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ATTACHMENT-7-1-3-2-AIR EMISSIONS IMPACT ASSESSMENT ADSIL CLONSHAUGH BUSINESS & TECHNOLOGY PARK, DUBLIN 17

Technical Report Prepared For

Amazon Data Services Ireland Limited

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Our Reference

EP/237501.0453AR01

Date of Issue

29 August 2025

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Document History

Document Reference		Original Issue Date	
EP/237501.0453AR01		1 July 2024	
Revision Level	**Revision Date**	**Description**	**Sections Affected**
EP/237501.0453AR01	24 March 2025	Update Based on RFI	All Sections
EP/237501.0453AR01	2 April 2025	Update Based on RFI2	All Sections
EP/237501.0453AR01	23 June 2025	Update Based on RFI3	All Sections
EP/237501.0453AR01	29 August 2025	Update Based on RFI4	See “Amendments to Report” section.

Record of Approval

Details	Written by	Approved by
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Date	29 August 2025	29 August 2025

EXECUTIVE SUMMARY

This report presents the assessment of air quality impacts as a result of the operation of the Amazon Data Services Ireland Ltd. ("ADSIL" or 'the applicant') data storage installation (the subject 'installation' under this licence review application) located at Clonshaugh Business & Technology Park, Dublin 17. The installation is occupied by five no. data storage installation buildings, termed Building W, Building X, Building Y, Building U and Building V, along with ancillary elements.

Outside of routine testing and maintenance, the operation of the emergency back-up generators is typically only required under the following emergency circumstances:

- A loss, reduction or instability of grid power supply,
- Critical maintenance to power systems,
- A request from the utility supplier (or third party acting on its behalf) to reduce grid electricity load.

The emergency back-up generators were modelled at 100% load for 150 hours per year. The model also included the following types of testing of the back-up generators:

- **Test 1:** Testing once per week of all 52 no. emergency back-up generators on the campus at 25% load for a maximum of 30 minutes each, one generator at a time, sequentially;
- **Test 2:** All 52 no. emergency back-up generators will be periodically tested on an individual basis at 100% load for a maximum of 16 hours per year. This is incorporated into the dispersion model as each generator operating on an individual basis, at 100% load, for four hours, once per quarter (assumed to be January, April, June and October for the purpose of this assessment).

The air dispersion modelling has been carried out using the United States Environmental Protection Agency's regulated model AERMOD(1). The AERMOD model has USEPA regulatory status and is one of the advanced models recommended within the air modelling guidance document 'Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)' published by the EPA in Ireland(2).

The modelling of air emissions from the installation, as well as cumulative emissions, was carried out to assess concentrations of nitrogen dioxide (NO_2), ammonia (NH_3), carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$) and sulphur dioxide (SO_2) at a variety of locations beyond the installation boundary.

The assessment has been undertaken for Buildings W, X, Y, U and V. These emission points are shown in Drawing No. 21_123F-00-XX-DR-C-2000 Emission Layout Plan.

- Building W: 13 no. emergency back-up generator stacks with a minimum height of 6 m above ground level.
- Building X: 20 no. emergency back-up generator stacks with a minimum height of 16 m above ground level.
- Building Y: 7 no. emergency back-up generator stacks with a minimum height of 16 m above ground level.
- Building U: 11 no. emergency back-up generator stacks with a minimum height of 25 m above ground level.
- Building V: 1 no. emergency back-up generator stack with a minimum height of 15.6 m above ground level.

Two of the back-up generators in each Building W, X and U and one of the back-up generators in Building Y are modelled as "catcher" generators to provide redundancy for the other back-up generators i.e. 45 no. of the 52 no. back-up generators are assumed to be running simultaneously in the event of a power failure to the installation.

A Licenced Operational scenario was investigated for the purposes of this modelling assessment. Both normal day-to-day testing operations are considered as well as emergency operations. Normal testing operations involve the emergency back-up generators operating for 30 minutes on a weekly basis at 25% load using diesel fuel, with no more than one generator tested at the same time. Quarterly maintenance testing of the generators was undertaken on an individual basis at 100% load for 4-hours each on a quarterly basis, which is equivalent to 16 hours per year using diesel fuel, was also included in the modelling assessment. Emergency operation is based on 150 emergency hours modelled according to the USEPA methodology. For the purposes of this assessment, the licenced operational scenario is a worst-case assessment which assumes that 45 of the 52 emergency back-up generators operate for 150 hours per year. However, in reality, it is likely that they will be in operation for only a few hours in any one year for testing and maintenance.

Cumulative Air Emissions

A cumulative impact assessment of the installation and nearby installations within a 1 km radius was also conducted. Installations which hold an Industrial Emissions Directive (IED) licence from the EPA were assessed for relevant air emissions.

The Applicant operates a separate data storage installation to the north-west of the subject installation which is referred to as Building A through F (Licence No. P1171-01). The Operator has sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at this second installation, and mass emissions of NO_X are above the threshold for a cumulative assessment, these emission sources have been included in the cumulative assessment for NO_X. There are two additional data centres, referred to as the Dataplex data centre (located at the eastern boundary of Licence No. P1171-01, and Digital Realty Trust, north of Buildings U and V, were identified within the study area. The operational details of these facilities about the emissions associated with emergency back-up generator testing, maintenance and emergency operations is available through a review of their planning permissions and thus these have been included in the cumulative assessment.

There are third-party 2 no. IE licenced installations within 1 km of the installation, Global Switch Property (Dublin) Ltd (Licence No. P0109), and Forest Laboratories Ireland Ltd (Licence No. P0306) within Clonshaugh Business & Technology Park. Global Switch Property (Dublin) Ltd, has no licenced NO_X emission points and thus has not been included in the cumulative air modelling assessment. Forest Laboratories Ireland Ltd does have NO_X emissions but as explained in Section 6.3 has emissions which are sub-threshold as defined by AG4 (EPA, 2020) and thus have been excluded from the cumulative assessment.

Assessment of the Data Storage Installation Air Quality Impact on Human Health

The results of the modelling assessment indicate that ambient ground level pollutant concentrations are in compliance with the relevant air quality standards for NO_2, CO, PM_{10}, $PM_{2.5}$, NH_3 and SO_2 under all operational scenarios assessed.

In summary, emissions to atmosphere of NO_2, as the main polluting substance (as defined in the Schedule of EPA (Industrial Emissions) (Licensing) Regulations 2013, S.I. No. 137 of 2013) from the Installation, will be in compliance with the ambient air quality standards which are based on the protection of the environment and human health. Therefore, no significant impacts to the ambient air quality environment are predicted.

Impact	Pollutant	Report Section
Licensed Operational Scenario		
Human Health	NO_X	Section 6.1.1
	CO	Section 6.1.2
	NH_3	Section 6.1.3
	PM_{10}	Section 6.1.4
	$PM_{2.5}$	Section 6.1.5
	SO_2	Section 6.1.6
Cumulative Assessment		
Human Health	NO_X	Section 6.3.1

Assessment of The Data Storage Installation Air Quality Impact on Ecology

The impact of emissions of NO_X, NH_3, SO_2 and nutrient and acid deposition from the installation, as well as the impact of cumulative emissions, on European Sites and nationally designated habitat sites within 10 km of the installation was also assessed.

Impact	Pollutant	Report Section
Licensed Operational Scenario		
Ecology	NO_X	Section 7.1.1
	NH_3	Section 7.1.2
	SO_2	Section 7.1.3
	Nitrogen deposition	Section 7.1.4
	Acid deposition	Section 7.1.5
Cumulative Assessment		
Ecology	NO_X	Section 7.2.1
	NH_3	n/a
	SO_2	Section 7.2.3
	Nitrogen deposition	Section 7.2.4
	Acid deposition	Section 7.2.5

The modelling assessment determined that emissions of NO_X, SO_2 and nutrient and acid deposition from the Installation do not exceed the relevant critical levels and worst-case critical load ranges for the sensitive features within the European sites assessed. The critical level for NH_3 may be exceeded, in terms of PEC % of critical level, at the Howth Head SAC in the Licenced Operational scenario. This exceedance is due to the NH_3 background concentration (the biggest contributor to which is the agricultural sector) exceeding the critical level, rather than the process contribution which is 0.029% of the critical level.

Emissions of NO_X, SO_2 and nutrient and acid deposition from the installation do not exceed the relevant critical levels and worst-case critical load ranges for the sensitive habitats within the sites assessed. The critical level for NH_3 may be exceeded, in terms of PEC, at the Royal Canal pNHA in the Licenced Operational scenario. This exceedance is due to the NH_3 background concentration (the biggest contributor to which is the agricultural sector) exceeding the critical level, rather than the process contribution which is 0.007% of the critical level.

The effect of emissions to air from the installation and surrounding facilities on ecological receptors is discussed further in the Appropriate Assessment (AA) Screening Report prepared by Moore Group.

CONTENTS

Amendments to Report

The following amendments have been made to this report (request for information (RFI) dated 22 August 2025), which are highlighted throughout in blue text:

1. Section 3.2.3, Table 3.3 – response to RFI 6 amended nitrogen deposition critical loads based on recommendation from the Agency that midpoint critical loads should only apply to qualifying features with EUNIS codes which feature in Table 3.2 of EPA report *Research 390: Nitrogen-Sulfur Critical Loads: Assessment of the Impacts of Air Pollution on Habitats*. Footnote to Table 3.3 has been removed and the text prior to this table amended to clarify the midpoint approach.
2. Section 4.7 – added background for Malahide Estuary SAC.
3. Section 5 – in response to RFI item 1, amended Table 5.1 to Table 5.5 to clarify type of operations and hours for each modelled emission point, as well as emission point ID (where available).
4. Section 7.1.1, Table 7.1, Section 7.1.2, Table 7.2, Section 7.1.3, Table 7.3 – amended in response to RFI item 2 regarding the North-west Irish Sea SPA.
5. Section 7.1.4, and Table 7.5 - amended in response to RFI item 6, clarification to the critical load considered for Santry Demesne pNHA revised to 10 kg/ha/yr for N deposition, and corrections in respect of nitrogen deposition critical loads as set out in point 1 above.
6. Section 7.2.1, Table 7.10, Section 7.2.3, Table 7.11, Section 7.2.3, – amended in response to RFI item 2 regarding the North-west Irish Sea SPA.
7. Section 7.2.1, Table 7.10 – corrected in response to RFI item 4 regarding the NOx at South Dublin Bay pNHA
8. Section 7.2.3, Table 7.11 - corrected in response to RFI item 5 South Dublin Bay and River Tolka Estuary SPA process contributions.
9. Section 7.1.4 and Table 7.5 - in response to RFI item 6, clarification to the critical load considered for Santry Demesne pNHA revised to 10 kg/ha/yr for N deposition, and corrections in respect of nitrogen deposition critical loads as set out in point 1 above.
10. Section 7.2.5, Table 7.14 NH_3 process contributions for North-west Irish Sea SPA corrected
11. Given that the IN2 1% threshold is only applied strictly to the Process Contribution (PC) from the application installation/facility alone at European sites within the zone of influence, in accordance with the EPA IN2 guidance. While the “considered for further assessment” was identified in earlier version in relation to the cumulative impact assessment this has been changed to more appropriately align with EPA IN2 to “N/A” (not applicable).

1.0 INTRODUCTION

This report presents the assessment of air quality impacts as a result of the operation of the Amazon Data Services Ireland Ltd. (“ADSIL” or ‘the applicant’) data storage installation (the subject ‘Installation’ under this licence review application) located at Clonshaugh Business & Technology Park, Dublin 17. The installation is occupied by five no. data storage installation buildings, termed Building W, Building X, Building Y, Building U and Building V, along with ancillary elements.

Outside of routine testing and maintenance, the operation of these back-up generators is typically only required under the following emergency circumstances:

- A loss, reduction or instability of grid power supply,
- Critical maintenance to power systems,

- A request from the utility supplier (or third party acting on its behalf) to reduce grid electricity load.

The air dispersion modelling has been carried out using the United States Environmental Protection Agency's regulated model AERMOD(1). The AERMOD model has USEPA regulatory status and is one of the advanced models recommended within the air modelling guidance document 'Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)' published by the EPA in Ireland(2). The modelling of air emissions is carried out to assess concentrations of nitrogen dioxide (NO_2) at a variety of locations beyond the installation boundary.

The modelling assessment has been undertaken for Buildings W, X, Y, U and V.

- Building W: 13 no. emergency back-up generator stacks with a minimum height of 6 m above ground level.
- Building X: 20 no. emergency back-up generator stacks with a minimum height of 16 m above ground level.
- Building Y: 7 no. emergency back-up generator stacks with a minimum height of 16 m above ground level.
- Building U: 11 no. emergency back-up generator stacks with a minimum height of 25 m above ground level.
- Building V: 1 no. emergency back-up generator stack with a minimum height of 15.6 m above ground level.

Two of the back-up generators in each Building W, X and U and one of the emergency back-up generators in Building Y are modelled as "catcher" generators to provide redundancy for the other emergency back-up generators i.e. 45 no. of the 52 no. back-up generators are assumed to be running simultaneously in the event of an emergency at the installation.

The assessment has determined the ambient air quality impact of the installation and any air quality constraints that may be present. The emergency back-up generators will be used solely for emergency operation (i.e. less than 500 hours per year) and thus the emission limit values outlined in the Medium Combustion Plant Directive are not applicable to the generators on installation.

A Licenced Operational scenario was investigated for the purposes of this modelling assessment. Both normal day-to-day testing operations are considered as well as emergency operations. Normal testing operations involves the generators using diesel fuel operating for 30 minutes on a weekly basis at 25% load with no more than one generator tested at the same time. Quarterly maintenance testing of the generators on an individual basis at 100% load for 4-hours each, which is equivalent to 16 hours per year was also included in the modelling assessment. Emergency operation is based on 150 emergency hours modelled according to the USEPA methodology.

A cumulative impact assessment of the Installation and nearby installations within a 1 km radius was also conducted. Installations which hold an IED licence from the EPA were assessed for relevant air emissions. The Applicant operates a separate data storage installation to the north-west of the subject installation which is referred to as Building A through F (Licence No. P1171-01). Because the Operator has sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at this second installation, and mass emissions of NO_X are above the threshold for a cumulative assessment, these emission sources have been included in the cumulative assessment for NO_X. Two additional data centre, referred to as the Dataplex data centre (located at the eastern boundary of the Building A to Building F installation), and Digital Realty Trust, north of Buildings U and V, were identified within the study area. The operational details of these facilities about the emissions associated with emergency back-up generator testing, maintenance and emergency operations is available through a review of their planning permissions and thus these have been included in the cumulative assessment.

There are 2 no. IE licenced installations within 1 km of the Installation, these are Global Switch Property (Dublin) Ltd (Licence No. P0109) and Forest Laboratories Ireland Ltd (Licence No. P0306) within Clonshaugh Business & Technology Park. Global Switch Property (Dublin) Ltd, has no licenced NO_X emission points and thus has not been included in the cumulative air modelling assessment. Forest Laboratories Ireland Ltd does have NO_X emissions but as explained in Section 6.3 has emissions which are sub-threshold as defined by AG4 (EPA, 2020) and thus have been excluded from the cumulative assessment.

The location of Buildings W, X, Y, U and V are shown below in Figure 1.1.

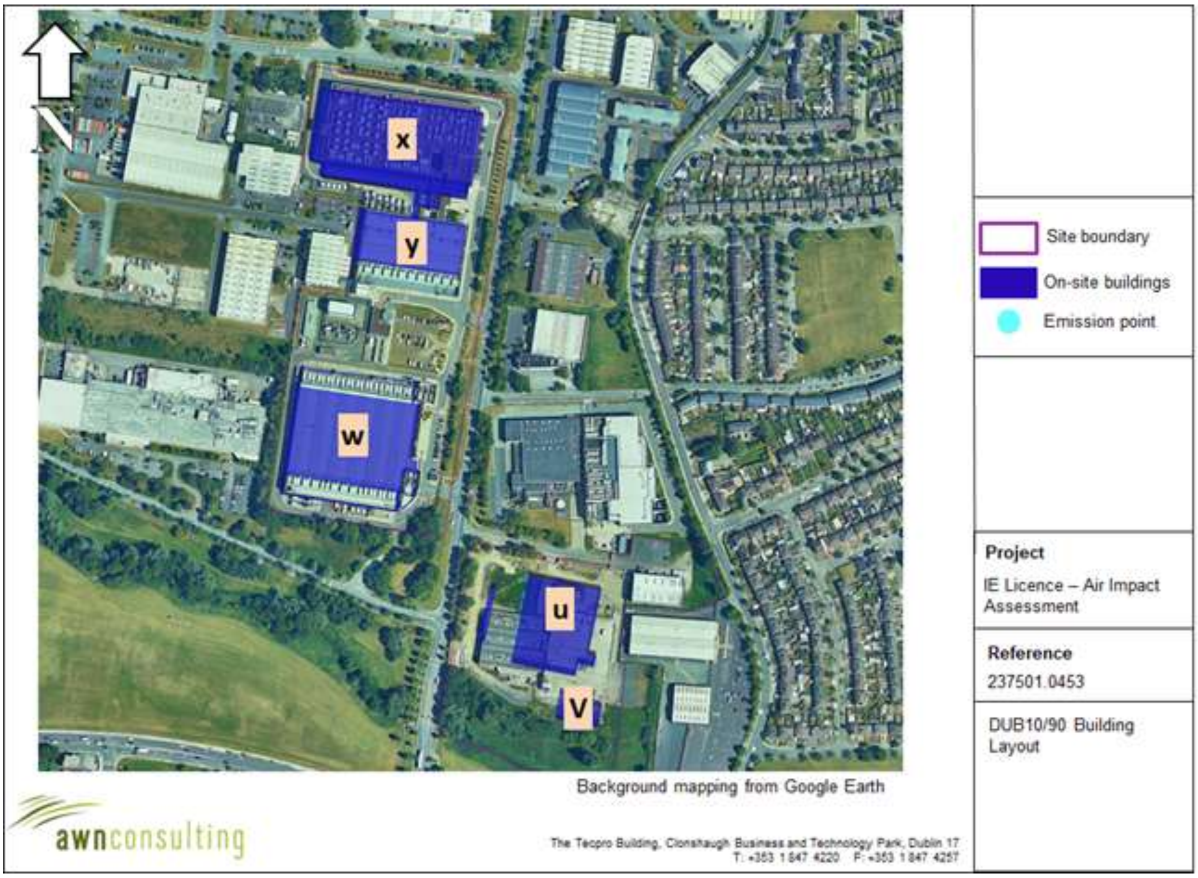

Figure 1.1. Location Of Buildings W, X, Y, U and V In Clonshaugh Business & Technology Park

Information supporting the conclusions of the air dispersion modelling assessment is detailed in the following sections. The assessment methodology and study inputs are presented in Section 2 and Section 3. Background pollutant concentrations are summarised in Section 4. The process emissions and modelling inputs for on-site plant are presented in Section 5. The dispersion modelling results are presented in Section 6 and 7 and the assessment summaries are presented in Section 8. The model formulation is detailed in Appendix I and a review of the meteorological data used is detailed in Appendix II.

2.0 ASSESSMENT CRITERIA

2.1 Ambient Air Quality Standards

Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. At present, the applicable standards in Ireland include the Air Quality Standards Regulations 2022 (S.I. 739 of 2022), which incorporate EU Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe (commonly called the 'CAFE Directive') (see Table 2.1).

In October 2024 the EU enacted Directive (EU) 2024/2881 of the European Parliament and of the Council of 23 October 2024 on ambient air quality and cleaner air for Europe (recast). This directive supersedes EU Directive 2008/50/EC and it sets out new AQS for pollutants to be reached by 2030 which are more closely aligned with the World Health Organisation (WHO) air quality guidelines. The revised AQS limit values outlined in Directive 2024/2881 are applicable from 1st January 2030 and have not yet been transposed into Irish law, and as such are not applicable to this IEL that relates to an Installation that will be operational prior to 2030. The current ambient air quality standards and limit values set out in Directive 2008/50/EC are the appropriate limits for assessing compliance of the Installation.

Ambient air quality legislation designed to protect human health and the environment is generally based on assessing ambient air quality at locations where the exposure of the population is significant relevant to the averaging time of the pollutant. However, in the current assessment, ambient air quality legislation has been applied to all locations within 10 km of the Installation regardless of whether any sensitive receptors (such as residential locations) are present. This represents a worst-case approach and an examination of the corresponding concentrations at the nearest sensitive receptors relative to the actual quoted maximum concentration indicates that these receptors generally experience ambient concentrations significantly lower than that reported for the worst-case location.

The ambient AQS applicable for the current assessment to determine the potential impact of NO_2, CO, PM_{10}, $PM_{2.5}$ and SO_2 emissions from the Installation on ambient air quality for protection of human health, and for the protection of vegetation and natural ecosystems in general are outlined in Table 2.1.

Table 2.1. CAFE Directive Ambient Air Quality Limit Values

Pollutant	Directive 2008/50/EC		Directive (EU) 2024/2881	
	Limit Type	Limit Value (applicable until 2030)[a]	Limit Type	Limit Value (to be attained by 2030)[a]
Nitrogen Dioxide (NO_2)	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	200 μg/m^3	Hourly limit for protection of human health - not to be exceeded more than 3 times/year	200 μg/m^3
	n/a	n/a	24-hour limit for protection of human health - not to be exceeded more than 18 times/year	50 μg/m^3
	Annual limit for protection of human health	40 μg/m^3	Annual limit for protection of human health	20 μg/m^3

Pollutant	Directive 2008/50/EC		Directive (EU) 2024/2881	
	Limit Type	Limit Value (applicable until 2030)[a]	Limit Type	Limit Value (to be attained by 2030)[a]
Nitrogen Oxides (NO_X)	Critical level for protection of vegetation (Annual)	30 µg/m^3	Critical level for protection of vegetation (Annual)	30 µg/m^3
Carbon Monoxide (CO)	8-hour limit (on a rolling basis) for protection of human health	10 mg/m^3	8-hour limit (on a rolling basis) for protection of human health	10 mg/m^3
	n/a	n/a	24-hour limit for protection of human health - not to be exceeded more than 18 times/year	4 mg/m^3
Particulate Matter (as PM_{10})	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50 µg/m^3	24-hour limit for protection of human health - not to be exceeded more than 18 times/year	45 µg/m^3
	Annual limit for protection of human health	40 µg/m^3	Annual limit for protection of human health	20 µg/m^3
Particulate Matter (as $PM_{2.5}$)	n/a	n/a	24-hour limit for protection of human health - not to be exceeded more than 18 times/year	25 µg/m^3
	Annual limit for protection of human health	25 µg/m^3	Annual limit for protection of human health	10 µg/m^3
Sulphur dioxide (SO_2)	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	350 µg/m^3	Hourly limit for protection of human health - not to be exceeded more than 3 times/year	350 µg/m^3
	24-hour limit for protection of human health - not to be exceeded more than 3 times/year	125 µg/m^3	24-hour limit for protection of human health - not to be exceeded more than 18 times/year	50 µg/m^3
	n/a	n/a	Annual limit for protection of human health	20 µg/m^3
	Annual limit value for the protection of vegetation	20 µg/m^3	Annual limit value for the protection of vegetation	20 µg/m^3

a. µg/m^3 (micrograms per cubic metre).

There are no specific EU or Irish regulatory standards for ammonia (NH_3) emissions in relation to human health. In the absence of such standards, this assessment has adopted the Environmental Assessment Levels (EALs) set out by the United Kingdom Environment Agency (UKEA) in Table 2.2.

These EALs are set out in the 2003 UKEA publication entitled "*IPPC Environmental* Assessment *and Appraisal of BAT*" and include both short-term and long-term environmental assessment levels (EAL) for ammonia for the protection of human health.

Table 2.2. Ammonia Ambient Air Quality Standards

Pollutant	Guideline	Guideline Type	Value
Ammonia (NH_3)	UK Environment Agency (2003)	Annual guideline for protection of human health	180 µg/m^3
		Hourly guideline for protection of human health	2,500 µg/m^3

2.2 Industrial Emissions Directive and Medium Combustion Plant Directive

The Industrial Emissions Directive (IED) (Directive 2010/75/EU) was adopted on 7 January 2013 and is the key European Directive which covers the regulation of the majority of processes in the EU. As part of the IED Article 15, paragraph 2, requires that Emissions Limit Values (ELVs) are based on best available techniques (BAT) and the relevant sector Reference Document of Best Available Techniques (BREF documents).

The most relevant BAT sector document for the activities at the installation is the Best Available Techniques (BAT) Reference Document for Large Combustion Plants LCP. There are no ELVs set out in the LCP BAT that are applicable to the individual emergency back-up generators.

The individual emergency back-up generators are greater than 1 MW_{th} and the Medium Combustion Plant (MCP) Regulations (S.I No. 595 of 2017), which transposed the Medium Combustion Plant Directive ((EU) 2015/2193) is a relevant consideration in respect of the individual plant.

The Installation requires a continuous supply of electricity to operate. During normal operations, the installation is supplied electricity from the national grid. Outside of normal operations, the installation is first supplied electricity by some or all of the onsite battery installations and then by some or all of the onsite backup generators. Outside of routine testing and maintenance, the operation of these back-up generators is typically only required under the following emergency circumstances:

- A loss, reduction or instability of grid power supply,
- Critical maintenance to power systems,
- A request from the utility supplier (or third party acting on its behalf) to reduce grid electricity load.

The generators are for emergency back-up only and are not anticipated to operate in excess of 500 hours per annum. Therefore, the emergency generators as proposed are exempt from complying with the relevant ELVs set out in the MCP Directive subject to Section 13(3) of the Medium Combustion Plant (MCP) Regulations.

2.3 Ecology Significance Criteria

In October 2024, the EPA published the draft guidance *Licence Application Instruction Note 2 (IN2) (DRAFT): Assessing the Impact of Ammonia Emissions to Air and Nitrogen Deposition from EPA licensable activities on European Sites* (hereafter referred to as IN2).

IN2, along with the accompanying flowchart (reproduced in Figure 2.1 from Appendix 1 of IN2) is designed to assist in determining the course of action to be taken when evaluating the impacts on European sites (Special Areas of Conservation (SACs) Special Protection Areas (SPAs)) and of ammonia emissions to air and nitrogen deposition from main air emission points at EPA licensable industrial sites (Industrial Emissions, Integrated Pollution Control and Waste), excluding intensive agriculture installations, for the purposes of an Appropriate Assessment (AA). This approach may also be applied to NO_X and SO_2 specifically in the context of AA.

The methodology from IN2 and the flowchart steps are considered appropriate for determining ecological impacts from a variety of air pollutant emission sources on European Sites, and have therefore been applied in this assessment:

1. The installation is not within 250 m of a European site. Proceed to Q2.
2. (i) Is the process contribution (PC) ≤1% of the relevant critical level and critical load at all European sites within the zone of influence, and (ii) can significant in-combination effects be ruled out?
    a. To address these criteria, PCs have been compared to the relevant critical levels and critical loads. The results of this screening exercise are presented in Section 7.0.
    b. Planning applications and the EPA register of Industrial Emissions (IE) licences were reviewed for developments and facilities with the potential for cumulative impact with the proposed development. There are several facilities within 1 km of the proposed development which operate sources of NO_2, therefore a cumulative impact assessment of this pollutant was required. In addition, although SO_2 emissions are below cumulative significance criteria, these emissions from nearby facilities within 1 km of the proposed development which operate sources of SO_2 have been included in the cumulative impact assessment.

In line with IN2 guidance, process contributions of NO_X and SO_2 at European sites have also been compared to the relevant critical levels, as suggested by IN2, to identify which sites require further assessment i.e. where the PC is greater than 1%.

The IN2 process applies specifically to European sites with international designation, namely Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). However, the same approach has been taken to assess the effect of emissions impacts on nationally designated sites such as Natural Heritage Areas (NHAs) and proposed Natural Heritage Areas (pNHAs). SACs and SPAs are protected under the EU Habitats Directive (92/43/EEC), and EU Birds Directive (2009/147/EC) respectively, and are also known as Natura 2000 sites. NHAs are designated under the Wildlife (Amendment) Act 2000, and pNHAs were identified as sites of conservation interest in the 1990s but have not since been statutorily proposed or designated therefore the IN2 assessment criteria do not apply.

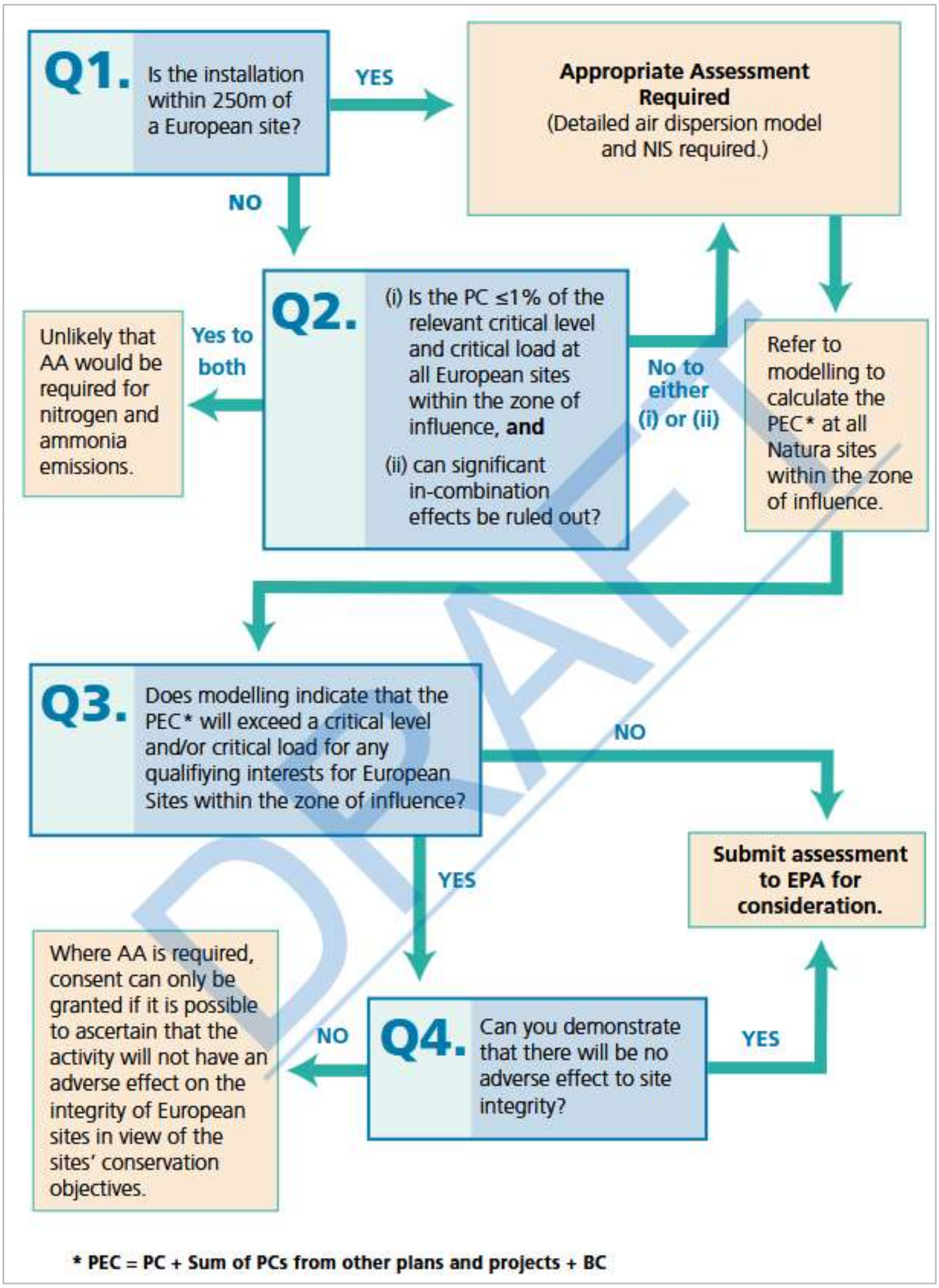

Figure 2.1. IN2 flowchart for assessing the impacts of nitrogen deposition and ammonia emissions to air on European Sites

3.0 ASSESSMENT METHODOLOGY

Emissions from the Installation are modelled using the AERMOD dispersion model (Version 24142) which has been developed by the U.S. Environmental Protection Agency (USEPA)[(1)] and following guidance issued by the EPA[(2)]. The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources and has replaced ISCST3[(7)] as the regulatory model by the USEPA for modelling emissions from industrial sources in both flat and rolling terrain[(8-10)]. The model has more advanced algorithms and gives better agreement with monitoring data in extensive validation studies[(11-13)]. An overview of the AERMOD dispersion model is outlined in Appendix I.

The air dispersion modelling input data consisted of information on the physical environment (including building dimensions and terrain features), design details from all emission points on-site and five years of appropriate hourly meteorological data. Using this input data the model predicted ambient ground level concentrations beyond the installation boundary for each hour of the modelled meteorological years. The model post-processed the data to identify the location and maximum of the worst-case ground level concentration. This worst-case concentration is then added to the background concentration to give the worst-case predicted environmental concentration (PEC). The PEC is then compared with the relevant ambient air quality standard to assess the significance of the releases from the installation.

The modelling aims to achieve compliance with the guidance outlined within the EPA *AG4 Guidance for Air Dispersion Modelling*[(2)]. Throughout this study a worst-case approach was taken. This will most likely lead to an over-estimation of the levels that will arise in practice. The worst-case assumptions are outlined below:

- Maximum predicted concentrations are reported in this study, even if no residential receptors are near the location of this maximum;
- Conservative background concentrations are used in the assessment;
- The effects of building downwash, due to on-site buildings, are included in the model;
- Emergency operations were assumed to occur for a maximum of 150 hours per year calculated according to USEPA methodology, in reality generators are likely to be used for maintenance and testing purposes only.

3.1 Air Dispersion Modelling Methodology

The United States Environmental Protection Agency (USEPA) approved AERMOD dispersion model has been used to predict the ground level concentrations (GLC) of compounds emitted from the principal emission sources on-site.

The modelling incorporated the following features:

- Two receptor grids are included at which concentrations are modelled. Receptors are mapped with sufficient resolution to ensure all localised “hot-spots” are identified without adding unduly to processing time. The receptor grids are based on Cartesian grids with the installation at the centre. The outer grid measures 10 x 10 km with the installation at the centre and with concentrations calculated at 250m intervals. The inner grid measures 2 x 2 km with the installation at the centre and with concentrations calculated at 50m intervals. Boundary receptor locations are also placed along the boundary of the installation, at 25m intervals, giving a total of 3,567 calculation points for the model.

- Discrete receptors are also added to the model to represent nearby residential receptors.
- All on-site and nearby buildings are mapped to create a three-dimensional visualisation of the installation and its emission points. Buildings and process structures can influence the passage of airflow over the emission stacks and draw plumes down towards the ground (termed building downwash). The stacks themselves can influence airflow in the same way as buildings by causing low pressure regions behind them (termed stack tip downwash). Both building and stack tip downwash are incorporated into the modelling.
- Detailed terrain has been mapped into the model using SRTM data with 30m resolution. The installation is located in an area of complex terrain. All terrain features have been mapped in detail into the model using the terrain pre-processor AERMAP[(14)].
- Hourly-sequenced meteorological information has been used in the model. Meteorological data over a five-year period (Dublin Airport 2018 – 2022) is used in the model (see Figure 3.1 and Appendix II).
- The source and emissions data, including stack dimensions, gas volumes and emission temperatures have been incorporated into the model.

3.1.1 Terrain

The AERMOD air dispersion model has a terrain pre-processor AERMAP[(14)] which is used to map the physical environment in detail over the receptor grid. The digital terrain input data used in the AERMAP pre-processor is obtained from SRTM. This data is run to obtain for each receptor point the terrain height and the terrain height scale. The terrain height scale is used in AERMOD to calculate the critical dividing streamline height, H_{crit}, for each receptor. The terrain height scale is derived from the Digital Elevation Model (DEM) files in AERMAP by computing the relief height of the DEM point relative to the height of the receptor and determining the slope. If the slope is less than 10%, the program goes to the next DEM point. If the slope is 10% or greater, the controlling hill height is updated if it is higher than the stored hill height.

In areas of complex terrain, AERMOD models the impact of terrain using the concept of the dividing streamline (H_c). As outlined in the AERMOD model formulation[(1)] a plume embedded in the flow below H_c tends to remain horizontal; it might go around the hill or impact on it. A plume above H_c will ride over the hill. Associated with this is a tendency for the plume to be depressed toward the terrain surface, for the flow to speed up, and for vertical turbulent intensities to increase.

The AERMOD model "captures the effect of flow above and below the dividing streamline by weighting the plume concentration associated with two possible extreme states of the boundary layer (horizontal plume and terrain-following). The relative weighting of the two states depends on: 1) the degree of atmospheric stability; 2) the wind speed; and 3) the plume height relative to terrain. In stable conditions, the horizontal plume "dominates" and is given greater weight while in neutral and unstable conditions, the plume traveling over the terrain is more heavily weighted"[(1)].

3.1.2 Meteorological Data

The selection of the appropriate meteorological data has followed the guidance issued by the USEPA[(1)]. A primary requirement is that the data used should have a data capture of greater than 90% for all parameters. Dublin Airport meteorological station, which is located approximately 2 km north-west of the installation, collects data in the correct format and has a data collection of greater than 90%. Long-term hourly observations at Dublin Airport meteorological station provide an indication of the prevailing wind conditions for the region (see Figure 3.1 and Appendix II). Results indicate that the prevailing wind direction is westerly to south-westerly in direction over the period 2018 – 2022. The mean wind speed is approximately 5.3 m/s over the period 2018 - 2022.

3.1.3 Geophysical Considerations

AERMOD simulates the dispersion process using planetary boundary layer (PBL) scaling theory[1]. PBL depth and the dispersion of pollutants within this layer are influenced by specific surface characteristics such as surface roughness, albedo and the availability of surface moisture. Surface roughness is a measure of the aerodynamic roughness of the surface and is related to the height of the roughness element. Albedo is a measure of the reflectivity of the surface whilst the Bowen ratio is a measure of the availability of surface moisture.

AERMOD incorporates a meteorological pre-processor AERMET[15] to enable the calculation of the appropriate parameters. The AERMET meteorological preprocessor requires the input of surface characteristics, including surface roughness (z_0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc) and vary with seasons and wind direction. The assessment of appropriate land-use type is carried out to a distance of 10km from the meteorological station for Bowen Ratio and albedo and to a distance of 1 km for surface roughness in line with USEPA recommendations[16,17] as outlined in Appendix II.

In relation to AERMOD, detailed guidance for calculating the relevant surface parameters has been published[15]. The most pertinent features are:

- The surface characteristics should be those of the meteorological site (Dublin Airport) rather than the installation;
- Surface roughness should use a default 1 km radius upwind of the meteorological tower and should be based on an inverse-distance weighted geometric mean. If land use varies around the site, the land use should be sub-divided by sectors with a minimum sector size of 30º;
- Bowen ratio and albedo should be based on a 10km grid. The Bowen ratio should be based on an un-weighted geometric mean. The albedo should be based on a simple un-weighted arithmetic mean.

AERMOD has an associated pre-processor, AERSURFACE[16] which has representative values for these parameters depending on land use type. The AERSURFACE pre-processor currently only accepts NLCD92 land use data which covers the USA. Thus, manual input of surface parameters is necessary when modelling in Ireland. Ordnance survey discovery maps (1:50,000) and digital maps such as those provided by the EPA, National Parks and Wildlife Service (NPWS) and Google Earth® are useful in determining the relevant land use in the region of the meteorological station. The Alaska Department of Environmental Conservation has issued a guidance note for the manual calculation of geometric mean for surface roughness and Bowen ratio for use in AERMET[17]. This approach has been applied to the current installation with full details provided in Appendix II.

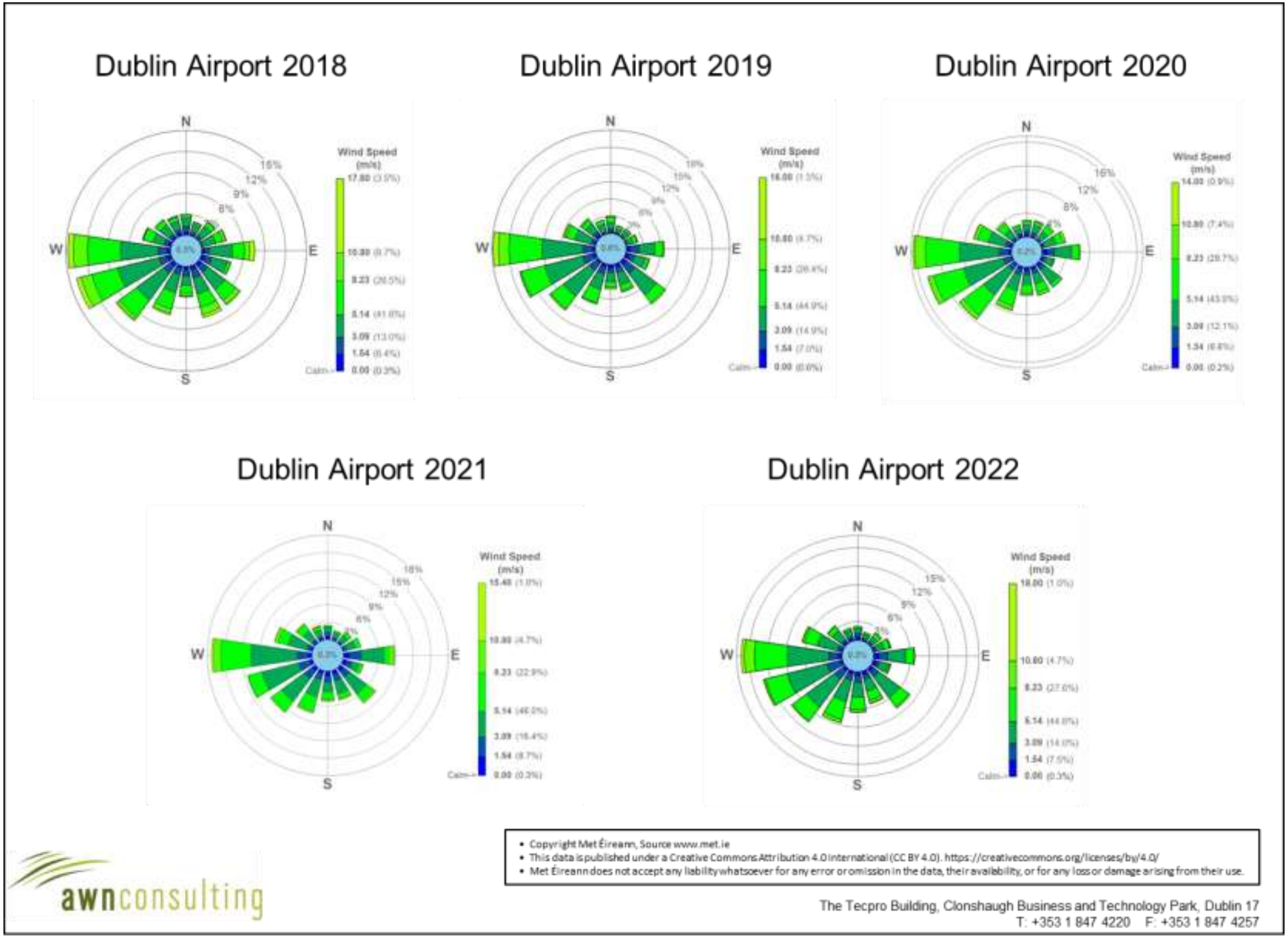

Figure 3.1. Dublin Airport Meteorological Station - Wind Roses

3.1.4 Building Downwash

When modelling emissions from an industrial installation, stacks which are relatively short can be subjected to additional turbulence due to the presence of nearby buildings. Buildings are considered nearby if they are within five times the lesser of the building height or maximum projected building width (but not greater than 800m).

The USEPA has defined the “Good Engineering Practice” (GEP) stack height as the building height plus 1.5 times the lesser of the building height or maximum projected building width. It is generally considered unlikely that building downwash will occur when stacks are at or greater than GEP(18).

When stacks are less than this height, building downwash will tend to occur. As the wind approaches a building it is forced upwards and around the building leading to the formation of turbulent eddies. In the lee of the building these eddies will lead to downward mixing (reduced plume centreline and reduced plume rise) and the creation of a cavity zone (near wake) where re-circulation of the air can occur. Plumes released from short stacks may be entrained in this airflow leading to higher ground level concentrations than in the absence of the building.

The Plume Rise Model Enhancements (PRIME)(12,13) plume rise and building downwash algorithms, which calculates the impact of buildings on plume rise and dispersion, have been incorporated into AERMOD. The building input processor BPIP-PRIME produces the parameters which are required in order to run PRIME. The model takes into account the position of each stack relative to each relevant building and the projected shape of each building for 36 wind directions (at 10º intervals). The model determines the change in plume centreline location with downwind distance based on the slope of the mean streamlines and coupled to a numerical plume rise model(13).

Given that the stacks are less than 2.5 times the lesser of the building height or maximum projected building width, building downwash will need to be taken into account and the PRIME algorithm run prior to modelling with AERMOD. The dominant building for each relevant stack will vary as a function of wind direction and relative building heights.

3.2 Ecology Methodology

3.2.1 Ecological Receptors

AWN has conducted a geospatial search to identify the nearest potentially sensitive ecological receptors within 10 km of the installation, including designated conservation areas such as Special Areas of Conservation (SACs), Special Protection Areas (SPAs), and Natural Heritage Areas (NHAs), and proposed Natural Heritage Areas (pNHAs). SACs and SPAs are protected under the EU Habitats Directive (92/43/EEC), and EU Birds Directive (2009/147/EC) respectively. NHAs are designated under the Wildlife (Amendment) Act 2000, and pNHAs were identified as sites of conservation interest in the 1990s but have not since been statutorily proposed or designated.

A geospatial search was conducted (NPWS, 2025) to identify all European sites (SACs and SPAs) within 10 km of the Installation that could potentially be affected by the project, and the nearest national sites (NHA or pNHA) within 10 km of the installation that could potentially be affected by the project, based on the methodology recommended by the UK Environment Agency (UK EA) in their 2025 guidance *Air emissions risk assessment for your environmental permit*. This search zone ensures that all European sites with the potential to be impacted via direct, indirect or cumulative pathways from air emissions are appropriately considered. Beyond these distances, the effects on ecology due to emissions from the installation are expected to be not significant.

The UKEA 2025 guidance *Air emissions risk assessment for your environmental permit* recommends that the screening distance for air emissions on protected conservation areas be increased to 15 km where emissions from *"natural gas (or fuels with a similarly low sulphur content) fired combustion plants with more than 500 megawatt thermal input, or from larger combustion plants using more sulphurous fuels with more than 50 megawatt thermal input"*, are being assessed. The Installation does not meet these criteria, therefore the screening distances of 10 km for SPAs and SPAs, and 10 km for nationally designated sites is appropriate for this assessment.

The closest Natura 2000 site to the Installation is the South Dublin Bay and River Tolka Estuary SPA (Site Code 004024) situated 3.9km to the south. The list of sites within 10km of the Installation is shown below in Table 3.1.

In terms of impacts in the national sites, the closest is the Santry Demesne pNHA (000178); c. 1.3km west of the Installation. The site comprises the remnants of a former demesne woodland.

Feltrim Hill pNHA is a quarry and considered by the NPWS for its value as a geological education site and is screened out of the assessment. All other pNHAs having dual designation are considered under their higher conservation status as a European site where applicable.

Table 3.1. Ecological Receptors

Site Code	Site name	Distance (km)
000178	Santry Demesne pNHA	1.3
004024	South Dublin Bay and River Tolka Estuary SPA	3.9
001208	Feltrim Hill pNHA	3.8
000206	North Dublin Bay pNHA (considered under North Dublin Bay SAC)	3.9
000206	North Dublin Bay SAC	4.4
004006	North Bull Island SPA	4.4
002103	Royal Canal pNHA	4.8
000199	Baldoyle Bay pNHA (considered under Baldoyle Bay SAC)	4.9
000199	Baldoyle Bay SAC	4.9
001763	Sluice River Marsh pNHA (considered under Baldoyle Bay SAC)	4.9
004016	Baldoyle Bay SPA	5.2
002104	Grand Canal pNHA	6.1
000205	Malahide Estuary SAC	6.3
004025	Malahide Estuary SPA	6.3
000205	Malahide Estuary pNHA (considered under Malahide Estuary SPA)	6.3
000201	Dolphins Dublin Docks pNHA (considered under South Dublin Bay and River Tolka Estuary SPA)	6.3
004236	North-West Irish Sea SPA	6.6
000210	South Dublin Bay SAC	6.7
000210	South Dublin Bay pNHA (considered under South Dublin Bay SAC)	6.8
000202	Howth Head pNHA (considered under Howth Head SAC)	7.9

Site Code	Site name	Distance (km)
000202	Howth Head SAC	8.3
003000	Rockabill to Dalkey Island SAC	9.1
004117	Ireland's Eye SPA	9.5
001205	Booterstown Marsh pNHA (considered under South Dublin Bay and River Tolka Estuary SPA)	9.6
000203	Ireland's Eye pNHA (considered under Ireland's Eye SAC)	9.7
002193	Ireland's Eye SAC	9.7

Emissions of NO_X have the potential to impact vegetation and sensitive plant species. Directive 2008/50/EC has set limit values for vegetation effects as per Table 2.1. As such it is typical to assess the impact of NO_X emissions from a installation on any nearby sensitive ecological areas in close proximity to the installation. There are no European sites within 1 km of the subject installation as noted above.
An annual limit value of 30 μg/m^3 for NO_X and 20 μg/m^3 for SO_2 is specified within EU Directive 2008/50/EC for the protection of ecosystems. The NO_X limit value is applicable only in highly rural areas away from major sources of NO_X such as large conurbations, factories and high road vehicle activity such as a dual carriageway or motorway. Annex III of EU Directive 2008/50/EC identifies that monitoring to demonstrate compliance with the NO_X limit value for the protection of vegetation should be carried out distances greater than:

- 5 km from the nearest motorway or dual carriageway;
- 5 km from the nearest major industrial installation;
- 20 km from a major urban conurbation.

There are sections of ecological receptors which are near the Installation that are close to industrial facilities, so the limit value for NO_X for the protection of ecosystems is not technically applicable at these installations. Regardless, the annual average concentrations for NO_X from all emission points at the Installation were predicted at receptors within the designated sites for all five years of meteorological data modelled (2018 – 2022). With receptor spacing of 500 m, 1,777 discrete receptors were modelled in total within the sensitive ecosystems.

3.2.2 Methodology for Determining Nitrogen and Acid Deposition

In order to consider the effects of nitrogen and acid deposition owing to emissions from the Installation on the designated receptors, the maximum annual mean NO_2, NH_3 and SO_2 predicted environmental concentrations must be converted firstly into a dry deposition flux using the equation below which is taken from UK EA publication "AGTAG06 – Technical Guidance On Detailed Modelling Approach For An Appropriate Assessment For Emissions To Air"[(3)]:

Dry deposition flux (μg/m^2/s) = ground-level concentration (μg/m^3) x deposition velocity (m/s)

The deposition velocities for NO_2, NH_3 and SO_2 are outlined in AQTAG06 and shown below in Table 3.2. The dry deposition flux is then multiplied by conversion factors shown in Table 3.2 (taken from AQTAG06) to convert it to a nitrogen (N) and sulphur (S) deposition flux (kg/ha/yr), and to an acid deposition flux (keq/ha/yr).

Table 3.2. Dry Deposition Fluxes for NO_2, NH_3 and SO_2

Chemical Species	Habitat Type	Recommended Deposition Velocity (m/s)	Nitrogen Deposition Conversion factor µg/m²/s to kg/ha/yr	Acid Deposition Conversion factor µg/m²/s to keq/ha/yr
NO_2	Grassland	0.0015	95.9	6.84
NH_3	Grassland	0.02	260	18.5
SO_2	Grassland	0.012	157.7	9.84

Background concentrations for NO_X, NH_3, SO_2, nitrogen and acid deposition at the relevant assessed ecological receptors were derived from the 1 km grid square concentrations provided on the Air Pollution Information System (APIS) website(4) in line with UKEA(5) and UK Defra(6) Guidance and are given in Section 4.7. The background concentrations are added directly to the modelled NO_X, NH_3, SO_2, nitrogen and acid deposition process contributions to give a total predicted environmental concentration as outlined in Section 7.0.

3.2.3 Critical Loads

A 'Critical Load' is defined by the United Nations Economic Commission for Europe (UNECE) as *"a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"*.(25)

Critical loads for N deposition and acid deposition were derived from the Air Pollution Information System (APIS) website(4) and are reproduced as shown in APIS in Table 3.3 and Table 3.4. Also shown in these tables are the site feature code and name (i.e. the qualifying feature the site is designated for), the corresponding critical load class and EUNIS codes (European Nature Information System (EUNIS) by the European Environment Agency).

Critical loads are only available for internationally designated habitats (Special Protection Area (SPA) and Special Area of Conservation (SAC)), and for nationally designated Natural Heritage Areas (NHA).

Critical loads for proposed Natural Heritage Areas (pNHAs) are not defined on the APIS website. In the absence of defined critical loads, and in order to carry out an assessment for pNHAs, the site synopsis for each pNHA (NPWS, 2025) relevant to this assessment was reviewed for its range of habitats. Where possible, pNHA habitats identified from the site synopsis was assigned an equivalent nitrogen deposition or critical load class. These equivalents were derived by searching APIS for the habitat type set out in the site synopsis for each pNHA, rather than a specific designated site, or by reviewing SACs and SPAs with similar habitat features. Where no equivalent critical load class could be assigned or a site synopsis was not available this has been denoted by "n/a".

It should be noted that pNHAs do not have formal legal designation under Irish law. As such, they have not undergone the same process of qualifying feature identification (which can then be processed by APIS). The critical load classes assigned to pNHA habitats are an interpretation as part of this assessment, and may vary from those identified in future should the pNHA become fully designated (and incorporated into APIS).

The critical loads from APIS and used for the assessment are detailed in Table 3.3 and Table 3.4. for the sites identified as relevant by the modelling assessment.

Acid deposition critical loads are further categorised by nitrogen (N) or sulphur (S) components. Modelled acid deposition process contributions are therefore calculated in terms of both nitrogen (N) and sulphur (S) (see Section 3.2.2).

Deposition of sulphur (as sulphate (SO_4^{2-})) and nitrogen (as nitrate (NO_3^-), ammonium (NH_4^+) and nitric acid (HNO_3^-)), can cause acidification and both sulphur and nitrogen compounds must be taken into account when assessing acidification of soils. For the purposes of determining links between critical loads and atmospheric emissions of sulphur and nitrogen, critical loads are further derived to produce a maximum critical load for sulphur (CLmaxS), a minimum critical load for nitrogen (CLminN) and a maximum critical load for nitrogen (CLmaxN). These components define the critical load function and when compared with deposition data for sulphur and nitrogen, they can be used to assess critical load exceedances.

The modelled acid deposition process contributions (as S) have been compared to the minimum critical load (S) (MinCLmaxS) i.e. the assessment criterion.

The modelled acid deposition process contributions (as N) have been compared to the minimum critical load (N) (MinCLminN) and the maximum critical load (N) range (MaxCLminN). Where a process contribution is greater than 1% of this minimum critical load, the Predicted Environmental Concentration (PEC) is calculated by adding the acid deposition background concentration to the process contribution. The PEC is then compared to the lower end of the maximum critical load (N) range i.e. MaxCLminN. This is in line with the *Screening Acidity Critical Loads* approach taken by APIS (available as a tab in the APIS app) for designated sites. Notably, APIS does not consider the critical load function to be exceeded unless the PEC is larger than the maximum critical load, not the minimum (which is typically considered worst case).

In order to determine the appropriate critical load for nitrogen deposition, the EPA publication "Research 390: *Nitrogen-Sulfur Critical Loads: Assessment of the Impacts of Air Pollution on Habitats*" (EPA, 2021) was consulted. In Table 3.32 of the publication empirical critical loads of nutrient nitrogen are outlined with a worst-case range of 5-10 kgN/ha/yr for certain habitat types.

In addition, for certain habitat types, the EPA publication recommends the midpoint is used to define the critical load (e.g. 7.5 kgN/ha/yr). Thus, the mid-range critical load for the worst-case habitat type within the relevant sites have been used to compare with modelled process contributions.

Critical Loads for proposed Natural Heritage Areas (pNHAs)

Critical loads for proposed Natural Heritage Areas (pNHAs) are not defined on the Air Pollution Information System (APIS) website. In the absence of defined critical loads, varying interpretations exist regarding the appropriate thresholds. To address this, AWN requested the project ecologist (Moore Group) to review the Santry Demesne pNHA (Site Code: 000178) and identify the potential critical load for nitrogen (N) deposition and acid deposition. Moore Group has determined the following:

The National Parks and Wildlife Service (NPWS) Site Synopsis for the Santry Demesne pNHA (Site code:000178) states *"The primary importance of this site is that it contains a legally protected plant species. The woodland, however, is of general ecological interest as it occurs in an area where little has survived of the original* *vegetation."* The woodland mix can be interpreted as the Fossitt (2000) habitat type of WD1 Mixed Broadleaved Woodland, this is not Annex I habitat under the Habitats Directive.

According to the National Woodlands Survey 2002–2008[30], the site is classified as the Fossitt (2000) habitat type of WD1 Mixed Broadleaved Woodland. Two sections of woodland within the demesne were included in the survey:

- *The north-western section comprises woodland along the course of a river. The canopy here includes ash (Fraxinus excelsior), beech (Fagus sylvatica), sycamore (Acer pseudoplatanus) and wild cherry (Prunus avium) with hazel (Corylus avellana) and wych elm (Ulmus glabra) in the understorey. The ground flora includes Heracleum sphondylium, Geum urbanum, Geranium robertianum and Phyllitis scolopendrium in the shadier parts. A tarmacadam footpath fragments this section.*
- *The second area in the east has an ash canopy with a well developed understorey of hazel and sycamore. The ground flora was dominated by Allium ursinum and Galium aparine. The relevé was located here as it is the least fragmented section. The area around the ornamental pond was excluded due to the area of water. Much of the ground flora here is mown and therefore fragmented. The ground flora of most of the southern section has been removed by levelling the site with a digger. The rare plants previously recorded here were not observed during this survey.*

Fossitt (2000) recognises seven types of semi-natural woodland, some of which may correspond to or contain Annex I habitats. However, Mixed Broadleaved Woodland falls under the lower-tier category of 'Highly Modified/Non-native Woodland'. The only comparable Annex I semi-natural woodland type with an established critical load for N deposition and acid deposition in the Air Pollution Information System (APIS) website / EPA *Research Report 390: Nitrogen–Sulfur Critical Loads: Assessment of the Impacts of Air Pollution on Habitat* is 'Old Sessile Oak Woods with *Ilex* and *Blechnum*' (Annex I code 91A0; EUNIS code G1), though this classification is made by exclusion, as the other semi-natural woodlands with an established critical load / level are typically associated with wetlands, rivers, or bogs and are therefore not comparable with the Santry Demesne pNHA.

Given these findings, Santry Demesne pNHA (site code: 000178) should be considered a general ecological receptor rather than a habitat of high conservation significance.

Table 3.3. Critical Loads for Nitrogen Deposition

Ecological Receptor		Feature Code	Feature Name	Critical loads for most sensitive feature*			Nitrogen Critical Load Class	EUNIS code	Is species sensitive due to nutrient nitrogen impacts on broad habitat?	Reason
Site Name	Site Code			Min. Critical Load for N (kg N/ha/yr)	Max. Critical Load for N (kg N/ha/yr)	Assessment Criteria				
European Sites (Natura 2000)										
Baldoyle Bay SAC	000199	H1330	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	No	-
Howth Head SAC	000202	H4030	European dry heaths	5	10	7.5	Dry heaths	F4.2	Yes	-
Ireland's Eye SAC	002193	n/a	No comparable habitat with established critical load estimate available	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Malahide Estuary SAC	000205	H1320	Spartina swards (Spartinion maritimae)	5	10	5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	No	-
North Dublin Bay SAC	000206	H1330	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	5	10	5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	No	-
Rockabill to Dalkey Island SAC	003000	S1351	Phocoena phocoena	n/a	n/a	n/a	Species' broad habitat not sensitive to eutrophication	-	-	No expected negative impact on species due to impacts on the species' broad habitat.
South Dublin Bay SAC	000210	H2110	Embryonic shifting dunes	5	10	5	Shifting coastal dunes	B1.3	-	-
Baldoyle Bay SPA	004016	A141	Pluvialis apricaria [North-western Europe]	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	-	1. Potential negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply.
Ireland's Eye SPA	004117	A017	Phalacrocorax carbo (North-western Europe)	n/a	n/a	n/a	No comparable habitat with established critical load estimate available	-	-	Decision to be taken at a site specific level since habitat sensitivity depends on N or P limitation.
Malahide Estuary SPA	004025	A005	Podiceps cristatus (North-western Europe - wintering)	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	-	Potential negative impact on species due to impacts on the species' broad habitat.
North Bull Island SPA	004006	A141	Pluvialis apricaria [North-western Europe]	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	-	1. Potential negative impact on species due to impacts on the

Ecological Receptor		Feature Code	Feature Name	Critical loads for most sensitive feature*			Nitrogen Critical Load Class	EUNIS code	Is species sensitive due to nutrient nitrogen impacts on broad habitat?	Reason
Site Name	Site Code			Min. Critical Load for N (kg N/ha/yr)	Max. Critical Load for N (kg N/ha/yr)	Assessment Criteria				
										species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply.
North-West Irish Sea SPA	004236	A141	Pluvialis apricaria [North-western Europe]	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	-	1. Potential negative impact on species due to impacts on the species' broad habitat. 2. Potential positive impact on species due to impacts on the species' food supply.
South Dublin Bay and River Tolka Estuary SPA	004024	A192	Sterna dougallii (Europe - breeding)	5	10	5	Shifting coastal dunes	B1.3	-	Potential negative impact on species due to impacts on the species' broad habitat.
National Sites										
Baldoyle Bay pNHA	000199	n/a	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	-	-
Booterstown Marsh pNHA	001205	n/a	Pioneer, low-mid, mid-upper saltmarshes	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	-	-
Dolphins, Dublin Docks pNHA	000201	n/a	No NPWS site synopsis available	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Feltrim Hill pNHA	001208	n/a	Considered by NPWS for its value as a geological education site - screened out of assessment.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Grand Canal pNHA	002104	n/a	Semi-dry Perennial calcareous grassland (basic meadow steppe)	5	15	5	Sub-atlantic semi-dry calcareous grassland	E1.26	Yes	-
Howth Head pNHA	000202	n/a	European dry heaths	5	10	7.5	Dry heaths	F4.2	Yes	-
Ireland's Eye pNHA	000203	n/a	No comparable habitat with established critical load estimate available	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Malahide Estuary pNHA	000205	n/a	Spartina swards (Spartinion maritimae)	5	10	5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	-	-

Ecological Receptor		Feature Code	Feature Name	Critical loads for most sensitive feature*			Nitrogen Critical Load Class	EUNIS code	Is species sensitive due to nutrient nitrogen impacts on broad habitat?	Reason
Site Name	Site Code			Min. Critical Load for N (kg N/ha/yr)	Max. Critical Load for N (kg N/ha/yr)	Assessment Criteria				
North Dublin Bay pNHA	000206	n/a	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	5	10	5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	-	-
Royal Canal pNHA	002103	n/a	Semi-dry Perennial calcareous grassland (basic meadow steppe)	5	15	5	Sub-atlantic semi-dry calcareous grassland	E1.26	Yes	-
Santry Demesne pNHA	000178	n/a	Broadleaved deciduous woodland	10	20	10	Broadleaved deciduous woodland	G1	-	-
Sluice River Marsh pNHA	001763	n/a	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	-	-
South Dublin Bay pNHA	000210	n/a	Embryonic shifting dunes	5	10	7.5	Shifting coastal dunes	B1.3	-	-

Table 3.4. Critical Loads for Acid Deposition

Ecological Receptor		Feature Code	Feature Name	Acidity Critical Load Class	Max. Critical Load Range (N) (keq/ha/yr)		Max. Critical Load (S) (keq/ha/yr)	Min. Critical Load Range (N) (keq/ha/yr)		Min. Critical Load (S) (keq/ha/yr)	Is species sensitive due to acidity impacts on broad habitat?	Reason
Site Name	Site Code				MaxCL minN	MaxCL maxN	MaxCL maxS	MinCL minN	MinCL maxN	MinCL maxS		
European Sites (Natura 2000)												
Baldoyle Bay SAC	000199	n/a	No information on this site.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Howth Head SAC	000202	H4030	European dry heaths	Dwarf shrub heath	0.714	4.985	4.27	0.143	4.378	4.236	-	-
Ireland's Eye SAC	002193	n/a	No information on this site.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Malahide Estuary SAC	000205	H2130	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	Acid grassland	0.714	5.007	4.293	0.143	4.26	4.117	-	-
North Dublin Bay SAC	000206	H2130	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	Acid grassland	0.714	4.927	4.213	0.143	4.249	4.107	-	-
Rockabill to Dalkey Island SAC	003000	n/a	No information on this site.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
South Dublin Bay SAC	000210	n/a	No information on this site.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Baldoyle Bay SPA	004016	A137	Charadrius hiaticula (Europe/Northern Africa - wintering)	Calcareous grassland (using base cation)	0.714	4.919	4.205	0.143	4.268	4.125	No	No expected negative impact on the species due to impacts on the species' broad habitat.
Ireland's Eye SPA	004117	n/a	No information on this site.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Malahide Estuary SPA	004025	A005	Podiceps cristatus (North-western Europe - wintering)	Freshwater	0.714	5.007	4.293	0.143	4.26	4.117	Yes	Potential negative impact on species due to impacts on the species' broad habitat.
North Bull Island SPA	004006	A054	Anas acuta (North-western Europe)	Freshwater	0.714	4.956	4.241	0.143	4.249	4.107	No	No expected negative impact on the species due to impacts on the species' broad habitat.
North-West Irish Sea SPA	004236	A054	Anas acuta (North-western Europe)	Freshwater	0.714	4.956	4.241	0.143	4.249	4.107	No	No expected negative impact on the species due to impacts on the species' broad habitat.

Ecological Receptor		Feature Code	Feature Name	Acidity Critical Load Class	Max. Critical Load Range (N) (keq/ha/yr)		Max. Critical Load (S) (keq/ha/yr)	Min. Critical Load Range (N) (keq/ha/yr)		Min. Critical Load (S) (keq/ha/yr)	Is species sensitive due to acidity impacts on broad habitat?	Reason
Site Name	Site Code				MaxCL minN	MaxCL maxN	MaxCL maxS	MinCL minN	MinCL maxN	MinCL maxS		
South Dublin Bay and River Tolka Estuary SPA	004024	A193	Sterna hirundo (Northern/Eastern Europe - breeding)	Acid grassland	0.714	4.919	4.205	0.143	4.242	4.099	Yes	Potential negative impact on species due to impacts on the species' broad habitat.
National Sites												
Baldoyle Bay pNHA	000199	n/a	Charadrius hiaticula (Europe/Northern Africa - wintering)	Calcareous grassland (using base cation)	0.714	4.919	4.205	0.143	4.268	4.125	No	No expected negative impact on the species due to impacts on the species' broad habitat.
Booterstown Marsh pNHA	001205	n/a	Pioneer, low-mid, mid-upper saltmarshes	Pioneer, low-mid, mid-upper saltmarshes	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Dolphins, Dublin Docks pNHA	000201	n/a	No information on this site.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Grand Canal pNHA	002104	n/a	-	Unmanaged Broadleafed/Coniferous Woodland	0.714	5.549	4.71	0.143	0.507	0.365	-	-
Howth Head pNHA	000202	n/a	European dry heaths	Dwarf shrub heath	0.714	4.985	4.27	0.143	4.378	4.236	-	-
Ireland's Eye pNHA	000203	n/a	No information on this site.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Malahide Estuary pNHA	000205	n/a	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	Acid grassland	0.714	5.007	4.293	0.143	4.26	4.117	-	-
North Dublin Bay pNHA	000206	n/a	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	Acid grassland	0.714	4.927	4.213	0.143	4.249	4.107	-	-
Royal Canal pNHA	002103	n/a	-	Unmanaged Broadleafed/Coniferous Woodland	0.714	5.549	4.71	0.143	0.507	0.365	-	-
Santry Demesne pNHA	000178	n/a	Old sessile oak woods with Ilex and Blechnum in the British Isles	Unmanaged Broadleafed/Coniferous Woodland	0.714	5.634	6.518	0.143	0.507	0.365	-	-
Sluice River Marsh pNHA	001763	n/a	No information on this site.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Ecological Receptor		Feature Code	Feature Name	Acidity Critical Load Class	Max. Critical Load Range (N) (keq/ha/yr)		Max. Critical Load (S) (keq/ha/yr)	Min. Critical Load Range (N) (keq/ha/yr)		Min. Critical Load (S) (keq/ha/yr)	Is species sensitive due to acidity impacts on broad habitat?	Reason
Site Name	Site Code				MaxCL minN	MaxCL maxN	MaxCL maxS	MinCL minN	MinCL maxN	MinCL maxS		
South Dublin Bay pNHA	000210	n/a	Sterna hirundo (Northern/Eastern Europe - breeding)	Acid grassland	0.714	4.919	4.205	0.143	4.242	4.099	Yes	Potential negative impact on species due to impacts on the species' broad habitat.

4.0 BACKGROUND CONCENTRATIONS OF POLLUTANTS

Air quality monitoring programmes have been undertaken in recent years by the EPA and Local Authorities. The most recent annual report on air quality "*Air Quality in Ireland 2023*", details the range and scope of monitoring undertaken throughout Ireland. As part of the implementation of the Framework Directive on Air Quality (1996/62/EC), four air quality zones have been defined in Ireland for air quality management and assessment purposes. Dublin is defined as Zone A and Cork as Zone B. Zone C is composed of 25 towns with a population of greater than 15,000. The remainder of the country, which represents rural Ireland but also includes all towns with a population of less than 15,000 is defined as Zone D. In terms of air monitoring, Clonshaugh is categorised as Zone A[19, 20].

In 2020 the EPA reported that Ireland was compliant with EU legal limits at all locations, however this was largely due to the reduction in traffic due to Covid-19 restrictions. The EPA report details the effect that the Covid-19 restrictions had on stations, which included reductions of up to 50% at some monitoring stations which have traffic as a dominant source. The report also notes that Central Statistics Office (CSO) figures show that while traffic volumes are still slightly below 2019 levels, they have significantly increased since 2020 levels. 2020 concentrations are therefore predicted to be an exceptional year and not consistent with long-term trends. For this reason, they have been reported in the baseline section but not included in the long-term trend analysis.

It is necessary to select monitoring stations that are representative of the site location. Not all monitoring stations are considered suitable for determining background pollutant concentrations and must be reviewed on a case-by-case basis to determine the most appropriate EPA monitoring sites for the current assessment.

The EPA, on their website (EPA, 2024), state that background sites generally represent overall area-wide exposure more closely than roadside sites. Roadside monitoring sites are heavily influenced by traffic emissions and are not considered representative of area-wide pollutant levels. Similarly, Dublin Airport is heavily influenced by aircraft emissions and are not considered representative of area-wide pollutant levels. The purpose of this assessment is to determine the predicted pollutant concentrations over a wide area, therefore roadside monitoring and Dublin Airport stations were not considered appropriate.

4.1 NO_2

NO_2 concentrations at the Zone A monitoring locations of Ballyfermot, Swords and Tallaght show that current levels of NO_2 are below both the annual and 1-hour limit values, with annual average levels ranging from 12 – 14 µg/m^3 in 2022 (see Table 4.1). The 5-year average data for Ballyfermot and Swords for the period 2017 – 2022 (excluding 2020 due to COVID-19) and 2-year average data for Tallaght (2021 – 2022) was used to estimate the current background NO_2 concentration in the region of the Installation. Over the period 2017 – 2022 annual mean NO_2 concentrations at the selected sites ranged from 11 – 20 µg/m^3 with an overall 5-year average across the three sites of 14.2 µg/m^3. In addition, there were no exceedances of the 1-hour limit value for NO_2.

Based on these results, a conservative estimate of the background NO_2 concentration in the region of the Installation is 15 µg/m^3.

Table 4.1. Annual Mean and 99.8th Percentile 1-Hour NO_2 Concentrations in Zone A Locations (µg/m^3)

Station	Averaging Period	Year					
		2018	2019	2020	2021	2022	2023
Ballyfermot	Annual Mean NO_2 (µg/m^3)	20	12	13	14	13	13
	99.8th%ile 1hr NO_2 (µg/m^3)	87	102	81	69	81	-
Swords	Annual Mean NO_2 (µg/m^3)	16	15	11	11	12	10
	99.8th%ile 1hr NO_2 (µg/m^3)	85	80	65	63	70	-
Tallaght	Annual Mean NO_2 (µg/m^3)	-	-	14	13	14	14
	99.8th%ile 1hr NO_2 (µg/m^3)	-	-	79	71	88	-

Note 1 Annual average limit value of 40 µg/m^3 and hourly limit value of 200 µg/m^3 (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

The Ozone Limiting Method (OLM) was used to model NO_2 concentrations. The OLM is a regulatory option in AERMOD which assumes that the amount of NO converted to NO_2 is proportional to the ambient ozone concentration. The concentration is usually limited by the amount of ambient O_3 that is entrained in the plume. Thus, the ratio of the moles of O_3 to the moles of NO_X gives the ratio of NO_2/NO_X that is formed after the NO_X leaves the stack. In addition, it has been assumed that 10% of the NOx from the backup generators is already in the form of NO_2 before the gas leaves the stack. The equation used in the algorithm to derive the ratio of NO_2/NO_X is:

$$NO_2/NO_X = (\text{moles } O_3 / \text{ moles } NO_X) + 0.10$$

A background ozone concentration of 55 µg/m^3 was used in the modelling assessment, based on a review of worst case background ozone data for Zone A sites.

For the modelling assessment as per Section 3.0, the modelled process concentration is added to the background concentration to give the worst-case predicted environmental concentration (PEC). The PEC is then compared with the relevant ambient air quality standard to assess the significance of the releases from the installation. NO_2 has ambient air quality standards for both annual mean and hourly concentrations that must be complied with (see Section 2.1). In relation to the annual average background, the ambient background concentration was added directly to the process concentration with the short-term (hourly) peaks assumed to have an ambient background concentration of twice the annual mean background concentration.

4.2 CO

In terms of CO, monitoring has been conducted at the suburban background Zone A site of Dublin Airport over the period 2020 – 2023. There are no other suitably representative CO monitoring stations within Zone A. Monitored concentrations of CO are significantly below the ambient limit value of 10 mg/m^3. Maximum 8-hour concentrations at the Dublin Airport site ranged from 0.7 mg/m^3 – 3.7 mg/m^3 over the period 2020 – 2023. Based on these results a background 8-hour CO concentration of 3.7 mg/m^3 has been used in the modelling assessment.

This estimated background concentration has been added directly to the modelled 8-hour maximum result to produce the predicted environmental concentration (PEC) in terms of CO.

4.3 NH_3

Background concentrations for NH_3 were derived from the 1 km grid square concentrations provided on the Air Pollution Information System (APIS) website(4). The modelling results were reviewed and the areas of maximum process contributions were identified (shown in the results tables and concentration contour figures in Section 6.1.3). The corresponding APIS 1 km grid squares were then identified and a maximum background NH_3 concentration of 1.5 µg/Nm^3 determined. This background concentration was added directly to the modelled process contributions to give a total predicted environmental concentration. A value of twice the annual mean background concentration has been added to the 1-hour modelled process concentration.

Derivation of the background concentrations from APIS supersedes the older EPA research report source of "*Ambient Atmospheric Ammonia in Ireland, 2013-2014*", which previously informed an ambient background value of 1 µg/m^3.

4.4 PM_{10}

Continuous PM_{10} monitoring carried out at the suburban background locations of Ballyfermot, Dún Laoghaire, Finglas, Marino, Phoenix Park, and St. Anne's Park showed annual mean concentrations ranging from 9–12 µg/m^3 in 2023 (Table 4.2), with no exceedances of the daily limit value of 50 µg/m^3 (35 exceedances are permitted per year). Sufficient data is available for Ballyfermot, Dún Laoghaire, Finglas, Marino, Phoenix Park and St. Anne's Park to observe trends over the period 2019 – 2023. Average annual mean PM_{10} concentrations ranged from 9 – 14 µg/m^3 over this period, suggesting an upper average concentration of no more than 16 µg/m^3. Based on these results, a conservative estimate of the background PM_{10} concentration in the region of the Installation is 16 µg/m^3.

Table 4.2. Annual Mean and 24-Hour Mean PM_{10} Concentrations In Zone A Locations ($\mu g/m^3$)

Station	Averaging Period	Year				
		2019	2020	2021	2022	2023
Ballyfermot	Annual Mean PM_{10} ($\mu g/m^3$)	14	12	12	13	11
	24-hr Mean > 50 $\mu g/m^3$ (days)	7	2	0	1	-
	90.4^{th}%ile 24-hr PM_{10} ($\mu g/m^3$)	26	20	21	21	0
Dún Laoghaire	Annual Mean PM_{10} ($\mu g/m^3$)	12	12	11	12	12
	24-hr Mean > 50 $\mu g/m^3$ (days)	2	0	0	1	-
	90.4^{th}%ile 24-hr PM_{10} ($\mu g/m^3$)	24	20	19	21	0
Finglas	Annual Mean PM_{10} ($\mu g/m^3$)	13	12	12	12	12
	24-hr Mean > 50 $\mu g/m^3$ (days)	2	0	0	1	-
	90.4^{th}%ile 24-hr PM_{10} ($\mu g/m^3$)	-	21	20	19	0
Marino	Annual Mean PM_{10} ($\mu g/m^3$)	14	13	12	14	12
	24-hr Mean > 50 $\mu g/m^3$ (days)	4	0	0	3	-
	90.4^{th}%ile 24-hr PM_{10} ($\mu g/m^3$)	74	23	20	23	0
Phoenix Park	Annual Mean PM_{10} ($\mu g/m^3$)	11	10	10	11	9
	24-hr Mean > 50 $\mu g/m^3$ (days)	2	0	0	0	-
	90.4^{th}%ile 24-hr PM_{10} ($\mu g/m^3$)	18	18	17	18	0
St. Anne's Park	Annual Mean PM_{10} ($\mu g/m^3$)	12	11	11	13	11
	24-hr Mean > 50 $\mu g/m^3$ (days)	1	0	0	1	-
	90.4^{th}%ile 24-hr PM_{10} ($\mu g/m^3$)	-	19	18	22	0

Note 1 Annual average limit value of 40 $\mu g/m^3$ and 24-hourly limit value of 50 $\mu g/m^3$ (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

In relation to the annual averages, the ambient background concentration is added directly to the process concentration. However, in relation to the short-term peak concentration, concentrations due to emissions from elevated sources cannot be combined in the same way. Guidance from the UK DEFRA(5) and the EPA(2) advises that for PM_{10} an estimate of the maximum combined pollutant concentration can be obtained as shown below:

PM_{10} - The 90.4^{th}%ile of total 24-hour mean PM_{10} is equal to the maximum of either A or B below:

a) 90.4^{th}%ile of 24-hour mean background PM_{10} + annual mean process contribution PM_{10}
b) 90.4^{th}%ile 24-hour mean process contribution PM_{10} + annual mean background PM_{10}

A 90.4^{th} percentile 24-hour background concentration of 23 $\mu g/m^3$ was used in the assessment, based on average concentrations for the above stations over the period 2018 – 2022.

4.5 $PM_{2.5}$

Continuous $PM_{2.5}$ monitoring carried out at the Zone A suburban background locations of Ballyfermot, Dún Laoghaire, Finglas, Marino, Phoenix Park, and St. Anne's Park showed annual mean concentrations ranging from 6 – 7 $\mu g/m^3$ in 2023 (see Table 4.3). Sufficient data is available for Ballyfermot, Dún Laoghaire, Finglas, Marino, Phoenix Park, and St. Anne's Park to observe trends over the period 2019 – 2023. Average annual mean $PM_{2.5}$ concentrations ranged from 6 – 10 µg/m^3 over this period, suggesting an upper average concentration of no more than 10 µg/m^3. Based on this information, a conservative estimate of the background $PM_{2.5}$ concentration in the region of the Installation is 10 µg/m^3.

Table 4.3. Annual Mean $PM_{2.5}$ Concentrations In Zone A Locations (µg/m^3)

Station	Averaging Period	Year				
		2019	2020	2021	2022	2023
Ballyfermot	Annual Mean $PM_{2.5}$ (µg/m^3)	10	8	8	8	7
Dun Laoghaire	Annual Mean $PM_{2.5}$ (µg/m^3)	10	8	8	8	7
Finglas	Annual Mean $PM_{2.5}$ (µg/m^3)	9	7	8	7	7
Marino	Annual Mean $PM_{2.5}$ (µg/m^3)	9	8	8	9	7
Phoenix Park	Annual Mean $PM_{2.5}$ (µg/m^3)	8	7	6	6	6
St. Anne's Park	Annual Mean $PM_{2.5}$ (µg/m^3)	8	7	7	8	7

Note 1 Annual average limit value of 25 µg/m^3 (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

4.6 SO_2

Continuous monitoring by the EPA is carried out at a number of monitoring stations within Zone A; these include urban background sites, roadside (traffic) sites, Dublin Airport and suburban background sites.

It is necessary to select monitoring stations that are representative of the site location. Not all monitoring stations are considered suitable for determining background pollutant concentrations and must be reviewed on a case-by-case basis to determine the most appropriate EPA monitoring sites for the current assessment.

The EPA, on their website(19), state that background sites generally represent overall area-wide exposure more closely than roadside sites. Roadside monitoring sites are heavily influenced by traffic emissions and are not considered representative of area-wide pollutant levels. The purpose of this assessment, and particularly the cumulative assessment, is to determine the predicted pollutant concentrations over a wide area, therefore roadside monitoring stations were not considered appropriate. Similarly, Dublin Airport and Dublin Port will not be representative of the area-wide pollutant levels. Thus, the level of SO_2 at Dublin Airport (annual average of 5.8 µg/m^3) is only representative of a small area around Dublin Airport and would not be representative of levels in the region of Clonshaugh Business & Technology Park. Measurements at Rathmines and Ringsend will be more presentative of urban background levels in Dublin.

Continuous SO_2 monitoring carried out at the Zone A locations of Rathmines and Ringsend showed annual mean concentrations ranging from 1.9 – 2.2 µg/m^3 in 2023 (see Table 4.4). Sufficient data is available for Rathmines and Ringsend to observe trends over the period 2018 – 2023. Average annual mean SO_2 concentrations ranged from 1.1 – 3.3 µg/m^3 over the period of 2018 – 2023, suggesting an upper average concentration of no more than 3.3 µg/m^3. Based on this information, a conservative estimate of the background SO_2 concentration in the region of the Installation is 4 µg/m^3. The 99.7th%ile of 1-hour means in 2022 ranged from 8 – 13 µg/m^3 whilst the 99.2th%ile of 24-hour means in 2022 ranged from 5 – 6 µg/m^3.

A 1-hour background of 51 µg/m^3 was used in the assessment based on the maximum 1-hour concentrations over the period 2018 – 2023 (Ringsend, 2018). A 24-hour background concentration of 20 µg/m^3 was used in the assessment based on the maximum 24-hour concentrations over the period 2018 – 2023 (Ringsend, 2018).

Table 4.4. Annual Mean, 1-Hour and 24-Hour Mean SO_2 Concentrations In Zone A Locations (µg/m^3)

Station	Averaging Period	Year					
		2018	2019	2020	2021	2022	2023
Rathmines	Annual Mean SO_2 (µg/m^3) Note 1	2.3	1.3	1.4	1.1	1.8	2.2
	99.7th%ile of 1-hour mean SO_2 (µg/m^3) Note 2	25	10	10	-	8	-
	99.2th%ile of 24-hour mean SO_2 (µg/m^3) Note 3	8	4	4	5	5	-
Dublin Airport	Annual Mean SO_2 (µg/m^3)	-	-	3.8	4.6	5.8	5.3
	99.7th%ile of 1-hour mean SO_2 (µg/m^3) Note 2	-	-	14	-	13	-
	99.2th%ile of 24-hour mean SO_2 (µg/m^3) Note 3	-	-	13	17	12	-
Dublin Port	Annual Mean SO_2 (µg/m^3)	-	-	3.7	2.3	1.7	1.6
	99.7th%ile of 1-hour mean SO_2 (µg/m^3) Note 2	-	-	43	-	20	-
	99.2th%ile of 24-hour mean SO_2 (µg/m^3) Note 3	-	-	16	13	10	-
Ringsend	Annual Mean SO_2 (µg/m^3)	3.3	1.4	2.1	2.7	2.9	1.9
	99.7th%ile of 1-hour mean SO_2 (µg/m^3) Note 2	51	43	10	-	13	-
	99.2th%ile of 24-hour mean SO_2 (µg/m^3) Note 3	20	7	7	7	6	-

Note 1 Annual average limit value of 20 µg/m^3 (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

Note 2 24 hour limit value of 125 µg/m^3 not to be exceeded more than 3 times per year (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

Note 3 Hourly limit value of 350 µg/m^3 not to be exceeded more than 24 times per year (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

When calculating the short-term peak results, concentrations due to emissions from stacks cannot be combined by directly adding the annual background level to the modelling results. Guidance from the UK DEFRA(5) and EPA(2) advises that for SO_2 an estimate of the maximum combined pollutant concentrations can be obtained as shown below:

SO_2 - The 99.2th%ile of total 24-hour SO_2 is equal to the maximum of either A or B below:

a) 99.2th%ile of 24-hour mean background SO_2 + (2 x annual mean process contribution SO_2)
b) 99.2th%ile 24-hour mean process contribution SO_2 + (2 x annual mean background contribution SO_2)

SO_2 - The 99.7th%ile of total 1-hour SO_2 is equal to the maximum of either A or B below:

a) 99.7th%ile hourly background SO_2 + (2 x annual mean process contribution SO_2)
b) 99.7th%ile hourly process contribution SO_2 + (2 x annual mean background contribution SO_2)

4.7 Ecology

Background concentrations for NO_X, NH_3, SO_2, and nitrogen and acid deposition all ecological receptors within 10 km of the installation, were derived from the 1 km grid square concentrations provided on the Air Pollution Information System (APIS) website(4), in line with UKEA(6) and UK Defra(5) guidance and are shown in Table 4.5. The background concentrations are added directly to the modelled process contributions to give a total predicted environmental concentration.

Table 4.5. Background Concentrations for NO_X, NH_3, SO_2, Nitrogen and Acid Deposition (Grid Average) (APIS, 2025)

Closest Sensitive Designated Habitat	NO_x (µg/m^3)	NH_3 (µg/m^3)	SO_2 (µg/m^3)	Nitrogen Deposition (kg/ha/yr)	Acid Deposition (keq/ha/yr)
Baldoyle Bay SAC	10.9	1.3	1.6	6.0	0.5
Howth Head SAC	12.5	1.1	2.4	6.3	0.5
Ireland's Eye SAC	-	-	-	-	-
Malahide Estuary SAC	13.4	1.7	1.1	6.2	0.5
North Dublin Bay SAC	28.8	1.1	9.4	6.5	0.5
Rockabill to Dalkey Island SAC	12.1	1.2	2.2	5.7	0.5
South Dublin Bay SAC	16.2	1.3	2.9	7.1	0.59
Baldoyle Bay SPA	11.1	1.4	1.8	6.0	0.5
Ireland's Eye SPA	-	-	-	-	-
Malahide Estuary SPA	12.2	1.6	1.0	6.1	0.5
North Bull Island SPA	28.8	1.1	9.4	6.5	0.5
North-west Irish Sea SPA	12.1	1.0	2.2	5.4	0.4
South Dublin Bay and River Tolka Estuary SPA	29.8	1.3	7.4	6.8	0.59
Baldoyle Bay pNHA	11.7	1.4	1.8	6.0	0.5
Booterstown Marsh pNHA	15.5	1.2	1.3	6.0	0.6
Dolphins, Dublin Docks pNHA	15.2	1.0	2.4	5.3	0.6
Grand Canal pNHA	3.3	2.6	0.2	7.1	0.9
Howth Head pNHA	12.5	1.1	2.4	6.3	0.5
Ireland's Eye pNHA	-	-	-	-	-
Malahide Estuary pNHA	13.4	1.7	1.1	6.2	0.5
North Dublin Bay pNHA	28.8	1.3	9.9	7.6	0.6
Royal Canal pNHA	22.7	2.2	4.3	7.1	0.9
Santry Demesne pNHA	17.1	1.5	2.1	7.0	0.5
Sluice River Marsh pNHA	10.2	1.4	1.2	5.8	0.9
South Dublin Bay pNHA	16.2	1.3	2.9	7.1	0.7

5.0 PROCESS EMISSIONS

5.1 Emissions Overview

The installation has no major emissions to air and only has minor (emergency generators) emissions that will generate quantities of air pollutants listed as a Principal Pollution Substance (*S.I. No. 137/2013 - Environmental Protection Agency (Industrial Emissions) (Licensing) Regulations 2013*).

The modelling assessment has been undertaken for Buildings W, X, Y, U and V.

- Building W: 13 no. emergency back-up generator stacks with a minimum height of 6 m above ground level.
- Building X: 20 no. emergency back-up generator stacks with a minimum height of 16 m above ground level.
- Building Y: 7 no. emergency back-up generator stacks with a minimum height of 16 m above ground level.
- Building U: 11 no. emergency back-up generator stacks with a minimum height of 25 m above ground level.
- Building V: 1 no. emergency back-up generator stack with a minimum height of 15.6 m above ground level.

Two of the back-up generators in each Building W, X and U and one of the back-up generators in Building Y are modelled as “catcher” generators to provide redundancy for the other back-up generators i.e. 45 no. of the 52 no. back-up generators are assumed to be running simultaneously in the event of an emergency to the installation.

In addition to the emergency back-up generators the installation also includes 6 no. diesel powered fire sprinkler pumps (two at 0.423 MWth, two at 0.337 MWth and two at 0.57 MWth). The diesel powered fire sprinkler pumps are less than 1 MW thermal input and have been scoped out of this air modelling assessment as it is not expected that they would cause any significant impacts on ambient air quality considering their smaller scale compared to the emergency back-up generators) and the low number required for use at any one time.

5.2 Operational Emissions Scenarios

The scenarios modelled for this assessment also include the following types of testing of the back-up generators:

- **Test 1:** Testing once per week of all 52 no. back-up generators on the campus at 25% load for a maximum of 30 minutes each, one generator at a time, sequentially;
- **Test 2:** All 52 no. back-up generators will be periodically tested on an individual basis at 100% load for a maximum of 16 hours per year. This is incorporated into the dispersion model as each generator operating on an individual basis, at 100% load, for four hours, once per quarter (assumed to be January, April, June and October for the purpose of this assessment); and
- All testing is assumed to only occur between 8am and 5pm, Monday to Friday.

The modelling is undertaken to assess the impact to ambient air quality from the following scenarios:

- **Licenced Operations by the Installation:** This includes the emergency operation of 45 no. of the 52 no. generators (the remaining seven generators serving as "catcher" generators for Buildings W, X, Y, U and V) using diesel fuel. The scenario also included testing of all 52 no. generators as described above. The process emissions are outlined in Table 5.1, Table 5.2 and Table 5.3;

- **Cumulative Impact Scenario:** A cumulative impact assessment of the Installation and nearby installations within a 1km radius was also conducted. Installations which hold an IED licence from the EPA were assessed for relevant air emissions.
  - The Applicant operates a separate data storage Installation Licence No. P1171-01 to the north-west of the subject installation which is referred to as Building A, B, C, D, E and F, these emission sources have been included in the cumulative assessment for NO_X with emission details outlined in Table 5.4.
  - Two additional data centres, referred to as the Dataplex data centre (located at the eastern boundary of the Building A to Building F installation (Licence No. P1171-01)) and Digital Realty data centre, located directly north of Building U have been identified within the study area. The operational details of these facilities are known through a review of the relevant planning permissions and sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at these facilities is available and thus these have been included in the cumulative assessment with emission details outlined in Table 5.5.

There are 2 no. additional IE licenced installations within 1km of the Installation, these are Global Switch Property (Dublin) Ltd (Licence No. P0109) and Forest Laboratories Ireland Ltd (Licence No. P0306) within Clonshaugh Business & Technology Park. However, one of these facilities, Global Switch Property (Dublin) Ltd, has no licenced NO_X emission points and thus has not been included in the cumulative air modelling assessment. Forest Laboratories Ireland Ltd does have NO_X emissions but as explained in Section 6.3 has emissions which are sub-threshold as defined by AG4(2) and thus have been excluded from the cumulative assessment.

5.3 Diesel / Hydrotreated Vegetable Oil Fuel

The air impact assessment has been based on the emissions from standard diesel fuel, as approach conservatively assesses the environmental impact, ensuring that the highest potential emissions levels are considered. By using the emissions associated with diesel in this worst-case scenario, the assessment ensures that when operating on HVO (likely to be lower or equivalent emissions) are appropriately accounted for.

The emissions from combustion plant (such as emergency generators) when operating on hydrotreated vegetable oil (HVO) fuel are no higher than those produced when using standard diesel fuel. While HVO has been shown to significantly reduce CO_2 emissions, its impact on other pollutants – such as nitrogen oxides (NO_X), sulphur oxides (SO_X), particulate matter (PM), and carbon monoxide (CO) – is guaranteed by equipment suppliers to be comparable to or less than that of standard diesel fuel.

5.4 Selective Catalytic Reduction System

The emergency back-up generators (excluding the 1 no. 2.19 MW_{th}) for Buildings U (10 no. 6.49 MW_{th}) and V (1 no. 3.6 MW_{th}) are each fitted with a Selective Catalytic Reduction (SCR) unit to reduce exhaust emission gases to air.

The results of the air dispersion model undertaken for the Installation has assumed a

NOx reduction achieved by the SCR abatement of approximately 10%, therefore the emissions are set out in Table 5.2 are a worst-case assessment.

5.5 Emergency Operations Methodology

The generators will operate in an emergency scenario as per the criteria in Section 2.2. In addition, testing of the generators will be required as outlined above.

There are two methodologies used to determine the impact from the operation of the generators using diesel fuel on ambient air quality. Both methodologies from the USEPA and UK EA have been used in this assessment, this follows the guidance outlined in Appendix K of the Irish EPA document AG4(2). Emission details can be seen in Tables 8, 9 and 10.

USEPA Guidance suggests that for emergency operations, an average hourly emission rate should be used rather than the maximum hourly rate(22). As a result, the maximum hourly emission rates from the generators are reduced by $\frac{150}{8760}$ and the generators are modelled over a period of one full year.

A second methodology has been published by the UK Environment Agency. The consultation document is entitled "*Diesel Generator Short-Term NO_2 Impact Assessment*"(23). The methodology is based on considering the statistical likelihood of an exceedance of the NO_2 hourly limit value (18 exceedances are allowable per year before the air standard is deemed to have been exceeded). The assessment assumes a hypergeometric distribution to assess the likelihood of exceedance hours coinciding with the emergency operational hours of the generators. The cumulative hypergeometric distribution of 19 and more hours per year is computed and the probability of an exceedance determined. The guidance suggests that the 95th percentile confidence level should be used to indicate if an exceedance is likely. More recent guidance(24) has recommended this probability should be multiplied by a factor of 2.5 and therefore the 98th percentile confidence level should be used to indicate if an exceedance is likely. The guidance suggests that the assessment should be conducted at the nearest residential receptor or at locations where people are likely to be exposed and that there should be no running time restrictions on these generators when providing power on site during an emergency.

Both the methodology advised in the USEPA guidance as well as the approach described in the UK EA guidance have been applied for the emergency scenario modelled in this study to ensure a robust assessment of predicted air quality impacts from the generators. This also follows the guidance outlined in Appendix K of the EPA AG4 guidance(2).

Table 5.1. Summary of Process Emission Information for all Buildings associated with the Installation

Stack Reference	Building	Stack Height AboveGround Level (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Type of Operations	Temp (K)	Volume Flow (Nm^3/hr at 15% Ref. O_2)	Exit Velocity (m/sec actual)
A3-01 to A3-13 (Building W) A3-14 to A3-33 (Building X) A3-34 to A3-40 (Building Y) (back-up generators)	W, X, Y	16.0 – Building X and Y 6.0 – Building W	0.5	0.20	Emergency (100% load)	784.3	16,724	41.4
					Testing (100% load)			
					Testing (25% load)	619.1	4,516	13.8
A3-41 to A3-51 (back-up generators)	U	25.0	0.3	0.07	Emergency (100% load)	738.2	19,557	120
					Testing (100% load)			
					Testing (25% load)	655.2	8,300	49.8
A3-51 (1 no. 2.19 MWth back-up generator)	U	25.0	0.3	0.07	Emergency (100% load)	816.2	5,013	34.8
					Testing (100% load)			
					Testing (25% load)	686.2	2,657	16.7
A3-51 (back-up generators)	V	15.6	0.4	0.13	Emergency (100% load)	790.2	9,126	33.4
					Testing (100% load)			
					Testing (25% load)	639.2	4,032	13.3

Table 5.2. Summary of Emission Concentration Information for all Buildings associated with the Installation

Stack Reference	Operations	Hours of Operations (per year, per plant)	NO_x		CO		PM_{10} / $PM_{2.5}$		SO_2	
			Concentration (mg/Nm³ at 15% Ref. O_2)	Mass Emission (g/s)	Concentration (mg/Nm³ at 15% Ref. O_2)	Mass Emission (g/s)	Concentration (mg/Nm³ at 15% Ref. O_2)	Mass Emission (g/s)	Concentration (mg/Nm³ at 15% Ref. O_2)	Mass Emission (g/s)
A3-01 to A3-13 (Building W) A3-14 to A3-33 (Building X) A3-34 to A3-40 (Building Y)	Emergency (100% load)	150	673	0.054	172	0.014	15.7	0.001	18.6	0.001
	Testing (100% load)	4 hrs per quarter	673	3.13	172	0.80	15.7	0.07	18.6	0.09
	Testing (25% load)	30 mins per week	847	1.06	122	0.15	27.1	0.03	18.6	0.02
A3-41 to A3-50 (Building U)	Emergency (100% load)	150	726	0.068	98	0.009	8.5	0.001	14.1	0.001
	Testing (100% load)	4 hrs per quarter	726	3.94 Note 1	98	0.53	8.5	0.05	14.1	0.08
	Testing (25% load)	30 mins per week	600	1.38 Note 1	98	0.23	8.5	0.02	14.1	0.03
A3-51 (Building U)	Emergency (100% load)	150	1,311	0.031	577	0.014	7.5	0.0002	35.3	0.0008
	Testing (100% load)	4 hrs per quarter	1,311	1.82	577	0.80	7.5	0.010	35.3	0.049
	Testing (25% load)	30 mins per week	983	0.73	577	0.73	8.5	0.006	14.1	0.019
A3-52 (Building V)	Emergency (100% load)	150	726	0.032 Note 1	379	0.017	19.7	0.001	18.6	0.001
	Testing (100% load)	4 hrs per quarter	726	1.84 Note 1	379	0.96	19.7	0.05	18.6	0.05
	Testing (25% load)	30 mins per week	600	0.81 Note 1	85	0.09	8.9	0.01	18.6	0.02

Note 1 As a worst-case, SCR reduction of 10% for NO_x has been used in the modelling assessment as a conservative assumption.

Table 5.3. Summary of Ammonia Process Emission Information for Buildings U & V associated with the Installation

Stack Reference	Stack Height Above Ground Level (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Operations	Hours of Operations (per year, per plant)	Temp (K)	Volume Flow (Nm^3/hr at 15% Ref. O_2)	Exit Velocity (m/sec actual)	NH_3	
									Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)
A3-41 to A3-51 (Building U)	25.0	0.3	0.07	Emergency (100% load)	150	738.2	19,557	120	11	0.0010
				Testing (100% load)	4 hrs per quarter				11	0.060
				Testing (25% load)	30 mins per week	655.2	8,300	49.8	11	0.025
A3-52 (Building V)	15.6	0.4	0.13	Emergency (100% load)	150	790.2	9,126	33.4	11	0.00047
				Testing (100% load)	4 hrs per quarter				11	0.028
				Testing (25% load)	30 mins per week	639.2	4,032	13.3	11	0.012

Table 5.4 Summary of Process Emission Information for all Buildings associated with Installation P1171-01

Stack Reference	Stack Height Above Ground Level (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Volume Flow (Nm3/hr at 15% Ref. O_2)	Exit Velocity (m/sec actual)	Operations	Hours of Operations (per year, per plant)	NO_x	
									Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)
A3-1 to A3-17 (Building A) A3-18 to A3-35 (Building B) A3-36 to A3-53 (Building C) A3-54 to A3-71 (Building D) A3-71 to A3-87 (Building E) A3-88 to A3-103 (Building F)	20.0 – Building A, C, D and E 25.0 – Building B 26.5 – Building F	0.5	0.20	754.2	20,382	46.0	Emergency (90% load)	72	775.9	0.036
							Testing (90% load)	4 hrs per quarter	775.9	4.393
		0.5	0.20	720.1	7,760	12.4	Testing (25% load)	30 mins per week	860.6	1.38
A3-104 (Building E) A3-104 (Building F)	21.6 – Building E 27.8 – Building F	0.3	0.07	816.2	5,012	34.8	Emergency (90% load)	72	1,301	0.015
							Testing (90% load)	4 hrs per quarter	1,301	1.8
		0.3	0.07	709.0	2,246	13.6	Testing (25% load)	30 mins per week	1,007	0.63

Table 5.5 Dataplex Clonshaugh and Digital Realty Data Storage Facilities Standby Diesel Generator Emission Detail

Stack Reference	Height Above Ground Level (m)	Exit Diameter (m)	Temp (K)	Max Volume Flow at 15% O_2 (Nm^3/hr) Note 1	Exit Velocity (m/sec actual)	Operations	Hours of Operations (per year, per plant)	NO_2 Concentration at 15% O_2 (mg/Nm^3)	NO_2 Mass Emission (g/s)
Dataplex Proposed Standby Diesel Generators (Emergency Operations)	6	0.66	749.15	35,695	46.3	Emergency (100% Load)	100	685	0.078
4 emission points	6	0.66	749.15	35,695	46.3	Testing (100% Load)	Weekly	685	6.8
Dataplex Existing Standby Diesel Generators (Emergency Operations)	6	0.66	698.15	15,984	19.5	Emergency (100% Load)	100	1113	0.056
3 emission points	6	0.66	698.15	15,984	19.5	Testing (100% Load)	Weekly	1113	4.94
Digital Realty DUB004 Standby Diesel Generators (Emergency Operations)	4	0.50	783.15	15,588	38.5	Testing (90% Load)	4 hrs per quarter	1,135	4.92
						Emergency (90% Load)	72	1,135	0.04
5 emission points	4	0.50	691.15	5,576	14.2	Testing (25% Load)	Weekly	651	1.75
Digital Realty D91 Standby Diesel Generators	6.8	0.50	670.15	20.525	41.2	Testing (90% Load)	4 hrs per quarter	1,373	7.83
						Emergency (90% Load)	72	1,373	0.06
8 emission points	6.8	0.50	655.15	8,300	17.9	Testing (25% Load)	Weekly	600	1.38

Note 1 For the purposes of this assessment normalised conditions are 273K, 101.3 kPa, dry gas, 15% O_2.

6.0 RESULTS – HUMAN HEALTH

6.1 Licenced Operational Scenario (USEPA Methodology)

The USEPA is the preferred method to determine the operational impact of the installation and the preferred method to determine the allowable operational hours of the backup emergency generators. This is based on the operation of 45 of the 52 no. back-up generations for 150 hours per year using diesel fuel, and using the USEPA methodology outlined within the guidance document titled '*Additional Clarification Regarding Application of Appendix W Modelling Guidance for the 1-Hour National Ambient Air Quality Standard'*[3] as well as considering scheduled weekly testing and quarterly maintenance testing of all 52 no. back-up generators from the installation.

6.1.1 NO_2 - Licenced Operational Scenario

The NO_2 modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 6.1.

The results indicate that the ambient ground level concentrations are within the relevant air quality standards for NO_2. For the worst-case year modelled, PC emissions from the installation lead to an ambient NO_2 concentration (excluding background) which is 78% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 53% of the annual mean limit value at the worst-case off-site receptor.

For the worst-case year modelled, PEC emissions from the installation lead to an ambient NO_2 concentration (including background) which is 93% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) (boundary receptor, location shown in Figure 6.1) and 90% of the annual mean limit value at the worst-case off-site receptor (boundary receptor, location shown in Figure 6.2). Concentrations decrease with distance from the installation boundary. The geographical variations in the 1-hour mean (99.8th percentile) and annual mean NO_2 ground level concentrations for the Normal Operations scenario are illustrated as concentration contours in Figure 6.1 and Figure 6.2. The locations of the maximum concentrations for NO_2 are close to the boundary of the installation with concentrations decreasing with distance from the installation.

Table 6.1 Licenced Operational Scenario - Dispersion Model Results for Nitrogen Dioxide (NO_2)

Pollutant/ Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution (PC) (µg/m^3)	PC as a % of Limit Value	Background Concentration (µg/m^3)	Predicted Environmental Concentration (PEC) (µg/m^3)	Limit Value (µg/Nm^3) Note 1	PEC as a % of Limit Value
NO_2 / 2018	Annual Mean	684911, 5920658	19.6	49%	15	34.6	40	86%
	99.8th%ile of 1-hr means	684911, 5920659	146.8	73%	30	176.8	200	88%
NO_2 / 2019	Annual Mean	684911, 5920658	20.9	52%	15	35.9	40	90%
	99.8th%ile of 1-hr means	684911, 5920659	152.7	76%	30	182.7	200	91%
NO_2 / 2020	Annual Mean	684911, 5920658	21.1	53%	15	36.1	40	90%
	99.8th%ile of 1-hr means	684914, 5920683	146.4	73%	30	176.4	200	88%
NO_2 / 2021	Annual Mean	684911, 5920658	19.8	50%	15	34.8	40	87%
	99.8th%ile of 1-hr means	684905, 5920609	155.7	78%	30	185.7	200	93%
NO_2 / 2022	Annual Mean	684911, 5920658	20.1	50%	15	35.1	40	88%
	99.8th%ile of 1-hr means	684905, 5920609	147.7	74%	30	177.7	200	89%

Note 1 Air Quality Standards 2022 (from EU Directive 2008/50/EC and S.I. 739 of 2022)

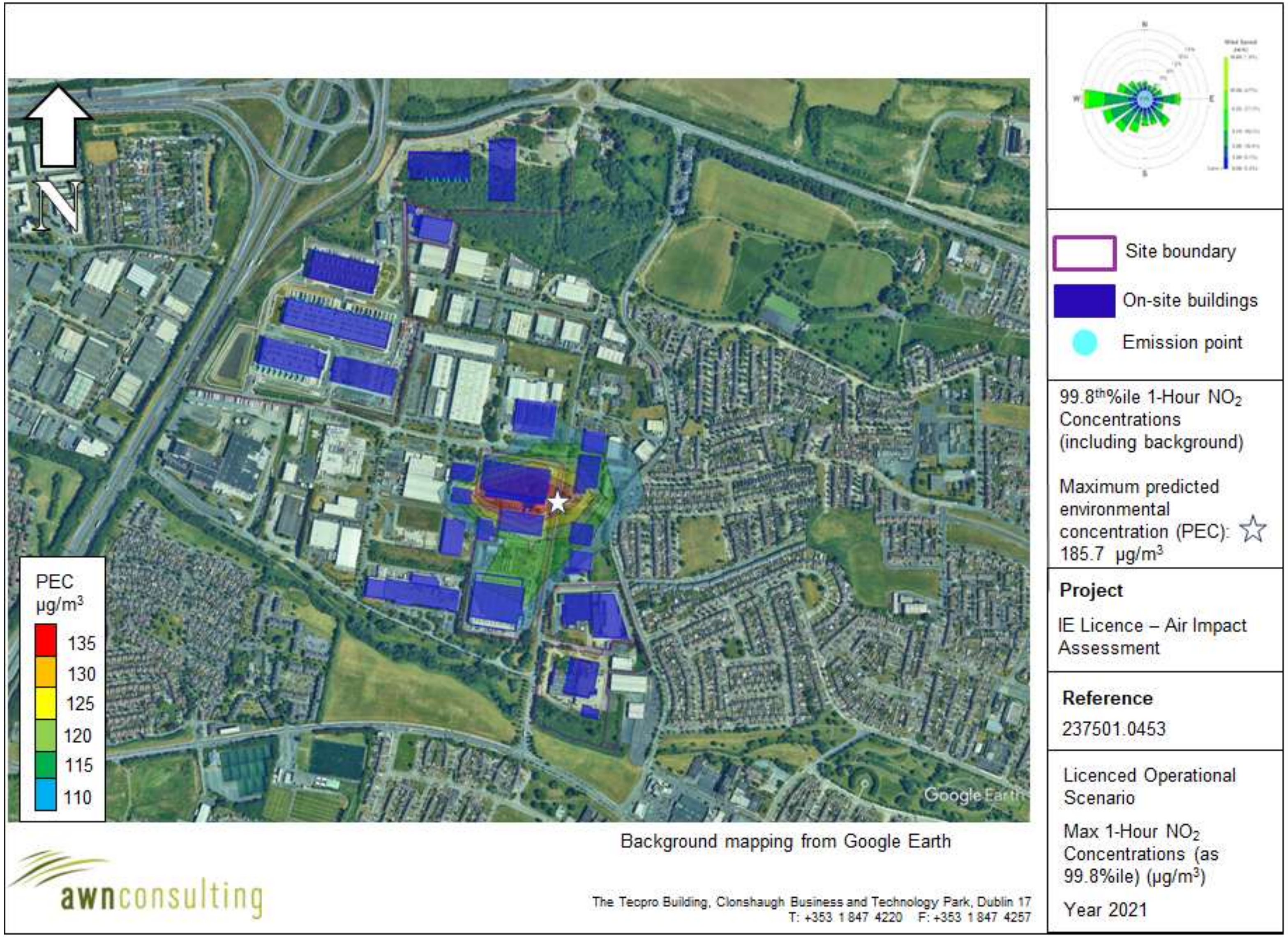

Figure 6.1. Licenced Operational Scenario - Maximum 1-Hour NO_2 Concentrations (as a 99.8th%ile) (µg/m^3) (including background concentrations)

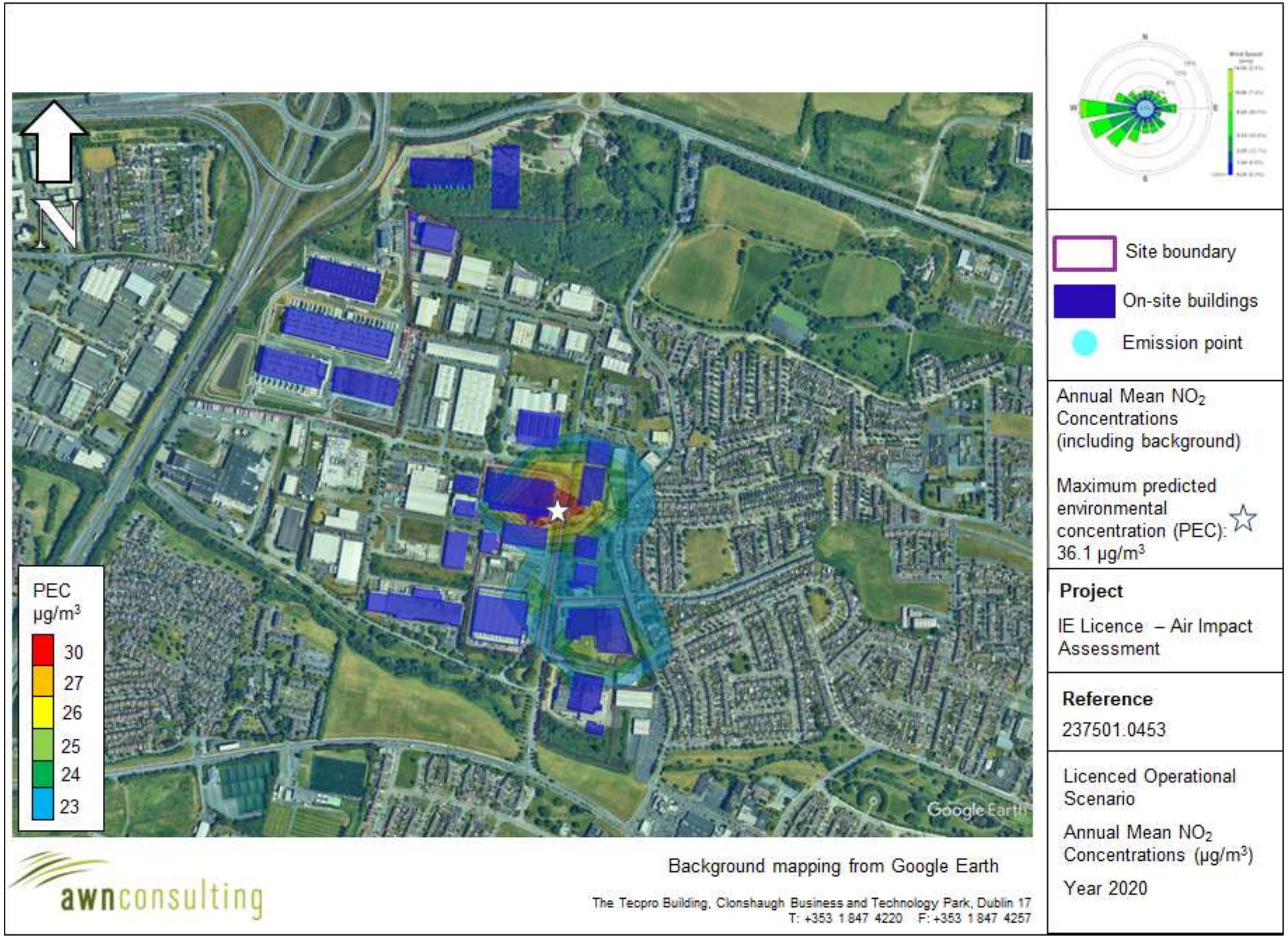

Figure 6.2. Licenced Operational Scenario – Annual Mean NO_2 Concentrations (μg/m^3) (including background concentrations)

6.1.2 CO - Licenced Operational Scenario

The CO modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 6.2. The PC results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for CO. For the worst-case year, emissions from the installation lead to an ambient CO concentration (excluding background) which is 3% of the maximum ambient 8-hour limit value at the worst-case receptor.

For the worst-case year, PEC emissions from the installation lead to an ambient CO concentration (including background) which is 40% of the maximum ambient 8-hour limit value at the worst-case receptor. The locations of the maximum concentrations for CO are close to the boundary of the installation with concentrations decreasing with distance from the installation.

Table 6.2. Licenced Operational Scenario – Dispersion Model Results for Carbon Monoxide (CO)

Pollutant/ Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution (PC) (mg/m^3)	PC as a % of Limit Value	Background Concentration (mg/m^3)	Predicted Environmental Concentration (PEC) (mg/m^3)	Limit Value (mg/Nm^3) Note 1	PEC as a % of Limit Value
CO / 2018	Maximum Daily 8-Hour Mean	684862, 5920735	0.23	2%	3.7	3.93	10	39%
CO / 2019	Maximum Daily 8-Hour Mean	684911, 5920658	0.23	2%	3.7	3.93	10	39%
CO / 2020	Maximum Daily 8-Hour Mean	684837, 5920738	0.32	3%	3.7	4.02	10	40%
CO / 2021	Maximum Daily 8-Hour Mean	684905, 5920609	0.24	2%	3.7	3.94	10	39%
CO / 2022	Maximum Daily 8-Hour Mean	684837, 5920738	0.32	3%	3.7	4.02	10	40%

Note 1 Air Quality Standards 2022 (from EU Directive 2008/50/EC and S.I. 739 of 2022)

6.1.3 NH_3 - Licenced Operational Scenario

The ammonia modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 6.3. The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality limits for ammonia.

For the worst-case year, PC emissions from the installation result in an ambient ammonia concentration (excluding background) which is 0.44% of the maximum ambient 1-hour limit value at the worst-case receptor, and 0.04% of the annual mean limit value at the worst-case receptor (excluding background). Concentrations are at most 0.40% of the 99th percentile 1-hour mean limit value at the worst-case receptor (excluding background).

For the worst-case year, PEC emissions from the installation result in an ambient ammonia concentration (including background) which is 0.56% of the maximum ambient 1-hour limit value at the worst-case receptor (boundary receptor, location shown in Figure 6.3), and 0.89% of the annual mean limit value at the worst-case receptor (boundary receptor, location shown in Figure 6.4). Concentrations are at most 1.4% of the 99th percentile 1-hour mean limit value at the worst-case receptor (boundary receptor). The locations of the maximum concentrations for ammonia are close to the boundary of the installation with concentrations decreasing with distance from the installation.

Table 6.3. Licenced Operational Scenario – Dispersion Model Results for Ammonia (NH_3)

Pollutant / Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution (µg/m^3)	PC as a % of Limit Value	Back-ground (µg/m^3)	Predicted Environmental Concentration (µg/m^3)	Limit Value (µg/m^3) Note 1	PEC as a % of Limit Value
NH_3 / 2018	Annual Mean	684992, 5920304	0.1	0.04%	1.5	1.6	180	0.89%
	Maximum 1-Hour	685000, 5920350	10.6	0.42%	3	13.6	2500	0.54%
	99th%ile of 1-Hour Means	684984, 5920305	1.2	0.40%	3	4.2	300	1.40%
NH_3 / 2019	Annual Mean	684992, 5920304	0.1	0.03%	1.5	1.6	180	0.89%
	Maximum 1-Hour	685024, 5920314	9.9	0.40%	3	12.9	2500	0.52%
	99th%ile of 1-Hour Means	685200, 5920250	0.5	0.15%	3	3.5	300	1.17%
NH_3 / 2020	Annual Mean	684992, 5920304	0.1	0.03%	1.5	1.6	180	0.89%
	Maximum 1-Hour	684992, 5920304	9	0.36%	3	12	2500	0.48%
	99th%ile of 1-Hour Means	684984, 5920305	0.9	0.30%	3	3.9	300	1.30%
NH_3 / 2021	Annual Mean	684992, 5920304	0.1	0.03%	1.5	1.6	180	0.89%
	Maximum 1-Hour	684992, 5920304	9.9	0.40%	3	12.9	2500	0.52%
	99th%ile of 1-Hour Means	685200, 5920200	0.4	0.12%	3	3.4	300	1.13%
NH_3 / 2022	Annual Mean	684992, 5920304	0.1	0.04%	1.5	1.6	180	0.89%
	Maximum 1-Hour	685000, 5920350	11	0.44%	3	14	2500	0.56%
	99th%ile of 1-Hour Means	684984, 5920305	0.7	0.25%	3	3.7	300	1.23%

Note 1 *IPPC Environmental Assessment and Appraisal of BAT* (UK Environment Agency, 2003)

Note 2 Danish Environmental Guidelines, *Guidelines For Air Emission Regulation "C"* (2002)

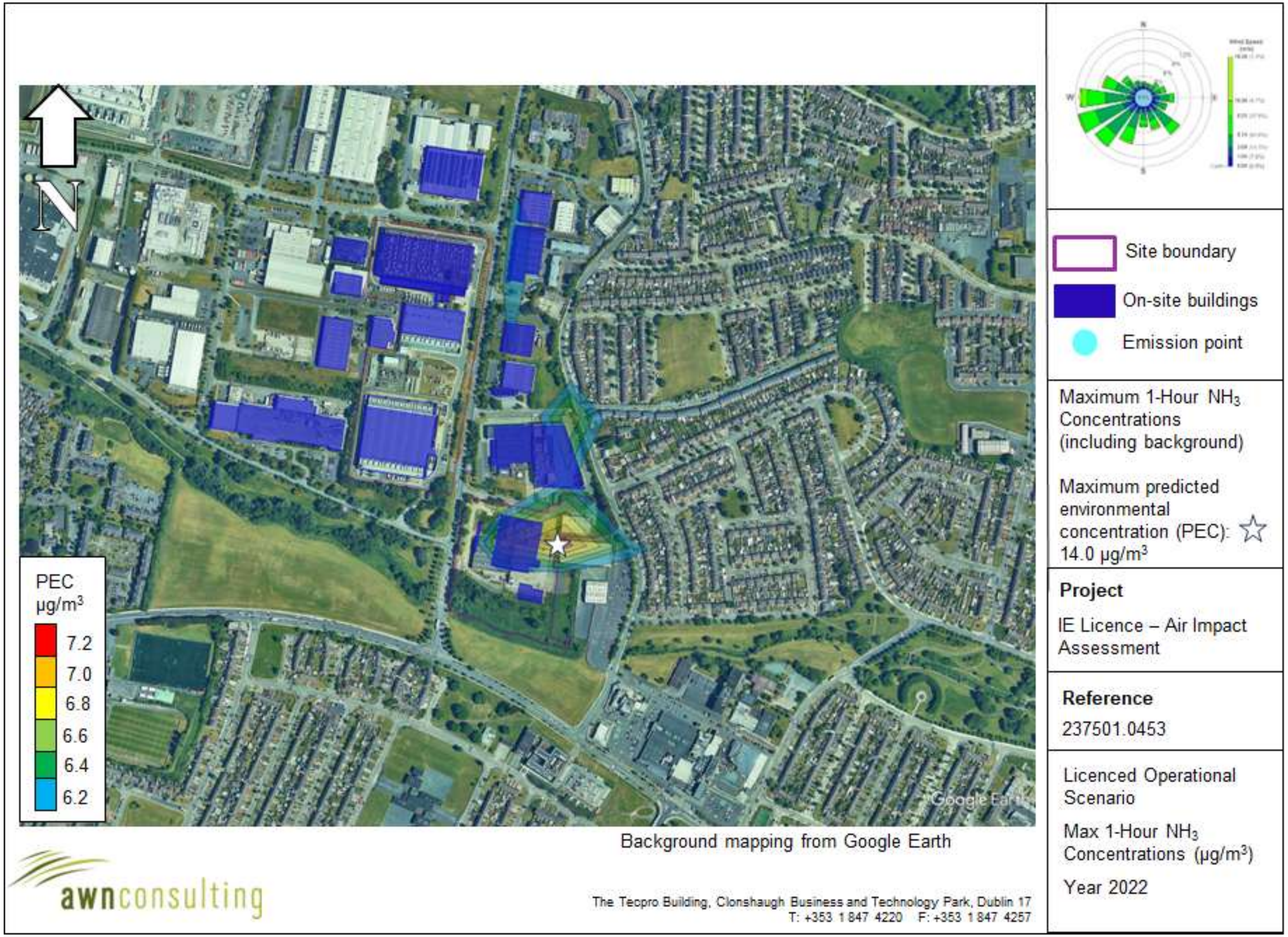

Figure 6.3. Licenced Operational Scenario - Maximum 1-Hour NH_3 Concentration (µg/m³) (including background concentrations)

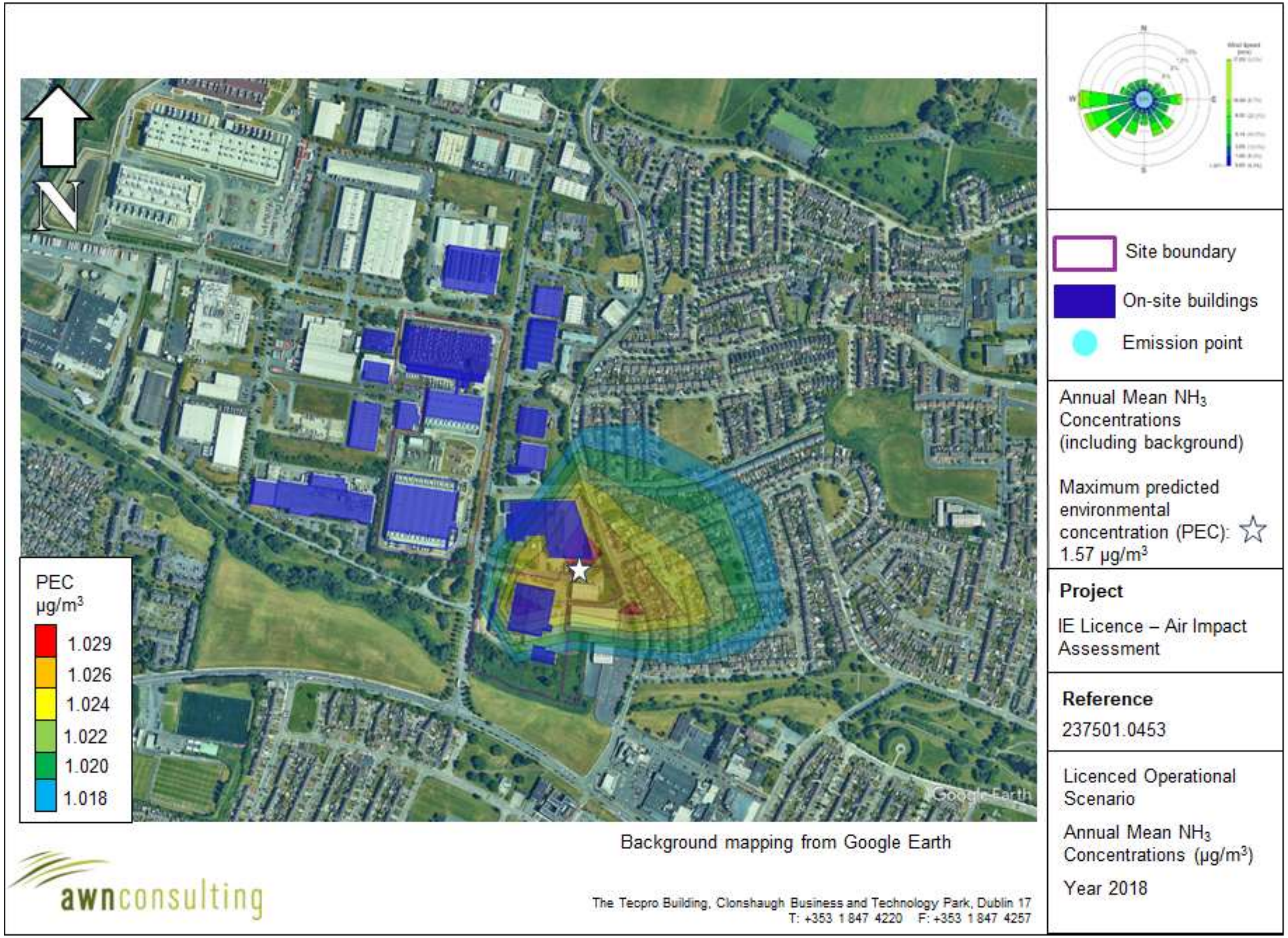

Figure 6.4. Licenced Operational Scenario - Annual Mean NH_3 Concentration (µg/m^3) (including background concentrations)

6.1.4 PM_{10} - Licenced Operational Scenario

Ambient Ground Level Concentrations (GLCs) of PM_{10} modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 6.4. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for all modelled years for PM_{10}.

For the worst-case year, PEC emissions from the installation lead to an ambient PM_{10} concentration (including background) which is 48% of the maximum ambient 24-hour limit value (measured as a 90.4^{th}%ile) at the worst-case receptor (gridded receptor, location shown in Figure 6.5) and 42% of the annual mean limit value at the worst-case receptor (boundary receptor, location shown in Figure 6.6).

Calculating the maximum 24-hour mean PM_{10} (90.4^{th}%ile) PEC is not a simple addition of background concentration to process contribution but is instead calculated in line with guidance from the UK DEFRA[(5)] and EPA[(2)], as explained in Section 4.4, which states that for PM_{10} an estimate of the maximum PEC can be obtained from the methods shown below:

PM_{10} - The 90.4^{th}%ile of total 24-hour mean PM_{10} is equal to the maximum of either A or B below:

a) Annual mean process contribution PM_{10} + 90.4^{th}%ile of 24-hour mean background PM_{10}
b) 90.4^{th}%ile 24-hour mean process contribution PM_{10} + annual mean background PM_{10}

The results of this calculation process are shown in Table 6.4 as “PEC A” and “PEC B”, and determined that the maximum 24-hour mean PM_{10} (90.4^{th}%ile) PEC is based on method A (“PEC A”).

The geographical variation in the 24-hour mean (90.4^{th}%ile) and annual mean PM_{10} ground level predicted environmental concentrations (PEC) beyond the installation boundary for the worst-case years modelled are illustrated as concentration contours in Figure 6.5 and Figure 6.6, to demonstrate the direction and extent of the emission plume. Concentration contours are produced directly from the model output (process contribution), with the appropriate background added in post processing (note that adding a background to determine PEC does not alter the direction or extent of the plume).

As a concentration contour must be based on the process contribution to display the plume correctly, the 24-hour mean PM_{10} (90.4^{th}%ile) contours shown in Figure 6.5 must be based on method B (“PEC B”).

Where Table 6.4 shows that the maximum PEC is the result of method A (“PEC A”), this cannot be shown on the 24-hour mean PM_{10} concentration contour. This is to be expected as method A is based on annual mean process contribution, which is not relevant for demonstrating daily mean plume behaviour. Therefore, the concentration contours may not align with the maximum shown in Table 6.4, which is to be expected and in line with UK DEFRA[(5)] and EPA[(2)] guidance.

Table 6.4. Licenced Operational Scenario – Dispersion Model Results for Particulate Matter (PM_{10})

Pollutant / Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Concentrations (µg/m³)					Max. PEC as % of Limit
			PC	Back-ground	PEC A	PEC B	Limit Value	
PM_{10} / 2018	Annual Mean	684911, 5920658	0.867	16	16.87	16.87	40	42%
	24-hr Mean (as 90.4th%ile)	684911, 5920659	2.333	23	23.87	18.33	50	48%
PM_{10} / 2019	Annual Mean	684911, 5920658	0.945	16	16.95	16.95	40	42%
	24-hr Mean (as 90.4th%ile)	684911, 5920659	2.206	23	23.94	18.21	50	48%
PM_{10} / 2020	Annual Mean	684911, 5920658	0.958	16	16.96	16.96	40	42%
	24-hr Mean (as 90.4th%ile)	684911, 5920659	2.483	23	23.96	18.48	50	48%
PM_{10} / 2021	Annual Mean	684911, 5920658	0.904	16	16.90	16.90	40	42%
	24-hr Mean (as 90.4th%ile)	684908, 5920634	2.082	23	23.90	18.08	50	48%
PM_{10} / 2022	Annual Mean	684911, 5920658	0.842	16	16.84	16.84	40	42%
	24-hr Mean (as 90.4th%ile)	684908, 5920634	2.111	23	23.84	18.11	50	48%

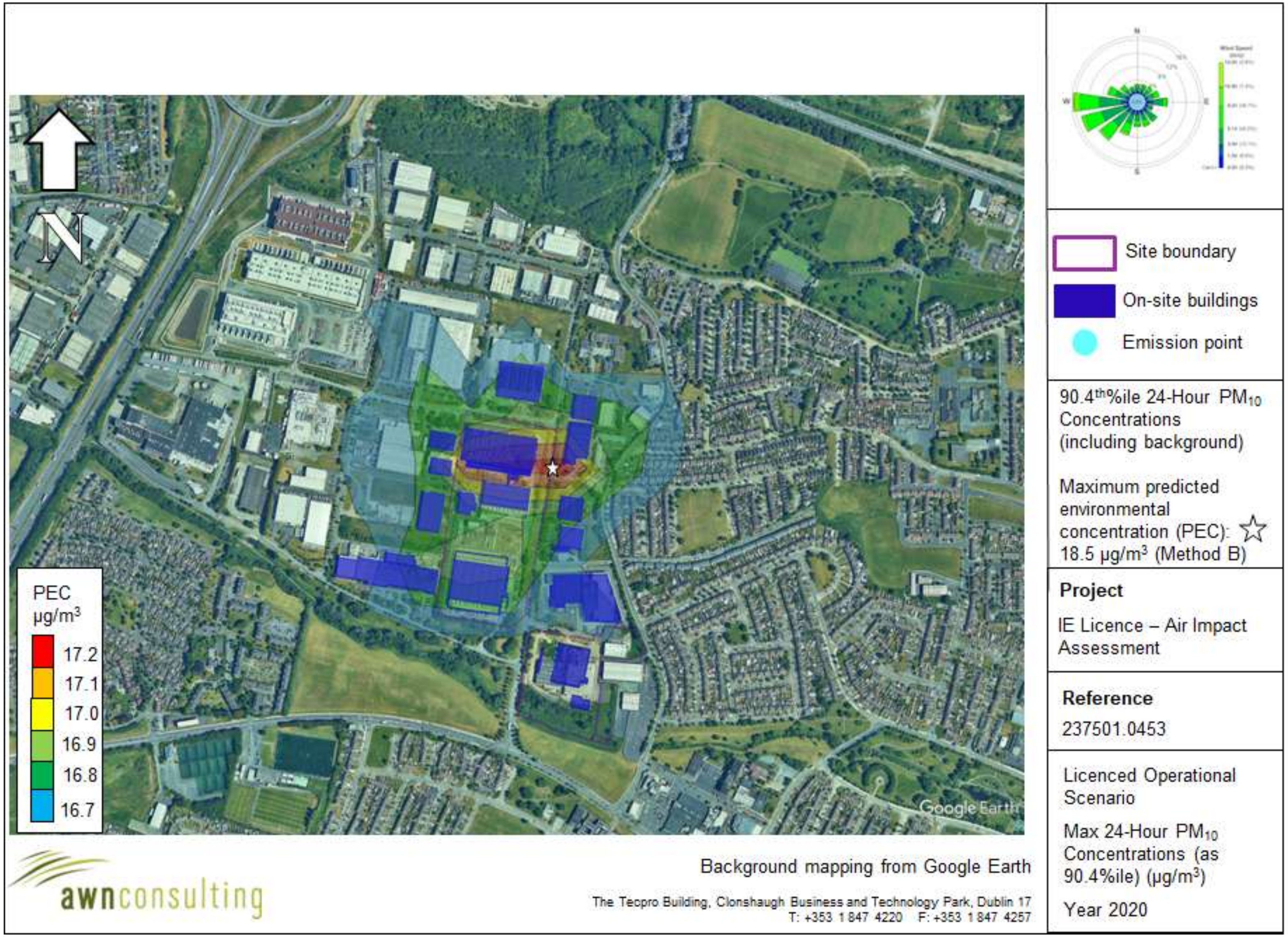

Figure 6.5. Licenced Operational Scenario - Maximum 24-Hour PM_{10} Concentration (µg/m³) (including background concentrations)

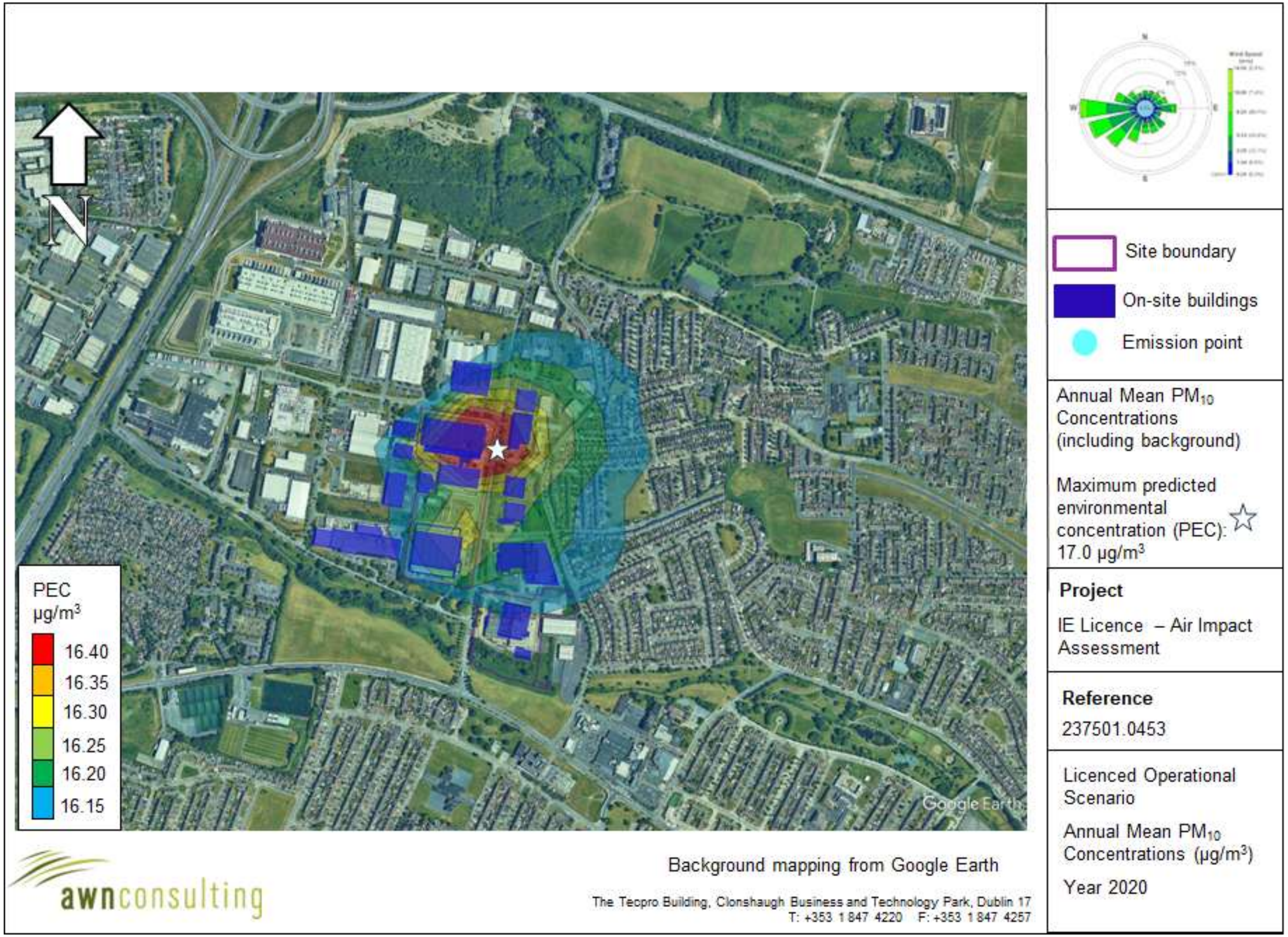

Figure 6.6. Licenced Operational Scenario - Annual Mean PM_{10} Concentration (µg/m^3) (including background concentrations)

6.1.5 $PM_{2.5}$ - Licenced Operational Scenario

The $PM_{2.5}$ modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 6.5. These are derived from a worst-case assumption that all PM_{10} emissions from the installation are of a particle size of 2.5 microns or less ($PM_{2.5}$). This assumption is necessitated due to the lack of availability of $PM_{2.5}$ emission concentration data for emission sources and therefore $PM_{2.5}$ emissions could not be directly modelled. In reality, particles greater than 2.5 microns will also be present and thus the mass of $PM_{2.5}$ released has been overestimated.

For the worst-case year, ambient concentrations (excluding background) will be 4% of the annual mean $PM_{2.5}$ limit value of 25 µg/m^3 at the worst-case receptor. For the worst-case year, ambient concentrations (including background) will be 44% of the annual mean $PM_{2.5}$ limit value of 25 µg/m^3 at the worst-case receptor (boundary receptor, location shown in Figure 6.6). As the annual mean $PM_{2.5}$ concentrations have been conservatively assumed equal to the annual mean PM_{10} concentrations, the direction and extent of the emission plume is identical to that shown in Figure 6.6.

Table 6.5. Licenced Operational Scenario – Dispersion Model Results for Particulate Matter ($PM_{2.5}$)

Pollutant / Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution (µg/m^3)	PC as % of Limit Value	Back-ground (µg/m^3)	Predicted Environmental Concentration (µg/m^3)	Limit Value (µg/m^3) Note 1	PEC as % of Limit Value
$PM_{2.5}$ / 2018	Annual Mean	684911, 5920658	0.87	3%	10	10.87	25	43%
$PM_{2.5}$ / 2019	Annual Mean	684911, 5920658	0.94	4%	10	10.94	25	44%
$PM_{2.5}$ / 2020	Annual Mean	684911, 5920658	0.96	4%	10	10.96	25	44%
$PM_{2.5}$ / 2021	Annual Mean	684911, 5920658	0.90	4%	10	10.90	25	44%
$PM_{2.5}$ / 2022	Annual Mean	684911, 5920658	0.84	3%	10	10.84	25	43%

Note 1 Air Quality Standards 2022 (from EU Directive 2008/50/EC and S.I. 739 of 2022)

6.1.6 SO_2 - Licenced Operational Scenario

The SO_2 modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 6.6. The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for SO_2. PC emissions from the installation lead to an ambient SO_2 concentration (excluding background) which is 6% of the maximum 1-hour limit value (measured as a 99.7th%ile) at the worst-case receptor and 5% of the maximum 24-hour limit value (measured as a 99.2nd%ile) at the worst-case receptor.

PEC emissions from the installation lead to an ambient SO_2 concentration (including background) which is 15% of the maximum 1-hour limit value (measured as a 99.7th%ile) at the worst-case receptor (off-site gridded receptor, location shown in Figure 6.7) and 18% of the maximum 24-hour limit value (measured as a 99.2nd%ile) at the worst-case receptor (off-site gridded receptor, location shown in Figure 6.8). The locations of the maximum concentrations for SO_2 are close to the boundary of the installation with concentrations decreasing with distance from the installation.

The geographical variations in ground level SO_2 process contribution (PC) concentrations beyond the installation boundary for the worst-case years modelled are illustrated as concentration contours in Figure 6.7 and Figure 6.8 to demonstrate the direction and extent of the emission plume.

Calculating the maximum 1-hour mean SO_2 (99.7th%ile) and 24-hour mean SO_2 (99.2nd%ile) PEC is not a simple addition of background concentration to process contribution but is instead calculated in line with guidance from the UK DEFRA[(5)] and EPA[(2)], as explained in detail in Section 4.6 which states that for SO_2 an estimate of the maximum combined pollutant concentrations can be obtained as shown below:

99.2nd%ile of total 24-hour SO_2 - The 99.2th%ile of total 24-hour SO_2 is equal to the maximum of either A or B below:

a) 99.2th%ile of 24-hour mean background SO_2 + (2 x annual mean process contribution SO_2)
b) 99.2th%ile 24-hour mean process contribution SO_2 + (2 x annual mean background contribution SO_2)

99.7th%ile of total 1-hour SO_2 - The 99.7th%ile of total 1-hour SO_2 is equal to the maximum of either A or B below:

a) 99.7th%ile hourly background SO_2 + (2 x annual mean process contribution SO_2)
b) 99.7th%ile hourly process contribution SO_2 + (2 x annual mean background contribution SO_2)

Thus for **Year 2018**, the calculation for the maximum 1-hour PEC is as follows with the highest of the two results reported:

SO_2 - The 99.7th%ile of total 1-hour SO_2 is equal to the maximum of either A or B below:

a) 99.7th%ile hourly background SO_2 (51 µg/m^3) + (2 x annual mean process contribution SO_2 (2 X 0.97 µg/m^3) = **52.94 µg/m^3**

b) 99.7th%ile hourly process contribution SO_2 (23.86 µg/m^3) + (2 x annual mean background contribution SO_2) (2 x 4.0 µg/m^3) = **31.86 µg/m^3**

Thus for **Year 2018**, the calculation for the maximum 24-hour PEC is as follows with the highest of the two results reported:

SO_2 - The 99.2th%ile of total 24-hour SO_2 is equal to the maximum of either A or B below:

a) 99.2th%ile of 24-hour mean background SO_2 (20 µg/m^3) + (2 x annual mean process contribution SO_2) (2 X 0.97 µg/m^3) = **21.94 µg/m^3**

b) 99.2th%ile 24-hour mean process contribution SO_2 (6.98 µg/m^3) + (2 x annual mean background contribution SO_2) (2 x 4.0 µg/m^3) = **14.98 µg/m^3**

The results for 2019-2022 are also calculated in the same manner.

The results of this calculation process are shown in Table 6.6 as "PEC A" and "PEC B", and determined that the maximum 1-hour mean SO_2 (99.7th%ile) PEC is based on method A ("PEC A"), while the maximum 24-hour mean SO_2 (99.2nd%ile) PEC is based on method B ("PEC B").

The geographical variations in ground level SO_2 predicted environmental concentration (PEC) beyond the installation boundary for the worst-case years modelled are illustrated as concentration contours in Figure 6.7 and Figure 6.8, to demonstrate the direction and extent of the emission plume. Concentration contours are produced directly from the model output (process contribution), with the appropriate background added in post processing (note that adding a background to determine PEC does not alter the direction or extent of the plume).

As a concentration contour must be based on the process contribution to display the plume correctly, the 1-hour mean SO_2 (99.7th%ile) and 24-hour mean SO_2 (99.2nd%ile) contours shown in Figure 6.7 and Figure 6.8 must be based on method B ("PEC B").

Where Table 6.6 shows that the maximum PEC is the result of method A ("PEC A"), this cannot be shown on the concentration contours. This is to be expected as method A is based on annual mean process contribution, which is not relevant for demonstrating hourly or daily mean plume behaviour. Therefore, the concentration contours may not align with the maximum shown in Table 6.6, which is to be expected and in line with UK DEFRA[5] and EPA[2] guidance.

Table 6.6. Licenced Operational Scenario – Dispersion Model Results for Sulphur Dioxide (SO_2)

Pollutant / Year	Averaging Period	Worst Case Receptor		Concentrations ($\mu g/m^3$)					Max. PEC as % of Limit
		Type	X,Y (UTM Zone 29 N)	PC	Back-ground	PEC A	PEC B	Limit Value	
SO_2 / 2018	Annual Mean	Sensitive	684911, 5920658	0.97	4	4.97	4.97	-	-
	1-hr Mean (99.7th%ile)	Grid	684911, 5920659	23.86	51	52.94	31.86	350	15%
	24-hr Mean (99.2nd%ile)	Grid	684911, 5920659	6.98	20	21.94	14.98	125	18%
SO_2 / 2019	Annual Mean	Sensitive	684911, 5920658	1.04	4	5.04	5.04	-	-
	1-hr Mean (99.7th%ile)	Grid	684911, 5920659	26.03	51	53.08	34.03	350	15%
	24-hr Mean (99.2nd%ile)	Grid	684911, 5920659	8.58	20	22.08	16.56	125	18%
SO_2 / 2020	Annual Mean	Boundary	684911, 5920658	1.06	4	5.06	5.06	-	-
	1-hr Mean (99.7th%ile)	Grid	684914, 5920683	24.44	51	53.12	32.44	350	15%
	24-hr Mean (99.2nd%ile)	Grid	684905, 5920609	7.43	20	22.12	15.43	125	18%
SO_2 / 2021	Annual Mean	Sensitive	684911, 5920658	1.00	4	5.00	5.00	-	-
	1-hr Mean (99.7th%ile)	Grid	684905, 5920607	26.39	51	53.01	34.39	350	15%
	24-hr Mean (99.2nd%ile)	Grid	684905, 5920607	9.23	20	22.01	17.23	125	18%
SO_2 / 2022	Annual Mean	Boundary	684911, 5920658	0.93	4	4.93	4.93	-	-
	1-hr Mean (99.7th%ile)	Grid	684905, 5920609	25.12	51	52.87	33.12	350	15%
	24-hr Mean (99.2nd%ile)	Grid	684905, 5920609	7.52	20	21.87	15.52	125	17%

Note 1 Air Quality Standards 2022 (from EU Directive 2008/50/EC and S.I. 739 of 2022)

Note 2 1-hour mean (as 99.7th %ile) and 24-hour mean (as 99.2nd %ile) SO_2 predicted environmental concentrations derived from calculation as per UK DEFRA and EPA guidance, as described above, and is not a simple addition of background concentration to process contribution.

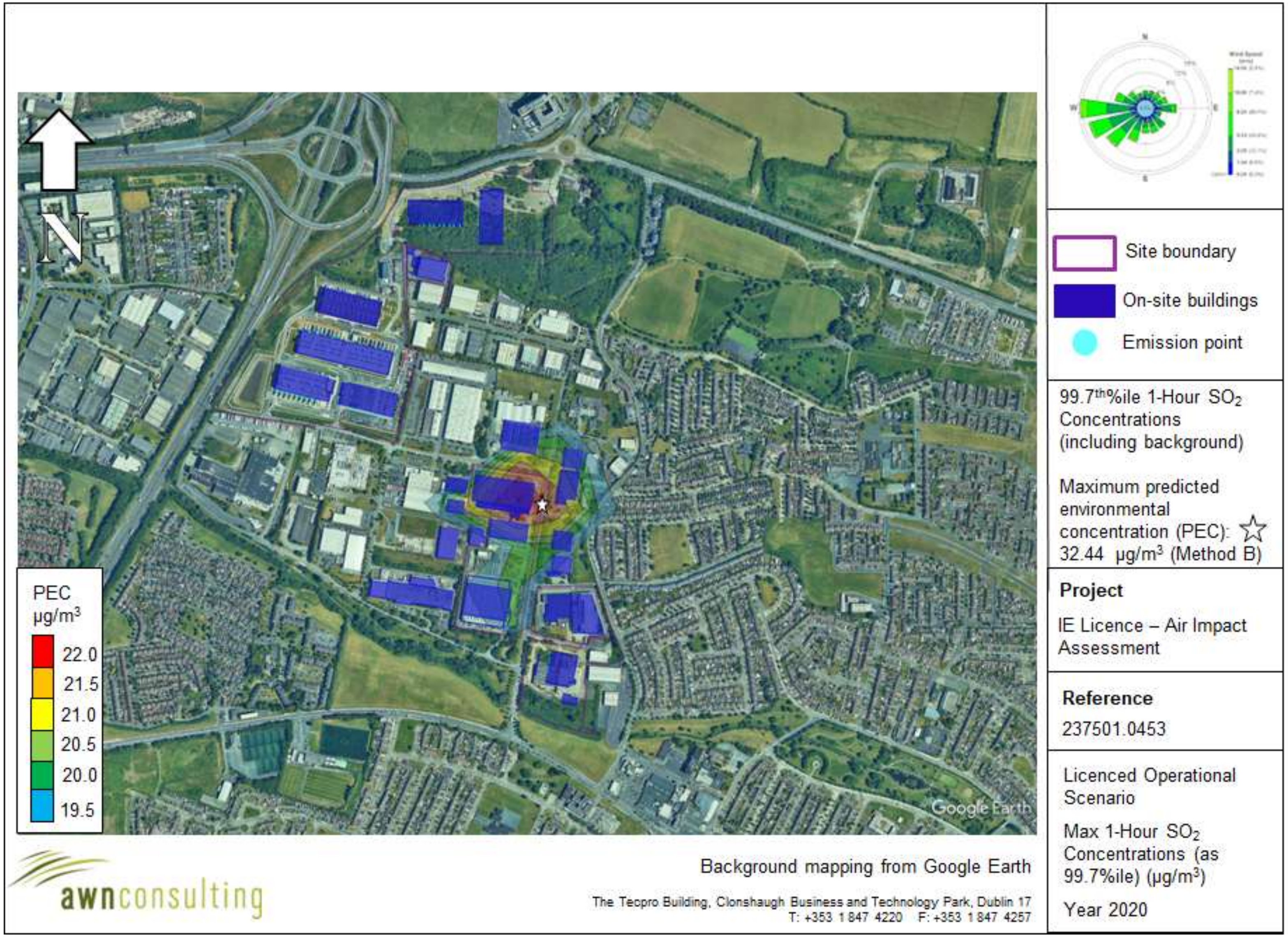

Figure 6.7. Licenced Operational Scenario - Maximum 1-Hour SO_2 Concentrations (as a 99.7th%ile) ($\mu g/m^3$) (including background concentrations)

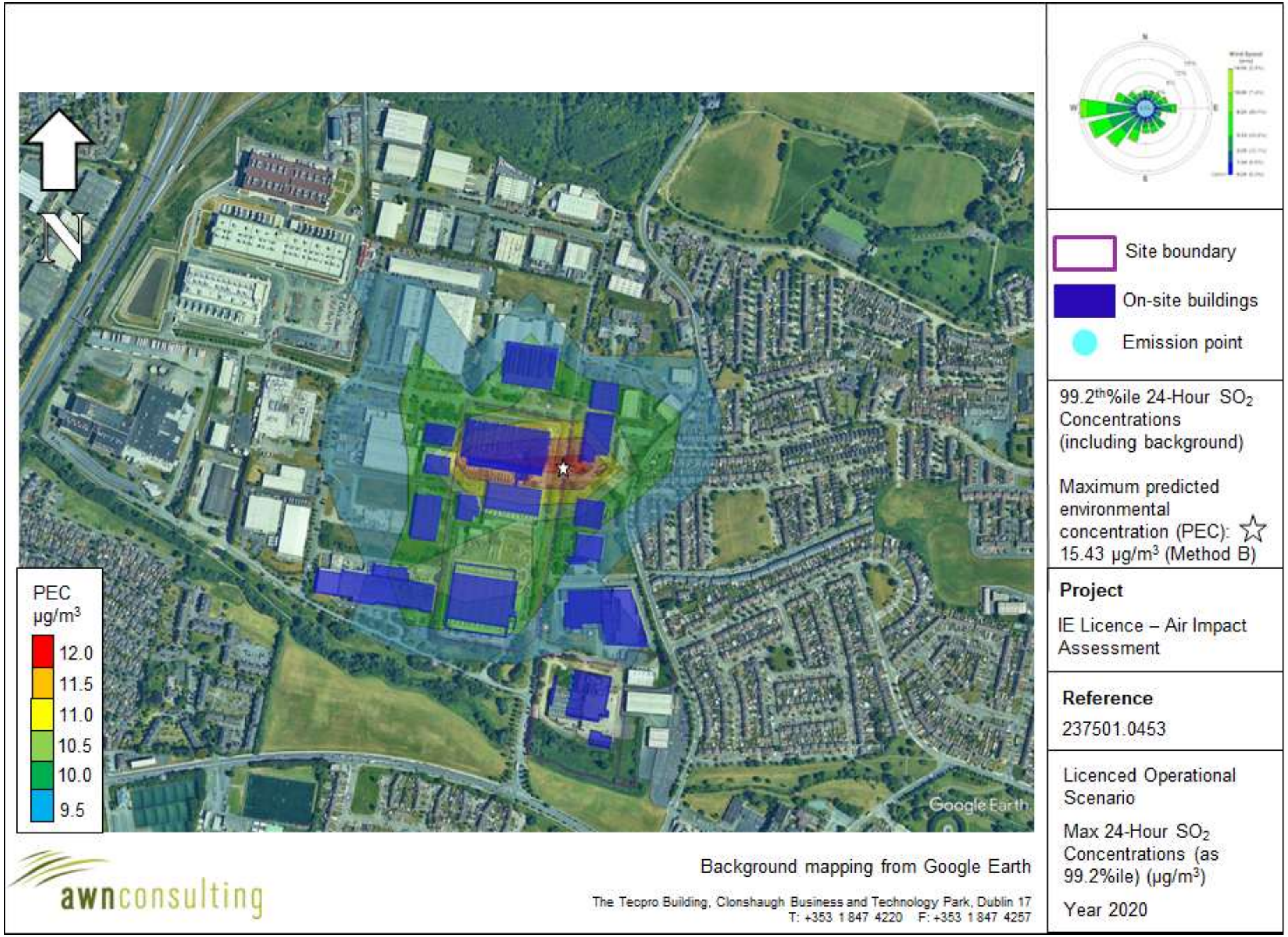

Figure 6.8. Licenced Operational Scenario – Maximum 24-Hour SO_2 Concentrations (as a 99.2th%ile) (including background concentrations)

6.2 Licenced Operational Scenario (UK EA Methodology)

Emissions of NO_2 from 45 of the 52 no. standby generators were assessed using the UK EA methodology. The methodology, based on considering the statistical likelihood of an exceedance of the NO_2 hourly limit value assuming a hypergeometric distribution, has been undertaken at the worst-case residential receptor. The cumulative hypergeometric distribution of 19 and more hours per year is computed and the probability of an exceedance determined. The results have been compared to the 98th percentile confidence level to indicate if an exceedance is likely at various operational hours for the generators.

The results (Table 6.7 and Figure 6.9) indicate that in the worst-case year, the generators can operate for the 137 hours per year before there is a likelihood of an exceedance of the ambient air quality standard (at a 98th percentile confidence level). However, the USEPA is the preferred method to determine the operational impact of the installation and the preferred method to determine the allowable operational hours of the emergency backup generators.

Table 6.7. Hypergeometric Statistical Results at Worst-case Residential Receptor – Licenced Operational Scenario

Pollutant / Year / Scenario	Hours of operation (Hours) (98th%ile) Allowed Prior To Exceedance Of Limit Value	UK Guidance – Probability Value = 0.02 (98th%ile)$^{Note\ 1}$
NO_2 / 2018	344	0.02
NO_2 / 2019	330	
NO_2 / 2020	137	
NO_2 / 2021	317	
NO_2 / 2022	141	

Note 1 Guidance Outlined In UK Environment Agency (2019) Emissions from specified generators - Guidance on dispersion modelling for oxides of nitrogen assessment from specified generators

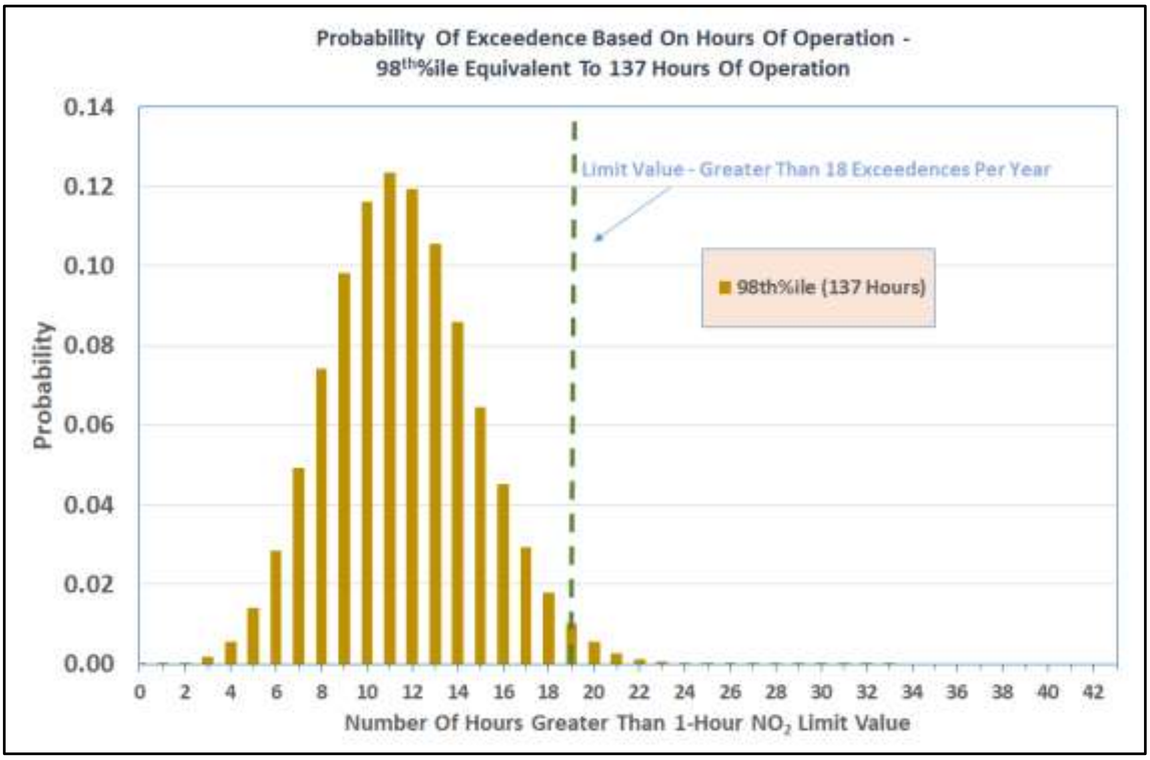

Figure 6.9. Hypergeometric Statistical Result at Worst-case Residential Receptor – Licenced Operational

Scenario

6.3 Cumulative Assessment

A cumulative impact assessment has been undertaken based on the approach outlined in EPA AG4(2). Cumulative emissions of NO_X have been assessed for nearby data centres including the ADSIL installation to the north-west of the installation (P1171-01). An IE Licenced installation (Forest Laboratories Ireland Ltd, P0306-04) was also reviewed for NO_X emissions based on the threshold for cumulative assessment methodology, as shown in Figure 6.10 (Figure A2 in AG4).

The guidance indicates that a cumulative assessment should be considered if annual NO_X emissions from the nearby installation are greater than 100 tonnes/annum. However, as shown in Table 6.8, based on assuming all emission points operate continuously for a full year the annual tonnage is 31.5 tonnes (in reality most of these emission points are duty/standby). Thus, as this is below the 100 tonnes threshold, the installation has been excluded from the cumulative assessment for NO_X.

Table 6.8. Summary of NO_X Emission Concentrations and Mass Emission Rates for Forest Laboratories Ireland Ltd

Main Emission Point Note 1	Volume Flow Limit (m^3/hr) Note 2	Concentration ELV for NO_X (mg/m^3) Note 1	Mass Emission ELV for NO_X (g/hr)	Mass Emission (Tonnes / year)
A1-1	3,000	200	600.0	5.3
A1-2	3,000	200	600.0	5.3
A1-3	3,000	200	600.0	5.3
A1-4	1,000	200	200.0	1.8
A1-5	1,000	200	200.0	1.8
A1-6	3,000	200	600.0	5.3
A1-7	3,000	200	600.0	5.3
A1-8	1,000	200	200.0	1.8
Total			**31.5** tonnes	

Note 1 Emissions referenced to 273.15 K, 101.3 Pa, 3% O2, dry gas

Annual emission totals of NO_X, CO, SO_2, NH_3 and PM_{10} have been determined for the ADSIL installation to the north-west of the installation (P1171-01) in order to determine which pollutants should be considered in the cumulative assessment. The guidance in AG4(2) states that a cumulative assessment should be considered if annual emissions of each of these pollutants are greater than 100 tonnes/annum from each nearby installation. However, as shown in Table 6.9, all pollutants except NO_X are well below the assessment threshold and thus have been excluded from the human health cumulative assessment.

A cumulative assessment has been undertaken for NO_X as it is above the 100 tonnes threshold. Two other smaller data centres (Dataplex and Digital Realty) have also been included in the NO_X cumulative assessment for completeness as these were included in the air impact assessment during the original planning permission for the Installation. Emissions of CO, SO_2, NH_3 and PM_{10} from these two facilities will be a small fraction of the P1171-01 emission tonnages and thus will be well below the cumulative assessment threshold.

Table 6.9. Summary of Mass Emission Rates for ADSIL installation P1171-01

P1171-01	Tonnes per year (72 hours at 90% load) (tonnes)	Operational Generators During Emergency	Tonnes per year (16 hours at 90% load) (tonnes)	Operational Generators During Load Testing	Weekly testing (30 mins at 25% load) (tonnes)	Operational Generators During Weekly Testing	Annual Tonnage From Installation (tonnes)
NO_X (as NO_2)	1.03	94	0.23	105	0.130	105	**134**
CO	0.13	94	0.029	105	0.021	105	**17.3**
SO_2	0.019	94	0.004	105	0.003	105	**2.5**
NH_3	n/a	94	n/a	105	n/a	105	**n/a**
PM	0.011	94	0.003	105	0.002	105	**1.5**
Threshold (per pollutant) (tonnes)							**100**

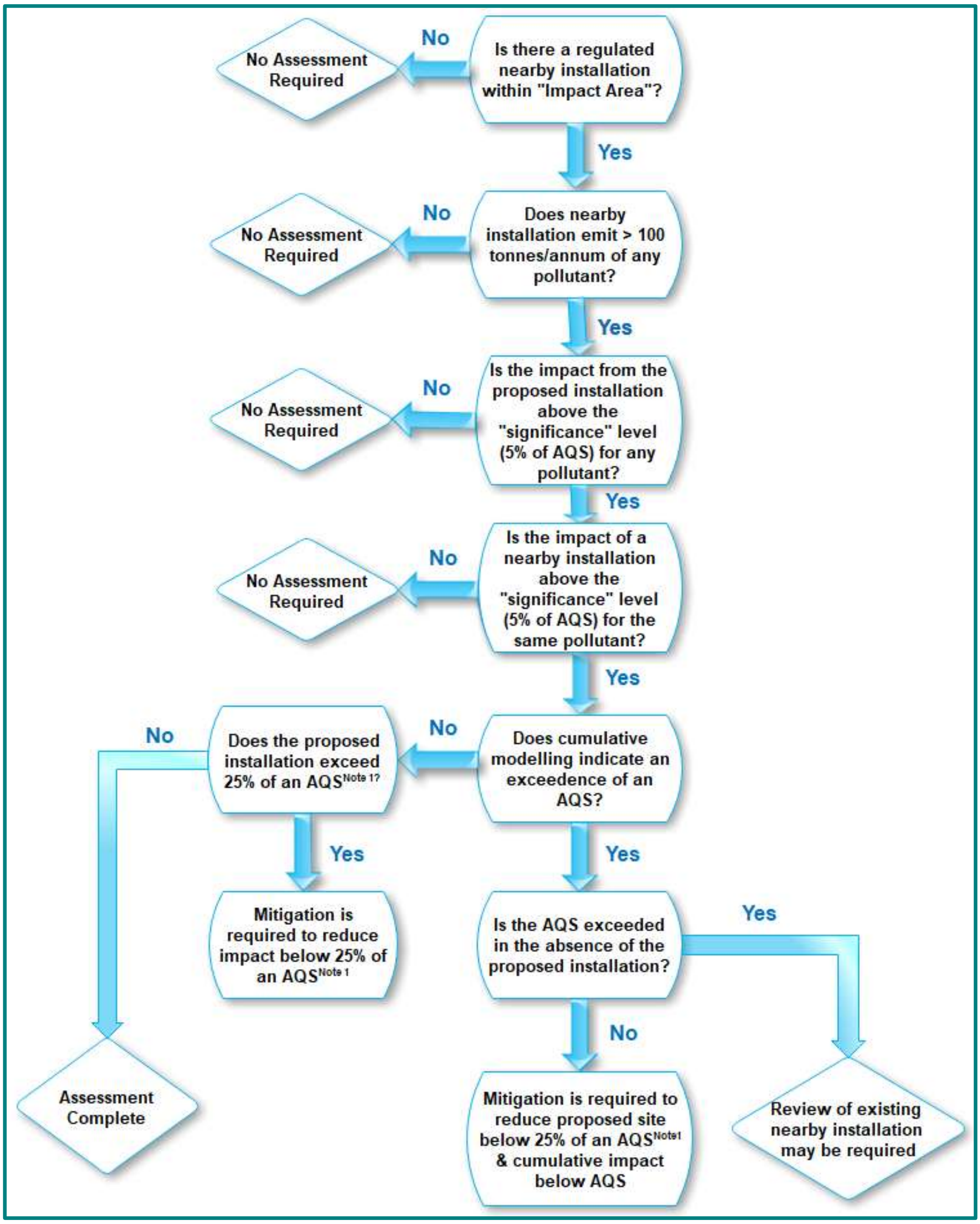

Figure 6.10. Flowchart for undertaking a cumulative impact assessment of a nearby industrial installation (based on the USEPA PSD approach)[(2)].

6.3.1 Cumulative Scenario (USEPA Methodology)

The cumulative NO_2 modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 6.10 based on the operation of 45 of the 52 no. back-up generators for 150 hours per year using diesel fuel, using the USEPA methodology outlined within the guidance document titled '*Additional Clarification Regarding Application of Appendix W Modelling Guidance for the 1-Hour National Ambient Air Quality Standard*'[3] as well as considering scheduled weekly testing and quarterly maintenance testing of all 52 no. back-up generators from the subject installation in addition to emissions associated with a number of other data storage facilities within 1 km of the subject installation as outlined in Section 5.1.

The results indicate that the ambient ground level concentrations are within the relevant air quality standards for NO_2. For the worst-case year modelled, cumulative process contributions (CPC) emissions from the installation lead to an ambient NO_2 concentration (excluding background) which is 79.3% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 60.2% of the annual mean limit value at the worst-case off-site receptor.

For the worst-case year modelled, cumulative PEC emissions from the installation lead to an ambient NO_2 concentration (including background) which is 94.3% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 97.7% of the annual mean limit value at the worst-case off-site receptor, both of which are at the boundary of the installation. Concentrations decrease with distance from the installation boundary. The geographical variations in the 1hour mean (99.8th percentile) and annual mean NO_2 ground level concentrations for the Cumulative Scenario are illustrated as concentration contours in Figure 6.12 and Figure 6.13. The locations of the maximum concentrations for NO_2 are close to the boundary of the installation with concentrations decreasing with distance from the installation.

Table 6.10. Dispersion Model Results for Nitrogen Dioxide (NO_2) – Cumulative Operations

Pollutant/ Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Cumulative Process Contribution (CPC) (μg/m³)	CPC as a % of Limit Value	Background Concentration (μg/m³)	Predicted Environmental Concentration (PEC) (μg/m³)	Limit Value (μg/Nm³) Note 1	PEC as a % of Limit Value
NO_2 / 2018	Annual Mean	684911, 5920658	22.6	56.6%	15	37.65	40	94.1%
	99.8th%ile of 1-hr means	684911, 5920659	146.8	73.4%	30	176.77	200	88.4%
NO_2 / 2019	Annual Mean	684911, 5920658	23.9	59.7%	15	38.87	40	97.2%
	99.8th%ile of 1-hr means	684911, 5920659	152.7	76.3%	30	182.69	200	91.3%
NO_2 / 2020	Annual Mean	684911, 5920658	24.1	60.2%	15	39.08	40	97.7%
	99.8th%ile of 1-hr means	684905, 5920609	148.4	74.2%	30	178.39	200	89.2%
NO_2 / 2021	Annual Mean	684911, 5920658	23.1	57.7%	15	38.06	40	95.2%
	99.8th%ile of 1-hr means	684905, 5920609	158.6	79.3%	30	188.60	200	94.3%

Pollutant/ Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Cumulative Process Contribution (CPC) (μg/m^3)	CPC as a % of Limit Value	Background Concentration (μg/m^3)	Predicted Environmental Concentration (PEC) (μg/m^3)	Limit Value (μg/Nm^3) Note 1	PEC as a % of Limit Value
NO_2 / 2022	Annual Mean	684911, 5920658	23.3	58.4%	15	38.34	40	95.9%
	99.8th%ile of 1-hr means	684905, 5920609	152.2	76.1%	30	182.20	200	91.1%

Note 1 Air Quality Standards 2022 (from EU Directive 2008/50/EC and S.I. 739 of 2022)

6.3.2 Cumulative Scenario (UK EA Methodology)

The methodology, based on considering the statistical likelihood of an exceedance of the NO_2 hourly limit value assuming a hypergeometric distribution, has been undertaken at the worst-case residential receptor for the Cumulative Scenario. The cumulative hypergeometric distribution of 19 and more hours per year is computed and the probability of an exceedance determined. The results have been compared to the 98th percentile confidence level to indicate if an exceedance is likely at various operational hours for the generators.

The results (Table 6.11 and Figure 6.11) indicate that in the worst-case year, the generators can operate for the 80 hours per year before there is a likelihood of an exceedance of the ambient air quality standard (at a 98th percentile confidence level). However, the USEPA is the preferred method to determine the operational impact of the installation and the preferred method to determine the allowable operational hours of the backup emergency generators.

Table 6.11. Hypergeometric Statistical Results at Worst-case Residential Receptor – Cumulative Assessment

Pollutant / Year / Scenario	Hours of operation (Hours) (98th%ile) Allowed Prior To Exceedance Of Limit Value	UK Guidance – Probability Value = 0.02 (98th%ile)Note 1
NO_2 / 2018	144	0.02
NO_2 / 2019	80	
NO_2 / 2020	114	
NO_2 / 2021	106	
NO_2 / 2022	110	

Note 1 Guidance Outlined In UK Environment Agency (2019) Emissions from specified generators - Guidance on dispersion modelling for oxides of nitrogen assessment from specified generators

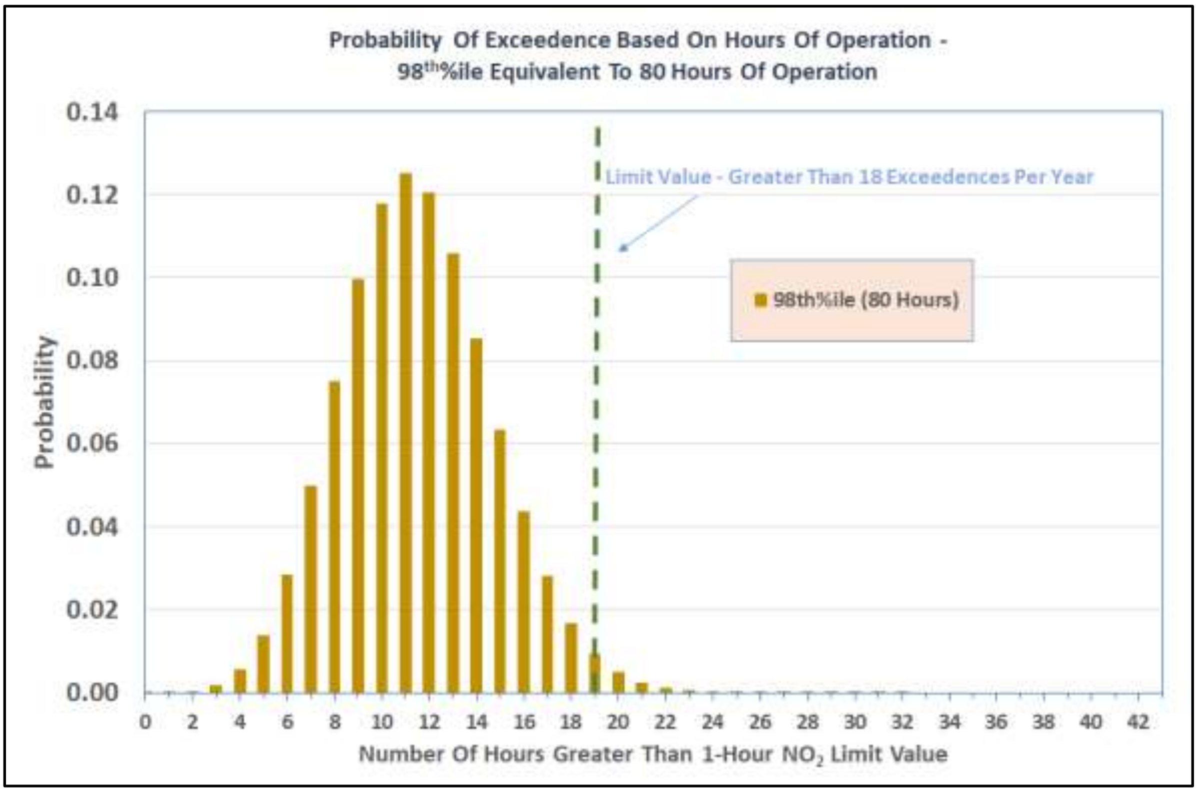

Figure 6.11. Hypergeometric Statistical Result at Worst-case Residential Receptor – Cumulative Assessment

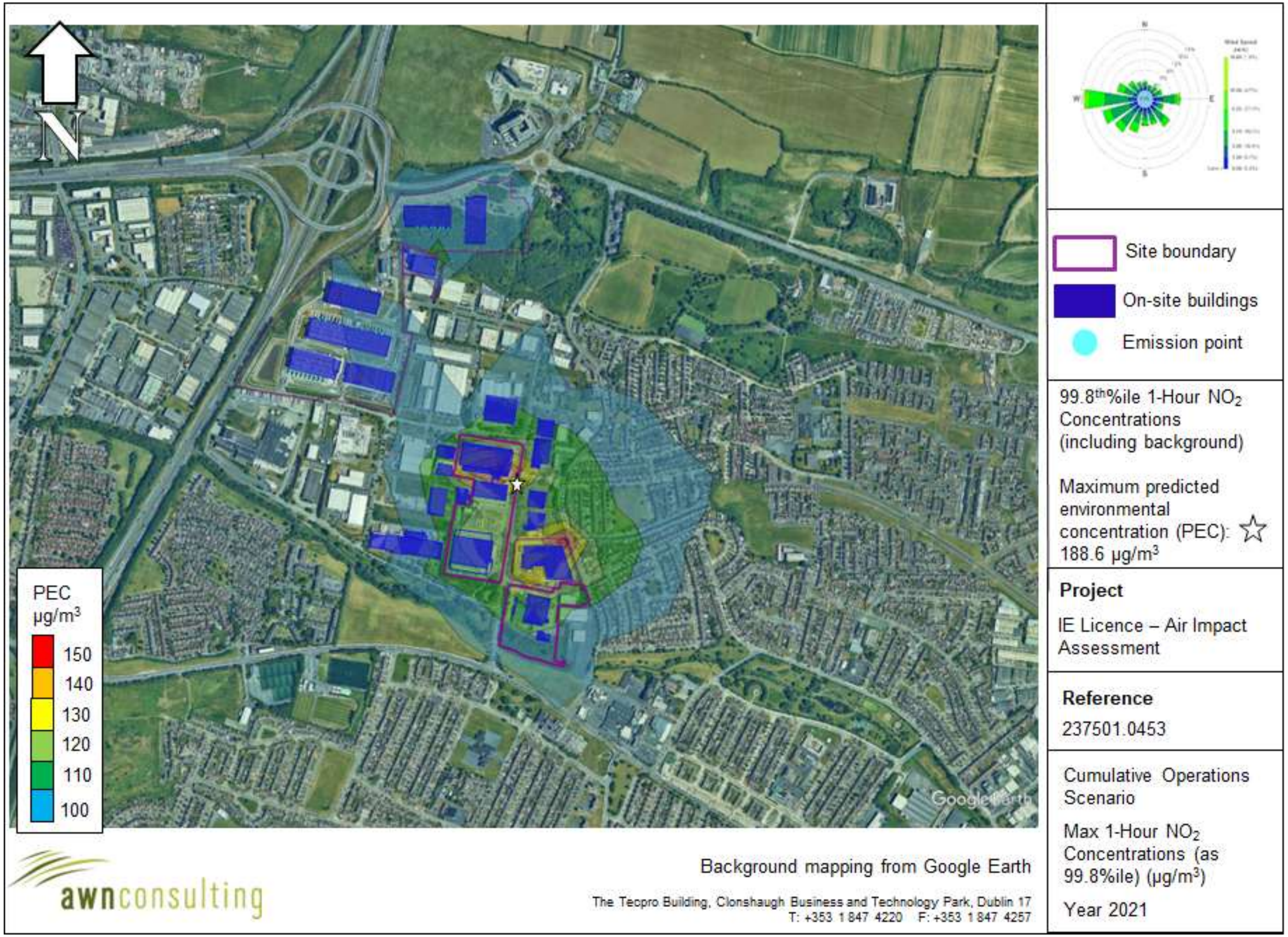

Figure 6.12. Cumulative Assessment - Maximum 1-Hour NO_2 Concentrations (as a 99.8th%ile) (µg/m^3) (including background concentrations)

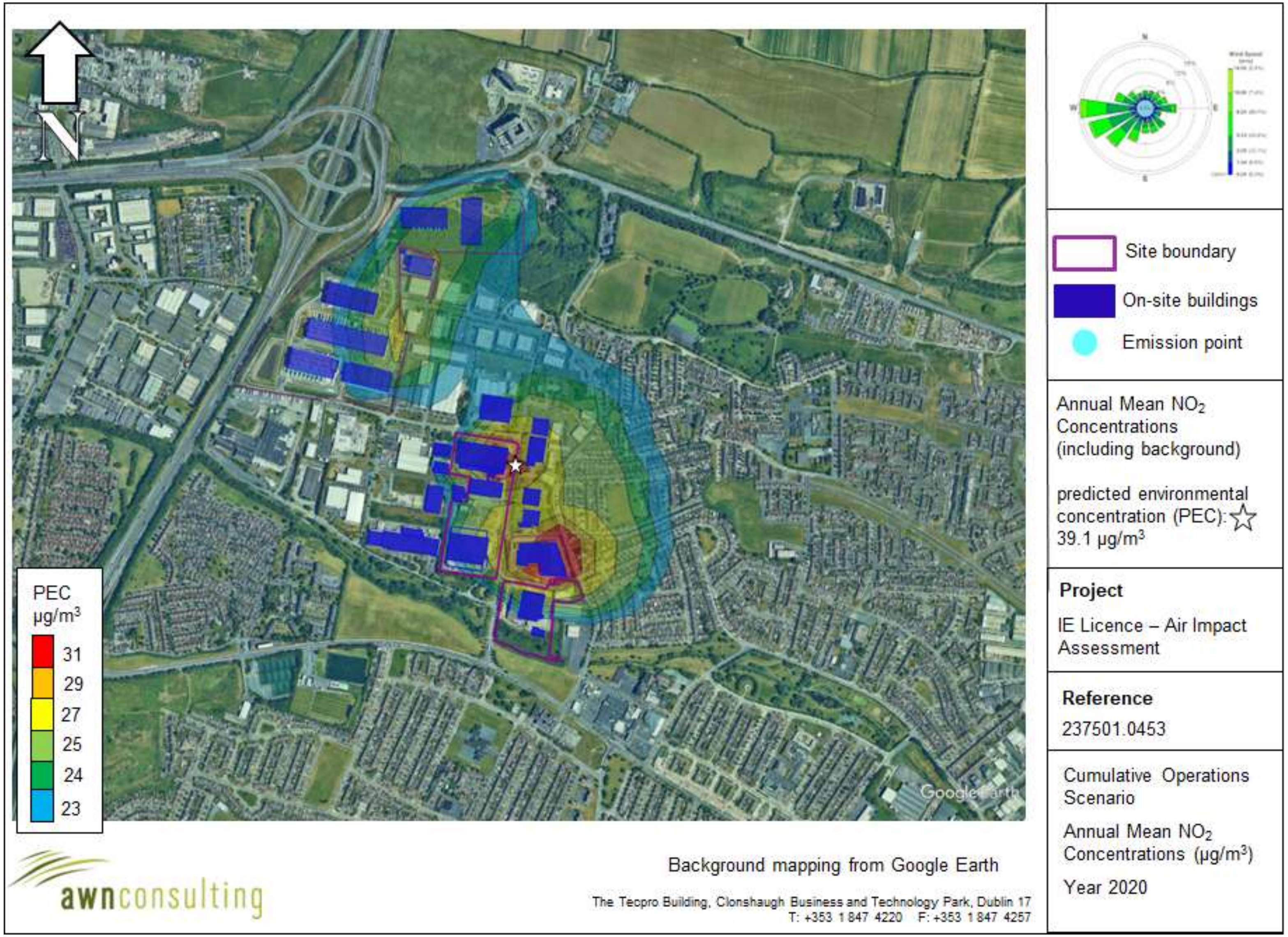

Figure 6.13. Cumulative Assessment - Annual Mean NO_2 Concentrations (µg/m^3) (including background concentrations)

7.0 RESULTS – ECOLOGY

7.1 Licenced Operational Scenario

7.1.1 NO_X – Licenced Operational Scenario

As per Section 3.2 process contributions (PCs) of NO_X at the ecological receptors within the model study area identified in Section 3.2 were compared to the relevant critical level (identified in Section 3.2). The NO_X modelling results are detailed in Table 7.1.

Where a PC is greater than 1% of the critical level, this installation has been included in further assessment where the PEC is determined by combining the background concentration with the PC.

There are no PCs greater than 1% of the critical level at any of the modelled European sites (Natura 2000 receptors), therefore no further assessment (i.e. calculation of PEC) is required as per IN2 guidance. However, at the request of the Agency, PECs have been presented for informational purposes.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC and Baldoyle Bay SPA), at the worst-case location, PEC emissions from the installation lead to an ambient NO_X concentration (including background) which is at most 38% of the critical level over the five years of meteorological data modelled. The process contribution (PC) NO_X concentration is at most 0.9% of the critical level over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) Natura 2000 receptor (South Dublin Bay and River Tolka Estuary SPA), at the worst-case location, PEC emissions from the installation lead to an ambient NO_X concentration (including background) which is at most 99.5% of the critical level over the five years of meteorological data modelled. However, the process contribution (PC) NO_X concentration is at most 0.2% of the critical level over the five years of meteorological data modelled.

Within the most impacted national site (in terms of process contributions) (Santry Demesne pNHA), at the worst-case location, PEC emissions from the installation lead to an ambient NO_X concentration (including background) which is at most 58% of the critical level over the five years of meteorological data modelled. The process contribution (PC) NO_X concentration is at most 1.4% of the critical level over the five years of meteorological data modelled.

Within the most impacted ecological receptor (in terms of PEC) (North Dublin Bay pNHA), at the worst-case location, PEC emissions from the installation lead to an ambient NO_X concentration (including background) which is at most 97% of the critical level over the five years of meteorological data modelled. However, the process contribution (PC) NO_X concentration is at most 0.5% of the critical level over the five years of meteorological data modelled.

Table 7.1. NO_X Dispersion Model Results at Most Impacted Ecological Receptors – Licenced Operational Scenario Operations

Ecological Receptor	NO_X Process Contributions (µg/m^3)					Critical Level (µg/m^3)	Max PC % of Critical Level	Considered for further assessment?	Back-ground (µg/m^3)	PEC (µg/m^3)	PEC % of critical level
	2018	2019	2020	2021	2022						
European Sites (Natura 2000)											
Baldoyle Bay SAC	0.26	0.27	0.27	0.26	0.26	30	0.9%	No	10.90	11.17	37%
Howth Head SAC	0.08	0.10	0.10	0.11	0.11	30	0.4%	No	12.48	12.59	42%
Ireland's Eye SAC	0.10	0.13	0.12	0.12	0.11	30	0.4%	No	-	-	-
Malahide Estuary SAC	0.18	0.17	0.19	0.17	0.21	30	0.7%	No	13.42	13.62	45%
North Dublin Bay SAC	0.11	0.14	0.14	0.15	0.16	30	0.5%	No	28.80	28.96	97%
Rockabill to Dalkey Island SAC	0.13	0.14	0.14	0.15	0.14	30	0.5%	No	12.12	12.26	41%
South Dublin Bay SAC	0.05	0.03	0.04	0.05	0.03	30	0.2%	No	16.19	16.24	54%
Baldoyle Bay SPA	0.26	0.27	0.27	0.26	0.26	30	0.9%	No	11.14	11.41	38%
Ireland's Eye SPA	0.10	0.13	0.12	0.12	0.11	30	0.4%	No	-	-	-
Malahide Estuary SPA	0.18	0.17	0.19	0.17	0.21	30	0.7%	No	12.17	12.38	41%
North Bull Island SPA	0.11	0.14	0.14	0.15	0.16	30	0.5%	No	28.80	28.96	97%
North-west Irish Sea SPA	0.08	0.10	0.10	0.11	0.11	30	0.4%	No	12.12	12.23	41%
South Dublin Bay and River Tolka Estuary SPA	0.05	0.03	0.04	0.05	0.03	30	0.2%	No	29.80	29.85	99.5%
National Sites											
Baldoyle Bay pNHA	0.26	0.27	0.28	0.26	0.26	30	0.9%	No	11.69	11.97	40%
Booterstown Marsh pNHA	0.01	0.01	0.01	0.01	0.01	30	0.05%	No	15.50	15.51	52%
Dolphins, Dublin Docks pNHA	0.03	0.02	0.03	0.03	0.02	30	0.1%	No	15.20	15.23	51%
Grand Canal pNHA	0.02	0.01	0.02	0.02	0.02	30	0.1%	No	3.30	3.32	11%
Howth Head pNHA	0.08	0.10	0.10	0.11	0.11	30	0.4%	No	12.48	12.59	42%
Ireland's Eye pNHA	0.10	0.13	0.11	0.12	0.11	30	0.4%	No	-	-	-
Malahide Estuary pNHA	0.18	0.17	0.19	0.17	0.21	30	0.7%	No	13.42	13.62	45%
North Dublin Bay pNHA	0.11	0.14	0.14	0.15	0.15	30	0.5%	No	28.80	28.95	97%

Ecological Receptor	NO_X Process Contributions ($\mu g/m^3$)					Critical Level ($\mu g/m^3$)	Max PC % of Critical Level	Considered for further assessment?	Back-ground ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PEC % of critical level
	2018	2019	2020	2021	2022						
Royal Canal pNHA	0.02	0.02	0.03	0.02	0.02	30	0.1%	No	22.70	22.73	76%
Santry Demesne pNHA	0.38	0.43	0.33	0.43	0.38	30	1.4%	Yes	17.10	17.53	58%
Sluice River Marsh pNHA	0.28	0.26	0.29	0.25	0.29	30	0.97%	No	10.20	10.49	35%
South Dublin Bay pNHA	0.05	0.03	0.04	0.05	0.03	30	0.2%	No	16.19	16.24	54%

7.1.2 NH_3 – Licenced Operational Scenario

As per Section 3.2 process contributions (PCs) of NH_3 at the ecological receptors within the model study area identified in Section 3.2 were compared to the relevant critical level (identified in Section 3.2). The NH_3 modelling results are detailed in Table 7.2.

Where a PC is greater than 1% of the critical level, this installation has been included in further assessment where the PEC is determined by combining the background concentration with the PC.

There are no PCs greater than 1% of the critical level at any of the modelled European sites (Natura 2000 receptors), therefore no further assessment (i.e. calculation of PEC) is required as per IN2 guidance. However, at the request of the Agency, PECs have been presented for informational purposes.

Within the most impacted (in terms of PC and PEC) Natura 2000 receptor (Howth Head SAC), at the worst-case location, PEC emissions from the installation lead to an ambient NH_3 concentration (including background) which is at most 108% of the critical level over the five years of meteorological data modelled. However, this exceedance is due to the NH_3 background concentration (the biggest contributor to NH_3 in Ireland is the agricultural sector) exceeding the critical level, rather than the process contribution which is 0.029% of the critical level.

Within the most impacted ecological receptor (in terms of process contributions) (Santry Demesne pNHA), at the worst-case location, PEC emissions from the installation lead to an ambient NH_3 concentration (including background) which is at most 50% of the critical level over the five years of meteorological data modelled. The process contribution (PC) NH_3 concentration is at most 0.036% of the critical level over the five years of meteorological data modelled.

Within the most impacted ecological receptor (in terms of PEC as a % of the critical level) (Royal Canal pNHA), at the worst-case location, PEC emissions from the installation lead to an ambient NH_3 concentration (including background) which is at most 220% of the critical level over the five years of meteorological data modelled. This exceedance is due to the NH_3 background concentration (the biggest contributor to NH_3 in Ireland is the agricultural sector) exceeding the critical level, rather than the process contribution which is 0.007% of the critical level.

All process contributions of NH_3 from the installation at all modelled ecological receptors are also below the limit of detection of 0.02 ug/m^3 achievable by ALPHA (Adapted Low-cost Passive High-Absorption) samplers for ammonia[(28)]. Limit of detection is defined as the smallest concentration that can be reliably measured by an analytical procedure. The EPA guidelines(29) define an imperceptible effect as *"an effect capable of measurement but without significant consequences".* An NH_3 process contribution that is below a monitoring instrument's limit of detection is not measurable and will therefore have a less than imperceptible effect.

Table 7.2. NH_3 Dispersion Model Results at Most Impacted Ecological Receptors – Licenced Operational Scenario

Ecological Receptor	NH_3 Process Contributions (µg/m³)					Critical Level (µg/m³)	Max PC % of Critical Level	Considered for further assessment?	Back-ground (µg/m³)	PEC (µg/m³)	PEC % of critical level
	2018	2019	2020	2021	2022						
European Sites (Natura 2000)											
Baldoyle Bay SAC	0.0006	0.0006	0.0005	0.0005	0.0005	3	0.019%	No	1.300	1.301	43%
Howth Head SAC	0.0002	0.0003	0.0002	0.0003	0.0003	1	0.029%	No	1.077	1.077	108%
Ireland's Eye SAC	0.0002	0.0003	0.0003	0.0002	0.0002	3	0.011%	No	-	-	-
Malahide Estuary SAC	0.0004	0.0004	0.0004	0.0004	0.0004	3	0.013%	No	1.723	1.723	57%
North Dublin Bay SAC	0.0003	0.0003	0.0003	0.0003	0.0004	3	0.013%	No	1.149	1.149	38%
Rockabill to Dalkey Island SAC	0.0003	0.0003	0.0003	0.0003	0.0003	n/a	-	No	1.180	1.180	39%
South Dublin Bay SAC	0.0001	0.0001	0.0001	0.0001	0.0001	3	0.004%	No	1.337	1.337	45%
Baldoyle Bay SPA	0.0006	0.0006	0.0005	0.0005	0.0005	3	0.019%	No	1.373	1.374	46%
Ireland's Eye SPA	0.0002	0.0003	0.0003	0.0002	0.0002	3	0.011%	No	-	-	-
Malahide Estuary SPA	0.0004	0.0004	0.0004	0.0004	0.0004	3	0.013%	No	1.604	1.604	53%
North Bull Island SPA	0.0003	0.0003	0.0003	0.0003	0.0004	3	0.013%	No	1.149	1.149	38%
North-west Irish Sea SPA	0.0002	0.0003	0.0002	0.0003	0.0003	3	0.010%	No	1.100	1.100	37%
South Dublin Bay and River Tolka Estuary SPA	0.0001	0.0001	0.0001	0.0001	0.0001	3	0.004%	No	1.338	1.338	45%
National Sites											
Baldoyle Bay pNHA	0.00057	0.00056	0.00054	0.00049	0.00052	3	0.019%	No	1.373	1.374	46%
Booterstown Marsh pNHA	0.00003	0.00002	0.00002	0.00003	0.00003	3	0.001%	No	1.200	1.200	40%
Dolphins, Dublin Docks pNHA	0.00005	0.00005	0.00005	0.00008	0.00004	n/a	-	No	1.000	1.000	33%
Grand Canal pNHA	0.00004	0.00004	0.00005	0.00004	0.00003	3	0.002%	No	2.600	2.600	87%
Howth Head pNHA	0.00021	0.00028	0.00022	0.00028	0.00026	1	0.029%	No	1.077	1.077	36%
Ireland's Eye pNHA	0.00024	0.00034	0.00026	0.00023	0.00024	3	0.011%	No	-	-	-
Malahide Estuary pNHA	0.00041	0.00036	0.00039	0.00035	0.00041	3	0.014%	No	1.723	1.723	57%
North Dublin Bay pNHA	0.00029	0.00034	0.00030	0.00035	0.00038	3	0.013%	No	1.300	1.300	43%
Royal Canal pNHA	0.00007	0.00005	0.00006	0.00005	0.00004	1	0.007%	No	2.200	2.200	220%
Santry Demesne pNHA	0.00098	0.00109	0.00063	0.00100	0.00093	3	0.036%	No	1.500	1.501	50%
Sluice River Marsh pNHA	0.00059	0.00050	0.00056	0.00048	0.00057	3	0.020%	No	1.400	1.401	47%
South Dublin Bay pNHA	0.00008	0.00007	0.00007	0.00012	0.00005	3	0.004%	No	1.337	1.337	45%

7.1.3 SO_2 – Licenced Operational Scenario

As per Section 3.2, process contributions (PCs) of SO_2 at the ecological receptors within the model study area identified in Section 3.2 were compared to the relevant critical level (identified in Section 3.2). The SO_2 modelling results are detailed in Table 7.3.

Where a PC is greater than 1% of the critical level, this site has been included in further assessment where the PEC is determined by combining the background concentration with the PC.

There are no PCs greater than 1% of the critical level at any of the modelled European sites (Natura 2000 receptor), therefore no further assessment (i.e. calculation of PEC) is required as per IN2 guidance. However, at the request of the Agency, PECs have been presented for informational purposes.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC and Baldoyle Bay SPA), at the worst-case location, emissions from the installation lead to an ambient SO_2 PEC (including background) which is at most 9% of the critical level over the five years of meteorological data modelled. The process contribution (PC) SO_2 concentration is at most 0.04% of the critical level over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) Natura 2000 receptor (North Dublin Bay SAC and North Bull Island SPA), at the worst-case location, PEC emissions from the installation lead to an ambient SO_2 concentration (including background) which is at most 47% of the critical level over the five years of meteorological data modelled. However, the process contribution (PC) SO_2 concentration is at most 0.02% of the critical level over the five years of meteorological data modelled.

Within the most impacted national site (in terms of process contributions) (Santry Demesne pNHA), at the worst-case location, PEC emissions from the installation lead to an ambient SO_2 concentration (including background) which is at most 11% of the annual mean limit value over the five years of meteorological data modelled. The process contribution (PC) SO_2 concentration is at most 0.06% of the critical level over the five years of meteorological data modelled.

Within the most impacted national site (in terms of PEC) (North Dublin Bay pNHA), at the worst-case location, PEC emissions from the installation lead to an ambient SO_2 concentration (including background) which is at most 50% of the critical level over the five years of meteorological data modelled. However, the process contribution (PC) SO_2 concentration is at most 0.02% of the critical level over the five years of meteorological data modelled.

Table 7.3. SO_2 Dispersion Model Results at Most Impacted Ecological Receptor – Licenced Operational Scenario

Ecological Receptor	SO_2 Process Contributions (µg/m^3)					Critical Level (µg/m^3)	Max PC % of Critical Level	Considered for further assessment?	Back-ground (µg/m^3)	PEC (µg/m^3)	PEC % of critical level
	2018	2019	2020	2021	2022						
European Sites (Natura 2000)											
Baldoyle Bay SAC	0.007	0.007	0.007	0.007	0.007	20	0.04%	No	1.600	1.607	8%
Howth Head SAC	0.002	0.003	0.003	0.003	0.003	20	0.01%	No	2.387	2.390	12%
Ireland's Eye SAC	0.003	0.003	0.003	0.003	0.003	20	0.02%	No	-	-	-
Malahide Estuary SAC	0.005	0.004	0.005	0.004	0.005	20	0.03%	No	1.125	1.130	6%
North Dublin Bay SAC	0.003	0.004	0.004	0.004	0.004	20	0.02%	No	9.416	9.420	47%
Rockabill to Dalkey Island SAC	0.003	0.004	0.004	0.004	0.004	20	0.02%	No	2.178	2.182	11%
South Dublin Bay SAC	0.001	0.001	0.001	0.001	0.001	20	0.01%	No	2.870	2.871	14%
Baldoyle Bay SPA	0.007	0.007	0.007	0.007	0.007	20	0.04%	No	1.773	1.780	9%
Ireland's Eye SPA	0.003	0.003	0.003	0.003	0.003	20	0.02%	No	-	-	-
Malahide Estuary SPA	0.005	0.004	0.005	0.004	0.005	20	0.03%	No	1.007	1.012	5%
North Bull Island SPA	0.003	0.004	0.004	0.004	0.004	20	0.02%	No	9.416	9.420	47%
North-west Irish Sea SPA	0.002	0.003	0.003	0.003	0.003	20	0.01%	No	2.400	2.403	12%
South Dublin Bay and River Tolka Estuary SPA	0.001	0.001	0.001	0.001	0.001	20	0.01%	No	7.400	7.401	37%
National Sites											
Baldoyle Bay pNHA	0.0068	0.0070	0.0072	0.0067	0.0068	20	0.036%	No	1.773	1.780	9%
Booterstown Marsh pNHA	0.0003	0.0002	0.0003	0.0004	0.0003	20	0.002%	No	1.300	1.300	7%
UpdateDolphins, Dublin Docks pNHA	0.0007	0.0006	0.0007	0.0009	0.0005	20	0.004%	No	2.400	2.401	12%
Grand Canal pNHA	0.0005	0.0004	0.0005	0.0005	0.0004	20	0.003%	No	0.200	0.201	1%
Howth Head pNHA	0.0021	0.0029	0.0027	0.0029	0.0028	20	0.014%	No	2.387	2.390	12%
Ireland's Eye pNHA	0.0026	0.0033	0.0030	0.0030	0.0029	20	0.017%	No	-	-	-
Malahide Estuary pNHA	0.0047	0.0045	0.0049	0.0045	0.0054	20	0.027%	No	1.125	1.130	6%
North Dublin Bay pNHA	0.0029	0.0037	0.0037	0.0040	0.0040	20	0.020%	No	9.900	9.904	50%
Royal Canal pNHA	0.0006	0.0005	0.0007	0.0005	0.0005	20	0.003%	No	4.300	4.301	22%
Santry Demesne pNHA	0.0096	0.0109	0.0087	0.0112	0.0097	20	0.056%	No	2.100	2.111	11%
Sluice River Marsh pNHA	0.0072	0.0067	0.0074	0.0064	0.0076	20	0.038%	No	1.200	1.208	6%
South Dublin Bay pNHA	0.0012	0.0008	0.0009	0.0014	0.0009	20	0.007%	No	2.870	2.871	14%

7.1.4 Nitrogen Deposition – Licenced Operational Scenario

In order to consider the effects of nitrogen deposition (as N) owing to emissions from the installation on the sensitive ecological receptors, the maximum annual mean NO_2 and NH_3 process contribution concentrations (PC) are converted into the dry deposition fluxes and then nitrogen deposition fluxes (as described in Section 3.2.2 and shown in Table 7.4 and Table 7.5).

As per Section 3.2 process contributions (PCs) of nitrogen deposition at the ecological receptors within the model study area identified in Section 3.2 were compared to the relevant load (identified in Section 3.2).

Where a PC is greater than 1% of lowest critical load, this site has been included in further assessment where the PEC is determined by combining the background concentration with the PC.

There are no PCs greater than 1% of the critical load at any of the modelled European sites (Natura 2000 receptor), therefore no further assessment (i.e. calculation of PEC) is required as per IN2 guidance. However, at the request of the Agency, PECs have been presented for informational purposes.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC and Baldoyle Bay SPA), at the worst-case location, the maximum nitrogen deposition PEC (including background) is 6.038 kg/ha/yr. This is within the critical load range of 5-10 kg/ha/yr for the most sensitive features *“Atlantic salt meadows (Glauco-Puccinellietalia maritimae)” (feature code: H1330)* in the Baldoyle Bay SAC and *“Pluvialis apricaria [North-western Europe]” (feature code: A141)* in the Baldoyle Bay SPA, and is below the midpoint critical load of 7.5 kg/ha/yr. The process contribution (PC) nitrogen deposition (as N) is at most 0.5% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC), at the worst-case location, the maximum nitrogen deposition PEC (including background) which is 7.065 kg/ha/yr. This is within the critical load range of 5-10 kg/ha/yr for the most sensitive feature *“Embryonic shifting dunes” (feature code: H2110),* and is below the midpoint critical load of 7.5 kg/ha/yr. The process contribution (PC) nitrogen deposition (as N) is at most 0.1% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of process contributions) national site (Santry Demesne pNHA), at the worst-case location, the maximum nitrogen deposition PEC (including background) which is 7.062 kg/ha/yr. This is below the lower end of the critical load range of 10-20 kg/ha/yr for the identified relevant comparable sensitive feature *“Broadleaved deciduous woodland”* (G1), as the site does not contain formally listed Annex I habitats. The process contribution (PC) nitrogen deposition (as N) is at most 0.6% of the relevant lower range critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) national site (North Dublin Bay pNHA), at the worst-case location, the maximum nitrogen deposition PEC (including background) which is 7.622 kg/ha/yr. This is within the critical load range of 5-10 kg/ha/yr for the most sensitive feature *“Atlantic salt meadows (Glauco-Puccinellietalia maritimae)”*, and is above the midpoint critical load of 7.5 kg/ha/yr. The process contribution (PC) nitrogen deposition (as N) is at most 0.3% of the relevant critical load over the five years of meteorological data modelled.

All NO_2 and NH_3 process contributions (from which nitrogen deposition levels are derived), from the installation at all modelled ecological receptors, are also below the limit of detection of 0.5 ug/m^3 which must be achieved by chemiluminescence-based automated NO_X/NO_2 analysers(31) and below the limit of detection of 0.02 ug/m^3 achievable by ALPHA (Adapted Low-cost Passive High-Absorption) samplers for ammonia(28). Limit of detection is defined as the smallest concentration that can be reliably measured by an analytical procedure. The EPA guidelines(29) define an imperceptible effect as *"an effect capable of measurement but without significant consequences".* An NH_3 process contribution that is below a monitoring instrument's limit of detection is not measurable and will therefore have a less than imperceptible effect.

Table 7.4. Nitrogen Deposition at Most Impacted Ecological Receptor – Licenced Operational Scenario

NO_2							
Ecological Receptor	**NO_2 Process Contributions (µg/m^3)**					**NO_2 Dry Deposition (µg/m^2/s)**	**NO_2 Nitrogen Deposition (kg/ha/year)**
	2018	**2019**	**2020**	**2021**	**2022**		
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.23	0.24	0.25	0.23	0.23	0.0004	0.035
Howth Head SAC	0.07	0.10	0.09	0.10	0.10	0.0002	0.015
Ireland's Eye SAC	0.09	0.12	0.10	0.10	0.10	0.0002	0.017
Malahide Estuary SAC	0.16	0.15	0.17	0.15	0.19	0.0003	0.027
North Dublin Bay SAC	0.10	0.13	0.13	0.14	0.14	0.0002	0.020
Rockabill to Dalkey Island SAC	0.12	0.13	0.13	0.13	0.13	0.0002	0.019
South Dublin Bay SAC	0.04	0.03	0.03	0.05	0.03	0.0001	0.007
Baldoyle Bay SPA	0.23	0.24	0.25	0.23	0.23	0.0004	0.035
Ireland's Eye SPA	0.09	0.12	0.10	0.10	0.10	0.0002	0.017
Malahide Estuary SPA	0.16	0.15	0.17	0.15	0.19	0.0003	0.027
North Bull Island SPA	0.10	0.13	0.13	0.14	0.14	0.0002	0.020
North-west Irish Sea SPA	0.07	0.10	0.09	0.10	0.10	0.0002	0.015
South Dublin Bay and River Tolka Estuary SPA	0.04	0.03	0.03	0.05	0.03	0.0001	0.007
National Sites							
Baldoyle Bay pNHA	0.23	0.24	0.25	0.23	0.23	0.00037	0.036
Booterstown Marsh pNHA	0.01	0.01	0.01	0.01	0.01	0.00002	0.002
Dolphins, Dublin Docks pNHA	0.03	0.02	0.02	0.03	0.02	0.00005	0.004
Grand Canal pNHA	0.02	0.01	0.02	0.02	0.01	0.00003	0.003
Howth Head pNHA	0.07	0.10	0.09	0.10	0.10	0.00015	0.014
Ireland's Eye pNHA	0.09	0.12	0.10	0.10	0.10	0.00017	0.017
Malahide Estuary pNHA	0.16	0.15	0.17	0.16	0.19	0.00028	0.027
North Dublin Bay pNHA	0.10	0.13	0.13	0.14	0.14	0.00021	0.020
Royal Canal pNHA	0.02	0.02	0.02	0.02	0.02	0.00004	0.003
Santry Demesne pNHA	0.34	0.38	0.30	0.39	0.34	0.00058	0.056
Sluice River Marsh pNHA	0.25	0.23	0.26	0.22	0.26	0.00040	0.038
South Dublin Bay pNHA	0.04	0.03	0.03	0.05	0.03	0.00007	0.007
NH_3							
Ecological Receptor	**NH_3 Process Contributions (µg/m^3)**					**NH_3 Dry Deposition (µg/m^2/s)**	**NH_3 Nitrogen Deposition (kg/ha/year)**
	2018	**2019**	**2020**	**2021**	**2022**		
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.0006	0.0006	0.0005	0.0005	0.0005	0.000011	0.003
Howth Head SAC	0.0002	0.0003	0.0002	0.0003	0.0003	0.000006	0.002

Ireland's Eye SAC	0.0002	0.0003	0.0003	0.0002	0.0002	0.000007	0.002
Malahide Estuary SAC	0.0004	0.0004	0.0004	0.0004	0.0004	0.000008	0.002
North Dublin Bay SAC	0.0003	0.0003	0.0003	0.0003	0.0004	0.000008	0.002
Rockabill to Dalkey Island SAC	0.0003	0.0003	0.0003	0.0003	0.0003	0.000007	0.002
South Dublin Bay SAC	0.0001	0.0001	0.0001	0.0001	0.0001	0.000002	0.001
Baldoyle Bay SPA	0.0006	0.0006	0.0005	0.0005	0.0005	0.000011	0.003
Ireland's Eye SPA	0.0002	0.0003	0.0003	0.0002	0.0002	0.000007	0.002
Malahide Estuary SPA	0.0004	0.0004	0.0004	0.0004	0.0004	0.000008	0.002
North Bull Island SPA	0.0003	0.0003	0.0003	0.0003	0.0004	0.000008	0.002
North-west Irish Sea SPA	0.0002	0.0003	0.0002	0.0003	0.0003	0.00001	0.0015
South Dublin Bay and River Tolka Estuary SPA	0.0001	0.0001	0.0001	0.0001	0.0001	0.000002	0.001
National Sites							
Baldoyle Bay pNHA	0.00057	0.00056	0.00054	0.00049	0.00052	0.000011	0.0030
Booterstown Marsh pNHA	0.00003	0.00002	0.00002	0.00003	0.00003	0.000001	0.0002
Dolphins, Dublin Docks pNHA	0.00005	0.00005	0.00005	0.00008	0.00004	0.000002	0.0004
Grand Canal pNHA	0.00004	0.00004	0.00005	0.00004	0.00003	0.000001	0.0003
Howth Head pNHA	0.00021	0.00028	0.00022	0.00028	0.00026	0.000006	0.0015
Ireland's Eye pNHA	0.00024	0.00034	0.00026	0.00023	0.00024	0.000007	0.0018
Malahide Estuary pNHA	0.00041	0.00036	0.00039	0.00035	0.00041	0.000008	0.0021
North Dublin Bay pNHA	0.00029	0.00034	0.00030	0.00035	0.00038	0.000008	0.0020
Royal Canal pNHA	0.00007	0.00005	0.00006	0.00005	0.00004	0.000001	0.0004
Santry Demesne pNHA	0.00098	0.00109	0.00063	0.00100	0.00093	0.000022	0.0057
Sluice River Marsh pNHA	0.00059	0.00050	0.00056	0.00048	0.00057	0.000012	0.0031
South Dublin Bay pNHA	0.00008	0.00007	0.00007	0.00012	0.00005	0.000002	0.0006

Table 7.5. Nitrogen Deposition at Most Impacted Ecological Receptor – Licenced Operational Scenario (continued)

Ecological Receptor	Total PC Nitrogen Deposition kg/ha/yr)	Assessment critical load (kg/ha/yr)	PC % of critical load	Considered for further assessment?	APIS Background Nitrogen Deposition (kg/ha/yr)	Total PEC Nitrogen Deposition (kg/ha/yr)
European Sites (Natura 2000)						
Baldoyle Bay SAC	0.038	7.5	0.5%	No	6.000	6.038
Howth Head SAC	0.016	7.5	0.2%	No	6.338	6.354
Ireland's Eye SAC	0.018	n/a	n/a	No	-	-
Malahide Estuary SAC	0.029	5.0	0.6%	No	6.215	6.244
North Dublin Bay SAC	0.022	5.0	0.4%	No	6.529	6.551
Rockabill to Dalkey Island SAC	0.021	n/a	n/a	No	5.651	5.672
South Dublin Bay SAC	0.007	5.0	0.1%	No	7.058	7.065
Baldoyle Bay SPA	0.038	7.5	0.5%	No	6.000	6.038
Ireland's Eye SPA	0.018	n/a	n/a	No	-	-
Malahide Estuary SPA	0.029	7.5	0.4%	No	6.069	6.098
North Bull Island SPA	0.022	7.5	0.3%	No	6.529	6.551
North-west Irish Sea SPA	0.016	7.5	0.2%	No	5.387	5.403
South Dublin Bay and River Tolka Estuary SPA	0.007	5.0	0.1%	No	6.800	6.807
National Sites						
Baldoyle Bay pNHA	0.039	7.5	0.5%	No	6.000	6.039
Booterstown Marsh pNHA	0.002	7.5	0.03%	No	6.000	6.002
Dolphins, Dublin Docks pNHA	0.005	n/a	n/a	No	5.300	5.305
Grand Canal pNHA	0.003	5.0	0.06%	No	7.100	7.103
Howth Head pNHA	0.016	7.5	0.2%	No	6.338	6.354
Ireland's Eye pNHA	0.018	n/a	n/a	No	-	-
Malahide Estuary pNHA	0.029	5.0	0.6%	No	6.215	6.244
North Dublin Bay pNHA	0.022	5.0	0.4%	No	7.600	7.622
Royal Canal pNHA	0.004	5.0	0.07%	No	7.100	7.104
Santry Demesne pNHA	0.062	10.0	0.6%	No	7.000	7.062
Sluice River Marsh pNHA	0.041	7.5	0.5%	No	5.800	5.841
South Dublin Bay pNHA	0.007	5.0	0.1%	No	7.058	7.065

7.1.5 Acid Deposition – Licenced Operational Scenario

Acid deposition (as N)

In order to consider the effects of acid deposition (as N) owing to emissions from the installation on the ecological habitat sites, the maximum annual mean NO_2 and NH_3 process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes (as described in Section 3.2.2 and shown in Table 7.6 and Table 7.7.

As per Section 3.2 process contributions (PCs) of nitrogen acid deposition at the ecological receptors within the model study area identified in Section 3.2 were compared to the relevant load (identified in Section 3.2).

Where a PC is greater than 1% of the lowest critical load, this site has been included in further assessment where the PEC is determined by combining the background concentration with the PC.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC and Baldoyle Bay SPA), at the worst-case location, the maximum acid deposition (as N) PEC (including background) is 0.503 keq/ha/yr. This is below the critical load range of 0.714 – 4.919 keq/ha/yr for the most sensitive feature *"Charadrius hiaticula (Europe/Northern Africa - wintering)" (feature code: A137)* in the Baldoyle Bay SPA (no critical load information available for Baldoyle Bay SAC). The process contribution (PC) acid deposition (as N) is at most 1.9% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay and River Tolka Estuary SPA), at the worst-case location, the maximum acid deposition (as N) PEC (including background) which is 0.591 keq/ha/yr. This is below the critical load range of 0.714 – 4.919 keq/ha/yr for the most sensitive features *"Sterna hirundo (Northern/Eastern Europe - breeding)" (feature code: A193)* in the South Dublin Bay and River Tolka Estuary SPA and *"Embryonic shifting dunes" (feature code: H2110)* in the South Dublin Bay SAC (no critical load information available for South Dublin Bay SAC). The process contribution (PC) acid deposition (as N) is at most 0.4% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of process contributions) national site (Santry Demesne pNHA), at the worst-case location, the maximum acid deposition (as N) PEC (including background) which is 0.504 keq/ha/yr. This is below the critical load range of 0.714 – 5.634 keq/ha/yr for the most sensitive feature *"Old sessile oak woods with Ilex and Blechnum in the British Isles"*. The process contribution (PC) acid deposition (as N) is at most 3.1% of the relevant critical load over the five years of meteorological data modelled.

There is no appropriate critical load information available for the most impacted (in terms of PEC) national site (Sluice River Marsh pNHA), therefore the next most impacted (in terms of PEC) national site (Royal Canal pNHA) with available critical loads is discussed. At the worst-case location, the maximum acid deposition (as N) PEC (including background) which is 0.900 keq/ha/yr. This is below the critical load range of 0.714 – 4.919 keq/ha/yr for the most sensitive feature *"Unmanaged Broadleafed/Coniferous Woodland"*. The process contribution (PC) acid deposition (as N) is at most 0.2% of the relevant critical load over the five years of meteorological data modelled.

Table 7.6. Acid Deposition (as N) at Most Impacted Ecological Receptor – Licenced Operational Scenario

NO_2							
Ecological Receptor	NO_2 Process Contributions (µg/m^3)					NO_2 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/yr)
	2018	2019	2020	2021	2022		
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.23	0.24	0.25	0.23	0.23	0.0004	0.0025
Howth Head SAC	0.07	0.10	0.09	0.10	0.10	0.0002	0.0010
Ireland's Eye SAC	0.09	0.12	0.10	0.10	0.10	0.0002	0.0012
Malahide Estuary SAC	0.16	0.15	0.17	0.15	0.19	0.0003	0.0019
North Dublin Bay SAC	0.10	0.13	0.13	0.14	0.14	0.0002	0.0014
Rockabill to Dalkey Island SAC	0.12	0.13	0.13	0.13	0.13	0.0002	0.0014
South Dublin Bay SAC	0.04	0.03	0.03	0.05	0.03	0.0001	0.0005
Baldoyle Bay SPA	0.23	0.24	0.25	0.23	0.23	0.0004	0.0025
Ireland's Eye SPA	0.09	0.12	0.10	0.10	0.10	0.0002	0.0012
Malahide Estuary SPA	0.16	0.15	0.17	0.15	0.19	0.0003	0.0019
North Bull Island Bay SPA	0.10	0.13	0.13	0.14	0.14	0.0002	0.0014
North-west Irish Sea SPA	0.07	0.10	0.09	0.10	0.10	0.0002	0.0010
South Dublin Bay and River Tolka Estuary SPA	0.04	0.03	0.03	0.05	0.03	0.0001	0.0005
National Sites							
Baldoyle Bay pNHA	0.23	0.24	0.25	0.23	0.23	0.00037	0.0025
Booterstown Marsh pNHA	0.01	0.01	0.01	0.01	0.01	0.00002	0.0001
Dolphins, Dublin Docks pNHA	0.03	0.02	0.02	0.03	0.02	0.00005	0.0003
Grand Canal pNHA	0.02	0.01	0.02	0.02	0.01	0.00003	0.0002
Howth Head pNHA	0.07	0.10	0.09	0.10	0.10	0.00015	0.0010
Ireland's Eye pNHA	0.09	0.12	0.10	0.10	0.10	0.00017	0.0012
Malahide Estuary pNHA	0.16	0.15	0.17	0.16	0.19	0.00028	0.0019
North Dublin Bay pNHA	0.10	0.13	0.13	0.14	0.14	0.00021	0.0014
Royal Canal pNHA	0.02	0.02	0.02	0.02	0.02	0.00004	0.0002
Santry Demesne pNHA	0.34	0.38	0.30	0.39	0.34	0.00058	0.0040
Sluice River Marsh pNHA	0.25	0.23	0.26	0.22	0.26	0.00040	0.0027
South Dublin Bay pNHA	0.04	0.03	0.03	0.05	0.03	0.00007	0.0005
NH_3							
Ecological Receptor	**NH_3 Process Contributions (µg/m^3)**					**NH_3 Dry Deposition (µg/m^2/s)**	**NH_3 Acid Deposition (keg/ha/yr)**
	2018	**2019**	**2020**	**2021**	**2022**		
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.00057	0.00057	0.00054	0.00049	0.00051	0.000011	0.00021
Howth Head SAC	0.00021	0.00029	0.00022	0.00028	0.00025	0.000006	0.00011
Ireland's Eye SAC	0.00024	0.00033	0.00026	0.00023	0.00024	0.000007	0.00012
Malahide Estuary SAC	0.00040	0.00035	0.00039	0.00035	0.00040	0.000008	0.00015
North Dublin Bay SAC	0.00029	0.00033	0.00030	0.00034	0.00038	0.000008	0.00014
Rockabill to Dalkey Island SAC	0.00030	0.00034	0.00032	0.00032	0.00031	0.000007	0.00013
South Dublin Bay SAC	0.00008	0.00007	0.00007	0.00012	0.00005	0.000002	0.00004

Baldoyle Bay SPA	0.00057	0.00057	0.00054	0.00049	0.00051	0.000011	0.00021
Ireland's Eye SPA	0.00024	0.00033	0.00026	0.00023	0.00024	0.000007	0.00012
Malahide Estuary SPA	0.00040	0.00035	0.00039	0.00035	0.00040	0.000008	0.00015
North Bull Island SPA	0.00029	0.00033	0.00030	0.00034	0.00038	0.000008	0.00014
North-west Irish Sea SPA	0.00021	0.00029	0.00022	0.00028	0.00025	0.000006	0.00011
South Dublin Bay and River Tolka Estuary SPA	0.00008	0.00007	0.00007	0.00012	0.00005	0.000002	0.00004
National Sites							
Baldoyle Bay pNHA	0.00057	0.00056	0.00054	0.00049	0.00052	0.000011	0.00021
Booterstown Marsh pNHA	0.00003	0.00002	0.00002	0.00003	0.00003	0.000001	0.00001
Dolphins, Dublin Docks pNHA	0.00005	0.00005	0.00005	0.00008	0.00004	0.000002	0.00003
Grand Canal pNHA	0.00004	0.00004	0.00005	0.00004	0.00003	0.000001	0.00002
Howth Head pNHA	0.00021	0.00028	0.00022	0.00028	0.00026	0.000006	0.00010
Ireland's Eye pNHA	0.00024	0.00034	0.00026	0.00023	0.00024	0.000007	0.00013
Malahide Estuary pNHA	0.00041	0.00036	0.00039	0.00035	0.00041	0.000008	0.00015
North Dublin Bay pNHA	0.00029	0.00034	0.00030	0.00035	0.00038	0.000008	0.00014
Royal Canal pNHA	0.00007	0.00005	0.00006	0.00005	0.00004	0.000001	0.00003
Santry Demesne pNHA	0.00098	0.00109	0.00063	0.00100	0.00093	0.000022	0.00040
Sluice River Marsh pNHA	0.00059	0.00050	0.00056	0.00048	0.00057	0.000012	0.00022
South Dublin Bay pNHA	0.00008	0.00007	0.00007	0.00012	0.00005	0.000002	0.00004

Table 7.7. Acid Deposition (as N) at Most Impacted Ecological Receptor – Licenced Operational Scenario (continued)

Ecological Receptor	PC Acid Dep. (N) (keq/ ha/yr)	Critical load (MinCL minN) for PC (keq/ ha/yr)	PC % of critical load	Considered for further assessment?	APIS Back-ground Acid Dep. (keq/ ha/yr)	Total PEC Acid Dep. (N) (keq/ ha/yr)	Critical load (MaxCL minN) for PEC (keq/ ha/yr)
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.0027	n/a	n/a	No	0.500	0.503	n/a
Howth Head SAC	0.0011	0.143	0.8%	No	0.500	0.501	0.714
Ireland's Eye SAC	0.0013	n/a	n/a	No	n/a	n/a	n/a
Malahide Estuary SAC	0.0020	0.143	1.4%	Yes	0.500	0.502	0.714
North Dublin Bay SAC	0.0016	0.143	1.1%	Yes	0.500	0.502	0.714
Rockabill to Dalkey Island SAC	0.0015	n/a	n/a	No	0.500	n/a	n/a
South Dublin Bay SAC	0.0005	n/a	n/a	No	0.590	0.591	n/a
Baldoyle Bay SPA	0.0027	0.143	1.9%	Yes	0.500	0.503	0.714
Ireland's Eye SPA	0.0013	n/a	n/a	No	n/a	n/a	n/a
Malahide Estuary SPA	0.0020	0.143	1.4%	Yes	0.500	0.502	0.714
North Bull Island SPA	0.0016	0.143	1.1%	Yes	0.500	0.502	0.714
North-west Irish Sea SPA	0.0011	0.143	0.8%	No	0.400	0.401	0.714
South Dublin Bay and River Tolka Estuary SPA	0.0005	0.143	0.4%	No	0.590	0.591	0.714
National Sites							
Baldoyle Bay pNHA	0.0028	0.143	1.9%	Yes	0.471	0.474	0.714
Booterstown Marsh pNHA	0.0001	n/a	n/a	No	0.597	0.597	n/a
Dolphins, Dublin Docks pNHA	0.0003	n/a	n/a	No	0.597	0.597	n/a

Ecological Receptor	PC Acid Dep. (N) (keq/ ha/yr)	Critical load (MinCL minN) for PC (keq/ ha/yr)	PC % of critical load	Considered for further assessment?	APIS Back-ground Acid Dep. (keq/ ha/yr)	Total PEC Acid Dep. (N) (keq/ ha/yr)	Critical load (MaxCL minN) for PEC (keq/ ha/yr)
Grand Canal pNHA	0.0002	0.143	0.1%	No	0.900	0.9002	0.714
Howth Head pNHA	0.0011	0.143	0.8%	No	0.495	0.496	0.714
Ireland's Eye pNHA	0.0013	n/a	n/a	No	-	-	n/a
Malahide Estuary pNHA	0.0021	0.143	1.5%	Yes	0.467	0.469	0.714
North Dublin Bay pNHA	0.0016	0.143	1.1%	Yes	0.597	0.599	0.714
Royal Canal pNHA	0.0003	0.143	0.2%	No	0.900	0.9003	0.714
Santry Demesne pNHA	0.0044	0.143	3.1%	Yes	0.500	0.504	0.714
Sluice River Marsh pNHA	0.0029	n/a	n/a	No	0.900	0.903	n/a
South Dublin Bay pNHA	0.0005	0.143	0.4%	No	0.709	0.710	0.714

Acid deposition (as S)

In order to consider the effects of acid deposition (as S) owing to emissions from the installation on the ecological habitat sites, the maximum annual mean SO_2 process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes (as described in Section 3.2.2 and shown in Table 7.8 and Table 7.9).

As per Section 3.2 process contributions (PCs) of acid deposition at the ecological receptors within the model study area identified in Section 3.2 were compared to the relevant load (identified in Section 3.2).

Where a PC is greater than 1% of lowest critical load, this site has been included in further assessment where the PEC is determined by combining the background concentration with the PC.

There are no PCs greater than 1% of the critical level at any of the modelled European sites (Natura 2000 receptor), therefore no further assessment (i.e. calculation of PEC) is required as per IN2 guidance. However at the request of the Agency, PECs have been presented for informational purposes.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC and Baldoyle Bay SPA), at the worst-case location, the maximum acid deposition (as S) PEC (including background) is 0.501 keq/ha/yr. This is below the critical load range of 4.125 – 4.205 keq/ha/yr for the most sensitive features "*Atlantic salt meadows (Glauco-Puccinellietalia maritimae)*" *(feature code: H1330*) in the Baldoyle Bay SAC and *"Charadrius hiaticula (Europe/Northern Africa - wintering)" (feature code: A137*) in the Baldoyle Bay SPA. The process contribution (PC) acid deposition (as S) is at most 0.02% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay and River Tolka Estuary SPA), at the worst-case location, the maximum acid deposition (as N) PEC (including background) which is 0.590 keq/ha/yr. This is below the critical load range of 4.099 – 4.205 keq/ha/yr for the most sensitive features *"Sterna hirundo (Northern/Eastern Europe - breeding)" (feature code: A193)* in the South Dublin Bay and River Tolka Estuary SPA and *"Embryonic shifting dunes" (feature code: H2110)* in the South Dublin Bay SAC (no critical load information available for South Dublin Bay SAC). The process contribution (PC) acid deposition (as S) is at most 0.004% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of process contributions) national site (Santry Demesne pNHA), at the worst-case location, the maximum acid deposition (as S) PEC (including background) which is 0.501 keq/ha/yr. This is within the critical load range of 0.365 – 6.518 keq/ha/yr for the most sensitive feature *"Old sessile oak woods with Ilex and Blechnum in the British Isles"*. The process contribution (PC) acid deposition (as S) is at most 0.4% of the relevant critical load over the five years of meteorological data modelled.

There is no appropriate critical load information available for the most impacted (in terms of PEC) national site (Sluice River Marsh pNHA), therefore the next most impacted (in terms of PEC) national site (Royal Canal pNHA) with available critical loads is discussed. At the worst-case location, the maximum acid deposition (as S) PEC (including background) which is 0.900 keq/ha/yr. This is within the critical load range of 0.365 – 4.71 keq/ha/yr for the most sensitive feature *"Unmanaged Broadleafed/Coniferous Woodland"*. The process contribution (PC) acid deposition (as S) is at most 0.02% of the relevant critical load over the five years of meteorological data modelled.

Table 7.8. Acid Deposition (as S) at Most Impacted Ecological Receptor - Licenced Operational Scenario

Ecological Receptor	SO_2 Process Contributions (µg/m^3)					SO_2 Dry Deposition (µg/m^2/s)	SO_2 Acid Deposition (S) (keq/ha/year)
	2018	2019	2020	2021	2022		
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.007	0.007	0.007	0.007	0.007	0.00009	0.00084
Howth Head SAC	0.002	0.003	0.003	0.003	0.003	0.00004	0.00034
Ireland's Eye SAC	0.003	0.003	0.003	0.003	0.003	0.00004	0.00040
Malahide Estuary SAC	0.005	0.004	0.005	0.004	0.005	0.00006	0.00063
North Dublin Bay SAC	0.003	0.004	0.004	0.004	0.004	0.00005	0.00048
Rockabill to Dalkey Island SAC	0.003	0.004	0.004	0.004	0.004	0.00005	0.00046
South Dublin Bay SAC	0.001	0.001	0.001	0.001	0.001	0.00002	0.00016
Baldoyle Bay SPA	0.007	0.007	0.007	0.007	0.007	0.00009	0.00084
Ireland's Eye SPA	0.003	0.003	0.003	0.003	0.003	0.00004	0.00040
Malahide Estuary SPA	0.005	0.004	0.005	0.004	0.005	0.00006	0.00063
North Bull Island SPA	0.003	0.004	0.004	0.004	0.004	0.00005	0.00048
North-west Irish Sea SPA	0.002	0.003	0.003	0.003	0.003	0.00004	0.00034
South Dublin Bay and River Tolka Estuary SPA	0.001	0.001	0.001	0.001	0.001	0.00002	0.00016
National Sites							
Baldoyle Bay pNHA	0.0068	0.0070	0.0072	0.0067	0.0068	0.000086	0.00085
Booterstown Marsh pNHA	0.0003	0.0002	0.0003	0.0004	0.0003	0.000004	0.00004
Dolphins, Dublin Docks pNHA	0.0007	0.0006	0.0007	0.0009	0.0005	0.000011	0.00010
Grand Canal pNHA	0.0005	0.0004	0.0005	0.0005	0.0004	0.000006	0.00006
Howth Head pNHA	0.0021	0.0029	0.0027	0.0029	0.0028	0.000035	0.00034
Ireland's Eye pNHA	0.0026	0.0033	0.0030	0.0030	0.0029	0.000040	0.00039
Malahide Estuary pNHA	0.0047	0.0045	0.0049	0.0045	0.0054	0.000065	0.00063
North Dublin Bay pNHA	0.0029	0.0037	0.0037	0.0040	0.0040	0.000048	0.00047
Royal Canal pNHA	0.0006	0.0005	0.0007	0.0005	0.0005	0.000008	0.00008
Santry Demesne pNHA	0.0096	0.0109	0.0087	0.0112	0.0097	0.000134	0.00132
Sluice River Marsh pNHA	0.0072	0.0067	0.0074	0.0064	0.0076	0.000092	0.00090

Ecological Receptor	SO_2 Process Contributions (µg/m^3)					SO_2 Dry Deposition (µg/m^2/s)	SO_2 Acid Deposition (S) (keq/ha/year)
	2018	2019	2020	2021	2022		
South Dublin Bay pNHA	0.0012	0.0008	0.0009	0.0014	0.0009	0.000016	0.00016

Table 7.9. Acid Deposition (as S) at Most Impacted Ecological Receptor - Licenced Operational Scenario (continued)

Ecological Receptor	PC Acid Dep. (S) (keq/ha/yr)	Critical load (MinCL maxS) (keq/ha/yr)	PC % of critical load	Considered for further assessment?	APIS Back-ground Acid Dep. (keq/ha/yr)	Total PEC Acid Dep. (S) (keq/ha/yr)
Natura 2000						
Baldoyle Bay SAC	0.00084	n/a	n/a	No	0.500	0.501
Howth Head SAC	0.00034	4.236	0.01%	No	0.500	0.500
Ireland's Eye SAC	0.00040	n/a	n/a	No	n/a	n/a
Malahide Estuary SAC	0.00063	4.117	0.02%	No	0.500	0.501
North Dublin Bay SAC	0.00048	4.107	0.01%	No	0.500	0.500
Rockabill to Dalkey Island SAC	0.00046	n/a	n/a	No	0.500	n/a
South Dublin Bay SAC	0.00016	n/a	n/a	No	0.590	0.590
Baldoyle Bay SPA	0.00084	4.125	0.02%	No	0.500	0.501
Ireland's Eye SPA	0.00040	n/a	n/a	No	n/a	n/a
Malahide Estuary SPA	0.00063	4.117	0.02%	No	0.500	0.501
North Bull Island SPA	0.00048	4.107	0.01%	No	0.500	0.500
North-west Irish Sea SPA	0.0003	4.107	0.01%	No	0.400	0.400
South Dublin Bay and River Tolka Estuary SPA	0.00016	4.099	0.004%	No	0.590	0.590
National Sites						
Baldoyle Bay pNHA	0.00085	4.125	0.02%	No	0.471	0.472
Booterstown Marsh pNHA	0.00004	n/a	n/a	No	0.597	0.597
Dolphins, Dublin Docks pNHA	0.00010	n/a	n/a	No	0.597	0.597
Grand Canal pNHA	0.00006	0.365	0.02%	No	0.900	0.900
Howth Head pNHA	0.00034	4.236	0.01%	No	0.495	0.495
Ireland's Eye pNHA	0.00039	n/a	n/a	No	-	-
Malahide Estuary pNHA	0.00064	4.117	0.02%	No	0.467	0.468
North Dublin Bay pNHA	0.00047	4.107	0.01%	No	0.597	0.597
Royal Canal pNHA	0.00008	0.365	0.02%	No	0.900	0.900
Santry Demesne pNHA	0.00132	0.365	0.4%	No	0.500	0.501
Sluice River Marsh pNHA	0.00090	n/a	n/a	No	0.900	0.901
South Dublin Bay pNHA	0.00016	4.099	0.004%	No	0.709	0.709

7.2 Cumulative Assessment

7.2.1 NO_X – Cumulative Scenario

The NO_X modelling results are detailed in Table 7.10.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC and Baldoyle Bay SPA), at the worst-case location, PEC emissions from the installation lead to an ambient NO_X concentration (including background) which is at most 38% and 39%, respectively, of the critical level over the five years of meteorological data modelled. The process contribution (PC) NO_X concentration is at most 1.9% of the critical level over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) Natura 2000 receptor (South Dublin Bay and River Tolka Estuary SPA), at the worst-case location, PEC emissions from the installation lead to an ambient NO_X concentration (including background) which is at most 99.7% of the critical level over the five years of meteorological data modelled. The process contribution (PC) NO_X concentration is at most 0.4% of the critical level over the five years of meteorological data modelled.

Within the most impacted national site (in terms of process contributions) (Santry Demesne pNHA), at the worst-case location, PEC emissions from the installation lead to an ambient NO_X concentration (including background) which is at most 61% of the critical level over the five years of meteorological data modelled. The process contribution (PC) NO_X concentration is at most 3.6% of the critical level over the five years of meteorological data modelled.

Within the most impacted ecological receptor (in terms of PEC) (North Dublin Bay pNHA), at the worst-case location, PEC emissions from the installation lead to an ambient NO_X concentration (including background) which is at most 97% of critical level over the five years of meteorological data modelled. The process contribution (PC) NO_X concentration is at most 1% of the annual mean limit value over the five years of meteorological data modelled.

Table 7.10. NO_X Dispersion Model Results at Most Impacted Ecological Receptors – Cumulative Scenario

Ecological Receptor	NO_X Process Contributions (μg/m³)					Critical Level (μg/m³)	Max PC % of Critical Level	Considered for further assessment?	Back-ground (μg/m³)	PEC (μg/m³)	PEC % of critical level
	2018	2019	2020	2021	2022						
European Sites (Natura 2000)											
Baldoyle Bay SAC	0.53	0.57	0.54	0.53	0.51	30	1.9%	N/A	10.90	11.47	38%
Howth Head SAC	0.17	0.21	0.21	0.23	0.22	30	0.8%	N/A	12.48	12.71	42%
Ireland's Eye SAC	0.22	0.29	0.25	0.25	0.24	30	1.0%	N/A	-	-	-
Malahide Estuary SAC	0.39	0.38	0.41	0.38	0.44	30	1.5%	N/A	13.42	13.85	46%
North Dublin Bay SAC	0.22	0.28	0.28	0.30	0.30	30	1.0%	N/A	28.80	29.10	97%
Rockabill to Dalkey Island SAC	0.26	0.31	0.28	0.31	0.29	30	1.0%	N/A	12.12	12.43	41%
South Dublin Bay SAC	0.09	0.07	0.07	0.11	0.07	30	0.4%	N/A	16.19	16.29	54%
Baldoyle Bay SPA	0.53	0.57	0.54	0.53	0.51	30	1.9%	N/A	11.14	11.71	39%
Ireland's Eye SPA	0.22	0.29	0.25	0.25	0.24	30	1.0%	N/A	-	-	-
Malahide Estuary SPA	0.39	0.38	0.41	0.38	0.44	30	1.5%	N/A	12.17	12.61	42%
North Bull Island SPA	0.22	0.28	0.28	0.30	0.30	30	1.0%	N/A	28.80	29.10	97%
North-west Irish Sea SPA	0.17	0.21	0.21	0.23	0.22	30	0.8%	N/A	12.12	12.35	41%
South Dublin Bay and River Tolka Estuary SPA	0.09	0.07	0.07	0.11	0.07	30	0.4%	N/A	29.80	29.91	99.7%
National Sites											
Baldoyle Bay pNHA	0.54	0.57	0.55	0.54	0.52	30	1.9%	N/A	11.69	12.26	41%
Booterstown Marsh pNHA	0.03	0.02	0.02	0.03	0.02	30	0.1%	N/A	15.50	15.53	52%
Dolphins, Dublin Docks pNHA	0.06	0.05	0.06	0.07	0.04	30	0.2%	N/A	15.20	15.27	51%
Grand Canal pNHA	0.04	0.03	0.04	0.04	0.03	30	0.1%	N/A	3.30	3.34	11%
Howth Head pNHA	0.17	0.22	0.21	0.23	0.23	30	0.8%	N/A	12.48	12.71	42%
Ireland's Eye pNHA	0.22	0.28	0.25	0.25	0.24	30	0.9%	N/A	-	-	-
Malahide Estuary pNHA	0.40	0.38	0.42	0.39	0.44	30	1.5%	N/A	13.42	13.86	46%
North Dublin Bay pNHA	0.22	0.28	0.28	0.30	0.30	30	1.0%	N/A	28.80	29.10	97%
Royal Canal pNHA	0.05	0.04	0.05	0.04	0.04	30	0.2%	N/A	22.70	22.75	76%
Santry Demesne pNHA	0.92	0.93	0.92	1.09	0.89	30	3.6%	N/A	17.10	18.19	61%

Ecological Receptor	NO_X Process Contributions (µg/m³)					Critical Level (µg/m³)	Max PC % of Critical Level	Considered for further assessment?	Back-ground (µg/m³)	PEC (µg/m³)	PEC % of critica l level
	2018	2019	2020	2021	2022						
Sluice River Marsh pNHA	0.60	0.59	0.61	0.55	0.61	30	2.0%	N/A	10.20	10.81	36%
South Dublin Bay pNHA	0.09	0.07	0.07	0.10	0.07	30	0.3%	N/A	16.19	16.29	54%

7.2.2 NH_3 – Cumulative Scenario

There are no facilities within a 1 km radius of the Installation with the potential for cumulative effect of NH_3 emissions with the Installation. No cumulative assessment of the effect NH_3 emissions on ecology was therefore required.

7.2.3 SO_2 – Cumulative Scenario

The SO_2 modelling results are detailed in Table 7.11.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC and Baldoyle Bay SPA), at the worst-case location, emissions from the installation lead to an ambient SO_2 PEC (including background) which is at most 8% and 9%, respectively, of the critical level over the five years of meteorological data modelled. The process contribution (PC) SO_2 concentration is at most 0.06% of the critical level over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) Natura 2000 receptor (North Dublin Bay SAC and North Bull Island SPA), at the worst-case location, PEC emissions from the installation lead to an ambient SO_2 concentration (including background) which is at most 47% of the critical level over the five years of meteorological data modelled. The process contribution (PC) SO_2 concentration is at most 0.03% of the critical level over the five years of meteorological data modelled.

Within the most impacted national site (in terms of process contributions) (Santry Demesne pNHA), at the worst-case location, PEC emissions from the installation lead to an ambient SO_2 concentration (including background) which is at most 11% of the critical level over the five years of meteorological data modelled. The process contribution (PC) SO_2 concentration is at most 0.12% of the critical level over the five years of meteorological data modelled.

Within the most impacted national site (in terms of PEC) (North Dublin Bay pNHA), at the worst-case location, PEC emissions from the installation lead to an ambient SO_2 concentration (including background) which is at most 50% of the critical level over the five years of meteorological data modelled. The process contribution (PC) SO_2 concentration is at most 0.03% of the critical level over the five years of meteorological data modelled.

Table 7.11. SO_2 Dispersion Model Results at Most Impacted Ecological Receptor – Cumulative Scenario

Ecological Receptor	SO_2 Process Contributions (µg/m³)					Critical Level (µg/m³)	Max PC % of Critical Level	Considered for further assessment?	Back-ground (µg/m³)	PEC (µg/m³)	PEC % of critical level
	2018	2019	2020	2021	2022						
European Sites (Natura 2000)											
Baldoyle Bay SAC	0.012	0.012	0.012	0.012	0.011	20	0.06%	N/A	1.600	1.612	8%
Howth Head SAC	0.004	0.005	0.005	0.005	0.005	20	0.03%	N/A	2.387	2.392	12%
Ireland's Eye SAC	0.005	0.006	0.005	0.005	0.005	20	0.03%	N/A	-	-	-
Malahide Estuary SAC	0.008	0.008	0.009	0.008	0.009	20	0.05%	N/A	1.125	1.134	6%
North Dublin Bay SAC	0.005	0.006	0.006	0.007	0.007	20	0.03%	N/A	9.416	9.423	47%
Rockabill to Dalkey Island SAC	0.006	0.007	0.007	0.007	0.007	20	0.03%	N/A	2.178	2.185	11%
South Dublin Bay SAC	0.002	0.002	0.002	0.002	0.002	20	0.01%	N/A	2.870	2.872	14%
Baldoyle Bay SPA	0.012	0.012	0.012	0.012	0.011	20	0.06%	N/A	1.773	1.785	9%
Ireland's Eye SPA	0.005	0.006	0.005	0.005	0.005	20	0.03%	N/A	-	-	-
Malahide Estuary SPA	0.008	0.008	0.009	0.008	0.009	20	0.05%	N/A	1.007	1.016	5%
North Bull Island SPA	0.005	0.006	0.006	0.007	0.007	20	0.03%	N/A	9.416	9.423	47%
North-west Irish Sea SPA	0.004	0.005	0.005	0.005	0.005	20	0.03%	N/A	2.400	2.405	12%
South Dublin Bay and River Tolka Estuary SPA	0.002	0.002	0.002	0.002	0.002	20	0.01%	N/A	7.400	7.402	37%
National Sites											
Baldoyle Bay pNHA	0.012	0.012	0.012	0.012	0.011	20	0.06%	N/A	1.773	1.785	9%
Booterstown Marsh pNHA	0.001	0.0005	0.001	0.001	0.001	20	0.003%	N/A	1.300	1.301	7%
Dolphins, Dublin Docks pNHA	0.001	0.001	0.001	0.002	0.001	20	0.01%	N/A	2.400	2.402	12%
Grand Canal pNHA	0.001	0.001	0.001	0.001	0.001	20	0.004%	N/A	0.200	0.201	1%
Howth Head pNHA	0.004	0.005	0.005	0.005	0.005	20	0.02%	N/A	2.387	2.392	12%
Ireland's Eye pNHA	0.005	0.006	0.005	0.005	0.005	20	0.03%	N/A	-	-	-
Malahide Estuary pNHA	0.009	0.008	0.009	0.008	0.010	20	0.05%	N/A	1.125	1.135	6%
North Dublin Bay pNHA	0.005	0.006	0.006	0.007	0.007	20	0.03%	N/A	9.900	9.907	50%
Royal Canal pNHA	0.001	0.001	0.001	0.001	0.001	20	0.01%	N/A	4.300	4.301	22%
Santry Demesne pNHA	0.020	0.020	0.020	0.024	0.019	20	0.12%	N/A	2.100	2.124	11%
Sluice River Marsh pNHA	0.013	0.013	0.013	0.012	0.013	20	0.07%	N/A	1.200	1.213	6%
South Dublin Bay pNHA	0.002	0.001	0.002	0.002	0.002	20	0.01%	N/A	2.870	2.872	14%

7.2.4 Nitrogen Deposition – Cumulative Scenario

In order to consider the effects of nitrogen deposition (as N) owing to emissions from the installation on the sensitive ecological receptors, the maximum annual mean NO_2 and NH_3 process contribution concentrations (PC) are converted into the dry deposition fluxes and then nitrogen deposition fluxes (as described in Section 3.2.2 and shown in Table 7.12 and Table 7.13).

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC and Baldoyle Bay SPA), at the worst-case location, the maximum nitrogen deposition PEC (including background) is 6.076 kg/ha/yr. This is within the critical load range of 5-10 kg/ha/yr for the most sensitive features *"Atlantic salt meadows (Glauco-Puccinellietalia maritimae)" (feature code: H1330)* in the Baldoyle Bay SAC and *"Pluvialis apricaria [North-western Europe]" (feature code: A141)* in the Baldoyle Bay SPA, and is below the midpoint critical load of 7.5 kg/ha/yr. The process contribution (PC) nitrogen deposition (as N) is at most 1% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC), at the worst-case location, the maximum nitrogen deposition PEC (including background) which is 7.072 kg/ha/yr. This is within the critical load range of 5-10 kg/ha/yr for the most sensitive feature *"Embryonic shifting dunes" (feature code: H2110),* and is below the midpoint critical load of 7.5 kg/ha/yr. The process contribution (PC) nitrogen deposition (as N) is at most 0.2% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of process contributions) national site (Santry Demesne pNHA), at the worst-case location, the maximum nitrogen deposition PEC (including background) which is 7.147 kg/ha/yr. This is below the lower end of the critical load range of 10-20 kg/ha/yr for the identified relevant comparable sensitive feature *"Broadleaved deciduous woodland"* (G1), as the site does not contain formally listed Annex I habitats. The process contribution (PC) nitrogen deposition (as N) is at most 1.5% of the relevant lower range critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) national site (North Dublin Bay pNHA), at the worst-case location, the maximum nitrogen deposition PEC (including background) which is 7.641 kg/ha/yr. This is within the critical load range of 5-10 kg/ha/yr for the most sensitive feature *"Atlantic salt meadows (Glauco-Puccinellietalia maritimae)"*, and is above the midpoint critical load of 7.5 kg/ha/yr. The process contribution (PC) nitrogen deposition (as N) is at most 0.6% of the relevant critical load over the five years of meteorological data modelled.

The majority of NO_2 and all of NH_3 process contributions (from which nitrogen deposition levels are derived), from the installation at all modelled ecological receptors, are also below the limit of detection of 0.5 ug/m^3 which must be achieved by chemiluminescence-based automated NO_X/NO_2 analysers(31) and below the limit of detection of 0.02 ug/m^3 achievable by ALPHA (Adapted Low-cost Passive High-Absorption) samplers for ammonia(28). Limit of detection is defined as the smallest concentration that can be reliably measured by an analytical procedure. The EPA guidelines(29) define an imperceptible effect as *"an effect capable of measurement but without significant consequences".* An NH_3 process contribution that is below a monitoring instrument's limit of detection is not measurable and will therefore have a less than imperceptible effect.

Table 7.12. Nitrogen Deposition at Most Impacted Ecological Receptor – Cumulative Scenario

NO_2							
Ecological Receptor	**NO_2 Process Contributions (µg/m^3)**					**NO_2 Dry Deposition (µg/m^2/s)**	**NO_2 Nitrogen Deposition (kg/ha/year)**
	2018	**2019**	**2020**	**2021**	**2022**		
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.47	0.51	0.49	0.48	0.46	0.0008	0.073
Howth Head SAC	0.15	0.20	0.19	0.21	0.20	0.0003	0.030
Ireland's Eye SAC	0.19	0.26	0.23	0.22	0.22	0.0004	0.037
Malahide Estuary SAC	0.35	0.34	0.37	0.34	0.39	0.0006	0.056
North Dublin Bay SAC	0.20	0.25	0.25	0.27	0.27	0.0004	0.039
Rockabill to Dalkey Island SAC	0.25	0.28	0.27	0.28	0.28	0.0004	0.041
South Dublin Bay SAC	0.08	0.06	0.07	0.09	0.06	0.0001	0.014
Baldoyle Bay SPA	0.47	0.51	0.49	0.48	0.46	0.0008	0.073
Ireland's Eye SPA	0.19	0.26	0.23	0.22	0.22	0.0004	0.037
Malahide Estuary SPA	0.35	0.34	0.37	0.34	0.39	0.0006	0.056
North Bull Island SPA	0.20	0.25	0.25	0.27	0.27	0.0004	0.039
North-west Irish Sea SPA	0.07	0.10	0.09	0.10	0.10	0.0002	0.015
South Dublin Bay and River Tolka Estuary SPA	0.08	0.06	0.07	0.09	0.06	0.0001	0.014
National Sites							
Baldoyle Bay pNHA	0.48	0.51	0.50	0.48	0.47	0.0008	0.073
Booterstown Marsh pNHA	0.02	0.02	0.02	0.03	0.02	0.00004	0.004
Dolphins, Dublin Docks pNHA	0.05	0.04	0.05	0.07	0.04	0.0001	0.009
Grand Canal pNHA	0.04	0.03	0.04	0.03	0.03	0.0001	0.005
Howth Head pNHA	0.15	0.20	0.19	0.21	0.20	0.0003	0.030
Ireland's Eye pNHA	0.19	0.26	0.23	0.22	0.21	0.0004	0.037
Malahide Estuary pNHA	0.36	0.34	0.38	0.35	0.40	0.0006	0.057
North Dublin Bay pNHA	0.20	0.25	0.25	0.27	0.27	0.0004	0.039
Royal Canal pNHA	0.04	0.03	0.05	0.04	0.03	0.0001	0.007
Santry Demesne pNHA	0.83	0.83	0.83	0.98	0.80	0.0015	0.141
Sluice River Marsh pNHA	0.54	0.53	0.55	0.50	0.55	0.0008	0.080
South Dublin Bay pNHA	0.08	0.06	0.07	0.09	0.06	0.0001	0.014
NH_3							
Ecological Receptor	**NH_3 Process Contributions (µg/m^3)**					**NH_3 Dry Deposition (µg/m^2/s)**	**NH_3 Nitrogen Deposition (kg/ha/year)**
	2018	**2019**	**2020**	**2021**	**2022**		
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.0006	0.0006	0.0005	0.0005	0.0005	0.000011	0.003
Howth Head SAC	0.0002	0.0003	0.0002	0.0003	0.0003	0.000006	0.002
Ireland's Eye SAC	0.0002	0.0003	0.0003	0.0002	0.0002	0.000007	0.002
Malahide Estuary SAC	0.0004	0.0004	0.0004	0.0004	0.0004	0.000008	0.002
North Dublin Bay SAC	0.0003	0.0003	0.0003	0.0003	0.0004	0.000008	0.002
Rockabill to Dalkey Island SAC	0.0003	0.0003	0.0003	0.0003	0.0003	0.000007	0.002
South Dublin Bay SAC	0.0001	0.0001	0.0001	0.0001	0.0001	0.000002	0.001
Baldoyle Bay SPA	0.0006	0.0006	0.0005	0.0005	0.0005	0.000011	0.003
Ireland's Eye SPA	0.0002	0.0003	0.0003	0.0002	0.0002	0.000007	0.002
Malahide Estuary SPA	0.0004	0.0004	0.0004	0.0004	0.0004	0.000008	0.002
North Bull Island SPA	0.0003	0.0003	0.0003	0.0003	0.0004	0.000008	0.002
North-west Irish Sea SPA	0.0002	0.0003	0.0002	0.0003	0.0003	0.00001	0.0015
South Dublin Bay and	0.0001	0.0001	0.0001	0.0001	0.0001	0.000002	0.001

River Tolka Estuary SPA							
National Sites							
Baldoyle Bay pNHA	0.00057	0.00056	0.00054	0.00049	0.00052	0.000011	0.0030
Booterstown Marsh pNHA	0.00003	0.00002	0.00002	0.00003	0.00003	0.000001	0.0002
Dolphins, Dublin Docks pNHA	0.00005	0.00005	0.00005	0.00008	0.00004	0.000002	0.0004
Grand Canal pNHA	0.00004	0.00004	0.00005	0.00004	0.00003	0.000001	0.0003
Howth Head pNHA	0.00021	0.00028	0.00022	0.00028	0.00026	0.000006	0.0015
Ireland's Eye pNHA	0.00024	0.00034	0.00026	0.00023	0.00024	0.000007	0.0018
Malahide Estuary pNHA	0.00041	0.00036	0.00039	0.00035	0.00041	0.000008	0.0021
North Dublin Bay pNHA	0.00029	0.00034	0.00030	0.00035	0.00038	0.000008	0.0020
Royal Canal pNHA	0.00007	0.00005	0.00006	0.00005	0.00004	0.000001	0.0004
Santry Demesne pNHA	0.00098	0.00109	0.00063	0.00100	0.00093	0.000022	0.0057
Sluice River Marsh pNHA	0.00059	0.00050	0.00056	0.00048	0.00057	0.000012	0.0031
South Dublin Bay pNHA	0.00008	0.00007	0.00007	0.00012	0.00005	0.000002	0.0006

Table 7.13. Nitrogen Deposition at Most Impacted Ecological Receptor – Cumulative Scenario (continued)

Ecological Receptor	Total PC Nitrogen Deposition kg/ha/yr)	Assessment critical load (kg/ha/yr)	PC % of critical load	Considered for further assessment?	APIS Background Nitrogen Deposition (kg/ha/yr)	Total PEC Nitrogen Deposition (kg/ha/yr)
European Sites (Natura 2000)						
Baldoyle Bay SAC	0.076	7.5	1.0%	N/A	6.000	6.076
Howth Head SAC	0.031	7.5	0.4%	N/A	6.338	6.369
Ireland's Eye SAC	0.039	n/a	n/a	N/A	-	-
Malahide Estuary SAC	0.059	5.0	1.2%	N/A	6.215	6.274
North Dublin Bay SAC	0.041	5.0	0.8%	N/A	6.529	6.570
Rockabill to Dalkey Island SAC	0.043	n/a	n/a	N/A	5.651	5.694
South Dublin Bay SAC	0.014	5.0	0.3%	N/A	7.058	7.072
Baldoyle Bay SPA	0.076	7.5	1.0%	N/A	6.000	6.076
Ireland's Eye SPA	0.039	n/a	n/a	N/A	-	-
Malahide Estuary SPA	0.059	7.5	0.8%	N/A	6.069	6.128
North Bull Island SPA	0.041	7.5	0.5%	N/A	6.529	6.570
North-west Irish Sea SPA	0.031	7.5	0.4%	N/A	5.387	5.418
South Dublin Bay and River Tolka Estuary SPA	0.014	5.0	0.3%	N/A	6.800	6.814
National Sites						
Baldoyle Bay pNHA	0.076	7.5	1.0%	N/A	6.000	6.076
Booterstown Marsh pNHA	0.004	7.5	0.1%	N/A	6.000	6.004
Dolphins, Dublin Docks pNHA	0.010	n/a	n/a	N/A	5.300	5.310
Grand Canal pNHA	0.006	5.0	0.1%	N/A	7.100	7.106
Howth Head pNHA	0.031	7.5	0.4%	N/A	6.338	6.369
Ireland's Eye pNHA	0.038	n/a	n/a	N/A	-	-
Malahide Estuary pNHA	0.059	5.0	1.2%	N/A	6.215	6.274
North Dublin Bay pNHA	0.041	5.0	0.8%	N/A	7.600	7.641
Royal Canal pNHA	0.007	5.0	0.1%	N/A	7.100	7.107
Santry Demesne pNHA	0.147	10.0	1.5%	N/A	7.000	7.147
Sluice River Marsh pNHA	0.083	7.5	1.1%	N/A	5.800	5.883
South Dublin Bay pNHA	0.014	5.0	0.3%	N/A	7.058	7.072

7.2.5 Acid Deposition – Cumulative Scenario

Acid deposition (as N)

In order to consider the effects of acid deposition (as N) owing to emissions from the installation on the ecological habitat sites, the maximum annual mean NO_2 and NH_3 process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes (as described in Section 3.2.2 and shown in Table 7.14 and Table 7.15.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC and Baldoyle Bay SPA), at the worst-case location, the maximum acid deposition (as N) PEC (including background) is 0.505 keq/ha/yr. This is below the critical load range of 0.714 – 4.919 keq/ha/yr for the most sensitive feature *"Charadrius hiaticula (Europe/Northern Africa - wintering)" (feature code: A137)* in the Baldoyle Bay SPA (no critical load information available for Baldoyle Bay SAC). The process contribution (PC) acid deposition (as N) is at most 4% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay and River Tolka Estuary SPA), at the worst-case location, the maximum acid deposition (as N) PEC (including background) which is 0.591 keq/ha/yr. This is below the critical load range of 0.714 – 4.919 keq/ha/yr for the most sensitive features *"Sterna hirundo (Northern/Eastern Europe - breeding)" (feature code: A193)* in the South Dublin Bay and River Tolka Estuary SPA and *"Embryonic shifting dunes" (feature code: H2110)* in the South Dublin Bay SAC (no critical load information available for South Dublin Bay SAC). The process contribution (PC) acid deposition (as N) is at most 0.7% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of process contributions) national site (Santry Demesne pNHA), at the worst-case location, the maximum acid deposition (as N) PEC (including background) which is 0.510 keq/ha/yr. This is below the critical load range of 0.714 – 5.634 keq/ha/yr for the most sensitive feature *"Old sessile oak woods with Ilex and Blechnum in the British Isles"*. The process contribution (PC) acid deposition (as N) is at most 7% of the relevant critical load over the five years of meteorological data modelled.

There is no appropriate critical load information available for the most impacted (in terms of PEC) national site (Sluice River Marsh pNHA), therefore the next most impacted (in terms of PEC) national site (Royal Canal pNHA) with available critical loads is discussed. At the worst-case location, the maximum acid deposition (as N) PEC (including background) which is 0.901 keq/ha/yr. This is within the critical load range of 0.714 – 4.919 keq/ha/yr for the most sensitive feature *"Unmanaged Broadleafed/Coniferous Woodland"*. The process contribution (PC) acid deposition (as N) is at most 0.4% of the relevant critical load over the five years of meteorological data modelled.

Table 7.14. Acid Deposition (as N) at Most Impacted Ecological Receptor – Cumulative Scenario

NO_2							
Ecological Receptor	NO_2 Process Contributions (µg/m³)					NO_2 Dry Deposition (µg/m²/s)	NO_2 Acid Deposition (keq/ha/yr)
	2018	2019	2020	2021	2022		
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.47	0.51	0.49	0.48	0.46	0.0008	0.005
Howth Head SAC	0.15	0.20	0.19	0.21	0.20	0.0003	0.002
Ireland's Eye SAC	0.19	0.26	0.23	0.22	0.22	0.0004	0.003
Malahide Estuary SAC	0.35	0.34	0.37	0.34	0.39	0.0006	0.004
North Dublin Bay SAC	0.20	0.25	0.25	0.27	0.27	0.0004	0.003
Rockabill to Dalkey Island SAC	0.25	0.28	0.27	0.28	0.28	0.0004	0.003
South Dublin Bay SAC	0.08	0.06	0.07	0.09	0.06	0.0001	0.001
Baldoyle Bay SPA	0.47	0.51	0.49	0.48	0.46	0.0008	0.005
Ireland's Eye SPA	0.19	0.26	0.23	0.22	0.22	0.0004	0.003
Malahide Estuary SPA	0.35	0.34	0.37	0.34	0.39	0.0006	0.004
North Bull Island SPA	0.20	0.25	0.25	0.27	0.27	0.0004	0.003
North-west Irish Sea SPA	0.15	0.20	0.19	0.21	0.20	0.0003	0.002
South Dublin Bay and River Tolka Estuary SPA	0.08	0.06	0.07	0.09	0.06	0.0001	0.001
National Sites							
Baldoyle Bay pNHA	0.48	0.51	0.50	0.48	0.47	0.0008	0.005
Booterstown Marsh pNHA	0.02	0.02	0.02	0.03	0.02	0.00004	0.000
Dolphins, Dublin Docks pNHA	0.05	0.04	0.05	0.07	0.04	0.0001	0.001
Grand Canal pNHA	0.04	0.03	0.04	0.03	0.03	0.0001	0.000
Howth Head pNHA	0.15	0.20	0.19	0.21	0.20	0.0003	0.002
Ireland's Eye pNHA	0.19	0.26	0.23	0.22	0.21	0.0004	0.003
Malahide Estuary pNHA	0.36	0.34	0.38	0.35	0.40	0.0006	0.004
North Dublin Bay pNHA	0.20	0.25	0.25	0.27	0.27	0.0004	0.003
Royal Canal pNHA	0.04	0.03	0.05	0.04	0.03	0.0001	0.001
Santry Demesne pNHA	0.83	0.83	0.83	0.98	0.80	0.0015	0.010
Sluice River Marsh pNHA	0.54	0.53	0.55	0.50	0.55	0.0008	0.006
South Dublin Bay pNHA	0.08	0.06	0.07	0.09	0.06	0.0001	0.001
NH_3							
Ecological Receptor	NH_3 Process Contributions (µg/m³)					NH_3 Dry Deposition (µg/m²/s)	NH_3 Acid Deposition (keg/ha/yr)
	2018	2019	2020	2021	2022		
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.0006	0.0006	0.0005	0.0005	0.0005	0.000011	0.00021
Howth Head SAC	0.0002	0.0003	0.0002	0.0003	0.0003	0.000006	0.00011
Ireland's Eye SAC	0.0002	0.0003	0.0003	0.0002	0.0002	0.000007	0.00012
Malahide Estuary SAC	0.0004	0.0004	0.0004	0.0004	0.0004	0.000008	0.00015

North Dublin Bay SAC	0.0003	0.0003	0.0003	0.0003	0.0004	0.000008	0.00014
Rockabill to Dalkey Island SAC	0.0003	0.0003	0.0003	0.0003	0.0003	0.000007	0.00013
South Dublin Bay SAC	0.0001	0.0001	0.0001	0.0001	0.0001	0.000002	0.00004
Baldoyle Bay SPA	0.0006	0.0006	0.0005	0.0005	0.0005	0.000011	0.00021
Ireland's Eye SPA	0.0002	0.0003	0.0003	0.0002	0.0002	0.000007	0.00012
Malahide Estuary SPA	0.0004	0.0004	0.0004	0.0004	0.0004	0.000008	0.00015
North Bull Island SPA	0.0003	0.0003	0.0003	0.0003	0.0004	0.000008	0.00014
North-west Irish Sea SPA	0.0002	0.0003	0.0002	0.0003	0.0003	0.000006	0.00011
South Dublin Bay and River Tolka Estuary SPA	0.0001	0.0001	0.0001	0.0001	0.0001	0.000002	0.00004
National Sites							
Baldoyle Bay pNHA	0.00057	0.00056	0.00054	0.00049	0.00052	0.000011	0.00021
Booterstown Marsh pNHA	0.00003	0.00002	0.00002	0.00003	0.00003	0.000001	0.00001
Dolphins, Dublin Docks pNHA	0.00005	0.00005	0.00005	0.00008	0.00004	0.000002	0.00003
Grand Canal pNHA	0.00004	0.00004	0.00005	0.00004	0.00003	0.000001	0.00002
Howth Head pNHA	0.00021	0.00028	0.00022	0.00028	0.00026	0.000006	0.00010
Ireland's Eye pNHA	0.00024	0.00034	0.00026	0.00023	0.00024	0.000007	0.00013
Malahide Estuary pNHA	0.00041	0.00036	0.00039	0.00035	0.00041	0.000008	0.00015
North Dublin Bay pNHA	0.00029	0.00034	0.00030	0.00035	0.00038	0.000008	0.00014
Royal Canal pNHA	0.00007	0.00005	0.00006	0.00005	0.00004	0.000001	0.00003
Santry Demesne pNHA	0.00098	0.00109	0.00063	0.00100	0.00093	0.000022	0.00040
Sluice River Marsh pNHA	0.00059	0.00050	0.00056	0.00048	0.00057	0.000012	0.00022
South Dublin Bay pNHA	0.00008	0.00007	0.00007	0.00012	0.00005	0.000002	0.00004

Table 7.15. Acid Deposition (as N) at Most Impacted Ecological Receptor – Cumulative Scenario (continued)

Ecological Receptor	PC Acid Dep. (N) (keq/ ha/yr)	Critical load (MinCL minN) for PC (keq/ ha/yr)	PC % of critical load	Considered for further assessment?	APIS Back-ground Acid Dep. (keq/ ha/yr)	Total PEC Acid Dep. (N) (keq/ ha/yr)	Critical load (MaxCL minN) for PEC (keq/ ha/yr)
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.0055	n/a	n/a	N/A	0.500	0.505	n/a
Howth Head SAC	0.0022	0.143	2%	N/A	0.500	0.502	0.714
Ireland's Eye SAC	0.0028	n/a	n/a	N/A	n/a	n/a	n/a
Malahide Estuary SAC	0.0042	0.143	3%	N/A	0.500	0.504	0.714
North Dublin Bay SAC	0.0029	0.143	2%	N/A	0.500	0.503	0.714
Rockabill to Dalkey Island SAC	0.0030	n/a	n/a	N/A	0.500	0.503	n/a
South Dublin Bay SAC	0.0010	n/a	n/a	N/A	0.590	0.591	n/a
Baldoyle Bay SPA	0.0055	0.143	4%	N/A	0.500	0.505	0.714

Ecological Receptor	PC Acid Dep. (N) (keq/ ha/yr)	Critical load (MinCL minN) for PC (keq/ ha/yr)	PC % of critical load	Considered for further assessment?	APIS Back-ground Acid Dep. (keq/ ha/yr)	Total PEC Acid Dep. (N) (keq/ ha/yr)	Critical load (MaxCL minN) for PEC (keq/ ha/yr)
Ireland's Eye SPA	0.0028	n/a	n/a	N/A	n/a	n/a	n/a
Malahide Estuary SPA	0.0042	0.143	3%	N/A	0.500	0.504	0.714
North Bull Island SPA	0.0029	0.143	2%	N/A	0.500	0.503	0.714
North-west Irish Sea SPA	0.0023	0.143	2%	N/A	0.400	0.402	0.714
South Dublin Bay and River Tolka Estuary SPA	0.0010	0.143	0.7%	N/A	0.590	0.591	0.714
National Sites							
Baldoyle Bay pNHA	0.0054	0.143	4%	N/A	0.471	0.476	0.714
Booterstown Marsh pNHA	0.0003	n/a	n/a	N/A	0.597	0.597	n/a
Dolphins, Dublin Docks pNHA	0.0007	n/a	n/a	N/A	0.597	0.598	n/a
Grand Canal pNHA	0.0004	0.143	0.3%	N/A	0.900	0.900	0.714
Howth Head pNHA	0.0022	0.143	1.5%	N/A	0.495	0.497	0.714
Ireland's Eye pNHA	0.0027	n/a	n/a	N/A	n/a	n/a	n/a
Malahide Estuary pNHA	0.0042	0.143	3%	N/A	0.467	0.471	0.714
North Dublin Bay pNHA	0.0029	0.143	2%	N/A	0.597	0.600	0.714
Royal Canal pNHA	0.0005	0.143	0.4%	N/A	0.900	0.901	0.714
Santry Demesne pNHA	0.0105	0.143	7%	N/A	0.500	0.510	0.714
Sluice River Marsh pNHA	0.0059	n/a	n/a	N/A	0.900	0.906	n/a
South Dublin Bay pNHA	0.0054	0.143	0.7%	N/A	0.709	0.710	0.714

Acid deposition (as S)

In order to consider the effects of acid deposition (as S) owing to emissions from the installation on the ecological habitat sites, the maximum annual mean SO_2 process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes (as described in Section 3.2.2 and shown in Table 7.16 and Table 7.17.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC and Baldoyle Bay SPA), at the worst-case location, the maximum acid deposition (as S) PEC (including background) is 0.501 keq/ha/yr. This is below the critical load range of 4.125 – 4.205 keq/ha/yr for the most sensitive features "*Atlantic salt meadows (Glauco-Puccinellietalia maritimae)*" *(feature code: H1330*) in the Baldoyle Bay SAC and *"Charadrius hiaticula (Europe/Northern Africa - wintering)" (feature code: A137*) in the Baldoyle Bay SPA. The process contribution (PC) acid deposition (as S) is at most 0.04% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay and River Tolka Estuary SPA), at the worst-case location, the maximum acid deposition (as N) PEC (including background) which is 0.590 keq/ha/yr. This is below the critical load range of 4.099 – 4.205 keq/ha/yr for the most sensitive features *"Sterna hirundo (Northern/Eastern Europe - breeding)" (feature code: A193)* in the South Dublin Bay and River Tolka Estuary SPA and *"Embryonic shifting dunes" (feature code: H2110)* in the South Dublin Bay SAC (no critical load information available for South Dublin Bay SAC). The process contribution (PC) acid deposition (as S) is at most 0.01% of the relevant critical load over the five years of meteorological data modelled.

Within the most impacted (in terms of process contributions) national site (Santry Demesne pNHA), at the worst-case location, the maximum acid deposition (as S) PEC (including background) which is 0.503 keq/ha/yr. This is within the critical load range of 0.365 – 6.518 keq/ha/yr for the most sensitive feature *"Old sessile oak woods with Ilex and Blechnum in the British Isles"*. The process contribution (PC) acid deposition (as S) is at most 0.8% of the relevant critical load over the five years of meteorological data modelled.

There is no appropriate critical load information available for the most impacted (in terms of PEC) national site (Sluice River Marsh pNHA), therefore the next most impacted (in terms of PEC) national site (Royal Canal pNHA) with available critical loads is discussed. At the worst-case location, the maximum acid deposition (as S) PEC (including background) which is 0.900 keq/ha/yr. This is within the critical load range of 0.365 – 4.71 keq/ha/yr for the most sensitive feature *"Unmanaged Broadleafed/Coniferous Woodland"*. The process contribution (PC) acid deposition (as S) is at most 0.04% of the relevant critical load over the five years of meteorological data modelled.

Table 7.16. Acid Deposition (as S) at Most Impacted Ecological Receptor - Cumulative Scenario

Ecological Receptor	SO_2 Process Contributions (µg/m^3)					SO_2 Dry Deposition (µg/m^2/s)	SO_2 Acid Deposition (S) (keq/ha/yr)
	2018	2019	2020	2021	2022		
European Sites (Natura 2000)							
Baldoyle Bay SAC	0.012	0.012	0.012	0.012	0.011	0.00015	0.00145
Howth Head SAC	0.004	0.005	0.005	0.005	0.005	0.00006	0.00060
Ireland's Eye SAC	0.005	0.006	0.005	0.005	0.005	0.00007	0.00072
Malahide Estuary SAC	0.008	0.008	0.009	0.008	0.009	0.00011	0.00112
North Dublin Bay SAC	0.005	0.006	0.006	0.007	0.007	0.00008	0.00078
Rockabill to Dalkey Island SAC	0.006	0.007	0.007	0.007	0.007	0.00008	0.00081
South Dublin Bay SAC	0.002	0.002	0.002	0.002	0.002	0.00003	0.00028
Baldoyle Bay SPA	0.012	0.012	0.012	0.012	0.011	0.00015	0.00145
Ireland's Eye SPA	0.005	0.006	0.005	0.005	0.005	0.00007	0.00072
Malahide Estuary SPA	0.008	0.008	0.009	0.008	0.009	0.00011	0.00112
North Bull Island SPA	0.005	0.006	0.006	0.007	0.007	0.00008	0.00078
North-west Irish Sea SPA	0.004	0.005	0.005	0.005	0.005	0.00006	0.00060
South Dublin Bay and River Tolka Estuary SPA	0.002	0.002	0.002	0.002	0.002	0.00003	0.00028
National Sites							
Baldoyle Bay pNHA	0.012	0.012	0.012	0.012	0.011	0.00015	0.00145
Booterstown Marsh pNHA	0.001	0.000	0.001	0.001	0.001	0.00001	0.00007
Dolphins, Dublin Docks pNHA	0.001	0.001	0.001	0.002	0.001	0.00002	0.00019
Grand Canal pNHA	0.001	0.001	0.001	0.001	0.001	0.00001	0.00011
Howth Head pNHA	0.004	0.005	0.005	0.005	0.005	0.00006	0.00059
Ireland's Eye pNHA	0.005	0.006	0.005	0.005	0.005	0.00007	0.00071
Malahide Estuary pNHA	0.009	0.008	0.009	0.008	0.010	0.00012	0.00114
North Dublin Bay pNHA	0.005	0.006	0.006	0.007	0.007	0.00008	0.00079
Royal Canal pNHA	0.001	0.001	0.001	0.001	0.001	0.00001	0.00014
Santry Demesne pNHA	0.020	0.020	0.020	0.024	0.019	0.00028	0.00279
Sluice River Marsh pNHA	0.013	0.013	0.013	0.012	0.013	0.00016	0.00159
South Dublin Bay pNHA	0.002	0.001	0.002	0.002	0.002	0.0000	0.000

Table 7.17 Acid Deposition (as S) at Most Impacted Ecological Receptor - Cumulative Scenario (continued)

Ecological Receptor	PC Acid Dep. (S) (keq/ha/yr)	Critical load (MinCL maxS) (keq/ha/yr)	PC % of critical load	Considered for further assessment?	APIS Back-ground Acid Dep. (keq/ ha/yr)	Total PEC Acid Dep. (S) (keq/ ha/yr)
Natura 2000						
Baldoyle Bay SAC	0.0014	n/a	n/a	N/A	0.500	0.501
Howth Head SAC	0.0006	4.236	0.01%	N/A	0.500	0.501
Ireland's Eye SAC	0.0007	n/a	n/a	N/A	n/a	n/a
Malahide Estuary SAC	0.0011	4.117	0.03%	N/A	0.500	0.501
North Dublin Bay SAC	0.0008	4.107	0.02%	N/A	0.500	0.501
Rockabill to Dalkey Island SAC	0.0008	n/a	n/a	N/A	0.500	n/a
South Dublin Bay SAC	0.0003	n/a	n/a	N/A	0.590	0.590
Baldoyle Bay SPA	0.0014	4.125	0.04%	N/A	0.500	0.501
Ireland's Eye SPA	0.0007	n/a	n/a	N/A	n/a	n/a
Malahide Estuary SPA	0.0011	4.117	0.03%	N/A	0.500	n/a
North Bull Island SPA	0.0008	4.107	0.02%	N/A	0.500	0.501
North-west Irish Sea SPA	0.0006	4.107	0.01%	N/A	0.400	0.401
South Dublin Bay and River Tolka Estuary SPA	0.0003	4.099	0.01%	N/A	0.590	0.590
National Sites						
Baldoyle Bay pNHA	0.0014	4.125	0.04%	N/A	0.471	0.472
Booterstown Marsh pNHA	0.0001	n/a	n/a	N/A	0.597	0.597
Dolphins, Dublin Docks pNHA	0.0002	n/a	n/a	N/A	0.597	0.597
Grand Canal pNHA	0.0001	0.365	0.03%	N/A	0.900	0.900
Howth Head pNHA	0.0006	4.236	0.01%	N/A	0.495	0.496
Ireland's Eye pNHA	0.0007	n/a	n/a	N/A	n/a	n/a
Malahide Estuary pNHA	0.0011	4.117	0.03%	N/A	0.467	0.468
North Dublin Bay pNHA	0.0008	4.107	0.02%	N/A	0.597	0.598
Royal Canal pNHA	0.0001	0.365	0.04%	N/A	0.900	0.900
Santry Demesne pNHA	0.0028	0.365	0.8%	N/A	0.500	0.503
Sluice River Marsh pNHA	0.0016	n/a	n/a	N/A	0.900	0.902
South Dublin Bay pNHA	0.0014	4.099	0.01%	N/A	0.709	0.709

8.0 ASSESSMENT SUMMARY

The air dispersion modelling assessment has investigated the impact of emissions from the installation to ambient air quality under a number of scenarios summarised as follows:

Licenced Operational Scenario

- Operation of 45 of the 52 no. back-up generators for 150 hours per year using diesel fuel using the USEPA methodology outlined within the guidance document titled '*Additional Clarification Regarding Application of Appendix W Modelling Guidance for the 1-Hour National Ambient Air Quality Standard*' as well as considering scheduled weekly testing and quarterly maintenance testing of all 52 no. back-up generators from the installation (Building W, Building X, Building Y, Building U and Building V).

Cumulative Assessment Scenario

- Based on the operation of 45 of the 52 no. back-up generators for 150 hours per year using diesel fuel, using the USEPA methodology. The cumulative assessment included:
    - the emergency operation of Buildings W, X, Y, U and V
    - the emergency operation of Buildings A – F (EPA Reg. No. P1171-01),
    - scheduled weekly testing of all back-up generators from Buildings W, X, Y, U and V
    - scheduled weekly testing of all back-up generators from Buildings A – F (EPA Reg. No. P1171-01),
    - scheduled quarterly maintenance testing of all back-up generators from Buildings W, X, Y, U and V with each generator running for four hours
    - scheduled quarterly maintenance testing of all back-up generators from Buildings A – F (EPA Reg. No. P1171-01) with each generator running for one hour,
    - emergency operations, scheduled weekly testing and scheduled quarterly maintenance testing of the Dataplex and Digital Realty data centres.

Emissions have been modelled at the proposed IE Licence concentrations and flow rates for licenced facilities. In relation to Dataplex and Digital Realty, the relevant data was obtained from a review of the planning files for these facilities.

8.1 Conclusion (Human Health)

The modelling of air emissions from the installation, as well as cumulative emissions, was carried out to assess concentrations of nitrogen dioxide (NO_2), ammonia (NH_3), carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$) and sulphur dioxide (SO_2) at a variety of locations beyond the installation boundary. The results of the modelling assessment indicate that ambient ground level pollutant concentrations are in compliance with the relevant air quality standards for NO_2, CO, PM_{10}, $PM_{2.5}$, NH_3 and SO_2 under all operational scenarios assessed.

In summary, emissions to atmosphere of NO_2, as the main polluting substance (as defined in the Schedule of EPA (Industrial Emissions) (Licensing) Regulations 2013, S.I. No. 137 of 2013) from the standby generators, will be in compliance with the ambient air quality standards which are based on the protection of the environment and human health. Therefore, no significant impacts to the ambient air quality environment are predicted.

8.2 Conclusion (Ecology)

The impact of emissions of NO_X, NH_3, SO_2 and nutrient and acid deposition from the installation, as well as the impact of cumulative emissions, on European habitat sites and nationally designated habitat sites within 10 km of the installation was also assessed. A summary of the most impacted ecological receptors is shown in Table 8.1.

Table 8.1. Ecology Impacts Summary

Scenario	Pollutant	Most Impacted (in terms of PC)			Most Impacted (in terms of PEC)		
		Ecological Receptor	PC less than 1%	PEC within critical level/load range	European Site	PC less than 1% Note 1	PEC within critical level/load range
European Sites							
Licenced Operational	NO_X	Baldoyle Bay SAC / Baldoyle Bay SPA	Yes	Yes	South Dublin Bay and River Tolka Estuary SPA	Yes	Yes
	NH_3	Howth Head SAC	Yes	No	Howth Head SAC	Yes	No
	SO_2	Baldoyle Bay SAC / Baldoyle Bay SPA	Yes	Yes	North Dublin Bay SAC / North Bull Island SPA	Yes	Yes
	Nitrogen Deposition	Baldoyle Bay SAC / Baldoyle Bay SPA	Yes	Yes	South Dublin Bay SAC	Yes	Yes
	Acid Deposition (as N)	Baldoyle Bay SAC / Baldoyle Bay SPA	No	Yes	South Dublin Bay SAC / South Dublin Bay and River Tolka Estuary SPA	Yes	Yes
	Acid Deposition (as S)	Baldoyle Bay SAC / Baldoyle Bay SPA	Yes	Yes	South Dublin Bay SAC / South Dublin Bay and River Tolka Estuary SPA	Yes	Yes
Cumulative	NO_X	Baldoyle Bay SAC / Baldoyle Bay SPA	No	Yes	South Dublin Bay and River Tolka Estuary SPA	Yes	Yes
	NH_3	n/a	n/a	n/a	n/a	n/a	n/a
	SO_2	Baldoyle Bay SAC / Baldoyle Bay SPA	Yes	Yes	North Dublin Bay SAC / North Bull Island SPA	Yes	Yes
	Nitrogen Deposition	Baldoyle Bay SAC / Baldoyle Bay SPA	No	Yes	South Dublin Bay SAC	Yes	Yes
	Acid Deposition (as N)	Baldoyle Bay SAC / Baldoyle Bay SPA	No	Yes	South Dublin Bay SAC / South Dublin Bay and River Tolka Estuary SPA	Yes	Yes
	Acid Deposition (as S)	Baldoyle Bay SAC / Baldoyle Bay SPA	Yes	Yes	South Dublin Bay SAC / South Dublin Bay and River Tolka Estuary SPA	Yes	Yes
National Sites							
Licenced Operational	NO_X	Santry Demesne pNHA	No	Yes	North Dublin Bay pNHA	Yes	Yes
	NH_3	Santry Demesne pNHA	Yes	Yes	Royal Canal pNHA	Yes	No
	SO_2	Santry Demesne pNHA	Yes	Yes	North Dublin Bay pNHA	Yes	Yes
	Nitrogen Deposition	Santry Demesne pNHA	Yes	Yes	North Dublin Bay pNHA	Yes	No

Scenario	Pollutant	Most Impacted (in terms of PC)			Most Impacted (in terms of PEC)		
		Ecological Receptor	PC less than 1%	PEC within critical level/load range	European Site	PC less than 1% Note 1	PEC within critical level/load range
	Acid Deposition (as N)	Santry Demesne pNHA	No	Yes	Royal Canal pNHA	Yes	Yes
	Acid Deposition (as S)	Santry Demesne pNHA	Yes	Yes	Royal Canal pNHA	Yes	Yes
Cumulative	NO_X	Santry Demesne pNHA	No	Yes	North Dublin Bay pNHA	No	Yes
	NH_3	n/a	n/a	n/a	n/a	n/a	n/a
	SO_2	Santry Demesne pNHA	Yes	Yes	North Dublin Bay pNHA	Yes	Yes
	Nitrogen Deposition	Santry Demesne pNHA	No	Yes	North Dublin Bay pNHA	Yes	Yes
	Acid Deposition (as N)	Santry Demesne pNHA	No	Yes	Royal Canal pNHA	Yes	Yes
	Acid Deposition (as S)	Santry Demesne pNHA	Yes	Yes	Royal Canal pNHA	Yes	Yes

Note 1 The 1% threshold is not technically applicable to in-combination effects, according to IN2, however as there are no suitable alternatives available it has been included for information purposes.

The modelling assessment determined that emissions of NO_X, SO_2 and nutrient and acid deposition from the installation do not exceed the relevant critical levels and worst-case critical load ranges for the sensitive features within the European sites assessed in both the Licenced Operational and the Cumulative Assessment scenarios. The critical level for NH_3 may be exceeded, in terms of PEC % of critical level, at the Howth Head SAC in the Licenced Operational scenario. This exceedance is due to the NH_3 background concentration (the biggest contributor to which is the agricultural sector) exceeding the critical level. However, the process contribution from the Installation is 0.029% of the critical level.

Emissions of NO_X, SO_2 and acid deposition from the installation do not exceed the relevant critical levels and worst-case critical load ranges for the sensitive habitats within the national sites assessed in both the Licenced Operational and the Cumulative Assessment scenarios. The critical level for NH_3 may be exceeded, in terms of PEC, at the Royal Canal pNHA in the Licenced Operational scenario. This exceedance is due to the NH_3 background concentration (the biggest contributor to which is the agricultural sector) exceeding the critical level, rather than the process contribution which is 0.007% of the critical level. The maximum nitrogen deposition level, in terms of PEC, at the North Dublin Bay pNHA is within the critical load range of 5-10 kg/ha/yr for the most sensitive feature *"Atlantic salt meadows (Glauco-Puccinellietalia maritimae)"*, and is above the midpoint critical load of 7.5 kg/ha/yr. This is due to a background nitrogen deposition of 7.6 kg/ha/yr, as the process contribution (PC) nitrogen deposition (as N) is at most 0.6% of the midpoint critical load.

The potential for likely significant effects on this European site, either alone or in combination with other plans or projects, in view of the sites' conservation objectives, is evaluated by the project ecologist as part of the Appropriate Assessment (AA) Screening Report prepared by Moore Group.

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APPENDIX I

Description of the AERMOD Model

The AERMOD dispersion model has been developed in part by the U.S. Environmental Protection Agency (USEPA)[1,5]. The model is a steady-state Gaussian model used to assess pollutant concentrations associated with industrial sources. The model is an enhancement on the Industrial Source Complex-Short Term 3 (ISCST3) model which has been widely used for emissions from industrial sources.

Improvements over the ISCST3 model include the treatment of the vertical distribution of concentration within the plume. ISCST3 assumes a Gaussian distribution in both the horizontal and vertical direction under all weather conditions. AERMOD with PRIME, however, treats the vertical distribution as non-Gaussian under convective (unstable) conditions while maintaining a Gaussian distribution in both the horizontal and vertical direction during stable conditions. This treatment reflects the fact that the plume is skewed upwards under convective conditions due to the greater intensity of turbulence above the plume than below. The result is a more accurate portrayal of actual conditions using the AERMOD model. AERMOD also enhances the turbulence of night-time urban boundary layers thus simulating the influence of the urban heat island.

In contrast to ISCST3, AERMOD is widely applicable in all types of terrain. Differentiation of the simple versus complex terrain is unnecessary with AERMOD. In complex terrain, AERMOD employs the dividing-streamline concept in a simplified simulation of the effects of plume-terrain interactions. In the dividing-streamline concept, flow below this height remains horizontal, and flow above this height tends to rise up and over terrain. Extensive validation studies have found that AERMOD (precursor to AERMOD with PRIME) performs better than ISCST3 for many applications and as well or better than CTDMPLUS for several complex terrain data sets[7].

Due to the proximity to surrounding buildings, the PRIME (Plume Rise Model Enhancements) building downwash algorithm has been incorporated into the model to determine the influence (wake effects) of these buildings on dispersion in each direction considered. The PRIME algorithm takes into account the position of the stack relative to the building in calculating building downwash. In the absence of the building, the plume from the stack will rise due to momentum and/or buoyancy forces. Wind streamlines act on the plume leads to the bending over of the plume as it disperses. However, due to the presence of the building, wind streamlines are disrupted leading to a lowering of the plume centreline.

When there are multiple buildings, the building tier leading to the largest cavity height is used to determine building downwash. The cavity height calculation is an empirical formula based on building height, the length scale (which is a factor of building height & width) and the cavity length (which is based on building width, length and height). As the direction of the wind will lead to the identification of differing dominant tiers, calculations are carried out in intervals of 10 degrees.

In PRIME, the nature of the wind streamline disruption as it passes over the dominant building tier is a function of the exact dimensions of the building and the angle at which the wind approaches the building. Once the streamline encounters the zone of influence of the building, two forces act on the plume. Firstly, the disruption caused by the building leads to increased turbulence and enhances horizontal and vertical dispersion. Secondly, the streamline descends in the lee of the building due to the reduced pressure and drags the plume (or part of) nearer to the ground, leading to higher ground level concentrations. The model calculates the descent of the plume as a function of the building shape and, using a numerical plume rise model, calculates the change in the plume centreline location with distance downwind.

The immediate zone in the lee of the building is termed the cavity or near wake and is characterised by high intensity turbulence and an area of uniform low pressure. Plume mass captured by the cavity region is re-emitted to the far wake as a ground-level volume source. The volume source is located at the base of the lee wall of the building but is only evaluated near the end of the near wake and beyond. In this region, the disruption caused by the building downwash gradually fades with distance to ambient values downwind of the building.

AERMOD has made substantial improvements in the area of plume growth rates in comparison to ISCST3[4,8]. ISCST3 approximates turbulence using six Pasquill-Gifford-Turner Stability Classes and bases the resulting dispersion curves upon surface release experiments. This treatment, however, cannot explicitly account for turbulence in the formulation. AERMOD is based on the more realistic modern planetary boundary layer (PBL) theory which allows turbulence to vary with height. This use of turbulence-based plume growth with height leads to a substantial advancement over the ISCST3 treatment.

Improvements have also been made in relation to mixing height[4,8]. The treatment of mixing height by ISCST3 is based on a single morning upper air sounding each day. AERMOD, however, calculates mixing height on an hourly basis based on the morning upper air sounding and the surface energy balance, accounting for the solar radiation, cloud cover, reflectivity of the ground and the latent heat due to evaporation from the ground cover. This more advanced formulation provides a more realistic sequence of the diurnal mixing height changes.

AERMOD also has the capability of modelling both unstable (convective) conditions and stable (inversion) conditions. The stability of the atmosphere is defined by the sign of the sensible heat flux. Where the sensible heat flux is positive, the atmosphere is unstable whereas when the sensible heat flux is negative the atmosphere is defined as stable. The sensible heat flux is dependent on the net radiation and the available surface moisture (Bowen Ratio). Under stable (inversion) conditions, AERMOD has specific algorithms to account for plume rise under stable conditions, mechanical mixing heights under stable conditions and vertical and lateral dispersion in the stable boundary layer.

AERMOD also contains improved algorithms for dealing with low wind speed (near calm) conditions. As a result, AERMOD can produce model estimates for conditions when the wind speed may be less than 1 m/s, but still greater than the instrument threshold.

APPENDIX II
Meteorological Data - AERMET

AERMOD incorporates a meteorological pre-processor AERMET(14). AERMET allows AERMOD to account for changes in the plume behaviour with height. AERMET calculates hourly boundary layer parameters for use by AERMOD, including friction velocity, Monin-Obukhov length, convective velocity scale, convective (CBL) and stable boundary layer (SBL) height and surface heat flux. AERMOD uses this information to calculate concentrations in a manner that accounts for changes in dispersion rate with height, allows for a non-Gaussian plume in convective conditions, and accounts for a dispersion rate that is a continuous function of meteorology.

The AERMET meteorological preprocessor requires the input of surface characteristics, including surface roughness (z_0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. A morning sounding from a representative upper air station, latitude, longitude, time zone, and wind speed threshold are also required.

Two files are produced by AERMET for input to the AERMOD dispersion model. The surface file contains observed and calculated surface variables, one record per hour. The profile file contains the observations made at each level of a meteorological tower, if available, or the one-level observations taken from other representative data, one record level per hour.

From the surface characteristics (i.e. surface roughness, albedo and amount of moisture available (Bowen Ratio)) AERMET calculates several boundary layer parameters that are important in the evolution of the boundary layer, which, in turn, influences the dispersion of pollutants. These parameters include the surface friction velocity, which is a measure of the vertical transport of horizontal momentum; the sensible heat flux, which is the vertical transport of heat to/from the surface; the Monin-Obukhov length which is a stability parameter relating the surface friction velocity to the sensible heat flux; the daytime mixed layer height; the nocturnal surface layer height and the convective velocity scale which combines the daytime mixed layer height and the sensible heat flux. These parameters all depend on the underlying surface.

The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc) and vary with seasons and wind direction. The assessment of appropriate land-use types is carried out in line with USEPA recommendations(5) and using the detailed methodology outlined by the Alaska Department of Environmental Conservation(16). AERMET has also been updated to allow for an adjustment of the surface friction velocity (u*) for low wind speed stable conditions based on the work of Qian and Venkatram (BLM, 2011). Previously, the model had a tendency to over-predict concentrations produced by near-ground sources in stable conditions.

Surface roughness

Surface roughness length is the height above the ground at which the wind speed goes to zero. Surface roughness length is defined by the individual elements on the landscape such as trees and buildings. In order to determine surface roughness length, the USEPA recommends that a representative length be defined for each sector, based on an upwind area-weighted average of the land use within the sector, by using the eight land use categories outlined by the USEPA. The inverse-distance weighted surface roughness length derived from the land use classification within a radius of 1km from Dublin Airport Meteorological Station is shown in Table A1.

Table A1 Surface Roughness based on an inverse distance weighted average of the land use within a 1km radius of Dublin Airport Meteorological Station.

Sector	Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter[Note 1]
0-360	100% Grassland	0.050	0.100	0.010	0.010

Note 1: Winter defined as periods when surfaces covered permanently by snow whereas autumn is defined as periods when freezing conditions are common, deciduous trees are leafless and no snow is present (Iqbal, 1983). Thus for the current location autumn more accurately defines "winter" conditions at the installation.

Albedo

Noon-time albedo is the fraction of the incoming solar radiation that is reflected from the ground when the sun is directly overhead. Albedo is used in calculating the hourly net heat balance at the surface for calculating hourly values of Monin-Obuklov length. A 10km x 10km square area is drawn around the meteorological station to determine the albedo based on a simple average for the land use types within the area independent of both distance from the station and the near-field sector. The classification within 10km from Dublin Airport Meteorological Station is shown in Table A2.

Table A2 Albedo based on a simple average of the land use within a 10km × 10km grid centred on Dublin Airport Meteorological Station.

Area-weighted Land Use Classification	Spring	Summer	Autumn	Winter[1]
0.5% Water, 30% Urban, 0.5% Coniferous Forest 38% Grassland, 19% Cultivated Land	0.155	0.180	0.187	0.187

(1) For the current location autumn more accurately defines "winter" conditions in Ireland.

Bowen Ratio

The Bowen ratio is a measure of the amount of moisture at the surface of the earth. The presence of moisture affects the heat balance resulting from evaporative cooling which, in turn, affects the Monin-Obukhov length which is used in the formulation of the boundary layer. A 10km x 10km square area is drawn around the meteorological station to determine the Bowen Ratio based on geometric mean of the land use types within the area independent of both distance from the station and the near-field sector. The classification within 10km from Dublin Airport Meteorological Station is shown in Table A3.

Table A3 Bowen Ratio based on a geometric mean of the land use within a 10km × 10km grid centred on Dublin Airport Meteorological Station.

Geometric Mean Land Use Classification	Spring	Summer	Autumn	Winter[1]
0.5% Water, 30% Urban, 0.5% Coniferous Forest 38% Grassland, 19% Cultivated Land	0.549	1.06	1.202	1.202

(1) For the current location autumn more accurately defines "winter" conditions in Ireland.