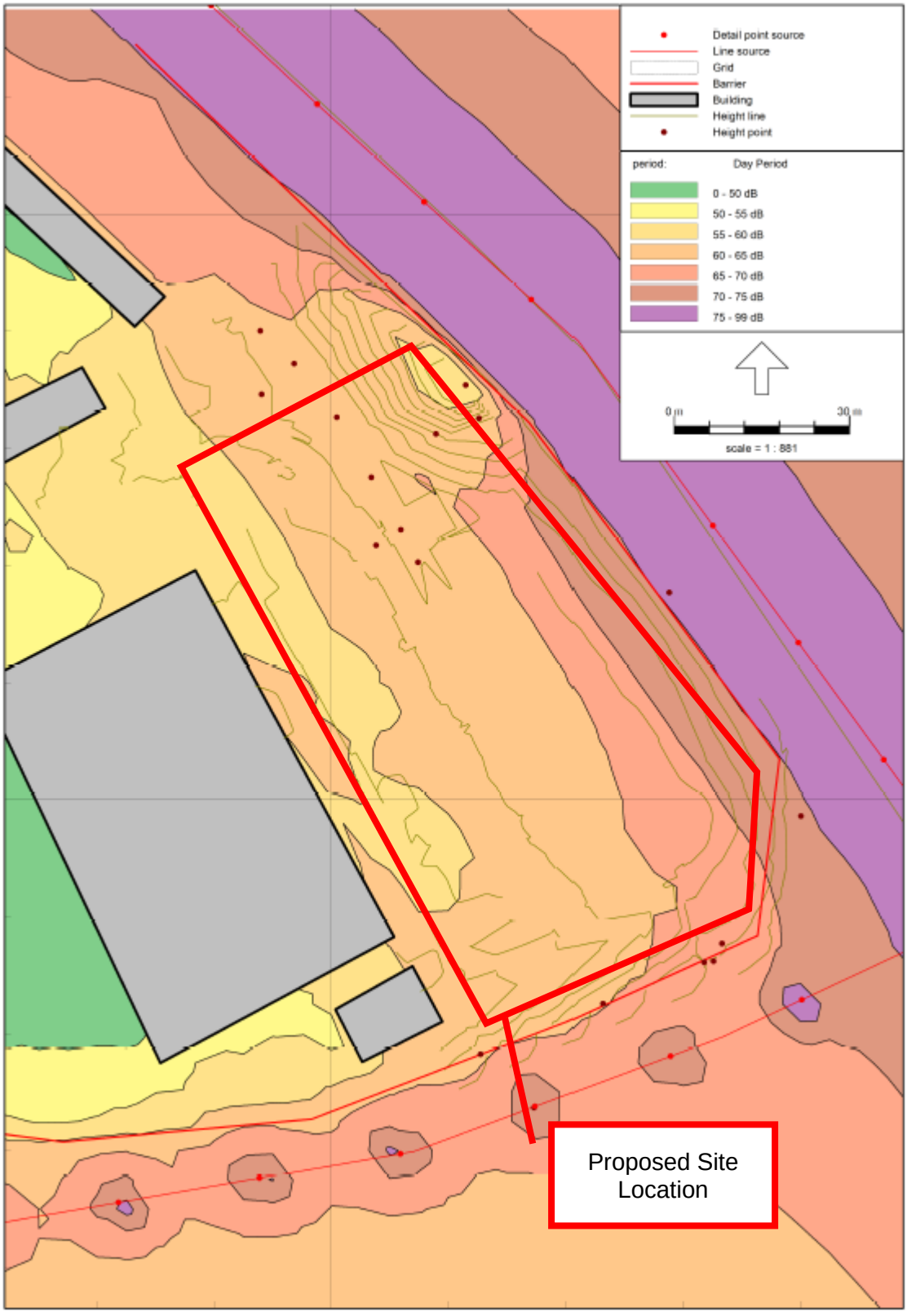

Figure 7 Daytime Noise Levels at 1.5m Above Ground

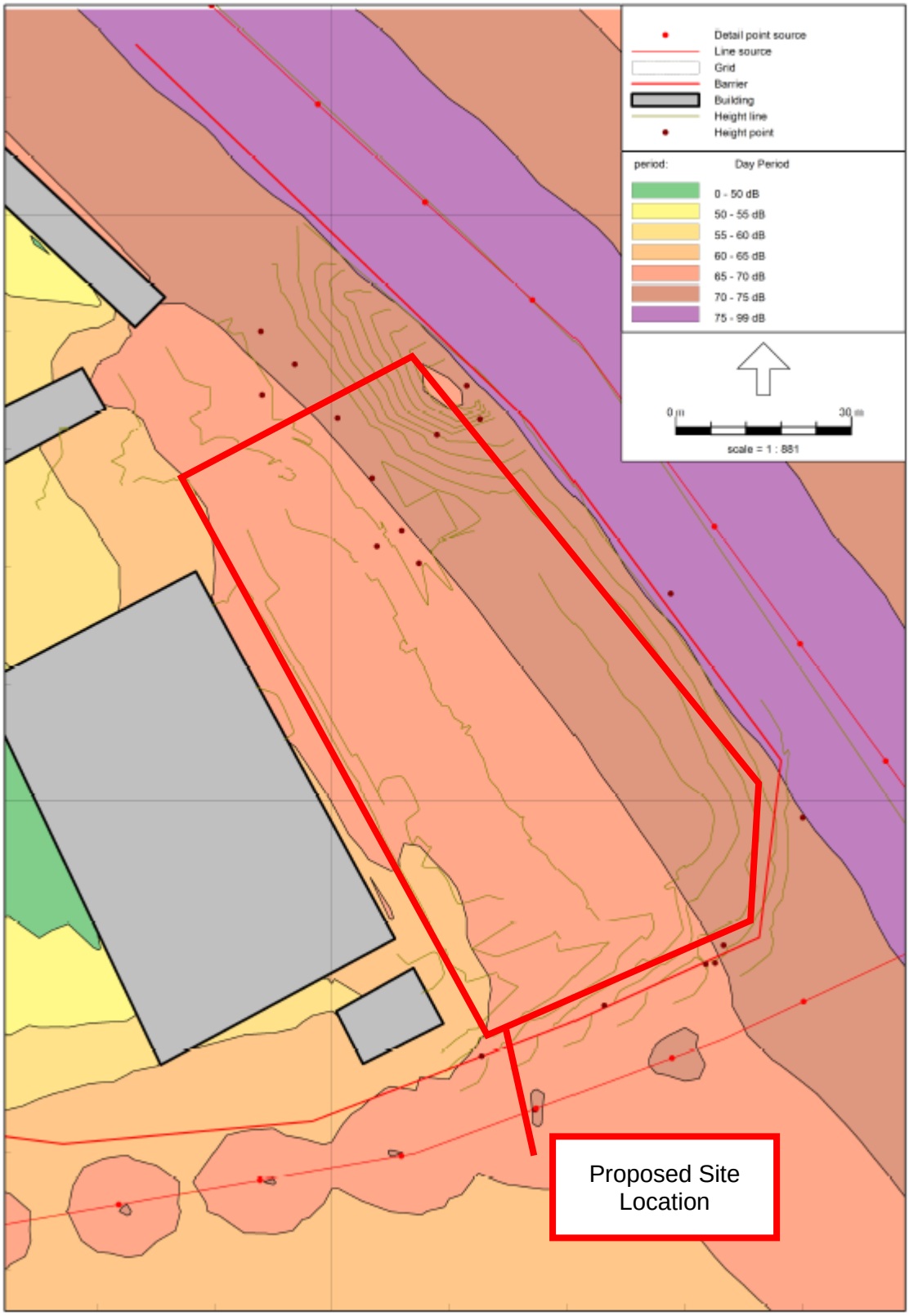

Figure 8 Daytime Noise Levels at 4.5m Above Ground

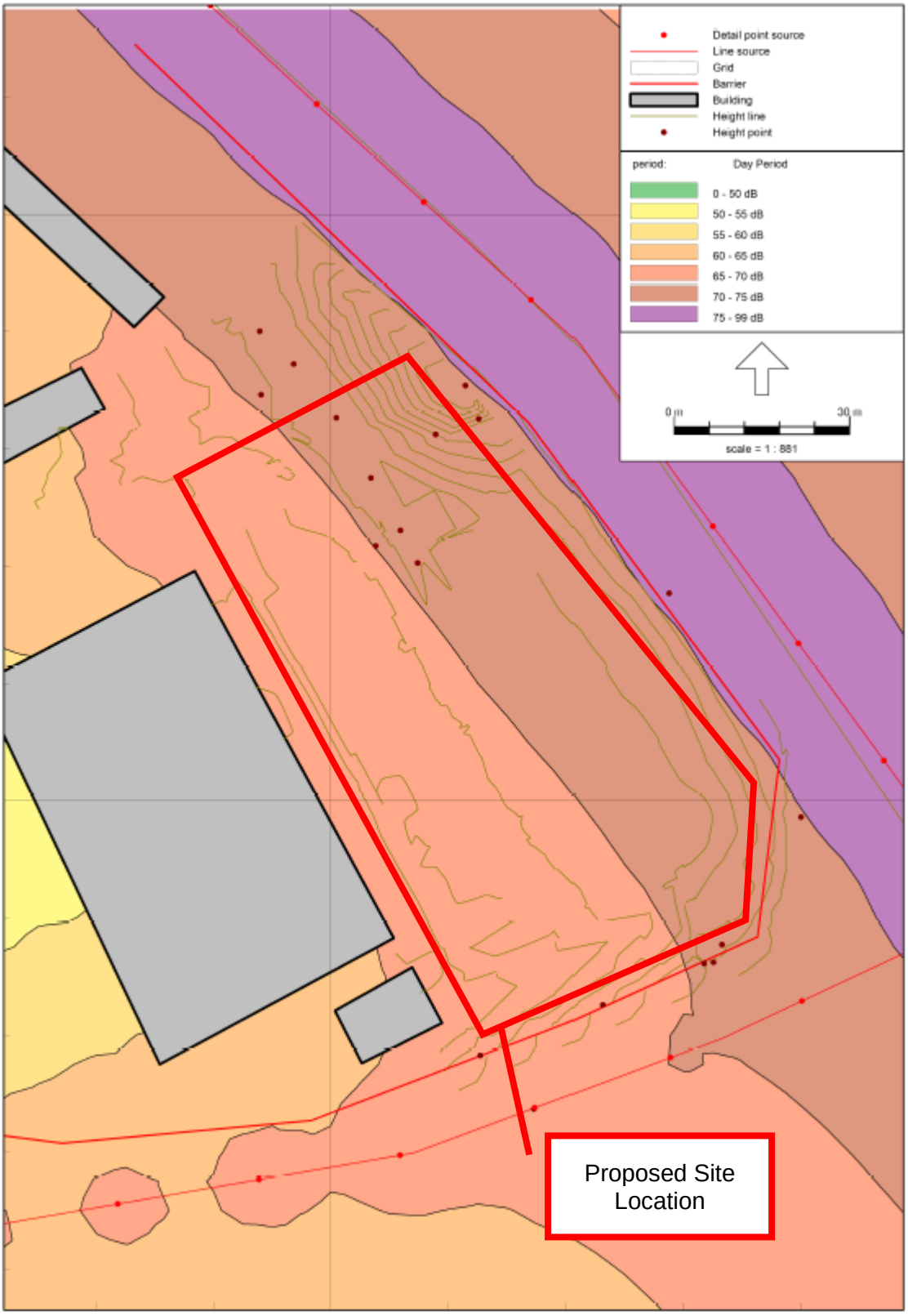

Figure 9 Daytime Noise Levels at 7.5m Above Ground

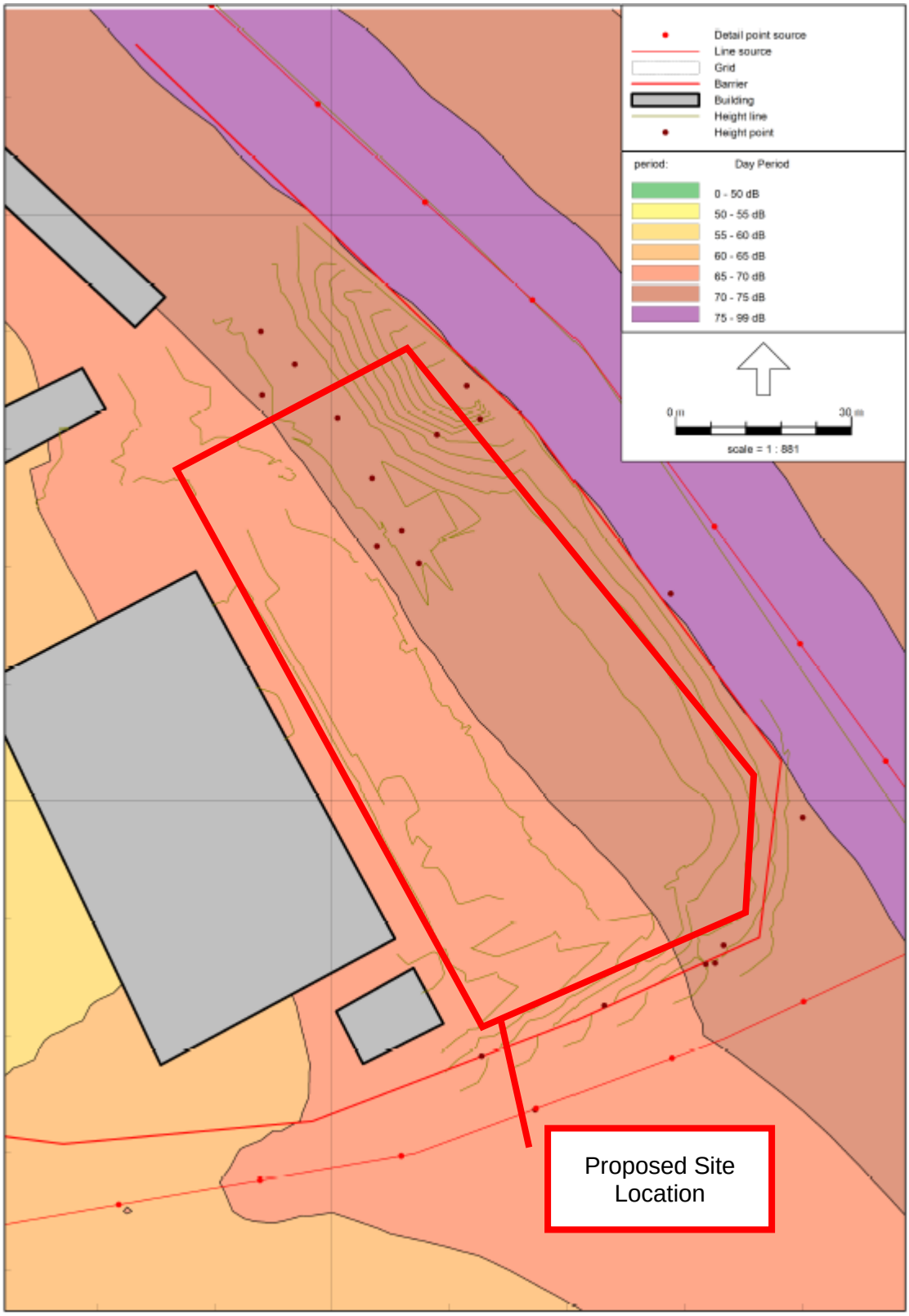

Figure 10 Daytime Noise Levels at 10.5m Above Ground

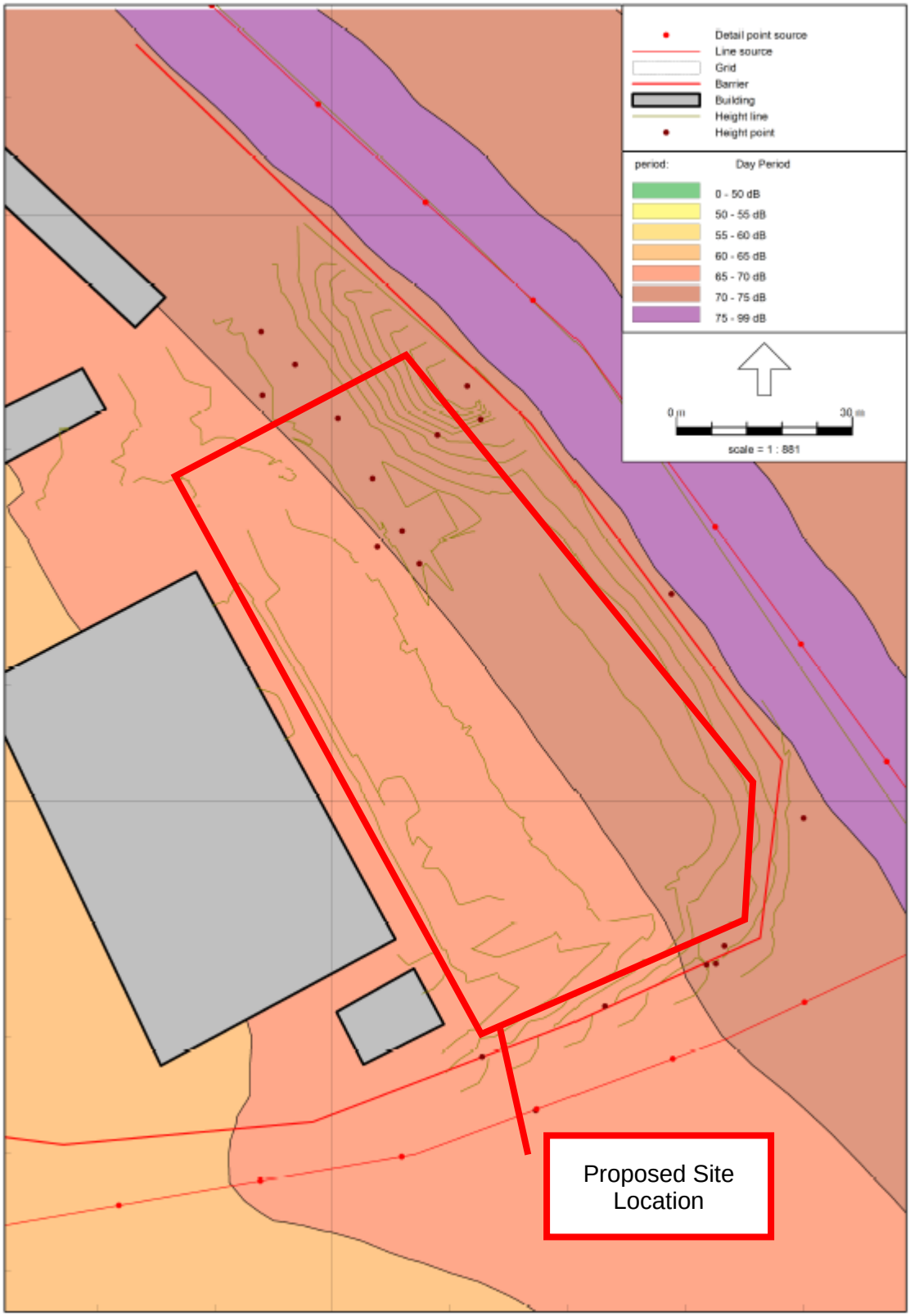

Figure 11 Daytime Noise Levels at 13.5m Above Ground

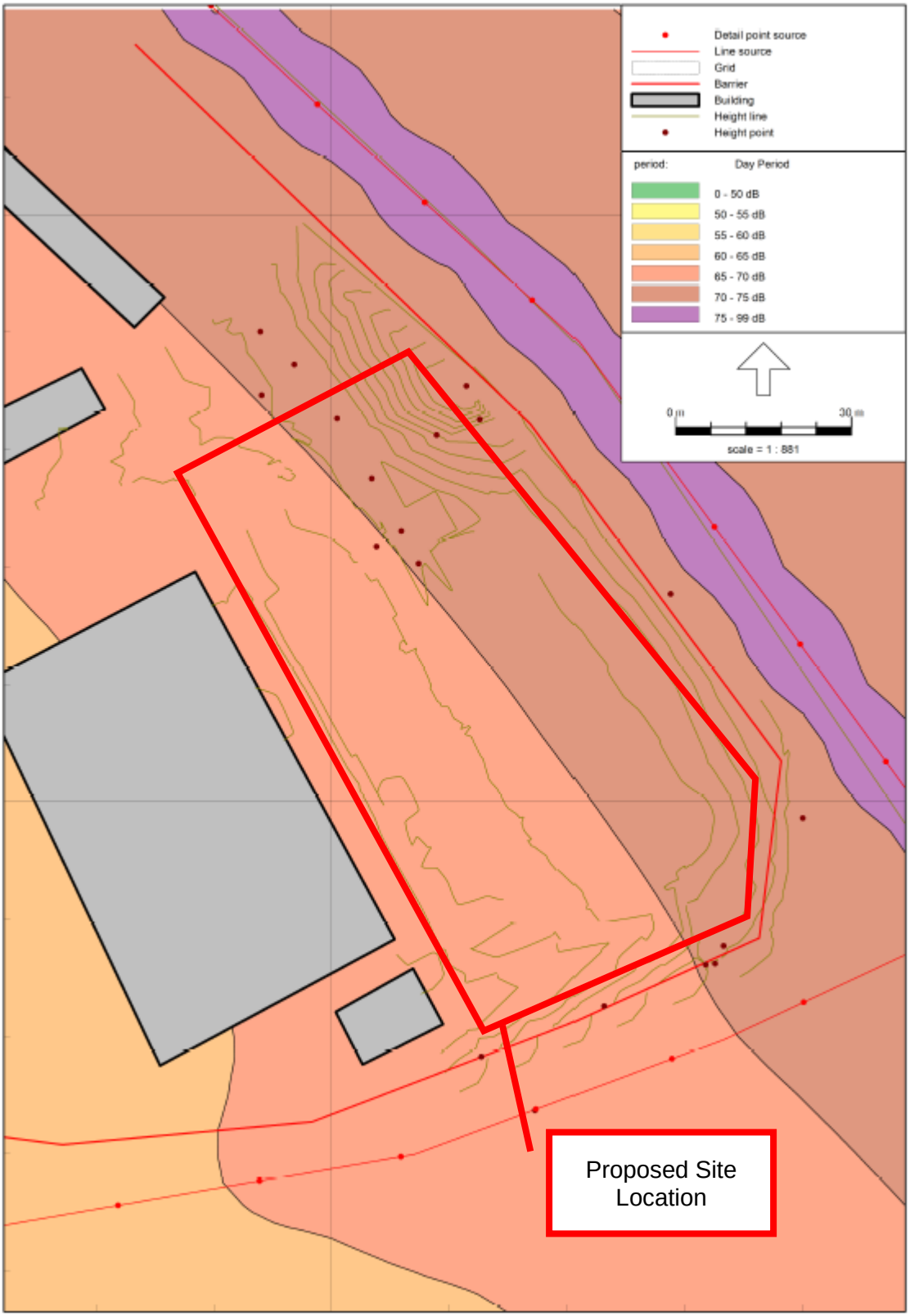

Figure 12 Daytime Noise Levels at 16.5m Above Ground

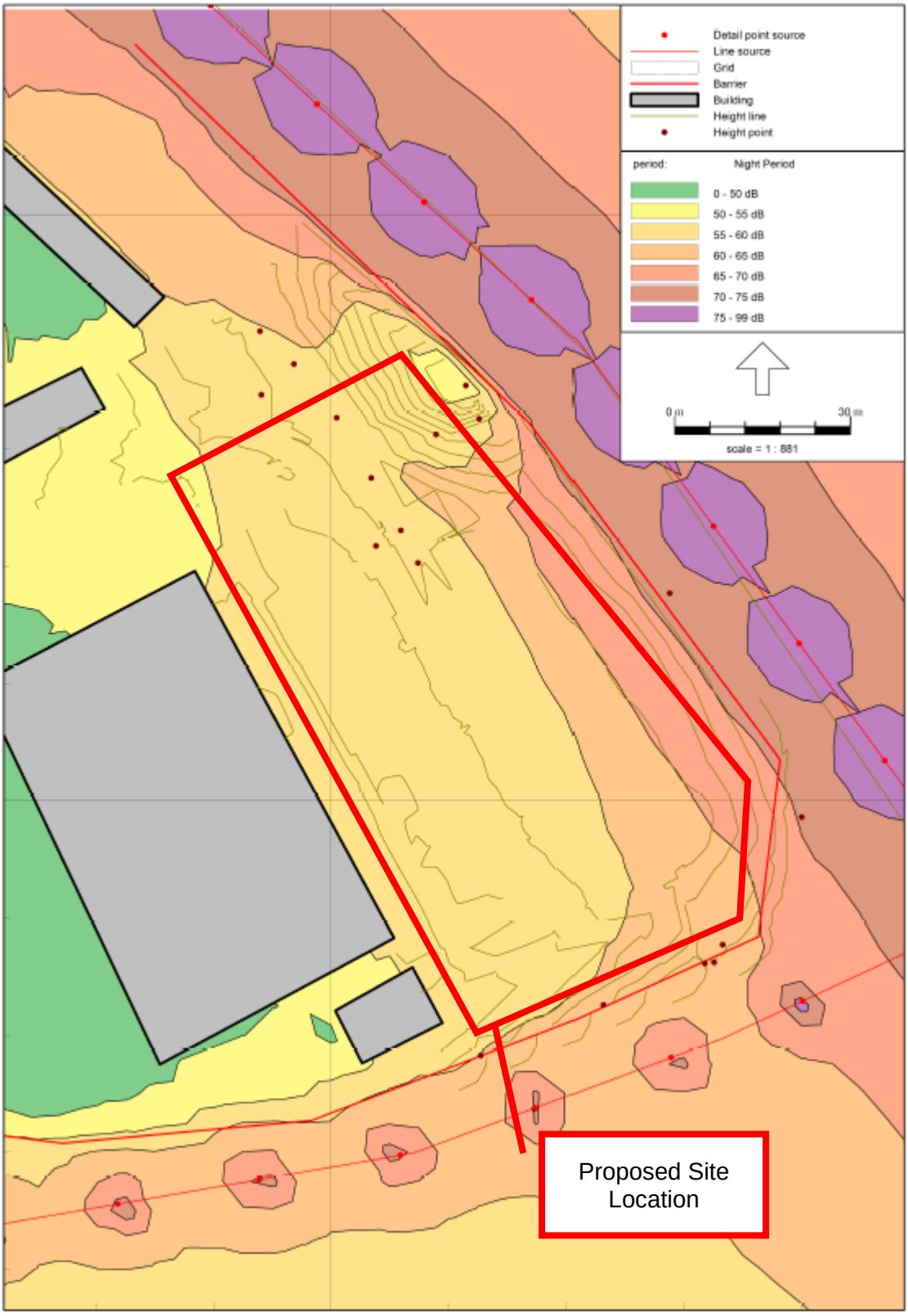

Figure 13 Night Noise Levels at 1.5m Above Ground

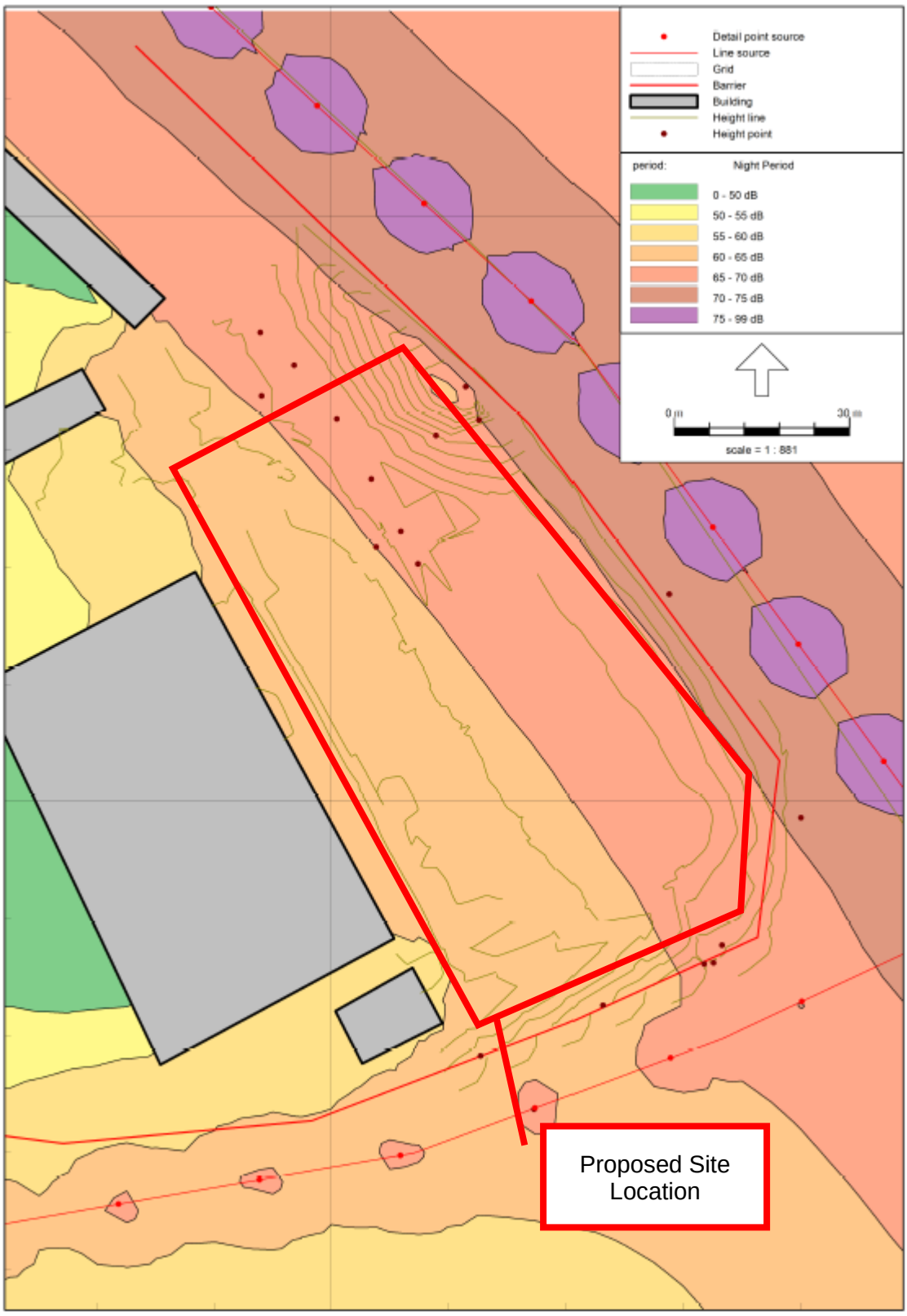

Figure 14 Night Noise Levels at 4.5m Above Ground

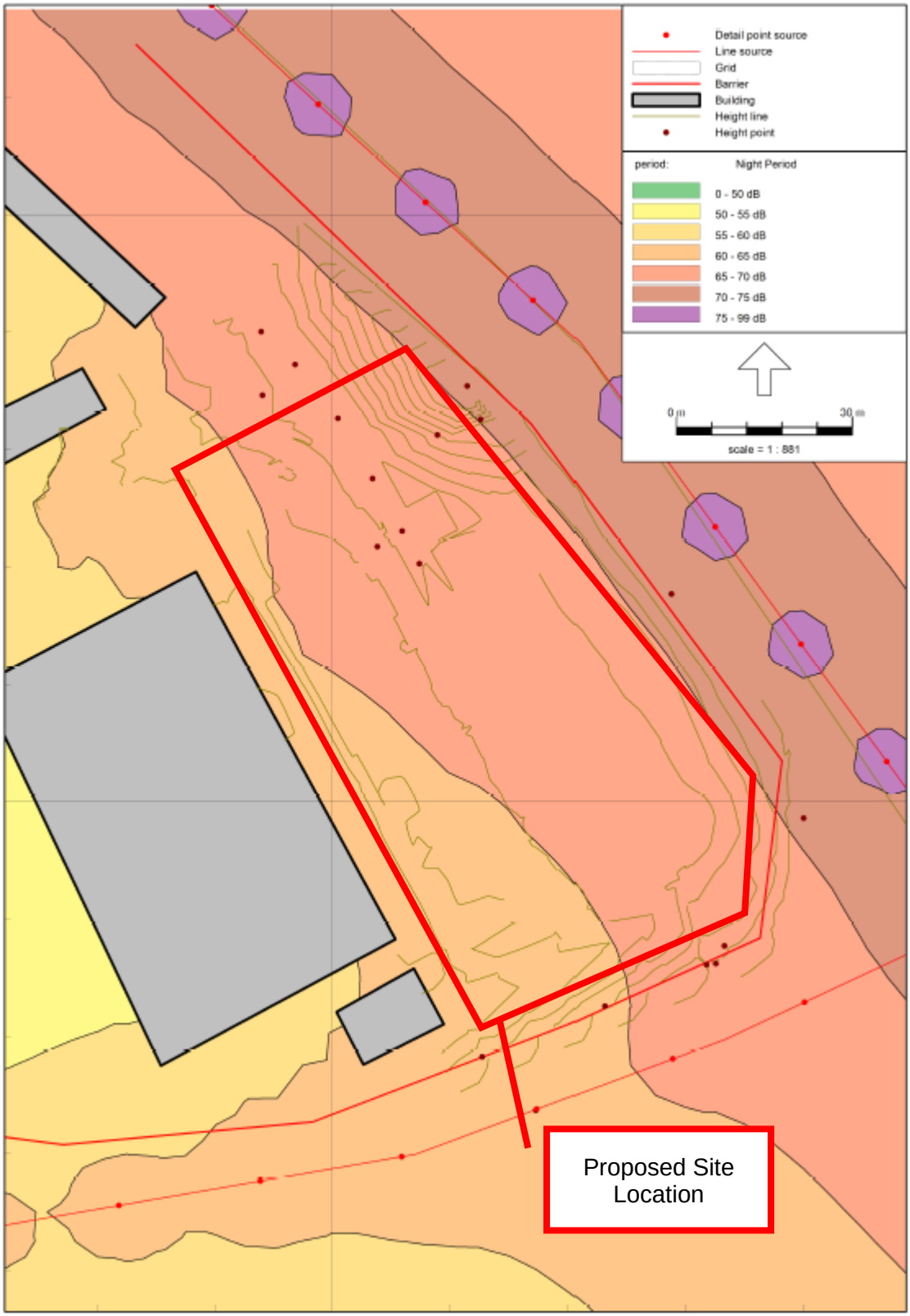

Figure 15 Night Noise Levels at 7.5m Above Ground

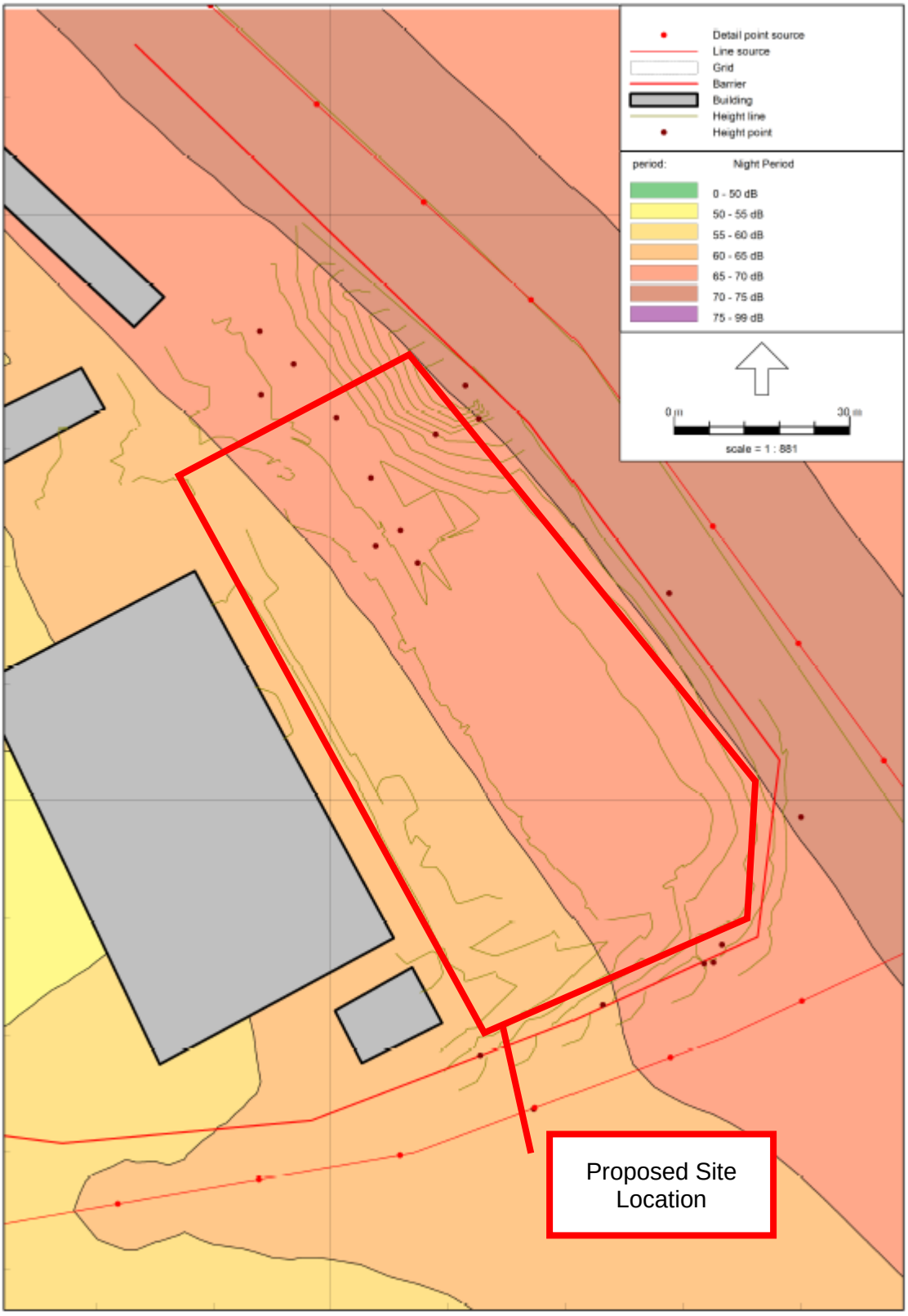

Figure 16 Night Noise Levels at 10.5m Above Ground

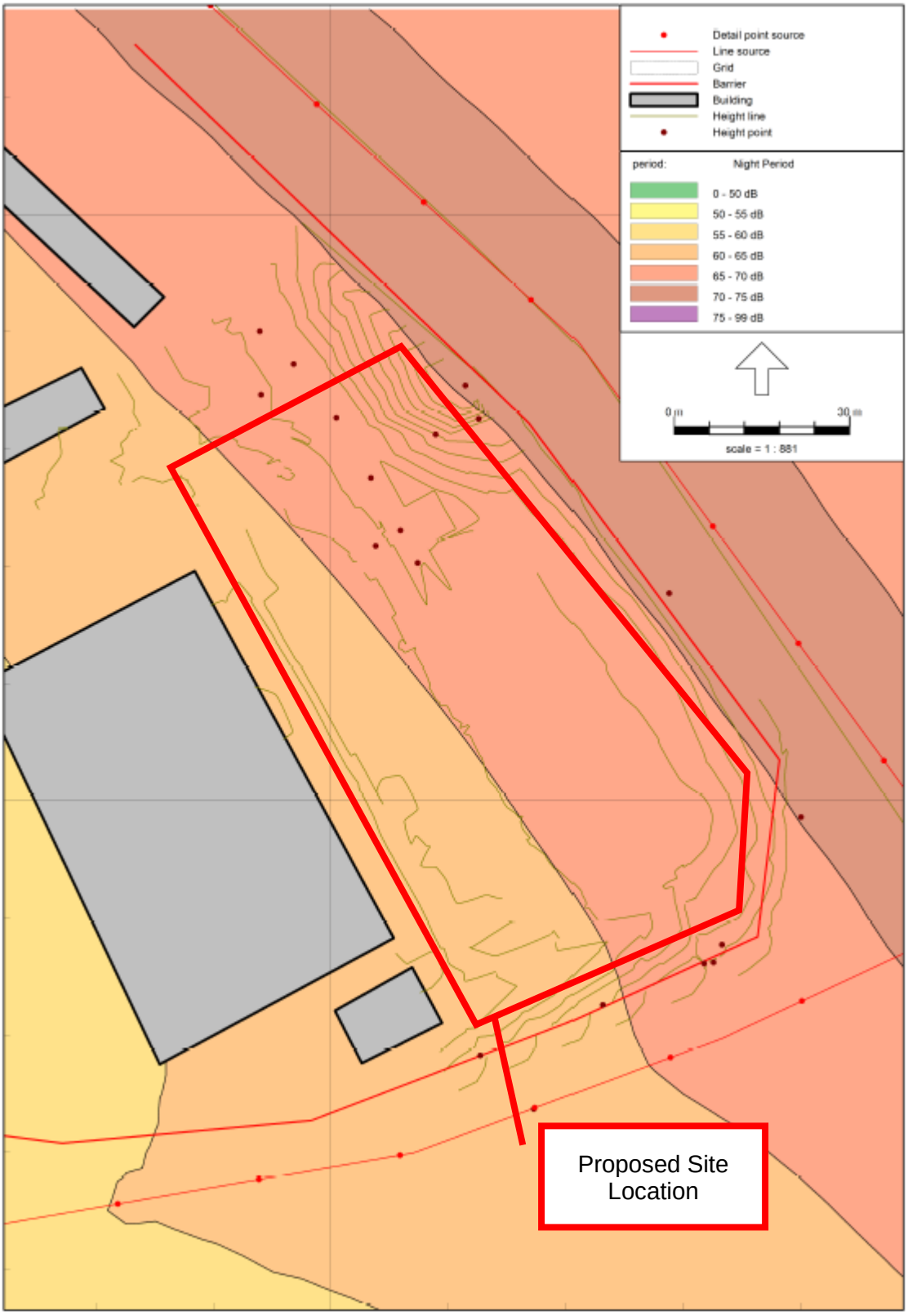

Figure 17 Night Noise Levels at 13.5m Above Ground

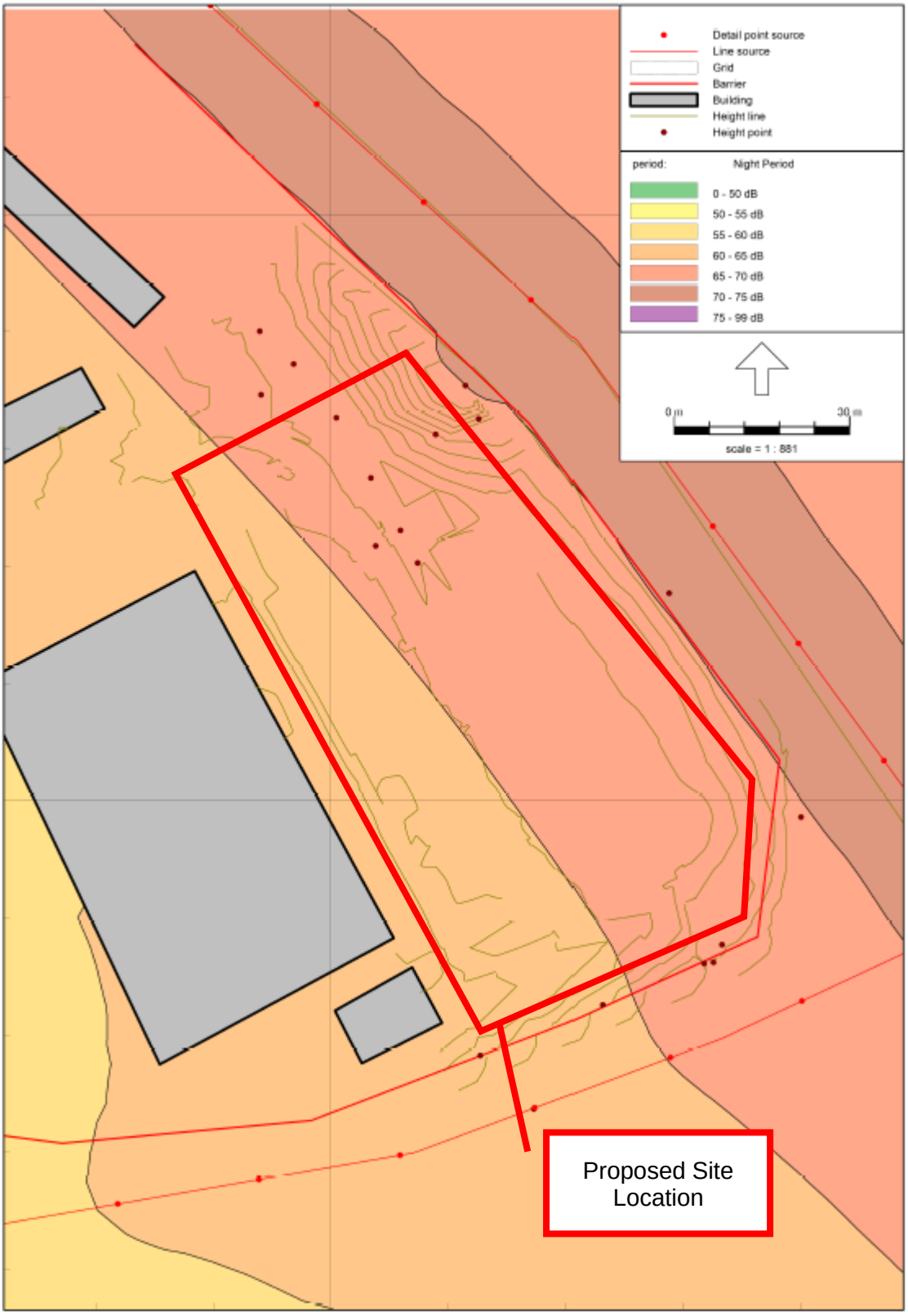

Figure 18 Night Noise Levels at 16.5m Above Ground

3.4 Noise Risk Assessment Conclusion

Giving consideration to the measured and predicted noise levels presented in the previous sections the initial site noise risk assessment has concluded that the level of risk across the site varies from medium to high noise risk.

Additionally, the Stage 1 Noise Risk Assessment requires analyses of the L_{AFmax} noise levels. In the case of the AWN survey the L_{AFmax} noise levels typically ranged from 77 to 83 dB during the night. The results indicate that there is the potential for L_{AFmax} noise levels to exceed 80 dB more than 20 times per night for which ProPG recommends that the site is considered as high risk.

ProPG states the following with respect to medium and high risks:

Medium Risk — *As noise levels increase, the site is likely to be less suitable from a noise perspective and any subsequent application may be refused unless a good acoustic design process is followed and is demonstrated in an ADS which confirms how the adverse impacts of noise will be mitigated and minimised, and which clearly demonstrate that a significant adverse noise impact will be avoided in the finished development.*

High Risk — *High noise levels indicate that there is an increased risk that development may be refused on noise grounds. This risk may be reduced by following a good acoustic design process that is demonstrated in a detailed ADS. Applicants are strongly advised to seek expert advice.*

Given the above it can be concluded that the development site may be categorised as *Medium to High Risk* and as such an Acoustic Design Strategy will be required to demonstrate that suitable care and attention has been applied in mitigating and minimising noise impact to such an extent that an adverse noise impact will be avoided in the final development.

It should be noted that ProPG states the following with regard to how the initial site noise risk is to be used,

> *"2.12 It is important that **the assessment of noise risk at a proposed residential development site is not the basis for the eventual recommendation to the decision maker**. The recommended approach is intended to give the developer, the noise practitioner, and the decision maker an early indication of the likely initial suitability of the site for new residential development from a noise perspective and the extent of the acoustic issues that would be faced. Thus, a site considered to be high risk will be recognised as presenting more acoustic challenges than a site considered as low risk. A site considered as negligible risk is likely to be acceptable from a noise perspective and need not normally be delayed on noise grounds. A potentially problematical site will be flagged at the earliest possible stage, with an increasing risk indicating the increasing importance of good acoustic design."*

Therefore, following the guidance contained in ProPG does not preclude residential development on sites that are identified as having medium or high-risk noise levels. It merely identifies the fact that a more considered approach will be required to ensure the developments on the higher risk sites are suitable designed to mitigate the noise

levels. The primary goal of the approach outlined in ProPG is to ensure that the best possible acoustic outcome is achieved for a particular site.

4.0 ProPG STAGE 2 – ACOUSTIC DESIGN STATEMENT

4.1 Element 1 – Good Acoustic Design Process

4.1.1 ProPG Guidance

In practice, good acoustic design should deliver the optimum acoustic design for a particular site without adversely affecting residential amenity or the quality of life or occupants or compromising other sustainable design objectives. It is important to note that ProPG specifically states that good acoustic design is not equivalent to overdesign or "*gold plating"* of all new development but that it seeks to deliver the optimum acoustic environment for a given site.

Section 2.23 of the ProPG outlines the following checklist for Good Acoustic Design (GAD):

- Check the feasibility of relocating, or reducing noise levels from relevant sources;
- Consider options for planning the site or building layout;
- Consider the orientation of proposed building(s);
- Select construction types and methods for meeting building performance requirements;
- Examine the effects of noise control measures on ventilation, fire regulation, health and safety, cost, CDM (construction, design and management) etc;
- Assess the viability of alternative solutions; and,
- Assess external amenity area noise.

In the context of the proposed development, each of the considerations listed above have been addressed in the following subsections.

4.1.2 Application of GAD Process to Proposed Application

Relocation or Reduction of Noise from Source

The N11 and R825 are located outside the redline boundary of the site and therefore it is beyond the scope of this development to introduce any noise mitigation at source.

Planning, Layout and Orientation

Consideration has been given to the location of both the buildings and external amenity areas. In the first instance, a primary consideration was to ensure that buildings are located as far as possible from the road, however this has been limited by the masterplan approach that has been agreed through meetings with Dun Laoghaire Rathdown planning and the proposed development on the Leisureplex site which is being developed concurrently. This, in conjunction with a Land Transfer agreement and a minimum planning separation distances of 21m, has necessitated parameters requiring both developments to be set back from the common boundary, which dictates the building position.

Notwithstanding the above gardens to the rear of the development have been orientated in a manner that provides some reduction in incident noise levels.

Select Construction Types for meeting Building Regulations

Masonry constructions will be used in constructing the external walls of the development. This construction type offers high levels of sound insulation performance. However, as is typically the case the glazed elements and ventilation will be the weakest elements in the façade in terms of sound insulation performance.

Consideration will therefore be given to the provision of upgraded glazing and mechanical ventilation. The proposal here will be to provide dwelling units with glazed elements that have good acoustic insulation properties so that when the windows are closed the noise levels internally are good.

In order to ensure indoor air-quality, a mechanical ventilation system with heat recovery will be utilised as per Part F of the Building Regulations, providing the requisite air changes per hour. The fresh air provided to all the apartments is tempered and filtered as part of the delivery process. Residents will not need to open their windows in terms of providing fresh air. In terms of extract, all of the bathrooms, kitchens and utility spaces will be exhausted to the outside via the mechanical ventilation system on a continuous basis. Inhabitants will be able to open the windows if they wish, however, doing so will increase the internal noise level. This approach to mitigation is supported in ProPG where it states the following:

"2.22 *Using fixed unopenable glazing for sound insulation purposes is generally unsatisfactory and should be avoided; occupants generally prefer the ability to have control over the internal environment using openable windows, even if the acoustic conditions would be considered unsatisfactory when open. Solely relying on sound insulation of the building envelope to achieve acceptable acoustic conditions in new residential development, when other methods could reduce the need for this approach, is not regarded as good acoustic design. Any reliance upon building envelope insulation with closed windows should be justified in supporting documents* "

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

2.34 *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. In such circumstances, internal noise levels can be assessed with windows closed but with any façade openings used to provide "whole dwelling ventilation" in accordance with Building Regulations Approved Document F (e.g. trickle ventilators) in the open position (see Supplementary Document 2). Furthermore, in this scenario the internal L_{Aeq} target noise levels should not generally be exceeded*."

Impact of noise control measures on fire, health and safety etc

The good acoustic design measures that have been implemented on site, e.g. locating properties away from the road and placing outdoor space on the quiet side of buildings, are considered to be cost neutral and do not have any significant impact on other issues.

Assess Viability of Alternative Solutions

Due to the height and location of the proposed buildings it is considered that any acoustic screens along the boundary of the site to attenuate traffic noise would be ineffective.

Assess External Amenity Area Noise

ProPG provides the following advice with regards to external noise levels for amenity areas in the development:

> *"The acoustic environment of external amenity areas that are an intrinsic part of the overall design should always be assessed and noise levels should ideally not be above the range 50 – 55 dB $L_{Aeq,16hr}$."*

In general, balcony spaces located to the rear of Block B are expected to achieve daytime noise levels of the order of 55 dB $L_{Aeq,16hr}$ or lower. Referring to the guidance in ProPG this level of external noise would be considered to offer good amenity for an outdoor space.

For balconies that have an aspect facing on to the neighbouring roads the intention is to provide a winter garden to meet the recommended external noise level of 55 dB $L_{Aeq,16hr}$. Figure 19 to Figure 21 indicates the balconies that will be afforded Winter Gardens (highlighted in red).

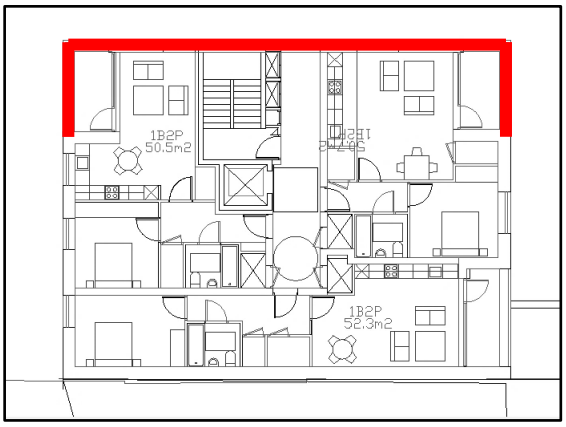

Figure 19 Block A Winter Gardens

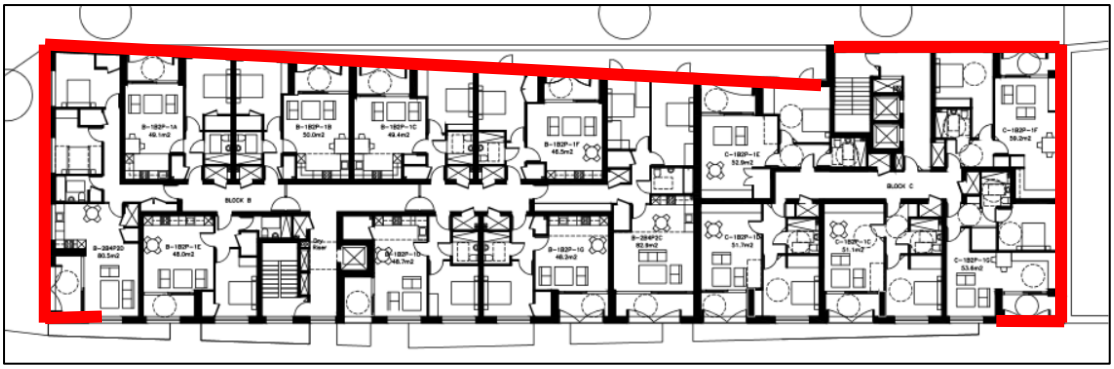

Figure 20 Block B Winter Gardens (Lower Floors***)***

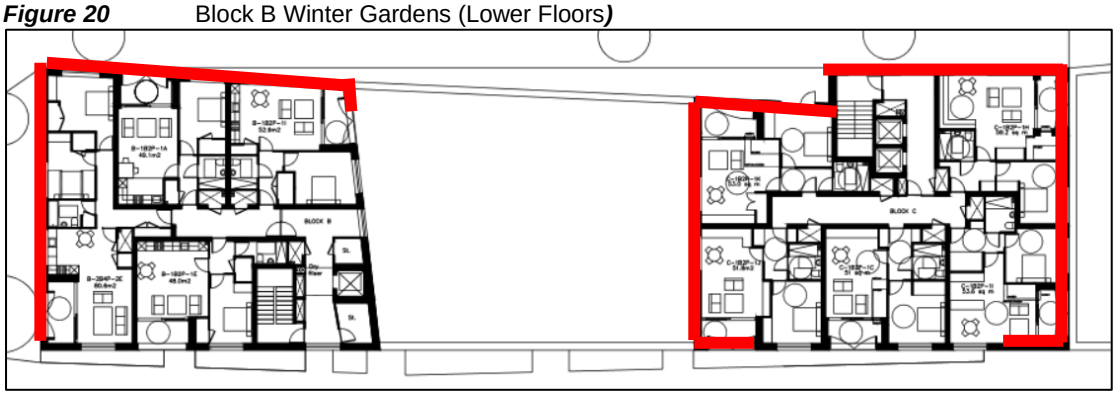

Figure 21 Block B Winter Gardens (Upper Floors)

In addition to the above, good acoustic design principals employed have ensured that the external spaces to the rear of Block B are positioned to benefit from the screening effect of the development buildings. Figure 22 illustrates that the vast majority of the outdoor amenity area achieves a noise level ≤ 55 dB $L_{Aeq,16hr}$.

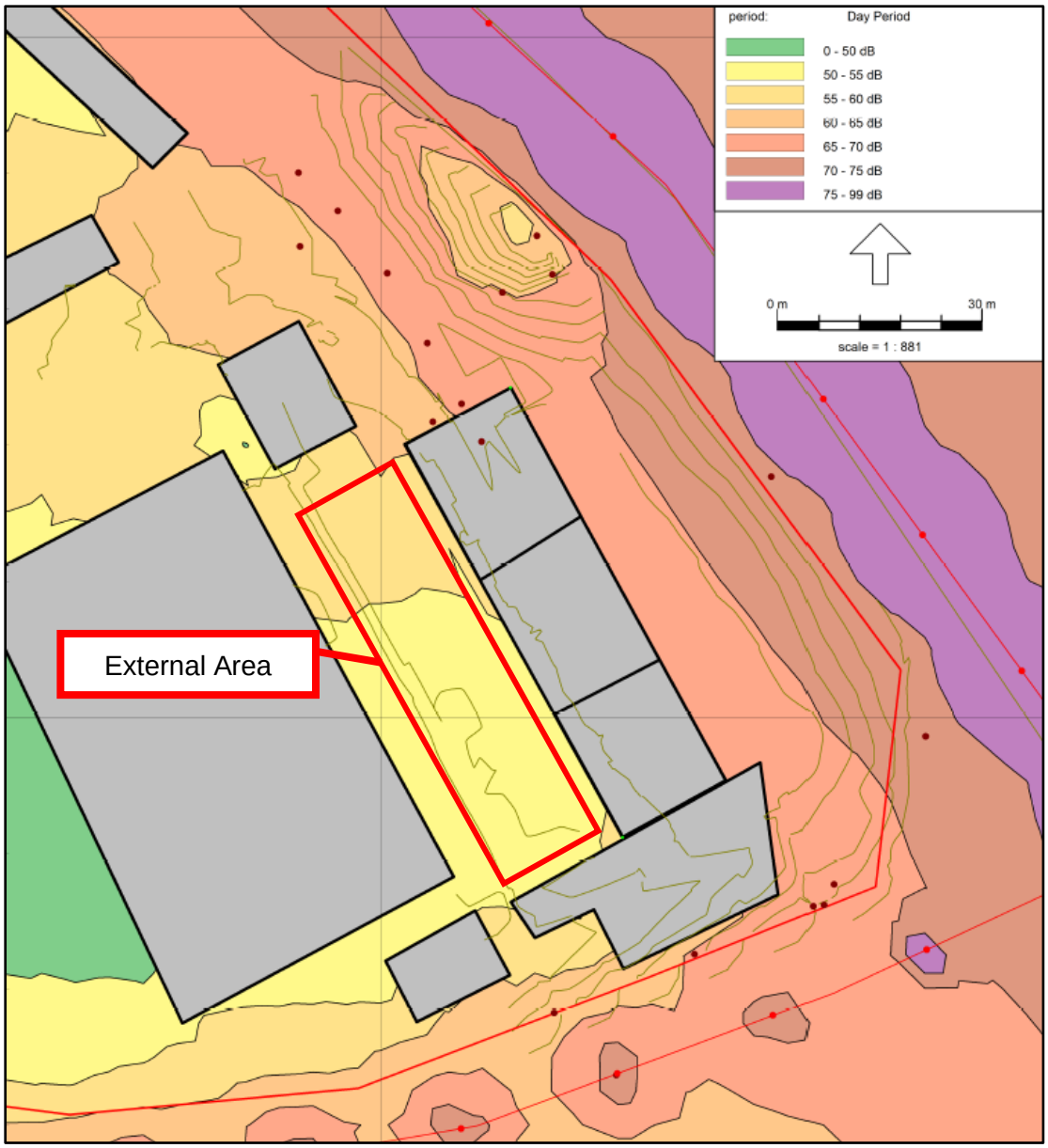

Figure 22 Noise Contours for External Area

Summary

Considering the constraints of the site, in so far as possible and without limiting the extent of the development area, the principles of Good Acoustic Design have been applied to the development.

In terms of viable alternatives to acoustic treatment of façade elements, there are no further options for mitigation outside of proprietary acoustic glazing and mechanical ventilation.

4.2 Element 2 – Internal Noise Guidelines

4.2.1 Internal Noise Criteria

Element 2 of the ProPG document sets out recommended internal noise targets derived from BS 8233 and WHO's *Community Noise Guidelines*. The recommended indoor ambient noise levels are set out in Table 8 and are based on annual average data, that is to say they omit occasional events such as New Year's Eve.

Activity	Location	(07:00 to 23:00hrs)	(23:00 to 07:00hrs)
Resting	Living room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$ 45 dB $L_{Amax,T}$*

Table 8 ProPG Internal Noise Levels

*Note The document comments that the internal $L_{AFmax,T}$ noise level may be exceeded no more than 10 times per night without a significant impact occurring.

Giving consideration to the external noise levels, it will be necessary to use acoustic glazing and mechanical ventilation to meet the recommended internal noise levels.

In terms of the ventilation strategy it is understood that the air supply will be via mechanical ventilation which typically provides a sound insulation performance substantially improved over passive in-frame or wall vents.

4.2.2 Façade Levels

Table 9 and Table 10 along with Figure 23 and Figure 24 present the noise levels predicted to be incident on the façade during day and night-time periods respectively.

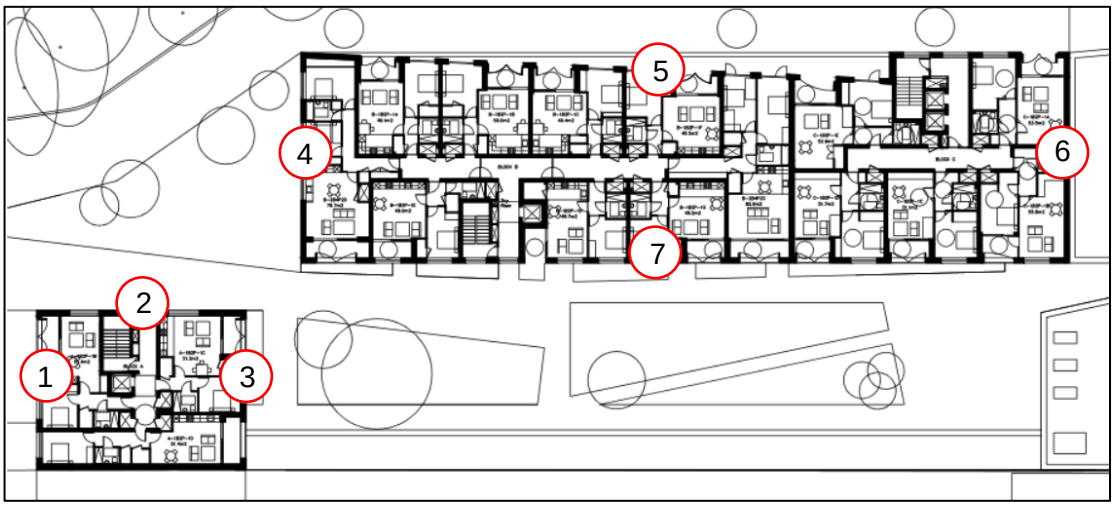

Figure 23 Designation of Predicted Noise Levels for Each Façade (Lower Levels)

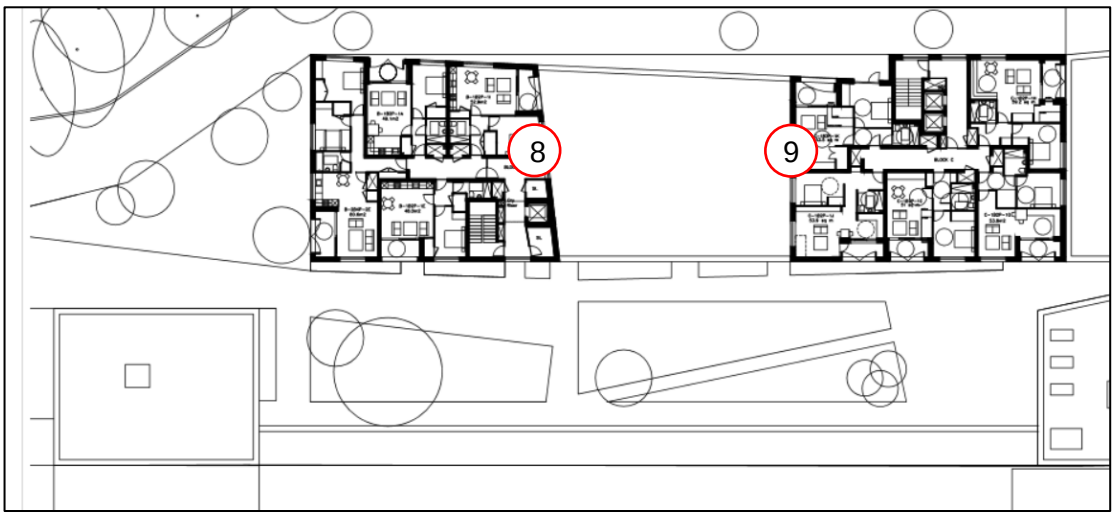

Figure 24 Designation of Predicted Noise Levels for Each Façade (Upper Levels)

Ref	Period (T)	$L_{Aeq,\ T}$ dB	Octave Band Centre Frequency (Hz)					
			125	250	500	1k	2k	4k
1	DAY (16hr)	68	61	61	62	66	59	48
	NIGHT (8hr)	64	54	55	57	62	56	43
2	DAY (16hr)	70	63	63	64	68	61	50
	NIGHT (8hr)	66	56	57	59	64	58	45
3	DAY (16hr)	64	57	57	58	62	55	44
	NIGHT (8hr)	60	50	51	53	58	52	39
4	DAY (16hr)	71	64	64	65	69	62	51
	NIGHT (8hr)	67	57	58	60	65	59	46
5	DAY (16hr)	72	65	65	66	70	63	52
	NIGHT (8hr)	68	58	59	61	66	60	47
6	DAY (16hr)	68	61	61	62	66	59	48
	NIGHT (8hr)	64	54	55	57	62	56	43
7	DAY (16hr)	62	55	55	56	60	53	42
	NIGHT (8hr)	58	48	49	51	56	50	37
8	DAY (16hr)	68	61	61	62	66	59	48
	NIGHT (8hr)	64	54	55	57	62	56	43
9	DAY (16hr)	67	60	60	61	65	58	47
	NIGHT (8hr)	63	53	54	56	61	55	42

Table 9 Summary of Predicted Façade Noise Levels

Ref	L_{Amax}, dB	Octave Band Centre Frequency (Hz)					
		125	250	500	1k	2k	4k
1	75	72	71	69	69	68	69
2	80	77	76	74	74	73	74
3	75	72	71	69	69	68	69
4	80	77	76	74	74	73	74
5	80	77	76	74	74	73	74
6	80	77	76	74	74	73	74
7	70	67	66	64	64	63	64
8	80	77	76	74	74	73	74
9	80	77	76	74	74	73	74

Table 10 Summary of Predicted Maxima Events (Night)

4.2.4 Proposed Façade Treatment

The British Standard BS EN 12354-3: 2000: *Building acoustics – Estimation of acoustic performance of buildings from the performance of elements – Part 3: Airborne sound insulation against outdoor sound* provides a calculation methodology for determining the sound insulation performance of the external envelope of a building. The method is based on an elemental analysis of the building envelope and can take into account both the direct and flanking transmission paths.

The Standard allows the acoustic performance of the building to be assessed taking into account the following:

- Construction type of each element (i.e. windows, walls, etc.);
- Area of each element;
- Shape of the façade, and;
- Characteristics of the receiving room.

The principals outlined in BS EN 12354-3 are also referred to in BS8233 and Annex G[1] of BS8233 provides a calculation method to determine the internal noise level within a building using the composite sound insulation performance calculated using the methods outlined in BS EN 12354-3. The methodology outlined in Annex G of BS8233 has been adopted here to determine the required performance of the building facades.

Glazing

As is the case in most buildings, the glazed elements of the building envelope are typically the weakest element from a sound insulation perspective. In this instance it has been calculated that the various facades are to be provided with glazing that, when closed, achieve the minimum sound insulation performance as set out in Table 11 (and assigned to each façade in Figure 25 & Figure 26). Note that the façade glazing specifications are also applicable to the internal glazed element within the winter gardens. The external glazed element for winter gardens is also detailed within the Table.

[1] The methodology contained within Annex G of BS8233 is based on the assumption that the source is a line source (such as a road) and that the building facades are simple, i.e. do not have balconies. These assumptions are considered valid for the purposes of this assessment and have been adopted.

Façade	Octave Band Centre Frequency (Hz)					
	125	250	500	1k	2k	4k
Red	24	29	37	43	43	43
Orange	16	22	27	35	35	35
Blue	24	28	36	42	42	43
Green	18	24	25	33	33	33
Winter Gardens (External Element)	18	23	30	35	27	32

Table 11 Sound Insulation Performance Requirements for Glazing, SRI (dB)

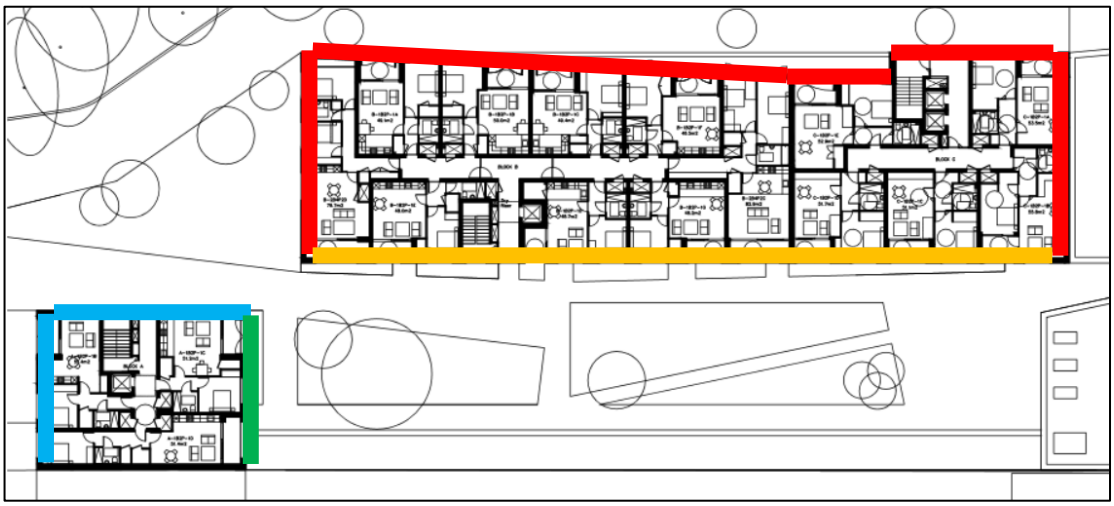

Figure 25 Façade Designations (Lower Floors)

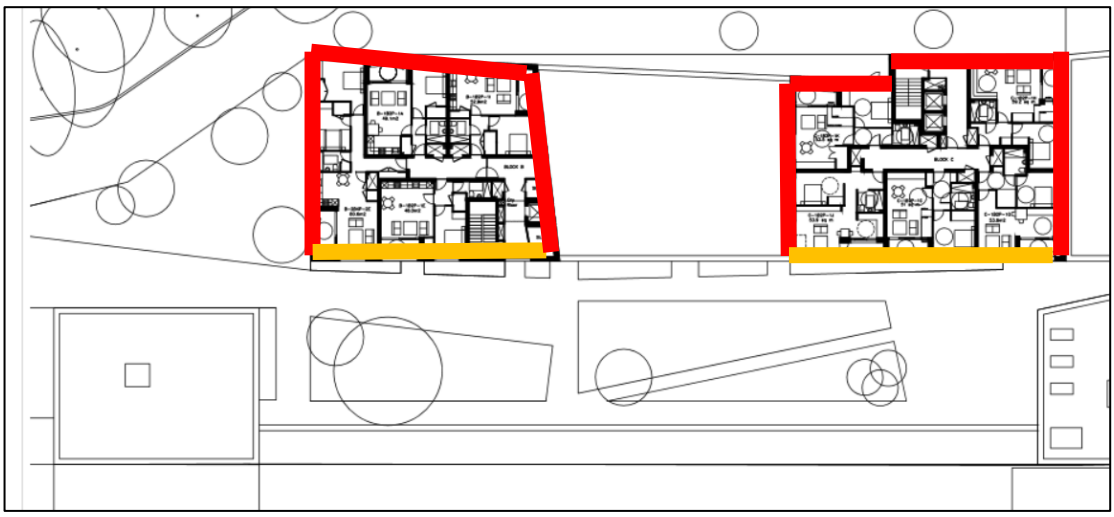

Figure 26 Façade Designations (Upper Floors)

Using the propriety software package Insul the constructions of triple glazing have been predicted to achieve the specification are as follows:

- **Red / Blue** – 8.8lam/12/4/15/8.8lam
- **Orange / Green** – 4/18/4/18/4

Note that the above are predictions of triple glazing constructions to meet the specifications. Test data should be sought from the supplier of the glazing at detailed design stage to ensure that the acoustic specification is met.

The external glazing specification for the winter gardens can typically be achieved with single glazed units of 8 mm thickness.

It is important to note that the acoustic performance specifications detailed herein are minimum requirements which apply to the overall glazing system. In the context of the acoustic performance specification the 'glazing system' is understood to include any and all of the component parts that form part of the glazing element of the façade, i.e. glass, frames, seals, openable elements etc.

The assessment has demonstrated that the recommended internal noise criteria can be achieved through consideration of the proposed façade elements at the design stage. The calculated glazing specifications are preliminary and are intended to form the basis for noise mitigation at the detailed design stage. Consequently, these may be subject to change as the project progresses.

Wall Construction

In general, all wall constructions (i.e. block work or concrete) offer a high degree of sound insulation, much greater than that offered by the glazing systems. Therefore, noise intrusion via the wall construction will be minimal. The calculated internal noise levels across the building façade have assumed a minimum sound reduction index of 63 dB R_w for this construction.

Ventilation

The ventilation strategy for the development is for mechanical ventilation. Mechanical ventilation systems typically offer a high performance in terms of preventing sound intrusion from external sources, consequently there is no assessment of the ventilation system required for this noise impact assessment.

Internal Noise Levels

Taking into account the external façade levels and the specified building envelope the internal noise levels have been calculated. In all instances the good internal noise criteria are achieved for daytime and night-time periods.

4.3 Element 3 – External Amenity Area Noise Assessment

As previously discussed, where required, balconies will be afforded winter gardens to ensure they achieve a noise level of ≤ 55 dB $L_{Aeq,16hr}$. In terms of the external area to the rear of Block B, Figure 22 illustrates that the vast majority of this area achieves a noise level of ≤ 55 dB $L_{Aeq,16hr}$.

4.4 Element 4 – Assessment of Other Relevant Issues

Element 4 gives consideration to other factors that *may* prove pertinent to the assessment, these are defined in the document as:

- 4(i) compliance with relevant national and local policy
- 4(ii) magnitude and extent of compliance with ProPG
- 4(iii) likely occupants of the development
- 4(iv) acoustic design v unintended adverse consequences
- 4(v) acoustic design v wider planning objectives

Each is discussed in turn below.

4.4.1 Compliance with Relevant National and Local Policy

There are no National policy documents relating to the acoustic design of residential dwellings. Locally the Draft Dún Laoghaire Rathdown Noise Action Plan specifies that the guidance contained within ProPG should be used in assessing the noise impact on new residential developments.

This Acoustic Design Statement has been prepared in compliance with the requirements of ProPG and therefore complies with the requirements of local policy.

4.4.2 Magnitude and Extent of Compliance with ProPG

As discussed within this report the following conclusions have been drawn with regards to the extent of compliance with ProPG:

- All dwellings as part of the development have been designed to achieve the good level of internal noise levels specified within ProPG.
- All external amenity areas have been shown to have an external noise level that complies with the recommended criterion set out in ProPG.

Based on the preceding it is concluded that the proposed development is in full compliance with the requirements of ProPG.

4.4.3 Likely Occupants of the Development

This element is not considered relevant here as the future occupants are unknown. It is included within ProPG to allow for some discussion on how the acoustic conditions may change depending on the likely occupants.

4.4.4 Acoustic Design v Unintended Adverse Consequences

There is some conflict on this site between good acoustic design and other design elements. For example, good acoustic design would prefer to have Block B situated further back from the N11, however, this is not possible due to the desire of avoiding overlooking onto other proposed developments to the rear.

4.4.5 Acoustic Design v Wider Planning Objectives

As discussed above, there is a wider planning objective to ensure that proposed developments currently progressing through pre-planning are not overlooked, consequently the design of this development has allowed for a buffer between the proposed buildings and the site boundary to the west.

4.5 Acoustic Design Statement Conclusion

An initial site noise risk assessment has been carried out on the proposed residential development at St Laurence Park, Stillorgan. The assessment has classified the development site as having a range of noise risks associated ranging from medium to high risk. This was determined through a combination of measurements of noise levels on site and through the development of a 3D noise model of the site and surrounds.

Further discussion is presented in terms of the likely noise impact of both the external and internal areas of the proposed development. It has been found that the majority of the inhabitants will have access to a quiet external area that is screened by the development itself from road traffic noise. All habitable rooms will achieve a good internal noise environment with the enhanced acoustic glazing and mechanical ventilation.

5.0 INWARD IMPACT – LIBRARY

This section of the report defines the recommended specification of noise mitigation for the Library so that the recommended criteria as defined in Section 2.1.2 can be met. The location of the proposed library building is the junction of the N11 and Lower Kilmacud Road as indicated in Figure 27.

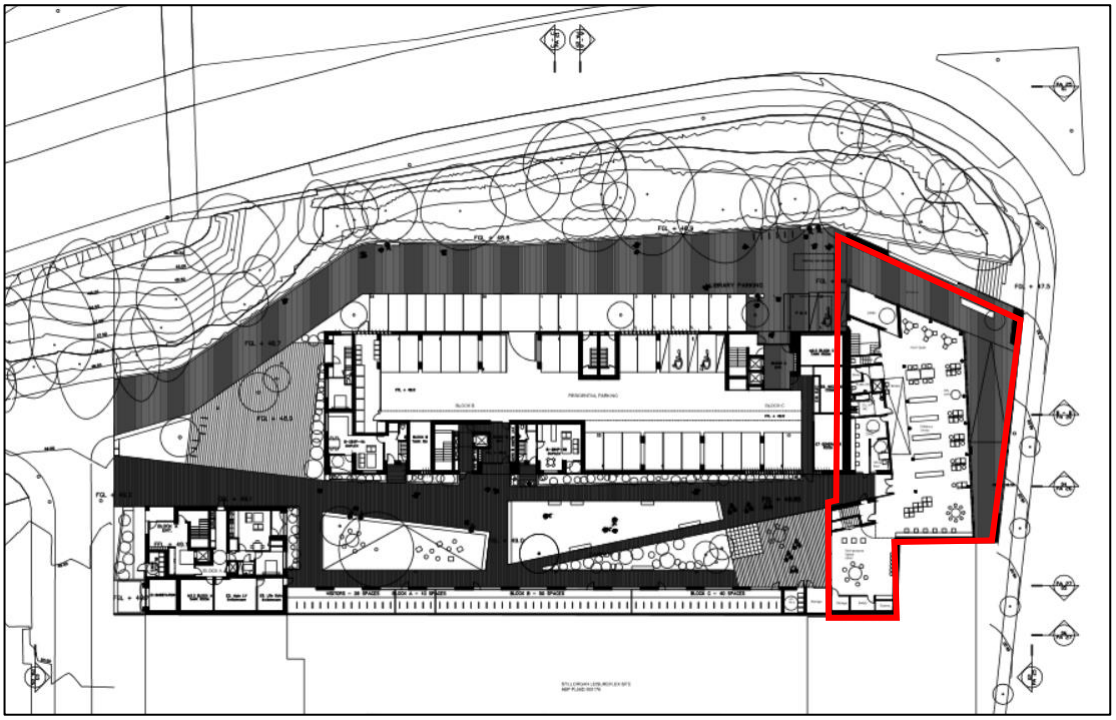

Figure 27 Library Location

5.1 Assumed Noise Levels

Utilising the noise prediction model as detailed in Section 3.3 of this report, the noise levels predicted as incident on the façade of the proposed Library building during the daytime are as detailed within Table 12.

Ref	$L_{Aeq,16hr}$ dB	Octave Band Centre Frequency (Hz)					
		125	250	500	1k	2k	4k
Library	71	64	64	65	69	62	51

Table 12 Noise Level Incident on Library Façade

5.2 Façade design and intrusive noise

Façade sound insulation performance requirements have been derived by calculation, based on the floor plans and cross section drawings issued by ABK Architects. The resultant acoustic performance requirements for the building façade are summarised in Table 13.

Ref	Octave Band Centre Frequency (Hz)					
	125	250	500	1k	2k	4k
Library	20	24	31	38	40	40

Table 13 Library Glazing Specification

This specification can be achieved with double glazed units with acoustic laminate glazing such as 7.3lam/12/4.

The resultant internal noise level of the Library with the above glazing specification is calculated as 40 dB $L_{Aeq,16hr}$.

Note that this calculation assumes that the Library will be mechanically ventilated.

The assessment has demonstrated that the recommended internal noise criteria can be achieved through consideration of the proposed façade elements at the design stage. Note that the calculated glazing specification is preliminary and is intended to form the basis for noise mitigation at the detailed design stage. Consequently, the specification may be subject to change as the project progresses.

6.0 VEHICULAR TRAFFIC NOISE ASSESSMENT

An assessment of noise due to traffic from the proposed development has been undertaken to determine the impact, if any, of increased traffic on nearby and adjacent roads.

Peak hour junction data has been derived from a report produced by AECOM titled *Proposed Mixed Development at Stillorgan Library Site. St Laurence's Park, Stillorgan* dated 27 June 2018. The data has been used to compare Do Nothing and Do Something scenarios and assess the potential change in noise level due to the development.

Junction	Traffic Numbers		Change in Noise Level (dB)
	Do Nothing	Do Something	
AM Peak			
1 - Site Access / St Laurence's Park (E) / St Laurence's Park (N)	25	47	2.7
2 - Old Dublin Road (N) / Old Dublin Road (S) / St Laurence's Park	707	729	0.1
3 - Lower Kilmacud Road (W) / Lower Kilmacud Road (E) / The Hill	1760	1776	0.0
PM Peak			
1 - Site Access / St Laurence's Park (E) / St Laurence's Park (N)	67	105	2.0
2 - Old Dublin Road (N) / Old Dublin Road (S) / St Laurence's Park	760	798	0.2
3 - Lower Kilmacud Road (W) / Lower Kilmacud Road (E) / The Hill	1814	1837	0.1

Table 14 Vehicular Noise Assessment

The predictions indicate that the subjective reaction to the change in noise levels will range from inaudible to barely perceptible. The associated impacts with these changes in noise level will range from no change to negligible.

7.0 PLANT NOISE ASSESSMENT

Table 15 and Figure 28 present the average background noise levels (in terms of L_{A90}) measured or predicted in the vicinity of the site during the day and night periods at the front and rear of the site (Location A and B).

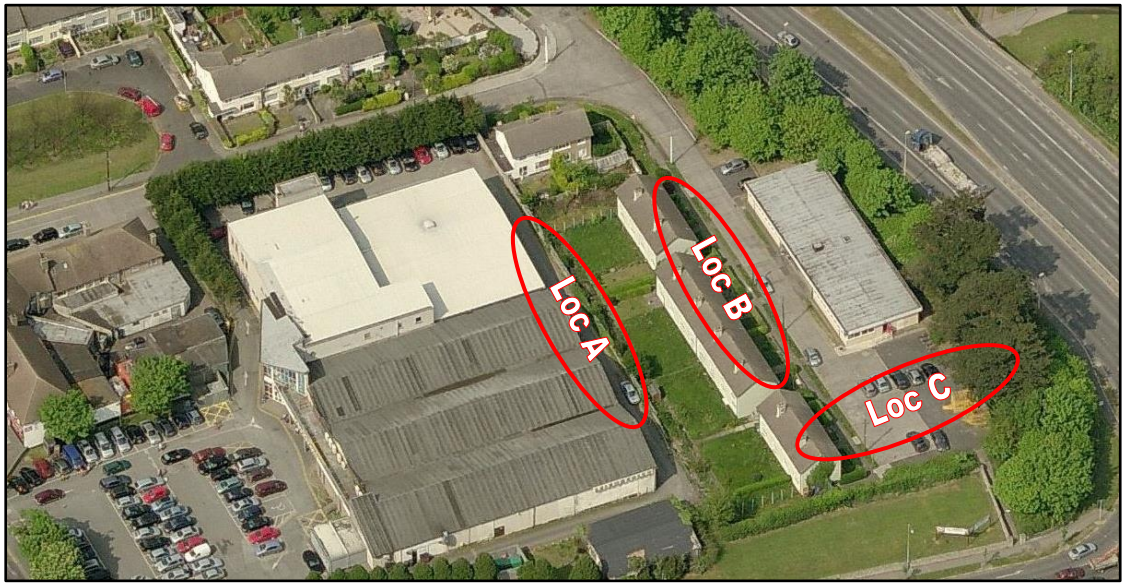

Figure 28 Background Noise Level Location References

Location Ref	Average Background Noise Level (L_{A90} dB)	
	Day	Night
A	47	43
B	47	43
C	52	45

Table 15 Background Noise Levels

Location A is representative of the existing Leisureplex and proposed residential development to the west of the site. Locations B and C are representative of the south west and south east facing façades of Block B, respectively.

Taking into account the recommendation from BS 4142 that if the plant noise level does not exceed the background sound level it is an indication of a low impact, it is recommended in this instance that noise emissions from all plant installed on site (considered cumulatively) do not exceed the background noise levels presented in Table 15.

It is understood that various external plant items are proposed for the development, including an AHU and condenser unit. These items of plant have the potential to emit noise to the environment and consequently an exercise should be undertaken at detailed design stage to ensure that the finalised items of plant do not exceed the proposed noise thresholds. Noise mitigation measures may be required to meet the thresholds, as an indication these measures could include attenuators to the AHU and acoustic barriers or louvres around the plant area.

8.0 CONSTRUCTION NOISE ASSESSMENT

A variety of items of plant will be in use for the purposes of site clearance/groundworks and construction. There will be vehicular movements to and from the site that will make use of existing roads. Due to the nature of these activities, there is potential for the generation of elevated levels of noise.

During the construction phase, it is anticipated that there will be a number of HGV's to/from site. Excavators will be employed to move existing ground and piling rigs will be used for foundation work following which standard construction tools and methods will be employed for general construction and landscaping.

It is possible to predict indicative noise levels using guidance set out in BS 5228-1:2009+A1:2014 for the main phases of the proposed construction works. Table 16 summarises the construction noise prediction calculations at the nearest residences (i.e. 25m from the residence to the outline plan of the proposed Block A as indicated in Figure 29). The predictions assume a 66 % on-time for all items of plant (i.e. the items of plant are operational for 8 of the 12 hour period) and 5 dB attenuation due to partial screening of plant from the receptors.

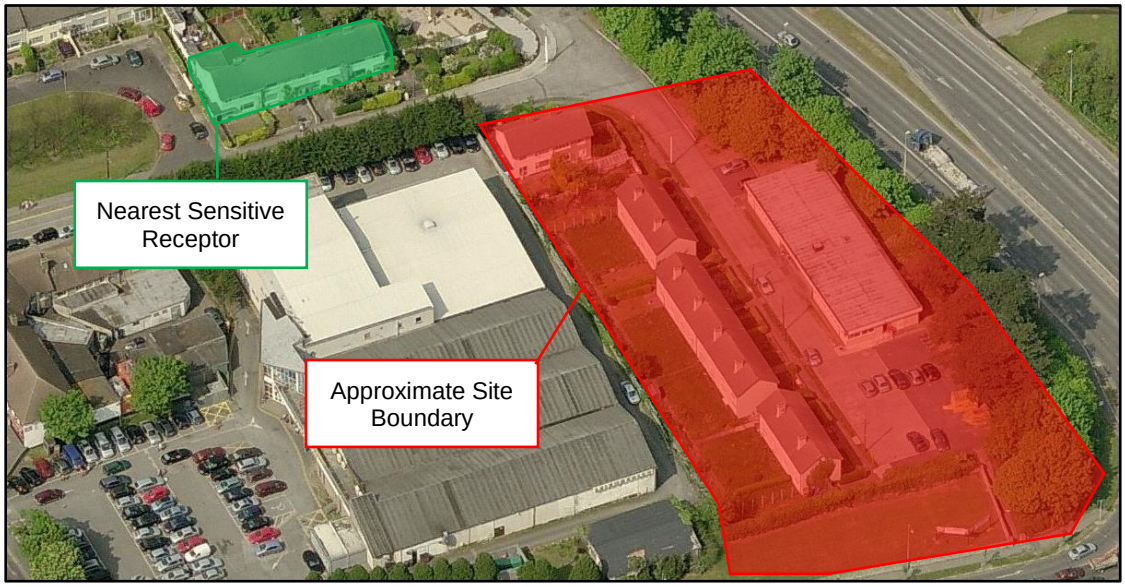

Figure 29 Indication of Sensitive Receptor Location Compared to Site

Construction Phase	Item of Plant (BS 5228-1:2009+A1:2014 Ref)	BS5228 Reference Noise Level dB L_{Aeq} at 10m	Predicted at Receiver (25m distance) dB L_{Aeq}
Site Clearance/ Groundworks	Tracked excavator (C2.21)	71	56
	Dump Truck (C2.30)	79	64
	Telescopic Handler (C4.54)	79	64
	Tracked Mobile Crane (C4.50)	71	56
	Diesel Generator (C4.76)	61	46
	Total Site Clearance		**68**
Piling	Large Rotary Bored Piling Rig (C3.14)	83	68
	Tracked excavator (D2.21)	71	56
	Concrete Mixer Truck and Pump (C4.28)	75	60

Construction Phase	Item of Plant (BS 5228-1:2009+A1:2014 Ref)	BS5228 Reference Noise Level dB L_{Aeq} at 10m	Predicted at Receiver (25m distance) dB L_{Aeq}
	Total Piling		**69**
General Construction	Dump Truck (D2.30)	79	64
	Tracked excavator (D2.21)	71	56
	Compressor (D7.08)	70	55
	Telescopic Handler (D4.54)	79	64
	Hand Held Circular Saw (D4.72)	79	64
	Diesel Generator (D4.76)	61	46
	Internal Fit out	70	55
	Total General Construction		**70**
Landscaping and Road	Asphalt Paver & Tipping Lorry (D5.30)	75	60
	Electric Water Pump (D5.40)	68	53
	Vibratory Roller (D5.20)	75	60
	Total Landscaping and Road Works		**64**

Table 16 Predicted Construction Noise Levels

The predicted noise levels detailed in the above table indicate that the construction activities can operate within the designated thresholds when taking into account noise mitigation from barriers.

It is important to note that the calculations set out above are based on assumed site activity and a combination of plant items operating simultaneously, as such they are typically worst-case scenarios. The use of construction noise and vibration mitigation measured measures will be employed during the construction phase with a view to minimising noise impacts.

Note that Leisureplex located to the West of the site is also potentially a sensitive location, however BS-5228 does not provide an assessment of significance for commercial properties. In this instance due care and consideration should be given to the Leisureplex to ensure no significant effect occurs. In terms of noise mitigation, the following measures may be utilised to reduce the effects of noise on the surrounding receptors:

- Use of a standard site hoarding, typically 2.4m height will be erected around the perimeter of the construction site for the duration of works;
- Limiting the hours during which site activities likely to create high levels of noise or vibration are permitted;
- Monitoring levels of noise and vibration during critical periods and at sensitive locations;
- Maintaining site access roads even so as to mitigate the potential for vibration from lorries;
- Selection of plant with low inherent potential for generation of noise and/ or vibration;
- Erection of barriers as necessary around items such as generators or high duty compressors;
- Situate any noisy plant as far away from sensitive properties as is reasonably practicable and the use of vibration isolated support structures where necessary

- Establishing channels of communication between the contractor/developer, Local Authority and residents, and;
- Appointing a site representative responsible for matters relating to noise and vibration.

APPENDIX A
GLOSSARY OF ACOUSTIC TERMINOLOGY

Ambient noise — The totally encompassing sound in a given situation at a given time, usually composed of sound from many sources, near and far.

Background noise — The steady existing noise level present without contribution from any intermittent sources. The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90 per cent of a given time interval, T ($L_{AF90,T}$).

dB — Decibel - The scale in which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the RMS pressure of the sound field and the reference pressure of 20 micro-pascals (20 µPa).

dB(A) — An 'A-weighted decibel' - a measure of the overall noise level of sound across the audible frequency range (20 Hz – 20 kHz) with A-frequency weighting (i.e. 'A'–weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.

$D_{n,e,w}$ — Weighted element-normalized level difference. This is the value of sound insulation performance of a ventilator measured under laboratory conditions. It is a weighted single figure index that is derived from values of sound insulation across a defined frequency spectrum. Technical literature for acoustic ventilators typically presents sound insulation data in terms of the $D_{n,e,w}$ parameter.

Hertz (Hz) — The unit of sound frequency in cycles per second.

$L_{Aeq,T}$ — This is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T).The closer the L_{Aeq} value is to either the L_{AF10} or L_{AF90} value indicates the relative impact of the intermittent sources and their contribution. The relative spread between the values determines the impact of intermittent sources such as traffic on the background.

L_{AFN} — The A-weighted noise level exceeded for N% of the sampling interval. Measured using the "Fast" time weighting.

L_{AF90} — Refers to those A-weighted noise levels in the lower 90 percentile of the sampling interval; it is the level which is exceeded for 90% of the measurement period. It will therefore exclude the intermittent features of traffic and is used to estimate a background level. Measured using the "Fast" time weighting.

L_{AF10} — Refers to those A-weighted noise levels in the upper 10 percentile of the sampling interval; it is the level which is exceeded for 10% of the measurement period. It is typically representative of traffic noise levels. Measured using the "Fast" time weighting.

L_{AFmax} is the instantaneous fast time weighted maximum sound level measured during the sample period.

Octave band A frequency interval, the upper limit of which is twice that of the lower limit. For example, the 1,000Hz octave band contains acoustical energy between 707Hz and 1,414Hz. The centre frequencies used for the designation of octave bands are defined in ISO and ANSI standards.

PPV Peak Particle Velocity (PPV) is defined as the instantaneous maximum velocity reached by a vibrating element as it oscillates about its rest position and is measured in mm/s.

R_w Weighted Sound Reduction Index – This is the value of the sound insulation performance of a partition or element measured under laboratory conditions. It is a weighted single figure index that is derived from values of sound insulation across a defined frequency spectrum. Technical literature typically presents sound insulation data in terms of the R_w parameter.

R'_w Weighted Apparent Sound Reduction Index – This is similar to R_w but is used to express *in-situ* sound insulation performance, where issues such as flanking issue noise transfer may affect the measured level. As stated previously, technical literature typically uses the R_w parameter. In order to reflect the likely *in-situ* performance of an element an appropriate correction should be applied for the expected reduction in performance. Note that in instances where significant flanking issues are present the *in-situ* performance may be further reduced.

VDV Vibration Dose Value (VDV). This is an assessment of the effect of building vibration on the people within. The VDV is the fourth root of the integral of the fourth power of acceleration after it has been frequency-weighted (as defined in BS6472: 2008). The frequency-weighted acceleration is measured in m/s^2 and the time period over which the VDV is measured is in seconds. This yields VDVs in $m/s^{1.75}$.