SD22A/0420

Intended for
Property Management Branch of the Department of Defence

Document type
Technical Note

Date
November 2022

VANTAGE DATA CENTERS

DUB-13 - INFORMATION TO SUPPORT THE PROPERTY MANAGEMENT BRANCH OF THE DEPARTMENT OF DEFENCE

RAMBOLL Bright ideas. Sustainable change.

Confidential

VANTAGE DATA CENTERS
DUB-13 - INFORMATION TO SUPPORT THE PROPERTY MANAGEMENT BRANCH OF THE DEPARTMENT OF DEFENCE

Project no.	**1620014388**
Recipient	**PROPERTY MANAGEMENT BRANCH OF THE DEPARTMENT OF DEFENCE**
Document type	**Technical Note**
Version	**1.0**
Date	**2022/10/12**
Prepared by	**MBEAG**
Checked by	**MBEAG**
Approved by	**CMCE**K

Ramboll
240 Blackfriars Road
London
SE1 8NW
United Kingdom

T +44 20 7631 5291
https://uk.ramboll.com

Doc ID RUK2022N00456-RAM-RP-00001 / Version 1.0

Ramboll UK Limited
Registered in England & Wales
Company No: 03659970
Registered office:
240 Blackfriars Road
London
SE1 8NW

CONTENTS

1. INFORMATION FOR PROPERTY MANAGEMENT BRANCH OF THE DEPARTMENT OF DEFENCE

1.1 Engagement with Property Management Branch of the department of Defence

An assessment of any potential impact on flight procedures, communication, navigation and surveillance equipment has been produced incorporating the following:

- Flue emissions from proposed stacks;
- Aircraft hazard due to wildlife (birds) attracted to the site both during and after construction and bird mitigation measures planned; and
- Glint and Glare from roof PV panels.

This note serves to summarise the analysis and assessment completed and further provides a narrative on that information for the Property Management Branch of the Department of Defence for their review and consideration.

1.2 Flue Emissions

A computational fluid dynamics (CFD) model has been developed as part of the design for the Proposed Development. The assessment of flue emissions, their dispersal and movements are considered as part of the Environmental Impact Assessment Report and were modelled using Atmospheric Dispersion Modelling System (ADMS 5).

Appendix 1 includes an excerpt of the of the Air Quality EIAR Chapter. The section considers the outputs of the air dispersion modelling.

Figure 1-1 illustrates the maximum annual average NO2 PC values resultant from the proposed development during the reasonable worst case scenario.

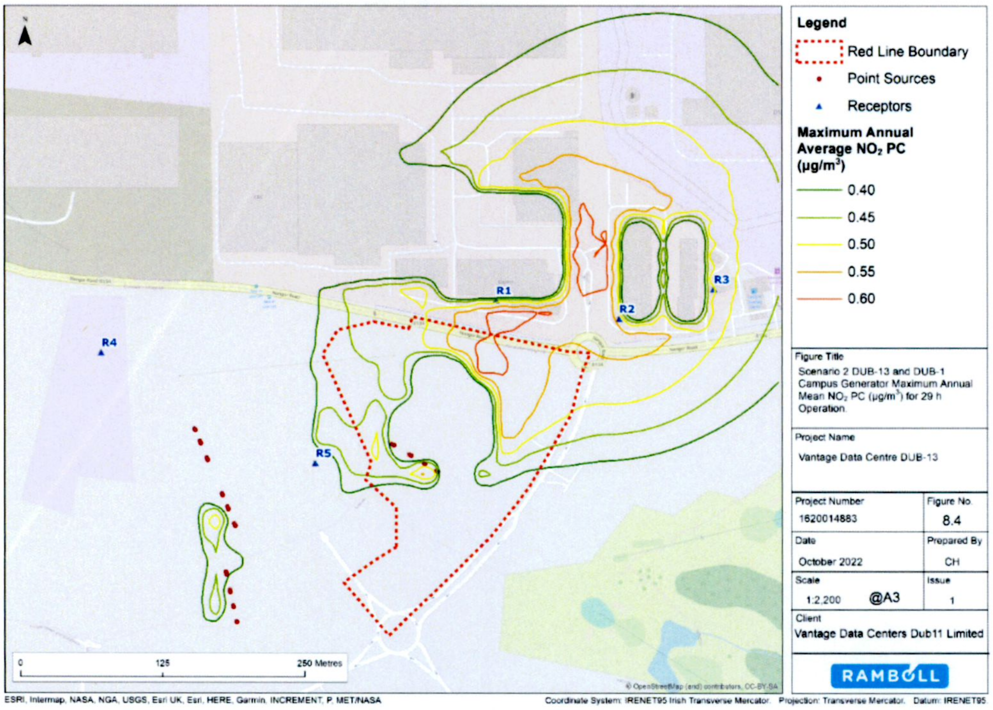

Figure 1-1 - Air Quality Mapping illustrating the zones of influence and proximity to the proposed development.

As illustrated in Appendix 1 in regard to Casement Aerodrome the development predominantly matches the existing environment and does not present a significant probability of increasing flue emissions as aviation hazard. The analysis of flue emissions identified substantive dispersal of emissions and return to ambient levels within relatively close proximity to the development.

The proposed development does not increase risks to aircraft operating out of Baldonnel Aerodrome.

1.3 Aviation Wildlife Impact Assessment

A detailed Aviation Wildlife Impact Assessment is included in Appendix 2 of this Report. In summary, the development plans predominantly match the existing environment and do not present a significant probability of increasing hazardous bird presence and thus increasing risk to aircraft operating out of Casement Aerodrome.

The assessment recommends that a bird hazard management plan is established in operation of the development to reduce the presence of any hazardous birds that may arrive during the construction phase of the development.

Similarly, the planting palette used for landscaping shall not exceed 15% berry bearing bushes and the permanent wetland should be modified to remove the islands and to enhance biodiversity whilst reducing hazardous bird access to the site.

Where this is not implemented, a longer term BHMP that aims to disturb and prevent hazardous waterfowl nesting at the site may be beneficial. This may also include a plan to prevent gulls from nesting on the rooftop of the site should it be suitable for such species to breed.

1.4 PV Glint and Glare Assessment

A 30km study area is chosen for receptors. Four aviation assets are located within 30km of the Proposed Development: Casement Baldonnel Aerodrome, Weston Airport, Dublin Airport and Gowran Grange Airfield. Only Casement Baldonnel Aerodrome, Weston Airport and Dublin Airport required a detailed assessment due to the Proposed Development falling within their respective safeguarding buffer zones.

Geometric analysis was conducted for 12 runway approach paths and four Air Traffic Control Tower's (ATCT) at Casement Baldonnel Aerodrome, Weston Airport and Dublin Airport.

The assessment concludes that:

- Casement Baldonnel Aerodrome: Green glare (Low potential for after-image) was predicted to impact upon the Runway 10 approach path, which is an **acceptable impact** according to the FAA guidelines for the runways and can be deemed **Not Significant**. No glare was predicted to impact upon the Runway 04, 22 and 28 approach paths or the air traffic control tower.
- Weston Airport: No glare was predicted to impact upon the Runway 07 and 25 approach paths or the air traffic control tower. Therefore, the impact is **None**.
- Dublin Airport: No glare was predicted to impact upon the Runway 10R, 28L, 10L, 28R, 16 and 34 approach paths or the air traffic control towers. Therefore, the impact is **None**.

Overall impacts on aviation receptors are **acceptable** and **Not Significant**.

1.5 Conclusion

In response to clarification sought from the Property Management Branch of the Department of Defence it is noted that the proposed development does not increase risks to aircraft operating out of Casement Aerodrome specifically in consideration of:

- Flue emissions from proposed stacks;
- Aircraft hazard due to wildlife (birds) attracted to the site both during and after construction and bird mitigation measures planned; and
- Glint and Glare from roof PV panels.

APPENDIX 1
EXCERPT OF AIR QUALITY EIAR CHAPTER

8 AIR QUALITY

8.1 Introduction

8.1.1 This chapter of the EIAR reports on the likely significant air quality effects to arise from the demolition and construction stage and the operation stage of the proposed development.

8.1.2 The chapter describes the air quality policy context; the methods used to assess the potential impacts and likely effects; the baseline conditions at and surrounding the site; the likely air quality effects taking into consideration embedded mitigation; the need for additional mitigation and enhancement; the significance of residual effects; and inter-project cumulative effects.

8.1.3 The potential exists for dust deposition and increased particulate matter concentrations to occur during the demolition and construction stage, as well as increased air emissions resulting from the operational phases of the proposed development. The main air pollutants of concern are dust and particulate matter with an aerodynamic diameter of less than 10 µm (PM_{10}), typically generated during demolition and construction activities, and nitrogen oxides (NO_x) represented as nitrogen dioxide (NO_2) typically generated by combustion engine emissions and road traffic.

8.1.4 The chapter is supported by the following technical appendices in EIAR Volume 3:

- Appendix 8.1: Air Quality Modelling Inputs.
- Appendix 8.2: Air Quality Detailed Results

8.2 Methodology

8.2.1 The assessment has been informed by the below legislation, policies, and published guidance and those outlined in Chapter 2: EIA Process and Methodology. The relevant policies are discussed throughout this chapter in more detail in the appropriate sections.

- International Legislation:
  - European Air Quality Framework Directive 2004/107/EC[1] and daughter Directive 2008/50/EC[2] on ambient air quality and cleaner air for Europe (CAFE), which set out a series of limit values for the protection of human health and critical levels for the protection of vegetation;
  - Directive 2010/75/EU industrial emissions (integrated pollution prevention and control)[3] known as Industrial Emissions Directive (IED);
  - Directive (EU) 2015/2193 on the limitation of emissions of certain pollutants into the air from medium combustion plants (MCPD)[4];
- National Legislation and Policy:
  - Air Pollution Act 1987[5];
  - Environmental Protection Agency Act, 1992[6];
  - Protection of The Environment Act 2003[7]
  - Air Quality Standards (AQS) Regulations 2011[8] amended by the AQS (Amendment) and Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air (Amendment) Regulations 2016[9], which transposed the European Directive 2008/50/EC into Irish legislation;
  - European Union (Medium Combustion Plants) Regulations 2017[10] which transposed the European Directive 2015/2193 into Irish legislation;
  - The National Climate Action Plan 2021[11]
- Guidance and industry standards:
  - Institute of Air Quality Management (IAQM) guidance on the Assessment of Dust from Demolition and Construction, 2014[12];
  - Environmental Protection UK/IAQM (EPUK/IAQM) guidance on Land Use and Development Control for Air Quality, 2017[13];
  - Environmental Protection Agency (EPA) Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)[14];
  - U.S. Environmental Protection Agency (USEPA) Additional Clarification Regarding Application of Appendix W Modelling Guidance for the 1-Hour National Ambient Air Quality Standard[15]; and
  - UK Environment Agency Specified generators: dispersion modelling assessment [16, 17].

8.2.2 Specific Irish and European guidance and industry standards have been used to inform this assessment where available. International guidance and protocols from the UK or USA were used to supplement methodologies gaps where specific national guidance was not available, with a particular focus on UK guidance and protocols due to geographical proximity and for methodology consistency.

8.3 Assessment Scope

8.3.1 Dispersion of air pollutants is impacted by several factors including the height and location of a release, the prevailing meteorology, and the arrangement of buildings in the immediate vicinity. This EIAR has been based on the architectural and engineering design and drawings that accompany this application.

Technical Scope

8.3.2 The assessment considers the effects of the proposed development using the methodology set out below within the context of the policy framework and baseline conditions. The assessment considers the following potential impacts and associated likely effects:

1 European Air Quality Directive 2004/107/EC. European Air Quality Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons in ambient air.
2 European Commission. Directive 2008/50/EC. 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.
3 Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control).
4 Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants.
5 Air Pollution Act, 1987. Number 6 of 1987
6 Environmental Protection Agency Act, 1992. Number 7 of 1992.
7 Protection of the Environment Act 2003. Number 27 of 2003.
8 Statutory Instruments S.I. No. 180/2011 - Air Quality Standards Regulations 2011.
9 Statutory Instruments S.I. No. 659 of 2016 – Air Quality Standards (Amendment) and Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air (Amendment) Regulations 2016.
10 Statutory Instruments S.I. No. 595/2017 - European Union (Medium Combustion Plants) Regulations 2017.
11 Government of Ireland, 2021. Climate Action Plan. Department of the Environment, Climate and Communications
12 Holman et al, 2014. IAQM Guidance on the Assessment of Dust from Demolition and Construction, Institute of Air Quality Management, London.
13 Moorcroft and Barrowcliffe. et al., 2017. Land-use Planning & Development Control: Planning for Air Quality. v1.2. Institute of Air Quality Management, London.
14 Environmental Protection Agency Office of Environment Enforcement (OEE), 2019. Air Dispersion Modelling from Industrial Installations Guidance Note (AG4).
15 USEPA, 2011. Additional Clarification Regarding Application of Appendix W Modelling Guidance for the 1-Hour National Ambient Air Quality Standard.
16 Guidance Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment [Accessed on 04/08/2021]
17 UK Environmental Agency. Guidance Specified generators: dispersion modelling assessment. Available at: https://consult.environment-agency.gov.uk/psc/mcp-and-sg-regulations/supporting_documents/Specified%20Generators%20Modelling%20GuidanceINTERIM%20FINAL.pdf [Accessed on 04/08/2021]

- Development works, the resulting dust impacts from the demolition and construction and the associated effects on human health receptors and amenity, as per the IAQM Guidance on assessment of dust from demolition and construction[12];
- Development works demolition and construction stage and operation stage traffic emission effects on human health receptors, as per the IAQM Guidance on land use and development control for air quality[13].
- Operation of the proposed development data center associated emissions arising from combustion plant effects on human health receptors beyond the site boundary.

8.3.3 The UK EPUK/IAQM guidance is applicable to assessing the effect of changes in exposure of member of the public resulting from developments where a proposal could affect local air quality and for which no other appropriate guidance exists in Ireland, as such this guidance has been adopted. The guidance considers the proximity to an Air Quality Management Area (AQMA), which is an area likely to approach or exceed the values set by AQS. The guidance provides an indicative criterion to determine the level of an air quality assessment due to road traffic flows emissions:

- A change of Light Duty Vehicles (LDVs) flows of more than 100 Average Annual Daily Traffic (AADT) within or adjacent to an Air Quality Management Area (AQMA) or more than 500 AADT elsewhere.
- A change of Heavy-Duty Vehicles (HDVs) flows of more than 25 AADT within or adjacent to an AQMA or more than 100 AADT elsewhere.

8.3.4 The proposed development site and study area are not expected to approach or exceed the AQS (as shown in the Baseline Conditions of this Chapter) and therefore the criteria outside an AQMA would apply to determine the significance of effects arising on local air quality due to the proposed development traffic flows.

8.3.5 The estimated demolition and construction stage peak vehicle movements would result in a combined LGV and HGV two-way 156 daily trips, of which 44 two-way trips would be HGV. However, when the movements are averaged over a full year period (24-hour AADT), these would be expected to be lower than 12-hour daily movements. Demolition and construction works' traffic flows would therefore not be expected to exceed the threshold of 500 AADT LGV movements or the 100 AADT HGVs for a detailed modelling assessment to be necessary according to EPUK/IAQM guidance. In addition, HGV movements would be controlled through the implementation of a Construction Environmental Management Plan (CEMP) as described in Chapter 5: Construction Description, which would be secured by means of an appropriately worded planning condition. The effects of demolition and construction related traffic emissions would be short-term, negative, and imperceptible with relation to human health and considered to be not significant in line with the IAQM guidance. Accordingly, demolition and construction traffic emissions have not been considered further within this chapter.

8.3.6 The operational stage would be expected to generate 63 daily vehicles, i.e., well below the EPUK/IAQM criteria. The effects of operation stage related traffic emissions would be long-term to permanent, negative, and not significant with relation to human health in line with the EPUK/IAQM guidance. Accordingly, operational stage traffic emissions have not been considered further within this chapter.

8.3.7 There are no protected European sites, designated under the EC Habitats Directive (92/43/EEC)[18], or National Heritage Areas (NHAs), designated under the Wildlife Acts[19], within the proposed development boundary. The nearest European sites to the Proposed Development are the Rye Water Valley/ Carton Special Area of Conservation (SAC), approximately 5.8 km north-west of the site, and Glenasmole Valley SAC, approximately 8.0 km south-east of the site. The Grand Canal proposed NHA is located approximately 1.3 km north of the site. The nearest protected European sites and NHAs are considered to fall outside the zone of influence of the proposed development and therefore the demolition and construction stage and operation stage air quality effects would be expected to be long-term, negative, and imperceptible and have not been considered further within this chapter.

18 https://www.npws.ie/legislation/eu-directives

8.3.8 The Proposed Development will incorporate emergency diesel generators to provide power to the data center in the event of failure of the electricity supply. When in use in an emergency, all of the generators could be operational and therefore the impacts during an emergency are higher than those when individual or groups of generators are being routinely tested. The impacts during an emergency have therefore been assessed as the worst-case scenario.

8.3.9 The assessment includes a quantitative assessment of Proposed Developments emergency generators and the cumulative impact of all emergency generators running for DUB-13 and DUB-1 campus simultaneously. None of the other plant associated with the proposed development (i.e., chillers) would give rise to significant emissions of air pollutants.

8.3.10 The potential impact to air quality during the operation phase is a breach of the ambient AQS associated with emissions from proposed development combustion engines (emergency generators). The main pollutant of concern in relation to emissions from the combustion engines is NO_2 and the assessment concentrates on the impacts of NO_2 emissions on human health receptors. In relation to carbon monoxide (CO), sulphur (SO2), PM_{10}, $PM_{2.5}$ and benzene no detailed modelling was undertaken as combustion engines emissions of these pollutants' would be significantly lower when compared with NOx emissions relative to their respective ambient air quality standard. Ensuring compliance with NO_2 AQS would ensure compliance of other pollutants.

8.3.11 It is considered that the proposed development would not give rise to any odour impacts and associated effects and odour is not assessed as part of the EIAR Chapter.

Spatial Scope

8.3.12 The study area for the demolition and construction stage assessment is defined as up to 350 m from the site boundary for the assessment of demolition and construction dust emissions, and 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s) as per the IAQM guidance on the Assessment of Dust from Demolition and Construction[12].

8.3.13 For the operation stage assessment, the study area encompasses the application site, representative off-site receptors identified as at risk of impacts from the proposed development and receptor Cartesian grids with the site at the centre, as recommended by EPA AG4 guidance[14]. The off-site receptors and receptor grids are presented in the Baseline Conditions section of this EIAR. The study area also considers identified neighbouring cumulative development and commercial activities adjacent to the site (see Chapter 2: EIA Process and Methodology).

Temporal Scope

8.3.14 The assessment has considered impacts arising during the demolition and construction stage which would be of expected to be temporary (less than one year) and from the operation stage which would be expected to be long-term (15 to 60 years) to permanent (>60 years) in nature.

8.3.15 The assessment of the proposed development has been undertaken in line with the information provided in Chapter 5: Construction Description of this EIAR Volume. The works are anticipated to be undertaken over a 11-month period, with a completion targeted of Q4 2024. The indicative start of operation is Q2 2025. There is no phasing during the construction of the Proposed Development.

8.3.16 For the operational stage air quality assessment consideration has been given to the modelling scenarios outlined in Chapter 2: EIA Process and Methodology. Three scenarios have been proposed as the proposed development would be powered via the EirGrid connection through the wider DUB-1 campus or powered by the consented Multifuel Generation Plant (MFGP) on the DUB-1 campus. The MFGP has been designed to include the proposed data center and no change in capacity will be required to power the proposed development. The proposed development would not result in an increase in the MFGP air emissions, which have previously been assessed during its planning application (planning reference

19 https://www.npws.ie/legislation/irish-law

SD21A/0241). The proposed data center does not create any additional MFGP air emissions that have not already been assessed and consented and therefore no detailed modelling assessment of the MFGP air emissions have been carried out in this EIAR. From an air quality perspective, Chapter 2: EIA Process and Methodology proposed scenario 1 and scenario 2 would not generate additional air emissions and have therefore been scope out of this assessment. Only the Emergency scenario (Scenario 3) listed in Chapter 2: EIA Process and Methodology, has been assessed for the proposed development.

8.3.17 The proposed development is an extension to the July 2022 DUB-1 consented development and would operate as part the wider data center campus. As per Chapter 2: EIA Process and Methodology, the future baseline includes the operation of the July 2022 DUB-1 consented development reported within the DUB-1 EIAR. The proposed development operation future baseline has been assumed to be 2025, which is the projected year when the proposed development would become operational and is also when the July 2022 DUB-1 consented development would become fully operational with the MFGP powered by gas.

8.4 Baseline Characterisation Method

Desk Study

8.4.1 To establish baseline air quality conditions in the study area, relevant data was reviewed and assessed. Local air quality monitoring data was obtained from EPA air quality continuous monitoring network[20] and from cumulative schemes EIAR as outlined in Chapter 2: EIA Process and Methodology.

8.4.2 Traffic flows were provided by the project transport consultant (Ramboll) as per Chapter 7: Transport and Accessibility.

8.4.3 The air quality impacts for the July 2022 DUB-1 consented development and the cumulative developments described in Chapter 2: EIA Process and Methodology have been extracted from the EIARs submitted as part of the schemes planning applications.

Field Study

8.4.4 No site-specific field study was undertaken at the site as the data collected from other sources was deemed to be adequate and representative of the site and local air quality conditions.

8.5 Assessment Method

8.5.1 The assessment has been based on the planning application drawings and plans and the development description presented in Chapter 4: Proposed Development Description, as well as reported in Chapter 5: Demolition and Construction Environmental.

8.5.2 Full details of both demolition and construction stage, and operation stage assessment methodology, data and modelling parameters are provided in Technical Appendix 8.1 in the EIAR Volume 3.

Methodology

Demolition and Construction Stage

8.5.3 During the demolition and construction stage, the main potential impacts would be dust annoyance and locally elevated concentrations of PM_{10}. These impacts have the potential to occur when dust generating activities coincide with dry, windy conditions, and where sensitive receptors are located downwind of the dust source. Separation distance is also an important factor as significant dust annoyance is usually limited to within a few hundred metres of its source. This is due to the rapid decrease in concentrations with distance from the source due to dispersion.

8.5.4 Likely effects associated with demolition and construction dust emissions, unlike other air borne pollutants, cannot be accurately predicted and quantified because they are highly dependent on local weather conditions and mitigation measures implemented at source. This assessment has followed the guidance published by the IAQM on the assessment of the effects of demolition and construction on air quality[12].

8.5.5 The guidance recommends that the risk of dust emission magnitude is combined with the sensitivity of the area surrounding the site to determine the risk of dust impacts from demolition and construction stage activities. The risk of dust arising in sufficient quantities to cause annoyance and/or health impacts is determined using four risk categories: high, medium, low, or negligible. Depending on the level of risk for each activity, appropriate mitigation is selected. Full details of the dust risk assessment methodology which includes the assessment criteria are provided in Technical Appendix 8.1 in the EIAR Volume 3.

Operation Stage

8.5.6 Air dispersion modelling was carried out using Atmospheric Dispersion Modelling System (ADMS 5)[21] to ensure that adequate stack height was selected to aid dispersion of the emissions and achieve compliance with the NO_2 human health ambient AQS beyond the site boundary, considering the existing baseline level on ambient air quality concentrations.

8.5.7 ADMS is recommended as an appropriate model to assess the impact of air emissions from industrial facilities in the EPA Guidance AG4[14]. ADMS uses representative meteorological data for the local area and plant emissions data to predict ambient concentrations of pollutants in the vicinity of the site. A detailed description of the ADMS 5 model is provided in Technical Appendix 8.1 in the EIAR Volume 3. The air dispersion modelling input data consisted of information on the physical environment, design details for all emission points on-site, building configuration, etc. Full details of the model parameters are presented in Technical Appendix 8.1 in the EIAR Volume 3.

8.5.8 The proposed development Emergency Scenario 1 consists of:

- Building DUB-13 with 13 diesel emergency back-up generators and associated 22.3 metres flues operating in the unlikely event of an outage of the MFGP and grid connection.

8.5.9 The proposed development Emergency Scenario 2 consists of:

- Building DUB-13, and DUB-1 Campus with 49 diesel emergency back-up generators and associated 22.3 metres flues operating in the unlikely event of an outage of the MFGP and grid connection.

8.5.10 For dispersion modelling purposes it is assumed that for the relevant scenarios, the emergency generators would to be operating continuously all year round for the assessment of NO_2 annual average and hourly impacts.

8.5.11 Controlled maintenance including periodic testing of the emergency diesel generators is required so that they are ready to be started at full load during an emergency power failure. The testing regime and testing times are not currently known, but based on professional experience, the generators are likely to be tested one generator at a time and sequentially with a periodic testing regime of weekly run test at reduced load and quarterly at full load. The periodic test would be expected run for a short period of time between 30 minutes to one hour. Given the expected short period of testing operation and the elevated exhaust improving dispersion, it is unlikely that the NO_2 ambient AQS would be exceeded. When in use in an emergency, all the generators could be operational at full load and therefore the impacts during an emergency are higher than those when individual or groups of generators are being routinely tested. The impacts during the testing regimes have been scoped out of the modelling assessment and the emergency operation have therefore been assessed as the worst-case scenario.

8.5.12 The operation of the emergency generators has been assessed according to the methodology published by the UK Environment Agency guidance[16,17]. The UK guidance is a conservative probabilistic approach which uses the emergency generators maximum hourly emissions to determine the number of hours

20 EPA, 2021, EPA Website: http://www.epa.ie/whatwedo/monitoring/air/ [Accessed on 03/10/2022]

21 Available at: http://www.cerc.co.uk/environmental-software/ADMS-model.html [Accessed on 03/10/2022]

that all the generators could operate simultaneously in any one year with a 1% chance of exceeding the 1-hour mean objective based on the worst modelled meteorological year. The USEPA methodology[15] to assess the 1-hour NO_2 ambient AQS considers that a probabilistic method is too conservative and proposes to model impacts from intermittent emissions based on an average hourly rate (i.e., maximum hourly rate factored to a certain number of more realistic operating hours), rather than maximum hourly emissions. Given the conservative approach of the UK guidance, this assessment considers the UK guidance more suitable for protection of sensitive receptors and to demonstrate compliance with the ambient AQS and therefore it has been used to assess the likelihood of exceedance of the 1-hour NO_2 ambient AQS.

8.5.13 Following the UK Environment Agency methodology, the hourly emissions and the allowable operating hours for emergency operation were estimated from a statistical analysis of the likelihood of breaching the 1-hour objective for NO_2 concentrations by using the hypergeometric distribution function. The allowable operating hours were calculated for a 1% probability of exceeding the one-hour mean objective at the most impacted receptor location. In accordance with the emissions from specified generators guidance, in an emergency when the operating period is greater than one hour, the calculated probability has been multiplied by 2.5. For compliance with the annual mean AQS, the predicted concentrations were scaled to the total annual operating hours that the generators were determined to run for the 1% probability of exceeding the one-hour mean objective.

8.5.14 The likelihood of exceeding the 1-hour mean objective also considers the baseline pollutant concentrations in the vicinity of the site. For the short-term assessment, the background concentration is assumed to be twice the annual mean background concentration. As the dispersion modelling was undertaken for NOx emissions, for estimating the number of exceedances of the hourly mean NO_2 objective, the exceedance concentration in the model was set as follows:

- Model exceedance concentration = 200 – twice annual mean background)/0.35.

8.5.15 For the accessed scenarios, guidance on air emissions risk assessments produced by the UK Environment Agency[22] was used to support an assessment of the overall impact of the emissions resulting from the installations to confirm that the emissions are acceptable (i.e., do not cause significant environmental pollution). Emissions of NOx from combustion sources include both nitric oxide (NO) and NO_2, with the majority being in the form of NO. During the process of combustion, atmospheric and fuel nitrogen is partially oxidised via a series of complex combustion reactions, because of high temperature, to NO. In ambient air, NO is oxidised to form NO_2, a more harmful form of NOx with more significant health impacts. For this assessment, the conversion of NOx to NO_2 has been estimated using the worst-case assumptions set out in the UK Environment Agency guidance:

- For the assessment of long term (annual mean) impacts at receptors 70% of NOx is converted to NO_2; and
- For the assessment of short term (hourly mean) impacts at receptors 35% of NOx is converted to NO_2.

8.5.16 The UK Environment Agency assumptions offer a worst-case assessment as the conversion rates may be conservative as the oxidation of NO to NO_2 is not an instantaneous process particularly at short distance from the emissions source where the maximum impacts are predicted to occur.

8.5.17 Tall buildings can have a substantial impact on the dispersion of pollutants from stacks, as a result of building downwash i.e., pollutants being drawn down in the wake of a building, giving rise to high concentrations close to the base of the buildings. The buildings include in the ADMS model are shown in Technical Appendix 8.1 in the EIAR Volume 3. An initial model run was undertaken to confirm the flues heights would ensure adequate dispersion

8.5.18 To undertake the assessment, the emergency generators were allocated their own flues and the flues combined in ADMS in triples or quadruples when adjacent, according to the plan's configuration. The location and flue parameters used in the model are shown in Technical Appendix 8.1 in the EIAR Volume 3.

8.5.19 The dispersion modelling has been undertaken with five years of hourly sequenced meteorology data for the years 2015 to 2019 inclusive, from Casement Aerodrome which is approximately 1 km to the south of the site. Adopting the maximum hourly stack emissions across the five years of meteorological data will ensure the worst-case long and short-term concentrations from the stacks are considered within the assessment. The Casement Aerodrome windroses are presented in Technical Appendix 8.1 in the EIAR Volume 3.

8.5.20 For the emergency generators, emission rates, volumetric flowrates and stack parameters have been provided by the lead project consultant, Burns & McDonnell. Flue heights and diameters were taken from the CAD layout drawings. The emergency generators model input data used in the model is provided in Table 8-1.

Table 8-1: Stack Emissions Modelling Input Parameters

Plant	Equipment	Temperature (ºC)	Volume Flux (Am^3/s)	Height (m)	Diameter (m)	NO_2 Emission Rate at discharge conditions (g/s)
Emergency Generators	CAT 3516E, EM4789	422	10.0	22.3	0.6	4.2

Cumulative Stage

8.5.21 Cumulative effects have been included in this Chapter following the review the cumulative schemes EIARs submitted as part of the planning applications as outlined in Chapter 2: EIA Process and Methodology

8.5.22 Additional cumulative development data center facilities with emergency only emission points would only operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis or simultaneously with the proposed development. Emergency generators emission points associated with the cumulative developments were not considered for the purpose of this assessment.

8.6 Assessment Criteria

8.6.1 The criteria used to assess if an effect is significant or not, is set out in subsequent sub-sections. This is determined by consideration of the sensitivity of the receptor, magnitude of impact and scale of the effect. In considering the significance of an effect, consideration has been given to the duration of the effect, the geographical extent of the effect and the application of professional judgement.

Receptor Sensitivity/Value Criteria

Demolition and Construction Stage

8.6.2 The sensitivities of people to dust soiling effect has been classified as low, medium, or high, in line with the IAQM guidance criteria, as set out in Table 8-2.

22 UK Environment Agency. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit. [Accessed on 04/08/2021]

Table 8-2: Sensitivities of People to Dust Soiling Effect– Demolition and Construction Stage

Sensitivity	Criteria
Low	• The enjoyment of amenity would not reasonably be expected; or • Property would not reasonably be expected to be diminished in appearance, aesthetics, or value by soiling; or • There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. • Indicative examples include playing fields, farmland (unless commercially sensitive horticultural), footpaths, short-term car parks and roads.
Medium	• Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or • First occupants moving into residential dwellings on a large, phased housing development; or • The appearance, aesthetics or value of their property could be diminished by soiling; or • The people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. • Indicative examples include parks and places of work.
High	• Users can reasonably expect enjoyment of a high level of amenity; or • The appearance, aesthetics or value of their property would be diminished by soiling; and • The people or property would reasonably be expected to be present continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. • Indicative examples include dwellings, museums, and other culturally important collections, medium- and long-term car parks and car showrooms.

Operation Stage

8.6.3 To protect human health, national and European statutory bodies defined health or environmental-based AQS for a range of air pollutants. There are no degrees of sensitivity of receptors to poor air quality, rather, the assessment is based on whether members of the public are likely to be present for the proposed averaging period of the objective and air quality significance criteria are assessed based on compliance with the appropriate standards or limit values.

8.6.4 The AQS are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects on human health (including sensitive sub-groups) or ecosystems. In general, these are concentration limits, above which sensitive members of the public (e.g. children, the elderly and the unwell) might experience adverse health effects. Standards are values often expressed as maximum concentrations not to be exceeded either without exception or with a limited number of exceedances within a specified timescale.

8.6.5 The applicable standards in Ireland include the AQS Regulations 2011[8.10], which incorporate European Commission Directive 2008/50/EC[2], and set limit values for NO_2, PM_{10} and $PM_{2.5}$ relevant to this assessment, as described in Table 8-3.

Table 8-3: Human Health Air Quality Standard

Pollutant	Time Period	Value
NO_2	Annual Mean for protection of Human Health	40 µg/m^3
	1-hour mean	200 µg/m^3 not to be exceeded more than 18 times a year
Particulate Matter (as PM_{10})	24 hours mean	50 µg/m^3 not to be exceeded more than 35 times per year
	Annual mean	40 µg/m^3
$PM_{2.5}$	Annual mean	25 µg/m^3

Impact Magnitude Criteria

Demolition and Construction Stage

8.6.6 The criteria provided in the guidance produced by the IAQM[12] was used to assess the potential risk of impacts to air quality from demolition and construction stage activity in the absence of mitigation during demolition and construction stage of the proposed development. The methodology combines the magnitude of dust emissions together with the sensitivity of the receptor to identify low, medium, or high risk of dust impacts in the absence of mitigation for the four stages of construction: demolition, earthworks, construction and trackout.

Operation Stage

8.6.7 The operation of the emergency generators has been assessed according to the methodology published by the UK Environment Agency [16,17] to determine the statistical likelihood of exceedance of the NO_2 hourly limit value. The allowable hours for emergency operation are estimated from a statistical analysis of the likelihood of breaching the hourly mean NO_2 AQS (considering baseline pollutant concentrations).

8.6.8 The hypergeometric probability distribution test (see Appendix 8.1 in Volume 3 for more details) provides an estimate of the probability of breaching the AQO given random use of the generators for a total number of operating hours per year. Table 8-4 shows how the calculated probabilities are judged; the 1% probability is normally used as the benchmark to calculate the allowable operating hours during emergency operation; if the generators had a life of less than 20 years then it may be possible to use the 5% probability level although this does not increase the allowable operating hours significantly.

Table 8-4: Probability Significance for hourly mean NO_2 AQS

Probability	Significance
1%	Indicates exceedance is highly unlikely
5%	Indicates that exceedance is unlikely provided generator lifetime is less than 20 years
>5%	Indicates potential for exceedance

8.6.9 To assess the potential impacts and associated likely effects of the emergency generators, the 5 years worst case NO_2 modelled concentration at sensitive receptors, known as process contribution (PC), were added to the background concentrations to obtain the process environmental contribution (PEC). The PEC was then compared with the relevant ambient AQS to assess the significance of the air quality effects associated with the proposed development emissions.

8.6.10 To consider the model uncertainty, this assessment also refers to the recommendations outlined within the EPA AG4 guidance[14]. The guidance recommends that if the facility is operated continually at close to the maximum licenced mass emission rate the PC should be less than 75% of the ambient AQS and less than this where background levels account for a significant fraction of the ambient air quality standard based on the formula:

- Maximum Allowable Process Contribution= 0.75*(AQS-Background)

8.6.11 Based on the above and the average background concentrations in the study area described in the baseline conditions section of the Chapter, the annual mean PC should not exceed the value of 17.0 µg/m³ and the 1-hour average PC should not exceed the value of 137.3 µg/m³.

Scale of Effect Criteria

Demolition and Construction Stage

8.6.12 The IAQM guidance recommends that no assessment of the significance of dust effects is made without mitigation in place, as mitigation is assumed to be secured by industry best practice, planning conditions, legal requirements or required by regulations. With appropriate mitigation in place, the effect of demolition and construction stage dust emission impacts on air quality is always assessed as not significant in EIA terms. The purpose of the demolition and construction stage dust assessment has therefore been to identify the appropriate level of mitigation to employ.

8.6.13 Using the IAQM assessment methodology to identify the appropriate level of mitigation, and on the assumption that the identified mitigation measures are applied and are commensurate with the risk of potential dust impacts, the guidance indicates that that the potential for dust effects to arise during the demolition and construction stage would be at worst 'slight negative' and would be temporary in nature.

Operation Stage

8.6.14 The potential impact to air quality from the proposed development plant is a breach of the ambient AQS as a result of air emissions from the proposed development emergency generators.

8.6.15 In determining the significance of reported effects, the assessment has considered the Environmental Protection Agency's (EPA) Guidelines on the information to be contained in Environment Impact Assessment Reports (2022), as described in Chapter 2: EIA Process and Methodology, effects ranging from 'moderate' to 'profound' are considered 'significant' in terms of EIA.

Nature of Effect Criteria

8.6.16 The nature of the effect has been described as either negative, neutral, or positive as outlined in Chapter 2: EIA Process and Methodology.

8.7 Assumptions and Limitations

8.7.1 The assessment has relied on data extracted from the EPA and planning application EIAR air quality assessments. It has been assumed that the data sets have been reported correctly.

8.7.2 There are many components that contribute to the uncertainty in predicted concentrations. Although the model has been extensively validated against field data sets and their use has gained wide acceptance, no computer-based model is able to totally replicate actual conditions as it is required to simplify real-world conditions into a series of algorithms. The model used in this assessment is also dependent upon several sources of data which will have inherent uncertainties associated with them.

8.7.3 Tall buildings can have a substantial impact on the dispersion of pollutants from stacks, as a result of building downwash i.e., pollutants being drawn down in the wake of a building, giving rise to high concentrations close to the base of the buildings. ADMS5 can take account of this potential impact by the inclusion of rectangular buildings in the model. The buildings included within the modelling were based on the interpretation of the development parameters and plans.

8.7.4 The terrain within the study area is relatively flat with slopes less than 10 %, and therefore terrain effects have not been included within the modelling.

8.7.5 Emission rates, volumetric flowrates and flue parameters have been based on data provided by the project architect consultant, Burns & McDonnell. It has been assumed that the up-to-date data sets have been provided and reported correctly.

8.7.6 Overall, when considering the assumed number of operating hours; the approach taken to meteorological conditions; and the assumed NOx to NO_2 relationship, the assessment is expected to over-predict the impacts of the proposed development. The approach used therefore provides a robust assessment.

8.8 Baseline Conditions

Existing Baseline

8.8.1 Under the Ambient Air Quality and Cleaner Air for Europe Directive (2008/50/EC), Ireland designated four air quality zones for the purpose of air quality management and assessment[23]. In terms of air monitoring, the development site is within Dublin Zone A.

NO_2

8.8.2 Air Quality monitoring is carried out by the EPA and local authorities at Dublin Zone A urban and suburban background locations. A summary of the closest and most representative monitoring locations is presented in Table 8-5 and the locations shown in Figure 8.1.

Table 8-5: Measured Annual Average NO_2 Concentrations (µg/m³)

Station	Type	Distance from Site (km)	2015	2016	2017	2018	2019	5 years Average
Ballyfermot	Suburban Background	≈ 6.5	16	17	17	17	20	17
Rathmines	Urban Background	≈ 11.8	18	20	17	20	22	19
Dun Laoghaire	Suburban Background	≈ 21.1	16	19	17	19	15	17
Swords	Suburban Background	≈ 21.8	13	16	14	16	15	15
AQS			40					

8.8.3 Measured NO_2 concentrations at the closest background automatic monitoring station to the site, Ballyfermot, have been well below the ambient AQS with an average annual mean concentration of approximately 17 µg/m³ between 2015-2019.

23 https://www.epa.ie/air/quality/zones/ [Accessed on 03/10/2022]

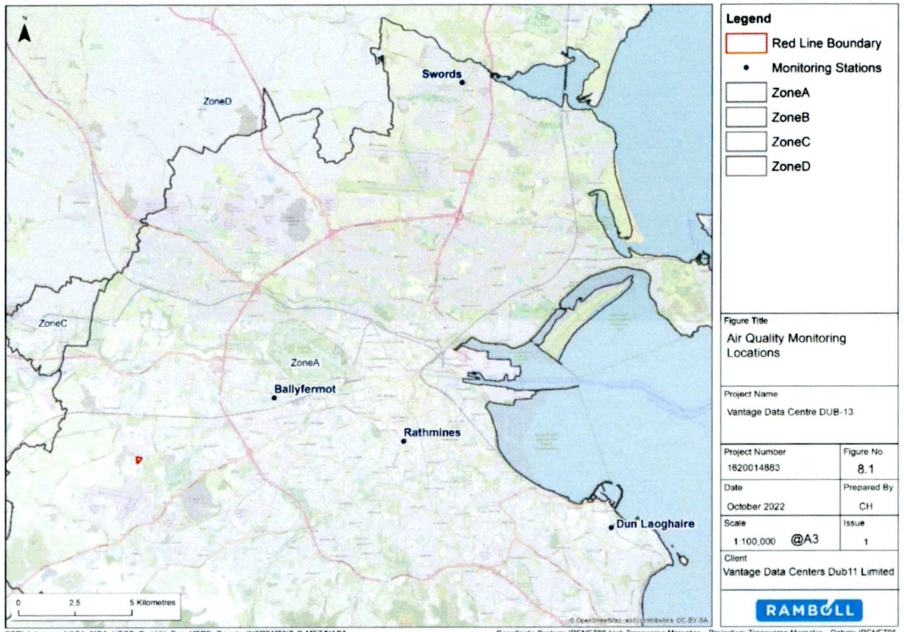

Figure 8-1: Nearest Monitoring Locations

Particulates (PM_{10} and $PM_{2.5}$)

8.8.4 Measured continuous PM_{10} monitoring carried out within Dublin Zone A background locations have been well below the ambient AQS with an average annual mean concentration of approximately 15 µg/m^3.

8.8.5 Measured continuous $PM_{2.5}$ monitoring carried out within Dublin Zone A locations have been well below the ambient AQS with an average annual mean concentration of approximately 11 µg/m^3.

Assessment of Monitoring Data

8.8.6 Ballyfermot background station is the closest station to the site and would therefore be considered representative of the air quality within study area. Measured NO_2 and PM_{10} at Ballyfermot have been well below the relevant AQS and therefore background concentrations at the site and within the study area would be expected to be below the AQS.

8.8.7 Measured $PM_{2.5}$ within Dublin Zone A have been well below the relevant AQS and therefore $PM_{2.5}$ background concentrations at the site and within the study area would be expected to be below the AQS.

8.8.8 For the purposes of this assessment, Ballyfermot NO_2 average background concentration measured between 2015-2019 with the value of 17 µg/m^3 has been used to estimate the PEC.

Future Baseline

8.8.9 As per Chapter 2: EIA Process and Methodology, the future baseline includes the operation of the July 2022 DUB-1 consented development reported within the DUB-1 EIAR. The MFGP permitted as part of the July 2022 DUB-1 consented development was designed to include the proposed data center and no change in capacity will be required to power the proposed development, as such the proposed development would not result in an increase in the MFGP air emissions further to those described as part of the EIAR for the July 2022 DUB-1 consented development. Moreover, the proposed development emergency generators would only operate in case of an outage of the MFGP and grid connection, and therefore would not operate simultaneously with the MFGP. The July 2022 DUB-1 EIAR Chapter 8 Air Quality showed that the operation of the MFGP powered by gas would result in a maximum annual mean NO_2 concentrations of approximately 1 µg/m^3. The MFGP process contribution, when combined with existing local background of 17 µg/m^3, would result in an overall concentration of approximately 18 µg/m^3 and therefore well below the AQS.

8.8.10 Air quality at background and roadside locations is expected to improve in future years due to the gradual improvement in vehicle combustion technologies and enforcement of national policies such as the Government of Ireland Climate Action Plan[24]. The climate plan proposes to achieve a net zero target by 2050 and commits to evaluate in detail the changes required to adopt such a goal in Ireland. Future baseline air quality within the study area would therefore be expected to improve and remain well below the AQS.

8.8.11 Although air emissions are predicted to decline with time, to take into account the uncertainties regarding future local air quality, the proposed development operational stage emergency generators PC were added to the 2019 measured background concentrations to obtain the PEC. This is considered to provide an appropriately conservative assessment assuming no future improvements on local air quality.

Sensitive receptors

8.8.12 The site is surrounded by large commercial areas occupied by industrial uses to the north and south within the Kilcarbery Park, Grange Castle Business Park and Profile Park. The closest potential residential property is located approximately 125 m to the northeast of the site boundary along Nangor Road. Residential development is primarily located in Deansrath, Clondalkin, approximately 600 m south of the site. The residential property within the site boundary is proposed to be demolished as part of the development.

8.8.13 Relevant sensitive locations are places where members of the public might be expected to be regularly present over the averaging period of the AQS. For the annual mean and hourly mean AQS that are the focus of this assessment, sensitive receptors will generally be residential properties, schools, nursing homes and temporary residence caravan parks. The locations of existing receptors were chosen to represent locations where impacts from the proposed development are likely to be the greatest.

8.8.14 The existing receptors identified as being sensitive to the proposed development and which have been 'scoped-in' to the assessment are summarised Table 8-6 and displayed on Figure 8.2. Existing receptor locations were modelled at a height of 1.5 m and 4.5 m representing typical two storey property with exposure at ground floor and top floor level, except for R1, R2 and R5 which have additional heights of 18 m and 12 m respectively, modelled representing top floor commercial exposure.

Table 8-6: Summary of Sensitive Receptors

Receptor ID	Location	X (m)	Y (m)	Type Exposure
R1	Kilcarbery Park	703862	730924	Commercial/Industrial
R2	Kilcarbery Park	703970	730908	Commercial/Industrial
R3	Nangor Lea, Nangor Road	704053	730934	Potential Residential
R4	Nangor Road	703515	730878	Industrial/Commercial

24 Government of Ireland, 2021. Climate Action Plan 2021. Securing our future. https://www.gov.ie/en/publication/6223e-climate-action-plan-2021/# [Accessed on 03/10/2022]

Table 8-6: Summary of Sensitive Receptors

R5	DUB-1	703703	730781	Industrial
R6	Castlegrange Green	704731	731119	Residential
R7	Oldcastlepark Lawn Caravan park	704658	731156	Residential
R8	Oldcastlepark Lawn Caravan park	704652	731171	Residential
R9	Kilbride House, Baldonnel Road	703686	730091	Residential
R10	Casement Aerodrome, Baldonnel	703654	730026	Residential
R11	Casement Aerodrome, Baldonnel	703482	730024	Residential
R12	Aungierstown, Baldonnel Road	703286	730109	Residential
R13	Aungierstown, Baldonnel Road	703257	730117	Residential
R14	Aungierstown, Baldonnel Road	703200	730136	Residential
R15	Aungierstown, Baldonnel Road	703129	730165	Residential
R16	Baldonnel Road	703027	730288	Residential
R17	Baldonnel Road	703014	730327	Residential
R18	Baldonnel Road	702964	730384	Residential
R19	Baldonnel Road	703024	730476	Residential
R20	Baldonnel Road	702940	730528	Residential
R21	Baldonnel Road	702897	730569	Residential
R22	Baldonnel Road	702876	730595	Residential
R23	Baldonnel Road Comex Mc Kinnon	702850	730615	Commercial

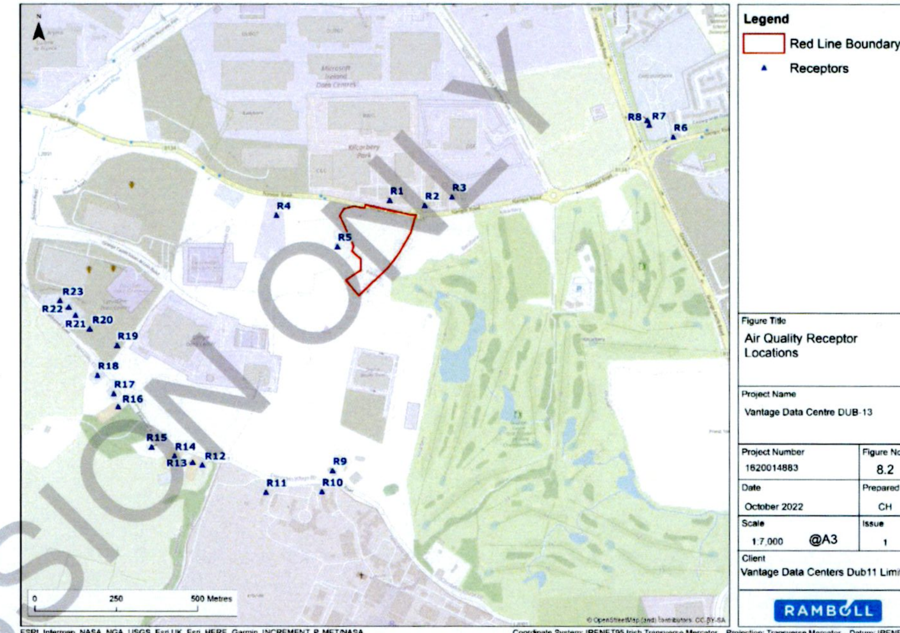

Figure 8-2: Air Quality Receptor Locations

8.8.15 Concentrations were also predicted for a grid of receptors (contours) mapped with sufficient resolution to ensure all localised "hot-spots" were identified and to visually demonstrate the pattern of dispersion, as recommended by EPA AG4 guidance. The grids were based on a Cartesian grid with the site at the centre and are described in Table 8-7 and modelled at a height of 4.m representing 1st floor residential buildings.

Table 8-7: Receptor Grids

Grid	Measure	Spacing (m)
Outer Grid	5x5 km	500
Middle Grid	3x3 km	100
Inner Grid	500x500 m	20

8.9 Assessment of Effects

Demolition and Construction Effects

8.9.1 The main activities with potential to cause emissions of dust construction will include:

- Demolition of existing buildings;
- Earthworks and site preparation;
- Construction of building structures, including foundations;

- Materials Handling such as storage of materials in stockpiles and spillage;
- Construction of on-site highway improvements; and
- Hard and soft landscaping.

8.9.2 Dust impacts would be greatest in dry weather following long periods without rain and with the wind blowing towards sensitive receptors. Depending on wind speed and turbulence it is likely that most of the dust will be deposited within 100 m of the source. Meteorological data for Casement Aerodrome, shown in Technical Appendix 8.1 in EIAR Volume 3, suggests that prevailing winds are typically south-westerly.

8.9.3 The risk of potential air quality impacts from demolition, earthworks, construction and trackout (the transport of dust and dirt from the application site onto the public road network) was assessed according to guidance developed by the IAQM to identify the appropriate level of mitigation.

8.9.4 Using the evaluation criteria within the IAQM's Guidance, the potential dust emission magnitude has been identified for each stage of the proposed development as shown in Table 8-8 based on information presented in Chapter 5: Construction Description of this Volume.

Table 8-8: Dust Emission Impact Magnitude for Proposed Development Works

Activity	Dust Emission Magnitude	Justification
Demolition	Small	Demolition of the former residential property within the site. The total building volume is estimated to be <20,000 m^3. Demolition activities would occur at height of more than 10 m above ground level.
Earthworks	Large	Total site area over 10,000 m^2.
Construction	Medium	The proposed development would have a total estimated construction volume of between 25,000m^3 - 100,000 m^3.
Trackout	Medium	HDV movements over the course of the worst-case phase would be up to 10-50 HDV movements in one day. Unpaved road length would be between 50 m- 100m.

8.9.5 The closest sensitive receptor to construction activity within 350 m of the site would be potential residential property to the north east of the site, identified as Receptor R3 in Table 8.6, and the places of work at Kilcarbery Park, identified as receptor R1.

8.9.6 The next stage of the process is to define the sensitivity of the assessment area to dust soiling and human health impacts. This process combines the sensitivity of the receptor with the distance from the source to determine the overall sensitivity. The sensitivity of the area to dust impacts (considering distance to construction activity) is provided in Table 8-9.

Table 8-9: Sensitivity of Study Area to Dust Impacts

Sensitivity to Dust Soiling	Sensitivity to Human Health Impacts
Low: places of work within 50 m of the site.	Medium: places of work within 50 m of the site. Average measured PM_{10} concentrations are below 24 µg/m^3 (see Baseline Conditions section).

8.9.7 The dust emission magnitude determined in Table 8-8 has been combined with the sensitivity assessment in Table 8-9 to define the risk of impacts for each stage of the proposed development works in the absence of mitigation, as shown in Table 8-10.

Table 8-10: Risk of Dust Impacts in Absence of Mitigation at Proposed Development

	Dust Emission Magnitude for Each Phase of Works			
Sensitivity of Study Area	Demolition (Small)	Earthworks (Large)	Construction (Medium)	Trackout (Medium)
Dust Soiling (Low)	Negligible Risk	Low Risk	Low Risk	Low Risk
Human Health (Medium)	Low Risk	Medium Risk	Medium Risk	Low Risk

8.9.8 Therefore, using professional judgement, the overall risk of dust impacts in the absence of mitigation has been assessed as the highest resulting risk, i.e. as being Medium Risk.

Embedded Mitigation and Standard Good Practice

8.9.9 The control of dust and construction traffic emissions from a demolition and construction site relies upon good site management and mitigation techniques to reduce emissions of dust and limit dispersion. A summary of the mitigation measures recommended IAQM guidance to reduce impacts from medium risk sites is provided Table 8-11. The mitigation measures for both direct impacts and those from traffic would be detailed within the site's CEMP. It is noted that these measures have already been accounted for in EIAR Chapter 5: Construction Description of this Volume.

Table 8-11: Dust Mitigation Measures for Medium Risk Sites

Phase	Mitigation Measure
Communications	• Develop and implement a stakeholder communications plan that includes community engagement before work commences on site • Display name and contact details of responsible person for dust issues on the site boundary (e.g. hoarding) in addition to head/regional office contact information. • Display the head or regional office contact information.
Dust Management Plan	• Develop and implement a Dust Management Plan (DMP) which is included as part of the CEMP.
Site Management	• Record all complaints and incidents in a site log. • Take appropriate measures to reduce emissions in a timely manner, and record the measures taken within the log. • Make the complaints log available to the Local Authority if requested. • Record any exceptional dust incidents on- or off-site. • Hold regular liaison meeting with other high-risk construction sites within 500 m.
Monitoring	• Undertake daily on and off-site visual inspections where there are nearby receptors. • Carry out regular inspections to ensure compliance with the DMP and record results in the site logbook. • Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.
Preparing and Maintaining the Site	• Plan site layout to locate dust generating activities as far as possible from receptors. • Use solid screens around dusty activities and around stockpiles. • Avoid site runoff of water and mud. • Fully enclose the site or specific operations where there is a high potential for dust production and the site is active for an extensive period. • Keep site fencing barriers and scaffolding clean using wet methods. • Remove dusty materials from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below • Minimise emissions from stockpiles by covering, seeding, fencing, or damping down.

Table 8-11: Dust Mitigation Measures for Medium Risk Sites

Phase	Mitigation Measure
Operating Vehicle/ Machinery and Sustainable Travel	• Enforce an on-site speed limit of 15 mph on surfaced roads and 10 mph on unsurfaced areas. • Ensure vehicles switch off engines when stationary. • Avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment where practicable. • Produce a Construction Logistics Plan (CLP) to manage the sustainable delivery of goods and materials. • Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing).
Operations	• Only undertake cutting, grinding, or sawing equipment with suitable dust suppression equipment or techniques. • Ensure adequate water supply for effective dust and particulate matter suppression. • Use enclosed chutes, conveyors, and covered skips. • Minimise drop heights of materials. • Ensure suitable cleaning material is available at all times to clean up spills.
Waste Management	• Avoid bonfires. • Avoid explosive blasting using appropriate manual or mechanical techniques. • Bag and remove any biological debris.
Measures Specific to Demolition	• Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust). • Ensure effective water suppression during demolition. • Avoid explosive blasting, using appropriate manual or mechanical alternatives. • Bag and remove any biological debris or damp down such material before demolition.
Measures Specific to Construction	• Ensure aggregates are stored in bunded areas and are not allowed to dry out. • Avoid concrete scabbling where possible. • Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos. • For smaller supplies of fine powder materials ensure bags are sealed after use and stored appropriately to prevent dust.
Measures Specific to Trackout	• Use water-assisted dust sweepers to clean access and local roads. • Avoid dry sweeping of large areas. • Ensure vehicles entering and leaving the site are appropriately covered. • Record inspections of haul roads in site log, including any remedial action taken. • Implement a wheel washing system. • Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit. • Access gates to be located at least 10 m from the receptors where possible.
Measures Specific to Earthworks	• Re-vegetate earthworks and exposed areas / soil stockpiles to stabilise surfaces as soon as practicable. • Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil. • Only remove the cover in small areas during work and not all at once.

8.9.10 As per this chapter scale of effects section, the purpose of the demolition and construction stage dust risk assessment is to identify the appropriate level of mitigation to employ and no assessment of the significance of demolition and construction stage effects is made without mitigation in place. With the implementation of the CEMP and CLP (i.e. the measures outlined in Chapter 5: Construction Description), the demolition and construction dust and on-site vehicle emissions effects in the study would be Temporary, Imperceptible and Negative, i.e. Not Significant in terms of EIA.

Operation Effects

Emergency Scenario 1: DUB-13 emergency scenario.

8.9.11 The modelling has been undertaken to determine the DUB-13 emergency operation with a 1% probability of exceeding the 1-hour objective. The detailed results of the dispersion modelling at the sensitive receptors identified in Table 8.6 are shown in Technical Appendix 7.2 in Volume 3.

8.9.12 Table 8-12 shows the results of the modelling for the highest impacted receptor for any of the assessed receptor locations.

Table 8-12: Emergency Scenario 1 DUB-13 Emergency Generators Emergency Operation

Plant	Operating hours for 1% probability of exceeding the 1-hour mean objective
DUB-13 Emergency Generator	62

8.9.13 The DUB-13. Emergency Generators would operate for 62 hours to reach a 1% probability of exceeding the objective the 1-hour mean objective.

8.9.14 Table 8.13 shows the maximum predicted annual mean NO_2 concentrations at the worst-case receptor with the highest predicted concentration for the DUB-13 emergency generator maximum of 62 emergency operation hours. It should be recognised however that it is extremely unlikely that the generators would operate for maximum number of hours determined. It is considered that the predicted impacts are conservative as it would require a loss of grid power to this area of Ireland for approximately 2.6 days in a year.

Table 8-13: Emergency Scenario 1 DUB-13 Emergency Generators Maximum Annual Mean Concentrations for 62 hours Operation

Receptor	Height	NO_2 PC (µg/m^3)	PC % AQS	NO_2 Average Background (µg/m^3)	Annual Mean PEC (µg/m^3)	PEC % AQS
R1 GF	1.5	0.36	0.89	17.4	17.8	44.4
R1 TF	7.5	0.79	1.99	17.4	18.2	45.5
R2 GF	1.5	0.43	1.07	17.4	17.8	44.6
R2 TF	7.5	0.59	1.49	17.4	18.0	45.0
R3 GF	1.5	0.45	1.12	17.4	17.8	44.6
R3 TF	7.5	0.45	1.14	17.4	17.9	44.6
R4 GF	1.5	0.05	0.12	17.4	17.4	43.6
R4 TF	7.5	0.05	0.12	17.4	17.4	43.6
R5 GF	1.5	0.12	0.31	17.4	17.5	43.8
R5 TF	7.5	0.21	0.53	17.4	17.6	44.0
R6	1.5	0.10	0.24	17.4	17.5	43.7
R7	1.5	0.11	0.28	17.4	17.5	43.8
R8	1.5	0.11	0.28	17.4	17.5	43.8

Table 8-13: Emergency Scenario 1 DUB-13 Emergency Generators Maximum Annual Mean Concentrations for 62 hours Operation

Receptor	Height	NO_2 PC (µg/m³)	PC % AQS	NO_2 Average Background (µg/m³)	Annual Mean PEC (µg/m³)	PEC % AQS
R9	1.5	0.01	0.02	17.4	17.4	43.5
R10	1.5	0.01	0.02	17.4	17.4	43.5
R11	1.5	0.01	0.02	17.4	17.4	43.5
R12	1.5	0.01	0.03	17.4	17.4	43.5
R13	1.5	0.01	0.03	17.4	17.4	43.5
R14	1.5	0.01	0.03	17.4	17.4	43.5
R15	1.5	0.02	0.04	17.4	17.4	43.5
R16	1.5	0.02	0.05	17.4	17.4	43.6
R17	1.5	0.02	0.06	17.4	17.4	43.6
R18	1.5	0.03	0.07	17.4	17.4	43.6
R19	1.5	0.04	0.10	17.4	17.4	43.6
R20	1.5	0.04	0.11	17.4	17.4	43.6
R21	1.5	0.04	0.11	17.4	17.4	43.6
R22	1.5	0.04	0.11	17.4	17.4	43.6
R23	1.5	0.04	0.10	17.4	17.4	43.6

GF = Ground Floor exposure
TF = Top floor Exposure

8.9.15 The maximum predicted annual mean PC concentrations occurs at receptor R1, on the top floor. As this property is commercial, annual mean AQS does not apply. The maximum predicted annual mean PC concentration at a residential property occurs at R3 (Top Floor), northeast of site, where the PC is below the maximum allowable PC recommended by EPA AG4 guidance.

8.9.16 The maximum results indicate that the ambient level concentrations due to emissions arising from the emergency scenario would be comfortably below the relevant NO_2 AQS. For the worst-case year modelled, predicted PEC (including background) would be below 75% of the ambient NO_2 annual AQS at all assessed receptors, with maximum PEC predicted at receptor R1 where concentrations would be approximately 45% of the NO_2 annual AQS.

8.9.17 The geographical variation in annual mean NO_2 PC concentrations (without background) resulting from 62 h emergency operation of DUB-13 are shown in Figure 8.3.

8.9.18 The localised air quality effects of the emergency generators are considered Long-term to Permanent, Imperceptible and Neutral, i.e. Not Significant in terms of EIA.

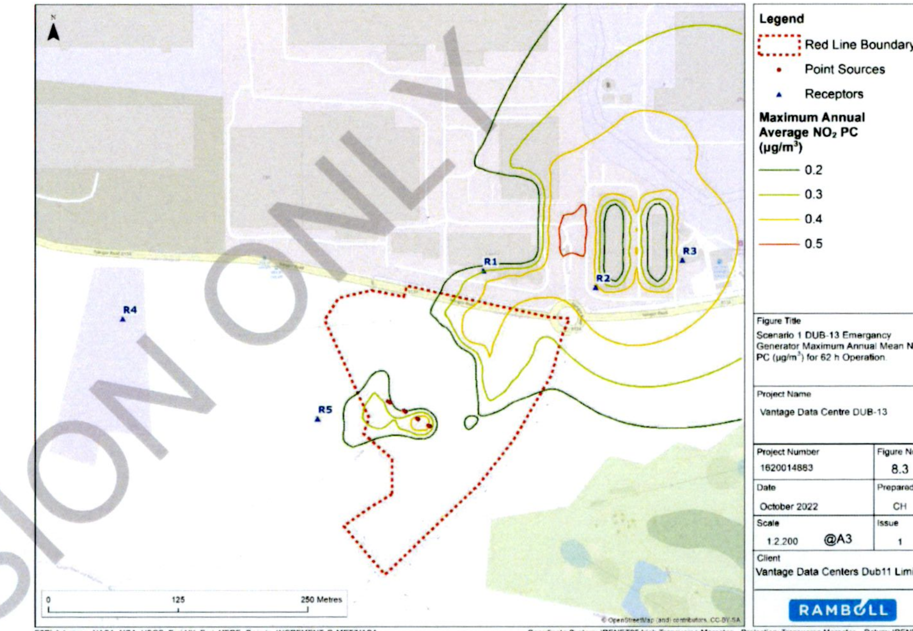

Figure 8-3: Emergency Scenario 1 DUB-13 Emergency Generator Maximum Annual Mean NO_2 PC (µg/m³) for 62 h Operation.

Emergency Scenario 2: DUB-13 and DUB-1 Campus emergency scenario.

8.9.19 The modelling has been undertaken to determine the DUB-13 and DUB-1 combined emergency operation with a 1% probability of exceeding the 1-hour objective. The detailed results of the dispersion modelling at the sensitive receptors identified in Table 8-14 are shown in Technical Appendix 7.2 in Volume 3.

8.9.20 Table 8.14 shows the results of the modelling for the highest impacted receptor for any of the assessed receptor locations.

Table 8.14: Emergency Scenario 2 DUB-13 and DUB-1 Emergency Generators

Plant	Operating hours for 1% probability of exceeding the 1-hour mean objective
DUB-13 and DUB-1 Campus Emergency Generator	29

8.9.21 DUB-13 and DUB-1 Campus Emergency Generators would operate for 29 hours to reach a 1% probability of exceeding the objective the 1-hour mean objective.

8.9.22 Table 8.15 shows the maximum predicted annual mean NO_2 concentrations at the worst-case receptor with the highest predicted concentration for the DUB-13 and DUB-1 Campus emergency generator maximum of 26 emergency operation hours. It should be recognised however that it is unlikely that the generators will be required to operate for maximum number of hours determined. It is considered that the predicted impacts are conservative as it would require a loss of grid power to this area of Ireland for approximately 1.2 days in a year.

Table 8.15: Emergency Scenario 2 DUB-13 and DUB-1 Campus Emergency Generators Maximum Annual Mean Concentrations for 29 hours Operation

Receptor	Height	NO_2 PC (µg/m³)	PC % AQS	NO_2 Average Background (µg/m³)	Annual Mean PEC (µg/m³)	PEC % AQS
R1 GF	1.5	0.58	1.45	17.4	18.0	45.0
R1 TF	7.5	0.89	2.22	17.4	18.3	45.7
R2 GF	1.5	0.56	1.39	17.4	18.0	44.9
R2 TF	7.5	0.66	1.64	17.4	18.1	45.1
R3 GF	1.5	0.51	1.28	17.4	17.9	44.8
R3 TF	7.5	0.52	1.29	17.4	17.9	44.8
R4 GF	1.5	0.08	0.21	17.4	17.5	43.7
R4 TF	7.5	0.09	0.22	17.4	17.5	43.7
R5 GF	1.5	0.44	1.10	17.4	17.8	44.6
R5 TF	7.5	0.53	1.33	17.4	17.9	44.8
R6	1.5	0.14	0.34	17.4	17.5	43.8
R7	1.5	0.15	0.38	17.4	17.6	43.9
R8	1.5	0.15	0.38	17.4	17.6	43.9
R9	1.5	0.02	0.05	17.4	17.4	43.5
R10	1.5	0.02	0.04	17.4	17.4	43.5
R11	1.5	0.01	0.03	17.4	17.4	43.5
R12	1.5	0.02	0.04	17.4	17.4	43.5
R13	1.5	0.02	0.04	17.4	17.4	43.5
R14	1.5	0.02	0.05	17.4	17.4	43.6
R15	1.5	0.03	0.06	17.4	17.4	43.6
R16	1.5	0.04	0.10	17.4	17.4	43.6
R17	1.5	0.05	0.12	17.4	17.4	43.6
R18	1.5	0.06	0.14	17.4	17.5	43.6
R19	1.5	0.08	0.20	17.4	17.5	43.7
R20	1.5	0.09	0.22	17.4	17.5	43.7
R21	1.5	0.09	0.22	17.4	17.5	43.7
R22	1.5	0.09	0.21	17.4	17.5	43.7
R23	1.5	0.08	0.20	17.4	17.5	43.7

GF = Ground Floor exposure
TF = Top floor Exposure

8.9.23 The maximum predicted annual mean PC concentrations occurs at receptor R1 (Top floor). As this property is commercial, annual mean AQS do not apply. The Maximum predicted annual mean PC concentrations at a residential property occurs at R3 (Top Floor), northeast of site, where the PC is below the maximum allowable PC recommended by EPA AG4 guidance.

8.9.24 The maximum results indicate that the ambient level concentrations due to emissions arising from the emergency scenario would be comfortably below the relevant NO_2 AQS. For the worst-case year modelled, predicted PEC (including background) would be below 75% of the ambient NO_2 annual AQS at all assessed receptors, with maximum PEC predicted at receptor R1 where concentrations would be approximately 45% of the NO_2 annual AQS.

8.9.25 The geographical variation in annual mean NO_2 PC concentrations (without background) resulting from 29 h emergency operation of DUB-13 and DUB-1 Campus emissions are shown in Figure 8.4.

8.9.26 The localised air quality effects of the emergency generators are considered Long-term to Permanent, Neutral and Imperceptible, i.e., **Not Significant** in terms of EIA.

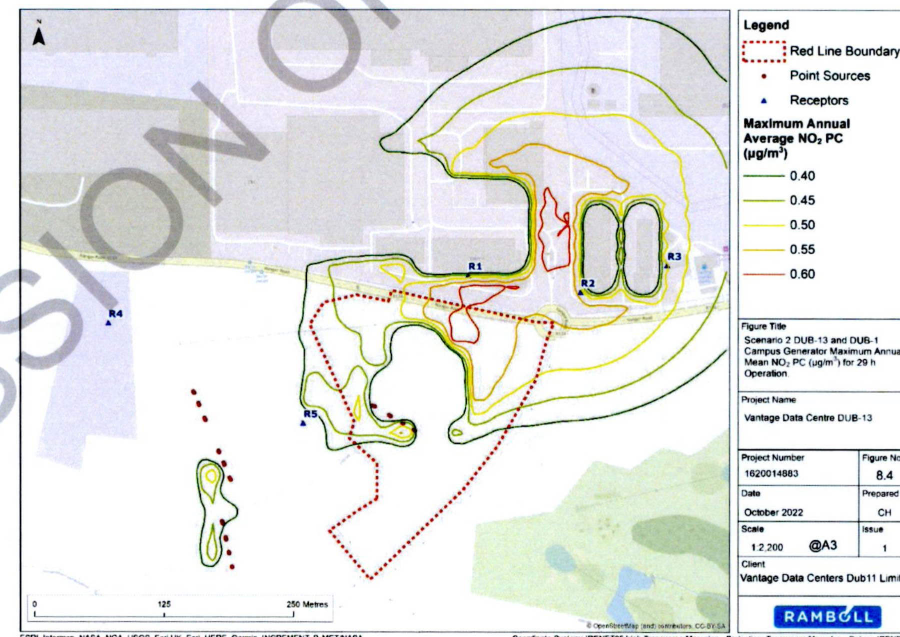

Figure 8-4: Emergency Scenario 2 DUB-13 and DUB-1 Campus Generator Maximum Annual Mean NO_2 PC (µg/m³) for 29 h Operation.

8.10 Additional Mitigation

Demolition and Construction Stage

8.10.1 No significant negative effects are predicted and consequently no additional mitigation is required.

Operation Stage

8.10.2 No significant negative effects are predicted and consequently no additional mitigation is required.

8.11 Enhancement Measures

8.11.1 No enhancement measures are proposed in respect of air quality.

8.12 Assessment of Residual Effects

Construction and Demolition

8.12.1 With the IAQM recommended mitigation measures include within the CEMP, the residual demolition and construction effects remain as reported in the assessment of effects section as being Temporary, Imperceptible and Negative, i.e. Not Significant in terms of EIA.

Operation Residual Effects

8.12.2 As no additional mitigation would be required, the residual operation effects of Emergency Scenario 1, DUB-13 emergency generators remain as reported in the assessment of effects section, Long-term to Permanent, Neutral and Imperceptible, i.e. Not Significant in terms of EIA.

8.12.3 As no additional mitigation would be required, the residual operation effects of Emergency Scenario 2, DUB-1 Campus and DUB-13 emergency generators remain as reported in the assessment of effects section, Long-term to Permanent, Neutral and Imperceptible, i.e. Not Significant in terms of EIA.

8.12.4 As no additional mitigation would be required, the residual operation effects remain as reported in the assessment of effects section.

Summary of Residual Effects

8.12.5 Table 8-16 provides a summary of the outcomes of the air quality assessment of the proposed development. Where significant positive effects are likely these are highlighted in bold green and where significant negative effects are predicted these are highlighted in bold red.

Table 8-16: Summary of Residual Effects

Receptor	Description of Residual Effect	Additional Mitigation	Scale and Significance of Residual Effect **	Nature of Residual Effect*				
				+ -	L U	D I	R IR	M B T St Mt Lt P**
Demolition and Enabling Works								
Existing Off-site Human Health and Amenity	Dust Soiling and PM_{10} due to demolition and construction works	None required	Imperceptible (not significant)	-	L	D	R	T
Existing Off-site Human Health	Change in NO_2, PM_{10} and $PM_{2.5}$ levels due to vehicle emissions	None required	Imperceptible (not significant)	-	L	D	R	T
Operation								
Existing Off-site Human Health	Change in NO_2, PM_{10} and $PM_{2.5}$ levels due to vehicle emissions	None required	Not significant	-	L	D	IR	Lt to P
Existing Off-site Human Health	Change in NO_2 levels due to DUB-13 emergency generators	None required	Imperceptible (not significant)	-	L	D	IR	Lt to P
Existing Off-site Human Health	Change in NO_2 levels due to DUB-13 and DUB-1 campus emergency generators	None required	Imperceptible (not significant)	-	L	D	IR	Lt to P

Notes:
* - = Negative/ + = Positive / +/- = Neutral; R = Reversible, IR = Irreversible; D = Direct, ID = Indirect; L= Likely, U = Unlikely; M = Momentary, B = Brief, T= Temporary, St = Short-term, Mt = Medium-term, Lt = Long-term, P = Permanent.
** Imperceptible, Not Significant, Slight, Moderate, Significant, Very Significant, Profound.

8.13 Cumulative Effects

Intra-Project Effects

8.13.1 As explained in Chapter 2: EIA Process and Methodology, intra-project cumulative effects are discussed in Chapter 16: Cumulative Effects.

Inter-Project Effects

8.13.2 A review of potential cumulative schemes has been undertaken as listed in Chapter 1: Introduction and Chapter 2: EIA Process and Methodology.

8.13.3 The demolition and construction stage cumulative effects exercise has been undertaken for cumulative schemes within 350 m of the proposed development as demolition and construction stage effects of cumulative schemes beyond 350 m are not expected to combine with the demolition and construction effects of the proposed development according to IAQM guidance.

8.13.4 Table 8-17 provides a summary of the likely inter-project cumulative effects resulting from the proposed development and the cumulative developments.

Table 8-17: Inter-Project Cumulative Effects

Cumulative Development	Demolition and Construction		Operation	
	Cumulative Effects Likely?	Reason	Cumulative Effects Likely?	Reason
Microsoft - Grange Castle Business Park, Nangor Road, Clondalkin, Dublin 22 [SD20A/0283]	No	Development constructed.	No	Microsoft application assessed the NO_2 Impacts for the continuous operation of gas generators, and backup generators. Emissions are unlikely to overlap with proposed development emergency generator emissions. Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis.

Table 8-17: Inter-Project Cumulative Effects

Cumulative Development	Demolition and Construction		Operation	
	Cumulative Effects Likely?	Reason	Cumulative Effects Likely?	Reason
UBC Properties - Townlands within Grange Castle South Business Park, Baldonnel, Dublin 22 [SD20A/0121]	No	Development located to the west beyond 350m of the site.	No	UBC properties Townlands only assessed emergency point generator emissions. Emissions are unlikely to overlap with proposed development emergency generator emissions. Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis.
UBC Properties - Grange Castle South Business Park, Dublin 22 [An Bord Pleanála Reference – 308585]	No	Scheme located west of the site at the edge of the 350m distance considered. Scheme anticipated to employ dust mitigation techniques as the proposed development.	No	There are no significant emission sources associated with UBC Properties Grange castle. Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis.
Digital Reality Trust - Profile Park, Baldonnel, Dublin 22, D22 TY06 [SD17A/0377]	No	Development located beyond the 350m of the site and constructed.	No	Digital Reality Trust only assessed emissions from emergency point generators. Emissions are unlikely to overlap with proposed development emergency generator emissions. Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis.
Cyrus One - Grange Castle Business Park, Clondalkin, Dublin 22 [SD18A/0134]	No	Development located to the west beyond the 350m of the site.	No	Cyrus One, Grange Castle only assessed emissions from emergency point generators. Emissions are unlikely to overlap with proposed development emergency generator emissions. Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis.
Cyrus One Townlands within Grange Castle South Business Park, Baldonnel, Dublin 22 [SD20A/0295]	No	Development located to the west beyond the 350m of the site.	No	Cyrus One, Townlands only assessed emissions from emergency point generators. Emissions are unlikely to overlap with proposed development emergency generator emissions. Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis.
Cyrus One - Grange Castle South Business Park, Baldonnel, Dublin 22 [An Bord Pleanála Ref - 309146]	No	Development located to the west beyond the 350m of the site.	No	There are no significant emission sources associated with Cyrus One, Grange castle. Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis.
Centrica Business Solutions – Profile Park, Baldonnel, Dublin 22 [SD21A/0167]	Yes	Development located immediately to the south of the site. There will be a potential for overlap with the site's development works.	No	Centrica day-to-day basis gas fired power plant emissions unlikely to overlap with proposed development emergency generator emissions.

Table 8-17: Inter-Project Cumulative Effects

Cumulative Development	Demolition and Construction		Operation	
	Cumulative Effects Likely?	Reason	Cumulative Effects Likely?	Reason
		Scheme anticipated to employ dust mitigation techniques as the proposed development.		Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis.
Equinix (Ireland) Ltd – Plot 100, Profile Park, Nangor Road, Clondalkin, Dublin 22 [SD21A/0186]	Yes	Development located immediately to the east of the site. There will be a potential for overlap with the site's development works. Scheme anticipated to employ dust mitigation techniques as the proposed development.	No	Equinix, Plot 100, only assessed emissions from emergency point generators. Emissions are unlikely to overlap with proposed development emergency generator emissions. Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis.
Equinix (Ireland) Ltd – Plot 100, Profile Park, Nangor Road, Clondalkin, Dublin 22 [SD22A/0156]	Yes	Development located immediately to the east of the site. There will be a potential for overlap with the site's development works. Scheme anticipated to employ dust mitigation techniques as the proposed development.	No	Equinix, Plot 100, only assessed emissions from emergency point generators. Emissions are unlikely to overlap with proposed development emergency generator emissions. Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis
Digital Netherlands VIII B.V - Profile Park, Nangor Road, Clondalkin, Dublin 22 [SD21A/0217]	Yes	Development located to the south in within the 350m distanced considered. Scheme anticipated to employ dust mitigation techniques as the	No	Digital Netherlands day-to-day basis gas fired power plant emissions and emergency generators are unlikely to overlap with proposed development emergency generator emissions.

Table 8-17: Inter-Project Cumulative Effects

Cumulative Development	Demolition and Construction		Operation	
	Cumulative Effects Likely?	Reason	Cumulative Effects Likely?	Reason
		proposed development.		Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis.
Vantage Data Centers Dub 11 Limited - Profile Park Business Park and partly within Grange Castle Business Park, Dublin 22 [An Bord Pleanála Ref - 312793]	No	Development located immediately to the south of the site. There will be a potential for overlap with the site's development works. Scheme anticipated to employ dust mitigation techniques as the proposed development.	No	Vantage Data centres, only assessed emissions from emergency point generators. Emissions are unlikely to overlap with proposed development emergency generator emissions. Proposed development emergency only emission points would operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis.

Demolition and Construction Cumulative Effects

8.13.5 Demolition and construction significant cumulative effects are unlikely to occur as the Equinix and Centrica Business Solutions development are anticipated to employ similar dust mitigation techniques such that the individual construction stage effects are not significant, alone or in combination.

Operation Cumulative Effects

8.13.6 Nearby data centres with emergency emission points would only operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis. The emergency generators emission points associated with the nearby data storage facilities are unlikely to cause a significant cumulative impact.

8.14 Summary of Assessment

Background

8.14.1 This chapter has detailed the potential air quality effects due to the construction and operation stages of the proposed development. The assessment of construction and operation stages has been undertaken considering the relevant national and local guidance and regulations. Potential sources of emissions have been identified and assessed in the context of existing air quality and the nature and location of receptors.

8.14.2 The main air pollutants of concern are dust and particulate matter with an aerodynamic diameter of less than 10 microgram (PM_{10}), typically generated during demolition and construction activities and nitrogen dioxide (NO_2), typically generated by road traffic and combustion engines.

8.14.3 Air quality monitoring data was obtained from the EPA monitoring stations to establish the status of existing air quality. The data was used as the basis for air quality modelling and predictions.

8.14.4 NO_2 concentrations at the site and within the study area would be expected to be similar to measured concentrations at the closest monitoring sites and therefore likely to comfortably meet the relevant air quality standards.

Demolition and Construction Effects

8.14.5 During the demolition and construction works, there is the potential for vehicle emissions and dust emissions to arise at existing off-site human health receptors, as well as a loss of amenity at nearby existing residential and commercial properties.

8.14.6 The predicted annual average demolition and construction traffic flows are not expected to exceed the Institute of Air Quality Management (IAQM) guidance threshold such as to require formal assessment. In addition, traffic flows would be controlled through the implementation of the Construction Environmental Management Plan (CEMP). The effects of demolition and construction related traffic emissions would be temporary and not of a scale that would give rise to significant effects.

8.14.7 Based on criteria set out in the IAQM guidance, the construction works would present a medium risk of from dust impacts in the absence of appropriate mitigation. With the implementation of suitable mitigation measures, already incorporated within the proposed development's CEMP, it is anticipated that dust effects could be mitigated to at worst result in temporary negative, but not significant, effects at existing off-site receptors.

8.14.8 Overall, the demolition of existing buildings on the site and construction of the proposed development would result in an imperceptible effect on air quality and identified receptors, and as such would not give rise to significant negative effects on air quality in terms of EIA.

Operational Effects

8.14.9 The predicted annual average completed development traffic flows are not expected to exceed the Institute of Air Quality Management (IAQM) guidance threshold such as to require formal assessment. The effects of operation stage related traffic emissions would be long-term and not of a scale that would give rise to significant effects.

8.14.10 Concentrations of NO_2 have been predicted for several worst-case locations representing existing sensitive receptors in the study area.

8.14.11 The potential impact to air quality during the operation stage of the proposed development is a breach of the ambient air quality standards because of air emissions from the proposed development emergency engines. The modelled predicted concentrations are below the relevant standards at all the existing receptor locations for the operation stages.

8.14.12 It is considered that the operation of the proposed development emergency generators would result in an imperceptible effect on air quality and identified receptor that is Not Significant in terms of EIA.

Cumulative Effects

8.14.13 Demolition and construction stages of approved cumulative schemes within 350 m of the proposed development are not expected to combine with the demolition and construction stage of the proposed development. Significant cumulative effects are unlikely to occur as each scheme is anticipated to employ similar dust mitigation techniques such that the individual construction stage effects are not significant, alone or in combination.

8.14.14 The cumulative for emergency only emission points from other data centres which would only operate under exceptional circumstances (except for testing purposes) and therefore would not be expected to be in operation on a day-to-day basis. i.e. Not Significant in terms of EIA.

8.14.15 Overall, no significant long term cumulative effects on air quality are anticipated as a result of the operation of the proposed development.

APPENDIX 2
AVIATION WILDLIFE IMPACT ASSESSMENT REPORT

Intended for
Vantage Data Centers DUB11 Limited

Date
October 2022

Date
1620014388

VANTAGE DATA CENTERS
DUB-13 AVIATION WILDLIFE IMPACT

RAMBOLL Bright ideas. Sustainable change.

Confidential

VANTAGE DATA CENTERS
DUB-13 AVIATION WILDLIFE IMPACT ASSESSMENT

Project no.	**1620014388**
Document type	**Technical Note**
Version	**1.0**
Date	**2022/10/05**
Prepared by	**DOLIVE**
Checked by	**MBEAG**
Approved by	**CMCEK**

Ramboll
240 Blackfriars Road
London
SE1 8NW
United Kingdom

T +44 20 7631 5291
https://uk.ramboll.com

Ramboll UK Limited
Registered in England & Wales
Company No: 03659970
Registered office:
240 Blackfriars Road
London
SE1 8NW

CONTENTS

1. BACKGROUND

1.1 Site Location

The site is located at Irish grid reference O 03687 30780, within Profile Park, as presented in Figure 1.1

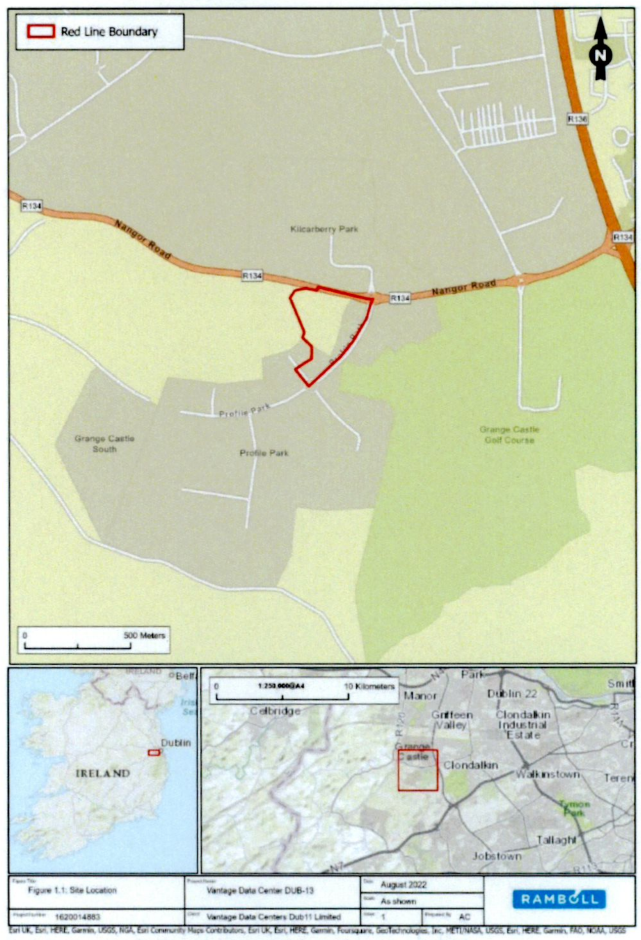

Figure 1.1: Site Location Plan

1.2 Site Description

The site boundaries are defined by:

- New Nangor Road (R134) to the north;
- Falcon Avenue, Equinix and Grange Castle Golf Club to the east;
- Falcon Avenue to the south; and
- The consented Vantage data centre development (planning reference SD21A/0241) to the west, currently agricultural fields.

The site is a triangular parcel of agricultural land, with a residential dwelling located in the north-west corner of the site, and an area of hardstanding within the south-west of the site. The site covers a total area of 3.31 ha and lies at an elevation between approximately 74 and 75 m Above Ordnance Datum (m AOD).

The existing Baldonnel steam flows through the south of the site, orientated in a south-east to north-west direction, and entering in the south-east and flowing west.

The site can currently be accessed from three access points, two from the north off New Nangor Road (R134), and one from Falcon Avenue on the eastern border, which leads to a roundabout on the R134 New Nangor Road.

Representative photographs of the site are shown in Figure 1.2.

Figure 1-2: Representative Photographs of the Site (left upper image looking north-west across the site, left lower image looking south-west across the site, right upper image looking north-east across the site, and right lower image looking south-east at the residential dwelling on site)

This proposed development is located approximately 1.6km to the north of Runway 29 at Baldonnel (Casement) Aerodrome.

1.3 Legislation

Airports are bound by the United Nations International Convention on Civil Aviation standards and recommended practices enacted under the International Civil Aviation Organisation (ICAO), Annex 14. Chapter 9.5.4 requires airports to protect flights from the risks posed by wildlife hazards with guidance provided to enable these actions under national law.

The requirements provide for any development within the vicinity of an airport (guided as a 13km radius from an aerodrome reference point), that has the potential to attract hazardous birds

(birds that have the possibility of causing damage to aircraft) to be reviewed and the risks eliminated or reduced to as low as reasonably practicable.

1.4 General risks to Aircraft

As bird strikes are not an uncommon occurrence, most aircraft have design parameters that include airframe and engine testing in relation to different size individual and flocks of birds.

As a military aerodrome that supports private aviation, Baldonnel aerodrome is used by aircraft that are generally more susceptible to damage from birds and other wildlife than civil airliners.

Developments that attract birds that have the potential to cause damage require consideration in relation to any increase in risk that may occur.

1.5 Development Risk

The wetland ponds, building roof and planting palette all present potential attractants to hazardous wildlife. There are similar sized ponds with islands that exist at similar distances to the airfield at present. These include waterbodies within the City West Hotel Golf club and Grange Castle Golf Club as well as at Kilmatead and on the south side of Greenogue Business Park. A small burn also runs around the west side of the airfield (the Griffeen River) and is identified on flood drawings as part of the development plans.

The proposals for the Data Center include landscaping for tree/shrub habitats thathas the potential to attract species of birds that will be hazardous to aviation. The habitat must be reviewed within the context of the existing background populations of hazardous birds and habitats within the area in order to determine any changes to risk.

The roof of the development may offer opportunities for nesting birds (e.g. Herring (*Larus argentatus*) or Lesser Black-backed (*Larus fuscus*) gulls) that could pose a threat to air safety. Other species that may potentially be attracted and are considered a hazard to aviation include arboreal birds such as Crows and other corvids (Corvidae) and Wood Pigeons (*Columba palumbus*) that may be attracted to the planting regime along with common waterbirds such as Mallard (*Anas platyrhncos*), feral geese (Branta/Anser spp), Mute Swan (*Cygnus olor*) and potentially fish eating birds such as Grey Heron (*Ardea cineria*) to the waterbodies. The probability of these residing at levels different to the existing background populations, however, will vary. There are densities of existing trees both currently at the development site and within the surrounding area that indicate that the proposed planting scheme will not affect background levels and will not, therefore constitute an increase in risk.

The planting regime does not require modification as it matches existing background habitats. At this distance from the airport, however, the species planted, is targeted to have no more than 15% berry or fruit bearing trees or bushes as these may attract larger numbers of arboreal species.

The rooftop is proposed within an area with several industrial estates present and is thus unlikely to add significantly to any attractant that already exists. It remains prudent to have a bird hazard management plan attached to the building that prevents roof nesting gulls from establishing. This would require access to the roof to enable checks and / or dispersal / nest removal to be undertaken under licence. If annual checks in April occur and do not identify nesting gull presence, no further action would be required. As gulls have been known to cause roof damage it would be practical to have such a condition in place anyway in order to prevent any potential for roof damage that could result in water ingress to such a building. A simple annual check and subsequent licensed removal or prevention to stop nesting would be all that would be required.

The water retention ponds (designed to provide soakaway and reduce flooding but not to hold permanent water), are likely to result in less overall open water and for shorter periods of time than water corridors that already exist and local natural flooding areas would produce. As such, water retention ponds are unlikely to result in any increase in hazardous waterbird presence and do not require design modifications.

The proposed permanent waterbodies are not large enough to provide a site for a nocturnal gull roost, and, with overhead trees and planting is unlikely to be an attractant to gulls for bathing or resting during the day. Given that the site is designed for nature conservation and does not feature feeding opportunities, there will be little additional attraction to gulls or other scavenging birds that may be of concern to the airport. Some attraction may occur to species such as Grey Heron that may visit the site to hunt fish or amphibians that may be introduced or would naturally colonise the water. It is unlikely, however, that the site would increase the numbers of Grey Herons in the area as any birds that may visit such a site would be most likely to be related to birds that already occur in the area and utilise existing water corridors and ponds. Reducing the ability of such birds to use the waterbody would be beneficial.

The proposed ponds do not have islands. This significantly reduces the potential for nesting opportunities for larger hazardous waterfowl including Mallard, feral geese or Mute Swans. The presence of such birds can result in a significant issue for flight safety.

1.6 Management options

In order to minimise the risk of large hazardous waterfowl, all large islands shall be removed entirely. Doing so removes the security provided by being surrounded by water and discourages the use of the site by such species. e.g. feral geese and mute swan.

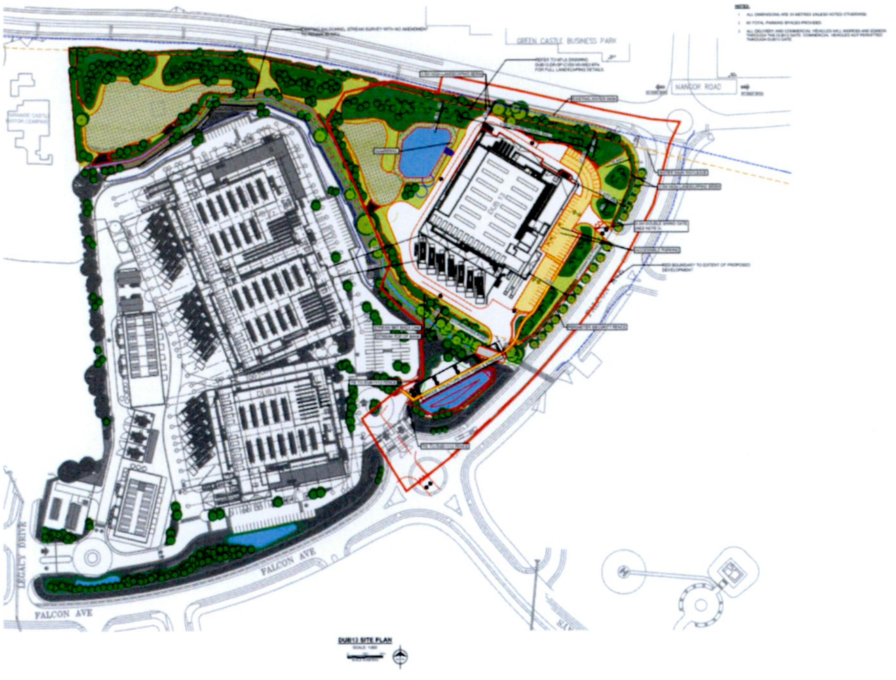

Figure 1.3: Site Layout Plan

Further reductions in the risk from other hazardous birds that may be attracted would include steepening the sides of the embankments and reducing any short vegetation adjoining the margins. Planting a barrier along the shoreline with, for example, shrubs and brambles will enhance the biodiversity of the site for non-hazardous species whilst reducing the presence of hazardous birds on a pond this small.

Similarly, the planting of a wide barrier of tall marginal vegetation such as Reedmace (*Typha latifolia*) will reduce the surface area of the water that acts as an attractant, prevent any potential 'feeding of the ducks', and again provide an enhanced habitat for small birds whilst reducing the ability of more hazardous birds to enter or exit the water.

1.7 Construction Phase

Any development that involves disruption of the ground has the potential to attract scavenging species particularly small gulls (e.g. *Chroicocephalus ridibundus*) and corvids (e.g. *Corvus frugilegus*). Any significant presence of these birds over and above that which would otherwise be present may present a significant flight safety risk should birds transit over or through the critical airspace. A construction phase bird hazard management plan (BHMP) would be put in place to ensure that, when the development is being constructed, no significant numbers of hazardous birds are allowed to forage on the site.

The contractor would ensure that enabling works occur in sections (cut/fill), reducing the area of land exposed (which may attract flocks of foraging birds) at any given time. The presence of humans and loud machinery on site is also likely to deter large flocks. The creation of any habitat likely to attract foraging birds will be small in area and temporary.

Whilst this is unlikely to require any action, a BHMP that requires the developer to disperse any increased presence of scavenging birds should be initiated. As such a site at this distance from the airport a suggested dispersal action, for example, would occur whenever more than 20 gulls, corvids or Starlings attempted to use areas where ground works or other activities on site resulted in their presence. The objective should be to ensure that all such birds are dispersed off-site within 30 minutes of their detection. If necessary, the developer should equip and train staff in the use of a small starter pistol and instruct staff to record a log of any actions taken. A range of techniques may be used, including but not limited to, human presence, arm waving, flags, or acoustic noises.

1.8 Summary

The development plans predominantly match the existing environment and do not present a significant probability of increasing hazardous bird presence and thus increasing risk to aircraft operating out of Baldonnel Aerodrome.

Never the less, it is recommended that a bird hazard management plan is provided to reduce the presence of any hazardous birds that arrive during the construction phase of the development. Similarly, the planting palette used for landscaping shall not exceed 15% berry bearing bushes and the permanent wetland should be modified to remove the islands and to enhance biodiversity whilst reducing hazardous bird access to the site.
Where this cannot be delivered, a longer term BHMP that aims to disturb and prevent hazardous waterfowl nesting at the site may be beneficial. This may also include a plan to prevent gulls from nesting on the rooftop of the site should it be suitable for such species to breed.

APPENDIX 3
PV GLINT AND GLARE ASSESSMENT REPORT

Aviation Glint and Glare Assessment

Profile Park DUB13 Solar Array

30/09/2022

Disclaimer

Neo Environmental Limited shall have no liability for any loss, damage, injury, claim, expense, cost or other consequence arising as a result of use or reliance upon any information contained in or omitted from this document.

Neo Environmental Ltd	
Head Office - Glasgow: Wright Business Centre, 1 Lonmay Road, Glasgow. G33 4EL T 0141 773 6262 E: info@neo-environmental.co.uk	
Warrington Office: Cinnamon House, Crab Lane, Warrington, WA2 0XP. T: 01925 661 716 E: info@neo-environmental.co.uk	**Rugby Office:** Valiant Suites, Lumonics House, Valley Drive, Swift Valley, Rugby, Warwickshire, CV21 1TQ. T: 01788 297012 E: info@neo-environmental.co.uk
Ireland Office: Johnstown Business Centre, Johnstown House, Naas, Co. Kildare. T: 00 353 (0)45 844250 E: info@neo-environmental.ie	**Northern Ireland Office:** 83-85 Bridge Street Ballymena, Co. Antrim BT43 5EN T: 0282 565 04 13 E: info@neo-environmental.co.uk

ENVIRONMENTAL

Prepared For:

Ramboll

Prepared By:

David Thomson BSc (Hons) MSc

Tom Saddington BEng, MSc.

Michael McGhee TechIOA BSc

	Name	Date
Edited By:	Tom Saddington	30/09/2022
Checked By:	Michael McGhee	30/09/2022
	Name	**Signature**
Approved By	Paul Neary	

Contents

1. EXECUTIVE SUMMARY

1.1. There is no guidance or policy available across Ireland in relation to the assessment of glint and glare from Proposed Development. However, as identified by UK policy, it is recognised as a potential impact which needs to be considered for a proposed solar development.

1.2. A 30km study area is chosen for receptors. Four aviation assets are located within 30km of the Proposed Development: Casement Baldonnel Aerodrome, Weston Airport, Dublin Airport and Gowran Grange Airfield. Only Casement Baldonnel Aerodrome, Weston Airport and Dublin Airport required a detailed assessment due to the Proposed Development falling within their respective safeguarding buffer zones outlined in **paragraph 4.21**.

1.3. Geometric analysis was conducted for 12 runway approach paths and four Air Traffic Control Tower's (ATCT) at Casement Baldonnel Aerodrome, Weston Airport and Dublin Airport.

1.4. The assessment concludes that:

- Casement Baldonnel Aerodrome: Green glare (Low potential for after-image) was predicted to impact upon the Runway 10 approach path, which is an **acceptable impact** according to the FAA guidelines for the runways and can be deemed **Not Significant**. No glare was predicted to impact upon the Runway 04, 22 and 28 approach paths or the air traffic control tower.
- Weston Airport: No glare was predicted to impact upon the Runway 07 and 25 approach paths or the air traffic control tower. Therefore, the impact is **None**.
- Dublin Airport: No glare was predicted to impact upon the Runway 10R, 28L, 10L, 28R, 16 and 34 approach paths or the air traffic control towers. Therefore, the impact is **None**.
- Overall impacts on aviation receptors are **acceptable and Not Significant**.

2. INTRODUCTION

BACKGROUND

2.1. Neo Environmental Ltd has been appointed by Ramboll (the "Applicant") to undertake a Glint and Glare Assessment for a proposed solar array development (the "Proposed Development") on the roof of the proposed DUB13 building in Profile Park, approximately 11km west of Dublin City Centre (the "Application Site").

2.2. Please see **Figure 1: Appendix A** for the roof layout of the Proposed Development.

DEVELOPMENT DESCRIPTION

2.3. The Proposed Development comprises of approximately 120m^2 of roof mounted solar array being installed on the roof of the proposed DUB13.

SCOPE OF REPORT

2.4. Although there may be small amounts of glint and glare from the metal structures associated with the solar array, the main source of glint and glare will be from the panels themselves and this will be the focus of this assessment.

2.5. Solar panels are designed to absorb as much light as possible and not to reflect it. However, glint can be produced as a reflection of the sun from the surface of the solar PV panel. This can also be described as a momentary flash. This may be an issue due to visual impact and viewer distraction on ground-based receptors and on aviation.

2.6. Glare is significantly less intense in comparison to glint and can be described as a continuous source of bright light, relative to diffused lighting. This is not a direct reflection of the sun, but a reflection of the sky around the sun.

2.7. This report will concentrate on the impacts of glint and glare and their effects on aviation assets and will be supported with the following Appendices:

- Appendix A: Figures

  – Figure 1: Layout Plan

  – Figure 2: Roof Elevations

- Figure 3: Casement Baldonnel Aerodrome Chart
- Figure 4: Weston Aerodrome Chart
- Figure 5: Dublin Aerodrome Chart

- Appendix B: Aviation Receptor Glare Results
- Appendix C: Solar Module Glare and Technical Memo[1]

STATEMENT OF AUTHORITY

2.8. This Glint and Glare Assessment has been produced by David Thomson, Tom Saddington and Michael McGhee of Neo Environmental. Having completed a civil engineering degree in 2012, Michael has produced Glint and Glare assessments for over 1GW of solar farm developments across the UK and Ireland. Tom has an undergraduate degree in Bioengineering and graduated with an MSc in Environmental and Energy Engineering in January 2020. He has been working on various technical assessments including glint and glare reports for numerous solar farms in Ireland and the UK. David has an undergraduate degree in physics, as well as a MSc in sensor design and a MSc in nanoscience. He is an Environmental Engineer currently being trained in Glint and Glare assessments.

DEFINITIONS

2.9. This study examined the potential hazard and nuisance effects of glint and glare in relation to aviation-based receptors. The Federal Aviation Guidance (FAA) in their "*Technical Guidance for Evaluating Selected Solar Technologies on Airports*"[2] have defined the terms 'Glint' and 'Glare' as meaning;

- Glint – "*A momentary flash of bright light*"
- Glare – "*A continuous source of bright light*"

2.10. Glint and glare are essentially the unwanted reflection of sunlight from reflective surfaces. This study used a multi-step process of elimination to determine which receptors had the potential to experience the effects of glint and glare. It then examined, using a computer-generated

---

[1] Sunpower Corporation (September 2009), T09014 Solar Module Glare and Reflectance Technical Memo

[2] Harris, Miller, Miller & Hanson Inc. (November 2010). Technical Guidance for Evaluating Selected Solar Technologies on Airports; 3.1.2 Reflectivity. Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at:

https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide.pdf geometric model, the times of the year and the times of the day such effects could occur. This is based on the relative angles between the sun, the panels, and the receptor throughout the year.

Time Zones / Datum's

2.11. Locations in this report were given in Eastings and Northings using the 'OSNI 1952 Irish National Grid' grid reference system unless otherwise stated. Ireland uses Irish Standard Time (IST, UTC+01:00) in the summer months and Greenwich Mean Time (UTC+0) in the winter period. For the purposes of this report all time references were in GMT, however if reference was made to a time which falls within the IST then this was outlined in the report.

3. LEGISLATION AND GUIDANCE

PLANNING POLICY

3.1. The National Planning Framework (NPF) was adopted by the Irish Government on the 29th of May 2018. However, this policy document provides no current provision within the Irish Planning System for the requirement of Glint and Glare Assessments to support applications for the installation of ground mounted solar PV systems. It is therefore considered appropriate to defer to extant policy guidance within the UK planning system; the National Planning Policy Guidance (NPPG) on Renewable and Low Carbon Energy[3].

3.2. Paragraph 013 sets out planning considerations that relate to large scale ground-mounted solar PV farms. This determines that the deployment of large-scale solar farms can have a negative impact on the rural environment, particularly in undulating landscapes. However, the visual impact of a well-planned and well-screened solar farm can be properly addressed within the landscape if planned sensitively. Considerations to be taken into account by local planning authorities are;

- *"the proposal's visual impact, the effect on landscape of glint and glare and on neighbouring uses and aircraft safety;*
- *the extent to which there may be additional impacts if solar arrays follow the daily movement of the sun."*

INTERIM CAA GUIDANCE – SOLAR PHOTOVOLTAIC SYSTEMS (2010)

3.3. There is little guidance on the assessment of glint and glare from solar farms with regards to aviation safety. The Civil Aviation Authority (CAA) has published interim guidance on 'Solar Photovoltaic Systems[4]', they also intend to undertake a review of the potential impacts of solar PV developments upon aviation, however this is yet to be published.

---

[3] NPPG Renewable and Low Carbon Energy. Available at:
http://planningguidance.communities.gov.uk/blog/guidance/renewable-and-low-carbon-energy/particular-planning-considerations-for-hydropower-active-solar-technology-solar-farms-and-wind-turbines/#paragraph_012

[4] *CAA (2010) Interim CAA Guidance – Solar Photovoltaic Systems. Available at:
https://publicapps.caa.co.uk/modalapplication.aspx?catid=1&appid=11&mode=detail&id=4370*

3.4. The interim guidance identifies the key safety issues with regards to aviation, including *"glare, dazzling pilots leading them to confuse reflections with aeronautical lights."* It is outlined that solar farm developers should be aware of the requirements to comply with the Air Navigation Order (ANO), published in 2016 and amended in 2022. In particular, developers should be cognisant of the following articles of the ANO[5], including:

- ***Article 240*** *– Endangering safety of an aircraft – "A person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft."*

- ***Article 224*** *- Lights liable to endanger – "A person must not exhibit in the United Kingdom any light which:*

– *a) by reason of its glare is liable to endanger aircraft taking off or from landing at an aerodrome; or*

– *b) by reason of its liability to be mistaken for an aeronautical ground light liable to endanger aircraft"*

- ***Article 225*** *– Lights which dazzle or distract – "A person must not in the United Kingdom direct or shine any light at any aircraft in flight so as to dazzle or distract the pilot of the aircraft."*

3.5. Relevant studies generally agree that there is potential for glint and glare from photovoltaic panels to cause a hazard or nuisance for surrounding receptors, but that the intensity of such reflections is similar to that emanating from still water. This is considerably lower than for other manmade materials such as glass, steel or white concrete (SunPower – 2009).

3.6. These Articles are considered within the assessment of glint and glare of the Proposed Development.

CAA – CAP738: Safeguarding of Aerodromes 3rd Edition[6]

3.7. In 2003 the CAA first introduced the CAP738 document to help provide advice and guidance to ensure aerodrome safeguarding. Subsequently, there have been two updates to this document in 2006 and 2020.

3.8. Within the latest edition of CAP738, it outlines that the purpose of the document is to protect an aerodrome and to ensure safe operation. Specifically stating:

[5] CAA (2016) Air Navigation: The Order and Regulations. Available at: https://www.caa.co.uk/media/1a2cigrq/air-navigation-order-2016-amended-april-2022-version.pdf

[6] Civil Avaition Authority (2020). CAP738 – Safeguarding of Aerodromes 3rd Edition. Available at: https://publicapps.caa.co.uk/docs/33/CAP738%20Issue%203.pdf

"Its purpose is to protect:

Aircraft from the risk of glint and glare e.g. solar panels."

3.9. Within the section named as "Appendix C – Solar Photovoltaic Cells", the following is stated:

"Policy

1. In 2010 the CAA published interim guidance on Solar Photovoltaic Cells (SPCs). At that time, it was agreed that we would review our policy based on research carried out by the Federal Aviation Authorities (FAA) in the United States, in addition to reviewing guidance issued by other National Aviation Authorities. New information and field experience, particularly with respect to compatibility and glare, has resulted in the FAA reviewing its original document 'Technical Guidance for Evaluating Selected Solar Technologies on Airports', which is likely to be subject to change, see link; https://www.federalregister.gov/documents/2013/10/23/2013-24729/interimpolicy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports

2. In the United Kingdom there has been a further increase in SPV cells, including some located close to aerodrome boundaries; to date the CAA has not received any detrimental comments or issues of glare at these established sites. Whilst this early indication is encouraging, those responsible for safeguarding should remain vigilant to the possibility."

3.10. The above is stating that to date, there has not been any complications on airfields due to glare originating from solar farms across the UK.

US FEDERAL AVIATION ADMINISTRATION POLICY

3.11. The US Federal Aviation Administration (FAA) in their Solar Guide (Federal Aviation Authority, 2010)[7] incorporates a chapter on the impact and assessment of glint from solar panels. It concludes that (although subject to revision):

"...evidence suggests that either significant glare is not occurring during times of operation or if glare is occurring, it is not a negative effect and is a minor part of the landscape to which pilots and tower personnel are exposed."

3.12. The interim policy (Federal Register, 2013)[8] demands that an ocular impact assessment must be assessed at 1-minute intervals from when the sun rises above the horizon until the sun sets below the horizon. Specifically, the developer must use the 'Solar Glare Hazard Analysis Tool'

[7] FAA (2010), Technical Guidance for Evaluating Selected Solar Technologies on Airports. Available at https://www.faa.gov/airports/environmental/policy_guidance/media/airport-solar-guide-print.pdf

[8] FAA (2013), Interim Policy, *FAA Review of Solar Energy System Projects on Federally Obligated Airports*. Available at https://www.federalregister.gov/documents/2013/10/23/2013-24729/interim-policy-faa-review-of-solar-energy-system-projects-on-federally-obligated-airports

(SGHAT) tool specifically and reference its results as this was developed by the FAA and Sandia National Laboratories as a standard and approved methodology for assessing potential impacts on aviation interests, although it notes other assessment methods may be considered. The SGHAT tool has since been licensed to a private organisation who were also involved in its development and it is the software model used in this assessment.

3.13. Crucially, the policy provides a quantitative threshold which is lacking in the English guidance. This outlines that a solar development will not automatically receive an objection on glint grounds if low intensity glint is visible to pilots on final approach. In other words, low intensity glint with a low potential to form a temporary after-image (Green Glare) would be considered acceptable under US guidance. Due to the lack of legislation and guidance within England, this US document has been utilised as guidance for this report.

3.14. The FAA guidance states that for a solar PV development to obtain FAA approval or to receive no objection, the following two criteria must be met:

- No potential for glint or glare in the existing or planned Air Traffic Control Tower (ATCT); and
- No potential for glare (glint) or "low potential for after-image" (Green Glare) along the final approach path for any existing or future runway landing thresholds (including planned or interim phases), as shown by the approved layout plan (ALP). The final approach path is defined as 2 miles from 50 feet above the landing threshold using a standard 3-degree glide path.

3.15. The geometric analysis included later in this report, which defines the extent and time at which glint may occur, is required by the FAA as the methodology to be used when assessing glint and glare impacts on aviation receptors. This report follows the methodology required by the FAA as it offers the most robust assessment method currently available.

FAA Policy: Review of Solar Energy Systems Projects on Federally - Obligated Airports[9]

3.16. The FAA updated their Interim Policy from 2013 as part of their commitment to "*update policies and procedures as part of an iterative process as new information and technologies become available.*" The main development regarding Glint and Glare since the Interim Policy is the following:

[9] FAA (2021). FAA Policy: Review of Solar Energy Systems Projects on Federally – Obligated Airports. Available at: https://www.federalregister.gov/documents/2021/05/11/2021-09862/federal-aviation-administration-policy-review-of-solar-energy-system-projects-on-federally-obligated

"Initially, FAA believed that solar energy systems could introduce a novel glint and glare effect to pilots on final approach. FAA has subsequently concluded that in most cases, the glint and glare from solar energy systems to pilots on final approach is similar to glint and glare pilots routinely experience from water bodies, glass-façade buildings, parking lots, and similar features. However, FAA has continued to receive reports of potential glint and glare from on-airport solar energy systems on personnel working in ATCT cabs."

3.1. This is outlining that solar panels are similar to nuisances that are already caused by other existing infrastructure, such as; car parks, glass buildings and water bodies. Furthermore, the ATCT has been outlined as the key receptor to be assessed when determining Glint and Glare impacts from a solar farm.

Dublin City Development Plan

3.2. The Dublin City Development Plan 2016 – 2022[10] was adopted by Dublin City Council at a Special Council Meeting on 23rd September 2016. The plan came into effect on 21st October 2016.

3.3. The plan states the following in **Policy CC3**:

'It is the Policy of Dublin City Council:

To promote energy efficiency, energy conservation, and the increased use of renewable energy in existing and new developments.'

3.4. There are no policies contained within the CDP which are of relevance to this Glint and Glare Assessment.

3.5. Dublin City Council is reviewing the current Dublin City Development Plan 2016 – 2022 and preparing a new City Development Plan (the Plan)[11] up to 2028. The review is currently in stage 3 of the development plan making process. Public consultation for this stage concluded on 1st September 2022. After the consultation period, the Chief Executive will prepare a report on all submissions and observations received and submit the report to the Elected Members by 29th September for their consideration. The Elected Members will make the Dublin City Development Plan 2022 – 2028 with or without amendment at the end of October (date to be confirmed).

3.6. The plan states the following in **Policy CA10**:

'It is the Policy of Dublin City Council:

To support the production of energy from renewable sources, such as from solar energy, hydro energy, wave/tidal energy, geothermal, wind energy, combined heat and power (CHP), heat

---

[10] Dublin City Development Plan 2016 – 2022. Available at: https://www.dublincity.ie/dublin-city-development-plan-2016-2022

[11] Dublin City Development Plan 2022 – 2028. Available at: https://www.dublincity.ie/residential/planning/strategic-planning/dublin-city-development-plan/development-plan-2022-2028

energy distribution such as district heating/cooling systems, and any other renewable energy sources, subject to normal planning and environmental considerations.'

3.7. The plan states the following in **Section 15.18.8 Solar Energy**:

3.8. 'Large scale proposals for solar panels or any development in the vicinity of the airport will be required to submit a Glint and Glare Assessment. Domestic applications will be assessed on a case by case basis. All large scale proposals involving for solar panels shall be sent to Irish Aviation Authority as part of the statutory consultee process.'

4. METHODOLOGY

4.1. A desk-based assessment was undertaken to identify when and where glint and glare may be visible at aviation receptors within the vicinity of the Proposed Development, throughout the day and the year.

SUN POSITION AND REFLECTION MODEL

Sun Data Model

4.2. The calculations in the solar position calculator are based on equations from Astronomical Algorithms[12]. The sunrise and sunset results are theoretically accurate to within a minute for locations between +/- 72° latitude, and within 10 minutes outside of those latitudes. However, due to variations in atmospheric composition, temperature, pressure, and conditions, observed values may vary from calculations.

Solar Reflection Model

4.3. The position of the sun is calculated at one-minute intervals of a typical year, in this instance the year assessed is 2022.

4.4. To determine if a reflection will reach a receptor, the following variables are required:

- Sun position;
- Observer location; and
- Tilt, orientation, and extent of the modules in the solar array.

4.5. The model assumes that the azimuth and horizontal angle of the sun is the same across the whole solar farm. This is considered acceptable due to the distance of the sun from the Proposed Development and the miniscule differences in location of the sun over the Proposed Development.

4.6. Once the position of the sun is known for each time interval, a vector reflection equation determines the reflected sun vector, based on the normal vector of the solar array panels. This assumes that the angle of reflection is equal to the angle of incidence reflected across a normal plane. In this instance, the plane being the vector which the solar panels are facing.

4.7. On knowing the vector of the solar reflection, the azimuth is calculated and the horizontal reflection from multiple points within the solar farm. These are then compared with the

[12] Jean Meeus, *Astronomical Algorithms* (Second Edition), 1999

azimuth and horizontal angle of the receptor from the solar farm to determine if it is within range to receive solar reflections.

4.8. The solar reflection in the model is considered to be specular as a worst-case scenario. In practice, the light from the sun will not be fully reflected as solar panels are designed to absorb light rather than reflect it. The previous text and **Appendix C** outline the reflective properties of solar glass and compares it to other reflective surfaces. Although the exact figures in this report are not conclusive, it is included as a visual guide and it agrees with most other reports, in that solar glass has less reflective properties than other types of glass and that the amount of reflective energy decreases as the angle of incidence decreases.

4.9. Most modern panels have a slight surface texture which should have a small effect on diffusing the solar radiation further; although, this has not been modelled to conform with the worst-case scenario assessment.

4.10. The panel reflectivity has been modelled to assume an anti-reflective coating (ARC) which is the industry standard for photo-voltaic panels and further reduces the reflective properties of the PV panels.

Determination of Ocular Impact

4.11. The software used for this assessment is based on the Sandia Laboratories Solar Glare Hazard Analysis Tool (SGHAT). This tool is specifically mentioned in the FAA guidance as the software which should be used in this type of assessment.

4.12. Determination of the ocular impact requires knowledge of the direct normal irradiance, PV module reflectance, size and orientation of the array, optical properties of the PV module, and ocular parameters. These values are used to determine the retinal irradiance and subtended source angle used in the ocular hazard plot.

4.13. The ocular impact[13] of viewed glare can be classified into three levels based on the retinal irradiance and subtended source angle: low potential for after-image (green), potential for after-image (yellow), and potential for permanent eye damage (red).

4.14. Green glare can be ignored when looking at ground based and some aviation receptors. Green glare does not cause temporary flash blindness and happens at an instant with very slight disturbance. As per FAA guidelines mitigation is only required for green glare when affecting an Air Traffic Control Tower, but not for when affecting pilots. Therefore, it can be assumed that green glare is acceptable for ground-based receptors.

[13] Ho, C.K., C.M. Ghanbari, and R.B. Diver, 2011, Methodology to Assess Potential Glint and Glare Hazards From Concentrating Solar Power Plants: Analytical Models and Experimental Validation, Journal of Solar Energy Engineering-Transactions of the Asme, 133(3).

4.15. The subtended source angle represents the size of the glare viewed by an observer, while the retinal irradiance determines the amount of energy impacting the retina of the observer. Larger source angles can result in glare of high intensity, even if the retinal irradiance is low.

4.16. The modelling software outputs a hazard plot for each receptor predicted to be impacted by glare from the photovoltaic (PV) array. An orange dot is plotted for each minute of glare indicating the irradiance (power density) of the reflected solar light. A yellow dot is plotted to show the irradiance of the Sun when it is viewed directly. The hazard plot shows that the irradiance of the Sun is approximately three orders of magnitude greater than the reflected irradiance, i.e., the power density of solar reflections from photovoltaic panels are approximately 0.1% that of viewing the Sun. Due to the disparity in irradiance, whenever the Sun is observed in the same frame as solar reflections from a PV array, the Sun will be main source of glare impacts upon the observer. In such a case, the impact is deemed to be **Low** as a worst-case scenario.

Relevant Parameters of the Proposed Development

4.17. The photovoltaic (PV) panels are oriented in a direction to align with the structures on the roof and will remain in a fixed position throughout the day and during the year (i.e. they will not rotate to track the movement of the sun). The panels will be installed on the roof and will be inclined at an angle of 10 degrees.

4.18. The height of each building has been used and can be seen in **Figure 2: Appendix A**.

IDENTIFICATION OF RECEPTORS

Aviation

4.19. Glint is only considered to be an issue with regards to aviation safety when the solar development lies within proximity to a runway, particularly when the aircraft is descending to land. En-route activities are not considered an issue as the flight will most likely be at a higher altitude than the solar reflection.

4.20. Should a solar development be proposed within the safeguarded zone of an aerodrome, a full geometric study may be required (depending on the orientation from the Proposed Development) which would determine if there is potential for glint and glare at key locations, most likely on the descent to land.

4.21. Buffer zones to identify aviation assets vary depending on the safeguarding criteria of that asset. All aerodromes within 30km will be identified, however generally the detailed assessments are only required within: 20km for large international aerodromes, 10km for military aerodromes and 5km for small aerodromes.

MAGNITUDE OF IMPACT

Moving Receptors (Aviation)

Approach Paths

4.22. Each final approach path which has the potential to receive glint is assessed using the Solar Glare Hazard Analysis Tool (SGHAT) model. The model assumes an approach bearing on the runway centreline, a 3-degree glide path with the origin 50ft (15.24m) above the runway threshold.

4.23. The computer model considers the pilots field of view. The azimuthal field of view ("AFOV") or horizontal field of view ("HFOV") as it is sometimes referred, refers to the extents of the pilot's horizontal field of view measured in degrees left and right from directly in front of the cockpit. The vertical field of view ("VFOV") refers to the extents of the pilot's vertical field of view measured in degrees from directly in front of the cockpit. The HFOV is modelled at 50 degrees left and right from the front of the cockpit whilst the VFOV is modelled at 30 degrees.

4.24. The FAA guidance states that there should be no potential for glare or "low potential for after-image" at any existing or future planned runway landing thresholds in order for the proposed Development to be acceptable.

Air Traffic Control Tower (ATCT)

4.25. An air traffic controller uses the visual control room to monitor and direct aircraft on the ground, approaching and departing the aerodrome. It is essential that air traffic controllers have a clear and unobstructed view of aviation activity. The key areas on an aerodrome are the views towards the runway thresholds, taxiways, and aircraft bays.

4.26. The FAA guidance states that no solar reflection towards the ATCT should be produced by a proposed solar development, however this should be assessed on a site by site basis and will depend on the operations at a particular aerodrome.

4.27. In order to determine the impact on the ATCT, the location and height of the tower will need to be fed into the SGHAT model and where there is a potential for 'low potential for After-Image' or more, then mitigation measures will be required.

ASSESSMENT LIMITATIONS

4.28. Below is a list of assumptions and limitations of the model and methods used within this report:

- The model does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc;
- The model does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results;
- Due to variations in atmospheric composition, temperature, pressure and conditions, observed values may vary slightly from calculated positions; and
- The model does not account for the effects of diffraction; however, buffers are applied as a factor of safety.
- The model assumes clear skies at all times and does not account for meteorological effects such as cloud cover, fog, or any other weather event which may screen the sun.

4.29. Due to these assumptions and limitations the model overestimates the number of minutes of glint and glare which are possible at each receptor and presents the worst-case scenario. Where glint and glare are predicted a visibility assessment is carried out to determine a more accurate, real-world prediction of the impacts.

5. BASELINE CONDITIONS

Aviation Receptors

5.1. Aerodromes within 30km of the proposed solar development can be found in **Table 5 - 1**.

Table 5 - 1: Airfields within 30km of the Proposed Development

Airfield	Distance (km)	Use
Casement Baldonnel Aerodrome	1.17km	Military
Weston Airport	4.83km	Licensed airport
Dublin Airport	15.34km	Licensed airport
Gowran Grange Airfield	19.87km	Small grass strip

5.2. The Proposed Development is located within the safeguarding buffer zones of three aviation assets. Only Casement Baldonnel Aerodrome, Weston Airport and Dublin Airport will require a detailed assessment.

5.3. As the Proposed Development does not fall within the safeguarding buffer zones of the other aviation receptor, there is no need for a detailed assessment. This is in accordance with what was outlined in the methodology chapter above.

Casement Aerodrome

5.4. Casement Aerodrome (ICAO code EIME) is designated as an IFR/VFR Military Aerodrome. It is located approximately 6.5NM (12km) west of Dublin.

5.5. The elevation of the aerodrome at the Aerodrome Reference Point (ARP) is 319ft (97.2m). It has two asphalt strip runways, details of which are given in **Table 5 - 2**.

Table 5 - 2: Runways at Casement Aerodrome

Runway Designation	True Bearing (°)	Length (m)	Width (m)
04	044	1463	45
22	224	1463	45
10	105	1829	45
28	285	1829	45

5.6. The threshold location and height of the runway at Casement Aerodrome are given in **Table 5 - 3**.

Table 5 - 3: Runway Threshold Locations and Heights

Runway Designation	Threshold Latitude	Threshold Longitude	Height AOD (m)
04	53° 17′ 62″ N	006° 27′ 25″ W	97.2
22	53° 18′ 20″ N	006° 26′ 37″ W	92.9
10	53° 18′ 27″ N	006° 28′ 13″ W	86.5
28	53° 18′ 05″ N	006° 26′ 53″ W	95.7

5.7. The ARP is located north of the midpoint of Runway 10/28. The actual location of the ARP and the ATCT is given in **Table 5 - 4**. The height of the ATCT is estimated to be 10m based off a Google Image search.

Table 5 - 4: Casement Aerodrome Reference Point

	Latitude	Longitude	Eastings	Northings
ARP	53° 17′ 59.56′′ N	006° 26′ 52.14′′ W	303526	228829
ATCT	53° 18′ 19.78′′ N	006° 26′ 30.43′′ W	303915	229460

Weston Airport

5.8. Weston Airport (ICAO code EIWT) is designated as a VFR only Aerodrome. It is located approximately 8NM (11.11 km) west of Dublin.

5.9. The elevation of the aerodrome at the Aerodrome Reference Point (ARP) is 155ft (47.24m). It has one bitumen/macadam strip runway, details of which are given in **Table 5 - 5**.

Table 5 - 5: Runways at Weston Airport

Runway Designation	True Bearing (°)	Length (m)	Width (m)
07	063	924	23
25	243	924	23

5.10. The threshold location and height of the runway at Weston Airport are given in **Table 5 - 6**.

Table 5 - 6: Runway Threshold Locations and Heights

Runway Designation	Threshold Latitude	Threshold Longitude	Height AOD (m)
07	53° 21′ 01.48″ N	006° 29′ 40.17″ W	47.24
25	53° 21′ 15.03″ N	006° 28′ 55.66″ W	46.33

5.11. The ARP is located 501m from the Runway 25 threshold. The actual location of the ARP and the ATCT is given in **Table 5 - 7**. The height of the ATCT is estimated to be 15m based off Google Earth images.

Table 5 - 7: Weston Airport Reference Point

	Latitude	Longitude	Eastings	Northings
ARP	53° 21′ 08.25′′ N	006° 29′ 17.92′′ W	300710	234595
ATCT	53° 35′ 55.98′′ N	006° 48′ 94.50′′ W	300615	234971

Dublin Airport

5.12. Dublin Airport (ICAO code EIDW) is designated as an IFR/VFR aerodrome. It is located approximately 5.4NM (10km) north of the city of Dublin.

5.13. The elevation of the aerodrome at the Aerodrome Reference Point (ARP) is 243ft (74.1m). It has three asphalt strip runways, details of which are given in **Table 5 - 8**.

Table 5 - 8: Runways at Dublin Airport

Runway Designation	True Bearing (°)	Length (m)	Width (m)
10R	095.24	2,637	45
28L	275.27	2,637	45
16	156.59	2,072	45
34	336.60	2,072	45
10L	095.25	3109	45
28R	275.28	3109	45

5.14. The threshold location and height of the runways at Dublin Airport are given in **Table 5 - 9**.

Table 5 - 9: Runway Threshold Locations and Heights

Runway Designation	Threshold Latitude	Threshold Longitude	Height AOD (m)
10R	53° 25′ 20.75″ N	006° 17′ 24.27″ W	73.76
28L	53° 25′ 12.94″ N	006° 15′ 02.08″ W	61.57
16	53° 26′ 13.16″ N	006° 15′ 43.12″ W	66.14
34	53° 25′ 11.66″ N	006° 14′ 58.54″ W	61.57
10L	53° 26′ 14.50″ N	006° 17′ 02.98″ W	73
28R	53° 25′ 11.66″ N	006° 14′ 58.54″ W	68

5.15. The ARP is located at the midpoint of Runway 10R/28L. The actual location of the ARP and the ATCT is given in **Table 5 - 10**. The height of the old ATCT is 22m and the height of the new ATCT is 86.9m.

Table 5 - 10: Dublin Airport Reference Point

	Latitude	Longitude	Eastings	Northings
ATCT (New)	53° 25′ 44″ N	006° 15′ 52″ W	315404	243465
ATCT	53° 25′ 42″ N	006° 15′ 43″ W	315550	243429
ARP	53° 25′ 17″ N	006° 16′ 12″ W	315002	242623

6. IMPACT ASSESSMENT

6.1. Following the methodology outlined earlier in this report, geometrical analysis comparing the azimuth and horizontal angle of the receptors from the Proposed Development and the solar reflection was conducted. Although this assessment did not consider obstructions such as intervening vegetation and buildings, discussion on the potentially impacted receptors is provided where necessary.

Aviation Receptors

6.2. **Table 6 - 1** shows a summary of the modelling results for each of the runway approach paths as well at the ATCT whilst the detailed results and ocular impact charts can be viewed in **Appendix B**.

Table 6 - 1: Summary of Glare Results

Component	Green Glare (mins)	Yellow Glare (mins)	Red Glare (mins)
Casement Baldonnel Aerodrome			
Runway 04	0	0	0
Runway 22	0	0	0
Runway 10	3472	0	0
Runway 28	0	0	0
ATCT	0	0	0
Weston Airport			
Runway 07	0	0	0
Runway 25	0	0	0
ATCT	0	0	0
Dublin Airport			
Runway 10L	0	0	0
Runway 10R	0	0	0
Runway 16	0	0	0
Runway 28L	0	0	0

Runway 28R	0	0	0
Runway 34	0	0	0
ATCT – New	0	0	0
ATCT – Old	0	0	0

6.3. As can be seen in **Table 6 - 1**, only green glare is expected to impact upon the Runway 10 approach path at Casement Baldonnel Aerodrome. Green glare is described as 'Low Potential for After Image' which is an **acceptable impact** when pilots are approaching runways/helipads, according to the FAA guidance. The impact on approach at this runway is therefore deemed as **Not Significant**.

6.4. **Table 6 - 1**shows that no glare is predicted to impact upon the Runway 04, 22 and 28 approach paths or the air traffic control tower at Casement Baldonnel Aerodrome. No glare is predicted to impact upon the Runway 07 and 25 approach paths or the air traffic control tower at Weston Airport. No glare is predicted to impact upon the Runway 10R, 28L, 10L, 28R, 16 and 34 approach paths or the air traffic control towers at Dublin Airport. Therefore, the impact upon these aviation assets is **None**.

7. SUMMARY

7.1. There is no guidance or policy available across Ireland in relation to the assessment of glint and glare from Proposed Development. However, as identified by UK policy, it is recognised as a potential impact which needs to be considered for a proposed solar development.

7.2. A 30km study area is chosen for receptors. Four aviation assets are located within 30km of the Proposed Development: Casement Baldonnel Aerodrome, Weston Airport, Dublin Airport and Gowran Grange Airfield. Only Casement Baldonnel Aerodrome, Weston Airport and Dublin Airport required a detailed assessment due to the Proposed Development falling within their respective safeguarding buffer zones outlined in **paragraph 4.21**.

7.3. Geometric analysis was conducted for 12 runway approach paths and four Air Traffic Control Tower's (ATCT) at Casement Baldonnel Aerodrome, Weston Airport and Dublin Airport.

7.4. The assessment concludes that:

- Casement Baldonnel Aerodrome: Green glare (Low potential for after-image) was predicted to impact upon the Runway 10 approach path, which is an **acceptable impact** according to the FAA guidelines for the runways and can be deemed **Not Significant**. No glare was predicted to impact upon the Runway 04, 22 and 28 approach paths or the air traffic control tower.
- Weston Airport: No glare was predicted to impact upon the Runway 07 and 25 approach paths or the air traffic control tower. Therefore, the impact is **None**.
- Dublin Airport: No glare was predicted to impact upon the Runway 10R, 28L, 10L, 28R, 16 and 34 approach paths or the air traffic control towers. Therefore, the impact is **None**.

7.5. Overall impacts on aviation receptors are **acceptable and Not Significant**.

8. APPENDICES

Appendix A: Figures

- Figure 1: Layout Plan
- Figure 2: Roof Elevations
- Figure 3: Casement Baldonnel Aerodrome Chart
- Figure 4: Weston Airport Aerodrome Chart
- Figure 5: Dublin Airport Aerodrome Chart

Appendix B: Aviation Receptor Glare Results

Appendix C: Solar Module Glare and Reflectance Technical Memo