Ford Sludge Treatment Centre

Air quality assessment to accompany permit application

22 February 2024

Mott MacDonald
St Vincent Plaza
319 St Vincent Street
Glasgow G2 5LD
United Kingdom

T +44 (0)141 222 4500
mottmac.com

Southern Water Services Ltd
Southern House
Yeoman Road
Worthing
BN13 3NX

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Mott MacDonald Limited. Registered in England and Wales no. 1243967. Registered office: Mott MacDonald House, 8-10 Sydenham Road, Croydon CR0 2EE, United Kingdom

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Contents

1 Introduction

1.1 Overview

This report has been prepared to support the Bespoke Installation Permit for Ford Sludge Treatment Centre (STC). An H1 air quality screening assessment accompanying an Industrial Emissions Directive (IED) environmental permit application for the Ford Sludge Treatment Centre (STC) identified a potential for exceedances of long term and short-term Environmental Assessment Levels (EALs). Therefore, as specified in the 'Air emissions risk assessment for your environmental permit'[1] guidance, these air emissions cannot be screened out and detailed modelling is required. This Air Quality Assessment report presents the results of detailed modelling of emissions from the combustion of biogas at a Combined Heat and Power (CHP) plant and auxiliary biogas boilers.

The assessment has accounted for the requirements set out within the 'Air emissions risk assessment for your environmental permit'1 guidance. As stated in this guidance document, where existing data have not been available, either estimates based on similar operations elsewhere or worst-case estimates have been used to complete the assessment. All assumptions that have been made for these estimates are detailed in this report.

1.2 Site description

Ford is a STC (hereafter referred to as the 'Site') owned and operated by Southern Water Services Ltd. The anaerobic digestion (AD), which is part of the STC, facility treats indigenously produced and imported sludges. Biogas produced by the AD facility is combusted by the CHP to recover heat and electricity. The heat is used at the AD facility. If the CHP is not operational, biogas will be combusted via the back-up boilers and/or an on-site flare stack. The combustion plant at the Site consists of:

- A 1.8MWth input CHP plant (MTU Stamford PE743A), which combusts the biogas produced by the AD facility to generate heat and electricity. All heat and electricity generated is used on site and is not exported to the National Grid.
- Two back-up boilers (2x Ideal Viscount GTS 17) with a thermal input of 1.2MWth each. These boilers operate as duty/standby (i.e. only one is in operation at any time), as backup in the event of a CHP plant failure in order to maintain digester temperature. The boilers operate on biogas.
- A flare, which is used to burn off excess biogas.
- One standby diesel generator for emergency use and testing with a thermal input of 4.6MWth, operational less than 50 hours per year.

1.3 Site location

The Site address is Ford Road, Arundel, West Sussex, BN18 0DD (National Grid Reference: SU 994030). The Site is within the administrative area of Arun District Council (ADC). The Site is surrounded by Arun Sports Arena to the west, a recycling centre to the north, and agricultural fields to the east and south.

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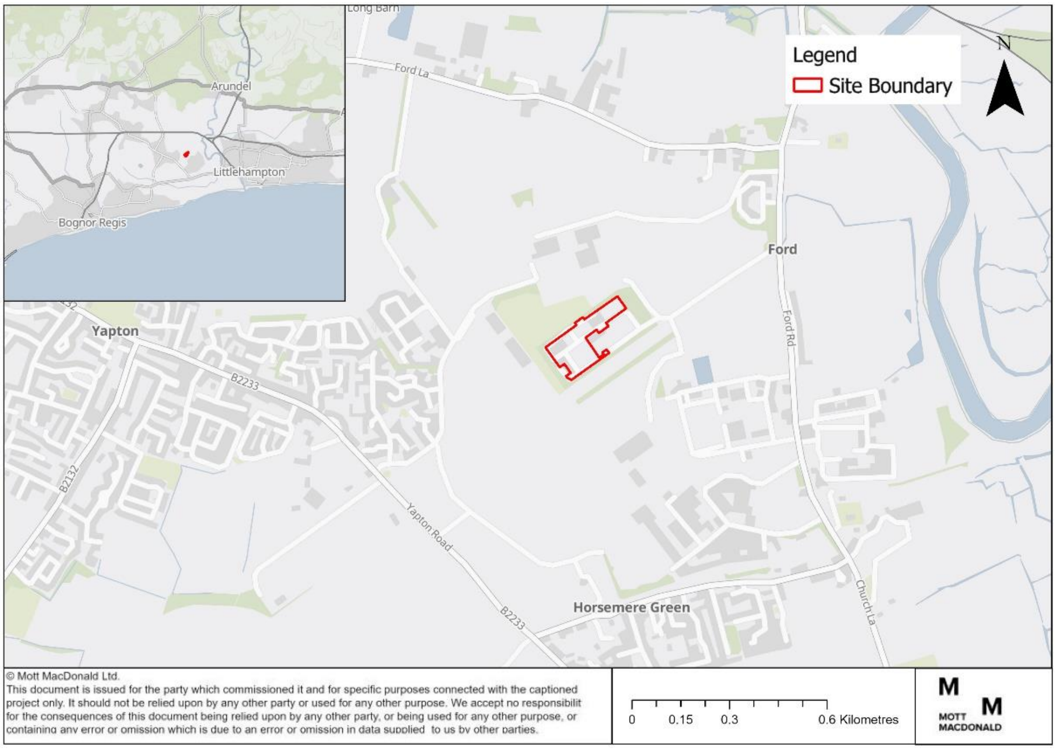
[1] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

The nearest human health receptors to the Site are Arun Sports Arena (ST) approximately 55m to the west of the site and residential receptors on Beagle Drive approximately 355m to the west of the site boundary. Figure 1.1 shows the location of the Site and the extent of the Site boundary.

Figure 1.1: Site location



1.4 Summary of key pollutants

This assessment has considered emissions of oxides of nitrogen (NO_x), volatile organic compounds (VOCs) and sulphur dioxide (SO_2). These are the key pollutants of potential concern, given that the main fuel used on the Site is biogas.

The following sub-sections present a brief description of the key pollutants referred to above and their behaviour in the atmosphere.

1.4.1 Oxides of nitrogen

Oxides of nitrogen is a term used to describe a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2), referred to collectively as NOx. These are primarily formed from atmospheric and fuel nitrogen as a result of high temperature combustion. The most important sources in the UK are road traffic and power generation.

During the process of combustion, atmospheric and fuel nitrogen is partially oxidised via a series of complex reactions to NO. The process is dependent on the temperature, pressure, oxygen concentration and residence time of the combustion gases in the combustion zone. Most NOx exhausted from a combustion process is in the form of NO, which is a colourless and tasteless gas. It is readily oxidised to NO_2, a more harmful form of NOx, by a chemical reaction with ozone and other chemicals in the atmosphere. NO_2 is a yellowish-orange to reddish-brown gas with a pungent, irritating odour and is a strong oxidant.

1.4.2 Sulphur dioxide

SO_2 is a colourless, non-flammable gas with a penetrating odour that can irritate the eyes and air passages. It reacts on the surface of a variety of airborne solid particles, is soluble in water and can be oxidised within airborne water droplets. The most common sources of SO_2 include fossil fuel (coal and oil) combustion, smelting, manufacture of sulphuric acid, conversion of wood pulp to paper, incineration of waste and production of elemental sulphur. The most common natural source of SO_2 is volcanoes.

1.4.3 Volatile organic compounds

Volatile organic compounds (VOCs) are a collection of organic chemical compounds that have high enough vapour pressures under normal conditions to significantly vaporize and enter the atmosphere. A wide range of carbon-based molecules, such as aldehydes, ketones, and other light hydrocarbons are VOCs. Common artificial VOCs include paint thinners, dry cleaning solvents, and some constituents of fuels (e.g. petrol and natural gas).

The VOCs which are harmful to health are known as non-methane VOCs (NMVOC) as they do not contain methane (CH4). Examples of NMVOCs include benzene, formaldehyde and acetone which can be produced during combustion, agricultural practices and from the use of solvents.

For the purpose of this assessment, only benzene has been considered as this is the VOC for which relevant Environmental Quality Standards exist.

2 Legislative context

2.1 Overview

This section summarises the relevant international and national legislation, policy and guidance in relation to air quality at the Site.

2.2 England

The Air Quality Standards Regulations 2010[2], Air Quality Standards (amendment) Regulations 2016[3], Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019[4] and Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020[5] implement the EU's Directive 2008/50/EC on ambient air quality.

Part IV of the Environment Act 1995[6] (as amended in Schedule 11 of the Environment Act 2021[7]) requires that every local authority shall carry out a review of air quality within its designated area. Local authorities have to consider and assess whether current and forecasted air quality levels in their areas are likely to exceed the objectives set out in the Air Quality (England) Regulations 2000[8] and the Air Quality (England) (Amendment) Regulations 2002[9].The objectives that are set out in these regulations are, in most cases, numerically synonymous with the limit values specified within the legislation, although compliance dates differ. Where an area exceeds an air quality objective, an Air Quality Management Area (AQMA) must be declared and an Air Quality Action Plan (AQAP) must be prepared to specify and implement measures to improve air quality.

The Environment Act 1995 requires the UK Government to produce a national 'Air Quality Strategy' (AQS). The AQS establishes the UK framework for air quality improvements. Measures agreed at the national and international level are the foundations on which the strategy is based. The first Air Quality Strategy was adopted in 1997.

The UK Government revised its national Air Quality Strategy[10] in 2023. This revision replaces the 2007 strategy and compliments the Clean Air Strategy 2019 (CAS). The 2023 revision sets out the actions the government expects local authorities in England to take in support of achieving the Government's long-term air quality goals.

Although the CAS does not set legally binding objectives, the CAS instead has targets for reducing total UK emissions of NOx from sectors such as road transport, domestic sources and industry.

[2] Statutory Instrument. (2010), 'The Environmental Permitting (England and Wales) Regulations', Queen's Printer of Acts of Parliament.

[3] Statutory Instrument (2016) The Air Quality Standards (Amendment) Regulations, No. 1184.

[4] Statutory Instrument (2019) Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations., No. 74.

[5] Statutory Instrument. (2020) Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020, No. 1313.

[6] Department for Environment Food and Rural Affairs. (2009). Part IV of the Environment Act 1995 Local Air Quality Management Policy Guidance (PG09). London: Defra.

[7] Statutory Instrument. (2021) Chapter 30, Schedule 11 Local Air Quality Management Framework of Environment Act 2021

[8] Statutory Instrument. (2000), 'Air Quality (England) Regulations', No. 928. UK statutory instrument

[9] Statutory Instrument. (2002), 'Air Quality (England) (Amendment) Regulations', No. 3043. UK statutory instrument

[10] Draft revised Air Quality Strategy available at https://consult.defra.gov.uk/air-quality-strategy-review-team/consultation-on-the-draft-revised-air-quality-stra/ [last accessed 21st April 2023]

2.3 Permitting requirements and associated guidance

2.4 Overview

Depending on the potential level of risk to air quality, the preparation of a permit application can include the requirement for an air quality assessment. Key guidance issued by the Environment Agency to assist with undertaking an air quality assessment for an environmental permit includes:

- Air emissions risk assessment for your environmental permit[11]
- Environmental permitting: air dispersion modelling reports[12]
- Specified generators: dispersion modelling assessment guidance[13]
- Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air[14]

2.4.1 Permitting requirements at the Site

Southern Water is applying to vary their existing Environmental Permit EPR/KP3130KX into a Bespoke Installation Permit for the STC waste activity. This is because a joint Environment Agency and DEFRA decision has been made that AD treatment facilities at WTWs and STCs are covered by the Industrial Emissions Directive and can no longer operate standard environmental permits or exemptions.

The primary permitted installation activity will be the AD treatment facility. The AD facility will treat indigenously produced and imported sludges. Permitted Directly Associated Activities (DAAs) will be the import of waste from other WTW assets; the physio-chemical treatment of imported and indigenously produces sludges; the storage of indigenously produced sludges, imported sludges and the sludge cake from the AD facility; the storage of biogas derived from the AD treatment of waste and the combustion of biogas in an on-site CHP plant. In the event the CHP cannot run in an emergency or due to operational issues, biogas will be combusted via an on-site flare stack and back-up boiler system.

With the changes on the Environmental Permitting Regulations due after 2023, fats, oil and grease and food wastes will be treated (in the future) in the AD facility and co-digested to improve the quality of cake produced and the biogas yields produced for combustion in the on-site CHP.

The Standard Rules 'SR2021 No 10: anaerobic digestion of non-hazardous sludge at a wastewater treatment works, including the use of the resultant biogas'[15] set Emission Limit Values (ELVs)[16] for boilers and other combustion plant including:

[11] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[12] Environment Agency, 2014. Environmental permitting: air dispersion modelling reports. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

[13] Environment Agency, 2019. Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

[14] Environment Agency (2006). Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air: Habitats Directive 2004 (AQTAG 06).

[15] SR2021 No 10: anaerobic digestion of non-hazardous sludge at a waste water treatment works, including the use of the resultant biogas. https://www.gov.uk/government/publications/sr2021-no-10-anaerobic-digestion-of-non-hazardous-sludge-at-a-waste-water-treatment-works-including-the-use-of-the-resultant-biogas

[16] All limits are defined at a temperature of 273.15 K, a pressure of 101.3 kPa and after correction for the water vapour content of the waste gases at a standardised O_2 content of 5% for gas engines (CHP) and 3% for boilers

- ELVs of 250mg/Nm^3 for NO_x and 200mg/m^3 for SO_2 for existing (operational before 20 December 2018) boilers and 200mg/Nm^3 for NO_x and 100mg/m^3 for SO_2 (reference conditions at 3% O_2, 0°C, 0% H_2O) for new (operational after 20 December 2018) boilers that are medium combustion plant (MCP).
  - The Site's boilers were operational from 2023 and are more than 1MWth input therefore the lower ELVs for new boilers are applicable. However, for the purposes of this assessment, the higher ELVs for existing boilers have been adopted for the emissions data as a conservative assumption.
- ELVs of 500mg/Nm^3 for NO_x and 350mg/m^3 for SO_2 (reference conditions at 5% O_2, 0°C, 0% H_2O) for combustion plant burning biogas.
  - These ELVs are applicable to the CHP.

Emission monitoring undertaken at the CHP plant to date demonstrates compliance with the SR2021 No 10 combustion plant emission limits for NOx and SO_2.

2.4.2 Assessment criteria

The following section presents the relevant air quality standards that are applicable to the Site. These are collectively described as the Environmental Quality Standards (EQS).

The Environment Agency's risk assessment guidance[17] provides guidelines on Ambient Air Directive (AAD) limit values, UK air quality objectives and environmental assessment levels (EALs) that the impact should be compared against. Further EQS to assess the potential impact at designated sites are available from the Air Pollution Information System[18] (APIS).

Air quality limit values and objectives

Table 2.1 summarises the AAD limit values and air quality objectives for the pollutants relevant to this assessment.

Table 2.1: Summary of relevant air quality objectives and AAD limit values

Pollutant	Averaging period	Objective / limit value (µg/m³)	Allowance
For the protection of human health			
Nitrogen dioxide (NO_2)	1-hour	200	18 times pcy
	Annual	40	–
Sulphur dioxide (SO_2)	15-minute	266	35 times pcy
	1-hour	350	24 times pcy
	24-hour	125	3 times pcy
VOCs (as benzene)	Annual	5	–
For the protection of vegetation and ecosystems			
Nitrogen oxides (NO_X)	Annual	30	–
Sulphur dioxide (SO_2)	Annual	20	–

Notes: pcy = per calendar year

The limit values apply everywhere with the exception of:

a) Any locations situated within areas where members of the public do not have access and there is no fixed habitation.

[17] Environment Agency. (2016) 'Air Emissions Risk Assessment for your Environmental Permit'.
[18] UK Air Pollution Information System (APIS) www.apis.ac.uk [last accessed 09/07/2019]

b) In accordance with Article 2(1), on factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply
c) On the carriageway of roads, and
d) On the central reservations of roads except where there is normally pedestrian access to the central reservation.

Table 2.2 provides examples of the locations where the UK air quality objectives apply for the protection of human health. This has been used to define where the AAD limit values and air quality objectives should apply within the assessment.

Table 2.2: Locations where air quality objectives apply

Averaging period	Objectives should apply at:	Objectives should not apply at:
Annual	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
24 hour	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
1 hour	All locations where the annual mean and 24 and 8-hour mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

Specified generator guidance published by the Environment Agency[19] states that the annual and hourly NO_2 objectives should be considered at sensitive receptors where "there is relevant public exposure". Relevant public exposure is defined as a location where members of the public:

- Have access
- Are regularly present, and
- Can be exposed for a significant portion of the averaging time of the standard.

Consequently, the standards do not apply where health and safety at work provisions exist and where members of the public do not have access, such as within the Site boundary.

Environmental Assessment Levels

In addition to the AAD limit values and air quality objectives, the Environment Agency risk assessment guidance[20] provides further assessment criteria in the form of Environmental Assessment Levels (EALs). The EALs cover a wide range of pollutants and specify target values for the protection of conservation areas. Any exceedances of these EALs may result in further action needing to be taken to reduce the impact on the environment. EALs applicable to

[19] Environment Agency, 2019. Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

[20] Environment Agency. (2016) 'Air Emissions Risk Assessment for your Environmental Permit'.

the assessment (also referred to as critical levels in the context of designated sites) are presented in Table 2.3.

Table 2.3: Summary of relevant EALs/critical levels for the protection of human health and ecosystems

Pollutant	Averaging period	EAL/critical level (µg/m³)
For the protection of human health		
VOCs (as benzene)	24 hour	30
For the protection of vegetation and ecosystems		
Nitrogen oxides (NOx)	24 hours	75
	Annual	30*

* Numerically synonymous with the annual AAD limit value

In addition to these EALs, APIS provides targets for nitrogen and acid deposition for specific habitats and species. These EALs, also known as critical loads, are provided for specific habitats within Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSI). Generic critical loads for broad habitat classes are also available on APIS.

3 Methodology

3.1 Overview

In accordance with Environment Agency risk assessment guidance[21], the approach to the air quality assessment has involved the following key elements:

- Calculation of the environmental concentration of pollutants released to the air (Process Contributions (PC) and Predicted Environmental Concentrations (PEC))
- Identification of whether the PCs and PECs have a significant environmental impact by comparing with the relevant EQS

PECs have been calculated by adding the PC to a representative value for the background concentration. Section 3.2.10 provides further details on the background concentrations used in this assessment.

Detailed modelling has been undertaken to calculate PCs and PECs to determine whether emissions from the Site are significant.

3.2 Modelling approach

3.2.1 Model selection

Commercially available dispersion models are available to predict ground level concentrations arising from emissions to air from elevated point sources.

ADMS is a "new generation" dispersion model, developed by Cambridge Environmental Research Consultants (CERC), which models a wide range of buoyant and passive releases to the atmosphere either individually or in combination. ADMS brings together the results of recent research on dispersion modelling. The model calculates the mean concentration over flat terrain, allowing for the effect of plume rise, complex terrain, buildings, radioactive decay and deposition. The model has been subject to extensive validation. ADMS comprises of a number of individual modules each representing one of the processes contributing to dispersion or an aspect of data input and output. The latest version of the model, ADMS 6.0.0.1, has been used in this assessment.

3.2.2 Buildings

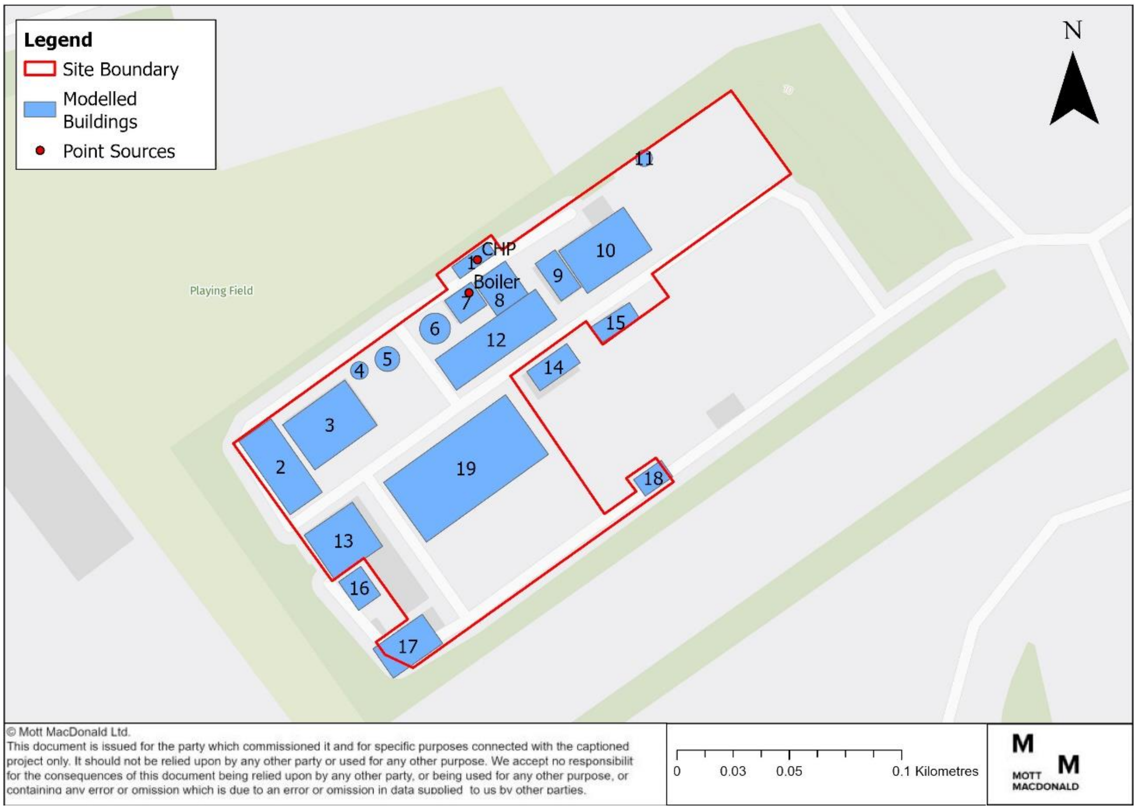
The movement of air over and around buildings generates areas of flow circulation, which can lead to increased ground level concentrations in the building wakes. Where building heights are greater than about 30 - 40% of the stack height, downwash effects can be significant. ADMS includes a building effects module to calculate the dispersion of pollution from sources near large structures. The buildings likely to have a dominant effect (i.e. with the greatest dimensions likely to promote turbulence) which have been included within the model are listed in Table 3.1 and illustrated in Figure 3.1.

[21] Environment Agency. (2016) 'Air Emissions Risk Assessment for your Environmental Permit'.

Table 3.1: Building dimensions used within the assessment

No	X (m)	Y (m)	Height (m)	Length (m)	Width (m)	Angle (°)
1	499462	103155	4	6.4	19.4	145
2	499376	103063	9	17.5	39.8	235
3	499398	103082	9	24.7	34.2	144
4	499411	103106	5	7.9	7.9	0
5	499423	103111	10	11.0	11.0	0
6	499444	103125	9	13.7	13.7	0
7	499458	103136	4	12.4	14.4	145
8	499474	103143	7	17.0	17.9	55
9	499499	103148	4	10.8	20.3	55
10	499520	103160	12	34.8	22.8	56
11	499537	103201	13	7.4	7.4	0
12	499471	103120	10	54.6	16.6	55
13	499404	103030	10	26.0	23.8	56
14	499497	103108	7	10.4	21.8	145
15	499525	103127	6	8.4	20.2	147
16	499411	103009	5	15.5	12.0	145
17	499432	102984	5	15.9	26.8	145
18	499541	103058	5	9.0	15.0	145
19	499458	103063	3	66.9	32.7	54

Figure 3.1: Building layout



3.2.3 Meteorology

The most important meteorological parameters governing the atmospheric dispersion of pollutants are wind direction, wind speed and atmospheric stability as described below:

- Wind direction determines the sector of the compass into which the plume is dispersed.
- Wind speed affects the distance the plume travels over time and can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise.
- Atmospheric stability is a measure of the turbulence of the air, and particularly of its vertical motion. It therefore affects the spread of the plume as it travels away from the source. ADMS uses a parameter known as the Monin-Obukhov length that, together with the wind speed, describes the stability of the atmosphere.

For meteorological data to be suitable for dispersion modelling purposes, 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 sites where the required meteorological measurements are made.

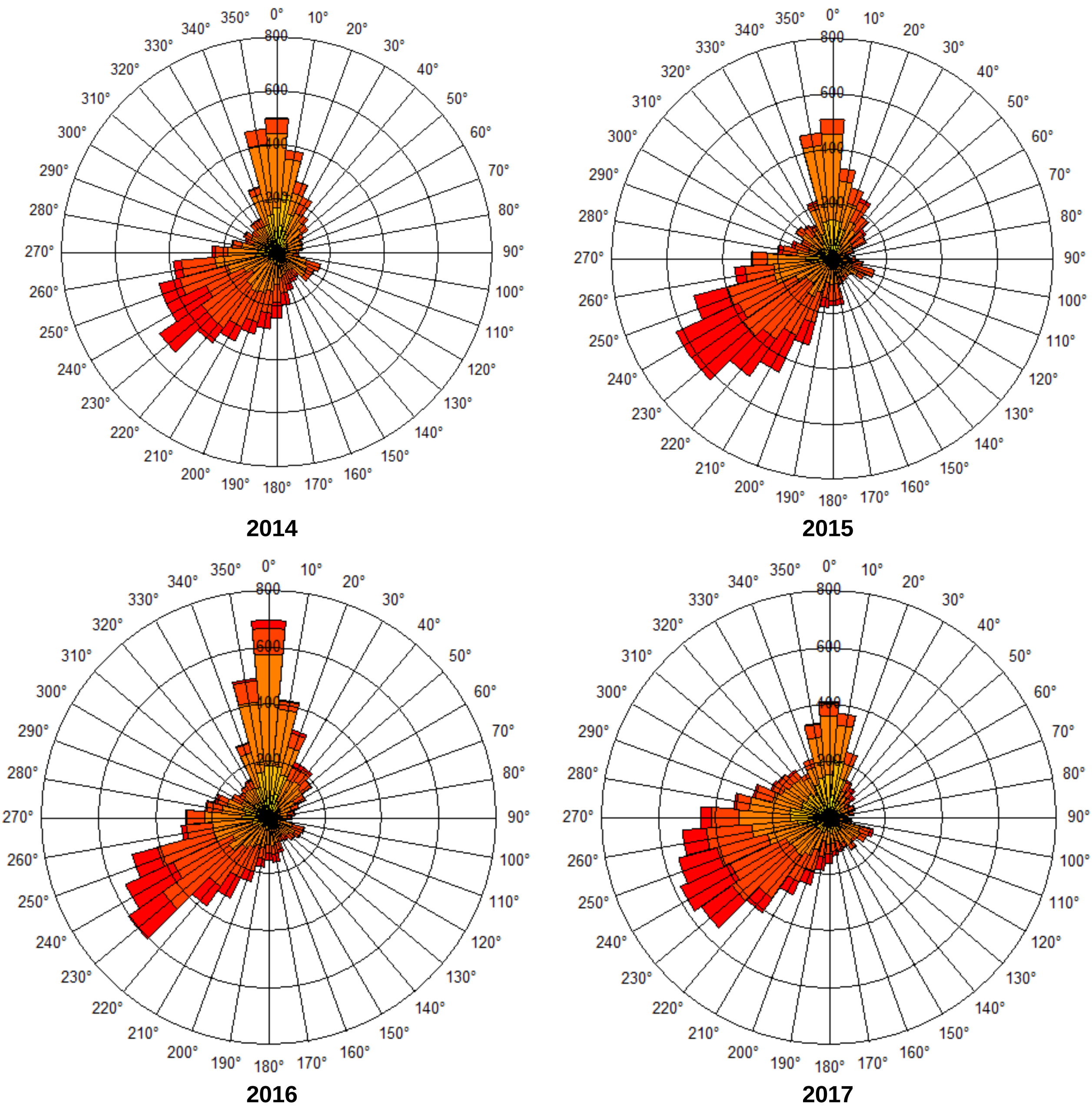
The year of meteorological data that is used for a modelling assessment can have a significant effect on source contribution concentrations. As recommended by the Environment Agency dispersion modelling guidance[22], modelling was undertaken using five years of data. Data from the Shoreham Airport meteorological station was used as this was considered the most

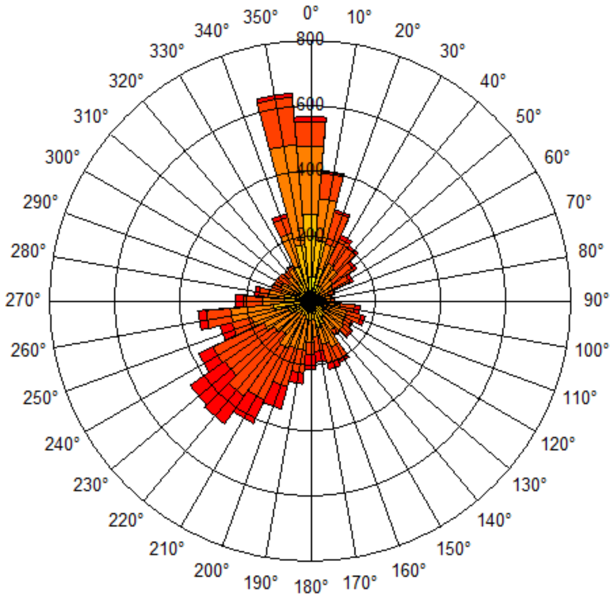
[22] Environment Agency, 2014. Environmental permitting: air dispersion modelling reports. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

representative station due to its proximity to the Site (approximately 20 km to the east). Five years of data from 2014 to 2028 were used.

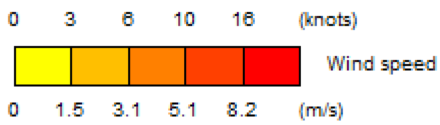
Wind roses have been constructed for each of the five years of meteorological data used in this assessment. The wind roses presented in Figure 3.2 illustrate that in all years there is dominance in winds from the south west and frequent winds from the north.

Figure 3.2: Wind roses for Shoreham Airport (2014 – 2018)





2018



Scale

3.2.4 Terrain

The presence of elevated terrain can significantly affect ground level concentrations of pollutants emitted from elevated sources such as stacks by reducing the distance between the plume centre line and ground level and increasing turbulence and, hence, plume mixing.

Terrain in the region of the Site is generally flat and there are no slopes with gradients more than 10% over extensive distances near the Site. Therefore, in accordance with Environment Agency guidance[23], terrain data has not been included in the dispersion model.

3.2.5 Surface roughness

The roughness of the terrain over which a plume passes can have a significant effect on dispersion by altering the velocity profile with height and the degree of atmospheric turbulence. This is accounted for by a parameter called the surface roughness length.

A roughness length of 0.5m has been used in this assessment which is consistent with the predominantly rural and residential model domain. A surface roughness length of 0.2m has been assigned to the Shoreham Airport meteorological site.

3.2.6 Modelled scenario

As detailed in Section 1.20, the combustion plant at the Site consists of a CHP plant, two backup boilers, a flare, and an emergency backup diesel generator.

Only the CHP plant and backup boilers have been considered in the assessment; the backup diesel generator is only used for up to 50 hours per year for emergencies and testing whilst the flare is only used during emergencies and maintenance of the CHP engine which are likely to be infrequent occurrences. Therefore, emissions from the backup diesel generator and flare are considered to be infrequent and for very short periods and have not been considered further.

[23] Environment Agency, 2019. Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

The CHP is estimated to be operational for 93% of the hours in the year, while the two boilers are estimated to be operational in duty/standby configuration for up to 6% of the hours in the year. Therefore, the CHP and boilers are not in continuous operation. For the purposes of this assessment, it has been assumed that the CHP and one boiler will operate continuously year-round (8760 hours a year) and at full load, which is a conservative approach considering these combustion plant do not operate concurrently. One boiler has been modelled because of the duty/standby configuration where only one boiler is operational at any time. Emissions from operation of the combustion plant would therefore likely be lower than assumed for this modelling assessment.

3.2.7 Emissions data

Emissions used in this assessment are based on a plant load of 100% and assumes that exhaust gases will contain the maximum concentration of pollutants permitted. Exhaust gases from the CHP and back-up boilers are each released from their own, individual flue.

The NO_x and SO_2 emissions modelled for the CHP are based on the SR2021 ELVs of 500mg/Nm^3 and 350 mg/Nm^3 (5% O_2, 0°C, dry), respectively. The most recent stack emissions monitoring assessment for this CHP carried out in July 2023[24] shows compliance with these ELVs.

The emissions of VOCs from the CHP are based on the latest monitored emissions concentration[24] of 1024 mg/Nm^{3s} as there is no set ELV for VOCs emissions from the CHP. As discussed in Section 3.2.7, it has been assumed that 100% of the VOCs emitted from the CHP will be benzene, because this is the VOC for which a relevant EQS exists. The monitored total VOCs concentration does not speciate the VOCs so the actual benzene emission rate is not known. However, the assumption of 100% benzene emissions is likely to be a substantial overestimate and therefore highly conservative. The UK National Atmospheric Inventory (NAEI) report ‘Speciation of UK emissions of non-methane volatile organic compounds’[25] provides a review of published VOC speciation profiles, the profiles relevant to this assessment have been summarised in Table 3.2 below. Although none of these are specific to combustion plant burning biogas, this range of published benzene fractions is likely to be indicative of the likely benzene fraction for the VOCs emissions from the CHP. The highest % benzene for any source listed in the table below is 9.1%. Therefore, it is likely that the assumption of 100% benzene adopted for this assessment is an overestimate of the actual benzene emissions by at least a factor of 10.

Table 3.2: Benzene fractions from combustion sources published by the NAEI

Source	% Benzene
Domestic combustion of gas	9%
Industrial combustion of gas	9.1%
Electricity generation using gas	nil
Internal combustion engine - natural gas	0.5%
Flares – natural gas	nil

[24] Element Materials Technology Environmental UK, Stack Emissions Testing Report, 3 October 2023.

[25] N R Passant, Speciation of UK emissions of non-methane volatile organic compounds, February 2002

The NOx and SO_2 emissions modelled in this assessment for the boilers are based on the Standard Rules 2021 No 10 ELVs for existing (operational before December 2018) boilers burning biogas, which are 250mg/Nm^3 for NOx and 200 mg/Nm^3 for SO_2 (3% O_2, 0°C, dry).

Monitored SO_2 emission concentrations from the CHP emissions test report and monitored sulphur levels in the latest biogas test report[26] suggest that the actual SO_2 emission rates are likely to be considerably lower (approximately a factor of 10-15 lower) than the SO_2 emission rates adopted for this assessment.

Table 3.3 presents the emission parameters used in the dispersion modelling. The data used for any calculations are included in the 'Notes' section of the table. Emission rates for NOx and SO_2 have been calculated using the equations presented below:

Emission rate = Plant emission limit x Normalised gas flow.

Correcting for water content:

Dry value = Measured value x 100 / (100 – H_2O measured concentrations [%]).

Correcting for oxygen content:

Corrected value = Measured value x (21 – O_2 Reference value [%] / 21 – O_2 Measured Value [%]).

Correcting for temperature:

Corrected value = Measured value x (Temperature of measured value [K] / 273 [K]).

Table 3.3: Stack emission parameters

Parameter	Units	CHP	Boiler
Stack location	x,y	499463, 103155	499459, 103141
Stack height	m	7	4.5
Stack diameter	m	0.3	0.53
Exit temperature	°C	129	210
Efflux velocity	m/s	20.0	4.2
Volumetric flow rate (actual)	Am^3/s	1.41[(a)]	0.90[(b)]
Volumetric flow rate (normalisedl)	Nm^3/s	0.65[(c)]	0.37[(d)]
NO_x emission	g/s	0.33[(e)]	0.09[(f)]
SO_2 emission	g/s	0.23[(e)]	0.07[(f)]
VOCs emission	g/s	0.68[(g)]	-

Notes: (a) Calculated from the monitored oxygen content of the flue gas (8.5%, dry) and the thermal input of the CHP (1.8MWth).
(b) Calculated from the thermal input of the boiler (1.2MWth)
(c) Normalised conditions = 5% O_2, 0°C, 0% H_2O
(d) Normalised conditions = 3% O_2, 0°C, 0% H_2O
(e) Calculated from the SR2021 No 10. ELVs for combustion plant burning biogas of 500 mg/Nm^3 for NOx and 350 mg/Nm^3 for SO_2. (Pressure of 101.3 kPA, dry, 0°C, 5% O_2) and the thermal input of the CHP (1.8MWth).
(f) Calculated from the SR2021 No 10. ELVs for existing boilers of 250 mg/Nm^3 for NOx and 200 mg/Nm^3 for SO_2 (Pressure of 101.3 kPA, dry, 0°C, 3% O_2) and the thermal input of the boiler (1.2MWth)
(g) Based on the latest monitored VOCs emissions concentration of 1024 mg/Nm^3 (Pressure of 101.3 kPA, dry, 0°C, 5% O_2

[26] DynaGreen Environmental UK, Analysis of Biogas Constituents, 23 June 2023.

3.2.8 NOx to NO_2 relationship

The NOx emissions associated with combustion activities at the Site will typically comprise approximately 90-95% nitric oxide (NO) and 5-10% nitrogen dioxide (NO_2) at source. As described previously, the NO oxidises in the atmosphere in the presence of sunlight, ozone and volatile organic compounds to form NO_2, which is the principal concern in terms of environmental health effects.

There are various techniques available for estimating the portion of the NOx that is converted to NO_2, which will increase with distance from the source. The Environment Agency's modelling guidance[27] identifies that a 70% conversion of NOx to NO_2 should be used for calculation of annual average concentrations and a 35% conversion of NOx to NO_2 should be used for calculation of short-term concentrations. The Environment Agency's recommended conversion rates have been used in this assessment.

3.2.9 Assessment of short- and long-term concentrations

The long-term and short-term modelling undertaken assumes that the boiler and CHP will operate at full load continuously for 24 hours each day, which equates to 8760 hours a year. As discussed in Section 3.2.6, this is a very conservative approach because these combustion plant do not operate simultaneously in practice.

3.2.10 Background/ambient concentrations

Background concentrations, also known as ambient concentrations (AC), are added to the PCs to determine the PEC at modelled receptors. Environment Agency dispersion modelling guidance[28] states that Defra background maps or local authority/Defra monitoring data can be used as a representative value for the background concentrations in the assessment. However, the Environment Agency specified generator guidance[29] states that low resolution grid average background values may not be suitable for receptor locations close to other sources such as busy roads or major industry. The results of air quality monitoring undertaken by ADC has been reviewed for representative data that can be applied to this assessment.

As the concentrations from the background maps and diffusion tube monitoring are long-term (annual) average concentrations, short-term background concentrations have been estimated by doubling the long-term background concentrations. The short-term backgrounds are applied to the 15-minute, hourly and 24-hour averaged concentrations. This is in accordance with Environment Agency risk assessment guidance[30].

3.3 Sensitive receptors

Gridded receptors and discrete human health and ecological receptors have been considered within this assessment.

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[27] Environment Agency, 2019. Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

[28] Environment Agency, 2014. Environmental permitting: air dispersion modelling reports. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

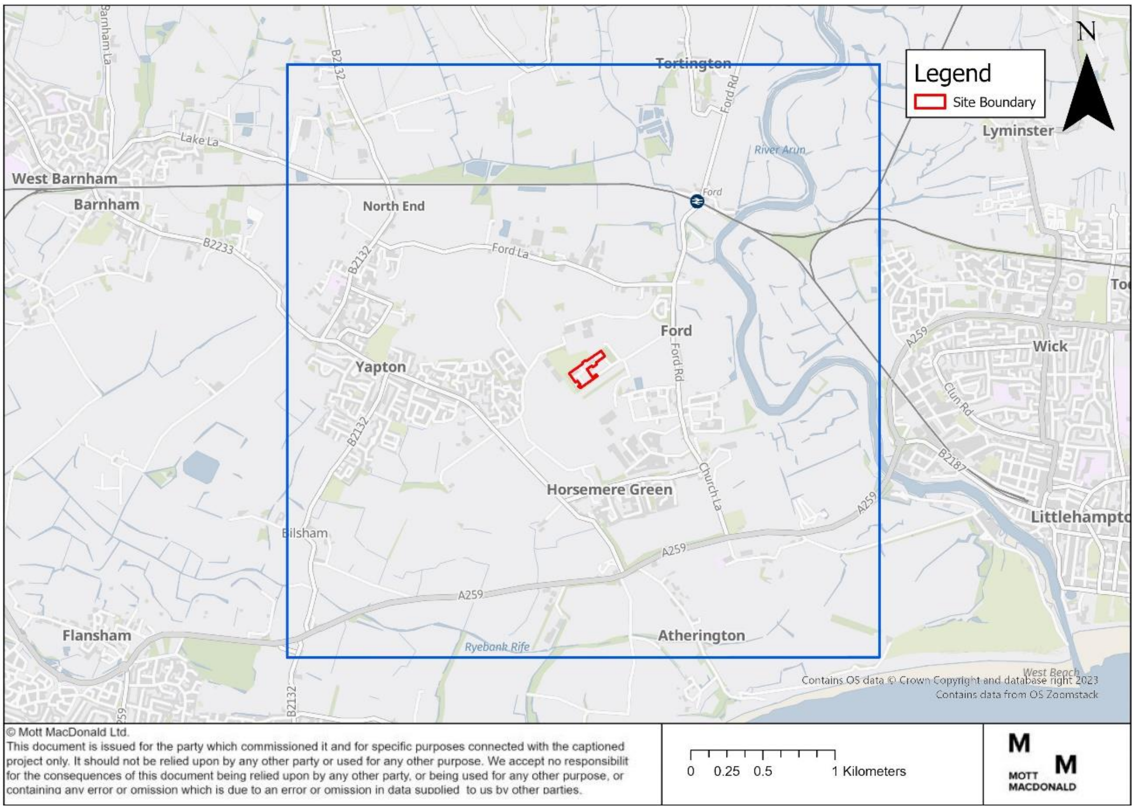
[29] Environment Agency, 2019. Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

[30] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

3.3.1 Gridded receptors

Pollutant concentrations have been modelled across a Cartesian grid with 20 metre spacing up to 500m from the Site and at 100m spacing beyond this up to 2km from the Site. The finer 20m resolution captures the maximum modelled impacts which fall near to the Site while the 2km grid extent is sufficient to fully cover the range of modelled concentrations in the surrounding area. The maximum predicted PCs occur within this grid extent. The extent of the grid has been presented in Figure 3.3. This assessment has not considered on-site concentrations as the EQSs would not apply at these locations as there is no relevant public exposure.

Figure 3.3: Gridded receptor model extent



3.3.2 Human health

Eleven discrete human health receptors representing the closest sensitive receptors have been included within the model so that a comparison against the EQSs can be made. The short-term objective applies at receptors 1 and 2 and both the long-term and short long-term objectives apply at residential receptors 3-11 (see Table 2.2 for details). Table 3.4 and Figure 3.4 show the locations of the discrete receptors considered within this assessment.

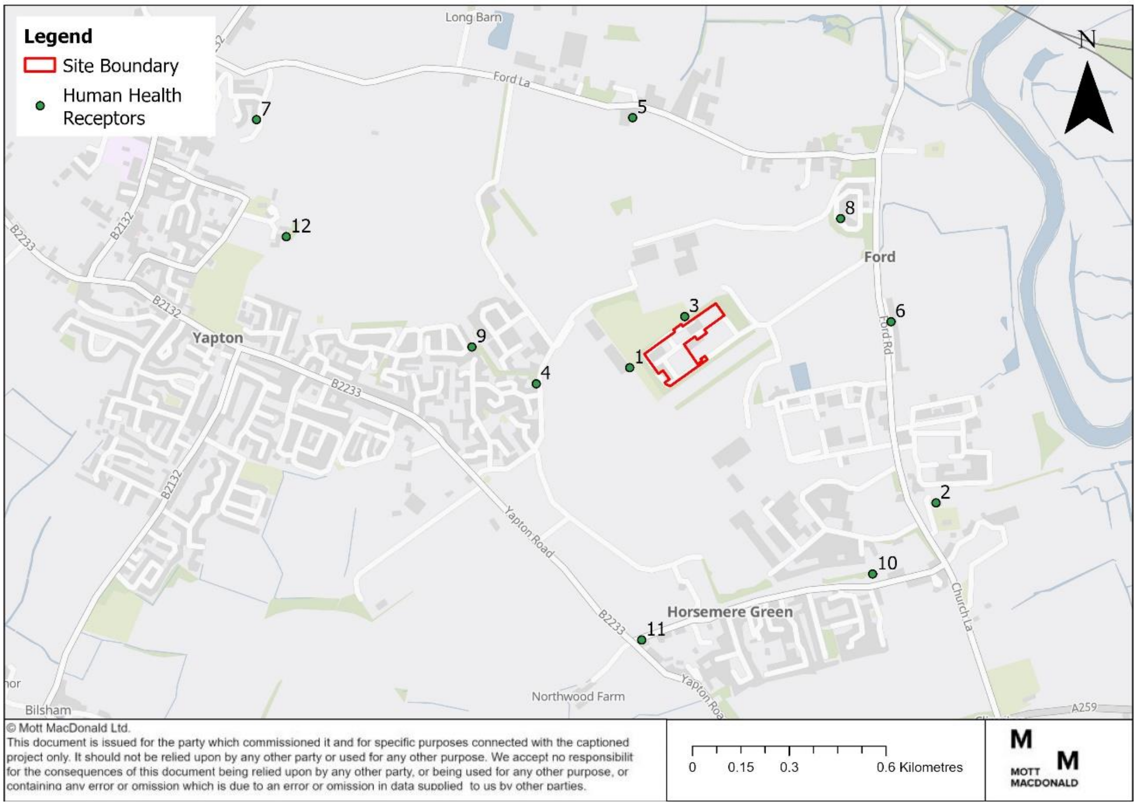
Table 3.4: Modelled human health receptors

Receptor number	Receptor name	Receptor type	X	Y	Height (m)
1	Arun Sports Arena (ST)	Recreational grounds	499310	103031	1.5

Receptor number	Receptor name	Receptor type	X	Y	Height (m)
2	St Mary's Church (ST)	Church	500259	102613	1.5
3	Arun Sports Arena Playing Fields (ST)	Recreational grounds	499480	103190	1.5
4	Beage Drive	Residential	499019	102981	1.5
5	Ford Lane	Residential	499319	103806	1.5
6	Ford Road	Residential	500119	103174	1.5
7	Saturn Drive	Residential	498152	103800	1.5
8	Rodney Crescent	Residential	499963	103493	1.5
9	Navigation Drive	Residential	498820	103096	1.5
10	Horsemere Green Lane	Residential	500063	102392	1.5
11	Yapton Road	Residential	499346	102188	1.5
12	Binsted Farms	Residential	498245	103438	1.5

Note: Only the short-term objectives for NO2 and SO2 apply at modelled receptors with 'ST' included in the receptor name.

Figure 3.4: Modelled human health receptors



3.3.3 Ecological receptors

A review of ecological receptors has been carried out. Specific sites designated for their ecological importance need only be considered where they fall within set distances from the assessment site, as specified in the Environment Agency risk assessment guidance[31].

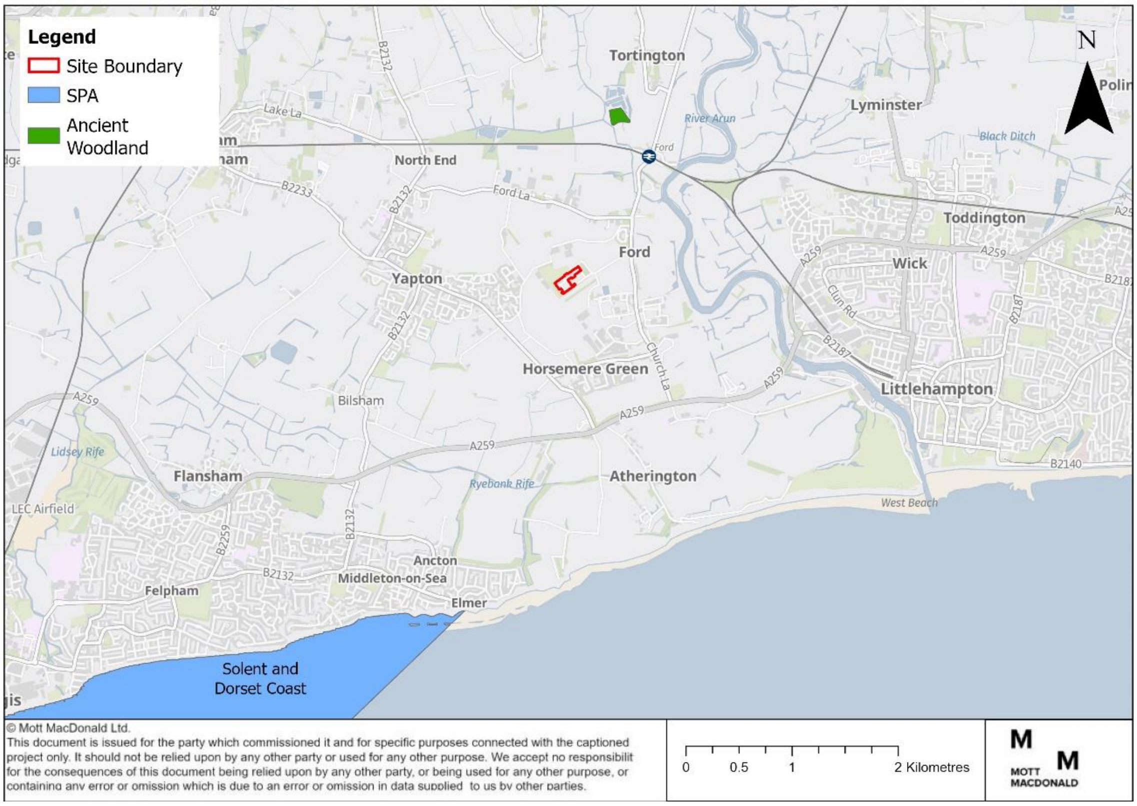
- Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or Ramsar sites within 10km
- Sites of Special Scientific Interest (SSSIs) within 2km
- Other locally and nationally designated habitat sites including National Nature Reserves (NNRs), Local Nature Reserves (LNRs), Ancient Woodland sites (AWs) and Local Wildlife Sites (LWSs) within 2km.

The following ecological sites are located within the above screening distances and have been considered in this assessment:

- Solent and Dorset Coast SPA
- Parcel of Ancient Woodland 1.4km north of the site

Figure 3.5 shows the locations of the ecological receptors modelled in this assessment.

Figure 3.5: Modelled ecological receptors



[31] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

3.4 Effects on conservation sites

In accordance with the Environment Agency risk assessment guidance[32],the impact of NOx and SO_2 on conservation sites should be assessed against site relevant:

- Critical levels
- Nutrient nitrogen critical loads
- Acid deposition critical loads

3.4.1 Critical levels

Critical levels for the protection of vegetation and ecosystems are presented in Table 2.3. The contribution of NOx and SO_2 at the designated sites has been calculated for comparison against the identified critical levels presented in Section 2.4.2.

The critical levels correspond to national environmental standards for protected conservation areas and apply at all locations within the designated site boundaries. The closest point at each of the habitat sites listed above has been modelled.

3.4.2 Critical loads

Critical loads are a quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive elements of the environment do not occur according to present knowledge. Critical load data are applicable to specific habitats and it may be necessary to consider the spatial distribution of various habitats present within the designation boundary of a site. For Solent and Dorset Coast SPA, the most sensitive habitat listed on the APIS website has been assumed to be present at the closest point within the designation boundary to the Site. For the parcel of Ancient Woodland, the APIS Search by Location tool was used to determine the relevant critical load data for the 'broadleaved, mixed and yew woodland' habitat class.

The critical loads for the designated sites considered within the assessment are presented in Table 3.5.

Table 3.5: Critical loads for the modelled ecological sites

Site name	APIS Nitrogen Critical Load Class	Modelled Location (x, y)(b)	Nitrogen deposition Lower critical load (kg/ha/yr)	Acid deposition critical loads		
				CLmaxS (keq/ha/ yr)	CLminN (keq/ha/ yr)	CLmaxN (keq/ha/ yr)
Solent and Dorset Coast SPA	Coastal dune grasslands (grey dunes) - acid type	498506, 99983	5	4.000	0.856	4.856
Ancient Woodland Site	Broadleaved, mixed and yew woodland	499897, 104567	10	10.944	0.357	11.301

Source: APIS website

[32] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

3.4.2.1 Critical loads – acidification

Percentage contributions to acid deposition have been derived from dispersion modelling. Deposition rates were calculated using empirical methods recommended by Environment Agency guidance[33] as follows:

- Calculate dry deposition flux. NOx: 0.0015 m/s for grassland, 0.003 m/s for forest. SO_2: 0.012m/s for grassland, 0.024 m/s for forest
- Dry deposition flux (µg/m^2/s) = ground level concentration (µg/m^3) x deposition velocity (m/s)
- Convert units from µg/m^2/s to units of keq/ha/yr by multiplying the dry deposition flux by standard conversion factors (6.84 for NO_2 and 9.84 for SO_2)

Wet deposition in the near field is not significant compared with dry deposition and therefore for the purposes of this assessment, wet deposition has not been considered.

Predicted contributions to acid deposition have been calculated and compared with the relevant critical load function for each habitat type associated with each designated site, as derived from the APIS.

3.4.2.2 Critical loads – eutrophication

Percentage contributions to nutrient nitrogen deposition have been derived from dispersion modelling. Deposition rates were calculated using empirical methods recommended by Environment Agency guidance, as follows:

- Calculate NO_2 dry deposition flux (0.0015 m/s for grassland, 0.003 m/s for forest assumed as deposition velocity):
  - Dry deposition flux (µg/m^2/s) = ground level concentration (µg/m^3) x deposition velocity (m/s)
- Convert units from µg/m^2/s to units of kg/ha/yr by multiplying the dry deposition flux by a standard conversion factor (95.9 for NO_2).

Wet deposition in the near field is not significant compared with dry deposition and therefore for the purposes of this assessment, wet deposition has not been considered.

Predicted contributions to nitrogen deposition have been calculated and compared with the relevant critical load range for each habitat type associated with each designated site, as derived from the APIS.

3.5 Significance criteria

Several approaches can be used to determine whether the potential air quality effects of a development are significant. However, there remains no universally recognised definition of what constitutes 'significance'.

Guidance is available from a range of regulatory authorities and advisory bodies on how best to determine and present the significance of effects within an air quality assessment. It is generally considered good practice that, where possible, an assessment should communicate effects both numerically and descriptively.

Definitions of significance have been adopted from the Environment Agency's air dispersion modelling guidance[34]. This guidance provides criteria for the screening out of insignificant PCs

[33] Environment Agency. (2006) Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air: Habitats Directive 2004 (AQTAG 06).

[34] Environment Agency, 2014. Environmental permitting: air dispersion modelling reports. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

however does not provide explicit criteria regarding the significance of PECs. This guidance advises that an assessment must explain how significance has been judged and base this on site-specific circumstances. For this assessment, the conservative assumptions regarding the operational load for the combustion plant and the emissions data adopted for NOx and SO_2 will strongly bias the modelled concentrations towards the worst-case, where it is highly likely that the actual concentrations would be lower than reported. Therefore, it is considered appropriate for the Site to judge that the PECs are insignificant where they do not exceed the EQS.

Table 3.6 provides a summary of criteria used to screen out insignificant impacts.

Table 3.6: Summary of assessment criteria

Parameter	Long-term standards	Short-term standards
Screen out insignificant emissions (PCs)	Emissions can be seen as insignificant where: PC long-term <= 1% of standard	Emissions can be seen as insignificant where: PC short-term <= 10% of standard
Screening for SPAs, SACs, Ramsar and SSSIs	The long-term PC is less than 1% of the long-term environmental standard for protected conservation areas	The short-term PC is less than 10% of the short-term environmental standard for protected conservation areas
Screening for local wildlife sites*	The short term PC is less than 100% of the short term environmental standard for protected conservation areas	The long term PC is less than 100% of the long term environmental standard for protected conservation areas
Screen out insignificant PECs	Resulting PEC does not exceed the relevant EQS	

Note: PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Ambient Concentration, AC)
*Local wildlife sites include Ancient Woodlands, NNRs, LNRs and other non-statutory wildlife sites

4 Baseline conditions

4.1 Introduction

Information on air quality in the UK can be obtained from a variety of sources including local authorities, national network monitoring sites and other published sources. For the purpose of this assessment, data has been obtained from ADC[35]. Data from the most recent year of monitoring data, 2022, has been used in this assessment.

4.2 Review and assessment of air quality in the study area

ADC currently does not have any declared AQMAs.

4.2.1 Local authority automatic monitoring

ADC has no automatic (continuous) monitoring stations.

4.2.2 Local authority diffusion tube monitoring

ADC undertakes diffusion tube monitoring at 22 locations across its administrative boundary. The nearest of these to the Site is located within the village of Ford approximately 1.4km north east of the Site. None of the 22 diffusion tube monitoring locations are considered representative of the Site and surrounding receptors because they are not near to the Site and are typically sited on busy roads which is not a characteristic of the Site and surrounding receptors.

ADC reported no exceedances of the annual mean objective for NO_2 within its administrative area during 2022.

4.3 Defra projected background pollutant concentrations

Defra provides estimates of background pollution concentrations for NO_X and NO_2 across the UK for each one-kilometre grid square for every year from 2018 to 2030. Data is also available from Defra on SO_2 concentrations, however the most recent year of data available for SO_2 and VOCs is 2022.

Data from these sources has been collected for the grid square containing the Site and the grid squares containing the discrete human health receptors.

The Defra projected background concentrations for the grid square containing the Site for 2023 are presented in Table 4.1. These ACs have been added to the PCs to determine the PEC at the gridded receptors. The ACs used for the human health receptors correspond to the concentrations for the grid square the receptor is located within.

As discussed in Section 3.2.10, short-term background concentrations have been assumed to be twice the annual mean concentrations in line with Environment Agency guidance.[36]

[35] Arun District Council, 2023. 2023 Air Quality Annual Status Report.

[36] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Table 4.1: 2023 Defra projected background concentrations for the Site (μg/m³)

Pollutant	Long-term	Short-term
NO_X	11.4	22.7
NO_2	8.7	17.4
SO_2	1.2	2.4
VOCs	0.4	0.8

Notes: Results rounded to 1 decimal place
Pollutant concentrations for OS grid square 499500, 103500 is presented
Background concentrations of SO_2 and VOCs presented for 2022, which is the most recent year of data presented on Defra's website https://uk-air.defra.gov.uk/data/pcm-data

4.3.1 Summary

A review of air quality monitoring undertaken by ADC has been undertaken to determine baseline air quality levels in the vicinity of the Site. There are no monitoring locations within the local authority considered representative of the Site or surrounding receptors. However, the Defra projected background concentrations for 2023 at the Site indicates that there are no exceedances of the annual mean NO_2 objectives and that background concentrations are low.

5 Results

5.1 Overview

The results of modelling atmospheric emissions from the Site at gridded and human health receptors are summarised and interpreted below. The model results are presented in tabular form and as contour plots. The PCs and PECs have been compared against the EQSs and assessment criteria stated within Environment Agency's risk assessment guidance[37], as presented in Table 3.6, to assess the significance of the air quality impacts from the Site.

It is important to note that in order to undertake a conservative modelling assessment, the CHP and back-up boiler have been assumed to be all operating at full load, continuously all year. In practice, these combustion plant do not operate concurrently. Furthermore, as discussed in Section 3.2.7, the SO_2 emission rates adopted for this assessment are likely to be much higher than the actual SO_2 emission rates as based on conservative emission limits rather than the sulphur content of the biogas. The modelling of VOCs assumes the fraction of benzene in the VOCs emitted from the CHP is 100%. As discussed in Section 3.2.7, this is likely to lead to an overestimation of the actual benzene emissions by at least a factor of 10. The modelled impacts for VOCs below are therefore highly conservative and not a realistic prediction of the actual benzene concentrations.

5.2 Gridded receptors

Table 5.1 presents the maximum predicted NO_2 and SO_2 PCs at offsite locations across the modelled grid.

Each of the predicted PCs for NO_2, SO_2 and VOCs are above 1% of the long-term EQS and above 10% of the short-term EQS. Therefore, these impacts cannot be screened out according to the Environment Agency significance criteria[38] so the PECs have also been considered.

[37] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[38] the PCs are greater than 1% of the long-term standards, and the 10% of the short-term standards

Table 5.1: Maximum NO_2, SO_2 and VOCs process contributions (PCs) (µg/m³) – Gridded receptors

Pollutant	Averaging period	Max PC	Max PC as % of EQS	EQS (µg/m3)
NO_2	99.79 %'ile of hourly averages	83.9	**42%**	200
	Annual average	20.1	**50%**	40
SO_2	99.9 %'ile of 15-minute averages	197.5	**74%**	266
	99.73 %'ile of hourly averages	187.4	**54%**	350
	99.18 %'ile of 24-hour averages	102.1	**82%**	125
VOCs	100 %'ile of 24-hour averages	182.3	**608%**	30
	Annual average	27.8	**555%**	5

Notes: Results rounded to 1 decimal place
PC = Process Contribution; EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
The results in **bold** are those that cannot be screened out as insignificant according to Environment Agency criteria

The PECs shown in Table 5.2 are for the pollutants and averaging periods which have not be screened out above. Each of the PECs for NO_2 and SO_2 are below the relevant EQS and therefore considered insignificant. The PECs for VOCs are above the relevant EQS and as such are considered potentially significant.

Contour plots of the PECs in the worst-case meteorological years are presented in Figure 5.1 to Figure 5.5. These contours demonstrate that the maximum offsite annual and hourly PCs for NO_2 and 15-minute, hourly and 24-hour SO_2 PCs are highly localised close to the perimeter of the Site.

There is no relevant public exposure at the land immediately adjacent to the site perimeter for long term or short term air quality impacts. The PECs are below the EQS and are considered insignificant.

For the daily and annual EQSs for VOCs, contour plots presented in Figure 5.6 and Figure 5.7 show that the daily and annual mean PECs are above the EQS at the land surrounding the site boundary up to a distance of approximately 120m from the site. The EQSs are exceeded at agricultural fields, playing fields associated with Arun Sports Arena, and part of the recycling centre to the north of the Site, where is no relevant exposure for the annual or daily EQSs. Therefore, the modelled impacts for VOCs are considered insignificant.

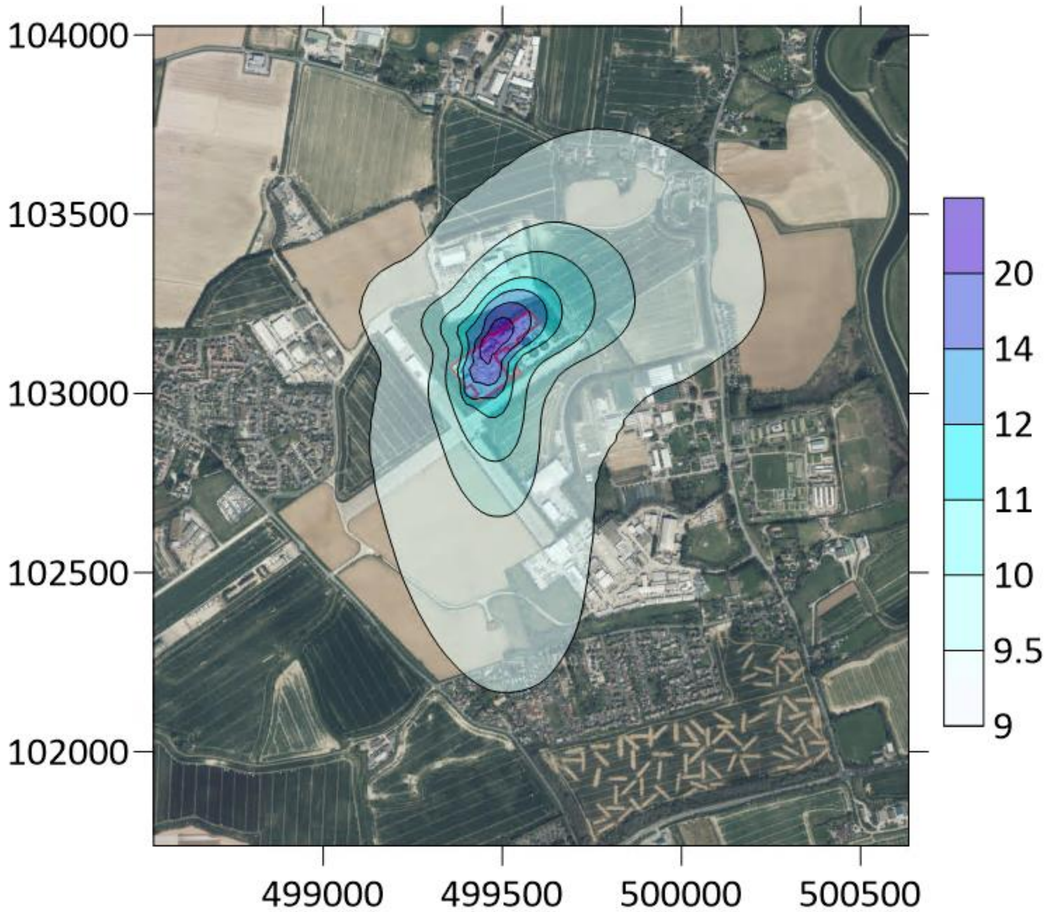
Table 5.2: Maximum NO_2 and SO_2 predicted environmental concentration (PECs) (µg/m³) – Gridded receptors

Pollutant	Averagin g period	EQS	AC	Max PC	Max PEC	Max PEC as % of EQS
NO_2	99.79 %'ile of hourly averages	200	17.4	83.9	101.4	51%
	Annual average	40	8.7	20.1	28.8	72%

Pollutant	Averaging period	EQS	AC	Max PC	Max PEC	Max PEC as % of EQS
SO_2	99.9 %'ile of 15-minute averages	266	2.4	197.5	199.9	75%
	99.73 %'ile of hourly averages	350	2.4	187.4	189.8	54%
	99.18 %'ile of 24-hour averages	125	2.4	102.1	104.5	84%
VOCs	100 %'ile of 24-hour averages	30	0.8	182.3	183.1	**610%**
	Annual average	5	0.4	27.8	28.2	**563%**

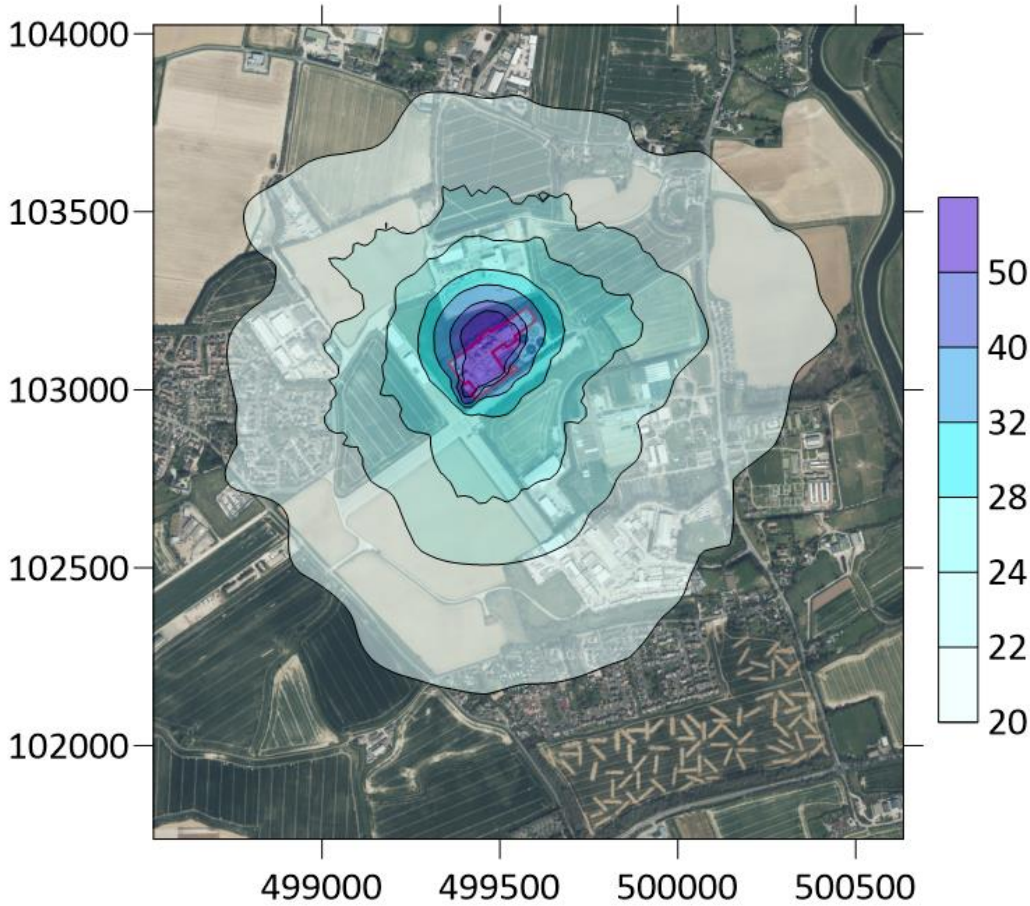
Notes: Results rounded to 1 decimal place
AC= Ambient Concentration (2023 Defra background concentration); PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
The results in **bold** are those that cannot be screened out as insignificant according to Environment Agency criteria

Figure 5.1: Annual mean NO_2 PEC (µg/m³)



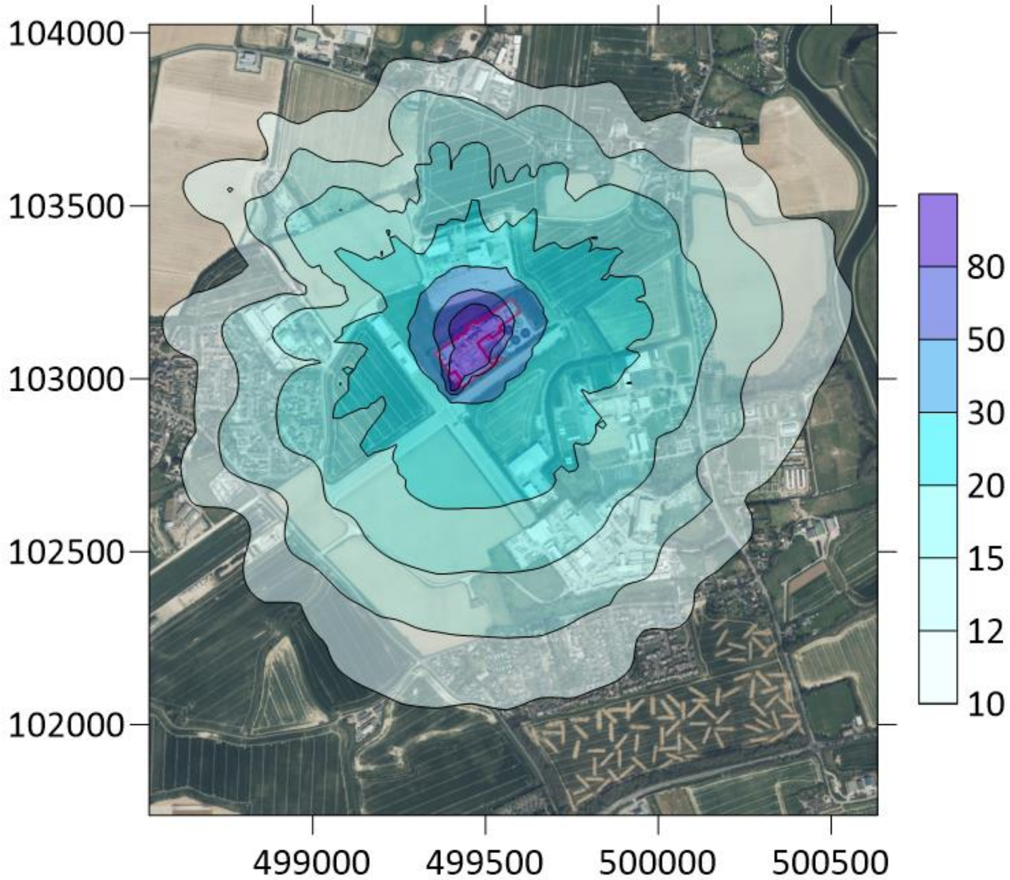
Note: Results presented for the worst case meteorological year of 2015. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary is outlined in red. The 2023 Defra background concentration for the grid square of the maximum PC has been assumed for the ambient concentrations for all gridded receptors. This 2023 Defra background concentration is 8.7 µg/m³.

Figure 5.2: Hourly mean (99.79th percentile) NO_2 PEC (µg/m³)



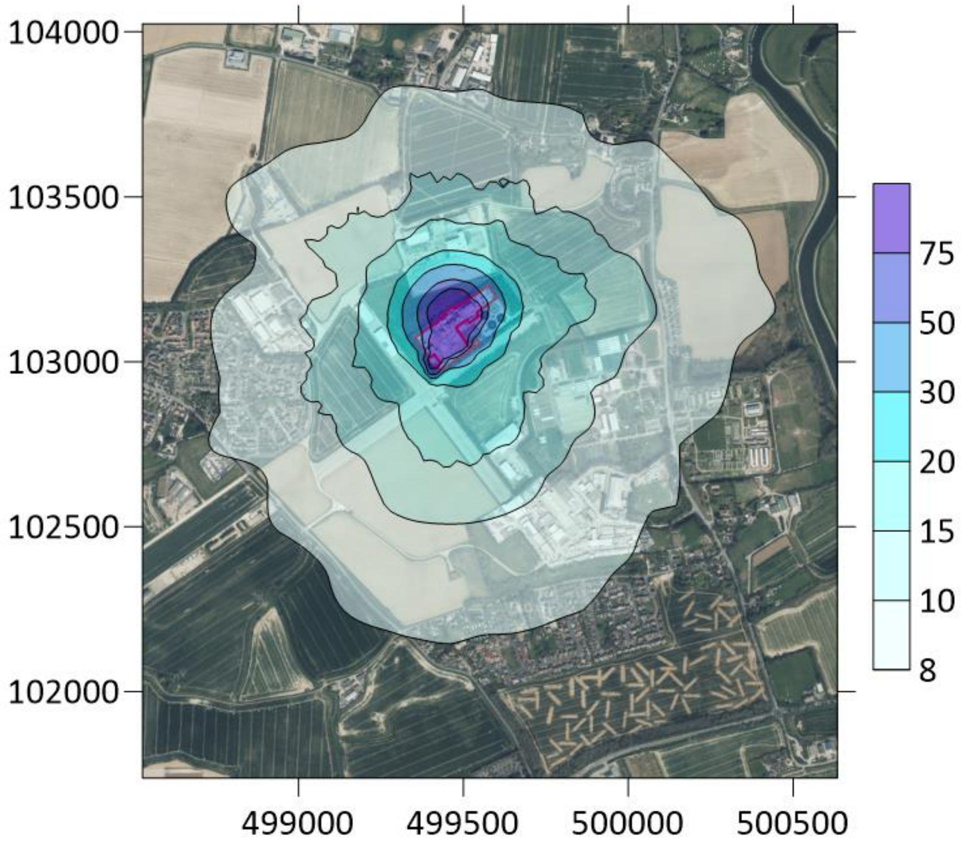
Note: Results presented for the worst case meteorological year of 2015. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2023 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2023 Defra background concentration is 17.4 µg/m³.

Figure 5.3: 15-minute mean (99.9th percentile) SO_2 PEC (µg/m³)



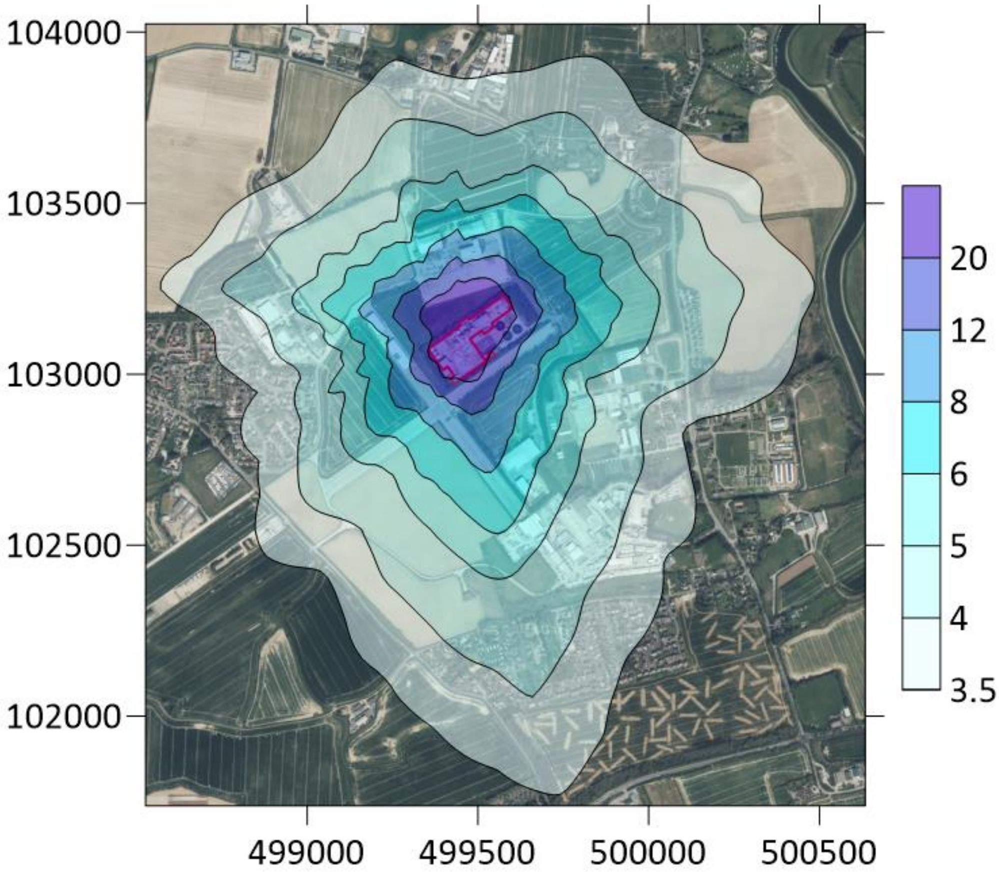
Note: Results presented for the worst case meteorological year of 2015. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2023 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2023 Defra background concentration is 2.4 µg/m³.

Figure 5.4: Hourly mean (99.73rd percentile) SO_2 PEC (µg/m³)



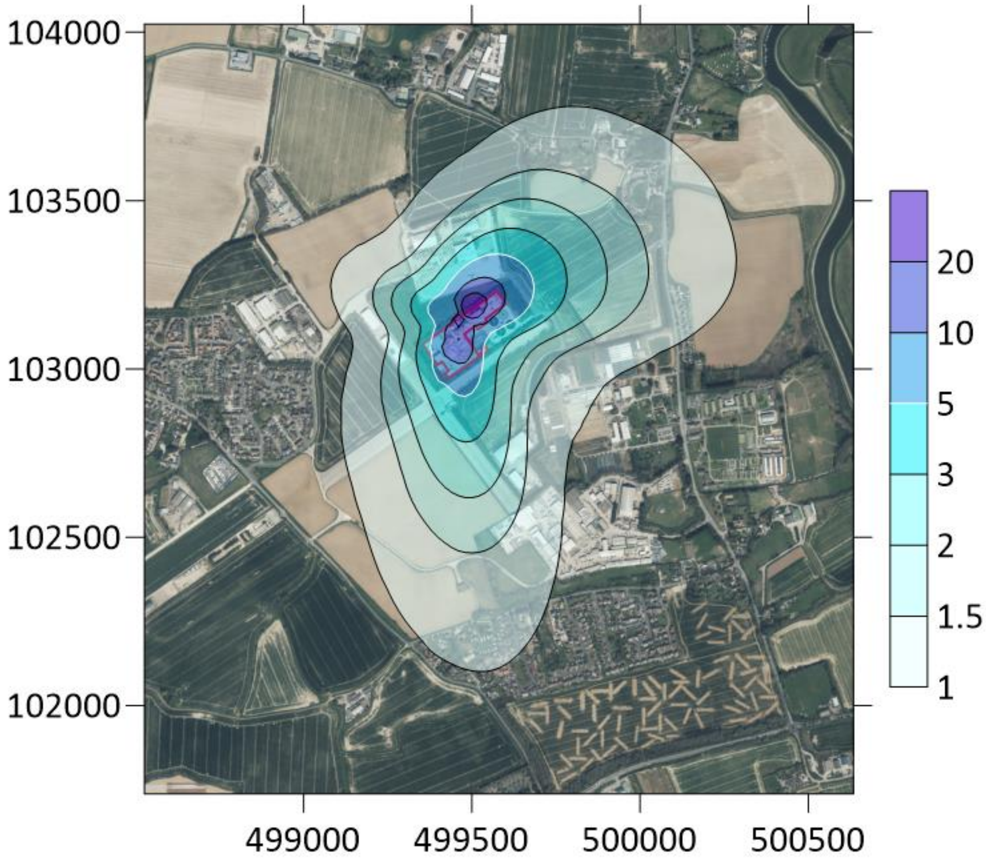
Note: Results presented for the worst case meteorological year of 2015. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2023 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2023 Defra background concentration is 2.4 µg/m³.

Figure 5.5: 24-hour mean (99.18th percentile) SO_2 PEC (µg/m³)



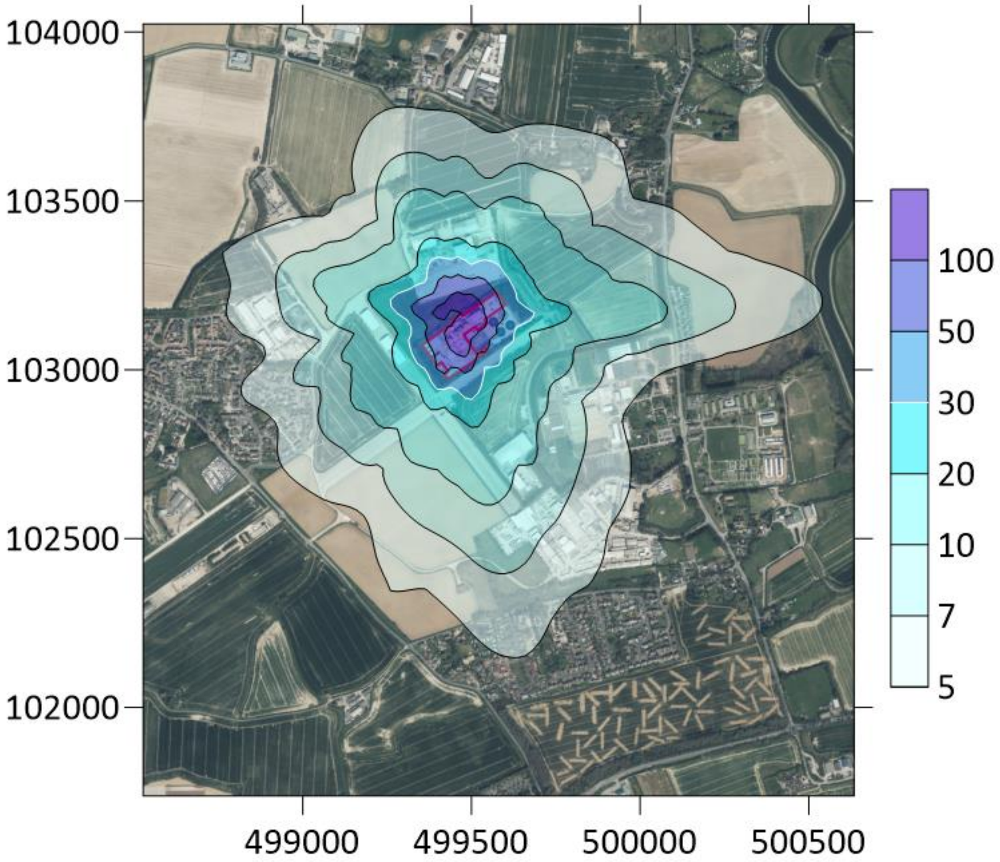
Note: Results presented for the worst case meteorological year of 2015. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2023 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2023 Defra background concentration is 2.4 µg/m³.

Figure 5.6: Annual mean VOCs (benzene) PEC (µg/m^3)



Note: Results presented for the worst case meteorological year of 2015. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2022 Defra background concentration for the grid square of the maximum PC has been assumed for the ambient concentrations for all gridded receptors. This 2022 Defra background concentration is 0.4 µg/m^3. The EQS of 5µg/m^3 is indicated by the white contour line.

Figure 5.7: 24-hour mean (100th percentile) VOCs (benzene) PEC (µg/m³)



Note: Results presented for the worst case meteorological year of 20150. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2022 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2022 Defra background concentration is 0.8 µg/m³. The EAL of 30µg/m³ is indicated by the white contour line.

5.3 Human health discrete receptors

5.3.1 NO_2 concentrations

The PCs and PECs for hourly and annual NO_2 at discrete human health receptors are summarised in Table 5.3 and Table 5.4.

The predicted hourly NO_2 PCs exceed 10% of the EQS at receptor 4, but the PECs are below the EQS at all receptors. Therefore, in accordance with Environment Agency guidance[39], the hourly impacts for NO_2 are considered insignificant.

For the annual mean, the predicted PC is above 1% of the EQS at receptors 6 and 8, but the PECs are well below the EQS. Therefore, the annual mean impacts for NO_2 are considered insignificant.

[39] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Table 5.3: Maximum process contributions (PCs) (µg/m³) – 99.79 %'ile of hourly averages - Discrete human health receptors

Receptor	EQS (µg/m^3)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1	200	11.2	5.6	17.4	28.6	14.3
2	200	2.5	1.3	14.6	17.1	8.6
3	200	49.9	**24.9**	17.4	67.3	33.7
4	200	5.2	2.6	15.5	20.6	10.3
5	200	2.9	1.5	17.4	20.4	10.2
6	200	4.2	2.1	14.9	19.1	9.6
7	200	1.2	0.6	15.4	16.6	8.3
8	200	4.1	2.1	17.4	21.5	10.8
9	200	3.6	1.8	15.4	19.0	9.5
10	200	2.4	1.2	14.6	17.0	8.5
11	200	2.7	1.3	15.5	18.1	9.1
12	200	1.4	0.7	15.4	16.8	8.4

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
Results rounded to 1 decimal place

Table 5.4: Maximum process contributions (PCs) (µg/m³) – Annual average - Discrete human health receptors

Receptor	EQS (µg/m^3)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
4	40	0.2	0.5	7.7	7.9	19.8
5	40	0.2	0.4	8.7	8.9	22.2
6	40	0.5	**1.2**	7.5	7.9	19.9
7	40	<0.1	0.1	7.7	7.7	19.3
8	40	0.5	**1.2**	8.7	9.2	23.0
9	40	0.1	0.3	7.7	7.8	19.5
10	40	0.1	0.3	7.3	7.4	18.6
11	40	0.3	0.8	7.7	8.1	20.1
12	40	<0.1	0.1	7.7	7.7	18.9

Notes: PC = Process Contribution;
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
PEC = Predicted Environmental Concentration (AC+PC=PEC)
Results rounded to 1 decimal place
The PCs in **bold** are those that cannot be screened out as insignificant
Modelled impacts at only the receptors where the annual mean EQS is applicable are presented.

5.3.2 SO_2 concentrations

The PCs and PECs for 15-minute, hourly and daily SO_2 at discrete human health receptors are summarised in Table 5.5 to Table 5.7.

The hourly daily PCs are below 10% of the EQS at all receptors. The 15-minute PCs exceed 10% of the EQS at receptors 1 and 3 and the hourly PCs exceed 10% of the EQS at receptor 3. All PECs are below the relevant EQSs. On that basis, all short term impacts for SO_2 are considered insignificant.

Table 5.5: Maximum SO_2 process contributions (PCs) (µg/m³) – 99.9 %'ile of 15-minute averages - Discrete human health receptors

Receptor	EQS (µg/m³)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1	266	28.8	**10.8**	2.4	31.2	11.7
2	266	9.0	3.4	2.0	11.0	4.1
3	266	108.3	**40.7**	2.4	110.7	41.6
4	266	18.4	6.9	3.1	21.5	8.1
5	266	11.2	4.2	2.4	13.6	5.1
6	266	13.9	5.2	1.9	15.8	5.9
7	266	4.8	1.8	2.5	7.3	2.8
8	266	14.2	5.3	2.4	16.6	6.2
9	266	11.8	4.4	2.5	14.3	5.4
10	266	8.8	3.3	2.0	10.8	4.1
11	266	8.9	3.3	3.1	12.0	4.5
12	266	5.3	2.0	2.5	7.8	2.9

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
PEC = Predicted Environmental Concentration (AC+PC=PEC)
Results rounded to 1 decimal place

Table 5.6: Maximum SO_2 process contributions (PCs) (µg/m³) – 99.73 %'ile of hourly averages - Discrete human health receptors

Receptor	EQS (µg/m³)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1	350	23.1	6.6	2.4	25.5	7.3
2	350	5.0	1.4	2.0	7.0	2.0
3	350	104.2	**29.8**	2.4	106.6	30.5
4	350	10.2	2.9	3.1	13.4	3.8
5	350	5.8	1.7	2.4	8.2	2.3
6	350	8.6	2.5	1.9	10.5	3.0
7	350	2.2	0.6	2.5	4.7	1.3
8	350	8.2	2.3	2.4	10.6	3.0
9	350	7.0	2.0	2.5	9.5	2.7
10	350	4.8	1.4	2.0	6.8	1.9
11	350	5.5	1.6	3.1	8.7	2.5
12	350	2.7	0.8	2.5	5.2	1.5

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
PEC = Predicted Environmental Concentration (AC+PC=PEC)
Results rounded to 1 decimal place

Table 5.7: Maximum SO_2 process contributions (PCs) (µg/m³) – 99.18 %'ile of 24-hour averages - Discrete human health receptors

Receptor	EQS (µg/m^3)	Max PC	Max PC as % of EQS
4	125	3.4	2.7
5	125	1.5	1.2
6	125	2.6	2.0
7	125	0.7	0.5
8	125	2.2	1.8
9	125	1.5	1.2
10	125	1.1	0.9
11	125	2.1	1.7
12	125	0.7	0.6

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
PEC = Predicted Environmental Concentration (AC+PC=PEC)
Results rounded to 1 decimal place
The PCs in **bold** are those that cannot be screened out as insignificant

5.3.3 VOCs (benzene) concentrations

The PCs and PECs for daily and annual VOCs at discrete human health receptors are summarised in Table 5.8 to Table 5.9.

The 24-hour PCs are predicted to be above 10% of the EQS at several receptors while the PECs are all below the EQS. Therefore, the daily mean impacts for VOCs are considered insignificant.

For the annual mean, the PCs are predicted to be above 1% of the EQS at all modelled receptors while the PECs are all below the EQS. Therefore, the annual mean impacts for VOCs are considered insignificant.

Table 5.8: Maximum VOCs (benzene) process contributions (PCs) (µg/m³) – 100 %'ile of 24-hour averages - Discrete human health receptors

Receptor	EQS (µg/m^3)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
4	30	10.8	**36.1%**	0.8	11.6	38.7%
5	30	5.0	**16.6%**	0.8	5.8	19.3%
6	30	8.6	**28.8%**	0.8	9.5	31.5%
7	30	1.8	6.0%	0.8	2.6	8.7%
8	30	5.5	**18.5%**	0.8	6.4	21.2%
9	30	6.0	**20.0%**	0.8	6.8	22.7%
10	30	3.3	**10.8%**	0.8	4.1	13.6%
11	30	5.9	**19.7%**	0.8	6.7	22.4%
12	30	2.1	6.9%	0.8	2.9	9.6%

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
PEC = Predicted Environmental Concentration (AC+PC=PEC)
Results rounded to 1 decimal place
The PCs in **bold** are those that cannot be screened out as insignificant

Table 5.9: Maximum VOCs (benzene) process contributions (PCs) (µg/m³) – annual average - Discrete human health receptors

Receptor	EQS (µg/m³)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
4	5	0.5	**9.4%**	0.4	0.9	17.5%
5	5	0.4	**7.4%**	0.4	0.8	15.6%
6	5	1.1	**21.7%**	0.4	1.5	30.0%
7	5	0.1	**1.9%**	0.4	0.5	10.0%
8	5	1.1	**21.7%**	0.4	1.5	29.9%
9	5	0.3	**5.5%**	0.4	0.7	13.6%
10	5	0.3	**6.1%**	0.4	0.7	14.4%
11	5	0.8	**15.1%**	0.4	1.2	23.1%
12	5	0.1	**2.3%**	0.4	0.5	10.3%

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
Results rounded to 1 decimal place

5.4 Ecological receptors

This section presents the maximum PCs and PECs for comparison with the relevant daily and annual NOx EQS (critical levels) and relevant nitrogen deposition and acid critical loads at nearby ecological sites.

The PCs and PECs modelled at the closest point at the boundaries of ecological sites to the Site are presented.

5.4.1 Assessment of critical levels

Table 5.10 and Table 5.11 present the maximum predicted annual and daily NOx PC and PECs at Solent and Dorset Coast SPA and the parcel of Ancient Woodland.

The maximum predicted annual NOx PC is below 1% of the relevant EQS at both sites. The impact is therefore considered insignificant.

The maximum daily NOx PC is below 10% of the relevant EQS at both sites. Therefore, this impact is also considered insignificant.

Table 5.12 presents the maximum annual SO_2 PC and PECs.

The maximum predicted annual SO_2 PC is below 1% of the relevant EQS at both sites. The impact is therefore considered insignificant.

Table 5.10: Maximum annual NOx critical level results

Receptor	EQS (µg/m³)	Max PC (µg/m³)	% PC of EQS
Solent and Dorset Coast SPA	30	<0.1	0.2%
Ancient Woodland	30	0.1	0.3%

Note: PC = Process Contribution; PEC=Predicted Environmental Concentration; AC=Ambient Concentration (2023 Defra NOx backgrounds); EQS = Environment Quality Standards

Arithmetic discrepancies may occur due to rounding of results, and due to differences in worst-case meteorological years

Table 5.11: Maximum daily NOx critical level results

Receptor	EQS (µg/m3)	Max PC (µg/m3)	% PC of EQS
Solent and Dorset Coast SPA	75	0.5	0.6%
Ancient Woodland	75	0.8	1.1%

Note: PC = Process Contribution; PEC=Predicted Environmental Concentration; AC=Ambient Concentration (2023 Defra NOx backgrounds); EQS = Environment Quality Standards
Arithmetic discrepancies may occur due to rounding of results, and due to differences in worst-case meteorological years

Table 5.12: Maximum annual SO_2 critical level results

Receptor	EQS (µg/m3)	Max PC (µg/m3)	% PC of EQS
Solent and Dorset Coast SPA	20	<0.1	0.2%
Ancient Woodland	20	0.1	0.3%

Note: PC = Process Contribution; PEC=Predicted Environmental Concentration; AC=Ambient Concentration (2022 Defra SO_2 backgrounds); EQS = Environment Quality Standards
PC presented to two decimal places to show concentrations are not zero
Arithmetic discrepancies may occur due to rounding of results, and due to differences in worst-case meteorological years

5.4.2 Assessment of critical loads

5.4.2.1 Critical loads – eutrophication

Table 5.13 presents the predicted nitrogen deposition rates at Solent and Dorset Coast SPA and the parcel of Ancient Woodland, which have been calculated from dispersion modelling and compared with the lower nitrogen critical load for each habitat.

The results show that the maximum predicted PC for nitrogen deposition is below 1% of the relevant minimum critical load both sites. The impact is therefore considered insignificant.

Table 5.13: Critical load results - nitrogen deposition

Designated site	APIS Habitat[(a)]	Minimum nitrogen deposition critical load[(b)]	Maximum ground level concentration of NO_2 (PC) (µg/m^3)	Total nitrogen deposition from the Site (PC) (kg/ha/yr)	% PC of minimum nitrogen deposition critical load
Solent and Dorset Coast SPA	Coastal dune grasslands (grey dunes) - acid type	5	<0.1	<0.1	0.1%

Designated site	APIS Habitat[(a)]	Minimum nitrogen deposition critical load[(b)]	Maximum ground level concentration of NO_2 (PC) ($\mu g/m^3$)	Total nitrogen deposition from the Site (PC) (kg/ha/yr)	% PC of minimum nitrogen deposition critical load
Ancient Woodland	Broadleaved, mixed and yew woodland	10	0.1	<0.1	0.1%

Note: PC = Process Contribution; PC presented to more than one decimal places to demonstrate change and is not an indication of model accuracy
[(a)]Each habitat has been classified as either “grassland” or “forest” to determine which conversion factor should be used to calculate dry deposition flux (see Section 3.4.2.2)
[(b)]The lower critical load for the ‘fen, marsh and swamp’ nitrogen critical load class from APIS has been applied
Arithmetic discrepancies may occur due to rounding of results, and due to differences in worst-case meteorological years

5.4.2.2 Critical loads - acidification

Table 5.14 Table 5.presents the predicted acid deposition rates at ecological receptors, which have been calculated from dispersion modelling and compared with the relevant acidity critical load.

The results show that the maximum PCs are below 1% of the lower CLmaxN critical load for acid deposition at both receptors. The impact is therefore considered insignificant.

Table 5.14: Critical load results - acid deposition*

Designated site	APIS Habitat[(a)]	Minimum CLmaxN (keq N/ha/yr)	Maximum ground level concentration of NO_2 (PC) ($\mu g/m^3$)	Maximum ground level concentration of SO_2 (PC) ($\mu g/m^3$)	Total acid deposition PC (keq/ha/yr)	% PC of minimum CLmaxN
Solent and Dorset Coast SPA	Deciduous woodland	4.856	<0.1	<0.1	0.005	0.1%
Ancient Woodland	Semi-natural dry grasslands and scrubland facies on calcareous substrates	11.301	0.1	0.1	0.016	0.1%

Note: PC = Process Contribution; PC presented to more than one decimal places to demonstrate change and is not an indication of model accuracy
(a) Each habitat has been classified as either “grassland” or “forest” to determine which conversion factor should be used to calculate dry deposition flux (see Section 3.4.2.1). Arithmetic discrepancies may occur due to rounding of results, and due to differences in worst-case meteorological years
N/A indicates that no critical load data for this habitat is available on APIS.

6 Conclusions

An assessment has been undertaken to determine the effect of emissions from the combustion of biogas at the CHP and auxiliary boilers at the Site on air quality in the surrounding area using advanced dispersion modelling. For gridded and human health receptors, the emissions of NOx, SO_2 and VOCs have been considered in accordance with Environment Agency guidance. Emissions of NOx and SO_2 and their contribution to nitrogen deposition has also been considered in terms of their impact on nearby ecological sites. The method of the assessment has taken a conservative approach by assuming worst-case conditions for factors such as emission characteristics, the operational hours and meteorological conditions. The modelled concentrations forecast in this assessment are likely to be higher than in reality, due to the worst-case assumptions regarding the combustion operating continuously at full load and the SO_2 emissions adopted for this assessment which are considerably higher than the monitored SO_2 emissions.

No exceedances of the EQSs for NO_2, SO_2 or VOCs (benzene) for human health receptors are predicted at locations of relevant public exposure. The modelled impacts for VOCs assume a fraction of 100% benzene which is likely to overestimate the modelled benzene concentrations by at least a factor of 10 and is therefore highly conservative.

The air quality effects are highly localised and considered insignificant at sensitive human health and ecological receptors in accordance with Environment Agency guidance. Effects from nitrogen and acid deposition at nearby ecological sites are also considered insignificant. The Site does not conflict with the relevant air quality regulations.

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