MOTT MACDONALD

Banbury STC

Air quality assessment to accompany permit application EPR/PP3409MH/A002

15 September 2023

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Contents

1 Introduction

1.1 Overview

Thames Water Utilities Ltd (TW) is applying for a biological treatment permit to comply with the requirements of the Industrial Emissions Directive (IED) for the Banbury Sludge Treatment Centre (STC) at Banbury Sewage Treatment Works (STW). The STC is located within Thorpe Industrial Estate, Banbury (hereafter referred to as “the Site”). The Site includes combustion plant which requires regulation under the Medium Combustion Plant Directive (MCPD).

This report provides an assessment of the point source emissions to air, and subsequent air quality effects, associated with the proposed operation of the Site to meet the requirements of the MCPD and Specified Generator (SG) regulations. This report will be submitted as part of the wider IED permit application. The assessment has been undertaken in accordance with current Environment Agency (EA) guidance.

1.2 Site description and operating envelope

The Site will consist of one new 1.1MWth combined heat and power (CHP) engine which will replace an existing 0.6MWth engine. Additional existing combustion sources on the Site include a 1.4MWth biogas boiler, two 0.4MWth back up biogas boilers and two backup diesel generators with rated thermal inputs of 0.3MWth and 0.2MWth respectively. The new CHP engine and existing plant will provide heat and power to the Site and any excess electricity will be exported to the National Grid.

The proposed operation of the plant on the Site includes:

- A 1.1MWth biogas CHP engine operated continuously with no restrictions to operational hours
- A 1.4MWth biogas boiler which is anticipated to run for less than 50% of the year, however it would be requested to have no restrictions on operating hours
- Two 0.4MWth biogas boilers principally operated as back-up only during testing or maintenance of the CHP or 1.4MWth boiler (due to the small size are not MCPs)
- Two diesel generators to be operated for less than 50 hours per year for testing or as emergency generators during emergency mains power failures (due to the very small size-mode of operation are not within the scope of the MCPD/SGC).

1.3 Scope of modelling assessment

The dispersion modelling undertaken for this assessment includes emissions from the

- A 1.1MWth biogas CHP engine
- A 1.4MWth biogas boiler

The 1.1 MWth CHP engine and the 1.4MWth boiler included in the dispersion modelling assessment are based on a plant load of 100% operating continuously. This is a conservative assumption as the 1.1MWth CHP will have downtime for maintenance and the 1.4MWth boiler is likely to be operated for less than 50% of the year. In addition, the dispersion modelling assumes that exhaust gases from both the CHP and 1.4MWth boiler will contain the maximum concentration of pollutants permitted. In practice, emissions concentrations are likely to be lower than those permitted.

The 0.4MWth boilers would only run as back-up on an as needed basis in the event that both the CHP or the 1.4MWth boiler are not available and the STC requires additional heat and therefore would not operate alongside these sources.

The 0.4MWth biogas boilers have therefore been excluded from the dispersion modelling assessment as

- the new larger CHP engine will supply the majority of the site's heat needs and the call for digester heat from the 1.4MWth boiler running will reduce accordingly;
- the 0.4MWth boilers will only operate as back-up on a need basis in the event that the CHP or the 1.4MWth boiler are not available. Individually, the CHP and 1.4MWth boiler can provide enough heat to the STC process;
- the dispersion modelling of the CHP engine and 1.4MWth boiler include conservative assumption relating to the operational profiles and emission concentrations;
- there are a limited number of operational hours of the 0.4MWth boilers; and
- modelling is not considered appropriate as the 0.4MWth boilers do not run concurrently with the 1.4MWth boiler and due to their much smaller size, the existing modelling assumptions are already more conservative than if the 0.4MWth were included.

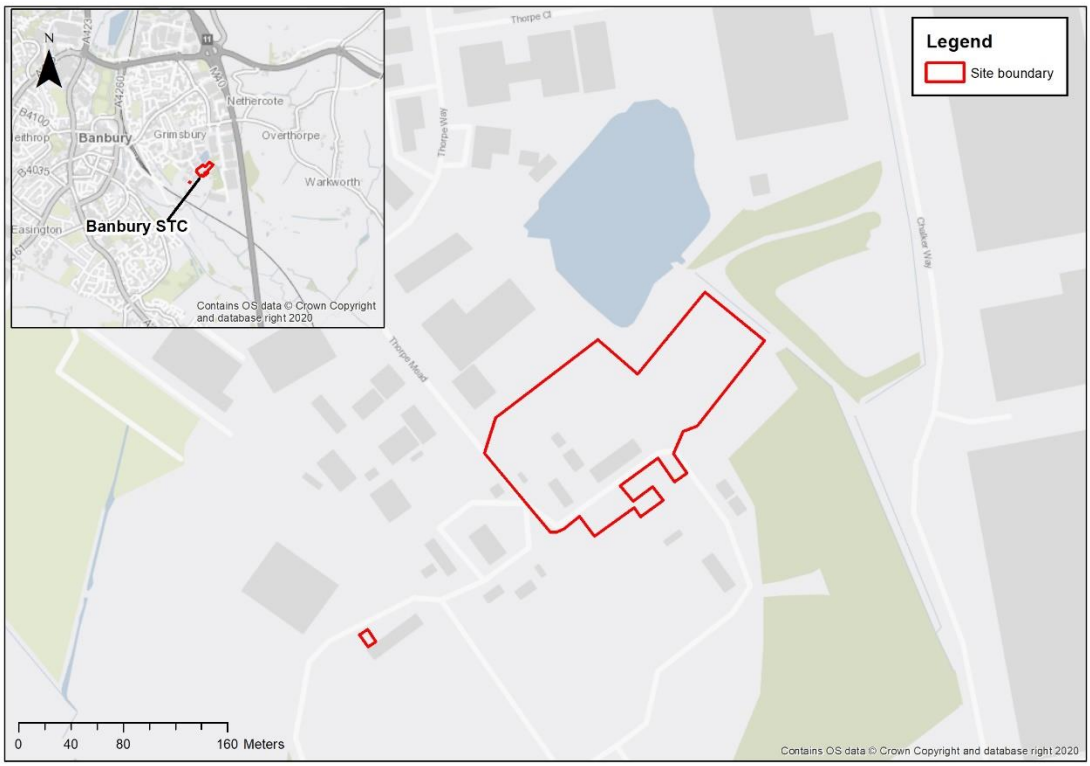
The two diesel generators have also been excluded from the dispersion modelling assessment as they will be operated for less than 50 hours per year for testing or as emergency generators during emergency mains power failures and are not within the scope of the MCPD/SGC.

Overall, the inclusion of the CHP and 1.4MWth boiler running in parallel all year is considered to provide a robust and conservative assessment of emissions from the Site suitable to determine likely impacts.

1.4 Site location

The Site, which is owned and operated by TW, is within the Thorpe Industrial Estate in Banbury, within the administrative area of Cherwell District Council (CDC). The Site is surrounded primarily by industrial/commercial land use and is approximately 280m from the neighbouring local authority of South Northamptonshire District Council (SNDC). The nearest residential receptors are approximately 330m to the west of the Site on Padbury Drive. Figure 1 shows the location of the Site and the extent of the Site boundary.

Figure 1: Site location



1.5 Key pollutants

The assessment includes consideration of emissions of oxides of nitrogen (NO_X) and sulphur dioxide (SO_2). These are the key pollutants of potential concern given that the fuel used by the new CHP is biogas. The following sub-sections present a brief description of the key pollutants referred to above and their behaviour in the atmosphere.

1.5.1 Oxides of nitrogen

Oxides of nitrogen is a term used to describe a mixture of nitric oxide (NO) and NO_2, referred to collectively as NO_X. These are primarily formed from atmospheric and fuel nitrogen as a result of high temperature combustion. The main 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 NO_X exhausting 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 NO_X, by chemical reactions 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.

1.5.2 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 combustion, smelting, manufacture of sulphuric acid, conversion of wood pulp to paper, incineration of waste and production of elemental sulphur. Coal burning is the single largest man-made source of sulphur dioxide accounting for about 50% of annual global emissions, with oil burning accounting for a further 25-30%. The most common natural source of SO_2 is volcanoes.

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

Part IV of the Environment Act 1995[6] 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[7] and the Air Quality (England) (Amendment) Regulations 2002[8].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[9] 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[10] and replaced by the Air Quality Strategy for England, Scotland, Wales and Northern Ireland, published in January 2000[11]. The 2000 Strategy has subsequently been replaced by the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007[12] and the Clean Air Strategy 2019 (CAS).[13]

[1] Statutory Instrument. (2010), *The Air Quality Standards Regulations,* No. 1001.

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

[3] Statutory Instrument. (2019) Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations

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

[5] European Union. (April 2008) *Directive on ambient air quality and cleaner Air for Europe, Directive 2008/50/EC* Official Journal, vol. 152, pp. 0001-0044

[6] Department for Environment Food and Rural Affairs. (2003) Part IV of the Environment Act 1995 Local Air Quality Management

[7] Statutory Instrument. (2000), 'Air Quality (England) Regulations', No. 928

[8] Statutory Instrument. (2002), 'Air Quality (England) (Amendment) Regulations', No. 3043

[9] Department for Environment Food and Rural Affairs. (2003) Part IV of the Environment Act 1995 Local Air Quality Management

[10] Department for Environment Food and Rural Affairs. (March 1997), 'The United Kingdom National Air Quality Strategy', Cm 3587, Department for Environment Food and Rural Affairs.

[11] Department for Environment Food and Rural Affairs. (January 2000), 'The Environment Strategy for England, Scotland, Wales and Northern Ireland – Working Together for Clean Air', Cm 4548, Department for Environment Food and Rural Affairs

[12] Department for Environment Food and Rural Affairs. (July 2007), 'The Air Quality Strategy for England, Scotland, Wales and Northern Ireland', Cm 7169, Department for Environment Food and Rural Affairs

[13] Department for Environment Food and Rural Affairs. (January 2019), 'The Clean Air Strategy'

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.

2.3 Permitting requirements and associated guidance

2.3.1 Overview

The Medium Combustion Plant Directive (MCPD) (Directive 2015/2193) [14] regulates emissions of NOx, SO_2 and particles into the air from combustion plants with a rated thermal input equal to or greater than 1 megawatt thermal (MWth) and less than 50 MWth. Schedules 25A and 25B of the Environmental Permitting (Amendment) Regulations 2018[15] implements this directive while also including additional provisions for generators. Generators are subject to the Environmental Permitting (EP) regulations if they:

- Have a capacity agreement or an agreement to provide balancing services, or,
- They form part of a specified generator[16] (SG) with a total rated thermal input of 1-50MWth.

Specified generators are subject to more stringent requirements than the MCPD in that, depending on the type of generator, they may be required to have a permit by an earlier date than would be required under the MCPD.

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 EA to assist with undertaking an air quality assessment for an environmental permit includes:

- Air emissions risk assessment for your environmental permit[17]
- Environmental permitting: air dispersion modelling reports[18]
- Specified generators: dispersion modelling assessment guidance[19]
- Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air[20]

2.3.2 Permitting requirements at the Site

TW are applying for a new IED AD installation permit where the new CHP engine will constitute a DAA to sludge treatment. The replacement CHP engine will be commissioned in early Summer 2023 and therefore would be classified as ‘new’ under the MCPD. The CHP is classified as a Tranche B specified generator so would be required to meet the requirements associated with generators under Schedule 25B of the EP (Amendment) Regulations 2018. This is in addition to the emission limits set out in the MCPD, as the new CHP engine will be operating for more than 500 hours a year.

[14] Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants.

[15] The Environmental Permitting (England and Wales) Regulations 2016 No.1154

[16] Specified generator = Individual or multiple generators at the same location or site, operated by the same Operator and for the same purpose

[17] 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

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

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

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

As the new CHP engine will be fired on biogas, the unit will be required to meet a NOx emission limit of 190mg/Nm^3 and a SO_2 emission limit of 40mg/Nm^3 (standard conditions[21], dry @ 15% O_2). The CHP will only operate on biogas so there are no applicable emission limits for carbon monoxide (CO) or dust/particulate matter. As the CHP has a rated thermal input of less than 20MWth, it is exempt from the requirements of Schedule 24 of the EP Regulations 2016 which implement the relevant requirements of the Energy Efficiency Directive (2012/27/EU).

The two 0.4MWth back-up boilers are excluded from the MCPD regulations as they are too small to be in scope. The diesel generators are also excluded from the MCPD regulations because of their small size as well as operating for less than 50 hours per year. These plant have therefore not been considered further within this report.

2.3.3 Assessment criteria

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

The EA's risk assessment guidance[22] 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[23] (APIS).

2.3.3.1 Air quality limit values and objectives

Table 1 summarises the AAD limit values and air quality objectives for the pollutants relevant to this assessment.

Table 1: Summary of relevant air quality objectives and AAD limit values

Pollutant	Averaging period	Objective / limit value (µg/m^3)	Allowance (per calendar year)
For the protection of human health			
Nitrogen dioxide (NO_2)	1-hour	200	18
	Annual	40	–
Sulphur dioxide (SO_2)	24-hour	125	3
	1-hour	350	24
	15-minute	266	35
Volatile organic compounds (VOC) (benzene)	Annual	5	–
For the protection of vegetation and ecosystems			
Nitrogen oxides (NO_x)	Annual	30	–
SO_2	Annual	20	–

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
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

[21] At a temperature of 273.15K, pressure of 101.3kPa

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

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

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 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: 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 EA[24] 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.

2.3.3.2 Environmental Assessment Levels

In addition to the AAD limit values and air quality objectives, the EA risk assessment guidance[25] provides further assessment criteria in the form of Environmental Assessment Levels (EALs). The EALs cover a wide range of pollutants and also 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 3.

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

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

Table 3: Summary of relevant EALs/critical levels for the protection of conservation areas or human health

Pollutant	Averaging period	Application	EAL/critical level (µg/m³)
NO_X	24 hours	Conservation areas	75
	Annual	Conservation areas	30[(a)]
SO_2	Annual	Conservation areas	10-20[(b)]
Benzene	24 hour mean	Human health	30

Notes: (a) Numerically synonymous with the annual AAD limit value
(b) 10µg/m³ where lichens or bryophytes are present, 20µg/m³ where they are not present

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 only available for Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSI).

3 Methodology

3.1 Overview

In accordance with EA risk assessment guidance[26], 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 3.3.3 provides further details on the background concentrations used in this assessment.

Detailed modelling has been undertaken for the scoped in combustion plant to calculate PCs and PECs to determine whether emissions from the Site are significant. A simple bespoke risk assessment cannot be undertaken using the Specified Generator Tranche B Screening tool as the Site includes a CHP engine operating on biogas.

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 4 and illustrated in Figure 2.

[26] Environment Agency. (2016) ‘Air Emissions Risk Assessment for your Environmental Permit’.

Table 4: Building dimensions used within the assessment

No.	Name	X (m)	Y (m)	Height (m)	Length (m)	Width (m)	Angle (°)
1	Secondary digester 1	447066	240286	4.1	17.4	17.4	0
2	New CHP Building	447054	240266	2.7	2.7	11.2	55
3	Gas Holder	447000	240255	11.6	15.0	15.0	0
4	Digester 1	446999	240274	13.6	12.5	12.5	0
5	Digester 2	447011	240282	13.6	12.5	12.5	0
6	Digester 3	447024	240292	13.6	12.5	12.5	0
7	Digester 4	447036	240301	13.6	12.5	12.5	0
8	Sludge blending tank	447025	240261	6.7	5.5	5.5	0
9	Sludge feed kiosk	447031	240265	3.5	7.5	9.8	55
10	CHP kiosk	447037	240259	2.1	7.7	2.5	56
11	Klampress building	447076	240249	5.5	41.6	11.4	54
12	LV Building	446984	240227	3.0	8.3	8.3	55
13	Secondary digester 2	447084	240299	4.1	17.4	17.4	0
14	Secondary digester 3	447071	240317	4.1	17.4	17.4	0
15	Boiler house	447043	240250	4.3	9.0	15.6	55

Figure 2: 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.

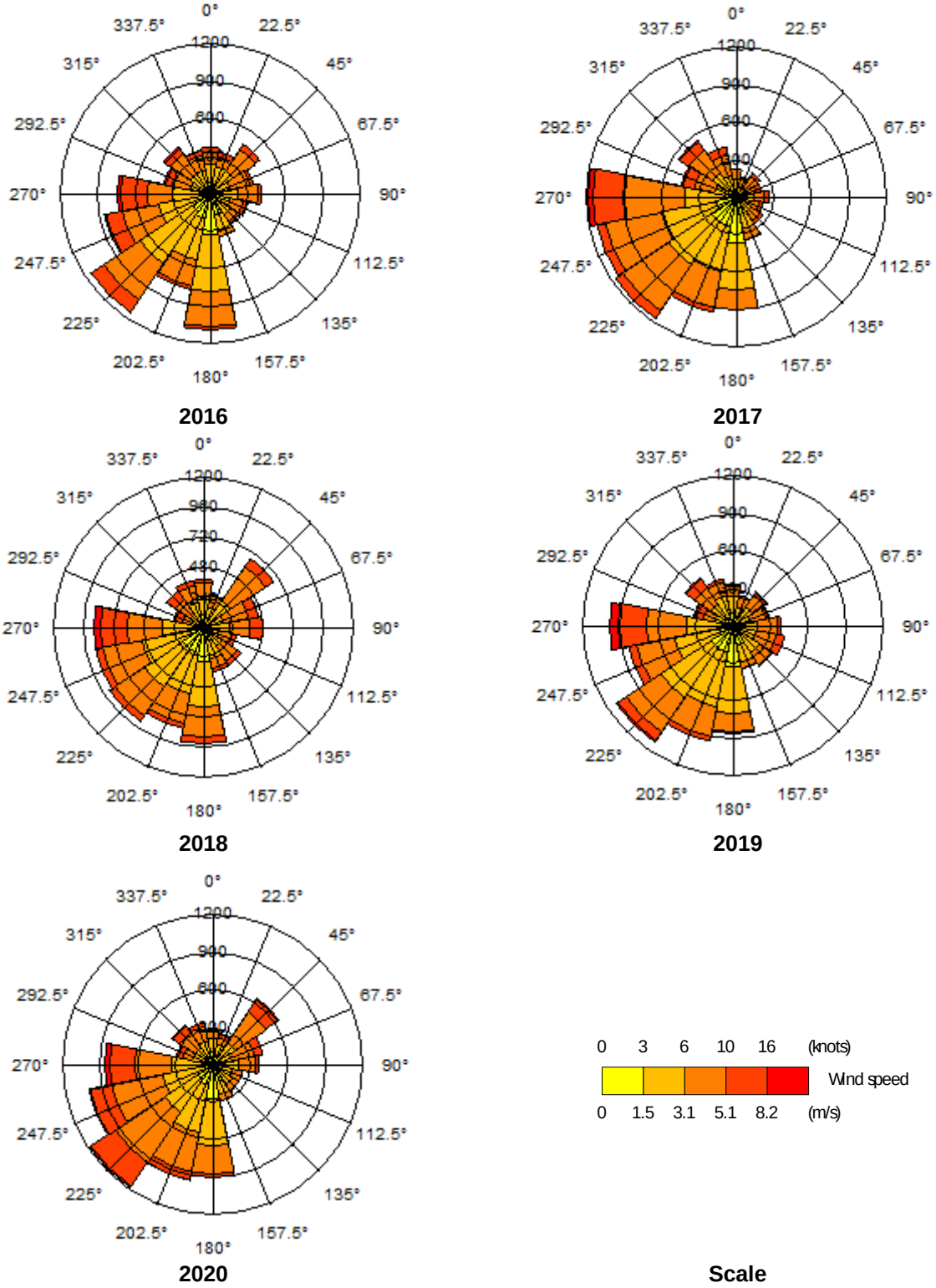
The year of meteorological data that is used for a modelling assessment can have a significant effect on source contribution concentrations. As recommended by the EA dispersion modelling

guidance[27], modelling was undertaken using five years of data. Data from Church Lawford meteorological station was used as this was the most representative station due to its proximity to the Site, located approximately 34 kilometres to the north, and is located at a similar elevation to the Site. Data from the last five years were used, comprising the years 2016 to 2020.

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 illustrate that in most years there is dominance in winds from the south west.

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

Figure 3: Wind roses for Church Lawford (2016 – 2020)



3.2.4 Terrain

The presence of elevated terrain can significantly affect (usually increase) 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, although there are some slopes with gradients more than 10%. Therefore, in accordance with EA specified generator guidance[28], terrain data has 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 surface roughness length of 0.5m has been assigned to the model domain while a surface roughness length of 0.3m has been assigned to the Church Lawford meteorological station.

3.2.6 Emissions data

Emissions for the new CHP engine and the 1.4MWth boiler 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. This is a conservative assumption as the 1.4MWth boiler is likely to be operated for less than 50% of the year.

The NOx and SO_2 emissions modelled in this assessment are based on the emissions guaranteed by the CHP manufacturer. These emission expectations are compliant with the MCP ELVs within the MCPD and the specified generator ELV within the EP regulations. Exhaust temperature and volumetric flow for the CHP are based on the technical specification provided by the manufacturer.

Emissions from the boiler are based on emission limit values within the MCPD and emissions testing from similar boilers operated by Thames Water.

Exhaust temperature and volumetric flow are not available when the 1.4 MWth boiler is firing on biogas. Therefore, volumetric flow is based on the mean average of actual volumetric flows from emissions monitoring undertaken at seven similar sized biogas boilers at three Thames Water sites. The range (maximum minus minimum) recorded volumetric flow across the seven sites was 0.1m^3/s and is considered low enough for the mean average to be representative of volumetric flow at the Site.

For exhaust temperature, the measured data at the other Thames Water sites was higher than the measured temperature for the 1.4MWth boiler when operating on natural gas (data is available for this) at the Site. Therefore, a conservative approach was adopted, by applying the measured 1.4MWth boiler temperature when operating on natural gas.

Actual emissions of VOCs are dependent on the biogas specification which is subject to variation and there is no ELV specified within the MCPD and the EP regulations. Therefore, total volatile organic compounds (TVOCs) have been modelled assuming an indicative emissions concentration 1000mg/m^3 from the CHP engine which is consistent with recent EA

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

communications. TVOC emissions from the boiler are expected to be minimal and have not been considered.

Table 5 presents the emission parameters used in the dispersion modelling and is based on information provided by the CHP engine supplier. Emission rates 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 5: Stack emission parameters

Parameter	Units	1.1MWth CHP	1.4MWth Boiler
Stack location	x,y	X:447056, Y:240268	X: 447035, Y: 240252
Stack height	m	7	6
Stack diameter	m	0.25	0.3
Exit temperature	°C	180[a]	116
Efflux velocity (actual)	m/s	17.88	7.3
Volumetric flow rate (actual)	Am^3/s	0.879 [b]	0.515[d]
Volumetric flow rate (normalised)	Nm^3/s	0.981[c]	0.247[e]
Volumetric flow rate (normalised)	Nm^3/s	0.363[f]	-
NO_x emission	mg/Nm^3	190[c]	250[e]
	g/s	0.186	0.06
SO_2 emission	mg/Nm^3	40[c]	200[e]
	g/s	0.039	0.05
TVOC emission	mg/Nm^3	1000[f]	-
	g/s	0.36	-

Notes: (a) Includes heat recovery from exhaust gas
(b) Actual conditions = 7.6% O_2, 464°C, 1 atm, 11.5% H_2O
(c) Normalised conditions (MCPD) = 15% O_2, 0°C, 1 atm, dry air
(d) based on average of actual volumetric flows from emissions monitoring undertaken at seven similar sized biogas boilers at three Thames Water sites. The range (maximum minus minimum) recorded volumetric flow across the seven sites was $0.1m^3/s$
(e) Normalised conditions (MCPD) = 3% O_2, 0°C, 1 atm, dry air
(f) Normalised conditions = 5% O_2, 0°C, 1 atm, dry air;

3.3 Post processing of results

3.3.1 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 EA's specified generator modelling guidance[29] 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 EA's recommended conversion rates have been used in this assessment.

3.3.2 Assessment of annual mean concentrations

The new CHP engineis proposed to operate for up to 8,322 hours per year with the remaining hours of the year accounted for by periods of downtime and maintenance. The 1.4MWth boiler is expected to operate for 50% of the year when additional heat is required. However, the model has been run assuming continuous operation all year and therefore represents a worst case.

3.3.3 Background/ambient concentrations

Background concentrations, or ambient concentrations (AC), are added to the PCs to determine the PEC at modelled receptors. EA dispersion modelling guidance[30] 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. Therefore, Defra background maps have been used to represent the AC at gridded receptors (see Section 4.3 for more details).

However, the EA specified generator guidance[31] 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. Receptors 6 and 7 are located within approximately 10m of Overthorpe Road and therefore the 2019 NO_2 concentration monitored at Middleton road (a nearby roadside site located at a similar location) has been used to represent the worst-case, long term AC at receptors 6 and 7 for NO_2. The Defra background maps have been used to represent the AC at the remaining discrete receptors, which are located away from busy roads and major industry.

As the concentrations from the background maps and monitoring locations are long-term (annual) average concentrations, short-term background concentrations have been estimated by doubling the long-term background concentrations. This is in accordance with EA risk assessment guidance[32].

3.4 Sensitive receptors

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

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

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

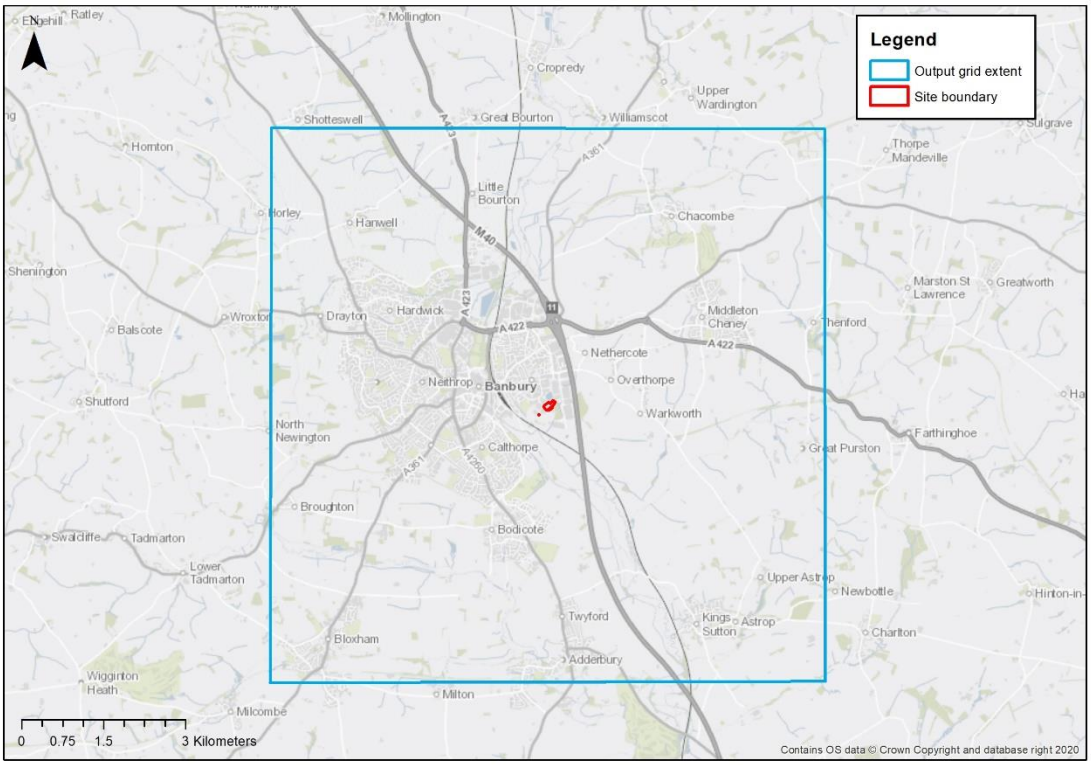
[31] Environment Agency, 2019. Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

[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

3.4.1 Gridded receptors

Pollutant concentrations have been modelled across a Cartesian grid with 20 metre spacing up to 1km from the Site and 100m spacing up to 5km from the Site. The extent of the grid has been presented in Figure 4. 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 4: Gridded receptor model extent



3.4.2 Human health

Eleven discrete human health receptors representing the façades of the closest sensitive receptors (residential properties, commercial properties and recreation areas) have been included within the model so that a comparison against the EQS can be made. Table 6 and Figure 5 show the locations of the discrete receptors considered within this assessment.

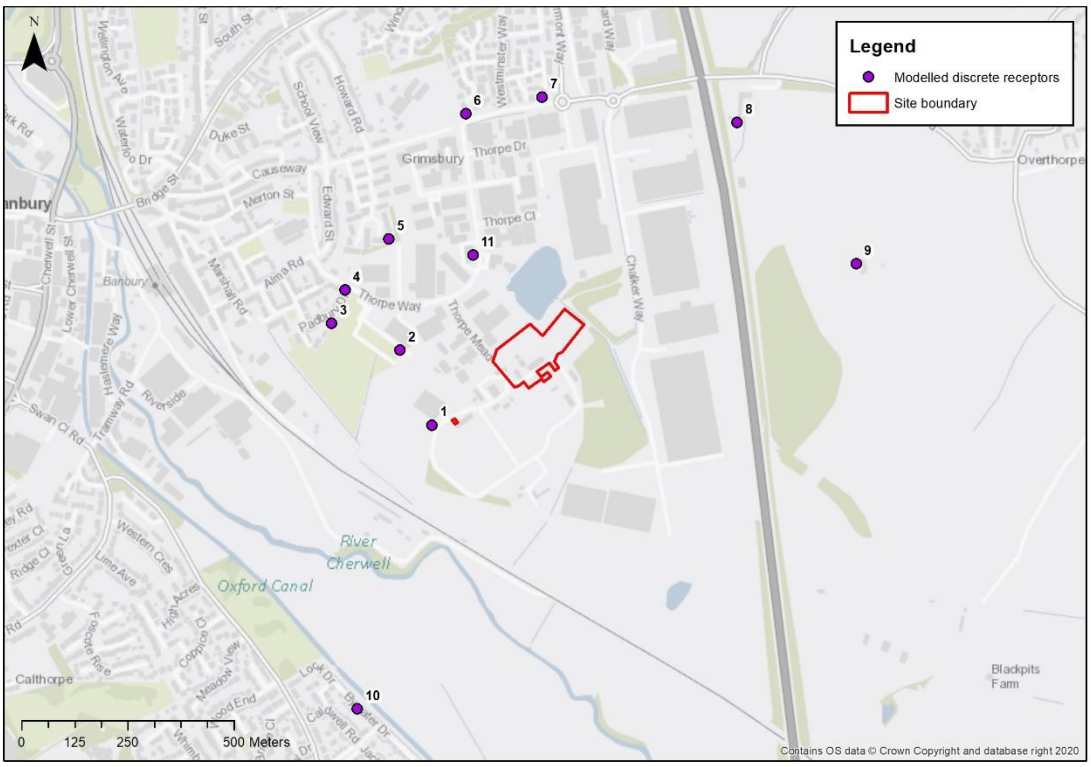
Table 6: Modelled human health receptors

Receptor number	Receptor name	X	Y	Height (m)
1	Recreational land (ST only) [(a)]	446832	240105	1.5
2	Allotment (ST only) [(a)]	446756	240281	1.5
3	Residential - Padbury Drive	446595	240344	1.5
4	Residential - Thorpe Way	446627	240423	1.5
5	Residential - Levenot Close	446730	240543	1.5
6	Residential - Beaulieu Close	446911	240838	1.5
7	Residential - Waltham Gardens	447091	240876	1.5

Receptor number	Receptor name	X	Y	Height (m)
8	The Bowling Green Hotel (ST only) [(a)]	447550	240817	1.5
9	Residential - Warkworth farm	447830	240485	1.5
10	Residential - Bywater Drive	446656	239437	1.5
11	Café (ST only) [(a)]	446928	240505	1.5

Note: (a) Annual objectives would not apply to these receptors, see Table 2 for more details

Figure 5: Modelled human health receptors



3.4.3 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 EA specified generator guidance[33]:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or Ramsar sites within 10km
- Sites of Special Scientific Interest (SSSIs) within 2km.

No SPAs, SACs or Ramsar sites are located within 10km of the Site. Whilst there is a one SSSI located within 2km of the Site (Neithrop Fields Cutting SSSI), this has been designated on geological grounds. Therefore, this SSSI is not considered sensitive to air quality so has not been considered within this assessment. As there are no relevant ecological designated sites

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

within the applicable screening distances, the effects of the Site on ecologically designated receptors has not been considered further within this assessment.

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 EA's air dispersion modelling guidance[34]. Where the PCs do not meet the EA's description of 'insignificant', the PEC is compared against the relevant EQS to establish if this is exceeded, as per the EA risk assessment guidance[35]. Table 7 provides a summary of criteria used to screen out insignificant impacts.

Table 7: 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
Screen out insignificant PECs	Resulting PEC does not exceed the relevant EQS	

Note: PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Ambient Concentration, AC)

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

[35] 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

4 Baseline conditions

4.1 Introduction

Information on air quality within the UK can be obtained from a variety of sources including local authorities, national network monitoring sites and other published sources. The primary sources of data examined in this assessment are from CDC[36] and Defra[37]. The most recent full year of monitoring data available is for 2021. However, data from 2020 and 2021 has the potential to be impacted by effects associated with the coronavirus (Covid-19) pandemic such as a reduction in traffic movements resulting in reduced monitored pollutant concentrations. This effect is demonstrated in Table 8, which shows a large reduction in 2020 and 2021 monitored concentrations relative to the trend between 2017 and 2019. Therefore, 2019 has been used as the most recent year of representative monitored concentrations.

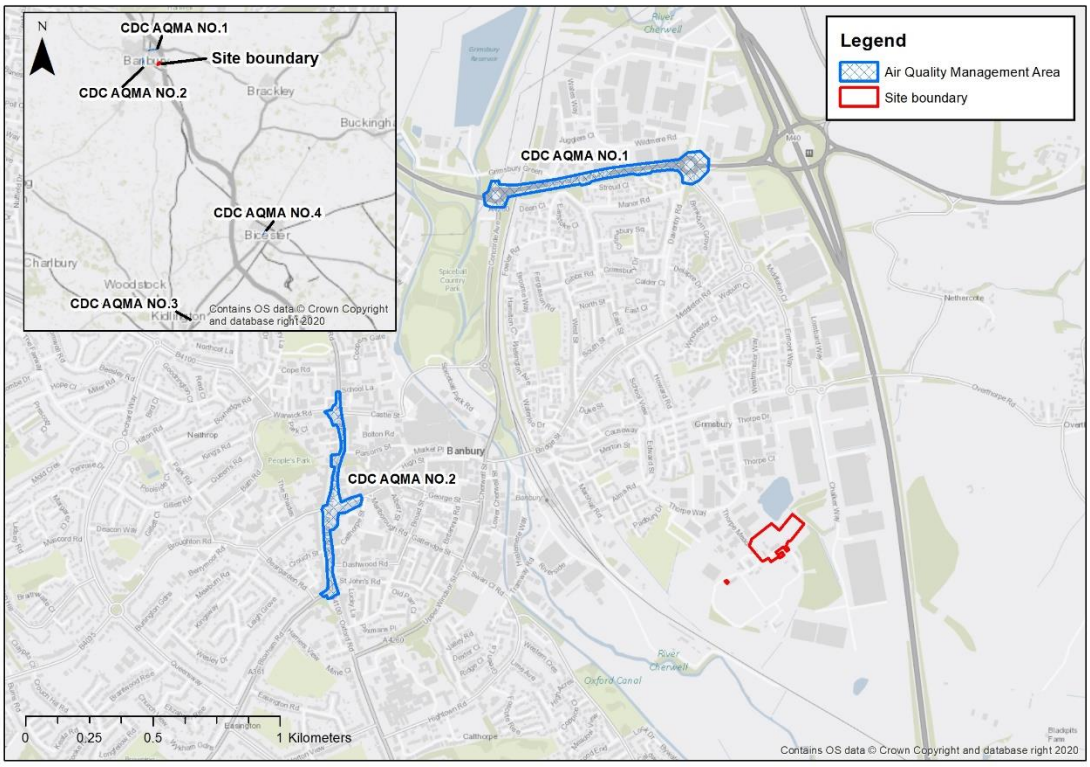
4.2 Review and assessment of air quality in the study area

Four AQMAs have been declared by CDC, one for exceedances of the annual and hourly NO_2 objective and the other three for exceedances of the annual NO_2 objective only. The nearest AQMAs to the Site (CDC AQMA No.1 and No.2) are located approximately 1.3km north west and 1.5km west respectively. The other two AQMAs are located over 20km from the Site. The locations of these AQMAs are presented in Figure 6.

[36] Cherwell District Council, 2022. 2022 Air Quality Annual Status Report.

[37] Department for Environment, Food and Rural Affairs (2023), Monitoring networks. Available at: https://uk-air.defra.gov.uk/networks

Figure 6: AQMAs in the area surrounding the Site



4.2.1 Local authority automatic monitoring

CDC does not undertake any automatic monitoring within the district. Additionally, the closest Automatic Urban Rural Network (AURN) monitoring, operated by Defra, is located over 25km north west of the Site in Royal Leamington Spa and is therefore not considered to be representative of air quality at the Site or nearby receptors.

4.2.2 Local authority diffusion tube monitoring

CDC undertakes diffusion tube monitoring at 42 locations across the district. Table 8 presents the monitoring results at the locations considered representative of the Site and nearby sensitive receptors.

The concentrations monitored at diffusion tubes indicate recent exceedances of the annual NO_2 objective at Horesfair and Hennef Way. Both of these sites are located within AQMAs and exceedances are likely to be attributed to contributions from road traffic. All remaining diffusion tubes identified indicate monitored concentrations below the annual NO_2 objective. Figure 7 present the location of these monitoring sites in relation to the Site.

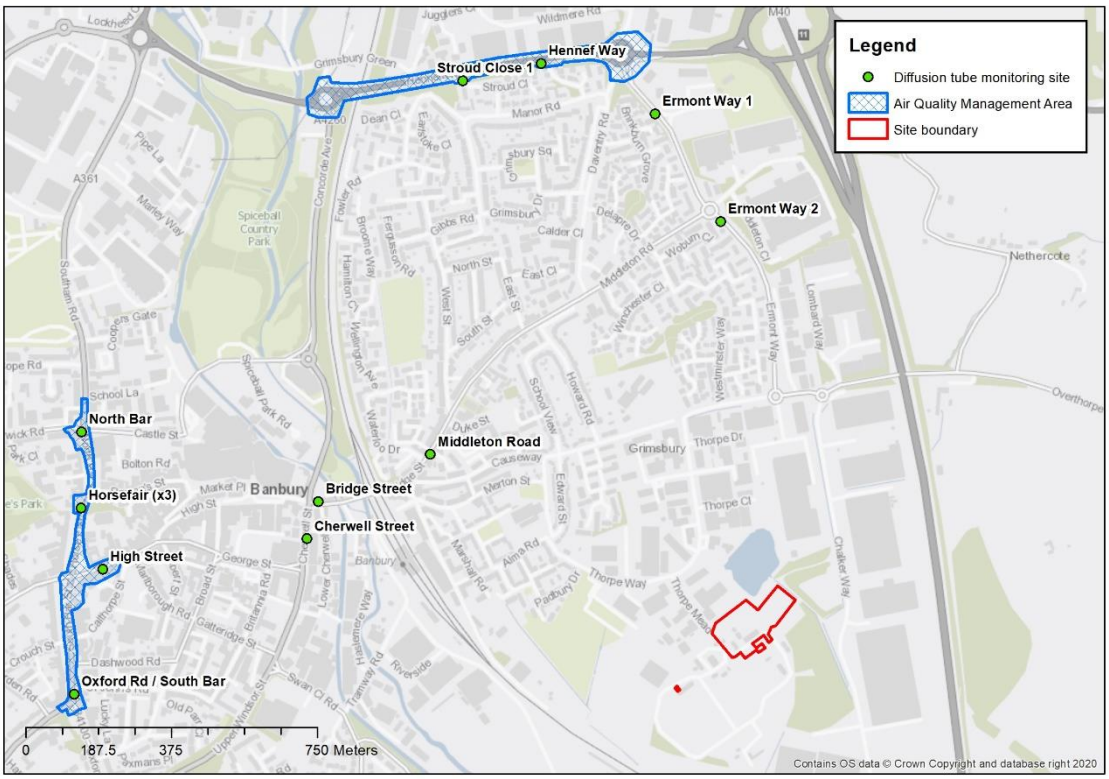
Table 8: Annual mean NO_2 diffusion tube monitoring data

Site Name	AQMA	Site Classification	National Grid Reference		Annual mean NO_2 concentration µg/m^3				
			X	Y	2017	2018	2019	2020	2021
Middleton Road	None	Kerbside	446250	240716	31.3	28.0	30.8	26.5	26.9

Site Name	AQMA	Site Classification	National Grid Reference		Annual mean NO_2 concentration $\mu g/m^3$				
			X	Y	2017	2018	2019	2020	2021
Bridge Street	None	Kerbside	445961	240595	33.1	32.0	32.3	28.2	28.5
Bankside	None	Roadside	446377	239620	17.0	18.8	17.2	14.9	15.1
High Street	AQMA No.2	Kerbside	445407	240421	35.0	32.3	34.6	28.2	28.6
North Bar	AQMA No.2	Kerbside	445352	240774	36.9	34.5	34.0	27.9	28.2
Cherwell Street	None	Roadside	445932	240499	37.3	36.4	29.9	32.4	32.8
Oxford Road/South Bar	AQMA No.2	Kerbside	445333	240100	33.4	36.1	35.3	27.2	27.6
Horesfair (x3)	AQMA No.2	Roadside	445351	240578	**41.8**	38.7	38.6	30.0	30.4
Hennef Way	AQMA No.1	Roadside	446535	241721	**91.6**	**81.2**	**77.5**	**57.9**	**58.6**
Stroud Close 1	AQMA No.1	Roadside	446334	241676	24.9	25.7	23.5	20.8	21.1
Ermont Way 1	None	Roadside	446828	241591	28.5	30.9	28.0	23.7	24.0
Ermont Way 2	None	Roadside	446997	241315	27.2	29.7	27.1	24.1	24.4

Source: Cherwell District Council, 2020. Annual Summary Report June 2020.
Note: Bias adjustment factor is 0.76 in 2019. Results presented in **bold** exceeded the annual mean NO_2 objective of $40\mu g/m^3$.

Figure 7: Nearby monitoring locations



Due to the close proximity and similar surrounding areas of monitoring location 'Middleton Road' to receptors 6 and 7, the 2019 NO_2 concentrations at these monitoring locations have been used to represent the worst-case long-term AC at the modelled receptors (see Section 3.3.3 for details). The remaining receptors are located away from busy roadsides, and therefore the Defra backgrounds have been used to represent the long-term ACs at these receptors (see Section 4.3 below).

4.3 Defra projected background pollutant concentrations

Defra provides estimates of background pollutant concentrations for NOx and NO_2 across the UK for each one-kilometre grid square for every year from 2018 to 2030[38]. Future year projections have been developed from the base year of the background maps, which is currently 2018. The maps include a breakdown of background concentrations by emission source, including road and industrial sources which have been calibrated against 2018 UK monitoring data. Defra also provides estimates of background concentrations for SO_2 and TVOCs (as benzene) across the UK for 2021[39].

The background concentrations for the 1km grid squares containing the Site for the current year of 2023 for NOx and NO_2 and for the most recent year of data available of 2021[40] for SO_2 and

[38] Department for Environment, Food and Rural Affair, Projected background mapping data https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018

[39] Department for Environment, Food and Rural Affairs, Modelled background pollution data, https://uk-air.defra.gov.uk/data/pcm-data

[40] Modelled background concentrations provided by Defra do not take account of changes in emissions caused by Covid-19 restrictions and are therefore still considered representative of existing background concentrations.

TVOCs (as benzene) are presented in Table 9. The data shows background concentrations are all below the relevant objectives.

Table 9: Defra projected annual concentration at the Site (µg/m^3)

1km Grid Square Location (OS Grid Reference)	2023 NO_x (a)	2023 NO_2 (a)	2021 SO_2 (b) (c)	2021 TVOCs (b) (c)
446500,240500	15.9	11.8	2.1	0.4
447500,240500	18.6	13.7	1.4	0.3
446500,239500	12.0	9.2	1.5	0.3
447500,239500	16.4	12.3	1.1	0.3

Source: (a) https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018
(b) https://uk-air.defra.gov.uk/data/pcm-data
(c) 2021 SO_2 and TVOC background concentration data is the latest available.

With the exception of receptors 6 and 7, 2023 NO_2 and NO_X and 2021 SO_2 and VOC Defra background concentrations have been used to represent the long-term AC at gridded and discrete human health receptors (see Section 3.3.3 for details). The concentrations used within the assessment correspond to the background concentrations for the 1km grid square the receptor is located within.

5 Results

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 EA's risk assessment guidance[41], as presented in Table 7, to assess the significance of the air quality impacts from the Site.

It is important to note that for the purpose of modelling, the new CHP engine and the 1.4MWth biogas boiler have been assumed to be operating continuously all year in order to undertake a conservative assessment. It is expected that the biogas boiler would only operate for 50% of the year. Additionally, these results are based on the process contribution from the new CHP and do not account for the removal of emissions from the older/existing CHP engine, which it will replace.

5.1 Gridded receptors

Table 10 presents the maximum NO_2, SO_2 and TVOC PCs at offsite locations across the modelled grid. The annual NO_2 and TVOC PC is greater than 1% of the long term EQS and the 15 minute, hourly and daily NO_2, SO_2 and TVOC PCs are greater than 10% of the short-term EQS. Therefore, these impacts cannot be screened out according to the EA significance criteria[42] so the PECs have been considered.

Table 10: Maximum PCs (µg/m³) – Gridded receptors

Averaging period	Max PC	Max PC as % of EQS	EQS (µg/m³)
NO_2 99.79 %'ile of hourly averages	42.5	**21.3**	200
NO_2 Annual average	6.6	**16.4**	40
SO_2 99.90th %'ile of 15-minute averages	57.3	**21.6**	266
SO_2 99.18th %'ile of 24-hour averages	25.6	**20.4**	125
SO_2 99.73rd %'ile of hourly averages	50.0	**14.3**	350
TVOC Annual average[(a)]	12.7	**254.4**	5
TVOC maximum 24-hour[(a)]	122.2	**407.4**	30

Notes: Values rounded to 1 decimal place
PC = Process Contribution; EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
[(a)] TVOCs as benzene
The results in **bold** are those that cannot be screened out as insignificant according to EA criteria

Table 11 presents the PECs at the locations of the maximum offsite PCs. The maximum NO_2 and SO_2 PECs, when assuming continuous operation all year, are well below the respective EQS so can be screened out as insignificant in accordance with the EA guidance.

[41] 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

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

The maximum annual and 24-hour TVOC PECs are greater than the EQS for benzene at the maximum point of impact offsite. A discussion of the maximum impact and spatial distribution is provided below.

Table 11: Maximum predicted environmental concentrations (PECs) (µg/m³) – Gridded receptors

Averaging period	EQS (µg/m³)	AC (µg/m³)	Max PC	Max PEC (µg/m³)	Max PEC as % of EQS (µg/m³)
NO_2 99.79 %'ile of hourly averages	200	27.4	42.5	69.9	35.0
NO_2 Annual average	40	13.7	6.6	20.3	50.7
SO_2 99.90th %'ile of 15-minute averages	266	2.8	57.3	60.1	22.6
SO_2 99.18th %'ile of 24-hour averages	125	2.8	25.6	28.4	22.7
SO_2 99.73rd %'ile of hourly averages	350	2.8	50.0	52.8	15.1
TVOC Annual average[(a)]	5	0.3	12.7	13.0	**260.4**
TVOC maximum 24-hour[(a)]	30	0.6	122.2	122.8	**409.4**

Notes: [(a)] TVOCs as benzene
Values rounded to 1 decimal place
AC= Ambient Concentration (Defra background concentration: 2023 for NO_2 and SO_2 and 2021 for VOC
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 EA criteria

Figure 8 and Figure 11 present contour plots of the annual and hourly NO_2 and annual and daily TVOC PECs respectively in the worst-case meteorological years. Contour plots for SO_2 are presented in Appendix B. The contours demonstrate that the air quality impacts from the Site are highly localised close to the perimeter of the Site.

The maximum offsite annual NO_2 PECs are found close to the north western boundary of the Site in an inaccessible area of woodland. The maximum hourly NO_2 PECs are found within the wider Banbury Wastewater Treatment Works (WTW) outside of the STW site boundary. There is no relevant public exposure at the locations of maximum offsite impacts and therefore the air quality objectives would not be applicable (see Table 2).

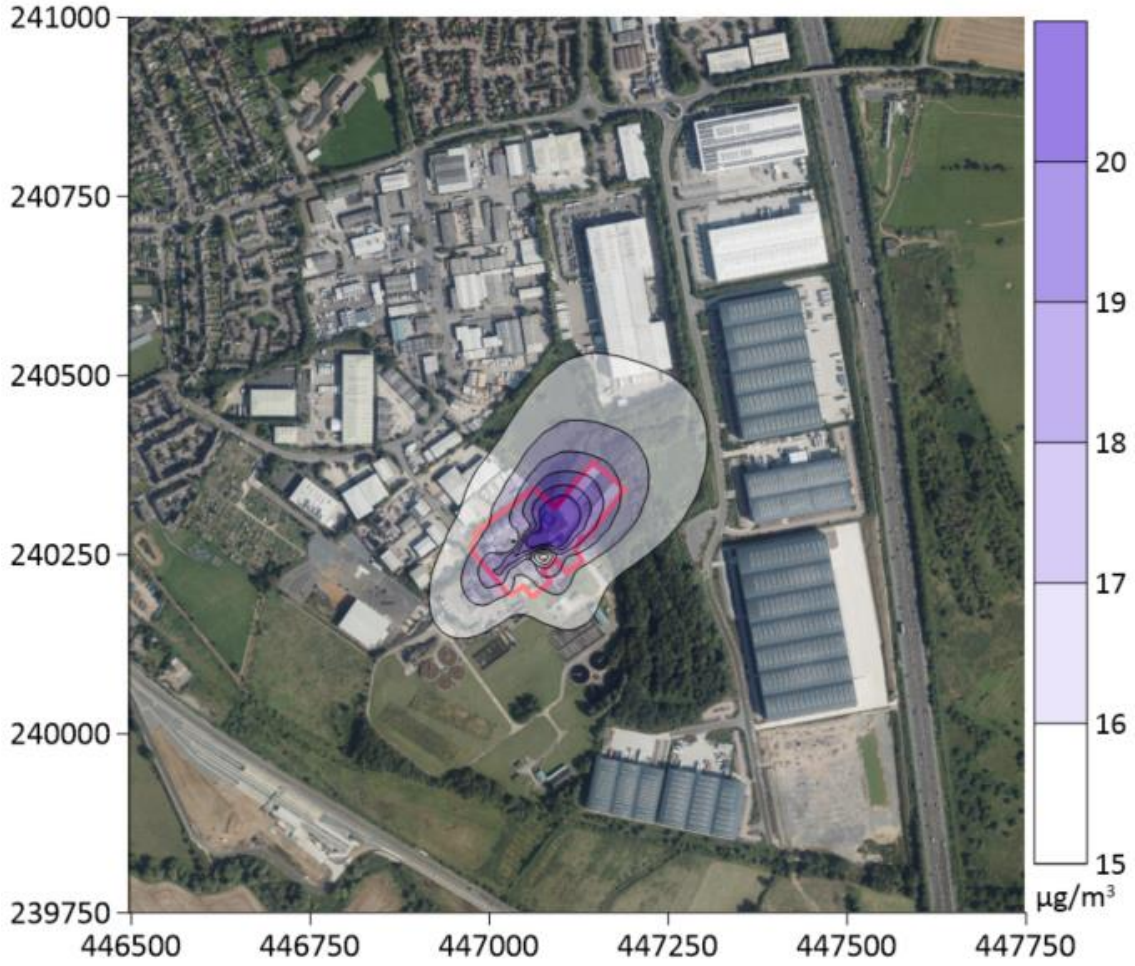
As the maximum PCs are found very close to the Site boundary, the emissions to air from the Site are expected to have de minimis impact on the nearest AQMA (which is approximately 1.3km to the north west). The closest receptor location to CDC AQMA 1 is R6, located approximately 850m closer to the Site than the AQMA and the closest receptor location to CDC AQMA 2 is R3, located approximately 1.1km closer to the Site than the AQMA. As discussed in Section 0, modelled impacts associated with annual and hourly mean NO_2 concentrations at both R3 and R6 are predicted to be insignificant. Impacts at each AQMA are likely to be less than those predicted at R3 and R6 are therefore also likely to be insignificant.

The area where the offsite TVOC PECs exceed the EQS are presented in Figure 10 and Figure 11. These areas are found close to the perimeter of the Site in an area of woodland to the north

and east, on industrial land to the west and within the wider Banbury WTW to the south. At these locations there would be no relevant public exposure and therefore the air quality objectives and EALs would not be applicable (see Table 2).

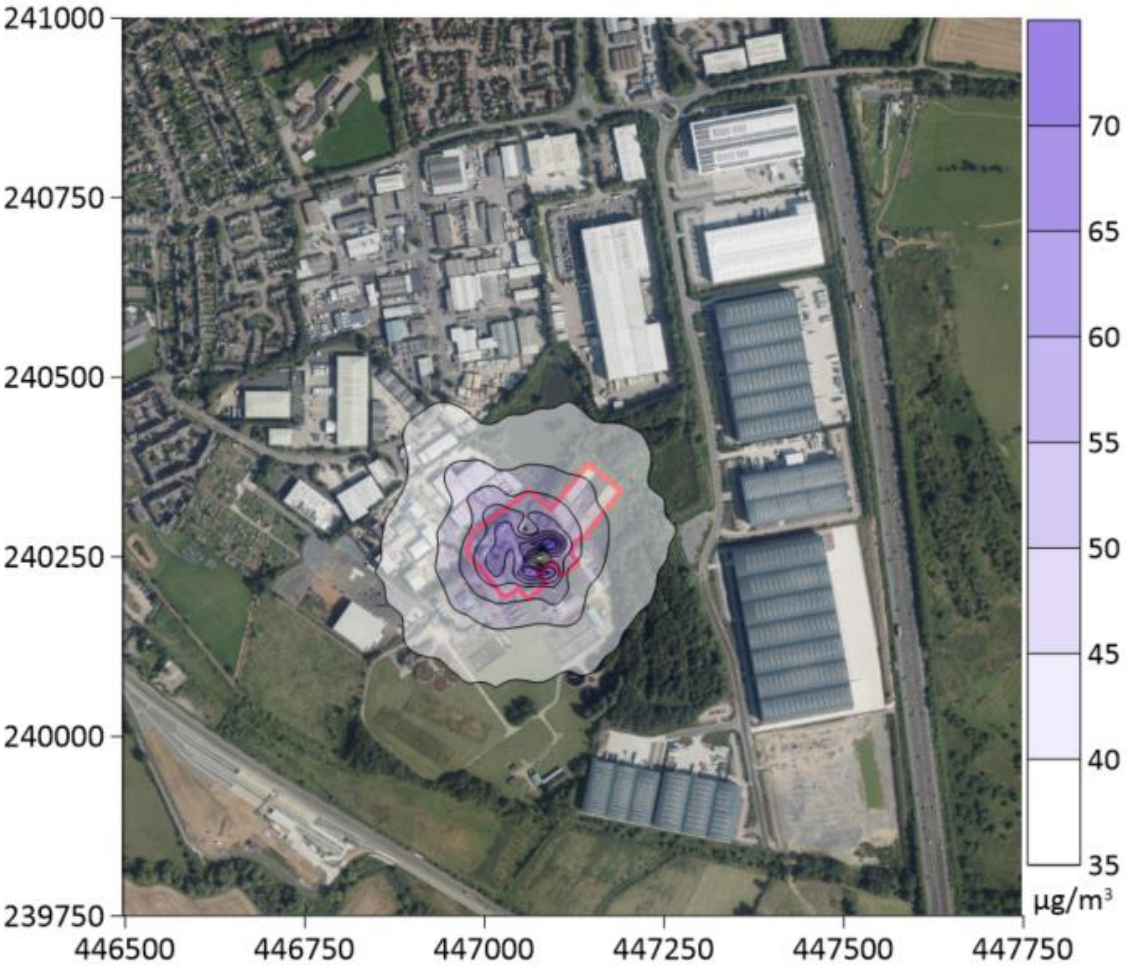
Therefore, as demonstrated by the concentrations modelled and the locations of the maximum NO_2 and TVOC concentrations, the impact at gridded receptors is considered insignificant with respect to NO_2, SO_2 and TVOC concentrations.

Figure 8: Annual mean NO_2 PEC (µg/m^3)



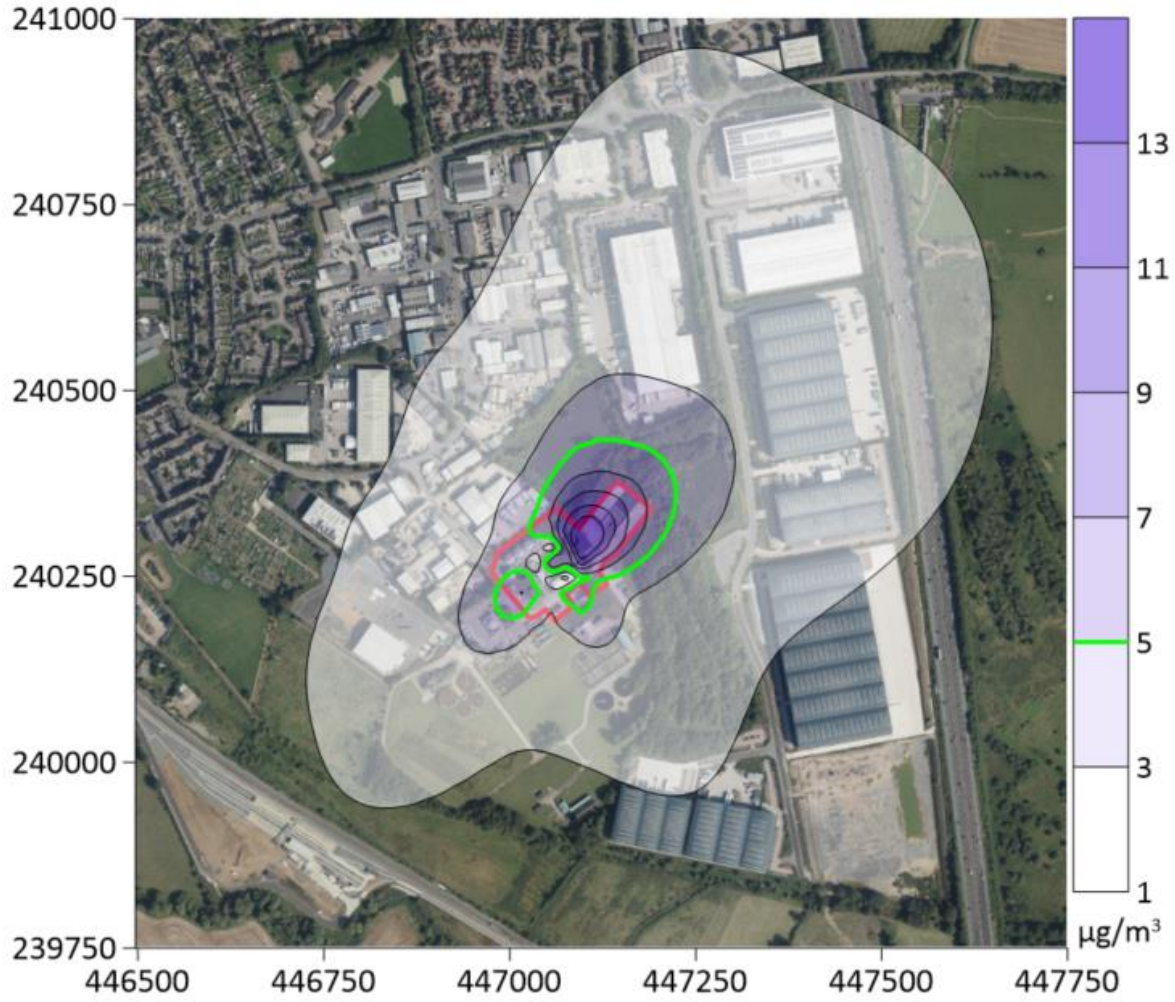
Note: Results presented for the worst case meteorological year of 2020. Contour interval = 1µg/m^3. Minimum contour = 15µg/m^3, maximum contour = 20µg/m^3. Site boundary outlined in red. 2023 Defra background concentrations have been assumed for the ambient concentrations for all gridded receptors.

Figure 9: Hourly mean NO_2 PEC (99.79th %ile) (µg/m³)



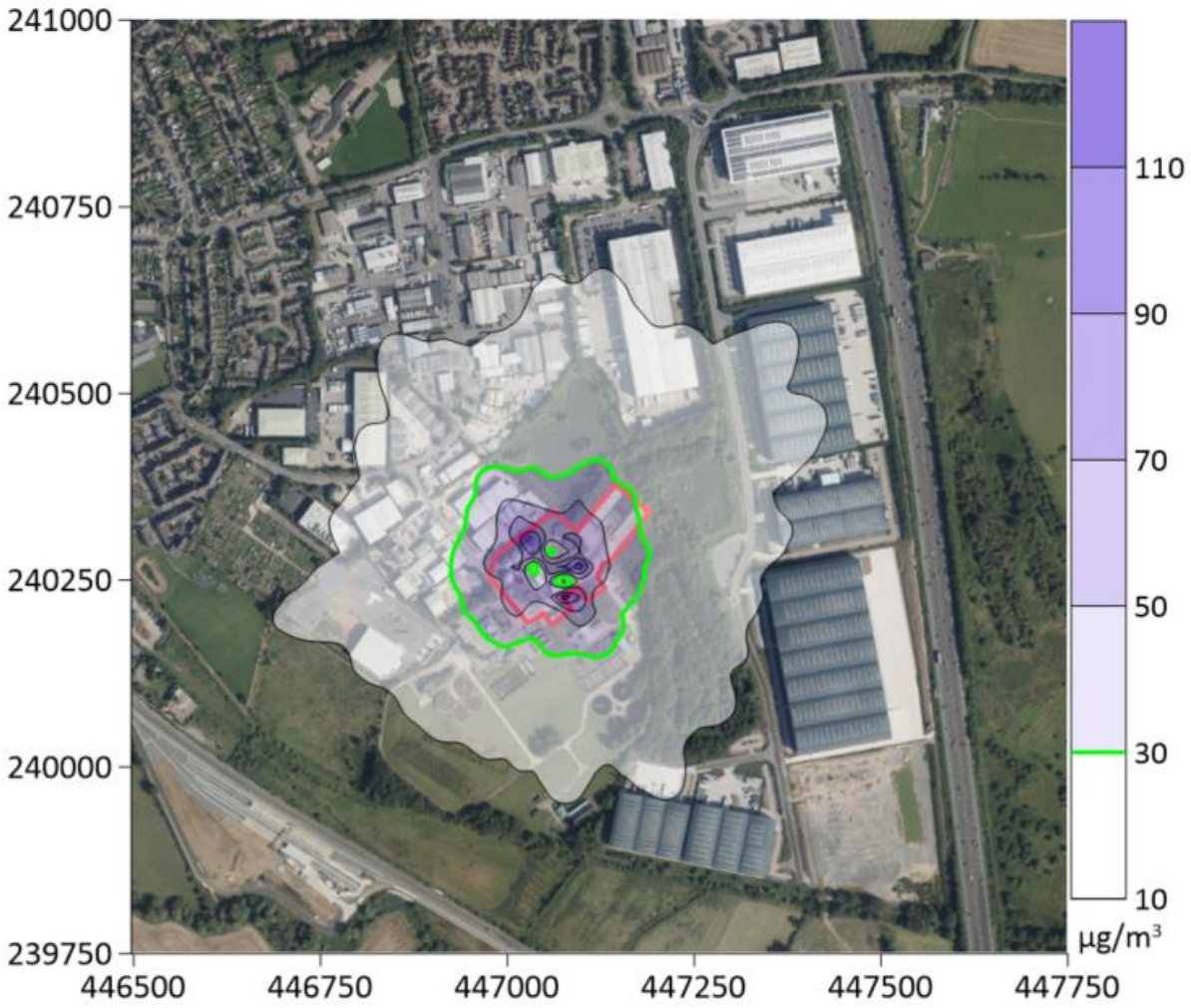
Note: Results presented for the worst case meteorological year of 2018. Contour interval = 5µg/m³. Minimum contour= 35µg/m³, maximum contour = 70µg/m³. Site boundary outlined in red. 2023 Defra background concentrations (multiplied by 2 to represent short-term backgrounds) have been assumed for the ambient concentrations for all gridded receptors.

Figure 10: Annual mean VOC PEC (µg/m³)



Note: Results presented for the worst case meteorological year of 2020. Contour interval = 2µg/m³. Minimum contour = 1µg/m³, maximum contour = 13µg/m³. Site boundary outlined in red. EQS outlined in green. 2021 Defra background concentrations have been assumed for the ambient concentrations for all gridded receptors.

Figure 11: Daily mean (24-hour max) VOC PEC (100th %ile) (µg/m³)



Note: Results presented for the worst case meteorological year of 2017. Contour interval = 20µg/m³. Minimum contour= 10µg/m³, maximum contour = 115µg/m³. Site boundary outlined in red. EQS outlined in green. 2021 Defra background concentrations (multiplied by 2 to represent short-term backgrounds) have been assumed for the ambient concentrations for all gridded receptors.

5.2 Human health discrete receptors

The NO_2, SO_2 and TVOC PCs and PECs at the discrete human health receptors are summarised in Table 12 and Table 13. The maximum hourly NO_2 (100th percentile) PC and PECs have been presented in Appendix A.

The largest conservative predicted process contributions are located at:

- receptor 11 (a café located approximately 200m north west of the Site) for hourly NO_2, 24-hour TVOC concentrations
- receptor 7 (a residential property at Waltham Gardens, located approximately 500m north of the Site) for annual NO_2 and TVOC concentrations

- receptor 1 (recreation land approximately 300m south west of the Site) for 15-minute and hourly SO_2

No exceedances of the NO_2, SO_2 or TVOC (as benzene) EQS are predicted at discrete receptors as a result of modelled emissions from the Site.

In accordance with EA risk assessment guidance[43], the short term mean NO_2 and SO_2 PCs at all modelled human health receptors are below 10% of the EQS and therefore can be screened out as insignificant. Therefore, the short-term impact at human health receptors are considered insignificant with respect to NO_2 and SO_2 concentrations.

For the annual mean NO_2, PCs are less than 1% of the EQS at all modelled receptors, as shown in Table 13, therefore the impact of the Site on human health receptors is also considered insignificant for annual mean NO_2.

For TVOCs, the PCs are greater than 10% of the 24-hour EQS and greater than 1% of the annual EQS so PCs cannot be considered insignificant. However, when assuming continuous operation all year, short-term and long-term PECs are well below the respective EQS so can be screened out as insignificant in accordance with the EA risk assessment guidance[43].

Table 12: Hourly NO_2 (99.79th %ile) PCs and PECs (µg/m^3) at discrete human health receptors

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1	6.1	200	3.0	23.6	29.7	14.8
2	5.5	200	2.8	23.6	29.1	14.6
3	3.6	200	1.8	23.6	27.2	13.6
4	3.5	200	1.7	23.6	27.1	13.5
5	3.8	200	1.9	23.6	27.4	13.7
6	2.9	200	1.4	61.6	64.5	32.2
7	2.8	200	1.4	61.6	64.4	32.2
8	2.4	200	1.2	27.4	29.8	14.9
9	2.0	200	1.0	27.4	29.4	14.7
10	1.6	200	0.8	18.4	20.0	10.0
11	6.4	200	3.2	23.6	30.0	15.0

Notes: AC= Ambient Concentration (based on the 2023 Defra background concentrations at all receptors except Receptors 6 and 7, which are based on the 2019 concentration monitored at Middleton Road); PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

Table 13: Annual NO_2 PCs and PECs (µg/m^3) at discrete human health receptors

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1 [(a)]	-	-	-	-	-	-
2 [(a)]	-	-	-	-	-	-
3	0.2	40	0.5	11.8	12.0	30.0
4	0.2	40	0.6	11.8	12.0	30.1
5	0.3	40	0.7	11.8	12.1	30.2
6	0.3	40	0.7	30.8	31.1	77.7

[43] 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

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
7	0.4	40	0.9	30.8	31.2	77.9
8 [(a)]	-	-	-	-	-	-
9	0.2	40	0.6	13.7	13.9	34.8
10	0.1	40	0.2	9.2	9.3	23.2
11 [(a)]	-	-	-	-	-	-

Notes: AC= Ambient Concentration (based on the 2023 Defra background concentrations at all receptors except Receptors 6 and 7, which are based on the 2019 concentration monitored at Middleton Road); PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard (a) annual objective would not apply at these locations and therefore have not been presented

Table 14: 15-minute mean SO_2 (99.90th %ile) PCs and PECs (µg/m^3) at discrete human health receptors

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1	11.5	266	4.3	4.2	15.7	5.9
2	10.0	266	3.8	4.2	14.2	5.3
3	6.6	266	2.5	4.2	10.8	4.1
4	6.3	266	2.4	4.2	10.5	4.0
5	6.4	266	2.4	4.2	10.6	4.0
6	5.0	266	1.9	4.2	9.2	3.5
7	4.9	266	1.8	2.8	7.7	2.9
8	3.9	266	1.5	2.8	6.7	2.5
9	3.3	266	1.2	2.8	6.1	2.3
10	3.1	266	1.2	3.0	6.1	2.3
11	10.3	266	3.9	4.2	14.5	5.5

Notes: AC= Ambient Concentration (based on the 2021 Defra background concentrations at all receptors); PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

Table 15: 24-hour mean SO_2 (99.18th %ile) PCs and PECs (µg/m^3) at discrete human health receptors

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1	3.2	125	2.5	4.2	7.4	5.9
2	3.0	125	2.4	4.2	7.2	5.7
3	1.5	125	1.2	4.2	5.7	4.6
4	1.3	125	1.1	4.2	5.5	4.4
5	1.6	125	1.2	4.2	5.8	4.6
6	1.4	125	1.1	4.2	5.6	4.5
7	1.5	125	1.2	2.8	4.3	3.5
8	1.1	125	0.9	2.8	3.9	3.1
9	0.7	125	0.6	2.8	3.5	2.8
10	0.6	125	0.5	3.0	3.6	2.9
11	3.6	125	2.9	4.2	7.8	6.2

Notes: AC= Ambient Concentration (based on the 2021 Defra background concentrations at all receptors); PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

Table 16: 1-hourly mean SO_2 (99.73rd %ile) PCs and PECs (µg/m³) at discrete human health receptors

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1	7.5	350	2.1	4.2	11.7	3.3
2	6.7	350	1.9	4.2	10.9	3.1
3	4.0	350	1.1	4.2	8.2	2.3
4	3.7	350	1.1	4.2	7.9	2.3
5	4.1	350	1.2	4.2	8.3	2.4
6	3.2	350	0.9	4.2	7.4	2.1
7	3.0	350	0.9	2.8	5.8	1.7
8	2.5	350	0.7	2.8	5.3	1.5
9	2.0	350	0.6	2.8	4.8	1.4
10	1.7	350	0.5	3.0	4.7	1.3
11	7.3	350	2.1	4.2	11.5	3.3

Notes: AC= Ambient Concentration (based on the 2021 Defra background concentrations at all receptors); PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

Table 17: 24-hour TVOC (100th %ile) PCs and PECs (µg/m³) at discrete human health receptors

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1	13.9	30	46.4	0.8	14.7	49.1
2	12.1	30	40.2	0.8	12.9	42.9
3	6.7	30	22.4	0.8	7.5	25.1
4	7.3	30	24.3	0.8	8.1	27.0
5	8.3	30	27.8	0.8	9.1	30.5
6	5.4	30	18.1	0.8	6.2	20.7
7	6.1	30	20.2	0.6	6.7	22.2
8	5.2	30	17.2	0.6	5.8	19.2
9	3.9	30	13.0	0.6	4.5	15.0
10	2.5	30	8.4	0.6	3.1	10.4
11	18.3	30	61.0	0.8	19.1	63.7

Notes: AC= Ambient Concentration (based on the 2021 Defra background concentrations at all receptors); PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard;

Table 18: Annual TVOC PCs and PECs (µg/m³) at discrete human health receptors

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1 [(a)]	-	-	-	-	-	-
2 [(a)]	-	-	-	-	-	-
3	0.4	5	8.0	0.4	0.8	16.0
4	0.5	5	10.0	0.4	0.9	18.0
5	0.6	5	12.0	0.4	1.0	20.0
6	0.5	5	10.0	0.4	0.9	18.0
7	0.7	5	14.0	0.3	1.0	20.0
8 [(a)]	-	-	-	-	-	-
9	0.5	5	10.0	0.3	0.8	16.0

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
10	0.2	5	4.0	0.3	0.5	10.0
11 [(a)]	-	-	-	-	-	-

Notes: AC= Ambient Concentration (based on the 2021 Defra background concentrations at all receptors; PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard; (a) annual objective would not apply at these locations and therefore have not been presented.

6 Conclusions

An assessment has been undertaken to determine the effect on air quality associated with emissions from the new CHP engine/existing boiler using advanced dispersion modelling. For gridded and human health receptors, the emissions of NO_2, SO_2 and TVOCs have been considered in accordance with EA guidance. The method of the assessment has taken a conservative approach by assuming worst-case conditions for factors such as emission characteristics, the operating envelope and meteorological conditions.

No exceedances of the EQS are predicted as a result of the operation of the new CHP engine and existing boiler at locations of relevant public exposure. The air quality effects are highly localised and the impact at sensitive human health receptors is insignificant in accordance with EA guidance. The Site is not considered to conflict with the relevant air quality regulations.

Appendices

A. Maximum hourly NO_2 PECs

In accordance with the EA specified generator guidance[44], the maximum hourly (100th %ile) PECs have been presented in Table 19. There is no EQS for this averaging period and therefore significance cannot be commented upon, however the maximum hourly NO_2 PEC is predicted to remain below the hourly NO_2 EQS, which is from the 99.79th percentile of values.

Table 19: Hourly max NO_2 (100th %ile) PCs and PECs (µg/m³) at discrete human health receptors

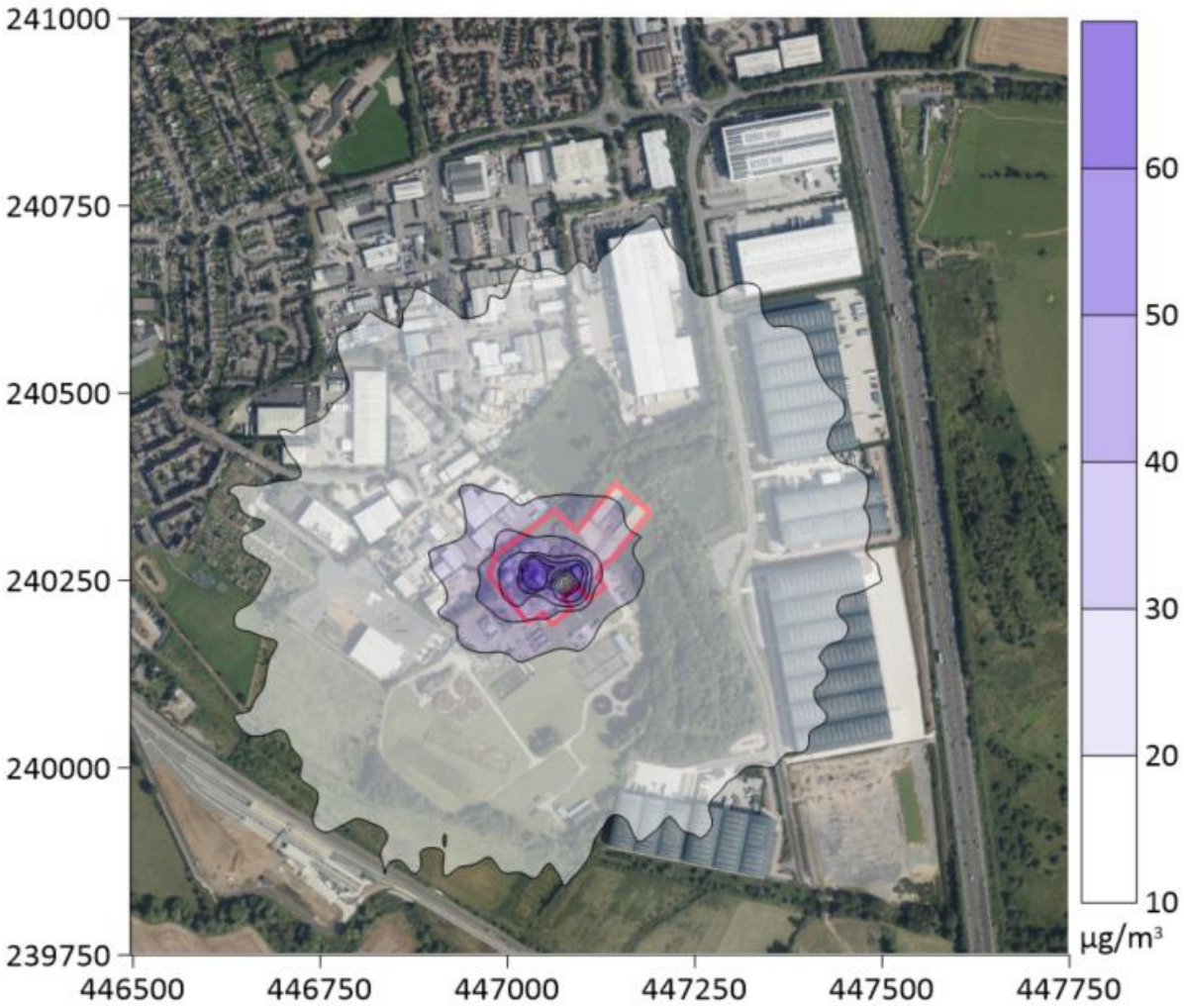
Receptor	Max PC	AC	Max PEC
1	22.2	23.7	45.9
2	19.1	23.7	42.8
3	13.4	23.7	37.1
4	14.5	23.7	38.2
5	14.5	23.7	38.2
6	9.5	61.6	71.1
7	9.0	61.6	70.6
8	8.3	27.4	35.7
9	6.6	27.4	34.0
10	6.2	18.4	24.6
11	22.3	23.7	46.0

Notes: AC= Ambient Concentration (based on the 2023 Defra background concentrations at all receptors except Receptors 6 and 7, which are based on the 2019 concentration monitored at Middleton Road); PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

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

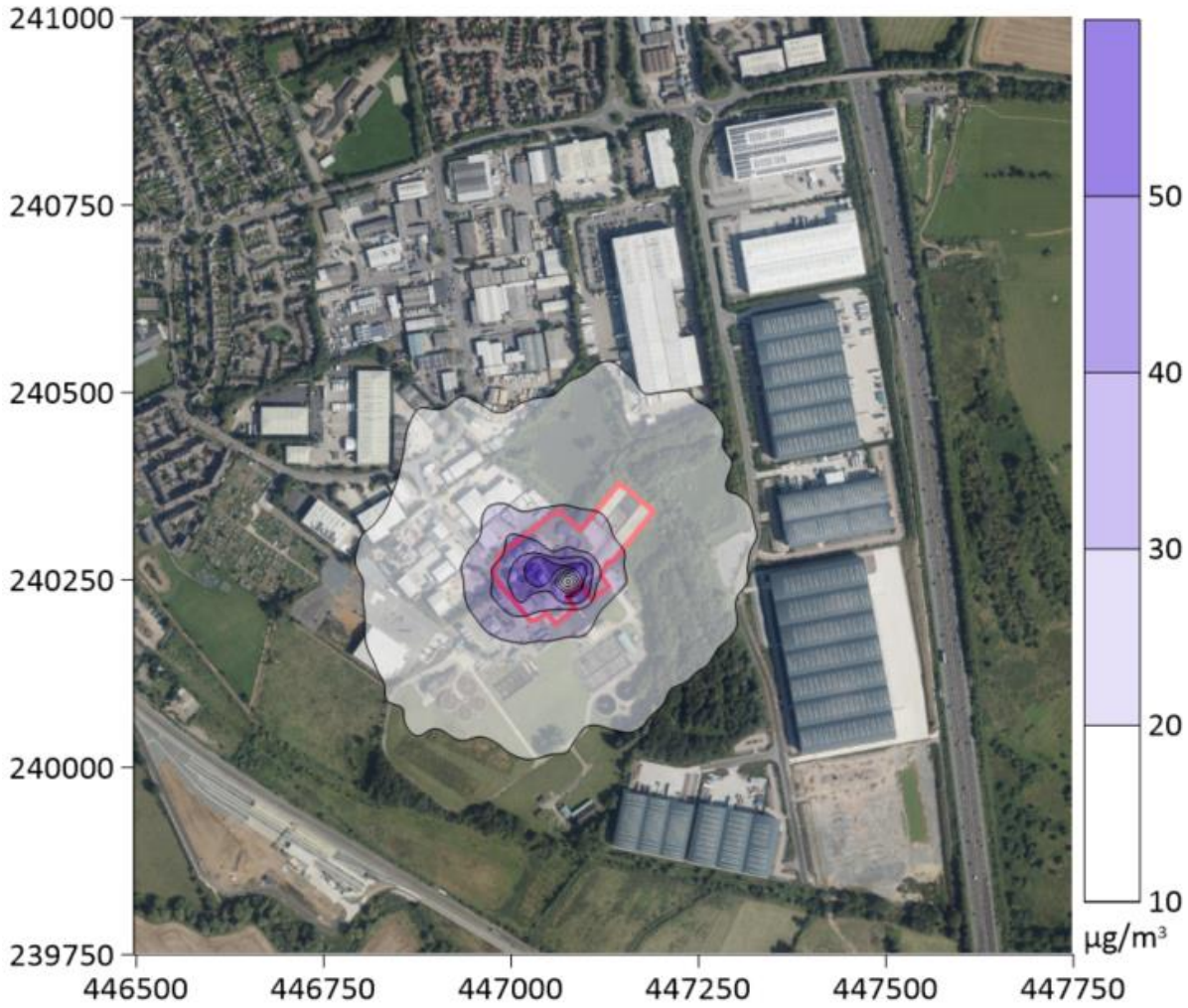
B. SO_2 contour plots

Figure B.1: 15-minute SO_2 PEC (99.9th %ile) (µg/m^3)



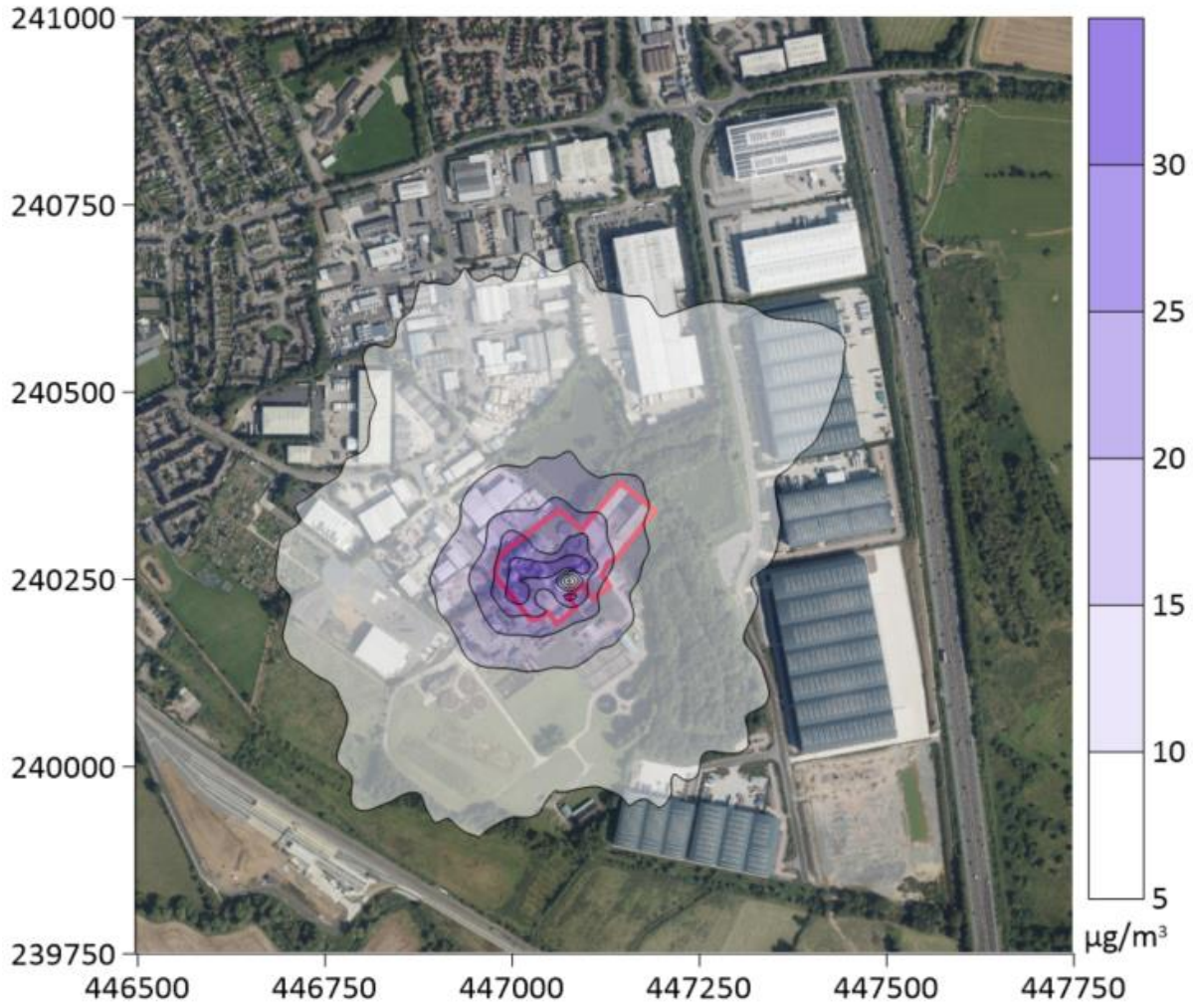
Note: Results presented for the worst case meteorological year of 2020. Contour interval = 10µg/m³. Minimum contour= 10µg/m^3, maximum contour = 60µg/m^3. Site boundary outlined in red. 2021 Defra background concentrations (multiplied by 2 to represent short-term backgrounds) have been assumed for the ambient concentrations for all gridded receptors.

Figure B.2: Hourly mean SO_2 PEC (99.73rd %ile) (µg/m³)



Note: Results presented for the worst case meteorological year of 2020. Contour interval = 10µg/m³. Minimum contour= 10µg/m³, maximum contour = 50µg/m³. Site boundary outlined in red. 2021 Defra background concentrations (multiplied by 2 to represent short-term backgrounds) have been assumed for the ambient concentrations for all gridded receptors.

Figure B.3: Daily mean SO_2 PEC (99.18th %ile) (µg/m^3)



Note: Results presented for the worst case meteorological year of 2016. Contour interval = 5µg/m³. Minimum contour= 5µg/m³, maximum contour = 30µg/m³. Site boundary outlined in red. 2021 Defra background concentrations (multiplied by 2 to represent short-term backgrounds) have been assumed for the ambient concentrations for all gridded receptors.