9. NOISE & VIBRATION

9.1 Introduction and Methodology

Potential noise and vibration impacts are assessed in this chapter. AWN Consulting Ltd. has been commissioned to carry out a noise and vibration impact assessment of the proposed mixed-use Phase 3 development at the Gateway Industrial Estate, Knocknacarra, Co. Galway. This section will provide information on the assessment of noise and vibration impacts on the surrounding environment during both the construction and operational phases. The principal objectives of the Noise and Vibration assessment will be to specify appropriate limit values and mitigation measures to ensure that the impact on the environment is minimised.

The proposed development comprises a mix of residential and retail units. The total gross site area comprises 2.8 hectares and is a greenfield site located adjacent to the Western Distributor Road.

In terms of the site, noise and vibration will be considered in terms of two aspects. The first is the outward impact of the development (i.e. the potential impact of the buildings on existing sensitive receptors in the study area) and the inward impact of existing noise and vibration sources on the development itself.

Assessment Overview

The study has been undertaken using the following methodology:

- Baseline noise monitoring has been undertaken across the development site to determine the range of noise levels at varying locations across the site;
- A review of the most applicable standards and guidelines has been conducted in order to set a range of acceptable noise and vibration criteria for the construction and operational phases of the proposed development, this is summarised in the following sections;
- Predictive calculations have been performed to estimate the likely noise emissions during the construction phase of the project at the nearest sensitive locations (NSL's) to the site;
- Predictive calculations have been performed to assess the potential impacts associated with the operation of the development at the most sensitive locations surrounding the development site;
- A schedule of mitigation measures has been proposed, where relevant, to control the noise and vibration emissions associated with both the construction and operational phases of the proposed development, and;
- The inward impact of noise in the surrounding environment into the proposed buildings has also been assessed to determine the requirements, for additional noise mitigation to provide suitable residential amenity.

Following a preliminary scoping exercise, it was concluded that the proposed development will not give rise to any noise impacts following commissioning, as operational phase emissions will be representative of a typical residential estate, similar to those seen across the surrounding area. The commissioned development will similarly not give rise to any vibration impacts.

Typical ambient noise levels across the local area have been measured, and these used to identify appropriate construction phase noise criteria. Proposed construction plant are also identified, and expected noise output data used to predict likely noise levels at surrounding receptors. Predicted levels are assess ed in the context of identified criteria, and mitigation measures, where required, are identified.

The following documents were consulted during the preparation of this chapter:

- Galway City Council Noise Action Plan 2019 – 2023 (NAP);
- BS 8233: 2014: Guidance on sound insulation and noise reduction for buildings;
- British Standard BS 4142: 2014: Methods for Rating and Assessing Industrial and Commercial Sound;
- Design Manual for Roads & Bridges – Volume 11 Section 3;
- British Standard BS 5228 (2009 +A1 2014): Code of Practice for Control of Noise and Vibration on Construction and Open Sites *Part 1: Noise & Part 2: Vibration;*
- British Standard BS 7385 (1993): Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration;
- *Calculation of Road Traffic Noise*, Department of Transport Welsh Office, HMSO, 1988;
- EPA: Guidance Note for Noise – Licence Applications, Surveys and Assessments in Relation to Scheduled Activities NG4 (2012);
- ISO 1996: 2017: Acoustics – Description, measurement and assessment of environmental noise, and;
- ISO 9613 (1996): Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation.

Statement of Authority

The noise and vibration assessment has been prepared by Dr. Aoife Kelly (Acoustic Consultant) who holds a BSc (Hons) in Environmental Health, a Diploma in Acoustics and Noise Control and a PhD in Occupational Noise and is a member of the Institute of Acoustics. Aoife has specialised in acoustics since 2014 and has extensive knowledge in the field of occupational noise risk assessments, environmental noise and vibration impact assessment and inward impact assessments. She has extensive experience in environmental and occupational noise surveying and environmental acoustics.

9.2 Guidance & criteria

9.2.1 Operational Noise Guidance (Outward & Inward Impacts)

Galway City Council Noise Action Plan

Here, consideration has been given to the content of the Galway City Council Noise Action Plan 2019 – 2023 (NAP). The policy states:

"Galway City Council will seek to address environmental noise from major roads within its functional area, will endeavour to maintain satisfactory noise environments where they exist and will have regard to acoustical planning in the planning process (within the confines of the 2000 Planning and Development Act as amended) to endeavour to ensure that future developments include provisions to protect the population from the effects of environmental noise in the interests of residential amenity and public health."

It is important to state the following extract from the document:

"Policy no. 9.10 Air Quality and Noise of the Galway City Development Plan 2017 – 2023 includes a policy to ensure that developments incorporate measures to minimise noise levels in their design, and reduce the emission and intrusion of any noise or vibration which might adversely impact on residential amenity, where appropriate.' Policy no. 9.10 also states that the NAP shall be considered in the assessment of relevant development applications, where appropriate and environmental noise reduction measures outlined therein shall be implemented."

This content will be reviewed and commented upon as appropriate in this and following sections.

In relation to noise limits the NAP states:

"There are no statutory limits in place in relation to environmental noise exposures at EU or national level. The EPA recommends that the proposed onset levels for assessment of noise mitigation measures for noise due to road traffic should be as follows:

- 70dB, Lden, and;
- 57dB, Lnight.

The proposed onset levels for assessment of noise level preservation for quiet areas, where the existing noise level is considered good are as follows:

- 55dB, Lden, and;
- 45dB, Lnight."

The long term aim of the NAP is to reduce the impact of environmental noise from major road sources to acceptable levels below 70dB (A) Lden and 57dB(A) Lnight at residential properties along major roads in the city.

Noise sensitive locations where a quieter noise environment is desirable is noted in the document as:

- Schools;
- Universities and third level colleges;
- Hospitals;
- Nursing homes and hospices, and;
- Places of worship.

The Galway City Council Noise Action Plan 2019 details measures required to lessen the effect of excessive noise in areas highlighted in associated noise maps. The onset assessment levels for noise mitigation measures are 70 dB Lden and 57 dB Lnight. The onset assessment levels for measures to preserve existing an noise situation are 55 dB Lden and 45 dB Lnight. These levels reflect an annual average 24 hour period.

The existing noise environment in the vicinity of the development will be commented upon in light of the above. The inward noise impact assessment presents in this chapter is based on the principles outlined in the Professional Guidance on Planning & Noise (ProPG) guidance document, which is currently considered a best practice approach in relation to the issue at hand.

Internal Noise (BS 8233)

There are no statutory guidelines or specific local guidelines relating to appropriate internal noise levels in dwellings. 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 several different building types 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 residential dwellings are set out in Table 9.1.

Table 9.1. Indoor Ambient Noise Levels for Dwellings from BS8233: 2014

Activity	Location	Day (07:00 to 23:00hrs)	Night (23:00 to 07:00hrs)
Resting	Living Room	35	--
Dining	Dining Room/Area	40	--
Sleeping (daytime resting)	Bedroom	35	30

BS 8233 also provides some guidance on individual noise events, it states:

"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_{AFMAX}, depending on the character and number of events per night. Sporadic noise events could require separate values."

Typically, a 45dB L_{AFmax} criterion is applied to individual noise events within bedrooms at night. This criterion is generally considered a noise level that should not typically be exceeded.

External Noise (BS 8233 Amenity Areas)

BS 8233 also provides desirable noise levels for external amenity areas such as gardens, patios and balconies. It states:

"For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited."

Offsite Noise Impacts

Once a development of this nature becomes fully operational, a variety of electrical and mechanical plant will be required to service the development. Most of this plant will be capable of generating noise to some degree. Some of this plant may operate 24 hours a day, and hence would be most noticeable during quiet periods (i.e. overnight). Noisy plant with a direct line-of-sight to noise sensitive properties would potentially have the greatest impact. Plant contained within plantrooms has the least potential for impact once consideration is given to appropriate design of the space.

The following wording would be considered typically suitable for a planning condition related to operational noise (plant) associated with a development of this nature:

"Noise levels from the proposed development should not be so loud, so continuous, so repeated, of such duration or pitch or occurring at such times as to give reasonable cause for annoyance to a person in any premises in the neighbourhood or to a person lawfully using any public space. In particular the rated noise levels from the proposed development shall not constitute reasonable grounds for complaint as provided for in B.S. 4142. Method for rating industrial noise affecting mixed residential and industrial area.

Reason: In order to ensure a satisfactory standard of development, in the interests of residential amenity."

The typical planning condition outlined above related to noise emissions from mechanical plant items makes reference to the *British Standard BS 4142: 2014: Methods for Rating and Assessing Industrial and Commercial Sound*. This document is the industry standard method for analysing building services plant noise emissions to residential receptors and is the document used by Galway City Council in their standard planning conditions and also in complaint investigations.

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 2dB penalty for a tone which is just perceptible at the noise receptor, 4dB where it is clearly perceptible, and 6dB 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 +10dB 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 +5dB 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.

Change in Traffic Noise Levels

The main potential source of outward noise impact associated with the proposed development relates to additional traffic flows on the surrounding road network. Given that traffic from the development will make use of existing roads already carrying traffic volumes, it is appropriate to consider the increase in traffic noise level that arises as a result of vehicular movements associated with the development.

In order to assist with the interpretation of the noise associated with vehicular traffic on public roads, Table 9.2 offers guidance as to the likely impact associated with any particular change in traffic noise level (Source DMRB, 2011).

Table 9.2. Likely Impact Associated with Change in Traffic Noise Level. Source: (DMRB 2011)

Change in Sound Level, dB(A)	Subjective Reaction	Magnitude of Impact
0	Inaudible	Neutral
0.1 – 2.9	Barely Perceptible	Imperceptible
3 – 4.9	Perceptible	Slight
5 – 9.9	Up to a doubling of loudness	Moderate
10+	Doubling of loudness and above	Significant

9.2.2 Construction Noise Guidance (BS 5228)

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. Local authorities normally control construction activities by imposing limits on the hours of operation and consider noise limits at their discretion.

In the absence of specific noise limits, appropriate criteria relating to permissible construction noise levels for a development of this scale may be found in the British Standard 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 exiting ambient noise levels in the absence of construction noise. This then sets a threshold noise value that, if exceeded at this location, indicates a potential significant noise impact is associated with the construction activities.

This document sets out guidance on permissible noise levels relative to the existing noise environment. Table 9.3 sets out the values which, when exceeded, signify a potential significant effect at the facades of residential receptors as recommended by BS 5228 – 1. These are cumulative levels, i.e. the sum of both ambient and construction noise levels.

Table 9.3. Example Threshold of Potential Significant Effect at Dwellings

Assessment category and threshold value period (L_{Aeq})	Threshold value, in decibels (dB)		
	Category A Note A	Category B Note B	Category C Note C
Night-time (23:00 to 07:00hrs)	45	50	55
Evenings and weekends Note D	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75

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

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

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

Note D) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

It should be noted that this assessment method is only valid for residential properties.

This assessment process determines if a significant construction noise impact is likely. Notwithstanding the outcome of this assessment, the overall acceptable levels of construction noise set out in the Transport Infrastructure Ireland (TII) publication *Guidelines for the Treatment of Noise and Vibration in National Road Schemes*[1], which should not be exceeded at noise sensitive locations during the construction phase of the development. Table 9.4 sets out these levels.

Table 9.4. Maximum Permissible Noise Levels at the Facade of Dwellings during Construction

Days and Times	Noise Levels (dB re. $2x10^{-5}$ Pa)	
	$L_{Aeq(1hr)}$	L_{Amax}
Monday to Friday 07:00 to 19:00hrs	70	80
Monday to Friday 19:00 to 22:00hrs	60*	65*
Saturdays 08:00 to 16:30hrs	65	75
Sundays & Bank Holidays 08:00 to 16:30hrs	60*	65*

Note * Construction activity at these times, other than that required for emergency works, will normally require the explicit permission of the relevant local authority.

In exceptional circumstances there may be a requirement that certain construction works are carried out during night-time periods. Therefore, based on the above the following construction noise criteria are proposed for the site:

- 65dB $L_{Aeq,1hr}$ at noise sensitive location
- 75dB $L_{Aeq,1hr}$ at commercial property

9.2.3 Vibration Guidance

Peak particle Velocity (PPV)

Peak particle velocity (PPV) is commonly used to assess the structural response of buildings to vibration. Reference to the following documents has been made for the purposes of this assessment in order to discuss appropriate PPV limit values.

- British Standard BS7385: 1993: Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration, and;
- British Standard BS5228-2: 2009 + A1: 2014: Code of practice for noise and vibration control on construction and open sites – Vibration.

[1] Guidelines for the Treatment of Noise and Vibration in National Road Schemes, Revision 1, 25 October 2004, Transport Infrastructure Ireland

BS5228-2 and BS7385 advise that, for soundly constructed residential property and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e. non-structural) damage should be taken as a peak component particle velocity (in frequency range of predominant pulse) of 15mm/s at 4Hz increasing to 20mm/s at 15Hz and 50mm/s at 40Hz and above. The standard also notes that below 12.5 mm/s PPV the risk of damage tends to zero.

The recommended vibration limits in order to avoid cosmetic damage to buildings, as set out in both documents referred to above, are reproduced in Table 9.5. The documents note that minor structural damage can occur at vibration magnitudes which are greater than twice those presented in Table 9.5. Major damage to a building structure is possible at vibration magnitudes greater than four times the values set out in the Table. It should be noted that these values refer to the base of the building.

Table 9.5. Transient Vibration Guide Values for Cosmetic Damage

Vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of		
4 to 15 Hz	**15 to 40Hz**	**40Hz and above**
15 mm/s	20 mm/s	50 mm/s

Human response to vibration stimuli occurs at orders of magnitudes below those associated with any form of building damage, hence vibration levels lower than those indicated in Table 9.5 can lead to concern. BS5228-2 also provides a useful guide relating to the assessment of human response to vibration in terms of PPV. Whilst the guide values are commonly used to compare typical human response to construction works, they tend to relate closely to general levels of vibration perception from other general sources. Table 9.6 summarises the range of vibration values and the associated potential effects on humans.

Table 9.6. Guidance on Effects of Human Response to PPV Magnitudes

Vibration Level, PPV	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies. At lower frequencies people are less sensitive to vibration.
0.3 mm/s	Vibration might be just perceptible in residential environments.
1 mm/s	It is likely that a vibration level of this magnitude in residential environments will cause complaint.

The standard notes that single or infrequent occurrences of these levels do not necessarily correspond to the stated effect in every case. Where these values are routinely measured or expected then an assessment in accordance with BS 6472-1 might be more appropriate to determine whether time varying exposure is likely to give rise to any degree of adverse comment.

Vibration Dose Value (VDV)

Guidance relating to human response to vibration is contained within BS 6472 Guide to evaluation of human exposure to vibration in buildings (2008): Part 1 - Vibration sources other than blasting.

BS 6472 uses the Vibration Dose Value (VDV) which is measured or forecast over the day or night-time periods in terms of $m/s^{1.75}$. The VDV parameter takes into account how people respond to vibration in terms of frequency content, vibration magnitude and the number of vibration events during an assessment period.

The following table, as set out in the standard, details the values of VDV where various comments from occupiers are possible. The standard notes that the values are applicable for both vertical and horizontal vibration with the appropriate weighting applied. The values in Table 9.7 will be adopted for this assessment.

Table 9.7. VDV (m/s-1.75) above which Various Degree of Adverse Comment may be Expected in Residential Buildings

Building Type	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential building – Day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential building – Night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

9.3 Baseline Environment

9.3.1 Location & Land Use

The site area comprises approximately 2.8 hectares of land located within the townland of Rahoon, to the west of Galway City. The site is bounded by Gort na Bro to the east and the retail park link road to the west. The Western Distributor Road, an arterial route serving the city, is located to the south. The surrounding area is characterised by the established residential suburb of Knocknacarra. The lands adjoining the site to the west are the location of the Gateway Retail Park.

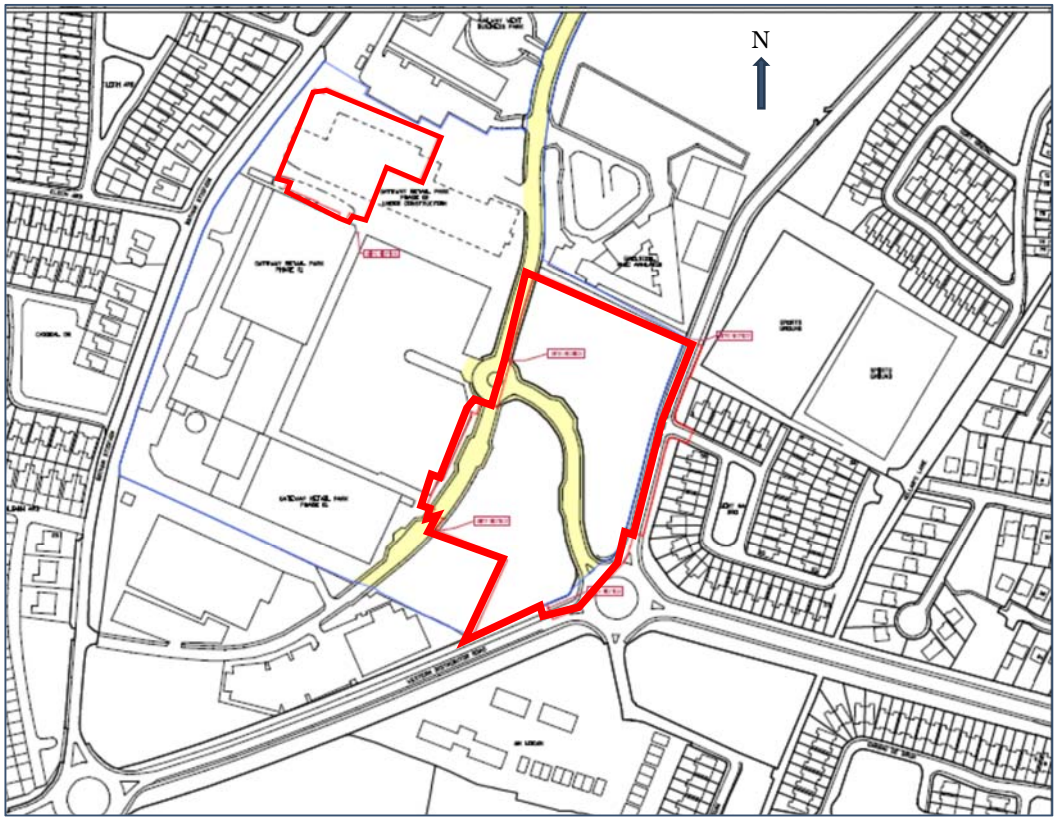

Figure 9.1: Proposed development site outlined red.

9.3.2 Receptors

The site is greenfield land, separated into two sites. Site 1 is bounded by the Western Distributor Road to the south, commercial lands/plots to the west and residential properties to the east. Site 2 is located to the north of Site 1 and is bounded by a school to the north, residential properties to the east and commercial lands/plots to the west. The existing noise and vibration environments across the development site and in the vicinity of the nearest existing noise sensitive locations are dictated by

transportation sources in the study area including the existing Western Distributor Road and Gort na Bró.

The nearest existing residential noise sensitive locations to the proposed development are those located in the Gort na Bró estate some 20m to the east of Site 2 and those residential properties in the Logan estate some 35m to the south of Site 1, along Western Distributor Road.

Apart from the receptors identified above, there is an educational facility located 10m adjacent to the northern section of Site 2.

9.3.3 Ambient noise survey

Baseline noise monitoring has been undertaken across the development site to determine the range of noise levels at varying locations across the site and to establish the existing noise climate the nearest noise sensitive locations and across the development site itself.

The survey was conducted in general accordance with *ISO 1996: 2017: Acoustics – Description, measurement and assessment of environmental noise*. Specific details are set out below.

Choice of Measurement Locations

Unattended noise monitoring was undertaken at one location within the development site (N1). An additional three attended monitoring locations (N2 to N4) were undertaken within the site representative of the existing noise environment at the closest noise sensitive locations and the noise climate within the development site. The locations are described below in Table 9.8 and shown in Figure 9.2 and Plates 9.1-9.4.

Table 9.8. Measurement Locations

Station	ITM NGR	Description	Reason
N1	527718, 725074	Unattended monitor. South west corner of site along Western Distributor Road.	The data collected at this location has been used to predict expected noise levels across the development site which in turn have been used to inform the ProPG assessment presented in the body of this chapter.
N2	526847, 725127	Attended monitoring E of Site 1, 80m from nearest dwelling at Gort na Bró and 100m from nearest dwelling at An Logán	This is considered to be representative of noise levels at nearest noise sensitive locations in the Logan Housing Estate, to the south of the proposed development site, as it was set back a comparable distance from the Western Distributor Road.
N3	526842, 725207	Attended monitoring N of Site 2, 100m from school.	To represent school to north east and dwellings in the Gort na Bró estate
N4	526732, 725101	Attended monitoring SW of the corner of Site 1, along common boundary site with commercial lands to the W.	To represent commercial properties to the west

Figure 9.2 Noise Monitoring Locations (Source : Google Earth)

Plate 9-1 N1, looking SE towards dwellings at An Logán

Plate 9-2 N2, looking E towards dwellings at Gort na Bró

Plate 9-3 N3, looking N towards school

Plate 9-4 N4, looking NE towards existing commercial properties.

Survey Periods

The survey was undertaken over the following surveys periods:

Unattended noise monitoring was undertaken at N1 was undertaken between 14:16hrs on 15 February 2019 and 11:10hrs on 18 January 2019, and 14:19hrs on 22 February 2019;

Attended noise monitoring was undertaken at Locations B to D between 10:55 to 13:40hrs on 15 February 2019 and 11:33 to 14:15hrs on 22 February 2019.

Monitoring Equipment

The surveys were undertaken using the following monitoring equipment:

Table 9.9. Instrumentation Details

Location	Manufacturer	Model	Serial Number
N1-N4	Brüel & Kjaer	2250	2479724

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 instantaneous maximum sound level measured during the sample period using the 'F' time weighting.

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.

Survey Results

The results of the noise monitoring completed at the various locations are discussed in the following sections.

Unattended Noise Monitoring

Location N1

Table 9.10 reviews the measured noise levels at Location N1. Road traffic noise was the dominant noise sources noted at this location, along with intermittent construction noise from a nearby site during the daytime. Full survey data is included in Appendix 9.1.

Table 9.10. Noise Monitoring Results at Location A

Period	Measured Noise Levels, dB	
	$L_{Aeq,16hr}$	$L_{A90,16hr}$
Day (07:00 – 23:00hrs)	58	50
Period	Measured Noise Levels, dB	
	$L_{Aeq,8hr}$	$L_{A90,8hr}$
Night (23:00 – 07:00hrs)	51	38

Daytime noise levels along the boundary of the site with the Western Distributor Road are the order of 58dB $L_{Aeq,16hr}$ with ambient and background noise levels being dictated by road traffic and intermittent construction noise. Background noise levels across the sample day period were the order 50dB $L_{A90,16hr}$.

Again, road traffic movements along the Western Distributor Road dictated overall ambient noise levels at this location during the night-time period with levels of the order of 51dB $L_{Aeq,8hr}$ being reported. With the reduction of traffic volumes over the night period the background noise levels reduced to an average of 38dB $L_{Aeq,8hr}$.

The L_{AFmax} levels are also of an interest here, in particular in relation to night-time periods. The L_{AFmax} values were measured at 15-minute intervals over the duration of the unattended monitoring survey. Figure 9.3 presents the distribution of the magnitude of L_{AFmax} events during the night period at the noise monitoring location considered for this assessment. More than 200 events measured above 60dB L_{AFmax}. Two events were measured at or above 80dB L_{AFmax}.

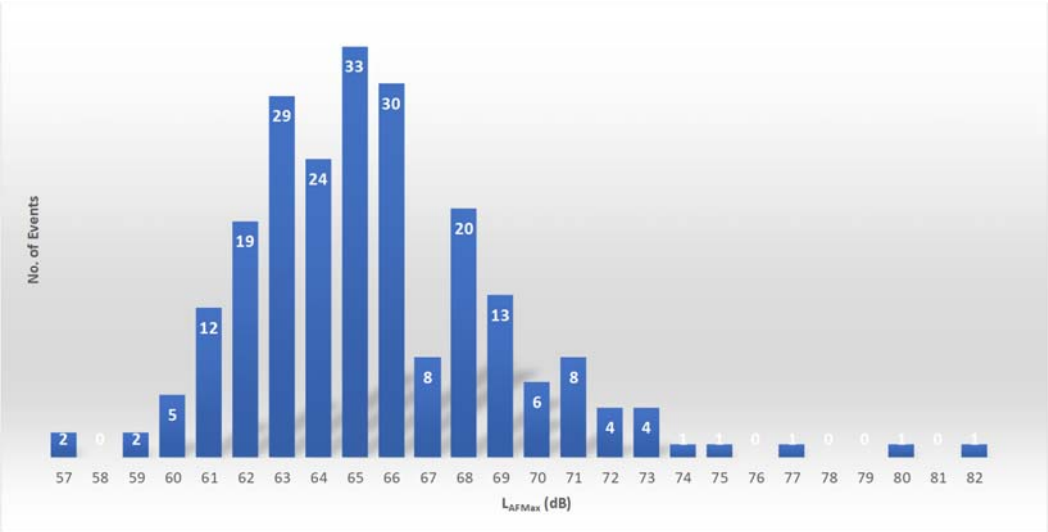

Figure 9.3 Number of LAFmax Events Measured During the Night Periods

Note these levels were measured inside the perimeter of the site and some consideration needs to be given to slightly elevated noise levels that will be expected at the facades of the proposed buildings. This will be discussed and considered as appropriate in relation to the inward noise impact assessment presented in the body of this report.

No significant level of vibration was noted at this location during setup and removal of the equipment from site.

Location N2

Table 9.11 presents the results of the noise monitoring completed at Location N2 (i.e. representative of nearby residential properties).

Table 9.11. Noise Monitoring Results at Location N2

Date	Period	Time	Measured Noise Levels, dB		
			L_{Aeq}	L_{AFmax}	L_{A90}
15 February 2019	Day	10:55-11:10	62	73	55
		11:52-12:07	60	71	55
		12:48-13:03	62	73	55
22 February 2019		11:33-11:48	62	73	57
		12:29-12:44	62	71	55
		13:25-13:40	64	85	57

Daytime ambient noise levels at this location were dictated by the movement of local car movements, traffic noise from the Western Distributor Road, intermittent construction noise from a nearby site and a degree of bird song noise. Background noise levels were typically dictated by distant road traffic activity in the wider area. Noise levels were in the range of 60 to 64dB $L_{Aeq,15min}$ and 55 to 57dB $L_{A90,15min}$.

No significant level of vibration was noted at this location during site attendances.

Location N3

Table 9.12 presents the results of the noise monitoring completed at Location N3.

Table 9.12. Noise Monitoring Results at Location N3

Date	Period	Time	Measured Noise Levels, dB		
			L_{Aeq}	L_{AFmax}	L_{A90}
15 February 2019	Day	11:14-11:29	62	79	52
		12:09-12:24	62	72	53
		13:06-13:21	62	75	54
22 February 2019		11:50-12:05	62	77	55
		12:47-13:02	62	75	51
		13:42-13:57	62	79	52

Road traffic noise from the nearby Western Distributor Road was the dominant noise source noted at this location. Intermittent local traffic and construction noise from a nearby site were also noted as a source of noise. Noise levels were 62dB $L_{Aeq,15min}$ and 51 to 54dB $L_{A90,15min}$.

No significant level of vibration was noted at this location during site attendances.

Location N4

Table 9.13 presents the results of the noise monitoring completed at Location N4.

Table 9.13. Noise Monitoring Results at Location N4

Date	Period	Time	Measured Noise Levels, dB		
			L_{Aeq}	L_{AFmax}	L_{A90}
15 February 2019	Day	11:33-11:48	68	84	53
		12:28-12:43	69	89	54
		13:25-13:40	68	85	54
22 February 2019		12:08-12:23	69	85	56
		13:06-13:21	68	85	54
		14:00-14:15	68	84	53

Road traffic noise from the nearby Western Distributor Road was the dominant noise source noted at this location. Intermittent local traffic and construction noise from a nearby site were also noted as a source of noise. Noise levels were in the range of 68 to 69dB $L_{Aeq,15min}$ and 53 to 56dB $L_{A90,15min}$.

No significant level of vibration was noted at this location during site attendances.

9.3.4 Characteristics of the proposed development

The proposed development comprises a mixed-use development of residential apartments and various ground floor commercial units. The development also includes ancillary developments including car and bicycle parking areas, internal road layouts and landscaping. A full description of the development can be found in Chapter 3.

The potential noise and vibration impact on the surroundings are considered for both the construction and operational phases of this development.

During the construction phase the main site activities will include site clearance, foundation works, building construction, road works, and landscaping. This phase has the greatest potential noise and vibration impacts on its surrounding environment, however this phase will be of short-term impact.

During the operational phase of the development, the primary source of outward noise in the operational context relates to any changes in traffic flows along the local road network and building services noise associated with commercial spaces.

The potential associated with each phase is assessed in the following sections.

9.4 Potential Impact of the Proposed Development

9.4.1 Construction Phase - Noise

A variety of items of plant will be in use for the purposes site clearance and construction. The type and number of equipment will vary between the varying construction phases depending on the phasing of the works. 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.

The closest noise sensitive locations to the main building works is the school to the north, which is at a distance of 10m to the site boundary. Other sensitive receptors are the residential properties to the east (Gort Na Bró) and south (An Logán), which are at distances of approximately 25m and 50m from building construction works respectively. The nearest commercial properties are to the west of the site, at approximately a 35m distance. These distances relate to the closest boundaries to the nearest

residential noise sensitive locations. The remainder of works will take place across the site at varying distances. Reference to the noise baseline survey results (Section 10.3) and guidance contained in BS 5228 Part 1 for construction noise levels discussed in Table 9.3, the threshold for significance from constriction activities is set as follows for the closest residential noise sensitive locations:

Significance Category - A: ,

Daytime (08:00 – 19:00hrs)/ Saturdays (08:00 – 14:00hrs) **65dB $L_{Aeq,1hr}$**

Evening and Weekends **55dB $L_{Aeq,1hr}$**

An appropriate construction noise limit at the nearest commercial buildings is considered to be **75dB $L_{Aeq,1hr}$**.

Due to the fact that the construction programme has been established in outline form only, it is difficult to calculate the actual magnitude of noise emissions to the local environment. However, it is possible to predict typical noise levels using guidance set out in *BS 5228-1: 2009 +A1 2014*. Table 9.14 outlines typical plant items and associated noise levels that are anticipated for various phases of the construction programme.

Table 9.14. Typical Noise Levels Associated with Construction Plant Items

Item of Plant (BS 5228-1 Ref.)	Construction Noise Level at 10m Distance (dB $L_{Aeq(1hour)}$)	No of Items assumed	Item of Plant (BS 5228-1 Ref.)
Site Preparation/ Clearance	Track Excavator (C2 22)	72	3
	Wheeled Loader Lorry (C2.28)	76	2
	Dozer (C2.13)	78	2
	Dump Truck (C4.2)	78	2
	Generator (C4.78)	66	2
	Water pump (C2.45)	65	2
Substructure	Dump truck (tipping fill) C2.30	79	2
	Tracked Excavator (C3.24)	74	3
	Concrete Pump (C3.25)	78	2
	Compressor (D7 6)	77	2
	Poker Vibrator (C4 33)	78	2
Steel Erection	Mobile Telescopic Crane 100 tonne(C4.41)	71	2
	Telescopic Handler 4 tonne (C.4.54)	70	2
	Articulated lorry (C11.10)	77	2
General Construction	Hand tools	81	4
	Pneumatic Circular Saw (D7.79)	75	3
	Internal fit – out	70	2
Landscaping	Dozer (C2.13)	78	4
	Dump Truck (C4.2)	78	4
	Surfacing (D8.25)	68	2

Predictions have been presented for construction works associated with the key phases of the proposed development at the school to the north (N1) and the closest residential dwellings located to the east (N2) and south (N3) of the proposed development illustrated in Figure 9.4.

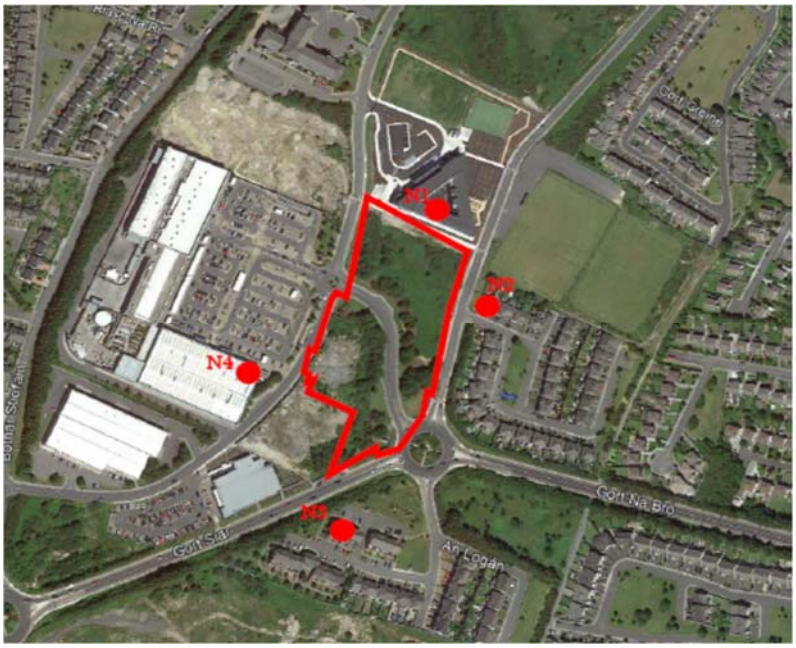

Figure 9.4 Noise Assessment Locations

Predictions are based on the utilisation of plant for 66% of a working day and assume no screening between the works and the calculated locations. The distances used in the calculations for all construction works are based on the closest distance between construction works and the nearest noise sensitive locations assessed. For the purpose of the assessment, a standard site hoarding of 2.4m high has been included in the calculations for noise sensitive boundaries. Prediction calculations are presented in Table 9.15.

Table 9.15. Review of Potential Construction Noise Impacts

Location	Phase	Predicted Construction Noise Level $L_{Aeq(1hour)}$ (dB)	Daytime Construction Noise Criteria $L_{Aeq(1hour)}$ (dB)	Complies?
N1 (North - School)	Site clearance/ preparation	76	65	N
	Substructure	78		N
	Steel Erection	72		N
	General Construction	78		N
	Landscaping	77		N
N2 (East-Residential)	Site clearance/ preparation	63	65	Y
	Substructure	65		Y
	Steel Erection	59		Y
	General Construction	65		Y
	Landscaping	64		Y
N3 (South-Residential)	Site clearance/ preparation	55	65	Y
	Substructure	57		Y
	Steel Erection	51		Y
	General Construction	58		Y
	Landscaping	57		Y
N4 (West-Commercial)	Site clearance/ preparation	59	75	Y
	Substructure	61		Y
	Steel Erection	55		Y
	General Construction	62		Y
	Landscaping	61		Y

The worst-case predicted noise levels detailed in the Table 9.15 above indicate that, during the main building works, the residential and commercial properties would not be expected to exceed the

significance threshold of 65dB $L_{Aeq,1hr}$ and 75dB $L_{Aeq,1hr}$ respectively. At these nearest locations the associated construction noise impact is not considered significant.

Due to the close proximity of the school (north of site) i.e. school building is some 10m distance from site boundary, there is a potential for the adopted criteria to be exceeded when construction works are taking place immediately along the northern works boundary. This assumes, however, that all items of equipment assessed are operating simultaneously along this boundary. Given that these noise levels constitute worst case conditions with the listed construction activities all being conducted at the closest development area to the nearest noise sensitive location, actual construction noise level emission will likely be lower than the levels listed above. Notwithstanding, suitable noise mitigation measures must be adopted to reduce the noise exposure at this location e.g. restricted operating hours during school times when works are within 25m distance of northern site boundary.

A schedule of best practice noise mitigation measures is included in Section 9.7.

9.4.1.1 Construction Traffic

No construction traffic information has been made available. An increase of 25% in traffic is required to increase overall traffic noise levels by 1dB, which is insignificant in the overall context of the noise environment along the four roads in the immediate vicinity of the site. Therefore, the short-term noise environment assumed for this project is expected to be within at least 1dB of the baseline scenario, which would give a magnitude of increase in traffic noise that is negligible and is not significant.

9.4.2 Construction Phase – Vibration

Potential for vibration impacts during the construction phase programme are likely to be limited given the ground-breaking, piling and excavations required. There is potential for piling to be used for foundations for apartment buildings. For the purposes of this assessment the expected vibration levels during piling assuming augured or bored piles have been determined through reference to published empirical data. The British Standard BS 5228 – Part 2: Vibration, publishes the measured magnitude of vibration of rotary bored piling using a 600mm pile diameter for bored piling into soft ground over rock, (Table D.6, Ref. No. 106):

- 0.54mm/s at a distance of 5m, for auguring;
- 0.22mm/s at a distance of 5m, for twisting in casing;
- 0.42mm/s at a distance of 5m, for spinning off, and;
- 0.43mm/s at a distance of 5m, for boring with rock auger.

Considering the low vibration levels at very close distances to the piling rigs, vibration levels at the nearest buildings are not expected to pose any significance in terms of cosmetic or structural damage. In addition, the range of vibration levels is typically below a level which would cause any disturbance to occupants of nearby buildings.

In this instance, taking account of the distance to the nearest sensitive off-site buildings, vibration levels at the closest neighbouring buildings are expected to be orders of magnitude below the limits set out in Table 9.5 to avoid any cosmetic damage to buildings. Vibration levels are also expected to be below a level that would cause disturbance to building occupants, as set out in Table 9.6. The potential vibration impact during the construction phase if of short-term, neutral and imperceptible impact.

9.4.3 Operational Phase – Noise

Once the development is operational, the potential noise impacts to the surrounding environment are minimal. The residential aspect of the development is not expected to generate any significant noise sources over and above those which form part of the existing environment at neighbouring residential

areas (road traffic noise, estate vehicle movements, children playing etc.) and hence no significant impact are expected from this area of the development site.

The main potential noise impact associated with the proposed development is considered therefore to relate to the generation of additional traffic to and from the site as a result of the new residential and commercial buildings. Potential noise impacts also relate to operational plant serving the commercial and apartment buildings, where relevant.

Once operational, there are no vibration sources associated with the development site.

9.4.3.1 Additional Vehicular Traffic on Surrounding Roads

For the purposes of assessing potential noise impact, it is appropriate to consider the relative increase in noise level associated with traffic movements on existing roads and junctions with and without the development given that traffic from the development will make use of the existing road network.

A traffic impact assessment relating to the proposed development has been prepared by Atkins as part of this EIAR. Information from this report has been used to determine the predicted change in noise levels in the vicinity of a number of roads in the area surrounding the proposed development i.e. PCUs for the baseline + committed (existing levels in 2018 plus Phase 2 traffic) and opening year with development (Phase 3). The calculated change in noise levels during these two years are summarised in Table 9.16.

Table 9.16. Change in Traffic Noise Levels with Proposed Development

Link	Link Name	NSL ID	2018 Baseline + Committed	2020 Opening Year with Development	Change in noise levels, dB
3	Gort na Bró/Unnamed road (internal)	N1-School	458	473	0.8
4	Retail Park Internal Roundabout	N4- Commercial	1351	1543	1.6
5	Gort na Bró/Unnamed road (external)	N2- Gort na Bró estate	876	975	1.1
6	Gort na Bró/Western Distributor	N3- An Logán estate	1587	1690	0.9

The predicted increase in PCU traffic levels associated with the development is between 0.8-1.6dB(A) in the vicinity of the majority of roads assessed for the opening year. This is largely due to the existing volume of traffic along the surrounding road network onto which the development traffic will travel. Reference to Table 9.2 confirms that this increase is barely perceptible and of imperceptible effect.

In summary, the predicted increase in noise levels associated with vehicles at road junctions in the vicinity of the proposed development is of long-term imperceptible impact.

9.4.3.2 Building Services Plant

Once operational, there will be building services plant items required to serve the commercial and residential aspect of the development. These will typically be limited to heating and cooling plant and extract units, depending on the building design and user requirements. Given the use of these buildings, the majority of commercial plant items are likely to be required during daytime hours only, however, there may be requirement for night-time operational plant, depending on specific requirements.

As the location or type of building services plant has not yet been established, therefore it is not possible to calculate noise levels to the surrounding environment. In this instance, it is best practice to set appropriate noise limits that will inform the detailed design during the selection and layout of building services for the development.

The plant will be selected at a later stage, however, they will be designed and located so that there is no negative impact on sensitive receivers within the development itself. The cumulative operational noise level from building services plant at the nearest noise sensitive location within the development (e.g. apartments, etc.) will be designed/attenuated to meet the relevant BS 4142 noise criteria for day and night-time periods as set out in this assessment.

The apartments will be provided with mechanical ventilation with heat recovery systems. These MVHR systems will be ducted to louvres on the apartment façade. Based on the 39W power consumption of the proposed MVHP unit being considered, it is understood that the unit offers the following noise levels at maximum power consumption, as summarised in Table 9.17 below.

Table 9.17. Sound Power Levels of Heat Recovery Units

39W power consumption	Sound Power Level per Octave Band Centre Freq (Hz)								L_{wA}	L_{pA} at 3m
	63	125	250	500	1000	2000	4000	8000	dB	dB
Open Inlet	44	39	46	44	36	34	20	19	44	26
Open Outlet	44	48	52	53	48	41	29	25	53	36
Breakout	50	48	51	48	38	33	25	21	48	30

Based on the baseline noise data collected for this assessment it is considered an appropriate design criterion is the order of **40dB $L_{Aeq,15min}$** during daytime periods and **35dB $L_{Aeq,15min}$** at night. This limit is set in order to achieve acceptable internal noise levels within residential spaces based on prevailing noise levels in the area. Provision of heat recovery units with the ratings detailed above will achieve these limits.

Taking into account that sensitive receivers within the development are much closer than off-site sensitive receivers, once the relevant noise criteria is achieved within the development it is expected that there will be no negative impact at sensitive receivers off site.

9.5 Potential cumulative impacts

The proposed development combined with other permitted developments in the area have the potential to result in cumulative noise or vibration impacts at surrounding noise sensitive locations during the construction and operational phases of the development.

The baseline scenario as measured, takes into account existing road traffic and other noise sources in the area.

Potential operational cumulative impacts relate to increased traffic flows resulting from other developments and any building services plant from other sources. The traffic noise assessment discussed in Table 9.16 considers the cumulative impact of this proposed development combined with existing flows and those associated with the residential development permitted in the wider area and future zoned lands. The noise impacts are determined to be long-term, imperceptible.

There are no expected cumulative noise impacts associated with building services plant from the proposed development and other development in the vicinity at external noise sensitive locations. The operation of any mechanical or electrical services associated with the proposed development will be designed to ensure the overall impact is deemed to be long-term and not significant.

9.6 'Do Nothing' Impact

In the absence of the proposed development being constructed, the noise environment at the nearest noise sensitive locations and across the development site itself will remain largely unchanged. The noise and vibration levels measured/noted during the baseline studies are considered representative of the Do-Nothing scenario. The Do-Nothing scenario is therefore considered neutral impact.

9.7 Avoidance, Remedial & Mitigation Measures

9.7.1 Construction Phase

Best practice noise and vibration control measures will be employed by the contractor during the construction phase in order to avoid significant impacts at the nearest sensitive buildings. The best practice measures set out in BS 5228 (2009 +A1 2014) Parts 1 and 2 will be complied with. This includes guidance on several aspects of construction site mitigation measures, including, but not limited to:

- selection of quiet plant;
- noise control at source;
- screening, and;
- liaison with the public.

Further comment is offered on these items in the following paragraphs. Noise control measures that will be considered include the selection of quiet plant, enclosures and screens around noise sources, limiting the hours of work and noise monitoring, where required.

Selection of Quiet Plant

This practice is recommended in relation to static plant such as compressors and generators. It is recommended that these units be supplied with manufacturers' proprietary acoustic enclosures. The potential for any item of plant to generate noise will be assessed prior to the item being brought onto the site. The least noisy item should be selected wherever possible. Should a particular item of plant already on the site be found to generate high noise levels, the first action should be to identify whether or not said item can be replaced with a quieter alternative.

Noise Control at Source

If replacing a noisy item of plant is not a viable or practical option, consideration will be given to noise control "at source". This refers to the modification of an item of plant or the application of improved sound reduction methods in consultation with the supplier. For example, resonance effects in panel work or cover plates can be reduced through stiffening or application of damping compounds; rattling and grinding noises can often be controlled by fixing resilient materials in between the surfaces in contact.

The following best practice migration measures should be considered:

- Site compounds should be located away from noise sensitive boundaries within the site constraints. The use lifting bulky items, dropping and loading of materials within these areas should be restricted to normal working hours.
- For mobile plant items such as cranes, dump trucks, excavators and loaders, maintaining enclosure panels closed during operation can reduce noise levels over normal operation. Mobile plant should be switched off when not in use and not left idling.
- For steady continuous noise, such as that generated by diesel engines, it may be possible to reduce the noise emitted by fitting a more effective exhaust silencer system.

- For percussive tools such as pneumatic breakers, a number of noise control measures include fitting muffler or sound reducing equipment to the breaker 'tool' and ensure any leaks in the air lines are sealed. Erect localised screens around breaker or drill bit when in operation in close proximity to noise sensitive boundaries.
- For concrete mixers, control measures should be employed during cleaning to ensure no impulsive hammering is undertaken at the mixer drum.
- For all materials handling ensure that materials are not dropped from excessive heights, lining drops chutes and dump trucks with resilient materials.
- For compressors, generators and pumps, these can be surrounded by acoustic lagging or enclosed within acoustic enclosures providing air ventilation.
- All items of plant should be subject to regular maintenance. Such maintenance can prevent unnecessary increases in plant noise and can serve to prolong the effectiveness of noise control measures.

Screening

Screening is an effective method of reducing the noise level at a receiver location and can be used successfully as an additional measure to all other forms of noise control. Standard construction site hoarding (2.4m in height) with a mass per unit of surface area greater than 7 kg/m2 can provide adequate sound insulation. This is recommended, as a minimum around the south, south-east and south-west perimeters.

Liaison with the Public

A designated noise liaison officer will appointed to site during construction works. Any noise complaints should be logged and followed up in a prompt fashion by the liaison officer. In addition, prior to particularly noisy construction activity, e.g. piling, the liaison officer will inform the nearest noise sensitive locations of the time and expected duration of the noisy works.

Project Programme

The phasing programme will be arranged so as to control the amount of disturbance in noise and vibration sensitive areas at times that are considered of greatest sensitivity. If piling works are in progress on a site at the same time as other works of construction that themselves may generate significant noise and vibration, the working programme will be phased so as to ensure noise limits are not exceeded due to cumulative activities. This will be reviewed in relation to other potential cumulative works occurring on adjacent construction site in close proximity to noise sensitive properties which have the potential to lead to significant construction noise impacts.

9.7.2 Operational Phase

During the operational phase of the development, noise mitigation measures with respect to the outward impact of the development are not deemed necessary.

9.7.2.1 Additional Traffic on Adjacent Roads

During the operational phase of the development, noise mitigation measures with respect to the outward impact of traffic from the development are not deemed necessary.

9.7.2.2 Building Services Plant

Taking into account that sensitive receivers within the development are much closer than off-site sensitive receivers, once the relevant noise criteria included in Section 10.5 (i.e. 40dB $L_{Aeq,15min}$ at noise

sensitive locations within the proposed development itself). is achieved within the development it is expected that there will be no negative impact at sensitive receivers off site, and therefore no further mitigation required.

9.8 Predicted Impacts of the Proposed Development

9.8.1 Construction Phase

During the construction phase of the project there is the potential for temporary noise impacts on nearby noise sensitive properties due to noise emissions from site activities. The application of binding noise limits and hours of operation, along with implementation of appropriate noise and vibration control measures, will ensure that noise and vibration impact is kept to a minimum as far as practicable.

During periods when construction works are occurring at distances of up to 25m from the nearest noise sensitive locations to the site boundary, there is potential for temporary, negative, moderate to significant noise impacts to occur.

For the remainder of construction periods, construction noise impacts will be short-term, negative, slight to moderate.

Vibration impacts during the construction phase will be short-term and negligible.

9.8.2 Operational Phase

The predicted change noise levels associated with additional traffic is predicted to be of imperceptible impact along the existing road network. In the context of the existing noise environment, the overall contribution of induced traffic is considered to be of neutral, imperceptible and long-term impact to nearby residential locations.

Noise levels associated with building services plant are expected to be well within the adopted day and night-time noise limits at the nearest noise sensitive properties taking into account the site layout, the nature and type of units proposed and distances to nearest residences. Assuming the operational noise levels do not exceed the adopted design goals, the resultant residual noise impact from this source will be of neutral, imperceptible, long term impact.

9.9 Monitoring

9.9.1 Construction Phase

The contractor will be required to ensure construction activities operate within the noise limits set out within this assessment. The contractor will be required to undertake regular noise monitoring at locations representative of the closest sensitive locations to ensure the relevant criteria are not exceeded.

Noise monitoring should be conducted in accordance with the International Standard ISO 1996: 2017: *Acoustics – Description, measurement and assessment of environmental noise*.

9.9.2 Operational Phase

Noise or vibration monitoring is not required once the development is operational.

9.10 Reinstatement

Not applicable.

9.11 Interactions

In compiling this impact assessment, reference has been made to the project description provided by the project co-ordinators, project drawings provided by the project architects and traffic flow projections associated with the development provided by the traffic consultants.

9.12 Difficulties Encountered in Compiling

No difficulties were encountered in compiling this chapter.

9.13 Inward Noise Impact

The development lands in question are in proximity to the Western Distributor Road to the south of the site and Gort na Bró road to the east of the site. The link road between the development and the other Phase 1 and Phase 2 commercial units will also be realigned to pass through the centre of the site. The operation of these roads elements are potential noise sources to the residential developments proposed for the site itself.

9.13.1 Existing Noise Climate

The existing noise and vibration climate within the development lands was surveyed and the results summarised in Section 9.3.3 of this report. The results of the survey have indicated that the Western Distributor Road, Gort na Bró, Link and local roads contribute significant noise levels at the measurement locations on all boundaries of the site.

In order to determine the inward noise impact for noise sensitive properties proposed as part of the development, it is necessary to determine the internal noise levels within the proposed buildings. These can then be compared against appropriate internal noise criteria from BS 8233, as summarised in Section 9.2.2 (Table 9.3).

It is possible to calculate internal noise levels within the residential properties proposed within the site, taking account of the existing and future potential noise environment, proposed constructions and the relevant sound insulation provided by the building elements (i.e. walls, roof, glazing etc.).

9.13.2 Noise Model of Site

In order to calculate noise levels across the site, an acoustic model was developed in order to initially calibrate against noise survey data recorded on site. 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 selected source.

The following information was included in the model:

- Site layout drawings of proposed development, and;
- OS mapping of surrounding environment.

9.13.3 Calibration of Noise Model

Noise levels recorded during the unattended survey location N1 was used to calibrate the noise model. Noise levels are calculated at the same locations using the developed noise model. The results are presented in Table 9.18 below for daytime periods, i.e. 07:00 to 23:00hrs and night-time periods, 23:00 to 07:00hrs and compared against those measured on site.

Table 9.18. Predicted & Measured Noise Levels at Development Site

Location	Time Period	Measured Noise Level, dB	Predicted Noise Level, dB
N1	Daytime, $L_{Aeq,16hr}$	57	57
	Night-time, $L_{Aeq,16hr}$	50	50

The model results are considered an accurate representation of road noise levels across the site, taking account other sources that contribute to the noise environment at the monitoring locations also.

Figures 9.5 and 9.6 display the calculated noise contours across the existing site for day and night-time periods at a height of 4m above ground. The results of the modelling exercise demonstrate that highest noise levels are experienced along the site boundaries on all four existing roads (Western Distributor, Gort na Bró, Link road and local road within Gateway development. As there is no existing screening from buildings on site, the noise levels only reduce by the order of 5dB to 10dB as the distance from the road increases in the centre of the site. The lowest levels are provided to the north due to screening afforded by the existing school building adjacent to the greenfield site.

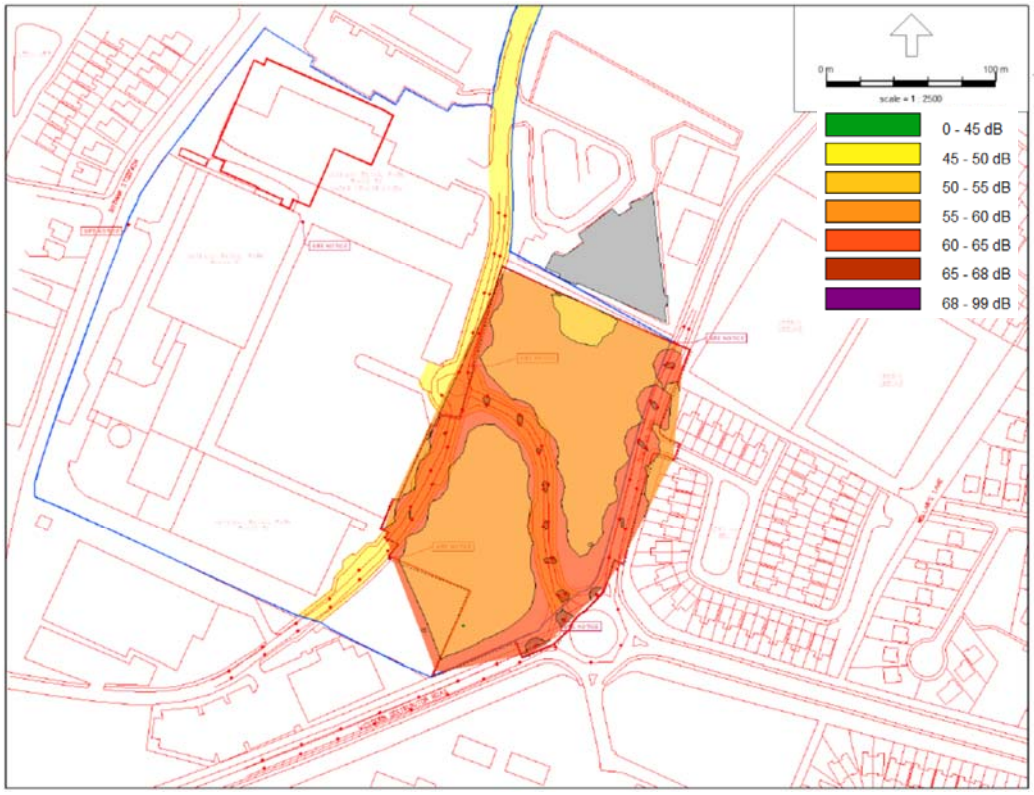

Figure 9.5 Predicted Existing Noise Contour Across the Development Site – Daytime

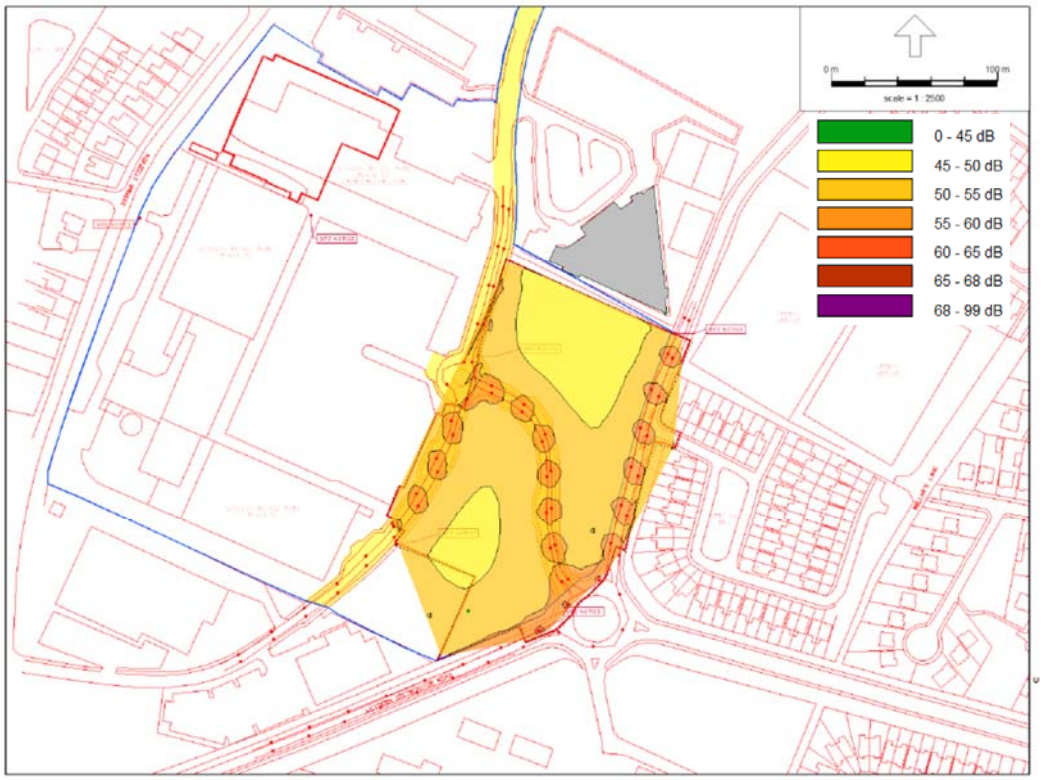

Figure 9.6 Predicted Existing Noise Contour Across the Development Site – Night

Road traffic noise levels calculated across the site during daytime periods are highest along the western, eastern, southern boundaries along with the lands immediately in the vicinity of the link road cross sectioning through the site from west to south east (60-65dB $L_{Aeq,16hr}$). As the distance from the roads increases, the noise level decreases across the site (55-60dB $L_{Aeq,16hr}$). A small portion of the northern boundary of the site has a reduced calculated noise level, 50–55dB $L_{Aeq,16hr}$, due to screening offered by the existing school building on the adjacent site.

Road traffic noise levels calculated across the site during night-time periods are highest along the south eastern boundary and in the immediate vicinity of the roads bounding the site (55-60dB $L_{Aeq,8hr}$). As the distance from the roads increases, the noise level decreases across the site (50-55dB $L_{Aeq,8hr}$). A northern section of the site has a reduced noise level <50dB $L_{Aeq,8hr}$, due to screening offered by the existing school building on the adjacent site.

The ProPG document is the most relevant and recent document used to assess new residential development in an area with an existing climate of environmental noise. This has therefore been used for the development site in question.

9.13.4 ProPG (2017)

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 and has been widely adopted in the absence of equivalent Irish 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 Design Process
    - Element 2 - Noise Level Guidelines;
    - Element 3 - External Amenity Area Noise Assessment

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, to illustrate overall compliance of the scheme with best practice guideline. 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 9.7.

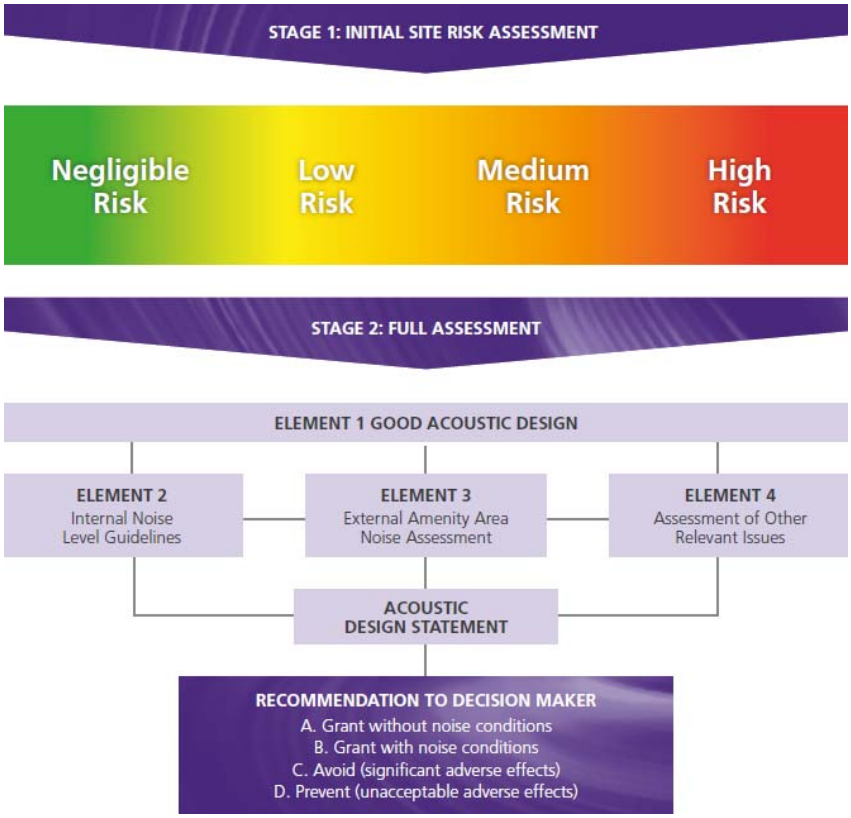

Figure 9.7 ProPG Approach (Source: ProPG)

Stage 1 – Noise Risk Assessment

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 9.8 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."

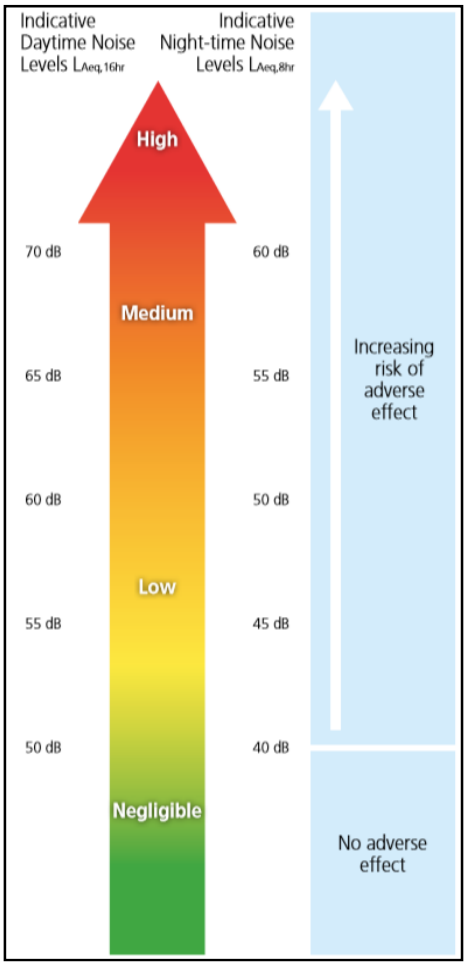

Figure 9.8 ProPG Stage 1 – Initial Noise Risk Assessment

In this instance reference is made to baseline noise surveys undertaken at the site and the noise contours calculated across the site for existing noise sources. ProPG states the following with respect to the initial risk assessment:

"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."

The noise model prepared for this assessment has been used to predict noise levels across the greenfield site. As previously outlined in Figures 9.5 and 9.6, the noise levels calculated across the majority of the site during the daytime periods are between 55-65dB $L_{Aeq,16hr.}$ Night-time noise levels are in the order of 45-60 $L_{Aeq,8hr}$.

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 measured up to 70dB during the night with rare sporadic events also recorded above this level. ProPG guidance considers 20 night events over 80dB to be a high risk, therefore this site would be considered a medium risk in terms of maxima events.

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.

Proposed Development

The noise model was updated to incorporate the proposed buildings and realignment of the Link road dissecting the site from west to east, in order to determine noise levels across the site taking into account the screening effect of the new buildings and to determine specific noise levels at the most exposed residential facades. Figures 9.9 and 9.10 display the calculated noise contours across the site at a height of 4m for day and night-time periods respectively using the predicted road traffic +15 years from opening year.

Figure 9.9 Predicted Noise Contour Across the Developed Site – Daytime

The results of the assessment indicate that during daytime periods, noise levels are highest at the units / apartments with a direct line of sight of the local commercial road (western boundary) and properties to the north of the Link road. The predicted noise levels along these exposed facades, close to the roads, are between 65-68dB $L_{Aeq,16hr.}$ On the eastern and southern side of the site, the units / apartments with a direct line of site to the Western Distributor road and Gort na Bró road have a predicted noise level between 60-65dB $L_{Aeq,16hr.}$ The remaining façades without a line of sight to a road have predicted noise levels approximately between 40 to 55dB $L_{Aeq,16hr}$ depending on the façade orientation.

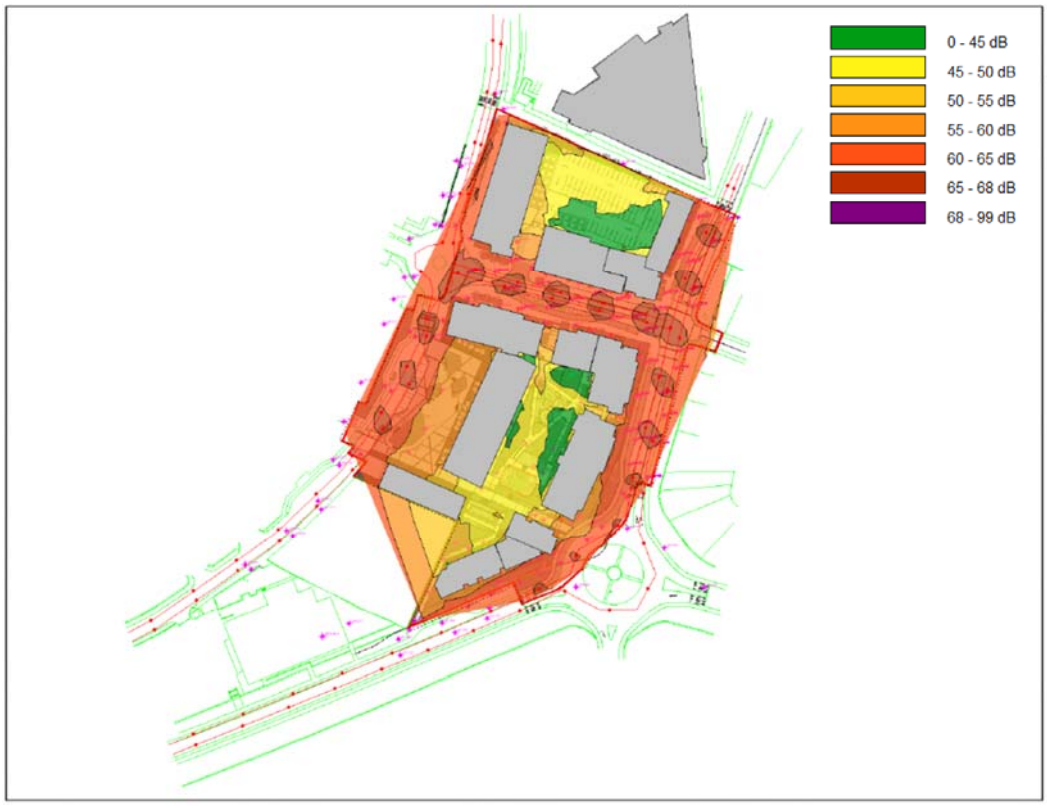

Figure 9.10 Predicted Noise Contour Across the Developed Site – Night

The results of the assessment indicate that during night-time periods, noise levels are highest at the units / apartments with a direct line of sight to the four roads; Western Distributor, Gort na Bró, Link and the local commercial road. The predicted noise levels along these exposed facades, close to the roads, are between 60-65dB $L_{Aeq,8hr.}$ The remaining façades, set back from the roads or without a line of sight to a road have predicted noise levels approximately between 40 to 60dB $L_{Aeq,16hr}$ depending on the façade orientation.

Stage 2 – Full Acoustic Assessment

Element 1 – Good Acoustic Design Process

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. Section 2.23 of the ProPG outlines the following checklist for Good Acoustic Design:

- 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.

Relocation of Reduction of Noise from Source

Noise sources incident upon the development site have been determined to be medium to high. With regards to road noise, this source is located outside the redline boundary for three of the bounding roads. They may be scope within this development to use a PSMA road surface for the Link road, which passes from west to east internally in the development. A PSMA road surface would be expected to provide a 1dB reduction applied compared to the standard HRA road surface. Screening proposed as part of landscaping works will benefit noise levels across the site at ground level but will have no significant benefit in terms of residential units at upper levels that retain a direct line of sight to the bounding roads.

Planning, Layout and Orientation

As part of the project design, the proposed buildings are set back from the road boundary. The orientation of the site is such that the buildings themselves screen the common external amenity areas associated with the development.

Select Construction Types for meeting Building Regulations

The design of all buildings is required to meet with all relevant parts of the Building Regulations. The specific detail of which will be completed at detailed design stage. In terms of the building sound insulation, the glazed elements and any required ventilation paths to achieve compliance with Part F of the Building Regulations will be the weakest elements in the façade. For the purposes of this assessment it is assumed that the building with be ventilated by heat recovery units therefore removing the need to open windows to ventilate living spaces.

Consideration will therefore be given to the provision of sound insulation performance for glazing, where required to achieve suitable internal noise levels within the development. Achievement of acceptable internal ambient noise levels does not form part of building regulation requirements; however, this will be incorporated into the building design in line with best practice and compliance with the guidance set out in ProPG.

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 are considered to be cost neutral and do not have any significant impact on other issues.

Assess Viability of Alternative Solutions

The main noise sources incident on the site are road traffic. These sources are largely mitigated by the distance to the building, screening by the on-site building and orientation of building layouts to avoid overlooking of sensitive amenity spaces to the main noise sources. All the measures listed above aid in the control of noise intrusion to the residential and commercial buildings across the development site.

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 $L_{Aeq,16hr}$."

Noise levels across external amenity areas are all below 55dB $L_{Aeq,16hr}$.

Summary

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

Element 2 – Internal Noise Levels

Internal Noise Criteria

Element 2 of the ProPG document sets out recommended internal noise targets derived from BS 8233 (2014). The recommended indoor ambient noise levels are set out in Table 9.3 and are based on annual average data.

In addition to these absolute internal noise levels ProPG provides guidance on flexibility of these internal noise level targets. For instance, in cases where the development is considered necessary or desirable, and noise levels exceed the external WHO guidelines, then a relaxation of the internal L_{Aeq} values by up to 5dB can still provide reasonable internal conditions.

Façade Noise Levels

Noise levels have been predicted across the development site during day and night-time periods. Table 9.19 presents the predicted noise levels for the various facades of the buildings on site that have been assumed for this assessment.

9.13.5 Façade Levels

Table 9. 19 along with Figures 9.11 and 9.12, present the noise levels predicted to be incident on the various façades during day and night-time periods respectively. Where predicted noise levels across a façade are within a range the higher level has been presented in the respective tables.

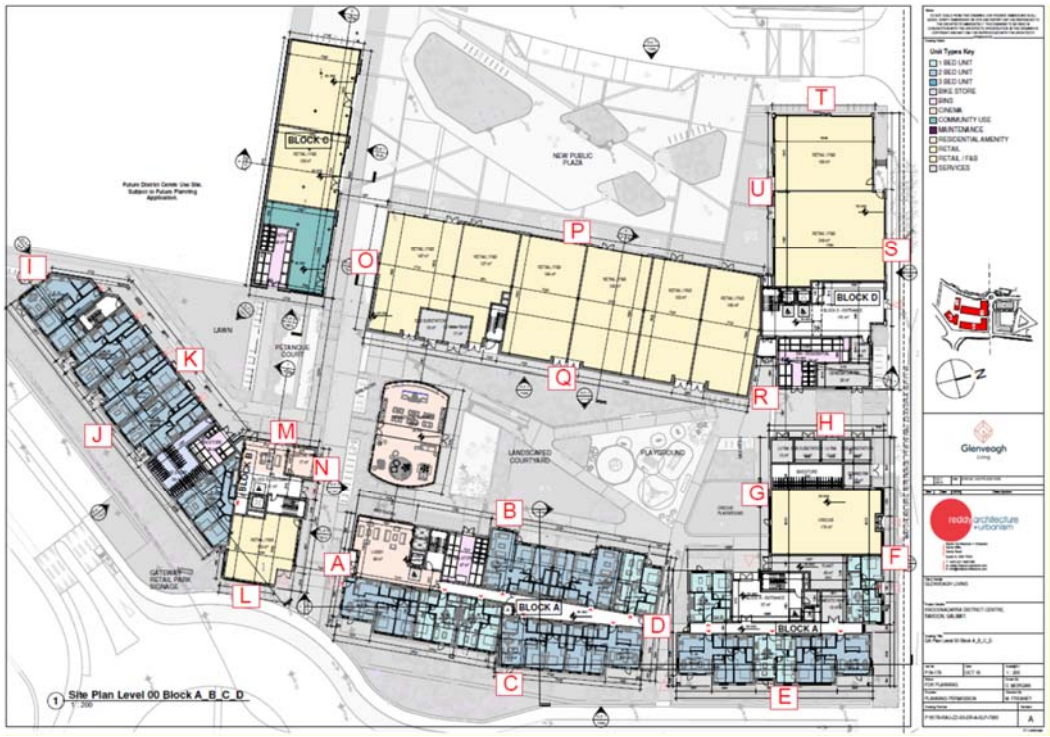

Figure 9.11 Designation of Predicted Noise Levels for Each Façade – Blocks A-D

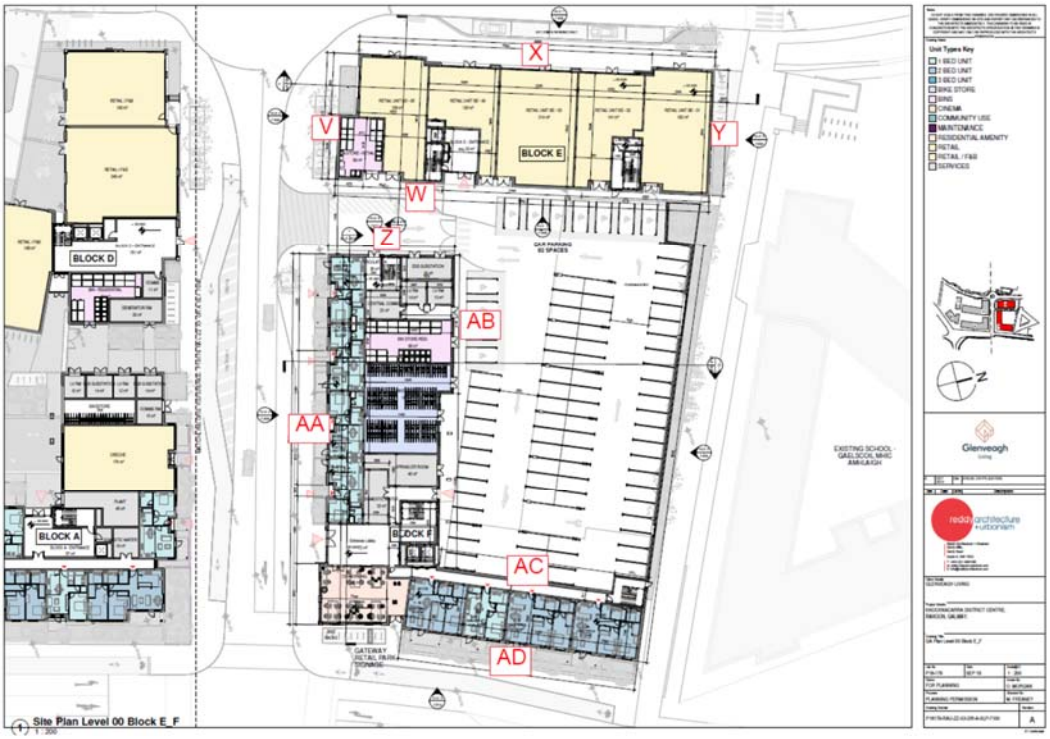

Figure 9.12 Designation of Predicted Noise Levels for Each Façade – Blocks E-F

Table 9.19. Summary of Predicted Façade Noise Levels

Ref	Period (T)	$L_{Aeq,T}$dB	Ref	Period (T)	$L_{Aeq,T}$dB
A	Day (16hr)	58	V	Day (16hr)	65
	Night (8hr)	51		Night (8hr)	58
B	Day (16hr)	57	W	Day (16hr)	60
	Night (8hr)	50		Night (8hr)	53
C	Day (16hr)	63	X	Day (16hr)	65
	Night (8hr)	56		Night (8hr)	58
D	Day (16hr)	63	Y	Day (16hr)	56
	Night (8hr)	56		Night (8hr)	49
E	Day (16hr)	63	Z	Day (16hr)	57
	Night (8hr)	56		Night (8hr)	50
F	Day (16hr)	63	AA	Day (16hr)	66
	Night (8hr)	56		Night (8hr)	59
G	Day (16hr)	45	AB	Day (16hr)	56
	Night (8hr)	37		Night (8hr)	49
H	Day (16hr)	57	AC	Day (16hr)	45
	Night (8hr)	50		Night (8hr)	38
I	Day (16hr)	62	AD	Day (16hr)	63
	Night (8hr)	54		Night (8hr)	56
J	Day (16hr)	62			
	Night (8hr)	53			
K	Day (16hr)	56			
	Night (8hr)	48			
L	Day (16hr)	63			
	Night (8hr)	54			
M	Day (16hr)	52			
	Night (8hr)	44			
N	Day (16hr)	57			
	Night (8hr)	48			
O	Day (16hr)	51			
	Night (8hr)	44			
P	Day (16hr)	57			
	Night (8hr)	50			
Q	Day (16hr)	53			
	Night (8hr)	45			
R	Day (16hr)	57			
	Night (8hr)	50			
S	Day (16hr)	64			
	Night (8hr)	57			
T	Day (16hr)	64			
	Night (8hr)	57			
U	Day (16hr)	58			
	Night (8hr)	51			

Table 9.20. Summary of Predicted Façade Noise Levels

Ref	Period	$L_{Aeq,T}$dB
RED	Day	60 – 66
	Night	55 - 60
ORANGE	Day	55 - 59
	Night	50 -54
GREEN	Day	<55
	Night	<50

It is important to note that any enhanced façade specification identified in the mark ups below, do not apply to retail space at ground level, as it would require a less stringent internal noise requirement. Enhanced facades are identified for residential spaces only, across all floor levels.

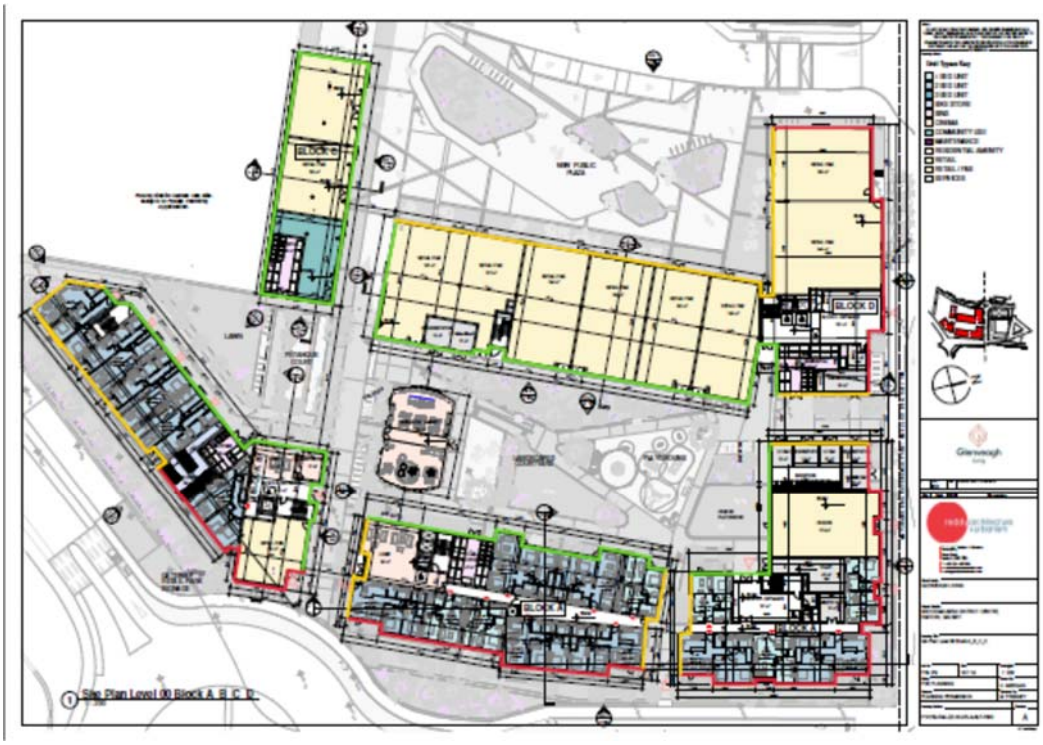

Figure 9.13 Façade Noise Levels (see Table 9.20) Block A-D

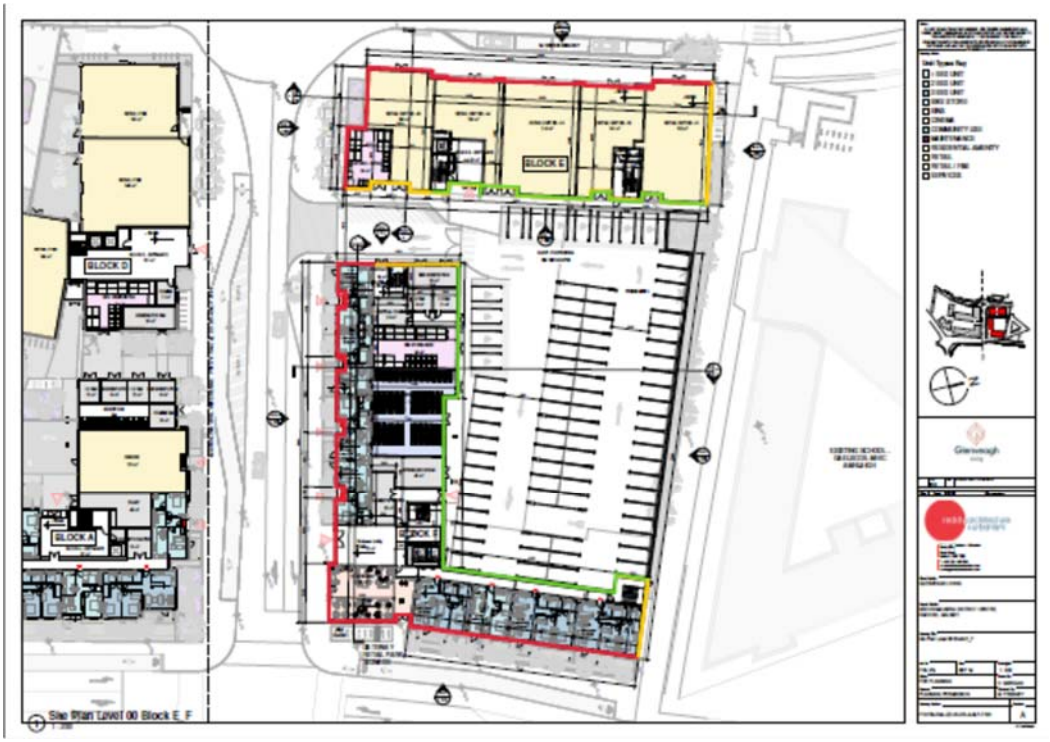

Figure 9.14 Façade Noise Levels (see Table 9.20) Block E-F

Discussion on Open/Closed Windows

The level of sound reduction offered by a partially open window is typically applied as 15dB[2] to 18dB.

Considering the design goals outlined in Table 9.3 and sound reduction across an open window of 15dB, the free-field noise levels that would be required to ensure that internal noise levels do not exceed 'good' or 'reasonable' internal noise levels have been summarised in Table 9.21.

Table 9.21. External Noise Levels Required to Achieve Internal Noise Levels

Level Desired	Day 07:00 to 23:00hrs	Night 23:00 to 07:00hrs
Good (i.e. at or below the internal noise levels)	50 – 55dB $L_{Aeq,16hr}$	45dB $L_{Aeq,8hr}$
Reasonable (i.e. 5 dB above the internal noise levels)	55 – 60dB $L_{Aeq,16hr}$	50dB $L_{Aeq,8hr}$

For sensitive rooms that face on to the Western Distributor, Gort na Bró, Link and Local roads, a reasonable internal noise level will not be achieved with windows open. For those marked green highlight facades with good levels will be achieved with windows open.

2 Section 2.33 of ProPG, additional information can be found in the DEFRA NANR116: *'Open/Closed Window Research' Sound Insulation Through Ventilated Domestic Windows'*

A mechanical heat recovery ventilation (MHRV) system is proposed for the development therefore there is no requirement to have windows open to achieve background ventilation requirements. An appropriate acoustic specification for windows shall be provided in this instance to ensure the rooms achieve good internal noise levels.

In this assessment we have assumed that there will be negligible noise intrusion via ducting associated with the MVHR system.

Recommend 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 of BS8233 provide 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. This approach corrects the noise levels to account for the frequency content of the source in question. In this instance, rail and road traffic noise, depending on the buildings in question.

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 the facades will be provided with glazing that achieves the minimum sound insulation performance as set out in Table 9.22.

Table 9.22. Sound Insulation Performance Requirements for Glazing, SRI (dB)

Glazing Specification	Octave Band Centre Frequency (Hz)						R$_w$
	125	250	500	1k	2k	4k	
Red	27	24	34	39	42	49	37
Orange	20	19	29	38	36	45	33
Green	22	17	24	37	41	38	30

The glazing performance requirement for the various facades can be confirmed by reviewing the mark up presented in Figures 9.13 and 9.14.

The overall R_w outlined above are provided for information purposes only. The over-riding requirement is the Octave Band sound insulation performance values which may also be achieved using alternative glazing configurations. Any selected system will be required to provide the same level of sound insulation performance set out in Table 9.22 or greater.

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.

It is advised that the window supplier provides laboratory tests confirming the sound insulation performance, (to British Standard 2750 Part 3:1980 and British Standard 5821, or British Standard EN ISO 140 Part 3 1995 and British Standard EN ISO 717, 1997). It is important to note that the acoustic performance specifications detailed herein are minimum requirements which apply to the overall glazing system when installed on site.

Wall Construction

In general, all wall constructions (i.e. block work or concrete and spandrel elements) 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 50 dB R_w for this construction.

Internal Noise Levels

Taking into account the external façade levels and the specified acoustic performance to the building envelope, the internal noise levels have been calculated.

All locations are predicted to achieve good internal noise levels with windows closed. For locations highlighted orange and green in Figures 9.13 and 9.14, the good to reasonable internal noise levels are achieved with both windows open and closed.

Element 3 – External Amenity Areas

External noise levels within the public open spaces and private gardens across the development site are within the recommended range of noise levels from ProPG of between 50 – 55 dB $L_{Aeq,16hr}$ as illustrated in Figures 9.9 and 9.10. It is considered that the objectives of achieving suitable external noise levels is achieved within the overall site.

Conclusion

An initial site noise risk assessment has been carried out on the proposed mixed use development at the Gateway Phase 3 site. The initial site assessment has classified the development site as having a medium to high noise risk in accordance with ProPG guidance. This was determined through a review of baseline noise measurements, noise modelling of the site for existing road noise.

The assessment concluded that overall environmental noise levels at the proposed residential buildings, are not significant on the internal facades facing without any line of sight to the four bounding roads and hence would not require any specific noise mitigation measures in order to achieve suitable internal noise levels with windows open and closed.

Highest noise levels are calculated at units with a direct line of sight to the four bounding roads; Western Distributor, Gort na Bró, Link and Local roads.

Boundary treatment is proposed along these boundary apartments as part of proposed landscaping works. In addition to this physical screening, enhanced acoustic glazing are recommended along facades with a direct line of sight to the four bounding roads. Specific details of boundary treatments and glazing requirements are set out in the relevant sections of this assessment.