ARUP

Amazon Data Services Ireland Limited

IE Licence Application

Attachment 7-1-3-2 Air Emissions Impact Assessment RFI Revision

Reference

Issue | 2 July 2025

Job number 305131-00

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ARUP

Document Verification

Project title	IE Licence Application
Document title	Attachment 7-1-3-2 Air Emissions Impact Assessment RFI Revision
Job number	305131-00
Document ref	
File reference	

Revision	**Date**	**Filename**			
		Description			
			Prepared by	**Checked by**	**Approved by**
		Name			
		Signature			
		Filename			
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			Prepared by	**Checked by**	**Approved by**
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		Filename			
		Description			
			Prepared by	**Checked by**	**Approved by**
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

Tables

Figures

Appendices

Executive Summary

Amazon Data Services Ireland Limited (ADSIL) (‘*the Applicant*’) is applying to the Environmental Protection Agency (‘*the Agency*’) for an Industrial Emissions (IE) Licence for its data storage facility (hereafter referred to as the ‘*Installation*’) located at Data Centre Building B1, Kildare Innovation Campus (KIC), Barnhall Road, Leixlip, County Kildare, Ireland. The Installation comprises of 1 no. data storage facility building, termed ‘Data Centre Building B1’, along with ancillary elements which will include 14 no. critical emergency generators, 1 no. house emergency generator and 2 no. fire sprinkler pumps.

This report presents the assessment of air quality impacts as a result of the operation of the Installation which will require a continuous supply of electricity to operate. During normal operations, the Installation will be supplied electricity from the national grid. Outside of normal operations, the Installation will first be supplied electricity by an uninterruptible power supply (UPS) which will provide temporary power for a limited time while the generators start up, to allow the generators to activate without losing power to the data storage rooms and then by some or all of the onsite emergency generators.

The air dispersion modelling has been carried out using the United States Environmental Protection Agency’s (USEPA) regulated model AERMOD. The AERMOD model 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. The modelling of air emissions is carried out to assess concentrations of various pollutants at locations beyond the Installation site boundary. The modelling assessment includes the impact of operations of the Installation alone (termed ‘the Installation Operations Assessment’) and the cumulative impact of additional facilities with emissions near the Installation (termed ‘the Cumulative Operations Assessment’).

The Installation Operations Assessment modelled emissions of NO_x, NO_2, SO_2, CO, $PM_{2.5}$, PM_{10} and nitrogen deposition from the 14 no. critical and 1 no. house emergency generators at the Installation for the following circumstances:

- The continuous operation of the 14 no. critical and 1 no. house emergency generators at 100% load on the Installation site for 250 hours per year at factored rates;
- Load bank testing at 100% load for each of 14 no. critical and 1 no. house emergency generators for a maximum of one hour each, one generator at a time, sequentially four times per year;
- Scheduled weekly testing of all 14 no. critical and 1 no. house emergency generators at 25% load for 30 minutes each, one generator at a time, sequentially.

The Cumulative Operations Assessment considers the cumulative air impact of the operation of all emission sources on the KIC Masterplan site, as part of the KIC Masterplan site planning application (KCC Planning Ref. 23/60047). This air emissions impact assessment report reviews these results from a cumulative perspective (i.e. the modelled worst-case scenario conditions of the KIC Masterplan site which includes the Installation) and compares these results to relevant limits. The Cumulative Operations Assessment modelled NO_2 emissions at the KIC Masterplan site for the following circumstances:

- The continuous operation of the gas combustion turbines associated with the energy centre (although in reality they will not operate more than 330 days per year) in addition to the operation of 72 no. of 80 no. critical emergency generators for 250 hours per year at factored rates;
- Load bank testing at 100% load for each of the critical emergency generators for a maximum of one hour each, one generator at a time, sequentially four times per year; and
- Scheduled weekly testing of all 80 no. critical emergency generators at 25% load for 30 minutes each, one generator at a time, sequentially.

In addition, a cumulative modelling assessment was undertaken in accordance with AG4 to consider other EPA Installations within the impact area of the Installation.

Conclusion

In summary, emissions to atmosphere of NO_x, NO_2, SO_2, CO, PM_{10}, $PM_{2.5}$ and nitrogen deposition as the main polluting substances from the emergency generators, will comply with the air quality standards and applicable limits. Therefore, no significant impacts to the ambient air quality environment are predicted.

The nearest European site is Rye Water Valley/Carton SAC (site code 001398), located 1.6km north of the Installation and the next closest European site within the zone of influence is Glenasmole Valley SAC (site code 001209), located 13.8km southeast of the Installation. Negligible concentrations of nitrogen oxides and nitrogen deposition are predicted at these sites due to emissions from the Installation.

1. Introduction

Amazon Data Services Ireland Limited (ADSIL) (‘*the Applicant*’) is applying to the Environmental Protection Agency (‘*the Agency*’) for an Industrial Emissions (IE) Licence for its data storage facility (hereafter referred to as the ‘*Installation*’) located at Data Centre Building B1, Kildare Innovation Campus (KIC), Barnhall Road, Leixlip, County Kildare, Ireland.

The Installation site covers an area of c. 3.645 hectares (ha) in total and is situated within the wider KIC Masterplan site, which was granted planning permission in January 2024 by Kildare County Council (KCC) (KCC Planning Ref. 23/60047). An Environmental Impact Assessment Report (EIAR) and Appropriate Assessment (AA) Screening Report were prepared as part of this planning application and have been submitted with this IE Licence application, refer to Attachment 6-3-6 and Attachment 6-2-1 respectively. A revised AA Screening has been submitted as part of the RFI Response to this IE Licence application (see Attachment AA Screening Kildare Innovation Campus_Rev2).

ADSIL holds a long-term lease that concerns lands within the Installation site, which sits in the northwest corner of the KIC Masterplan site. The proposed IE licence application relates only to the area concerning the Installation. The remaining areas within the KIC Masterplan site are controlled by the KIC Masterplan site owner, hereafter referred to as *“the Landowner”*.

This report presents the assessment of air quality impacts as a result of the operation of the Installation. The Installation will comprise of 1 no. data storage facility building, termed ‘Data Centre Building B1’, along with ancillary elements, including 14 no. critical emergency generators, 1 no. house emergency generator and 2 no. fire sprinkler pumps.

The Installation will require a continuous supply of electricity to operate. During normal operations, the Installation will be supplied electricity from the national grid. Outside of normal operations, the Installation will first be supplied electricity by an uninterruptible power supply (UPS) which will provide temporary power for a limited time while the generators start up, to allow the generators to activate without losing power to the data storage rooms and then by some or all of the onsite emergency generators. Outside of routine testing and maintenance, the operation of these emergency generators will typically only be required under the following emergency circumstances:

- A loss, reduction or instability of grid power supply;
- Critical maintenance to power systems; and/or
- 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 (USEPA) regulated model AERMOD (USEPA, 2021). 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 (EPA, 2020). The modelling of air emissions is carried out to assess concentrations of various pollutants at locations beyond the Installation site boundary. The modelling assessment includes the impact of operations of the Installation alone (termed ‘the Installation Operations Assessment’) and the cumulative impact of additional facilities with emissions near the Installation (termed ‘the Cumulative Operations Assessment’).

The assessment determined the ambient air quality impact of the Installation and any air quality constraints that may be present. The emergency generators will be used solely for emergency operation (i.e. less than 500 hours per year) and thus the generators as proposed are exempt from complying with the emission limit values subject to Section 13(3) of the Medium Combustion Plant (MCP) Regulations.

HVO, where supply is available, will be the preferred source of fuel for the operation of the emergency generators at the Installation. Where insufficient quantities of HVO are available, a blend of diesel and HVO will be supplied to the generators, and in the absence of HVO, diesel will be supplied to the generators. Where a blend of HVO and diesel is supplied to the generators, the ratio of HVO : diesel supplied will vary with the availability of HVO. For the purposes of this assessment, a "worst-case scenario" where only diesel is used to power emergency generators is assumed. It should be noted that this is a worst-case scenario as the use of HVO, rather than diesel, offers a reduction in CO_2 emissions of up to 90% as well as significantly reduced NOx and particulates.[1]

The nearest IE Licensed facility is Intel Ireland Limited (P0207-05) located >2km north of the Installation, the nearest Integrated Pollution Control (IPC) Licensed facility is General Paints Limited (P0229) located >1.9km southwest of the Installation, and the nearest Waste Licensed facility is Westside Waste (W0162) located >5km northwest of the Installation. A cumulative modelling assessment was undertaken in accordance with AG4 to consider other EPA Installations within the impact area of the Installation.

Please note that since the submission of this IE Licence application, the model type of the critical emergency generators to be installed at the Installation site has been finalised. A revised air modelling assessment is provided which assesses the potential impact of the specific equipment being procured for the Installation. Input data used in the model was sourced from supplier data sheets. The results indicate that the procured equipment does not change the conclusions of the original assessment and all predicted concentrations remain in compliance with air quality standards.

2. Assessment Criteria

2.1 Ambient Air Quality Standards

The statutory ambient air quality standards in Ireland are outlined in Ambient Air Quality Standards Regulations 2022 (S.I. No. 739 of 2022) (hereafter referred to as the Air Quality Regulations), for a range of air pollutants.

The purpose of the Air Quality Regulations is to:

- Establish limit values and alert thresholds for concentrations of certain pollutants;
- Provide for the assessment of certain pollutants using methods and criteria common to other European member states;
- Ensure that adequate information on certain pollutant concentrations is obtained and made publicly available; and
- Provide for the maintenance and improvement of ambient air quality where necessary.

The limit values established under the Air Quality Regulations relevant to the assessment of human health for the pollutants of concern (NO_x, NO_2, SO_2, CO, $PM_{2.5}$ and PM_{10}) are included in Table 1. The standards are used to determine the potential impact of NO_x, NO_2, SO_2, CO, $PM_{2.5}$ and PM_{10} emissions from the Installation on ambient air quality.

Table 1: Ambient Air Quality Standards Regulations 2022

Pollutant	Limit Type	Value (µg/m^3)
NOx	Annual mean value / Critical level for protection of vegetation	30
NO_2	Hourly limit for protection of human health – not to be exceeded more than 18 times/year	200
	Annual limit for protection of human health	40

[1] HVO-Report-Alternative-Fuel-Assessment_Final.pdf

SO_2	Hourly limit for protection of human health – not to be exceeded more than 24 times/year	350
	Daily limit for protection of human health – not to be exceeded more than 3 times/year	125
CO	8-hour limit for protection of human health	10,000
PM_{10}	24-hour limit for protection of human health – not to be exceeded more than 35 times/year	50
	Annual limit for protection of human health	40
$PM_{2.5}$	Annual limit for protection of human health	25

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 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 generators.

The MCP regulation applies to combustion plants with a rated thermal input equal to or greater than 1 MW and less than 50 MW irrespective of the fuel that they use. The rated power input of each emergency generator at the Installation is greater than 1 MW and less than 50 MW, therefore, they are considered MCPs.

As per the regulation, the registration of a MCP is required where it is not already on a site holding an Industrial Emissions (IE) Licence. However, it is likely that the Installation will operate in advance of the granting of the IE Licence and during that period the MCP regulations will apply. During this period, the MCPs will need to be registered with the EPA under the regulations.

In accordance with Section 13, new medium combustion plants which do not operate more than 500 operating hours per year, as a rolling average over a period of three years, shall not be required to comply with the emission limit values set out in Part 2 of Schedule 2. As the generators will not run for more than 500 hours per year, the emission limit values do not apply to the Installation.

The Installation will require a continuous supply of electricity to operate. During normal operation, the Installation will be supplied electricity from the national grid. Outside of normal operations, the Installation will first be supplied electricity by an uninterruptible power supply (UPS) which will provide temporary power for a limited time while the generators start up, to allow the generators to activate without losing power to the data storage rooms and then by some or all of the onsite emergency generators. Outside of routine testing and maintenance, the operation of these emergency generators will typically only be required under the following emergency circumstances:

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

The generators are for emergency use only and are not anticipated to operate in excess of 500 hours per annum. Therefore, the generators are exempt from complying with the emission limit values subject to Section 13(3) of the MCP Regulations.

2.3 Ecologically Sensitive Areas

Emissions of NO_X have the potential to impact vegetation and sensitive plant species. The air quality standards set limit values for vegetation effects as per Table 1. As such it is typical to assess the impact of NO_X emissions from a data storage facility on any nearby sensitive ecological areas in close proximity to the data storage facility.

An Appropriate Assessment (AA) Screening Report prepared by Ecology Ireland Wildlife Consultants Ltd. was previously submitted to KCC as part of the planning application for the KIC Masterplan site (Planning Ref. 23/60047) and has been submitted with this IE Licence application (refer to Attachment 6-2-1 AA Screening Planning July 2023).

Ecology Ireland Wildlife Consultants Ltd. concluded that the KIC Masterplan site (including the Installation site) is not within or proximal to a European conservation site. The closest sensitive ecological area and European site is the Rye Water Valley/Carton Special Area of Conservation (SAC) (site code 001398) which is located 1.6km north of the Installation. The next closest European site is Glenasmole Valley SAC (site code 001209) located 13.8km southeast of the Installation.

Nitrogen deposition minimum critical loads are obtained from the Air Pollution Information System (APIS) website[2] for the Rye Water Valley/Carton SAC and Glenasmole Valley SAC and are outlined in Table 2 below.

Table 2: Natura 2000 Site's Minimum Critical Loads (APIS)

Natura 2000 Site Name	Minimum Critical Load (kg N/ha/yr)
Rye Water Valley/Carton SAC	5
Glenasmole Valley SAC	5

3. Assessment Methodology

3.1 Introduction

The Installation is situated in, and forms a part of, the KIC Masterplan site, which was granted permission by KCC (Planning Ref. 23/60047). The Environmental Impact Assessment Report (EIAR) prepared for the KIC Masterplan site planning application is included in this IE Licence application (see Attachment 6-3-6-EIAR Planning July 2023). The EIAR identifies several key proposed operations at the KIC Masterplan site which will have a potential impact on air quality during operation. The proposed operations are:

- 4 no. data centre buildings (including the Installation) which will consists of a total of 80 no. critical emergency generators of which 2 no. of the generators in each building are 'catcher' generators to provide redundancy to the remaining generators (i.e. 72 of the 80 no. generators will operate in the event of a power failure to the site); and the
- energy centre which will consists of 9 no. Combustion Turbine Generators (CTGs), of which 1 no. CTG is a back-up to provide redundancy to the remaining CTGs.

This report considers the air dispersion modelled to assess the operations of the Installation and cumulative operations of the Installation, the KIC Masterplan site and other EPA Installations within the impact area of the Installation.

[2] APIS website: APIS app | Air Pollution Information System.

The air dispersion modelling assesses the impact of the operation of the Installation on the surrounding environment by evaluating a set of air quality parameters.

3.1.1 Installation Operations Assessment

The Installation Operations Assessment modelled emissions of NO_x, NO_2, SO_2, CO, $PM_{2.5}$, PM_{10} and nitrogen deposition from the 14 no. critical and 1 no. house emergency generators at the Installation using EPA methodology:

- The continuous operation of the 14 no. critical and 1 no. house emergency generators at 100% load on the Installation site for 250 hours per year at factored rates;
- Load bank testing at 100% load for each of 14 no. critical and 1 no. house emergency generators for a maximum of one hour each, one generator at a time, sequentially four times per year;
- Scheduled weekly testing of all 14 no. critical and 1 no. house emergency generators at 25% load for 30 minutes each, one generator at a time, sequentially.

3.1.2 Cumulative Operations Assessment

The Cumulative Operations Assessment modelled NO_2 emissions at the KIC Masterplan site using EPA methodology:

- The continuous operation of the CTGs associated with the energy centre (although in reality they will not operate more than 330 days per year) in addition to the operation of 72 no. of 80 no. critical emergency generators (no more than 72 will be in operation at any one time) for 250 hours per year at factored rates at 100% load;
- Load bank testing at 100% load for each of the critical emergency generators for a maximum of one hour each, one generator at a time, sequentially four times per year; and
- Scheduled weekly testing of all 80 no. critical emergency generators at 25% load for 30 minutes each, one generator at a time, sequentially.

In addition, a cumulative modelling assessment was undertaken in accordance with AG4 to consider other EPA Installations within the impact area of the Installation.

3.1.3 Assessment of Potential Ecological Impacts

The assessment of potential ecological impacts modelled the nitrogen deposition emissions at the Installation using EPA methodology.

This assessment assessed the potential impacts of the Installation on ecological sites of importance within the zone of influence and has been prepared in accordance with the *EPA 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 (2024).*

3.2 Air Dispersion Modelling Methodology

The air dispersion modelling study has been carried out using the internationally approved Breeze AERMOD computer package to predict the potential effect of emissions on ambient air quality. Two approaches are applied for the assessment of the emergency scenario:

1. USEPA Methodology**:** The scenario modelled includes emissions from the emergency operation of the generators factored down by the maximum number of operational hours per year (as described in EPA AG4 Volume 2 Appendix 7; for emergency or intermittent operations, an average hourly emission rate should be used rather than the maximum hourly rate).
2. UKEA Methodology**:** Statistical approach for modelling emergency generators and determines the number of hours for which the generators can operate without exceeding the ambient air quality

standards at the 95th%ile confidence level. For modelling purposes, all emergency generators are assumed to run simultaneously for every hour of the year at the actual maximum hourly emission rate for NO_x, and results are predicted for every hour of the year at the worst-case sensitive receptor.

3.2.1 AERMOD

Emissions from the Installation are modelled using the AERMOD dispersion model (Version 21112) which has been developed by the USEPA. 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 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, referred to as Process Contribution (PC), 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. 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 250 hours per year calculated according to USEPA methodology, in reality generators are likely to be used for maintenance and testing purposes only. As a result, the maximum hourly emission rates from the generators are reduced by 250/8760 to give an average hourly emission rate and the generators are modelled over a period of one full year for the Installation and Cumulative Operations Assessments.

Features and meteorological information used for Cumulative Operations Assessments are outlined in the air modelling presented in the EIAR submitted as part of the KIC Masterplan site planning application (KCC Planning Ref. 23/60047).

3.2.2 UKEA Methodology

The UK EA methodology considers 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 operational hours of the back-up 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 has recommended this probability should be multiplied by a factor of 2.5 and thus the 98th percentile confidence level should be used (UKEA, 2019).

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.

3.2.3 Terrain

The AERMOD air dispersion model has a terrain pre-processor AERMAP (USEPA, 2019) which was used to map the physical environment in detail over the receptor grid. The digital terrain input data used in the

AERMAP pre-processor was obtained from the Shuttler Radar Topography Mission (SRTM). This data was 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 (USEPA, 2021) 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.*' (USEPA, 2021).

The terrain in the region of the Installation site is complex in the sense that the maximum terrain in the modelling domain peaks at 92m which is above the release height of the emissions. However, in general, the region of the Installation site has gently sloping terrain particularly in the immediate vicinity of the site.

The modelling incorporated the following features:

- Two receptor grids:
  - Outer grid – 10km x 10km centred on Installation with spacing of 200m
  - Inner grid – 5km x 5km centred on Installation with spacing of 50m.

3.2.4 Surface Characteristics

AERMOD simulates the dispersion process using planetary boundary layer (PBL) scaling theory (USEPA, 2021). 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 (USEPA, 2019) 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 1km for surface roughness in line with EPA recommendations.

In relation to AERMOD, the most pertinent features are:

- The surface characteristics should be those of the meteorological site (Casement Aerodrome) rather than the Installation;
- Surface roughness should use a default 1km radius upwind of the meteorological tower and should be based on an inverse-distance weighted geometric mean. If land use varies around the Installation, 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 (USEPA, 2008) 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 (ADEC, 2009). This approach has been applied to the current Installation with full details provided in Appendix II.

3.2.5 Meteorological Data

The selection of the appropriate meteorological data for the Installation and Cumulative Operations Assessments has followed the AG4 Guidance issued by the EPA (EPA, 2020). Meteorological data for the Installation Operations Assessment is outlined below and meteorological data pertaining to the Cumulative Operations Assessment is outlined in the air modelling presented in the EIAR submitted as part of the KIC Masterplan site planning application (KCC Planning Ref. 23/60047), refer to Attachment 6-3-6 EIAR Planning July 2023.

A primary requirement is that the data used should have a data capture of greater than 90% for all parameters. Casement Aerodrome meteorological station, which is located approximately 6 km south-east of the Installation, collects data in the correct format and has a data collection of greater than 90%. Long-term hourly observations at Casement Aerodrome meteorological station provide an indication of the prevailing wind conditions for the region (see Figure 1 and Appendix II) (Met Eireann, 2022). Results indicate that the prevailing wind direction is westerly to south-westerly in direction over the period 2016 – 2020.

In line with the EPA AG4 Guidance, five consecutive years of meteorological data from a suitable station, as described above, must be used. Casement Aerodrome was identified as the most appropriate station, with available data for the period 2016 – 2020. Thus, this timeframe was selected for the Installation Operations Assessment.

It should be noted that the Cumulative Operations Assessment was undertaken as part of the EIAR submitted with the planning application to KCC for the KIC Masterplan site. Meteorological data used for this assessment is from 2017 to 2021. However, it should be noted that the years of the worst case results from the two assessments overlap.

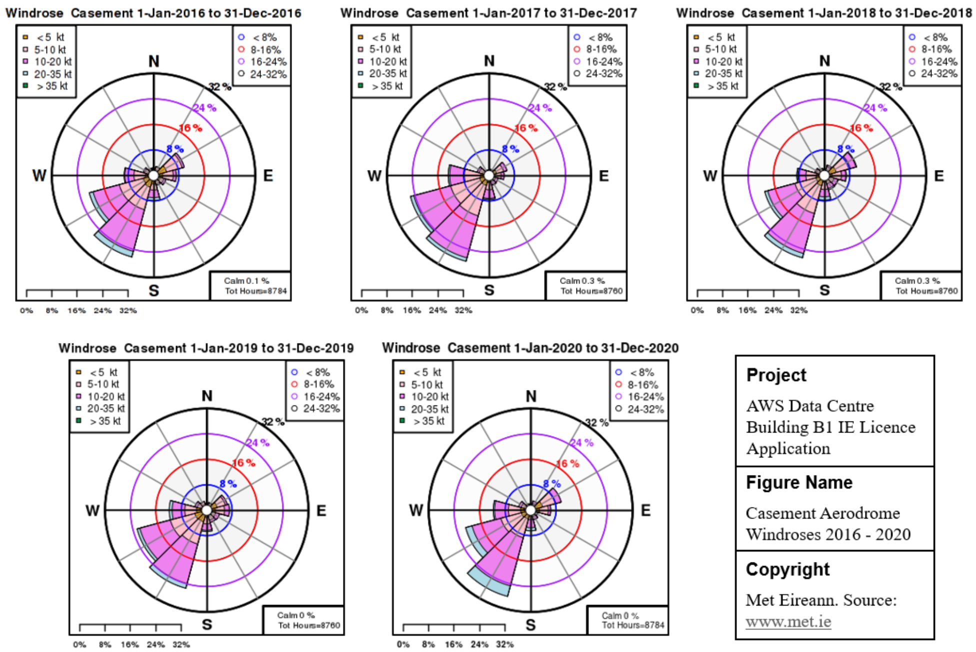

Figure 1: Windroses for Casement Aerodrome 2016-2020 (Source: www.met.ie).

3.2.6 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 (USEPA, 1985).

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) (Schulman, 2000; Paine, 1997) 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 (Paine, 1997).The stack heights are 18m and the overall building height is 13.6m. 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.

It should be noted that a stack height of 18m was used for the purposes of the air modelling assessment carried out as part of the EIAR included in the KIC Masterplan site planning application. The air modelling assessment undertaken as part of the original documentation submitted for this IE Licence application aligned with the approach used in the EIAR prepared as part of the KIC Masterplan site planning application, hence, a stack height of 18m was assumed.

However, as per the building drawings submitted with the planning application for the KIC Masterplan site, which includes the Installation, the actual stack height is18.6m. Therefore, in this revised air modelling assessment submitted as part of the RFI Response to this IE Licence application, a stack height of 18.6m was assumed.

3.2.7 Emission data

Please note that since the submission of this IE Licence application, the model type of the critical emergency generators to be installed at the Installation site has been finalised. This revised air modelling and impact assessment was completed to assess the impact of the specific equipment being procured for the Installation.

The emission data used in the revised modelling assessment is outlined in Table 3 and Table 4 below.

Table 3: Summary of Process Emission Data – Critical Emergency Generators.

Stack conditions	Stack Height Above Ground Level (m)	Exit Diameter (m)	Velocity (m/s)	Temp (K)	Volume Flow (Nm^3 /hr at 15% Ref. O_2) Exit	Pollutant	Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)
Emergency operations and test - 100% load	18.6	0.6	37.7	763.75	22,820	NO_x	817.8	0.15 Note 1 / 5.18 Note 2
						PM	10.6	0.002 Note 1 / 0.07 Note 2
						SO_2	3.7	0.0007 Note 1 / 0.02 Note 2
						CO	175.2	0.03 Note 1 / 1.11 Note 2
Test - 25% load			14.9	701.55	9,827	NO_x	446.3	2.83 Note 3
						PM	16.6	0.11 Note 3
						SO_2	3.7	0.02 Note 3
						CO	180	1.14 Note 3

Note 1: Reduced emission rates based on USEPA protocol (assuming 250 hours/annum) used to model emissions during emergency operation of generators

Note 2: Maximum emission rates for diesel generators (based on 100% load) used to model emissions during emergency operation of generators for UK EA assessment methodology and for Test 2 assumptions for USEPA assessment methodology.

Note 3: Emission rates used to model emissions during Test 1 assumed to occur once per week, per generator.

Table 4: Summary of Process Emission Data – House Emergency Generators.

Stack conditions	Stack Height Above Ground Level (m)	Exit Diameter (m)	Velocity (m/s)	Temp (K)	Volume Flow (Nm^3 /hr at 15% Ref. O_2) Exit	Pollutant	Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)
Emergency operations and test - 100% load	18.6	0.4	27.59	782.45	7,243	NO_x	724.9	0.04 Note 1 / 1.46 Note 2
						PM	4.5	0.0003 Note 1 / 0.009 Note 2

						SO_2	3.7	0.0002 [Note 1] / 0.007 [Note 2]
						CO	38.2	0.03 [Note 1] / 1.11 [Note 2]
Test - 25% load			8.71	629.1	2,846	NO_x	868.9	1.75 [Note 3]
						PM	18.7	0.04 [Note 3]
						SO_2	3.7	0.007 [Note 3]
						CO	183.4	1.14 [Note 3]

Note 1: Reduced emission rates based on USEPA protocol (assuming 250 hours/annum) used to model emissions during emergency operation of generators

Note 2: Maximum emission rates for diesel generators (based on 100% load) used to model emissions during emergency operation of generators for UK EA assessment methodology and for Test 2 assumptions for USEPA assessment methodology.

Note 3: Emission rates used to model emissions during Test 1 assumed to occur once per week, per generator.

3.2.8 Conversion of NO_X to NO_2

To carry air dispersion modelling of ground level NO_2 concentrations, the Ozone Limiting Method (OLM) approach was followed to convert NO_X to NO_2. For this conversion, an initial NO_2 /NO_X ratio of 0.1 and a background ozone level of 58 µg/m^3 based on a review of EPA data for Zone C locations was assumed.

3.2.9 Nitrogen deposition calculation

The nitrogen deposition at the ecologically sensitive areas was calculated in line with EPA Guidance Note AG4 and IN2. The approach taken estimated the deposition flux by applying specific deposition velocities to maximum annual average ground-level concentrations of designated sites.

A deposition velocity (m/s) of 0.0015 was used for the calculations in line with the assumptions that the designated sites assessed were of the Grassland type.

The dry deposition flux was calculated using the following formula:

Dry Deposition Flux (µg m^{-2} s^{-1}) = ground-level process contribution (µg/m^3) x deposition velocity (m/s)

4. Background Concentrations of Pollutants

Air quality monitoring programs 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*' (EPA, 2024a), 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 (EPA, 2024b). Dublin is defined as Zone A and Cork as Zone B. Zone C is composed of 23 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, the Installation site is categorized as Zone C (EPA, 2024c).

Refer to Table 5 for further details on the annual mean background concentrations (ug/m^3) at Zone C monitoring stations (Dundalk, Kilkenny and Portlaoise) for the following pollutants: NO_2, SO_2, CO, $PM_{2.5}$ and PM_{10}.

Table 5: Annual Mean Background Concentrations In Zone C Locations (ug/m^3) (EPA, 2024a).

Year	Dundalk	Kilkenny	Portlaoise
	Annual Mean Background Concentration (ug/m^3)		

	NO_2	SO_2	$PM_{2.5}$	PM_{10}	CO	NO_2	SO_2	$PM_{2.5}$	PM_{10}	CO	NO_2	SO_2	$PM_{2.5}$	PM_{10}	CO
2018	14	3.8	-	15	500	6	-	-	-	-	11	3	-	11	200
2019	12	1.5	-	14	100	5	-	-	18	-	11	1.3	-	15	100
2020	10	2	-	13	300	4	-	-	19	-	11	1.6	8	12	100
2021	11	2.3	-	11.7	100	4	-	-	16.7	-	8	1.9	8.1	11.4	400
2022	10.4	3.8	19.8	12.3	300	4.8	-	-	17.5	-	9	2.9	8.1	12	200
2023	9.3	2.1	8.9	13.2	300	4.4	-	-	13.9	-	8.3	4	7.4	11	300
Max. Annual Mean	**14**	3.8	**19.8**	15	**500**	6	**-**	**-**	**19**	-	11	**4**	8.1	15	400
Limit	40	20	25	40	10,000	40	20	25	40	10,000	40	20	25	40	10,000

Note: Grey entries are those where measurements were not published by the EPA for that monitoring station

Background concentrations were combined with predicted process contribution to obtain the PEC. In line with the EPA Guidance Note AG4, the following methods were used to combine short-term peak concentrations with annual background concentrations:

- CO 8-hour: 8-hr process contribution CO + (annual mean background CO);
- NO_2 1-hour: 99.8th%ile process contribution NO_x + (2 x annual mean background NO_2);
- SO_2 1-hour: 99.7th%ile hourly process contribution SO_2 + (2 x annual mean background SO_2);
- SO_2 24-hour: 99.2th%ile 24-hr mean process contribution SO_2 + (2 x annual mean background SO_2); and
- PM_{10} 24-hour: 90.4th%ile 24-hr mean process contribution PM_{10} + (annual mean background PM_{10}).

Furthermore, annual predicted PECs for NO_2, SO_2, PM_{10}, and $PM_{2.5}$ are calculated in line with the EPA Guidance Note AG4 as follows:

- Process contribution + (1 x annual mean background).

Background concentrations of NOx at the Rye Water Valley/Carton SAC and Glenasmole Valley SAC , were obtained in June 2025 from the APIS website[3], refer to Table 6. These values are used for the purposes of a background concentrations.

Table 6: Maximum modelled background concentration of NOx (www.apis.co.uk)

Site Name	Site Code	Distance from Installation (km)	Background Concentration NO_X (ug/m^3)
Rye Water Valley/Carton SAC	001398	1.6km northwest	7.2
Glenasmole Valley	001209	13.8km southeast	4

Maximum estimated background levels of nitrogen deposition at the Rye Water Valley/Carton SAC are 6.7kg/ha/yr as per the APIS database.

[3] APIS website: APIS app | Air Pollution Information System.

5. Modelling Results

5.1 Introduction

The Installation Operations Assessment NO_2, SO_2, CO, PM_{10}, and $PM_{2.5}$ modelling results at the IE Licence site boundary are detailed in Table 7, Table 8, Table 9, Table 10, and Table 11. Details regarding the methodologies used and operations modelled are included in Section 3.

5.1.1 NO_2 Results

The results indicate that the ambient ground level concentrations are within the relevant air quality standards for NO_2, refer to Table 7. For the maximum year modelled, emissions from the Installation lead to an ambient NO_2 concentration (including background) which is 66% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 80% of the annual limit value at the maximum off-site receptor. Concentrations decrease with distance from the Installation. The geographical variations in the 1-hour mean (99.8th percentile) and annual mean NO_2 ground level concentrations for the Installation Operations Assessment are illustrated as concentration contours in Figure 2.

Table 7: Dispersion Model Results for NO_2 - Emergency Operations Scenario & Scheduled Testing at the Installation

Pollutant /Year	Averaging Period	Background Conc. (μg/m³)	Process Conc. (μg/m³)	PEC (μg/m³)	AQS Value (μg/m³)	%age of AQS Note 1
NO_2/2016	Annual	14	16.05	30.05	40	75
	99.8% of 1-hour	28	97.96	125.96	200	63
NO_2/2017	Annual	14	17.98	31.98	40	80
	99.8% of 1-hour	28	98.61	126.61	200	63
NO_2/2018	Annual	14	16.78	30.78	40	77
	99.8% of 1-hour	28	104.95	132.95	200	66
NO_2/2019	Annual	14	15.99	29.99	40	75
	99.8% of 1-hour	28	98.54	126.54	200	63
NO_2/2020	Annual	14	15.74	29.74	40	74
	99.8% of 1-hour	28	98.51	126.51	200	63

Note 1 Air Quality Standards 2022

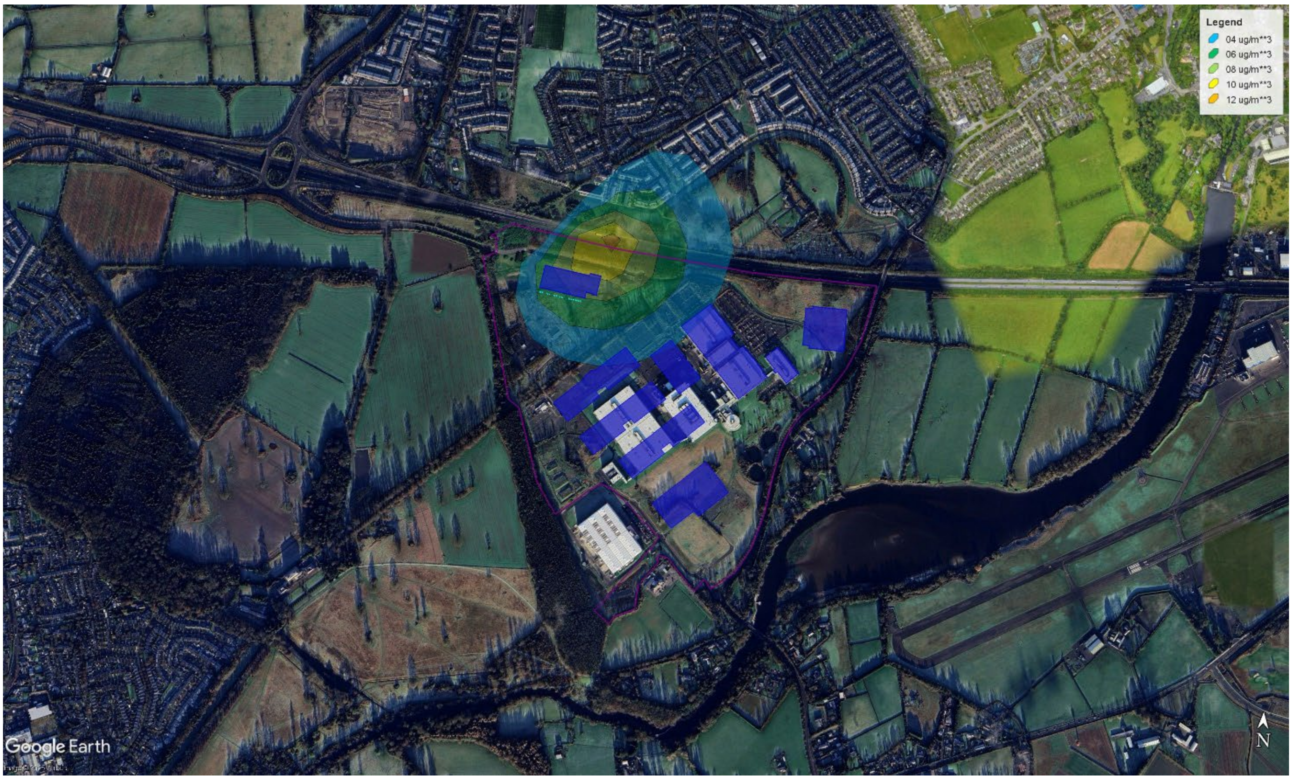

Figure 2: Maximum annual NO_2 Concentrations 2017 (ug/m^3) (Excluding background)

5.1.2 SO_2 Results

The results indicate that the ambient ground level concentrations are within the relevant air quality standards for SO_2, refer to Table 8. For the maximum year modelled, emissions from the Installation lead to an ambient SO_2 concentration (including background) which is 3% of the maximum ambient 1-hour limit value (measured as a 99.73th percentile), 7% of the 24-hour limit value (measured as a 99.18th percentile), and 21% of the annual limit value at the maximum off-site receptor. Concentrations decrease with distance from the Installation. The geographical variations 24-hour mean SO_2 (99.18th percentile) ground level concentrations for the Installation Operations Assessment are illustrated in Figure 3.

Table 8: Dispersion Model Results for SO_2 - Emergency Operations Scenario & Scheduled Testing at the Installation

Pollutant /Year	Averaging Period	Background Conc. (µg/m^3)	Process Conc. (µg/m^3)	PEC (µg/m^3)	AQS Value (µg/m^3)	%age of AQS Note 1
SO_2/2016	(99.73%) 1-hour	8	2.27	10.27	350	3
	(99.18%) 24-hours	8	0.54	8.54	125	7
	Annual	4	0.09	4.09	20	20
SO_2/2017	(99.73%) 1-hour	8	2.25	10.25	350	3
	(99.18%) 24-hours	8	0.57	8.57	125	7
	Annual	4	0.11	4.11	20	21
SO_2/2018	(99.73%) 1-hour	8	2.68	10.68	350	3
	(99.18%) 24-hours	8	0.54	8.54	125	7
	Annual	4	0.10	4.10	20	21
SO_2/2019	(99.73%) 1-hour	8	2.59	10.59	350	3
	(99.18%) 24-hours	8	0.61	8.61	125	7
	Annual	4	0.10	4.10	20	20
SO_2/2020	(99.73%) 1-hour	8	2.47	10.47	350	3

Pollutant /Year	Averaging Period	Background Conc. (µg/m³)	Process Conc. (µg/m³)	PEC (µg/m³)	AQS Value (µg/m³)	%age of AQS Note 1
	(99.18%) 24-hours	8	0.53	8.53	125	7
	Annual	4	0.10	4.10	20	20

Note 1 Air Quality Standards 2022

Figure 3: Maximum 24-Hour Mean SO_2 Concentrations (ug/m³) 2019 (Excluding Background)

5.1.3 CO Results

The results indicate that the ambient ground level concentrations are within the relevant air quality standards for CO, refer to Table 9. For the maximum year modelled, emissions from the Installation lead to an ambient CO concentration (including background) which is 6% of the maximum ambient 8-hour limit value at the maximum off-site receptor. Concentrations decrease with distance from the Installation. The geographical variations in the annual mean CO level concentrations for the Installation Operations Assessment are illustrated as concentration contours in Figure 4.

Table 9: Dispersion Model Results for CO - Emergency Operations Scenario & Scheduled Testing at the Installation

Pollutant /Year	Averaging Period	Background Conc. (µg/m³)	Process Conc. (µg/m³)	PEC (µg/m³)	AQS Value (µg/m³)	%age of AQS Note 1
CO/2016	8-hour	500	97.79	597.79	10,000	6
CO/2017	8-hour	500	85.05	585.05	10,000	6
CO/2018	8-hour	500	110.31	610.31	10,000	6
CO/2019	8-hour	500	95.32	595.32	10,000	6
CO/2020	8-hour	500	108.89	608.89	10,000	6

Note 1 Air Quality Standards 2022

Figure 4: Maximum 8-Hour Mean CO Concentrations (ug/m^3) 2018 (Excluding Background)

5.1.4 PM_{10} Results

The results indicate that the ambient ground level concentrations are within the relevant air quality standards for PM_{10}, refer to Table 10. For the maximum year modelled, emissions from the Installation lead to an ambient PM_{10} concentration (including background) which is 39% of the maximum ambient 24-hour limit value (measured as a 90th percentile) and 48% of the annual limit value at the maximum off-site receptor. Concentrations decrease with distance from the Installation. The geographical variations in the annual mean PM_{10} level concentrations for the Installation Operations Assessment are illustrated as concentration contours in Figure 5.

Table 10: Dispersion Model Results for PM_{10} - Emergency Operations Scenario & Scheduled Testing at the Installation

Pollutant / Year	Averaging Period	Background Conc. (μg/m^3)	Process Conc. (μg/m^3)	PEC (μg/m^3)	AQS Value (μg/m^3)	%age of AQS Note 1
PM_{10}/2016	Annual	19	0.30	19.30	40	48
	90% of 24-hours	19	0.59	19.59	50	39
PM_{10}/2017	Annual	19	0.33	19.33	40	48
	90% of 24-hours	19	0.62	19.62	50	39
PM_{10}/2018	Annual	19	0.33	19.33	40	48
	90% of 24-hours	19	0.61	19.61	50	39
PM_{10}/2019	Annual	19	0.31	19.31	40	48
	90% of 24-hours	19	0.58	19.58	50	39
PM_{10}/2020	Annual	19	0.31	19.31	40	48
	90% of 24-hours	19	0.57	19.57	50	39

Note 1 Air Quality Standards 2022

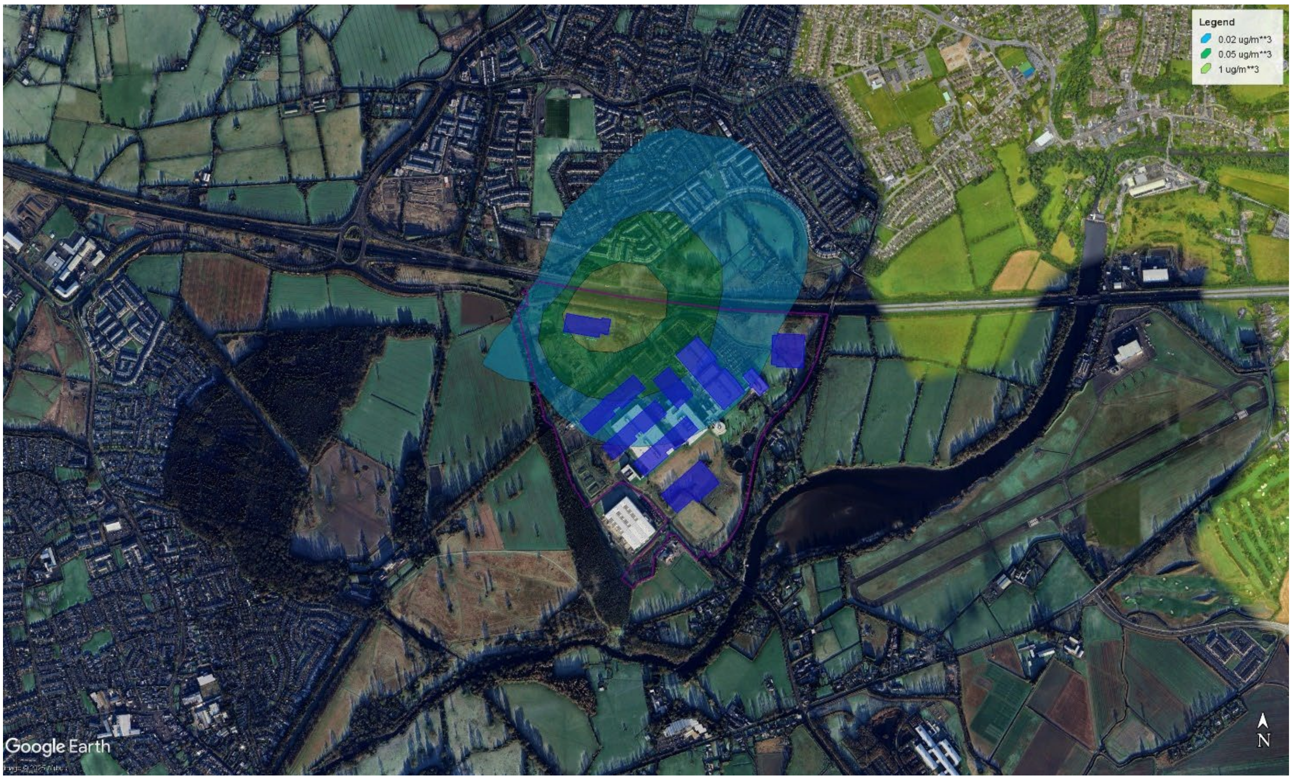

Figure 5: Annual Mean PM_{10} Concentrations 2017 (ug/m^3) (Excluding Background)

5.1.5 $PM_{2.5}$ Results

The results indicate that the ambient ground level concentrations are within the relevant air quality standards for $PM_{2.5}$. For the maximum year modelled, emissions from the Installation lead to an ambient $PM_{2.5}$ concentration (including background) which is 81% of the maximum ambient annual limit value at the maximum off-site receptor. Concentrations decrease with distance from the Installation.

Table 11: Dispersion Model Results for $PM_{2.5}$ - Emergency Operations Scenario & Scheduled Testing at the Installation

Pollutant / Year	Averaging Period	Background Conc. (µg/m^3)	Process Conc. (µg/m^3) Note 2	PEC (µg/m^3)	AQS Value (µg/m^3)	%age of AQS Note 1
$PM_{2.5}$/2016	Annual	19.8	0.31	20.11	25	80
$PM_{2.5}$/2017	Annual	19.8	0.35	20.15	25	81
$PM_{2.5}$/2018	Annual	19.8	0.34	20.14	25	81
$PM_{2.5}$/2019	Annual	19.8	0.32	20.12	25	80
$PM_{2.5}$/2020	Annual	19.8	0.32	20.12	25	80

Note 1: Air Quality Standards 2022

Note 2: Based on an assumption of PM_{10} to $PM_{2.5}$ ratio of 19:19.8 from maximum background concentrations outlined in Table 5.

5.2 Cumulative Operations Assessment

5.2.1 Introduction

This section considers the following:

- Assessment of cumulative effects from the KIC Masterplan and Installation using USEPA methodology;
- Assessment of cumulative effects from the KIC Masterplan and Installation using UK EA methodology; and

- Assessment of other EPA Installations.

5.2.2 Cumulative effects - USEPA Methodology

The Cumulative Operations Assessment NO_2 modelling results are detailed in Table 12, Figure 6 and Figure 7.

The results indicate that the ambient ground level concentrations are within the relevant air quality standards for NO_2. For the maximum year modelled, emissions from the KIC Masterplan site leads to an ambient NO_2 concentration (including background) which is 65% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 99% of the annual limit value at the maximum off-site receptor. Concentrations decrease with distance from the KIC Masterplan site.

Table 12: Dispersion Model Results for NO_2 – Cumulative Operations Assessment (KCC, 2023) | AWN Consulting Limited ©

Pollutant /Year	Annual Mean Background Conc. ($\mu g/m^3$) Note 1	Averaging Period	Process Contribution ($\mu g/m^3$)	PEC ($\mu g/m^3$)	Standard ($\mu g/m^3$) Note 2	PEC as a %age of Standard Value
NO_2/2017	14	Annual Mean	25.4	39.4	40	99
	28	99.8^{th}%ile of 1-hr means	98.7	126.7	200	63
NO_2/2018	14	Annual Mean	23.5	37.5	40	94
	28	99.8^{th}%ile of 1-hr means	98.7	126.7	200	63
NO_2/2019	14	Annual Mean	23.1	37.1	40	93
	28	99.8^{th}%ile of 1-hr means	98.6	126.6	200	63
NO_2/2020	14	Annual Mean	24.7	38.7	40	97
	28	99.8^{th}%ile of 1-hr means	101.4	129.4	200	65
NO_2/2021	14	Annual Mean	22.9	36.9	40	93
	28	99.8^{th}%ile of 1-hr means	100.8	128.8	200	64

Note 1 Please note that this value has been revised to reflect more recent background data obtained as part of this assessment outlined in Section 4). Thus, this value differs from the one presented in the EIAR submitted as part of the planning application to KCC for the KIC Masterplan site.

Note 2 Air Quality Standards 2022

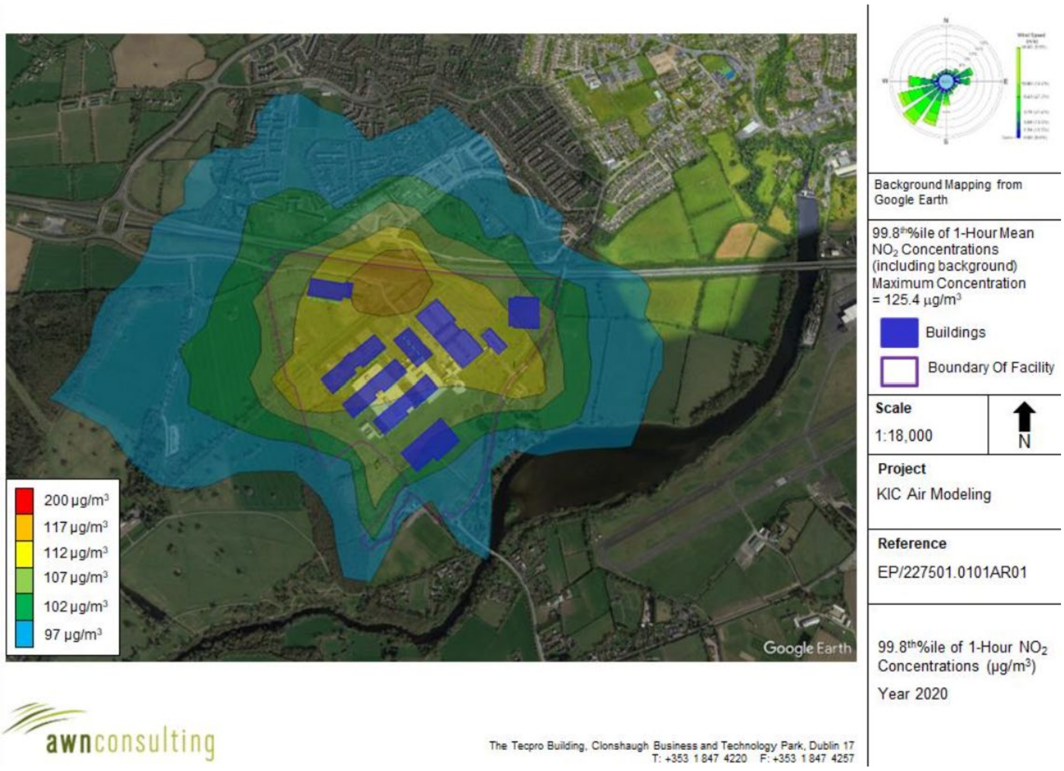

Figure 6: Max 1-Hour NO_2 Concentrations 2020 (as 99.8%ile) (ug/m^3) (Cumulative Operations Assessment) (KCC, 2023) | AWN Consulting Limited ©

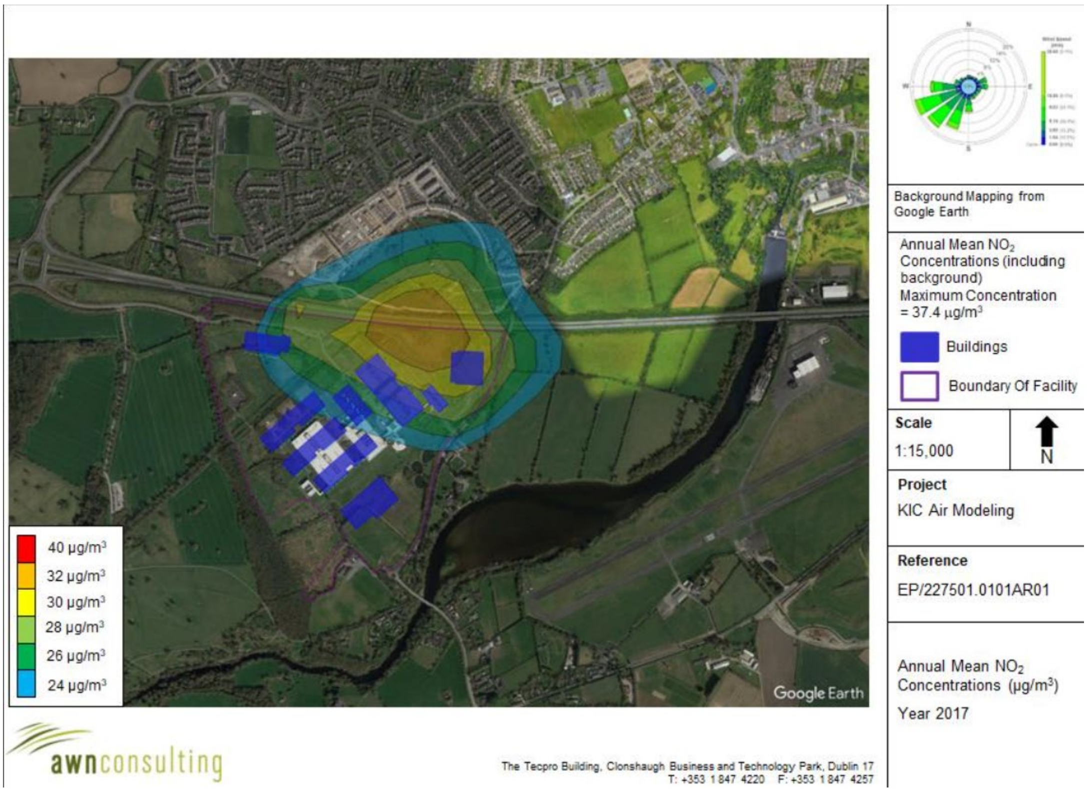

Figure 7: Annual Mean NO_2 Concentrations 2017 (ug/m^3) (Cumulative Operations Assessment) (KCC, 2023) | AWN Consulting Limited ©

5.2.3 Cumulative Effects - UK EA Methodology

The results in Table 13 indicate that in the maximum year, the critical emergency generators of the data centre element of the KIC Masterplan site, which includes the Installation, can operate for up to 345 hours per year in addition to the continuous operation of the CTGs of the energy centre, as a worst-case, before there is a likelihood of an exceedance of the ambient air quality standard (at a 98th percentile confidence level). However, the UK guidance recommends that there should be no running time restrictions placed on emergency generators which provide power on site only in the event of a grid emergency.

The results have been compared to the 98th percentile confidence level to indicate if an exceedance is likely at various operational hours for the emergency generators. Refer to Table 13 and Figure 8.

Table 13: Hypergeometric Statistical Results at Worst-case Residential Receptor – Cumulative Operations Assessment (KCC, 2023) | AWN Consulting Limited ©

Pollutant/ Year	Hours of operation (Hours) (98^{th}%ile) Allowed Prior To Exceedance Of Limit Value	UK Guidance – Probability Value = 0.02 (98^{th}%ile) Note 1
NO_2/2017	446	0.02
NO_2/2018	360	
NO_2/2019	383	
NO_2/2020	345	
NO_2/2021	440	

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

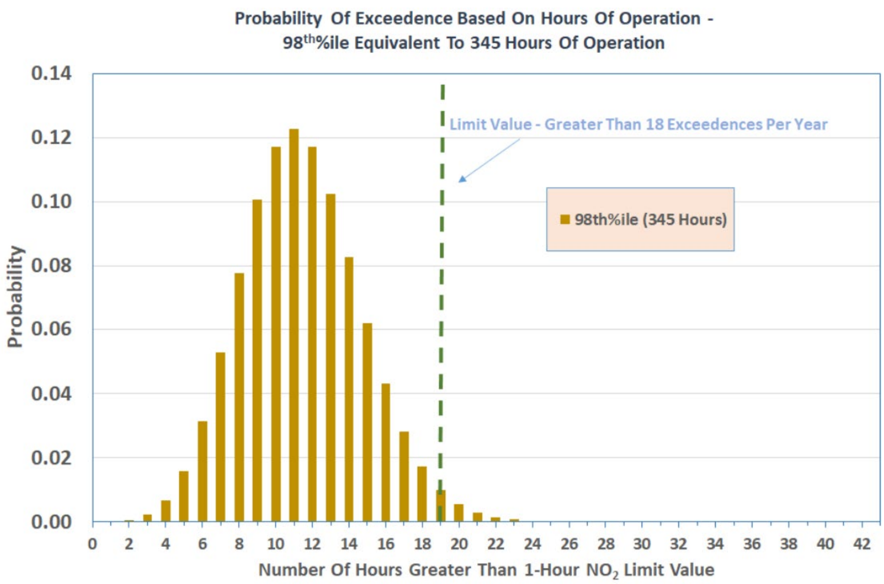

Figure 8: Probability of Exceedance of 1-Hour NO_2 Ambient Air Quality Limit Value based on Hours of Operation for Emergency Generators for KIC Masterplan site (Cumulative Operations Assessment) (KCC, 2023) | AWN Consulting Limited ©

Nonetheless, the generators will only operate for 250 hours per year.

5.2.4 Cumulative Effects – Other IE Licenced Sites

As outlined in Appendix E of the Air Dispersion Modelling from Industrial Installations Guidance Note (AG4), when a nearby major air emission point source is identified close to a proposed installation, a structured methodology is required to determine whether it must be included in the dispersion modelling and for which pollutants. Once a review has been completed and a cumulative assessment deemed necessary, a further methodology must be applied to determine whether the cumulative impact is significant.

In this case, a review was undertaken in line with this guidance, and no nearby installations were identified that would justify inclusion in the modelling assessment. The dispersion modelling for the Installation has been used to define the impact area as described in AG4 Appendix E, following the USEPA methodology. This defines the impact area as:

"a circular area with a radius extending from the source to the most distant point where dispersion modelling predicts a 'significant' ambient impact (i.e. >5% of an Air Quality Standard) will occur, irrespective of pockets of insignificant impact occurring within it."

For NO_2, the significant area of ambient impact corresponds to 2 µg/m^3. Based on the results of the dispersion model, the 2 µg/m^3 contour—representing the boundary of significant ambient impact—is limited to the immediate surroundings of the Installation. This defines the Installation's impact area, which does not overlap with any other licensed point sources in the region. Refer to Figure 9 for a visual representation for the impact area of the Installation.

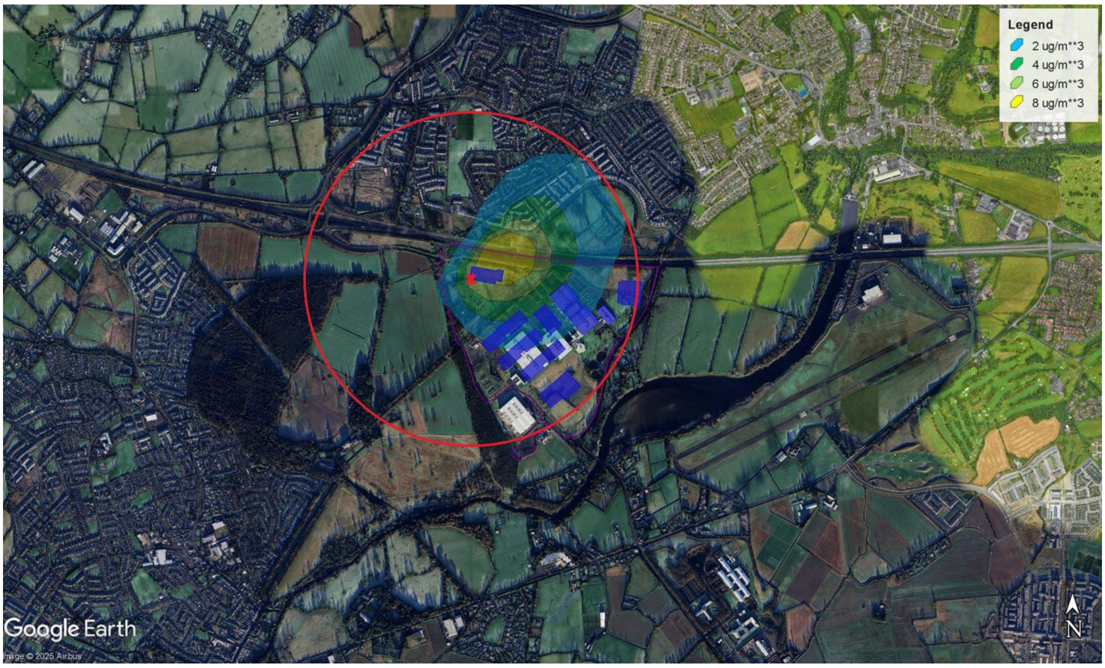

Figure 9: Maximum annual NO_2 Concentrations 2017 (ug/m^3) (Excluding background) - Impact Area for Cumulative Assessment.

In line with AG4, only nearby sources expected to cause a significant concentration gradient within the defined impact area are required to be included in the cumulative assessment. The impact area extends approximately 1km from the Installation. The nearest EPA Installations to the Installation are P0207-05 (Intel Ireland Ltd. at over 2km from the Installation) and P0229 (General Paints Ltd. at approximately 1.9km from the Installation). As no sources are located within, or in, proximity to the impact area, no further assessment is required.

5.3 Assessment of Potential Ecological Impacts

The assessment has been prepared in accordance with the *EPA 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 (2024).*

This assessment considers European Natura 2000 sites within the zone of influence of the Installation. For the purposes of this assessment the definition of the zone of influence of the Installation aligns with the one applied in the AA Screening submitted as part of the planning application to KCC for the KIC Masterplan site.

The zone of influence of the Installation includes Natura 2000 sites situated within 15km of the Installation site and also considers, on a precautionary basis, Natura 2000 sites that are located outside 15km that may be significantly impacted as a result of the operation of the Installation.

5.3.1 Nitrogen Oxides

The nearest European site to the Installation is the Rye Water Valley/Carton SAC (site code 001398), located 1.6km to the north of the Installation. Pollutant concentrations predicted at the location of this European site are presented in Table 14.

Table 14: Dispersion Model Results for NO_x - Emergency Operations & Scheduled Testing at the Installation - Rye Water Valley/Carton SAC

Pollutant / Year	Averaging Period	Background Conc. (μg/m³)	Process Conc. (μg/m³)	PEC (μg/m³)	Limit Value (μg/m³)	% of AQS Note 1
NOx / 2016	Annual	7.2	0.51	7.71	30	26
NOx / 2017	Annual	7.2	0.54	7.74	30	26
NOx / 2018	Annual	7.2	0.53	7.73	30	26
NOx / 2019	Annual	7.2	0.47	7.67	30	26
NOx / 2020	Annual	7.2	0.44	7.65	30	25

Note 1: Air Quality Standards 2022

The next closest European site is Glenasmole Valley SAC (site code 001209), located 13.8km southeast of the Installation. The pollutant concentration predicted at the location of this European site for the worst-case year, 2018, is presented in Table 15.

Table 15: Dispersion Model Results for NOx - Emergency Operations & Scheduled Testing at the Installation - Glenasmole Valley SAC

Pollutant / Year	Averaging Period	Background Conc. (μg/m³)	Process Conc. (μg/m³)	PEC (μg/m³)	Threshold Value (μg/m³)	% of AQS Note 1
NOx / 2016	Annual	4	0.0055	4.01	30	13
NOx / 2017	Annual	4	0.0031	4.00	30	13
NOx / 2018	Annual	4	0.0040	4.00	30	13
NOx / 2019	Annual	4	0.0061	4.01	30	13
NOx / 2020	Annual	4	0.0035	4.00	30	13

Note 1 Air Quality Standards 2022

The process contributions from the Installation at the European sites within the zone of influence are negligible and comply with relevant air quality standards.

5.3.2 Nitrogen Deposition

Nitrogen deposition arising from emissions associated with the Installation has been assessed at designated European sites within the Installation's zone of influence. Table 16 presents the process contribution of nitrogen deposition at the worst-case receptor location within each Natura 2000 site, expressed as a percentage of the minimum nitrogen critical load relevant to the most sensitive qualifying interest at each site based on the methodology outlined in 3.2.9.

Table 16: Total Nitrogen Deposition Process Contribution at the Worst-Case Location and Year within each Natura 2000 Site

Natura 2000 Site Name	Nitrogen dioxide process contribution (µg/m^3)	Dry Deposition Flux (µg/m^2)	Deposition (kgN/ha/yr)	Minimum Critical Load (kgN/ha/yr)	% of Critical Load
Rye Water Valley/Carton SAC (001398) (Worst-case year: 2017)	0.489	0.00073	0.07	5	1%
Glenasmole Valley SAC (001209) (Worst-case year: 2019)	0.006	0.0000092	0.001	5	0%

The nitrogen deposition process contribution from the Installation remains well below the minimum critical load threshold, indicating no significant impact on the assessed European sites will occur as a result of the Installation. As the process contribution is equal to 1% of the critical load and there are no other EPA Installations within the defined impact area which can result in significant in-combination effects, no further assessment is required, as per IN2 guidance.

5.3.3 Conclusion

It can be concluded that significant air quality effects on European sites can be excluded on the basis of the scale of the predicted effect.

This concurs with the outcome of the AA screening report prepared as part of the planning application for the KIC Masterplan site, which includes the Installation, (KCC Planning Ref. 23/60047) which concludes "*that there is no likelihood of any significant effects on the Natura 2000 sites as a result of emissions from the proposed development site.*" Refer to Attachment 6-2-1 AA-Screening July 2023.

The AA Screening was revised to account for EPA Instruction note: "*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, 2024*" and has been submitted as part of the RFI Response to this IE Licence application.

The conclusion of the revised AA Screening aligns with those of the original screening and this report. The revised AA Screening reaffirms that "*it can be objectively concluded, based on the best scientific knowledge available, no significant effects whether arising from the project itself or in combination with any other plan or project, are likely to occur to the Natura 2000 sites: South Dublin Bay and River Tolka Estuary SPA, South Dublin Bay SAC, North Dublin Bay SAC and North Bull Island SPA or any other European site in the wider hinterland. This conclusion is reached in light of the special conservation and qualifying interests of the sites in question and in view of the site's conservation objectives.*"

6. Assessment Summary

The assessment was carried out to determine the ambient air quality impact of the emergency operation of generators at the Installation site. It is determined that the emergency generators will be used solely for emergency operation (i.e. less than 500 hours per year) and thus the ELVs outlined in the MCP Regulations are not applicable to emergency generators on site.

The Installation Operations Assessment involved modelling of NO_x, NO_2, SO_2, CO, $PM_{2.5}$, PM_{10} and nitrogen deposition for the operation of the 14 no. critical and 1 no. house emergency generators for 250 hours per year as well as the scheduled weekly testing, and quarterly maintenance testing, of all emergency generators on the Installation site, using the EPA assessment methodology.

The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for NO_2, SO_2, CO, $PM_{2.5}$, and PM_{10}:

- For the worst-case year, emissions from the Installation site lead to a maximum ambient NO_2 concentration (including background) which is 66% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 80% of the annual limit value at the worst-case off-site receptor.
- For the worst-case year, emissions from the Installation site lead to a maximum ambient SO_2 concentration (including background) which is 3% of the maximum ambient 1-hour limit value (measured as a 99.73th percentile) and 7% of the 24-hour limit value (measured as a 99.18th percentile), and 21% of the annual limit value at the maximum off-site receptor at the worst-case off-site receptor.
- For the worst-case year, emissions from the Installation site lead to a maximum ambient CO concentration (including background) which is 6% of the maximum ambient 8-hour limit value.
- For the worst-case year, emissions from the Installation site lead to a maximum ambient PM_{10} concentration (including background) which is 39% of the maximum ambient 24-hour limit value (measured as a 90th percentile) and 48% of the annual limit value at the worst-case off-site receptor.
- For the worst-case year, emissions from the Installation site lead to an ambient $PM_{2.5}$ concentration (including background) which is 81% of the maximum ambient annual limit value at the maximum off-site receptor.

An assessment of potential ecological impacts was prepared in accordance with the *EPA 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 (2024).* This assessment found that the nearest European site to the Installation is the Rye Water Valley/Carton SAC (site code 001398) located 1.6km north of the Installation. The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for NO_x and nitrogen deposition:

- For the worst-case year at the nearest (and most impacted) European site, emission from the Installation site leads to a maximum NOx concentration which is 26% of the maximum annual limit value. The process contributions from the Installation at the other European sites within the zone of influence are negligible and comply with relevant air quality standards.
- The nitrogen deposition process contribution from the Installation remains well below the relevant critical load thresholds, indicating no significant impact on the assessed European sites will occur as a result of the Installation. The process contribution at the nearest European site is equal to 1% of the critical load and there are no other EPA Installations within the defined impact area, therefore, no further assessment is required.

The Cumulative Operations Assessment involved modelling of NO_2 emissions for the continuous operation of 8 no. CTGs (with 1 no. CTG for backup) and 72 no. of the 80 no. critical emergency generators for 250 hours per year as well as the scheduled weekly testing, and quarterly maintenance testing, of all emergency generators on the KIC Masterplan site, using the USEPA and UK EA assessment methodologies. The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for NO_2:

- For the worst-case year, emissions from the KIC Masterplan site led to an ambient NO_2 concentration (including background) which is 65% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 99% of the annual limit value at the worst-case off-site receptor.

- In any year, the emergency generators can run for 345 hours before there is a likelihood of an exceedance at the nearest residential receptor (at a 98th percentile confidence level).

In line with AG4, only nearby sources expected to cause a significant concentration gradient within the defined impact area are required to be included in the cumulative assessment. The impact area extends approximately 1km from the Installation. The nearest EPA Installations to the Installation are P0207-05 (Intel Ireland Ltd.) at over 2km from the Installation and P0229 (General Paints Ltd.) at approximately

1.9km from the Installation. As no sources are located within, or in, close proximity to the impact area, no further cumulative assessment is required.

7. Conclusion

In summary, emissions to atmosphere of NO_x, NO_2, SO_2, CO, $PM_{2.5}$ and PM_{10} from the emergency generators at the Installation site, 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.

No significant adverse impact on air quality is predicted to arise due to cumulative air emissions from sources to be located within the KIC Masterplan site and from other EPA Installations.

The nearest (and most impacted) European site is Rye Water Valley/Carton SAC (site code 001398) which is located 1.6km north of the Installation. The next closest European site within the Installation site's Zone of Influence is Glenasmole Valley SAC (site code 001209) located 13.8km southeast of the Installation. The process contribution from the Installation at these sensitive sites is negligible.

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A.1 Appendix I

Description of the AERMOD Model

The AERMOD dispersion model has been developed in part by the U.S. USEPA (USEPA, 2021, 2017). 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 (USEPA, 1998).

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 (USEPA, 1995, 2003). 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 (USEPA, 1995, 2003). 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.

A.2 Appendix II

Meteorological Data – AERMET

AERMOD incorporates a meteorological pre-processor AERMET (USEPA, 2019). 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, MoninObukhov 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 (USEPA, 2017) and using the detailed methodology outlined by the Alaska Department of Environmental Conservation (ADEC) (ADEC, 2009). 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 (Qian & Venkatram, 2011). Previously, the model had a tendency to over-predict concentrations produced by near-ground sources in stable conditions.

<u>Surface roughness</u>

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 geometric mean of the inverse distance area-weighted land use within the sector, by using the eight land use categories outlined by the USEPA. The area-weighted surface roughness length derived from the land use classification within a radius of 1km from Casement Aerodrome is shown in Table 17.

Table 17: Surface Roughness based on an inverse distance weighted average of the land use within a 1km radius of Casement Aerodrome 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

Sector	Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter Note 1

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. The area-weighted arithmetic mean albedo derived from the land use classification over a 10km x 10km area centred on Casement Aerodrome is shown in Table 18.

Table 18: Albedo based on a simple average of the land use within a 10km × 10km grid centred on Casement Aerodrome Meteorological Station

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

Note 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. The area-weighted geometric mean Bowen ratio derived from the land use classification over a 10km x 10km area cantered on Casement Aerodrome is shown in Table 19.

Table 19: Bowen Ratio based on a geometric mean of the land use within a 10km × 10km grid centred on Casement Aerodrome Meteorological Station.

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

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