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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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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 facility (the subject 'installation' under this licence review application) located at Clonshaugh Business & Technology Park, Dublin 17. The site is occupied by five no. data storage facility buildings, termed Building W, Building X, Building Y, Building U and Building V, along with ancillary elements.

The installation requires a continuous supply of electricity to operate. During normal operations, the facility is supplied electricity from the national grid. Outside of normal operations, the facility is first supplied electricity by some or all of the onsite battery installations which is the Uninterruptible Power Supply (UPS) system, which are contained in small Backup Battery Units (BBUs). BBUs are installed within individual server racks internally within the data halls of each building. The BBUs will maintain data hall operation during brief power outages. BBUs are designed to operate for up to 4 minutes to allow time for the emergency back-up generators to start up and stabilize. Thereafter, some or all of the onsite emergency back-up generators will operate. Outside of routine testing and maintenance, the operation of these 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 is carried out to assess concentrations of nitrogen dioxide (NO_2) at a variety of locations beyond the site boundary. The assessment has been undertaken for Buildings W, X, Y, U and V. Building W has 13 no. back-up generators, Building X has 20 no. back-up generators, Building Y has 7 no. back-up generators, Building U has 11 no. back-up generators and Building V has 1 no. back-up generator. In total, the air dispersion modelling includes 52 no. emergency back-up generators on the campus.

A number of modelling scenarios are investigated for the purposes of this 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 all of the 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 facility and nearby sites within a 1 km radius was also conducted. Sites which hold an Industrial Emissions Directive (IED) licence from the EPA were assessed for relevant air emissions. There are third-party 2 no. IE licenced sites within 1 km of the facility, these are Global Switch Property (Dublin) Ltd (Licence No. P0109) and Forest Laboratories Ireland Ltd (Licence No. P0306) within Clonshaugh Business & Technology Park. However, both of these facilities have no licenced NO_X emission points and thus have not been included in the cumulative air modelling assessment.

Additionally, the Applicant operates a separate data storage facility to the north-west of the 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 facility, these emission sources have been included in the cumulative assessment. There are two additional data centres, referred to as the Dataplex data centre (located at the eastern boundary of the Applicants Installation located in the north west of the Business Park (Licence No. P1171-01), and Digital Realty Trust, north of the Installation, were identified within the study area. The operational details of these facilities are known and sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at these facilities are available and thus these have been included in the cumulative assessment.

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

The NO_2 modelling results at the worst-case location at and beyond the site boundary are 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*' 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).

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 site 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) and 90% of the annual limit value at the worst-case off-site receptor. For the worst-case year modelled, emissions from the site 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 55% of the annual limit value at the worst-case off-site receptor.

The UK EA assessment methodology determined that, in any year, the generators can run for 137 hours using diesel fuel before there is a likelihood of an exceedance at the nearest residential receptor (at a 98th percentile confidence level).

CO concentrations are also in compliance with the relevant ambient air quality standards. In the worst-case year, concentrations of CO (including background) are at most 40% of the maximum 8-hour limit value at the worst case receptor modelled.

The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for NH_3. For the worst-case year, emissions from the site 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 limit value at the worst-case receptor (excluding background). Concentrations are at most 0.42% of the 99th percentile 1-hour limit value at the worst-case receptor (excluding background). For the worst-case year, emissions from the site lead to an ambient NH_3 concentration (including background) which is 0.5% of the maximum ambient 1-hour limit value and 0.6% of the annual limit value at the worst-case off-site receptor.

Regarding particulate matter, concentrations of PM_{10} and $PM_{2.5}$ are in compliance with the relevant limit values. Concentrations of PM_{10} (including background) are 48% of the maximum ambient 24-hour limit value (measured as a 90.4th%ile) (2.5% of the limit value excluding background) at the worst-case receptor and 42% of the annual limit value at the worst-case receptor (5% of the limit value excluding background).

Modelled concentrations of SO_2 reached at most 15% of the maximum 1-hour limit value (measured as a 99.7th%ile) and 17% of the maximum 24-hour limit value (measured as a 99.2nd%ile) at the worst-case receptor modelled, including background concentrations. Emissions from the facility 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.

Under the Licenced Operational Scenario the dispersion modelling has determined that concentrations of all pollutants are in compliance with the relevant ambient air quality standards.

Assessment of the Cumulative Air Quality Impact on Human Health

The NO_2 modelling results at the worst-case location at and beyond the site boundary are 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 and the emergency operation of Buildings A - F (Licence No. P1171-01),
- scheduled weekly testing of all back-up generators from Buildings W, X, Y, U and V and scheduled weekly testing of all back-up generators from Buildings A – F (Licence 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 and scheduled quarterly maintenance testing of all back-up generators from Buildings A – F (Licence 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.

This assessment is a highly conservative approach and the probability of it occurring is extremely low. 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, the cumulative emissions from the site lead to an ambient NO_2 concentration (including background) which is 94% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 98% of the annual limit value at the worst-case off-site receptor.

The UK EA assessment methodology determined that, in any year, the generators can run for 80 hours before there is a likelihood of an exceedance at the nearest residential receptor (at a 98th percentile confidence level). However, the USEPA approach, based on 150 hours of operation, is the preferred approach to determine the allowable operational hours of the backup generators for the facility.

Conclusion (Human Health)

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.

Assessment of The Data Storage Facility Air Quality Impact on Ecological Receptors

Santry Demesne pNHA

Regarding the most impacted ecological receptor, the Santry Demesne pNHA (000178), operations will lead to ambient NO_X, NH_3 and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 27%, 50% and 7% respectively of the annual limit value. The process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 1.4%, 0.04% and 0.06% of the annual limit value over the five years of meteorological data modelled.

The nitrogen deposition flux in the Santry Demesne pNHA (000178) for the worst-case year is 7.061 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr established in Section 2.3, indicating that the effects of nitrogen deposition on ecological receptors due to the facility are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 0.87% of the annual limit value over the five years of meteorological data modelled.

The total acid deposition (as N and S) flux in the in the Santry Demesne pNHA (000178) for the worst-case year is 0.506 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 5.611 keq/ha/yr (established in Section 2.3), indicating that the effects of acid deposition (as N and S) on ecological receptors due to the facility are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 1.13% of the annual limit value over the five years of meteorological data modelled.

Baldoyle Bay SAC

Regarding the most impacted (in terms of Process Contributions) Natura 2000 receptor, the Baldoyle Bay SAC, operations will lead to ambient NO_X, NH_3 and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 14%, 50% and 5% respectively of the annual limit value. The process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 0.9%, 0.02% and 0.04% of the annual limit value over the five years of meteorological data modelled.

The nitrogen deposition flux for the worst-case year is 6.038 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr for the most sensitive feature "Atlantic salt meadows (*Glauco-Puccinellietalia* maritimae)" (feature code: H1330) located in the Baldoyle Bay

SAC, indicating that the effects of nitrogen deposition on designated sites due to the facility are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 0.63% of the annual limit value over the five years of meteorological data modelled.

The total acid deposition (as N and S) flux for the worst-case year is 0.504 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the most sensitive feature “Fixed coastal dunes with herbaceous vegetation (“grey dunes”)” (feature code: H2130) in the North Dublin Bay SAC (there is no data for acid deposition critical loads in the Baldoyle Bay SAC and thus North Dublin Bay SAC has been referenced), indicating that the effects of acid deposition (as N and S) on designated sites due to the facility are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 0.71% of the annual limit value over the five years of meteorological data modelled.

South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA

Regarding the closest (and most impacted in terms of Predicted Environmental Concentration (PEC)) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, operations will lead to ambient NO_X, NH_3 and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 99%, 42% and 37% respectively of the annual limit value. The process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 0.2%, 0.004% and 0.046% of the annual limit value over the five years of meteorological data modelled.

At the South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, the nitrogen deposition flux for the worst-case year is 6.807 kg/ha/yr. This is below the midrange critical load of 7.5 kg/ha/yr(2) for the most sensitive feature “*Tringa totanus* (Eastern Atlantic - wintering)” (feature code: A162), indicating that the effects of nitrogen deposition on designated sites due to the facility are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 0.11% of the annual limit value over the five years of meteorological data modelled.

At the South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, the total acid deposition (as N and S) flux for the worst-case year is 0.591 keq/ha/yr. This is below the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the most sensitive feature "*Sterna hirundo* (Northern/Eastern Europe - breeding)” (feature code: A193), indicating that the effects of acid deposition (as N and S) on designated sites due to the facility are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 0.12% of the annual limit value over the five years of meteorological data modelled.

The effect of nitrogen deposition due to the facility on these features is discussed further in the Appropriate Assessment (AA) Screening Report prepared by Moore Group.

Assessment of The Cumulative Air Quality Impact on Ecology

Santry Demesne pNHA

Regarding the most impacted ecological receptor, the Santry Demesne pNHA (000178), cumulative operations will lead to ambient NO_X, NH_3 and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 61%, 50% and 9% respectively of the annual limit value. The cumulative process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 3.7%, 0.02% and 0.16% of the annual limit value over the five years of meteorological data modelled.

The nitrogen deposition flux for the worst-case year is 7.149 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr for the habitat types (broadleaved deciduous woodland) in the Santry Demesne Proposed NHA (000178), indicating that the effects of nitrogen deposition on ecological receptors due to the facility and other nearby facilities are not significant. The cumulative process contribution (PC) nitrogen deposition (as N) is at most 2.1% of the annual limit value over the five years of meteorological data modelled.

The total acid deposition (as N and S) flux in the in the Santry Demesne Proposed NHA (000178) for the worst-case year is 0.514 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 5.611 keq/ha/yr established in Section 2.3 which is based on the acidity range for “old sessile oak woods with Ilex and Blechnum in the British Isles”, indicating that the effects of acid deposition (as N and S) on ecological receptors due to the facility and other nearby facilities are not significant. The cumulative process contribution (PC) total acid deposition (as N and S) flux is at most 2.9% of the annual limit value over the five years of meteorological data modelled.

<u>Baldoyle Bay SAC</u>

Regarding the most impacted (in terms of process contributions) Natura 2000 designated receptor, the Baldoyle Bay SAC, cumulative operations will lead to ambient NO_X, NH_3 and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 38%, 50% and 9% respectively of the annual limit value. The cumulative process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 1.9%, 0.02% and 0.08% of the annual limit value over the five years of meteorological data modelled.

The nitrogen deposition flux for the worst-case year is 6.077 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr for the habitat type “Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)” (feature code: H1330) in the Baldoyle Bay SAC, indicating that the effects of nitrogen deposition on designated sites due to the facility and other nearby facilities are not significant. The cumulative process contribution (PC) nitrogen deposition (as N) is at most 1.3% of the annual limit value over the five years of meteorological data modelled.

The total acid deposition (as N and S) flux for the worst-case year is 0.507 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the habitat type “Fixed coastal dunes with herbaceous vegetation (“grey dunes”)” (feature code: H2130) in the North Dublin Bay SAC (there is no data for acid deposition critical loads in the Baldoyle Bay SAC and thus North Dublin Bay SAC has been referenced), indicating that the effects of acid deposition (as N and S) on designated sites due to the facility and other nearby facilities are not significant. The cumulative process contribution (PC) total acid deposition (as N and S) flux is at most 2.9% of the annual limit value over the five years of meteorological data modelled.

<u>South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA</u>

At the South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, cumulative operations will lead to ambient NO_X, NH_3 and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 99.7%, 42% and 37% respectively of the annual limit value. The process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 0.35%, 0.004% and 0.010% of the annual limit value over the five years of meteorological data modelled.

The cumulative nitrogen deposition flux for the worst-case year is 6.812 kg/ha/yr. This is below the midrange critical load of 7.5 kg/ha/yr(2) for the feature “*Tringa totanus* (Eastern Atlantic - wintering)” (feature code: A162), indicating that the effects of nitrogen deposition on designated sites due to the facility and other nearby facilities are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 0.21% of the annual limit value over the five years of meteorological data modelled.

The total acid deposition (as N and S) flux for the worst-case year is 0.591 keq/ha/yr. This is below the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the feature "*Sterna hirundo* (Northern/Eastern Europe - breeding)" (feature code: A193), indicating that the effects of acid deposition (as N and S) on designated sites due to the facility and other nearby facilities are not significant. The cumulative process contribution (PC) total acid deposition (as N and S) flux is at most 0.23% of the annual limit value over the five years of meteorological data modelled.

CONTENTS

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 facility (the subject ‘installation’ under this licence review application) located at Clonshaugh Business & Technology Park, Dublin 17. The site is occupied by five no. data storage facility buildings, termed Building W, Building X, Building Y, Building U and Building V, along with ancillary elements.

The installation requires a continuous supply of electricity to operate. During normal operations, the facility is supplied electricity from the national grid. Outside of normal operations, the facility is first supplied electricity by some or all of the onsite battery installations which is the Uninterruptible Power Supply (UPS) system, which are contained in small Backup Battery Units (BBUs). BBUs are installed within individual server racks internally within the data halls of each building. The BBUs will maintain data hall operation during brief power outages. BBUs are designed to operate for up to 4 minutes to allow time for the emergency back-up generators to start up and stabilize. Thereafter, some or all of the onsite emergency back-up generators will operate.. 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 site boundary. The assessment has been undertaken for Buildings W, X, Y, U and V. Building W has 13 no. back-up generators, Building X has 20 no. back-up generators, Building Y has 7 no. back-up generators, Building U has 11 no. back-up generators and Building V has 1 no. back-up generators. In total, the air dispersion modelling includes 52 no. back-up generators on the campus.

The assessment has determined the ambient air quality impact of the site and any air quality constraints that may be present. The 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 site.

A number of modelling scenarios are investigated for the purposes of this 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 facility and nearby sites within a 1 km radius was also conducted. Sites which hold an IED licence from the EPA were assessed for relevant air emissions. There are 2 no. IE licenced sites within 1 km of the facility, these are Global Switch Property (Dublin) Ltd (Licence No. P0109) and Forest Laboratories Ireland Ltd (Licence No. P0306) within Clonshaugh Business & Technology Park. However, both of these facilities have no licenced NO_X emission points and thus have not been included in the cumulative air modelling assessment.

Additionally, the Applicant operates a separate data storage facility to the north-west of the 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 facility, these emission sources have been included in the cumulative assessment. There are two additional data centres, referred to as the Dataplex data centre (located at the eastern boundary of the Applicants Installation located in the north west of the Business Park (Licence No. P1171-01), and Digital Realty Trust, north of the Installation, were identified within the study area. The operational details of these facilities are known and sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at these facilities are available and thus these have been included in the cumulative assessment.

The location of Buildings W, X, Y, U and V are shown below in Diagram 1.

Diagram 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 the assessment summaries are presented in Section 7. 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

In order to reduce the risk to health from poor air quality, national and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values or "Air Quality Standards" are health or environmental-based levels for which additional factors may be considered. The applicable standards in Ireland include the Air Quality Standards Regulations 2022, implement the obligations under 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 (see Table 1). The ambient air quality standards applicable for NO_2, CO, PM_{10}, $PM_{2.5}$ and SO_2 and are outlined in this Directive.

Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. The standards outlined in Table 1 have been used in the current assessment to determine the potential impact of air emissions from the facility on ambient air quality.

Table 1 *Ambient Air Quality Standards*

Pollutant	Regulation/ Guideline	Limit Type	Value
Nitrogen Dioxide (NO_2)	2008/50/EC Note 1	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	200 μg/m^3 Note 2
		Annual limit for protection of human health	40 μg/m^3
Carbon Monoxide (CO)	2008/50/EC	8-hour limit (on a rolling basis) for protection of human health	10,000 μg/m^3
Particulate Matter (as PM_{10})	2008/50/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50 μg/m^3
		Annual limit for protection of human health	40 μg/m^3
Particulate Matter (as $PM_{2.5}$) Stage 1	2008/50/EC	Annual limit for protection of human health	25 μg/m^3
Particulate Matter (as $PM_{2.5}$) Stage 2	2008/50/EC	Annual limit for protection of human health	20 μg/m^3 Note 3
Sulphur Dioxide (SO_2)	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	350 μg/m^3
		24-Hourly limit for protection of human health - not to be exceeded more than 3 times/year	125 μg/m^3
		Critical level for protection of vegetation (annual and winter)	10-30 μg/m^3

Note 1 EU 2008/50/EC – Clean Air For Europe (CAFÉ) Directive replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC

Note 2 µg/m^3 (micrograms per cubic metre)
Note 3 Stage 2 indicative limit value to be reviewed by the European Commission in 2013. Due to come into force in January 2020, however, no update from the Commission has been published.

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 facility is supplied electricity from the national grid. Outside of normal operations, the facility 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.

The UK Environment Agency assessment methodology in Section 6.2 below determined that the standby generators could operate for 137 hours 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 standby generators which provide power on site only during an emergency power outage.

3.0 ASSESSMENT METHODOLOGY

Emissions from the facility are modelled using the AERMOD dispersion model (Version 23132) 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 site 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 site.

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 site at the centre. The outer grid measures 10 x 10 km with the site at the centre and with concentrations calculated at 250m intervals. The inner grid measures 2 x 2 km with the site at the centre and with concentrations calculated at 50m intervals. Boundary receptor locations are also placed along the boundary of the site, 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 site 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 site 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 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

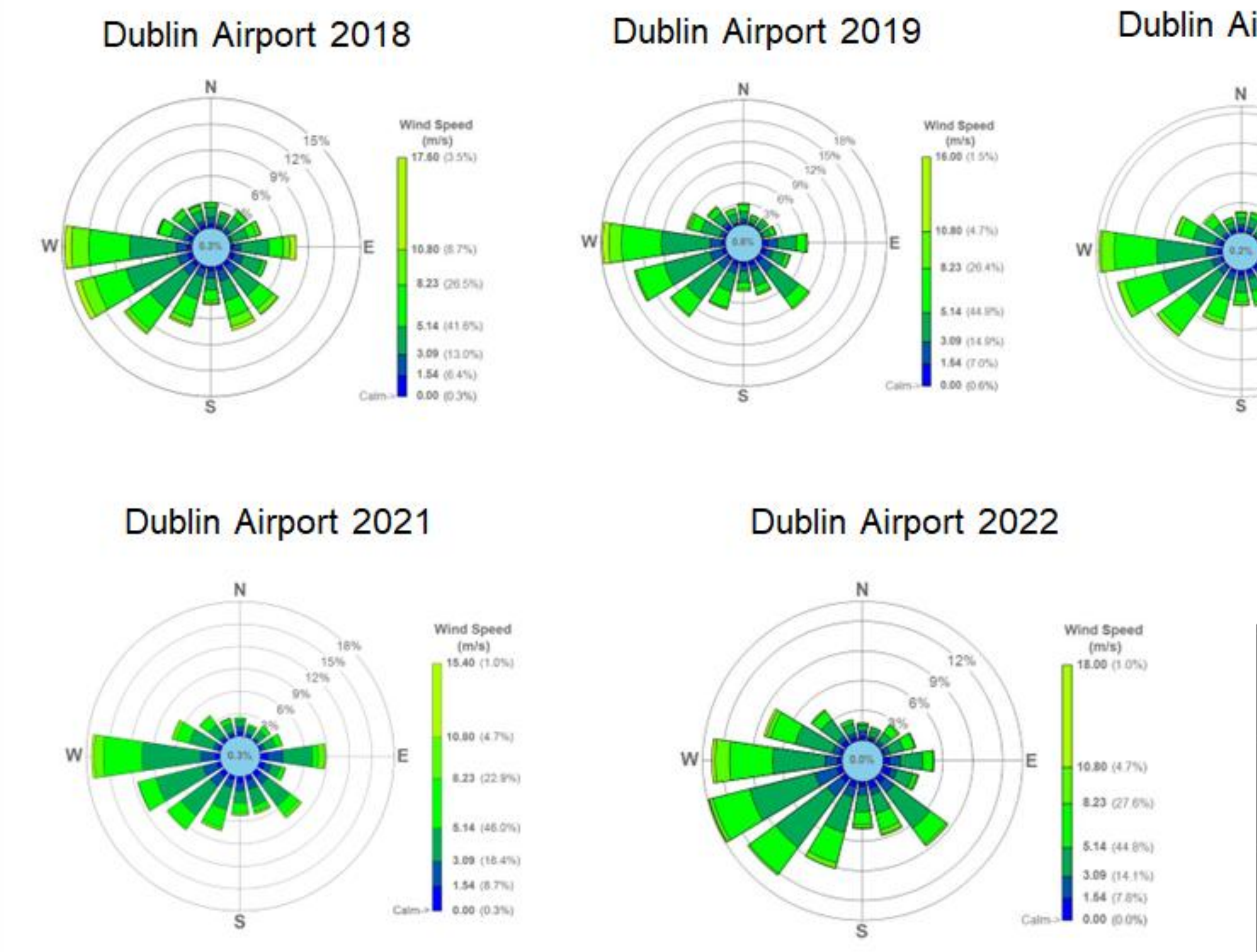
The AERMOD air dispersion model has a terrain pre-processor AERMAP[14] which is used to map the physical environment in detail over the receptor grid. The digital terrain input data used in the AERMAP pre-processor is obtained from SRTM. This data is run to obtain for each receptor point the terrain 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 site, 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 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.



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Project
IE Licence – Air Impact Assessment

Reference
237501.0453

Figure 1
Dublin Airport Windrose 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 site with full details provided in Appendix II.

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 site, 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. 10km has been selected as an appropriate distance to model as the process contribution from the facility reduces to below 1% of all appropriate critical levels within this distance.

The closest Natura 2000 sites to the Installation are the South Dublin Bay SAC (Site Code 000210) and South Dublin Bay and River Tolka Estuary SPA (Site Code 004024) situated 3.9km to the south, and the most impacted (in terms of Process Contributions) Baldoyle Bay SAC (Site Code 000199) at 4.9km east of the site. The list of sites within 10km of the facility is shown below.

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.

Site Code	Site name	Distance (km)
000178	Santry Demesne pNHA	1.5
000210	South Dublin Bay SAC	3.9

Site Code	Site name	Distance (km)
004024	South Dublin Bay and River Tolka Estuary SPA	3.9
001208	Feltrim Hill pNHA	4.1
000206	North Dublin Bay pNHA	4.4
000206	North Dublin Bay SAC	4.4
004006	North Bull Island SPA	4.4
002103	Royal Canal pNHA	4.8
000199	Baldoyle Bay pNHA	4.9
000199	Baldoyle Bay SAC	4.9
001763	Sluice River Marsh pNHA	5.1
004016	Baldoyle Bay SPA	5.2
002104	Grand Canal pNHA	6.2
000205	Malahide Estuary SAC	6.6
004025	Malahide Estuary SPA	6.6
000205	Malahide Estuary pNHA	6.6
000210	South Dublin Bay pNHA	6.8
000210	South Dublin Bay SAC	6.8
004236	North-West Irish Sea SPA	6.9
000202	Howth Head pNHA	8.4
000202	Howth Head SAC	8.4
003000	Rockabill to Dalkey Island SAC	9.3
000203	Ireland’s Eye pNHA	9.9
002193	Ireland’s Eye SAC	9.9
004117	Ireland’s Eye SPA	9.9

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 1. As such it is typical to assess the impact of NO_X emissions from a facility on any nearby sensitive ecological areas in close proximity to the site. There are no European sites within 1 km of the subject site 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 facility that are close to industrial facilities, so the limit value for NO_X for the protection of ecosystems is not technically applicable at these sites. Regardless, the annual average concentrations for NO_X from all emission points at the facility 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.

Dispersion modelling of NO_X emissions from the installation has been conducted within the Santry Demesne pNHA to determine the potential impact to vegetation as a result of emissions from the back-up generators on site. Emissions from the back-up generators are not predicted to be significant at this distance from the installation as emission concentrations peak at the site boundary and fall off rapidly with increasing distance from the installation.

In terms of impacts in the nearby ecologically sensitive areas, the closest and most impacted (in terms of process contributions (PC)) is the Santry Demesne pNHA (000178); c. 1.5km west of the facility. The site comprises the remnants of a former demesne woodland.

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 facility 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 Environment Agency publication "AGTAG06 – Technical Guidance On Detailed Modelling Approach For An Appropriate Assessment For Emissions To Air"(3):

Dry deposition flux (µg/m²/s) = ground-level concentration (µg/m³) 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 2. The dry deposition flux is then multiplied by conversion factors shown in Table 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 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 4.0. 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 6.

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. These 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 Natura 2000 Sites

The critical loads from AIPS and used for the assessment are detailed in Table 3 for the Natura 2000 sites identified as relevant by the modelling assessment. In order to determine the appropriate critical load, the EPA publication "Research 390: *Nitrogen-Sulfur Critical Loads: Assessment of the Impacts of Air Pollution on Habitats*" (EPA, 2021) was consulted. In Table 3.2 of the publication empirical critical loads of nutrient nitrogen are outlined with a worst-case range of 5-10 kgN/ha/yr for most habitat types.

In addition, for most 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 process contributions.

Table 3. *Critical Loads for Nitrogen and Acid Deposition (Natura 2000 Sites)*

Ecological Receptor	Pollutant	Feature Code	Feature Name	Nitrogen Critical Load Class	EUNIS code	Critical Load Range for most sensitive feature*		Is species sensitive due to nutrient nitrogen impacts on broad habitat?	Reason
						Range	Assessment Criteria		
Baldoyle Bay SAC	N Deposition	H1330	Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	5-10 kgN/ha/yr	7.5 kgN/ha/yr	Yes	-
	Acid deposition	No information on this site on APIS.							
South Dublin Bay SAC	N Deposition	H2110	Embryonic shifting dunes	Shifting coastal dunes	B1.3	5-10 kgN/ha/yr	7.5 kgN/ha/yr	Yes	-
	Acid deposition	No information on this site on APIS.							
South Dublin Bay and River Tolka Estuary SPA	N Deposition	A162	*Tringa totanus* (Eastern Atlantic - wintering)	Low and medium altitude hay meadows	E2.2	5-10 kgN/ha/yr	7.5 kgN/ha/yr	Yes	Potential negative impact on species due to impacts on the species' broad habitat.
		A192	*Sterna dougallii* (Europe - breeding)	Shifting coastal dunes	B1.3	5-10 kgN/ha/yr	7.5 kgN/ha/yr	Yes	Potential negative impact on species due to impacts on the species' broad habitat.
				Coastal stable dune grasslands	B1.4				
				Coastal stable dune grasslands - calcareous type	B1.4 - calcareous				
		A193	*Sterna hirundo* (Northern/Eastern Europe - breeding)	Shifting coastal dunes	B1.3	5-10 kgN/ha/yr	7.5 kgN/ha/yr	Yes	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.
				Coastal stable dune grasslands	B1.4				
				Coastal stable dune grasslands - calcareous type	B1.4 - calcareous				
		A194		Shifting coastal dunes	B1.3	5-10 kgN/ha/yr	7.5 kgN/ha/yr	Yes	1. Potential negative impact on species due to

Ecological Receptor	Pollutant	Feature Code	Feature Name	Nitrogen Critical Load Class	EUNIS code	Critical Load Range for most sensitive feature*		Is species sensitive due to nutrient nitrogen impacts on broad habitat?	Reason
						Range	Assessment Criteria		
			Sterna paradisaea (Arctic - breeding/Southern Oceans - wintering)	Coastal stable dune grasslands	B1.4				impacts on the species' broad habitat.
				Coastal stable dune grasslands - calcareous type	B1.4 - calcareous				2. Potential positive impact on species due to impacts on the species' food supply.
	Acid deposition	A193	*Sterna hirundo* (Northern/Eastern Europe - breeding)	Acid grassland	-	0.714-4.919 keq/ha/yr	0.714 keq/ha/yr	Yes	Potential negative impact on species due to impacts on the species' broad habitat.
				Calcareous grassland (using base cation)	-			Yes	

* EPA publication (EPA, 2021) recommends the midpoint is used to define the critical load (e.g. 7.5 kg N $ha^{-1} yr^{-1}$) in most cases.

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 (Perrin et al. 2008, Vol. 3), 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.

In the absence of an established critical load level for the Santry Demesne pNHA, there is no definitive threshold available for assessment. Given this, and based on EPA

Report No.390: Nitrogen–Sulfur Critical Loads: Assessment of the Impacts of Air Pollution on Habitat, AWN has determined a conservative critical load level for the purpose of this assessment as 7.5 kg N ha^{-1} yr^{-1} (this is the conservative critical load based on the midrange of the worst-case critical loads outlined in Table 3.2 of Report 390).

Although other ecologically sensitive sites are located within 10km of the facility, the assessment has focused on the Santry Demesne pNHA (Site Code 000178), Baldoyle Bay SAC (Site Code 000199), South Dublin Bay SAC and South Dublin Bay (Site Code 000210) and River Tolka Estuary SPA (Site Code 004024) as these sites will be most impacted by the facility both in terms of process contribution (PC) and in terms of predicted environmental concentration (PEC).

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 2022*", 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.

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). 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 facility. 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 facility is 15 µg/m^3.

Table 4. Annual Mean and 99.8th Percentile 1-Hour NO_2 Concentrations In Zone A Locations (µg/m^3)

Station	Averaging Period	Year					
		2017	2018	2019	2020	2021	2022
Ballyfermot	Annual Mean NO_2 (µg/m^3)	17	20	12	13	14	13
	99.8th%ile 1hr NO_2 (µg/m^3)	112	87	102	81	69	81
Swords	Annual Mean NO_2 (µg/m^3)	14	16	15	11	11	12
	99.8th%ile 1hr NO_2 (µg/m^3)	79	85	80	65	63	70
Tallaght	Annual Mean NO_2 (µg/m^3)	-	-	-	14	13	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 site. 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.

CO

In terms of CO, monitoring has been conducted at the suburban background Zone A site of Dublin Airport over the period 2020 – 2022. 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 – 2022. 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.

NH_3

An EPA research study entitled "Ambient Atmospheric Ammonia in Ireland, 2013-2014"[(21)] has been used to inform background ammonia concentrations. A background value of 1 µg/m^3 has been added to the annual mean modelled process concentration for ammonia. A value of twice the annual mean background concentration has been added to the 1-hour modelled process concentration.

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 11–14 µg/m^3 in 2022 (Table 5), with at most 7 exceedances (in Ballyfermot) 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 2018 – 2022. Average annual mean PM_{10} concentrations ranged from 10 – 16 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 facility is 16 µg/m^3.

Table 5. Annual Mean and 24-Hour Mean PM_{10} Concentrations In Zone A Locations (µg/m^3)

Station	Averaging Period	Year				
		2018	2019	2020	2021	2022
Ballyfermot	Annual Mean PM_{10} (µg/m^3)	16	14	12	12	13
	24-hr Mean > 50 µg/m^3 (days)	0	7	2	0	1
	90.4th%ile 24-hr PM_{10} (µg/m^3)	26	26	20	21	21
Dún Laoghaire	Annual Mean PM_{10} (µg/m^3)	13	12	12	11	12
	24-hr Mean > 50 µg/m^3 (days)	0	2	0	0	1
	90.4th%ile 24-hr PM_{10} (µg/m^3)	25	24	20	19	21
Finglas	Annual Mean PM_{10} (µg/m^3)	11	13	12	12	12
	24-hr Mean > 50 µg/m^3 (days)	1	2	0	0	1
	90.4th%ile 24-hr PM_{10} (µg/m^3)	-	-	21	20	19
Marino	Annual Mean PM_{10} (µg/m^3)	12	14	13	12	14
	24-hr Mean > 50 µg/m^3 (days)	0	4	0	0	3
	90.4th%ile 24-hr PM_{10} (µg/m^3)	-	74	23	20	23
Phoenix Park	Annual Mean PM_{10} (µg/m^3)	11	11	10	10	11
	24-hr Mean > 50 µg/m^3 (days)	0	2	0	0	0
	90.4th%ile 24-hr PM_{10} (µg/m^3)	19	18	18	17	18
St. Anne's Park	Annual Mean PM_{10} (µg/m^3)	11	12	11	11	13
	24-hr Mean > 50 µg/m^3 (days)	0	1	0	0	1
	90.4th%ile 24-hr PM_{10} (µg/m^3)	-	-	19	18	22

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)

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

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

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

A 90.4th percentile 24-hour background concentration of 22.9 µg/m^3 was used in the assessment, based on average concentrations for the above stations over the period 2018 – 2022.

$PM_{2.5}$

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 – 9 µg/m^3 in 2022 (see Table 6). Sufficient data is available for Ballyfermot, Dún Laoghaire, Finglas, Marino, Phoenix Park, and St. Anne's Park to observe trends over the period 2018 – 2022. 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 facility is 10 µg/m^3.

Table 6. Annual Mean $PM_{2.5}$ Concentrations In Zone A Locations (µg/m^3)

Station	Averaging Period	Year				
		2018	2019	2020	2021	2022
Ballyfermot	Annual Mean $PM_{2.5}$ (µg/m^3)	7.0	10.0	8.0	7.8	7.5
Dublin Airport	Annual Mean $PM_{2.5}$ (µg/m^3)	-	-	6.0	6.4	6.7
Finglas	Annual Mean $PM_{2.5}$ (µg/m^3)	8.0	9.0	7.0	7.5	7.3
Marino	Annual Mean $PM_{2.5}$ (µg/m^3)	6.0	9.0	8.0	7.9	8.9
Phoenix Park	Annual Mean $PM_{2.5}$ (µg/m^3)	6.0	8.0	7.0	6.4	6.3
St. Anne's Park	Annual Mean $PM_{2.5}$ (µg/m^3)	7.0	8.0	7.0	6.9	7.8

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

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 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 suburban background locations of Rathmines and Dublin Airport showed annual mean concentrations ranging from 1.7 – 5.8 µg/m^3 in 2022 (see Table 7). Sufficient data is available for Rathmines and Ringsend to observe trends over the period 2018 – 2022. Average annual mean SO_2 concentrations ranged from 1.1 – 3.3 µg/m^3 over the period of 2018 – 2022, 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 facility is 4 µg/m^3. The 99.7th%ile of 1-hour means in 2022 ranged from 7.9 – 19.7 µg/m^3 whilst the 99.2th%ile of 24-hour means in 2022 ranged from 4.7 – 12.1 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 – 2022 (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 – 2022 (Ringsend, 2018).

Table 7. 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
Rathmines	Annual Mean SO_2 (µg/m^3) Note 1	2.3	1.3	1.4	1.1	1.8
	99.7th%ile of 1-hour mean SO_2 (µg/m^3) Note 2	25.0	29.3	14.6	23.1	7.9
	99.2th%ile of 24-hour mean SO_2 (µg/m^3) Note 3	8.0	4.3	5.1	6.1	4.7
Dublin Airport	Annual Mean SO_2 (µg/m^3)	-	-	3.8	4.6	5.8
	99.7th%ile of 1-hour mean SO_2 (µg/m^3) Note 2	-	-	20.2	23.9	13.3
	99.2th%ile of 24-hour mean SO_2 (µg/m^3) Note 3	-	-	13.6	18.4	12.1
Dublin Port	Annual Mean SO_2 (µg/m^3)	-	-	2.4	2.3	1.7
	99.7th%ile of 1-hour mean SO_2 (µg/m^3) Note 2	-	-	84.3	49.9	19.7
	99.2th%ile of 24-hour mean SO_2 (µg/m^3) Note 3	-	-	26.6	22.1	10.1
Ringsend	Annual Mean SO_2 (µg/m^3)	3.3	1.4	2.1	2.7	2.9
	99.7th%ile of 1-hour mean SO_2 (µg/m^3) Note 2	51.0	42.8	18.4	12.5	12.8
	99.2th%ile of 24-hour mean SO_2 (µg/m^3) Note 3	20.0	6.9	8.1	8.0	5.6

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)

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 0.747 µg/m^3) = **52.49 µg/m^3**

b) 99.7th%ile hourly process contribution SO_2 (17.5 µg/m^3) + (2 x annual mean background contribution SO_2) (2 x 4.0 µg/m^3) = **25.5 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 0.747 µg/m^3) = **21.49 µg/m^3**

b) 99.2th%ile 24-hour mean process contribution SO_2 (5.4 µg/m^3) + (2 x annual mean background contribution SO_2) (2 x 4.0 µg/m^3) = **13.4 µg/m^3**

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

Sensitive Ecological Receptors

Background concentrations for NO_X, NH_3, SO_2, and nitrogen and acid deposition at the most impacted modelled designated habitats, Baldoyle Bay SAC (Site Code 000199), South Dublin Bay and River Tolka Estuary SPA (Site Code 004024) and the Santry

Demesne pNHA, 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 8. The background concentrations are added directly to the modelled process contributions to give a total predicted environmental concentration.

Table 8. Background Concentrations for NO_X, SO_2, Nitrogen and Acid Deposition (Grid Average) (APIS, 2024)

Closest Sensitive Designated Habitat	NO_x ($\mu g/m^3$)	NH_3 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	Nitrogen Deposition (kg/ha/yr)	Acid Deposition (keq/ha/yr)
Santry Demesne pNHA	17.1	1.5	1.8	7.0	0.50
Baldoyle Bay SAC	10.9	1.5	1.8	6.0	0.50
South Dublin Bay & Tolka Estuary SPA	29.79	1.27	7.4	6.8	0.59

5.0 PROCESS EMISSIONS

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*).

Building W has been modelled with 13 no. back-up generator stacks which have a minimum height of 6m above ground level and Building X has 7 no. back-up generator stacks which have a minimum height of 16m above ground level. Building Y has 20 no. back-up generator stacks which have a minimum height of 16m above ground level. Building U has 11 no. back-up generator stacks which have a minimum height of 25m above ground level whilst Building V has 1 no. back-up generator stack which has a minimum height of 15.6m above ground level. Two of the back-up generators in each Building W, Y and U and one of the back-up generators in Building X 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 site.

In addition to the emergency back-up generators which will power the site in the event of a power failure to the site, the site also includes 6 no. Fire Pump generators (two at 0.423 MWth, two at 0.337 MWth and two at 0.57 MWth). The Fire Pump generators 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 data hall back-up generators) and the low number required for use at any one time.

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.

5.1 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).

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

- **Licenced Operational Scenario:** 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 9, 10 and 11;

- **Cumulative Impact Scenario:** A cumulative impact assessment of the facility and nearby sites within a 1km radius was also conducted. Sites which hold an IED licence from the EPA were assessed for relevant air emissions. There are 2 no. IE licenced sites within 1km of the facility, these are Global Switch Property (Dublin) Ltd (Licence No. P0109) and Forest Laboratories Ireland Ltd (Licence No. P0306) within Clonshaugh Business & Technology Park.

However, both of these facilities have no licenced NO_X emission points and thus have not been included in the cumulative air modelling assessment. Additionally, the Applicant operates a separate data storage facility to the north-west of the 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 facility, these emission sources have been included in the cumulative assessment. There are two additional data centres, referred to as the Dataplex data centre (located at the eastern boundary of the Applicants Installation located in the north west of the Business Park (Licence No. P1171-01), and Digital Realty Trust, north of the Installation, were identified within the study area. The operational details of these facilities are known and sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at these facilities are available and thus these have been included in the cumulative assessment.

Table 9. *Summary of Process Emission Information for all Buildings associated with the Facility*

Stack Reference	Stack Height Above Ground Level (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Volume Flow (Nm^3/hr at 15% Ref. O_2)	Exit Velocity (m/sec actual)
Emergency Operation and Testing of Back-up Generators in Buildings W, X and Y (100% load)	16.0 – Building X and Y 6.0 – Building W	0.5	0.20	784.3	16,724	41.4
Testing of Generators (25% load) in Buildings W, X, and Y				619.1	4,516	13.8
Emergency Operation and Testing of Back-up Generators in Building U (100% load)	25.0 – Building U	0.3	0.07	738.2	19,557	120
Testing of Generators (25% load) in Building U				655.2	8,300	49.8
Emergency Operation and Testing of Back-up Generator in Building V (100% load)	15.6 – Building V	0.4	0.13	790.2	9,126	33.4
Testing of Generator (25% load) in Building V				639.2	4,032	13.3

Table 10. *Summary of Process Emission Information for all Buildings associated with the Facility*

Stack Reference	NO_x		CO		PM_{10} / $PM_{2.5}$		SO_2	
	Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)	Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)	Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)	Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)
Emergency Operation and Testing of Back-up Generators in Buildings W, X and Y (100% load)	673	0.054 [Note 1] / 3.13 [Note 2]	172	0.014 [Note 1] / 0.80 [Note 2]	15.7	0.001 [Note 1] / 0.07 [Note 2]	18.6	0.001 [Note 1] / 0.09 [Note 2]
Testing of Generators (25% load) in Buildings W, X, and Y	847	1.06 [Note 3]	122	0.15 [Note 3]	27.1	0.03 [Note 3]	18.6	0.02 [Note 3]
Emergency Operation and Testing of Back-up Generators in Building U (100% load)	726	0.068 [Note 1, 4] / 3.94 [Note 2, 4]	98	0.009 [Note 1] / 0.53 [Note 2]	8.5	0.001 [Note 1] / 0.05 [Note 2]	14.1	0.001 [Note 1] / 0.08 [Note 2]
Testing of Generators (25% load) in Building U	600	1.38 [Note 3, 4]	98	0.23 [Note 3]	8.5	0.02 [Note 3]	14.1	0.03 [Note 3]
Emergency Operation and Testing of Back-up Generators in Building V (100% load)	726	0.032 [Note 1, 4] / 1.84 [Note 2, 4]	379	0.017 [Note 1] / 0.96 [Note 2]	19.7	0.001 [Note 1] / 0.05 [Note 2]	18.6	0.001 [Note 1] / 0.05 [Note 2]
Testing of Generators (25% load) in Building V	600	0.81 [Note 3, 4]	85	0.09 [Note 3]	8.9	0.01 [Note 3]	18.6	0.02 [Note 3]

Note 1 Reduced emission rates based on USEPA protocol (assuming 150 hours / annum) used to model emissions during emergency operation of generators (100% load)

Note 2 Maximum emission rates for generators (based on 100% load using diesel fuel) used to model emissions during emergency operation of generators for UK EA assessment methodology and for quarterly testing for USEPA assessment methodology

Note 3 Normal testing operations involve the 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.

Note 4 As a worst-case, pre-SCR NO_X levels have been used in the modelling assessment. With SCR in operation levels are likely to be between 75-90% lower.

Table 11. *Summary of Ammonia Process Emission Information for Buildings U & V associated with the Facility*

Stack Reference	Stack Height Above Ground Level (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	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)
Emergency Operation and Testing of Back-up Generators in Building U (100% load)	25.0 – Building U	0.3	0.07	738.2	19,557	120	11	0.0010 Note 1 / 0.060 Note 2
Testing of Generators (25% load) in Building U				655.2	8,300	49.8	11	0.025
Emergency Operation and Testing of Back-up Generator in Building V (100% load)	15.6 – Building V	0.4	0.13	790.2	9,126	33.4	11	0.00047 Note 1 / 0.028 Note 2
Testing of Generator (25% load) in Building V				639.2	4,032	13.3	11	0.012

Note 1 Reduced emission rates based on USEPA protocol (assuming 150 hours / annum) used to model emissions during emergency operation of generators (100% load)
Note 2 Maximum emission rates for generators (based on 100% load using diesel fuel) used for quarterly testing

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 facility and the preferred method to determine the allowable operational hours of the backup emergency generators.

6.1.1 NO_2

The NO_2 modelling results at the worst-case location at and beyond the site boundary are detailed in Table 12 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.

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 site 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 55% of the annual limit value at the worst-case off-site receptor.

For the worst-case year modelled, PEC emissions from the site 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 2) and 90% of the annual limit value at the worst-case off-site receptor (boundary receptor, location shown in Figure 3). Concentrations decrease with distance from the site 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 Figures 2 and 3. The locations of the maximum concentrations for NO_2 are close to the boundary of the site with concentrations decreasing with distance from the facility.

Table 12. 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)

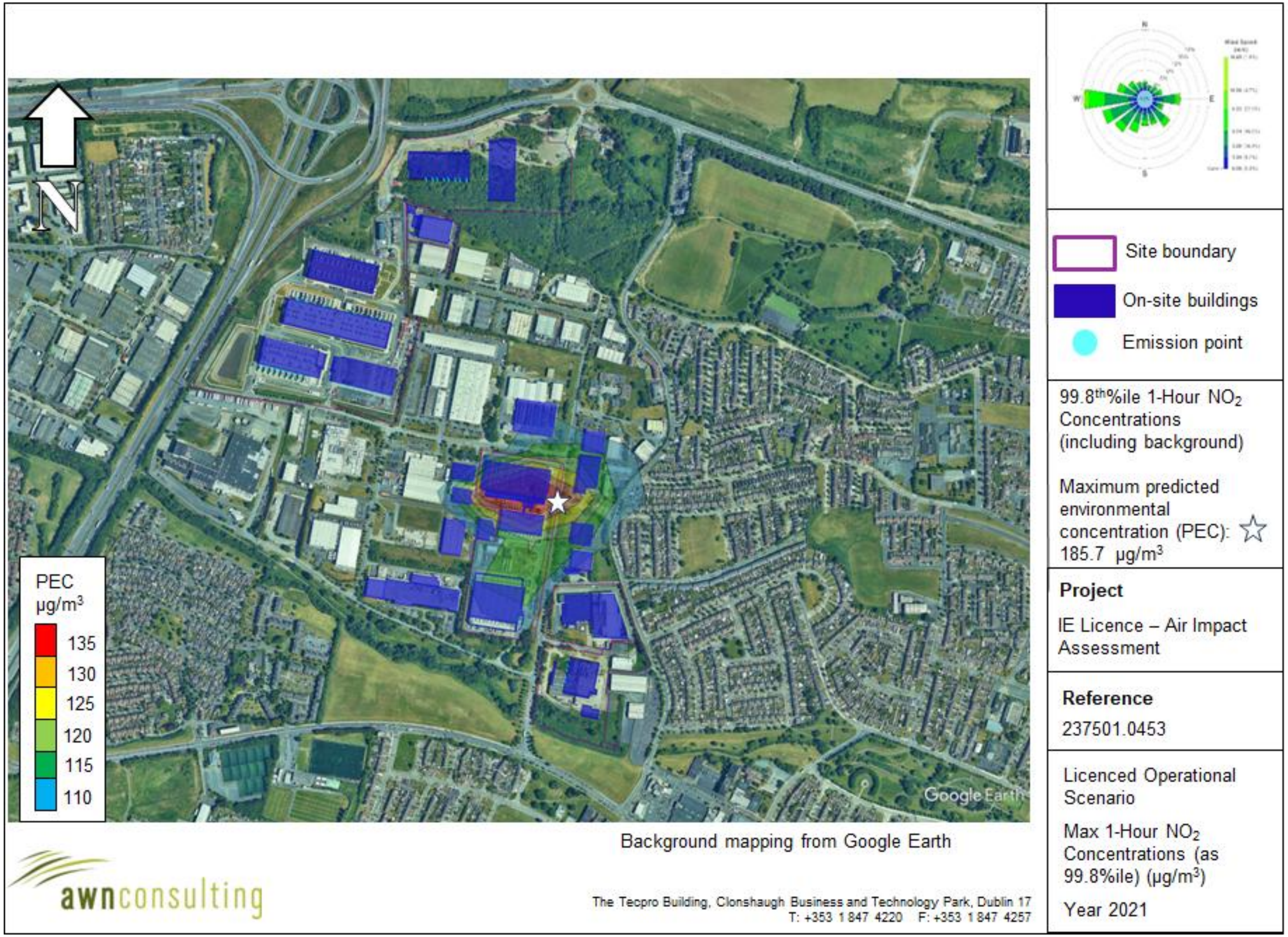

Figure 2 Licenced Operational Scenario - Maximum 1-Hour NO_2 Concentrations (as a 99.8th%ile) (µg/m^3) (including background concentrations)

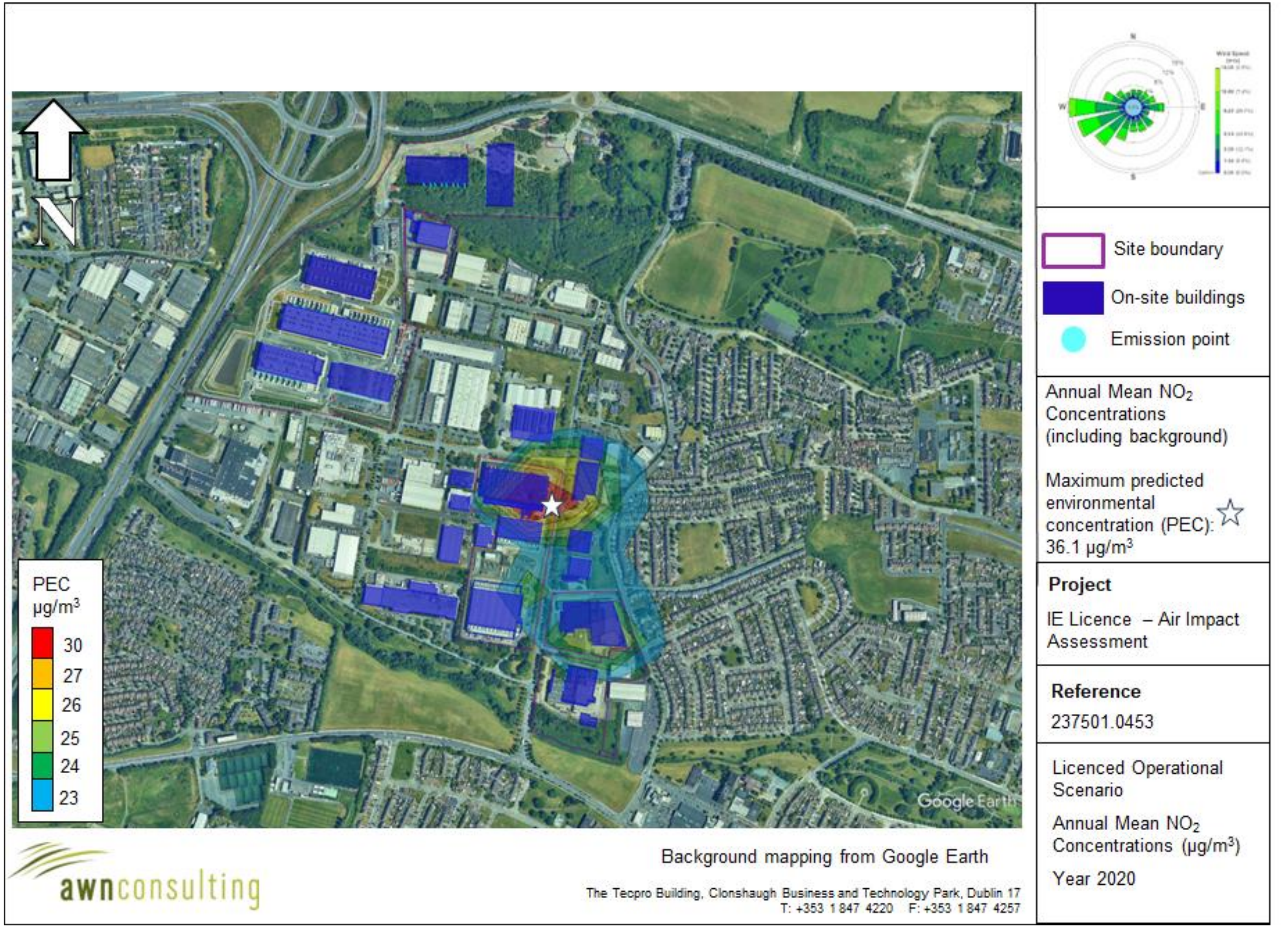

Figure 3 Licenced Operational Scenario – Annual Mean NO_2 Concentrations (µg/m³) (including background concentrations)

6.1.2 CO

The CO modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 13. 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 site 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 site 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 site with concentrations decreasing with distance from the facility.

Table 13. 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*

The ammonia modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 14. 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 site 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 limit value at the worst-case receptor (excluding background). Concentrations are at most 0.42% of the 99th percentile 1-hour limit value at the worst-case receptor (excluding background).

For the worst-case year, PEC emissions from the site result in an ambient ammonia concentration (including background) which is 0.55% of the maximum ambient 1-hour limit value at the worst-case receptor (boundary receptor, location shown in Figure 4) and 0.60% of the annual limit value at the worst-case receptor (boundary receptor, location shown in Figure 5). Concentrations are at most 1.0% of the 99th percentile 1-hour limit value at the worst-case receptor (boundary receptor, location). The locations of the maximum concentrations for ammonia are close to the boundary of the site with concentrations decreasing with distance from the facility.

Table 14. 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%	1.00	1.07	180	0.59%
	Maximum 1-Hour	685000, 5920350	10.6	0.42%	2.00	12.60	2500	0.50%
	99th%ile of 1-Hour Means	684984, 5920305	1.2	0.40%	2.00	3.20	300	1.07%
NH_3 / 2019	Annual Mean	684992, 5920304	0.1	0.03%	1.00	1.06	180	0.59%
	Maximum 1-Hour	685024, 5920314	9.9	0.40%	2.00	11.91	2500	0.48%
	99th%ile of 1-Hour Means	685200, 5920250	0.5	0.15%	2.00	2.45	300	0.82%
NH_3 / 2020	Annual Mean	684992, 5920304	0.1	0.03%	1.00	1.06	180	0.59%
	Maximum 1-Hour	684992, 5920304	9.0	0.36%	2.00	11.03	2500	0.44%
	99th%ile of 1-Hour Means	684984, 5920305	0.9	0.30%	2.00	2.89	300	0.96%
NH_3 / 2021	Annual Mean	684992, 5920304	0.1	0.03%	1.00	1.06	180	0.59%
	Maximum 1-Hour	684992, 5920304	9.9	0.40%	2.00	11.91	2500	0.48%
	99th%ile of 1-Hour Means	685200, 5920200	0.4	0.12%	2.00	2.35	300	0.78%
NH_3 / 2022	Annual Mean	684992, 5920304	0.1	0.04%	1.00	1.06	180	0.59%
	Maximum 1-Hour	685000, 5920350	11.0	0.44%	2.00	13.03	2500	0.52%
	99th%ile of 1-Hour Means	684984, 5920305	0.7	0.25%	2.00	2.75	300	0.92%

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)

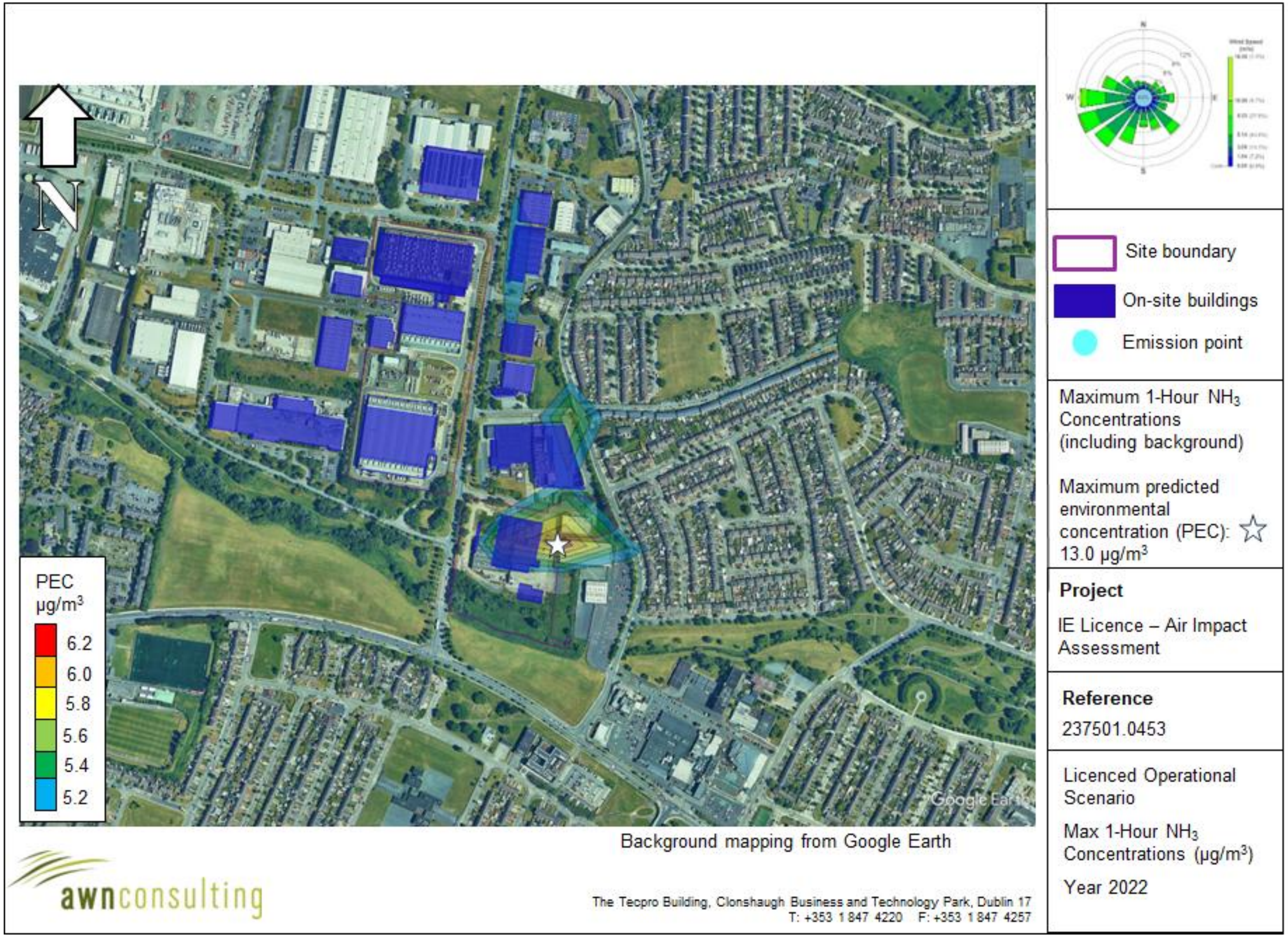

Figure 4 Licenced Operational Scenario - Maximum 1-Hour NH_3 Concentration ($\mu g/m^3$) (including background concentrations)

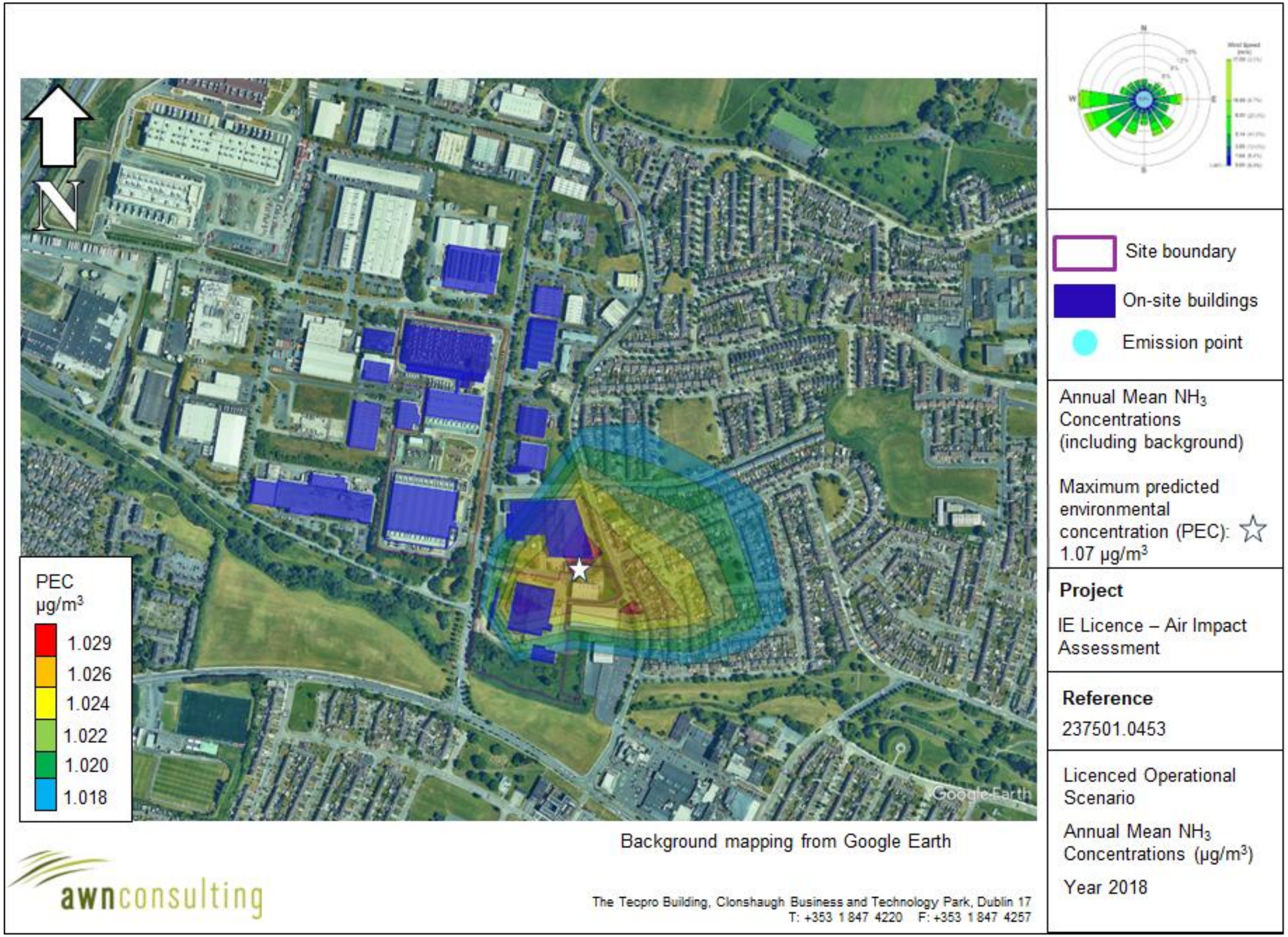

Figure 5 Licenced Operational Scenario - Annual Mean NH_3 Concentration (µg/m^3) (including background concentrations)

6.1.4 PM_{10}

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 15. 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 site 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) (2.5% of the limit value excluding background) at the worst-case receptor (boundary receptor, location shown in Figure 6) and 42% of the annual limit value at the worst-case receptor (5% of the limit value excluding background) (boundary receptor, location shown in Figure 7).

The geographical variation in the 24-hour mean (90.4^{th}%ile) ground level process contribution (PC) concentrations and annual mean PM_{10} ground level predicted environmental concentrations (PEC) are illustrated as concentration contours in Figure 6 and Figure 7, to demonstrate the direction and extent of the emission plume.

The 24-hour mean PM_{10} predicted environmental concentration contours are not displayed in Figure 6 due to the methodology for calculating the PEC. This is calculated in line with guidance from the UK DEFRA(5) and EPA(2) explained in detail in Section 4.0 which states that the 90.4^{th}%ile of 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}

Calculating the 24-hour mean (90.4^{th}%ile) PM_{10} PEC using the above two methods results in a maximum PEC based on method A. This is presented in Table 15. Therefore, a contour plot of the 24-hour mean (90.4^{th}%ile) PEC would be based on the annual mean rather than demonstrate the plume behaviour of the 24-hour mean (90.4^{th}%ile) process contribution.

Table 15. Licenced Operational Scenario – Dispersion Model Results for Particulate Matter (PM_{10})

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) Note 2	Limit Value (µg/m^3) Note 1	PEC as % of Limit Value
PM_{10} / 2018	Annual Mean	684911, 5920658	0.87	2%	16	16.87	40	42%
	90.4^{th}%ile 24-hr Mean	684911, 5920659	2.33	5%	23	23.87	50	48%
PM_{10} / 2019	Annual Mean	684911, 5920658	0.94	2%	16	16.94	40	42%
	90.4^{th}%ile 24-hr Mean	684911, 5920659	2.21	4%	23	23.94	50	48%
PM_{10} / 2020	Annual Mean	684911, 5920658	0.96	2%	16	16.96	40	42%
	90.4^{th}%ile 24-hr Mean	684911, 5920659	2.48	5%	23	23.96	50	48%
PM_{10} / 2021	Annual Mean	684911, 5920658	0.90	2%	16	16.90	40	42%
	90.4^{th}%ile 24-hr Mean	684908, 5920634	2.08	4%	23	23.90	50	48%

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) Note 2	Limit Value (µg/m^3) Note 1	PEC as % of Limit Value
PM_{10} / 2022	Annual Mean	684911, 5920658	0.84	2%	16	16.84	40	42%
	90.4th%ile 24-hr Mean	684908, 5920634	2.11	4%	23	23.84	50	48%

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

Note 2 24-hour mean (as 90.4th %ile) PM_{10} predicted environmental concentration derived from calculation as per UK DEFRA(5) and EPA(2) guidance, as described above, and is not a simple addition of background concentration to process contribution.

6.1.5 *$PM_{2.5}$*

The $PM_{2.5}$ modelling results are detailed in Table 16. These are derived from a worst-case assumption that all PM_{10} emissions from the facility 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 or 5% of the Stage 2 annual mean limit value of 20 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 or 55% of the Stage 2 annual mean limit value of 20 µg/m^3 at the worst-case receptor (boundary receptor, location shown in Figure 7). 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 7.

Table 16. 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)

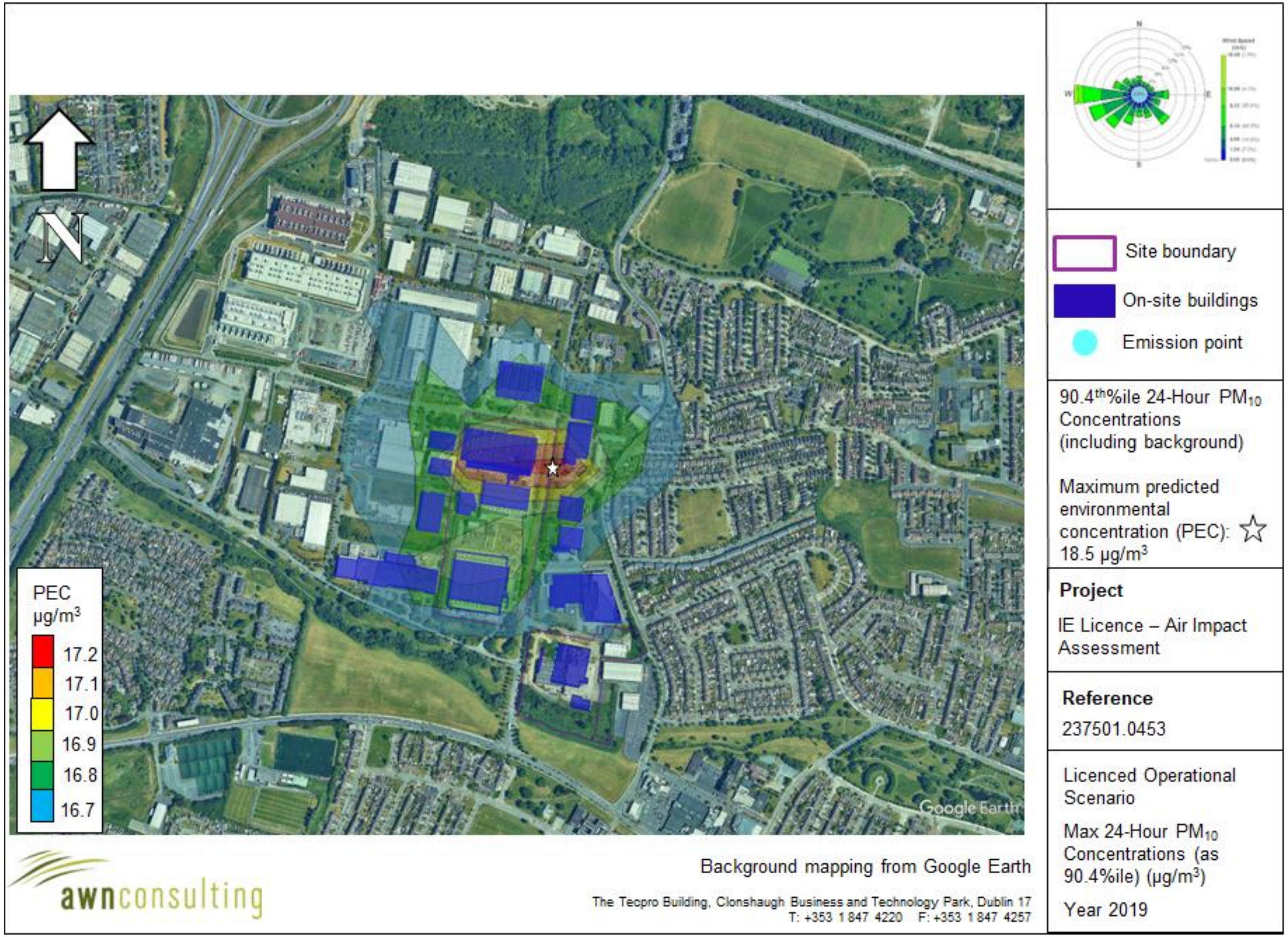

Figure 6 Licenced Operational Scenario - Maximum 24-Hour PM_{10} Concentration (µg/m^3) (including background concentrations)

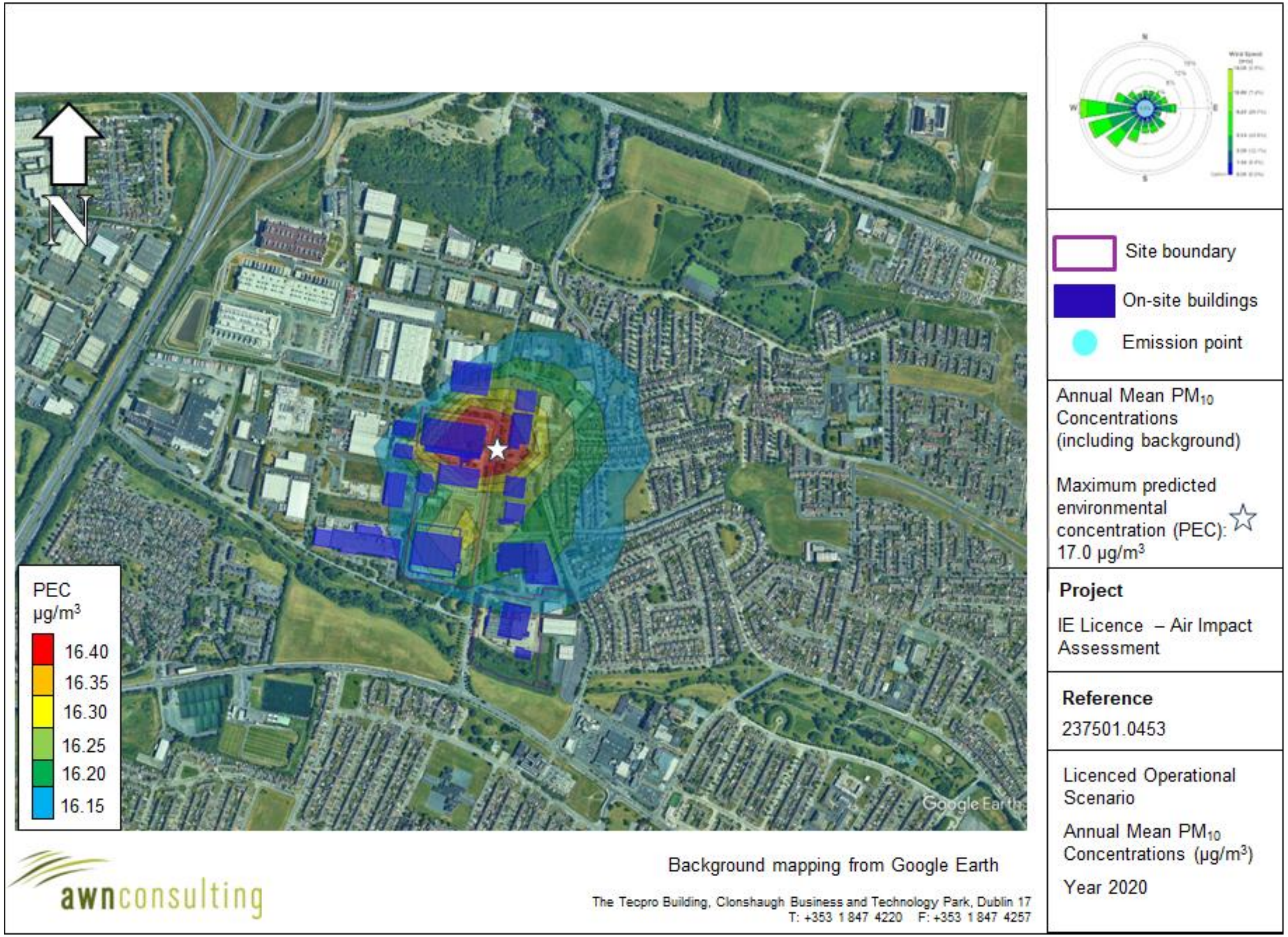

Figure 7 Licenced Operational Scenario - Annual Mean PM_{10} Concentration (µg/m^3) (including background concentrations)

6.1.6 SO_2

The SO_2 modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 17. 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 facility lead to an ambient SO_2 concentration (excluding background) which is 6% of the maximum 1-hour limit value (measured as a 99.7^{th}%ile) at the worst-case receptor and 5% of the maximum 24-hour limit value (measured as a 99.2^{nd}%ile) at the worst-case receptor.

PEC emissions from the facility lead to an ambient SO_2 concentration (including background) which is 15% of the maximum 1-hour limit value (measured as a 99.7^{th}%ile) at the worst-case receptor (boundary receptor, location shown in Figure 8) and 17% of the maximum 24-hour limit value (measured as a 99.2^{nd}%ile) at the worst-case receptor (off-site gridded receptor, location shown in Figure 9). The locations of the maximum concentrations for SO_2 are close to the boundary of the site with concentrations decreasing with distance from the facility.

The geographical variations in ground level SO_2 process contribution (PC) concentrations beyond the facility boundary for the worst-case years modelled are illustrated as concentration contours in Figure 8 and Figure 9 to demonstrate the direction and extent of the emission plume.

The 24-hour mean SO_2 (99.2^{nd}%ile) and the 1-hour mean SO_2 (99.7^{th}%ile) predicted environmental concentration contours are not displayed in Figure 8 and Figure 9 due to the methodology for calculating the PEC. This is calculated in line with guidance from the UK DEFRA(5) and EPA(2), explained in detail in Section 3.2.3 which states that for SO_2 an estimate of the maximum combined pollutant concentrations can be obtained as shown below:

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

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

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

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

Calculating the 24-hour mean SO_2 (99.2^{nd}%ile) and the 1-hour mean SO_2 (99.7^{th}%ile) PEC using the above two methods results in a maximum PEC based on method A. This is presented in Table 17. Therefore contour plots of the 24-hour mean SO_2 (99.2^{nd}%ile) and the 1-hour mean SO_2 (99.7^{th}%ile) PEC would be based on the annual mean rather than demonstrate the plume behaviour of the 24-hour mean SO_2 (99.2^{nd}%ile) and the 1-hour mean SO_2 (99.7^{th}%ile) process contributions.

Table 17. Licenced Operational Scenario – Dispersion Model Results for Sulphur Dioxide (SO_2)

Pollutant / Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution (µg/m³)	PC as a % of Limit Value	Back-ground (µg/m³)	Predicted Emission Concentration (µg/m³) Note 2	Limit Value (µg/m³) Note 1	PEC as a % of Limit Value
SO_2 / 2018	Annual Mean	684922, 5920663	0.7	-	4	4.75	-	
	99.7th%ile 1-hr Mean	684733, 5920712	17.5	5%	51	52.49	350	15%
	99.2nd%ile 24-hr Mean	684733, 5920712	5.4	4%	20	21.49	125	17%
SO_2 / 2019	Annual Mean	684921, 5920651	0.8	-	4	4.81	-	
	99.7th%ile 1-hr Mean	684922, 5920429	18.3	5%	51	52.62	350	15%
	99.2nd%ile 24-hr Mean	684921, 5920651	6.3	5%	20	21.62	125	17%
SO_2 / 2020	Annual Mean	684921, 5920651	0.8	-	4	4.84	-	
	99.7th%ile 1-hr Mean	684723, 5920638	19.3	6%	51	52.67	350	15%
	99.2nd%ile 24-hr Mean	684723, 5920638	6.2	5%	20	21.67	125	17%
SO_2 / 2021	Annual Mean	684921, 5920651	0.8	-	4	4.80	-	
	99.7th%ile 1-hr Mean	684723, 5920638	17.8	5%	51	52.61	350	15%
	99.2nd%ile 24-hr Mean	684922, 5920663	5.9	5%	20	21.61	125	17%
SO_2 / 2022	Annual Mean	684921, 5920651	0.8	-	4	4.76	-	
	99.7th%ile 1-hr Mean	684723, 5920638	19.2	5%	51	52.52	350	15%
	99.2nd%ile 24-hr Mean	684861, 5920742	5.7	5%	20	21.52	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.

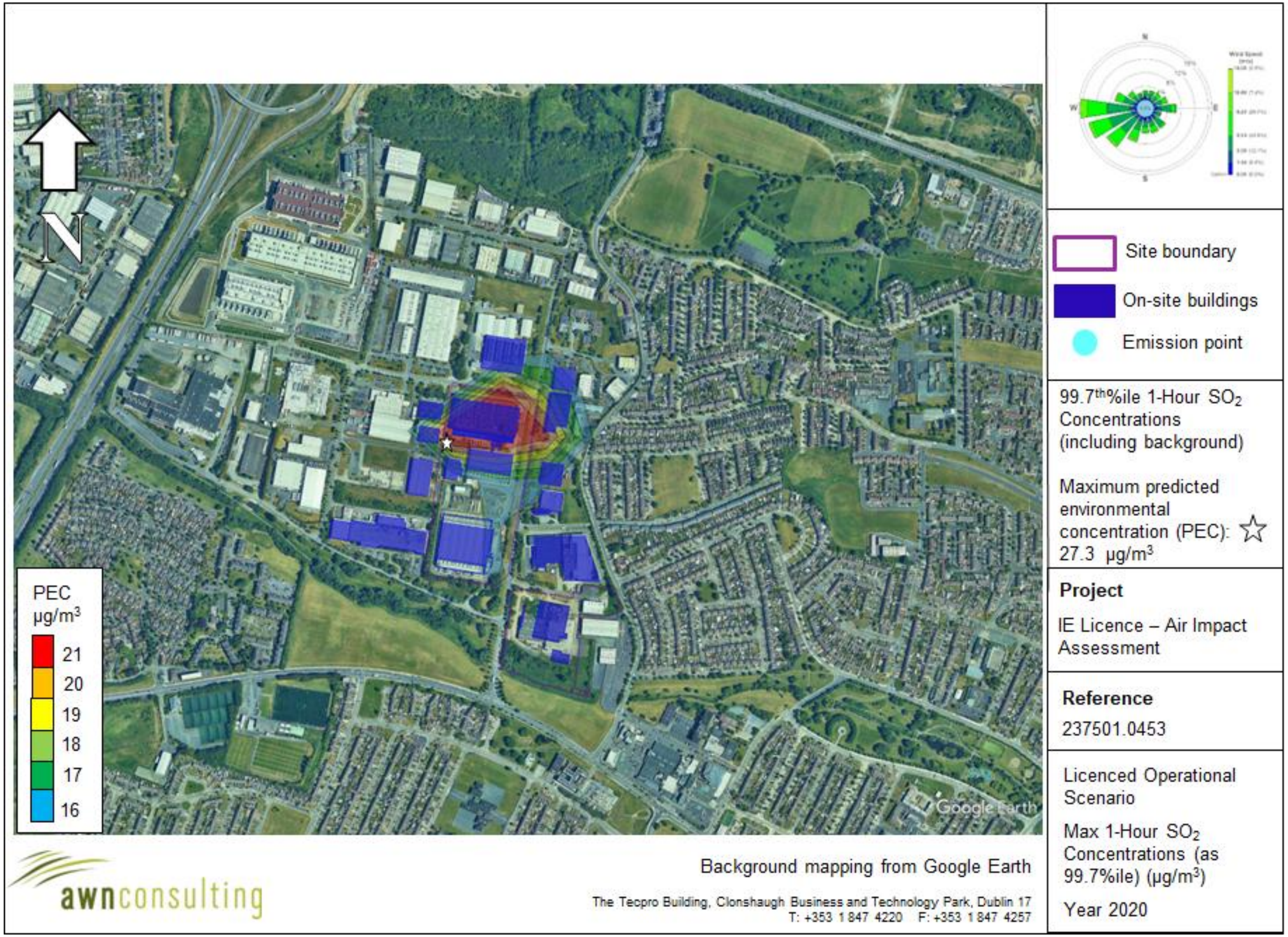

Figure 8 Licenced Operational Scenario - Maximum 1-Hour SO_2 Concentrations (as a 99.7th%ile) (µg/m^3) (including background concentrations)

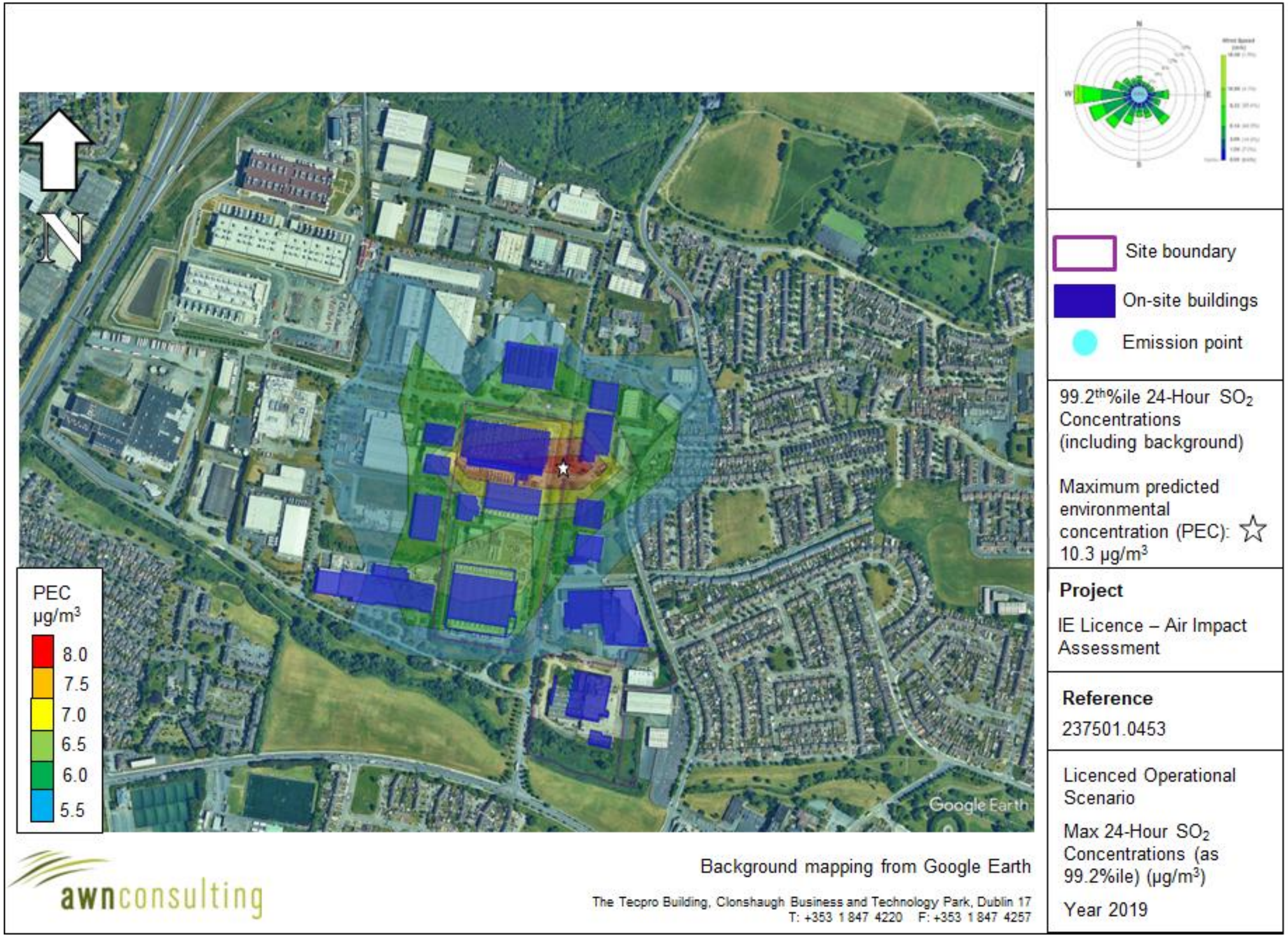

Figure 9 Licenced Operational Scenario – Maximum 24-Hour SO_2 Concentrations (as a 99.2th%ile) (including background concentrations)

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 Environment Agency 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 Facility 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 18 and Figure 10) indicate that in the worst-case year, the generators can operate for the 137 hours per year using diesel fuel 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 facility and the preferred method to determine the allowable operational hours of the backup emergency generators.

Table 18. *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

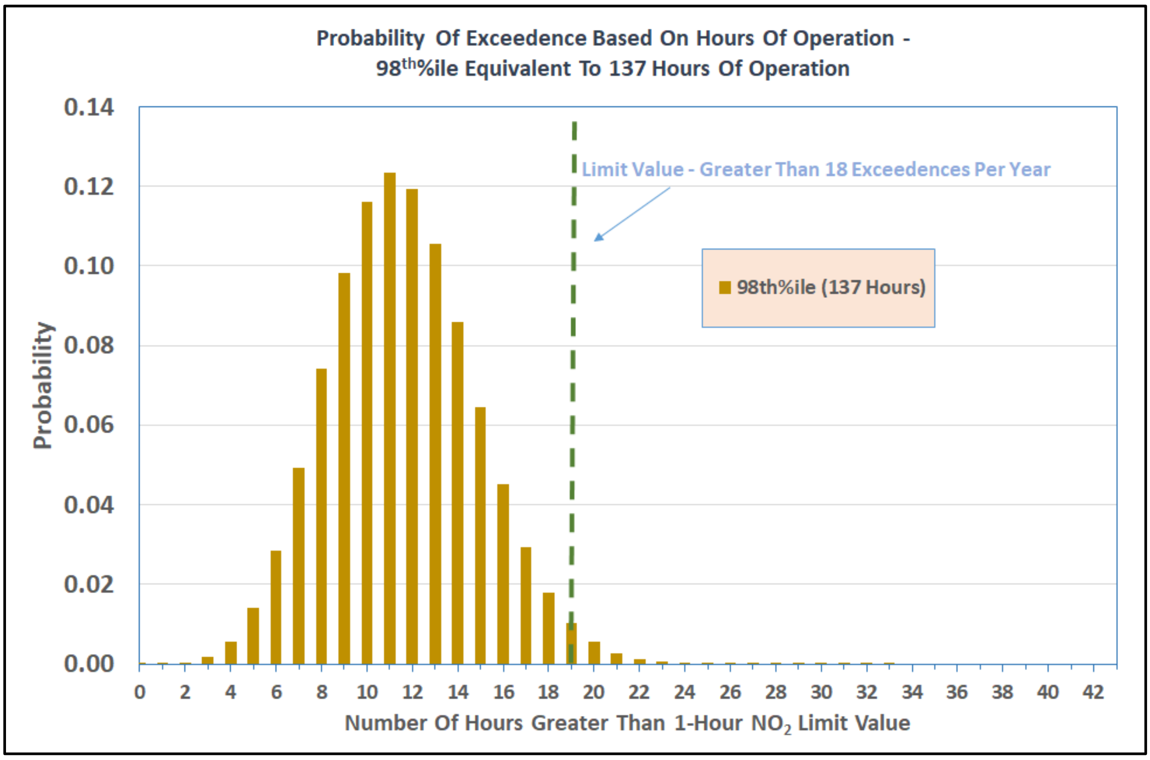

Figure 10 Hypergeometric Statistical Result at Worst-case Residential Receptor – Licenced Operational Scenario

6.3 Cumulative Assessment

6.3.1 Cumulative Scenario (USEPA Methodology)

The cumulative NO_2 modelling results at the worst-case location at and beyond the site boundary are detailed in Table 19 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 site in addition to emissions associated with a number of other data storage facilities within 1 km of the subject site 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 site lead to an ambient NO_2 concentration (excluding background) which is 79% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 60% of the annual limit value at the worst-case off-site receptor.

For the worst-case year modelled, cumulative PEC emissions from the site lead to an ambient NO_2 concentration (including background) which is 94% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 98% of the annual limit value at the worst-case off-site receptor, both of which are at the boundary of the facility. Concentrations decrease with distance from the site boundary. The geographical variations in the 1-hour mean (99.8th percentile) and annual mean NO_2 ground level concentrations for the Cumulative Scenario are illustrated as concentration contours in Figures 11 and 12. The locations of the maximum concentrations for NO_2 are close to the boundary of the site with concentrations decreasing with distance from the facility.

Table 19. 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/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 / 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%

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
	99.8th%ile of 1-hr means	684905, 5920609	158.6	79.3%	30	188.60	200	94.3%
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 20 and Figure 13) 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 facility and the preferred method to determine the allowable operational hours of the backup emergency generators.

Table 20. 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	
NO_2 / 2019	80	
NO_2 / 2020	114	0.02
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

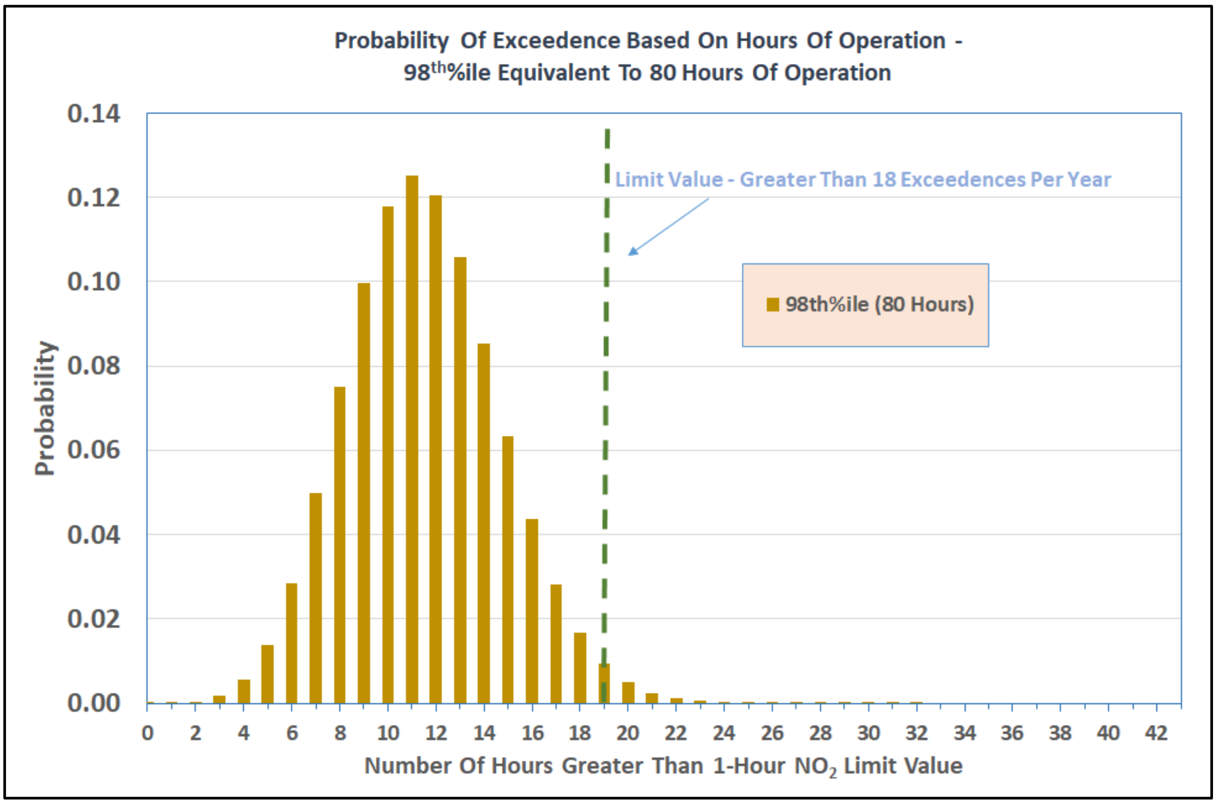

Figure 13 Hypergeometric Statistical Result at Worst-case Residential Receptor – Cumulative Assessment

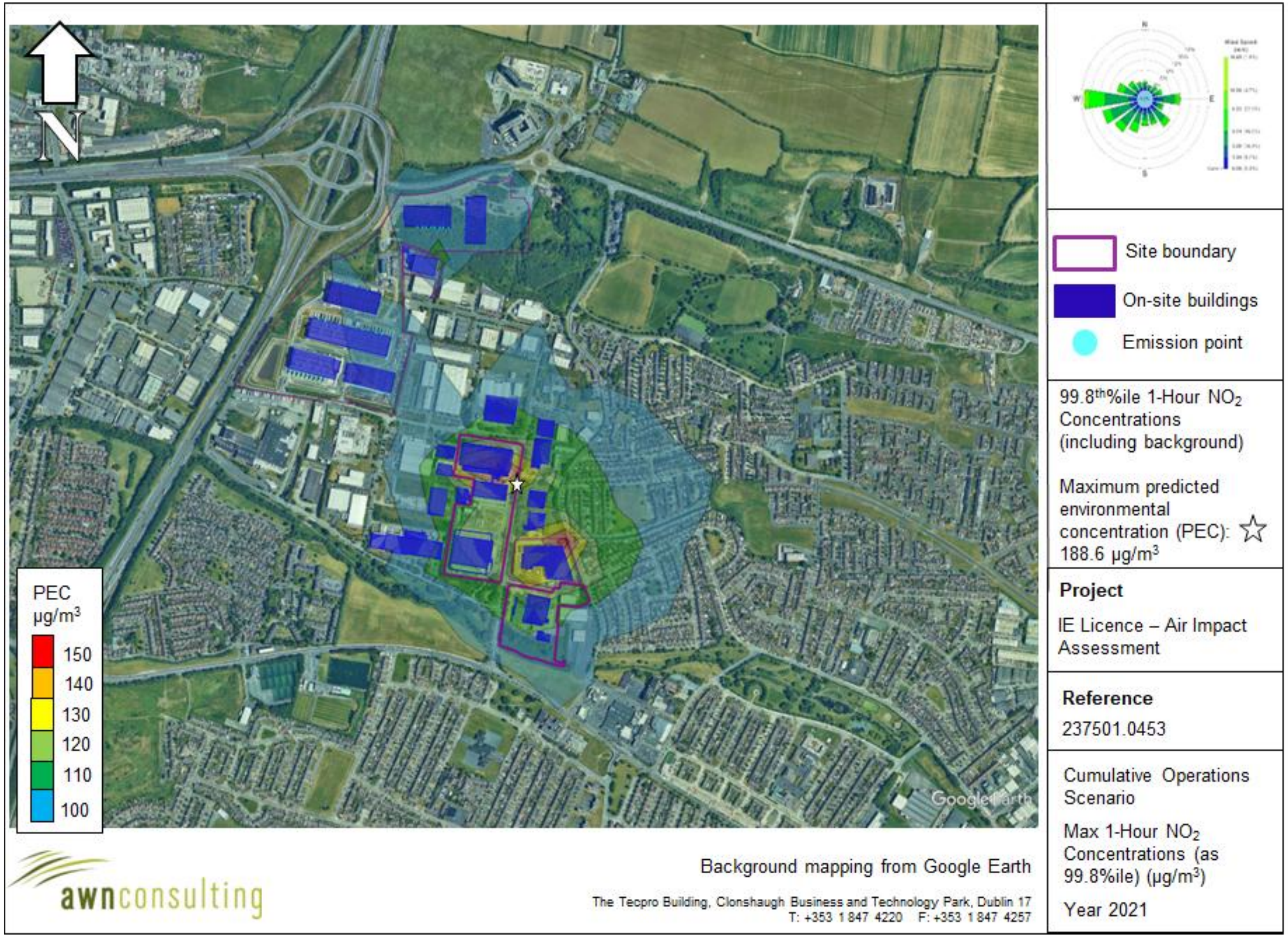

Figure 11 Cumulative Assessment - Maximum 1-Hour NO_2 Concentrations (as a 99.8th%ile) (µg/m³) (including background concentrations)

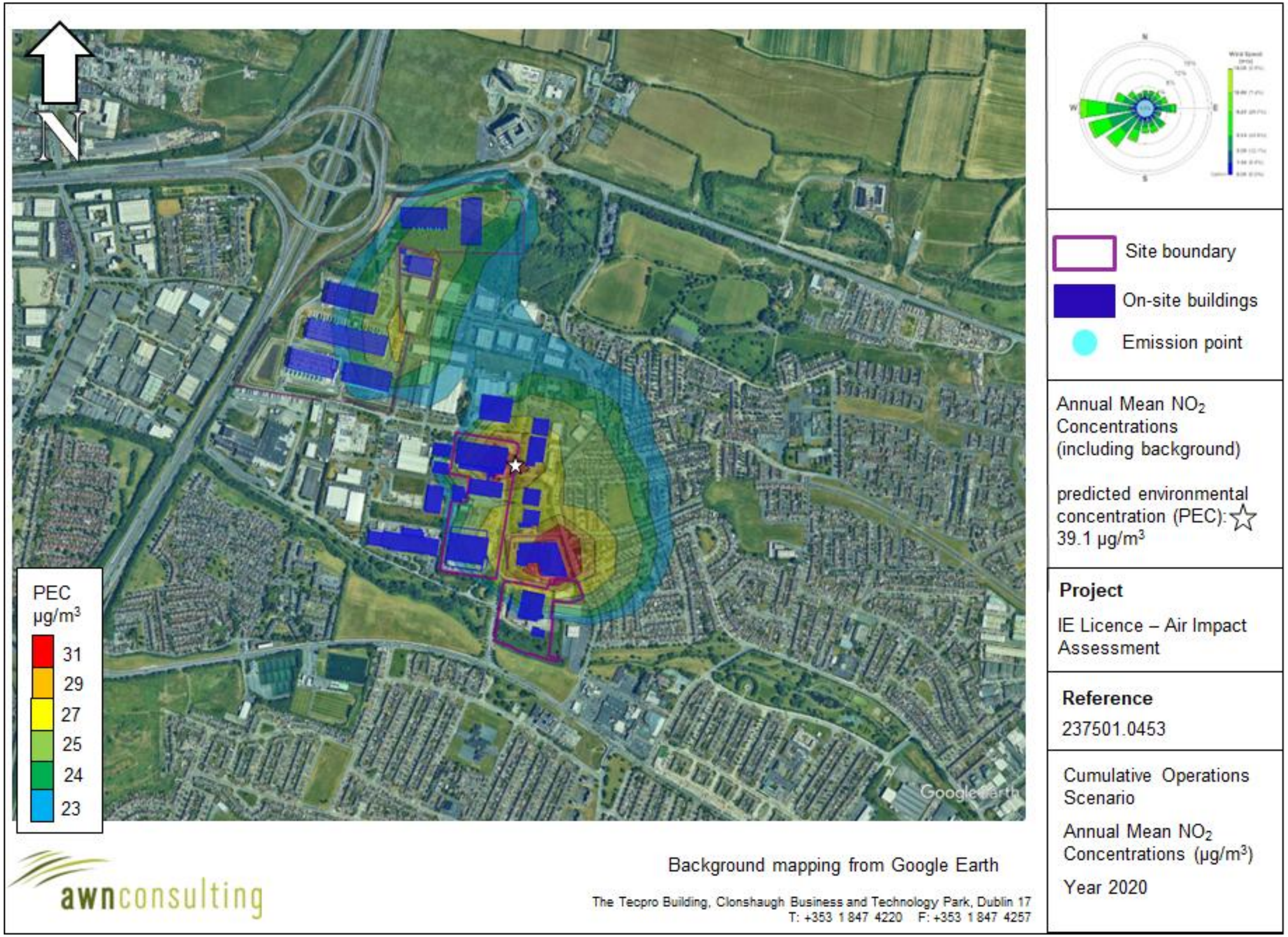

Figure 12 Cumulative Assessment - Annual Mean NO_2 Concentrations (µg/m³) (including background concentrations)

7.0 RESULTS - ECOLOGY

7.1 Most Impacted Ecological Receptor (PC)

The ecological receptor closest to and most impacted by the Installation, and where the highest modelled process contributions are predicted, is the Santry Demesne pNHA. The most impacted (in terms of process contributions) Natura 2000 receptor is the Baldoyle Bay SAC.

7.1.1 NO_X

The NO_X modelling results are detailed in Table 21. Within the most impacted ecological receptor (Santry Demesne pNHA), at the worst-case location, PEC emissions from the facility lead to an ambient NO_X concentration (including background) which is at most 58% of the annual limit value over the five years of meteorological data modelled. The process contribution (PC) NO_X concentration is at most 1.4% of the annual limit value over the five years of meteorological data modelled.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC), at the worst-case location, PEC emissions from the facility lead to an ambient NO_X concentration (including background) which is at most 37% of the annual limit value over the five years of meteorological data modelled. The process contribution (PC) NO_X concentration is at most 0.9% of the annual limit value over the five years of meteorological data modelled.

Table 21. NO_X Dispersion Model Results at Most Impacted Ecological Receptors – Licenced Operational Scenario Operations

Pollutant / Year	Designated Habitat	Annual Mean Process Contribution (µg/m^3)	PC % of Limit Value	Annual Mean Back-ground (µg/m^3)	Annual Mean Predicted Environmental Concentration (µg/m^3)	Limit Value (µg/m^3)	PEC % of Limit Value
NO_X / 2018	Santry Demesne pNHA	0.38	1.3%	17.10	17.48	30	58%
	Baldoyle Bay SAC	0.26	0.9%	10.90	11.16		37%
NO_X / 2019	Santry Demesne pNHA	0.43	1.4%	17.10	17.53	30	58%
	Baldoyle Bay SAC	0.27	0.9%	10.90	11.17		37%
NO_X / 2020	Santry Demesne pNHA	0.33	1.1%	17.10	17.43	30	58%
	Baldoyle Bay SAC	0.27	0.9%	10.90	11.17		37%
NO_X / 2021	Santry Demesne pNHA	0.43	1.4%	17.10	17.53	30	58%
	Baldoyle Bay SAC	0.26	0.9%	10.90	11.16		37%
NO_X / 2022	Santry Demesne pNHA	0.38	1.3%	17.10	17.48	30	58%
	Baldoyle Bay SAC	0.26	0.9%	10.90	11.16		37%

7.1.2 NH_3

The NH_3 modelling results are detailed in Table 22. Within the most impacted ecological receptor (Santry Demesne pNHA), at the worst-case location, PEC emissions from the facility lead to an ambient NH_3 concentration (including background) which is at most 50% of the annual limit value over the five years of meteorological data modelled. The process contribution (PC) NH_3 concentration is at most 0.04% of the annual limit value over the five years of meteorological data modelled.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC), at the worst-case location, PEC emissions from the facility lead to an ambient NH_3 concentration (including background) which is at most 50% of the annual limit value over the five years of meteorological data modelled. The process contribution (PC) NH_3 concentration is at most 0.02% of the annual limit value over the five years of meteorological data modelled.

Table 22. NH_3 Dispersion Model Results at Most Impacted Ecological Receptors – Licenced Operational Scenario

Pollutant / Year	Designated Habitat	Annual Mean Process Contribution (µg/m^3)	PC % of Limit Value	Annual Mean Background (µg/m^3)	Annual Mean Predicted Environmental Concentration (µg/m^3)	Limit Value (µg/m^3)	PEC % of Limit Value
NH_3 / 2018	Santry Demesne pNHA	0.00088	0.03%	1.5	1.50088	3.0	50%
	Baldoyle Bay SAC	0.00055	0.02%	1.5	1.50055		50%
NH_3 / 2019	Santry Demesne pNHA	0.0011	0.04%	1.5	1.5011	3.0	50%
	Baldoyle Bay SAC	0.00055	0.02%	1.5	1.50055		50%
NH_3 / 2020	Santry Demesne pNHA	0.00066	0.02%	1.5	1.50066	3.0	50%
	Baldoyle Bay SAC	0.00055	0.02%	1.5	1.50055		50%
NH_3 / 2021	Santry Demesne pNHA	0.00099	0.03%	1.5	1.50099	3.0	50%
	Baldoyle Bay SAC	0.00044	0.01%	1.5	1.50044		50%
NH_3 / 2022	Santry Demesne pNHA	0.00088	0.03%	1.5	1.50088	3.0	50%
	Baldoyle Bay SAC	0.00044	0.01%	1.5	1.50044		50%

7.1.3 SO_2

The SO_2 modelling results are detailed in Table 23. Within the most impacted ecological receptor (Santry Demesne pNHA), at the worst-case location, PEC emissions from the facility lead to an ambient SO_2 concentration (including background) which is at most 9.1% of the annual limit value over the five years of meteorological data modelled. The process contribution (PC) SO_2 concentration is at most 0.06% of the annual limit value over the five years of meteorological data modelled.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC), at the worst-case location, PEC emissions from the facility lead to an ambient SO_2 concentration (including background) which is at most 9.0% of the annual limit value over the five years of meteorological data modelled. The process contribution (PC) SO_2 concentration is at most 0.04% of the annual limit value over the five years of meteorological data modelled.

Table 23. SO_2 Dispersion Model Results at Most Impacted Ecological Receptor – Licenced Operational Scenario

Pollutant / Year	Designated Habitat	Annual Mean Process Contribution (µg/m3)	PC % of Limit Value	Annual Mean Background (µg/m3)	Annual Mean Predicted Environmental Concentration (µg/m3)	Limit Value (µg/m3)	PEC % of Limit Value
SO2 / 2018	Santry Demesne pNHA	0.010	0.05%	1.800	1.810	20.0	9.0%
	Baldoyle Bay SAC	0.007	0.03%	1.800	1.807		9.0%
SO2 / 2019	Santry Demesne pNHA	0.011	0.05%	1.800	1.811	20.0	9.1%
	Baldoyle Bay SAC	0.007	0.04%	1.800	1.807		9.0%
SO2 / 2020	Santry Demesne pNHA	0.009	0.04%	1.800	1.809	20.0	9.0%
	Baldoyle Bay SAC	0.007	0.04%	1.800	1.807		9.0%
SO2 / 2021	Santry Demesne pNHA	0.011	0.06%	1.800	1.811	20.0	9.1%
	Baldoyle Bay SAC	0.007	0.03%	1.800	1.807		9.0%
SO2 / 2022	Santry Demesne pNHA	0.010	0.05%	1.800	1.810	20.0	9.0%
	Baldoyle Bay SAC	0.007	0.03%	1.800	1.807		9.0%

7.1.4 Nitrogen Deposition

In order to consider the effects of nitrogen deposition (as N) owing to emissions from the facility 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 2.3 and shown in Table 24).

In order to determine the appropriate worst-case critical load, the EPA publication "*Nitrogen-Sulfur Critical Loads: Assessment of the Impacts of Air Pollution on Habitats*" (EPA, 2021) was consulted. In Table 3.2 of the publication empirical critical loads of nutrient nitrogen are outlined with a worst-case range of 5-10 kg N ha^{-1} yr^{-1} for most habitat types. In addition, for most habitat types, it is recommended the midpoint is used to define the critical load (7.5 kg N ha^{-1} yr^{-1}).

The nitrogen deposition flux for the worst-case year is 7.061 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr (as outlined in Section 2.3) in the Santry Demesne pNHA (000178), indicating that the effects of nitrogen deposition on ecological receptors due to the facility are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 0.87% of the annual limit value over the five years of meteorological data modelled.

The nitrogen deposition flux for the worst-case year is 6.038 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr for the most sensitive feature "Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)" (feature code: H1330) in the Baldoyle Bay SAC, indicating that the effects of nitrogen deposition on designated sites due to the facility are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 0.63% of the annual limit value over the five years of meteorological data modelled.

Table 24. Nitrogen Deposition at Most Impacted Ecological Receptor – Licenced Operational Scenario

Met. Year	Designated Habitat	NO_2 Annual Mean PC (µg/m^3)	NH_3 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NH_3 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/year)	NH_3 Acid Deposition (keq/ha/year)	APIS Background Nitrogen Deposition (kg/ha/yr)	Total (NO_2 + NH_3) PEC Nitrogen Deposition kg/ha/yr	PC % of Critical Load
2018	Santry Demesne pNHA	0.34	0.0009	0.0005	0.00002	0.048	0.005	7.0	7.053	0.76%
	Baldoyle Bay SAC	0.23	0.0005	0.0003	0.00001	0.033	0.003	6.0	6.036	0.60%
2019	Santry Demesne pNHA	0.38	0.0011	0.0006	0.00002	0.055	0.005	7.0	7.061	0.87%
	Baldoyle Bay SAC	0.24	0.0005	0.0004	0.00001	0.035	0.003	6.0	6.038	0.63%
2020	Santry Demesne pNHA	0.30	0.0006	0.0004	0.00001	0.043	0.003	7.0	7.046	0.66%
	Baldoyle Bay SAC	0.24	0.0005	0.0004	0.00001	0.035	0.003	6.0	6.038	0.63%
2021	Santry Demesne pNHA	0.39	0.0009	0.0006	0.00002	0.056	0.005	7.0	7.061	0.87%
	Baldoyle Bay SAC	0.23	0.0005	0.0003	0.00001	0.033	0.002	6.0	6.036	0.59%
2022	Santry Demesne pNHA	0.34	0.0009	0.0005	0.00002	0.049	0.005	7.0	7.053	0.76%
	Baldoyle Bay SAC	0.23	0.0005	0.0003	0.00001	0.033	0.003	6.0	6.036	0.60%

7.1.5 Acid Deposition

In order to consider the effects of acid deposition (as N) owing to emissions from the facility on the most impacted ecological receptor, the maximum annual mean NO_2, NH_3 and SO_2 process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes (as described in Section 2.3 and shown in Table 25 and Table 26).

The total acid deposition (as N and S) flux in the in the Santry Demesne pNHA (000178) for the worst-case year is 0.506 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 5.611 keq/ha/yr, which is based on the acidity range for "old sessile oak woods with Ilex and Blechnum in the British Isles" (established in Section 2.3), indicating that the effects of acid deposition (as N and S) on ecological receptors due to the facility are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 1.13% of the annual limit value over the five years of meteorological data modelled.

The total acid deposition (as N and S) flux for the worst-case year is 0.504 keq/ha/yr. the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the most sensitive feature "Fixed coastal dunes with herbaceous vegetation ("grey dunes")" (feature code: H2130) in the North Dublin Bay SAC (there is no data for acid deposition critical loads in the Baldoyle Bay SAC and thus North Dublin Bay SAC has been referenced), indicating that the effects of acid deposition (as N and S) on designated sites due to the facility are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 0.71% of the annual limit value over the five years of meteorological data modelled.

Table 25. Acid Deposition (as N) at Most Impacted Ecological Receptor – Licenced Operational Scenario

Met. Year	Designated Habitat	NO_2 Annual Mean PC (µg/m^3)	NH_3 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NH_3 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/year)	NH_3 Acid Deposition (keq/ha/year)	Total (NO_2 + NH_3) PC Acid Deposition (as N) keq/ha/yr)
2018	Santry Demesne pNHA	0.335	0.0009	0.0005	0.000018	0.003	0.0003	0.004
	Baldoyle Bay SAC	0.231	0.0005	0.0003	0.000011	0.002	0.0002	0.003
2019	Santry Demesne pNHA	0.383	0.0011	0.0006	0.000021	0.004	0.0004	0.004
	Baldoyle Bay SAC	0.244	0.0005	0.0004	0.000011	0.003	0.0002	0.003
2020	Santry Demesne pNHA	0.299	0.0006	0.0004	0.000012	0.003	0.0002	0.003
	Baldoyle Bay SAC	0.245	0.0005	0.0004	0.000010	0.003	0.0002	0.003
2021	Santry Demesne pNHA	0.388	0.0009	0.0006	0.000019	0.004	0.0003	0.004
	Baldoyle Bay SAC	0.231	0.0005	0.0003	0.000009	0.002	0.0002	0.003
2022	Santry Demesne pNHA	0.339	0.0009	0.0005	0.000017	0.003	0.0003	0.004
	Baldoyle Bay SAC	0.231	0.0005	0.0003	0.000010	0.002	0.0002	0.003

Table 26. Acid Deposition (as S) at Most Impacted Ecological Receptor

Year	Designated Habitat	SO_2 Annual Mean PEC (µg/m^3)	SO_2 Dry Deposition (µg/m^2/s)	SO_2 Sulphur Deposition (kg/ha/year)	SO_2 Acid Deposition (as S) (keq/ha/year)	APIS Background Acid Deposition (keq/ha/yr)	Total (NO_2 + NH_3 +SO_2) PEC Acid Deposition (keq/ha/yr)	PC % of Critical Load
2018	Santry Demesne pNHA	0.0096	0.0001	0.0182	0.0011	0.500	0.505	0.98%
	Baldoyle Bay SAC	0.0067	0.0001	0.0126	0.0008	0.500	0.503	0.67%
2019	Santry Demesne pNHA	0.0109	0.0001	0.0207	0.0013	0.500	0.506	1.12%
	Baldoyle Bay SAC	0.0070	0.0001	0.0133	0.0008	0.500	0.504	0.70%
2020	Santry Demesne pNHA	0.0087	0.0001	0.0164	0.0010	0.500	0.504	0.86%

Year	Designated Habitat	SO_2 Annual Mean PEC (µg/m³)	SO_2 Dry Deposition (µg/m²/s)	SO_2 Sulphur Deposition (kg/ha/year)	SO_2 Acid Deposition (as S) (keq/ha/year)	APIS Background Acid Deposition (keq/ha/yr)	Total (NO_2 + NH_3 +SO_2) PEC Acid Deposition (keq/ha/yr)	PC % of Critical Load
	Baldoyle Bay SAC	0.0071	0.0001	0.0134	0.0008	0.500	0.504	0.71%
2021	Santry Demesne pNHA	0.0112	0.0001	0.0211	0.0013	0.500	0.506	1.13%
	Baldoyle Bay SAC	0.0067	0.0001	0.0127	0.0008	0.500	0.503	0.67%
2022	Santry Demesne pNHA	0.0097	0.0001	0.0184	0.0011	0.500	0.505	0.99%
	Baldoyle Bay SAC	0.0067	0.0001	0.0127	0.0008	0.500	0.503	0.67%

7.2 Most Impacted Ecological Receptor (PEC)

7.2.1 NO_X

The ecological receptor most impacted in terms of Predicted Environmental Concentration (PEC), and where the highest modelled concentrations are predicted, is the South Dublin Bay and River Tolka Estuary SPA (Site Code 004024). At the worst-case location in the South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA, emissions from the facility lead to an ambient NO_X concentration (including background) which is at most 99% of the annual limit value over the five years of meteorological data modelled as shown in Table 27, although the impact of the facility (without background) at this location is less than 0.2% of the annual limit value.

Table 27. NO_X Dispersion Model Results at Most Impacted European Receptor – Licenced Operational Scenario

Pollutant / Year	Designated Habitat	Annual Mean Process Contribution (µg/m³)	PC % of Limit Value	Annual Mean Back-ground (µg/m³)	Annual Mean Predicted Environmental Concentration (µg/m³)	Limit Value (µg/m³)	PEC % of Limit Value
2018	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.05	0.15%	29.79	29.84	30	99%
2019	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.03	0.11%	29.79	29.82	30	99%
2020	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.04	0.12%	29.79	29.83	30	99%
2021	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.05	0.18%	29.79	29.84	30	99%
2022	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.03	0.11%	29.79	29.82	30	99%

7.2.2 NH_3

The NH_3 modelling results are detailed in Table 28. Within the closest Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, emissions from the facility lead to an ambient NH_3 concentration (including background) which is at most 42% of the annual limit value over the five years of meteorological data modelled. The process contribution (PC) NH_3 concentration is at most 0.0004% of the annual limit value over the five years of meteorological data modelled.

Table 28. NH_3 Dispersion Model Results at Most Impacted European Receptor – Licenced Operational Scenario

Pollutant / Year	Designated Habitat	Annual Mean Process Contribution (μg/m^3)	PC % of Limit Value	Annual Mean Background (μg/m^3)	Annual Mean Predicted Environmental Concentration (μg/m^3)	Limit Value (μg/m^3)	PEC % of Limit Value
2018	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.00008	0.0003%	1.27	1.2701	3	42%
2019	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.00007	0.0002%	1.27	1.2701	3	42%
2020	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.00007	0.0002%	1.27	1.2701	3	42%
2021	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.00012	0.0004%	1.27	1.2701	3	42%
2022	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.00006	0.0002%	1.27	1.2701	3	42%

7.2.3 SO_2

The SO_2 modelling results are detailed in Table 29. Within the closest Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, emissions from the facility lead to an ambient SO_2 concentration (including background) which is at most 37% of the annual limit value over the five years of meteorological data modelled. The process contribution (PC) SO_2 concentration is at most 0.0046% of the annual limit value over the five years of meteorological data modelled.

Table 29. SO_2 Dispersion Model Results at Most Impacted European Receptor – Licenced Operational Scenario

Pollutant / Year	Designated Habitat	Annual Mean Process Contribution (µg/m³)	PC % of Limit Value	Annual Mean Background (µg/m³)	Annual Mean Predicted Environmental Concentration (µg/m³)	Limit Value (µg/m³)	PEC % of Limit Value
2018	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0012	0.0040%	7.4	7.4012	20	37%
2019	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0009	0.0028%	7.4	7.4009	20	37%
2020	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0009	0.0031%	7.4	7.4009	20	37%
2021	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0014	0.0046%	7.4	7.4014	20	37%
2022	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0009	0.0030%	7.4	7.4009	20	37%

7.2.4 Nitrogen Deposition

In order to consider the effects of nitrogen deposition (as N) owing to emissions from the facility 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 2.3 and shown in Table 30).

Within the closest (and most impacted in terms of Predicted Environmental Concentration (PEC)) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, the nitrogen deposition flux for the worst-case year is 6.807 kg/ha/yr. This is below the midrange critical load of 7.5 kg/ha/yr(2) for the feature "*Tringa totanus* (Eastern Atlantic - wintering)" (feature code: A162), indicating that the effects of nitrogen deposition on designated sites due to the facility are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 0.11% of the annual limit value over the five years of meteorological data modelled.

Table 30. Nitrogen Deposition at Most Impacted Ecological Receptor – Licenced Operational Scenario

Met. Year	Designated Habitat	NO_2 Annual Mean PC (µg/m^3)	NH_3 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NH_3 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/year)	NH_3 Acid Deposition (keq/ha/year)	APIS Background Nitrogen Deposition (kg/ha/yr)	Total (NO_2 + NH_3) PEC Nitrogen Deposition kg/ha/yr	PC % of Critical Load
2018	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.04	0.000077	0.000062	0.000002	0.0059	0.0004	6.8	6.806	0.09%
2019	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.03	0.000066	0.000044	0.000001	0.0042	0.0003	6.8	6.805	0.07%
2020	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.03	0.000066	0.000048	0.000001	0.0046	0.0003	6.8	6.805	0.07%
2021	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.05	0.000121	0.000071	0.000002	0.0068	0.0006	6.8	6.807	0.11%
2022	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.03	0.000055	0.000046	0.000001	0.0044	0.0003	6.8	6.805	0.07%

7.2.5 Acid Deposition

In order to consider the effects of acid deposition (as N and S) owing to emissions from the facility on the closest ecological receptor, the maximum annual mean NO_2, NH_3 and SO_2 process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes (as described in Section 2.3 and shown in Table 31 and Table 32).

Within the closest (and most impacted in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, the total acid deposition (as N and S) flux for the worst-case year is 0.591 keq/ha/yr. This is below the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the feature "*Sterna hirundo* (Northern/Eastern Europe - breeding)" (feature code: A193), indicating that the effects of acid deposition (as N and S) on designated sites due to the facility are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 0.12% of the annual limit value over the five years of meteorological data modelled.

Table 31. Acid Deposition (as N) at Most Impacted European Receptor – Licenced Operational Scenario

Met. Year	Designated Habitat	NO_2 Annual Mean PC (µg/m^3)	NH_3 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NH_3 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/year)	NH_3 Acid Deposition (keq/ha/year)	Total (NO_2 + NH_3) PC Acid Deposition (as N) (keq/ha/yr)
2018	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.041	0.00008	0.00006	0.000002	0.00042	0.00003	0.00045
2019	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.030	0.00007	0.00004	0.000001	0.00030	0.00002	0.00033
2020	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.032	0.00007	0.00005	0.000001	0.00033	0.00002	0.00035
2021	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.048	0.00012	0.00007	0.000002	0.00049	0.00004	0.00053
2022	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.030	0.00006	0.00005	0.000001	0.00031	0.00002	0.00033

Table 32. Acid Deposition (as S) at Most Impacted European Receptor – Licenced Operational Scenario

Year	Designated Habitat	SO_2 Annual Mean PEC (µg/m^3)	SO_2 Dry Deposition (µg/m^2/s)	SO_2 Sulphur Deposition (kg/ha/year)	SO_2 Acid Deposition (as S) (keq/ha/year)	APIS Background Acid Deposition (keq/ha/yr)	Total (NO_2 + NH_3 +SO_2) PEC Acid Deposition (keq/ha/yr)	PC % of Critical Load
2018	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0012	0.00001	0.00227	0.00014	0.59	0.5906	0.10%
2019	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0009	0.00001	0.00161	0.00010	0.59	0.5904	0.07%
2020	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0009	0.00001	0.00176	0.00011	0.59	0.5905	0.08%
2021	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0014	0.00002	0.00259	0.00016	0.59	0.5907	0.12%
2022	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0009	0.00001	0.00168	0.00011	0.59	0.5904	0.07%

7.3 Cumulative Air Quality Impact on Ecological Receptors (PC)

7.3.1 NO_2

The cumulative NO_X modelling results are detailed in Table 33. Within the most impacted ecological receptor (Santry Demesne pNHA), at the worst-case location, cumulative PEC emissions lead to an ambient NO_X concentration (including background) which is at most 61% of the annual limit value over the five years of meteorological data modelled although the CPC impact of the facility (without background) at this location is less than 3.7 % of the annual limit value.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC), at the worst-case location, cumulative PEC emissions lead to an ambient NO_X concentration (including background) which is at most 38% of the annual limit value over the five years of meteorological data modelled although the CPC impact of the facility (without background) at this location is less than 1.9% of the annual limit value..

Table 33. Cumulative NO_x Dispersion Model Results - Ecological Receptors (PC)

Pollutant / Year	Designated Habitat	Annual Mean Process Contribution ($\mu g/m^3$)	CPC % of Limit Value	Annual Mean Back-ground ($\mu g/m^3$)	Annual Mean Predicted Environmental Concentration ($\mu g/m^3$)	Limit Value ($\mu g/m^3$)	PEC % of Limit Value
NO_X / 2018	Santry Demesne pNHA	0.94	3.1%	17.10	18.04	30	60%
	Baldoyle Bay SAC	0.53	1.8%	10.90	11.43		38%
NO_X / 2019	Santry Demesne pNHA	0.94	3.1%	17.10	18.04	30	60%
	Baldoyle Bay SAC	0.57	1.9%	10.90	11.47		38%
NO_X / 2020	Santry Demesne pNHA	0.94	3.1%	17.10	18.04	30	60%
	Baldoyle Bay SAC	0.55	1.8%	10.90	11.45		38%
NO_X / 2021	Santry Demesne pNHA	1.11	3.7%	17.10	18.21	30	61%
	Baldoyle Bay SAC	0.54	1.8%	10.90	11.44		38%
NO_X / 2022	Santry Demesne pNHA	0.90	3.0%	17.10	18.00	30	60%
	Baldoyle Bay SAC	0.52	1.7%	10.90	11.42		38%

7.3.2 NH_3

NH_3 results are the same as per Table 22.

7.3.3 SO_2

The SO_2 modelling results are detailed in Table 34. Within the most impacted ecological receptor (Santry Demesne pNHA), at the worst-case location, cumulative PEC emissions lead to an ambient SO_2 concentration (including background) which is at most 9.2% of the annual limit value over the five years of meteorological data modelled. The cumulative process contribution (PC) SO_2 concentration is at most 0.16% of the annual limit value over the five years of meteorological data modelled.

Within the most impacted (in terms of process contributions) Natura 2000 receptor (Baldoyle Bay SAC), at the worst-case location, cumulative PEC emissions lead to an ambient SO_2 concentration (including background) which is at most 9.1% of the annual limit value over the five years of meteorological data modelled. The cumulative process contribution (PC) SO_2 concentration is at most 0.08% of the annual limit value over the five years of meteorological data modelled.

Table 34. Cumulative SO_2 Dispersion Model Results - Ecological Receptors (PC)

Pollutant / Year	Designated Habitat	Annual Mean Process Contribution (µg/m^3)	CPC % of Limit Value	Annual Mean Background (µg/m^3)	Annual Mean Predicted Environmental Concentration (µg/m^3)	Limit Value (µg/m^3)	PEC % of Limit Value
SO_2 / 2018	Santry Demesne pNHA	0.027	0.13%	1.800	1.827	20.0	9.1%
	Baldoyle Bay SAC	0.015	0.07%	1.800	1.815		9.1%
SO_2 / 2019	Santry Demesne pNHA	0.027	0.13%	1.800	1.827	20.0	9.1%
	Baldoyle Bay SAC	0.016	0.08%	1.800	1.816		9.1%
SO_2 / 2020	Santry Demesne pNHA	0.027	0.14%	1.800	1.827	20.0	9.1%
	Baldoyle Bay SAC	0.015	0.08%	1.800	1.815		9.1%
SO_2 / 2021	Santry Demesne pNHA	0.032	0.16%	1.800	1.832	20.0	9.2%
	Baldoyle Bay SAC	0.015	0.08%	1.800	1.815		9.1%
SO_2 / 2022	Santry Demesne pNHA	0.026	0.13%	1.800	1.826	20.0	9.1%
	Baldoyle Bay SAC	0.015	0.07%	1.800	1.815		9.1%

7.3.4 Nitrogen Deposition

In order to consider the effects of nitrogen deposition (as N) owing to cumulative emissions 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 and shown in Table 35.

The nitrogen deposition flux for the worst-case year is 7.149 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr (as outlined in Section 2.3) in the Santry Demesne Proposed NHA (000178), indicating that the effects of nitrogen deposition on ecological receptors due to the facility and other nearby facilities are not significant. The cumulative process contribution (PC) nitrogen deposition (as N) is at most 2.1% of the annual limit value over the five years of meteorological data modelled.

Regarding the most impacted (in terms of process contributions) Natura 2000 receptor, the Baldoyle Bay SAC, the nitrogen deposition flux for the worst-case year is 6.077 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr for the habitat type "Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)" (feature code: H1330) in the Baldoyle Bay SAC, indicating that the effects of nitrogen deposition on Natura 2000 receptors due to the facility and other nearby facilities are not significant. The cumulative process contribution (PC) nitrogen deposition (as N) is at most 1.3% of the annual limit value over the five years of meteorological data modelled.

Table 35. Cumulative Nitrogen Deposition Results - Ecological Receptors (PC)

Met. Year	Designated Habitat	NO_2 Annual Mean PC (µg/m^3)	NH_3 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NH_3 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/year)	NH_3 Acid Deposition (keq/ha/year)	APIS Background Nitrogen Deposition (kg/ha/yr)	Total (NO_2 + NH_3) PEC Nitrogen Deposition kg/ha/yr	CPC % of Critical Load
2018	Santry Demesne pNHA	0.84	0.0009	0.0013	0.00002	0.121	0.0047	7.0	7.126	1.8%
	Baldoyle Bay SAC	0.48	0.0005	0.0007	0.00001	0.069	0.0028	6.0	6.071	1.2%
2019	Santry Demesne pNHA	0.85	0.0011	0.0013	0.00002	0.122	0.0055	7.0	7.127	1.8%
	Baldoyle Bay SAC	0.51	0.0005	0.0008	0.00001	0.074	0.0027	6.0	6.077	1.3%
2020	Santry Demesne pNHA	0.84	0.0006	0.0013	0.00001	0.122	0.0032	7.0	7.125	1.8%
	Baldoyle Bay SAC	0.49	0.0005	0.0007	0.00001	0.071	0.0027	6.0	6.073	1.2%
2021	Santry Demesne pNHA	1.00	0.0011	0.0015	0.00002	0.144	0.0055	7.0	7.149	2.1%
	Baldoyle Bay SAC	0.48	0.0005	0.0007	0.00001	0.070	0.0027	6.0	6.072	1.2%
2022	Santry Demesne pNHA	0.81	0.0009	0.0012	0.00002	0.117	0.0045	7.0	7.121	1.7%
	Baldoyle Bay SAC	0.46	0.0005	0.0007	0.00001	0.067	0.0025	6.0	6.069	1.2%

7.3.5 Acid Deposition

In order to consider the effects of acid deposition (as N and S) owing to cumulative emissions on the most impacted ecological receptor, the maximum annual mean NO_2, NH_3 and SO_2 process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes as shown in Table 36 and Table 37.

The total acid deposition (as N and S) flux in the in the Santry Demesne Proposed NHA (000178) for the worst-case year is 0.514 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 5.611 keq/ha/yr, which is based on the acidity range for “old sessile oak woods with Ilex and Blechnum in the British Isles” (established in Section 2.3), indicating that the effects of acid deposition (as N and S) on ecological receptors due to the facility and other nearby facilities are not significant. The cumulative process contribution (PC) total acid deposition (as N and S) flux is at most 2.9% of the annual limit value over the five years of meteorological data modelled.

The total acid deposition (as N and S) flux for the worst-case year is 0.507 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the most sensitive feature ““Fixed coastal dunes with herbaceous vegetation (“grey dunes”)” (feature code: H2130) in the North Dublin Bay SAC (there is no data for acid deposition critical loads in the Baldoyle Bay SAC and thus North Dublin Bay SAC has been referenced), indicating that the effects of acid deposition (as N and S) on Natura 2000 receptors due to the facility and other nearby facilities are not significant, as shown in Table 36 and Table 37. The cumulative process contribution (PC) total acid deposition (as N and S) flux is at most 1.5% of the annual limit value over the five years of meteorological data modelled.

Table 36. Cumulative Acid Deposition (as N) Results - Ecological Receptors (PC)

Met. Year	Designated Habitat	NO_2 Annual Mean PC (µg/m^3)	NH_3 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NH_3 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/ year)	NH_3 Acid Deposition (keq/ha/ year)	Total (NO_2 + NH_3) PC Acid Deposition (as N) keq/ha/yr)
2018	Santry Demesne pNHA	0.841	0.0009	0.0013	0.00002	0.009	0.0003	0.009
	Baldoyle Bay SAC	0.477	0.0005	0.0007	0.00001	0.005	0.0002	0.005
2019	Santry Demesne pNHA	0.848	0.0011	0.0013	0.00002	0.009	0.0004	0.009
	Baldoyle Bay SAC	0.514	0.0005	0.0008	0.00001	0.005	0.0002	0.005
2020	Santry Demesne pNHA	0.845	0.0006	0.0013	0.00001	0.009	0.0002	0.009
	Baldoyle Bay SAC	0.491	0.0005	0.0007	0.00001	0.005	0.0002	0.005
2021	Santry Demesne pNHA	0.999	0.0011	0.0015	0.00002	0.010	0.0004	0.011
	Baldoyle Bay SAC	0.483	0.0005	0.0007	0.00001	0.005	0.0002	0.005
2022	Santry Demesne pNHA	0.813	0.0009	0.0012	0.00002	0.008	0.0003	0.009
	Baldoyle Bay SAC	0.464	0.0005	0.0007	0.00001	0.005	0.0002	0.005

Table 37. Cumulative Acid Deposition (as S) Results - Ecological Receptors (PC)

Year	Designated Habitat	SO_2 Annual Mean PEC (µg/m^3)	SO_2 Dry Deposition (µg/m^2/s)	SO_2 Sulphur Deposition (kg/ha/year)	SO_2 Acid Deposition (as S) (keq/ha/year)	APIS Background Acid Deposition (keq/ha/yr)	Total (NO_2 + NH_3 +SO_2) PEC Acid Deposition (keq/ha/yr)	PC % of Critical Load
2018	Santry Demesne pNHA	0.027	0.0003	0.050	0.003	0.500	0.512	2.4%
	Baldoyle Bay SAC	0.015	0.0002	0.028	0.002	0.500	0.507	1.4%
2019	Santry Demesne pNHA	0.027	0.0003	0.050	0.003	0.500	0.512	2.4%
	Baldoyle Bay SAC	0.016	0.0002	0.030	0.002	0.500	0.507	1.5%
2020	Santry Demesne pNHA	0.027	0.0003	0.051	0.003	0.500	0.512	2.4%
	Baldoyle Bay SAC	0.015	0.0002	0.029	0.002	0.500	0.507	1.4%
2021	Santry Demesne pNHA	0.032	0.0004	0.060	0.004	0.500	0.514	2.9%

Year	Designated Habitat	SO_2 Annual Mean PEC (µg/m³)	SO_2 Dry Deposition (µg/m²/s)	SO_2 Sulphur Deposition (kg/ha/year)	SO_2 Acid Deposition (as S) (keq/ha/year)	APIS Background Acid Deposition (keq/ha/yr)	Total (NO_2 + NH_3 +SO_2) PEC Acid Deposition (keq/ha/yr)	PC % of Critical Load
	Baldoyle Bay SAC	0.015	0.0002	0.029	0.002	0.500	0.507	1.4%
2022	Santry Demesne pNHA	0.026	0.0003	0.048	0.003	0.500	0.512	2.3%
	Baldoyle Bay SAC	0.015	0.0002	0.027	0.002	0.500	0.507	1.3%

7.4 Cumulative Air Quality Impact on Most Impacted European Site (PEC)

7.4.1 NO_X

The cumulative NO_X modelling results are detailed in Table 38. Within the closest (and most impacted in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, cumulative PEC emissions lead to an ambient NO_X concentration (including background) which is at most 99.7% of the annual limit value over the five years of meteorological data modelled. The cumulative process contribution (PC) NO_X concentration is at most 0.35% of the annual limit value over the five years of meteorological data modelled.

Table 38. Cumulative NO_X Results - Most Impacted European Site (PEC)

Pollutant / Year	Designated Habitat	Annual Mean Process Contribution (µg/m³)	PC % of Limit Value	Annual Mean Background (µg/m³)	Annual Mean Predicted Environmental Concentration (µg/m³)	Limit Value (µg/m³)	PEC % of Limit Value
2018	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.09	0.31%	29.79	29.88	30	99.6%
2019	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.07	0.23%	29.79	29.86	30	99.5%
2020	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.07	0.25%	29.79	29.86	30	99.5%
2021	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.11	0.35%	29.79	29.90	30	99.7%
2022	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.07	0.23%	29.79	29.86	30	99.5%

7.4.2 NH_3

NH_3 results are the same as per Table 28.

7.4.3 SO_2

The cumulative SO_2 modelling results are detailed in Table 39. Within the closest (and most impacted in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, cumulative PEC emissions lead to an ambient SO_2 concentration (including background) which is at most 37% of the annual limit value over the five years of meteorological data modelled. The cumulative process contribution (PC) SO_2 concentration is at most 0.010% of the annual limit value over the five years of meteorological data modelled.

Table 39. Cumulative SO_2 Results - Most Impacted European Site (PEC)

Pollutant / Year	Designated Habitat	Annual Mean Process Contribution (μg/m^3)	PC % of Limit Value	Annual Mean Background (μg/m^3)	Annual Mean Predicted Environmental Concentration (μg/m^3)	Limit Value (μg/m^3)	PEC % of Limit Value
2018	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0026	0.009%	7.4	7.403	20	37%
2019	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0019	0.006%	7.4	7.402	20	37%
2020	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0021	0.007%	7.4	7.402	20	37%
2021	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0030	0.010%	7.4	7.403	20	37%
2022	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.0020	0.007%	7.4	7.402	20	37%

7.4.4 Nitrogen Deposition

In order to consider the effects of nitrogen deposition (as N) owing to cumulative PEC emissions 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 and shown in Table 40.

Within the closest (and most impacted in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, the cumulative nitrogen deposition flux for the worst-case year is 6.814 kg/ha/yr. This is below the midrange critical load of 7.5 kg/ha/yr(2) for the feature "*Tringa totanus* (Eastern Atlantic - wintering)" (feature code: A162), indicating that the effects of nitrogen deposition on designated sites due to the facility and other nearby facilities are not significant. The cumulative process contribution (PC) nitrogen deposition (as N) is at most 0.21% of the annual limit value over the five years of meteorological data modelled.

Table 40. Cumulative Nitrogen Deposition Results - Most Impacted European Site (PEC)

Met. Year	Designated Habitat	NO_2 Annual Mean PC (µg/m^3)	NH_3 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NH_3 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/year)	NH_3 Acid Deposition (keq/ha/year)	APIS Background Nitrogen Deposition (kg/ha/yr)	Total (NO_2 + NH_3) PEC Nitrogen Deposition kg/ha/yr	CPC % of Critical Load
2018	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.08	0.00008	0.00013	0.000002	0.0120	0.0004	6.8	6.812	0.18%
2019	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.06	0.00007	0.00009	0.000001	0.0089	0.0003	6.8	6.809	0.14%
2020	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.07	0.00007	0.00010	0.000001	0.0095	0.0003	6.8	6.810	0.15%
2021	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.10	0.00012	0.00014	0.000002	0.0138	0.0006	6.8	6.814	0.21%
2022	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.06	0.00006	0.00009	0.000001	0.0089	0.0003	6.8	6.809	0.14%

7.4.5 Acid Deposition

In order to consider the effects of acid deposition (as N and S) owing to cumulative emissions on the closest ecological receptor, the maximum annual mean NO_2, NH_3 and SO_2 process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes and shown in Table 41 and Table 42.

Within the closest (and most impacted in terms of PEC) Natura 2000 receptor(South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, the total acid deposition (as N and S) flux for the worst-case year is 0.5914 keq/ha/yr. This is below the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the feature "*Sterna hirundo* (Northern/Eastern Europe - breeding)" (feature code: A193), indicating that the effects of acid deposition (as N and S) on designated sites due to the facility and other nearby facilities are not significant. The cumulative process contribution (PC) total acid deposition (as N and S) flux is at most 0.23% of the annual limit value over the five years of meteorological data modelled.

Table 41. Cumulative Acid Deposition (as N) Results - Most Impacted European Site (PEC)

Met. Year	Designated Habitat	NO_2 Annual Mean PC (µg/m^3)	NH_3 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NH_3 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/year)	NH_3 Acid Deposition (keq/ha/year)	Total (NO_2 + NH_3) PC Acid Deposition (as N) keq/ha/yr)
2018	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.08	0.00008	0.00013	0.000002	0.0009	0.00003	0.00089

Met. Year	Designated Habitat	NO_2 Annual Mean PC (µg/m^3)	NH_3 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NH_3 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/year)	NH_3 Acid Deposition (keq/ha/year)	Total (NO_2 + NH_3) PC Acid Deposition (as N) keq/ha/yr)
2019	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.06	0.00007	0.00009	0.000001	0.0006	0.00002	0.00066
2020	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.07	0.00007	0.00010	0.000001	0.0007	0.00002	0.00070
2021	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.10	0.00012	0.00014	0.000002	0.0010	0.00004	0.00103
2022	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.06	0.00006	0.00009	0.000001	0.0006	0.00002	0.00066

Table 42. Cumulative Acid Deposition (as S) Results - Most Impacted European Site (PEC)

Year	Designated Habitat	SO_2 Annual Mean PEC (µg/m^3)	SO_2 Dry Deposition (µg/m^2/s)	SO_2 Sulphur Deposition (kg/ha/year)	SO_2 Acid Deposition (as S) (keq/ha/ year)	APIS Background Acid Deposition (keq/ha/yr)	Total (NO_2 + NH_3 +SO_2) PEC Acid Deposition (keq/ha/yr)	CPC % of Critical Load
2018	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.003	0.00003	0.005	0.0003	0.59	0.5912	0.20%
2019	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.002	0.00002	0.004	0.0002	0.59	0.5909	0.15%
2020	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.002	0.00002	0.004	0.0002	0.59	0.5909	0.16%
2021	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.003	0.00004	0.006	0.0004	0.59	0.5914	0.23%
2022	South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA	0.002	0.00002	0.004	0.0002	0.59	0.5909	0.15%

8.0 ASSESSMENT SUMMARY

8.1 Assessment of the Licenced Operational Scenario Air Quality Impact on Human Health

The NO_2 modelling results at the worst-case location at and beyond the site boundary are 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*' 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).

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, PEC emissions from the site lead to an ambient NO_2 concentration (including background) which is 93% of the maximum ambient 1-hour limit value (measured as a 99.8^{th} percentile) and 90% of the annual limit value at the worst-case off-site receptor. For the worst-case year modelled, PC emissions from the site lead to an ambient NO_2 concentration (excluding background) which is 78% of the maximum ambient 1-hour limit value (measured as a 99.8^{th} percentile) and 55% of the annual limit value at the worst-case off-site receptor.

The UK EA assessment methodology determined that, in any year, the generators can run for 137 hours using diesel fuel before there is a likelihood of an exceedance at the nearest residential receptor (at a 98^{th} percentile confidence level). However, USEPA is the preferred method to determine the operational impact of the facility and the preferred method to determine the allowable operational hours of the backup emergency generators.

CO concentrations are also in compliance with the relevant ambient air quality standards. In the worst-case year, PEC concentrations of CO (including background) are at most 40% of the maximum 8-hour limit value at the worst case receptor modelled.

The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for NH_3. For the worst-case year, PC emissions from the site 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 limit value at the worst-case receptor (excluding background). Concentrations are at most 0.42% of the 99^{th} percentile 1-hour limit value at the worst-case receptor (excluding background). For the worst-case year, PEC emissions from the site lead to an ambient NH_3 concentration (including background) which is 0.5% of the maximum ambient 1-hour limit value and 0.6% of the annual limit value at the worst-case off-site receptor.

Regarding particulate matter, concentrations of PM_{10} and $PM_{2.5}$ are in compliance with the relevant limit values. Concentrations of PM_{10} (including background) are 48% of the maximum ambient 24-hour limit value (measured as a 90.4^{th}%ile) (2.5% of the limit value excluding background) at the worst-case receptor and 42% of the annual limit value at the worst-case receptor (5% of the limit value excluding background).

Modelled PEC concentrations of SO_2 reached at most 15% of the maximum 1-hour limit value (measured as a 99.7^{th}%ile) and 17% of the maximum 24-hour limit value (measured as a 99.2^{nd}%ile) at the worst-case receptor modelled, including background concentrations. PC emissions from the facility 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.

Under the Licenced Operational Scenario the dispersion modelling has determined that concentrations of all pollutants are in compliance with the relevant ambient air quality standards.

8.2 Assessment of The Cumulative Air Quality Impact on Human Health

The NO_2 modelling results at the worst-case location at and beyond the site boundary are 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 and the emergency operation of Buildings A - F,
- scheduled weekly testing of all back-up generators from Buildings W, X, Y, U and V and scheduled weekly testing of all back-up generators from Buildings A - F,
- scheduled quarterly maintenance testing of all back-up generators from Buildings W, X, Y, U and V with each generator running for four hours and scheduled quarterly maintenance testing of all back-up generators from Buildings A – F 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.

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, PEC emissions from the site lead to an ambient NO_2 concentration (including background) which is 94% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 98% of the annual limit value at the worst-case off-site receptor.

The UK EA assessment methodology determined that, in any year, the generators can run for 80 hours before there is a likelihood of an exceedance at the nearest residential receptor (at a 98th percentile confidence level). However, USEPA is the preferred method to determine the operational impact of the facility and the preferred method to determine the allowable operational hours of the backup emergency generators.

Conclusion (Human Health)

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.

8.3 Assessment of The Data Storage Facility Air Quality Impact on Ecology

Santry Demesne pNHA

Regarding the most impacted ecological receptor, the Santry Demesne pNHA (000178), operations will lead to ambient NO_X, NH_3 and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 27%, 50% and 7% respectively of the annual limit value. The process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 1.4%, 0.04% and 0.06% of the annual limit value over the five years of meteorological data modelled.

In order to determine the appropriate, worst-case critical load, the EPA publication "*Nitrogen-Sulfur Critical Loads: Assessment of the Impacts of Air Pollution on Habitats*" (EPA, 2021) was consulted. In Table 3.2 of the publication empirical critical loads of nutrient nitrogen are outlined with a worst-case range of 5-10 kg N ha^{-1} yr^{-1} for most habitat types. In addition, for most habitat types, the EPA publication recommends the midpoint is used to define the critical load (7.5 kg N ha^{-1} yr^{-1}).

The nitrogen deposition flux in the Santry Demesne pNHA (000178) for the worst-case year is 7.061 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr established in Section 2.3, indicating that the effects of nitrogen deposition on ecological receptors due to the facility are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 0.87% of the annual limit value over the five years of meteorological data modelled.

The total acid deposition (as N and S) flux in the in the Santry Demesne pNHA (000178) for the worst-case year is 0.506 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 5.611 keq/ha/yr (established in Section 2.3), indicating that the effects of acid deposition (as N and S) on ecological receptors due to the facility are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 1.13% of the annual limit value over the five years of meteorological data modelled.

Baldoyle Bay SAC

Regarding the most impacted (in terms of Process Contributions) Natura 2000 receptor, the Baldoyle Bay SAC, operations will lead to ambient NO_X, NH_3 and SO_2 PEC concentrations (including background) which are in compliance with the relevant limit values, reaching at most 14%, 50% and 5% respectively of the annual limit value. The process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 0.9%, 0.02% and 0.04% of the annual limit value over the five years of meteorological data modelled.

The nitrogen deposition flux for the worst-case year is 6.038 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr for the most sensitive feature "Atlantic salt meadows (*Glauco-Puccinellietalia* maritimae)" (feature code: H1330) located in the Baldoyle Bay SAC, indicating that the effects of nitrogen deposition on designated sites due to the facility are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 0.63% of the annual limit value over the five years of meteorological data modelled.

The total acid deposition (as N and S) flux for the worst-case year is 0.504 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the most sensitive feature "Fixed coastal dunes with herbaceous vegetation ("grey dunes")" (feature code: H2130) in the North Dublin Bay SAC (there is no data for acid deposition critical loads in the Baldoyle Bay SAC and thus North Dublin Bay SAC has been referenced), indicating that the effects of acid deposition (as N and S) on designated sites due to the facility are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 0.71% of the annual limit value over the five years of meteorological data modelled.

South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA

Regarding the closest (and most impacted in terms of Predicted Environmental Concentration (PEC)) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, operations will lead to ambient NO_X, NH_3 and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 99%, 42% and 37% respectively of the annual limit value. The process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 0.2%, 0.004% and 0.046% of the annual limit value over the five years of meteorological data modelled.

Within the closest (and most impacted in terms of Predicted Environmental Concentration (PEC)) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, the nitrogen deposition flux for the worst-case year is 6.807 kg/ha/yr. This is below the midrange critical load of 7.5 kg/ha/yr(2) for the most sensitive feature "*Tringa totanus* (Eastern Atlantic - wintering)" (feature code: A162), indicating that the effects of nitrogen deposition on designated sites due to the facility are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 0.11% of the annual limit value over the five years of meteorological data modelled.

Within the closest (and most impacted in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, the total acid deposition (as N and S) flux for the worst-case year is 0.591 keq/ha/yr. This is below the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the most sensitive feature "*Sterna hirundo* (Northern/Eastern Europe - breeding)" (feature code: A193), indicating that the effects of acid deposition (as N and S) on designated sites due to the facility are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 0.12% of the annual limit value over the five years of meteorological data modelled.

The effect of nitrogen deposition due to the facility on these features is discussed further in the Appropriate Assessment (AA) Screening Report prepared by Moore Group.

8.4 Assessment of the Cumulative Air Quality Impact on Ecology

Santry Demesne pNHA

Regarding the most impacted ecological receptor, the Santry Demesne pNHA (000178), cumulative PEC operations will lead to ambient NO_X, NH_3 and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 61%, 50% and 9% respectively of the annual limit value. The process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 3.7%, 0.02% and 0.16% of the annual limit value over the five years of meteorological data modelled.

The nitrogen deposition flux for the worst-case year is 7.149 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr for the habitat types (broadleaved deciduous woodland) in the Santry Demesne Proposed NHA (000178), indicating that the effects of nitrogen deposition on ecological receptors due to the facility and other nearby facilities are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 2.1% of the annual limit value over the five years of meteorological data modelled.

The total acid deposition (as N and S) flux in the in the Santry Demesne Proposed NHA (000178) for the worst-case year is 0.514 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 5.611 keq/ha/yr established in Section 2.3 which is based on the acidity range for “old sessile oak woods with Ilex and Blechnum in the British Isles”, indicating that the effects of acid deposition (as N and S) on ecological receptors due to the facility and other nearby facilities are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 2.9% of the annual limit value over the five years of meteorological data modelled.

Baldoyle Bay SAC

Regarding the most impacted (in terms of process contributions) Natura 2000 designated receptor, the Baldoyle Bay SAC, cumulative PEC operations will lead to ambient NO_X, NH_3 and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 38%, 50% and 9% respectively of the annual limit value. The process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 1.9%, 0.02% and 0.08% of the annual limit value over the five years of meteorological data modelled.

The nitrogen deposition flux for the worst-case year is 6.077 kg/ha/yr and is below the midpoint critical load of 7.5 kg/ha/yr for the habitat type “Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)” (feature code: H1330) in the Baldoyle Bay SAC, indicating that the effects of nitrogen deposition on designated sites due to the facility and other nearby facilities are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 1.3% of the annual limit value over the five years of meteorological data modelled.

The total acid deposition (as N and S) flux for the worst-case year is 0.507 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the habitat type “Fixed coastal dunes with herbaceous vegetation (“grey dunes”)” (feature code: H2130) in the North Dublin Bay SAC (there is no data for acid deposition critical loads in the Baldoyle Bay SAC and thus North Dublin Bay SAC has been referenced), indicating that the effects of acid deposition (as N and S) on designated sites due to the facility and other nearby facilities are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 2.9% of the annual limit value over the five years of meteorological data modelled.

South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA

Regarding the closest (and most impacted in terms of Predicted Environmental Concentration (PEC)) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, cumulative PEC operations will lead to ambient NO_X, NH_3 and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 99.7%, 42% and 37% respectively of the annual limit value. The process contribution (PC) NO_X, NH_3 and SO_2 concentrations is at most 0.35%, 0.004% and 0.010% of the annual limit value over the five years of meteorological data modelled.

Within the closest (and most impacted in terms of PEC) Natura 2000 receptor (South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, the cumulative nitrogen deposition flux for the worst-case year is 6.812 kg/ha/yr. This is below the midrange critical load of 7.5 kg/ha/yr(2) for the feature "*Tringa totanus* (Eastern Atlantic - wintering)" (feature code: A162), indicating that the effects of nitrogen deposition on designated sites due to the facility and other nearby facilities are not significant. The process contribution (PC) nitrogen deposition (as N) is at most 0.21% of the annual limit value over the five years of meteorological data modelled.

Within the closest (and most impacted in terms of PEC) Natura 2000 receptor(South Dublin Bay SAC and South Dublin Bay & River Tolka Estuary SPA), at the worst-case location, the total acid deposition (as N and S) flux for the worst-case year is 0.591 keq/ha/yr. This is below the worst case maximum critical load range of 0.714 – 4.927 keq/ha/yr for the feature "*Sterna hirundo* (Northern/Eastern Europe - breeding)" (feature code: A193), indicating that the effects of acid deposition (as N and S) on designated sites due to the facility and other nearby facilities are not significant. The process contribution (PC) total acid deposition (as N and S) flux is at most 0.23% of the annual limit value over the five years of meteorological data modelled.

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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 facility.

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.