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EQUINIX

DB8
STAGE 3 PLANNING NOISE ASSESSMENT

Technical Report Prepared For

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Doc Ref: DB080-AWN-XX-XX-RP-Y-XXXX-0002
Rev: P01
Purpose of Issue: S3

Our Reference

DK/20/11952NR02

Date of Issue

14 June 2021

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Document History

Document Reference		Original Issue Date	
DK/20/11952NR02		14 June 2021	
Revision Level	Revision Date	Description	Sections Affected

Record of Approval

Details	Written by	Approved by
Signature		
Name	Damian Kelly	Mike Simms
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Date	14 June 2021	14 June 2021

EXECUTIVE SUMMARY

The following conclusions are presented in relation to this noise assessment:

- The existing noise environment in the vicinity of the nearest noise sensitive locations is dictated by local and distant road traffic movements and a degree of plant noise. Review of preliminary noise monitoring and noise data to hand from nearby sites indicates that background noise levels at the nearest noise sensitive locations fall in the range of 38 dB(A) to 40 dB(A) during night-time periods.

- A review of best practice guidance has identified the following noise criteria that are considered likely to be appropriate in terms of any planning application progressed in relation to the site:

Day to Day Operation (Noise Sensitive Daytime) – 55 dB $L_{Aeq,15min}$
Day to Day Operation (Noise Sensitive Evening) – 50 dB $L_{Aeq,15min}$
Day to Day Operation (Noise Sensitive Night) – 38 to 40 dB $L_{Aeq,15min}$
Day to Day Operation (Commercial) – 55 dB $L_{Aeq,15min}$
Day to Day Operation (Grange Castle Golf Couse Boundary) – 55 dB $L_{Aeq,15min}$
Emergency Operation (Noise Sensitive) – 55 dB $L_{Aeq,15min}$
Emergency Operation (Commercial) – 65 dB $L_{Aeq,15min}$

- Noise predictions for the following scenarios have been presented and commented upon in the following sections:

Scenario A	Day to Day Operations
Scenario B	Emergency Operations
Scenario C	Generator Testing

- The noise model predictions conclude the relevant adopted noise criteria are satisfied in all instances.

- Comment is presented in relation to construction noise and vibration impacts along with typical mitigation measures that will be employed.

CONTENTS

1.0 INTRODUCTION

AWN has been commissioned to prepare a noise assessment of a proposed DB8 Equinix data centre buildings. The site in question is located off the Nagor Road, Grangecastle, Co. Dublin. Figure 1 below illustrates the site location. The relevant planning authority is South Dublin County Council (SDCC).

Figure 1 Site Location & Context

The following methodology has been followed in order to prepare this assessment:

- A review of noise survey data on public file of existing noise environment in the vicinity of the site in order to assist to establish likely and suitable noise criteria;
- Identify the nearest noise sensitive locations to the proposed site;
- Review of local and best practice guidance in relation to noise that may dictate noise conditions that will be applied to site operations;
- Confirmation of assumptions in relation to noise sources proposed for the site based on similar projects and limited data to hand at this early stage, and;
- Development of a 3D noise model and production of noise contours for day to day, generator testing and emergency scenarios.

Appendix A presents a glossary of the acoustic terminology used in this report.

2.0 EXISTING NOISE ENVIRONMENT

2.1 Background Noise Survey

Baseline noise monitoring has been completed at a number of representative locations in the vicinity of the development and is reviewed here to inform a preliminary discussion of the existing noise environment.

2.2 Choice of Measurement Locations

Figure 2 illustrates the approximate location of the noise monitoring locations being considered here.

Figure 2 Noise Monitoring Locations

Location A Located to the north of the site in the vicinity of a number of dormer bungalows (R14) that are considered to be the closed noise sensitive residences to the north.

Location B Located to the north west of the site in the vicinity of R09.

Location C Located to the east of the site in the vicinity of the boundary with the Grangecastle golf course. This location would be considered to be representative of noise levels that would be experienced on the golf course itself.

Location D Located to the south of the site. The location would be considered to be representative of noise levels at Location R01 and background noise levels at properties along the Baldonnel Road (i.e. R02 to R05).

2.3 Measurement Periods

Noise measurements were conducted during typical day, evening and night-time periods. The night survey represents the time of night that provides a measure of existing background noise levels during a period where people are attempting to go to sleep or are sleeping. Due to the fact that the units in question here will operate on a 24-hour basis their potential impact during night-time periods is the critical issue. The survey was conducted during the following periods:

Surveys were completed during the following periods:

Daytime	10:30 hrs to 14:25 hrs on 2 March 2021;
Evening	21:34 hrs to 22:47 hrs on 2 March 2021, and;
Night	22:53 hrs on 2 March 2021 to 01:21 hrs on 3 March 2021.

Weather conditions were dry and calm during all periods with temperatures of the order of 10°C during the daytime period, 5°C during the evening and 3°C during the night.

2.4 Instrumentation

A Brüel & Kjær Type 2250 Sound Level Meter (S/N 2818091) was used for all survey periods. Before, after and during each survey period, the measurement instrument was check calibrated using a Brüel & Kjær Type 4231 Sound Level Calibrator.

2.5 Measurement Procedure

Measurements were conducted at the locations noted above. Sample periods for the noise measurements were typically 15 minutes. The results were noted onto a Survey Record Sheet immediately following each sample and were also saved to the instrument memory for later analysis if required. Survey personnel noted the primary noise sources contributing to noise build-up.

2.6 Results

This section documents the typical background noise levels measured in the vicinity of the noise sensitive locations in closest proximity to the proposed development site. Table 1 presents the measured noise levels at Locations A, B, C and D.

Location	Period	Time	Sound Pressure Level (dB)	
			$L_{Aeq,15min}$	$L_{AF90,15min}$
A	Day	10:31 – 10:46	64	55
		11:52 – 12:07	63	50
		13:06 – 13:21	63	51
		Average	63	52
	Evening	21:34 – 21:49	58	42
	Night	22:55 – 23:10	59	41
		00:12 – 00:27	52	37
		Average	57	39
B	Day	10:53 – 11:08	54	52
		12:10 – 12:25	52	48
		13:49 – 14:04	51	47
		Average	52	49
	Evening	21:56 – 22:09	45	42
	Night	23:15 – 23:30	44	41
		00:31 – 00:46	42	40
		Average	43	40
C	Day	11:14 – 11:29	49	46
		12:29 – 12:44	48	45
		13:31 – 13:46	51	45
		Average	50	45
	Evening	22:14 – 22:29	42	40
	Night	23:32 – 23:47	42	39
		00:48 – 01:03	40	37
		Average	41	38
D	Day	11:32 – 11:47	46	45
		12:47 – 13:03	45	43
		14:07 – 14:23	45	42
		Average	45	43
	Evening	22:32 – 22:47	40	38
	Night	23:50 – 00:05	40	37
		01:06 – 01:21	40	37
		Average	40	37

Table 1 Noise Monitoring Results

Note 1 Average L_{Aeq} are logarithmic averages, Average L_{A90} values are arithmetic averages.

3.0 NEAREST NOISE SENSITIVE LOCATIONS

The nearest noise sensitive locations to the site are highlighted on Figure 3.

Figure 3 Nearest Noise Sensitive Locations

In the first instance it is considered appropriate to define a noise sensitive location. In this context is considered prudent to give consideration to definition supplied by the Environmental Protection Agency (EPA) which states the following:

> *"NSL – any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or other area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels."*

Table 2 reviews the various noise sensitive locations identified on Figure 3.

Location	Description
NSL 01	Existing derelict single storey residence some 350m west of the site.
NSL 02	Existing double storey residence some 160m west of the site. It is understood this unit will be demolished as part of proposed works in this area. It is not considered a long term residential noise sensitive location.
NSL 03	Golf tee associated with the adjacent Grangecastle Golf Club some 35m from the north eastern corner of the site.
NSL 04	Golf green associated with the adjacent Grangecastle Golf Club some 25m from the southern boundary of the site.
NSL 05	Golf green associated with the adjacent Grangecastle Golf Club some 25m from the south western corner of the site.
NSL 06	Profile Park Marketing suite located some 130m to the south of the development site.
NSL 07	Existing Nangor Lea dormer bungalows located some 50m north on the far side of the Nangor Road.
NSL 08	Commercial offices associated with Kilcarbery Business Park some 85m from the north western corner of the site.

Table 2 Review of Noise Sensitive Locations

4.0 RELEVANT GUIDANCE

The relevant local authority, SDCC, does not have any standard noise conditions listed in the *Dublin Agglomeration Environmental Noise Action Plan December 2018 – November 2023 – Volume 4: South Dublin County Council.* Therefore, consideration has been given to the following best practice and national guidance and a review of planning conditions recently applied to similar developments in the area.

It is noted that the overall site development considers the development of a number of buildings containing several data halls. The criteria detailed here relate to the potential development of the full site. A phased development of the site will therefore need to consider this issue in order that sufficient headroom is available in terms of the potential development of the overall site at a future date.

4.1 EPA – NG4

In order to establish whether the noise sensitive locations in the vicinity of the site would be considered 'low background noise' areas as defined in the Environmental Protection Agency (EPA) publication *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities* (NG4 2016) guidance, the noise levels measured during the environmental noise survey need to satisfy the following criteria:

- Arithmetic Average of L_{A90} During Daytime Period ≤40dB L_{A90}, and;
- Arithmetic Average of L_{A90} During Evening Period ≤35dB L_{A90}, and;
- Arithmetic Average of L_{A90} During Night-time Period ≤30dB L_{A90}.

Determining Appropriate Noise Criteria

Table 3 below outlines the noise emission limit criteria detailed in the NG4 document.

Scenario	Daytime Noise Criterion, dB $L_{Ar,T}$ (07:00 to 19:00hrs)	Evening Noise Criterion, dB $L_{Ar,T}$ (19:00 to 23:00hrs)	Night Noise Criterion, dB L_{Aeq} (23:00 to 07:00hrs)
Areas of Low Background Noise	45dB	40dB	35dB
All Other Areas	55dB	50dB	45dB

Table 3 NG4 Approach for Determining Appropriate Noise Criteria

Based on a review of the noise data to hand in the vicinity of the development site, the noise sensitive locations in the vicinity of the site are not defined as areas of low background noise as per the NG4 guidance. In this instance a 45dB $L_{Aeq,T}$ night-time criterion would be applied to day to day operations of the site.

Note if buildings were designed to this level, plant noise would be a clearly audible source of noise at number of noise sensitive locations in close proximity of the development.

Note if an EPA IED licence is required for the operations it should be noted that the current intent of the EPA on similar sites to apply a 50dB $L_{Aeq,15min}$ criterion to emergency operations associated with the site and that emergency operations are only permitted to occur for a maximum of 72 hours per annum.

4.2 BS 4142:2014

BS 4142:2014+A1:2019: *Methods for rating and assessing industrial and commercial sound* is the industry standard method for analysing building services plant sound emissions to residential receptors. BS 4142 describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident. It should also be noted that the EPA NG4 document indicates that this assessment methodology should be used in the assessment of complaints associated with a site's operations. Whilst the current site will not be licenced, the guidance contained therein needs to be given due regard.

For an appropriate BS 4142 assessment it is necessary to compare the measured external background sound 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 sound emissions are found to be tonal, impulsive, intermittent or to have other sound characteristics that are readily distinctive against the residual acoustic environment, BS 4142 advises that penalties be applied to the specific level to arrive at the rating level.

The subjective method for applying a penalty for tonal sound characteristics outlined in BS 4142 recommends the application of a 2dB penalty for a tone which is just perceptible at the receptor, 4dB where it is clearly perceptible, and 6dB where it is highly perceptible. In relation to intermittency, BS 4142 recommends that *If the intermittency us readily is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.* The following definitions as discussed in BS 4142 as summarised below:

"*ambient sound level,* $L_{Aeq,T}$"	equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at any given time, usually from many sources near and far, at the assessment location over a given time interval, T.
"*residual sound level,* $L_{Aeq,T}$"	equivalent continuous A-weighted sound pressure level of the residual sound (i.e. ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound) at the assessment location over a given time interval, T.
"*specific sound level,* $L_{Aeq,T}$"	equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T_r.
"*rating level,* $L_{Ar,T}$"	specific sound level plus any adjustment for the characteristic features of the sound.
"*background sound level,* $L_{A90,T}$"	A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels.

In order to establish an *initial estimate* of impact, BS 4142 states the following:

Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level, and consider the following.

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

Adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact.

The assessment methodology described above (i.e. comparison of rated sound level to background sound level) is quoted in BS 4142 as representing a methodology to '*obtain an initial estimate*' of impact. It is important to note that BS 4142 also comments that *'Where the initial estimate of the impact needs to be modified due to the context, take all pertinent factors into consideration'*. BS 4142 provides a list of potential pertinent factors that can influence the *'initial estimate'*. The plant noise assessment conducted in the following sections has been carried out with consideration of the guidance contained in BS 4142 as summarised above.

4.3 Commercial Properties

A number of commercial / industrial properties are located in the vicinity of the site. In terms of noise emissions from the site it is considered that an appropriate noise criterion at these locations is 55dB $L_{Aeq,15min}$.

4.4 Emergency Operation

In order to provide continuity of service a number of stand by generators are present on site and will be added to as part of the current proposal. These generators will only operate in a situation where there is a failure in the electricity supply from the national grid. Section 4.4.1 of the Environmental Protection Agency (EPA) document "*Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities*" (NG4 - 2016) contains the following comments in relation to emergency plant items:

'In some instances, ...sites will have certain items of emergency equipment (e.g. standby generators) that will only operate in urgent situations (e.g. grid power failure). Depending upon the context, it may be deemed permissible for such items of equipment to give rise to exceedances in the noise criteria/limits during limited testing and emergency operation only. If such equipment is in regular use for any purposes other than intermittent testing, it is subject to the standard limit values for the site'.

It is therefore considered that the proposed noise criterion of 55dB $L_{Aeq,T}$ on these emergency units is appropriate. Generators will be designed and mitigated in order to achieve this design goal at nearby residential noise sensitive locations.

The above aside, note if an EPA IED licence is required for the operations it should be noted that the current intent, on similar sites, of the EPA to apply a 50dB $L_{Aeq,15min}$ criterion to emergency operations associated with the site and that emergency operations are only permitted to occur for a maximum of 72 hours per annum.

4.5 Golf Couse Boundary

The adjacent golf course would be considered noise sensitive and it is recommended that noise limits associated with the operations of the data centre would not exceed 55 dB $L_{Aeq,15min}$ along the common boundary between the two sites in order to protect the recreational amenity of the facility.

4.6 Recommended Criteria

Following review of relevant guidance and examples of relevant planning permissions, the following noise criteria are proposed for the development:

Day to Day Operation (Noise Sensitive Daytime) – 55 dB $L_{Aeq,15min}$
Day to Day Operation (Noise Sensitive Evening) – 50 dB $L_{Aeq,15min}$
Day to Day Operation (Noise Sensitive Night) – 37 to 39 dB $L_{Aeq,15min}$
Day to Day Operation (Commercial) – 55 dB $L_{Aeq,15min}$
Day to Day Operation (Grange castle Golf Couse Boundary) – 55 dB $L_{Aeq,15min}$
Emergency Operation (Noise Sensitive) – 55 dB $L_{Aeq,15min}$
Emergency Operation (Commercial) – 65 dB $L_{Aeq,15min}$

Note plant noise emissions are to be designed such that they are not tonal and do not have impulsive characteristics at the nearest noise sensitive locations.

5.0 NOISE MODEL

The following sections outline the noise assumptions made in the preparation of this assessment. Limited information is to hand at this stage of the project therefore where specific noise source data was not available, assumptions have been made based on similar projects.

5.1 Source Sound Power Data

The noise modelling competed indicates the following assumed data in relation to various items of plant associated with the overall site development. It is assumed any plant associated with the development is neither tonal nor impulsive in nature.

Source	L_w - Octave Band Centre Frequency								dB (A)
	63	125	250	500	1k	2k	4k	8k	
Air Cooled Chillers Note A	--	108	95	91	92	87	82	78	97
Generator Intake Note B	81	80	76	73	63	61	55	69	85
Generator Rear Note B	84	78	68	67	69	67	70	62	86
Generator Stack Note B	84	78	68	67	69	67	70	62	86
Generator Sides & Roof Note B	78	87	86	82	76	65	53	55	91
Generator Façade Inlet	81	80	76	73	63	61	55	69	85
Generator Façade Exhaust	84	78	68	67	69	67	70	62	86
Gen Room Façade (m^2) Note C	89	84	78	70	66	63	48	49	75
Outdoor Condenser 1 Note D	104	93	91.5	90	83.5	81.5	77	72	91
DC AHU Supply Note E	66	62	71	64	57	55	48	42	66
DC AHU Exhaust Note E	68	68	77	74	76	72	68	64	80
AHU Supply Note F	65	71	68	79	80	76	75	64	84
AHU Exhaust Note F	60	70	64	76	78	75	74	62	82
HRU Supply Note F	66	82	69	78	79	74	71	62	82
HRU Exhaust Note F	64	76	66	76	76	72	68	59	80
Outdoor Condenser 2 Note G	--	--	--	--	73	--	--	--	73
Electrical Room Extract Fan Ground Floor Note H	74	76	72	69	67	65	60	55	72
Electrical Room Extract Fan Second Floor Note I	80	86	79	76	79	79	78	73	85

Table 4 L_w levels Utilised in Noise Model

Note A 9 chillers are proposed. It is advised only 7 chillers will operate at any one time.

Note B Generator data assumed from AWN database in absence of specific data. Data based on a Cummings unit. Unit assumed relates to a unit with an average noise level of some 75 dB(A) at 1m.

Note C An additional source has been added to the model to consider the emitting façade associated with the internally located generator for Scenario 3 and 4. This assumes an internal noise level in the room of some 127dB(A) with the façade cladding formed from the following Kingspan element:

Item	SRI per Octave Band Centre Freq (Hz)							
	63	125	250	500	1000	2000	4000	8000
Façade KS1000 AWP(60)	18	23	35	44	49	50	61	61

Table A Façade Sound Reduction Index

Note D Assumed unit will operate on a 75% load. Based on data to hand this would indicate a 8 dB reduction in the noise levels presented. This has been assumed as part of the modelling exercise.

Note E 4 systems proposed. It is assumed that the exhaust element will incorporate additional attenuation that offers the minimum sound insertion loss presented in Table B.

Item	SRI per Octave Band Centre Freq (Hz)							
	63	125	250	500	1000	2000	4000	8000
Attenuator	4	6	11	20	21	17	11	10

Table B Sound Insertion Loss for Additional Attenuation

Note F 1 system proposed. It is assumed that the exhaust element will incorporate additional attenuation that offers the minimum sound insertion loss presented in Table C.

Item	SRI per Octave Band Centre Freq (Hz)							
	63	125	250	500	1000	2000	4000	8000
Attenuator	4	6	11	20	21	17	11	10

Table C Sound Insertion Loss for Additional Attenuation

Note G 4 systems proposed.

Note H 4 systems proposed.

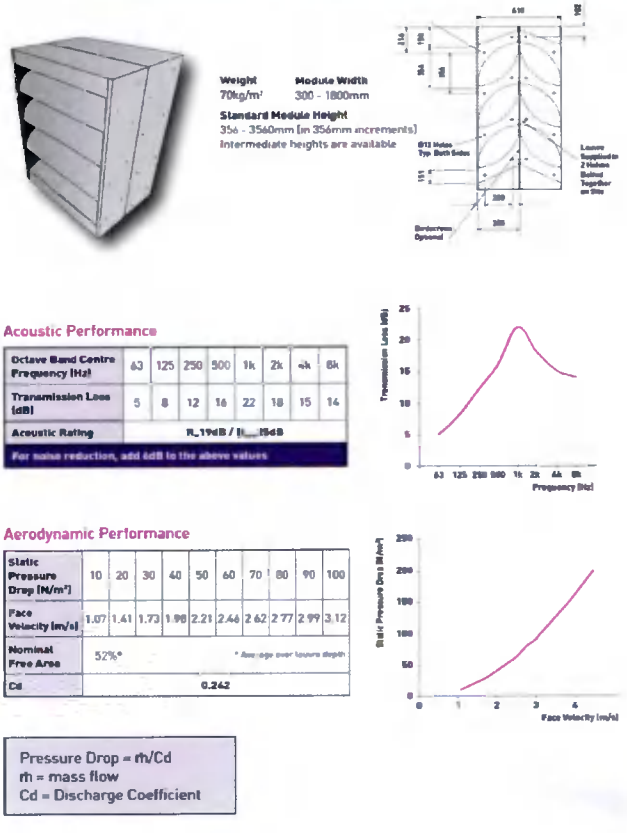
Note I 4 systems proposed. It is assumed that the exhaust element will incorporate additional attention that offers the minimums sound insertion loss presented in Table D.

Item	SRI per Octave Band Centre Freq (Hz)							
	63	125	250	500	1000	2000	4000	8000
Attenuator	4	6	11	20	21	17	11	10

Table D Sound Insertion Loss for Additional Attenuation

Figure 4 presents a 3D render of the developed site noise model for the fully developed site.

A 3.5 m high solid acoustic screen is proposed around the chiller yard as illustrated in Figure 4. In addition, a 4.5m high louvreed screen is proposed around the containerized generator units at ground floor level. A suitable screen is as follows:



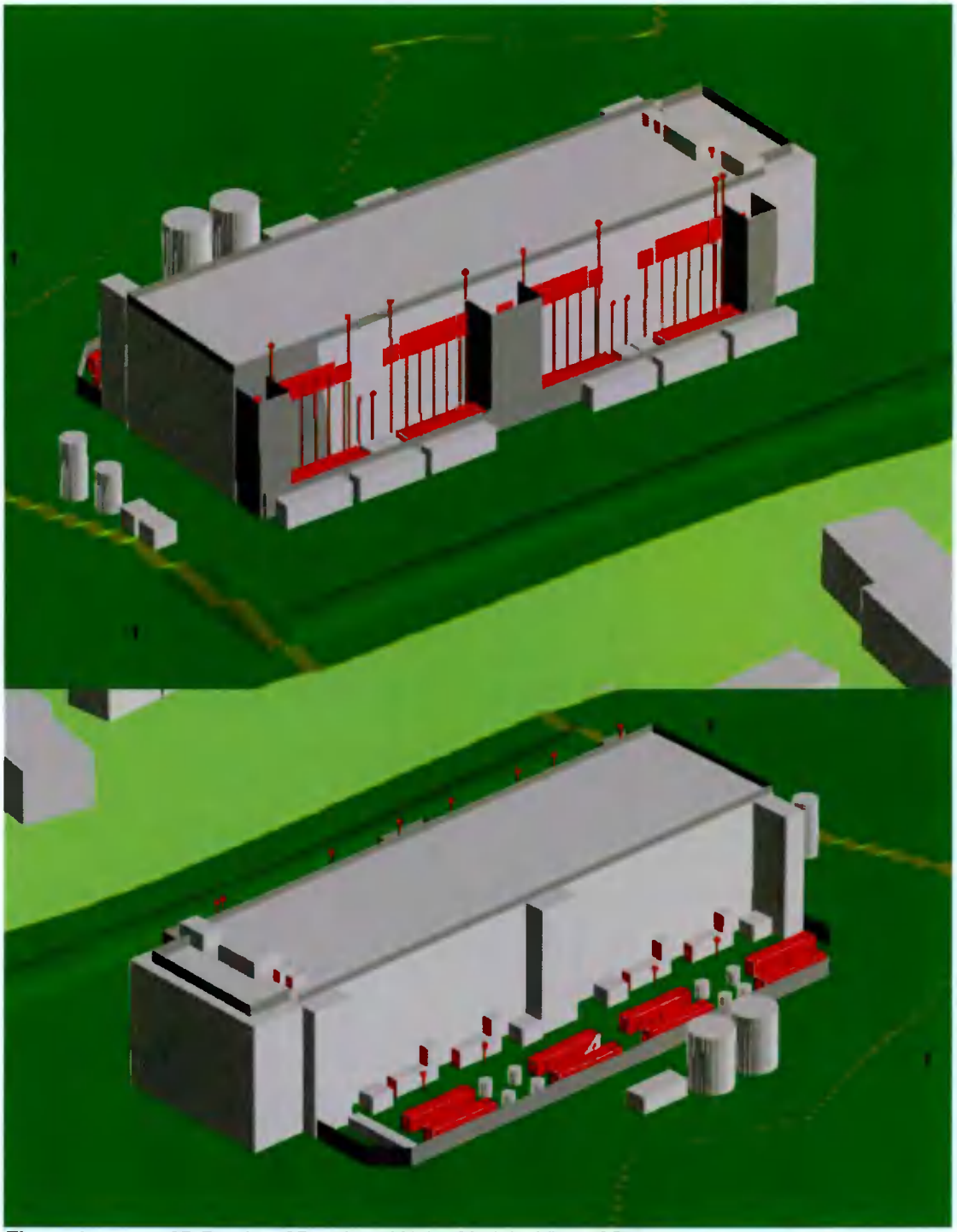


Figure 4 3D Render of Developed Noise Model – View of Site

5.2 Modelling Calculation Parameters[1]

Prediction calculations for plant noise have been conducted in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996.*

A ground attenuation factor of 0.5 have been assumed. No metrological corrections were assumed for the calculations. The atmospheric attenuation outlined in Table 5 has been assumed for all calculations.

Temp (°C)	% Humidity	Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
10	70	0.12	0.41	1.04	1.92	3.66	9.70	33.06	118.4

Table 5 Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

[1] See Appendix C for further discussion of calculation parameters.

6.0 NOISE PREDICTIONS & ASSESSMENT

Noise predictions for the following scenarios have been presented and commented upon in the following sections:

Scenario A Day to Day Operations
Scenario B Emergency Operations
Scenario C Generator Testing

6.1 Day to Day Operations

Figure 5 presents the predicted noise contour for the development considering day to day operations with the two buildings on the site built out. The extent of the predicted 35dB $L_{Aeq,15min}$ contour is presented.

Table 6 reviews the predicted noise levels against the design criteria adopted for this assessment.

Ref.	Scenario A dB $L_{Aeq,15min}$	Period	Adopted Criterion dB $L_{Aeq,15min}$	Excess (dB)
NSL 01	30	Day	55	--
		Evening	50	--
		Night	39	--
NSL 02	36	Day	55	--
		Evening	50	--
		Night	40	--
NSL 03	38	Day	55	--
		Evening	55	--
		Night	N/A	--
NSL 04	53	Day	55	--
		Evening	55	--
		Night	N/A	--
NSL 05	43	Day	55	--
		Evening	55	--
		Night	N/A	--
NSL 06	42	Day	55	--
		Evening	55	--
		Night	N/A	--
NSL 07	37	Day	55	--
		Evening	50	--
		Night	39	--
NSL 08	34	Day	55	--
		Evening	55	--
		Night	N/A	--

Table 6 Review of Predicted Noise Levels – Scenario A

Based on day to day operations of the development, the modelling indicates the predicted noise levels from the site are achieve the adopted criteria in relation at all locations assessed.

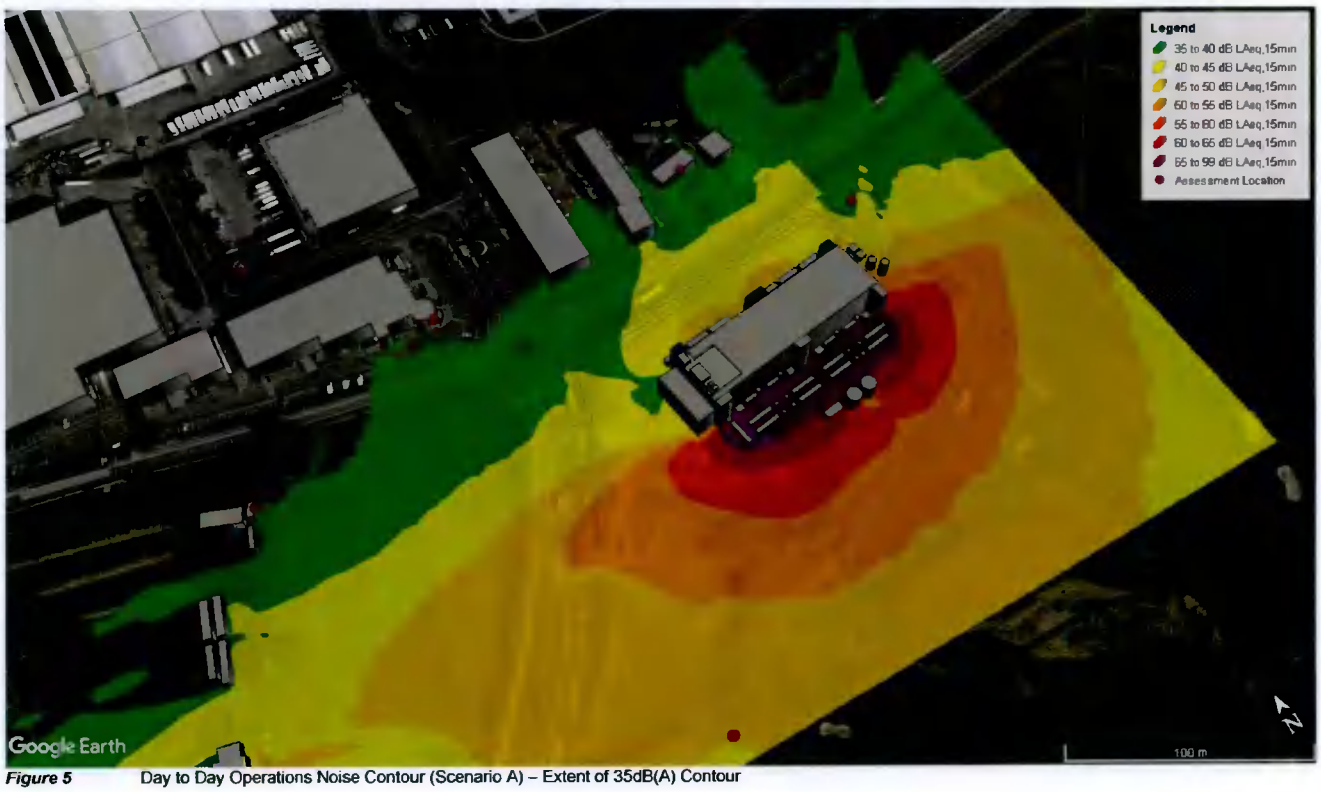


Figure 5 Day to Day Operations Noise Contour (Scenario A) – Extent of 35dB(A) Contour

6.2 Emergency Operations

Figure 6 presents the predicted noise contour for the proposed development considering emergency operations.

Table 7 reviews the predicted noise levels against the design criteria adopted for this assessment.

Ref.	Scenario B dB $L_{Aeq,15min}$	Adopted Criterion dB $L_{Aeq,15min}$	Excess (dB)
NSL01	39	55	--
NSL02	44	55	--
NSL03	52	55	--
NSL04	53	55	--
NSL05	44	55	--
NSL06	43	65	--
NSL07	53	55	--
NSL08	49	65	--

Table 7 Review of Predicted Noise Levels – Scenario B

Based on emergency operations, the modelling indicates the predicted noise levels from the site satisfy the adopted criterion at the eight locations assessed.

Figure 6 Emergency Operations Noise Contour (Scenario B) – Extent of 55dB(A) Contour

6.3 Generator Testing

Figure 7 presents the predicted noise contour for the proposed development considering generator testing operations. One generator is assumed to be tested at a time during daytime periods. For the purposes of this assessment the external generator closest to NSL07 has been modelling in testing mode.

Table 8 reviews the predicted noise levels against the design criteria adopted for this assessment.

Ref.	Scenario C dB $L_{Aeq,15min}$	Adopted Criterion dB $L_{Aeq,15min}$	Excess (dB)
NSL01	33	55	--
NSL02	38	55	--
NSL03	45	55	--
NSL04	53	55	--
NSL05	43	55	--
NSL06	42	55	--
NSL07	47	55	--
NSL08	40	55	--

Table 8 Review of Predicted Noise Levels – Scenario C

Based on generator testing operations the modelling indicates the predicted noise levels from the site satisfy the adopted criterion at the eight locations assessed.

Figure 7 Generator Testing Noise Contour (Scenario C) – Extent of 55dB(A) Contour

7.0 CONSTRUCTION NOISE & VIBRATION

The following sections review best practice guidance that is commonly adopted in relation to developments such as the one under consideration here.

7.1 Construction Phase Noise

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 may 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 an NSL into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. A threshold noise value is applied to each category. Exceedances (construction noise only) of the threshold value, at the facade of a sensitive receptor during construction, indicates a potential significant noise impact associated with the construction activities. The threshold values recommended by *BS5228-1* are depicted in Table 9.

Assessment category and threshold value period (T)	Threshold value, in $L_{Aeq,T}$ 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 – 19:00hrs) and Saturdays (07:00 – 13:00hrs)	65	70	75

Table 9 Example Threshold Potential Significant Effect at Dwellings

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. For the appropriate period (e.g. daytime) the ambient noise level is determined and rounded to the nearest 5 dB. Based on review of baseline noise monitoring to hand the relevant BS5228-1 threshold values at the various assessment locations are discussed in the relevant section of this report.

Guidance on the degree of significance is presented the UK document Design Manual for Roads and Bridges (2020) *LA 111 Sustainability & Environmental Appraisal. Noise and Vibration Rev 2.* The approach is as follows:

- to determine the threshold value for construction noise according to the method from BS5228 described above and
- to compare the predicted construction noise level with the existing noise levels and the threshold value according to the criteria in the Table 10.

Potentially this procedure is to be followed separately for each noise-sensitive location, however in this instance as the existing noise levels at all survey locations correspond in Category A according to table above, all noise-sensitive locations are considered together.

Similarly, for this proposed development the vast majority of construction works will take place within the 'Daytime' period, i.e. 07:00 – 19:00 on Mondays to Fridays and 07:00 – 13:00 on Saturdays.

The magnitude of the construction noise impact according the DMRB is mapped to the EPA significance terms as detailed in Table 10:

Predicted Construction Noise Level is	Magnitude of Impact (DMRB)	EPA Significance of Effect
Below or equal Baseline Noise Level	Negligible	Not Significant
Above Baseline and below or equal to threshold	Minor	Slight – Moderate
Above threshold and below or equal to threshold + 5dB	Moderate	Moderate – Significant
Above threshold + 5dB	Major	Significant – Very Significant

Table 10 Description of the magnitude of impacts. Adapted from DMRB Table 3.16

Taking the above into account, it is considered that the 70dB $L_{Aeq,1hr}$ is a suitable criterion for daytime construction noise at residential and amenity noise-sensitive locations and 75 dB $L_{Aeq,1hr}$ at commercial locations.

7.2 Construction Phase Vibration

Vibration standards come in two varieties: those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. With respect to this development, the range of relevant criteria used for building protection is expressed in terms of Peak Particle Velocity (PPV) in mm/s.

Guidance relevant to acceptable vibration within buildings is contained in the following documents:

- British Standard BS 7385 – *Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration (BSI, 1993);* and
- British Standard BS 5228-2:2009+A1:2014 – *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration* (BSI, 2014).

BS 7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15 mm/s at low frequencies rising to 20 mm/s at 15 Hz and 50 mm/s at 40 Hz and above. These guidelines relate to relatively modern buildings and should be reduced to 50% or less for more critical buildings.

BS 5228 recommends that, for a 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 particle velocity of 15 mm/s for transient vibration at frequencies below 15 Hz and 20 mm/s at frequencies above than 15 Hz. Below these vibration magnitudes minor damage is unlikely, although where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is such that resonances are excited within structures the limits discussed above may need to be reduced by 50%.

The Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) publication *Guidelines for the Treatment of Noise and Vibration in National Road Schemes (NRA, 2004)* also contains information on the permissible construction vibration levels during the construction phase as shown in Table 11.

Allowable vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of		
Less than 10 Hz	10 to 50 Hz	50 to 100 Hz (and above)
8 mm/s	12.5 mm/s	20 mm/s

Table 11 Allowable Vibration at Sensitive Properties (TII)

Following review of the guidance documents set out above, the values in Table 11 are considered appropriate for this assessment as they provide more stringent vibration criteria.

7.3 Construction Noise Assessment

A variety of items of plant will be in use for the purposes of site preparation, construction and site works. There will be vehicular movements to and from the site that will make use of existing roads. There is the potential for generation of significant levels of noise from these activities.

Due to the nature of construction activities it is difficult to calculate the actual magnitude of emissions to the local environment in the absence of a detailed construction programme. The standard best practice approach is to predict typical noise levels at the nearest sensitive receptor using guidance set out in BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*. Construction noise predictions have been carried out using guidance set out in British Standard BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*.

The methodology adopted for the assessment of construction noise is to analyse the various elements of the construction phase in isolation. For each element, the typical construction noise sources are assessed along with typical sound pressure levels and spectra from BS 5228 at various distances from these works.

It is predicted that the construction programme will create typical construction activity related noise on site. During the construction phase of the proposed development, a variety of items of plant will be in use, such as excavators, lifting equipment, dumper trucks, compressors and generators.

The proposed general construction hours are 07:00 to 18:00hrs, Monday to Friday and 08:00 to 14:00hrs on Saturdays. Occasional weekday evening works may also be required; however evening activities will be significantly reduced in order to manage any associated noise impacts in an appropriate manner and more stringent construction noise criteria will be applicable during any evening works that may be required. As a result, noise emissions from evening activities are expected to be significantly lower than for other general daytime activities.

Due to the nature of daytime activities undertaken on a construction site of this nature, there is potential for generation of significant levels of noise. The flow of vehicular traffic to and from a construction site is also a potential source of relatively high noise levels. The potential for vibration at neighbouring sensitive locations during construction is typically limited to excavation works and lorry movements on uneven road surfaces. Due to the proximity of sensitive locations to site works

however, there is little likelihood of structural or even cosmetic damage to existing neighbouring dwellings as a result of vibration.

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. Table 12 outlines typical plant items and associated noise levels that are anticipated for various phases of the construction programme.

For the purposes of the assessment, we have assumed that standard good practice measures for the control of noise from construction sites will be implemented. These issues are commented upon in further detail in the mitigation section of this report.

Phase	Item of Plant (BS 5228-1 Ref.)	Construction Noise Level at 10m Distance (dB $L_{Aeq,1hr}$)
1 – Site Preparation	Pneumatic Breaker (C5.6)	95
	Rock Breaker (C9.12)	85
	Wheeled Loader Lorry (C2 28)	74
	Tracked Semi-Mobile Crusher (C9.14)	90
	Track Excavator (C2 22)	72
	Dozer (C2.13)	78
	Dump Truck (C4.2)	78
2 – Foundations	Large Rotary Bored Piling Rig – Cast In-Situ (C3.14)	83
	Tracked Excavator (C3.24)	74
	Concrete Pump (C3.25)	78
	Compressor (C3 19)	75
	Poker Vibrator (C4 33)	78
3 – Steel Erection	Tower Crane (C4.48)	76
	Sarens SCG 120 Crane	86
	Articulated lorry (C11.10)	77
4 – General Construction	Hand tools	81
	Pneumatic Circular Saw (D7.79)	75
	Internal fit – out	70
	Dozer (C2.13)	78
5 - Landscaping	Dump Truck (C4.2)	78
	Surfacing (D8.25)	68

Table 12 Typical Construction Noise Emission Levels

Table 13 presents the predicted construction noise levels in the vicinity of the site. Calculations have assumed an on time 66% for each item of plant i.e. 8-hours over a 12 hours assessment period.

Ref.	Baseline Noise Level dB $L_{Aeq,1hr}$	BS5228-1 Threshold dB $L_{Aeq,1hr}$	Predicted Construction Noise Level for Various Phases (dB $L_{Aeq,1hr}$)				
			Site Preparation	Foundations	Steel Erection	General Construction	Landscaping
NSL01	63	70	51	45	47	43	37
NSL02	52	70	57	50	52	49	42
NSL03	63	70	65	58	58	55	49
NSL04	50	70	66	58	60	57	51

Ref.	Baseline Noise Level dB $L_{Aeq,1hr}$	BS5228-1 Threshold dB $L_{Aeq,1hr}$	Predicted Construction Noise Level for Various Phases (dB $L_{Aeq,1hr}$)				
			Site Preparation	Foundations	Steel Erection	General Construction	Landscaping
NSL05	50	70	60	52	53	49	44
NSL06	50	70	56	49	51	47	41
NSL07	63	70	66	58	58	56	49
NSL08	63	70	61	54	56	52	46

Table 13 Review of Potential Daytime Construction Noise Levels
Note 1 Commercial Property, therefore Threshold of 70 dB $L_{Aeq,1hr}$ applies.

Table 13 details the baseline noise level measured at the nearest survey noise monitoring location or based on expected ambient noise levels in the vicinity of the location based on proximity to an existing noise source (e.g. road). If the predicted construction noise level is below this value, the associated impact is deemed to be 'Not Significant'.

Where the predicted construction noise level is above the baseline noise level but below the stated BS5228-1 threshold value the associated impact is deemed be between 'Slight' and 'Moderate'. Where the predicted construction noise level is 5dB or more than the BS5228-1 threshold value the impact is assumed to be 'Moderate' to 'Significant'.

Note, where a non-residential assessment location is being considered a threshold value of 70 dB $L_{Aeq,1hr}$ has been adopted.

Based on the above rationale, and the predicted noise levels presented the assigned impacts are summarised as follows:

Ref.	Predicted Construction Noise Impacts for Various Phases				
	Site Preparation	Foundations	Steel Erection	General Construction	Landscaping
NSL01	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant
NSL02	Slight	Not Significant	Not Significant	Not Significant	Not Significant
NSL03	Slight	Not Significant	Not Significant	Not Significant	Not Significant
NSL04	Slight	Slight	Slight	Slight	Slight
NSL05	Slight	Slight	Slight	Not Significant	Not Significant
NSL06	Slight	Not Significant	Slight	Not Significant	Not Significant
NSL07	Slight	Not Significant	Not Significant	Not Significant	Not Significant
NSL08	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

Table 14 Review of Potential Daytime Construction Noise Impact

In the majority of cases, the construction noise impact is Not Significant; in a number of cases, a Slight impact is predicted.

7.4 Vibration Comment

Due to the distance of the proposed works from sensitive locations significant vibration effects are not expected.

7.5 Mitigation Measures

The assessment of potential impact has demonstrated that the proposed development is expected to comply with the identified criteria for the construction, operational and decommissioning phases. However, to ameliorate any noise and vibration effects, a schedule of noise control measures has been formulated for both construction/decommissioning and operational phases.

The comments in this section relate primarily to the construction phase, but are apply equally to the decommissioning phase.

Regarding construction/decommissioning activities, reference shall be made to BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*, which offers detailed guidance on the control of noise and vibration from construction activities. It is proposed that various practices be adopted during construction as required, including the following:

- limiting the hours during which site activities likely to create high levels of noise or vibration are permitted;
- establishing channels of communication between the contractor/developer, Local Authority and residents;
- appointing a site representative responsible for matters relating to noise and vibration;
- monitoring typical levels of noise and vibration during critical periods and at sensitive locations; and
- keeping the surface of the site access roads even to mitigate the potential for vibration from lorries.

Furthermore, a variety of practicable noise control measures will be employed. These include:

- selection of plant with low inherent potential for generation of noise and/ or vibration;
- placing of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints, and;
- regular maintenance and servicing of plant items.

7.5.1 Construction Noise

The contract documents shall specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures when deemed necessary to comply with the recommendations of BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*. The following list of measures will be considered, where necessary, to ensure compliance with the relevant construction noise criteria:

- No plant used on site will be permitted to cause an on-going public nuisance due to noise.
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models, fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.

- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, which is required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen.
- During the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Table using methods outlined in BS 5228-1:2009+A1:2014 *Code of practice for noise and vibration control on construction and open sites – Noise*.
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 7:00hrs and 19:00hrs weekdays and between 7:00hrs and 19:00hrs on Saturdays. However, to ensure that optimal use is made of good weather period or at critical periods within the programme (i.e. concrete pours) or to accommodate delivery of large turbine component along public routes it could be necessary on occasion to work outside of these hours. Any such out of hours working will be agreed in advance with the local Planning Authority.

7.5.2 Construction Vibration

Vibration associated with construction activities will be limited to the values set out in Table 11. It should be noted that these limits are not absolute but provide guidance as to magnitudes of vibration that are very unlikely to cause cosmetic damage.

On review of the likely vibration levels associated with construction activities, it is concluded that the construction of the proposed development is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or cosmetic damage to buildings.

In the unlikely event of vibration levels giving rise to human discomfort, in order to minimise such impacts, the following measures shall be implemented during the construction period:

- A clear communication programme will be established to inform closest building occupants in advance of any potential intrusive works which may give rise to vibration levels likely to exceed perceptible levels. The nature and duration of the works will be clearly set out in all communication circulars.
- Alternative less intensive working methods and/or plant items shall be employed, where feasible.
- Appropriate vibration isolation shall be applied to plant, where feasible.
- Cut off trenches to isolate the vibration transmission path shall be installed where required.
- Monitoring will be undertaken at identified sensitive buildings, where proposed works have the potential to be at or exceed the vibration limit values.

8.0 CONCLUSIONS

The following conclusions are presented in relation to this noise assessment:

- The existing noise environment in the vicinity of the nearest noise sensitive locations is dictated by local and distant road traffic movements and a degree of plant noise. Review of preliminary noise monitoring and noise data to hand from nearby sites indicates that background noise levels at the nearest noise sensitive locations fall in the range of 38 dB(A) to 40 dB(A) during night-time periods.

- A review of best practice guidance has identified the following noise criteria that are considered likely to be appropriate in terms of any planning application progressed in relation to the site:

Day to Day Operation (Noise Sensitive Daytime) – 55 dB $L_{Aeq,15min}$
Day to Day Operation (Noise Sensitive Evening) – 50 dB $L_{Aeq,15min}$
Day to Day Operation (Noise Sensitive Night) – 38 to 40 dB $L_{Aeq,15min}$
Day to Day Operation (Commercial) – 55 dB $L_{Aeq,15min}$
Day to Day Operation (Grange castle Golf Couse Boundary) – 55 dB $L_{Aeq,15min}$
Emergency Operation (Noise Sensitive) – 55 dB $L_{Aeq,15min}$
Emergency Operation (Commercial) – 65 dB $L_{Aeq,15min}$

- Noise predictions for the following scenarios have been presented and commented upon in the following sections:

Scenario A	Day to Day Operations
Scenario B	Emergency Operations
Scenario C	Generator Testing

- The noise model predictions conclude the relevant adopted noise criteria are satisfied in all instances.

- Comment is presented in relation to construction noise and vibration impacts along with typical mitigation measures that will be employed.

APPENDIX A
GLOSSARY OF ACOUSTIC TERMINOLOGY

ambient noise	The totally encompassing sound in a given situation at a given time, usually composed of sound from many sources, near and far.
background noise	The steady existing noise level present without contribution from any intermittent sources. The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90 per cent of a given time interval, T ($L_{AF90,T}$).
broadband	Sounds that contain energy distributed across a wide range of frequencies.
dB	Decibel - The scale in which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the RMS pressure of the sound field and the reference pressure of 20 micro-pascals (20 μPa).
dB L_{pA}	An 'A-weighted decibel' - a measure of the overall noise level of sound across the audible frequency range (20 Hz – 20 kHz) with A-frequency weighting (i.e. 'A'–weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Hertz (Hz)	The unit of sound frequency in cycles per second.
impulsive noise	A noise that is of short duration (typically less than one second), the sound pressure level of which is significantly higher than the background.
$L_{Aeq,T}$	This is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T). The closer the L_{Aeq} value is to either the L_{AF10} or L_{AF90} value indicates the relative impact of the intermittent sources and their contribution. The relative spread between the values determines the impact of intermittent sources such as traffic on the background.
L_{AFN}	The A-weighted noise level exceeded for N% of the sampling interval. Measured using the "Fast" time weighting.
L_{AFmax}	is the instantaneous slow time weighted maximum sound level measured during the sample period (usually referred to in relation to construction noise levels).
$L_{Ar,T}$	The Rated Noise Level, equal to the L_{Aeq} during a specified time interval (T), plus specified adjustments for tonal character and impulsiveness of the sound.
L_{AF90}	Refers to those A-weighted noise levels in the lower 90 percentile of the sampling interval; it is the level which is exceeded for 90% of the measurement period. It will therefore exclude the intermittent features of traffic and is used to estimate a background level. Measured using the "Fast" time weighting.

L_{AT}(DW)	equivalent continuous downwind sound pressure level.
L_{fT}(DW)	equivalent continuous downwind octave-band sound pressure level.
L_{day}	L_{day} is the average noise level during the day time period of 07:00hrs to 19:00hrs
L_{night}	L_{night} is the average noise level during the night-time period of 23:00hrs to 07:00hrs.
low frequency noise	LFN - noise which is dominated by frequency components towards the lower end of the frequency spectrum.
noise	Any sound, that has the potential to cause disturbance, discomfort or psychological stress to a person exposed to it, or any sound that could cause actual physiological harm to a person exposed to it, or physical damage to any structure exposed to it, is known as noise.
noise sensitive location	NSL – Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or other area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels.
octave band	A frequency interval, the upper limit of which is twice that of the lower limit. For example, the 1,000Hz octave band contains acoustical energy between 707Hz and 1,414Hz. The centre frequencies used for the designation of octave bands are defined in ISO and ANSI standards.
rating level	See $L_{Ar,T}$.
sound power level	The logarithmic measure of sound power in comparison to a referenced sound intensity level of one picowatt (1pW) per m^2 where: $$Lw = 10Log\frac{P}{P_0}\ \text{dB}$$ Where: p is the rms value of sound power in pascals; and P_0 is 1 pW.
sound pressure level	The sound pressure level at a point is defined as: $$Lp = 20Log\frac{P}{P_0}\ \text{dB}$$
specific noise level	A component of the ambient noise which can be specifically identified by acoustical means and may be associated with a specific source. In BS 4142, there is a more precise definition as follows: 'the equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval ($L_{Aeq,T}$)'.

tonal	Sounds which cover a range of only a few Hz which contains a clearly audible tone i.e. distinguishable, discrete or continuous noise (whine, hiss, screech, or hum etc.) are referred to as being 'tonal'.
$^1/_3$ octave analysis	Frequency analysis of sound such that the frequency spectrum is subdivided into bands of one–third of an octave each.

APPENDIX B
NOISE MODELLING DETAILS & ASSUMPTIONS

Noise Model

A 3D computer-based prediction model has been prepared in order to quantify the noise level associated with the proposed building. This section discusses the methodology behind the noise modelling process.

Brüel & Kjær Type 7810 Predictor

Proprietary noise calculation software has been used for the purposes of this modelling exercise. The selected software, iNoise, calculates noise levels in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996.*

iNoise is a proprietary noise calculation package for computing noise levels in the vicinity of noise sources. Predictor calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of A weighted sound power levels (L_{WA});
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impact at distances greater than approximately 400m).

Brief Description of ISO9613-2: 1996

ISO9613-2:1996 calculates the noise level based on each of the factors discussed previously. However, the effect of meteorological conditions is significantly simplified by calculating the average downwind sound pressure level, $L_{AT}(DW)$, for the following conditions:

- wind direction at an angle of ±45° to the direction connecting the centre of the dominant sound source and the centre of the specified receiver region with the wind blowing from source to receiver, and;
- wind speed between approximately $1ms^{-1}$ and $5ms^{-1}$, measured at a height of 3m to 11m above the ground.

The equations and calculations also hold for average propagation under a well-developed moderate ground based temperature inversion, such as commonly occurs on clear calm nights.

The basic formula for calculating $L_{AT}(DW)$ from any point source at any receiver location is given by:

$$L_{fT}(DW) = L_W + Dc - A \qquad \textbf{Eqn. A}$$

Where:
$L_{fT}(DW)$ is an octave band centre frequency component of $L_{AT}(DW)$ in dB relative to $2x10^{-5}$Pa;
L_W is the octave band sound power of the point source;
D_c is the directivity correction for the point source;
A is the octave band attenuation that occurs during propagation, namely attenuation due to geometric divergence, atmospheric absorption, ground effect, barriers and miscellaneous other effects.

The estimated accuracy associated with this methodology is shown in Table B.1 below:

Height, h*	Distance, d†	
	0 < d < 100m	100m < d < 1,000m
0<h<5m	±3dB	±3dB
5m<h<30m	±1dB	±3dB

Table B.1 Estimated Accuracy for Broadband Noise of $L_{AT}(DW)$

* h is the mean height of the source and receiver. † d is the mean distance between the source and receiver.
N.B. These estimates have been made from situations where there are no effects due to reflections or attenuation due to screening.

Input Data and Assumptions

The noise model has been constructed using data from various source as follows:

Site Layout The general site layout has been obtained from the drawings forwarded by RED Engineering.

Local Area The location of noise sensitive locations has been obtained from a combination of site drawings provided by RED Engineering and others obtained from Ordinance Survey Ireland (OSI).

Heights The heights of buildings on site have been obtained from site drawings forwarded by RED Engineering. Off-site buildings have been assumed to be 8m high with the exception of industrial buildings where a default height of 15m has been assumed.

Contours Due to the lack of contour information off the proposed site a flat ground model has been assumed for this study.

Modelling Calculation Parameters[2]

Prediction calculations for plant noise have been conducted in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996.*

Ground attenuation factors of 0.5 have been assumed. No metrological corrections were assumed for the calculations. The atmospheric attenuation outlined in Table B.2 has been assumed for all calculations.

Temp (°C)	% Humidity	Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
10	70	0.12	0.41	1.04	1.92	3.66	9.70	33.06	118.4

Table B.2 Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

[2] See Appendix C for further discussion of calculation parameters.

APPENDIX C – NOISE MODEL PARAMETERS

Prediction calculations for noise emissions have been conducted in accordance with *ISO 9613: Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996*. The following are the main aspects that have been considered in terms of the noise predictions presented in this instance.

Directivity Factor: The directivity factor (D) allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measures in a down wind direction, corresponding to the worst case propagation conditions and needs no further adjustment.

Ground Effect: Ground effect is the result of sound reflected by the ground interfering with the sound propagating directly from source to receiver. The prediction of ground effects is inherently complex and depend on source height receiver height propagation height between the source and receiver and the ground conditions. The ground conditions are described according to a variable defined as G, which varies between 0.0 for hard ground (including paving, ice concrete) and 1.0 for soft ground (includes ground covered by grass trees or other vegetation) Our predictions have been carried out using various source height specific to each plant item, a receiver heights of 1.6m for single storey properties and 4m for double. An assumed ground factor of G = 0.5 has been applied off site. Noise contours presented in the assessment have been predicted to a height of 4m in all instances.

Geometrical Divergence This term relates to the spherical spreading in the free-field from a point sound source resulting in attenuation depending on distance according to the following equation:

$$A_{geo} = 20 \times \log(\text{distance from source in meters}) + 11$$

Atmospheric Absorption Sound propagation through the atmosphere is attenuated by the conversion of the sound energy into heat. This attenuation is dependent on the temperature and relative humidity of the air through which the sound is travelling and is frequency dependent with increasing attenuation towards higher frequencies. In these predictions a temperature of 10°C and a relative humidity of 70% have been used, which give relativity low levels of atmosphere attenuation and corresponding worst case noise predictions.

Temp (°C)	% Humidity	Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
10	70	0.12	0.41	1.04	1.92	3.66	9.70	33.06	118.4

Table C.1 Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

Barrier Attenuation The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise.