Environmental Permit Application - Bracknell Sewage Treatment Works

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Thames Water Utilities Limited

IED Optioneering
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Executive summary

Under the Industrial Emissions Directive (IED) the anaerobic digestion assets at Bracknell Sewage Treatment Works (STW), require an Environmental Permit (EP). The scope of anaerobic digestion activities includes all treatment stages and incorporates directly associated activities such as the operation of the combined heat and power (CHP) gas engine and boilers.

Thames Water Utilities Limited operates a STW near the town of Bracknell, Berkshire (RG42 5AS). These operations include: an existing CHP engine (with a thermal input capacity of 1.4 MWth) and two existing duel fuelled boilers (each with a thermal input capacity of 0.7 MWth) as set out in the tables below.

Medium Combustion Plant Information			
MCP specific identifier (emission source reference)	CHP engine 1 (A1)	Boiler 1 (A2)	Boiler 2 (A3)
12 - digit grid reference or latitude/longitude	E 485998 N 171845	E 485955 N 171870	E 485955 N 171867
Rated thermal input (MW) of the MCP	1.4	0.7	0.7
Type of MCP (diesel engine, gas turbine, other engine or other MCP)	Gas engine	Boiler	Boiler
Type of fuels used: gas oil (diesel), natural gas, gaseous fuels other than natural gas	Biogas	Dual fuelled (biogas / gas-oil). Modelled with biogas.	Dual fuelled (biogas / gas-oil). Modelled with biogas.
Date when the new MCP was first put into operation (DD/MM/YYYY)	06/01/2016	n/a[1]	n/a[1]
Sector of activity of the MCP or the facility in which it is applied (NACE code**)	5	5	5
Expected number of annual operating hours of the MCP and average load in use	Modelled continuously (i.e. 8,760 hours) at maximum load	Modelled continuously (i.e. 8,760 hours) at maximum load	Modelled continuously (i.e. 8,760 hours) at maximum load
Where the option of exemption under Article 6(8) is used the operator (as identified on Form A) should sign a declaration here that the MCP will not be operated more than the number of hours referred to in this paragraph	N / A	N / A	N / A

Note 1: Technically, both boilers are below the 1 MW threshold to be classified as medium combustion pant (MCP).

The Air Quality Impact Assessment (AQIA) presented within this report is required to support the EP application and assesses the potential for significant air quality effects from the operation of the CHP engine and boilers at the Bracknell STW. The AQIA considers:

- the potential impact on human health due to emissions of pollutants. The pollutants considered include nitrogen dioxide (NO_2); carbon monoxide (CO); sulphur dioxide (SO_2), total volatile organic compounds (TVOC's) and particulate matter (PM_{10}, particles with an aerodynamic diameter of 10 microns or less and $PM_{2.5}$, particles with an aerodynamic diameter of 2.5 microns or less); and

- the potential impact on vegetation and ecosystems due to emissions of oxides of nitrogen (NOx) and SO_2.

Human receptors

The assessment indicates that the predicted modelled off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term Environmental Quality Standard (EQS).

The results indicate that for annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations, the respective PCs are less than 1% of the relevant long-term EQS and their impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2023), and therefore 'not significant'.

For short-term NO_2, CO, SO_2 and particulate concentrations, the PCs are either less than 10% of the relevant EQS or where the PCs are above 10% of the relevant EQS, the PECs are less than 70% of the relevant EQS and the impacts are considered 'not significant'.

For annual mean and maximum 24-hour mean TVOC concentrations, informed by a wider understanding of the properties of biogas, the emissions of TVOCs is considered 'not significant'.

This assessment has been carried out on the assumption that the CHP engine and boilers would operate continuously at maximum load throughout the year (i.e. 8,760 hours). In practice, the boilers are unlikely to operate simultaneously and for more than 6,000 hours per year. Therefore, when considering the conservative approach to the assessment and based on professional judgement, the emissions of assessed pollutants at sensitive human receptor locations and modelled off-site locations is considered 'not significant'.

Protected conservation areas

For critical levels, the results indicate that at the European designated sites and local nature sites, the annual mean NOx and SO_2 PCs are less than 1% and 100% of the relevant critical level, respectively, and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2023).

For the maximum 24-hour mean critical level for NOx, the results indicate that at the European designated sites and local nature sites, the PCs are less than 10% and 100% of the relevant critical level, respectively, and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2023).

For critical loads, the results indicate that at the European designated sites and local nature sites, the PCs are less than 1% and 100% of the relevant critical load value, respectively, for acid and nutrient nitrogen deposition and the impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2023).

Summary

Based on the above assessment, it is concluded that the operation of the assessed CHP engine and boilers are acceptable from an air quality perspective.

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Appendices

1. Introduction

1.1 Background

Under the Industrial Emissions Directive (IED)[1] (European Union, 2010), the anaerobic digestion assets at Bracknell Sewage Treatment Works (STW), require an Environmental Permit (EP). The scope of anaerobic digestion activities includes all treatment stages and incorporates directly associated activities such as the operation of the combined heat and power (CHP) gas engine and boilers.

Thames Water Utilities Limited (hereafter 'Thames Water') currently operates one biogas fuelled MWM TCG 2016 V12 CHP engine (with a thermal input capacity of 1.4 MWth) and two Strebel dual fuelled boilers[2] (each with a thermal input capacity of 0.7 MWth) at its STW near the town of Bracknell, Berkshire (RG42 5AS) (hereafter 'the site'). Jacobs UK Limited (hereafter 'Jacobs') has carried out an Air Quality Impact Assessment (AQIA) on behalf of Thames Water to assess the potential impact of emissions from the existing CHP engine and boilers.

1.2 Study Outline

This AQIA is required to support the EP application and assesses the likely significant air quality effects of emissions to air from the CHP engine and boilers at the site. The air quality assessment has been carried out following the relevant Environment Agency guidance (Environment Agency, 2021; 2023). The AQIA considers:

- the potential impact on human health due to emissions of nitrogen dioxide (NO_2); carbon monoxide (CO); sulphur dioxide (SO_2), total volatile organic compounds (TVOC's) and particulate matter (PM_{10}, particles with an aerodynamic diameter of 10 microns or less and $PM_{2.5}$, particles with an aerodynamic diameter of 2.5 microns or less); and
- the potential impact on vegetation and ecosystems due to emissions of oxides of nitrogen (NOx) and SO_2.

The site boundary (represented by the approximate site fenceline) is presented in Figure 1.

This report draws upon information provided from the following parties:

- Thames Water;
- ADM Ltd (meteorological data supplier);
- Centre for Ecology and Hydrology (CEH);
- ESG (operating now as 'SOCOTEC') (responsible for air quality monitoring of the assessed CHP engine);
- Department for Environment, Food and Rural Affairs (Defra); and
- Bracknell Forest Borough Council.

This report includes a description of the emission sources, description of methodology and significance criteria, a review of the baseline conditions including an exploration of the existing environment of the site and surrounding area, an evaluation of results and the potential impact of emissions on human health and protected conservation areas during operation and, finally, conclusions of the assessment.

1 European Directive 2010/75/EU.

2 Dual fuelled utilising biogas (primary fuel) or ultra-low sulphur gas oil.

2. Emission Sources

2.1 Emission Sources to Air

The location of the assessed CHP engine (emission point reference A1) and boilers (emission point reference A2 and A3) are presented in Figure 1.

The CHP engine and boilers (when utilising biogas) are fuelled by biogas generated from the site's anaerobic digestion process and emissions were modelled on this basis. As discussed previously, the boilers are a dual-fuel design and can run on biogas or gas-oil. However, for this assessment they have been modelled utilising biogas as this gives a worst-case scenario for emissions of NOx, typically the pollutant of main concern. The modelling only considers emissions from the CHP engine and boilers and no other emission points to air at the site have been included in the assessment.

It should be noted there are two generators on-site, which are only used during an emergency and typically operate less than 50 hours per year. These generators do not form part of the scope for Environmental Permit and have therefore not been included in the assessment.

Table 2-1 presents the emissions sources to air considered in this assessment.

Table 2-1: Combustion plant considered in this assessment

Parameters	MWM TCG 2016 V12 CHP engine (1.4 MWth)	Strebel boiler (0.7 MWth)	Strebel boiler (0.7 MWth)
Modelled fuel	Biogas	Duel fuelled (modelled as biogas)	Duel fuelled (modelled as biogas)
Emission point	A1	A2	A3

This assessment has been carried out on the assumption that the CHP engine and boilers operate continuously at maximum load throughout the year (i.e. 8,760 hours). This is a conservative assumption as, in practice, the CHP engine will have periods of shut-down and maintenance and may not always operate at maximum load. Furthermore, the boilers are unlikely to operate simultaneously and for more than 6,000 hours per year. However, for predicted modelled concentrations, it is assumed all assessed combustion plant operate continuously as this approach ensures that the worst-case or maximum long-term (i.e. annual mean) and short-term modelled concentrations are quantified (further consideration of this is provided in Appendix A).

2.2 Emissions Data

2.2.1 Emission concentration of pollutants

For the assessed CHP engine, the NOx, CO and TVOC emission concentrations were derived from the Environment Agency's guidance '*Guidance for monitoring landfill gas engine emissions*' (Environment Agency, 2010). It should be noted the NOx emission concentration applied as a basis of the assessment (i.e. 186 mg/Nm^3) is considerably higher than the NOx concentration recorded from on-site monitoring of the assessed boilers (i.e. 119 mg/Nm^3) (ESG, 2016).

For SO_2, in the absence of a specific emission limit value, the SO_2 emission concentration typically used in similar permit applications for biogas fuelled engines has been applied[3]. This is a conservative approach to the assessment as in practice, the CHP engine SO_2 emission concentration is likely to be lower than that applied in the model. For particulates, in the absence of a specific emission limit value, the emission concentration was derived from a previous study of landfill gas engines (Land Quality Management Ltd, 2002).

3 See Permit number EPR/PB3238RK/V002 which concerns a similar site configuration owned by Thames Water Utilities Limited at the Beckton Sewage Treatment Works Combustion Facility.

For the boilers, as a worst-case approach to the assessment, the NOx and SO_2 emission concentrations are based on the emission limit values for existing MCP (greater than 1 MWth) other than engines and gas turbines as regulated under the Medium Combustion Plant Directive (MCPD) EU/2015/2193[4] (European Union, 2015). This is a conservative approach as technically both boilers fall outside of the scope of MCPD as they are below the 1 MW threshold to be classified as MCP. For CO and TVOC, in the absence of a specific emission limit value, the CO emission concentration was obtained from the value for natural gas from Defra's Process Guidance Note 1/3,'*Statutory Guidance for Boilers and Furnaces 20-50MW thermal input*' (Defra, 2012) and the TVOC emission concentration was derived from the Environment Agency's guidance '*Guidance for monitoring landfill gas engine emissions*', (Environment Agency, 2010).

2.2.2 Other emission parameters

For the assessed CHP engine, the temperature, oxygen and moisture content and exhaust gas volumetric flow rate were obtained from monitoring of the assessed CHP engine (ESG, 2016).

For the boilers, the exhaust gas volumetric flow was determined using stoichiometric calculations based on the combustion of biogas fuel at the maximum thermal input rating of each boiler. In the absence of information regarding temperature, oxygen and moisture content of the boilers, the data used in the model is based on professional judgment.

The emissions inventory of releases to air from the CHP engine and boilers are provided in Appendix A.

4 European Parliament and the Council of the European Union, Medium Combustion Plant Directive EU/2015/2193 of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants and as transposed into Schedule 25A of The Environmental Permitting (England and Wales) (Amendment) Regulations 2018 (United Kingdom (UK) Government, 2018.

3. Assessment Methodology

This section presents a summary of the methodology used for the assessment of the potential impacts of the site. A full description of the study inputs and assumptions are provided in Appendix A.

3.1 Assessment Location

For this assessment, 26 of the closest sensitive human receptors (such as residential properties and Public Rights of Way (PRoW)) near the site were identified for modelling purposes. The location of these receptors are presented in Figure 2.

In line with the Environment Agency guidance '*Air emissions risk assessment for your environmental permit*' (Environment Agency, 2023), it is necessary to identify protected conservation areas within the following distances from the site:

- European sites (i.e. Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar sites) within 10 km; and
- Site of Special Scientific Interest (SSSI) and local nature sites (i.e. ancient woodlands, local wildlife sites (LWS) and national and local nature reserves (NNR and LNR)), within 2 km.

Based on these criteria, Windsor Forest & Great Park SAC & SSSI, Thames Basin Heaths SPA and 20 local nature sites comprising AW's, LNR's and LWS's, were included in the assessment.

The location of the assessed protected conservation areas are presented in Figure 3 and further details are set out in Appendix A.

3.2 Overall Methodology

The assessment was carried out using an atmospheric dispersion modelling technique. Atmospheric Dispersion Modelling System (ADMS) version 5.2.4 was used to model releases of the identified substances. The ADMS model predicts the dispersion of operational emissions from a specific source (e.g. a stack), and the subsequent concentrations over an identified area (e.g. at ground level across a grid of receptor points) or at specified points (e.g. a residential property). ADMS was selected because this model is fit for the purpose of modelling the emissions from the type of sources on-site (i.e. point source emissions from a combustion source) and is accepted as a suitable assessment tool by the Environment Agency.

The modelling assessment was undertaken in accordance with the Environment Agency guidance '*Air emissions risk assessment for your environmental permit*' (Environment Agency, 2023).

A summary of the dispersion modelling procedure is set out below.

1. Information on plant location and stack parameters were supplied by Thames Water (Thames Water, 2023). Information on the CHP engine and the boilers were obtained from various sources as described in Section 2.2.
2. Five years of hourly sequential data recorded at the Farnborough meteorological station (2015 – 2019 inclusive) were used for the assessment (ADM Ltd, 2022).
3. Information on the main buildings located on-site, that could influence dispersion of emissions from the CHP engine and boiler stacks were estimated from Defra's environmental open-data applications and datasets (Defra, 2023a) and Google Earth (Google Earth, 2023).
4. The maximum predicted concentrations (at a modelled height of 1.5 m or 'breathing zone') at the assessed sensitive human receptor locations R1 – R22 (representing long-term exposure at residential properties) were considered for the assessment of annual mean, 24-hour mean, 8-hour mean, 1-hour mean and 15-minute mean pollutant concentrations within the study area. For receptors R23-R26 (representing a PRoW), only the 1-hour mean and 15-minute mean concentrations were considered. The maximum predicted concentrations at an off-site location in the vicinity of the site were considered for the assessment of short-term (1-hour and 15-minute mean) concentrations.
5. The above information was entered into the dispersion model.
6. The dispersion model was run to provide the Process Contribution (PC). The PC is the estimated maximum environmental concentration of substances due to releases from the process alone. The results were then combined with baseline concentrations (see Section 4) to provide the Predicted Environmental Concentration (PEC) of the substances of interest.

7. The PECs were then assessed against the appropriate environmental standards for air emissions for each substance set out in the Environment Agency's guidance (Environment Agency, 2023) document to determine the nature and extent of any potential adverse effects.
8. Modelled concentrations were processed using geographic information system (GIS) software (ArcMap 10.8.1) to produce contour plots of the model results. These are provided for illustrative purposes only; assessment of the model results was based on the numerical values outputted by the dispersion model on the model grid (see Figure 2) and at the specific receptor locations and were processed using Microsoft Excel.
9. The predicted concentrations of NOx and SO_2 were also used to assess the potential impact on critical levels and critical loads (i.e. acid and nutrient nitrogen deposition) (see Section 3.3.2) at the assessed protected conservation areas. Details of the deposition assessment methodology are provided in **Error! Reference source not found.**.

In addition to the above, a review of existing ambient air quality in the area was undertaken to understand the baseline conditions at the site and at receptors within the study area. These existing conditions were determined by reviewing the monitoring data already available for the area and other relevant sources of information. The review of baseline air quality is set out in Section 4.

Where appropriate, a conservative approach has been adopted throughout the assessment to increase the robustness of the model predictions. In addition, an analysis of various sensitivity scenarios has also been carried out (see Section 5.3) to determine how changes to model parameters (e.g. differing surface roughness values or modelling without considering buildings) may impact on predicted concentrations at sensitive human receptors and off-site locations.

3.3 Assessment Criteria

3.3.1 Environmental Quality Standards: Human Receptors

In the UK, the focus on local air quality is reflected in the air quality objectives (AQOs) set out in the *Air Quality Strategy for England, Scotland, Wales and Northern Ireland* (AQS) (Defra and the Devolved Administrations, 2007). The AQS stipulates a number of air quality objectives for nine main air pollutants with respect to ambient levels of air quality (Defra, 2007). The AQOs are similar to the limit values that were transposed from the relevant EU directives into UK legislation by The Air Quality Standards Regulations 2010 (UK Government, 2010). The objectives are based on the current understanding of health effects of exposure to air pollutants and have been specified to control health and environmental risks to an acceptable level. They apply to places where people are regularly present over the relevant averaging period. The objectives set for the protection of human health and vegetation of relevance to the project are summarised in Table 3-1. Relevant Environmental Assessment Levels (EALs) set out in the Environment Agency guidance (Environment Agency, 2023) are also included in Table 3-1 where these supplement the AQOs.

For the purposes of reporting, the AQOs and EALs have been collectively termed as Environmental Quality Standards (EQSs).

Table 3-1: Air quality objectives and environmental assessment levels

Pollutant	EQS (µg/m^3)	Concentration measured as
NO_2	40	Annual mean
	200	1-hour mean, not to be exceeded more than 18 times a year (99.79th percentile)
CO	10,000	Maximum daily 8 hour running mean (100th percentile)
	30,000	Maximum 1-hour mean (100th percentile)
SO_2	125	24-hour mean not to be exceeded more than 3 times a year (99.18th percentile)
	350	1-hour mean not to be exceeded more than 24 times a year (99.73rd percentile)
	266	15-minute mean not to be exceeded more than 35 times a year (99.9th percentile)
PM_{10}	40	Annual mean
	50	24-hour mean, not to be exceeded more than 35 times a year (90.41st percentile)
$PM_{2.5}$	20	Annual mean
TVOC[1]	5[2]	Annual mean
	30[2]	Maximum 24-hour mean (100th percentile)

Note 1: VOCs may contain a wide range of organic compounds and it is often difficult to determine or identify each and every compound present. The TVOC emissions from the assessed combustion plant will largely comprise methane, which is not directly harmful to human health.
Note 2: For the purposes of this assessment, the annual mean and 24-hour mean AQO for benzene (C_6H_6) has been applied as it is a standard substitute that adequately represents a worst-case scenario for VOCs.

For the assessment of long-term average concentrations (i.e. the annual mean concentrations) at human receptors, impacts were described using the following criteria:

- if the PC is less than 1% of the long-term EQS, the contribution can be considered as 'insignificant' and not representative of a significant effect (i.e. not significant) (Environment Agency, 2023);
- if the PC is greater than 1% of the EQS but the PEC is less than 70% of the long-term air quality objective, based on professional judgement, this would be classed as 'not significant'; and
- where the PC is greater than 1% of the EQS and the PEC is greater than 70% of the EQS, professional judgement is used to determine the overall significance of the effect (i.e. whether the effect would be 'not significant' or 'significant'), taking account of the following:
    - the scale of the changes in concentrations;
    - whether or not an exceedance of an EQS is predicted to arise in the study area where none existed before, or an exceedance area is substantially increased as a result of the development; and
    - uncertainty, including the influence and validity of any assumptions adopted in undertaking the assessment.

For the assessment of short-term average concentrations (e.g. the 1-hour mean NO_2 concentrations, and the 15-minute, 1-hour and 24-hour mean SO_2 concentrations etc.), impacts were described using the following criteria:

- if the PC is less than 10% of the short-term EQS, this would be classed as 'insignificant' and not representative of a significant effect (i.e. not significant) (Environment Agency, 2023);
- if the PC is greater than 10% of the EQS but less than 20% of the headroom between the short-term background concentration and the EQS, based on professional judgement, this can also be described as not significant; and
- where the PC is greater than 10% of the EQS and 20% of the headroom, professional judgement is used to determine the overall significance of the effect (i.e. whether the effect would be not significant or significant) in line with the approach specified above for long-term average concentrations.

Environment Agency guidance recommends that further action will not be required if proposed emissions comply with Best Available Techniques Associated Emission Levels (BAT AELs) and resulting PECs do not exceed the relevant EQS (Environment Agency, 2023).

3.3.2 Environmental Quality Standards: Protected Conservation Areas

Critical levels

The environmental standards set for protected conservation areas of relevance to the project are summarised in Table 3-2 (Environment Agency, 2023).

Table 3-2: Air Quality Objectives and Environmental Assessment Levels for protected conservation areas

Pollutant	EQS ($\mu g/m^3$)	Concentration measured as
NOx	30	Annual mean limit value for the protection of vegetation (referred to as the "critical level")
	75	Maximum 24-hour mean for the protection of vegetation (referred to as the "critical level")
SO_2	10	Annual mean limit value for the protection of vegetation (referred to as the "critical level") where lichens or bryophytes are present
	20	Annual mean limit value for the protection of vegetation (referred to as the "critical level") where lichens or bryophytes are not present

Critical loads

Critical loads for pollutant deposition to statutorily designated habitat sites in the UK and for various habitat types have been published by the CEH and are available from the APIS website. Critical Loads are defined on the APIS website (Centre for Ecology and Hydrology, 2023) as:

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

Compliance with these benchmarks is likely to result in no significant adverse effects on the natural environment at these locations. The critical loads for the designated habitat sites considered in this assessment are set out in Table 3-3. For Windsor Forest & Great Park SAC & SSSI and Thames Basin Heaths SPA, the Site Relevant Critical Loads tool function on the APIS website was used to determine the relevant critical loads for the assessed protected conservation areas. It should be noted where both vegetation types (i.e. short or tall) are listed on the APIS website as being present at the assessed protected conservation areas, the most sensitive habitat for both short and tall vegetation was applied in the assessment, irrespective of whether the vegetation is actually present at the modelled locations.

For the assessed local nature sites, the Search by Location function on the APIS website was used. Where both short and tall vegetation type is assumed to inhabit the assessed local nature sites, the acid grassland and coniferous woodland habitat feature were selected on the APIS website which are generally the most sensitive short and tall vegetation type to nutrient nitrogen and acid deposition.

The critical loads for the designated habitat sites considered in this assessment are set out in Table 3-3.

Table 3-3: Critical loads for modelled protected conservation areas

Rec ref	Protected conservation area	Habitat feature applied	Vegetation type (for deposition velocity)	Critical load			
				Acid deposition (kEqH+/ha/year)			Nitrogen deposition (kg N/ha/year)
H1	Windsor Forest & Great Park SAC & SSSI	Acidophilous Quercus-dominated woodland	Tall	0.759	0.142	1.044	10
H2	Thames Basin Heaths SPA	Dry heaths	Short	0.211	0.499	0.862	10
		Unmanaged Broadleafed/Coniferous Woodland	Tall	0.251	0.142	0.536	5
H3	(Epoch 3: Levers Piece)(Tithe: Marsh Coppice) AW	Coniferous woodland	Tall	1.722	0.357	2.079	5

Rec ref	Protected conservation area	Habitat feature applied	Vegetation type (for deposition velocity)	Critical load			
				Acid deposition (kEqH+/ha/year)			Nitrogen deposition (kg N/ha/year)
H4	Hazelwood Copse AW	Coniferous woodland	Tall	2.351	0.357	2.708	5
H5	Hazelwood Copse (Tithe: Haughfords Grove) AW	Coniferous woodland	Tall	2.351	0.357	2.708	5
H6	Warfield Hall: The Grove AW	Coniferous woodland	Tall	2.354	0.357	2.711	5
H7	Long Copse (Tithe Long Coppice) AW & LWS	Coniferous woodland	Tall	2.351	0.357	2.708	5
H8	(Tithe: Furzes Coppice) AW	Coniferous woodland	Tall	2.352	0.357	2.709	5
H9	Tinker's Copse(Tithe: An Intake) AW and LNR	Acid grassland	Short	1.630	0.438	2.068	5
		Coniferous woodland	Tall	2.352	0.357	2.709	5
H10	Jock's Copse (Tithe: Jocks Coppice) AW& LNR	Acid grassland	Short	1.630	0.438	2.068	5
		Coniferous woodland	Tall	2.352	0.357	2.709	5
H11	(Tithe: Temple Coppice)(Bryony Copse/Temple Copse) AW, LNR & LWS	Acid grassland	Short	1.630	0.438	2.068	5
		Coniferous woodland	Tall	2.352	0.357	2.709	5
H12	Binfield Hall (Ancient & Semi-Natural Woodland ID 1504859) AW & LWS	Coniferous woodland	Tall	2.315	0.357	2.672	5
H13	Hawland's Copse(Tithe: Hawlands Coppice) AW & LWS	Coniferous woodland	Tall	2.314	0.357	2.671	5
H14	(Epoch 3. Point Copse. Tithe: Stackpool Coppice) AW	Coniferous woodland	Tall	1.719	0.357	2.076	5
H15	(Epoch 3: Wilson's Copse)(Tithe: Burgess Coppice; Rocque: Hasel Wood)) AW	Coniferous woodland	Tall	1.719	0.357	2.076	5
H16	Westhatch Corner AW	Coniferous woodland	Tall	2.355	0.357	2.712	5
H17	Piggy Wood LNR & LWS	Coniferous woodland	Tall	2.354	0.357	2.711	5
H18	Hazelwood Copse LWS	Coniferous woodland	Tall	2.354	0.357	2.711	5
H19	Hazelwood Meadow/ Hazelwood House Garden LWS	Acid grassland	Short	0.880	0.438	1.318	5
		Coniferous woodland	Tall	1.722	0.357	2.079	5
H20	Ryehurst Meadow LWS	Acid grassland	Short	1.630	0.438	2.068	5
		Coniferous woodland	Tall	2.351	0.357	2.708	5
H21	Binfield Manor LWS	Acid grassland	Short	1.630	0.438	2.068	5
		Coniferous woodland	Tall	2.351	0.357	2.708	5
H22	Tinkers Copse LWS and Jock's Copse LWS	Acid grassland	Short	1.630	0.438	2.068	5
		Coniferous woodland	Tall	2.352	0.357	2.709	5

Critical load functions for acid deposition are specified on the basis of both nitrogen and sulphur derived acid. The critical load function contains a value for sulphur derived acid and two values for nitrogen derived acid deposition (a minimum and maximum value). The APIS website provides advice on how to calculate the PC (i.e. emissions from the modelled process alone) and the PEC (i.e. the PC added to the existing deposition) as

a percentage of the acid critical load function and how to determine exceedances of the critical load function. This guidance was adopted for this assessment. The minimum of the range of nitrogen critical loads was used for the assessment in line with the advice on the APIS website (Centre for Ecology and Hydrology, 2023).

Significance Criteria – European designated sites (i.e. SPA's and SAC's)

With regard to concentrations at the assessed designated habitat site, the Environment Agency guidance (Environment Agency, 2023) states emissions can be described as 'insignificant' and no further assessment is required (including the need to calculate PECs) if:

- the short-term PC is less than 10% of the short-term environmental standard for protected conservation areas; or
- the long-term PC is less than 1% of the long-term environmental standard for protected conservation areas.

Where appropriate, the significance of the predicted long-term (annual mean) concentrations or deposition at protected conservation areas were determined in line with Environment Agency guidance (Environment Agency, 2023) summarised as follows:

- Where the PC is less than 1% of the relevant critical level or critical load, the emission is not likely to have a significant effect alone or in combination irrespective of the existing concentrations or deposition rates.
- Where the PC is above 1%, further consideration of existing background concentrations or deposition rates is required, and where the total concentration or deposition is less than 70% of the critical level or critical load, calculated in combination with other committed projects or developments as appropriate, the emission is not likely to have a significant effect.
- Where the contribution is above 1%, and the total concentration or deposition rate is greater than 70% of the critical level or critical load, either alone or in combination with other committed projects or developments, then this may indicate a significant effect and further consideration is likely to be required.

The above approach is used to give a clear definition of what effects can be disregarded as 'insignificant', and which need to be considered in more detail in relation to the predicted annual mean concentrations or deposition.

For short-term mean concentrations (i.e. the 24-hour mean critical level for NOx) where the PC is less than 10% of the critical level then it would be regarded as 'insignificant'. A potentially significant effect would be identified where the short-term PC from the modelled sources would lead to the total concentration exceeding the critical level. Further consideration is likely to be required in this situation.

Significance Criteria – Local nature sites (i.e. LNR's, LWS's and AW's)

The relevant significance criteria for these protected conservation areas are set out below.

With regard to concentrations or deposition rates at local nature sites, the Environment Agency guidance (Environment Agency, 2023) states emissions can be described as 'insignificant' and no further assessment is required (including the need to calculate PECs) if:

- the short-term PC is less than 100% of the short-term environmental standard for protected conservation areas; or
- the long-term PC is less than 100% of the long-term environmental standard for protected conservation areas.

The above approach is used to give a clear definition of what effects can be disregarded as 'insignificant', and which need to be considered in more detail in relation to the predicted annual mean concentrations or deposition.

4. Existing Environment

4.1 Location

The site is situated approximately 2.6 km north-northwest from the centre of the town of Bracknell, Berkshire. The area surrounding the site generally comprises open grassland and woodland interspersed with residential properties. Hazelwood Copse (tithe: Haughfords Grove) AW and Hazelwood Copse LWS are adjacent to the northern and eastern boundary of the site, respectively, and Hazelwood Lane (which is also a PRoW) runs alongside the southern and eastern boundary of the site.

There are several sensitive human receptors in the vicinity of the site in respect of potential air emissions from the process. The most relevant sensitive receptors have been identified from local mapping and are summarised in Appendix A and presented in Figure 2. The nearest modelled residential property is approximately 450 m northwest of the CHP engine. The nearest modelled receptor is a PRoW adjacent to the eastern and southern boundary of the site approximately 30 m south-southeast of the CHP engine at its closest point.

4.2 Local Air Quality Management

A review of baseline air quality was carried out prior to undertaking the air quality assessment. This was carried out to determine the availability of baseline air quality data recorded in the vicinity of the site and also if data from other regional or national sources such as the UK Air Information Resource (UK-AIR) (Defra, 2023b) website could be used to represent background concentrations of the relevant pollutants in the vicinity of the site.

As part of the Local Air Quality Management (LAQM) process, two Air Quality Management Areas (AQMAs) (termed 'Area 1 AQMA' and 'Area 2 AQMA') were declared in February 2011 by Bracknell Forest Borough Council for exceedances of the annual mean objective for NO_2. The closest of these AQMAs is 'Area 1 AQMA', which is approximately 2.9 km south-southeast of the CHP engine and is not considered further in the assessment due to its distance from the site.

Bracknell Forest Borough Council also carries out regular assessments and monitoring of air quality within the borough as part of the LAQM process. The most recent Air Quality Annual Status Report (Bracknell Forest Borough Council, 2022) was reviewed to determine the concentrations of NO_2 and PM_{10} in the vicinity for the site. It should be noted that none of the other assessed pollutants are monitored by Bracknell Forest Borough Council. Table 4-1 presents information on the nearest monitoring locations to the site. It should be noted that with the exception of monitoring location ID '130', Table 4-1 presents the 2019 monitored annual mean NO_2 concentrations as this dataset is the latest available representative data not affected by the Covid pandemic and related travel restrictions.

Table 4-1: Nearest monitoring locations to the site

Site ID	Description	Site type	Location	Distance and direction from CHP engine stack	Pollutants monitored	2019 Annual mean concentration ($\mu g/m^3$)
Automatic monitoring						
CM3	Downshire Way	Roadside	E 486501 N 168850	3.1 km, SSE	NO_2	33.6
					PM_{10}	17.2
Non-automatic monitoring (diffusion tubes)						
84	24/26 Dukes Ride (Playhouse)	Kerbside	E 484498 N 169700	2.6 km, SW	NO_2	23.9
130	Stet House, Albert Road, RG42 2AB	Kerbside	E 486802 N 169617	2.4 km, SSE	NO_2	18.8[1]

Note 1: Monitoring undertaken from 2020 onwards.

The automatic and non-automatic monitoring locations presented in Table 4-1 are not considered representative of the site due to the monitoring location type and/or distance from the site. In the case of automatic monitoring station CM3, the monitoring location is adjacent to the A322, it is not considered representative of the conditions experienced at the site.

For the assessed pollutants, information on background air quality in the vicinity of the site was obtained from Defra background map datasets (Defra, 2023b). The 2018-based background maps by Defra are estimates based upon the principal local and regional sources of emissions and ambient monitoring data. For SO_2 and CO concentrations, the 2001-based background maps were used. For TVOC concentrations, the 2010-based background maps for C_6H_6 were used. These background concentrations are presented in Table 4-2.

As it is necessary to determine the potential impact of emissions from the site at the assessed protected conservation areas, the background concentrations of NOx and SO_2 were also identified. These background concentrations were also obtained from the Defra background map datasets (Defra, 2023b) and are displayed in Table 4-2.

Table 4-2: Background concentrations: adopted for use in assessment for human receptors and protected conservation areas

Pollutant	Annual mean concentration ($\mu g/m^3$)	Description
Human receptors		
NO_2	10.1 – 11.0	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2023 map concentration
CO	165 – 185	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2001 based map concentration
PM_{10}	13.0 – 14.0	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2023 map concentration
$PM_{2.5}$	8.9 – 9.8	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2023 map concentration
SO_2	3.2 - 3.6	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2001 based map concentration
C_6H_6	0.4 – 0.5	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2010 map concentration for benzene
Protected conservation areas		
NOx	12.9 – 14.7	Defra 1 km x 1 km background map value for the assessed protected conservation areas, 2023 map concentration
SO_2	3.1 – 4.2	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2001based map concentration

The long-term background concentrations were doubled to estimate the short-term background concentrations in line with the Environment Agency guidance (Environment Agency, 2021).

4.3 Existing Deposition Rates

Existing acid and nutrient nitrogen deposition levels were obtained from APIS (Centre for Ecology and Hydrology, 2023). As a conservative approach to the assessment, it is assumed the vegetation type selected is present at the specific modelled location within the assessed protected conservation area.

The existing deposition values at the assessed ecological designations are set out in Table 4-3.

Table 4-3: Existing deposition at modelled habitat sites

Rec ref	Protected conservation area	Vegetation type (for deposition velocity)	Existing deposition rates	
			Existing acid deposition (kEqH+/ha/year)	Existing nutrient N deposition (kg N/ha/year)
			Nitrogen + Sulphur	Nitrogen
H1	Windsor Forest & Great Park SAC & SSSI	Tall	2.01	27.40
H2	Thames Basin Heaths SPA	Short	1.26	16.40
		Tall	2.20	29.10
H3	(Epoch 3: Levers Piece)(Tithe: Marsh Coppice) AW	Tall	2.16	27.52
H4	Hazelwood Copse AW	Tall	2.16	27.52
H5	Hazelwood Copse (Tithe: Haughfords Grove) AW	Tall	2.16	27.52
H6	Warfield Hall: The Grove AW	Tall	2.16	27.52
H7	Long Copse (Tithe Long Coppice) AW and LWS	Tall	2.16	27.52
H8	(Tithe: Furzes Coppice) AW	Tall	2.16	27.52
H9	Tinker's Copse(Tithe: An Intake) AW and LNR	Short	1.23	15.16
		Tall	2.16	27.52
H10	Jock's Copse (Tithe: Jocks Coppice) AW and LNR	Short	1.23	15.16
		Tall	2.16	27.52
H11	(Tithe: Temple Coppice)(Bryony Copse/Temple Copse) AW, LNR and LWS	Short	1.23	15.16
		Tall	2.16	27.52
H12	Binfield Hall (Ancient & Semi-Natural Woodland ID 1504859) AW & LWS	Tall	2.29	29.48
H13	Hawland's Copse(Tithe: Hawlands Coppice) AW and LWS	Tall	2.29	29.48
H14	(Epoch 3. Point Copse. Tithe: Stackpool Coppice) AW	Tall	2.16	27.52
H15	(Epoch 3: Wilson's Copse)(Tithe: Burgess Coppice; Rocque: Hasel Wood)) AW	Tall	2.16	27.52
H16	Westhatch Corner AW	Tall	2.16	27.52
H17	Piggy Wood LNR and Piggy Wood LWS	Tall	2.16	27.52
H18	Hazelwood Copse LWS	Tall	2.16	27.52
H19	Hazelwood Meadow/ Hazelwood House Garden LWS	Short	1.23	15.16
		Tall	2.16	27.52
H20	Ryehurst Meadow LWS	Short	1.23	15.16
		Tall	2.16	27.52
H21	Binfield Manor LWS	Short	1.23	15.16
		Tall	2.16	27.52
H22	Tinkers Copse LWS and Jock's Copse LWS	Short	1.23	15.16
		Tall	2.16	27.52

5. Results

5.1 Human Receptors

The results presented below are the maximum modelled concentrations predicted at any of the 26 assessed sensitive human receptor locations and the maximum modelled concentrations at any off-site location for the five years of meteorological data used in the study.

The results of the dispersion modelling are set out in Table 5-1, which presents the following information:

- EQS (i.e. the relevant air quality standard);
- estimated annual mean background concentration (see Section 4) that is representative of the baseline;
- PC, the maximum modelled concentrations due to the emissions from the assessed combustion plant;
- PEC, the maximum modelled concentration due to process emissions combined with estimated baseline concentrations;
- PC and PEC as a percentage of the EQS; and
- PC as a percentage of headroom (i.e. the PC as a percentage of the difference between the short-term background concentration and the EQS, for short-term predictions only).

The full results at assessed human receptor locations are presented in Appendix C.

Table 5-1: Results of detailed assessment

Pollutant	Averaging period	Assessment location	Location where maximum PC predicted	EQS ($\mu g/m^3$)	Baseline air quality level ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC / EQS (%)	PEC / EQS (%)	PC as a percentage of headroom (%)
CO	Maximum 8-hour running mean	Sensitive locations	R20	10,000	335	23.4	358.5	0.2%	3.6%	0.2%
	Maximum 1-hour mean	Maximum off-site	E 486018 N 171825	30,000	332	448.5	780.0	1.5%	2.6%	1.5%
		Sensitive locations	R25	30,000	349	362.6	712.1	1.2%	2.4%	1.2%
NO_2	Annual mean	Sensitive locations	R5	40	10.3	0.4	10.7	0.9%	26.8%	-
	1-hour mean (99.79th percentile)	Maximum off-site	E 486018 N 171825	200	20.7	68.9	89.6	34.4%	44.8%	38.4%
		Sensitive locations	R25	200	20.9	50.4	71.3	25.2%	35.7%	28.1%
SO_2	24-hour mean (99.18th percentile)	Sensitive locations	R20	125	6.3	3.7	10.0	2.9%	8.0%	3.1%
	1-hour mean (99.73rd percentile)	Maximum off-site	E 486018 N 171825	350	6.4	139.2	145.7	39.8%	41.6%	40.5%
		Sensitive locations	R25	350	6.5	103.4	109.9	29.5%	31.4%	30.1%
	15-minute mean (99.9th percentile)	Maximum off-site	E 486018 N 171825	266	6.4	151.4	157.8	56.9%	59.3%	58.3%
		Sensitive locations	R25	266	6.5	108.5	115.0	40.8%	43.2%	41.8%
PM_{10}	Annual mean	Sensitive locations	R5	40	13.2	0.01	13.2	0.02%	33.0%	-
	24-hour mean (90.41st percentile)	Sensitive locations	R20	50	26.0	0.03	26.1	0.1%	52.2%	0.1%
$PM_{2.5}$	Annual mean	Sensitive locations	R5	20	9.0	0.01	9.0	0.05%	45.1%	-
TVOC	Annual mean	Sensitive locations	R5	5 (C_6H_6)	0.4	1.7	2.0	33.4%	40.9%	-
	Maximum 24-hour mean	Sensitive locations	R19	30 (C_6H_6)	0.7	25.6	26.3	85.3%	87.8%	87.5%

Note 1: For annual mean NO_2, PM_{10} and $PM_{2.5}$ and TVOC concentrations, 24-hour mean PM_{10} and SO_2 concentrations and 8-hour mean CO concentrations, R23 – R26 have been omitted from analysis as these receptor locations represent PRoW (i.e. short-term exposure only). The full results are presented in Appendix D.

The results in Table 5-1 indicate that the predicted modelled off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term EQS.

Table 5-1 indicates that for annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations, the respective PCs are less than 1% of the relevant long-term EQS and their impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2023), and therefore 'not significant'.

For short-term NO_2, CO, SO_2 and particulate concentrations, the PCs are either less than 10% of the relevant EQS, or where the PCs are above 10% of the relevant EQS, the PECs are less than 70% of the relevant EQS and the impacts are considered 'not significant'.

For annual mean TVOC concentrations at a sensitive human receptor location, the maximum PC of 1.7 µg/m^3 is predicted at R5, which represents a residential property approximately 790 m east-northeast of the CHP engine. The corresponding PEC is less than 70% (i.e. 40.9%) of the annual mean EQS for C_6H_6.

For maximum 24-hour mean TVOC concentrations at a sensitive human receptor location, the maximum PC of 25.6 µg/m^3 is predicted at R19, which represents a residential property 450 m northwest of the CHP engine. The corresponding PEC of 26.3 µg/m^3 is within the 24-hour mean EQS for C_6H_6 (i.e. 30 µg/m^3).

This assessment assumes all TVOCs emitted by the assessed combustion plant are C_6H_6. This is an overly conservative assumption, and C_6H_6, if present in the exhaust gases, would constitute only a very small proportion of total TVOC emissions (e.g. less than 1%). Therefore, informed by a wider understanding of the properties of biogas, the emissions of TVOCs is considered 'not significant'.

The conservative approach adopted throughout the assessment means the predicted concentrations presented in Table 5-1 are likely to be higher than would reasonably be expected.

Isopleths (see Figures 4 and Figure 5) have been produced for annual mean and 1-hour mean (99.79th percentile) NO_2 concentrations. The figures are based on the year of meteorological data which resulted in the highest PC at a sensitive human receptor location.

5.2 Protected Conservation Areas

5.2.1 Assessment against Critical Levels

The environmental effects of releases from the site at the assessed protected conservation areas have been determined by comparing predicted concentrations of released substances with the EQSs for the protection of vegetation (critical levels) (see Table 3-2). The results of the detailed modelling at the assessed protected conservation area are shown in Table 5-2. The results presented are the maximum predicted concentrations at the modelled locations for the five years of meteorological data used in the study area.

For SO_2, the relevant EQS was based on the assumption that lichens and bryophytes were present at the assessed protected conservation areas, therefore adopting the lower critical level of 10 µg/m^3 (compared to 20 µg/m^3) as a conservative approach.

Table 5-2: Results of detailed assessment at assessed protected conservation sites for annual mean NOx and SO_2 concentrations and for maximum 24-hour mean NOx concentrations

Rec ref	Protected Conservation Area	EQS ($\mu g/m^3$)	Background concentration ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS (%)	PEC/EQS (%)
Annual mean NOx concentrations							
H1	Windsor Forest & Great Park SAC & SSSI	30	13.0	0.04	13.1	0.1%	43.6%
H2	Thames Basin Heaths SPA		14.1	0.01	14.1	0.0%	47.0%
H3	(Epoch 3: Levers Piece)(Tithe: Marsh Coppice) AW		13.4	0.99	14.4	3.3%	47.9%
H4	Hazelwood Copse AW		14.1	7.42	21.6	24.7%	71.8%
H5	Hazelwood Copse (Tithe: Haughfords Grove) AW		14.1	8.96	23.1	29.9%	77.0%
H6	Warfield Hall: The Grove AW		13.8	1.34	15.2	4.5%	50.5%
H7	Long Copse (Tithe Long Coppice) AW & LWS		14.1	0.15	14.3	0.5%	47.6%
H8	(Tithe: Furzes Coppice) AW		14.3	0.09	14.3	0.3%	47.8%
H9	Tinker's Copse(Tithe: An Intake) AW & LNR		14.3	0.07	14.3	0.2%	47.8%
H10	Jock's Copse AW & LNR		14.3	0.06	14.3	0.2%	47.7%
H11	(Tithe: Temple Coppice)(Bryony Copse/Temple Copse) AW, LNR & LWS		14.3	0.06	14.3	0.2%	47.7%
H12	Binfield Hall (Ancient & Semi-Natural Woodland ID 1504859) LWS and AW		14.0	0.05	14.0	0.2%	46.7%
H13	Hawland's Copse(Tithe: Hawlands Coppice) AW & LWS		12.9	0.04	12.9	0.1%	43.1%
H14	(Epoch 3. Point Copse. Tithe: Stackpool Coppice) AW		12.9	0.05	12.9	0.2%	43.2%
H15	(Epoch 3: Wilson's Copse)(Tithe: Burgess Coppice; Rocque: Hasel Wood)) AW		12.9	0.09	13.0	0.3%	43.3%
H16	Westhatch Corner AW		12.9	0.20	13.1	0.7%	43.7%
H17	Piggy Wood LNR and Piggy Wood LWS		14.7	0.05	14.8	0.2%	49.2%
H18	Hazelwood Copse LWS		13.8	11.54	25.3	38.5%	84.5%
H19	Hazelwood Meadow/ Hazelwood House Garden LWS		13.4	0.14	13.5	0.5%	45.1%
H20	Ryehurst Meadow LWS		14.1	0.40	14.5	1.3%	48.4%
H21	Binfield Manor LWS		14.1	0.24	14.4	0.8%	47.9%
H22	Tinkers Copse LWS and Jock's Copse LWS		14.3	0.09	14.4	0.3%	47.8%
Annual mean SO_2 concentrations							

Rec ref	Protected Conservation Area	EQS (µg/m^3)	Background concentration (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
H1	Windsor Forest & Great Park SAC & SSSI	10	3.3	0.03	3.3	0.3%	33.1%
H2	Thames Basin Heaths SPA		3.1	0.01	3.1	0.1%	30.8%
H3	(Epoch 3: Levers Piece)(Tithe: Marsh Coppice) AW		3.2	0.75	3.9	7.5%	39.0%
H4	Hazelwood Copse AW		3.3	5.72	9.0	57.2%	90.4%
H5	Hazelwood Copse (Tithe: Haughfords Grove) AW		3.3	6.93	10.2	69.3%	102.5%
H6	Warfield Hall: The Grove AW		3.2	1.00	4.2	10.0%	42.3%
H7	Long Copse (Tithe Long Coppice) AW & LWS		3.3	0.11	3.4	1.1%	34.3%
H8	(Tithe: Furzes Coppice) AW		3.5	0.06	3.6	0.6%	35.9%
H9	Tinker's Copse(Tithe: An Intake) AW & LNR		3.5	0.06	3.6	0.6%	35.9%
H10	Jock's Copse AW & LNR		3.5	0.05	3.6	0.5%	35.8%
H11	(Tithe: Temple Coppice)(Bryony Copse/Temple Copse) AW, LNR & LWS		3.5	0.04	3.6	0.4%	35.7%
H12	Binfield Hall (Ancient & Semi-Natural Woodland ID 1504859) LWS and AW		4.2	0.04	4.3	0.4%	42.8%
H13	Hawland's Copse(Tithe: Hawlands Coppice) AW & LWS		3.2	0.03	3.2	0.3%	32.0%
H14	(Epoch 3. Point Copse. Tithe: Stackpool Coppice) AW		3.1	0.04	3.1	0.4%	31.3%
H15	(Epoch 3: Wilson's Copse)(Tithe: Burgess Coppice; Rocque: Hasel Wood)) AW		3.1	0.06	3.2	0.6%	31.5%
H16	Westhatch Corner AW		3.2	0.15	3.4	1.5%	33.7%
H17	Piggy Wood LNR and Piggy Wood LWS		3.4	0.04	3.4	0.4%	34.0%
H18	Hazelwood Copse LWS		3.2	8.43	11.7	84.3%	116.6%
H19	Hazelwood Meadow/ Hazelwood House Garden LWS		3.2	0.11	3.3	1.1%	32.6%
H20	Ryehurst Meadow LWS		3.3	0.30	3.6	3.0%	36.2%
H21	Binfield Manor LWS		3.3	0.18	3.5	1.8%	35.0%
H22	Tinkers Copse LWS and Jock's Copse LWS		3.5	0.07	3.6	0.7%	36.0%
Maximum 24-hour mean NOx concentrations							
H1	Windsor Forest & Great Park SAC & SSSI	75	26.1	0.3	26.4	0.5%	35.2%
H2	Thames Basin Heaths SPA		28.2	0.3	28.5	0.4%	38.0%

Rec ref	Protected Conservation Area	EQS (µg/m^3)	Background concentration (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
H3	(Epoch 3: Levers Piece)(Tithe: Marsh Coppice) AW		26.8	8.8	35.5	11.7%	47.4%
H4	Hazelwood Copse AW		28.3	55.7	84.0	74.3%	112.0%
H5	Hazelwood Copse (Tithe: Haughfords Grove) AW		28.3	49.6	77.9	66.1%	103.8%
H6	Warfield Hall: The Grove AW		27.6	9.8	37.4	13.0%	49.9%
H7	Long Copse (Tithe Long Coppice) AW & LWS		28.3	2.9	31.1	3.8%	41.5%
H8	(Tithe: Furzes Coppice) AW		28.5	1.4	29.9	1.9%	39.9%
H9	Tinker's Copse(Tithe: An Intake) AW & LNR		28.5	1.2	29.7	1.6%	39.7%
H10	Jock's Copse AW & LNR		28.5	1.1	29.6	1.5%	39.5%
H11	(Tithe: Temple Coppice)(Bryony Copse/Temple Copse) AW, LNR & LWS		28.5	0.8	29.4	1.1%	39.1%
H12	Binfield Hall (Ancient & Semi-Natural Woodland ID 1504859) LWS and AW		27.9	1.2	29.2	1.6%	38.9%
H13	Hawland's Copse(Tithe: Hawlands Coppice) AW & LWS		25.8	1.0	26.8	1.4%	35.8%
H14	(Epoch 3. Point Copse. Tithe: Stackpool Coppice) AW		25.8	1.1	26.9	1.4%	35.8%
H15	(Epoch 3: Wilson's Copse)(Tithe: Burgess Coppice; Rocque: Hasel Wood)) AW		25.8	1.2	27.0	1.5%	35.9%
H16	Westhatch Corner AW		25.8	1.6	27.3	2.1%	36.5%
H17	Piggy Wood LNR and Piggy Wood LWS		29.4	1.0	30.4	1.3%	40.5%
H18	Hazelwood Copse LWS		27.6	47.7	75.3	63.6%	100.4%
H19	Hazelwood Meadow/ Hazelwood House Garden LWS		26.8	3.7	30.5	5.0%	40.7%
H20	Ryehurst Meadow LWS		28.3	4.6	32.9	6.1%	43.8%
H21	Binfield Manor LWS		28.3	2.9	31.2	3.9%	41.6%
H22	Tinkers Copse LWS and Jock's Copse LWS		28.5	1.4	29.9	1.9%	39.9%

The results in Table 5-2 indicate that at the assessed European designated sites and local nature sites, the annual mean NOx and SO_2 PCs are less than 1% and 100%, respectively, of the relevant critical level and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2023).

For the maximum 24-hour mean critical level for NOx, the results indicate that at the assessed European designated sites and local nature sites, the PCs are less than 10% and 100%, respectively, of the relevant critical level and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2023).

The conservative approach adopted throughout this assessment means that, based on professional judgement, it is not considered likely that there would be unacceptable impacts to air quality at the assessed protected conservation areas as a consequence of the operation of the assessed CHP engine and boilers with regard to ambient concentrations of NOx and SO_2.

5.2.2 Assessment against Critical Loads

The rate of deposition of acidic compounds and nitrogen containing species have been estimated at the assessed protected conservation areas. This allows the potential for adverse effects to be evaluated by comparison with critical loads for acid and nutrient nitrogen deposition. The assessment took account of emissions of NOx and SO_2 only.

Critical load functions for acid deposition are specified on the basis of both nitrogen-derived acid and sulphur-derived acid. This information, including existing deposition levels at habitat sites, is available from APIS (Centre for Ecology and Hydrology, 2023). Further information on the assessment of deposition is provided in **Error! Reference source not found.**. The full detailed modelled results are displayed in Table 5-3 and Table 5-4.

Table 5-3: Modelled acid deposition at assessed protected conservation areas

Ref	Habitat	Vegetation type (for deposition velocity)	Critical load (CL) (kEqH+/ha/year)			Existing acid deposition (kEqH+/ha/year)				
			CLMaxS	CLMinN	CLMaxN	Existing deposition (N) (S)	PC	PEC	PC/CL (%)	PEC/CL (%)
H1	Windsor Forest & Great Park SAC & SSSI	Tall	0.759	0.142	1.044	2.01	0.007	2.0	0.7%	193%
H2	Thames Basin Heaths SPA	Short	0.211	0.499	0.862	1.26	0.001	1.3	0.1%	146%
		Tall	0.251	0.142	0.536	2.20	0.002	2.2	0.4%	411%
H3	(Epoch 3: Levers Piece)(Tithe: Marsh Coppice) AW	Tall	1.722	0.357	2.079	2.16	0.191	2.4	9.2%	113%
H4	Hazelwood Copse AW	Tall	2.351	0.357	2.708	2.16	1.458	3.6	53.8%	134%
H5	Hazelwood Copse (Tithe: Haughfords Grove) AW	Tall	2.351	0.357	2.708	2.16	1.764	3.9	65.1%	145%
H6	Warfield Hall: The Grove AW	Tall	2.354	0.357	2.711	2.16	0.254	2.4	9.4%	89%
H7	Long Copse (Tithe Long Coppice) AW and LWS	Tall	2.351	0.357	2.708	2.16	0.029	2.2	1.1%	81%
H8	(Tithe: Furzes Coppice) AW	Tall	2.352	0.357	2.709	2.16	0.016	2.2	0.6%	80%
H9	Tinker's Copse(Tithe: An Intake) AW and LNR	Short	1.630	0.438	2.068	1.23	0.007	1.2	0.3%	60%
		Tall	2.352	0.357	2.709	2.16	0.014	2.2	0.5%	80%
H10	Jock's Copse (Tithe: Jocks Coppice) AW and LNR	Short	1.630	0.438	2.068	1.23	0.006	1.2	0.3%	60%
		Tall	2.352	0.357	2.709	2.16	0.012	2.2	0.4%	80%
H11	(Tithe: Temple Coppice)(Bryony Copse/Temple Copse) AW, LNR and LWS	Short	1.630	0.438	2.068	1.23	0.006	1.2	0.3%	60%
		Tall	2.352	0.357	2.709	2.16	0.011	2.2	0.4%	80%
H12	Binfield Hall (Ancient & Semi-Natural Woodland ID 1504859) AW & LWS	Tall	2.315	0.357	2.672	2.29	0.009	2.3	0.3%	86%
H13	Hawland's Copse(Tithe: Hawlands Coppice) AW and LWS	Tall	2.314	0.357	2.671	2.29	0.007	2.3	0.3%	86%
H14	(Epoch 3. Point Copse. Tithe: Stackpool Coppice) AW	Tall	1.719	0.357	2.076	2.16	0.009	2.2	0.5%	104%
H15	(Epoch 3: Wilson's Copse)(Tithe: Burgess Coppice; Rocque: Hasel Wood)) AW	Tall	1.719	0.357	2.076	2.16	0.017	2.2	0.8%	105%
H16	Westhatch Corner AW	Tall	2.355	0.357	2.712	2.16	0.039	2.2	1.4%	81%
H17	Piggy Wood LNR and Piggy Wood LWS	Tall	2.354	0.357	2.711	2.16	0.010	2.2	0.4%	80%
H18	Hazelwood Copse LWS	Tall	2.354	0.357	2.711	2.16	2.157	4.3	79.6%	159%
H19	Hazelwood Meadow/ Hazelwood House Garden LWS	Short	0.880	0.438	1.318	1.23	0.014	1.2	1.0%	94%

Ref	Habitat	Vegetation type (for deposition velocity)	Critical load (CL) (kEqH+/ha/year)			Existing acid deposition (kEqH+/ha/year)				
			CLMaxS	CLMinN	CLMaxN	Existing deposition (N) (S)	PC	PEC	PC/CL (%)	PEC/CL (%)
		Tall	1.722	0.357	2.079	2.16	0.028	2.2	1.3%	105%
H20	Ryehurst Meadow LWS	Short	1.630	0.438	2.068	1.23	0.038	1.3	1.8%	61%
		Tall	2.351	0.357	2.708	2.16	0.076	2.2	2.8%	83%
H21	Binfield Manor LWS	Short	1.630	0.438	2.068	1.23	0.023	1.3	1.1%	61%
		Tall	2.351	0.357	2.708	2.16	0.045	2.2	1.7%	81%
H22	Tinkers Copse LWS and Jock's Copse LWS	Short	1.630	0.438	2.068	1.23	0.009	1.2	0.4%	60%
		Tall	2.352	0.357	2.709	2.16	0.018	2.2	0.7%	80%

Table 5-4: Modelled nitrogen deposition at assessed protected conservation area

Ref	Habitat	Vegetation type (for deposition velocity)	Minimal Critical Load (CL)	Existing nutrient deposition (kgN/ha-year)				
				Existing deposition	PC	PEC	PC/CL (%)	PEC/CL(%)
H1	Windsor Forest & Great Park SAC & SSSI	Tall	10	27.4	0.008	27.4	0.1%	274%
H2	Thames Basin Heaths SPA	Short	10	16.4	0.001	16.4	<0.1%	164%
		Tall	5	29.1	0.002	29.1	<0.1%	582%
H3	(Epoch 3: Levers Piece)(Tithe: Marsh Coppice) AW	Tall	5	27.5	0.199	27.7	4.0%	554%
H4	Hazelwood Copse AW	Tall	5	27.5	1.494	29.0	29.9%	580%
H5	Hazelwood Copse (Tithe: Haughfords Grove) AW	Tall	5	27.5	1.805	29.3	36.1%	587%
H6	Warfield Hall: The Grove AW	Tall	5	27.5	0.270	27.8	5.4%	556%
H7	Long Copse (Tithe Long Coppice) AW and LWS	Tall	5	27.5	0.030	27.6	0.6%	551%
H8	(Tithe: Furzes Coppice) AW	Tall	5	27.5	0.017	27.5	0.3%	551%
H9	Tinker's Copse(Tithe: An Intake) AW and LNR	Short	5	15.2	0.007	15.2	0.1%	303%
		Tall	5	27.5	0.015	27.5	0.3%	551%

Ref	Habitat	Vegetation type (for deposition velocity)	Minimal Critical Load (CL)	Existing nutrient deposition (kgN/ha-year)				
				Existing deposition	PC	PEC	PC/CL (%)	PEC/CL(%)
H10	Jock's Copse (Tithe: Jocks Coppice) AW and LNR	Short	5	15.2	0.006	15.2	0.1%	303%
		Tall	5	27.5	0.013	27.5	0.3%	551%
H11	(Tithe: Temple Coppice)(Bryony Copse/Temple Copse) AW, LNR and LWS	Short	5	15.2	0.006	15.2	0.1%	303%
		Tall	5	27.5	0.012	27.5	0.2%	551%
H12	Binfield Hall (Ancient & Semi-Natural Woodland ID 1504859) AW & LWS	Tall	5	29.5	0.010	29.5	0.2%	590%
H13	Hawland's Copse(Tithe: Hawlands Coppice) AW and LWS	Tall	5	29.5	0.007	29.5	0.1%	590%
H14	(Epoch 3. Point Copse. Tithe: Stackpool Coppice) AW	Tall	5	27.5	0.010	27.5	0.2%	551%
H15	(Epoch 3: Wilson's Copse)(Tithe: Burgess Coppice; Rocque: Hasel Wood)) AW	Tall	5	27.5	0.017	27.5	0.3%	551%
H16	Westhatch Corner AW	Tall	5	27.5	0.041	27.6	0.8%	551%
H17	Piggy Wood LNR and Piggy Wood LWS	Tall	5	27.5	0.011	27.5	0.2%	551%
H18	Hazelwood Copse LWS	Tall	5	27.5	2.323	29.8	46.5%	597%
H19	Hazelwood Meadow/ Hazelwood House Garden LWS	Short	5	15.2	0.014	15.2	0.3%	303%
		Tall	5	27.5	0.029	27.5	0.6%	551%
H20	Ryehurst Meadow LWS	Short	5	15.2	0.040	15.2	0.8%	304%
		Tall	5	27.5	0.080	27.6	1.6%	552%
H21	Binfield Manor LWS	Short	5	15.2	0.024	15.2	0.5%	304%
		Tall	5	27.5	0.047	27.6	0.9%	551%
H22	Tinkers Copse LWS and Jock's Copse LWS	Short	5	15.2	0.009	15.2	0.2%	303%
		Tall	5	27.5	0.019	27.5	0.4%	551%

The results in Table 5-3 and Table 5-4 indicate that at the European designated sites and local nature sites, the PCs are less than 1% and 100%, respectively, of the relevant critical load value for acid and nutrient nitrogen deposition and the impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2023).

It should be noted acid and nitrogen deposition rates currently exceed their relevant critical loads at the majority of assessed protected conservation areas. However, this is a relatively common situation at protected conservation areas across the UK due to the high baseline deposition rates.

5.3 Sensitivity Analysis

A sensitivity study was undertaken to see how changes to the surface roughness and omission of the buildings in the 2017 model (which predicted the highest annual mean and 1-hour mean NO_2 concentrations at sensitive human receptor locations) and 2015 model (which predicted the highest 1-hour mean NO_2 concentrations at modelled off-site locations) may impact on predicted concentrations at sensitive human receptors and off-site locations. The results of the sensitivity analysis are presented in Table 5-5 to Table 5-7.

Table 5-5: Sensitivity analysis - fixed surface roughness of 0.1 m

Pollutant	Averaging period	Assessment location	Original PC (surface roughness 0.4 m) (µg/m^3)	Surface roughness length 0.1 m				
				PC (µg/m^3)	PEC (µg/m^3)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	0.4	0.4	11.0	1.0%	27.5%	0.1%
	1 hour mean (99.79th percentile)	Maximum off-site	68.9	85.1	106.3	42.5%	53.2%	8.1%
		Sensitive locations	50.4	59.7	81.2	29.8%	40.6%	4.7%

The results in Table 5-5 indicate that the change to maximum predicted annual mean concentrations for NO_2 is negligible when using a surface roughness value of 0.1 m compared to the original value of 0.4 m. For 1-hour mean (99.79th percentile) NO_2 concentrations at an off-site location and sensitive human receptor location, the PCs are higher. However, a surface roughness of 0.1 m (representing root crops) is not considered representative of the site and surrounding area.

Table 5-6: Sensitivity analysis - fixed surface roughness of 1 m

Pollutant	Averaging period	Assessment location	Original PC (surface roughness 0.4 m) (µg/m^3)	Surface roughness length 1 m				
				PC (µg/m^3)	PEC (µg/m^3)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	0.4	0.4	11.0	0.9%	27.4%	0.0%
	1 hour mean (99.79th percentile)	Maximum off-site	68.9	50.1	71.4	25.1%	35.7%	-9.4%
		Sensitive locations	50.4	39.1	60.6	19.6%	30.3%	-5.6%

The results in Table 5-6 indicate that the change to maximum predicted annual mean concentrations for NO_2 is negligible when using a surface roughness value of 1 m compared to the original value of 0.4 m. For 1-hour mean (99.79th percentile) NO_2 concentrations at an off-site location and sensitive human receptor locations, the PCs were lower modelling with an increased surface roughness value of 1 m. However, a surface roughness of 1 m (representing a large city centre location with built-up areas and tall buildings) is not considered representative of the site and surrounding area.

Table 5-7: Sensitivity analysis - no buildings

Pollutant	Averaging period	Assessment location	Original PC (with buildings) (µg/m^3)	No buildings				
				PC (µg/m^3)	PEC (µg/m^3)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	0.4	0.4	11.0	0.9%	27.5%	0.0%
	1 hour mean (99.79th percentile)	Maximum off-site	68.9	44.2	65.5	22.1%	32.7%	-12.3%
		Sensitive locations	50.4	36.6	58.1	18.3%	29.0%	-6.9%

The results in Table 5-7 indicate that the differences between the maximum predicted concentrations with and without the buildings is such that including buildings within the model is the preferred option for this study, to maintain a more realistic, and conservative, approach.

6. Conclusions

This report has assessed the potential air quality impacts associated with the operation of the biogas fuelled CHP engine and boilers at the Bracknell STW. The predicted impacts were assessed against the relevant air quality standards and guidelines for the protection of human health and protected conservation areas.

6.1 Human receptors

The assessment indicates that the predicted modelled off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term EQS.

The results indicate that for annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations, the respective PCs are less than 1% of the relevant long-term EQS and their impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2023), and therefore 'not significant'.

For short-term NO_2, CO, SO_2 and particulate concentrations, the PCs are either less than 10% of the relevant EQS or where the PCs are above 10% of the relevant EQS, the PECs are less than 70% of the relevant EQS and the impacts are considered 'not significant'.

For annual mean and maximum 24-hour mean TVOC concentrations, informed by a wider understanding of the properties of biogas, the emissions of TVOCs is considered 'not significant'.

This assessment has been carried out on the assumption that the CHP engine and boilers would operate continuously at maximum load throughout the year (i.e. 8,760 hours). In practice, the boilers are unlikely to operate simultaneously and for more than 6,000 hours per year.

Therefore, when considering the conservative approach to the assessment and based on professional judgement, the emissions of assessed pollutants at sensitive human receptor locations and modelled off-site locations is considered 'not significant'.

6.2 Protected conservation areas

For critical levels, the results indicate that at the European designated sites and local nature sites, the annual mean NOx and SO_2 PCs are less than 1% and 100% of the relevant critical level, respectively, and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2023).

For the maximum 24-hour mean critical level for NOx, the results indicate that at the European designated sites and local nature sites, the PCs are less than 10% and 100% of the relevant critical level, respectively, and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2023).

For critical loads, the results indicate that at the European designated sites and local nature sites, the PCs are less than 1% and 100% of the relevant critical load value, respectively, for acid and nutrient nitrogen deposition and the impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2023).

6.3 Summary

Based on the above assessment, it is concluded that the operation of the assessed CHP engine and boilers are acceptable from an air quality perspective.

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8. Figures

N

Gatherum Farm

Ryehurst La

Hazelwood Copse

A2 & A3

A1

rst Farm

Cabbage Hill La

0 0.05 0.1 0.2 Kilometers

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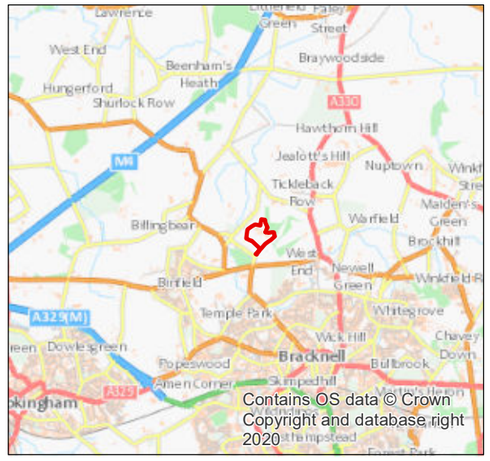
Legend

- Approximate site fenceline
- Modelled stack locations
- Modelled buildings



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	19/04/2023	Initial Issue	SE	DH	GW	HG

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT APPLICATION - BRACKNELL SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: APPROXIMATE SITE FENCELINE, MODELLED STACK LOCATION AND MODELLED BUILDINGS

Drawing Status: FINAL

Scale @ A3	1:2,800	DO NOT SCALE
Jacobs No.	B22849AZ	Rev 0
Client No.		

Drawing Number: FIGURE 1

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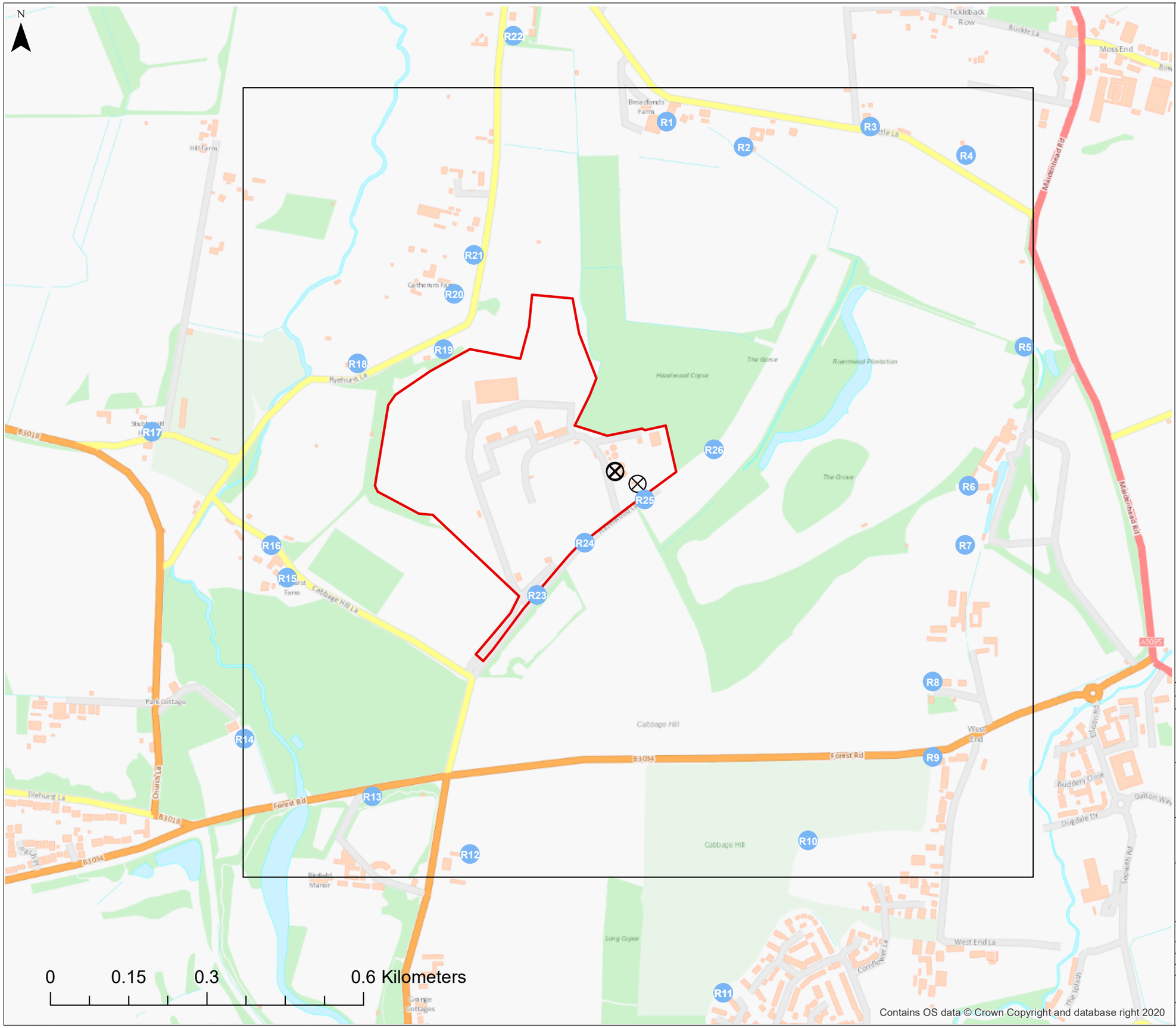
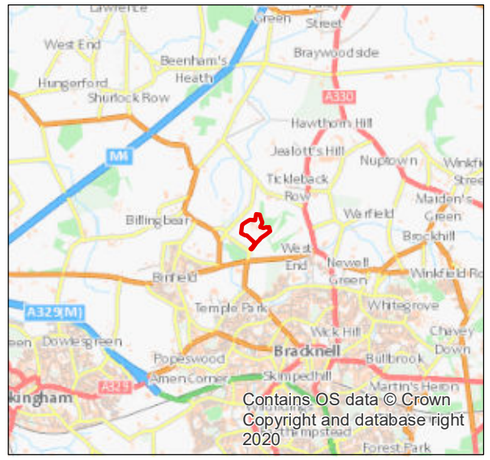


Legend

- Approximate site fenceline
- Modelled stack locations
- Extent of modelled grid
- R1 Sensitive human receptor locations



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	19/04/2023	Initial Issue	SE	DH	GW	HG

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT APPLICATION - BRACKNELL SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: EXTENT OF MODELLED GRID AND SENSITIVE HUMAN RECEPTOR LOCATIONS

Drawing Status: FINAL

Scale @ A3	1:7,000	DO NOT SCALE
Jacobs No.	B22849AZ	Rev 0
Client No.		

Drawing Number: FIGURE 2

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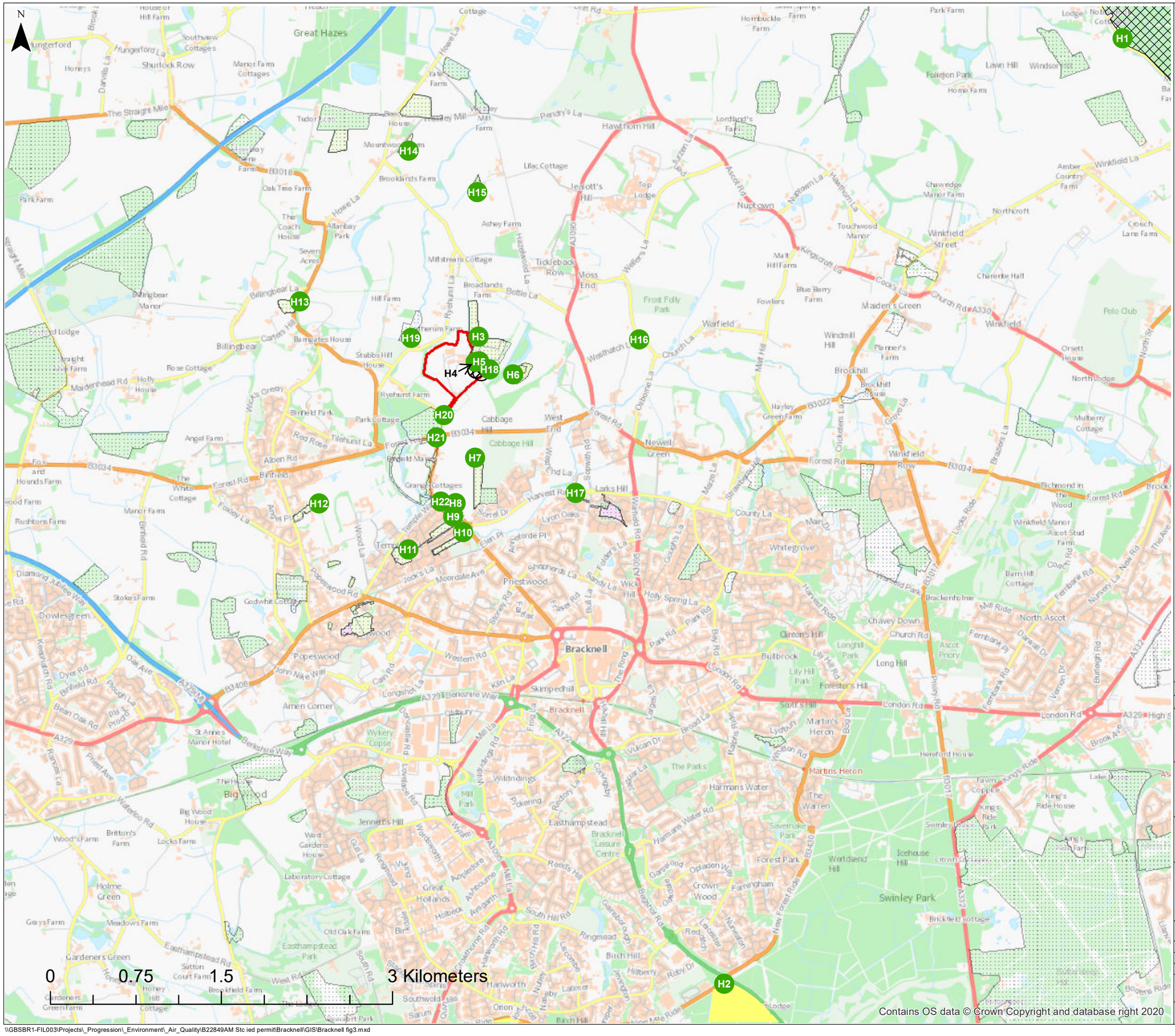

Legend

- Approximate site fenceline
- Modelled stack locations
- Special Area of Conservation (SAC)
- Special Protection Area (SPA)
- Ancient Woodland (AW)
- Local Nature Reserve (LNR)
- Local Wildlife Site (LWS)
- H1 Protected Conservation Area

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	19/04/2023	Initial Issue	SE	DH	GW	HG

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT APPLICATION - BRACKNELL SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: PROTECTED CONSERVATION AREAS

Drawing Status: FINAL

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Client No.		

Drawing Number: FIGURE 3

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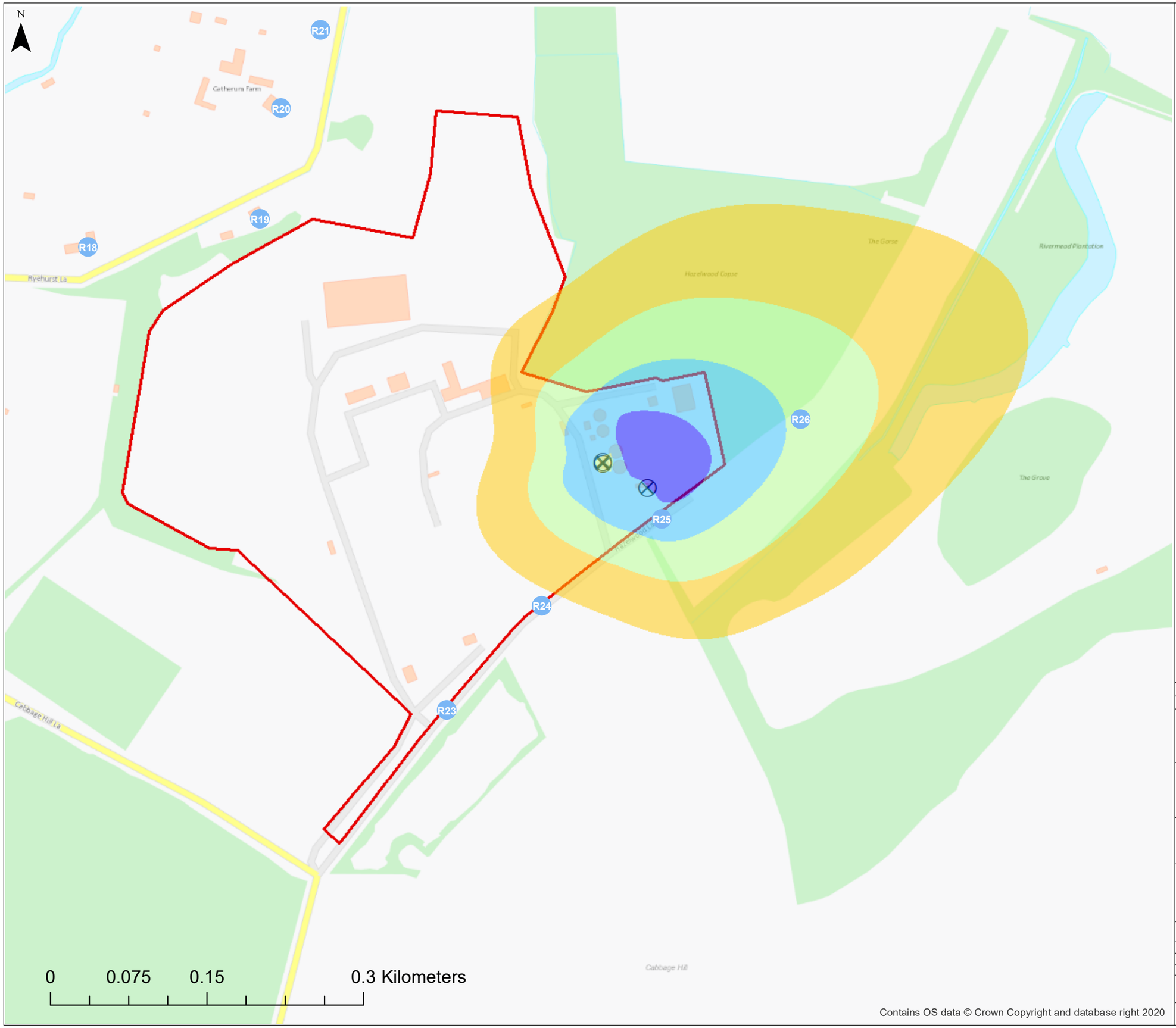

Legend

- Approximate site fenceline
- Modelled stacks
- R1 Sensitive human receptor locations

Annual mean nitrogen dioxide process contributions (µg/m^3)

- 0 - 1
- 1 - 2
- 2 - 4
- 4 - 10
- 10 - 22.5

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	19/04/2023	Initial Issue	SE	DH	GW	HG

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT APPLICATION - BRACKNELL SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: ANNUAL MEAN NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2017 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3	1:3,500	DO NOT SCALE
Jacobs No.	B22849AZ	Rev 0
Client No.		

Drawing Number: FIGURE 4

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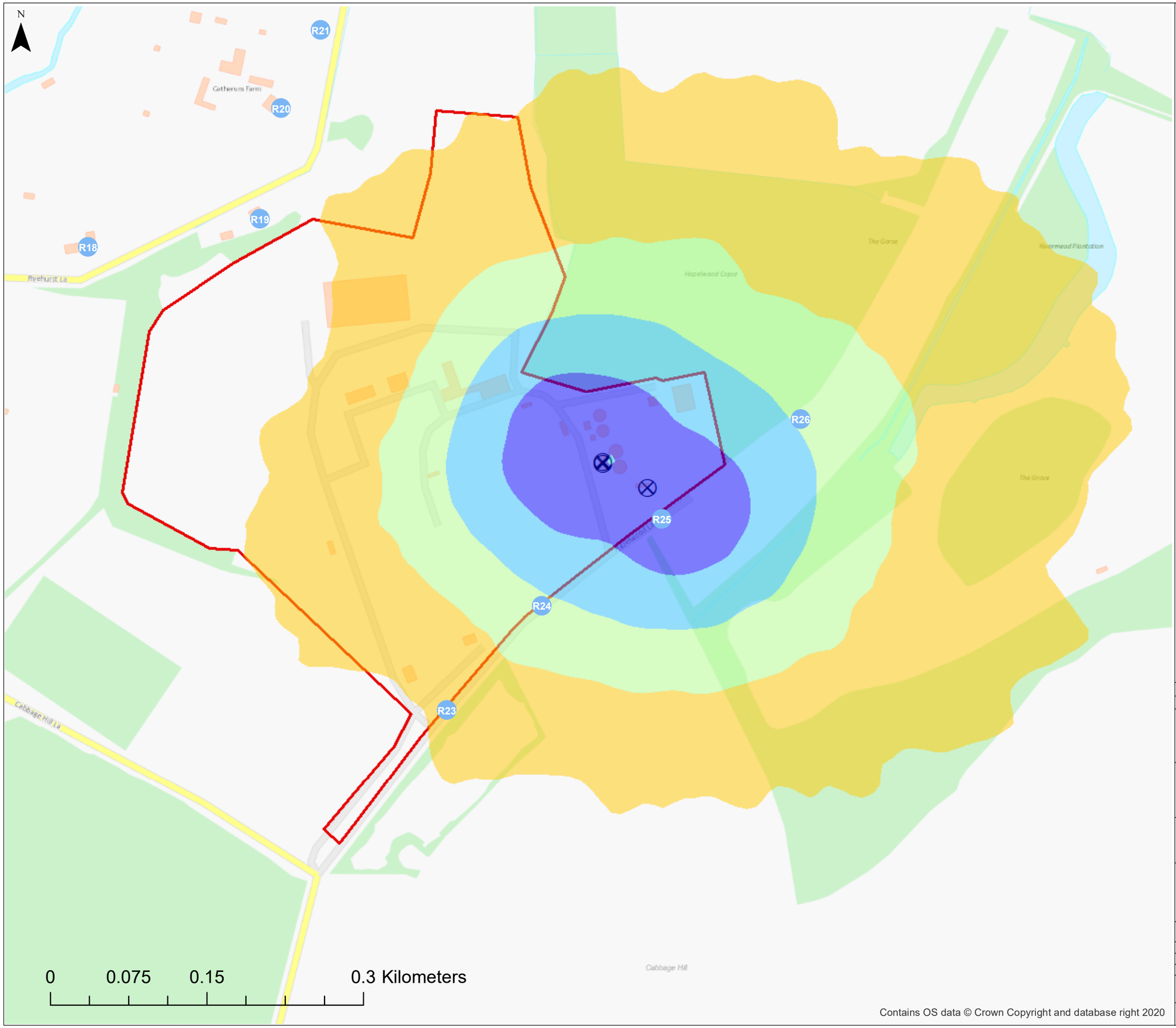

Legend

- Approximate site fenceline
- Modelled stacks
- R1 Sensitive human receptor locations

1-hour mean (99.79thpercentile) nitrogen dioxide process contributions (µg/m^3)

- 0 - 5
- 5 - 8
- 8 - 12
- 12 - 20
- 20 - 95.5

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	19/04/2023	Initial Issue	SE	DH	GW	HG

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT APPLICATION - BRACKNELL SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: 1-HOUR MEAN (99.79th PERCENTILE) NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2017 METEOROLOGICAL DATA

Drawing Status: FINAL

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Jacobs No.	B22849AZ	Rev 0
Client No.		

Drawing Number: FIGURE 5

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Appendix A. Dispersion Model Input Parameters

A.1 Emission Parameters

The emissions data used to represent the site for the scenario described in Section 2 is set out in Table A-1.

Table A-1. Dispersion modelling parameters

Parameters	Unit	MWM TCG 2016 V12 CHP engine (1.4 MWth)	Strebel boiler (0.7 MWth)	Strebel boiler (0.7 MWth)
Fuel	-	Biogas	Biogas	Biogas
Emission point	-	A1	A2	A3
Assessed annual operation hours	Hours	8,760	8,760	8,760
Stack location	m	E 485998 N 171845	E 485955 N 171870[2]	E 485955 N 171867[2]
Stack height	m	4.10	4.80	4.80
Stack diameter	m	0.25	0.30	0.30
Flue gas temperature	°C	185	152	152
Efflux velocity	m/s	13.4	10.1	10.1
Moisture content of exhaust gas	%	10.3	8.1	8.1
Oxygen content of exhaust gas (dry)	%	8.3	6.4	6.4
Volumetric flow rate (actual)	m^3/s	0.660	0.715	0.715
Volumetric flow rate (normal)[1]	Nm^3/s	0.753	0.341	0.341
NOx emission concentration[1]	mg/Nm^3	186 (190 after 1st January 2030)	250 (250 after 1st January 2030)	250 (250 after 1st January 2030)
NOx emission rate	g/s	0.140	0.085	0.085
CO emission concentration[1]	mg/Nm^3	519	100	100
CO emission rate	g/s	0.391	0.034	0.034
PM_{10} / $PM_{2.5}$ emission concentration[1]	mg/Nm^3	2.7	5	5
PM_{10} / $PM_{2.5}$ emission rate	g/s	0.002	0.002	0.002
SO_2 emission concentration[1]	mg/Nm^3	130	200	200
SO_2 emission rate	g/s	0.098	0.068	0.068
TVOC emission concentration[1]	mg/Nm^3	371	1,126	1,126
TVOC emission rate	g/s	0.279	0.384	0.384

Note 1: Normalised flows and concentrations presented at 273 K, 101.3 kPa, dry gas and oxygen content of 15% (CHP engine) or 3% (boilers).

Note 2: As the boiler stacks are in close proximity to each other, an aai file was used in the model to represent the effects of a single plume.

A.2 Dispersion Model Inputs

A.2.1 Structural influences on dispersion

The main structures within the site which have been included in the model to reflect the existing site layout are identified within Table A-2. A sensitivity study has been carried out to assess the sensitivity of the model to using the buildings module.

Table A-2. Building parameters

Building	Modelled building shapes	Length / diameter (m)	Width (m)	Height (m)	Angle of length to north	Centre point co-ordinates	
						Easting	Northing
Boiler house[1]	Rectangular	4.30	11.20	7.60	167	485956	171869
CHP engine housing[2]	Rectangular	2.60	12.50	3.40	85	485993	171847
Tank 1	Circular	3.10	12.90			485968	171879
Tank 2	Circular	3.10	12.80			485971	171865
Tank 3	Circular	3.80	12.20			485956	171899

Note 1: Modelled as the main building for the assessed boilers.

Note 2: Modelled as the main building for the assessed CHP engine.

A.2.2 Other model inputs

Other model input parameters are presented in Table A-3.

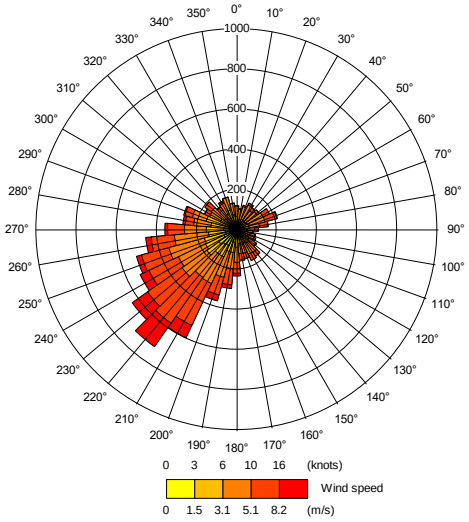
Table A-3. Other model inputs

Parameter	Value used	Comments
Surface roughness length for dispersion site	0.4 m	This is appropriate for the dispersion site where the surrounding local land-use is generally agricultural in nature. A sensitivity study has been carried out with fixed surface roughness values of 0.1 m and 1.0 m.
Surface roughness length at meteorological station site	0.3 m	This is appropriate for an area where the local land-is relatively flat such as Farnborough meteorological station.
Minimum Monin-Obukhov Length	1 m	Typical values for the dispersion site
Surface Albedo	0.23 m	Typical values for the dispersion site
Priestley-Taylor Parameter	1 m	Typical values for the dispersion site
Terrain	Not included	Guidance for the use of the ADMS model suggests that terrain is normally incorporated within a modelling study when the gradient exceeds 1:10. As the gradient in the vicinity of the site does not exceed 1:10, a terrain file was not included in the modelling.
Meteorological data	Farnborough meteorological station, 2015 - 2019	Farnborough Airport meteorological station is located approximately 18.2 km south of the site and is considered the closest most representative meteorological monitoring station to the site.
Combined flue option	Yes	As the boiler stacks are in close proximity to each other, an aai file was used in the model to represent the effects of a single plume.

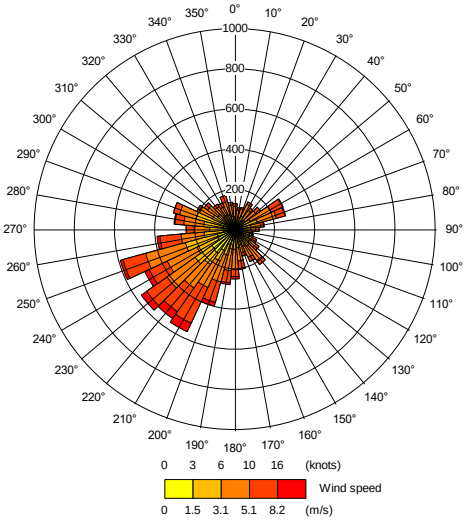
A.2.3 Meteorological Data

The wind roses for each year of meteorological data utilised in the assessment are shown overleaf.

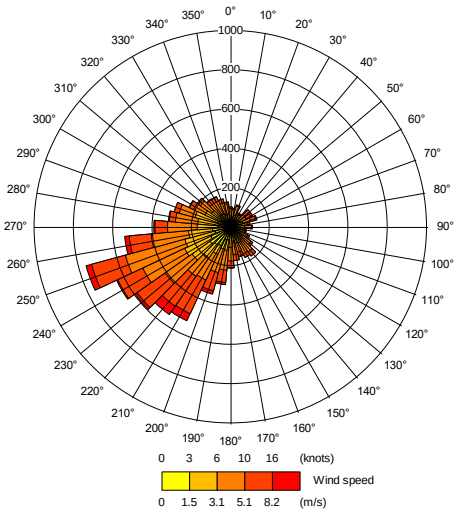
Farnborough meteorological station, 2015



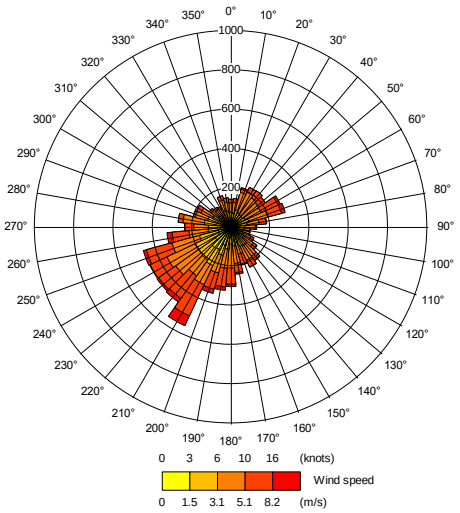
Farnborough meteorological station, 2016



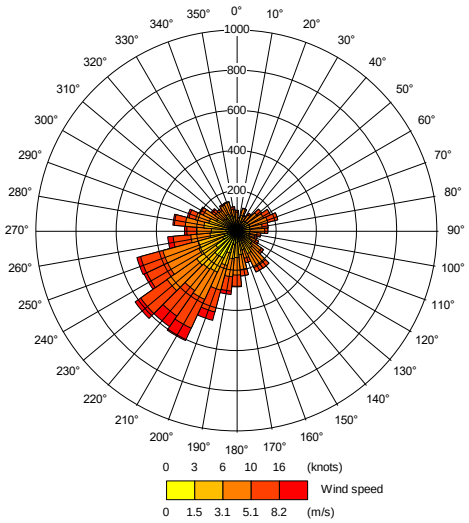
Farnborough meteorological station, 2017



Farnborough meteorological station, 2018



Farnborough meteorological station, 2019



A.2.4 Model Domain/Study Area

The ADMS model calculates the predicted concentrations based on a user defined grid system. Generally, the larger the study area, the greater the distance between the grid calculation points and the lower the resolution of the dispersion model predictions. This is to be offset against the need to encompass an appropriately wide area within the dispersion modelling study to capture the dispersion of the stack emissions.

The modelled grid was specified as a 1.5 km x 1.5 km grid with calculation points every 10 m (i.e. 151 points along each grid axis) with a grid height of 1.5 m. This size of grid was selected to provide a good grid resolution and also encompass a sufficient area so that the maximum predicted concentrations would be determined. The area within the site boundary was excluded from the modelled grid as it is not accessible to the general public. The modelled grid parameters are presented in Table A-4.

Table A-4. Modelled grid parameters

	Start	Finish	Number of grid points	Grid spacing (m)
Easting	485248	486748	151	10
Northing	171095	172595	151	10
Grid height	1.5	1.5	1	-

As well as the modelled grid, the potential impact at 26 sensitive human receptors (e.g. exposure locations such as residential properties and a PRoW) and 22 protected conservation areas within the required study area were assessed. The receptor locations are shown in Figure 2 and Figure 3 and further details of the human receptor locations and protected conservation areas are provided in Table A-5 and Table A-6, respectively.

Table A-5. Assessed sensitive human receptor

Receptor	Description	Grid reference		Distance from the CHP engine stack (km)	Direction from the CHP engine stack
		Easting	Northing		
R1	Residential property on Bottle Lane	486054	172538	0.70	N
R2	Residential property on Bottle Lane	486202	172490	0.68	NNE
R3	Residential property on Bottle Lane	486444	172529	0.82	NNE
R4	Residential property on Bottle Lane	486628	172474	0.89	NE
R5	Residential property on Maidenhead Road	486740	172107	0.79	ENE
R6	Residential property on Forest Road	486633	171840	0.64	E
R7	Residential property on Forest Road	486626	171727	0.64	E
R8	Residential property on Forest Road	486564	171465	0.68	SE
R9	Residential property on Forest Road	486564	171320	0.77	SE
R10	Residential property on Hyacinth Grove	486325	171160	0.76	SSE
R11	Residential property on Charlock Place	486163	170868	0.99	S
R12	Residential property on Binfield Road	485677	171134	0.78	SSW
R13	Residential property on Forest Road	485490	171245	0.79	SW
R14	Residential property on Church Lane	485245	171355	0.90	WSW
R15	Residential property on Cabbage Hill Lane	485327	171664	0.69	WSW
R16	Residential property on Cabbage Hill Lane	485297	171726	0.71	W
R17	Residential property on Stubbs Hill	485068	171944	0.94	W
R18	Residential property on Ryehurst Lane	485462	172075	0.58	WNW

Receptor	Description	Grid reference		Distance from the CHP engine stack (km)	Direction from the CHP engine stack
		Easting	Northing		
R19	Residential property on Ryehurst Lane	485627	172102	0.45	NW
R20	Residential property on Ryehurst Lane	485647	172208	0.51	NW
R21	Residential property on Ryehurst Lane	485685	172283	0.54	NW
R22	Residential property on Ryehurst Lane	485760	172703	0.89	NNW
R23	PRoW on Hazelwood Lane	485806	171631	0.29	SW
R24	PRoW on Hazelwood Lane	485897	171731	0.15	SW
R25	PRoW on Hazelwood Lane	486012	171814	0.03	SSE
R26	PRoW on Hazelwood Lane	486145	171910	0.16	ENE

Table A-6. Assessed protected conservation area locations

Receptor	Description	Grid reference		Distance from the CHP engine stack (km)	Direction from the CHP engine stack
		Easting	Northing		
H1	Windsor Forest & Great Park SAC & SSSI	491622	174773	6.34	ENE
H2	Thames Basin Heaths SPA	488128	166478	5.77	SSE
H3	(Epoch 3: Levers Piece)(Tithe: Marsh Coppice) AW	485974	172157	0.31	N
H4	Hazelwood Copse AW	485949	171935	0.10	NNW
H5	Hazelwood Copse (Tithe: Haughfords Grove) AW	485979	171940	0.10	N
H6	Warfield Hall: The Grove AW	486278	171826	0.28	E
H7	Long Copse (Tithe Long Coppice) AW & LWS	485944	171093	0.75	S
H8	(Tithe: Furzes Coppice) AW	485774	170695	1.17	S
H9	Tinker's Copse(Tithe: An Intake) AW & LNR	485753	170578	1.29	S
H10	Jock's Copse AW & LNR	485840	170440	1.41	S
H11	(Tithe: Temple Coppice)(Bryony Copse/Temple Copse) AW, LNR & LWS	485359	170288	1.68	SSW
H12	Binfield Hall (Ancient & Semi-Natural Woodland ID 1504859) LWS and AW	484577	170692	1.83	SW
H13	Hawland's Copse(Tithe: Hawlands Coppice) AW & LWS	484409	172465	1.71	WNW
H14	(Epoch 3. Point Copse. Tithe: Stackpool Coppice) AW	485362	173788	2.04	NNW
H15	(Epoch 3: Wilson's Copse)(Tithe: Burgess Coppice; Rocque: Hasel Wood)) AW	485963	173423	1.58	N
H16	Westhatch Corner AW	487383	172133	1.41	ENE
H17	Piggy Wood LNR and Piggy Wood LWS	487046	170671	1.57	SE
H18	Hazelwood Copse LWS	486072	171869	0.08	ENE
H19	Hazelwood Meadow/ Hazelwood House Garden LWS	485385	172145	0.68	WNW
H20	Ryehurst Meadow LWS	485670	171469	0.50	SW
H21	Binfield Manor LWS	485606	171272	0.69	SW

Receptor	Description	Grid reference		Distance from the CHP engine stack (km)	Direction from the CHP engine stack
		Easting	Northing		
H22	Tinkers Copse LWS and Jock's Copse LWS	485645	170709	1.19	SSW

A.2.5 Treatment of oxides of nitrogen

It was assumed that 70% of NOx emitted from the assessed combustion plant will be converted to NO_2 at ground level in the vicinity of the site, for determination of the annual mean NO_2 concentrations, and 35% of emitted NOx will be converted to NO_2 for determination of the hourly mean NO_2 concentrations, in line with guidance provided by the Environment Agency (Environment Agency, 2021). This approach is likely to overestimate the annual mean NO_2 concentrations considerably at the most relevant assessment locations close to the site.

A.2.6 Calculation of PECs

In the case of long-term mean concentrations, it is relatively straightforward to combine modelled process contributions with baseline air quality levels, as long-term mean concentrations due to plant emissions could be added directly to long-term mean baseline concentrations.

It is not possible to add short-period peak baseline and process concentrations directly. This is because the conditions which give rise to peak ground-level concentrations of substances emitted from an elevated source at a particular location and time are likely to be different to the conditions which give rise to peak concentrations due to emissions from other sources.

As described in the Environment Agency guidance (Environment Agency, 2021), for most substances the short-term peak PC values are added to twice the long-term mean baseline concentration to provide a reasonable estimate of peak concentrations due to emissions from all assessed sources.

A.2.7 Modelling Uncertainty

There are always uncertainties in dispersion models, in common with any environmental modelling study, because a dispersion model is an approximation of the complex processes which take place in the atmosphere. Some of the key factors which lead to uncertainty in atmospheric dispersion modelling are as follows.

- The quality of the model output depends on the accuracy of the input data enter the model. Where model input data are a less reliable representation of the true situation, the results are likely to be less accurate.
- The meteorological data sets used in the model are not likely to be completely representative of the meteorological conditions at the site. However, the most suitable available meteorological data was chosen for the assessment.
- Models are generally designed on the basis of data obtained for large scale point sources and may be less well validated for modelling emissions from smaller scale sources.
- The dispersion of pollutants around buildings is a complex scenario to replicate. Dispersion models can take account of the effects of buildings on dispersion; however, there will be greater uncertainty in the model results when buildings are included in the model.
- Modelling does not specifically take into account individual small-scale features such as vegetation, local terrain variations and off-site buildings. The roughness length (zo) selected is suitable to take general account of the typical size of these local features within the model domain.
- To take account of these uncertainties and to ensure the predictions are more likely to be over-estimates than under-estimates, the conservative assumptions described below have been used for this assessment.

A.2.8 Conservative Assumptions

The conservative assumptions adopted in this study are summarised below.

- The CHP engine and boilers were assumed to operate for 8,760 hours each calendar year but in practice, the combustion plant will have periods of shut-down and maintenance and may not always operate at maximum load. Furthermore, the boilers are unlikely to operate simultaneously and for more than 6,000 hours per year.
- The study is based on emissions being continuously at the emission limits and calculated emissions specified.
- The maximum predicted concentrations at any residential areas as well as off-site locations were considered for the assessment of short-term concentrations and the maximum predicted concentrations at any residential areas were considered for assessment of annual mean concentrations within the air quality study area. Concentrations at other locations will be less than the maximum values presented.
- The highest predicted concentrations obtained using any of the five different years of meteorological data have been used in this assessment. During a typical year the ground level concentrations are likely to be lower.
- It was assumed that 100% of the particulate matter emitted from the plant is in the PM_{10} size fraction. The actual proportion will be less than 100%.
- It was assumed that 100% of the particulate matter emitted from the plant is in the $PM_{2.5}$ size fraction. The actual proportion will be less than 100%.
- It was assumed the vegetation type selected for the respective protected conservation areas is present at the specific modelled location where the highest PC was predicted.
- This assessment assumes all TVOCs emitted by the combustion plant are C_6H_6 in the absence of EQSs for TVOC.

Appendix B. Calculating Acid and Nitrogen Deposition

B.1 Methodology

Nitrogen and acid deposition have been predicted using the methodologies presented in the Air Quality Technical Advisory Group (AQTAG) guidance note: AQTAG 06 *'Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air'* (AQTAG, 2014).

When assessing the deposition of nitrogen, it is important to consider the different deposition properties of nitric oxide and nitrogen dioxide. It is generally accepted that there is no wet or dry deposition arising from nitric oxide in the atmosphere. Thus, it is normally necessary to distinguish between nitric oxide (NO) and nitrogen dioxide in a deposition assessment. In this case, the conservative assumption that 70% of the oxides of nitrogen are in the form of nitrogen dioxide was adopted.

Information on the existing nitrogen and acid deposition was obtained from the APIS database (Centre for Ecology and Hydrology, 2023). Information on the deposition critical loads for the SSSI and local nature sites were also obtained from the APIS database using the Site Relevant Critical Load function and Search by Location function, respectively.

The annual dry deposition flux can be obtained from the modelled annual average ground level concentration via use of the formula:

Dry deposition flux ($\mu g/m^2/s$) = ground level concentration ($\mu g/m^3$) x deposition velocity (m/s)

(where µg refers to µg of the chemical species under consideration).

The deposition velocities for various chemical species recommended for use (AQTAG, 2014) are shown below in Table B-1.

Table B-1. Recommended dry deposition velocities

Chemical species	Recommended deposition velocity (m/s)	
NO_2	Grassland (short)	0.0015
	Forest (tall)	0.003
SO_2	Grassland (short)	0.012
	Forest (tall)	0.024

To convert the dry deposition flux from units of $\mu g/m^2/s$ (where µg refers to µg of the chemical species) to units of kg N/ha/yr (where kg refers to kg of nitrogen) multiply the dry deposition flux by the conversion factors shown in Table B-2. To convert dry deposition flux to acid deposition multiply by factors shown in Table B-3 .

Table B-2. Dry deposition flux conversion factors for nutrient nitrogen deposition

$\mu g/m^2/s$ of species	Conversion factor to kg N/ha/yr
NO_2	95.9

Table B-3. Dry deposition flux conversion factors for acidification

$\mu g/m^2/s$ of species	Conversion factor to keq/ha/yr
NO_2	6.84
SO_2	9.84

Appendix C. Results at Sensitive Human Locations

Table C-1. Results of detailed assessment at sensitive human receptor locations for maximum 8-hour mean and 1-hour mean CO predicted concentrations

Receptor ID	Baseline air quality level ($\mu g/m^3$)	Maximum 8-hour running mean					Maximum 1-hour mean				
		EQS ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS (%)	PEC/EQS (%)	EQS ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS (%)	PEC/EQS (%)
R1	332	10,000	9.5	341	0.1%	3.4%	30,000	23.5	355	0.1%	1.2%
R2	332		9.9	341	0.1%	3.4%		24.3	356	0.1%	1.2%
R3	332		19.0	351	0.2%	3.5%		20.9	352	0.1%	1.2%
R4	332		9.8	341	0.1%	3.4%		19.8	351	0.1%	1.2%
R5	332		12.8	344	0.1%	3.4%		21.6	353	0.1%	1.2%
R6	349		11.8	361	0.1%	3.6%		26.1	376	0.1%	1.3%
R7	349		14.2	364	0.1%	3.6%		25.7	375	0.1%	1.3%
R8	349		13.1	363	0.1%	3.6%		24.2	374	0.1%	1.2%
R9	349		10.8	360	0.1%	3.6%		22.3	372	0.1%	1.2%
R10	349		9.3	359	0.1%	3.6%		19.1	368	0.1%	1.2%
R11	369		5.8	375	0.1%	3.7%		17.3	386	0.1%	1.3%
R12	352		8.0	360	0.1%	3.6%		20.3	372	0.1%	1.2%
R13	352		9.2	361	0.1%	3.6%		18.9	371	0.1%	1.2%
R14	352		12.2	364	0.1%	3.6%		19.3	371	0.1%	1.2%
R15	352		17.1	369	0.2%	3.7%		24.3	376	0.1%	1.3%
R16	352		15.3	367	0.2%	3.7%		22.9	375	0.1%	1.2%
R17	352		12.9	365	0.1%	3.6%		17.2	369	0.1%	1.2%
R18	335		11.9	347	0.1%	3.5%		27.7	363	0.1%	1.2%
R19	335		18.5	354	0.2%	3.5%		36.9	372	0.1%	1.2%
R20	335		23.4	358	0.2%	3.6%		33.5	369	0.1%	1.2%
R21	335		17.7	353	0.2%	3.5%		28.8	364	0.1%	1.2%
R22	335		9.9	345	0.1%	3.4%		19.6	355	0.1%	1.2%
R23	352		27.2	379	0.3%	3.8%		47.8	400	0.2%	1.3%
R24	352		52.9	405	0.5%	4.1%		67.7	420	0.2%	1.4%

Receptor ID	Baseline air quality level (µg/m^3)	Maximum 8-hour running mean					Maximum 1-hour mean				
		EQS (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
R25	349		321.1	671	3.2%	6.7%		362.6	712	1.2%	2.4%
R26	349		54.9	404	0.5%	4.0%		68.1	418	0.2%	1.4%

Table C-2. Results of detailed assessment at sensitive human receptor locations for annual mean and 1-hour mean (99.79th percentile) NO_2 predicted concentrations

Receptor ID	Annual mean						99.79th percentile of 1-hour mean					
	Baseline air quality level (µg/m^3)	EQS (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m^3)	Baseline air quality level (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
R1	10.3	40	0.2	10.6	0.5%	26.4%	200	20.7	3.2	23.9	1.6%	11.9%
R2	10.3		0.3	10.6	0.7%	26.5%		20.7	3.0	23.7	1.5%	11.8%
R3	10.3		0.2	10.6	0.6%	26.5%		20.7	2.7	23.4	1.4%	11.7%
R4	10.3		0.2	10.6	0.6%	26.5%		20.7	2.6	23.3	1.3%	11.7%
R5	10.3		0.4	10.7	0.9%	26.8%		20.7	3.2	23.9	1.6%	12.0%
R6	10.5		0.3	10.8	0.8%	26.9%		20.9	3.3	24.2	1.6%	12.1%
R7	10.5		0.3	10.7	0.6%	26.8%		20.9	3.6	24.5	1.8%	12.3%
R8	10.5		0.2	10.6	0.4%	26.6%		20.9	3.0	24.0	1.5%	12.0%
R9	10.5		0.1	10.6	0.3%	26.4%		20.9	2.2	23.2	1.1%	11.6%
R10	10.5		0.1	10.6	0.3%	26.4%		20.9	2.5	23.4	1.2%	11.7%
R11	11.0		0.1	11.1	0.2%	27.8%		22.1	1.8	23.9	0.9%	11.9%
R12	10.7		0.1	10.8	0.3%	27.0%		21.3	2.4	23.7	1.2%	11.9%
R13	10.7		0.1	10.8	0.3%	27.0%		21.3	2.0	23.4	1.0%	11.7%
R14	10.7		0.1	10.8	0.3%	26.9%		21.3	2.3	23.6	1.2%	11.8%
R15	10.7		0.2	10.8	0.4%	27.1%		21.3	3.1	24.5	1.6%	12.2%

Receptor ID	Annual mean						99.79th percentile of 1-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R16	10.7		0.1	10.8	0.4%	27.0%		21.3	2.8	24.1	1.4%	12.1%
R17	10.7		0.1	10.7	0.2%	26.8%		21.3	1.8	23.2	0.9%	11.6%
R18	10.1		0.1	10.3	0.3%	25.7%		20.3	3.0	23.3	1.5%	11.7%
R19	10.1		0.3	10.4	0.6%	26.0%		20.3	4.7	25.0	2.4%	12.5%
R20	10.1		0.3	10.4	0.7%	26.0%		20.3	4.6	24.9	2.3%	12.5%
R21	10.1		0.3	10.4	0.6%	26.0%		20.3	4.4	24.7	2.2%	12.4%
R22	10.1		0.1	10.3	0.3%	25.6%		20.3	2.2	22.5	1.1%	11.2%
R23	10.7		0.7	11.4	1.7%	28.4%		21.3	6.1	27.5	3.1%	13.7%
R24	10.7		1.9	12.6	4.8%	31.4%		21.3	11.4	32.7	5.7%	16.4%
R25	10.5		6.6	17.1	16.6%	42.8%		20.9	50.4	71.3	25.2%	35.7%
R26	10.5		3.5	14.0	8.8%	34.9%		20.9	11.6	32.5	5.8%	16.3%

Table C-3. Results of detailed assessment at sensitive human receptor locations for 24-mean (99.18th percentile) and 1-hour mean (99.73rd percentile) SO_2 predicted concentrations

Receptor ID	99.18th percentile of 24-hour mean						99.73rd percentile of 1-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	6.4	125	1.6	8.0	1.3%	6.4%	350	6.4	6.0	12.5	1.7%	3.6%
R2	6.4		1.7	8.2	1.4%	6.5%		6.4	5.8	12.2	1.7%	3.5%
R3	6.4		1.5	7.9	1.2%	6.3%		6.4	5.4	11.8	1.5%	3.4%
R4	6.4		1.5	7.9	1.2%	6.3%		6.4	5.3	11.7	1.5%	3.3%

Receptor ID	99.18th percentile of 24-hour mean						99.73rd percentile of 1-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R5	6.4		1.7	8.2	1.4%	6.5%		6.4	6.4	12.9	1.8%	3.7%
R6	6.5		1.9	8.4	1.5%	6.7%		6.5	6.7	13.2	1.9%	3.8%
R7	6.5		2.1	8.6	1.7%	6.8%		6.5	7.0	13.4	2.0%	3.8%
R8	6.5		1.6	8.1	1.3%	6.4%		6.5	6.0	12.4	1.7%	3.6%
R9	6.5		1.2	7.7	1.0%	6.1%		6.5	4.4	10.8	1.3%	3.1%
R10	6.5		1.8	8.3	1.4%	6.6%		6.5	4.8	11.2	1.4%	3.2%
R11	7.1		1.1	8.2	0.9%	6.6%		7.1	3.4	10.5	1.0%	3.0%
R12	6.6		1.5	8.1	1.2%	6.5%		6.6	4.8	11.4	1.4%	3.3%
R13	6.6		1.5	8.1	1.2%	6.5%		6.6	3.9	10.5	1.1%	3.0%
R14	6.6		1.4	8.1	1.1%	6.4%		6.6	4.6	11.2	1.3%	3.2%
R15	6.6		2.1	8.7	1.7%	7.0%		6.6	6.3	13.0	1.8%	3.7%
R16	6.6		1.7	8.3	1.3%	6.6%		6.6	5.5	12.1	1.6%	3.5%
R17	6.6		1.2	7.8	1.0%	6.3%		6.6	3.6	10.3	1.0%	2.9%
R18	6.3		2.0	8.3	1.6%	6.7%		6.3	5.7	12.0	1.6%	3.4%
R19	6.3		3.4	9.7	2.7%	7.8%		6.3	9.5	15.8	2.7%	4.5%
R20	6.3		3.7	10.0	2.9%	8.0%		6.3	9.6	15.9	2.8%	4.6%
R21	6.3		2.9	9.2	2.4%	7.4%		6.3	9.1	15.4	2.6%	4.4%
R22	6.3		1.3	7.6	1.0%	6.1%		6.3	4.5	10.8	1.3%	3.1%
R23	6.6		6.6	13.2	5.3%	10.6%		6.6	12.6	19.2	3.6%	5.5%
R24	6.6		16.7	23.3	13.3%	18.7%		6.6	24.5	31.1	7.0%	8.9%
R25	6.5		65.0	71.5	52.0%	57.2%		6.5	103.4	109.9	29.5%	31.4%
R26	6.5		14.1	20.6	11.3%	16.5%		6.5	24.2	30.6	6.9%	8.7%

Table C-4. Results of detailed assessment at sensitive human receptor locations for 15-minute mean (99.9th percentile) SO_2 predicted concentrations

Receptor ID	99.9th percentile of 15-minute mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	6.4	266	11.3	17.8	4.3%	6.7%
R2	6.4		10.5	16.9	3.9%	6.4%
R3	6.4		10.4	16.9	3.9%	6.3%
R4	6.4		10.1	16.5	3.8%	6.2%
R5	6.4		12.8	19.2	4.8%	7.2%
R6	6.5		11.8	18.3	4.4%	6.9%
R7	6.5		13.5	20.0	5.1%	7.5%
R8	6.5		10.1	16.6	3.8%	6.2%
R9	6.5		8.8	15.2	3.3%	5.7%
R10	6.5		10.0	16.4	3.7%	6.2%
R11	7.1		6.2	13.3	2.3%	5.0%
R12	6.6		9.5	16.1	3.6%	6.1%
R13	6.6		8.5	15.2	3.2%	5.7%
R14	6.6		8.3	14.9	3.1%	5.6%
R15	6.6		11.5	18.1	4.3%	6.8%
R16	6.6		11.5	18.1	4.3%	6.8%
R17	6.6		6.9	13.6	2.6%	5.1%
R18	6.3		10.1	16.4	3.8%	6.1%
R19	6.3		16.9	23.2	6.4%	8.7%
R20	6.3		15.9	22.2	6.0%	8.4%
R21	6.3		14.2	20.5	5.3%	7.7%
R22	6.3		8.3	14.6	3.1%	5.5%
R23	6.6		16.6	23.3	6.3%	8.8%
R24	6.6		26.7	33.3	10.0%	12.5%

Receptor ID	99.9th percentile of 15-minute mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R25	6.5		108.5	115.0	40.8%	43.2%
R26	6.5		28.3	34.7	10.6%	13.1%

Table C-5. Results of detailed assessment at sensitive human receptor locations for annual mean and 24-hour mean (90.41st) percentile) PM_{10} predicted concentrations

Receptor ID	Annual mean						90.41st percentile of 24-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	13.2	40	0.01	13.2	0.01%	33.0%	50	26.4	0.02	26.4	0.0%	52.8%
R2	13.2		0.01	13.2	0.02%	33.0%		26.4	0.02	26.4	0.0%	52.8%
R3	13.2		0.01	13.2	0.02%	33.0%		26.4	0.02	26.4	0.0%	52.8%
R4	13.2		0.01	13.2	0.02%	33.0%		26.4	0.02	26.4	0.0%	52.8%
R5	13.2		0.01	13.2	0.02%	33.0%		26.4	0.03	26.4	0.1%	52.8%
R6	13.4		0.01	13.4	0.02%	33.5%		26.8	0.02	26.8	0.0%	53.7%
R7	13.4		0.01	13.4	0.02%	33.5%		26.8	0.02	26.8	0.0%	53.7%
R8	13.4		0.00	13.4	0.01%	33.5%		26.8	0.02	26.8	0.0%	53.7%
R9	13.4		0.00	13.4	0.01%	33.5%		26.8	0.01	26.8	0.0%	53.6%
R10	13.4		0.00	13.4	0.01%	33.5%		26.8	0.01	26.8	0.0%	53.6%
R11	14.0		0.00	14.0	0.00%	35.0%		28.0	0.01	28.0	0.0%	56.1%
R12	13.1		0.00	13.1	0.01%	32.6%		26.1	0.02	26.1	0.0%	52.3%
R13	13.1		0.00	13.1	0.01%	32.6%		26.1	0.01	26.1	0.0%	52.3%
R14	13.1		0.00	13.1	0.01%	32.6%		26.1	0.01	26.1	0.0%	52.3%
R15	13.1		0.00	13.1	0.01%	32.7%		26.1	0.02	26.1	0.0%	52.3%

Receptor ID	Annual mean						90.41st percentile of 24-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R16	13.1		0.00	13.1	0.01%	32.7%		26.1	0.02	26.1	0.0%	52.3%
R17	13.1		0.00	13.1	0.00%	32.6%		26.1	0.01	26.1	0.0%	52.2%
R18	13.0		0.00	13.0	0.01%	32.6%		26.0	0.01	26.1	0.0%	52.1%
R19	13.0		0.01	13.0	0.02%	32.6%		26.0	0.03	26.1	0.1%	52.2%
R20	13.0		0.01	13.0	0.02%	32.6%		26.0	0.03	26.1	0.1%	52.2%
R21	13.0		0.01	13.0	0.02%	32.6%		26.0	0.03	26.1	0.1%	52.1%
R22	13.0		0.00	13.0	0.01%	32.6%		26.0	0.01	26.1	0.0%	52.1%
R23	13.1		0.02	13.1	0.05%	32.7%		26.1	0.08	26.2	0.2%	52.4%
R24	13.1		0.05	13.1	0.13%	32.8%		26.1	0.22	26.3	0.4%	52.7%
R25	13.4		0.16	13.6	0.41%	33.9%		26.8	0.67	27.5	1.3%	55.0%
R26	13.4		0.09	13.5	0.23%	33.7%		26.8	0.25	27.1	0.5%	54.1%

Table C-6. Results of detailed assessment at sensitive human receptor locations for annual mean $PM_{2.5}$ predicted concentrations

Receptor ID	Annual mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	9.0	20	0.01	9.0	0.0%	45.1%
R2	9.0		0.01	9.0	0.0%	45.1%
R3	9.0		0.01	9.0	0.0%	45.1%
R4	9.0		0.01	9.0	0.0%	45.1%
R5	9.0		0.01	9.0	0.0%	45.1%
R6	9.2		0.01	9.2	0.0%	46.1%

Receptor ID	Annual mean					
	Baseline air quality level ($\mu g/m^3$)	EQS ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS (%)	PEC/EQS (%)
R7	9.2		0.01	9.2	0.0%	46.1%
R8	9.2		0.00	9.2	0.0%	46.1%
R9	9.2		0.00	9.2	0.0%	46.1%
R10	9.2		0.00	9.2	0.0%	46.1%
R11	9.8		0.00	9.8	0.0%	49.1%
R12	9.0		0.00	9.0	0.0%	44.9%
R13	9.0		0.00	9.0	0.0%	44.9%
R14	9.0		0.00	9.0	0.0%	44.9%
R15	9.0		0.00	9.0	0.0%	44.9%
R16	9.0		0.00	9.0	0.0%	44.9%
R17	9.0		0.00	9.0	0.0%	44.9%
R18	8.9		0.00	8.9	0.0%	44.3%
R19	8.9		0.01	8.9	0.0%	44.3%
R20	8.9		0.01	8.9	0.0%	44.3%
R21	8.9		0.01	8.9	0.0%	44.3%
R22	8.9		0.00	8.9	0.0%	44.3%
R23	9.0		0.02	9.0	0.1%	44.9%
R24	9.0		0.05	9.0	0.3%	45.1%
R25	9.2		0.16	9.4	0.8%	46.9%
R26	9.2		0.09	9.3	0.5%	46.5%

Table C-7. Results of detailed assessment at sensitive human receptor locations for annual mean and maximum 24-hour mean TVOC predicted concentrations

Receptor ID	Annual mean						100th percentile of maximum 24-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	0.4	5	1.0	1.4	19.8%	27.3%	30	0.8	12.3	13.0	40.9%	43.4%
R2	0.4		1.2	1.6	24.9%	32.5%		0.8	9.1	9.9	30.4%	32.9%
R3	0.4		1.1	1.5	22.5%	30.0%		0.8	8.1	8.9	27.1%	29.6%
R4	0.4		1.2	1.5	23.2%	30.7%		0.8	7.6	8.3	25.3%	27.8%
R5	0.4		1.7	2.0	33.4%	40.9%		0.8	11.2	11.9	37.2%	39.8%
R6	0.4		1.4	1.9	28.5%	37.1%		0.9	9.8	10.6	32.6%	35.5%
R7	0.4		1.2	1.6	23.5%	32.1%		0.9	10.9	11.8	36.4%	39.3%
R8	0.4		0.8	1.2	15.0%	23.6%		0.9	8.0	8.9	26.8%	29.6%
R9	0.4		0.5	0.9	10.3%	18.9%		0.9	8.0	8.8	26.6%	29.4%
R10	0.4		0.5	0.9	9.3%	17.8%		0.9	9.1	9.9	30.2%	33.1%
R11	0.5		0.3	0.8	6.2%	15.6%		0.9	5.6	6.6	18.8%	21.9%
R12	0.4		0.6	1.0	12.4%	20.8%		0.8	7.4	8.2	24.5%	27.3%
R13	0.4		0.6	1.0	12.4%	20.8%		0.8	7.8	8.6	26.0%	28.8%
R14	0.4		0.5	0.9	10.4%	18.7%		0.8	8.7	9.6	29.1%	31.9%
R15	0.4		0.8	1.2	16.0%	24.4%		0.8	12.4	13.2	41.2%	44.0%
R16	0.4		0.7	1.1	14.0%	22.3%		0.8	10.7	11.6	35.8%	38.6%
R17	0.4		0.3	0.7	6.3%	14.7%		0.8	8.9	9.7	29.6%	32.4%
R18	0.4		0.6	1.0	12.0%	19.4%		0.7	12.7	13.4	42.3%	44.8%
R19	0.4		1.2	1.6	24.4%	31.8%		0.7	25.6	26.3	85.3%	87.8%
R20	0.4		1.3	1.7	25.6%	33.1%		0.7	21.1	21.8	70.3%	72.8%
R21	0.4		1.2	1.6	24.3%	31.7%		0.7	22.9	23.6	76.3%	78.8%
R22	0.4		0.5	0.9	10.6%	18.0%		0.7	8.8	9.5	29.2%	31.7%
R23	0.4		3.3	3.7	65.9%	74.2%		0.8	33.5	34.3	111.7%	114.5%

Receptor ID	Annual mean						100th percentile of maximum 24-hour mean					
	Baseline air quality level (µg/m^3)	EQS (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m^3)	Baseline air quality level (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
R24	0.4		8.9	9.3	178.1%	186.5%		0.8	84.2	85.0	280.5%	283.3%
R25	0.4		26.6	27.0	531.9%	540.5%		0.9	272.9	273.8	909.8%	912.6%
R26	0.4		15.2	15.6	304.2%	312.8%		0.9	75.3	76.2	251.1%	253.9%