Ashford Sewage Treatment Centre

Air quality assessment to accompany permit application

19 January 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

Ashford Sewage Treatment Centre

Air quality assessment to accompany permit application

19 January 2024

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

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	January 2024	M Bell	H Whalley	C Mills	First draft

Document reference: 100419175 | 1 | A

Information class: Standard

Contents

1 Introduction

1.1 Overview

This report has been prepared to support the Bespoke Installation Permit variation application for Ashford Wastewater Treatment Works (WTW) and Sludge Treatment Centre (STC). An H1 air quality screening assessment has been undertaken for air emissions from the associated Anaerobic Digestion (AD) facility which 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 two auxiliary boilers.

The assessment has accounted for the requirements set out within the 'Air emissions risk assessment for your environmental permit'[1] and Specified generators: dispersion modelling assessment guidance[2]. As stated in these guidance documents, 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

Ashford is a WTW and STC (hereafter referred to as the 'Site') owned and operated by Southern Water Services Ltd. The AD facility, which is part of the STC, 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 within 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 5.9MWth input CHP plant (Caterpillar G3520C), which combusts the biogas produced by the anaerobic digestion facility to generate heat and electricity. All heat and electricity generated is used on site and electricity is not exported to the National Grid.
- Two back-up boilers (1x Strebel boiler RU3S-10 and 1x Strebel boiler RU2S-12) with thermal inputs of approximately 0.96MWth and 1.07MWth, respectively, which operate when the CHP plant is not operating. The boilers operate on biogas.
- One flare, which is used to burn off excess biogas.
- One standby diesel generator for emergency use and testing, operational less than 50 hours per year.

1.3 Site location

The Site address is Kinneys Lane, Off Canterbury Road, Bybrook, Ashford, TN24 9QB (National Grid Reference: TR 0213 4330). The Site is within the administrative area of Ashford Borough

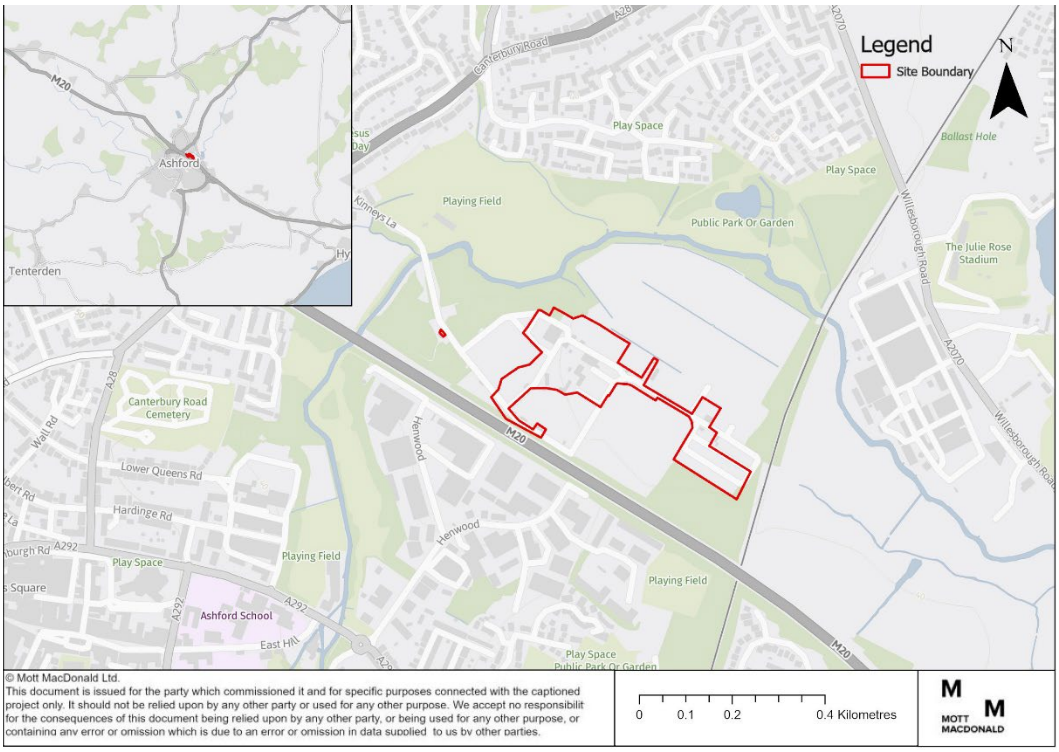
[1] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

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

Council (ABC). The Site is surrounded by parkland to the west and north, agricultural fields to the east and the M20 motorway and Henwood industrial area to the south.

The nearest human health receptor to the Site is Ashford Rugby Club playing fields located 100m to the north west. The nearest residential receptor is on Peter Candler Way approximately 400m to the north. 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[3], Air Quality Standards (amendment) Regulations 2016[4], Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019[5] and Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020[6] implement the EU's Directive 2008/50/EC on ambient air quality.

Part IV of the Environment Act 1995[7] (as amended in Schedule 11 of the Environment Act 2021[8]) 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[9] and the Air Quality (England) (Amendment) Regulations 2002[10].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[11] 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.

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

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

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

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

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

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

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

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

[11] 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]

A revised national Air Quality Strategy[12] was open for public consultation between 11th April and 21st April 2023 with the final revised national Air Quality Strategy expected to be released later in 2023. The revised Air Quality Strategy is intended to complement, rather than replicate or replace the CAS, and is a locally-focused document to enable local authorities to clearly understand their role, responsibilities and powers relating to air quality.

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[13]
- Environmental permitting: air dispersion modelling reports[14]
- Specified generators: dispersion modelling assessment guidance[15]
- Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air[16]

2.4.1 Permitting requirements at the Site

The Site currently has two Environmental Permits in operation – EPR/BP3296SB - Non-hazardous allowing for a maximum of 690,000tpa to be accepted at the Site and EPR/KP3736GS for the CHP system, sludge dewatering and drying plant. Southern Water are applying to vary EPR/BP3296SB to incorporate anaerobic digestion and consolidate EPR/KP3736GS for the CHP system. 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 under T21 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 produced 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/or back-up boiler system.

[12] 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]

[13] 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

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

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

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

The Standard Rules 'SR2021 No 10: anaerobic digestion of non-hazardous sludge at a wastewater treatment works, including the use of the resultant biogas'[17] set Emission Limit Values (ELVs)[18] for boilers and other combustion plant including:

- ELVs of 250mg/Nm^3 for NO_x and 200mg/m^3 for SO_2 for existing (operational before 20 December 2018) boilers that are medium combustion plant (MCP), and 200mg/Nm^3 for NO_x and 100mg/m^3 for SO_2 for new boilers (operational after 20th December 2018). One of the Site's boilers (Strebel RU3S-10) was operational before the year 2018 however is less than 1MWth input and as such are not required to meet these ELVs. The second boiler (Strebel RU2S-12) was installed in the year 2022 and is more than 1MWth input therefore the ELVs for new boilers are applicable.
- ELVs of 500mg/Nm^3 for NO_x and 350mg/m^3 for SO_2. These ELVs are applicable to the CHP.

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[19] 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[20] (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:

[17] 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

[18] 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

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

[20] UK Air Pollution Information System (APIS) www.apis.ac.uk [last accessed 09/07/2019]

a) Any locations situated within areas where members of the public do not have access and there is no fixed habitation.
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[21] 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[22] provides further assessment criteria in the form of Environmental

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

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

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 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[23], 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

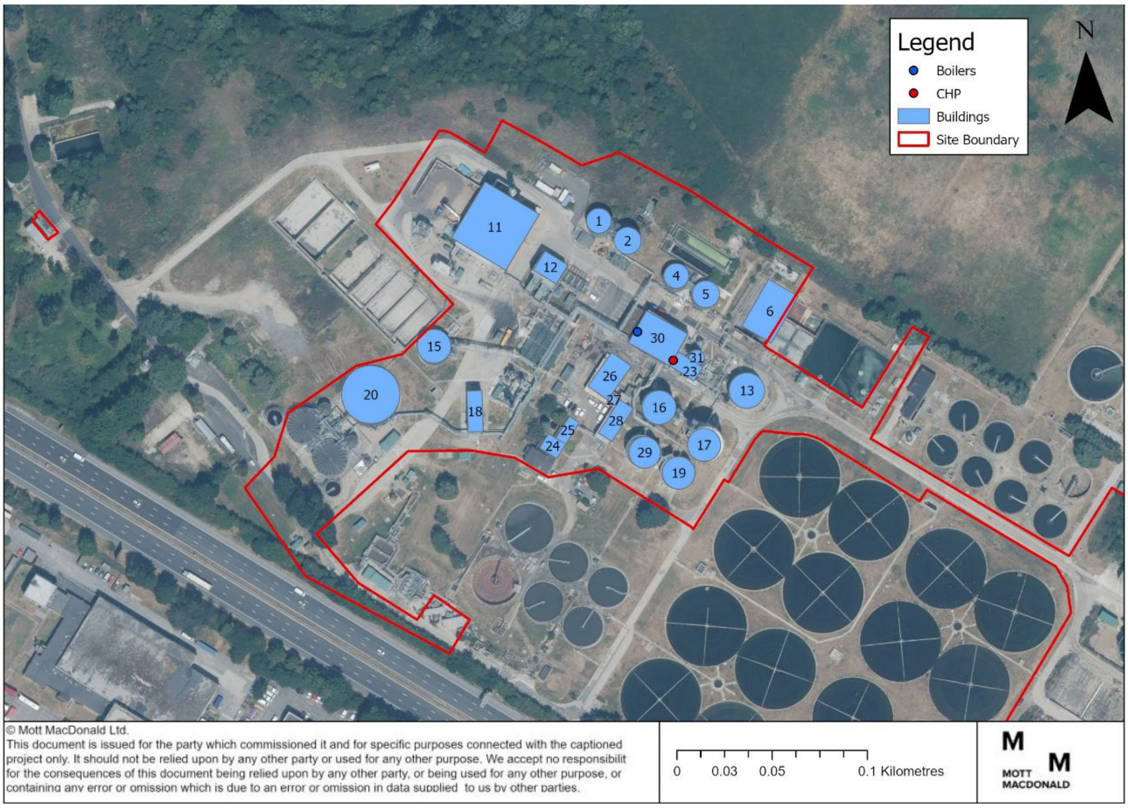
The movement of air over and around buildings generates areas of flow circulation, which can lead to increased ground level concentrations in the building wakes. Where building heights are greater than about 30 - 40% of the stack height, downwash effects can be significant. ADMS includes a building effects 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.

[23] 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	602106	143466	9.0	13	13	0
2	602121	143456	9.0	14	14	0
4	602147	143437	5.0	13	13	0
5	602162	143428	6.0	14	14	0
6	602196	143419	3.0	28	18	30
11	602051	143464	13.0	34	33	31
30	602137	143405	9.0	19	25	29
13	602184	143377	14.0	19	19	0
16	602137	143368	14.0	18	18	0
17	602161	143349	18.0	17	17	0
20	601986	143375	5.0	31	31	0
12	602081	143442	9.0	12	14	32
15	602019	143400	7.5	18	18	0
18	602041	143366	9.0	22	8	358
19	602148	143334	8.5	17	17	0
26	602112	143385	5.0	22	13	35
28	602115	143361	5.0	21	9	33
29	602130	143345	12.0	17	17	0
31	602157	143394	10.5	8	8	0
27	602114	143372	5.0	4	5	36
23	602152	143390	4.0	9	15	32
24	602082	143348	5.0	9	11	32
25	602089	143356	5.0	14	6	32

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.

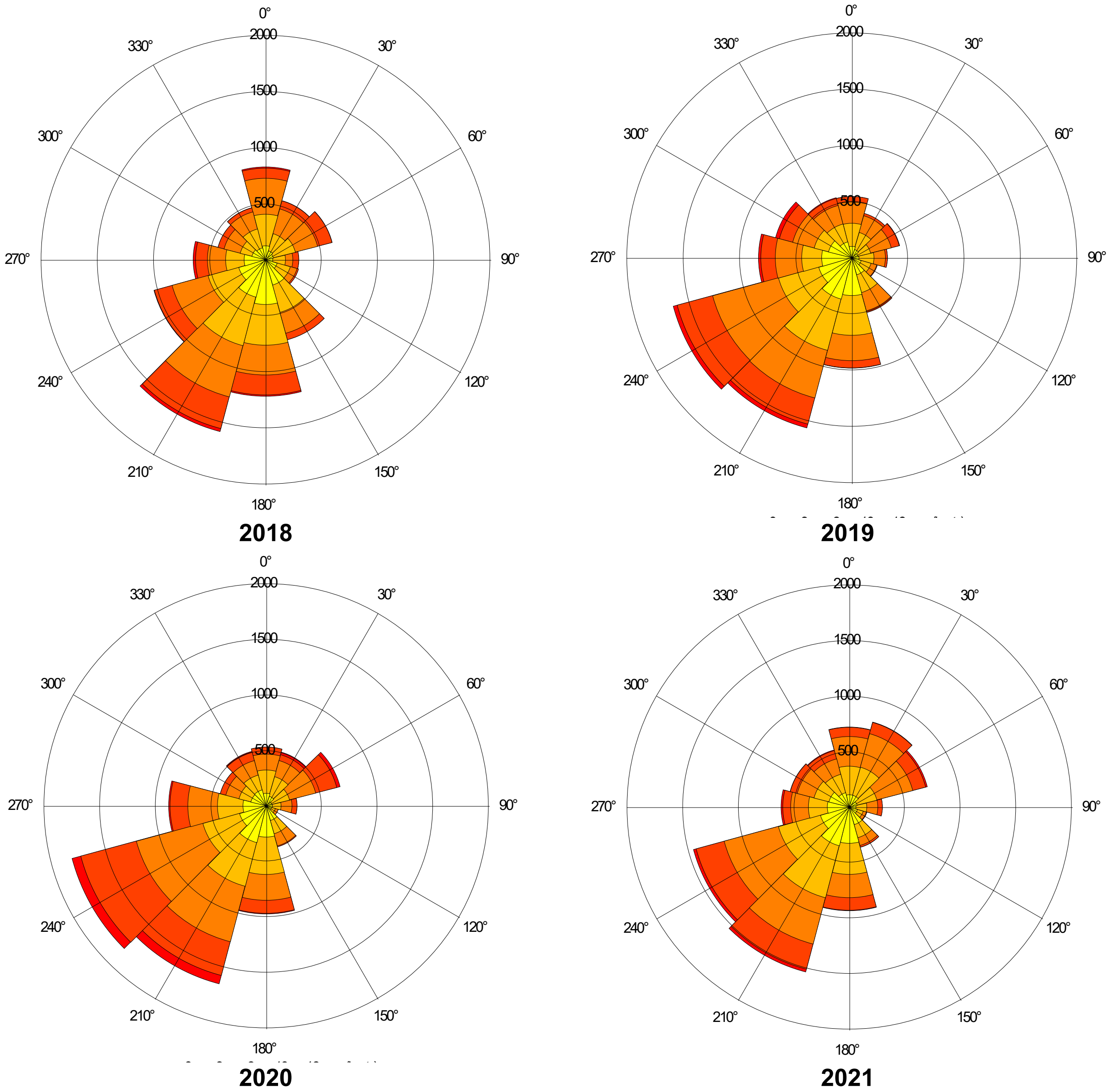
The year of meteorological data that is used for a modelling assessment can have a significant effect on source contribution concentrations. As recommended by the Environment Agency dispersion modelling guidance[24], modelling was undertaken using five years of data. Data from the East Malling meteorological station was used as this was considered the most

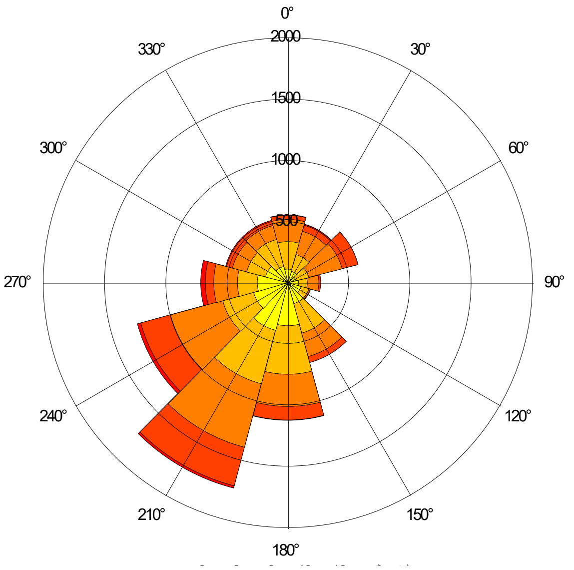
[24] Environment Agency, 2014. Environmental permitting: air dispersion modelling reports. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

representative station due to its proximity to the Site (approximately 30 km to the north east). Five years of data from 2018 to 2022 were used.

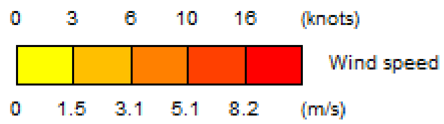
Wind roses have been constructed for each of the five years of meteorological data used in this assessment. The wind roses presented in Figure 3.2 illustrate that in all years there is dominance in winds from the south west, with frequent periods from the north.

Figure 3.2: Wind roses for East Malling (2018 – 2022)





2022



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 vicinity 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[25], 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 industrial, residential, parkland and woodland land cover across the model domain. A surface roughness length of 0.2m has been assigned to East Malling Airport.

3.2.6 Modelled scenario

As detailed in Section 1.2, the combustion plant at the Site consists of a CHP plant, two backup boilers, a flare, and four emergency backup diesel generators.

Only the CHP plant and two 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.

[25] 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 91% of the hours in the year, while the boilers are operational for approximately 9% 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 both boilers 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. 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. Each of the CHP and boiler exhaust gases are 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 350mg/Nm^3, respectively (5% O_2, 0°C, dry).

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 (5% O_2, 0°C, dry).. Emissions data from the boiler manufacturer are not available therefore these SR2021 ELVs for existing boilers have been adopted as worst-case estimates. Although the Strebel RU2S-12 boiler is a new boiler and the lower SR2021 ELVs are applicable, the higher ELVs for existing boilers have been adopted for the purposes of this assessment as a worst case assumption.

Monitored SO_2 emission concentrations from 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.

The VOCs emissions concentration for the CHP is unknown, it has been assumed that the VOCs emission concentration is 1800 mg/Nm^3. This is a conservative high estimate based upon the maximum monitored VOCs emissions concentrations for similar CHPs at other sites. There is no set ELV for VOCs emissions from the CHP.

Monitored VOCs emissions concentrations do not typically 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'[27] 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 and flare. 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%

[26] DynaGreen Environmental UK Ltd, Analysis of Biogas Constituents, 2 August 2023.

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

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

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 1	Boiler 2
Manufacturer and model	-	Caterpillar G3520C	Strebel RU3S-10	Strebel RU2S-12
Stack location	x,y	602145,143393	602126,143408	602126,143408
Stack height	m	15	12	12
Stack diameter	m	0.5	0.35	0.35
Exit temperature	°C	129	229.5	219.2
Efflux velocity	m/s	17.92	7.26	8.22
Volumetric flow rate (actual)	Am^3/s	3.52[(a)]	0.70[(b)]	0.79[(c)]
Volumetric flow rate (normalisedl)	Nm^3/s	1.38[(d)]	0.28[(e)]	0.31[(e)]
NO_x emission	g/s	0.69[(f)]	0.07[(g)]	0.08[(g)]
SO_2 emission	g/s	0.48[(h)]	0.05[(g)]	0.06[(g)]
VOCs emission	g/s	2.49[(h)]	-	-

Notes: (a) Calculated from an exhaust gas flow rate of 10124 kg/hr
(b) Calculated from the thermal output of the boiler (0.8MWth at 90% efficiency)
(c) Calculated from the thermal output of the boiler (0.93MWth at 94% efficiency)
(d) Normalised conditions = 5% O_2, 0°C, 0% H_2O
(e) Normalised conditions = 3% O_2, 0°C, 0% H_2O
(f) Calculated from the the SR2021 No 10. ELVs for combustion plant burning biogas of 500 mg/Nm³ for NOx and 350 mg/Nm³ for SO_2 (Pressure of 101.3 kPA, dry, 0°C, 5% O_2) and the rated electrical output of the CHP engine of 1.6MWe at 41% efficiency.

(g) Calculated from the the SR2021 No 10. ELVs for existing boilers of 250 mg/Nm³ for NOx and 200 mg/Nm³ for SO_2 (Pressure of 101.3 kPA, dry, 0°C, 3% O_2) and the 0.8MWth thermal output for each boiler.
(h) Based an assumed VOCs emissions concentration of 1800 mg/Nm^3 (Pressure of 101.3 kPA, dry, 0°C, 5% O_2)

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[28] 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 boilers 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[29] 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[30] 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 ABC has been reviewed for representative data that can be applied to this assessment.

As the concentrations from the background maps 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[31].

---

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

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

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

[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

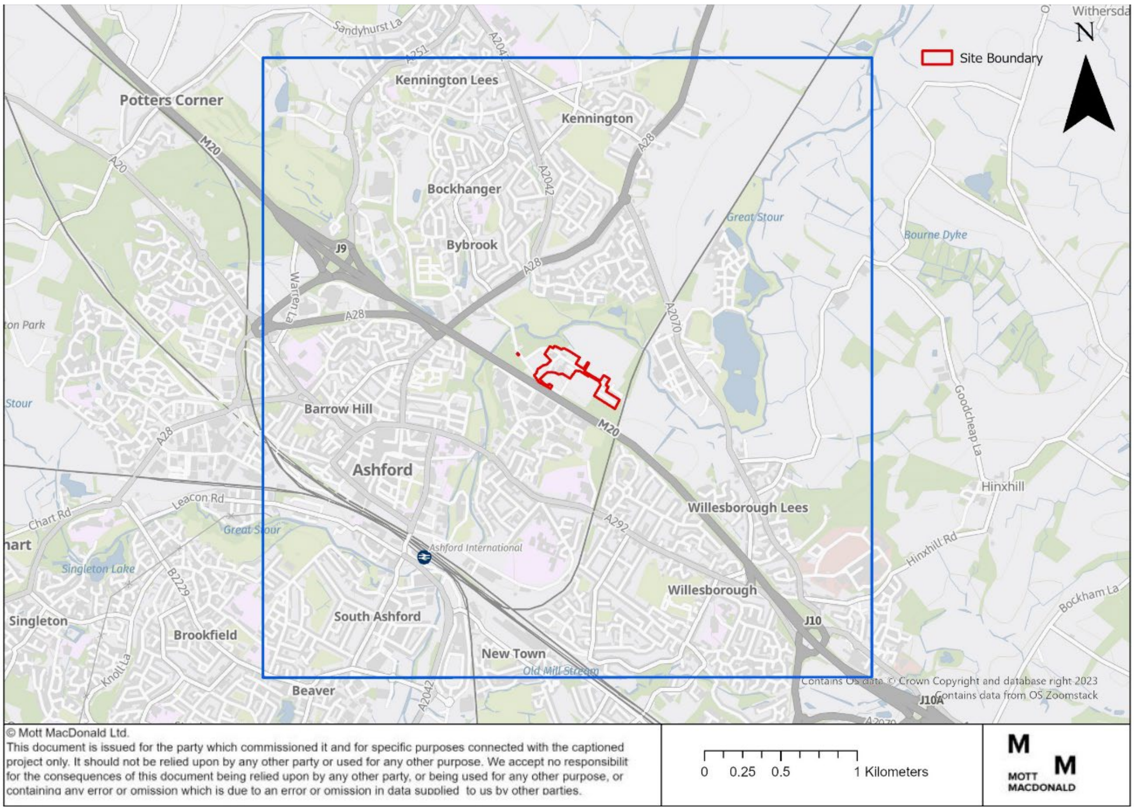
3.3 Sensitive receptors

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

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

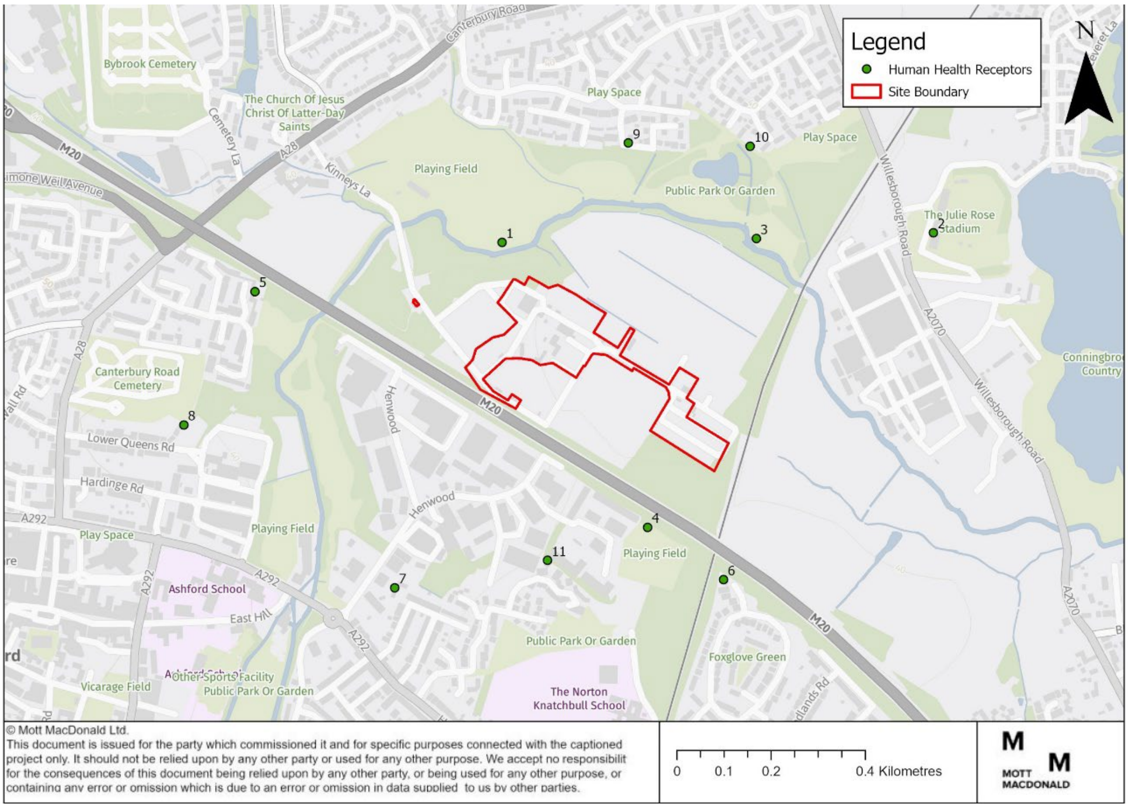
Eleven discrete human health receptors representing the closest sensitive receptors have been included within the model so that a comparison against the EQSs can be made. The short-term objective applies at receptors 1-4 and both the long-term and short long-term objectives apply at residential receptors 5-11 (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	Ashford Rugby Club (ST)	Public Park	601998	143593	1.5
2	Julie Rose Stadium (ST)	Public Park	602914	143613	1.5
3	Great Stour Foot Path (ST)	Public Park	602538	143601	1.5
4	Cradlebridge Rugby Fields (ST)	Residential	602307	142987	1.5
5	Nutley Close	Residential	601473	143488	1.5
6	Birch Close	Residential	602469	142875	1.5
7	Wallis Road	Residential	601770	142858	1.5
8	Lower Queens Road	Residential	601322	143204	1.5
9	Peter Candler Way	Residential	602267	143804	1.5
10	Raymond Fuller Way	Residential	602525	143797	1.5
11	Kennard Way	Residential	602094	142916	1.5

Note: Only the short-term objectives for NO_2 and SO_2 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[32].

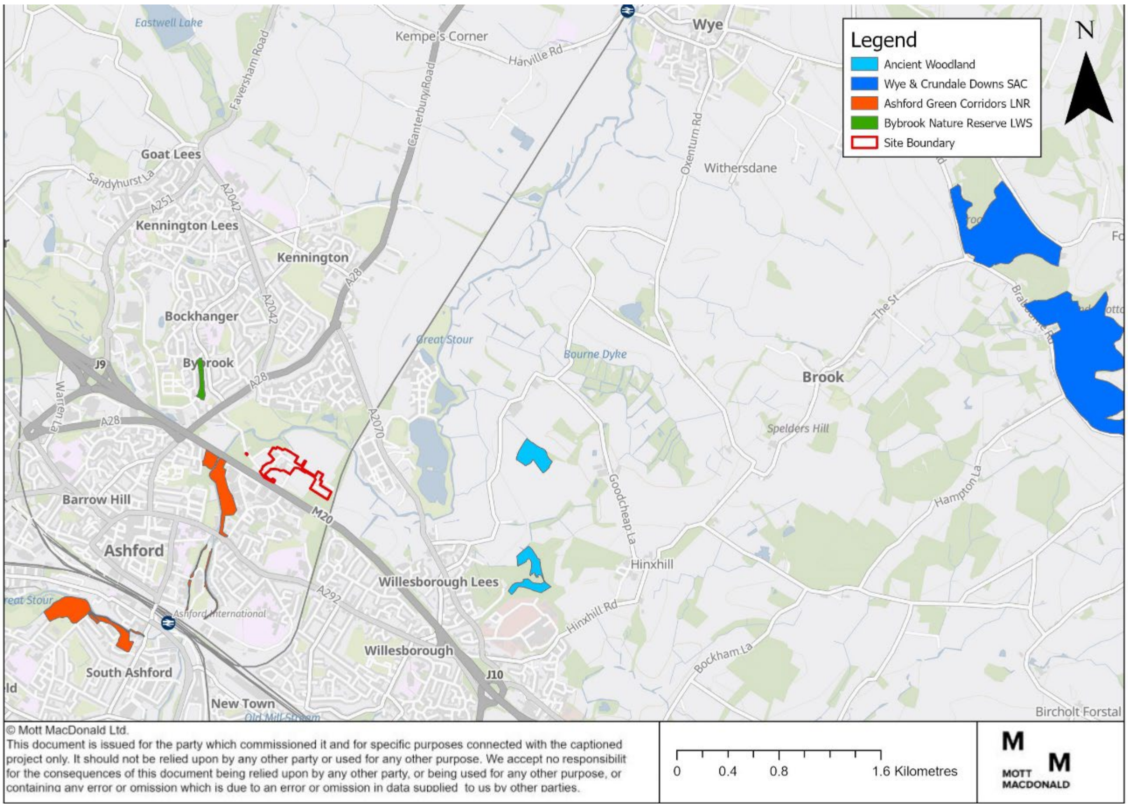
- Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or Ramsar sites within 10km
- Sites of Special Scientific Interest (SSSIs) within 2km
- Other locally and nationally designated habitat sites including National Nature Reserves (NNRs), Local Nature Reserves (LNRs), Ancient Woodland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

- Wye & Crundale Downs SAC
- Ashford Green Corridors LNR
- Three parcels of Ancient Woodland east of the Site
- Bybrook Nature Reserve LWS

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

Figure 3.5: Modelled ecological receptors



[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 Effects on conservation sites

In accordance with the Environment Agency risk assessment guidance[33],the impact of NOx 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 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 points at the designation boundaries to the Site have been modelled and the maximum modelled concentrations have been compared against the critical levels.

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 Wye & Crundale Downs SAC, the critical loads for the most sensitive habitat listed on APIS website for this site, ‘fagus forest on non-acid and acid soils’, has been applied to the modelled point at the designation boundary as a worst-case assumption.

For Ashford Green Corridors LNR, the modelled Ancient Woodland sites and Bybrook Nature Reserve LWS, the APIS Search by Location tool was used to determine the relevant critical loads for the ‘broadleaved, mixed and yew woodland’ critical load class. This habitat has been assumed to be present at the designation boundaries at these sites.

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

Table 3.5: Critical load data for modelled ecological receptors

Site name	APIS Nitrogen Critical Load Class	Modelled Location (x, y)	Nitrogen deposition Lower critical load (kg/ha/yr)	Acid deposition critical loads		
				CLmaxS (keq/ha/ yr)	CLminN (keq/ha/ yr)	CLmaxN (keq/ha/ yr)
Wye & Crundale Downs SAC	Fagus forest on non-acid and acid soils	607909, 144636	10	0.357	3.284	2.927
Ashford Green	Broadleaved mixed and	600653, 142149	10	0.142	2.950	2.800

[33] 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

Site name	APIS Nitrogen Critical Load Class	Modelled Location (x, y)	Nitrogen deposition Lower critical load (kg/ha/yr)	Acid deposition critical loads		
				CLmaxS (keq/ha/ yr)	CLminN (keq/ha/ yr)	CLmaxN (keq/ha/ yr)
Corridors LNR	yew woodland'					
Ancient Woodland	Broadleaved mixed and yew woodland'	603933, 142660	10	0.142	1.102	0.960
Bybrook Nature Reserve SINC	Broadleaved, mixed and yew woodland'	601477, 143896	10	0.142	2.954	2.812

Source: APIS website

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[34] 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/m²/s) = ground level concentration (µg/m³) x deposition velocity (m/s)
- Convert units from µg/m²/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/m²/s) = ground level concentration (µg/m³) x deposition velocity (m/s)
- Convert units from µg/m²/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.

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

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[35]. This guidance provides criteria for the screening out of insignificant PCs 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 the site-specific circumstances. For this assessment, the conservative assumptions regarding the operational load for the combustion plant the emissions data adopted for 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

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

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 ABC[36]. 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

ABC has not declared any AQMAs.

4.2.1 Local authority automatic monitoring

ABC does not undertake any automatic monitoring within the borough.

4.2.2 Local authority diffusion tube monitoring

ABC undertook diffusion tube monitoring at 25 locations during 2022. The nearest of these is located approximately 600m to the south of the Site on Hythe Road. This site is located near a busy road and monitored concentrations are unlikely to be representative of the Site and the surrounding receptors. There are no other diffusion tube monitoring locations that are likely to be representative.

ABC have not reported exceedances of the annual mean objective for NO_2 at any monitoring locations within the borough for the period from 2018-2022.

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.[37]

Table 4.1: 2023 Defra projected background concentrations for the Site (µg/m^3)

Pollutant	Long-term	Short-term
NO_X	15.3	30.6

[36] Adur and Worthing Councils, 2023. 2023 Air Quality Annual Status Report.

[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

Pollutant	Long-term	Short-term
NO_2	11.5	22.9
SO_2	2.1	4.1
VOCs	0.5	1.0

Notes: Results rounded to 1 decimal place
Pollutant concentrations for OS grid square 602500, 143500 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

Air quality monitoring undertaken by ABC for the period from demonstrates that there were no exceedances of the annual mean NO_2 objectives within the borough from 2018 to 2022. Defra projected background concentrations for 2023 at the Site also indicate that there a 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[38], 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 boilers have been assumed to be all operating at full load, continuously all year. In practice, these combustion plant do not operate concurrently for extended periods of time. 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 benzene emissions are also based on assumption of a 100% benzene fraction for the VOCs which is highly conservative.

5.2 Gridded receptors

Table 5.1 presents the maximum predicted PCs for NO_2, SO_2 and VOCs 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[39] so the PECs have also been considered.

Table 5.1: Maximum NO_2 and SO_2 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	38.5	**19%**	200
	Annual average	8.8	**22%**	40
SO_2	99.9 %'ile of 15-minute averages	95.4	**36%**	266
	99.73 %'ile of hourly averages	77.3	**22%**	350
	99.18 %'ile of 24-hour averages	51.3	**41%**	125
VOCs	100 %'ile of 24-hour averages	237.5	**792%**	30
	Annual average	31.6	**633%**	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

[38] 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

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

Table 5.2 presents the maximum predicted PECs for NO_2, SO_2 and VOCs at offsite locations across the modelled grid.

Each of the PECs for NO_2 and SO_2 are below the relevant EQS and therefore considered insignificant in accordance with Environment Agency significance criteria. Contour plots of the PECs in the worst-case meteorological years are presented in Figure 5.1 to Figure 5.7. For NO_2 and SO_2, 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 site perimeter for long term or short term air quality impacts. Although there is relevant exposure at Ashford Rigby Club Playing fields for the hourly EQS for NO_2 and 15-minute and hourly EQSs for SO_2, the PECs are below the EQS and are considered insignificant.

The maximum predicted offsite PECs for VOCs are above the relevant EQS and cannot be screened out as insignificant. For the daily and annual EQSs for VOCs, contour plots presented in Figure 5.6 and Figure 5.7 show that there is relevant exposure for PECs above the EQSs at residential receptors to the north of the site on Peter Calder Way and Kennard Way. However, 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. Adopting more realistic assumption of 10% benzene would reduce the PCs by a factor of 10 and the annual and 24-hour PECs would fall well below the relevant EQS. On that basis, 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

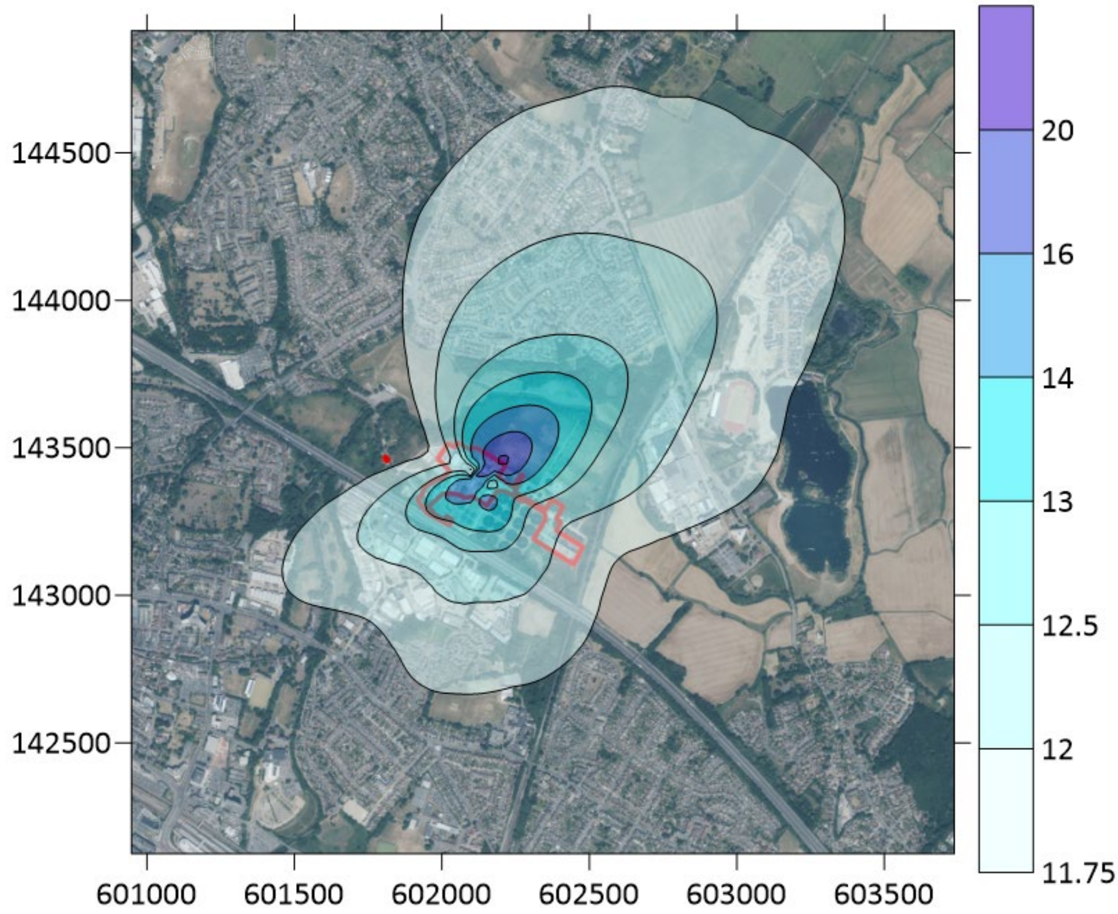
Pollutant	Averaging period	EQS	AC	Max PC	Max PEC	Max PEC as % of EQS
NO_2	99.79 %'ile of hourly averages	200	22.9	38.5	61.5	31%
	Annual average	40	11.5	8.8	20.3	51%
SO_2	99.9 %'ile of 15-minute averages	266	4.1	95.4	99.5	37%
	99.73 %'ile of hourly averages	350	4.1	77.3	81.4	23%
	99.18 %'ile of 24-hour averages	125	4.1	51.3	55.5	44%
VOCs	100 %'ile of 24-hour averages	30	1.0	237.5	238.4	**795%**
	Annual average	5	0.5	31.6	32.1	**642%**

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

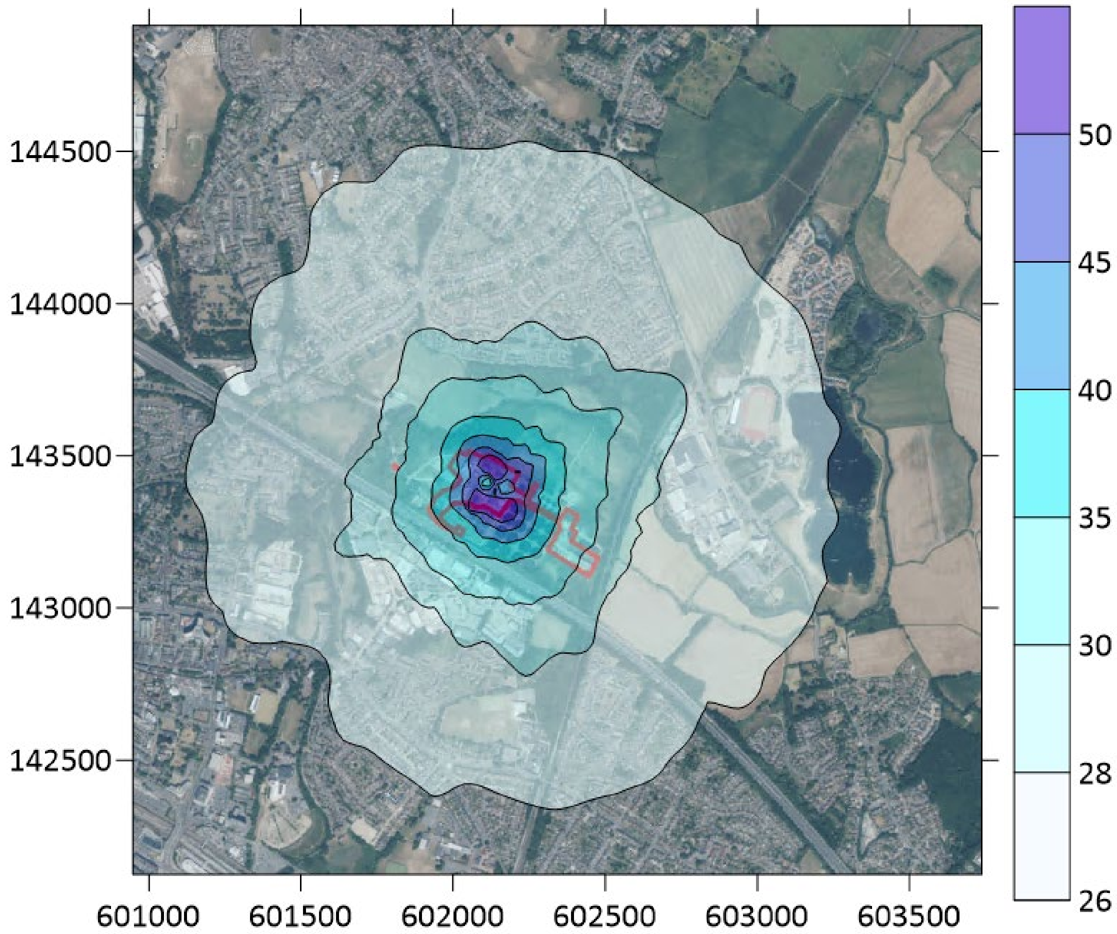
The results in **bold** are those that cannot be screened out as insignificant according to Environment Agency criteria

Figure 5.1: Annual mean NO_2 PEC (µg/m^3)



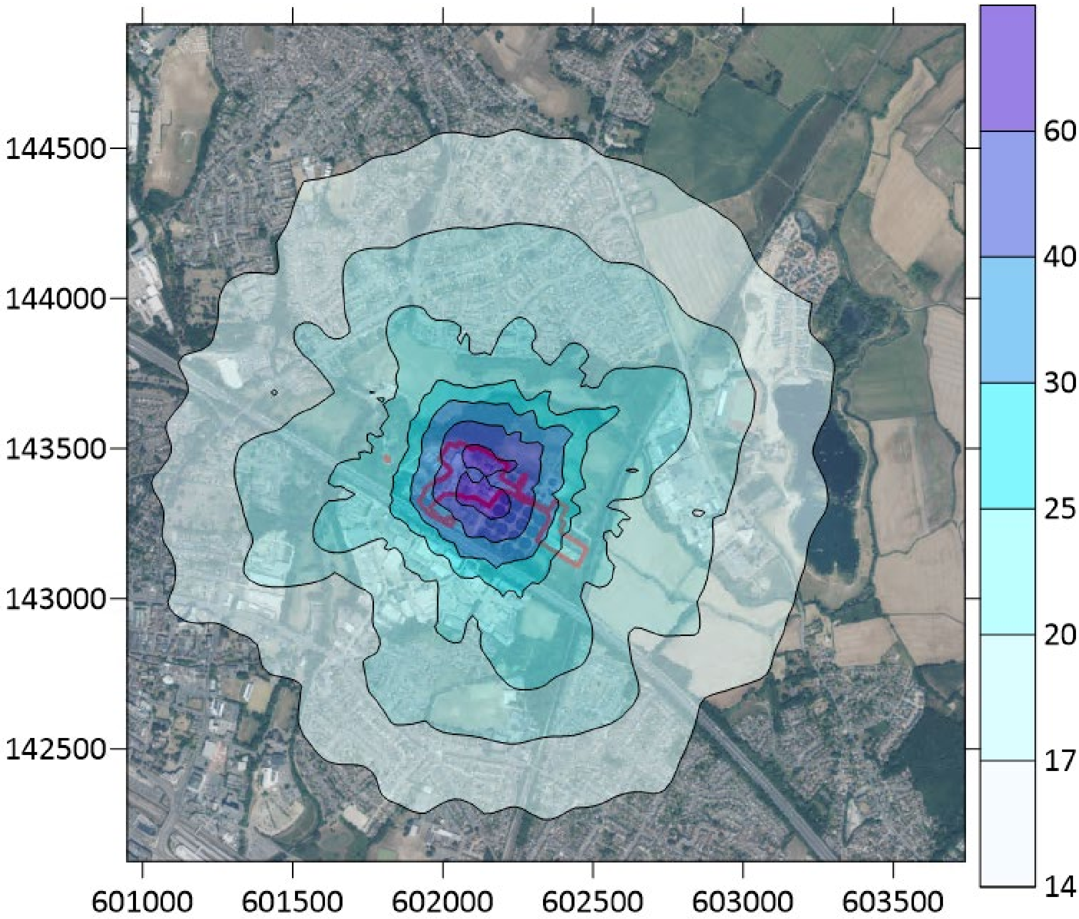
Note: Results presented for the worst case meteorological year of 2020. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary is outlined in red. The 2023 Defra background concentration for the grid square of the maximum PC has been assumed for the ambient concentrations for all gridded receptors. This 2023 Defra background concentration is 11.5 µg/m^3.

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



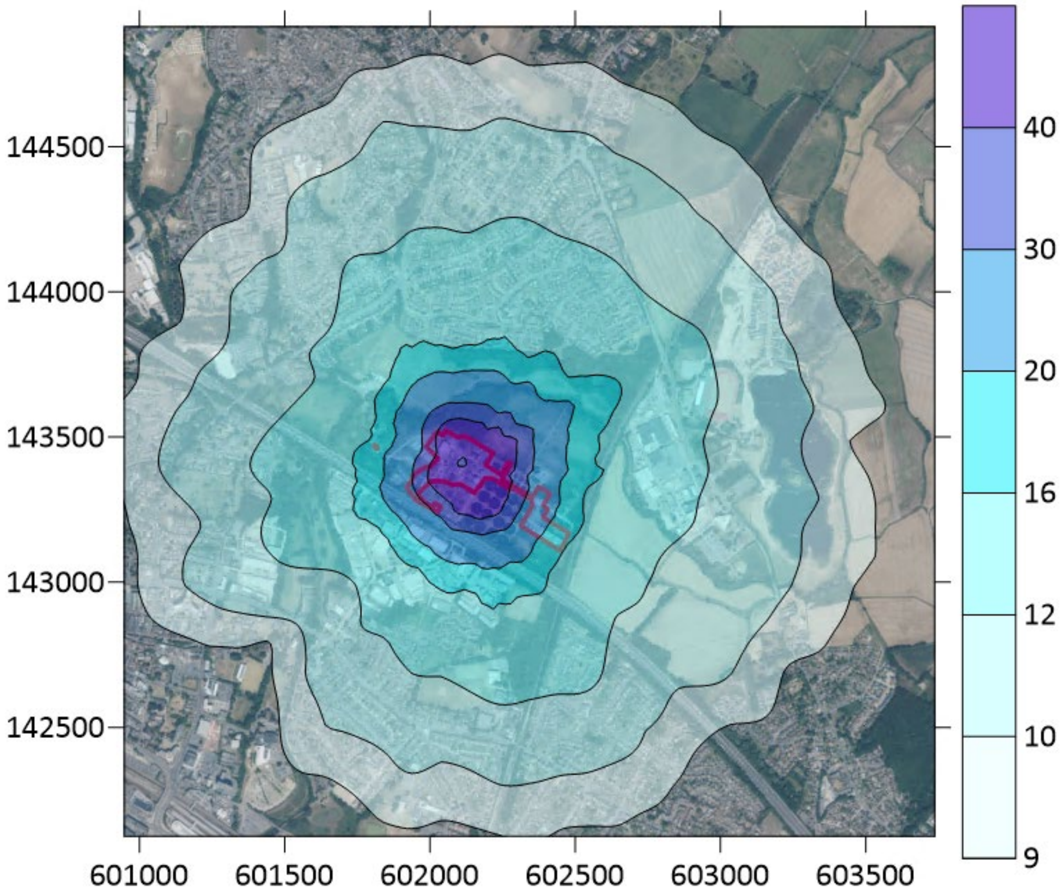
Note: Results presented for the worst case meteorological year of 2019. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2023 Defra background 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 22.9 μg/m³.

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



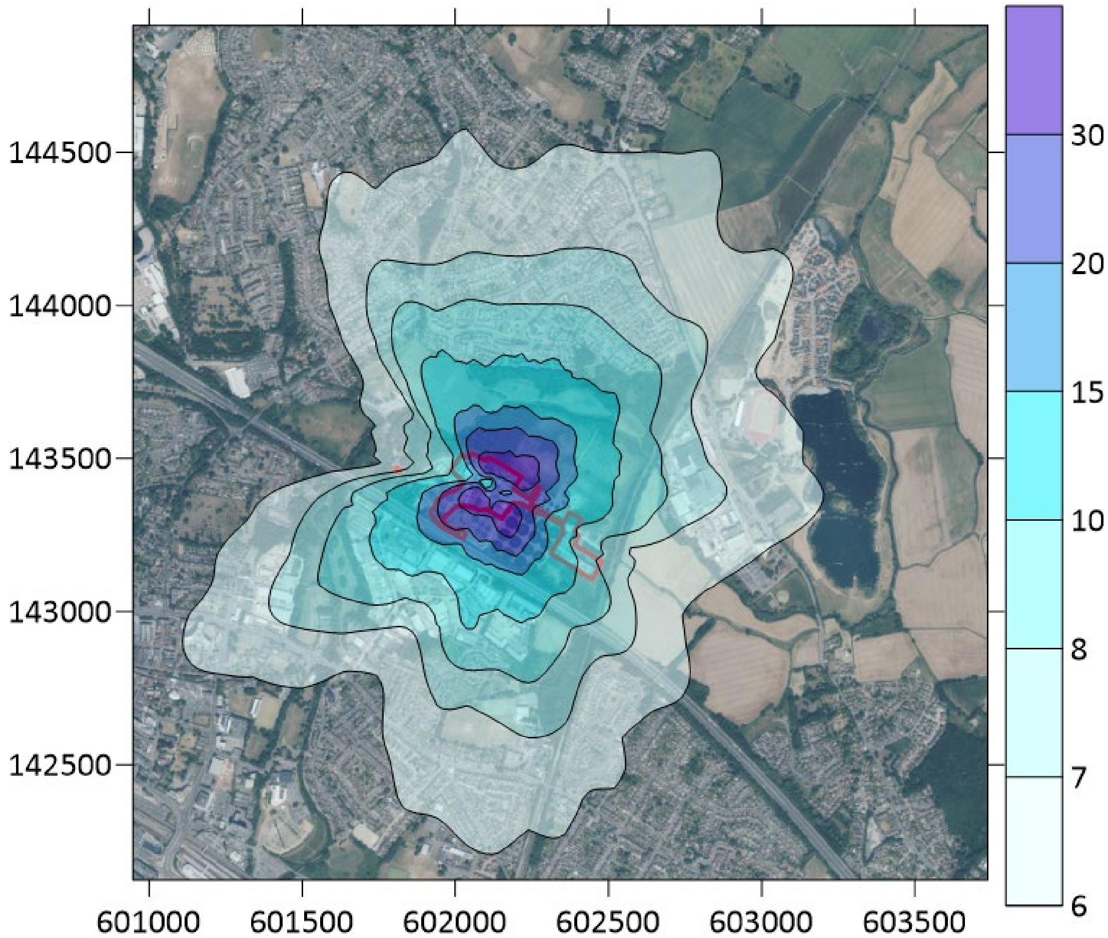
Note: Results presented for the worst case meteorological year of 2019. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2022 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2023 Defra background concentration is 4.1 µg/m³.

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



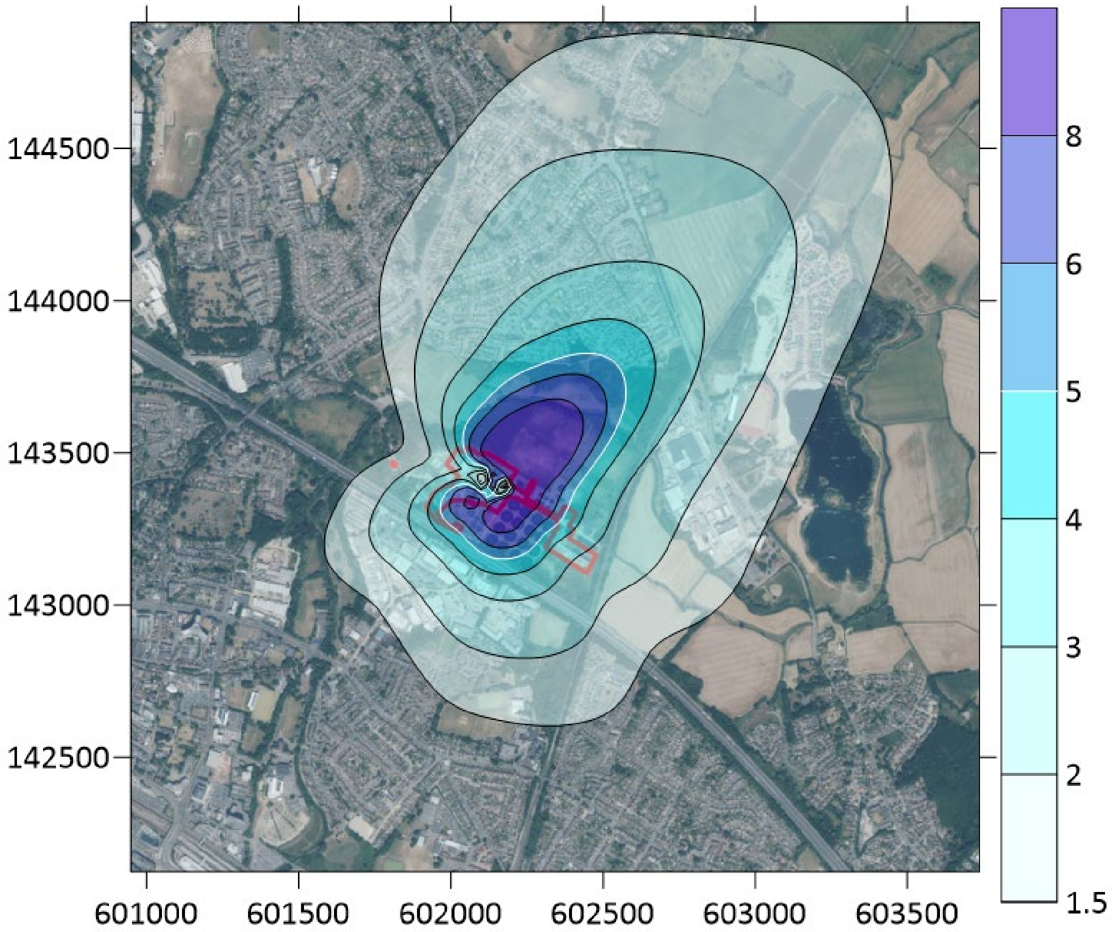
Note: Results presented for the worst case meteorological year of 2019. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2022 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2023 Defra background concentration is 4.1 µg/m³.

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



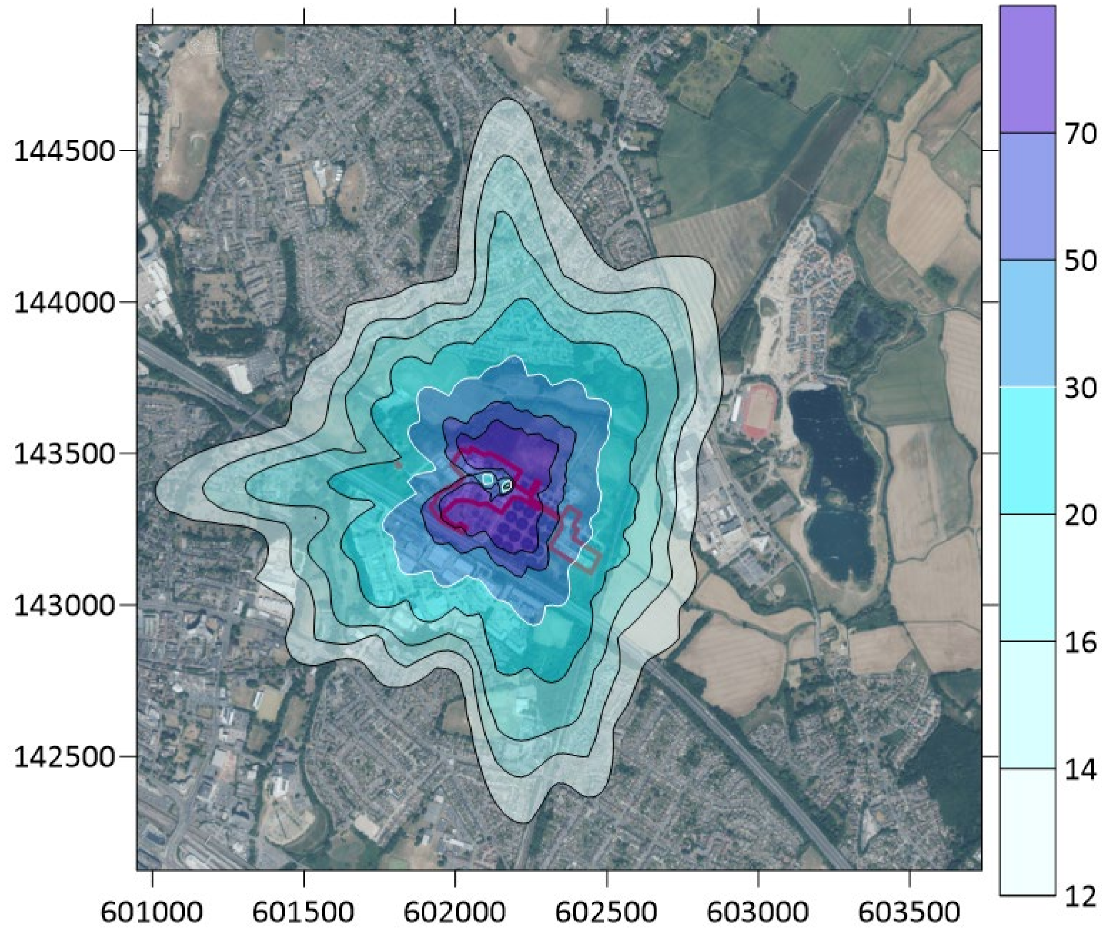
Note: Results presented for the worst case meteorological year of 2020. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2022 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2023 Defra background concentration is 4.1 µg/m³.

Figure 5.6: Annual mean VOCs (benzene) PEC (µg/m³)



Note: Results presented for the worst case meteorological year of 2019. 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 0.5 µg/m³. The EQS of 5µg/m³ 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 2019. 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 1.0 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 are below 10% of the EQS at all receptors. Therefore, in accordance with Environment Agency guidance[40], the hourly impacts for NO_2 are considered insignificant.

[40] 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

For the annual mean, the predicted PCs are above 1% of the EQS at receptors 9-11, but the PECs are well below the EQS. Therefore, in accordance with Environment Agency guidance, the annual mean impacts for NO_2 are considered insignificant.

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

Receptor	EQS (µg/m³)	Max PC	Max PC as % of EQS
1	200	12.5	6.2
2	200	4.2	2.1
3	200	7.2	3.6
4	200	7.1	3.6
5	200	4.1	2.1
6	200	5.4	2.7
7	200	4.0	2.0
8	200	3.5	1.7
9	200	6.4	3.2
10	200	5.0	2.5
11	200	5.8	2.9

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/m³)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
5	40	0.2	0.4	14.6	14.7	36.9
6	40	0.4	0.9	11.9	12.3	30.7
7	40	0.4	1.0	12.1	12.5	31.1
8	40	0.2	0.4	14.6	14.8	36.9
9	40	1.4	**3.5**	11.5	12.9	32.2
10	40	1.2	**3.0**	11.5	12.7	31.7
11	40	0.7	**1.7**	11.9	12.6	31.5

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
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 15-minute PCs exceed 10% of the EQS at receptor 1, but the 15-minute PECs do not exceed the EQS. Therefore, the 15-minute impacts for SO_2 are considered insignificant.

The hourly and 24-hour PCs do not exceed 10% of the EQS at any receptors. Therefore, the hourly and 24-hour impacts for SO_2 are also 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	31.8	**12.0**	5.4	37.3	14.0
2	266	14.6	5.5	4.1	18.7	7.0
3	266	22.0	8.3	4.1	26.1	9.8
4	266	23.5	8.8	3.8	27.3	10.3
5	266	14.7	5.5	5.4	20.1	7.6
6	266	19.0	7.2	3.8	22.9	8.6
7	266	13.4	5.1	5.7	19.2	7.2
8	266	12.8	4.8	5.4	18.3	6.9
9	266	19.2	7.2	4.1	23.3	8.8
10	266	15.8	5.9	4.1	19.9	7.5
11	266	17.4	6.5	3.8	21.2	8.0

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 5.6: 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
1	350	25.5	7.3
2	350	8.5	2.4
3	350	14.4	4.1
4	350	14.5	4.1
5	350	8.3	2.4
6	350	10.9	3.1
7	350	8.2	2.3
8	350	7.0	2.0
9	350	13.1	3.7
10	350	10.3	2.9
11	350	11.5	3.3

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

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/m³)	Max PC	Max PC as % of EQS
5	125	3.4	2.7
6	125	3.6	2.8
7	125	3.2	2.5

Receptor	EQS (µg/m³)	Max PC	Max PC as % of EQS
8	125	2.4	1.9
9	125	7.0	5.6
10	125	5.0	4.0
11	125	5.6	4.5

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
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.

5.3.3 VOCs concentrations

The PCs and PECs for daily and annual VOCs at discrete human health receptors are summarised in Table 5.5 to Table 5.7.

The 24-hour PCs are predicted to be above 10% of the EQS at all modelled receptors. The PECs exceed the EQS at receptor 9 only.

For the annual mean, the PCs are predicted to be above 1% of the EQS at all modelled receptors. The PECs are above the EQS at receptor 9 only.

The modelling of VOCs assumes the fraction of benzene in the VOCs emitted from the CHP and flare 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. Adopting more realistic assumption of 10% benzene would reduce the PCs by a factor of 10 and the annual and 24-hour PECs would fall well below the relevant EQS. On that basis, the modelled impacts for VOCs are considered insignificant.

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

Receptor	EQS (µg/m³)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
5	30	14.7	**49.1%**	1.0	14.7	49.1%
6	30	18.5	**61.7%**	1.0	18.5	61.7%
7	30	14.3	**47.6%**	1.0	14.3	47.6%
8	30	12.3	**41.0%**	1.0	12.3	41.0%
9	30	32.6	**108.7%**	1.0	32.6	108.7%
10	30	23.1	**77.0%**	1.0	23.1	77.0%
11	30	24.4	**81.3%**	1.0	24.4	81.3%

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 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
5	5	0.6	**12.5%**	0.5	0.6	12.5%
6	5	1.4	**28.1%**	0.5	1.4	28.1%
7	5	1.6	**31.9%**	0.5	1.6	31.9%
8	5	0.7	**14.0%**	0.5	0.7	14.0%
9	5	5.1	**102.8%**	0.5	5.1	102.8%
10	5	4.7	**93.9%**	0.5	4.7	93.9%
11	5	2.7	**53.7%**	0.5	2.7	53.7%

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 critical loads at ecological receptors.

The maximum PCs are presented below are based on the maximum concentrations modelled from a 20m grid across the site (see Section 3.3.3 for details).

5.4.1 Assessment of critical levels

Table 5.10 and Table 5.11 present the maximum predicted annual and daily NOx PCs.

The maximum predicted annual NOx PCs are below 1% of the relevant EQS at Wye & Crundale Downs SAC and below 100% of the EQS at the local wildlife sites. The impact is therefore considered insignificant in accordance with the Environment Agency risk assessment guidance.

The maximum predicted daily NOx PCs are below 10% of the relevant EQS at Wye & Crundale Downs SAC and below 100% of the EQS at the local wildlife sites. Therefore, this impact is also considered insignificant.

Table 5.10: Maximum annual NOx critical level results

Receptor	EQS (µg/m^3)	Max PC (µg/m^3)	% PC of EQS
Wye & Crundale Downs SAC	30	<0.1	0.2%
Ashford Green Corridors LNR	30	0.4	1.3%
Ancient Woodland Sites	30	0.2	0.5%
Bybrook Nature Reserve LWS	30	0.3	0.9%

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
The PCs in **bold** cannot be screened out as insignificant according to Environment Agency criteria.

Table 5.11: Maximum daily NOx critical level results

Receptor	EQS (µg/m^3)	Max PC (µg/m3)	% PC of EQS
Wye & Crundale Downs SAC	75	0.3	0.4%
Ashford Green Corridors LNR	75	8.8	11.8%
Ancient Woodland Sites	75	2.2	2.9%
Bybrook Nature Reserve LWS	75	4.1	5.5%

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 presents the maximum annual SO_2 PC and PECs.

The maximum predicted annual SO_2 PC is below 1% of the relevant EQS at Wye & Crundale Downs SAC and below 100% of the EQS at the local wildlife sites. The impact is therefore considered insignificant in accordance with the Environment Agency risk assessment guidance.

Table 5.12: Maximum annual SO_2 critical level results

Receptor	EQS (µg/m^3)	Max PC (µg/m^3)	% PC of EQS
Wye & Crundale Downs SAC	20	<0.1	0.2%
Ashford Green Corridors LNR	20	0.3	1.4%
Ancient Woodland Sites	20	0.1	0.6%
Bybrook Nature Reserve LWS	20	0.2	1.0%

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
The PCs in **bold** cannot be screened out as insignificant

5.4.2 Assessment of critical loads

5.4.2.1 Critical loads - acidification

Table 5.13 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 predicted PCs for acid deposition is below 1% of the minimum critical load at Wye & Crundale Downs SAC and below 100% of the minimum critical load at the local wildlife sites Therefore, in accordance with Environment Agency guidance, the impact of on acidification at nearby designated sites is considered to be insignificant.

Table 5.13: Critical load results - acid deposition

Designated site	APIS Habitat[(a)]	Minimum CLmaxN (keq N/ha/yr)	Maximum ground level concentration of NO_2 (PC) (µg/m^3)	Maximum ground level concentration of SO_2 (PC) (µg/m^3)	Total acid deposition (PC) (keq/ha/yr)	% PC of minimum CLmaxN
Wye & Crundale Downs SAC 1	Fagus forest on non-acid and acid soils	3.284	0.03	0.03	0.01	0.3%
Ashford Green Corridors LNR 1	Broadleaved woodland	2.950	0.27	0.28	0.07	2.4%
AW 2	Broadleaved woodland	1.102	0.11	0.12	0.03	2.7%
Bybrook Nature Reserve SINC	Broadleaved woodland	2.954	0.19	0.20	0.05	1.7%

5.4.2.2 Critical loads – eutrophication

Table 5.14 presents the predicted nitrogen deposition rates, which have been calculated from dispersion modelling and compared with the lower nitrogen critical load.

The results show that the maximum predicted PC for nitrogen deposition is below 1% of the minimum critical load at Wye & Crundale Downs SAC and below 100% of the minimum critical load at the local wildlife sites. Therefore, in accordance with Environment Agency guidance, the impact of acid deposition is considered to be insignificant.

Table 5.14: 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 (dry) (kg/ha/yr)	% PC of minimum nitrogen deposition critical load
Wye & Crundale Downs SAC	Fagus forest on non-acid and acid soils	10	<0.1	<0.1	0.1%
Ashford Green Corridors LNR	Broadleaved woodland	10	0.3	0.1	0.8%
Ancient Woodland Sites	Broadleaved woodland	10	0.1	<0.1	0.3%
Bybrook Nature Reserve LWS	Broadleaved woodland	10	0.2	0.1	0.6%

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)
[(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

6 Conclusions

An assessment has been undertaken to determine the effect of emissions from the combustion of biogas at the CHP and two 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 practice, 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 and SO_2 for human health receptors are predicted at locations of relevant public exposure. The modelling of VOCs assumes a benzene fraction of 100%. A review of published benzene fractions published by the NAEI suggests a fraction of 10% would be a more accurate assumption. Therefore, the modelled impacts for benzene are likely to be overestimated by at least a factor of 10 and the modelled exceedances of the EQSs for benzene are therefore considered insignificant.

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 deposition at nearby ecological sites are also considered insignificant. The Site does not conflict with the relevant air quality regulations.