Digital Realty

Redhill Data Centre

Air Dispersion Modelling Report

April 2024

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Executive Summary

Purpose of Report

Bureau Veritas was commissioned by EcoAct, on behalf of Digital Realty, to undertake an air quality assessment[1] for 21 back-up diesel generators at the Digital Realty site in Redhill, Surrey. This assessment provided supporting technical information for an Environmental Permit application to operate the site through the Environmental Permitting Regulations (EPR) regime.

The assessment has used detailed dispersion modelling to undertake a study of emissions to air during generator operation, comprising the following scenarios:

- Scenario 1: Monthly Testing;
- Scenario 2: Quarterly Testing;
- Scenario 3: Annual Test; and
- Scenario 4: Emergency Operation.

Each of the generators are operated using diesel as the fuel, hence, the following pollutants were included in the assessment: nitrogen oxides (NO_X), sulphur dioxide (SO_2), carbon monoxide (CO) and particulate matter (PM_{10} and $PM_{2.5}$).

Release rates for PM, NO_X and CO have been derived using information provided by the generator manufacturers to EcoAct. The release rate for SO_2 has been derived based on the sulphur content of the fuel used on site, which is Ultra-Low Sulphur Diesel (ULSD). Due to the short-term nature of emissions released from the plant, results have been post-processed, where relevant, to account for the generators running limited hours within a calendar year

Following submission of the permit application, the Environment Agency (EA) requested further assessment as follows[2]:

- *"You must include an assessment against nitrogen monoxide (NO) EALs; and*
- *You must provide an acute exposure risk assessment comparing the 100th percentile NO_2 predicted environmental concentrations against appropriate exposure criteria (such as the US EPA acute exposure guideline levels - AEGLs)".*

This report includes further information along with the original assessment information to address the additional two requirements for the assessed scenarios.

Summary of Conclusions

The assessment has resulted in the following conclusions:

- Considering annual mean results for all scenarios, all results at both human and ecological receptors were below the relevant assessment metric, owing to the minimal annual operating hours of the plant. The results for nitrogen deposition show exceedances at all ecological receptors considered in the assessment. However, this is due to the background deposition rate at all receptors exceeding the minimum critical load.

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[1] Bureau Veritas, 2022. AIR13073543 Air Dispersion Modelling Report – Digital Realty, Redhill.

[2] Email dated 04/04/2024 from Environmental Agency to EcoAct.

- As such, the generators are not expected to have a significant impact on annual mean pollutant concentrations in the surrounding area.

- Considering short-term results in Scenario 1 (Monthly Testing) and Scenario 2 (Quarterly Testing, all results at human and ecological receptors were below the relevant assessment metric, apart from for the 99.79 percentile 1-hour mean NO_2 metric. However, further analysis demonstrated the results for Scenario 1 and Scenario 2 could be considered not significant, due to minimal operating hours in each scenario.

- The majority of results for Scenario 3 (Annual Test) were below the relevant assessment metric for both Units. However, exceedances were predicted for the 1-hour mean NO_2 metric for Unit 3. As with Scenario 2, annual testing hours for both Units fall below the 18 hours of permissible exceedance for 1-hour mean NO_2 concentrations, so it is not possible that Scenario 3 operation, assessed individually, would cause a true exceedance of this metric. In addition, exceedances are also predicted for 24-hour mean NO_X concentrations at ecological receptors for annual testing of Unit 3. Overall, whist the results for Scenario 3 Unit 3 testing at ecological receptors cannot be considered as not significant, there is confidence that the model demonstrates a worst-case assessment and that it is unlikely that exceedances of short-term metrics will occur.

- Regarding Scenario 4, exceedances were predicted for 1-hour mean NO_2 concentrations at human receptors for both units for emergency operation. Exceedances were also predicted for 24-hour mean NO_X concentrations (ecological receptors) and for the 24-hour mean PM_{10} concentrations. However, emergency operation of the plant is extremely unlikely to take place, given that this only applies when there is a loss of main power to the site and that both Units have independent mains supplies.

- A further probability analysis was carried out, taking into account cumulative operating hours of all the standard testing scenarios, that is Scenario 1, 2 and 3, and using the annual operating hours recorded through 2020. This investigated the probability of exceeding the 1-hour mean NO_2 metric across both Units for a typical annual period, which demonstrated that the probability of a true exceedance was less than 0.01%.

- A further assessment was undertaken against predicted annual and 1-hour mean NO concentrations. There were no exceedances of the annual and 1-hour mean NO predicted at any receptors in any scenarios, with the exception of Scenario 4 where exceedances of the maximum 1-hour mean EAL for Unit 3 were observed. However, emergency operation of the plant is extremely unlikely to take place and coincide with the corresponding meteorological conditions that may lead to elevated NO concentrations at the assessed receptor locations.

- A further assessment was also undertaken against 1-hour mean US EPA AEGL 1 to 3 for NO_2. Exceedances of the NO_2 hourly mean US EPA AEGL 1 were predicted in Scenario 2 for Unit 3, and in Scenario 4 for both Units. US EPA AEGL 1 represents the least severe effects caused by exposure, with effects described as: "*Notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure*". There were no predicted exceedances of the US EPA AEGL 2 and 3, which represent more severe health effects, at any receptors in any scenarios.

- Due to worst-case conditions being employed through the assessment, the modelled predictions are expected to represent the upper limit of concentrations. If required, measures including assessing pollutant levels at the site boundary through ground level monitoring.

1 Introduction

Bureau Veritas have been commissioned by EcoAct, on behalf of Digital Realty, to undertake an air quality assessment for 21 back-up diesel generators located at the Digital Realty site in Redhill. This assessment provides supporting technical information for an Environmental Permit application for the site to operate through the Environmental Permitting Regulations (EPR) regime.

Each of the generators utilise diesel fuel, hence, the following pollutants were included in the assessment: nitrogen oxides (NO_X), sulphur dioxide (SO_2), carbon monoxide (CO) and particulate matter (PM_{10} and $PM_{2.5}$).

Following submission of the permit application, the Environment Agency (EA) requested further assessment information as follows[3]:

- *"You must include an assessment against nitrogen monoxide (NO) EALs; and*
- *You must provide an acute exposure risk assessment comparing the 100th percentile NO_2 predicted environmental concentrations against appropriate exposure criteria (such as the US EPA acute exposure guideline levels - AEGLs)".*

This report includes further information, along with the original assessment methodology and the subsequent results of the dispersion modelling of emissions to air, to address the additional two requirements for the assessed scenarios.

1.1 Site location

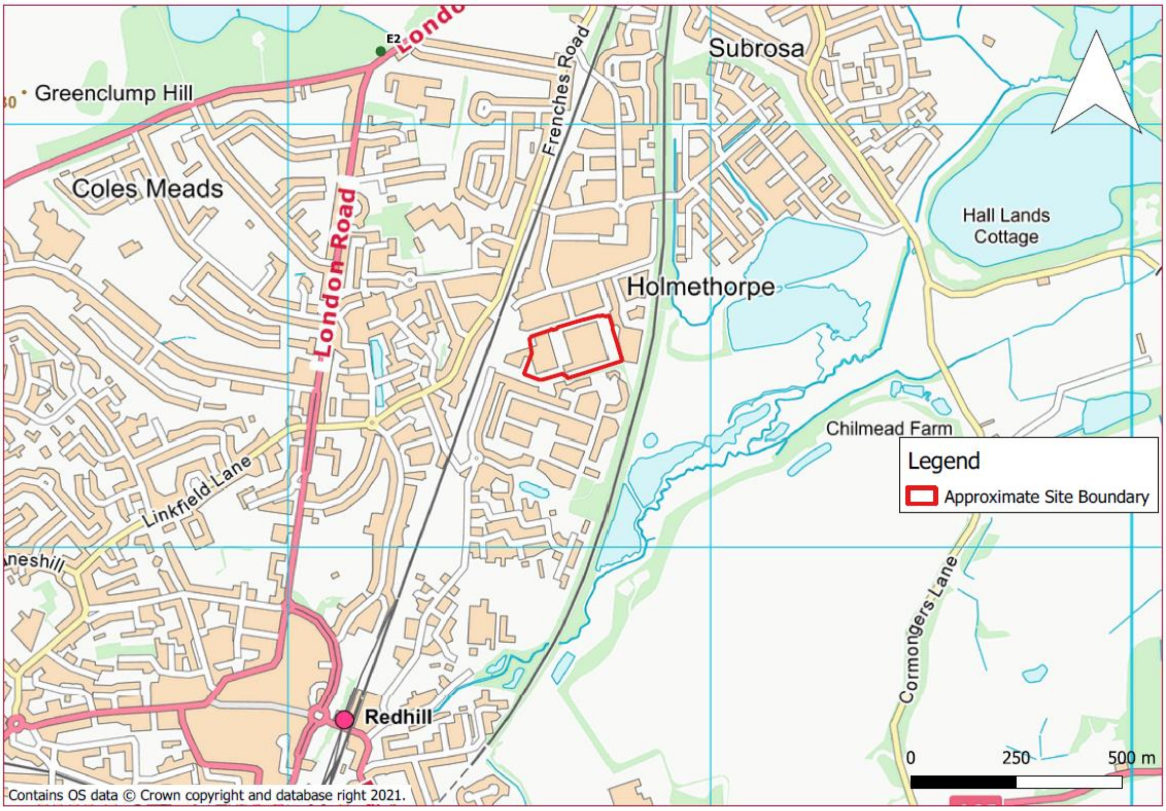
The site is located in Foxboro Business Park, about 1 km to the north east of Redhill town centre, in Surrey. The area to the north of site is primarily made up of light industry and commercial units, with Moors Nature Reserve to the east and residential areas to the south and west. The site location is shown in Figure 1.1.

The closest receptors to the site are residential properties on Goodworth Road, located within 50 m of the site boundary to the south. The closest ecological receptor, designated as Ancient Woodland, to the site is located approximately 780 m northwest of the site.

In terms of existing air quality conditions in the area, there are nine Air Quality Management Areas (AQMAs) declared within the jurisdiction of Reigate and Banstead Borough Council. The closest AQMA to the site is AQMA No. 12, located in Redhill town centre, and this is declared for concentrations of annual mean nitrogen dioxide (NO_2).

[3] Email dated 04/04/2024 from Environmental Agency to EcoAct.

Figure 1.1 - Site Location



2 Dispersion Modelling Methodology

ADMS 5 version 5.2 modelling software was used for this study. ADMS 5 is an advanced atmospheric dispersion model that has been developed and validated by Cambridge Environmental Research Consultants (CERC). The model was used to predict ground level concentrations of combustion products emitted to atmosphere from the generators at the Redhill site. The model is used extensively throughout the UK for regulatory compliance purposes. It is accepted as an appropriate air quality modelling tool by the Environment Agency (EA) and local authorities.

ADMS 5 parameterises stability and turbulence in the Atmospheric Boundary Layer (ABL) by the Monin-Obukhov length and the boundary layer depth. This approach allows the vertical structure of the ABL to be more accurately defined than by the stability classification methods of earlier dispersion models such as R91 or ISCST3. In ADMS, the concentration distribution follows a symmetrical Gaussian profile in the vertical and crosswind directions in neutral and stable conditions. However, the vertical profile in convective conditions follows a skewed Gaussian distribution to take account of the inhomogeneous nature of the vertical velocity distribution in the Convective Boundary Layer (CBL).

A number of complex modules, including the effects of plume rise, complex terrain, coastlines, concentration fluctuations, radioactive decay and buildings effects, are also included in the model, as well as the facility to calculate long-term averages of hourly mean concentration, dry and wet deposition fluxes, and percentile concentrations, from either statistical meteorological data or hourly average data.

A range of input parameters is required for the model. This includes, but is not limited to, data describing the local area, meteorological measurements, and emissions data. The data utilised within the modelling assessment is detailed in the following sections of this chapter.

2.1 Process Emissions

Details of the generators at the Digital Realty Redhill site have been provided to Bureau Veritas by EcoAct. The assessment has assumed the following numbers of generators (gens) across the two buildings (units) at the site:

- Unit 2 – Five gens total, made up of four gens at 1.6 MW_e and one gen at 0.2 MW_e (total 6.6 MW_e).

- Unit 3 – 16 gens total, made up of six gens at 1.28 MWe, nine gens at 1.6 MW_e and one gen at 0.22 MW_e (total 22.3 MW_e).

The total aggregated capacity of the site is therefore 28.9 MW_e. The model input parameters for each type of generator are detailed in Table 2.1.

Release rates for PM, NO_X and CO have been derived from information provided by the generator manufacturer or appropriate emissions standards. The release rate for SO_2 has been derived based on the sulphur content of the fuel used on site, which has been confirmed as being Ultra-Low Sulphur Diesel (ULSD).

All generators have been modelled as vertical point sources. Despite one generator being a horizontal release, due to model limitations, it was considered appropriate to model all sources as vertical releases, to demonstrate a worst-case assessment.

The calculations which have been undertaken to derive pollutant emission rates from information provided by the generator manufacturers are detailed in Table A1 of Appendix A. Assumed grid locations, taken from GIS, for each generator are provided in Table A2 of Appendix A.

Table 2.1 - Model Input Parameters

Parameter	Cummins QSK60-G3 2020	Cummins 6CTAA8.3G2	CAT 3512 GD	Cummins QSK60-G3	CAT GEH275-2
Number of Generators [a]	4	1	6	9	1
Rated Output (MW_e)	1.6	0.2	1.28	1.6	0.22
Stack Height (m) [b]	8.5	2.3	8	8.5	6.6
Stack Diameter (m) [b]	0.4	0.4	0.4	0.4	0.4
Efflux Velocity (m s^{-1})	41.55	5.49	29.35	35.32	5.76
Efflux Temperature (°C) [c]	475	580	423	475	500
Emission Concentrations and Rates (per generator)[d]					
NO_X (mg/m^3)	4359	9.2 (g/kWh)	1830.3	4359	6 (g/kWh)
NO_X (g/s)	6.74	0.51	2.148	5.73	0.37
SO_2 (mg/m^3)	1.28	1.28	1.28	1.28	1.28
SO_2 (g/s)	0.0020	0.0002	0.0015	0.0017	0.0003
CO (mg/m^3)	454	5 (g/kWh)	134.2	454	3.5 (g/kWh)
CO (g/s)	0.70	0.28	0.158	0.60	0.21
PM_{10} (mg/m^3)[e]	65	0.5 (g/kWh)	35.3	65	0.2 (g/kWh)
PM_{10} (g/s)	0.10	0.03	0.041	0.09	0.01

[a] Number of generators provided by EcoAct.

[b] Information provided by EcoAct.

[c] Temperature taken from generator specification sheets.

[d] Emission Rates for PM, NO_X and CO have been derived from emission information provided by generator manufacturers or appropriate emissions standards. The emission rate for SO_2 has been derived based on the sulphur content of the fuel used on site, which is known to be no greater than 0.001%.

[e] Ratio of emission between PM_{10} and $PM_{2.5}$ not known, therefore the emission rate for PM_{10} has also been used as a proxy for the emission of $PM_{2.5}$, as a conservative assumption.

The following scenarios have been included in this assessment, based on operating information provided by EcoAct.

Table 2.2 – Modelled Scenarios

Scenario No.	Scenario Name	Unit 2 Testing – Total 5 Gens	Unit 3 Testing – Total 16 Gens
1	Monthly testing	Two gens tested at a time (10 mins) and landlord gen tested on its own (10 mins).	Individual gen tested at a time (10 mins).
2	Quarterly testing	Two gens tested at a time for (20 mins) and landlord gen tested on its own (20 mins).	Each suite tested at a time, maximum three gens running at a time (20 mins).
3	Annual testing	Two gens at a time are tested for 1 hour. Landlord gen tested on its own (1 hour).	Each gen is run for 1 hour. Each gen is run individually.
4	Emergency	All four gens fire and then ramp down to two gens running to meet the site load - 24 hours for five days.	All gens fire and 12 gens (two in each data hall suite, plus S150 generator and landlord) keep running - 24 hours for five days.

Source groups have been used in the dispersion model to account for groups of generators running simultaneously in each of the scenarios considered.

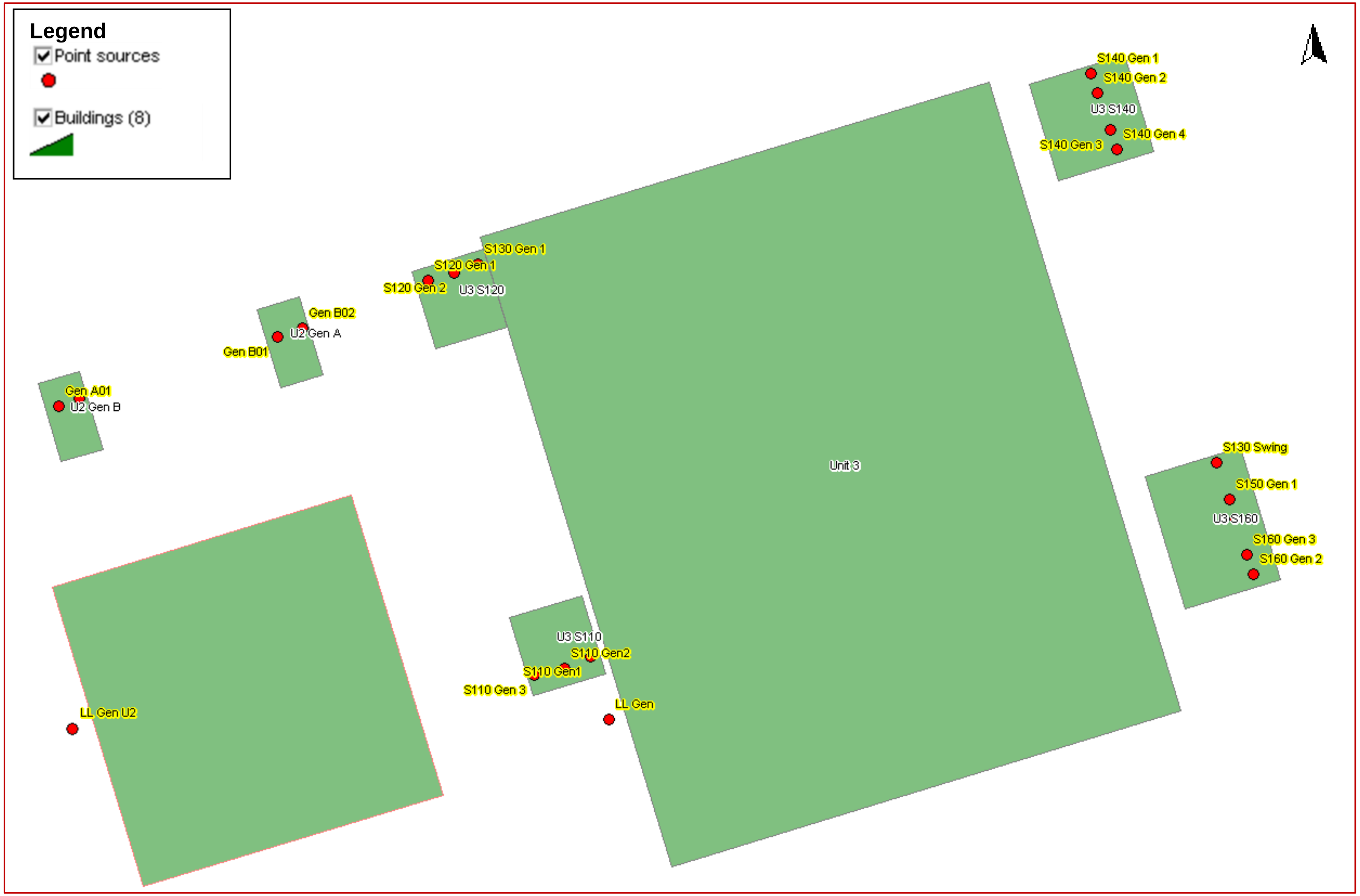
Since it is not known the exact time during the year when the gensets will operate, the model has assumed that they can operate any hour of the year. However, due to the short-term nature of operation of the plant, results have been post-processed to account for short-term averaging periods, according to the follow:

- For annual averaging periods, result have been post-processed using the factor n/8760, where 'n' is the total operating hours within an annual period.
- For averaging periods of 24 hours or 8 hours, results have been post-processed using the factor n/24, or n/8, where 'n' is the total operating hours within the relevant period.
- Where generators are tested for periods less than one hour, results have been post-processed using the factor n/60, where 'n' is the total operating minutes within an hour.

It is understood that Unit 2 and Unit 3 testing is not undertaken on the same day, therefore the maximum number of generators that may be running at any one time will be as a result of testing on Unit 3.

In the event of mains power failure, Unit 2 and Unit 3 have independent power supplies to each unit. It is therefore unlikely that the whole site will lose power completely, and it is extremely unlikely that all generators will need to operate simultaneously.

Figure 2.1 - Emission Points Visualisation



2.2 Meteorology

For meteorological data to be suitable for dispersion modelling purposes, a number of meteorological parameters need to be measured on an hourly basis. These parameters include wind speed, wind direction, cloud cover and temperature. There are only a limited number of monitoring sites where the required meteorological measurements are made. The year of meteorological data that is used for a modelling assessment can also have a significant effect on ground level concentrations.

This assessment has utilised meteorological data recorded at Charlwood meteorological station during across a five-year period (2016 to 2020). Charlwood meteorological station is located approximately 12.5 km to the south west of the Redhill site and offers data in a suitable format for the model. Figures 2.2 – 2.6 illustrate the frequency of wind directions and wind speeds for the years considered.

ADMS cannot, as standard, model calm weather conditions, since this results in a discontinuity produced by a 'divide by zero' calculation. Most Gaussian plume models simply skip lines of meteorological data where calm conditions occur. Met lines will also be skipped where any of the required meteorological input parameters are missing. The generally accepted best practice requirement is to ensure that no more than 10% of meteorological data is omitted from the model run.

Table 2.3 demonstrates that this requirement was not satisfied for the meteorological 'met' data years proposed for the assessment. As such, the model was run with the 'Calms' module applied, which adjusts the default minimum wind speed from 0.75 m/s to 0.3 m/s, allowing the model to include calculations for an increased number of met lines. This is presented in Table 2.4.

Table 2.3 – Meteorological Data Capture – No Calms

Year	Number of met lines used	Number of lines with calm conditions	Number of lines with inadequate data	Number of non-calm met lines with wind speed less than the minimum value of 0.75 m/s	Percentage of lines used
2016	6661	264	96	1763	76%
2017	6647	206	294	1613	76%
2018	6780	242	233	1505	77%
2019	6586	316	107	1751	75%
2020	6657	242	511	1374	76%

Table 2.4 – Meteorological Data Capture – Including Calms

Year	Number of met lines used	Number of lines with inadequate data	Percentage of lines used
2016	8688	96	99%
2017	8466	294	97%
2018	8527	233	97%
2019	8653	107	99%
2020	8273	511	94%

Figure 2.2 - 2016 Charlwood Wind Rose

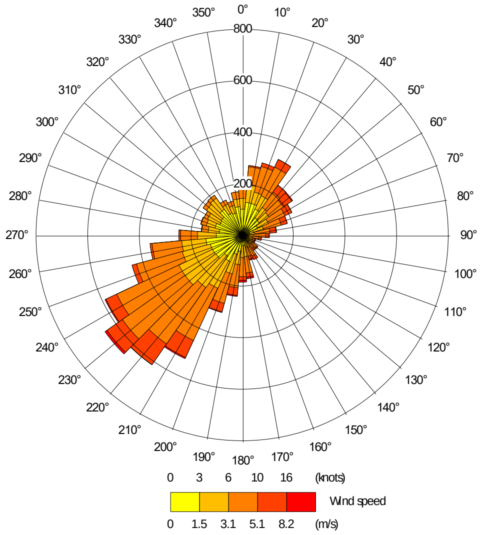


Figure 2.3 - 2017 Charlwood Wind Rose

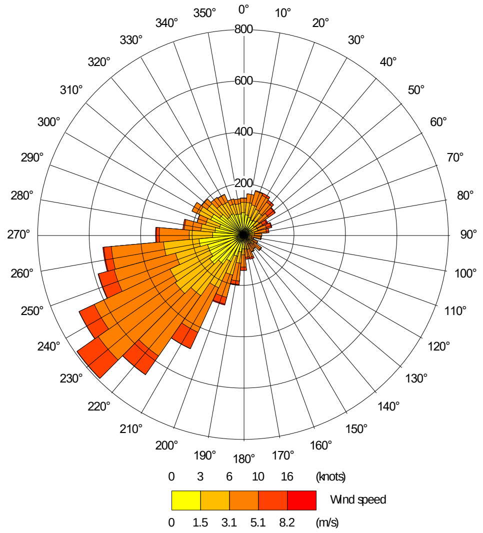


Figure 2.4 - 2018 Charlwood Wind Rose

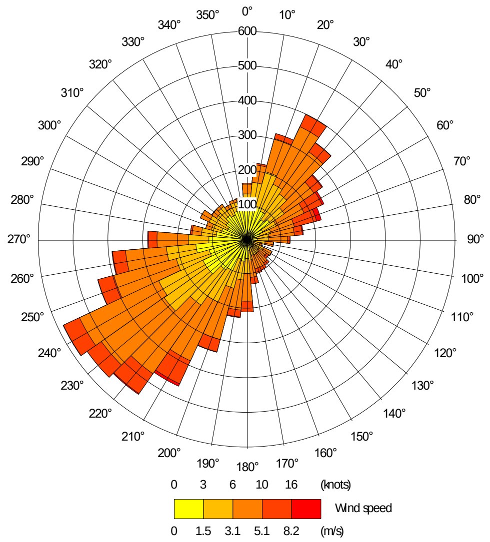


Figure 2.5 - 2019 Charlwood Wind Rose

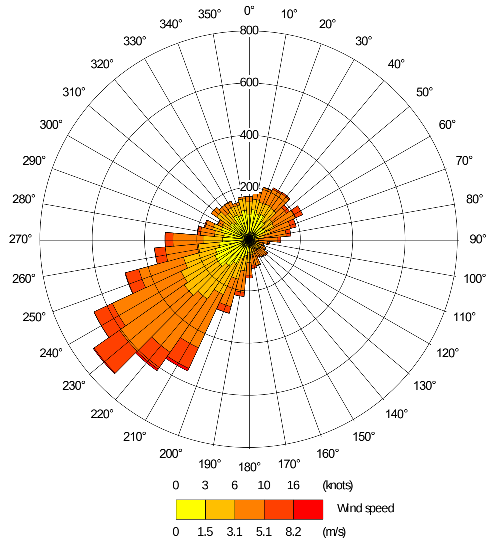
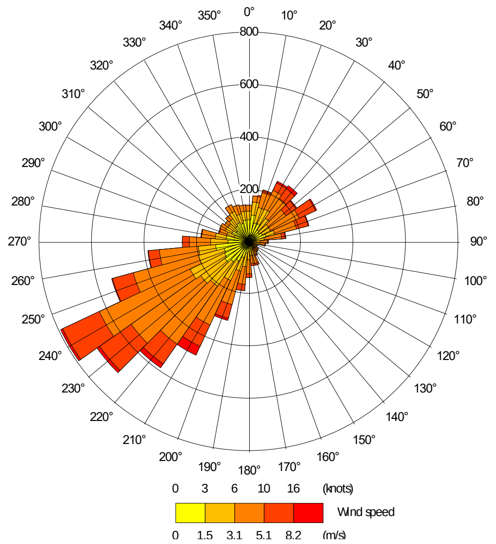


Figure 2.6 - 2020 Charlwood Wind Rose



2.3 Surface Characteristics

The predominant surface characteristics and land use in a model domain have an important influence in determining turbulent fluxes and, hence, the stability of the boundary layer and atmospheric dispersion. Factors pertinent to this determination are detailed below.

2.3.1 Surface Roughness

Roughness length, z_0, represents the aerodynamic effects of surface friction and is physically defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing.

The surface roughness length is related to the height of surface elements; typically, the surface roughness length is approximately 10% of the height of the main surface features. Thus, it follows that surface roughness is higher in urban and congested areas than in rural and open areas. Oke (1987) and CERC (2003) suggest typical roughness lengths for various land use categories (Table 2.5).

Table 2.5 - Typical Surface Roughness Lengths for Various Land Use Categories

Type of Surface	z_0 (m)
Ice	0.00001
Smooth snow	0.00005
Smooth sea	0.0002
Lawn grass	0.01
Pasture	0.2
Isolated settlement (farms, trees, hedges)	0.4
Parkland, woodlands, villages, open suburbia	0.5-1.0
Forests/cities/industrialised areas	1.0-1.5
Heavily industrialised areas	1.5-2.0

Increasing surface roughness increases turbulent mixing in the lower boundary layer. This can often have conflicting impacts in terms of ground level concentrations:

- The increased mixing can bring portions of an elevated plume down towards ground level, resulting in increased ground level concentrations closer to the emission source; however

- The increased mixing increases entrainment of ambient air into the plume and dilutes plume concentrations, resulting in reduced ground level concentrations further downwind from an emission source.

The overall impact on ground level concentration is, therefore, strongly correlated to the distance and orientation of a receptor from the emission source.

2.3.2 Surface Energy Budget

One of the key factors governing the generation of convective turbulence is the magnitude of the surface sensible heat flux. This, in turn, is a factor of the incoming solar radiation. However, not all solar radiation arriving at the Earth's surface is available to be emitted back to atmosphere in the form of sensible heat. By adopting a surface energy budget approach, it can be identified that, for fixed values of incoming short and long wave solar radiation, the surface sensible heat flux is inversely proportional to the surface albedo and latent heat flux.

The surface albedo is a measure of the fraction of incoming short-wave solar radiation reflected by the Earth's surface. This parameter is dependent upon surface characteristics and varies throughout the year. Oke (1987) recommends average surface albedo values of 0.6 for snow covered ground and 0.23 for non-snow covered ground, respectively.

The latent heat flux is dependent upon the amount of moisture present at the surface. The Priestly-Taylor parameter can be used to represent the amount of moisture available for evaporation:

$$\alpha = \frac{1}{S(B+1)}$$

Where:

α = Priestly-Taylor parameter (dimensionless)

$$S = \frac{s}{s+\gamma}$$

$$s = \frac{de}{dT}$$

e_s = Saturation specific humidity (kg H_2O / kg dry air)

T = Temperature (K)

$$\gamma = \frac{c_{pw}}{\lambda}$$

c_{pw} = Specific heat capacity of water (kJ kg^{-1} K^{-1})

λ = Specific latent heat of vaporisation of water (kJ kg^{-1})

B = Bowen ratio (dimensionless)

Areas where moisture availability is greater will experience a greater proportion of incoming solar radiation released back to atmosphere in the form of latent heat, leaving less available in the form of sensible heat and, thus, decreasing convective turbulence. Holstag and van Ulden (1983) suggest values of 0.45 and 1.0 for dry grassland and moist grassland respectively.

2.3.3 Selection of Appropriate Surface Characteristic Parameters for the Site

A detailed analysis of the effects of surface characteristics on ground level concentrations by Auld et al. (2002) led them to conclude that, with respect to uncertainty in model predictions:

> *"…the energy budget calculations had relatively little impact on the overall uncertainty"*

In this regard, it is not considered necessary to vary the surface energy budget parameters spatially or temporally, and annual averaged values have been adopted throughout the model domain for this assessment.

As snow covered ground is only likely to be present for a small fraction of the year, the surface albedo of 0.23 for non-snow covered ground advocated by Oke (1987) has been used whilst the model default α value of 1.0 has also been retained.

From examination of 1:10,000 Ordnance Survey maps, it can be seen that within the immediate vicinity of the site, land use is predominately light industrial and residential flats/apartments with more open land to the east. Consequently, a composite surface roughness length of 1.5 m has been deemed appropriate to take account of the respective land use categories in the model domain.

2.4 Buildings

Any large, sharp-edged object has an impact on atmospheric flow and air turbulence within the locality of the object. This can result in maximum ground level concentrations that are significantly different (generally higher) from those encountered in the absence of buildings. The building 'zone of influence' is generally regarded as extending a distance of 5L (where L is the lesser of the building height or width) from the foot of the building in the horizontal plane and three times the height of the building in the vertical plane.

The generators are housed within separate containers, which, due to the proximity of the containers to each other, have been included in the model as groups of buildings. In addition, the two units holding the data centres themselves have been modelled.

Details of the buildings included in the model are provided in Table 2.6. Unit 3 was used as the main building in the model for all Unit 3 generators. Unit 2 generator main buildings were adjusted to the relevant Unit 2 building.

Table 2.6 - Modelled Buildings

Name	Centre Easting (m)	Centre Northing (m)	Height (m)	Length / Diameter (m)	Width (m)	Angle (º)
Unit 2	528614	151439	13	50	50	343
Unit 3	528707	151473	13	105	85	343
U2 Gen A	528621	151494	5	13	7	343
U2 Gen B	528586	151482	5	13	7	343
U3 S110	528664	151446	5	13	12	343
U3 S120	528648	151501	5	13	12	343
U3 S140	528749	151530	5	16	16	343
U3 S160	528768	151465	5	22	16	343

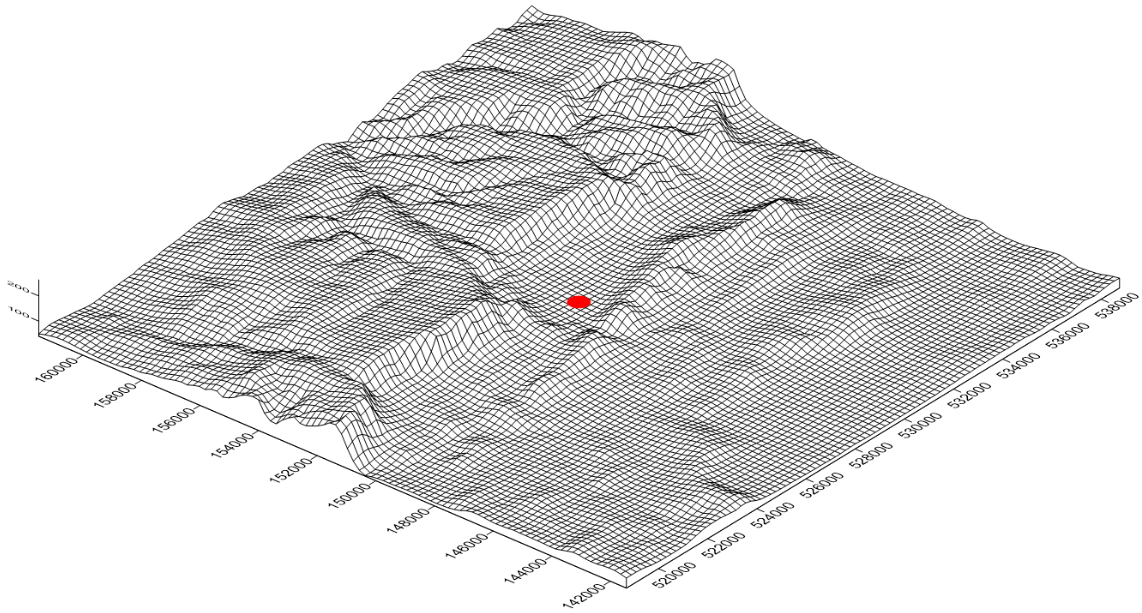
2.5 Terrain

The concentrations of an emitted pollutant found in elevated, complex terrain differ from those found in simple level terrain. There have been numerous studies on the effects of topography on atmospheric flows. A summary of the main effects of terrain on atmospheric flow and dispersion of pollutants are summarised below:

- Plume interactions with windward facing terrain features;
  - Plume interactions with terrain features whereby receptors on hills at a similar elevation to the stack experience elevated concentrations.
  - Direct impaction of the plume on hill slopes in stable conditions.
  - Flow over hills in neutral conditions can experience deceleration forces on the upwind slope, reducing the rate of dispersion and increasing concentrations.
- Plume interactions with lee sides of terrain features; and
  - Regions of recirculation behind steep terrain features can rapidly force pollutants towards the ground culminating in elevated concentrations.
  - Releases into the lee of a hill in stable conditions can also be recirculated, resulting in increased ground level concentrations.
- Plume interactions within valleys.
  - Releases within steep valleys experience restricted lateral dispersion due to the valley sidewalls. During stable overnight conditions, inversion layers develop within the valley essentially trapping all emitted pollutants. Following sunrise and the erosion of the inversion, elevated ground level concentrations can result during fumigation events.
  - Convective circulations in complex terrain due to differential heating of the valley side walls can lead to the impingement of plumes due to crossflow onto the valley sidewalls and the subsidence of plume centrelines, both having the impact of increasing ground level concentrations.

These effects are most pronounced when the terrain gradients exceed 1 in 10, i.e. a 100 m change in elevation per 1 km step in the horizontal plane. There are areas of terrain around the site that exceed this criterion and terrain has, therefore, been included within the model. A visual representation of the terrain file used is shown in Figure 2.7.

Figure 2.7 – Terrain File used in the Assessment (site indicated in red)



2.6 Modelled Domain and Receptors

2.6.1 Modelled Domain

A 1 km x 1 km Cartesian grid centred on the site was modelled, with an approximate receptor resolution of 10 m, to assess the impact of atmospheric emissions from the site on local air quality. This grid resolution has been selected to ensure that all local receptors are within the gridded area and the resolution is such that the maximum impact will be identified.

2.6.2 Human Receptors

The receptors considered were chosen based on locations where people may be located and judged in terms of the likely duration of their exposure to pollutants and proximity to the site, following the guidance given in Section 4 of this report. Details of the locations of human receptors are given in Table 2.7 and illustrated Figure 2.8 below. Human receptors have been modelled at a height of 1.5 m, representative of the normal 'breathing zone' height. In addition, some receptors have been modelled with a height of 6 m to account for residential flats.

The majority of human receptors are locations where both long-term and short-term pollutant averaging periods will apply (see Table 4.2). However, human receptors along a footpath at the adjacent Moors Nature Reserve have also been included for assessment against short-term pollutant averaging periods only, due to the potential short-term nature of exposure.

Workplace locations have been excluded in accordance with the guidance from Environmental Protection UK and the Air Quality Standards Regulations 2010. These guidance documents are detailed in Section 4 of this report.

Table 2.7 - Modelled Human Receptors

ID	Receptor Description	Easting (m)	Northing (m)	Height (m)	Note
H1	Residential	528775	151417	1.5	-
H2	Residential	528775	151417	6	-
H3	Residential	528757	151410	1.5	-
H4	Residential	528757	151410	6	-
H5	Residential	528700	151392	1.5	-
H6	Residential	528700	151392	6	-
H7	Residential	528678	151388	1.5	-
H8	Residential	528678	151388	6	-
H9	Residential	528659	151381	1.5	-
H10	Residential	528659	151381	6	-
H11	Residential	528730	151356	1.5	-
H12	Residential	528730	151356	6	-
H13	Residential	528788	151329	1.5	-
H14	Residential	528788	151329	6	-
H15	Residential	528631	151348	1.5	-
H16	Residential	528596	151358	1.5	-
H17	Residential	528534	151390	1.5	-
H18	Residential	528575	151300	1.5	-
H19	Residential	528667	151210	1.5	-
H20	Residential	528545	151348	1.5	-
H21	Residential	528431	151415	1.5	-
H22	Residential	528478	151523	1.5	-
H23	Residential	528553	151589	1.5	-
H24	Residential	528589	151600	1.5	-
H25	Residential	528510	151641	1.5	-
H26	Residential	528734	151619	1.5	-
H27	Residential	528925	151678	1.5	-
H28	Residential	528925	151678	6	-
H29	Residential	528923	151711	1.5	-
H30	Residential	528923	151711	6	-
H31	Residential	528923	151742	1.5	-
H32	Residential	528923	151742	6	-
H33	Residential	528993	151683	1.5	-
H34	Residential	529014	151663	1.5	-
H35	Residential	528991	151801	1.5	-
H36	Residential	529113	151749	1.5	-
H37	Foot path	528922	151572	1.5	Short-term only
H38	Foot path	528872	151376	1.5	Short-term only
H39	Foot path	528923	151491	1.5	Short-term only

Figure 2.8 - Location of Modelled Human Receptors

2.6.3 Ecological Receptors

The Environment Agency's AER Guidance provides the following detail regarding consideration of ecological receptors:

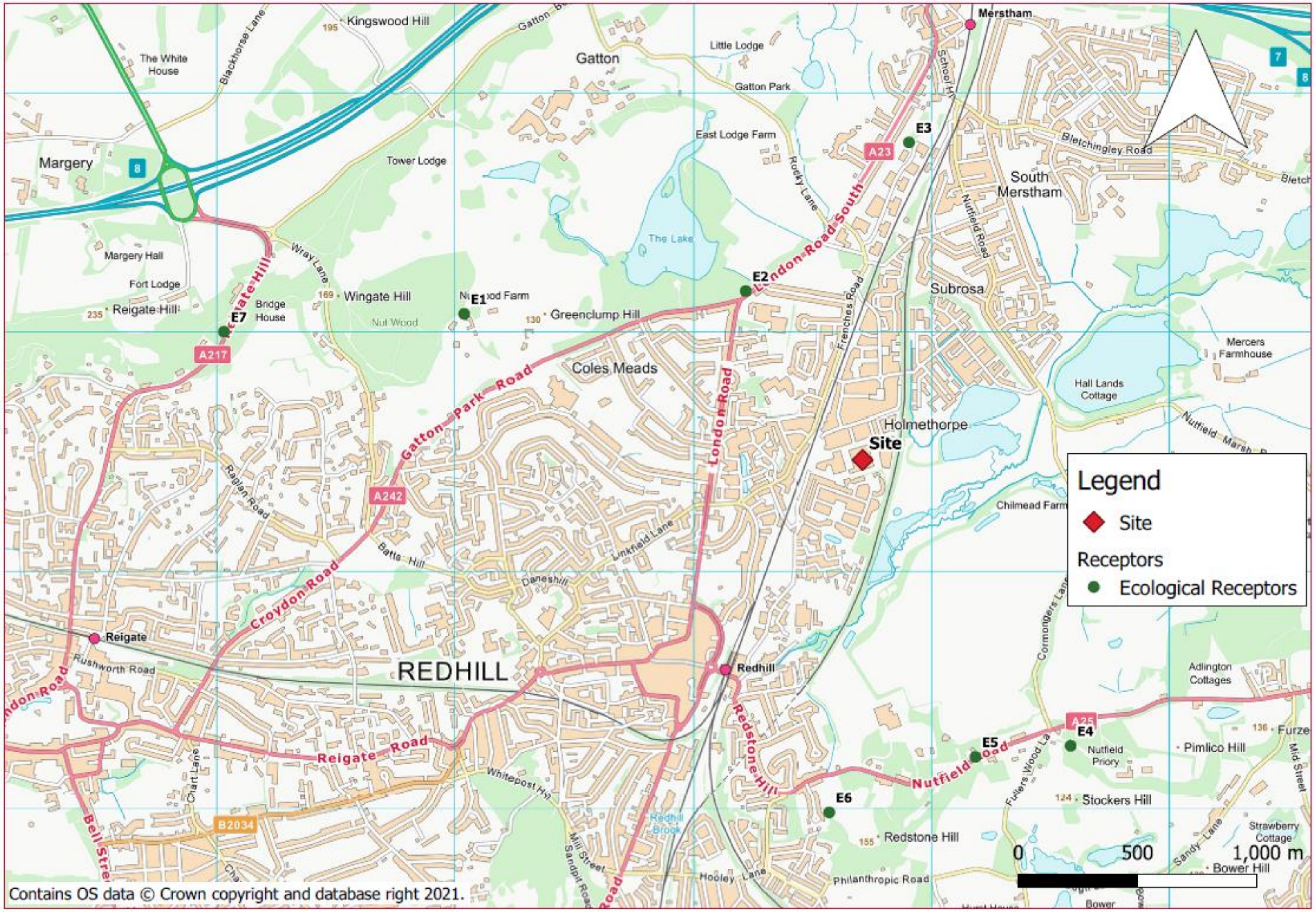
- Check if there are any of the following within 10 km of your site (within 15 km if you operate a large electric power station or refinery):
  - Special Protection Areas (SPAs)
  - Special Areas of Conservation (SACs)
  - Ramsar Sites (protected wetlands)
- Check if there are any of the following within 2 km of your site:
  - Sites of Special Scientific Interest (SSSIs)
  - Local Nature Sites (ancient woods, Local Wildlife Sites (LWS), Sites of Nature Conservation Importance (SNCIs) and national and Local Nature Reserves (LNR)).

Following the above guidance, Table 2.8 and Figure 2.9 provide details of 12 ecological receptor points which have been considered within this assessment.

Table 2.8 - Modelled Ecological Receptors

ID	Receptor Description	Easting (m)	Northing (m)	Height (m)
E1	Mole Gap to Reigate Escarpment SSSI	527038	152076	0
E2	Ancient & Semi-Natural Woodland	528220	152172	0
E3	Ancient & Semi-Natural Woodland	528906	152796	0
E4	Ancient & Semi-Natural Woodland	529585	150263	0
E5	Ancient & Semi-Natural Woodland	529185	150216	0
E6	Ancient & Semi-Natural Woodland	528571	149983	0
E7	Mole Gap to Reigate Escarpment SAC	526029	152001	0

Figure 2.9 - Location of Assessed Ecological Receptors



2.7 Deposition

The predominant route by which emissions to air will affect land in the vicinity of a process is by deposition of atmospheric emissions. Potential ecological receptors can be sensitive to the deposition of pollutants, particularly nitrogen and sulphur compounds, which can affect the character of the habitat through eutrophication and acidification.

Deposition processes in the form of dry and wet deposition remove material from a plume and alter the plume concentration. Dry deposition occurs when particles are brought to the surface by gravitational settling and turbulence. They are then removed from the atmosphere by deposition on the land surface. Wet deposition occurs due to rainout (within cloud) scavenging and washout (below cloud) scavenging of the material in the plume. These processes lead to a variation with downwind distance of the plume strength and may alter the shape of the vertical concentration profile as dry deposition only occurs at the surface.

Near to sources of pollutants (< 2 km), dry deposition is the predominant removal mechanism (Fangmeier et al. 1994). Dry deposition may be quantified from the near-surface plume concentration and the deposition velocity (Chamberlin and Chadwick, 1953);

$$F_d = v_d C(x, y, 0)$$

where:

F_d = dry deposition flux (μg m^{-2} s^{-1})

v_d = deposition velocity (m s^{-1})

$C(x, y, 0)$ = ground level concentration (μg/m^3)

Assuming irreversible uptake, the total wet deposition rate is found by integrating through a vertical column of air;

$$F_w = \int_0^z \Lambda C \; dz$$

where;

F_w = wet deposition flux (μg m^{-2} s^{-1})

Λ = washout co-efficient (s^{-1})

C = local airborne concentration (μg/m^3)

z = height (m)

The washout co-efficient is an intrinsic function of the rate of rainfall.

Environment Agency guidance AQTAG06 (Environment Agency, 2014) recommends deposition velocities for various pollutants, according to land use classification (Table 2.9).

Table 2.9 - Recommended Deposition Velocities

Pollutant	Deposition Velocity (m s^{-1})	
	Short Vegetation	Long Vegetation/Forest
NO_X	0.0015	0.003
SO_2	0.012	0.024
Source: Environment Agency (2014) 'Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air', AQTAG06 Updated Version (March 2014)'		

In order to assess the impacts of deposition, habitat-specific critical loads and critical levels have been created. These are generally defined as (e.g. Nilsson and Grennfelt, 1988):

> *"a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"*

It is important to distinguish between a critical load and a critical level. The critical load relates to the quantity of a material deposited from air to the ground, whilst critical levels refer to the concentration of a material in air. The UK Air Pollution Information System (APIS) provides critical load data for ecological sites in the UK.

The critical loads used to assess the impact of compounds deposited to land which result in eutrophication and acidification are expressed in terms of kilograms of nitrogen deposited per hectare per year (kg N ha^{-1} y^{-1}) and kilo equivalents deposited per hectare per year (keq ha^{-1} y^{-1}). To enable a direct comparison against the critical loads, the modelled total wet and dry deposition flux (µg m^{-2} s^{-1}) must be converted into an equivalent value.

For a continuous release, the annual deposition flux of nitrogen can be expressed as:

$$F_{NTot} = \left(\frac{K_2}{K_3}\right) \cdot t \cdot \sum_{i=1}^{T} F_i \left(\frac{M_N}{M_i}\right)$$

where:

F_{NYot} = Annual deposition flux of nitrogen (kg N ha^{-1} y^{-1})

K_2 = Conversion factor for m^2 to ha (= 1x104 m^2 ha^{-1})

K_3 = Conversion factor for µg to kg (= 1x109 µg kg^{-1})

t = Number of seconds in a year (= 3.1536x107 s y^{-1})

i = 1,2,3…….T

T = Total number of nitrogen containing compounds

F = Modelled deposition flux of nitrogen containing compound (µg m^{-2} s^{-1})

M_N = Molecular mass of nitrogen (kg)

M = Molecular mass of nitrogen containing compound (kg)

The unit eq (1 keq ≡ 1,000 eq) refers to molar equivalent of potential acidity resulting from e.g. sulphur, oxidised and reduced nitrogen, as well as base cations. Conversion units are provided in AQTAG(06):

- 1 keq ha^{-1} y^{-1} = 14 kg N ha^{-1} y^{-1}
- 1 keq ha^{-1} y^{-1} = 32 kg S ha^{-1} y^{-1}

For the purposes of this assessment, dry deposition rates of nitrogen and acidic equivalents at the identified ecological receptors have been calculated by applying the 'long vegetation' deposition velocities (as detailed in Table 2.9) to the modelled annual mean concentrations of NO_X and SO_2. Wet deposition has not been assessed since this is not a significant contributor to total deposition over shorter ranges (Fangmeier et al., 1994; Environment Agency, 2006).

2.8 Other Treatments

Specialised model treatments, for short-term (puff) releases, coastal models, fluctuations or photochemistry were not used in this assessment.

2.9 Conversion of NO to NO_2

Emissions of NO_X from combustion processes are predominantly in the form of nitric oxide (NO). Excess oxygen in the combustion gases and further atmospheric reactions cause the oxidation of NO to NO_2. NO_X chemistry in the lower troposphere is strongly interlinked in a complex chain of reactions involving Volatile Organic Compounds (VOCs) and Ozone (O_3). Two of the key reactions interlinking NO and NO_2 are detailed below:

$$NO_2 + hv \xrightarrow{O_2} NO + O_3 \qquad (R_1)$$

$$NO + O_3 \longrightarrow NO_2 + O_2 \qquad (R_2)$$

Where *hv* is used to represent a photon of light energy (i.e. sunlight).

Taken together, reactions R_1 and R_2 produce no net change in O_3 concentrations, and NO and NO_2 adjust to establish a near steady state reaction (photo-equilibrium). However, the presence of VOCs and CO in the atmosphere offer an alternative production route of NO_2 for photolysis, allowing O_3 concentrations to increase during the day with a subsequent decrease in the NO_2:NO_X ratio.

However, at night, the photolysis of NO_2 ceases, allowing reaction R_2 to promote the production of NO_2, at the expense of O_3, with a corresponding increase in the NO_2:NO_X ratio. Similarly, near to an emission source of NO, the result is a net increase in the rate of reaction R_2, suppressing O_3 concentrations immediately downwind of the source, and increasing further downwind as the concentrations of NO begin to stabilise to typical background levels (Gillani and Pliem, 1996).

Given the complex nature of NO_X chemistry, the Environment Agency's Air Quality Modelling and Assessment Unit (AQMAU) have adopted a pragmatic, risk-based approach in determining the conversion rate of NO to NO_2 which dispersion model practitioners can use in their detailed assessments[4]. The AQMAU guidance advises that the source term should be modelled as NO_X (as NO_2) and then suggests a tiered approach when considering ambient NO_2:NO_X ratios:

- **Screening Scenario:** 50 % and 100 % of the modelled NO_X process contributions should be used for short-term and long-term average concentration, respectively. That is, 50 % of the predicted NO_X concentrations should be assumed to be NO_2 for short-term

[4] http://www.environment-agency.gov.uk/static/documents/Conversion_ratios_for__NOx_and_NO2_.pdf

assessments and 100 % of the predicted NO_X concentrations should be assumed to be NO_2 for long-term assessments;

- **Worst Case Scenario:** 35 % and 70 % of the modelled NO_X process contributions should be used for short-term and long-term average concentration, respectively. That is, 35 % of the predicted NO_X concentrations should be assumed to be NO_2 for short-term assessments and 70 % of the predicted NO_X concentrations should be assumed to be NO_2 for long-term assessments; and

- **Case Specific Scenario:** Operators are asked to justify their use of percentages lower than 35 % for short-term and 70 % for long-term assessments in their application reports.

In line with the AQMAU guidance, this assessment has therefore used a NO_X to NO_2 ratio of 70% for long term average concentrations, 35% for short term concentrations.

Similarly, as approved by the EA[5], the assessment has used a NO_X to NO ratio of 30% for long term average concentrations and, 65% for short term concentrations, as detailed in the following section.

2.10 Additional Requirements

To address the EA's additional assessment requirements, the following methodology was adopted, which was accepted as suitable by the EA through email communications[5].

- Nitrogen monoxide (NO): NO_X emissions were modelled based upon the manufacturers quoted Emission Limit Values (ELVs). Using standard NO_X to NO_2 conversion ratios, NO_X concentration results were post-processed to provide NO_2 concentration results (70% conversion ratio for annual mean NO_2, 35% conversion for 1-hour mean NO_2). As NO_X is the sum of NO_2 and NO, to determine the corresponding NO concentration results, reverse proportions have been used (i.e. 30% conversion ratio for annual mean NO, 65% conversion for 1-hour mean NO). NO concentrations were assessed against the relevant EALs for NO, which have been derived from the old HSE EH40 Workplace Exposure Levels (WELs)[6] (specifically these are 4,400µg/m^3 for 1-hr mean, 310µg/m^3 for annual mean).

- Acute exposure Risk Assessment for P100 (maximum) 1-hour NO_2: NO_2 concentration data were assessed against the US EPA AEGL1-3[7] for 60-minute NO_2 (specifically these are 0.5ppm, 12ppm and 20ppm, respectively.

[5] Email dated 15/04/2024 from the Environmental Agency to Bureau Veritas and EcoAct.

[6] EA. Defra, 2023. Guidance - Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[7] US EPA. Nitrogen dioxide Result – AEGL Program. Available at: https://www.epa.gov/aegl/nitrogen-dioxide-result-aegl-program

3 Existing Ambient Data

3.1 Local Air Quality Management

Reigate and Banstead Borough Council ("the Council") under its Local Air Quality Management (LAQM) obligations, continually reviews and assesses concentrations of key air pollutants in the borough to ascertain the requirement, or otherwise, to declare an AQMA.

Due to the historical trend of high pollution levels, the Council have declared nine AQMAs within its jurisdiction. Redhill Data Centre is located approximately 790 m from the closest AQMA boundary, which is declared with respect to annual mean NO_2 concentrations.

The most recent publicly available monitoring data has been collated from the Council's Air Quality 2020 Annual Status Report[8], which contains monitoring data for 2019.

3.1.1 Continuous Monitoring Data

The Council operated four continuous monitors during 2019, two suburban sites, one rural site and one roadside site, all monitoring concentrations of NO_2. One of the sites (RG1) also monitored concentrations of PM_{10}.

Exceedances of the short-term 1-hour mean NO_2 objective were below the 18 allowed exceedances at all sites in 2019. Similarly, for the 24-hour mean PM_{10} metric, the number of exceedances were below the allowed 35 exceedances per year at RG1.

However, none of the automatic monitors are located within 2 km of the Redhill data centre. Since these locations may not be representative of air quality conditions within the model area, they have not been considered further within this assessment.

3.1.2 Passive Monitoring Data

The Council operated 151 non-automatic (passive) monitoring locations in 2019, of which three are within 1 km of the Redhill data centre. Table 3.1 contains the annual mean NO_2 concentration results for the diffusion tubes sites within 1 km of the site, for the years 2017 to 2019.

Table 3.1 - NO_2 Diffusion Tube Monitoring Results

Site Name	X	Y	Site Type	Annual Mean Concentration ($\mu g/m^3$)		
				2017	2018	2019
RB121	528092	150786	Kerbside	-	41.1	39.9
RB140	528122	150799	Roadside	25.5	22.6	24.3
RB152	528599	152439	Roadside	33.4	32.4	32.4
N.B. Data taken from Council's 2019 Annual Status Report.						

Current monitoring results show that recent and current concentrations of NO_2 in the area local to the Redhill site are, in the main, compliant with the annual mean NO_2 Air Quality Strategy objective, apart from at RB121 where the concentration exceeded the limit in 2018. This is not unexpected since the site is located on one of the main roads into Redhill town centre.

3.2 Defra Mapped Background Concentrations

Defra maintains a nationwide model of existing and future background air quality concentrations at a 1 km grid square resolution. The datasets include annual average concentration estimates for

[8] https://www.reigate-banstead.gov.uk/downloads/20333/air_quality

NO_X, NO_2, PM_{10}, $PM_{2.5}$, CO and SO_2 and benzene. The model used is empirical in nature: it uses the National Atmospheric Emissions Inventory (NAEI) emissions to model the concentrations of pollutants at the centroid of each 1 km grid square but then calibrates these concentrations in relation to actual monitoring data.

3.2.1 Background Concentrations used in the Assessment

Annual mean background concentrations at the assessed human and ecological receptor locations have been derived from the Defra background maps for the 1 km grid square in which they are located.

The annual average process contribution is added to the annual average background concentration to give a total concentration at each receptor location. This total concentration can then be compared against the relevant Air Quality Standard/Objective (AQS/O) and the likelihood of an exceedance determined.

It is not technically rigorous to add predicted short-term or percentile concentrations to ambient background concentrations not measured over the same averaging period, since peak contributions from different sources would not necessarily coincide in time or location. Without hourly ambient background monitoring data available it is difficult to make an assessment against the achievement or otherwise of the short-term AQS/O. For the current assessment, conservative short-term ambient levels have been derived by applying a factor of two to the annual mean background data as per the recommendation in Environment Agency guidance. Those background annual mean concentrations used in the assessment are detailed in Table 3.2.

As NO_X is the sum of NO_2 and NO, background NO concentrations were calculated by subtracting NO_2 background concentrations from NO_X background concentrations.

Table 3.2 - Background Annual Mean Concentrations used in the Assessment

Grid square (E, N)	2021 Annual Mean Pollutant Concentrations ($\mu g/m^3$)						
	NO_X [a]	NO_2 [a]	NO [a]	PM_{10} [a]	$PM_{2.5}$ [a]	CO [b]	SO_2 [b]
528500,151500	20.9	15.1	5.8	15.1	10.4	365	6.1
529500,151500	18.6	13.6	5.0	14.6	9.8	368	3.9
527500,152500	17.3	12.9	4.4	14.5	9.7	374	3.4
528500,152500	19.3	14.2	5.1	15.0	10.1	366	3.9
529500,150500	20.0	14.5	5.5	14.0	9.4	356	3.6
528500,149500	15.3	11.5	3.8	14.2	9.9	345	3.8
526500,152500	23.4	17.0	6.4	16.6	10.6	370	3.5

[a] 2021 annual mean background concentration of NO_2, NO_X, PM_{10} and $PM_{2.5}$ taken from Defra's UK Air Quality Archive (1 km x 1 km grid squares). 2021 annual mean background concentrations of NO were calculated by subtracting background concentrations of NO_2 from background concentrations of NO_X.

[b] Background concentration of SO_2 taken from Defra's UK Air Quality Archive (1 km x 1 km grid squares) 2001 background maps.

3.3 Background Deposition Rates

Estimated background deposition rates of nutrient nitrogen and total acid deposition for the UK are available via the Air Pollution Information Service (APIS) website (http://www.apis.ac.uk). Table 3.4 provides estimated deposition rates for the ecological receptors considered in this study, as obtained from the APIS website. It should be noted that the level of uncertainty associated with these modelled estimates is relatively high and the results are presented from the model across the UK on a 5 km grid square resolution.

Table 3.3 - Estimated Background Deposition Rates

ID	Background Nitrogen Deposition (kg N ha^{-1} y^{-1})	Background Nitric Acid Deposition (keq ha^{-1} y^{-1})	Background Sulphuric Acid Deposition (keq ha^{-1} y^{-1})
E1	30.10	1.27	0.20
E2	29.96	2.14	0.24
E3	29.96	2.14	0.24
E4	29.96	2.14	0.24
E5	29.96	2.14	0.24
E6	28.28	2.02	0.20
E7	30.10	1.27	0.20
Source: Air Pollution Information Service (APIS) website (http://www.apis.ac.uk)			

3.4 Sensitivity Analysis and Uncertainty

Wherever possible, this assessment has used worst-case scenarios, which will exaggerate the impact of the emissions on the surrounding area, including emissions, operational profile, ambient concentrations, meteorology and surface roughness. This assessment has considered the years predicting the highest ground-level concentrations at the nearest sensitive receptor for comparison with the AQS objectives.

Sensitivity analysis has been undertaken for a number of model input parameters to investigate the results of the model with respect to changes in buildings, surface roughness and model code.

3.4.1 Buildings

A sensitivity analysis has been undertaken to investigate the impact of modelling with and without buildings on the modelled results. Results have been normalised by the value obtained from the parameter resulting in the highest ground level process contribution at any modelled receptor location and are presented in Table 3.4.

Table 3.4 - Building Inclusion Sensitivity Analysis

Buildings	Normalised Maximum Ground Level Concentration	
	NO_X Annual Mean	NO_X 99.79 Percentile of 1-Hour Mean
With Buildings	1.00	1.00
Without Buildings	0.85	0.67

From the above predicted ground level concentrations, it can be seen that the inclusion of buildings in the model results in higher concentrations for both averaging periods. The model therefore used in this assessment included buildings in order to demonstrate a robust assessment.

3.4.2 Terrain

A sensitivity analysis has been undertaken to investigate the impact of modelling with and without terrain on the modelled results. Results have been normalised by the value obtained from the parameter resulting in the highest ground level process contribution at any modelled receptor location and are presented in Table 3.5.

Table 3.5 - Terrain Inclusion Sensitivity Analysis

Terrain	Normalised Maximum Ground Level Concentration	
	NO_X Annual Mean	NO_X 99.79 Percentile of 1-Hour Mean
With Terrain	1.02	1.17
Without Terrain	1.00	1.00

From the above predicted ground level concentrations, it can be seen that the inclusion of terrain in the model results in higher concentrations for both averaging periods. The model therefore used terrain in order to demonstrate a robust assessment.

3.4.3 Surface Roughness

A sensitivity analysis has been undertaken to investigate the impact of modelling with different surface roughness lengths. Results have been normalised by the value obtained from the parameter resulting in the highest ground level process contribution at any modelled receptor location and are presented below.

Table 3.6 – Surface Roughness Sensitivity Analysis

Parameter	Normalised Maximum Ground Level Concentration	
	NO_X Annual Mean	NO_X 99.79 Percentile of 1-Hour Mean
0.3 m	0.94	0.71
0.5 m	0.93	0.80
1 m	1.00	0.97
1.5 m	0.97	1.00

From the above predicted ground level concentrations, it can be seen that for the annual mean averaging period, a surface roughness of 1 m results in the highest results. However, for the 1-hour mean, a surface roughness length of 1.5 m predicts the highest result.

Given that the most likely pollutant and averaging period for non-compliance within this assessment is expected to be NO_X (as NO_2) 99.79 percentile 1-hour mean, a surface roughness value of 1.5 m has been used.

3.4.4 Meteorological Year Sensitivity Testing

Results in this assessment are presented for the meteorological year resulting in the highest concentrations at any receptor location, as a worst-case assumption. The worst-case meteorological year was determined separately for long and short-term concentrations at the worst-case receptor location for each pollutant, thus the worst-case data has been reported within Section 5.

For information, a table showing the inter-year variability of met conditions at the worst-case human receptor is provided below. The results have been normalised against the maximum value. At the worst-case human receptor, it demonstrates that 2020 and 2017 provide the worst-case conditions for long-term and short-term means, respectively. However, this can vary by receptor, hence the consideration of the worst-case meteorological year by receptor, as described above.

Table 3.7 - Inter-year Variability in Concentration (Normalised)

Receptor	Annual Mean					1-hour Mean				
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
H5/H26	0.80	0.92	0.74	0.84	1.00	0.76	1.00	0.63	0.83	0.93

3.4.5 Model Uncertainty

Dispersion modelling is inherently uncertain but is nonetheless a useful tool in plume footprint visualisation and prediction of ground level concentrations. The use of dispersion models has been widely used in the UK for both regulatory and compliance purposes for a number of years and is an accepted approach for this type of assessment.

In addition to all available input data. this assessment has incorporated a number of worst-case assumptions, as described above, which may result in an overestimation of the predicted ground level concentrations from the process. Therefore, the actual predicted ground level concentrations would be expected to be lower than this and, in some cases, significantly lower.

4 Relevant Legislation and Guidance

4.1 UK Legislation

4.1.1 The Air Quality Standards Regulations 2010

The Air Quality Standards Regulations 2010 (the 'Regulations') came into force on the 11th June 2010 and transpose EU Directive 2008/50/EC into UK legislation. The Directive's limit values are transposed into the Regulations as 'Air Quality Standards' (AQS) with attainment dates in line with the Directive.

These standards are legally binding 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 including the effects of sensitive groups or on ecosystems.

Similar to Directive 2008/50/EC, the Regulations define ambient air as:

> *"…outdoor air in the troposphere, excluding workplaces where members of the public do not have regular access."*

With direction provided in Schedule 1, Part 1, Paragraph 2 as to where compliance with the AQS' does not need to be assessed:

> *"Compliance with the limit values directed at the protection of human health does not need to be assessed at the following locations:*
>
> *a) any location situated within areas where members of the public do not have access and there is no fixed habitation;*
>
> *b) on factory premises or at industrial locations to which all relevant provisions concerning health and safety at work apply;*
>
> *c) on the carriageway of roads and on the central reservation of roads except where there is normally pedestrian access to the central reservation."*

4.1.2 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

The 2007 Air Quality Strategy for England, Scotland Wales and Northern Ireland provides a framework for improving air quality at a national and local level and supersedes the previous strategy published in 2000.

Central to the Air Quality Strategy are health-based criteria for certain air pollutants; these criteria are based on medical and scientific reports on how and at what concentration each pollutant affects human health. The objectives derived from these criteria are policy targets often expressed as a maximum ambient concentration not to be exceeded, without exception or with a permitted number of exceedances, within a specified timescale. Paragraph 22 of the 2007 Air Quality Strategy, states that the objectives are:

> *"…a statement of policy intentions or policy targets. As such, there is no legal requirement to meet these objectives except where they mirror any equivalent legally binding limit values…"*

The AQOs, based on a selection of the objectives in the Air Quality Strategy, were incorporated into UK legislation through the Air Quality Regulations 2000, as amended.

Paragraph 4(2) of The Air Quality (England) Regulations 2000 states:

"The achievement or likely achievement of an air quality objective prescribed by paragraph (1) shall be determined by reference to the quality of air at locations –

a) which are situated outside of buildings or other natural or man-made structures above or below ground; and

b) where members of the public are regularly present

Consequently, compliance with the AQOs should focus on areas where members of the general public are present over the entire duration of the concentration averaging period specific to the relevant objective.

4.1.3 Environment Act 2021

The Environment Act 2021 came into force on 9th November 2021, with Part 4 of the Act (and associated Schedules 11 and 12) reserved for matters pertaining to air quality.

The Environment Act 2021 includes amendments to Environment Act 1995 (further detail in Section 4.2) the Clean Air Act 1993 to give Local Authorities more power. It also requires the Secretary of State to set at least one long-term target in relation to air quality and, in addition, a short-term legally binding target to reduce $PM_{2.5}$.

4.2 Local Air Quality Management

Part IV of the Environment Act 1995 requires that Local Authorities periodically review air quality within their individual areas. As previously discussed, this Act has now been amended and supplemented by the Environment Act 2021 Schedule 11. Defra have said: "Responsibility for tackling local air pollution will now be shared with designated relevant public authorities, all tiers of local government and neighbouring authorities."

This process of Local Air Quality Management (LAQM) is an integral part of delivering the Government's AQOs.

To carry out an air quality Review and Assessment under the LAQM process, the Government recommends a three-stage approach. This phased review process uses initial simple screening methods and progresses through to more detailed assessment methods of modelling and monitoring in areas identified to be at potential risk of exceeding the objectives in the Regulations.

Review and assessments of local air quality aim to identify areas where national policies to reduce vehicle and industrial emissions are unlikely to result in air quality meeting the Government's AQOs by the required dates.

For the purposes of determining the focus of Review and Assessment, Local Authorities should have regard to those locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective.

Where the assessment indicates that some or all of the objectives may be potentially exceeded, the Local Authority has a duty to declare an AQMA. The declaration of an AQMA requires the Local Authority to implement an Air Quality Action Plan (AQAP), to reduce air pollution concentrations so that the required AQOs are met.

4.3 Other Guideline Values

In the absence of statutory standards for the other prescribed substances that may be found in the emissions, there are several sources of applicable air quality guidelines.

4.3.1 Air Quality Guidelines for Europe, the World Health Organisation (WHO)

The updated WHO Global Air Quality Guidelines (WHO, 2021) provides a basis for protecting public health from adverse effects of air pollutants and to eliminate or reduce exposure to those pollutants that are known or likely to be hazardous to human health or well-being. These guidelines are intended to provide guidance and information to international, national and local authorities making risk management decisions, particularly in setting air quality standards.

4.3.2 Environmental Assessment Levels (EALs)

The Environment Agency's AER Guidance provides methods for quantifying the environmental impacts of emissions to all media. The AER guidance contains long and short-term Environmental Assessment Levels (EALs) and Environmental Quality Standards (EQS) for releases to air derived from a number of published UK and international sources. For the pollutants considered in this study, with the exception of NO, these EALs and EQS are equivalent to the AQS and AQOs set in force by the Air Quality Strategy for England, Scotland Wales and Northern Ireland. The EALs for NO have been derived from the old HSE EH40 WELs.

4.3.3 US Environmental Protection Agency (US EPA) Acute Exposure Guideline Levels (AEGLs)

The US EPA provides exposure guidelines designed to help responders deal with emergencies involving chemical spills or other catastrophic events where members of the general public are exposed to a hazardous airborne chemical. AEGL "levels" are dictated by the severity of the toxic effects caused by the exposure, with Level 1 being the least and Level 3 being the most severe. Effects are described as follow[9]:

- Level 1: Notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure;
- Level 2: Irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape; and
- Level 3: Life-threatening health effects or death.

Annual mean NO_2 concentrations were assessed against the US EPA hourly mean AEGLs 1 to 3[10], as requested by the EA, to evaluate the acute exposure risk assessment (acute exposures are single, non-repetitive exposures that don't exceed 8 hours).

4.4 Air Quality Impacts of the Process

The atmospheric emissions of a number of pollutants have been identified as requiring detailed dispersion modelling. The emitted pollutants of primary concern to the local environment are:

- Oxides of nitrogen (NO_X as NO_2);
- Nitrogen monoxide (NO);
- Carbon monoxide (CO);
- Particulate matter (PM_{10} and $PM_{2.5}$); and

[9] US EPA. About Acute Exposure Guideline Levels (AEGLs). Available at: https://www.epa.gov/aegl/about-acute-exposure-guideline-levels-aegls

[10] US EPA. Nitrogen Dioxide - AEGL Program. Available at: https://www.epa.gov/aegl/nitrogen-dioxide-aegl-program

- Sulphur dioxide (SO_2).

A brief description of each pollutant is given in Table 4.1.

Table 4.1 - Summary of the Pollutants Assessed

Pollutant	Description and effect on human health and the environment	Principal Sources
Oxides of Nitrogen (NO_X) A, B, C	Nitrogen dioxide (NO_2) and Nitric oxide (NO) are both collectively referred to as oxides of Nitrogen (NO_X). It is NO_2 that is associated with adverse effects on human health. Most atmospheric emissions are in the form of NO which is converted to NO_2 in the atmosphere through reactions with Ozone. The oxidising properties of NO_2 theoretically could damage lung tissue, and exposure to very high concentrations of NO_2 can lead to inflammation of lung tissue, affect the ability to fight infection. The greatest impact of NO_2 is on individuals with asthma or other respiratory conditions, but consistent impacts on these individuals is at levels of greater than 564 µg/m^3, much higher than typical UK ambient concentrations.	All combustion processes produce NO_X emissions, and the principal source of NO_X is road transport, which accounted for 32% of total UK emissions in 2008. Emissions from power stations contributed a further 20%.
Carbon Monoxide (CO) B, C	The toxicity of CO results in it binding avidly to haemoglobin and thus reducing the oxygen-carrying capacity of the blood. In very high doses, the restriction of oxygen to the brain and heart can be fatal. At lower concentrations, CO can affect higher cerebral function, heart function and exercise capacity.	The principal source of CO is emissions from petrol vehicles, accounting for 54% of total UK emissions in 2008.
Particulate Matter (PM_{10} and $PM_{2.5}$)D,F	Particulate matter is the term used to describe all suspended solid matter. Particulate matter with an aerodynamic diameter of less than 10 µm (PM_{10}) is the subject of health concerns because of its ability to penetrate and remain deep within the lungs. The health effects of particles are difficult to assess, and evidence is mainly based on epidemiological studies. Evidence suggests that there may be associations between increased PM_{10} concentrations and increased mortality and morbidity rates, changes in symptoms or lung function, episodes of hospitalisation or doctors consultations. Recent reviews by the World Health Organisation (WHO) and Committee on the Medical Effects of Air Pollutants (COMEAP) have suggested exposure to a finer fraction of particles ($PM_{2.5}$) give a stronger association with the observed health effects. $PM_{2.5}$ typically makes up around two-thirds of PM_{10} emissions and concentrations.	Road transport, industrial processes and electricity generation. Other pollutants, including NO_2 and SO_2, have the potential to form secondary particulates which are often smaller than PM_{10}.
Sulphur Dioxide (SO_2) B	At high concentrations SO_2 is a potent bronchoconstrictor, and asthmatic individuals are more susceptible. It is likely that SO_2 contributes to respiratory symptoms, reduced lung function and rises in hospital admissions. Exposure to high levels of SO_2 over a long period can result in structural changes in the lungs and may enhance sensitisation to allergens.	The principal source of SO_2 is the combustion of fossil fuels containing sulphur and, in the UK, this is primarily through the combustion of coal in power stations, oil refining and solid fuel manufacturing, accounting for 57% of total UK SO_2 emissions in 2008.

A Defra, 2021, Part IV of the Environment Act 1995 Local Air Quality Management: Technical Guidance LAQM.TG(16).

B Harrison, R.M., *Air Pollution: Sources, Concentrations and Measurements*. In: Harrison, R.M., 2000, *Pollution: Causes, Effects and Controls*, 4th Edition Royal Society of Chemistry.

C Walters, S. and Ayers, J., *The Health Effects of Air Pollution*. In: Harrison, R.M., 2000, *Pollution: Causes, Effects and Controls*, 4th Edition Royal Society of Chemistry.

D Defra, 2007, The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

4.5 Criteria Appropriate to the Assessment

Table 4.2 sets out those AQS, AQOs and EALs that are relevant to the assessment with regard to human receptors.

Table 4.2 - Air Quality Standards, Objectives and Environmental Assessment Levels

Pollutant	AQS/AQO/ EAL/AEGL	Averaging Period	Value ($\mu g/m^3$)
Nitrogen dioxide (NO_2)	AQS	Annual mean	40
	AQS	1-hour mean, not more than 18 Exceedances a year (equivalent of 99.79 Percentile)	200
	AEGL 1	1-hour mean (100 Percentile)	956
	AEGL 2	1-hour mean (100 Percentile)	22,950
	AEGL 3	1-hour mean (100 Percentile)	38,250
Carbon monoxide (CO)	AQS	8-hour mean	10,000
	EAL	1-hour mean	30,000
PM_{10}	AQS	Annual mean	40
	AQS	24-hour mean, not more than 35 Exceedances per year (90.41 percentile)	50
$PM_{2.5}$	AQS	Annual mean	20
Sulphur dioxide (SO_2)	AQS	1-hour mean not to be exceeded more than 24 times a year (equivalent to 99.73 percentile)	350
	AQS	24-hour mean, not to be exceeded more than 3 times a year (equivalent to 99.18 percentile)	125
	AQO	15-min mean, not to be exceeded more than 35 times a year (equivalent to 99.9 percentile)	266
Nitrogen monoxide (NO)	EAL	1-hour mean (100 percentile)	4,400
	EAL	Annual mean	310

Note: US Environmental Protection Agency (EPA) Acute Exposure Guideline Levels (AEGL) are provided as ppm. They were converted to $\mu g/m^3$ using the European Commission (EC) conversion factor for NO_2 of 1 ppb = 1.9125$\mu g/m^3$ as recommended by Defra[11].

4.6 Critical Levels and Critical Loads Relevant to the Assessment of Ecological Receptors

A summary of the relevant AQS and EAL that apply to the emissions from the plant and their impact on ecological receptors are given in Table 4.3.

[11] Defra. Frequently Asked Questions. How do you convert ppb into $\mu g/m^3$? Available Online: https://uk-air.defra.gov.uk/air-pollution/faq?question=16

Table 4.3 - Relevant Air Quality Standards and Environmental Assessment Levels for Ecological Receptors

Pollutant	AQS/EAL	Averaging Period	Value ($\mu g/m^3$)
Oxides of nitrogen (NO_X)	AQS	Annual mean	30
Oxides of nitrogen (NO_X)	Target	Daily mean	75
	WHO Assessment Level	Daily mean	200*
Sulphur dioxide (SO_2)	AQS	Annual mean	20
*Where O_3 and SO_2 are not present above their respective critical levels.			

The Air Pollution Information System (APIS) website[12] provides specific information on the potential effects of nitrogen deposition on various habitats and species. This information, relevant to habitats of some of the ecological receptors considered in this assessment, is presented in Table 4.4.

[12] http://www.apis.ac.uk/

Table 4.4 - Typical Habitat and Species Information Concerning Nitrogen Deposition from APIS

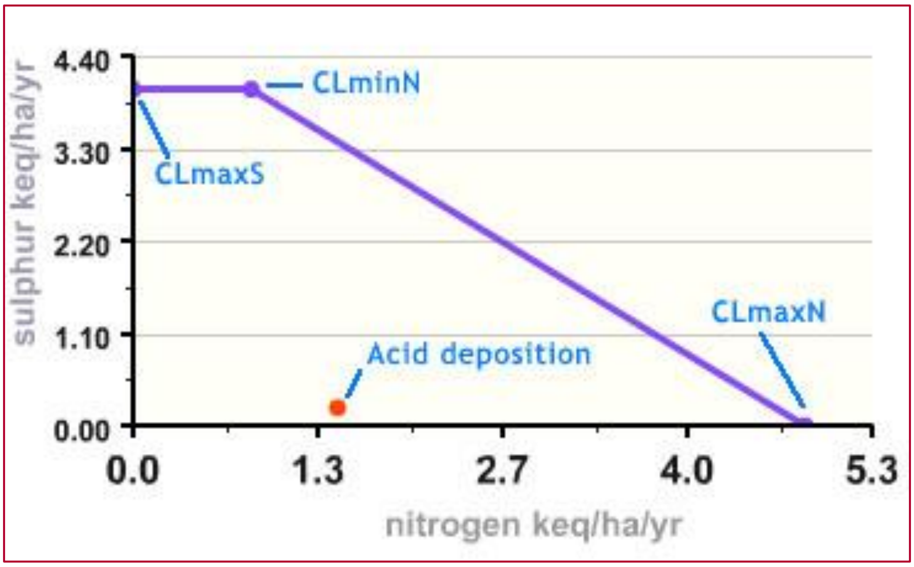
Habitat and Species Specific Information	**Critical Load (kg N ha^{-1} yr^{-1})**	**Specific Information Concerning Nitrogen Deposition**
Saltmarsh	30-40	Many saltmarshes receive large nutrient loadings from river and tidal inputs. It is unknown whether other types of species-rich saltmarsh would be sensitive to nitrogen deposition. Increase in late-successional species, increased productivity but only limited information available for this type of habitat.
Littoral Sediments Coastal Stable Dune Grasslands	20 - 30	Increase late successional species, increase productivity increase in dominance of graminoids.
	10-20	Foredunes receive naturally high nitrogen inputs. Key concerns of the deposition of nitrogen in these habitats relate to changes in species composition.
Alkaline Fens and Reed beds	10-35	Nitrogen deposition provides fertilization. Increase in tall graminoids (grasses or Carex species) resulting in loss of rare species and decrease in diversity of subordinate plant species.
Temperate and boreal forests	10-20	Increased nitrogen deposition in mixed forests increases susceptibility to secondary stresses such as drought and frost, can cause reduced crown growth. Also can reduce the diversity of species due to increased growth rates of more robust plants.
Hay Meadow	20-30	The key concerns are related to changes in species composition following enhanced nitrogen deposition. Indigenous species will have evolved under conditions of low nitrogen availability. Enhanced Nitrogen deposition will favour those species that can increase their growth rates and competitive status e.g. rough grasses such as false brome grass (Brachypodium pinnatum) at the expense of overall species diversity. The overall threat from competition will also depend on the availability of propagules
Acid Grasslands	10-25	Nitrogen deposition provides fertilization to acid grasslands, this increase robust grass growth that may limit other species reducing diversity.
Raised bog and blanket bog	5-10	Nitrogen deposition provides fertilization, this increase robust vegetation growth that may limit other species reducing diversity
Oak Woodland	10-15	Increased nitrogen deposition in Oak forests increases susceptibility to secondary stresses such as drought and frost, can cause reduced crown growth
Habitat and Species Specific Information	Critical Load (kg N ha^{-1} yr^{-1})	Specific Information Concerning Nitrogen Deposition

Information relating specifically to acid deposition is provided using three critical load parameters:

- $CL_{max}S$: the maximum critical load of sulphur, above which sulphur alone would be considered to cause an exceedance;
- $CL_{min}N$: a measure of the ability of the habitat/ecosystem to ‘consume’ deposited nitrogen; and
- $CL_{max}N$: the maximum critical load of nitrogen, above which nitrogen alone would be considered to cause an exceedance.

These three parameters define the critical load function, as illustrated in Figure 4.1. The region under the three-node line represents results where critical loads are not exceeded, whereas combinations of deposition above this line would be considered an exceedance.

Figure 4.1 - Critical Load Function (sourced from APIS)



Source: http://www.apis.ac.uk/clf-guidance

5 Assessment Results

This section sets out the results of the dispersion modelling and compares predicted ground level concentrations to ambient air quality standards. The predicted concentrations resulting from the process are presented with background concentrations and the percentage contribution that the predicted environmental concentrations would make towards the relevant Air Quality Assessment Level (AQAL), i.e. the relevant Air Quality Standard or Objective (AQS/AQO) or Environmental Assessment Level (EAL).

For reference, the scenarios assessed are detailed in Table 5.1.

Table 5.1 – Scenarios Assessed

Scenario No.	Scenario Name	Unit 2 Testing – Total 5 Gens	Unit 3 Testing – Total 16 Gens
1	Monthly testing	Two gens tested at a time (10 mins) and landlord gen tested on its own (10 mins).	Individual gen tested at a time (10 mins).
2	Quarterly testing	Two gens tested at a time for (20 mins) and landlord gen tested on its own (20 mins).	Each suite tested at a time, maximum three gens running at a time (20 mins).
3	Annual testing	Two gens at a time are tested for 1 hour. Landlord gen tested on its own (1 hour).	Each gen is run for 1 hour. Each gen is run individually.
4	Emergency	All four gens fire and then ramp down to two gens running to meet the site load - 24 hours for five days.	All gens fire and 12 gens (two in each data hall suite, plus S150 generator and landlord) keep running - 24 hours for five days.

Results are presented for the meteorological year resulting in the highest concentrations at any receptor location, as a worst-case assumption. Results that exceed the relevant AQAL are underlined within the results tables.

For Scenario 1 and Scenario 2, where the gens do not run for full hours, concentrations have been post-processed as follows:

- Scenario 1: concentration ÷ (60÷10) to account for each generator operating for 10 minutes of any hour; and
- Scenario 2: emission rate ÷ (60÷20) to account for each generator operating for 20 minutes of any hour (worst case).

5.1 Model Results for Annual Mean Metrics

Results assessed against annual mean metrics for NO_X, NO_2, PM_{10}, $PM_{2.5}$, SO_2 and NO need to take account total annual running hours for each Scenario, as they can all take place over the corresponding proportion of the year.

As such, results for annual mean metrics have been presented separately to short-term metrics, taking account of the cumulative annual operating hours across the three operating scenarios. Summary results are presented in Table 5.2 for the worst-case receptor for each parameter and are inclusive of Scenarios 1, 2 and 3. Full results tables are contained in Appendix C.

The annual operating hours for Unit 2 and Unit 3 through 2020 were as follows:

- Unit 2 in 2020: total generator hours = 13.6 hours. Therefore, annual factor: 13.6/8760 ≈ 0.0015.

- Unit 3 in 2020: total generator hours = 82.6 hours. Therefore, annual factor: 82.6/8760 ≈ 0.0094.

Annual results have therefore factored Unit 2 generator concentrations and Unit 3 generator concentrations separately, as per the factors above. These have then been summed to provide total annual mean results for the Site.

5.1.1 Concentrations in Air – All Scenarios

The summary results show that annual mean results for NO_2, NO, PM_{10} and $PM_{2.5}$ at human receptors and annual mean results for NO_X and SO_2 at ecological receptors are all comfortably below the relevant AQAL.

In terms of human receptors, the maximum long-term results were at receptor H10 (see Appendix C), located within 45 m of the site on Goodworth Road. The maximum result at any ecological receptor (in terms of PEC) is predicted to occur at Mole Gap to Reigate Escarpment SAC, located 2.7 km northwest of the site.

Table 5.2 - Maximum Annual Mean Concentrations in Air at Human and Ecological Receptors – All Scenarios: Unit 2 and Unit 3

Parameter	Annual Mean				
	AQAL µg/m³	PC µg/m³	PEC µg/m³	% PC OF AQAL	% PEC OF AQAL
Human Receptors					
Annual mean NO_2	40	2.63	17.75	6.6	44.4
Annual mean PM_{10}	40	0.06	15.19	0.2	38.0
Annual mean $PM_{2.5}$	20	0.06	10.47	0.3	52.4
Annual Mean NO	310	1.13	6.92	0.4	2.2
Ecological Receptors					
Annual mean NO_X	30	0.13	23.47	0.4	78.2
Annual mean SO_2	20	<0.01	3.87	<0.1	12.9
AQAL = Air Quality Assessment Level PC = Process Contribution PEC = Predicted Environmental Concentration (PC + background)					

5.1.2 Deposition – All Scenarios

The impact assessment for ecological receptors also includes an assessment of pollutants deposited to land in the form of nitrogen deposition and acid deposition. These are also based on annual mean metrics, as such, these results are presented in full in Table 5.3 for nitrogen deposition and Table 5.4 for acid deposition.

The results for acid deposition are presented in line with the Critical Load Function Tool as contained on the Air Pollution Information System (APIS) website[13]. As described on APIS: "the Critical Load Function is a three-node line on a graph representing the acidity critical load. Combinations of deposition above this line would exceed the critical load, while all areas below or on the line represent an "envelope of protection" where critical loads are not exceeded". Therefore, where 'no exceedance' is stated with regards to acid deposition, it denotes no exceedance of the critical load function.

[13] http://www.apis.ac.uk/critical-load-function-tool

The results for nitrogen deposition show exceedances at all ecological receptors considered in the assessment. However, this is due to the background deposition rate at all receptors exceeding the minimum critical load (CL). When taking the PC, this makes up less than 0.5% of the overall result at all ecological receptors considered, so the contribution from the plant can be considered not significant. In the same manner, all results for acid deposition can be described as not significant.

Table 5.3 - Nitrogen Deposition Rates at Ecological Receptors – All Scenarios: Unit 2 and Unit 3

Receptor ID	CL (kg N ha^{-1} yr^{-1})	PC (kg N ha^{-1} yr^{-1})	%PC of CL_{min}	Background Deposition rate (kg N ha^{-1} yr^{-1})	PEDR (kg N ha^{-1} yr^{-1})	%PEDR of CL_{min}
E1	5	0.005	0.1	30.10	30.1	602
E2	10	0.029	0.3	29.99	30.0	300
E3	10	0.038	0.4	30.00	30.0	300
E4	10	0.022	0.2	29.98	30.0	300
E5	10	0.018	0.2	29.98	30.0	300
E6	10	0.032	0.3	28.31	28.3	283
E7	5	0.009	0.2	30.11	30.1	602

CL = Critical load – *the CL selected for each designated site relates to its most N-sensitive habitat (or a similar surrogate) listed on the site citation for which data on Critical Loads are available and is also based on a precautionary approach using professional judgement.*

PC = Process contribution

PEDR = Predicted environmental deposition rate (PC + background)

Table 5.4 - Acid Deposition Rates at Ecological Receptors

Receptor ID	PC	Background	PEC	PC (% of CL function)	Background (% of CL function)	PEC (% of CL function)	Impact
E1	No exceedance	No exceedance	No exceedance	<0.1	33.1	33.1	Not significant
E2	No exceedance	No exceedance	No exceedance	0.1	72.1	72.2	Not significant
E3	No exceedance	No exceedance	No exceedance	0.1	72.1	72.2	Not significant
E4	No exceedance	0.3	0.3	0.1	114.6	114.7	Not significant
E5	No exceedance	0.3	0.3	0.1	114.6	114.7	Not significant
E6	No exceedance	No exceedance	No exceedance	0.1	73.6	73.7	Not significant
E7	No exceedance	No exceedance	No exceedance	<0.1	28.8	28.8	Not significant

CL = Critical load
PEC = Predicted environmental concentration (PC + background)
No exceedance as per the output of the critical load function tool available on APIS

5.2 Short-term Model Results for Scenario 1 (Monthly Testing)

Table 5.5 and Table 5.6 detail the results of the short-term impact assessment results for Scenario 1 operation for Unit 2 and Unit 3, respectively. This is because Monthly Testing will not be undertaken at Unit 2 and Unit 3 on the same day.

These are summary tables, providing the maximum result at any receptor for each pollutant and averaging period under Scenario 1 operating conditions. The full results are contained within Appendix C.

Table 5.5 - Short-term Results at Human and Ecological Receptors for Scenario 1: Unit 2

Parameter	Short-term Mean				
	AQAL µg/m³	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
Human Receptors					
99.79 percentile 1-hour mean NO_2	200	84.52	114.76	42.3	57.4
90.41 percentile 24-hour mean PM_{10}	50	0.26	30.51	0.5	61.0
1-hour mean CO	30,000	261.71	991.71	0.9	3.3
8-hour mean CO	10,000	43.87	773.87	0.4	7.7
99.18 percentile 24-hour mean SO_2	125	0.01	12.23	<0.1	9.8
99.73 percentile 1 hour mean SO_2	350	0.07	12.29	<0.1	3.5
99.9 percentile 15-minute mean SO_2	266	0.51	12.73	0.2	4.8
100 percentile 1-hour mean NO	4,400	309.85	321.42	7.0	7.3
US EPA AEGL 1 100 percentile 1-hour mean NO_2	956	166.84	197.07	17.5	20.6
US EPA AEGL 2 100 percentile 1-hour mean NO_2	22,950	166.84	197.07	0.7	0.9
US EPA AEGL 3 100 percentile 1-hour mean NO_2	38,250	166.84	197.07	0.4	0.5
Ecological Receptors					
24-hour mean NO_X	75	1.84	47.13	2.5	62.8

Table 5.6 - Short-term Results at Human and Ecological Receptors for Scenario 1: Unit 3

Parameter	Short-term Mean				
	AQAL µg/m³	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
Human Receptors					
99.79 percentile 1-hour mean NO_2	200	<u>379.37</u>	<u>409.60</u>	<u>189.7</u>	<u>204.8</u>
90.41 percentile 24-hour mean PM_{10}	50	2.77	33.02	5.5	66.0
1-hour mean CO	30,000	151.88	881.88	0.5	2.9
8-hour mean CO	10,000	178.72	908.72	1.8	9.1

Parameter	Short-term Mean				
	AQAL µg/m³	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
99.18 percentile 24-hour mean SO_2	125	0.17	12.39	0.1	9.9
99.73 percentile 1 hour mean SO_2	350	0.37	12.59	0.1	3.6
99.9 percentile 15-minute mean SO_2	266	2.44	14.66	0.9	5.5
100 percentile 1-hour mean NO	4,400	947.37	958.95	21.5	21.8
US EPA AEGL 1 100 percentile 1-hour mean NO_2	956	510.12	540.36	53.4	56.5
US EPA AEGL 2 100 percentile 1-hour mean NO_2	22,950	510.12	540.36	2.2	2.4
US EPA AEGL 3 100 percentile 1-hour mean NO_2	38,250	510.12	540.36	1.3	1.4
Ecological Receptors					
24-hour mean NO_X	75	25.57	64.17	34.1	85.6

Table 5.5 indicates that the results for the majority of short-term assessment metrics are below the relevant AQAL for both Units.

There are exceedances predicted for 1-hour mean NO_2 concentrations at human receptors for Unit 3 monthly testing (underlined within the table) in regard to the AQS. However, this is because the model considers that all generators are running continuously throughout the year, as it is not known when the generators will actually operate. A probability analysis for Unit 3 is provided below in relation to the likelihood of exceeding the threshold for 1-hour mean NO_2 concentrations.

With regard to Unit 2, since the total annual operating hours for Scenario 1 is equal to 10 minutes × 3 generator pairs × 12 months, resulting in 6 hours of operation per year, it is not possible that generator operation in this scenario could cause an exceedance of the 99.79th percentile 1-hour mean, as the operational events are below the 18 permissible hours of exceedance.

5.2.1 Probability Analysis – Scenario 1: Unit 3

The PEC is predicted to exceed the 99.79 percentile 1-hour mean for NO_2 with predicted values at receptors up to 205% of the AQS for Scenario 1. Although the 99.79 percentile is exceeded at 6 receptors (see Appendix C), this represents the predicted emissions during worst 19 hours of meteorological data for the year. As the generators in Scenario 1 will be operational in no more than 32 hours of the year (16 generators each operating for 10 minutes each month), it is unlikely these operational hours will coincide with all of the year worst case meteorological conditions.

The AQMAU 'Diesel generator short term NO_2 Impact assessment[14] details that the hypergeometric distribution, given below, can be used to calculate the probability of the worst-case meteorological conditions and the generator hours of operation occurring at the same time, where:

[14] Diesel generator short term NO_2 impact - Air Quality Modelling & Assessment Unit (AQMAU) 2016

$$P(X=k)=f(k;N,K,n)=\frac{\binom{K}{k}\binom{N-K}{n-k}}{\binom{N}{n}}$$

N is the population size (the number of hours in a year (8760).

K is the number of success states of the population (the number of meteorological lines in the year that will cause an exceedance).

n is the number of draws (the number of hours of generator operation).

k is the number of observed success (the number of predicted exceedances).

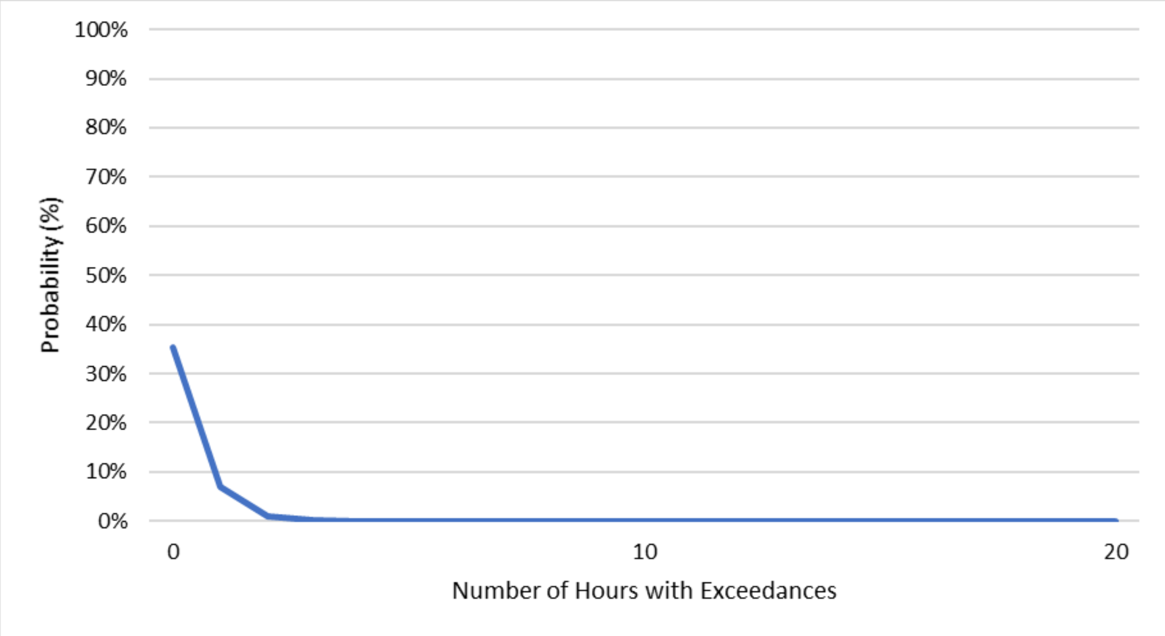
The worst-case receptor for Scenario 1: Unit 3 was H2, located to the south of the Site. The worst-case operation of gens running in any one hour is 6 gens running for 10 minutes each (10 minutes × 6 gens = 60 minutes) or, as an equivalent, 1 gen running for the full hour. This probability analysis has used the exceedance data output from the worst-case gen for the full hour, in order to demonstrate a worst-case assessment.

The model has predicted the greatest number of exceedances at the assessed receptors to be 118 of the 8,760 meteorological lines assessed for the year. The hypergeometric distribution has then been used to calculate the probability of those lines coinciding with the hours of operation to cause an exceedance.

Figure 5.1 shows the probability of Scenario 1 resulting in a specific number of exceedances using the hypergeometric distribution. The chance of exceeding the objective more than the 18 allowed exceedances is less than 0.01%. Consequently, it is unlikely that NO_2 emissions from the generators will cause adverse effects upon the health of the local population assuming the Scenario 1 operation.

If required, measures including assessing pollutant levels at the site boundary through ground level monitoring and avoiding the testing of generators when there are certain weather conditions and during specific times of day, e.g. rush hour, may be considered to further reduce risk of an exceedance.

Figure 5.1 - Predicted Number of Exceedances of the NO_2 1 hour mean AQS for Scenario 1 (Unit 3) using the Hypergeometric Distribution (worst-case receptor)



5.3 Short-term Model Results for Scenario 2 (Quarterly Testing)

Table 5.7 and Table 5.8 detail the results of the short-term impact assessment results for Scenario 2 operation for Unit 2 and Unit 3, respectively. This is because Quarterly Testing will not be undertaken at Unit 2 and Unit 3 on the same day.

These are summary tables, providing the maximum result at any receptor for each pollutant and averaging period under Scenario 2 operating conditions. The full results are contained within Appendix C.

Table 5.7 - Short-term Results at Human and Ecological Receptors for Scenario 2: Unit 2

Parameter	Short-term Mean				
	AQAL µg/m³	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
Human Receptors					
99.79 percentile 1-hour mean NO_2	200	169.04	199.28	84.5	99.6
90.41 percentile 24-hour mean PM_{10}	50	0.52	30.77	1.0	61.5
1-hour mean CO	30,000	523.42	1,253.42	1.7	4.2
8-hour mean CO	10,000	87.75	817.75	0.9	8.2
99.18 percentile 24-hour mean SO_2	125	0.01	12.23	<0.1	9.8
99.73 percentile 1 hour mean SO_2	350	0.14	12.36	<0.1	3.5
99.9 percentile 15-minute mean SO_2	266	0.42	12.64	0.2	4.8
100 percentile 1-hour mean NO	4,400	619.69	631.27	14.1	14.3

Parameter	Short-term Mean				
	AQAL µg/m³	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
US EPA AEGL 1 100 percentile 1-hour mean NO_2	956	333.68	363.91	34.9	38.1
US EPA AEGL 2 100 percentile 1-hour mean NO_2	22,950	333.68	363.91	1.5	1.6
US EPA AEGL 3 100 percentile 1-hour mean NO_2	38,250	333.68	363.91	0.9	1.0
Ecological Receptors					
24-hour mean NO_x	75	3.68	47.38	4.9	63.2

Table 5.8 - Short-term Results at Human and Ecological Receptors for Scenario 2: Unit 3

Parameter	Short-term Mean				
	AQAL µg/m³	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
Human Receptors					
99.79 percentile 1-hour mean NO_2	200	811.97	842.21	406.0	421.1
90.41 percentile 24-hour mean PM_{10}	50	2.08	32.33	4.2	64.7
1-hour mean CO	30,000	316.55	1,046.55	1.1	3.5
8-hour mean CO	10,000	134.04	864.04	1.3	8.6
99.18 percentile 24-hour mean SO_2	125	0.13	12.35	0.1	9.9
99.73 percentile 1 hour mean SO_2	350	0.79	13.01	0.2	3.7
99.9 percentile 15-minute mean SO_2	266	3.66	15.88	1.4	6.0
100 percentile 1-hour mean NO	4,400	1,974.53	1,986.11	44.9	45.1
US EPA AEGL 1 100 percentile 1-hour mean NO_2	956	1,063.21	1,093.44	111.2	114.4
US EPA AEGL 2 100 percentile 1-hour mean NO_2	22,950	1,063.21	1,093.44	4.6	4.8
US EPA AEGL 3 100 percentile 1-hour mean NO_2	38,250	1,063.21	1,093.44	2.8	2.9
Ecological Receptors					
24-hour mean NO_x	75	19.18	57.78	25.6	77.0

The results indicate that the concentrations for the majority of short-term assessment metrics are below the relevant AQAL. However, exceedances are predicted for 1-hour mean NO_2 concentrations at human receptors for Unit 3 (underlined in table).

Exceedances are also predicted for the maximum 1-hour mean NO_2 concentrations at human receptors for Unit 3 in regard to the US EPA AEGL 1 (underlined in table). AEGL 1 represents the least severe health effects, which are transient and reversible upon cessation of exposure. Maximum 1-hour mean NO_2 concentrations are well below the AEGL 2 and 3.

With regard to human receptors, since the total annual operating hours for Scenario 2 Unit 2 is equal to 20 minutes × 3 generator pairs × 4 quarters, resulting in 4 hours of operation per year, it is not possible that generator operation in this scenario could cause an exceedance of the 99.79th percentile 1-hour mean, as the operational events are below the 18 permissible hours of exceedance.

Similarly, since the total annual operating hours for Scenario 2 Unit 3 is equal to 20 minutes × 6 generator triplicates × 4 quarters, resulting in 8 hours of operation per year, it is not possible that generator operation in this scenario could cause an exceedance of the 99.79th percentile 1-hour mean, as the operational events are below the 18 permissible hours of exceedance.

5.4 Short-term Model Results for Scenario 3 (Annual Testing)

Table 5.9 and Table 5.10 detail the results of the short-term impact assessment results for Scenario 3 operation for Unit 2 and Unit 3, respectively. This is because Annual Testing will not be undertaken at Unit 2 and Unit 3 on the same day.

These are summary tables, providing the maximum result at any receptor for each pollutant and averaging period under Scenario 3 operating conditions. The full results are contained within Appendix C.

Table 5.9 - Short-term Results at Human and Ecological Receptors for Scenario 3: Unit 2

Parameter	Short-term Mean				
	AQAL µg/m^3	PC µg/m^3	PEC µg/m^3	% PC of AQAL	% PEC of AQAL
Human Receptors					
99.79 percentile 1-hour mean NO_2	200	129.17	159.41	64.6	79.7
90.41 percentile 24-hour mean PM_{10}	50	1.56	31.82	3.1	63.6
1-hour mean CO	30,000	127.67	857.67	0.4	2.9
8-hour mean CO	10,000	263.24	993.24	2.6	9.9
99.18 percentile 24-hour mean SO_2	125	0.04	12.26	<0.1	9.8
99.73 percentile 1 hour mean SO_2	350	0.11	12.33	<0.1	3.5
99.9 percentile 15-minute mean SO_2	266	0.42	12.64	0.2	4.8
100 percentile 1-hour mean NO	4,400	796.78	808.35	18.1	18.4
US EPA AEGL 1 100 percentile 1-hour mean NO_2	956	429.03	459.27	44.9	48.0
US EPA AEGL 2 100 percentile 1-hour mean NO_2	22,950	429.03	459.27	1.9	2.0
US EPA AEGL 3 100 percentile 1-hour mean NO_2	38,250	429.03	459.27	1.1	1.2

Parameter	Short-term Mean				
	AQAL µg/m³	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
Ecological Receptors					
24-hour mean NO_X	75	11.03	49.63	14.7	66.2

Table 5.10 - Short-term Results at Human and Ecological Receptors for Scenario 3: Unit 3

Parameter	Short-term Mean				
	AQAL µg/m³	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
Human Receptors					
99.79 percentile 1-hour mean NO_2	200	<u>558.26</u>	<u>588.5</u>	<u>279.1</u>	<u>294.2</u>
90.41 percentile 24-hour mean PM_{10}	50	16.61	46.87	33.2	93.7
1-hour mean CO	30,000	210.36	940.36	0.7	3.1
8-hour mean CO	10,000	123.59	853.59	1.2	8.5
99.18 percentile 24-hour mean SO_2	125	1.02	13.24	0.8	10.6
99.73 percentile 1 hour mean SO_2	350	0.53	12.75	0.2	3.6
99.9 percentile 15-minute mean SO_2	266	1.22	13.44	0.5	5.1
100 percentile 1-hour mean NO	4,400	1,312.15	1,323.73	29.8	30.1
US EPA AEGL 1 100 percentile 1-hour mean NO_2	956	706.54	736.78	73.9	77.1
US EPA AEGL 2 100 percentile 1-hour mean NO_2	22,950	706.54	736.78	3.1	3.2
US EPA AEGL 3 100 percentile 1-hour mean NO_2	38,250	706.54	736.78	1.8	1.9
Ecological Receptors					
24-hour mean NO_X	75	<u>153.41</u>	<u>192.01</u>	<u>204.5</u>	<u>256.0</u>

The results indicate that the concentrations for the majority of short-term assessment metrics are below the relevant AQAL for both Units.

With regard to human receptors, since the total annual operating hours for Scenario 3 Unit 2 is equal to 1 hour × 3 generator pairs × 1 annual test, resulting in 3 hours of operation per year, it is not possible that generator operation in this scenario could cause an exceedance of the 99.79th percentile 1-hour mean, as the operational events are below the 18 permissible hours of exceedance.

Similarly, since the total annual operating hours for Scenario 3 Unit 3 is equal to 1 hour × 16 generators × 1 annual test, resulting in 16 hours of operation per year, it is not possible that generator operation in this scenario could cause an exceedance of the 99.79th percentile 1-hour mean, as the operational events are below the 18 permissible hours of exceedance.

Exceedances are also predicted for 24-hour mean NO_X concentrations at ecological receptors for annual testing of Unit 3. Exceedances for 24-hour mean NO_X are predicted at all ecological receptors considered in the assessment using the daily mean target assessment level of 75 µg/m^3 (see Table 4.3). However, it is possible that not all the generators will be tested within the same 24-hour period and, as such, these results may be overestimated. In addition, the 24-hour mean NO_X results are below the WHO daily mean assessment level of 200 µg/m^3. Overall, whist the results for Scenario 3 cannot be considered as not significant, there is confidence that the model demonstrates a worst-case assessment and that it is unlikely that exceedances of short-term metrics will occur.

5.5 Short-term Model Results for Scenario 4 (Emergency Operation)

Table 5.11 and Table 5.12 detail the results of the short-term impact assessment results for Scenario 4 operation for Unit 2 and Unit 3, respectively. Emergency operation is extremely unlikely to occur, as it represents a complete loss of mains power to the Site. In addition, it is extremely unlikely that mains power to both Units will fail concurrently, as they have separate supplies.

These are summary tables, providing the maximum result at any receptor for each pollutant and averaging period under Scenario 4 operating conditions. The full results are contained within Appendix C.

Table 5.11 - Short-term Results at Human and Ecological Receptors for Scenario 4: Unit 2

Parameter	Short-term Mean				
	AQAL µg/m^3	PC µg/m^3	PEC µg/m^3	% PC of AQAL	% PEC of AQAL
Human Receptors					
99.79 percentile 1-hour mean NO_2	200	<u>507.13</u>	<u>537.37</u>	<u>253.6</u>	<u>268.7</u>
90.41 percentile 24-hour mean PM_{10}	50	12.52	42.77	25.0	85.5
1-hour mean CO	30,000	1,570.26	2,300.26	5.2	7.7
8-hour mean CO	10,000	701.98	1,431.98	7.0	14.3
99.18 percentile 24-hour mean SO_2	125	0.33	12.55	0.3	10.0
99.73 percentile 1 hour mean SO_2	350	0.43	12.65	0.1	3.6
99.9 percentile 15-minute mean SO_2	266	0.77	12.99	0.3	4.9
100 percentile 1-hour mean NO	4,400	1,859.07	1,870.65	42.3	42.5
US EPA AEGL 1 100 percentile 1-hour mean NO_2	956	<u>1,001.04</u>	<u>1,031.27</u>	<u>104.7</u>	<u>107.9</u>
US EPA AEGL 2 100 percentile 1-hour mean NO_2	22,950	1,001.04	1,031.27	4.4	4.5
US EPA AEGL 3 100 percentile 1-hour mean NO_2	38,250	1,001.04	1,031.27	2.6	2.7
Ecological Receptors					
24-hour mean NO_X	75	<u>88.20</u>	<u>126.81</u>	<u>117.6</u>	<u>169.1</u>

Table 5.12 - Short-term Results at Human and Ecological Receptors for Scenario 4: Unit 3

Parameter	Short-term Mean				
	AQAL µg/m³	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
Human Receptors					
99.79 percentile 1-hour mean NO_2	200	2,517.97	2,548.20	1,259.0	1,274.1
90.41 percentile 24-hour mean PM_{10}	50	24.92	55.17	49.8	110.3
1-hour mean CO	30,000	963.94	1,693.94	3.2	5.6
8-hour mean CO	10,000	536.17	1,266.17	5.4	12.7
99.18 percentile 24-hour mean SO_2	125	1.53	13.75	1.2	11.0
99.73 percentile 1 hour mean SO_2	350	3.47	15.69	1.0	4.5
99.9 percentile 15-minute mean SO_2	266	4.43	16.65	1.7	6.3
100 percentile 1-hour mean NO	4,400	6,036.5	6048.08	137.2	137.5
US EPA AEGL 1 100 percentile 1-hour mean NO_2	956	3,250.42	3,280.66	340.0	343.2
US EPA AEGL 2 100 percentile 1-hour mean NO_2	22,950	3,250.42	3,280.66	14.2	14.3
US EPA AEGL 3 100 percentile 1-hour mean NO_2	38,250	3,250.42	3,280.66	8.5	8.6
Ecological Receptors					
24-hour mean NO_X	75	230.11	268.71	306.8	358.3

The tables indicate that the results for the majority of short-term assessment metrics are below the relevant AQAL for both Units.

There are exceedances predicted for 1-hour mean NO_2 concentrations at human receptors for both units for emergency operation (underlined within the tables). Probability analyses are provided below in relation to the likelihood of exceeding the threshold for 1-hour mean NO_2 concentrations.

There are exceedances predicted for the maximum 1-hour mean NO_2 concentration at human receptors for both units for emergency operation in regard to the US EPA AEGL 1 (underlined within the tables). However, emergency operation of the plant is extremely unlikely to take place. Additionally, US EPA AEGL 1 represents the least severe health effects, which are transient and reversible upon cessation of exposure. Maximum 1-hour mean NO_2 concentrations are well below the AEGL 2 and 3.

There are exceedances predicted for the maximum 1-hour mean NO concentration at human receptors for Unit 3. However, emergency operation of the plant is extremely unlikely to take place and coincide with the corresponding meteorological conditions that may lead to elevated NO concentrations at the assessed receptor locations.

Exceedances are also predicted for 24-hour mean NO_X concentrations (ecological receptors) and for the 24-hour mean PM_{10} concentrations for emergency operation of Unit 3. However, emergency operation of the plant is extremely unlikely to take place.

5.5.1 Probability Analysis – Scenario 4: Unit 2

The PEC is predicted to exceed the 99.79 percentile 1-hour mean for NO_2 with predicted values at receptors up to 269% of the AQS for Scenario 4. This represents the predicted emissions during worst 19 hours of meteorological data for the year. Under Scenario 4 operation all 4 generators would fire and this would then reduce to 2 gens running 24 hours for 5 days.

The worst-case receptor for Scenario 4: Unit 2 was H26, located to the north of the Site. This probability analysis has used the exceedance data output from the worst-case gen for the full hour, in order to demonstrate a worst-case assessment.

The model has predicted the greatest number of exceedances at the assessed receptors to be 1,687 of the 8,760 meteorological lines assessed for the year. The hypergeometric distribution has then been used to calculate the probability of those lines coinciding with the hours of operation to cause an exceedance.

The chance of exceeding the objective more than the 18 allowed exceedances is 80%. Consequently, it is possible that NO_2 emissions from the generators will cause adverse effects upon the health of the local population assuming the Scenario 4 operation. However, Scenario 4 operation is, in itself, extremely unlikely to occur.

5.5.2 Probability Analysis – Scenario 4: Unit 3

The PEC is predicted to exceed the 99.79 percentile 1-hour mean for NO_2 with predicted values at receptors up to 1,274% of the AQS for Scenario 4. This represents the predicted emissions during worst 19 hours of meteorological data for the year. Under Scenario 4 operation all 16 generators would fire and this would then reduce to 12 gens running 24 hours for 5 days.

The worst-case receptor for Scenario 4: Unit 2 was H27, located to the north east of the Site. Note, the footpath receptors have been excluded from the exceedance calculation due to the transient nature of members of the public at these locations. This probability analysis has used the exceedance data output from the worst-case gen for the full hour, in order to demonstrate a worst-case assessment.

The model has predicted the greatest number of exceedances at the assessed receptors to be 2,571 of the 8,760 meteorological lines assessed for the year. The hypergeometric distribution has then been used to calculate the probability of those lines coinciding with the hours of operation to cause an exceedance.

The chance of exceeding the objective more than the 18 allowed exceedances is 99.9%. Consequently, it is possible that NO_2 emissions from the generators will cause adverse effects upon the health of the local population assuming the Scenario 4 operation. However, Scenario 4 operation is, in itself, extremely unlikely to occur.

5.6 Short-term Model Results – Cumulative Operating Hours

Considering each scenario separately, it has been demonstrated that the probability of exceeding the 99.79 percentile 1-hour mean NO_2 threshold is unlikely. However, a probability analysis has also been undertaken when considering the cumulative hours of all three testing scenarios.

As previously discussed, although the operating hours for Scenarios 1, 2 and 3 are minimal, as the generators may not run for full hours, the number of operational events, i.e., the number of hours where generators are running (no matter how long for) is greater. As such, the probability analysis has taken this into account, using the actual operating hours reported through 2020 (13.6 + 82.6 = 96.2).

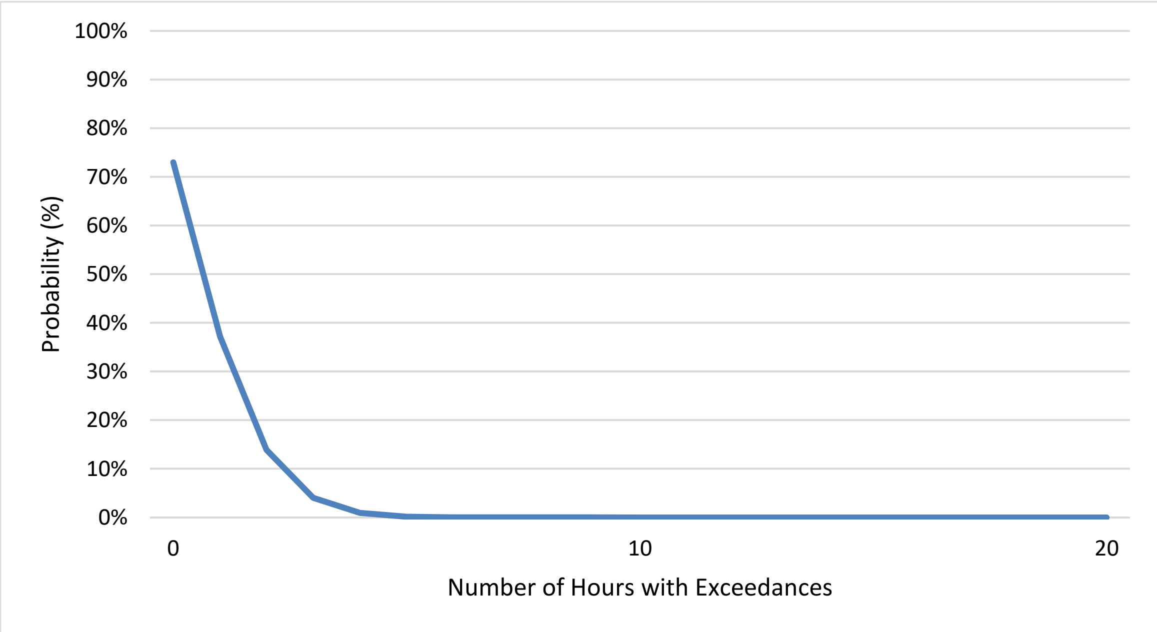
The worst-case receptor used in this analysis was H2, located to the south of the Site. This probability analysis has used the exceedance data output from the worst-case gen for the full hour, in order to demonstrate a worst-case assessment.

The model has predicted the greatest number of exceedances at the assessed receptors to be 118 of the 8,760 meteorological lines assessed for the year. The hypergeometric distribution has then been used to calculate the probability of those lines coinciding with the 96.2 hours of operation to cause an exceedance.

Figure 5.2 shows the probability of the annual operation resulting in a specific number of exceedances using the hypergeometric distribution. The chance of exceeding the objective more than the 18 allowed exceedances is less than 0.01%. Consequently, it is unlikely that NO_2 emissions from the cumulative operation of the generators will cause adverse effects upon the health of the local population assuming the usual annual testing operation (cumulative events for Scenario 1, 2 and 3).

If required, measures including assessing pollutant levels at the site boundary through ground level monitoring and avoiding the testing of generators when there are certain weather conditions and during specific times of day, e.g. rush hour, may be considered to further reduce risk of an exceedance.

Figure 5.2 - Predicted Number of Exceedances of the NO_2 1-hour mean AQS for Cumulative Hours (Unit 2 and Unit 3) using the Hypergeometric Distribution (worst-case receptor)



6 Conclusions

Bureau Veritas have been commissioned by EcoAct on behalf of Digital Realty to undertake an air quality impact assessment for the back-up generators at the Digital Realty site in Redhill, in order that the site can apply for a permit to operate.

The assessment has used detailed dispersion modelling to undertake a study of emissions to air during generator operation, comprising the following scenarios:

- Scenario 1: Monthly Testing;
- Scenario 2: Quarterly Testing;
- Scenario 3: Annual Testing; and
- Scenario 4: Emergency Operation.

Each of the generators are operated using gas oil as the fuel, hence, the following pollutants were included in the assessment: nitrogen oxides (NO_X), sulphur dioxide (SO_2), carbon monoxide (CO) and particulate matter (PM_{10} and $PM_{2.5}$).

Release rates for PM, NO_X and CO were derived using information provided by the generator manufacturers to EcoAct. The release rate for SO_2 was derived based on the sulphur content of the fuel used on site, which is known to be no greater than 0.001%. Due to the short-term nature of emissions released from the plant, results were post-processed, where relevant, to account for the generators running limited hours within a calendar year.

Following submission of the permit application, the Environment Agency (EA) requested further assessment as follows[15]:

- *"You must include an assessment against nitrogen monoxide (NO) EALs; and*
- *You must provide an acute exposure risk assessment comparing the 100th percentile NO_2 predicted environmental concentrations against appropriate exposure criteria (such as the US EPA acute exposure guideline levels - AEGLs)".*

This report includes further information, along with the original assessment methodology and the subsequent results of the dispersion modelling of emissions to air, to address the additional two requirements for the assessed scenarios.

The assessment has resulted in the following conclusions:

- Considering annual mean results for all scenarios, all results at both human and ecological receptors were below the relevant assessment metric, owing to the minimal annual operating hours of the plant.
- The results for nitrogen deposition show exceedances at all ecological receptors considered in the assessment. However, this is due to the background deposition rate at all receptors exceeding the minimum critical load. When taking the PC, this makes up less than 0.5% of the overall result at all ecological receptors considered, so the contribution from the plant can be considered not significant. In the same manner, all results for acid deposition can be described as not significant.

[15] Email dated 04/04/2024 from Environmental Agency to EcoAct.

- As such, the plant is not expected to have a significant impact on annual mean pollutant concentrations in the surrounding area.

- Considering short-term results in Scenario 1 (Monthly Testing), all results at human and ecological receptors were below the relevant assessment metric, apart from for the 99.79 percentile 1-hour mean NO_2 metric for Unit 3. The maximum result for this metric was predicted to be 205% of the AQS. Consequently, a probability analysis, using the hyper geometric distribution, was undertaken to investigate the probability of exceeding the 1-hour mean NO_2 metric for Unit 3 Scenario 1 testing. This demonstrated that the probability of a true exceedance was less than 0.01%. The results for Scenario 1 can therefore be considered not significant.

- Results for Scenario 2 (Quarterly Testing) were similar to those for Scenario 1, in that all but 1-hour mean NO_2 concentrations for Unit 3 were below the relevant assessment metric for both Units. Again, although exceedances were predicted, quarterly testing for both Units falls below the 18 hours of permissible exceedance for 1-hour mean NO_2 concentrations, so it is not possible that Scenario 2 operation would cause a true exceedance of this metric. The results for Scenario 2 can therefore be considered not significant.

- The majority of results for Scenario 3 (Annual Test) were below the relevant assessment metric for both Units. However, exceedances were predicted for the 1-hour mean NO_2 metric for Unit 3. As with Scenario 2, annual testing hours for both Units fall below the 18 hours of permissible exceedance for 1-hour mean NO_2 concentrations, so it is not possible that Scenario 3 operation would cause a true exceedance of this metric. In addition, exceedances are also predicted for 24-hour mean NO_X concentrations at ecological receptors for annual testing of Unit 3. For 24-hour mean metrics, it is possible that not all the generators will be tested within the same 24-hour period and as such these results may be overestimated. Overall, whist the results for Scenario 3 Unit 3 testing at ecological receptors cannot be considered as not significant, there is confidence that the model demonstrates a worst-case assessment and that it is unlikely that exceedances of short-term metrics will occur.

- Regarding Scenario 4, exceedances were predicted for 1-hour mean NO_2 concentrations at human receptors for both units for emergency operation. Exceedances were also predicted for 24-hour mean NO_X concentrations (ecological receptors) and for the 24-hour mean PM_{10} concentrations. However, emergency operation of the plant is extremely unlikely to take place, given that this only applies when there is a loss of main power to the site and that both Units have independent mains supplies.

- A further probability analysis was then carried out, taking into account cumulative operating hours of all the standard testing scenarios, that is Scenario 1, 2 and 3, and using the annual operating hours recorded through 2020. This investigated the probability of exceeding the 1-hour mean NO_2 metric across both Units for a typical annual period, which demonstrated that the probability of a true exceedance was less than 0.01%.

- A further assessment was undertaken for annual mean and 1-hour mean NO concentrations. There were no exceedances of the annual mean and 1-hour mean NO predicted at any receptors in any scenarios, with the exception of Scenario 4 where exceedances of the maximum 1-hour mean EAL for Unit 3 were observed. However, emergency operation of the plant is extremely unlikely to take place and coincide with the corresponding meteorological conditions that may lead to elevated NO concentrations at the assessed receptor locations.

- A further assessment was also undertaken against 1-hour mean US EPA AEGL 1 to 3 for NO_2. Exceedances of the NO_2 hourly mean US EPA AEGL 1 were predicted in Scenario 2 for Unit 3, and in Scenario 4 for both Units. US EPA AEGL 1 represents the least severe effects caused by exposure, with effects described as: "*Notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are* *transient and reversible upon cessation of exposure*". There were no predicted exceedances of the US EPA AEGL 2 and 3, representing more severe effects, at any receptors in any scenarios.

- Due to worst-case conditions being employed through the assessment, the modelled predictions are expected to represent the upper limit of concentrations. If required, measures including assessing pollutant levels at the site boundary through ground level monitoring.

Appendices

Appendix A:
Emission Calculations and Model Input Parameters

Table A1 - Generator Emission Rate Calculations

ID	Source Name	Calculation / Information Source[1]	Generator Model				
			Cummins QSK60-G3 2020	Cummins 6CTAA8.3G2	CAT 3512 GD	Cummins QSK60-G3	CAT GEH275-2
a	Electrical Output of Generators (kW)	Detailed on generator specification sheet [2]	1600	200	1280	1600	220
b	Efficiency (%)	Provided by EcoAct[3]	36%	39%	38%	43%	37%
c	Thermal Input (kW)	Calculated by **a/b**	4400	510	3340	3740	590
d	Discharge Diameter (mm)	Provided by EcoAct[3]	400	400	400	400	400
e	Discharge Height (m)	Provided by EcoAct[3]	8.5	2.3	8	8.5	6.6
f	Discharge Temperature (ºC)	Detailed on generator specification sheet [2]	475	580	423	475	500
g	Actual O_2 (%)	Data not available, proxy data used based on previous modelling.	8%				
h	Reference O_2 (%)	Provided by EcoAct[3]	5%				
i	Net Calorific Value of Diesel (MJ/kg)	Heat Values of various fuels (http://www.world-nuclear.org/information-library/facts-and-figures/heat-values-of-various-fuels.aspx)	44.5				
j	Fuel Required to provide energy input (kg/s)	Calculated by **c/i/1000**	0.10	0.01	0.08	0.08	0.01
k	Waste gas from combustion (m^3/kg)	Oil Fuel Properties http://www.globalcombustion.com/oil-fuel-properties/	12.55				
l	Total waste gas at 0% O_2 (m^3/s)	Calculated by **j*k**	1.5	0.2	1.2	1.3	0.2
m	Total waste gas at ambient temperature and 15% O_2 (Reference Conditions (m^3/s))	Calculated by **l**/((273+15)/273)*(20.9/(20.9-**h**))	1.241	0.144	0.942	1.055	0.166
n	Sulphur Content of Diesel Fuel (ppm)	Provided by EcoAct[3]	10				

[1] Where equations appear in **bold** in the Calculation / Information Source column these represent values in the table with the relevant labelled IDs in the first column.
[2] EcoAct provided manufacturer's specification sheets
[3] EcoAct document, Redhill Generators

Table A2 - Location of Modelled Sources

Source Name	Unit	Generator Make / Model	X (m)	Y (m)
Gen A01	U2	QSK60-G3 2020	528584	151484
Gen A02	U2	QSK60-G3 2020	528587	151485
Gen B01	U2	QSK60-G3 2020	528619	151495
Gen B02	U2	QSK60-G3 2020	528623	151496
LL Gen U2	U2	6CTAA8.3G2	528586	151432
S110 Gen1	U3	CAT 3512 GD	528669	151444
S110 Gen2	U3	CAT 3512 GD	528665	151442
S110 Gen 3	U3	CAT 3512 GD	528660	151441
S120 Gen 1	U3	CAT 3512 GD	528643	151504
S120 Gen 2	U3	CAT 3512 GD	528647	151505
S130 Gen 1	U3	CAT 3512 GD	528651	151507
S130 Swing	U3	QSK60-G3	528769	151475
S140 Gen 1	U3	QSK60-G3	528749	151537
S140 Gen 2	U3	QSK60-G3	528750	151534
S140 Gen 3	U3	QSK60-G3	528752	151528
S140 Gen 4	U3	QSK60-G3	528753	151525
S150 Gen 1	U3	QSK60-G3	528771	151469
S160 Gen 1	U3	QSK60-G3	528772	151466
S160 Gen 2	U3	QSK60-G3	528775	151457
S160 Gen 3	U3	QSK60-G3	528774	151460
LL Gen	U3	GFH275-2	528672	151434

Appendix B:
Pollutant Concentration Isopleths

Figure B1 - Annual Mean NO_2 PC isopleth for U2 and U3 (met 2017)

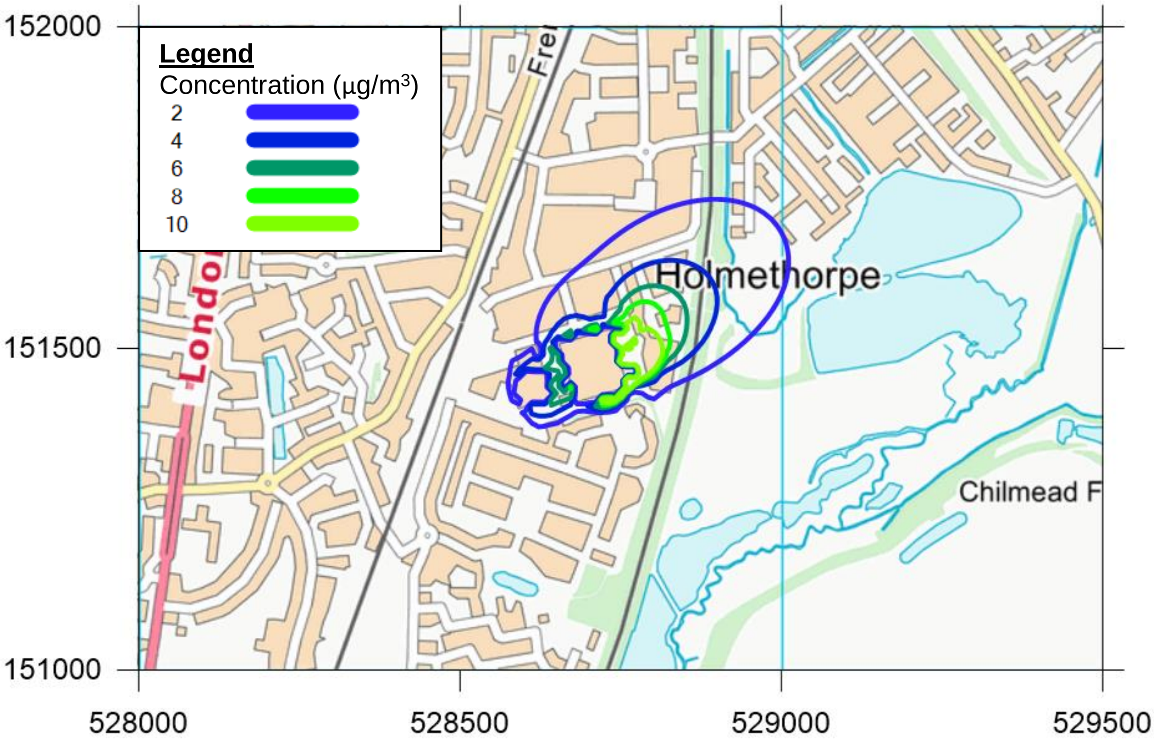


Figure B2 - 99.79th Percentile of 1 hour mean NO_2 PC isopleth for Scenario 3 U3 (met 2017)

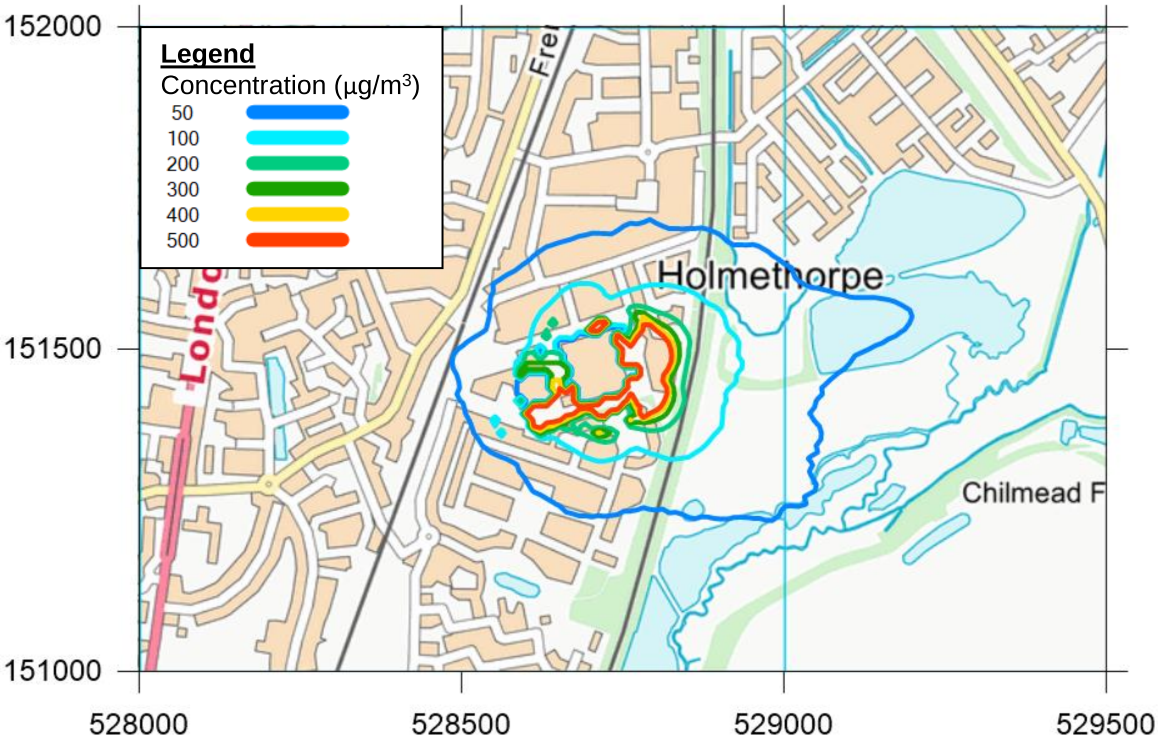
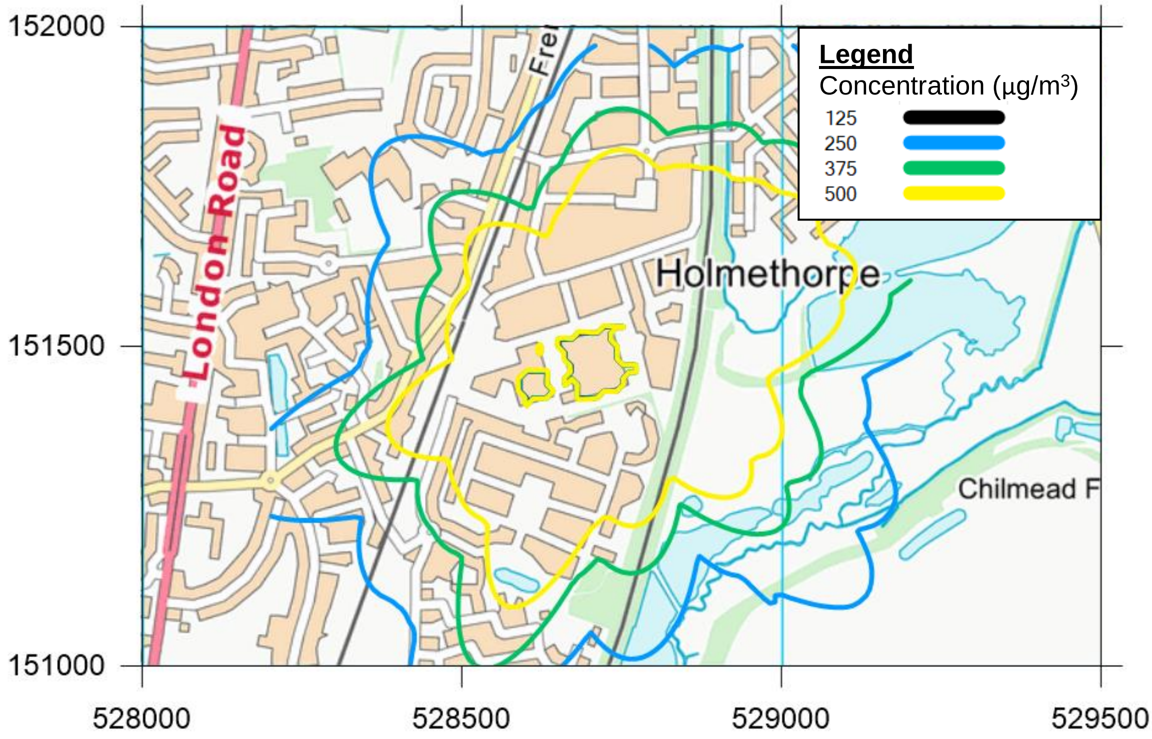


Figure B3 - 24-hour Mean NO_X PC isopleth for Scenario 3 U3 (met 2017)



Appendix C:
Full Results Tables

Appendix D:
Model Files