Queensferry

Air quality assessment to accompany permit application

4 November 2024

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1 Introduction

1.1 Overview

Dŵr Cymru Welsh Water (DCWW) is applying to Natural Resource Wales (NRW) for a new bespoke environmental permit to operate their sludge treatment facility at the Queensferry wastewater treatment works (WwTW) ('the Site'). Sludge treatment activities are covered by the Environmental Permitting Regulations (EPR) 2016[1], which incorporates the application of the Industrial Emissions Directive (IED)[2].

The Site does not currently hold an Environmental Permit under the EPR 2016 for sludge treatment activities. Following the joint NRW/Environment Agency and Defra decision that anaerobic digestion treatment facilities at WwTWs and sludge treatment centres (STCs) are covered by the Industrial Emissions Directive (IED), the intent of this application is to ensure the Site is permitted in line with the IED and the EPR 2016, as amended.

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. The assessment has been undertaken in accordance with current Environment Agency (EA) guidance, as detailed in Section 2.4.

1.2 Site description

The Site treats imported and indigenous sludge and currently consists of:

- A 0.493 megawatt thermal (MWth) input combined heat and power (CHP) plant (Ener-G gas engine) which combusts the biogas produced by the digesters during anaerobic digestion to generate heat and electricity.
- Three 0.39 MWth input dual fuel boilers (P5M 50G). Two of the boilers operate on biogas and will run continuously to combust the biogas produced by the digesters during anaerobic digestion to generate heat. The third boiler can operate on biogas or gas oil and will be used to provide hot water for the digestion process. Gas oil would only be used in emergencies when biogas is not available, which would be an infrequent occurrence.
- A flare, which is used during emergencies to combust excess biogas that cannot be stored in the gas bag holder.
- A 0.7MWth diesel standby generator (Cummins KTA2300G). This will only be used for emergencies when there is a mains power outage on site and for testing, which are likely to occur less than 50 hours per year. Therefore, emissions from the diesel standby generator are considered to be infrequent and for very short periods and have not been considered further in this assessment.

1.3 Site location

The Site, which is owned and operated by DCWW, is located in Deeside within the administrative area of Flintshire County Council (FCC). The Site is located in the Queensferry Industrial Estate and is bounded by a Riverside Travellers Site (residential use) to the north, industrial land use to the east and south and the A494 to its west. Beyond the immediate vicinity

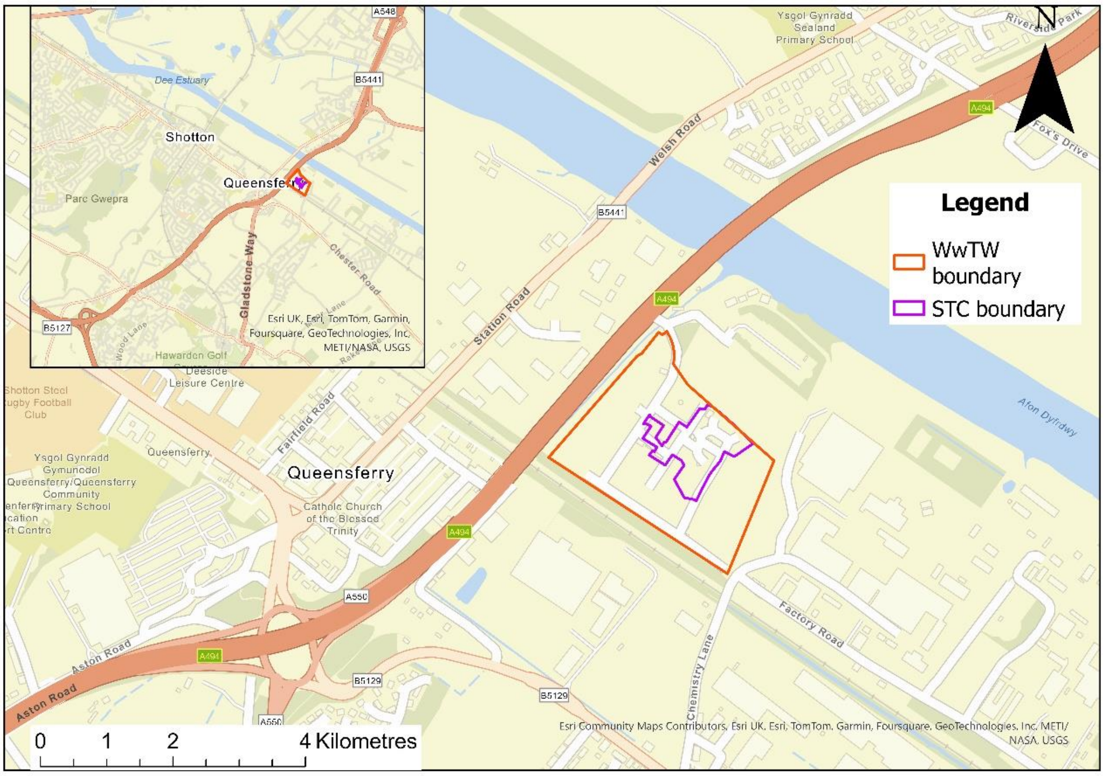
[1] Statutory Instrument (2016) The Environmental Permitting (England and Wales) Regulations 2016

[2] The European Parliament and the Council of the European Union (2010) Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

of the Site there is the River Dee to the north, residential properties to the south west, additional industrial properties to the west and an Army Reserve Centre to the north west.

The nearest human health receptor to the Site, which is an industrial property, is located approximately 90m to the east. The closest residential receptor to the Site is the Riverside Travellers Site located approximately 120m to the north. Figure 1.1 shows the location of the WwTW 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 that will be used on the Site will be 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 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 (CH_4). 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.

1.4.3 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.

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 Wales

The European Union Directive on ambient air quality and cleaner air for Europe (2008/50/EC)[3] sets legally binding limits for pollutant concentrations. This directive was made law in the Wales through The Air Quality Standards (Wales) Regulations 2010[4] (amended by The Air Quality Standards (Wales) (Amendment) (EU Exit) Regulations 2019[5] and the Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020[6]).

This Directive defines limit values and times by which they are to be achieved for the purpose of protecting human health and the environment by avoiding, reducing or preventing harmful concentrations of air pollutants. The Limit Values within the Directive are intended to apply everywhere with the exception of:

- Any locations situated within areas where members of the public do not have access and there is no fixed habitation.
- 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.
- On the carriageway of roads.
- On the central reservations of roads except where there is normally pedestrian access to the central reservation.

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, including predictions of likely future air quality. The air quality objectives specifically for use by local authorities in carrying out their air quality management duties are set out in The Air Quality (Wales) Regulations 2000[9] and The Air Quality (Wales) (Amendment) Regulations 2002[10]. In most cases, the air quality objectives are set at the same pollutant concentrations as the limit values transposed into UK law although compliance dates differ.

As part of the review of air quality, the local authority must assess whether air quality objectives are being achieved or are likely to be achieved within the relevant periods and identify the relevant sources of emissions it considers responsible for the failure to achieve the objectives. Any parts of a local authority’s area where the objectives are not being achieved or are not likely to be achieved within the relevant period must be identified and declared as an Air Quality

[3] The European Parliament and the Council of the European Union (2008) Directive 2008/50/EC of the European Parliament and of the Council

[4] Statutory Instrument (2010) The Air Quality Standards (Wales) Regulations

[5] Statutory Instrument (2019) The Air Quality Standards (Wales) (Amendment) (EU Exit) Regulations

[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) The Air Quality (Wales) Regulations, No. 1940 (W.138).

[10] Statutory Instrument (2002) The Air Quality (Amendment) (Wales) Regulations, No. 3182 (W.298).

Management Area (AQMA). Once such a declaration has been made, local authorities are under a duty to prepare an Action Plan which sets out measures to pursue the achievement of the air quality objectives within the AQMA.

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 AQS, first adopted in 1997[11] and its subsequent iterations, have now been superseded as of the 14th January 2019 with the Clean Air Strategy 2019 (CAS). [12]

The CAS does not set legally binding objectives, the CAS instead has targets for reducing total UK emissions of NOx and fine particulate matter ($PM_{2.5}$) from sectors such as road transport, domestic sources and construction plant (non-road mobile machinery (NRMM).

Further to this, the UK Government has produced a draft AQS revision in 2023. This revision replaces the 2007 strategy and compliments the 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, including their two new long-term $PM_{2.5}$ targets. The AQS does not mention local authorities in Wales and as such the long-term $PM_{2.5}$ targets currently only apply to England. Therefore, the revised draft AQS and new targets are not applicable to this project at the time of writing. However, the Environment (Air Quality and Soundscapes) (Wales) Act 2024[13] became law in Wales on 14th February 2024 to make provision for improving air quality. The Act requires Welsh Ministers to set a $PM_{2.5}$ air quality target within three years of this date. The Welsh Government have also published their own 'Clean Air Plan' for Wales in 2019 to provide a framework and actions for air quality improvements within Wales.

2.3 Permitting requirements and associated guidance

2.4 Overview

The Medium Combustion Plant Directive (MCPD) (Directive 2015/2193) [14] regulates emissions of NOx into the air from combustion plants with a rated thermal input equal to or greater than 1 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 or meet additional emission limits.

[11] 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.

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

[13] Acts of Senedd Cymru (2024) Environment (Air Quality and Soundscapes) (Wales) Act 2024

[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

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]

2.4.1 Permitting requirements at the Site

DCWW is applying for a new IED permit for the Site with associated Medium Combustion Plant (MCP) activities. The Site does not currently hold an Environmental Permit under the EPR 2016 for sludge treatment activities. The intent of the application is to ensure the Site is permitted in line with the IED and the EPR 2016, as amended.

None of the plant onsite are classified as an MCP; the three boilers each have a thermal capacity of 0.39MWth and were commissioned in 1993, the CHP has a thermal input of 0.493MWth and was first commissioned in 2004 with refurbishment in 2024, whilst the diesel standby generator has a thermal capacity of 0.7MWth and was commissioned in 1981. Therefore, the plant is not required to meet the ELVs set out in the MCPD. However, for the purposes of the assessment, the ELVs have been used to demonstrate achievable levels of emissions for the combustion plant and are outlined below:

- ELVs of 250mg/Nm^3 for NO_x and 200mg/Nm^3 for SO_2 for existing (operational before 20 December 2018) medium combustion plant (MCP) operating on biogas (3% O_2, 0°C, dry).
- ELV of 200mg/Nm^3 for NO_x for existing MCP operating on gas oil (3% O_2, 0°C, dry).
- There is no ELV for SO_2 for existing MCP boilers operating on gas oil given that the fuel used would have an ultra-low sulphur content. Therefore, the modelled SO_2 emissions for the gas oil boiler are based on the results of the emissions monitoring assessment carried out in August 2023 when the boiler was operating on gas oil.
- ELV of 190mg/Nm^3 for NOx and 60mg/Nm^3 for SO_2 at 15% O_2 for CHP operating on biogas. This is equivalent to 500 mg/Nm^3 at 5% O_2, which the manufacturer datasheet states the CHP would meet.
- Actual emissions of VOCs are dependent on the biogas specification which is subject to variation and there is no ELV specified within the MCPD. Therefore, total volatile organic compounds (TVOCs) have been modelled assuming an indicative emissions concentration of 1000mg/Nm^3 (5% O_2, 0°C, dry) from the CHP plant based on the Environmental Permitting (England & Wales) Regulations 2016 – Chapter 4 Standard rules SR2021 No 10[21]. TVOC emissions from the boilers are minimal and have not been considered.

[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).

[21] 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

The results of the emissions monitoring undertaken at the three boilers to date also demonstrate compliance with the MCPD ELVs.

The Environment Agency's 'Medium combustion plant: when you need a permit'[22] guidance states that 'MCPD controls do not apply to flares for disposal of waste gases as flares are not classed as MCP. Therefore, NOx, SO_2 and VOC emissions associated with the flare are assessed using emissions limits specified in LFTGN 05[23].

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 EA's risk assessment guidance[24] 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[25] (APIS).

Air quality limit values and objectives

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

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

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

Notes: pcy = per calendar year

The limit values apply everywhere with the exception of:

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

[22] Environment Agency, 'Medium Combustion Plant: When you need a permit' available at https://www.gov.uk/guidance/medium-combustion-plant-when-you-need-a-permit

[23] Environment Agency, Guidance for monitoring enclosed landfill gas flares (LFTGN05 V2 2010) available at https://www.gov.uk/government/publications/monitoring-enclosed-landfill-gas-flares-lftgn-05

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

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

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.

The EQS 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 EA risk assessment guidance[26] provides further assessment criteria in the form of Environmental Assessment Levels (EALs). The EALs cover a wide range of pollutants and specify target values for the protection of human 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 conservation areas

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 (NO_X)	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 only available on APIS for

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

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[27], 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.

As a complex bespoke permit is required, 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.

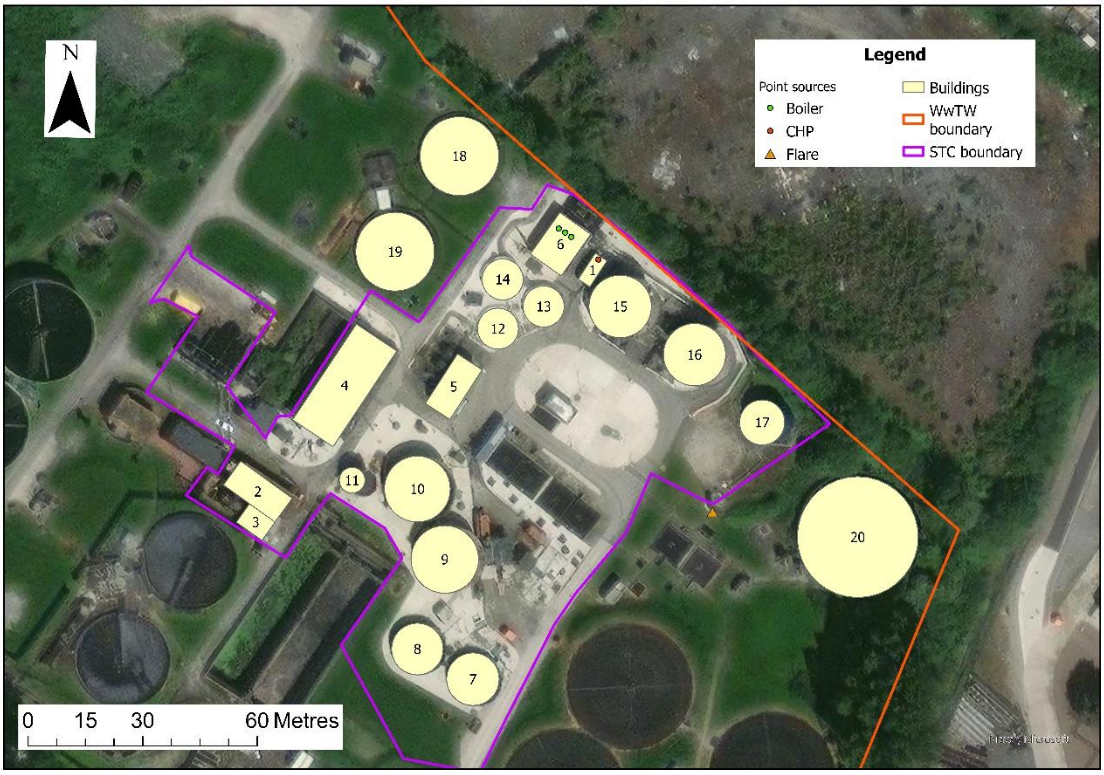
[27] Environment Agency. (2016) ‘Air Emissions Risk Assessment for your Environmental Permit’.

Table 3.1: Building dimensions used within the assessment

No.	Name	X (m)	Y(m)	Height (m)	Length/ diameter (m)	Width (m)	Angle (°)
1	Digested sludge tank (GFS) 1	332295.1	368190.2	5	13.6	-	-
2	Digested sludge tank (GFS) 2	332309.6	368182.3	5	13.8	-	-
3	Digested sludge holding tank 1	332295.0	368232.1	6	17.3	-	-
4	Digested sludge holding tank 2	332302.2	368213.7	6	17.7	-	-
5	Centrifuge feed tank	332278.0	368234.4	4	6.7	-	-
6	Centrifuge building	332253.3	368231.4	5	13.6	16.6	35.8
7	Sludge holding tanks (3 lanes)	332276.0	368259.2	1	30.1	12.7	33.7
8	Sludge thickener building	332304.6	368258.9	5	15.5	7.7	33.0
9	Sludge holding tank 1	332317.4	368287.0	1	10.7	-	-
10	Sludge holding tank 2	332316.2	368274.1	1	10.7	-	-
11	Digester feed tank	332328.1	368279.9	1	10.7	-	-
12	Boiler building	332332.5	368296.2	5	13.4	9.9	35.4
13	CHP container	332340.9	368289.5	2.5	8.1	3.7	33.3
14	Digester 1	332348.1	368279.9	10	16.4	-	-
15	Digester 2	332367.6	368267.3	10	16.3	-	-
16	Methane gas storage	332385.3	368249.5	15	11.8	-	-
17	Aeration tank 1	332306.1	368319.3	1*	20.7	-	-
18	Aeration tank 2	332289.2	368294.3	1*	20.7	-	-
19	Filter tank	332410.3	368219.5	1*	31.7	-	-

*Tank below ground level with 1m above ground level.

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.

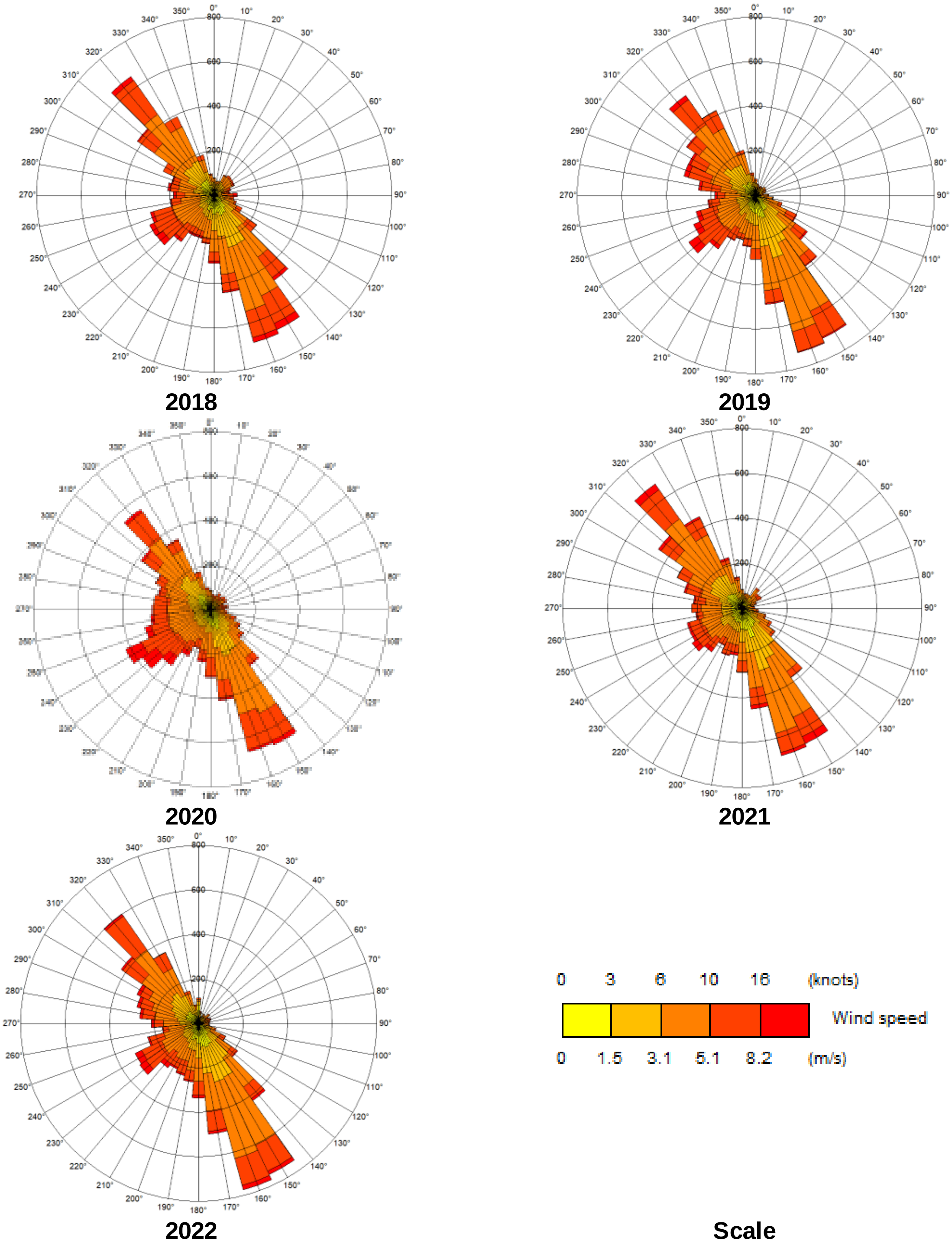
The year of meteorological data that is used for a modelling assessment can have a significant effect on source contribution concentrations. As recommended by the EA dispersion modelling guidance[28], modelling was undertaken using five years of data. Data from the Hawarden meteorological station was used as this was considered to be the most representative station

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

due to its proximity to the Site (approximately 3.9 km to the south east) and having similar land use. Data from the Shawbury meteorological station, which is the next closest station to the Site with similar land use, was used to infill gaps in the Hawarden dataset.

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

Figure 3.2: Wind roses for Hawarden (2018 – 2022)



3.2.4 Terrain

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

Terrain in the region of the Site is generally flat however terrain data was included in the dispersion model to take into account any slopes with gradients of more than 10% beyond the Site.

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 0.2m has been assigned to the Hawarden meteorological station.

3.2.6 Modelled scenario

As detailed in Section 1.2, the Site consists of a CHP plant, three boilers (two biogas and one biogas/gas oil), a flare and a diesel standby generator.

The CHP will operate up to 8500 hours a year and as such for the purposes of this assessment, it has been assumed that the CHP will operate at full load for 8500 hours a year.

It has been assumed that the boilers will run continuously all year (8760 hours a year) alongside the CHP and operate at full load, as a conservative approach. Further to this, for the third boiler that operates on biogas and gas oil, only emissions data for gas oil is available. As such, it has been conservatively assumed for this assessment that the third boiler will operate continuously on gas oil all year. This is considered to be a worst-case scenario, given that emissions of pollutants are greater from gas oil than biogas.

The flare will operate for up to approximately 17% of the year and will be used during emergencies to combust excess biogas that cannot be stored in the gas bag holder. As such, it has been assumed that the flare will operate for 1450 hours each year.

There is no emissions data available for the diesel standby generator, however it is assumed that it would only be used for up to 50 hours per year for emergencies when there is a mains power outage on site and for testing, which are likely to be infrequent occurrences. Therefore, emissions from the diesel standby generator are considered to be infrequent and for very short periods and have not been considered further.

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. All three boilers, CHP and flare exhaust gases are released from their own individual flue.

The NOx emissions modelled in this assessment for the CHP and three boilers are based on the permitted ELVs within the MCPD regulations. The NOx emissions from the flare are based on the NOx emissions limits specified in LFTGN 05[29].

The SO_2 emissions modelled for the CHP and two biogas boilers are based on the permitted ELVs within the MCPD regulations. There is no ELV for SO_2 for the third biogas/gas oil boiler when operating on gas oil. Therefore, the modelled SO_2 emissions for the boiler are based on

[29] Environment Agency, Guidance for monitoring enclosed landfill gas flares (LFTGN05 V2 2010) available at https://www.gov.uk/government/publications/monitoring-enclosed-landfill-gas-flares-lftgn-05

the results of the emissions monitoring assessment carried out in August 2023 when operating on gas oil. The SO_2 emissions modelled for the flare are based on 500ppm of H_2S in the biogas.

The emissions of VOCs from the CHP are based on an indicative emissions concentration of 1000 mg/Nm^3 at 5% O_2, 0°C, dry, which is equivalent to 375 mg/Nm^3 at 15% O_2, 0°C, dry. There is no ELV for VOC for biogas/gas oil boilers and VOC emissions from boilers are minimal and have not been considered further. The VOC emissions from the flare are based on the VOC emissions limits specified in LFTGN 05[29].

As discussed in Section 1.4.2, it has been assumed that 100% of the VOCs emitted from the CHP will be benzene, because this is the VOC for which a relevant EQS exists. The monitored total VOCs concentration does not speciate the VOCs so the actual benzene emission rate is not known. However, the assumption of 100% benzene emissions is likely to be a substantial overestimate and therefore highly conservative. The UK National Atmospheric Inventory (NAEI) report 'Speciation of UK emissions of non-methane volatile organic compounds'[30] provides a review of published VOC speciation profiles, the profiles relevant to this assessment have been summarised in Table 3.2 below. Although none of these are specific to combustion plant burning biogas, this range of published benzene fractions is likely to be indicative of the likely benzene fraction for the VOCs emissions from the CHP. The highest percentage of benzene for any source listed in the table below is 9.1%. Therefore, it is likely that the assumption of 100% benzene adopted for this assessment is an overestimate of the actual benzene emissions by at least a factor of 10.

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

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

Table 3.3 presents the emission parameters used in the dispersion modelling which are based on:

- The results of the emissions monitoring undertaken for the boilers on site.
- The results of the emissions monitoring undertaken for a CHP with a similar fuel specification at a similar DCWW WwTW, due to emissions monitoring data not being available for the CHP on site.
- Manufacturer technical datasheets for the CHP and flare.

Emission rates for NOx have been calculated using the equations presented below:

Emission rate = Plant emission limit x Normalised gas flow.

Correcting for water content:

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

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 (Biogas)	Boiler 2 (Biogas)	Boiler 3 (Gas oil)	Flare
Stack location	x,y	332342.5, 368292.2	332332.1, 368300.3	332333.7, 368299.3	332335.4, 368298.1	332372.3, 368226.3
Stack height	m	3	8	8	8	6
Stack diameter	m	0.3	0.245	0.245	0.295	1.5
Exit temperature	°C	180	208	208	205	1000
Efflux velocity	m/s	5.2	3.1	3.1	4.3	1.7
Volumetric flow rate (actual)	Am^3/s	0.36[a]	0.15[b]	0.15[b]	0.29[c]	3.1[d]
Volumetric flow rate (normalised)	Nm^3/s	0.47[e]	0.06[f]	0.06[f]	0.14[f]	0.54[f]
NOx emission concentration	mg/Nm^3	190[j]	250[f]	250[f]	200[f]	150
NO_x emission	g/s	0.09	0.02	0.02	0.03	0.08
SO_2 emission concentration	mg/Nm^3	60	200	200	-	-
SO_2 emission	g/s	0.03[g]	0.01	0.01	0.002[h]	0.11[i]
VOC emission concentration	mg/Nm^3	375	-	-	-	10
VOC emission	g/s	0.18	-	-	-	0.01

Notes: Arithmetic discrepancies may occur in the table and are a result of rounding.
Emissions concentrations are conservatively based on MCPD emission limit values rather than the lower emission guarantees provided by plant suppliers.
Emissions data for Biogas 1 (Biogas) has conservatively been assumed to be the same as Boiler 2 (Biogas)
(a) Actual conditions = 5.1% O_2, 180°C, 14.9% H_2O
(b) Actual conditions = 6.9% O_2, 208°C, 1.9% H_2O
(c) Actual conditions = 5.5% O_2, 205°C, 0.9% H_2O
(d) Actual conditions = 2.5% O_2,1000°C and 17.2% H_2O
(e) Normalised conditions = 15% O_2, 0°C, 0% H_2O, 101.3 kPA.
(f) Normalised conditions = 3% O_2, 0°C, 0% H_2O, 101.3 kPA
(g) In the absence of the sulphur content in the biogas, the mass emission has conservatively been based on the emission limit value and in reality would be lower
(h) Mass emission based on stack emissions monitoring when operating on gas oil
(i) Based on 500 ppm H_2S in biogas
(j) Equivalent to 500 mg/Nm^3 at 5% O_2, 0°C, 0% H_2O, 101.3 kPA

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 EA's specified generator modelling guidance[31] 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.

3.2.9 Assessment of short- and long-term concentrations

It is assumed that the CHP will operate for 8500 hours a year and the boilers continuously all year (8760 hours a year) alongside the CHP. The flare will operate for up to approximately 17% of the year and will be used during emergencies to burn exceed biogas that cannot be stored in the gas bag holder. As such it has been assumed that the flare will operate for 1450 hours each year.

As the model has been run assuming continuous operation all year, the annual mean PCs for the CHP and flare have been scaled by a factor of 8500/8760 and 1450/8760 respectively during post-processing. This has been undertaken so that the annual concentrations of pollutants at discrete receptors are representative.

The short-term concentrations have been predicted for all 8760 hours of the year so that an assessment against the worst-case meteorological conditions for dispersion could be made. The short-term PCs assume continuous operation all year so concentrations are considered to be more conservative than they would be given that the CHP and flare are expected to be used for up to 8500 and 1450 hours each year respectively.

3.2.10 Background/ambient concentrations

3.2.10.1 NO_2

Background concentrations, or ambient concentrations (AC), are added to the PCs to determine the PEC at modelled receptors. EA dispersion modelling guidance[32] 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, the 2024 Defra background maps have been used to represent the AC at gridded receptors (see Section 4.3 for more details).

However, EA guidance[33] 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. Therefore, local authority NO_2 monitoring data from FCC has been used to represent background concentrations at all human health receptors except receptor H4, which is located away from busy roads and industry. The annual mean NO_2 concentrations recorded by these local authority diffusion tubes are considered to be a worst-case scenario for AC given that they include contributions from existing roads and industry nearby.

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

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

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

The monitored concentrations from 2022 have been used as these are the most recent representative monitoring data available from FCC. The local authority monitoring data considered most representative of the human health receptor where applicable is detailed below in Table 3.4 whilst the locations of the monitoring sites in relation to the human health receptors are displayed in Figure 3.4.

For human health receptor H4, which is located away from busy roads and industry, the 2024 Defra background maps for NO_2 have been used to represent the AC.

As the concentrations from the background maps and local authority modelling 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[34].

Table 3.4: Ambient concentrations applied to each modelled human health receptor

Receptor number	Name of nearest main road	Distance to road (m)	Representative tube	Annual mean NO_2 concentration (ug/m^3)
H1	B5441 Jubilee Bridge	20	ADDC-116	15.5
H2	A494	30	ADDC-104	16.5
H3	A494	70	ADDC-104	16.5
H4	A494	460	Not applicable due to background location. Defra background concentration applied.	9.0
H5	A494	10	ADDC-104	16.5
H6	B5129 Chester Road East	40	ADDC-104	16.5
H7	B5129 Chester Road East	110	ADDC-037	18.3
H8	A494	160	ADDC-104	16.5

3.2.10.2 SO_2 and VOC

SO_2 and VOC concentrations are not monitored by FCC and as such Defra background concentrations have been used for this pollutant for all human health and gridded receptors. Concentrations for the latest year available, 2022, have been used.

As with NO_2, the concentrations from the background maps are long-term (annual) average concentrations. Therefore short-term background concentrations have been estimated by doubling the long-term background concentrations, in accordance with EA risk assessment guidance[34].

3.3 Sensitive receptors

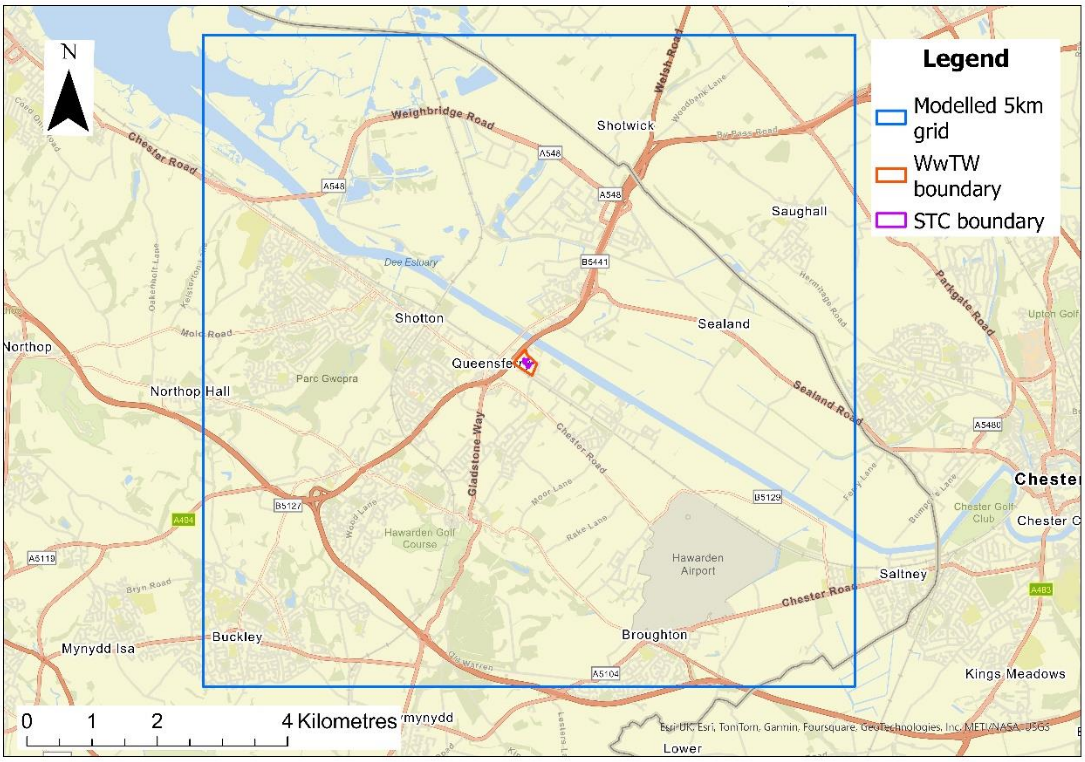
Gridded receptors and discrete human health and ecological receptors have been considered within this assessment.

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

3.3.1 Gridded receptors

Pollutant concentrations have been modelled across a Cartesian grid with 20m 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 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

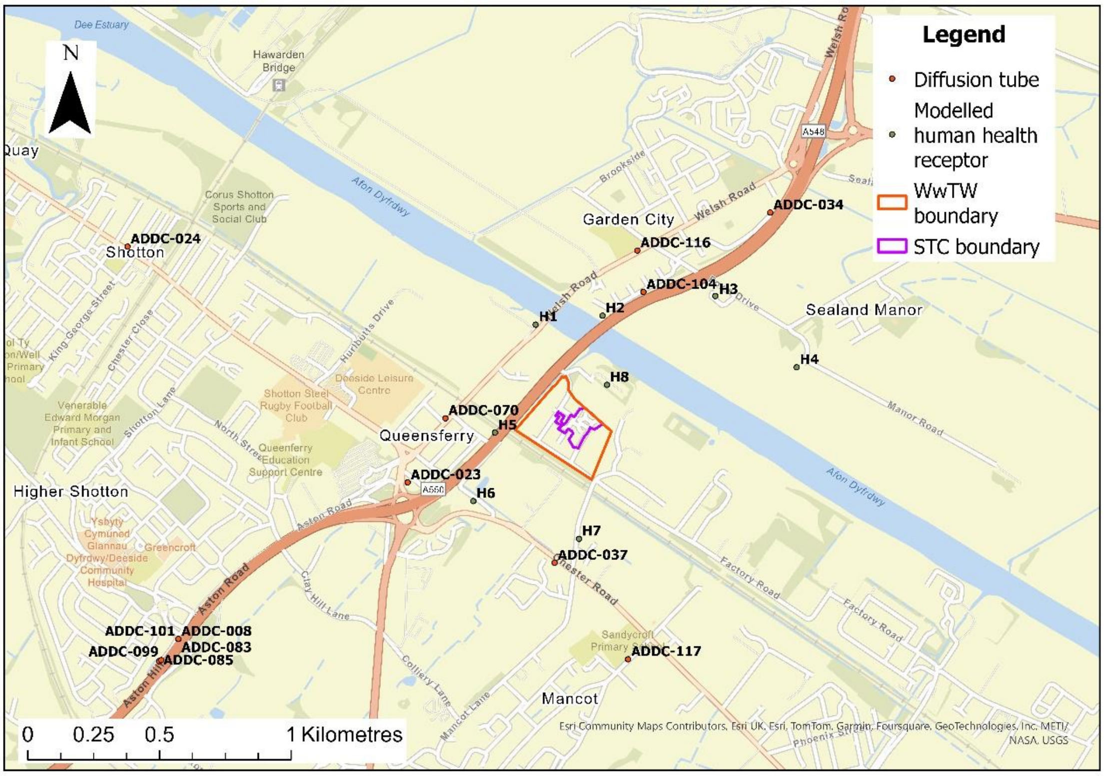
Eight discrete human health receptors representing the closest sensitive receptors (residential properties) have been included within the model so that a comparison against the EQS can be made. Both the long- and short-term NO_2, VOC and SO_2 objectives would apply to the receptors (see Table 2.2 for details). Table 3.5 and Figure 3.4 show the locations of the discrete receptors considered within this assessment.

Table 3.5: Modelled human health receptors

Receptor number	Receptor name	Receptor type	X	Y	Height (m)
H1	Bridge Villas	Residential	332148.9	368626	1.5
H2	Claremont Avenue	Residential	332402.7	368659.7	1.5
H3	Foxes Lane 1	Residential	332831.1	368734.5	1.5
H4	Foxes Lane 2	Residential	333140.2	368464.4	1.5
H5	Dundas Street	Residential	331994.1	368216.4	1.5
H6	Chester Road	Residential	331911.9	367957.0	1.5

Receptor number	Receptor name	Receptor type	X	Y	Height (m)
H7	Chemistry Lane	Residential	332313.3	367813.7	1.5
H8	Riverside Travellers Site	Residential	332419.5	368397.6	1.5

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 by EA[35]:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or Ramsar sites within 10km
- Sites of Special Scientific Interest (SSSIs) and local nature sites (ancient woods, local wildlife sites and national and local nature reserves) within 2km

Within 10km of the Site, there are two SPA, five SACs and two Ramsar sites, whilst within 2km there two SSSIs and two ancient woods, as listed below in Table 3.6.

[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

Table 3.6: Ecological receptors in vicinity of Site

Habitat type	Habitat name	Approximate distance from Site (km)
SPA	The Dee Estuary (Wales) SPA	1.1
	The Dee Estuary (England) SPA	5.1
SAC	River Dee and Bala Lake (Wales) SAC	0.2
	River Dee and Bala Lake (England) SAC	6.8
	Deeside and Buckley Newt sites	2.3
	Dee Estuary (Wales)	1.1
	Dee Estuary (England)	5.4
Ramsar	Dee Estuary (Wales)	1.1
	Dee Estuary (England)	5.2
SSSI	River Dee	0.2
	Dee Estuary	1.1
Ancient Woodland	Ancient Semi Natural Woodland – East of Ash Lane	1.8
	Restored Ancient Woodland Site – South of Chester Railway Path	1.6

Therefore based on the above, the two SPAs, five SACs and two Ramsar sites within 10km of the Site and two SSSIs and two ancient woods within 2km of the Site have been considered within this assessment.

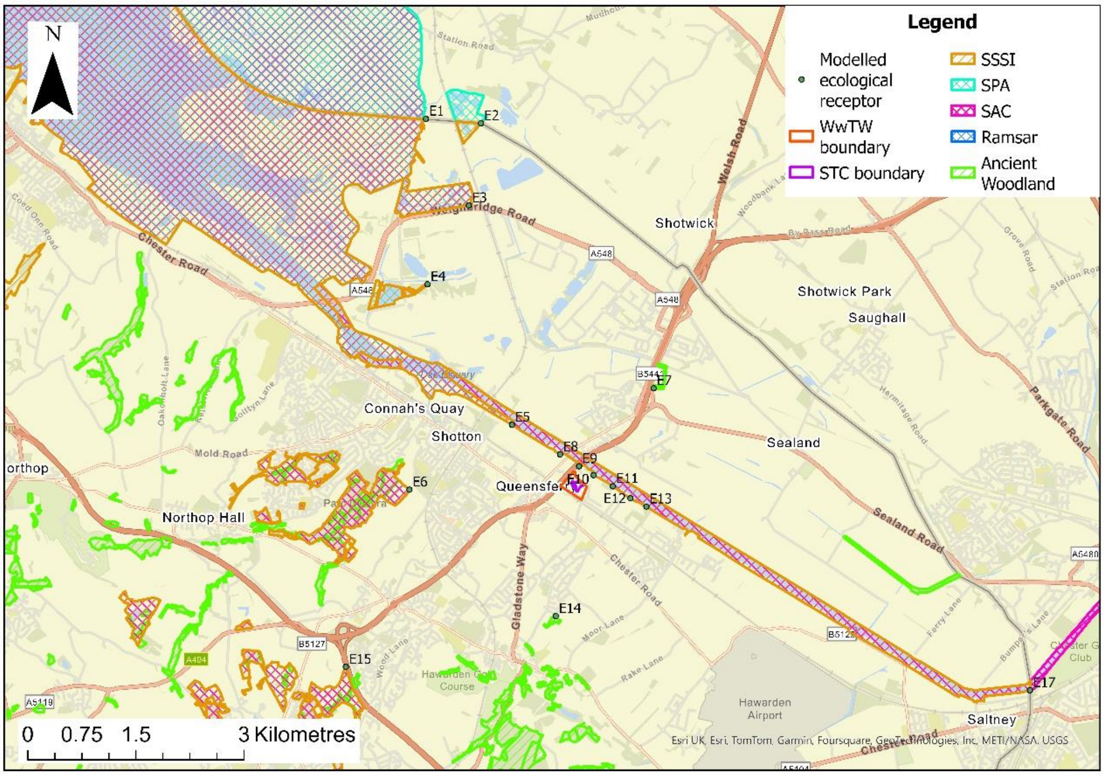
Table 3.7 and Figure 3.5 provide further details of the locations of the designated ecological sites considered within the assessment and the modelled discrete receptors which represent the locations within the designated ecological sites which are closest to the Site and therefore would experience the greatest PCs.

Table 3.7: Modelled ecological receptors

Receptor number	Habitat type	X	Y	Height (m)
E1	The Dee Estuary (England) SPA/ SAC/ Ramsar	330202.4	373319.3	0
E2	The Dee Estuary (England) SPA/ Ramsar	330965.7	373256.3	0
E3	The Dee Estuary (Wales) SSSI/ SPA/ SAC/ Ramsar	330798.0	372117.4	0
E4	The Dee Estuary (Wales) SPA/ Ramsar	330224.7	371025.1	0
E5	The Dee Estuary (Wales) SSSI/ SPA/ SAC/ Ramsar	331395.8	369079.0	0
E6	Deeside and Buckley Newt sites SAC	329973.1	368179.0	0
E7	Ancient Semi Natural Woodland – East of Ash Lane	333362.2	369583	0
E8	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	332064.3	368666.5	0
E9	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	332328.2	368502.9	0
E10	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	332530.8	368379.8	0
E11	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	332798.0	368225.7	0
E12	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	333041.8	368059.1	0
E13	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	333261.8	367943.7	0
E14	Restored Ancient Woodland Site – South of Chester Railway Path	332004.2	366426.9	0

Receptor number	Habitat type	X	Y	Height (m)
E15	Deeside and Buckley Newt sites SAC	329090.2	365723.1	0
E16	Deeside and Buckley Newt sites SAC	329375.4	364078.8	0
E17	River Dee SSSI/ River Dee and Bala Lake (England) SAC	338586.7	365398.3	0

Figure 3.5: Ecological receptors considered within the assessment



3.4 Effects on conservation sites

In accordance with the EA risk assessment guidance[36], 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

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

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

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.

Table 3.8 below presents the critical load ranges for these habitats. Where multiple habitat types fall under these categories, the most relevant habitat with the lowest critical load has been presented below as a worst-case.

Table 3.8: Critical loads for modelled ecological receptors

Habitat type	Habitat name	APIS Habitat[(a)]	Nitrogen deposition critical load (kg/ha/yr)	ClmaxS (keq/ha/yr)	ClminN (keq/ha/yr)	ClmaxN (keq N/ha/yr)
E1, E2	The Dee Estuary (England) SPA/ SAC/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	5	4	0.856	4.856
E3, E5	The Dee Estuary (Wales) SSSI/ SPA/ SAC/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	5	4	0.856	4.856
E4	The Dee Estuary (Wales) SPA/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	5	4	0.856	4.856
E6, E15, E16	Deeside and Buckley Newt sites SAC	Broadleaved, Mixed and Yew Woodland	10	1.448	0.142	1.720
E7	Ancient Semi Natural Woodland – East of Ash Lane	Broadleaved, Mixed and Yew Woodland	10	10.761	0.357	11.118
E8, E9, E10, E11, E12, E13	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	10	0.743	0.142	1.075
E14	Restored Ancient Woodland Site – South of Chester Railway Path	Broadleaved deciduous woodland	10	1.451	0.357	1.808
E17	River Dee SSSI/ River Dee and Bala Lake (England) SAC	Broadleaved, Mixed and Yew Woodland	10	0.743	0.142	1.075

Source: APIS website

3.4.2.1 Critical loads – acidification

Percentage contributions to acid deposition from NOx and SO_2 have been derived from dispersion modelling. Deposition rates were calculated using empirical methods recommended by EA guidance[37] as follows:

- Calculate dry deposition flux (0.0015 m/s for grassland, 0.003 m/s for forest). SO_2: 0.012m/s for grassland, 0.024 m/s for forest
- Dry deposition flux (µg/m^2/s) = ground level concentration (µg/m³) x deposition velocity (m/s)
- Convert units from µg/m^2/s to units of kg/ha/yr by multiplying the dry deposition flux by standard conversion factors (96 for NO_2, 157.7 for SO_2);
- Convert to units of equivalents (keq/ha/yr), which is a measure of how acidifying the chemical species can be, by multiplying the dry deposition flux (kg/ha/yr) by standard conversion factors (0.071428 for N, 0.0625 for SO_2) to determine total acid deposition.

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. To assess a worst-case, it has been assumed that the greatest deposition rates within each designated ecological site occur within each habitat type (when in reality, the greatest deposition rates may occur where none of these habitats are present).

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 EA guidance[38], as follows:

- Calculate NO_2 dry deposition flux (0.0015 m/s for grassland, 0.003 m/s for forest assumed as deposition velocity):
  – Dry deposition flux (µg/m^2/s) = ground level concentration (µg/m³) x deposition velocity (m/s)
- Convert units from µg/m^2/s to units of kg/ha/yr by multiplying the dry deposition flux by a standard conversion factor (96 for NO_2).

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

Predicted contributions to nitrogen deposition have been calculated and compared with the relevant critical load range for each habitat type associated with each designated site, as derived from the APIS. To assess a worst-case, it has been assumed that the greatest deposition rates within each designated ecological site occur at each habitat type (when in reality, the greatest deposition rates may occur where none of these habitats are present).

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'.

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

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

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[39]. 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[40]. Table 3.9 provides a summary of criteria used to screen out insignificant impacts.

Table 3.9: 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)

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

[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

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 the Defra Air Information Resource (AIR) website and FCC[41].

The most recent year of representative monitoring data available from FCC is for 2022.

4.2 Review and assessment of air quality in the study area

FCC has not declared any AQMAs within their administrative area; the closest AQMA to the Site is Chester City Centre AQMA located 8km away to the east, within the administrative area of Cheshire West and Chester Council (CWCC). This AQMA was declared for exceedances of the annual NO_2 objective as a result of emissions from road traffic. The location of this AQMA is presented in Figure 4.1 below.

Figure 4.1: AQMA in the area surrounding the Site

[41] North Wales Authorities Collaborative Project, 2023 Air Quality Progress Report.

4.2.1 Local authority automatic monitoring

As stated in FCC's latest air quality annual status report (ASR)[41] online, three of FCC's diffusion tubes (ADDC-008, ADDC-083, ADDC-101) are co-located with an automatic monitoring station. However, the automatic monitoring station is not owned by FCC and an external organisation undertakes the ratification of the monitoring data from this automatic monitoring station. The data from the automatic monitoring station is only used by FCC in the ASR to calculate a local bias adjustment factor. The data from the automatic monitoring station for 2022 was inaccessible and as such FCC was unable to calculate a local bias adjustment factor from this co-location survey. A national bias adjustment was therefore applied to the monitoring data for 2022 instead.

4.2.2 Local authority diffusion tube monitoring

FCC undertakes diffusion tube monitoring at 59 locations across its administrative boundary. Table 4.1 below presents the annual mean NO_2 concentrations monitored at the locations considered representative of the Site (the monitoring sites on or in close proximity to busy A or B roads), within 2km and with 2022 monitoring data. Across all the sites between 2018 and 2022, concentrations of NO_2 were below the annual mean objective.

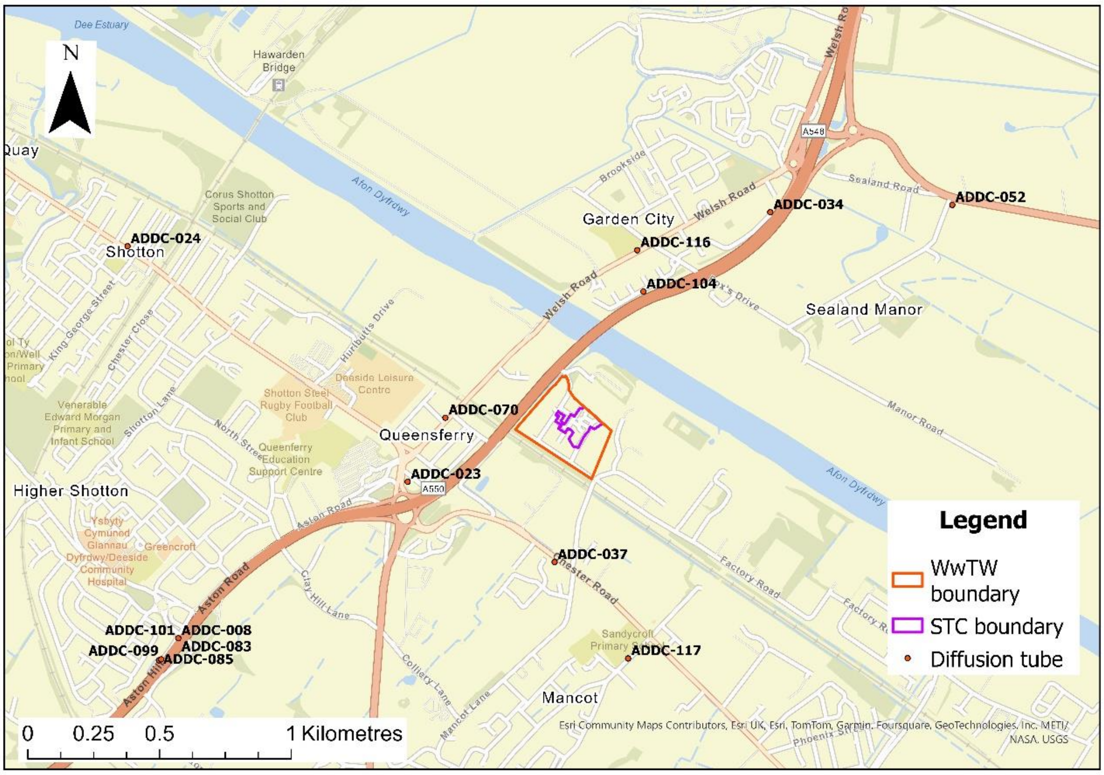
Figure 4.2 present the locations of the representative diffusion tube monitoring sites in relation to the Site.

Table 4.1: Annual mean NO_2 diffusion tube monitoring data

Site ID	Site name	Coordinates		Distance from Site (km)	Type	2022 data capture (%)	NO_2 annual mean concentrations (µg/m^3)				
		x	y				2018	2019	2020	2021	2022
ADDC-008	Lamppost Aston Hill co-loc (24&51) start 2 June	330792	367434	1.5	Kerbside	91.7	24.4	24.3	14.4	14.9	26.6
ADDC-085	Aston Hill Roadside	330718	367350	1.6	Kerbside	91.7	28.2	25.2	19.1	20.4	20.7
ADDC-117	Sandycroft CP School Leaches Lane CH5 2EH	332500	367357	0.7	Kerbside	91.7	33.9	32.5	10.0	11.1	10.3
ADDC-099	Aston Hill, Roadside -Additional Tube within 12m of ADDC/085	330727	367354	1.6	Kerbside	75.0	14.7	13.9	17.7	19	18.5
ADDC-023	4, Belvedere Close, Queensferry CH5 1TG	331663	368028	0.5	Urban Background	91.7	26.7	27.8	18.6	20.1	19.3
ADDC-024	32 Chester Road West, Shotton	330599	368922	1.6	Kerbside	83.3	24.7	24.3	17.6	20.5	20.1
ADDC-116	Sealand CP School Welsh Road CH5 2RA	332535	368907	0.5	Kerbside	83.3	20.7	22.1	14.6	14.7	15.5
ADDC-083	Lamppost Aston Hill co-loc (1&51) start 2 June	330792	367434	1.5	Kerbside	91.7	24.4	24.3	14.4	14.9	26.0
ADDC-034	89, Riverside Park, Garden City	333040	369051	1.0	Roadside	83.3	14.2	14.4	14.1	14.7	14.3
ADDC-037	28, Chester Road, Pentre, Deeside CH5 2DT	332221	367723	0.3	Kerbside	75.0	16.6	16.6	14.3	15.9	18.3
ADDC-070	43, Station Road, Queensferry CH5 1SU	331806	368271	0.3	Kerbside	91.7	19.8	17.6	18.7	16.3	17.3
ADDC-052	1 Manor Road, Sealand CH5 2SB	333731	369079	1.6	Kerbside	75.0	17.3	16.7	7.2	7	10.3
ADDC-101	Lamppost Aston Hill co-loc (1&24) start 2 June	330792	367434	1.5	Kerbside	91.7	24.4	24.3	14.4	14.9	24.3
ADDC-104	Claremont Ave GC opp N0. 28 Start 3 June	332558	368750	0.4	Kerbside	91.7	-	-	-	12.5	16.5

Source: North Wales Authorities Collaborative Project 2023 Air Quality Progress Report.
Note: Bias adjustment factors are: 2018=0.76, 2019=0.75, 2020=0.76, 2021=0.78, 2022=0.76.
Valid data capture for 2022 is at least 75% at all monitoring sites and as such no annualisation is required.

Figure 4.2: Representative monitoring site locations



4.3 Defra projected background pollutant concentrations

Defra provides estimates of background pollution concentrations for NO_X, NO_2, SO_2 and VOC across the UK for each one-kilometre grid square for every year from 2018 to 2030. 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.

The Defra background concentrations for the Site for 2024 are presented in Table 4.2. The data shows that the background NO_2 concentration for the grid squares the Site is located in is below the annual mean objective.

The Defra background concentrations have been added to the PCs to determine the PEC at the gridded receptors. As discussed in Section 3.2.10, short-term background concentrations have been assumed to be twice the annual mean concentrations in line with EA guidance.[42]

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

Table 4.2: 2024 Defra long-term background concentrations for the Site (µg/m^3)

Pollutant	Long-term	Short-term
NO_X	13.4	26.8
NO_2	10.2	20.5
SO_2 [(a)]	3.3	6.7
VOC [(a)]	0.4	0.7

Notes: Results rounded to 1 decimal place; arithmetic discrepancies may occur due to rounding
Maximum concentrations for OS grid square 332500, 368500 are presented
[(a)] Background concentrations of SO_2 and VOC 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

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[43], as presented in Table 3.9, to assess the significance of the air quality impacts from the Site.

It is important to note that for the purpose of modelling, the three boilers have been conservatively assumed to be operating continuously all year for both the long- and short-term concentrations, alongside the CHP, and the third boiler has been conservatively assumed to be operating on gas oil. As the CHP and flare are assumed to be operating for up to 8500 and 1450 hours a year respectively, the annual mean PCs from this emission source have been scaled by a factor of 8500/8760 and 1450/8760 respectively. The same method of scaling down cannot be applied to short-term averaging periods so the assessment assumes that the Site operates continuously all year and operation would coincide with the worst-case meteorological conditions for dispersion.

Furthermore, as discussed in Section 3.2.7, the SO_2 emission rate adopted for this assessment for the CHP is higher than the actual SO_2 emission rate as it is based on a conservative emission limit rather than the sulphur content of the biogas. The modelling of VOCs assumes the fraction of benzene in the VOCs emitted from the CHP is 100%. As discussed in Section 3.2.7, this is likely to lead to an overestimation of the actual benzene emissions by at least a factor of 10. The modelled impacts for VOCs below are therefore highly conservative and not a realistic prediction of the actual benzene concentrations.

5.1 Gridded receptors

Table 5.1 presents the maximum NO_2, SO_2 and VOC PCs at offsite locations across the modelled grid, whilst contour plots of worst-case meteorological years are presented in Figure 5.1 to Figure 5.5.

The PCs for the maximum predicted hourly NO_2, 24-hour VOC and 15-minute, hourly and daily SO_2 are above 10% of the short-term EQS. The maximum predicted annual PCs for NO_2 and VOCs are also greater than 1% of the long-term EQS. Therefore, these impacts cannot be screened out according to the EA significance criteria[44] so the PECs for annual and hourly NO_2, annual and 24-hour VOC and 15-minute, hourly and daily SO_2 have been considered.

For the hourly and annual NO_2 and 15-minute, hourly and 24-hourly SO_2 averaging periods, the PECs are less than the relevant EQS despite the conservative assumptions and therefore considered insignificant in accordance with EA significance criteria.

The PECs for the 24-hour and annual VOC averaging periods exceed the relevant EQS at the maximum offsite point of impact based on the highly conservative assumptions applied to the model. Also, as shown in the contour plots, the maximum offsite PECs for VOCs (as well as NO_2 and SO_2) for all periods considered are found close to the northern and eastern boundaries of the Site. The EQS would not apply at these locations (see Table 2.2) as there is no relevant public exposure, demonstrating that the impact at gridded receptors is insignificant with respect

[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

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

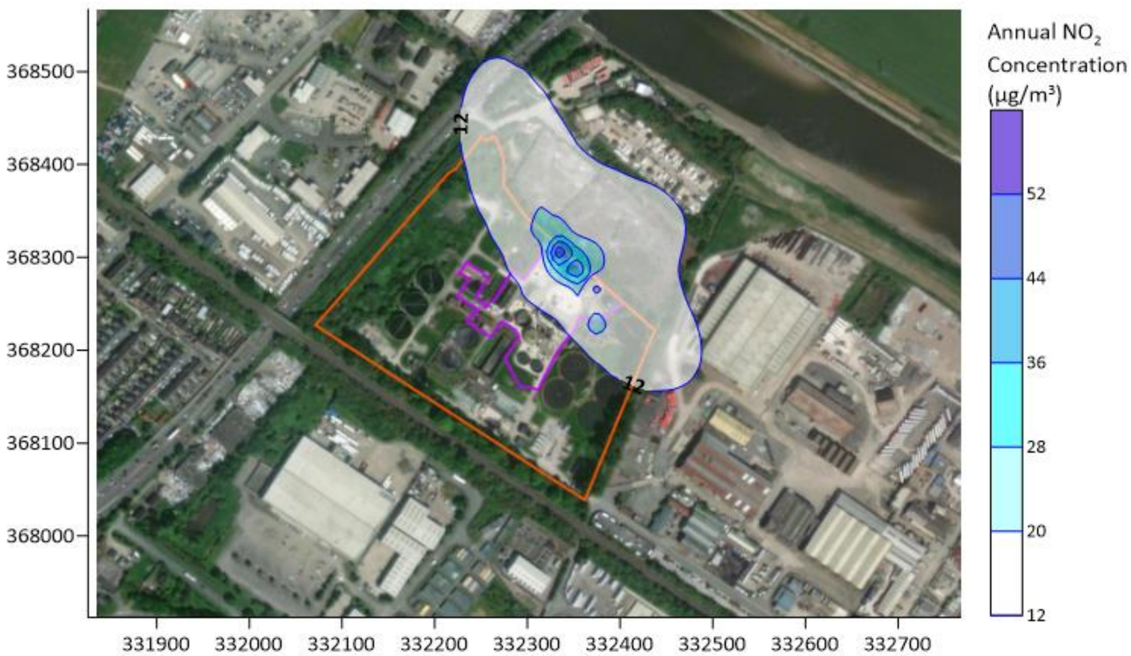
to annual and 24-hour VOC, annual and hourly NO_2 and 15-minute, hourly and 24-hourly SO_2 concentrations.

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

Pollutant	Averaging period	EQS (µg/m³)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
NO_2	99.79 %'ile of hourly averages	200	78.1	**39.1**	20.5	98.6	49.3
	Annual average	40	20.4	**51.0**	10.2	30.6	76.6
SO_2	99.9 %'ile of 15-minute averages	266	77.4	**29.1**	6.7	84.1	31.6
	99.73 %'ile of hourly averages	350	73.3	**20.9**	6.7	80.0	22.9
	99.18 %'ile of 24-hour averages	125	52.1	**41.7**	6.7	58.8	47.0
VOCs	100 %'ile of 24-hour averages	30	314.8	**1049.3**	0.7	315.5	1051.7
	Annual average	5	50.3	**1006.0**	0.4	50.7	1014.0

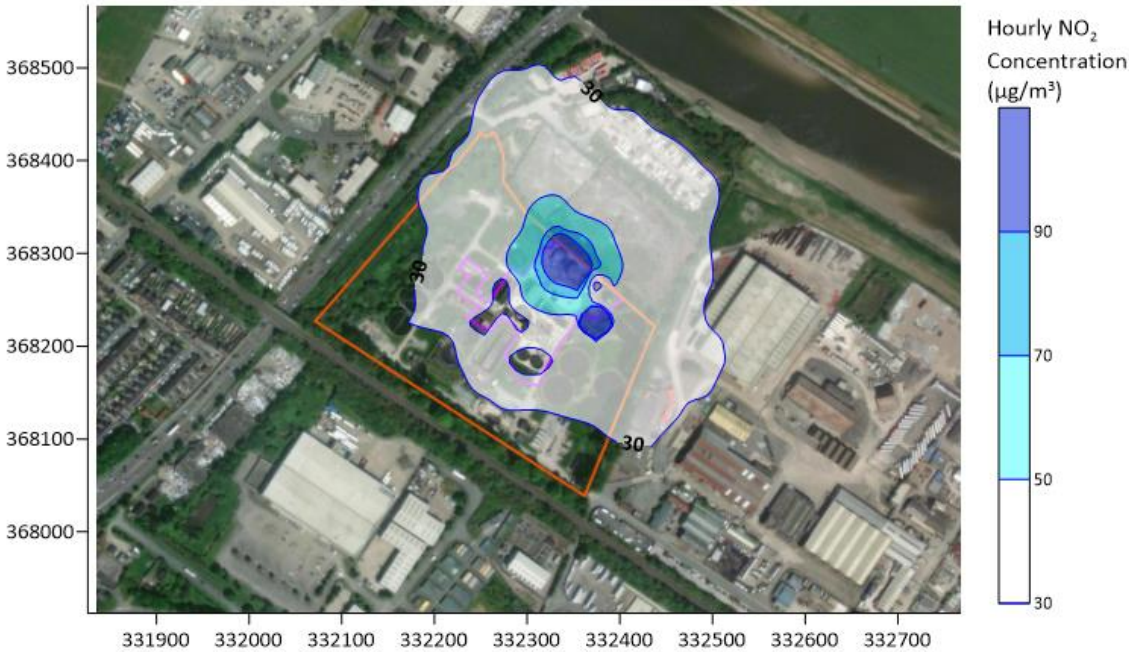
Notes: Results rounded to 1 decimal place
PC = Process Contribution; EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives; PEC = Predicted Environmental Concentration (AC+PC=PEC)
The PCs in **bold** are those that cannot be screened out as insignificant according to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

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



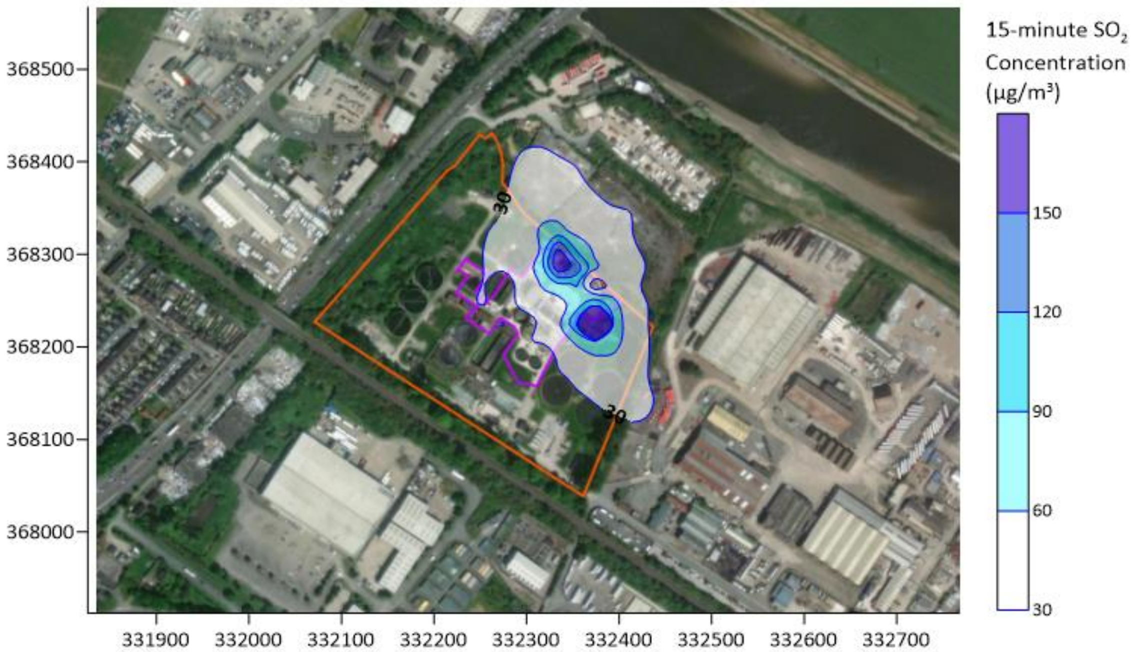
Note: Results presented for the worst case meteorological year of 2020. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Contour interval = 8µg/m³. Minimum contour= 12µg/m³, maximum contour = 52µg/m³. Site boundary is outlined in red and STC boundary in purple. Background concentration (Defra 2024)= 10.2µg/m³.

Figure 5.2: Hourly mean NO_2 PEC ($\mu g/m^3$)



Note: High concentration within the Site is caused by emissions from the flare at a single modelled onsite gridded receptor and rapidly decreases within a few metres. Results presented for the worst case meteorological year of 2018. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Contour interval = 20µg/m³. Minimum contour= 30µg/m³, maximum contour = 90µg/m³. Site boundary is outlined in red and STC boundary in purple. Background concentration (Defra 2024)= 20.5µg/m³.

Figure 5.3: 15-minute mean SO_2 PEC ($\mu g/m^3$)



Note: High concentration within the Site is caused by emissions from the flare at a single modelled onsite gridded receptor and rapidly decreases within a few metres. Results presented for the worst case meteorological year of 2018. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Contour interval = 30µg/m³. Minimum contour= 30µg/m³, maximum contour = 150µg/m³. Site boundary is outlined in red and STC boundary in purple. Background concentration (Defra 2022) = 6.7µg/m³.

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

Note: High concentration within the Site is caused by emissions from the flare at a single modelled onsite gridded receptor and rapidly decreases within a few metres. Results presented for the worst case meteorological year of 2018. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Contour interval = 30µg/m³. Minimum contour= 30µg/m³, maximum contour = 150µg/m³. Site boundary is outlined in red and STC boundary in purple. Background concentration (Defra 2022) = 6.7µg/m³.

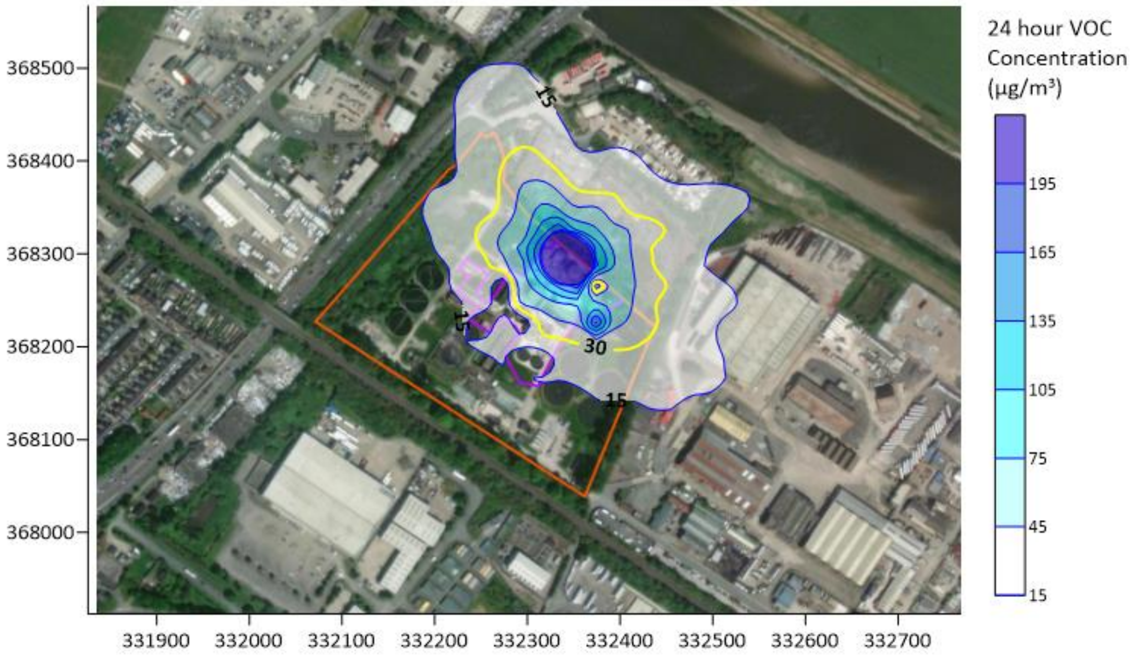
Figure 5.5: 24-hour mean SO_2 PEC (µg/m³)

Note: High concentration within the Site is caused by emissions from the flare at a single modelled onsite gridded receptor and rapidly decreases within a few metres. 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. Contour interval = 20µg/m³. Minimum contour= 20µg/m³, maximum contour = 100µg/m³. Site boundary is outlined in red and STC boundary in purple. Background concentration (Defra 2022) = 6.7µg/m³.

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

Note: High concentration within the Site is caused by emissions from the CHP at a two modelled onsite gridded receptors and rapidly decreases beyond the two receptors. Results presented for the worst case meteorological year of 2022. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Contour interval = 20µg/m³. Minimum contour= 5µg/m³, maximum contour = 105µg/m³. Site boundary is outlined in red and STC boundary in purple. Background concentration (Defra 2022) = 0.4µg/m³.

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



Note: High concentration within the Site is caused by emissions from the CHP at a small number of modelled onsite gridded receptors and rapidly decreases beyond these receptors. 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. Contour interval = 30µg/m³. Minimum contour= 15µg/m³, maximum contour = 195µg/m³. Site boundary is outlined in red and STC boundary in purple. Yellow line represents EAL of 30µg/m³. Background concentration (Defra 2022) = 0.7µg/m³.

5.2 Human health discrete receptors

5.2.1 NO_2 concentrations

The PCs and PECs for hourly and annual NO_2 at the discrete human health receptor with the greatest PCs are summarised in Table 5.2. Results for all modelled discrete human health receptors are presented in Appendix A. Receptor H8 at Riverside Travellers Site is predicted to experience the greatest hourly and annual NO_2 PCs.

In accordance with Environment Agency risk assessment guidance[45], the maximum hourly NO_2 PC is below 10% and therefore the impact is considered insignificant in accordance with Environment Agency significance criteria.

The maximum predicted annual NO_2 PC is above 1% of the EQS. This is likely due to the conservative assumptions used in the assessment including the assumptions that all three boilers will operate continuously for 8760 hours per year alongside the CHP and Boiler 3 will operate on gas oil all year. However, there are no predicted exceedances of the EQS at either receptor H8 or any other modelled discrete receptor presented Appendix A.

[45] 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

In accordance with Environment Agency significance criteria, the worst-case effects at human health receptors are considered to be insignificant with respect to hourly and annual mean NO_2 concentrations.

Table 5.2: Maximum process contributions (PCs) (µg/m³) at discrete human health receptor H8

Averaging period	EQS (µg/m^3)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
99.79 %'ile of hourly averages	200	13.2	6.6	33.0	46.2	23.1
Annual average	40	1.5	**3.8**	16.5	18.0	45.0

Notes: PC = Process Contribution; EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
Results rounded to 1 decimal place
The results in **bold** are those that cannot be screened out as insignificant according to EA criteria. ACs and PECs for the short term averaging period have been presented for completeness although can be screened out at PC stage as PCs are less than 10%

5.2.2 SO_2 concentrations

The PCs and PECs for 15-minute, hourly and daily SO_2 at the discrete human health receptor with the greatest PCs are summarised in Table 5.3. Results for all modelled discrete human health receptors are presented in Appendix A. Receptor H8 experiences the greatest 15-minute, hourly and 24-hour SO_2 PCs.

In accordance with Environment Agency risk assessment guidance[46], the 15-minute, hourly and daily PCs at all eight human health receptors are below 10% of the EQS and therefore the impacts are considered insignificant in accordance with Environment Agency significance criteria.

Table 5.3: Maximum process contributions (PCs) (µg/m³) – Discrete human health receptors

Averaging period	EQS (µg/m^3)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
99.9 %'ile of 15-minute averages	266	15.6	5.9	6.7	22.3	8.4
99.73 %'ile of hourly averages	350	11.9	3.4	6.7	18.6	5.3
99.18 %'ile of 24-hour averages	125	5.4	4.3	6.7	12.1	9.7

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

5.2.3 VOCs (benzene) concentrations

The PCs and PECs for daily and annual VOCs at discrete human health receptors are summarised in Table 5.4.

The 24-hour PCs are predicted to be above 10% of the EQS, while the PECs are all below the EQS. Therefore, the daily mean impacts for VOCs are considered insignificant in accordance with Environment Agency significance criteria.

[46] 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 PCs are predicted to be above 1% of the EQS at several receptors while the PECs are all below the EQS. Therefore, the annual mean impacts for VOCs are considered insignificant in accordance with Environment Agency significance criteria.

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

Averaging period	EQS (µg/m³)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
100 %'ile of 24-hour averages	30	**16.4**	54.7	0.7	17.1	57.0
Annual average	5	**2.5**	50.0	0.4	2.9	58.0

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2024 Defra background concentration)
PEC = Predicted Environmental Concentration (AC+PC=PEC)
Results rounded to 1 decimal place
The PCs in **bold** are those that cannot be screened out as insignificant

5.3 Ecological receptors

This section presents the ecological designation with the greatest predicted PCs for comparison with the relevant daily and annual NOx and SO_2 EQS (critical levels) and critical loads: this is the River Dee SSSI/ River Dee and Bala Lake SAC (Wales). Results for all modelled ecological designations are presented in Appendix B.

5.3.1 Assessment of critical levels

Table 5.5 and Table 5.6 present the maximum predicted daily and annual NOx PCs and PECs at the River Dee SSSI/ River Dee and Bala Lake SAC (Wales). The results show that the maximum predicted daily NOx PC at this SSSI/SAC is above 10% of the relevant EQS whilst the maximum annual NOx PC is above 1% of the relevant EQS, which is due to the conservative assumptions regarding the duration of operation. However, there are no predicted exceedances of either daily or annual EQS. Considering the conservative assumptions assumed, the worst-case effects at ecological receptors are considered to be insignificant with respect to daily and annual NOx concentrations.

Table 5.5: Maximum daily NOx critical level results

Receptor	EQS (µg/m³)	Max PC (µg/m³)	% PC of EQS	AC	PEC	% PEC of EQS
E8	75	4.9	6.5	26.8	31.7	42.3
E9	75	10.8	14.4	26.8	37.6	50.2
E10	75	12.3	16.4	26.8	39.1	52.2
E11	75	3.9	5.3	26.8	30.8	41.0
E12	75	2.4	3.2	23.3	25.7	34.3
E13	75	1.7	2.2	30.0	31.7	42.3

Notes: PC = Process Contribution; PEC=Predicted Environmental Concentration
AC=Ambient Concentration (as per the 2024 Defra NOx backgrounds)
EQS = Environment Quality Standards
Arithmetic discrepancies may occur due to rounding of results

Table 5.6: Maximum annual NOx critical level results

Receptor	EQS (µg/m³)	Max PC (µg/m³)	% PC of EQS	AC	PEC	% PEC of EQS
E8	30	0.8	2.8	13.4	14.3	47.5
E9	30	2.2	7.2	13.4	15.6	51.9

Receptor	EQS (µg/m³)	Max PC (µg/m³)	% PC of EQS	AC	PEC	% PEC of EQS
E10	30	1.4	4.6	13.4	14.8	49.4
E11	30	0.3	1.2	13.4	13.8	45.9
E12	30	0.2	0.7	11.7	11.9	39.5
E13	30	0.1	0.4	15.0	15.1	50.5

Notes: PC = Process Contribution PEC=Predicted Environmental Concentration
AC=Ambient Concentration (as per the 2024 Defra NOx backgrounds)
EQS = Environment Quality Standards

Table 5.7 presents the maximum predicted annual SO_2 PCs at the River Dee SSSI/ River Dee and Bala Lake SAC (Wales). The maximum predicted annual SO_2 PC at this SSSI/SAC is above 1% of the EQS, which is due to the conservative assumptions regarding the duration of operation, however, the PEC does not exceed the EQS. Considering the conservative assumptions assumed, the worst-case effects at ecological receptors are considered to be insignificant with respect to annual SO_2 concentrations.

Table 5.7: Maximum annual SO_2 critical level results

Receptor	EQS (µg/m³)	Max PC (µg/m³)	% PC of EQS	AC	PEC	% PEC of EQS
E8	20	0.3	1.5	3.3	3.6	18.2
E9	20	0.8	3.9	3.3	4.1	20.6
E10	20	0.5	2.5	3.3	3.8	19.2
E11	20	0.1	0.7	3.3	3.5	17.4
E12	20	0.1	0.4	3.2	3.3	16.5
E13	20	<0.1	0.2	4.0	4.1	20.3

Note: PC = Process Contribution; PEC=Predicted Environmental Concentration; AC=Ambient Concentration (2022 Defra SO_2 backgrounds); EQS = Environment Quality Standards
Arithmetic discrepancies may occur due to rounding of results

5.3.2 Assessment of critical loads

Critical loads - Acidification

Table 5.8 presents the predicted acid deposition rates at the River Dee SSSI/ River Dee and Bala Lake SAC (Wales), which have been calculated from dispersion modelling and compares them to the acidity critical load (CLMaxN).

The predicted PCs for acid deposition at the River Dee SSSI/ River Dee and Bala Lake SAC (Wales) are above 1% of the relevant critical load at five of the receptors, receptors E8 to E12. However, following discussions with a competent expert for ecology, this impact is considered not significant as there are no qualifying features sensitive to acid deposition at these locations. Therefore, significant impacts from acid deposition are not likely at the River Dee SSSI/ River Dee and Bala Lake SAC (Wales).

Therefore, in accordance with Environment Agency guidance, the impact of the Site on acid deposition at the SSSI/SAC can be screened out as insignificant so has not been considered further.

The predicted PCs for acid deposition at the other ecology sites considered are all below 1% of the relevant critical load, as shown in Table B.4 of Appendix B.

Table 5.8: Critical load results - acid deposition

Receptor	APIS Habitat (a)	CLmax N (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 CLmax N
E8	Broad-leaved, mixed and yew woodland (forest)	1.075	0.6	0.3	0.048	4.4
E9			1.5	0.8	0.122	11.4
E10			1.0	0.5	0.079	7.4
E11			0.2	0.1	0.020	1.9
E12			0.1	0.1	0.011	1.1
E13			0.1	<0.1	0.008	0.7

Note: PC = Process Contribution; acid deposition PC is presented to three 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). Receptors E8 to E13 have classified as forest.
Arithmetic discrepancies may occur due to rounding of results

Critical loads – Eutrophication

Table 5.9 presents the predicted nitrogen deposition (eutrophication) rates and the minimum nitrogen critical loads at the River Dee SSSI/ River Dee and Bala Lake SAC (Wales), which have been calculated from dispersion modelling.

The predicted PCs for nitrogen deposition at the River Dee SSSI/ River Dee and Bala Lake SAC (Wales) are above 1% of the relevant critical load at three of the receptors, receptors E8, E9 and E10. However, following discussions with a competent expert for ecology, this impact is considered not significant as there are no qualifying features sensitive to nitrogen deposition at these locations. Therefore, significant impacts from nitrogen deposition are not likely at the River Dee SSSI/ River Dee and Bala Lake SAC (Wales).

Therefore, in accordance with Environment Agency guidance, the impact of the Site on nitrogen deposition at the SSSI/SAC can be screened out as insignificant so has not been considered further.

The predicted PCs for nitrogen deposition at the other ecology sites considered are all below 1% of the relevant critical load, as shown in Table B.5 of Appendix B.

Table 5.9: Critical load results - nitrogen deposition

Receptor	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
E8	Broad-leaved, mixed and yew woodland (forest)	10	0.6	0.170	1.7
E9			1.5	0.437	4.4
E10			1.0	0.280	2.8
E11			0.2	0.070	0.7
E12			0.1	0.040	0.4
E13			0.1	0.026	0.3

Note: PC = Process Contribution; total nitrogen deposition from the Site is presented to three 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). Receptors E8 to E13 have classified as forest.
Arithmetic discrepancies may occur due to rounding of results

6 Conclusions

An assessment has been undertaken to determine the effect on air quality associated with emissions from the Site 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. Effects of atmospheric concentrations of NOx and SO_2 and resultant effects on acidification and eutrophication have also been assessed with respect to 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 operating envelope and meteorological conditions.

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

The air quality effects are highly localised and the impact at sensitive human health receptors is insignificant in accordance with Environment Agency guidance. At ecological receptors, the impact of NOx and SO_2 on critical levels and critical loads at nearby ecology sites is also considered to be insignificant. The Site is not considered to conflict with the relevant air quality regulations.

Appendices

A. Detailed Results for Human Health Discrete Receptors

Table A.1: Hourly NO_2 (99.79th %ile) PCs and PECs (µg/m³) at discrete human health receptors

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PC as % of EQS
H1	5.0	200	6.0	31.0	36.0	18.0
H2	4.8	200	2.4	33.0	37.8	18.9
H3	1.9	200	1.0	33.0	34.9	17.5
H4	1.7	200	0.9	17.9	19.6	9.8
H5	3.8	200	1.9	33.0	36.8	18.4
H6	2.6	200	1.3	33.0	35.6	17.8
H7	3.2	200	1.6	36.6	39.8	19.9
H8	13.2	200	6.6	33.0	46.2	23.1

Notes: Results rounded to 1 decimal place
AC= Ambient concentration; PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

Table A.2: Annual NO_2 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
H1	1.0	40	2.5	15.5	16.5	41.3
H2	0.4	40	1.0	16.5	16.9	42.3
H3	0.1	40	0.3	16.5	16.6	41.5
H4	0.1	40	0.3	9.0	9.1	22.7
H5	0.1	40	0.3	16.5	16.6	41.5
H6	0.1	40	0.3	16.5	16.6	41.5
H7	0.1	40	0.3	18.3	18.4	46.0
H8	1.5	40	3.8	16.5	18.0	45.0

Notes: Results rounded to 1 decimal place
AC= Ambient Concentration; PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

Table A.3: 15-minute SO_2 (99.90th %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
H1	9.1	266	3.4	6.7	15.8	5.9
H2	7.4	266	2.8	6.7	14.1	5.3
H3	3.6	266	1.4	6.7	10.3	3.9
H4	3.8	266	1.4	6.7	10.5	3.9
H5	5.8	266	2.2	6.7	12.5	4.7
H6	5.3	266	2.0	6.7	12.0	4.5

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
H7	6.3	266	2.4	6.7	13.0	4.9
H8	15.6	266	5.9	6.7	22.3	8.4

Notes: Results rounded to 1 decimal place
AC= Ambient Concentration; PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

Table A.4: Hourly SO_2 (99.73^{th} %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
H1	5.6	350	1.6	6.7	12.3	3.5
H2	4.8	350	1.4	6.7	11.5	3.3
H3	2.4	350	0.7	6.7	9.1	2.6
H4	2.3	350	0.7	6.7	9.0	2.6
H5	4.3	350	1.2	6.7	11.0	3.1
H6	3.2	350	0.9	6.7	9.9	2.8
H7	4.1	350	1.2	6.7	10.8	3.1
H8	11.9	350	3.4	6.7	18.6	5.3

Notes: Results rounded to 1 decimal place
AC= Ambient Concentration; PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

Table A.5: 24-hour SO_2 (99.18^{th} %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
H1	3.1	125	2.5	6.7	9.8	7.8
H2	1.4	125	1.1	6.7	8.1	6.5
H3	0.6	125	0.5	6.7	7.3	5.8
H4	0.8	125	0.6	6.7	7.5	6.0
H5	1.8	125	1.4	6.7	8.5	6.8
H6	1.6	125	1.3	6.7	8.3	6.6
H7	1.1	125	0.9	6.7	7.8	6.2
H8	5.4	125	4.3	6.7	12.1	9.7

Notes: Results rounded to 1 decimal place
AC= Ambient Concentration; PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

Table A.6: 24-hour VOC (100^{th} %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
H1	8.1	30	27.0	0.7	8.8	29.3
H2	3.7	30	12.3	0.7	4.4	14.7

Receptor	Max PC	EQS	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
H3	1.4	30	4.7	0.7	2.1	7.0
H4	2.1	30	7.0	0.7	2.8	9.3
H5	5.1	30	17.0	0.7	5.8	19.3
H6	3.2	30	10.7	0.7	3.9	13.0
H7	2.3	30	7.7	0.7	3.0	10.0
H8	16.4	30	54.7	0.7	17.1	57.0

Notes: Results rounded to 1 decimal place
AC= Ambient Concentration; PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

Table A.7: Annual VOC 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
H1	1.5	5	30.0	0.4	1.9	38.0
H2	0.6	5	12.0	0.4	1.0	20.0
H3	0.2	5	4.0	0.4	0.6	12.0
H4	0.2	5	4.0	0.4	0.6	12.0
H5	0.2	5	4.0	0.4	0.6	12.0
H6	0.1	5	2.0	0.4	0.5	10.0
H7	0.1	5	2.0	0.4	0.5	10.0
H8	2.5	5	50.0	0.4	2.9	58.0

Notes: Results rounded to 1 decimal place
AC= Ambient Concentration; PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard

B. Detailed Results for Ecological Discrete Receptors

Table B.1: Maximum daily NOx critical level results

Receptor	EQS (µg/m^3)	Max PC (µg/m^3)	% PC of EQS	AC	PEC	% PEC of EQS
E1	75	0.2	0.3	18.3	18.5	24.6
E2	75	0.2	0.2	18.3	18.4	24.6
E3	75	0.3	0.4	20.4	20.7	27.6
E4	75	0.3	0.4	25.0	25.3	33.7
E5	75	1.0	1.4	20.8	21.8	29.1
E6	75	0.2	0.3	19.3	19.6	26.1
E7	75	0.5	0.7	26.7	27.1	36.2
E8	75	4.9	6.5	26.8	31.7	42.3
E9	75	10.8	14.4	26.8	37.6	50.2
E10	75	12.3	16.4	26.8	39.1	52.2
E11	75	3.9	5.3	26.8	30.8	41.0
E12	75	2.4	3.2	23.3	25.7	34.3
E13	75	1.7	2.2	30.0	31.7	42.3
E14	75	0.3	0.4	20.6	20.9	27.9
E15	75	0.1	0.1	22.7	22.8	30.4
E16	75	0.1	0.1	19.3	19.4	25.8
E17	75	0.1	0.1	21.9	22.0	29.3

Notes: PC = Process Contribution PEC=Predicted Environmental Concentration
AC=Ambient Concentration (as per the 2024 Defra NOx backgrounds)

Table B.2: Maximum annual NOx critical level results

Receptor	EQS (µg/m^3)	Max PC (µg/m^3)	% PC of EQS	AC	PEC	% PEC of EQS
E1	30	<0.1	0.1	9.1	9.2	30.5
E2	30	<0.1	0.1	9.1	9.2	30.5
E3	30	<0.1	0.1	10.2	10.2	34.0
E4	30	<0.1	0.1	12.5	12.5	41.8
E5	30	0.1	0.3	10.4	10.5	34.9
E6	30	<0.1	<0.1	9.7	9.7	32.2
E7	30	<0.1	0.1	13.3	13.4	44.6
E8	30	0.8	2.8	13.4	14.3	47.5
E9	30	2.2	7.2	13.4	15.6	51.9
E10	30	1.4	4.6	13.4	14.8	49.4
E11	30	0.3	1.2	13.4	13.8	45.9
E12	30	0.2	0.7	11.7	11.9	39.5
E13	30	0.1	0.4	15.0	15.1	50.5
E14	30	<0.1	<0.1	10.3	10.3	34.3
E15	30	<0.1	<0.1	11.3	11.4	37.8
E16	30	<0.1	<0.1	9.7	9.7	32.2
E17	30	<0.1	<0.1	10.9	11.0	36.5

Notes: PC = Process Contribution PEC=Predicted Environmental Concentration
AC=Ambient Concentration (as per the 2024 Defra NOx backgrounds)
EQS = Environment Quality Standards

Table B.3: Maximum annual SO_2 critical level results

Receptor	EQS (µg/m³)	Max PC (µg/m³)	% PC of EQS	AC	PEC	% PEC of EQS
E1	20	<0.1	<0.1	1.8	1.8	9.2
E2	20	<0.1	<0.1	1.8	1.8	9.2
E3	20	<0.1	0.1	2.0	2.0	9.9
E4	20	<0.1	0.1	2.1	2.1	10.3
E5	20	<0.1	0.2	2.4	2.4	12.0
E6	20	<0.1	<0.1	2.3	2.3	11.5
E7	20	<0.1	0.1	2.7	2.7	13.7
E8	20	0.3	1.5	3.3	3.6	18.2
E9	20	0.8	3.9	3.3	4.1	20.6
E10	20	0.5	2.5	3.3	3.8	19.2
E11	20	0.1	0.7	3.3	3.5	17.4
E12	20	0.1	0.4	3.2	3.3	16.5
E13	20	<0.1	0.2	4.0	4.1	20.3
E14	20	<0.1	<0.1	2.8	2.8	13.9
E15	20	<0.1	<0.1	2.3	2.3	11.6
E16	20	<0.1	<0.1	2.0	2.0	10.1
E17	20	<0.1	<0.1	3.5	3.5	17.7

Note: PC = Process Contribution; PEC=Predicted Environmental Concentration; AC=Ambient Concentration (2022 Defra SO_2 backgrounds); EQS = Environment Quality Standards
Arithmetic discrepancies may occur due to rounding of results, and due to differences in worst-case meteorological years

Table B.4: Critical load results - acid deposition

Habitat type	Habitat name	APIS Habitat[(a)]	CLmaxN (keq N/ha/yr)	Maximum ground level concentration of NO_2 (PC) ($\mu g/m^3$)	Maximum ground level concentratio n of SO_2 (PC) ($\mu g/m^3$)	Total acid deposition (PC) (keq/ha/yr)	% PC of CLmaxN
E1	The Dee Estuary (England) SPA/ SAC/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	4.856	<0.1	<0.1	0.001	<0.1
E2	The Dee Estuary (England) SPA/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	4.856	<0.1	<0.1	0.001	<0.1
E3	The Dee Estuary (Wales) SSSI/ SPA/ SAC/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	4.856	<0.1	<0.1	0.002	<0.1
E4	The Dee Estuary (Wales) SPA/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	4.856	<0.1	<0.1	0.002	<0.1
E5	The Dee Estuary (Wales) SSSI/ SPA/ SAC/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	4.856	0.1	<0.1	0.004	0.1
E6	Deeside and Buckley Newt sites SAC	Broadleaved, Mixed and Yew Woodland	1.720	<0.1	<0.1	<0.001	<0.1
E7	Ancient Semi Natural Woodland - East of Ash Lane	Broadleaved, Mixed and Yew Woodland	11.118	<0.1	<0.1	0.002	<0.1
E8	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	1.075	0.6	0.3	0.048	4.4
E9	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	1.075	1.5	0.8	0.122	11.4
E10	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	1.075	1.0	0.5	0.079	7.4
E11	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	1.075	0.2	0.1	0.020	1.9

Habitat type	Habitat name	APIS Habitat[(a)]	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 CLmaxN
E12	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	1.075	0.1	0.1	0.011	1.1
E13	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	1.075	0.1	<0.1	0.008	0.7
E14	Restored Ancient Woodland Site – South of Chester Railway Path	Broadleaved deciduous woodland	1.808	<0.1	<0.1	0.001	<0.1
E15	Deeside and Buckley Newt sites SAC	Broadleaved, Mixed and Yew Woodland	1.720	<0.1	<0.1	<0.001	<0.1
E16	Deeside and Buckley Newt sites SAC	Broadleaved, Mixed and Yew Woodland	1.720	<0.1	<0.1	<0.001	<0.1
E17	River Dee SSSI/ River Dee and Bala Lake (England) SAC	Broadleaved, Mixed and Yew Woodland	1.075	<0.1	<0.1	<0.001	<0.1

Note: PC = Process Contribution; acid deposition PC is presented to three 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)

Table B.5: Critical load results - nitrogen deposition

Habitat type	Habitat name	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
E1	The Dee Estuary (England) SPA/ SAC/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	5	<0.1	0.002	<0.1
E2	The Dee Estuary (England) SPA/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	5	<0.1	0.002	<0.1

Habitat type	Habitat name	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
E3	The Dee Estuary (Wales) SSSI/ SPA/ SAC/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	5	<0.1	0.003	0.1
E4	The Dee Estuary (Wales) SPA/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	5	<0.1	0.003	0.1
E5	The Dee Estuary (Wales) SSSI/ SPA/ SAC/ Ramsar	Dunes, Shingle and Machair; Calcareous Grassland	5	0.1	0.008	0.2
E6	Deeside and Buckley Newt sites SAC	Broadleaved, Mixed and Yew Woodland	10	<0.1	0.001	<0.1
E7	Ancient Semi Natural Woodland - East of Ash Lane	Broadleaved, Mixed and Yew Woodland	10	<0.1	0.008	0.1
E8	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	10	0.6	0.170	1.7
E9	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	10	1.5	0.437	4.4
E10	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	10	1.0	0.280	2.8
E11	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	10	0.2	0.070	0.7
E12	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	10	0.1	0.040	0.4
E13	River Dee SSSI/ River Dee and Bala Lake SAC (Wales)	Broadleaved, Mixed and Yew Woodland	10	0.1	0.026	0.3
E14	Restored Ancient Woodland Site –	Broadleaved deciduous woodland	10	<0.1	0.002	<0.1

Habitat type	Habitat name	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
	South of Chester Railway Path					
E15	Deeside and Buckley Newt sites SAC	Broadleaved, Mixed and Yew Woodland	10	<0.1	0.001	<0.1
E16	Deeside and Buckley Newt sites SAC	Broadleaved, Mixed and Yew Woodland	10	<0.1	<0.001	<0.1
E17	River Dee SSSI/ River Dee and Bala Lake (England) SAC	Broadleaved, Mixed and Yew Woodland	10	<0.1	0.001	<0.1

Note: PC = Process Contribution; total nitrogen deposition from the Site is presented to three 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)
[(b)] The lowest critical load has been applied

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