Virtus Hayes Ltd.

VIRTUS LONDON 2 DATA CENTRE

Air Quality Assessment

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Virtus Hayes Ltd.

VIRTUS LONDON 2 DATA CENTRE

Air Quality Assessment

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1.1.2. The assessment demonstrates that ***no significant effects*** will result from the operation of the generators due to impacts on local air quality.

Table 1-1 – Report summary

EA Requirement	Location in Report	Pages
Requirements set out in: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment		
Describe the site setting	Section 5.1 Study Area and Site Setting Section 6.1 LBH Air Quality Review	14 18
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Characterise the emissions	Table 3-1 Appendix C	6 49
Model the effect of buildings and terrain	Building information set out in **Table 7-1**; Terrain not included (para 7.2.21).	30
Explain the background concentration	6.2 Background pollutant concentrations (Human Health) 6.3 Background pollutant concentrations (Ecology)	23 23
Use environmental standards for air	For human health: Table 4-1 – Relevant air quality standards Table 4-2 – AEGLs for nitrogen dioxide (µg/m3, with values in ppm given in brackets) For ecology Table 4-3 – Air quality critical levels used for the assessment of impacts on sensitive ecological receptors. Table 6-4	10 11 12 23
Impact on sensitive receptors	The indicative sensitive receptors used in the modelling are set out in **Table 5-1** and **Figure 2** in **Appendix B**.	14

EA Requirement	Location in Report	Pages
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NO_x to NO_2 conversion ratio	Atmospheric Chemistry	31
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Short term statistical analysis	Hypergeometric Function, para 7.3.3	32
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Explain your report	2.1 Project Background, 2.2 Scope 5.1 Study Area and Site Setting 3 Operational Scenarios	4 14 6
Include a location map	**Figure 1** in **Appendix B**.	
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EA Requirement	Location in Report	Pages
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Carry out impact assessment	Section 8 Human health Assessment results Section 9 Ecological assessment results	36 40
Include input files	Included as electronic files with submission	

2 INTRODUCTION

2.1 PROJECT BACKGROUND

2.1.1. WSP has been commissioned by Virtus Hayes Ltd (the 'Applicant') to carry out an air quality assessment in support of an application for a bespoke Environmental Permit for the site referred to as Hayes Campus, Western International Park, Hayes Road, Southall, UB2 5XX, hereafter referred to as the 'Site'.

2.1.2. The data centre at Hayes is connected to the local electricity transmission network via multiple grid connections. Given the nature of the data centre, and the requirement to have an available energy supply at all times, London 2 (LON2) is equipped with nine diesel-fired standby generators for low voltage generation. LON2 is operated independently but operates under a common management system and management structure as other Virtus Data Centres (DC) across North London. The Site is located wholly within the administrative area of the London Borough of Hounslow (LBH). The location of the Site and all nine generators are illustrated in **Figure 1** in **Appendix B**.

2.1.3. The generators will provide power to the Site in the event of an emergency situation; such as a failure of the electricity transmission network. During such events there is a potential for a delay between fault detection and initial operation of the back-up generators and the initial cover for loss of external power is provided by on-site battery arrays.

2.1.4. This document should be read in conjunction with the Environmental Permit Application[1] which contains full details of the Site's installation activities, the operating techniques and the engine emissions standards that will be implemented at the facility.

2.1.5. A glossary of terms included within this assessment and figures are provided in **Appendix A** and **Appendix B** respectively.

2.2 SCOPE

2.2.1. The scope of the air quality assessment is as follows:

- Dispersion modelling of the impact of the operation of the generators on local air quality (nitrogen oxide (NO_X), nitrogen dioxide (NO_2) and nitrogen deposition) at sensitive human and ecological receptor locations for the following scenarios:
  - Routine testing
  - A theoretical 72-hour outage scenario.

2.2.2. The modelling of impacts on particulate matter are scoped out of this assessment. Emissions of particulate matter from the diesel generators are typically two orders of magnitude lower than NO_x emissions at equivalent load. It can, therefore, readily be demonstrated that daily mean PM_{10} impacts from routine testing and emergency backup power generation will be negligible, and annual

[1] WSP (2022) *Virtus Hayes Ltd – Environmental Permit Application – Virtus London 2 Data Centre*. Glasgow: WSP UK Ltd.

mean impacts will be negligible. This is due in part to the low emissions and in part to the low operating hours in the year, and with only 3 days of emergency outage.

3 OPERATIONAL SCENARIOS

3.1 INSTALLED GENERATORS

3.1.1. Details of the nine generators installed on the Site are summarised in **Table 3-1**. The stated load during backup generation has been provided by the client and is based on the proposed IT Load at the DC at full capacity.

Table 3-1 – Summary of Installed Generators

Data Centre	Engine	No Installed	Capacity (kW) at 100% load	Emission Concentration at 100% (mg/Nm^3, @5% O_2, dry)	SCR Fitted	Load during backup generation
LON2	Mitsubishi S16R2-PTAW	8	2167	3900	No	100%
	MTU 16V4000G24F DS2500 TA-Luft optimized	1	1966	1603	No	100%

3.2 ASSESSMENT SCENARIOS

3.2.1. The operation of the generators will be limited to monthly testing and emergency situations. Consequently, the assessment of impacts presented in this report is based on the following operational scenarios:

- **Routine testing:**
  - **Virtus Test 1**: representative of a 15 minute “switch on” offload test; to be carried out on monthly basis in eleven months of the year. In reality this will be limited to approximately 5 minutes.
  - **Virtus Test 2:** representative of a full service onload test consisting of an initial 20 minutes at 100% load immediately followed by 120 minutes at 75% load; to be carried out once per year in the 12th month of the year.
- **Theoretical 72-hour Outage:**
  - **Virtus Emergency 2:** Theoretical complete mains electricity failure of 72 hours duration. In this scenario there is an initial period of 20-30 minutes where generators are required to run at 100% load, to recharge the UPS battery array before dropping to the actual building load required, designed to be around 60 - 100%. In the absence of available information it has been assumed that during this scenario, the generators will be required to run at 100% load throughout (as set out in **Table 3-1**).

3.2.2. Emergency scenario 2 is an Environment Agency specified scenario.

3.2.3. The operator calculated average annual operation emergency scenario assumed a power outage occurs once in every five or six years for 24 hours. This was based on Ofgem grid operator outage data and on-site outage worst case estimates. Generator operation was assumed to be required for an initial 20-minute start-up load and 220-minute subsequent stable operation. The Environment Agency's 72-hour outage is, therefore, highly conservative and should be considered a theoretical scenario only.

3.2.4. Aside from the routine monthly testing, none of the generators will be operated for any purpose other than to provide emergency back-up power generation. Virtus currently has a 100% uptime record which emphasises that the likelihood of occurrence of the theoretical 72-hour outage is very small, particularly since the incoming power system has been designed in such a way so as to ensure that only the most major power interruption event would trigger the need for the generators.

3.2.5. Furthermore, it has been assumed that planning restrictions have been placed on the Applicant that forbid the operation of the generators for testing and maintenance purpose during peak traffic periods e.g. between 16:00 to 19:00. Nor is the simultaneous testing of two or more generator sets permitted.

4 LEGISLATION, POLICY AND GUIDANCE

4.1 AIR QUALITY LEGISLATION AND POLICY

4.1.1. A summary of the air quality legislation and policy relevant to this assessment is provided below.

ENVIRONMENT ACT

4.1.2. Part IV of the Environment Act 1995[2] (as amended) required the Secretary of State to publish a national Air Quality Strategy[3,4] and set up a system of Local Air Quality Management (LAQM). An amendment, the Environment Act 2021[5], was subsequently enshrined into law in November 2021. Schedule 11 of this Act makes it clear that it remains a requirement for local authorities to periodically review and document local air quality with the aim of meeting the air quality objectives defined in the Air Quality Regulations. Where a local authority determines that one or more objective is unlikely to be achieved it is required to designate an Air Quality Management Area (AQMA). For each AQMA the local authority must produce an Air Quality Action Plan (AQAP) to secure improvements in air quality and show how it intends to work towards achieving air quality standards in the future.

AIR QUALITY REGULATIONS

4.1.3. The Air Quality (England) Regulations 2000[6] (as amended) set the objectives for ambient pollutant concentrations. The objectives apply where there is relevant exposure: *"at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present…".*

4.1.4. The Air Quality Standards Regulations[7] (as amended) and the Environment (Miscellaneous Amendments) (EU Exit) Regulations[8] set legally binding (mandatory) limit values for concentrations in outdoor air of major air pollutants that impact public health including NO_2 and particulate matter

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[2] The National Archives (1995) *Environment Act 1995* [online]. Available at: https://www.legislation.gov.uk/ukpga/1995/25/contents [Accessed July 2022].
[3] Defra (2007) *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1)* [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69336/pb12654-air-quality-strategy-vol1-070712.pdf [Accessed July 2022].
[4] Defra (2007) *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 2)* [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69337/pb12670-air-quality-strategy-vol2-070712.pdf [Accessed July 2022].
[5] The National Archives (2021) *Environment Act 2021* [online]. Available at: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted [Accessed July 2022].
[6] The National Archives (2000) *The Air Quality (England) Regulations 2000* [online]. Available at: https://www.legislation.gov.uk/uksi/2000/928/contents/made [Accessed July 2022].
[7] The National Archives (2010) *The Air Quality Standards Regulations 2010* [online]. Available at: https://www.legislation.gov.uk/uksi/2010/1001/contents/made [Accessed July 2022].
[8] The National Archives (2020) *The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020* [online]. Available at: https://www.legislation.gov.uk/uksi/2020/1313/introduction/made [Accessed July 2022].

(PM_{10} and $PM_{2.5}$). The Regulations also include critical levels for the protection of vegetation. The limit values are numerically the same as the objectives.

ENVIRONMENTAL PERMITTING (ENGLAND AND WALES) REGULATIONS (EPR), INDUSTRIAL EMISSIONS DIRECTIVE (IED)

4.1.5. Directive 2010/75/EU[9] on industrial emissions (integrated pollution prevention and control) (IED) recast seven directives related to industrial emissions, in particular Directive 2008/1/EC concerning integrated pollution prevention and control (IPPC)[10] and Directive 2001/80/EC[11] emissions from large combustion plants (LCPD), into a single legislative instrument. The aim of the IED was to improve the permitting, compliance and enforcement regimes adopted by Member States to the European Union.

4.1.6. The Environmental Permitting (England and Wales) Regulations 2016 (EPR 2016)[12], as amended, consolidated and replaced the EPR 2010 and subsequent amendments. The EPR 2016 is the main implementing regulations for the environmental permitting regime and transposed the requirements of the IED into UK legislation.

4.1.7. The Medium Combustion Plant Directive (Directive 2015/2193) (MCPD)[13] filled the regulatory gap between Large Combustion Plant (LCP) and certain small combustion plant covered by the Ecodesign Directive (2009/125/EC)[14].

4.1.8. The Environmental Permitting (England and Wales) (Amendment) Regulations 2018 SI 110 (EPR 2018)[15] transposed the requirements of the MCPD into legislation and introduced requirements for the control of emissions from 'Specified Generators'.

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[9] EUR-Lex (2010) *Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)* [online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32010L0075 [Accessed July 2022].
[10] EUR-Lex (2008) *Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integration pollution prevention and control* [online]. Available at: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32008L0001 [Accessed July 2022].
[11] EUR-Lex (2001) *Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants* [online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32001L0080 [Accessed July 2022].
[12] The National Archives (2016) *The Environmental Permitting (England and Wales) Regulations 2016 Statutory Instrument No. 1154* [online]. Available at: https://www.legislation.gov.uk/uksi/2016/1154/contents/made [Accessed July 2022].
[13] EUR-Lex (2015) *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* [online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015L2193 [Accessed July 2022].
[14] EUR-Lex (2009) *Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products* [online]. Available at: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:285:0010:0035:en:PDF [Accessed July 2022].
[15] The National Archives (2018) *The Environmental Permitting (England and Wales) (Amendment) Regulations 2018* [online]. Available at: https://www.legislation.gov.uk/uksi/2018/110/contents/made [Accessed July 2022].

CONSERVATION OF HABITATS AND SPECIES REGULATIONS 2010

4.1.9. The European Habitats Directive (92/43/EEC)[16] sets out the legal framework requiring EU member states to protect habitat sites supporting vulnerable and protected species, as listed within the Directive. This Directive is transposed into UK law by the Conservation of Habitats and Species Regulations 2010[17] and requires protection of ecological sites including Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSIs).

4.1.10. The Ambient Air Quality Directive[18] sets mandatory ambient air quality guidelines for NO_x for the protection of ecosystems. This imposes a long-term (annual average) limit for NO_x of 30µg/m^3 (critical level). This is mirrored in the Air Quality Standards Regulations 2010[7] (as discussed above).

4.1.11. Across the UK, site-specific critical loads (which relate to deposition of materials to soils) have been set for a variety of protected habitats and species in order to allow the quantitative assessment of the condition of ecologically sensitive sites and thus the protection of such sites by the relevant competent authorities.

4.2 AIR QUALITY ASSESSMENT CRITERIA

4.2.1. This section sets out the air quality assessment criteria relevant to the assessment, and provides information on their provenance.

4.2.2. The criteria for the assessment of impacts at sensitive human receptors are given in the Air Quality (England) Regulations 2000, the Air Quality (England) (Amendment) Regulations 2002 and the Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020, given in **Table 4-1**.

Table 4-1 – Relevant air quality standards

Pollutant	Concentration (µg/m^3)	Measured as	Requirement
Nitrogen dioxide (NO_2)	40	Annual mean	Not to be exceeded.
	200	1-hour (hourly) mean	Not to be exceeded, more than 18 times a year (i.e. the 99.79th percentile).

[16] EUR-Lex (1992) *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora* [online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31992L0043 [Accessed July 2022].
[17] The National Archives (2010) *The Conservation of Habitats and Species Regulations 2010 Statutory Instrument No. 490* [online]. Available at: https://www.legislation.gov.uk/uksi/2010/490/contents/made [Accessed July 2022].
[18] EUR-Lex (2008) *Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and clean air for Europe* [online]. Available at: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32008L0050 [Accessed July 2022].

4.2.3. The United States Environmental Protection Agency publishes Acute Exposure Guideline Levels (AEGL)[19] that are applicable to emergency exposure periods and *"represent threshold exposure limits for the general public."* They are defined as follows:

- AEGL-1 is the airborne concentration (expressed as ppm [parts per million] or mg/m^3 [milligrams per cubic meter]) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.
- AEGL-2 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
- AEGL-3 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death.

4.2.4. The Environment Agency has requested that the AEGLs for NO_2 are considered within the assessment of impacts to human health receptors. **Table 4-2** provides the AEGL for NO_2 by severity level and period of exposure.

Table 4-2 – AEGLs for nitrogen dioxide (µg/m^3, with values in ppm given in brackets)

	Exposure Period				
	10 min	**30 min**	**60 min**	**4 hour**	**8 hour**
AEGL 1	940 (0.50)	940 (0.50)	940 (0.50)	940 (0.50)	940 (0.50)
AEGL 2	37600 (20)	28200 (15)	22560 (12)	15416 (8.2)	12596 (6.7)
AEGL 3	63920 (34)	47000 (25)	37600 (20)	26320 (14)	20680 (11)
Note: values given in brackets are in units of ppm.					

4.2.5. For ecological impacts, two metrics are assessed: critical levels (which are expressed as the concentration of a pollutant in air) and critical loads (which are expressed as the deposition of a pollutant to the surface).

4.2.6. The criteria for assessment of impacts at sensitive ecological receptors are derived as follows:

[19] United States Environmental Protection Agency (2021) *About Acute Exposure Guideline Levels (AEGLs)* [online]. Available at: https://www.epa.gov/aegl/about-acute-exposure-guideline-levels-aegls#:~:text=Important%20user%20information-,Overview,which%20health%20effects%20may%20occur. [Accessed July 2022].

- Pollutant Concentrations (Critical Levels) derived from the UK Air Quality Strategy[3,4] and EA targets for protected conservation areas and World Health Organisation guidelines[20].
- Pollutant Deposition (Critical Loads) estimated by UNECE and others and set out on the Air Pollution Information System (APIS)[21] website.

4.2.7. Critical levels are not habitat or species specific and are the same for all sites. These are set out in **Table 4-3**. Impacts relating to acid and nutrient nitrogen deposition are habitat and species specific; the site-specific critical loads are set out in **Table 6-4** for the sensitive ecological receptors of interest.

Table 4-3 – Air quality critical levels used for the assessment of impacts on sensitive ecological receptors.

Pollutant	Concentration (µg/m^3)	Measured as	Requirement
Nitrogen oxide (NO_x)	30	Annual mean	Critical level for the protection of sensitive vegetation and ecosystems.
	75	24-hour (daily) mean	

4.3 GUIDANCE

4.3.1. A summary of the air quality guidance relevant to this assessment is provided below.

ENVIRONMENT AGENCY: RISK ASSESSMENTS FOR SPECIFIC ACTIVITIES: ENVIRONMENTAL PERMITS

4.3.2. The Air Emissions section of the Environment Agency (EA) guidance[22] has been referred to in the assessment of emissions to air from the generators. This guidance is intended to assist operators in assessing risks to air when applying for a permit under the Environmental Permitting Regulations. This is part of the 'Risk assessments for specific activities: environmental permits' collection. Included within the Air Emissions Risk Assessment (AERA) guidance are:

- An approach for undertaking screening assessments;
- Information on when detailed atmospheric modelling is required; and
- Environmental Assessment Levels (EALs) for a range of pollutants against which impact may be assessed.

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[20] World Health Organisation (2021) *WHO global air quality guidelines* [online]. Available at: https://apps.who.int/iris/bitstream/handle/10665/345329/9789240034228-eng.pdf?sequence=1&isAllowed=y [Accessed July 2022].
[21] Natural England (2022) *Air Pollution Information System* [online]. Available at: https://www.apis.ac.uk/ [Accessed July 2022].
[22] Environment Agency (2021) *Guidance – Air emissions risk assessment for your environmental permit* [online]. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit [Accessed July 2022].

ENVIRONMENT AGENCY: SPECIFIED GENERATORS: DISPERSION MODELLING ASSESSMENT

4.3.3. This guidance[23] provides advice on how to undertake dispersion modelling for NO_x emissions from 'specified generators', which are generators used for the purpose of generating electricity; or a group of such combustion plant located at the same site, operated by the same operator, and having the same purpose, between 1 and 50MWth. Whilst the generators assessed in this report are not specified generators, this EA guidance document details what needs to be included in the report produced to present the results of the dispersion modelling and sets out the recommended approach to the characterisation of emissions, the inclusion of buildings and terrain, and atmospheric chemistry, and the distance to which receptors (human and ecological) require consideration. The guidance also details the methods that can be used to undertake statistical analysis of short-term predictions.

ENVIRONMENT AGENCY: ENVIRONMENTAL PERMITTING: AIR DISPERSION MODELLING REPORTS

4.3.4. This EA guidance document[24] sets out what information needs to be provided in an air quality assessment report that has been prepared in support of an environmental permit application.

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[23] Environment Agency (2019) *Guidance - Specified generators: dispersion modelling assessment* [online]. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment#explain-the-background-concentration [Accessed July 2022].
[24] Environment Agency (2021) *Guidance – Environmental permitting: air dispersion modelling reports* [online]. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports [Accessed July 2022].

5 STUDY AREA

5.1 STUDY AREA AND SITE SETTING

5.1.1. The Site is located at the Western International Park, Hayes Road within the administrative area of LBH. A location map is provided in **Figure 1** in **Appendix A**.

5.1.2. The detailed study area extends 3km in all direction from the centre of the Site. This distance is sufficient to demonstrate the negligible impacts of the generators on air quality and conforms to the Environment Agency screening distances for nature conservation sites (see below).

5.1.3. The Site is located in an area of light industrial and commercial developments beyond which are residential properties. The nearest residential properties to the Site boundary are over 300m to the east and over 400m to the west.

5.1.4. The principal source of pollution in the immediate vicinity of the Site is road traffic on the local road network; particularly on Hayes Road, Southall Lane and the A312 The Parkway. The A312 the Parkway is approximately 292m to the west of the Site boundary and the M4 eastbound on-slip is approximately 400m to the south.

5.2 SENSITIVE RECEPTORS

5.2.1. Sensitive locations are places where the public may be exposed to emissions from the generator flues. These will include places where members of the public are likely to be regularly present over the period of time prescribed in the Air Quality Strategy[3,4].

5.2.2. To complete the assessment of impacts, a number of discrete human receptor locations were selected at which pollution concentrations were predicted. The discrete receptors represent the closest residential properties, schools and healthcare facilities to the Site, at which both the long-term and short-term will objectives apply.

5.2.3. The locations of the discrete human health receptors included in ADMS 5 are summarised in **Table 5-1**.

Table 5-1 – Modelled human health receptor locations

Receptor ID	Location	X, Y	Height above ground level (m)
R1	32 Bulls Bridge Road, Southall, UB25LU	511133.2, 178920.2	1.5
R2	Featherston Primary & Nursery School, Western Road, UB25JT	511424.2, 178918.6	1.5
R3	1 Wentworth Road, Hounslow, Southall, UB25TS	511311.0, 178785.3	1.5
R4	Pinsent Court, Convent Way, Hounslow, Southall, UB25UB	511285.6, 178670.2	1.5
R5	Airfield Court, Northfield Road, Hounslow, TW59JF	511629.9, 177663.3	1.5

Receptor ID	Location	X, Y	Height above ground level (m)
R6	Sidher House, 8 Southall Lane, Hounslow, TW5 9WD	510903.8, 177857.6	1.5
R7	Cranford Community College, High Street, Hounslow, TW59PD	510782.8, 177864.0	1.5
R8	The Cedars Primary School, High Street, Hounslow, TW59RU	510513.7, 177381.1	1.5
R9	Hartlands Caravan Park, The Hartlands, Hounslow, TW59RY	510699.7, 178007.1	1.5
R10	77 Roseville Road, Hayes, UB34QY	510260.5, 178545.5	1.5
R11	Cranford Park Academy, Phelps Way, Hayes, UB34LQ	509860.2, 178597.6	1.5
R12	41 Roseville Road, Hayes, UB34QX	510304.1, 178660.6	1.5
R13	3 Roseville Road, Hayes, UB34QX	510291.4, 178789.2	1.5
R14	North Hyde Practice, 167 North Hyde Road, Hayes, UB34NS	510239.9, 178849.7	1.5
R15	1 North Hyde Gardens, Hayes, UB34QR	510288.8, 178881.8	1.5
R16	Staycity Aparthotels, Station Approach, Hayes, UB34FL	509796.4, 179437.0	1.5
R17	Groove House, Blythe Road, Hayes, UB31BY	509700.5, 179464.9	1.5

5.2.4. The EA's Air Emissions Risk Assessment Guidance[22] provides advice on which ecological sites should be considered as sensitive receptors within dispersion modelling studies. The advice recommends that the following should be included:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or Ramsar sites within 10km of the installation; and
- Sites of Special Scientific Interest (SSSIs, extended to 10km for larger emitters), National Nature Reserves (NNRs), Local Nature Reserves (LNRs), Local Wildlife Sites (LWSs) and Ancient Woodland within 2km of the installation.

5.2.5. However, it should be noted that the EA guidance for dispersion modelling assessment of specified generators does not require impacts on LWSs to be considered.

5.2.6. A review of information available on Natural England's Multi-Agency Geographic Information for the Countryside (MAGIC) website[25] identified that the Southwest London Waterbodies Ramsar and SPA and the Richmond Park SAC are all located within 10km of the Site. Given the nature of the generator emissions (short term releases from individual generators across the Site with no regular pattern), in combination effects on these sensitive ecological sites with other plans and projects cannot be accurately assessed and in any event are likely to be very small given their distance from the Site. Therefore, consideration of in-combination effects has been scoped out of this assessment.

5.2.7. Whilst there are no SSSIs within 2km of the Site, there following are within 2km of the Site:

- Airlinks Pond Site of Local Importance for Nature Conservation (SLINC);
- Thornecliff Waste SLINC;
- Hartlands Wood & Lower Park Farm SLINC; and
- Unnamed Site of Metropolitan Importance for Nature Conservation (SMINC).

5.2.8. **Table 5-2** provides details regarding discrete ecological receptor points included within this assessment that are representative of the designated nature conservation sites boundary closest to the Site.

Table 5-2 – Modelled worst case ecological receptor locations

Receptor ID	Location	X, Y	Height above ground level (m)
E1	Southwest London Waterbodies Ramsar/SPA	503079.4, 175517.2	0
E2	Southwest London Waterbodies Ramsar/SPA	504627.2, 174210.8	0
E3	Southwest London Waterbodies Ramsar/SPA	505376.3, 174124.5	0
E4	Southwest London Waterbodies Ramsar/SPA	511824.3, 171003.3	0
E5	Southwest London Waterbodies Ramsar/SPA	511966.1, 170436.0	0
E6	Richmond Park SAC	518540.7, 173831.2	0
E7	Airlinks Pond SLINC	511313.4, 178486.6	0
E8	Thornecliff Waste SLINC	511823.5, 177715.3	0
E9	Hartlands Wood & Lower Park Farm SLINC	510875.7, 178109.6	0
E10	SMINC	510478.9, 178707.5	0
E11	SMINC	510399.0, 178102.0	0

[25] Natural England (2022) *Multi-Agency Geographic Information for the Countryside* [online]. Available at: https://magic.defra.gov.uk/ [Accessed June 2022].

5.2.9. In addition to the specified receptor points described above, NO_x concentrations were predicted at a height of 1.5m across a 3km x 3km cartesian grid with a 15m resolution, centred on the Site.

5.2.10. **Figure 2** and **Figure 3** show the locations of the specified human and ecological receptor locations and the extent of the model domain.

6 BASELINE

6.1 LBH AIR QUALITY REVIEW

6.1.1. The LBH declared a borough-wide Air Quality Management Area (AQMA) in 2006 for exceedances of the annual mean NO_2 AQS. The administrative boundaries of the London Borough of Hillingdon (LBHD) and the London Borough of Ealing (LBE) are approximately 335m north and 220m north east of the Site boundary respectively. The LBHD has also declared an AQMA due to exceedances of the annual mean NO_2 AQS. This AQMA encompasses the area from the southern local authority boundary north to the border defined by, the A40 corridor from the western borough boundary, east to the intersection with the Yeading Brook north until its intersection with the Chiltern-Marylebone railway line[26]. Similarly, the LBE designated a borough-wide AQMA due to exceedances of the annual mean NO_2 AQS and daily mean PM_{10} AQS[27].

CONTINUOUS MONITORING DATA

6.1.2. In 2019 the LBH managed seven Continuous Monitoring Sites (CMSs); one of which was within 2km of the Site boundary. The neighbouring LBHD also operated a CMS that is located within 2km of the Site boundary. **Table 6-1** shows the latest four years of data for CMSs within 2km of the Site. Data recorded at the background CMS 'HS2' in 2019 was compliant with the annual mean AQS (see **Table 4-1**). The annual mean NO_2 concentration recorded at the roadside CMS 'HIL5' however, was in exceedance of the AQS at 41µg/m^3.

Table 6-1 – Monitored annual mean NO_2 concentrations at CMS within 2km of the Site (µg/m^3)

Local Authority	Site ID	Location	Site Type	X, Y	Approx. distance to Site	Annual mean NO_2 concentration (µg/m^3)			
						2017	2018	2019	2020*
LBHD	HIL5	Hillingdon Hayes	Roadside	510303, 178882	0.5km north west	**47**	**43**	**41**	31
LBH	HS2	Cranford	Background	510373, 177199	1.5km south west	30	26	27	25

Bold text indicates an exceedance of the annual mean NO_2 AQS.

Data for LBHD was obtained from the 2021 Air Quality Annual Status Report[28].

[26] Defra (2022) *AQMAs Declared by the London Borough of Hillingdon* [online]. Available at: https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=342 [Accessed August 2022].
[27] Defra (2022) *AQMAs Declared by London Borough of Ealing* [online]. Available at: https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=334 [Accessed August 2022].
[28] London Borough of Hillingdon (2021) *London Borough of Hillingdon Air Quality Annual Status Report for 2020* [online]. Available at: http://www.hillingdon-air.info/pdf/LB_Hillingdon_ASR_2020_final.pdf [Accessed August 2022].

Local Authority	Site ID	Location	Site Type	X, Y	Approx. distance to Site	Annual mean NO_2 concentration (µg/m^3)			
						2017	2018	2019	2020*
*2020 monitoring data is not considered to be representative of normal conditions nor when making comparisons of long-term trends due to national lockdown restrictions attributed to the outbreak of the COVID-19 pandemic.									

DIFFUSION TUBE MONITORING DATA

6.1.3. In 2019 the LBH managed three diffusion tube monitoring sites within 2km of the Site boundary. The LBE also managed three diffusion tube sites and the LBHD managed eight sites (see **Table 6-2** overleaf). In 2019 annual mean NO_2 concentrations recorded at 12 of the 13 diffusion tube monitoring sites were compliant with the relevant AQS (**Table 4-1**). The maximum concentration of 40.5µg/m^3 was recorded at the road site EA08 approximately 1.5km to the north east of the Site. The closest diffusion tube monitoring location to the Site boundary is the roadside site EA10 approximately 0.6km to the north east. Concentrations recorded at EA10 were compliant with the annual mean NO_2 AQS for the three-year period from 2017 to 2019.

Table 6-2 - Monitored annual mean NO_2 concentrations at diffusion tube sites within 2km of the Site (µg/m^3)

Site ID	Location	Site Type	X, Y	Approx. distance to Site	Annual mean NO_2 concentrations (µg/m^3)			
					2017	2018	2019	2020*
London Borough of Hounslow								
CRAN	Cranford Avenue Park	Background	510373, 177199	1.5km south west	25.0	24.1	26.6	16.0
HS54	Cranford Lane / Cranford High Street Jct.	Roadside	510784, 177460	1.2km south	**40.8**	35.0	38.4	28.5
HS55	Cranford Library	Roadside	510750, 176684	2.0km south	**43.7**	33.8	33.9	23.7
London Borough of Hillingdon								
HILL18	Blyth Road, Hayes Lamp Post (4)	Roadside	509683, 179486	1.4km north west	**49.0**	38.5	37.4	29.9
HILL17	49 Silverdale Gardens, Hayes Lamp Post (8)	Background	510361, 179820	1.2km north	32.7	31.0	31.6	24.7
HILL08	15 Phelps Way Hayes	Roadside	509798, 178654	1.0km west	33.4	33.9	33.9	24.1
HILL07	Harold Avenue (first lamp post on left)	Roadside	509918, 179015	0.9km north west	**43.3**	37.7	36.9	28.1
HILL28	Blyth Road 2nd Tube, Hayes Lamp Post (17)	Roadside	509328, 179603	1.7km north west	35.7	31.7	31.7	23.0
HILL27	Botwell House RC Primary School	Roadside	509755, 179934	1.6km north west	33.8	32.5	33.2	24.5

Site ID	Location	Site Type	X, Y	Approx. distance to Site	Annual mean NO_2 concentrations (µg/m^3)			
					2017	2018	2019	2020*
HILL26	R/O 130 Cleave Avenue, Hayes Lamp Post (33)	Roadside	509499, 178370	1.3km south west	**51.5**	**42.0**	40.0	28.2
HILL44	"Hillingdon Hayes AQ site	Roadside	510303, 178882	0.5km west	-	-	-	32.6
London Borough of Ealing								
EA09	18 Western Rd, Southall	Roadside	512181, 179219	1.5km north east	31.9	30.9	31.5	22.4
EA08	55 King St, Southall	Roadside	512341, 179186	1.5km north east	**50.6**	**41.1**	**40.5**	27.0
EA10	150 Brent Rd, Southall	Roadside	511170, 179251	0.6km north east	34.6	35.0	33.2	23.4

Bold text indicates an exceedance of the annual mean NO_2 AQS.

-indicates that the monitoring site was closed.

Data for LBH was obtained from the 2021 Air Quality Annual Status Report[29].

Data for LBHD was obtained from the 2021 Air Quality Annual Status Report[28].

Data for LBE was obtained from the 2021 Air Quality Annual Status Report[30].

[29] LBH (2021) *London Borough of Hounslow Air Quality Annual Status Report for 2020* [online]. Available at: https://www.hounslow.gov.uk/downloads/file/3303/2020_annual_staus_report_published_2021 [Accessed August 2022].
[30] LBE (2021) *London Borough of Ealing Air Quality Annual Status Report for 2020* [online]. Available at: https://www.ealing.gov.uk/downloads/download/5860/air_quality_status_report [Accessed August 2022].

Site ID	Location	Site Type	X, Y	Approx. distance to Site	Annual mean NO_2 concentrations (µg/m^3)			
					2017	2018	2019	2020*
*2020 monitoring data is not considered to be representative of normal conditions nor when making comparisons of long-term trends due to national lockdown restrictions attributed to the outbreak of the COVID-19 pandemic.								

6.2 BACKGROUND POLLUTANT CONCENTRATIONS (HUMAN HEALTH)

6.2.1. The Department for Environment, Food and Rural Affairs (Defra) and the Devolved Administrations provide mapped background pollutant concentrations in the UK on a 1km x 1km grid. For NO_2, the latest available data are provided as hindcasts/projections for all years from 2018 to 2030.

6.2.2. **Table 6-3** shows that whilst the monitored concentrations at background locations near the Site have good agreement with the mapped data, and the majority are slightly higher. It is, therefore, appropriate to base the assessment of impacts on monitoring rather than mapped background concentrations for the assessment of human health.

6.2.3. The closest background monitoring CMS location to the Site is HS2 which measured a background NO_2 concentration in 2019 of 27.2µg/m^3. This value was used as the annual mean background concentration in the calculation of risk of exceedance of the NO_2 objective for the protection of health.

Table 6-3 – Comparison of mapped and monitored background NO_2 concentrations (µg/m^3) within 2km of the Site

Site ID	Site Type	Distance to Site (km)	2019 Monitored concentration (µg/m^3)	2019 Mapped concentration (µg/m^3)	Ratio Monitored / Mapped
HILL17	DT - Background	1.2km north	31.6	28.8	1.1
HS2	CMS - Background	1.5km south west	27.2	27.2	1.0
CRAN	DT - Background	1.5km south west	26.6	27.2	1.0
				Average Ratio Monitored/Mapped:	1.0

6.3 BACKGROUND POLLUTANT CONCENTRATIONS (ECOLOGY)

6.3.1. The APIS21 website provides mapped pollutant concentration and deposition data for the UK. **Table 6-4** shows the NO_x and nitrogen deposition data for the ecological sites within the study area.

6.3.2. Background NO_x concentrations exceed the critical level of 30µg/m^3 across all designated sites. Nitrogen deposition is below the lower critical load (20kgN/ha/yr) over the South West London Waterbodies, and for woodland habitats.

Table 6-4 – Mapped background concentrations and deposition over ecological sites (µg/m^3)

Site	Designation	Critical Level (µg/m^3)	NO_X (µg/m^3)	Critical Load (kgN/ha/yr)	N Deposition (kgN/ha/yr)
E1 - Southwest London Waterbodies	Ramsar/SPA	30	51.4	20	0.0003

Site	Designation	Critical Level (µg/m³)	NO_X (µg/m³)	Critical Load (kgN/ha/yr)	N Deposition (kgN/ha/yr)
E2 - Southwest London Waterbodies	Ramsar/SPA	30	34.1	20	0.0006
E3 - Southwest London Waterbodies	Ramsar/SPA	30	55.6	20	0.0007
E4 - Southwest London Waterbodies	Ramsar/SPA	30	31.8	20	0.0004
E5 - Southwest London Waterbodies	Ramsar/SPA	30	24.8	20	0.0003
E6 - Richmond Park	SAC	30	26.2	10	0.0011
E7 - Airlinks Pond	SLINC	30	38.5	10	0.0322
E8 - Thornecliff Waste	SLINC	30	41.8	10	0.0077
E9 - Hartlands Wood & Lower Park Farm	SLINC	30	50.4	10	0.0143
E10 - SMINC	SMINC	30	50.4	10	0.0326
E11 - SMINC	SMINC	30	50.4	10	0.0218

7 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

7.1 AIR DISPERSION MODELLING

7.1.1. Atmospheric dispersion modelling software (ADMS) version 5.2.4[31] developed by Cambridge Environmental Research Consultants (CERC) was used for quantifying the impact of emissions from generators on NO_x and NO_2 concentrations. ADMS uses detailed information regarding the pollutant releases, building effects and local meteorological conditions to predict pollutant concentrations at specific locations and areas as selected by the user and is approved by the EA for regulatory applications.

7.1.2. The model is a new generation Gaussian model that has been validated against both field studies and wind tunnel studies of dispersion and is widely used for air quality impact assessment in the UK.

7.2 MODEL INPUTS

STACK PARAMETERS

7.2.1. The full set of flue parameters and emissions to air used in the dispersion modelling for each scenarios are provided in **Appendix C.**

Exhaust Stack Diameter

7.2.2. The generator exhausts associated with LON2 are circular and are not restricted by noise baffles. They have an effective diameter circular release of 0.6m.

Plume Merging

7.2.3. In the routine testing scenarios, the generators are run consecutively, with no more than a single generator operating at any time. There is, therefore, no potential for the merging of plumes.

7.2.4. In the emergency backup operations, all nine generators are operating concurrently. The generators are arranged in linear banks adjacent to the DC. It is unrealistic to assume that all exhaust plumes will merge. However, it is equally unrealistic to assume that there will be no plume merging since some generators are located immediately adjacent to one another.

7.2.5. Sensitivity testing was undertaken in which the impacts of multiple generators were compared when modelled as

- 9 x Individual generators,
- 3 groups of generators with plumes merged from 2 generators, and
- 2 groups of generators with plumes merged from 3 generators.

7.2.6. It was found that, as expected, the maximum ground level impact decreased as increasing numbers of generator plumes were merged, but that after the initial merging of two generators, the relative impact of additional mergers decreased with successive mergers.

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[31] CERC (2022) *ADMS 5* [online]. Available at: http://www.cerc.co.uk/environmental-software/ADMS-model.html [Accessed July 2022].

7.2.7. It was, therefore, decided to model the emergency scenario of the operation of 9 generators as a total of 4 sources, the majority of which represent the merging of two generator plumes. This approach captured the majority of the beneficial impacts of plume merging, without overestimating the likely benefits. Where an uneven number of generators were located in a continuous bank, the generator group represented either 1 or 3 generator plumes. In the case of the 3 generator plumes, the bulk plume characteristics (volume flow rate, merged diameter, temperature) were retained for the two-generator case, to preserve the overall conservatism of the approach to plume merging, whilst the mass emission flow rate for nitrogen oxides represented the three generators.

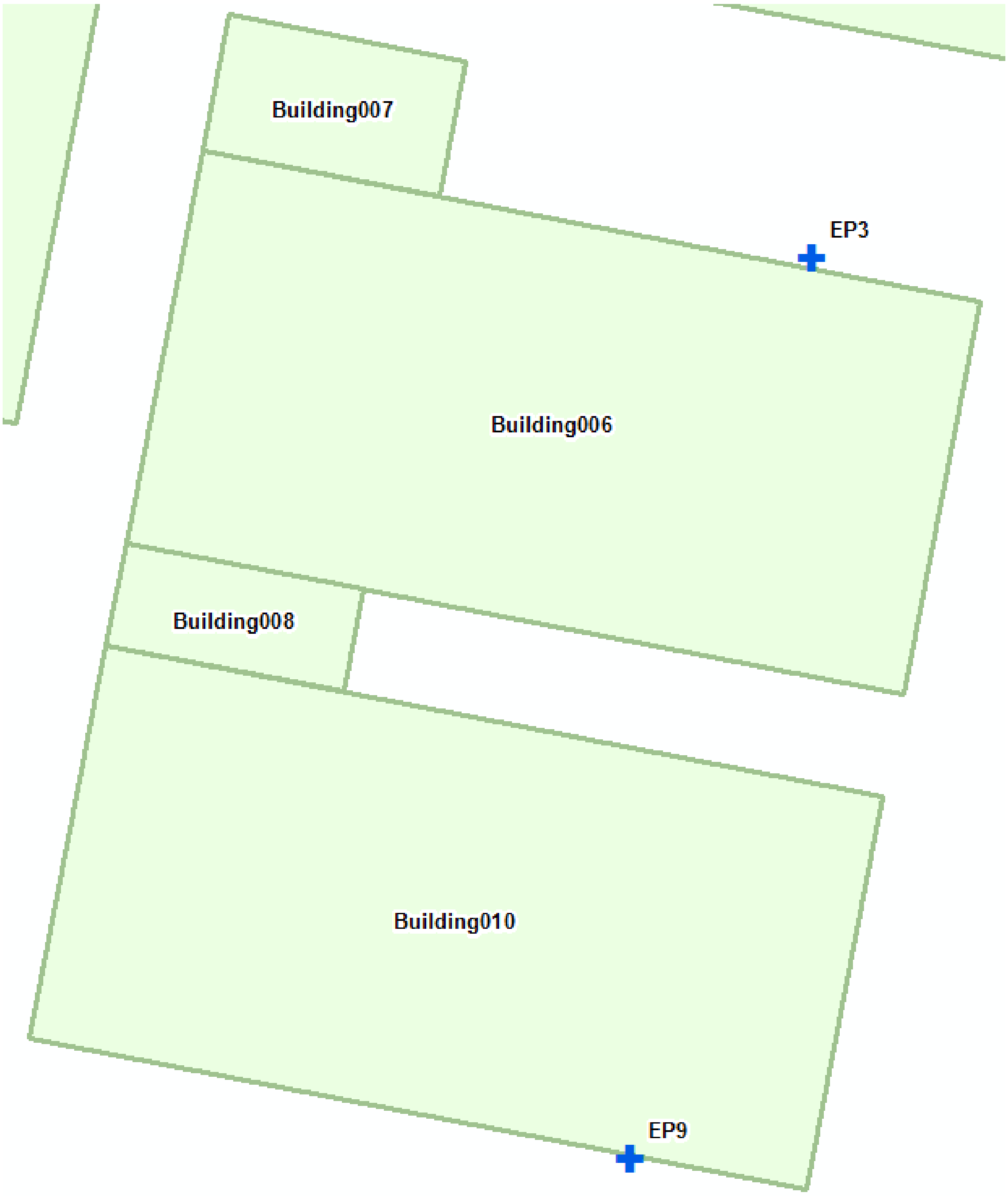
Routine Testing Scenarios

7.2.8. The exact sequencing of the generators during the monthly testing is unknown and may be variable, but it is possible that adjacent generators will be tested within a single hour. Offsite impacts from the use of generators that are located close to each other will be very similar, although impacts at individual receptors from generators at the extremes of the generator banks will be different.

7.2.9. Therefore, it is not possible to explicitly model any testing scenario and a pragmatic approach was adopted in which the emissions from indicative generator locations were modelled and then the output analysed to assess the statistical likelihood of exceedance of the AQS if all hours of testing were to occur at each generator location individually.

7.2.10. The indicative generator locations were taken to be those positioned on the northern and southern extremes of the DC, as illustrated in **Schematic 7-1,** to ensure that the closest generators to the sensitive human health receptors were represented. For each receptor, the impact was taken to be the maximum impact across all nine modelled locations.

7.2.11. Since the greatest impacts at a receptor are likely to occur under emissions from the closest generator, this approach is likely to overestimate the true impacts of sequential testing. Sensitivity testing was undertaken which demonstrated that the overestimation of impacts in any given hour is up to a factor of 4.



Schematic 7-1. Modelled sources for Routine Testing Scenarios

Virtus Test 1

7.2.12. For the routine testing in Months 1 to 11 (Virtus Test 1), all generators operate at 10% load. Further, it is assumed that the 15-minute tests are conducted immediately after one another, such that in any hour, four generators could potentially be tested for 15 minutes each. As will be demonstrated, this is a worst case.

7.2.13. The model parameters for Virtus Test 1 are shown in **Appendix C**.

Virtus Test 2

7.2.14. For the routine testing in Month 12 (Virtus Test 2), the generators are run at 100% for 20 minutes at the start of test, and then run for a further 120 minutes at 75% load. Following the conservative approach taken for Test 1, the Month 12 testing is modelled on the basis of the worst hour of the testing i.e.

- Worst hour for the Mitsubishi S16R2-PTAW generators, with 20 mins at 100% load and 120 mins at 75% load.

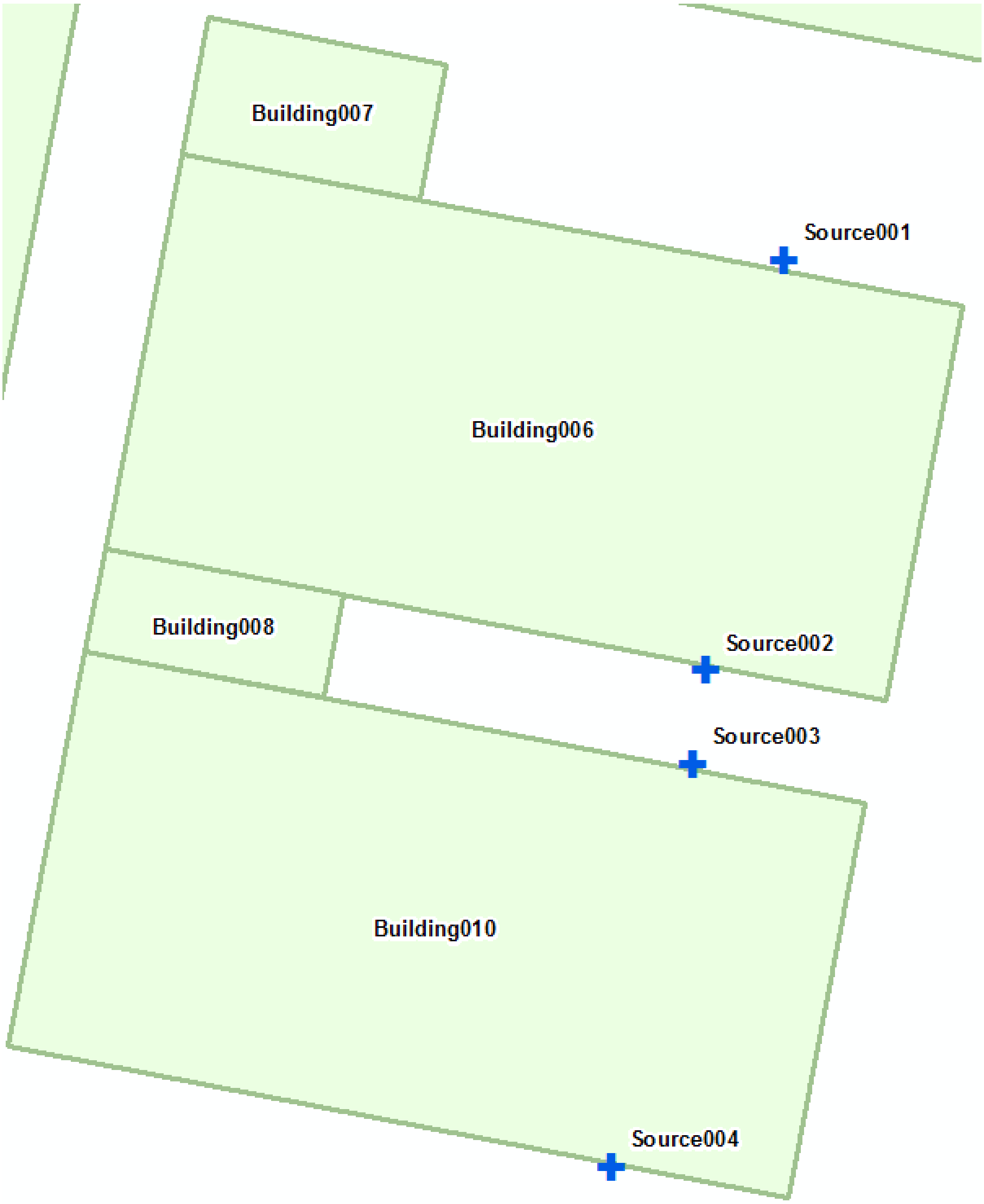
7.2.15. In this case, the modelling is based on the hourly average emission rate, calculated on the basis of the above operations (20mins at 100%, 120 mins at 75% load) whilst the bulk exhaust parameters are taken from the 75% operation to ensure the effects of plume rise are not overstated for the hour. This is a worst case.

7.2.16. The model parameters for Virtus Test 2 are shown in **Appendix C**.

Emergency Scenario 2

7.2.17. For the emergency scenario, the concurrent operation of all sources is modelled for the previously mentioned 4 sources as illustrated in **Schematic 7-2**.

7.2.18. For each generator, the impacts are modelled for the specific generator model at 100% load, as set out in **Table 3-1**.



Schematic 7-2 - Modelled sources for Emergency Scenario

7.2.19. The model parameters are provided in **Appendix C**.

BUILDING DOWNWASH

7.2.20. ADMS 5 takes into account the effects of building downwash[32] on pollutants. Downwash is the enhanced turbulent mixing of pollutants in the lee of buildings which can result in high pollutant concentrations in the wake of the building. A summary of the buildings included within the model set up are summarised in **Table 7-1** and their positions are illustrated in **Schematics 7-1** and **7-2**, and in **Figure 1** in **Appendix B**.

Table 7-1 – Buildings included in the dispersion modelling

Building	Shape	Easting	Northing	Height (m)	Length (m)	Width (m)	Angle (˚)
Building001	Rectangle	510865.0	178771.0	17.0	30.5	69.4	11.0
Building002	Rectangle	510977.2	178670.2	10.0	66.2	135.0	11.0
Building003	Rectangle	510995.2	178716.2	10.0	30.9	117.4	11.0
Building004	Rectangle	510822.4	178814.2	7.5	66.4	15.0	11.0
Building005	Rectangle	510881.3	178833.0	11.2	28.2	90.4	11.0
Building006	Rectangle	510855.4	178720.5	17.0	32.6	64.5	11.0
Building007	Rectangle	510837.6	178746.3	17.0	11.2	19.7	11.0
Building008	Rectangle	510829.5	178704.6	17.0	8.5	19.7	11.0
Building009	Rectangle	510866.4	178617.5	12.0	43.3	97.0	11.0
Building010	Rectangle	510847.5	178680.1	17.0	32.6	64.5	11.0
Building 011	Rectangle	510714.1	178674.4	7.5	78.3	46.6	4.0
Building 012	Rectangle	510719.5	178781.6	8.5	42.6	27.4	11.0
Building 013	Rectangle	510778.8	178745.2	7.5	36.1	73.9	11.0
Building 014	Rectangle	510767.1	178821.6	7.4	60.2	14.3	11.0

SURFACE ROUGHNESS AND TERRAIN

7.2.21. The area surrounding the Site is relatively flat (slope gradients <10%). Therefore, site specific terrain height data has not been included with the modelling.

[32] Downwash is the enhanced turbulent mixing of pollutants in the lee of buildings which can result in high pollutant concentrations in the wake of the building.

7.2.22. The roughness of the terrain, over which a plume from a point source passes, can have a significant effect on dispersion by altering the velocity profile with height, and the degree of atmospheric turbulence. Within the ADMS 5 model, this can be accounted for using a parameter called 'surface roughness length'.

7.2.23. The area surrounding the Site is largely industrial in nature. A surface roughness length of 0.5m was therefore used within the modelling to represent the average surface characteristics of the study area in the model. This is the value recommended by the model developers for areas of parkland and open suburbia.

7.2.24. In addition, the model can also take into account the effect of heat generation from buildings and traffic in built up areas on pollutant dispersal. This parameter, known as the minimum Monin-Obukhov Length, was set to 30m, which represents the recommended model setting for mixed urban areas, cities and large towns.

METEOROLOGICAL DATA

7.2.25. Meteorological data, including wind speed and direction, is used by the model to determine pollutant transportation and levels of dilution by the wind. Meteorological data used in the model was obtained from the Met Office observing station at Heathrow Airport. This station is approximately 4.4km to the south west of the Site and is considered to provide the most representative dataset for this assessment.

7.2.26. Five years of meteorological data were used in the assessment, which were for the years 2015 to 2019. Windroses for each year of meteorological data used are provided in **Appendix D**.

MODEL DOMAIN

7.2.27. The model domain extends 3km x 3km centred on the Site, with concentrations modelled on a cartesian grid with a resolution of 15m.

7.2.28. Impacts have also been modelled at indicative selected receptors. These receptors were set out in **Table 5-1** and **Table 5-2** and illustrated in **Figure 2** and **Figure 3** in **Appendix B**.

7.3 POST PROCESSING OF RESULTS

ATMOSPHERIC CHEMISTRY

7.3.1. Emissions of NO_x from combustion sources include both NO_2 and nitric oxide (NO), with the majority being in the form of NO. In ambient air, NO is oxidised to form NO_2, and it is NO_2 which has the more significant health impacts. For this assessment, the conversion of NO to NO_2 has been estimated using assumptions set out in the EA guidance[33], namely that

- For the assessment of long term (annual mean) impacts, at receptors 70% of NO_x is NO_2; and
- For the assessment of short term (hourly mean) impacts, at receptors 15% of NO_x is NO_2.

[33] NO_X to NO_2, conversion ratios to use – Environment Agency https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment#nosubxsub-to-nosub2sub-conversion-ratios-to-use . Accessed March 2020

7.3.2. The oxidation of NO to NO_2 is not an instantaneous process and, where the maximum impacts occur within a few hundred metres of the stacks (as will be shown to be the case for the generators), the EA standard assumption of 35% NO_X as NO_2 for short term impacts is likely to be conservative. Therefore, following EA guidance, the impacts are modelled using 15% NO_X as NO_2 for modelling on sub-daily times.

SHORT TERM IMPACTS

7.3.3. Given the intermittent and unknown pattern of operation of the generators, short-term impacts (on daily and sub-daily timescales) were assessed using the EA's recommended statistical approach based on the hypergeometric probability distribution[23].

7.3.4. The dispersion modelling was used to assess the theoretical maximum number of hours (and 4hr and 8hr periods) in the year that the short-term AQS and AEGLs for NO_2, and daily mean standard for NO_x for ecological receptors, are potentially exceeded assuming continuous operation. These potential exceedance hours are combined with likely operating hours in the year to calculate the likelihood of exceedance under realistic operations.

7.3.5. Since the generators may operate in consecutive hours and days, the probability of exceedance calculated using the hypergeometric methodology was multiplied by 2.5 as prescribed by EA guidance.

ANNUAL MEAN IMPACTS

7.3.6. For the assessment of annual mean impacts on ecological and human receptors, the model outputs assuming continuous operation were scaled by the assumed hours of operation, namely:

- Virtus Test 1: 11 months with 15-minute testing of each generator: 203.5hrs
- Virtus Test 2: 1 month with 2-hrs testing of each generator: 173hrs
- Virtus Emergency Scenario 2: 72-hrs of running of all generators: 72 hrs

POLLUTANT DEPOSITION

7.3.7. The deposition of NO_2 to ecological receptors was modelled using the following deposition velocities:

- Grassland/Meadows: 1.5mm/s
- Woodland: 3.0mm/s

SUB-HOURLY IMPACTS

7.3.8. AEGLs for NO_2 are set for 10-minute, 30-minute, 1-hour, 4-hours and 8-hours. With the ADMS model being run with hourly sequential meteorological data, the 1, 4 and 8-hour average concentrations can be modelled explicitly. However, the explicit modelling of sub-hourly timescales is less robust since the sub-hourly variation in meteorological conditions is not represented in the model input data.

7.3.9. Therefore, an empirical method linking the peak concentrations at various timescales has been used in the modelling to convert the 10-minute and 30-minute AEGLs to hourly mean concentrations for analysis. The method follows that set out in Turner[34] and is consistent with the EA guidance on modelling sub-hourly (15minute) sulphur dioxide (SO_2) concentrations where:

$$C_1 = C_2 \times \left(\frac{T_2}{T_1}\right)^p$$

where C_1 and C_2 are the peak concentrations at averaging times T_1 and T_2, and the exponent p is between 0.17 and 0.2 (set to 0.2 here). Using this relationship, the peak 10-minute concentration within an hour will be a factor of 1.43 higher than the hourly concentration, and the peak 30-minute concentration will be a factor of 1.15 higher. The potential exceedances of the 10-minute and 30-minute AEGLS are, therefore, modelled as the potential exceedances of hourly concentrations that are factors of 1.43 and 1.15 lower.

7.3.10. For the 10-minute averages, the potential that more than one 10-minute period in the hour exceeds the AEGL is taken into account by multiplying the hourly exceedances by a factor of 3 (i.e. assuming that, on average, 50% of the 10-minute average concentrations are higher than the hourly average and 50% are lower).

7.3.11. For AEGL2 and AEGL3, the resulting 'hourly equivalent' AEGL is greater than the actual hourly AEGL and, therefore, the probability of exceedance of an AEGL is appropriately represented by the probability of the hourly AEGL; without the need to assess the sub-hourly impacts. The above scaling is, therefore, only required for assessing the probability of exceedance of AEGL1 at sub-hourly timescales.

7.3.12. The resulting exceedance thresholds set in the modelling are set out in **Table 7-2**.

INCLUSION OF BACKGROUND CONCENTRATIONS

7.3.13. Total NO_x, NO_2 and nitrogen deposition (Predicted Environmental Concentrations (PECs)) were calculated from the relevant Process Contributions as follows:

PEC = PC + Background Concentration

7.3.14. The PECs were then compared with the relevant AQS provided in **Table 4-1**. At the ecological receptors, the NO_2 PCs were converted to nitrogen and acid deposition.

7.3.15. In the calculation of the likelihood of exceedance of a short-term standard (sub-daily), the Background Concentration was assumed to be 2 x Annual Mean Background as per EA guidance.

7.3.16. Therefore, the exceedance threshold was set to:

Exceedance Threshold (NO_2) = AQ Standard – 2 x Annual Mean Background

where the AQ Standard is either a UK Objective or an AEGL. Furthermore, the exceedance threshold was converted to NO_x prior to use in the modelling:

Exceedance Threshold (NO_x) = Exceedance Threshold (NO_2) / %NO_x_as_NO_2

[34] Turner, 1970, Workbook of Atmospheric Dispersion Estimates, available at https://nepis.epa.gov/

where $\%NO_x\_as\_NO_2$ is, as set out earlier, set to 15%.

7.3.17. The resulting exceedance thresholds for modelling are set out in **Table 7-2**.

Table 7-2 – Exceedance thresholds used for modelling. Model inputs highlighted in red cells

Metric	Standard		Averaging Time of Standard	Assessed as		Equivalent NO_2 PC after removing background[b] ($\mu g/m^3$)	Model Input Equivalent NO_x PC for modelling[c] ($\mu g/m^3$)
	ppm	$\mu g/m^3$		Conc. ($\mu g/m^3$)	Averaging Time		
UK Objective		200	1hr	200	1hr	138	923
AEGL1	0.5	940	10min	657[a]	1hr	595	3969
AEGL1	0.5	940	30min	818[a]	1hr	757	5045
AEGL1	0.5	940	1hr	940	1hr	878	5856
AEGL1	0.5	940	4hr	940	4hr	878	5856
AEGL1	0.5	940	8hr	940	8hr	878	5856
AEGL2	12	22560	1hr	22560	1hr	22498	149989
AEGL2	8.2	15416	4hr	15416	4hr	15354	102363
AEGL2	6.7	12596	8hr	12596	8hr	12534	83563
AEGL3	20	37600	1hr	37600	1hr	37538	250256
AEGL3	14	26320	4hr	26320	4hr	26258	175056
AEGL3	11	20680	8hr	20680	8hr	20618	137456

a. Calculated following para 7.3.9
b. Calculated using a background concentration of 32.3µg/m^3 following para 6.2.3
c. Calculated using a NOX to NO2 ratio of 15%, following para 7.3.1

7.4 SIGNIFICANCE CRITERIA

7.4.1. With regard to the significance of predicted long term impacts, the EA's guidance for undertaking air emissions risk assessment in support of environmental permit applications says that PC's can be screened out as insignificant at human health receptors if the following criterion is met:

- The short-term PC is less than 10% of the short-term environmental standard; and
- The long-term PC is less than 1% of the long-term environmental standard.

7.4.2. Emissions that affect LWS are insignificant if they meet the following criteria:

- The short-term PC is less than 100% of the short-term environmental standard; and

- The long-term PC is less than 100% of the long-term environmental standard.

7.4.3. For the assessment of short terms effects calculated using the cumulative hypergeometric distribution, the EA's guidance on undertaking dispersion modelling for specified generators says that where the probability is:

- 1% or less – exceedances are highly unlikely;
- Less than 5% - exceedances are unlikely as long as the generator plant operational lifetime is no more than 20 years; and
- More than or equal to 5% - there is potential for exceedances and the regulator will consider if acceptable on a case-by-case basis.

7.4.4. These criteria have therefore been used to determine the potential for exceedances of the hourly, 4 hourly and 8 hourly mean NO_2 AQS and AEGLs due to emissions from the generators during monthly testing and emergency outages.

7.5 LIMITATIONS AND ASSUMPTIONS

7.5.1. There are uncertainties associated with modelled pollutant concentrations. The dispersion model used in this assessment relies on input data, which also have uncertainties associated with them. The models simplify complex physical systems into a range of algorithms. In addition, local micro-climatic conditions may affect the concentrations of pollutants that the models will not take into account.

7.5.2. To reduce uncertainty associated with predicted concentrations, validated industry standard dispersion modelling software has been used in the assessment.

7.5.3. Model verification is not practical for point source models, and not possible at all in the case of the yet to be installed generators. Model uncertainty in terms of underprediction is addressed by considering the worst-case impacts over five years of meteorological data and adopting conservative assumptions.

8 HUMAN HEALTH ASSESSMENT RESULTS

8.1 INTRODUCTION

8.1.1. As set out in the methodology, the assessment of impacts from the intermittent use of the generators on the Site is based on model runs that simulate continuous operation of the generators, either as individual generators (testing scenarios) or concurrently (outage scenario). The model outputs are then subject to statistical analysis to determine the likelihood of exceedance of standards taking into account the likely hours of operation in the year.

8.1.2. In the description of the results below, the following metrics are presented:

- 100^{th} / 99.79^{th} percentiles of hourly, 4 hourly or 8 hourly concentrations
  - These metrics are assessed over 5 years of meteorological data and are the theoretical maximum impacts at each receptor assuming operation of the generator(s) coincides with the worst dispersion conditions for that receptor. The associated contour plots do not, therefore, reflect the distribution of impacts in any given hour but are a composite of the theoretical impacts over all potential meteorological conditions over 5 years.
  - If the 100^{th} percentile impact does not result in an exceedance of a standard, then the risk of exceedance of the standard is negligible.
- Annual exceedances of the standard
  - These are the maximum hours (or 4 / 8 hours) in a year that the standard (either 200µg/m^3 for the UK's objective or the AEGLs) is exceeded. The value presented is for the worst year within the 5 years of meteorological data tested.
  - The metric is used in the calculation of the probability of exceedance of the standard given the likely operating hours for a scenario and does not represent the actual hours of exceedance that would be experienced under the scenario.
- Risk of exceedance of the standard
  - This is the percentage risk of exceedance of the air quality objective for hourly mean NO_2 or the AEGLs taking into account likely operating hours, as output by the statistical analysis. The metric is based on the worst year over the 5 years of meteorological data tested.
  - As for all metrics, the spatial plots of the risk percentage do not reflect the potential exceedances that would occur at the same time. That is to say, the realisation of the risk at any given receptor is dependent on the wind blowing directly from generator to that receptor. The greater the angular separation of receptors, the less likely it is that an exceedance would occur at both receptors during the same operating event.

8.1.3. In Section 8.2 the results are presented for the selected human receptors (R1 – R17) and as a maximum at any offsite location.

8.2 AEGLS

8.2.1. The assessment has found that none of the AEGLs would be exceeded in any operational scenario.

8.2.2. **Table 8-1** shows the maximum modelled concentrations across the timescales relevant to the AEGLs. It is immediately apparent that the AEGL1, AEGL2 and AEGL3 levels are not exceeded, or at risk of being exceeded at any location offsite. The UK's air quality standard, 200µg/m^3, is also not exceeded at any discrete receptor locations, in the worst hour of the year (100th %ile).

8.2.3. There is a potential risk of exceeding the 1hr objective as a maximum on the grid in a car park to the south of the Site in an area where exposure of members of the public is likely to be transient.

8.2.4. At sub-hourly timescales, AEGL1 is not exceeded at the selected receptors, nor as a maximum on the grid. As such, ***no significant health effects are likely with the operation of the generators for backup power generation***.

Table 8-1 – Maximum modelled impacts for Emergency Scenario 2 as a function of averaging period. The maxima are taken over 5 years of modelled meteorological data. Data in bold exceed one or more of the Standards (without the addition of background concentrations).

Receptor	100th %ile 8-Hourly Mean PC for NO_2 (µg/m^3)	100th %ile 4-Hourly Mean PC for NO_2 (µg/m^3)	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	100th %ile 30min Mean PC for NO_2 (µg/m^3)[a]	100th %ile 10min Mean PC for NO_2 (µg/m^3)[a]
Standards	AEGL3 – 20680 AEGL2 – 12596 AEGL1 - 940	AEGL3 – 26320 AEGL2 – 15416 AEGL1 - 940	AEGL3 – 37600 AEGL2 – 22560 AEGL1 – 940 Objective - 200	AEGL3 – 47000 AEGL2 – 28200 AEGL1 - 940	AEGL3 – 63920 AEGL2 – 37600 AEGL1 - 940
R1	83.5	99.4	109.2	125.4	156.3
R2	36.8	41.7	56.0	64.4	80.2
R3	61.3	68.0	75.7	86.9	108.3
R4	60.3	68.5	81.9	94.0	117.2
R5	14.7	19.5	29.6	34.0	42.4
R6	27.2	29.9	41.0	47.1	58.7
R7	28.4	30.3	41.4	47.5	59.2
R8	16.9	19.3	29.4	33.7	42.0
R9	31.6	33.4	48.2	55.4	69.0
R10	36.1	42.4	52.6	60.4	75.3
R11	24.1	25.3	35.7	41.0	51.0
R12	42.8	46.0	60.9	69.9	87.1
R13	37.4	44.6	53.2	61.1	76.1
R14	30.2	37.2	47.3	54.4	67.8

Receptor	100th %ile 8-Hourly Mean PC for NO_2 (µg/m³)	100th %ile 4-Hourly Mean PC for NO_2 (µg/m³)	100th %ile Hourly Mean PC for NO_2 (µg/m³)	100th %ile 30min Mean PC for NO_2 (µg/m³)[a]	100th %ile 10min Mean PC for NO_2 (µg/m³)[a]
R15	28.1	39.9	52.1	59.9	74.6
R16	15.3	20.0	30.7	35.2	43.9
R17	12.7	19.4	28.5	32.7	40.8
Max on Grid	259.3	280.1	**455.7**	523.5	652.1

a) Estimated following power law relationship from hourly concentrations, as per para 7.3.9

8.2.5. **Table 8-2** shows the maximum hourly average modelled concentrations for each scenario and the risk of exceedance of the associated risk of exceedance of the hourly mean objective of 200µg/m³. All risks of exceedance modelled at discrete receptor locations will be negligible (i.e. 0%) for the Virtus Test 1 and Virtus Test scenarios.

8.2.6. **Table 8-2** also shows that for the Emergency Scenario 2, the risk of exceedances of the objective is negligible at discrete receptor locations and low risk (i.e. 10%) as a maximum on the grid; within 111m of the Site boundary.

Table 8-2 – Maximum modelled average hourly impacts for Virtus Test 1, Virtus Test 2 and Emergency Scenario 2. The maxima are taken over 5 years of modelled meteorological data. Data in bold exceed one or more of the Standards (without the addition of background concentrations).

Receptor	Virtus Test 1		Virtus Test 2		Emergency Scenario 2	
	100th %ile Hourly Mean PC for NO_2 (µg/m³)	Risk of exceedance of objective (200µg/m³)	100th %ile Hourly Mean PC for NO_2 (µg/m³)	Risk of exceedance of objective (200µg/m³	100th %ile Hourly Mean PC for NO_2 (µg/m³)	Risk of exceedance of objective (200µg/m³
R1	4.3	0%	18.3	0%	109.2	0%
R2	2.7	0%	12.9	0%	56.0	0%
R3	3.2	0%	13.3	0%	75.7	0%
R4	3.4	0%	13.4	0%	81.9	0%
R5	1.1	0%	6.1	0%	29.6	0%
R6	1.8	0%	8.3	0%	41.0	0%
R7	2.0	0%	8.8	0%	41.4	0%
R8	1.0	0%	5.5	0%	29.4	0%
R9	2.1	0%	8.5	0%	48.2	0%

Receptor	Virtus Test 1		Virtus Test 2		Emergency Scenario 2	
	100th %ile Hourly Mean PC for NO_2 (µg/m³)	Risk of exceedance of objective (200µg/m³)	100th %ile Hourly Mean PC for NO_2 (µg/m³)	Risk of exceedance of objective (200µg/m³	100th %ile Hourly Mean PC for NO_2 (µg/m³)	Risk of exceedance of objective (200µg/m³
R10	2.4	0%	10.3	0%	52.6	0%
R11	1.5	0%	7.8	0%	35.7	0%
R12	2.7	0%	10.5	0%	60.9	0%
R13	2.4	0%	9.1	0%	53.2	0%
R14	2.1	0%	7.9	0%	47.3	0%
R15	2.2	0%	8.4	0%	52.1	0%
R16	1.1	0%	5.7	0%	30.7	0%
R17	1.0	0%	5.2	0%	28.5	0%
Max on Grid	35.3	0%	142.8	**0%**	**455.7**	10%

9 ECOLOGICAL ASSESSMENT RESULTS

9.1 ANNUAL MEAN IMPACTS

9.1.1. The results of the dispersion modelling show that there is a negligible impact on annual mean NO_x concentrations and nitrogen deposition during both Virtus Test 1 and Virtus Test 2. Given the limited number of generators on Site, the impacts from testing on annual means are negligible and are therefore not considered further.

9.1.2. **Table 9-1** shows that annual average impacts on NO_X concentrations and nitrogen deposition are negligible for Emergency Scenario 2.

Table 9-1 – Annual mean NO_X impacts over designated ecological sites for Emergency Scenario 2

ID	Site	Annual mean nitrogen deposition (N-dep) (kgN/ha/yr)	N-dep as % of Critical Load	Annual mean PC for NO_x ($\mu g/m^3$)	Annual mean as % of Critical Level
E1	Southwest London Waterbodies Ramsar/SPA	0.0004	0.002%	<0.01	0.0%
E2	Southwest London Waterbodies Ramsar/SPA	0.0006	0.003%	0.01	0.0%
E3	Southwest London Waterbodies Ramsar/SPA	0.0008	0.004%	0.01	0.0%
E4	Southwest London Waterbodies Ramsar/SPA	0.0004	0.002%	<0.01	0.0%
E5	Southwest London Waterbodies Ramsar/SPA	0.0004	0.002%	<0.01	0.0%
E6	Richmond Park SAC	0.0012	0.01%	0.01	0.0%
E7	Airlinks Pond SLINC	0.0353	0.35%	0.17	0.6%
E8	Thornecliff Waste SLINC	0.0085	0.09%	0.04	0.1%
E9	Hartlands Wood & Lower Park Farm SLINC	0.0158	0.16%	0.08	0.3%
E10	SMINC	0.0352	0.35%	0.17	0.6%
E11	SMINC	0.0240	0.24%	0.12	0.4%

9.1.3. **Table 9-2** shows that in the Emergency Scenario 2, the risk of exceedance of the daily mean critical level at international ecological sites is negligible; even when assuming that an outage occurs every year. There is however, a high risk of exceedances at local sites. The probability of an exceedance a local sites decreases to less than 20% if an outage was to occur every 1 in 10 years and decreases to less than 10% if an outage were to occur every 1 in 20 years. ***Impacts are therefore likely to be moderate risk.***

9.1.4. **Table 9-2** also shows that in the Virtus Test 1 scenario, the risk of exceedance of the daily mean critical level at all ecological sites modelled is negligible. With regards to Virtus Test 2, in this scenario there is a negligible risk of exceedance of the critical level at all sites with the only exception of Hartlands Wood & Lower Park Farm SLINC and E10 SIMC at which there is a high risk of exceedance.

Table 9-2 – Daily mean NO_X impacts over designated ecological sites for all modelled scenarios

ID	Site	Virtus Test 1 Scenario		Virtus Test 2 Scenario		Emergency Scenario 2	
		100th %ile Daily mean PC for NO_x ($\mu g/m^3$)	Probability of Exceedance of Critical Level	100th %ile Daily mean PC for NO_x ($\mu g/m^3$)	Probability of Exceedance of Critical Level	100th %ile Daily mean PC for NO_x ($\mu g/m^3$)	Probability of Exceedance of Critical Level
E1	Southwest London Waterbodies Ramsar/SPA	0.6	0%	0.9	0%	5.7	0%
E2	Southwest London Waterbodies Ramsar/SPA	0.8	0%	1.1	0%	8.4	0%
E3	Southwest London Waterbodies Ramsar/SPA	0.9	0%	1.4	0%	10.5	0%
E4	Southwest London Waterbodies Ramsar/SPA	0.7	0%	1.4	2%	10.5	0%
E5	Southwest London Waterbodies Ramsar/SPA	0.6	0%	1.2	0%	8.8	0%

ID	Site	Virtus Test 1 Scenario		Virtus Test 2 Scenario		Emergency Scenario 2	
		100th %ile Daily mean PC for NO_x (µg/m^3)	Probability of Exceedance of Critical Level	100th %ile Daily mean PC for NO_x (µg/m^3)	Probability of Exceedance of Critical Level	100th %ile Daily mean PC for NO_x (µg/m^3)	Probability of Exceedance of Critical Level
E6	Richmond Park SAC	0.6	0%	1.0	2%	7.4	0%
E7	Airlinks Pond SLINC	20.4	0%	33.7	0%	224.4	100%
E8	Thornecliff Waste SLINC	6.9	0%	10.3	0%	56.3	16%
E9	Hartlands Wood & Lower Park Farm SLINC	17.7	0%	34.8	8%	202.7	91%
E10	SMINC	22.8	0%	54.9	26%	345.7	100%
E11	SMINC	13.9	0%	24.4	0%	165.4	100%

10 ASSESSMENT SUMMARY

10.1 HUMAN HEALTH

10.1.1. ***No significant health effects are likely with the operation of the generators on the Slough Campus***.

10.1.2. With the proposed routine generator testing regime for the Site, there is an insignificant risk of exceedance of either the UK's air quality objective for hourly mean NO_2 or the AEGLs 1 – 3.

10.1.3. With the emergency power outage scenario, the risk of exceedance of AEGLs 1 - 3 is also negligible. Average exposure at longer timescales (30mins, 1hr, 4hr, 8hr) does not exceed AEGL-1.

10.1.4. The risk of exceedance of the UK's air quality objective for hourly mean NO_2 is limited to a zone within 11m south of the Site, where exposure of members of the public is likely to be transient.

10.2 ECOLOGY

10.2.1. ***No significant effects on ecological sites are likely***.

10.2.2. Annual average impacts on NO_X concentrations and nitrogen deposition are negligible for all scenarios (routine testing and emergency outage.

10.2.3. Under the emergency outage scenario, there is a risk of exceedance of the daily mean critical level for NO_X. However, taking into account the likelihood of occurrence of a 72-hour complete site power outage, the risk of impacts is negligible.

Appendix A

GLOSSARY

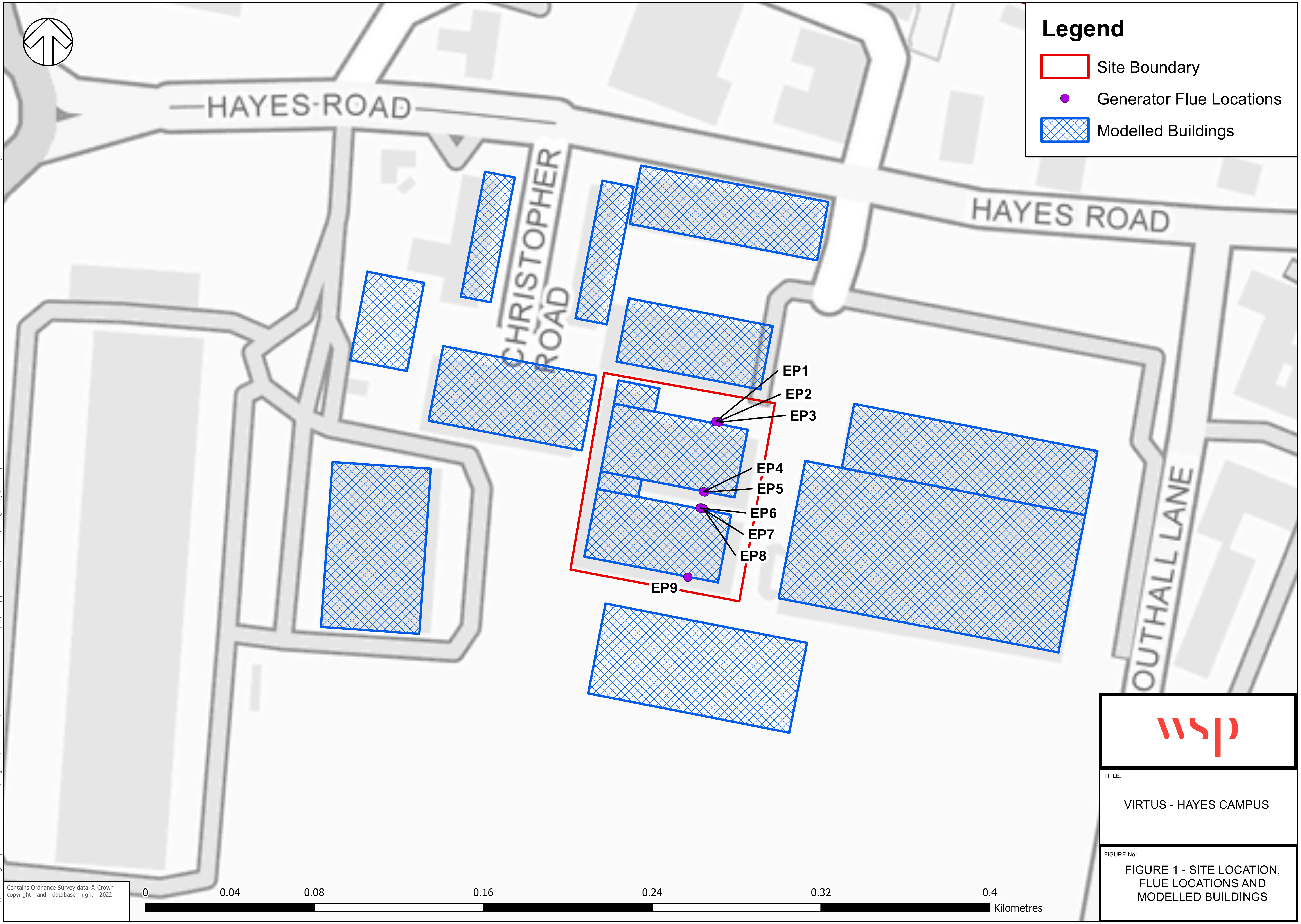
Table A-1 – Glossary of terms

Term	Definition
ADMS	Atmospheric Dispersion Modelling Software
AEGL	Acute Exposure Guideline Level
AERA	Air Emissions Risk Assessment
Air quality objective	Policy target generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedances within a specific timescale (see also air quality standard).
Air quality standard	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 of each pollutant on human health include the effects on sensitive subgroups (see also air quality objective).
Ambient air	Outdoor air in the troposphere, excluding workplace air.
Annual mean	The average (mean) of the concentrations measured for each pollutant for one year.
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
AQS	Air Quality Standards
CMS	Continuous Monitoring Site
Conservative	Tending to over-predict the impact rather than under-predict.
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EAL	Environmental Assessment Level
Emission rate	The quantity of a pollutant released from a source over a given period of time.
Exceedance	A period of time where the concentration of a pollutant is greater than the appropriate air quality standard.
LAQM	Local Air Quality Management
LBH	London Borough of Hillingdon
LNR	Local Nature Reserve
LWS	Local Wildlife Site
MAGIC	Multi-Agency Geographic Information for the Countryside

Term	Definition
NNR	National Nature Reserve
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
PC	Process Contribution
PEC	Predicted Environmental Concentration
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 micrometres.
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5 micrometres.
SAC	Special Area of Conservation
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
$\mu g/m^3$ micrograms per cubic metre	A measure of concentration in terms of mass per unit volume. A concentration of $1\mu g/m^3$ means that one cubic metre of air contains one microgram (millionth of a gram) of pollutant.

Appendix B

FIGURES



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TITLE:

VIRTUS - HAYES CAMPUS

FIGURE No:

FIGURE 1 - SITE LOCATION, FLUE LOCATIONS AND MODELLED BUILDINGS

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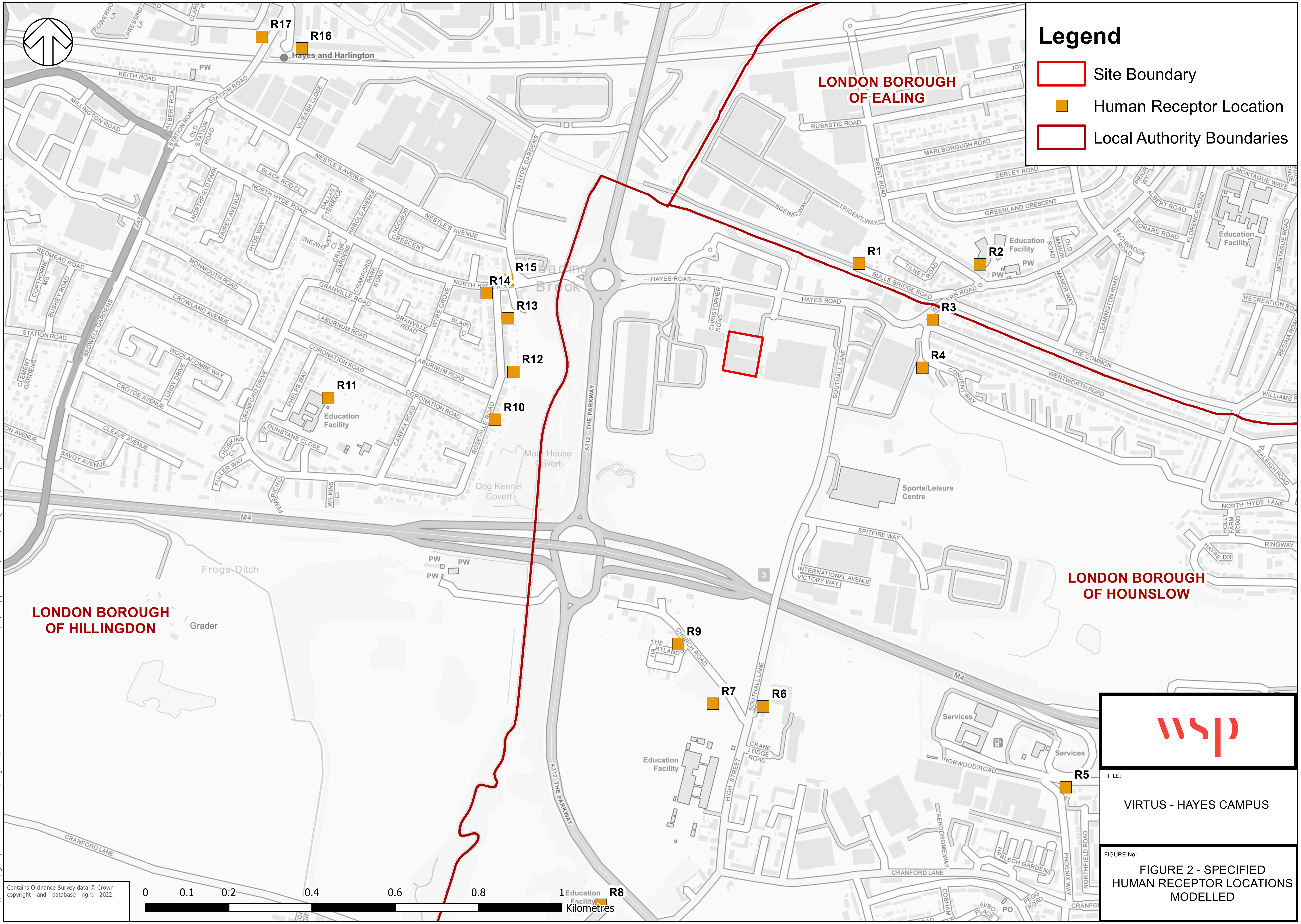
Drawn By: RR

Date Modified: AUGUST 2022



TITLE: VIRTUS - HAYES CAMPUS

FIGURE No: FIGURE 2 - SPECIFIED HUMAN RECEPTOR LOCATIONS MODELLED

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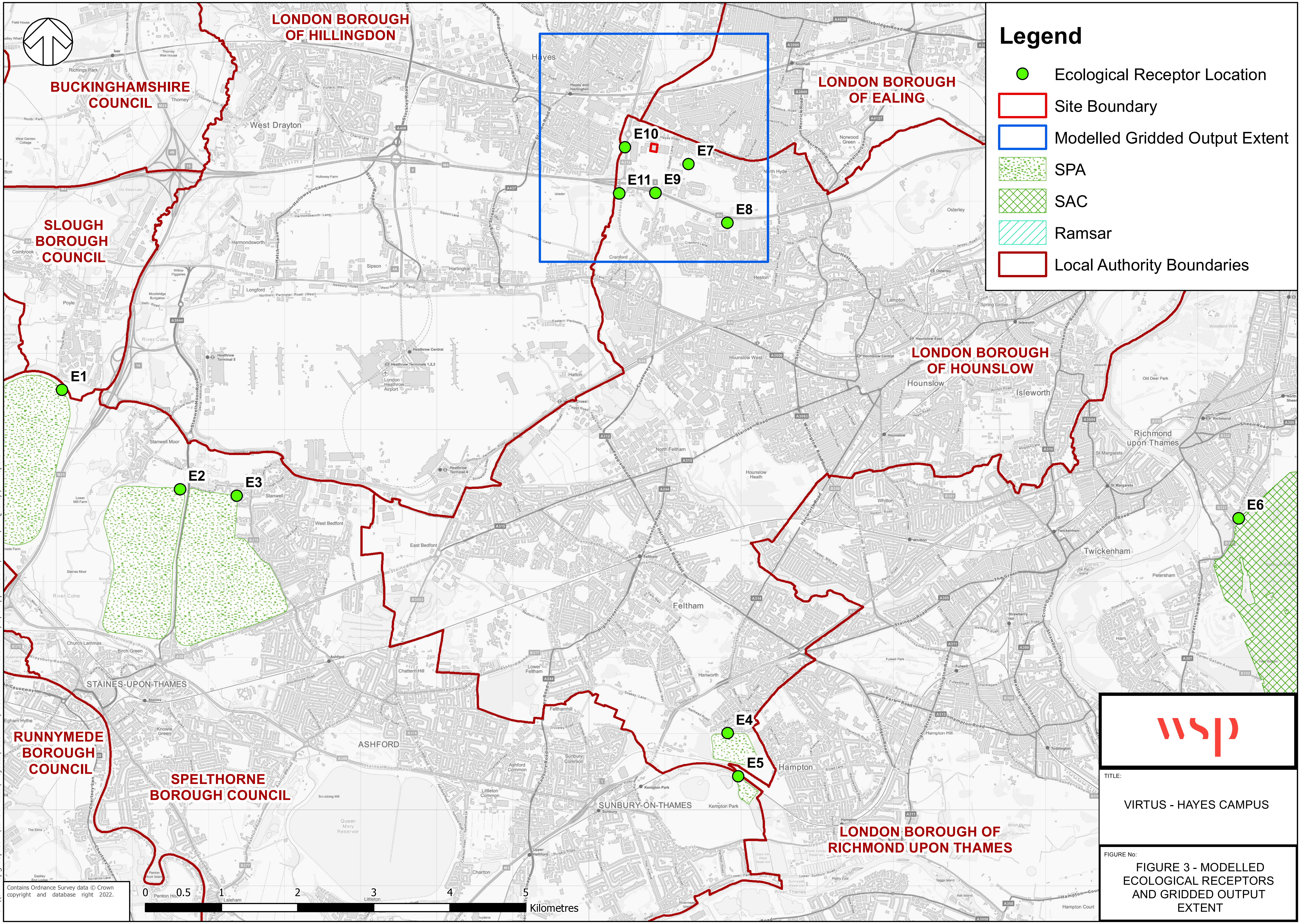

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VIRTUS - HAYES CAMPUS

FIGURE No:
FIGURE 3 - MODELLED ECOLOGICAL RECEPTORS AND GRIDDED OUTPUT EXTENT

Appendix C

GENERATOR FLUE PARAMETERS

Table C-1 - Flue parameters and emissions used in the Virtus Test 1 modelled scenario (Off-load, Based on Worst Case Mitsubishi Engine at 10% load)

Flue ID	Model ID	Generators represented *	X, Y	Stack Height (m)	Internal Stack Diameter (m)*	Stack efflux velocity (m/s)	Efflux temperature (˚C)	Exhaust actual volumetric flow rate (m^3/s)	NO_x emissions per generator (g/s)
EP3	Mitsubishi	All	510876.6, 178734.0	17.4	0.6	7.23	223	2.04	0.6577
EP9	Mitsubishi	All	510861.8, 178660.5	17.4	0.6	7.23	223	2.04	0.6577
*The output from each source is considered individually in the model.									

Table C-2 - Flue parameters and emissions used in the Virtus Test 2 modelled scenario (Onload, Worst Case based on bulk exhaust parameters from Mitsubishi Engine at 75% load, emissions average of 20mins @ 100% load plus 40 mins at 75% load)

Flue ID	Model ID	Generators represented*	X, Y	Stack Height (m)	Internal Stack Diameter (m)*	Stack efflux velocity (m/s)	Efflux temperature (˚C)	Exhaust actual volumetric flow rate (m^3/s)	NO_x emissions per generator (g/s)
EP3	Mitsubishi	All	510876.6, 178734.0	17.4	0.6	29.36	490	8.3	5.81
EP9	Mitsubishi	All	510861.8, 178660.5	17.4	0.6	29.36	490	8.3	5.81
*The output from each source is considered individually in the model.									

Table C-4 – Flue parameters and emissions used in the Virtus Emergency 2 Scenario (See Table 3-1 and Section 7.2 for assumptions used in calculating emissions)

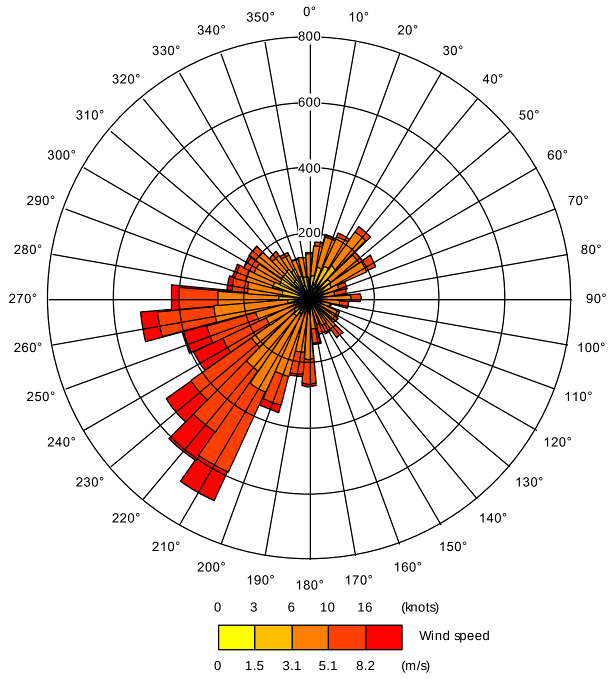
Flue ID	Generator Model	Generators represented*	X, Y	Stack Height (m)	Internal Stack Diameter (m)*	Stack efflux velocity (m/s)	Efflux temp-erature (˚C)	Exhaust actual volumetric flow rate (m^3/s)	NO_x emission per generator (g/s)
Source001	Mitsubishi	EP1, EP2, EP3	510875.8, 178734.1	17.40	0.85	29.36	490.00	16.66	17.43
Source002	Mitsubishi and MTU	EP4, EP5	510869.5, 178700.8	17.40	0.85	25.22	495.79	14.31	7.94
Source003	Mitsubishi	EP6, EP7, EP8	510868.4, 178693.2	17.40	0.85	29.36	490.00	16.66	17.43
Source004	Mitsubishi	EP9	510861.8, 178660.5	17.40	0.60	29.36	490.00	8.3	5.81

*The output from all sources is considered in combination in the model.

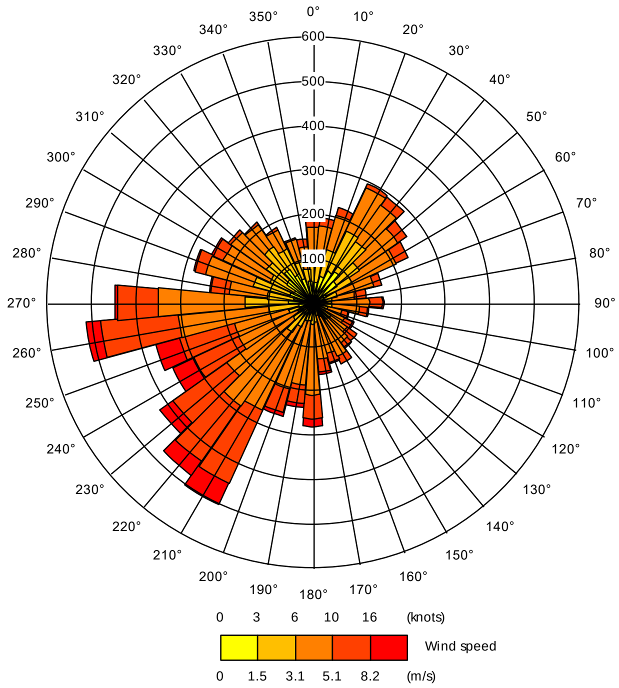
Appendix D

HEATHROW WINDROSES 2015 - 2019

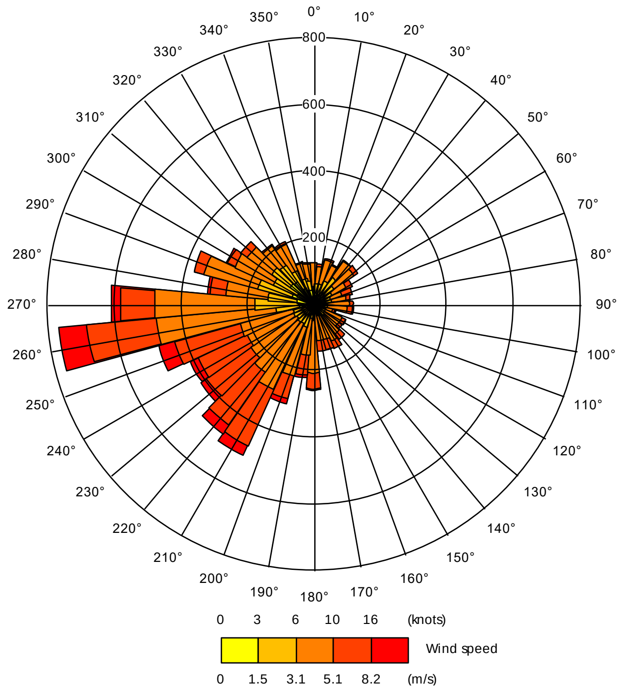
Public



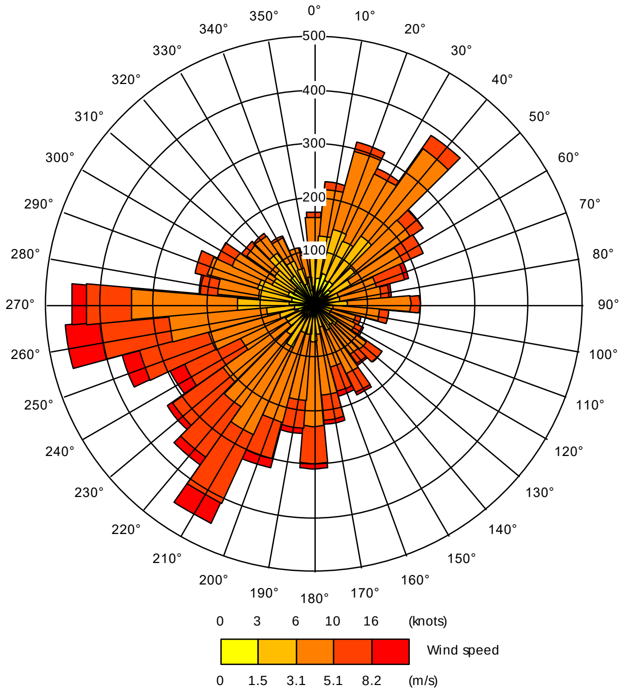
2015



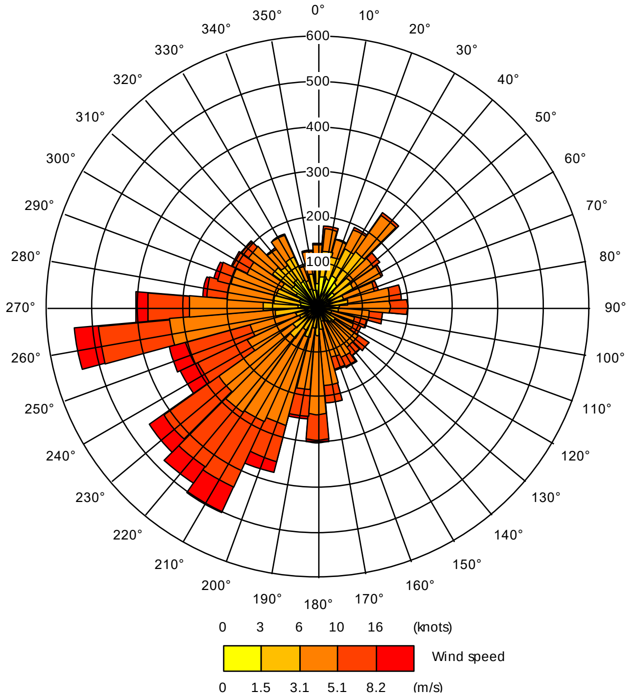
2016



2017



2018


0°
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
280°
290°
300°
310°
320°
330°
340°
350°
100
200
300
400
500
600
0 3 6 10 16 (knots)
Wind speed
0 1.5 3.1 5.1 8.2 (m/s)

2019

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