

**AbbVie IRELAND**

**NOISE IMPACT  
ASSESSMENT FOR EPA  
LICENCE REVIEW**

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Technical Report Prepared For

**AbbVie Ireland**

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Technical Report Prepared By

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Our Reference

217501.0917NR01Rev1

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Date of Issue



30 January 2024

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## Document History

Document Reference		Original Issue Date	
217501.0917NR01		30 March 2023	
Revision Level	Revision Date	Description	Sections Affected
Rev 1	30 January 2024	Update with 2023 data	

## Record of Approval

Details	Written by	Approved by
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Date	30 January 2024	30 January 2024

## EXECUTIVE SUMMARY

AbbVie Ireland NL B.V. (hereafter referred to as AbbVie) operates an integrated biochemical operation at their facility at Ballytivnan Sligo. The facility at Ballytivnan is located approximately 1.7 km north east of Sligo town centre. The site is also located approximately 1 km from another AbbVie facility on the Manorhamilton Road established in 2002.

As part of the application to update the existing EPA IED licence an updated noise impact assessment has been undertaken and details in relation to noise emissions associated with the operation of the site. This assessment is an update of the noise assessment submitted as part of the original licence application to consider the fact that a number of stack heights are lower than those assumed previously.

This technical report has been prepared to provide full details in relation to the noise impact assessment for the licence application. The assessment is based on the design details available for the development and has been prepared with due consideration of the guidance contained within the Environmental Protection Agency (EPA) document *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) 2016*.

Section 6 of the EPA's NG4 Guidance outlines the following assessment stages for the noise impact assessment for licence applications.

- Stage 1 – Baseline Noise Survey / Monitoring Locations;
- Stage 2 – Derivation of Noise Criteria;
- Stage 3 – Assessment of Noise Impact; and,
- Stage 4 – Reporting / Licence Application Form.

This report has been prepared with consideration of the four assessment stages outlined above.

An environmental noise survey was conducted to quantify the existing noise environment in the vicinity of nearest Noise Sensitive Receivers (NSL's) to the site. The survey was conducted in accordance with the EPA's NG4 Guidance.

Appropriate operational noise criteria have been derived for the site following review of noise survey data and receiving environment, in accordance with the relevant NG4 Guidance. The applicable noise criteria identified are in line with the typical limit values for noise from licensed sites.

To assess the impact of noise from the mechanical plant at nearby NSL's, a detailed computer-based noise model has been prepared using proprietary noise modelling software package, *iNoise V2023 Enterprise*. Noise prediction calculations have carried out in accordance with ISO 9613-2:1996 *Acoustics -- Attenuation of sound during propagation outdoors -- Part 2: General method of calculation*. The predicted noise levels at all NSL's for new mechanical plant and the levels of existing plant noise from the facility are considerably the day, evening, and night-time noise criteria for site operations.

In addition noise monitoring completed by others as part of existing licence requirements have been reviewed. These surveys have been completed with the lower boiler flue stacks in operation. Review of these reports confirm that the site is operating within the relevant noise conditions outlined in its IED licence.

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## 1.0 INTRODUCTION

AWN Consulting were commissioned to prepare a noise impact assessment for the operation of the facility to be compiled and submitted as part application for the revision/updated of the existing Industrial Emissions (IE) licence (Ref: P1087-1) associated with the AbbVie Ireland site.

As part of the application to update the exiting IED licence the EPA a noise impact assessment has been undertaken and details in relation to noise emissions associated with the operation of the site. This assessment is an update of the noise assessment submitted as part of the original licence application to consider the fact that a number of stack heights are lower than those assumed previously.

This assessment is based on the existing noise emissions from the facility and the design details available for the development and has been prepared with due consideration to the guidance contained within the Environmental Protection Agency *in Relation to Scheduled Activities (NG4)*".

This report has been prepared in accordance with the four noise impact assessment stages outlined in Section 6 of NG4, which are as follows:

- Stage 1 – Baseline Noise Survey / Monitoring Locations;
- Stage 2 – Derivation of Noise Criteria;
- Stage 3 – Assessment of Noise Impact; and,
- Stage 4 – Reporting / Licence Application Form.

Figure 1 illustrates the proposed site location in the context of the surrounding environment with the approximate site boundary outlined in red.



**Figure 1** Site Location & Context (Background Imagery Source: Google Earth)

The site is situated just off the Old Bundoran Road and approximately 500m east of the N15 national road. Appendix A presents a glossary of the acoustic terminology referred to in this document.

## 2.0 FUNDAMENTALS OF ACOUSTICS

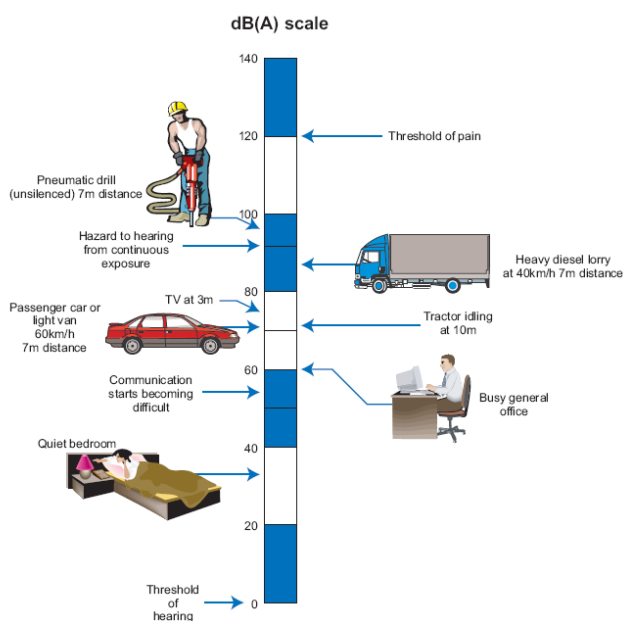
In order to provide a broader understanding of some of the technical discussion in this report, this section provides a brief overview of the fundamentals of acoustics and the basis for the preparation of this noise assessment.

A sound wave travelling through the air is a regular disturbance of the atmospheric pressure. These pressure fluctuations are detected by the human ear, producing the sensation of hearing. In order to take account of the vast range of pressure levels that can be detected by the ear, it is convenient to measure sound in terms of a logarithmic ratio of sound pressures. These values are expressed as Sound Pressure Levels (SPL) in decibels (dB).

The audible range of sounds expressed in terms of Sound Pressure Levels is 0dB (for the threshold of hearing) to 120dB (for the threshold of pain). In general, a subjective impression of doubling of loudness corresponds to a tenfold increase in sound energy which conveniently equates to a 10dB increase in SPL. It should be noted that a doubling in sound energy (such as may be caused by a doubling of traffic flows) increases the SPL by 3dB.

The frequency of sound is the rate at which a sound wave oscillates and is expressed in Hertz (Hz). The sensitivity of the human ear to different frequencies in the audible range is not uniform. For example, hearing sensitivity decreases markedly as frequency falls below 250Hz. In order to rank the SPL of various noise sources, the measured level has to be adjusted to give comparatively more weight to the frequencies that are readily detected by the human ear. Several weighting mechanisms have been proposed but the 'A-weighting' system has been found to provide one of the best correlations with perceived loudness. SPL's measured using 'A-weighting' are expressed in terms of dB(A). An indication of the level of some common sounds on the dB(A) scale is presented in Figure 2.

The established prediction and measurement techniques for the dB(A) parameter are well developed and widely applied. For a more detailed introduction to the basic principles of acoustics, reference should be made to an appropriate standard text<sup>1</sup>.



**Figure 2**  
Level of Typical Sounds on the dB(A) Scale – (TII Guidelines for the Treatment of Noise and Vibration in National Road Schemes, 2014)

<sup>1</sup> For example, *Woods Practical Guide to Noise Control* by Ian Sharland.

### 3.0 RECEIVING ENVIRONMENT

This section deals with 'Stage 1' of the noise impact assessment as outlined in the EPA's NG4 Guidance.

An environmental noise survey was conducted by AWN in support the planning application for the proposed extension in April 2018 (Sligo County Council planning application reference 18185). The purpose of the survey was to quantify the existing noise environment at nearby noise sensitive locations. The surveys were conducted in accordance with guidance contained in the EPA NG4 publication and ISO 1996: 2007: *Acoustics – Description, measurement and assessment of environmental noise*. Details of this survey are presented in the following Section.

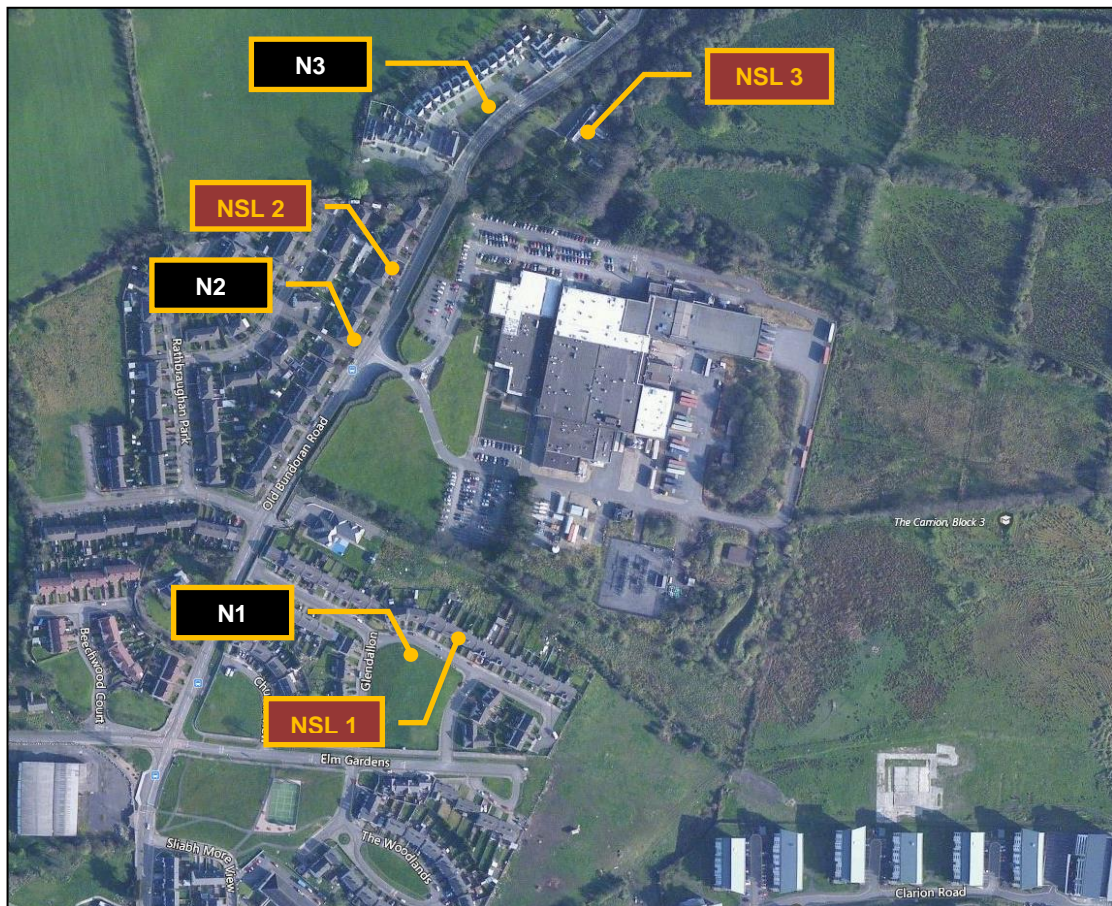
It should be noted that the noise surveys took account of noise from the existing facility at the time. It is understood that some of the noise sources that were in operation at the time of the surveys were decommissioned as part of the development.

The nearest NSL's to the site are the residential properties located the west of the site boundary along the old Bundoran Road, an isolated property situated to the north of the site and to the south of the site at the Glendallon housing estate.

#### 3.1 Choice of Measurement Locations

Following a review of the neighbouring environment and nearest NSL's, it was considered that three noise monitoring locations is appropriate for this assessment. Figure 3 illustrates the proposed site boundary in the context of the three nearest noise sensitive locations identified. Figure 3 also indicates the Noise Monitoring Locations (N1, N2 & N3) that were selected for the noise survey and deemed to be representative of the noise environment at NSL's. Each of the monitoring locations are described in turn below.

- N1** Situated to the south of the facility in the Glendallon housing estate close to NSL1 and approximately 80m south of the site boundary. The SLM was position on a grass mound in order to provide a clearer line of site to the facility.
- N2** Situated to the west of the facility outside houses along the old Bundoran Road close NSL2 and approximately 20m west of the site boundary.
- N3** Situated to the north west of the facility, just off the old Bundoran Road at Shannon Eighter housing estate. The monitoring location is considered representative of the noise environment at NSL3. The monitoring position is approximately 75m northwest of the site boundary.



**Figure 3** Noise Sensitive Locations (NSL's) and Noise Monitoring Locations (N1-N3)

### 3.2 Survey Periods

Noise measurements were conducted over the course of three survey periods as follows:

- Daytime 10:30hrs to 14:30hrs on 11 April 2018;
- Evening 21:00hrs to 23:00hrs on 11 April 2018, and;
- Night 23:00hrs to 00:40hrs 11/12 April 2018.

### 3.3 Personnel & Instrumentation

AWN conducted the noise measurements during all survey periods. The attended noise measurements were performed using a Brüel & Kjaer Type 2250 Sound Level Meter (SN. 2818080). Before and after the survey the instrument was check calibrated using a Brüel & Kjøer Type 4231 Sound Level Calibrator (SN. 2263026).

### 3.4 Procedure

Measurements were conducted at each location on a cyclical basis. Sample periods for the noise measurements were 15 minutes during all periods. The results were noted onto a Survey Record Sheet immediately following each sample and were also saved to the instrument memory for post analysis where appropriate. Survey personnel noted all primary noise sources contributing to noise build-up.

### 3.5 Measurement Parameters

The noise survey results are presented in terms of the following three 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.

$L_{AF10}$  is the sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for road traffic noise.

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

The “A” suffix denotes the fact that the sound levels have been “A-weighted” in order to account for the non-linear nature of human hearing. All sound levels in this report are expressed in terms of decibels (dB) relative to  $2 \times 10^{-5}$  Pa.

### 3.6 Survey Results

#### N1

The survey results for Location N1 are summarised in Table 1 below.

Period	Start Time	Measured Noise Levels (dB re. $2 \times 10^{-5}$ Pa)		
		$L_{Aeq}$	$L_{AF10}$	$L_{AF90}$
Day	11:19	46	47	40
	12:25	51	51	40
Evening / Night	21:40	56	53	37
	22:39	38	40	35
	00:04	42	44	37

**Table 1** Summary of Measured Noise Levels at N1

During daytime survey periods, steady plant noise from the existing AbbVie Ballytivnan facility was audible in the background throughout along with steady distant road traffic noise, intermittent noise from local anthropological sources were noted throughout the survey periods.

During the evening and night-time survey periods, the main source of noise was steady plant noise from the existing AbbVie Ballytivnan facility audible in the background along with distant road traffic. During the first evening measurement the measured  $L_{Aeq}$  level was elevated due to the presence of a dog barking in the vicinity.

No significant source of vibration was noted during the survey periods.

N2

The survey results for Location N2 are summarised in Table 2 below.

Period	Start Time	Measured Noise Levels (dB re. $2 \times 10^{-5}$ Pa)		
		L <sub>Aeq</sub>	L <sub>AF10</sub>	L <sub>AF90</sub>
Day	10:58	63	65	48
	12:04	64	66	46
	13:08	64	69	45
Evening / Night	21:19	59	58	43
	22:19	56	47	43
	23:44	58	52	44

**Table 2** Summary of Measured Noise Levels at N2

During daytime survey periods, the ambient noise in the vicinity were dominated by intermittent road traffic movements along the Old Bundoran Road and intermittent activity from the AbbVie site, noise from truck movements and the use of reverse alarms. The background noise was dominated by steady noise from the existing AbbVie Ballytivnan facility.

During the evening and night-time survey periods, the dominant source of noise was steady plant noise from the existing AbbVie Ballytivnan facility interrupted by intermittent road traffic movements along the Old Bundoran Road.

No significant source of vibration was noted during the survey periods.

N3

The survey results for Location N3 are summarised in Table 3 below.

Period	Start Time	Measured Noise Levels (dB re. $2 \times 10^{-5}$ Pa)		
		L <sub>Aeq</sub>	L <sub>AF10</sub>	L <sub>AF90</sub>
Day	10:36	52	56	42
	11:39	53	57	42
	12:49	50	54	41
Evening / Night	21:00	48	52	41
	22:00	44	42	40
	23:24	45	48	40

**Table 3** Summary of Measured Noise Levels at N3

During daytime survey periods, the ambient noise levels in the vicinity were dominated by intermittent road traffic movements along the Old Bundoran Road and birdsong. The background noise was dominated by steady and intermittent noise from the existing AbbVie Ballytivnan facility.

During the evening and night-time survey periods, steady plant noise from the existing AbbVie Ballytivnan facility was audible interrupted by intermittent road traffic movements along the Old Bundoran Road and occasionally dogs barking in the area.

## 4.0 REVIEW OF RELEVANT GUIDANCE

This section deals with 'Stage 2' of the noise impact assessment as outlined in the EPA's NG4 Guidance.

The derivation of appropriate IE Licence noise emission criteria for the proposed facility will be conducted in accordance with the NG4 document. This approach is summarised below in accordance with guidance detailed in Section 4 of the NG4 document.

### 4.1 Quiet Area Screening

The proposed development is not considered a quiet area in this instance as it fails to meet all the criteria outlined in EPA's Guidance. The most stringent of these criteria are noted in bullet point and commented on below.

- At least 3km from urban area with a population >1,000 people;

The town of Sligo is located less than 3km from the site and has a population of greater significantly greater than 1000.

- At least 3km away from any local industry;

The current facility is operational, in addition to this there are numerous facilities with 3km of the site.

- At least 5km away from any National Primary Route;

The site is located approximately 500m from the N15 national road.

### 4.2 Low Background Noise Area Screening

In order to establish whether the noise sensitive locations in the vicinity of the site would be considered 'low background noise' areas, the noise levels measured during the environmental noise survey need to satisfy all three of the following criteria:

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

The arithmetic average  $L_{A90}$  results at each location are compared against the criteria in Table 4.

Location	Period	Average $L_{A90,15min}$ (dB)	NG4 Screening (dB $L_{A90,15min}$ )	Satisfies All Criteria for Low Background Noise Area?
N1	Daytime	40	$\leq 40$	No
	Evening	36	$\leq 35$	
	Night-time	35	$\leq 30$	
N2	Daytime	46	$\leq 40$	No
	Evening	43	$\leq 35$	
	Night-time	43	$\leq 30$	
N3	Daytime	42	$\leq 40$	No
	Evening	41	$\leq 35$	
	Night-time	40	$\leq 30$	

**Table 4** Comparison of Measurement Results with NG4 Low Background Noise Area Criteria

As outlined in Table 4, none of the locations would be considered 'Areas of Low Background Noise' as the measured noise levels do not satisfy the criteria.

### 4.3 Determining Appropriate Noise Criteria

Based on the EPA NG4 guidance the following noise criteria are appropriate at the nearest NSL's to the facility:

- Daytime (07:00 to 19:00hrs) 55dB  $L_{Ar,15min}$
- Evening (19:00 to 23:00hrs) 50dB  $L_{Ar,15min}$
- Night time (23:00 to 07:00hrs) 45dB  $L_{Aeq,15min}$

During the night period, no tonal or impulsive noise from the facility should be clearly audible or measurable at any NSL. The applicable noise criteria identified are in line with the typical limit values for noise from licensed sites.

There are some plant items proposed for the development site that are designed to be used in emergency situations, for example, when grid power supplies fail. It is common practice to allow a relaxation of noise limits associated with emergency plant operations. Section 4.4.1 of EPA NG4 contains the following comments in relation to emergency plant items:

*"In some instances, licensed 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  $L_{Aeq,(15mins)}$  is appropriate in emergency scenarios for daytime, evening and night-time periods.

### 4.4 Compliance Noise Monitoring

See Attachment 7.5 of the Licence application for further details on the noise sensitive locations.

Given there may be potential access constraints at some noise sensitive locations and the presence of extraneous noise sources in the vicinity, it may be necessary to undertake compliance noise monitoring (if required) at the site boundary or at a suitable proxy location and assess to the nearest NSL's. Any such assessment should be undertaken in accordance with the guidance outlined in the EPA NG4 document and supported by a sufficiently detailed noise report outlining the calculation methods used to determine the noise emission levels at the NSL's. Simultaneous monitoring may be required initially to set appropriate limit values at alternative locations.

## 5.0 ASSESSMENT

This section deals with 'Stage 3' of the noise impact assessment as outlined in the EPA's NG4 Guidance.

The noise levels expected at nearest NSL's, due to the operation of the facility, must be considered and presented as part of the licence application.

The following sections present details of the assessment and the preliminary findings. Further information in relation to the noise prediction model, inputs, calculation settings and assessment assumptions are provided in Appendix B.

### 5.1 Noise Sensitive Locations

Noise prediction calculations have been carried out at the three nearest noise sensitive locations (NSL's) surrounding the site as previously identified, details of the NSL's used for the prediction calculations are presented in Table 5. Free field noise emission levels have been predicted at a height of 4m.

Noise Sensitive Location	Calculation Height	Location	
		North	East
NSL1	4m	569,655 ITM (N 337361)	837,378 ITM (E 169702)
NSL2	4m	569,627 ITM (N 337619)	837,634 ITM (E 169674)
NSL3	4m	569,772 ITM (N 337717)	837,732 ITM (E 169819)

**Table 5** Coordinates of Noise Sensitive Receivers

### 5.2 Noise Source Data

The main new sources of noise on the site are listed in Appendix B of this document and location of all these items and existing items that will remain operational on the site are shown in Drawing Ref. 101-004 of the Licence application.

#### 5.2.1 Existing Operational Noise

As outlined in Section 3.0, the existing AbbVie facility was operational during the noise survey. For this assessment, reference is made to the plant noise emissions that were measured during the survey to determine the expected cumulative noise emissions at the nearest noise sensitive locations for both the existing and new mechanical plant items.

As previously stated, it is understood that some of the noise sources operational at the existing facility at the time of the surveys were decommissioned as part of the development.

#### 5.2.2 New Mechanical Plant

There are several items of noise generating equipment associated with the development. It has been assumed for this assessment that all plant items will operate 24 hours a day as a worst case and that all plant items have omni-directional noise emissions (apart from AHU penthouse louvres and boiler stacks). The assessment considers all the major and minor noise sources of plant items that have been identified as having the potential to emit noise beyond the site boundary.

The details and location of all noise emission points and associated noise source data has been provided by Jacobs Engineering. Details on any assumptions made in relation to this data are outlined in Appendix B.

### 5.2.3 Details of Noise Control Measures

Control of noise has been considered as part of the design of the new facility. Where possible, external plant layout has utilised barrier screening of on-site buildings, low noise generating plant items such as attenuated cooling towers have been selected, and noisy plant items have been located within buildings.

For the purposes of this assessment we have assumed a nominal attenuation that would typically be provided for 2.5m of duct with 1 no. 90° bend and standard weather louvres at the atmosphere side in relation to rooftop AHU's.

We have assumed that the penthouse louvres for AHU's NE-2, NE-6 and NE-8 will be closed on the two sides that face to the north and west such most of the noise from the louvre will propagate to the south and east and away from the nearest noise sensitive receivers.

## 5.3 Calculation Methodology

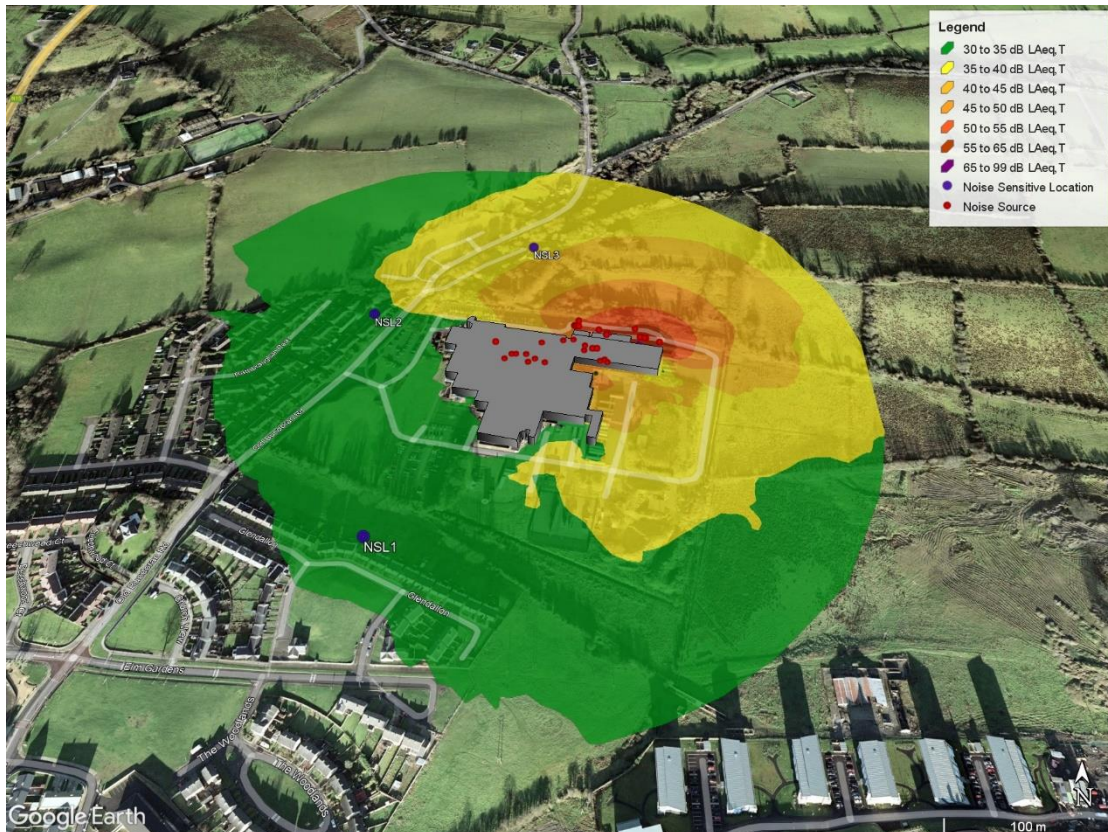
This assessment has been completed using a detailed computer-based noise model that has been prepared by AWN using proprietary noise modelling software package, *iNoise V2018 Enterprise*. All noise prediction calculations have been carried out in accordance with ISO 9613-2:1996 *Acoustics -- Attenuation of sound during propagation outdoors -- Part 2: General method of calculation*. This is the preferred calculation methodology as stated in the NG4 Guidance and in this instance, due to the number of noise sources and distances to the nearest NSL's, it is considered the most appropriate assessment method. This method has the scope to consider a range of factors affecting sound propagation, including:

- the magnitude of the noise source in terms of sound power;
- 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, humidity (these can have significant impact at distances greater than approximately 400m).

### 5.4 Predicted Noise Levels

This section presents the predicted noise levels at the nearest noise sensitive locations. It should be noted that as a worst case it is assumed that the plant (except emergency items) are operating continuously during daytime, evening and night periods for normal operation.

Figure 4 presents the predicted noise contour plot for mechanical services and factory process plant associate with the development at a calculation height of 4m above ground level.



**Figure 4** Predicted Operational Noise Contours dB LAeq,T for New Mechanical Plant

The predicted noise levels from new mechanical plant at each NSL are tabulated in Table 6.

Location	New Plant Predicted Level (dB)
NSL 1	32
NSL 2	33
NSL 3	40

**Table 6** Predicted Operational Noise Levels at NSL's for New Mechanical Plant Items

Table 7 presents an assessment of the resultant noise emissions predicted from the site considering the operation of all significant plant items. The existing plant noise levels have been calculated with due consideration of the guidance set out in Section 7.8 & 7.9 of the EPA NG4 guidance document and review of the noise survey data presented in Section 3.0 of this report. The measured LA<sub>F90</sub> parameter from noise survey has been judged to be an appropriate indicator for existing plant noise emissions in this instance.

Location	New Plant Predicted Level (dB)	Existing Plant Noise Level (dB)	Total Operational Plant Noise Level (dB)
NSL 1	32	35	37
NSL 2	33	43	43
NSL 3	40	40	43

**Table 7** Predicted Operational Plant Noise Levels at NSL's

Table 8 present the predicted plant noise emission levels at the nearest NSL's and compares the results against the relevant criteria that have been derived for the site.

Receptor	Predicted $L_{Aeq,15\text{minute}}$	Day (07:00 – 19:00hrs)		Evening (19:00 – 23:00hrs)		Night (23:00 – 07:00hrs)	
		Criterion dB $L_{Ar,T}$	Complies?	Criterion dB $L_{Ar,T}$	Complies?	Criterion dB $L_{Aeq,T}$	Complies?
NSL1	37	55	Yes	50	Yes	45	Yes
NSL2	43		Yes		Yes		Yes
NSL3	43		Yes		Yes		Yes

**Table 8** Predicted Operational Noise Levels vs Criteria

An emergency generator will operate in emergency situations and for periodic testing during daytime hours. To reiterate, the NG4 document allows for relaxed noise emission criteria for emergency use equipment. Regardless of this fact, the worst case predicted noise emissions from the operation of the generators are below the normal day, evening and night time noise criteria and any predicted increase in the noise emissions is expected to be not significant.

## 6.0 REVIEW OF 2022 and 2023 NOISE SURVEYS

AONA Environmental<sup>2,3</sup> have carried out noise surveys in the vicinity of the site in 2022 and 2023. The noise sources assessed in Section 5.0 were in normal operation during these survey periods. The results of these IED noise surveys have been reviewed to demonstrate that the current site operates within the relevant noise conditions outlined in the relevant sections of the existing licence Ref P1087-01.

P1087-01 states that:

*“Noise emissions will be mitigated through: imposing daytime, evening time and night-time noise limits at noise sensitive locations; and implementing monitoring, maintenance and control measures”.*

Paragraph 4.5 of P1087-01 states that:

*“Noise from the installation shall not give rise to sound pressure levels measured at the NSLs which exceed the limit value”.*

Paragraph 6.13 of P1087-01 states that:

*“The licensee shall carry out a noise survey of the site operations annually. The survey programme shall be undertaken in accordance with the methodology specified in the ‘Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)’ as published by the Agency”.*

Schedule B.4 Noise Emissions of P1087-01 outlines the following noise limits:

Daytime dB $L_{Ar,T}$ (30 minutes)	Evening Time dB $L_{Ar,T}$ (30 minutes)	Daytime dB $L_{Aeq,T}$ (30 minutes)
55	50	45

Note 1: *During night-time hours, there will be no clearly audible tonal component or impulsive component in the noise emission from the activity at any noise sensitive location.*

The noise sensitive locations considered in the AONA Environmental reports are as detailed in Table 9 and shown on Figure 5.

NML Ref.	Noise Measurement Location Description
NML 1	At Abbie southern site boundary in close proximity to Glendallon properties (EPA NSL 1). Located at site boundary fence near to Ferm Engineering site offices.
NML 2	At Abbie southern site boundary adjacent to new HSE Harmony care home near to the Old Bundoran Road.
NML 3	Outside Abbie site boundary - on road side near plant entrance adjacent to Rathbraughan properties (EPA NSL 2).
NML 4	At Abbie northern site boundary in close proximity to private residence north of the site (EPA NSL 3).

**Table 9** Annual Monitoring Noise Measurement Location Descriptions

<sup>2</sup> ENV-4015 Abbie Sligo - Ballytivnan Env Noise Report Sept 2022

<sup>3</sup> ENV-4015 Abbie Sligo - Ballytivnan Env Noise Report Oct 2023



**Figure 5** Annual Monitoring Noise Measurement Location (Source: AONA Env)

Table 10 reviews the results of the 2022 and 2023 noise monitoring carried out by AONA Environmental against the relevant noise criteria outlined above.

Location	Period	Year	Specific Site dB LAeq,30min	Criterion dB LAeq,30min	Complies?
NSL1	Day	2022	41	55	✓
		2023	52		✓
	Evening	2022	42	50	✓
		2023	43		✓
	Night	2022	44	45	✓
		2023	42		✓
NSL2	Day	2022	41	55	✓
		2023	55		✓
	Evening	2022	42	50	✓
		2023	42		✓
	Night	2022	41	45	✓
		2023	41		✓
NSL3	Day	2022	47	55	✓
		2023	63		✓
	Evening	2022	43	50	✓
		2023	59		✓
	Night	2022	44	45	✓
		2023	57		✓
NSL4	Day	2022	44	55	✓
		2023	49		✓
	Evening	2022	42	50	✓
		2023	42		✓
	Night	2022	44	45	✓
		2023	43		✓

**Table 10** Review of Annual Noise Monitoring Results

Note A

Note the dB LAeq,30min reported here is the arithmetic average of the LA90 values reported for the various periods due to the steady nature of the site noise emissions under consideration here.

For the 2023 survey, at NSL3, the LAeq values for the daytime, evening and night-time monitoring periods were ~63 dB(A), 59 dB(A) and ~51-57 dB(A) respectively. However, the LA90 values for the daytime, evening and night-time monitoring periods were ~47 dB(A), 42 dB(A) and ~42 dB(A) respectively. On this occasion daytime noise was influenced by construction work taking place within the site boundary.

Since the factory operations are relatively constant it is considered that the LA90 value is a good representation of the AbbVie plant noise contribution at this monitoring location. The noise monitoring location (NML) was at a kerbside location adjacent to the Old Bundoran Road in close proximity to the nearest noise sensitive location at Rathbraughan (EPA NSL 2).

From the frequency spectrum outlined in Chart 3 there is no evidence of significant tonal noise emanating from the AbbVie site at NML 3 due to on-site sources during the daytime, evening or night-time noise. The noise survey results exhibit compliance with the EPA noise limits of Daytime (07:00 to 19:00hrs) – 55 dB LAeq,T, Evening (19:00 to 23:00hrs) – 50 dB LAeq,T and Night-time (23:00 to 07:00hrs) – 45 dB LAeq,T.

Therefore, review of the results presented in Table 10 confirm that the current site operates within the relevant noise limits as detailed in the existing licence Ref P1087-01.

## **7.0 CONCLUSION**

A detailed noise survey has been completed at three noise sensitive locations surrounding the site to establish the existing noise environment. This work has demonstrated that the baseline noise environment is dictated by steady plant noise emissions from the operation of the existing facility and road traffic noise.

In accordance with the relevant NG4 Guidance, appropriate operational noise criteria have been derived for the site which are based on the existing noise environment at the nearest NSL's.

A noise impact assessment has been completed using information obtained from the design team for significant items of mechanical plant. A detailed computer-based noise model has been prepared using proprietary noise modelling software in accordance with the calculation method outlined in ISO 9613-2:1996.

The predicted noise levels at all NSL's are below the day, evening and night-time noise criteria that are applicable to the site operations.

AONA Environmental have carried out noise surveys in the vicinity of the site in 2022 and 2023. The results of these IED noise surveys have been reviewed to demonstrate that the current site operates within the relevant noise conditions detailed in the existing licence Ref P1087-01.

## APPENDIX A GLOSSARY OF ACOUSTIC TERMINOLOGY

<b>ambient noise</b>	The totally encompassing sound in a given situation at a given time, usually composed of sound from many sources, near and far.
<b>background noise</b>	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 ( $L_{AF90,T}$ ).
<b>broadband</b>	Sounds that contain energy distributed across a wide range of frequencies.
<b>dB</b>	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 $\mu$ Pa).
<b>dB <math>L_{pA}</math></b>	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.
<b>Hertz (Hz)</b>	The unit of sound frequency in cycles per second.
<b>impulsive noise</b>	A noise that is of short duration (typically less than one second), the sound pressure level of which is significantly higher than the background.
<b><math>L_{Aeq,T}</math></b>	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.
<b><math>L_{AFN}</math></b>	The A-weighted noise level exceeded for N% of the sampling interval. Measured using the "Fast" time weighting.
<b><math>L_{AFmax}</math></b>	is the instantaneous slow time weighted maximum sound level measured during the sample period (usually referred to in relation to construction noise levels).
<b><math>L_{Ar,T}</math></b>	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.
<b><math>L_{AF90}</math></b>	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.

**APPENDIX A**  
**GLOSSARY OF ACOUSTIC TERMINOLOGY (Continued)**

<b>L<sub>AT</sub>(DW)</b>	equivalent continuous downwind sound pressure level.
<b>L<sub>FT</sub>(DW)</b>	equivalent continuous downwind octave-band sound pressure level.
<b>low frequency noise</b>	LFN - noise which is dominated by frequency components towards the lower end of the frequency spectrum.
<b>noise</b>	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.
<b>noise sensitive location</b>	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.
<b>octave band</b>	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.
<b>rating level</b>	See L <sub>Ar,T</sub> .
<b>sound power level</b>	The logarithmic measure of sound power in comparison to a referenced sound intensity level of one picowatt (1pW) per m <sup>2</sup> where:
	$L_w = 10 \text{Log} \frac{P}{P_0} \text{ dB}$
	Where: p is the rms value of sound power in pascals; and P <sub>0</sub> is 1 pW.
<b>sound pressure level</b>	The sound pressure level at a point is defined as:
	$L_p = 20 \text{Log} \frac{P}{P_0} \text{ dB}$
<b>specific noise level</b>	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 <sub>Aeq,T</sub> )'.

**APPENDIX A**  
**GLOSSARY OF ACOUSTIC TERMINOLOGY (Continued)**

<b>tonal</b>	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'.
<b>1/3 octave analysis</b>	Frequency analysis of sound such that the frequency spectrum is subdivided into bands of one-third of an octave each.

## APPENDIX B NOISE MODEL AND IMPACT ASSESSMENT DETAILS

### B.1.1 Noise Sensitive Locations

Table B.1 presents the location of the various noise sensitive locations (NSL's) identified for the noise impact assessment.

Receptor	Co-ordinates (ITM)	
	N	E
NSL1	569,655	837,378
NSL2	569,627	837,634
NSL3	569,772	837,732

**Table B.1** Details of Noise Sensitive Locations

### B.1.2 Noise Model

A 3D computer-based prediction model has been prepared to quantify the operational noise emission levels from proposed development. This section discusses the methodology behind the noise modelling and noise impact assessment process.

### B.1.3 dGmR iNoise V2018 Enterprise

Proprietary noise calculation software has been used for the purposes of this modelling exercise. The selected software package was dGmR iNoise V2018 Enterprise, this package calculates noise levels in accordance with ISO 9613: *Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation, 1996*.

iNoise V2018 is a proprietary noise calculation package for computing noise level propagation from a range of noise source types. iNoise calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated considering a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of A weighted sound power levels (LWA);
- 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).

### B.1.4 Brief Description of ISO9613-2: 1996

ISO 9613-2:1996 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  $\pm 45^\circ$  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<sup>-1</sup> and 5ms<sup>-1</sup>, 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:

$$L_{IT(DW)} = L_W + D_c - A \quad \text{Equation A}$$

Where:

- $L_{IT(DW)}$  is an octave band centre frequency component of  $L_{AT(DW)}$  in dB relative to  $2 \times 10^{-5} \text{Pa}$ ;
- $L_W$  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.2 below:

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

**Table B.2** 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.

### B.1.5 Input Data and Assumptions

The noise model has been compiled using data from various sources as follows:

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

**Local Area** The Location of noise sensitive locations has been obtained from review of Ordinance Survey Ireland (OSI) maps and online mapping applications (e.g. Google Earth) and on-site observations.

**Heights** Onsite building heights have been obtained from the drawings forwarded from Jacobs Engineering.

The assessment considers all the major and minor noise sources of plant items that have been identified as having the potential to emit noise beyond the site boundary. The details and location of all noise emission points and associated noise source data has been provided by Jacobs Engineering. Details of the noise source data used for this assessment are provided in section B.1.7 and Drawing Ref. No. 0011.

The noise impact assessment has been completed using information previously obtained from the design team for significant items of plant. The noise data used in the assessment is considered worst case based on data provided by a range of vendors. In order to present a conservative assessment, the following assumptions have been made for noise sources in the noise model:

- omni-directional directivity, i.e. 360° propagation for all noise sources (apart from AHU penthouse louvres and boiler stacks);
- continuous 24/7 operation for all operational plant items;
- rooftop AHU's are likely to have acoustic attenuators fitted as standard, however, for the purposes of this assessment we have assumed no attenuators on the AHU's as a worst-case.

### B.1.6 Modelling Calculation Parameters

The atmospheric attenuation outlined in Table B.3 has been assumed for all calculations.

Temp (°C)	% Humidity	Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
10	80	0.11	0.38	1.02	1.97	3.57	8.76	28.72	103.21

**Table B.3** Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

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 calculated in a down wind direction, corresponding to the worst-case propagation conditions and needs no further adjustment. All noise sources have been assumed omni directional as a worst case with the exception of AHU penthouse louvres and boiler stack where a realistic directivity factor has been incorporated into the calculations.

*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 are 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 and 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 height of 4m for a two-story development. A ground factor of G = 0.3 has been applied in general in the noise prediction model.

**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:

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

**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 80% have been used, which give relatively low levels of atmosphere attenuation and corresponding worst case noise predictions.

**Barrier Attenuation:** The effect of any barrier (or building) 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.

### **B.1.7 Source Sound Power Data**

The source data that has been assumed for this assessment is outlined in Table B.4. Each noise source was input as sound power in octave bands. iNoise accepts sound power levels in octave bands from 63Hz to 8kHz. Overall sound power levels have been provided by Jacobs Engineering and the source locations have been obtained from the supplied drawings.

The list of noise sources included in the model are presented in Table B.4 this list includes all significant operational mechanical plant on the site.

The noise source emissions table is presented in Appendix C.

### APPENDIX C NOISE EMISSIONS TABLE

#### NOISE EMISSIONS – Normal Duty Significant Noise Sources –Noise Emission Summary

Source <sup>1</sup>	Emission point Ref. No <sup>2</sup>	Equipment Ref. No	Sound Power Level dB L <sub>WA</sub> <sup>3</sup>	Octave bands (Hz) Sound Power Levels dB(A) per band									Impulsive or tonal qualities <sup>4</sup>	Periods of Emission
				31.5	63	125	250	500	1K	2K	4K	8K		
AHU 531_01 IN	NE-1	n/a	67	--	37	51	60	64	60	56	43	33	n/a	Continuous
AHU 531_01 EX	NE-2	n/a	89	--	46	51	67	77	88	81	77	71	n/a	Continuous
AHU 532_01 IN	NE-3	n/a	65	--	33	45	58	61	58	56	44	34	n/a	Continuous
AHU 532_01 EX	NE-4	n/a	87	--	43	53	65	76	84	81	78	71	n/a	Continuous
AHU 533_01 IN	NE-5	n/a	66	--	36	50	59	63	59	56	43	33	n/a	Continuous
AHU 533_01 EX	NE-6	n/a	89	--	45	50	67	77	88	81	77	71	n/a	Continuous
AHU 534_01 IN	NE-7	n/a	63	--	31	45	56	59	56	54	41	31	n/a	Continuous
AHU 534_01 EX	NE-8	n/a	89	--	43	49	66	76	87	81	76	70	n/a	Continuous
AHU 535_01 IN	NE-9	n/a	67	--	37	52	58	63	61	58	47	38	n/a	Continuous
AHU 535_01 EX	NE-10	n/a	81	--	55	38	62	71	75	76	76	71	n/a	Continuous
LYO AHU - IN	NE-11	n/a	58	--	33	34	46	56	52	47	43	33	n/a	Continuous
LYO AHU - EX	NE-12	n/a	72	--	31	32	51	62	67	67	67	57	n/a	Continuous
WH AHU - IN	NE-13	n/a	63	--	33	51	56	59	56	53	40	31	n/a	Continuous
WH AHU - EX	NE-14	n/a	87	--	47	57	67	76	85	81	75	70	n/a	Continuous
PROCESS SUPPLY AHU	NE-15	n/a	63	--	33	44	56	60	54	49	34	23	n/a	Continuous
Cooling Unit	NE-28	n/a	81	--	44	54	60	69	75	76	74	69	n/a	Continuous
Cooling Unit	NE-29	n/a	81	--	44	54	60	69	75	76	74	69	n/a	Continuous
Cooling Unit	NE-37	n/a	81	--	44	54	60	69	75	76	74	69	n/a	Continuous
BOILER EXHAUST	NE-50	n/a	79	--	--	--	--	79	--	--	--	--	n/a	Continuous
BOILER EXHAUST	NE-54	n/a	72	--	--	--	--	72	--	--	--	--	n/a	Continuous
BOILER EXHAUST	NE-55	n/a	72	--	--	--	--	72	--	--	--	--	n/a	Continuous
BOILER EXHAUST	NE-56	n/a	72	--	--	--	--	72	--	--	--	--	n/a	Continuous
EXHAUST FLUE	NE-60	n/a	69	--	--	--	--	69	--	--	--	--	n/a	Continuous
PUMP	NE-74	n/a	85	--	48	58	64	73	79	80	78	73	n/a	Continuous
PUMP	NE-75	n/a	85	--	48	58	64	73	79	80	78	73	n/a	Continuous
PUMP	NE-77	n/a	81	--	44	54	60	69	75	76	74	69	n/a	Continuous
AHU - INLET LOUVRE	NE-79	n/a	76	--	42	65	71	70	68	66	54	44	n/a	Continuous
AHU - EXHAUST LOUVRE	NE-80	n/a	76	--	42	65	71	70	68	66	54	44	n/a	Continuous

Source <sup>1</sup>	Emission point Ref. No <sup>2</sup>	Equipment Ref. No	Sound Power Level dB L <sub>WA</sub> <sup>3</sup>	Octave bands (Hz) Sound Power Levels dB(A) per band								Impulsive or tonal qualities <sup>4</sup>	Periods of Emission	
				31.5	63	125	250	500	1K	2K	4K			8K
Chiller Louvre	NE-62	n/a	78	--	--	--	--	78	--	--	--	--	n/a	Continuous
COOLING TOWER	NE-70	n/a	84	--	71	73	75	78	79	77	72	66	n/a	Continuous
COOLING TOWER	NE-71	n/a	84	--	71	73	75	78	79	77	72	66	n/a	Continuous

1. See Drawing No. 0011 for location of all main noise sources on site.
2. Noise source emissions have been assumed from the preliminary noise impact assessments submitted as part of the IE Licence Application. See technical note ref. DB/18/10237NR01 (Preliminary Noise Impact assessment for IE Application).
3. Preliminary noise emission data, as part of the detailed design process, acoustic attenuators, enclosures, silencers and louvres and barriers will be utilised where appropriate to ensure that the noise emissions will not exceed the operational noise limits stipulated in the facilities EPA Licence.
4. It is understood that all noise sources are continuous and broadband in nature. A tonal assessment has not been undertaken.