Environmental Permit Application - East Hyde Sludge Treatment Centre

Air Quality Impact Assessment

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14 October 2021

Thames Water Utilities Limited

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Project No:	B22849AM
Document Title:	Air Quality Impact Assessment
Document No.:	1
Revision:	1
Document Status:	
Date:	14 October 2021
Client Name:	Thames Water Utilities Limited
Client No:	
Project Manager:	Eve Dee
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File Name:	B22849AM East Hyde Air Quality Impact Assessment_final

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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0	05/10/21	For client review	D Howells	G Wilson	G Wilson	E Dee
1	14/10/21	Ready for submission	D Howells	G Wilson	G Wilson	E Dee

Contents

Executive Summary

Under the Industrial Emissions Directive (IED) the existing anaerobic digestion assets at East Hyde Sludge Treatment Centre (STC) located at the East Hyde Sewage Treatment Works (STW) require an Environmental Permit. The scope of anaerobic digestion activities includes all treatment stages and incorporates directly associated activities such as a combined heat and power (CHP) gas engine and boiler.

Thames Water Utilities Limited operate a STW near the hamlet of East Hyde, Bedfordshire (LU1 3TS). These operations include an existing Caterpillar (CAT) CHP engine (with a thermal input capacity of 1.4 MW_{th}) and a Strebel auxiliary boiler (with a thermal capacity of 1.1 MW_{th}).

Assessed Combustion Plant

Medium Combustion Plant Information		
MCP specific identifier*	East Hyde - CHP 1	East Hyde- Boiler 1
12-digit grid reference or latitude/longitude	E 512171 N 217811	E 512172 N 217811
Rated thermal input (MW) of the MCP	1.4	1.1
Type of MCP (diesel engine, gas turbine, other engine or other MCP)	Gas engine	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.
Date when the new MCP was first put into operation (DD/MM/YYYY)	1998	Pre 2015
Sector of activity of the MCP or the facility in which it is applied (NACE code**)	E.37.00	E.37.00
Expected number of annual operating hours of the MCP and average load in use	TBC (modelled operating all year)	TBC (modelled operating all year)
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	

The Environmental Permit application is collated to include the required forms: Part A, B2.5 and F1. As the site has a CHP engine, the information required to complete Appendix 1 of application form Part B2.5 is included within this document.

The Air Quality Impact Assessment presented within this report is required to support the Environmental Permit application and assesses the potential for significant air quality effects from the operation of the CHP engine and boiler at the East Hyde Sewage Treatment Works.

The potential impacts were determined for the following aspects:

- 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).
- 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 air quality objective or guideline. At sensitive human receptor locations, the predicted long-term (i.e. annual mean) NO_2 and particulate (PM_{10} and $PM_{2.5}$) contributions are considered 'not significant'. For short-term NO_2, PM_{10}, SO_2 and CO concentrations at modelled off-site locations and sensitive human receptor locations, the contributions are also considered 'not significant'.

This assessment has been carried out on the assumption that the CHP engine and boiler would operate simultaneously and continuously at maximum load all year. This is a conservative assumption as, in practice, the assessed combustion plant will have periods of shut-down and maintenance and may not always operate at maximum load.

Protected conservation areas

For critical levels, the results indicate that at the assessed local nature sites, the respective annual mean NOx and SO_2 PCs are less than 100% of the long-term environmental standards and their impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2021a).

For the 24-hour mean critical level for NOx, the results indicate that at the assessed local nature sites, the short-term NOx PCs are less than 100% of the short-term environmental standard for protected conservation areas and the impact can be described as 'insignificant'.

For acid deposition and nutrient nitrogen deposition, the results indicate that at the assessed local nature sites, the respective PCs are less than 100% of the long-term environmental standard for protected conservation areas and the impact can be described as 'insignificant'.

Summary

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

1. Introduction

1.1 Background

Under the Industrial Emissions Directive (IED) the anaerobic digestion assets at East Hyde Sludge Treatment Centre (STC) located at the East Hyde Sewage Treatment Works (STW) are required to be included in an Environmental Permit. The scope of anaerobic digestion activities includes all treatment stages and incorporates directly associated activities such as the combined heat and power (CHP) gas engine and boiler.

Thames Water Utilities Limited (hereafter 'Thames Water') currently operates one Caterpillar (CAT) CHP engine (with a thermal input capacity of 1.4 MW_{th}) and a single duel-fuelled[1] Strebel boiler (thermal input capacity of 1.1 MW_{th}) at the East Hyde STW near the hamlet of East Hyde (LU1 3TS) (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 boiler.

1.2 Study Outline

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

- 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).
- 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;
- Air Quality England;
- Centre for Ecology and Hydrology (CEH);
- Department for Environment, Food and Rural Affairs (Defra);
- Central Bedfordshire Council (CBC);
- Luton Borough Council (LBC);
- North Hertfordshire District Council (NHDC); and
- St Albans City and District Council (SADC).

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 Duel-fuelled utilising biogas or gas-oil.

2. Emission Sources

2.1 Emission Sources to Air

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

The CHP engine and boiler (when utilising biogas) are fuelled by biogas generated from the sites' anaerobic digestion process and emissions were modelled on this basis. As discussed previously, the boiler is a dual-fuel design and can run on biogas or gas-oil. However, for this assessment it has 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 boiler and no other emission points to air at the site have been included in the assessment. It should be noted there are six generators on-site which are only used for the purposes of maintenance testing, black start, triad or genuine emergency running. These generators do not form part of the scope for this air dispersion modelling assessment.

Table 1 presents the emission sources to air considered in this assessment.

Table 1: Combustion plant to be assessed

Parameters	CAT CHP engine (1.4 MW_{th})	Strebel boiler (1.1 MW_{th})
Modelled fuel	Biogas	Biogas
Emission point	A1	A2

This assessment has been carried out on the assumption that the CHP engine and boiler would operate simultaneously and continuously at maximum load throughout the year. This is a conservative assumption as, in practice, the combustion plant will have periods of shut-down and maintenance and may not always operate at maximum load. This approach ensures that the worst-case or maximum short-term modelled concentrations are quantified (further consideration of this is provided in Appendix A).

2.2 Emissions Data

It should be noted from the 1st January 2030, certain pollutant emission concentrations from the assessed combustion plant must adhere to emission concentration limits as set out in the Medium Combustion Plant Directive (MCPD) EU/2015/2193[2] (Schedule 25A of the Environmental Permitting (England and Wales) (Amendment) Regulations 2018.

For the assessed CHP engine, the NOx, CO and TVOC emission concentrations[3] were derived from the Environment Agency's guidance '*Guidance for monitoring landfill gas engine emissions*' (Environment Agency, 2010). 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. 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).

For the boiler, 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 other than engines and gas turbines as regulated under the MCPD[2]. For CO and TVOC, in the absence of a specific emission limit value, the CO emission concentration was obtained from Defra's Process Guidance Note 1/3,*'Statutory Guidance for Boilers and Furnaces 20-50MW thermal input'*

2 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.

3 As the CHP engine was commissioned between 1 January 1998 and 31 December 2005, a NOx, CO and TVOC emission limit concentration of 650 mg/Nm^3 (at 5% oxygen), 1500 mg/Nm^3 (at 5% oxygen) and 1,750 mg/Nm^3 (at 5% oxygen), respectively, has been applied.

(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).

For the assessed combustion plant, the respective exhaust gas volumetric flows were determined using stoichiometric calculations based on the combustion of biogas at the maximum thermal input rating of the CHP engine and boiler. In the absence of information regarding oxygen, moisture content and exhaust gas temperature, the data used in the model is based on professional judgment acquired from previous work involving biogas fuelled combustion plant of a similar thermal input capacity.

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

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, schools, residential care homes 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, 2021a), 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)[4] and national and local nature reserves (NNR and LNR), within 2 km.

Based on these criteria, 7 ancient woodlands were identified; Graves Wood ancient woodland; Birch Wood ancient woodland; George Wood, Hyde ancient woodland and LWS, Hardingdell Wood ancient woodland; Flaskets Wood ancient woodland; Bramagar Wood ancient woodland and Round Wood ancient woodland were included in the assessment. Furthermore, 8 LWS's were identified from the Environment Agency screening service (Environment Agency, 2021a). It is noted that the names of some of the LWS's identified by the Environment Agency are unknown. Where this is the case, the names of the LWS's have been based on their geographic location. The LWS's considered in this assessment are; Kinsbourne Green Grassland LWS; Hardingdell and Fernell's Woods LWS; River Lea Pastures, N of Harpenden LWS; Luton Hoo Park LWS; Chiltern Green LWS; East Hyde Riverside LWS; Stockings Wood; Luton Hoo Park South and Circus Wood.

There are no European sites within 10 km of the site (based on the CHP stack location National Grid Reference (NGR) E 512171 N 217811).

It should be noted some of the designated sites described above encompass the same geographic area. However, for the assessment against critical loads (see Section 5.2.2), all protected conservation areas have been assessed individually for completeness.

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 local authorities and the Environment Agency.

4 Considered County Wildlife Sites (CWS) for the purpose of this assessment.

The modelling assessment was undertaken in accordance with the Environment Agency *Air emissions risk assessment for your environmental permit* guidance (Environment Agency, 2021a).

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, 2021). Information on the CHP engine and the boiler were obtained from various sources as described in Section 2.2.
2) Five years of hourly sequential data recorded at the Luton Airport meteorological station (2016 – 2020 inclusive) were used for the assessment (ADM Ltd, 2021).
3) Information on the main buildings located on-site, which could influence dispersion of emissions from the CHP engine and boiler stack, were estimated from Defra's environmental open-data applications and datasets (Defra, 2021a) and Google Earth (Google Earth, 2021).
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 total 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, 2021a) 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 area. Details of the deposition assessment methodology are provided in Appendix B.

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 Defra and the Devolved Administrations *Air Quality Strategy for England, Scotland, Wales and Northern Ireland* (AQS). 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*. 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 2. Relevant Environmental Assessment Levels (EALs) set out in the Environment Agency guidance (Environment Agency, 2021a) are also included in Table 2 where these supplement the AQOs.

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

Table 2: 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)
$PM_{2.5}$	25	Annual mean
TVOC	n/a[1]	Annual mean
		Maximum 1-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. Therefore, there is no health-based air quality standard or guideline.

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, 2021b);
- 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'
- 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, 2021b);
- 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;
- 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, 2021a).

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 (Environment Agency, 2021a).

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

Pollutant	EQS (µg/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, 2021) 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 4. 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 site, 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.

Table 4: Critical loads for modelled protected conservation areas

Receptor 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)
				CLMaxS	CLMinN	CLMaxN	Minimum
H1	Graves Wood AW & CWS (LWS)	Coniferous woodland	Tall	1.788	0.142	1.930	5
H2	Birch Wood AW & Luton Hoo Park CWS (LWS)	Acid grassland	Short	0.900	0.223	1.123	5
		Coniferous woodland	Tall	1.788	0.142	1.930	5
H3	George Wood AW & CWS (LWS)	Coniferous woodland	Tall	1.784	0.142	1.926	5
H4	Hardingdell Woods AW	Coniferous woodland	Tall	1.782	0.142	1.924	5
H5	Horselys Wood AW & Chiltern Green CWS (LWS)	Coniferous woodland	Tall	1.782	0.142	1.924	5
H6	Flaskets Wood AW & CWS (LWS)	Coniferous woodland	Tall	1.778	0.142	1.920	5
H7	Bramagar Wood AW & CWS (LWS)	Coniferous woodland	Tall	1.778	0.142	1.920	5
H8	Round Wood AW CWS (LWS)	Coniferous woodland	Tall	1.778	0.142	1.920	5
H9	Kinsbourne Green Grassland LWS	Acid grassland	Short	0.900	0.223	1.123	5
H10	Stockings Wood[1]	Acid grassland	Short	0.900	0.223	1.123	5
		Coniferous woodland	Tall	1.790	0.142	1.932	5
H11	Hardingdell and Fernell's Woods CWS (LWS)	Coniferous woodland	Tall	1.782	0.142	1.924	5
H12	Luton Hoo Park South[1]	Acid grassland	Short	0.900	0.223	1.123	5
		Coniferous woodland	Tall	1.778	0.142	1.920	5
H13	River Lea Pastures, N. of Harpenden LWS & East Hyde Riverside CWS (LWS)	Acid grassland	Short	0.900	0.223	1.123	5
		Coniferous woodland	Tall	1.787	0.142	1.929	5
H14	Circus Wood[1]	Coniferous woodland	Tall	1.790	0.142	1.932	5
H15a	River Lea CWS	Acid grassland	Short	0.900	0.223	1.123	5
		Coniferous woodland	Tall	1.782	0.142	1.924	5
H15b		Acid grassland	Short	0.900	0.223	1.123	5
		Coniferous woodland	Tall	1.783	0.142	1.925	5
H15c		Acid grassland	Short	0.900	0.223	1.123	5
		Coniferous woodland	Tall	1.783	0.142	1.925	5
H15d		Acid grassland	Short	0.900	0.223	1.123	5
		Coniferous woodland	Tall	1.783	0.142	1.925	5

Note 1: The name of the LWS is based on the geographic area they inhabit or are adjacent to.

Critical load functions for acid deposition are specified on the basis of both nitrogen-derived acid 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 process contribution (PC – emissions from the modelled process alone) and the predicted environmental concentrations (PEC – 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, 2021).

Significance Criteria – Local nature sites (i.e. LWS and ancient woodlands)

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, 2021a) 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 Site Location

The site is situated near the hamlet of East Hyde approximately 3 km north-northwest from the centre of the town of Harpenden, St Albans. The area surrounding the site generally comprises agricultural land use interspersed with sporadic residential properties. The River Lea flows adjacent to the eastern and northern 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 180 m north-northeast of the CHP engine (based on the stack location NGR E 512171 N 217811). The closest modelled receptor is a PRoW approximately 50 m southwest of the CHP engine stack.

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, 2021b) website could be used to represent background concentrations of the relevant pollutants in the vicinity of the site.

The site is located within the administrative borough of CBC but is also in close proximity to the administrative boroughs of LBC, NHDC and SADC. As part of the Local Air Quality Management (LAQM) process, CBC has declared three AQMAs across its administrative borough. However, the nearest AQMA to the site is Luton AQMA No 3, which was declared by LBC in May 2016 for exceedances of the annual mean NO_2 AQO. This AQMA is approximately 4.1 km northwest of the site and is not considered further in the assessment due to its distance from the site.

CBC, LBC, NHDC and SADC also carry out regular assessments and monitoring of air quality within the borough as part of the LAQM process. The most recent Air Quality Annual Status Reports (Central Bedfordshire, 2019); (Luton Borough Council2019); (St Albans City and District Council, 2019); (North Hertfordshire District Council, 2019) were reviewed to determine the concentrations of NO_2, PM_{10} and $PM_{2.5}$ and SO_2 in the vicinity of the site. It should be noted none of the other assessed pollutants are monitored by the relevant council boroughs. Additional sources of information including the Air Quality England website (Air Quality England, 2021) was also used. Table 5 presents information on the nearest monitoring locations to the site.

Table 5: Nearest monitoring locations to the site

Site ID	Description	Site type	Location	Distance and direction from CHP engine	Pollutants monitored	Annual mean concentration ($\mu g/m^3$)
Automatic monitoring						
HB006	London Luton Airport	Urban industrial	E 511868 N 221144	3.4 km, N	NO_2	10.8 (2020)
					PM_{10}	11.4 (2020)
					$PM_{2.5}$	9.6 (2020)
					SO_2	0.7 (2020)
Non-automatic monitoring						
SA109a	High Street Harpenden SA009	Kerbside	E 513345 N 214409	3.6 km, SSE	NO_2	31.4 (2018)

The automatic and non-automatic monitoring locations presented in Table 5 are not considered representative of the site due to the monitoring location type and distance from the site. Monitoring location SA109a is located adjacent to the A1081 road, which runs through Harpenden town centre.

For the assessed pollutants, information on background air quality in the vicinity of the site was obtained from Defra background map datasets (Defra, 2021b). 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. These background concentrations are presented in Table 6. It should be noted there are no background concentrations available for TVOC's.

As it is necessary to determine the potential impact of emissions from the site on the assessed protected conservation areas, the background concentrations of NOx and SO_2 were also identified for the assessed protected conservation areas. These background concentrations were obtained from Defra background map datasets (Defra, 2021b) and are displayed in Table 6 and Table 9 to Table 10.

Table 6: Background concentrations: adopted for use in assessment for assessed human receptors and protected conservation areas

Pollutant	Annual mean concentration (µg/m^3)	Description
Human receptors		
NO_2	10.6 – 11.9	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2021 map concentration
CO	150 - 160	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, scaled from 2001-based map to 2021 concentration
PM_{10}	14.1 – 15.7	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2021 map concentration
$PM_{2.5}$	9.3 – 9.6	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2021 map concentration
SO_2	3.3 – 3.6	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2001 concentration
TVOC	n/a	
Protected conservation areas		
NOx	13.4 – 17.9	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2021 map concentration
SO_2	3.3 – 3.6	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2001 concentration

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

4.3 Existing Deposition Rates

Existing acid and nutrient nitrogen deposition levels were obtained from APIS (Centre for Ecology and Hydrology, 2021). Where both vegetation types (i.e. short or tall) are listed on the APIS website as being present at the assessed protected conservation area, the most sensitive habitat for both short and tall vegetation, was used for the assessment to represent the differing deposition rates for these vegetation types. 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 habitat site are set out in Table 7.

Table 7: Existing deposition at modelled habitat sites

Receptor 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	Graves Wood AW & CWS (LWS)	Tall	2.40	0.19	33.60
H2	Birch Wood AW & Luton Hoo Park CWS (LWS)	Short	1.39	0.15	19.46
		Tall	2.40	0.19	33.60
H3	George Wood AW & CWS (LWS)	Tall	2.40	0.19	33.60
H4	Hardingdell Woods AW	Tall	2.40	0.19	33.60
H5	Horselys Wood AW & Chiltern Green CWS (LWS)	Tall	2.40	0.19	33.60
H6	Flaskets Wood AW & CWS (LWS)	Tall	2.40	0.19	33.60
H7	Bramagar Wood AW & CWS (LWS)	Tall	2.40	0.19	33.60
H8	Round Wood AW CWS (LWS)	Tall	2.40	0.19	33.60
H9	Kinsbourne Green Grassland LWS	Short	1.39	0.15	19.46
H10	Stockings Wood[1]	Short	1.39	0.15	19.46
		Tall	2.40	0.19	33.60
H11	Hardingdell and Fernell's Woods CWS (LWS)	Tall	2.40	0.19	33.60
H12	Luton Hoo Park South[1]	Short	1.39	0.15	19.46
		Tall	2.40	0.19	33.60
H13	River Lea Pastures, N. of Harpenden LWS & East Hyde Riverside CWS (LWS)	Short	1.39	0.15	19.46
		Tall	2.40	0.19	33.60
H14	Circus Wood[1]	Tall	2.40	0.19	33.60
H15a	River Lea CWS	Short	1.39	0.15	19.46
		Tall	2.40	0.19	33.60
H15b		Short	1.39	0.15	19.46
		Tall	2.40	0.19	33.60
H15c		Short	1.39	0.15	19.46
		Tall	2.40	0.19	33.60
H15d		Short	1.39	0.15	19.46
		Tall	2.40	0.19	33.60

Note 1: The name of LWS is based on the geographic areas they inhabit.

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 concentration 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 8, 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 8: Results of detailed assessment

Pollutant	Averaging period	Assessment location	Maximum receptor	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC / EQS (%)	PEC / EQS (%)	PC as a percentage of headroom (%)
CO	Maximum 8-hour running mean	Sensitive locations	R4	10,000	301	78.9	379.6	0.8%	3.8%	0.8%
	Maximum 1-hour mean	Maximum off-site	-	30,000	301	674.1	974.7	2.2%	3.2%	2.3%
		Sensitive locations	R24	30,000	301	199.0	499.6	0.7%	1.7%	0.7%
NO_2	Annual mean	Sensitive locations	R4	40	10.9	3.3	14.3	8.3%	35.6%	-
	1-hour mean (99.79th percentile)	Maximum off-site	-	200	23.8	48.3	72.0	24.1%	36.0%	27.4%
		Sensitive locations	R25	200	21.8	34.1	56.0	17.1%	28.0%	19.2%
SO_2	24-hour mean (99.18th percentile)	Sensitive locations	R4	125	6.9	14.2	21.1	11.3%	16.9%	12.0%
	1-hour mean (99.73rd percentile)	Maximum off-site	-	350	7.1	75.2	82.3	21.5%	23.5%	21.9%
		Sensitive locations	R25	350	6.9	57.7	64.7	16.5%	18.5%	16.8%
	15-minute mean (99.9th percentile)	Maximum off-site	-	266	7.1	128.6	135.8	48.4%	51.0%	49.7%
		Sensitive locations	R24	266	6.9	60.5	67.4	22.7%	25.3%	23.3%
PM_{10}	Annual mean	Sensitive locations	R4	40	15.1	0.06	15.2	0.2%	37.9%	-
	24-hour mean (90.41st percentile)	Sensitive locations	R4	50	30.2	0.2	30.4	0.4%	60.7%	1.0%
$PM_{2.5}$	Annual mean	Sensitive locations	R4	25	9.5	0.06	9.6	0.3%	38.3%	-
TVOC	Annual mean	Sensitive locations	R4	n/a		14.6	n/a			
	Maximum 1-hour mean	Maximum off-site	-			1,089.3				
		Sensitive locations	R24			321.5				

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 a PRoW that runs adjacent to the western boundary of the site (i.e. short-term exposure only). The full results are presented in Appendix C.

The results in Table 8 indicate that the predicted off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term air quality objective or guideline.

Table 8 indicates that the maximum PC for annual mean NO_2 at a sensitive human receptor location is 3.3 µg/m^3 (equating to 8.3% of the relevant EQS) and is predicted at R4 which represents a residential property approximately 0.18 km north-northeast of the CHP engine stack. The PC is greater than 1% of the relevant EQS but the PEC is less than 70% of the EQS (i.e. 35.6%) and based on professional judgement, the impact can be classed as 'not significant'.

This assessment assumes all assessed combustion plant operate simultaneously and continuously at maximum load when in practice, the plant will have periods of shutdown and may not always operate at maximum load.

For the assessment of 1-hour mean (99.79th percentile) NO_2 concentrations at a sensitive human receptor location, the maximum PC of 34.1 µg/m^3 (which equates to 17.1% of the relevant EQS) is predicted at R25 which represents a PRoW approximately 50 m southwest of the assessed CHP engine stack. The PC is greater than 10% of the short-term EQS but less than 20% of the headroom between the short-term background concentration and the EQS and based on professional judgement, is considered 'not significant'. For the assessment of 1-hour mean (99.79th percentile) NO_2 concentrations at the modelled off-site location, the maximum PC is 48.3 µg/m^3 which equates to 24.1% of the relevant EQS. The PC is greater than 10% of the short-term EQS and greater than 20% of the headroom. However, as the PEC is well within the relevant EQS, (i.e. 36.0%) based on professional judgement, the impact is considered 'not significant'. To note, this concentration is predicted at NGR E 512111 N 217801 which is situated on the PRoW that runs alongside the western boundary of the site.

For long-term PM_{10} and $PM_{2.5}$ concentrations, the respective PCs are less than 1% of the relevant long-term EQS and are considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2021a) and therefore 'not significant'. For 24-hour mean (90.41st percentile) PM_{10} concentrations, the maximum PC (i.e. 0.2 µg/m^3) is predicted at R4 and is less than 10% of the relevant short-term EQS (i.e. 0.4%). Therefore, its impacts can be described as 'insignificant' and therefore 'not significant'.

For short-term CO concentrations at both sensitive human receptor locations and modelled off-site locations, the respective PCs are less than 10% of the relevant short-term EQS and their impact is considered 'insignificant'.

For 24-hour mean (99.18th percentile) SO_2 concentrations at sensitive human receptor locations, the highest PC of 14.2 µg/m^3 is predicted at R4. The PC is just above 10% of the relevant short-term EQS but less than 20% of the headroom between the short-term background concentration and the EQS and based on professional judgement, is considered 'not significant'.

For 1-hour mean (99.73rd percentile) SO_2 concentrations at sensitive human receptor locations, the maximum PC of 57.7 µg/m^3 is predicted at R25. The PC is above 10% of the relevant short-term EQS but less than 20% of the headroom and based on professional judgement, is considered 'not significant'. For 1-hour mean (99.73rd percentile) SO_2 concentrations at a modelled off-site location, the maximum PC (i.e. 75.2 µg/m^3) is greater than 10% of the short-term EQS and greater than 20% of the headroom. However, as the PEC is well within the relevant EQS, (i.e. 23.5%) based on professional judgement, the impact is considered 'not significant'. To note, this concentration is predicted at NGR E 512121 N 217781 which is situated on the PRoW that runs alongside the western boundary of the site.

For 15-minute mean (99.9th percentile) SO_2 concentrations at sensitive human receptor locations, the maximum PC of 60.5 µg/m^3 is predicted at R24 which represents the PRoW approximately 110 m west-northwest of the CHP engine stack. The PC is greater than 10% of the relevant short-term EQS and greater than 20% of the headroom. However, as the PEC is well within the relevant EQS, (i.e. 25.3%) based on professional judgement, the impact is considered 'not significant'. For 15-minute mean (99.9th percentile) SO_2 concentrations at a modelled off-site location, the maximum PC (i.e. 128.6 µg/m^3) is greater than 10% of the short-term EQS and greater than 20% of the headroom. However, as the PEC is well within the relevant EQS, (i.e. 51.0%) based on professional judgement, the impact is considered 'not significant'. To note, this concentration is predicted at NGR E 512111 N 217801 which is situated on the PRoW that runs alongside the western boundary of the site.

For annual mean TVOC concentrations at sensitive human receptor locations, the highest PC of 14.6 $\mu g/m^3$ is predicted at R4. For maximum 1-hour mean TVOC concentrations at a sensitive human receptor location, the highest PC is 321.5 $\mu g/m^3$ which is predicted at R24. For maximum 1-hour mean TVOC concentrations at a modelled off-site location, the highest PC of 1,089.3 $\mu g/m^3$ is predicted at NGR E 512141 N 217771 which is situated on the PRoW that runs alongside the western boundary of the site.

As discussed previously, the TVOCs from the assessed combustion plant will largely comprise unburnt methane gas from the biogas fuel, which is not directly harmful to human health at the concentrations predicted by the dispersion modelling.

Summary

The results in Table 8 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 air quality objective or guideline. Furthermore, the conservative approach adopted throughout the assessment including the assumed operational hours of the plant and modelled emission concentrations, means the predicted concentrations presented in Table 8 are likely to be higher than would reasonably be expected.

Contour plots (see Figures 4 - 7) have been produced for annual mean and 1-hour mean (99.79^{th} percentile) NO_2 concentrations, 1-hour mean (99.73^{rd} percentile) and 15-minute mean (99.9^{th} percentile) SO_2 concentrations. For annual mean NO_2 concentrations, the figure is based on the year of meteorological data which resulted in the highest PC at a sensitive human receptor location. For short-term concentrations, the figures are based on the year of meteorological data which resulted in the highest PC at an off-site 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). The results of the detailed modelling at the assessed protected conservation areas are shown in Table 9 to Table 10. The results presented are the maximum predicted concentration at each assessed protected conservation area for the five years of meteorological data used in the study.

For SO_2, the relevant EQS was based on the assumption that lichens and bryophytes were present at each site, therefore adopting a conservative approach.

Table 9: Results of detailed assessment at assessed protected conservation sites for annual mean NOx and SO_2 concentrations

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	Graves Wood AW & CWS (LWS)	30	14.0	0.50	14.5	1.7%	48.3%
H2	Birch Wood AW & Luton Hoo Park CWS (LWS)		14.0	0.23	14.2	0.8%	47.4%
H3	George Wood AW & CWS (LWS)		17.9	0.10	18.0	0.3%	60.1%
H4	Hardingdell Woods AW		16.0	0.23	16.2	0.8%	54.0%
H5	Horselys Wood AW & Chiltern Green CWS (LWS)		16.0	0.24	16.2	0.8%	54.0%
H6	Flaskets Wood AW & CWS (LWS)		13.4	0.16	13.6	0.5%	45.4%
H7	Bramagar Wood AW & CWS (LWS)		13.4	0.16	13.6	0.5%	45.3%
H8	Round Wood AW CWS (LWS)		13.4	0.10	13.5	0.3%	45.1%
H9	Kinsbourne Green Grassland LWS		14.3	0.07	14.3	0.2%	47.8%
H10	Stockings Wood[1]		15.4	0.06	15.5	0.2%	51.7%
H11	Hardingdell and Fernell's Woods CWS (LWS)		16.0	0.37	16.3	1.2%	54.4%
H12	Luton Hoo Park South[1]		14.2	0.09	14.3	0.3%	47.7%
H13	River Lea Pastures, N. of Harpenden LWS & East Hyde Riverside CWS (LWS)		15.2	0.18	15.3	0.6%	51.1%
H14	Circus Wood[1]		14.7	0.04	14.8	0.1%	49.2%
H15a	River Lea CWS		16.0	2.52	18.5	8.4%	61.6%
H15b			14.5	7.45	21.9	24.8%	73.1%
H15c			14.5	7.04	21.5	23.5%	71.8%
H15d			14.5	3.01	17.5	10.0%	58.3%
Annual mean SO_2 concentrations							
H1	Graves Wood AW & CWS (LWS)	10	3.3	0.29	3.6	2.9%	35.9%
H2	Birch Wood AW & Luton Hoo Park CWS (LWS)		3.3	0.13	3.4	1.3%	34.3%
H3	George Wood AW & CWS (LWS)		3.5	0.06	3.5	0.6%	35.1%
H4	Hardingdell Woods AW		3.6	0.14	3.7	1.4%	37.1%
H5	Horselys Wood AW & Chiltern Green CWS (LWS)		3.6	0.14	3.7	1.4%	37.1%
H6	Flaskets Wood AW & CWS (LWS)		3.3	0.10	3.4	1.0%	34.3%
H7	Bramagar Wood AW & CWS (LWS)		3.3	0.09	3.4	0.9%	34.2%
H8	Round Wood AW CWS (LWS)		3.3	0.06	3.4	0.6%	33.9%
H9	Kinsbourne Green Grassland LWS		3.4	0.04	3.5	0.4%	34.5%
H10	Stockings Wood[1]		3.3	0.04	3.3	0.4%	33.1%
H11	Hardingdell and Fernell's Woods CWS (LWS)		3.6	0.22	3.8	2.2%	37.9%
H12	Luton Hoo Park South[1]		3.5	0.06	3.6	0.6%	35.6%
H13	River Lea Pastures, N. of Harpenden LWS & East Hyde Riverside CWS (LWS)		3.5	0.11	3.6	1.1%	36.2%

Ref	Protected Conservation Area	EQS (µg/m³)	Background concentration (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
H14	Circus Wood[1]		3.3	0.03	3.3	0.3%	32.8%
H15a	River Lea CWS		3.6	1.49	5.1	14.9%	50.6%
H15b			3.5	4.42	7.9	44.2%	78.9%
H15c			3.5	4.18	7.6	41.8%	76.5%
H15d			3.5	1.79	5.3	17.9%	52.6%

Note 1: The name of the LWS is based on the geographic area they inhabit.

The results in Table 9 indicate that at the assessed local nature sites, the respective annual mean NOx and SO_2 PCs are less than 100% of the relevant long-term environmental standard for protected conservation areas and the impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2021a).

The maximum short-term mean concentrations which were assessed against the 24-hour mean critical level for NOx (i.e. 75 µg/m³) are presented in Table 10.

Table 10: Results of detailed assessment at assessed protected conservation sites for maximum 24-hour mean NOx concentrations

Ref	Protected Conservation Area	EQS (µg/m³)	Background concentration (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
H1	Graves Wood AW & CWS (LWS)	75	28.0	6.0	34.0	7.9%	45.3%
H2	Birch Wood AW & Luton Hoo Park CWS (LWS)		28.0	4.2	32.3	5.7%	43.0%
H3	George Wood AW & CWS (LWS)		35.9	1.4	37.3	1.9%	49.7%
H4	Hardingdell Woods AW		31.9	2.7	34.7	3.7%	46.2%
H5	Horselys Wood AW & Chiltern Green CWS (LWS)		31.9	1.7	33.7	2.3%	44.9%
H6	Flaskets Wood AW & CWS (LWS)		26.9	1.0	27.9	1.4%	37.2%
H7	Bramagar Wood AW & CWS (LWS)		26.9	1.2	28.1	1.6%	37.5%
H8	Round Wood AW CWS (LWS)		26.9	0.8	27.7	1.1%	37.0%
H9	Kinsbourne Green Grassland LWS		28.5	0.9	29.4	1.1%	39.2%
H10	Stockings Wood[1]		30.9	1.0	31.9	1.4%	42.6%
H11	Hardingdell and Fernell's Woods CWS (LWS)		31.9	3.5	35.4	4.6%	47.2%
H12	Luton Hoo Park South[1]		28.4	3.5	32.0	4.7%	42.6%
H13	River Lea Pastures, N. of Harpenden LWS & East Hyde Riverside CWS (LWS)		30.3	2.8	33.1	3.7%	44.2%
H14	Circus Wood[1]		29.4	1.6	31.1	2.2%	41.4%
H15a	River Lea CWS		31.9	25.5	57.4	34.0%	76.5%
H15b			29.0	59.1	88.1	78.8%	117.4%
H15c			29.0	32.6	61.6	43.5%	82.1%
H15d			29.0	18.5	47.5	24.7%	63.3%

Note 1: The name of the LWS is based on the geographic area they inhabit.

The results in Table 10 indicate that at the assessed local nature sites, the short-term NOx PCs are less than 100% of the short-term environmental standard and the impact can also be described as 'insignificant'.

Summary

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 boiler 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, 2021). Further information on the assessment of deposition is provided in Appendix B. The full detailed modelled results are displayed in Table 11 and Table 12.

Table 11: 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)		PC	PEC	PC/CL (%)	PEC/CL(%)
			CLMaxS	CLMinN	CLMaxN	Existing deposition (N)	Existing deposition (S)				
H1	Graves Wood AW & CWS (LWS)	Tall	1.788	0.142	1.930	2.40	0.19	0.077	2.67	4.0%	138%
H2	Birch Wood AW & Luton Hoo Park CWS (LWS)	Short	0.900	0.223	1.123	1.39	0.15	0.017	1.56	1.6%	139%
		Tall	1.788	0.142	1.930	2.40	0.19	0.035	2.62	1.8%	136%
H3	George Wood AW & CWS (LWS)	Tall	1.784	0.142	1.926	2.40	0.19	0.015	2.61	0.8%	135%
H4	Hardingdell Woods AW	Tall	1.782	0.142	1.924	2.40	0.19	0.035	2.63	1.8%	136%
H5	Horselys Wood AW & Chiltern Green CWS (LWS)	Tall	1.782	0.142	1.924	2.40	0.19	0.037	2.63	1.9%	137%
H6	Flaskets Wood AW & CWS (LWS)	Tall	1.778	0.142	1.920	2.40	0.19	0.025	2.62	1.3%	136%
H7	Bramagar Wood AW & CWS (LWS)	Tall	1.778	0.142	1.920	2.40	0.19	0.024	2.61	1.3%	136%
H8	Round Wood AW CWS (LWS)	Tall	1.778	0.142	1.920	2.40	0.19	0.015	2.61	0.8%	136%
H9	Kinsbourne Green Grassland LWS	Short	0.900	0.223	1.123	1.39	0.15	0.006	1.55	0.5%	138%
H10	Stockings Wood[1]	Short	0.900	0.223	1.123	1.39	0.15	0.005	1.54	0.4%	138%
		Tall	1.790	0.142	1.932	2.40	0.19	0.010	2.60	0.5%	135%
H11	Hardingdell and Fernell's Woods CWS (LWS)	Tall	1.782	0.142	1.924	2.40	0.19	0.057	2.65	2.9%	138%
H12	Luton Hoo Park South[1]	Short	0.900	0.223	1.123	1.39	0.15	0.007	1.55	0.6%	138%
		Tall	1.778	0.142	1.920	2.40	0.19	0.014	2.60	0.7%	136%
H13	River Lea Pastures, N. of Harpenden LWS & East Hyde Riverside CWS (LWS)	Short	0.900	0.223	1.123	1.39	0.15	0.014	1.55	1.3%	138%
		Tall	1.787	0.142	1.929	2.40	0.19	0.028	2.62	1.5%	136%

Ref	Habitat	Vegetation type (for deposition velocity)	Critical load (CL) (kEqH+/ha/year)			Existing acid deposition (kEqH+/ha/year)		PC	PEC	PC/CL (%)	PEC/CL(%)
			CLMaxS	CLMinN	CLMaxN	Existing deposition (N)	Existing deposition (S)				
H14	Circus Wood[1]	Tall	1.790	0.142	1.932	2.40	0.19	0.007	2.60	0.4%	134%
H15a	River Lea CWS	Short	0.900	0.223	1.123	1.39	0.15	0.194	1.73	17.3%	154%
		Tall	1.782	0.142	1.924	2.40	0.19	0.389	2.98	20.2%	155%
H15b		Short	0.900	0.223	1.123	1.39	0.15	0.576	2.12	51.3%	188%
		Tall	1.783	0.142	1.925	2.40	0.19	1.151	3.74	59.8%	194%
H15c		Short	0.900	0.223	1.123	1.39	0.15	0.544	2.08	48.4%	186%
		Tall	1.783	0.142	1.925	2.40	0.19	1.088	3.68	56.5%	191%
H15d		Short	0.900	0.223	1.123	1.39	0.15	0.232	1.77	20.7%	158%
		Tall	1.783	0.142	1.925	2.40	0.19	0.465	3.05	24.1%	159%

Note 1: The name of the LWS is based on the geographic area they inhabit.

Table 12: Modelled nutrient nitrogen deposition at assessed protected conservation areas

Ref	Habitat	Vegetation type (for deposition velocity)	Existing nutrient deposition (kgN/ha-year)					
			Minimal Critical Load (CL)	Existing deposition	PC	PEC	PC/CL (%)	PEC/CL(%)
H1	Graves Wood AW & CWS (LWS)	Tall	5	33.60	0.100	33.70	2.0%	674%
H2	Birch Wood AW & Luton Hoo Park CWS (LWS)	Short	5	19.46	0.023	19.48	0.5%	390%
		Tall	5	33.60	0.045	33.65	0.9%	673%
H3	George Wood AW & CWS (LWS)	Tall	5	33.60	0.020	33.62	0.4%	672%
H4	Hardingdell Woods AW	Tall	5	33.60	0.046	33.65	0.9%	673%
H5	Horselys Wood AW & Chiltern Green CWS (LWS)	Tall	5	33.60	0.048	33.65	1.0%	673%
H6	Flaskets Wood AW & CWS (LWS)	Tall	5	33.60	0.033	33.63	0.7%	673%
H7	Bramagar Wood AW & CWS (LWS)	Tall	5	33.60	0.032	33.63	0.6%	673%

Ref	Habitat	Vegetation type (for deposition velocity)	Existing nutrient deposition (kgN/ha-year)					
			Minimal Critical Load (CL)	Existing deposition	PC	PEC	PC/CL (%)	PEC/CL(%)
H8	Round Wood AW CWS (LWS)	Tall	5	33.60	0.020	33.62	0.4%	672%
H9	Kinsbourne Green Grassland LWS	Short	5	19.46	0.007	19.47	0.1%	389%
H10	Stockings Wood[1]	Short	5	19.46	0.006	19.47	0.1%	389%
		Tall	5	33.60	0.013	33.61	0.3%	672%
H11	Hardingdell and Fernell's Woods CWS (LWS)	Tall	5	33.60	0.074	33.67	1.5%	673%
H12	Luton Hoo Park South[1]	Short	5	19.46	0.009	19.47	0.2%	389%
		Tall	5	33.60	0.019	33.62	0.4%	672%
H13	River Lea Pastures, N. of Harpenden LWS & East Hyde Riverside CWS (LWS)	Short	5	19.46	0.018	19.48	0.4%	390%
		Tall	5	33.60	0.037	33.64	0.7%	673%
H14	Circus Wood[1]	Tall	5	33.60	0.009	33.61	0.2%	672%
H15a	River Lea CWS	Short	5	19.46	0.253	19.71	5.1%	394%
		Tall	5	33.60	0.507	34.11	10.1%	682%
H15b		Short	5	19.46	0.750	20.21	15.0%	404%
		Tall	5	33.60	1.500	35.10	30.0%	702%
H15c		Short	5	19.46	0.709	20.17	14.2%	403%
		Tall	5	33.60	1.417	35.02	28.3%	700%
H15d		Short	5	19.46	0.303	19.76	6.1%	395%
		Tall	5	33.60	0.606	34.21	12.1%	684%

Note 1: The name of the LWS is based on the geographic area they inhabit.

The results in Table 11 and Table 12 indicate that for acid deposition and nutrient nitrogen deposition, at the assessed local nature sites, the respective PCs are less than 100% of the long-term environmental standard for protected conservation areas and the impact can be described as 'insignificant' as Environment Agency guidance (Environment Agency, 2021a).

It should be noted acid and nitrogen deposition rates currently exceed their relevant critical loads in the majority of the 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 2019 model (which predicted the highest annual mean at sensitive human receptor locations) and 2018 model (which predicted the highest 1-hour mean NO_2 concentrations at sensitive human receptor locations and 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 13, Table 14 and Table 15.

Table 13: 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	3.3	3.1	14.0	7.7%	35.1%	-0.6%
	1 hour mean (99.79th percentile)	Maximum off-site	48.3	47.7	71.5	23.9%	35.8%	-0.3%
		Sensitive locations	34.1	37.2	59.0	18.6%	29.5%	1.5%

The results in Table 13 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, the PC was marginally lower and at sensitive human receptor locations, the PC was higher when using a reduced surface roughness value of 0.1 m. However, a surface roughness of 0.1 m (representing root crops) is not considered representative of the site and surrounding area.

Table 14: Sensitivity analysis - fixed surface roughness of 1 m

Pollutant	**Averaging period**	**Assessment location**	**Original PC (surface roughness 0.4 m) (µg/m³)**	**Surface roughness length 1 m**				
				PC (µg/m³)	**PEC (µg/m³)**	**PC/EQS**	**PEC/EQS**	**% difference in PC/EQS compared to original**
NO_2	Annual mean	Sensitive locations	3.3	3.5	14.4	8.7%	36.0%	0.4%
	1 hour mean (99.79th percentile)	Maximum off-site	48.3	65.7	89.5	32.8%	44.7%	8.7%
		Sensitive locations	34.1	34.6	56.4	17.3%	28.2%	0.2%

The results in Table 14 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 location, the PCs were higher when 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 15: Sensitivity analysis - no buildings

Pollutant	**Averaging period**	**Assessment location**	**Original PC (with buildings) (µg/m³)**	**No buildings**				
				PC (µg/m³)	**PEC (µg/m³)**	**PC/EQS**	**PEC/EQS**	**% difference in PC/EQS compared to original**
NO_2	Annual mean	Sensitive locations	3.3	2.5	13.5	6.4%	33.7%	-2.0%
	1 hour mean (99.79th percentile)	Maximum off-site	48.3	15.9	39.7	8.0%	19.9%	-16.2%
		Sensitive locations	34.1	14.2	36.0	7.1%	18.0%	-10.0%

The results in Table 15 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 boiler at the East Hyde STW. The predicted impacts were assessed against the relevant air quality standards and guidelines for the protection of human health (referred to in the report as EQSs) and protected conservation areas (referred to as critical levels and critical loads).

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 air quality objective or guideline. At sensitive human receptor locations, the predicted long-term (i.e. annual mean) NO_2 and particulate (PM_{10} and $PM_{2.5}$) contributions are considered 'not significant'. For short-term NO_2, PM_{10}, SO_2 and CO concentrations at modelled off-site locations and sensitive human receptor locations, the contributions are also considered 'not significant'.

This assessment has been carried out on the assumption that the CHP engine and boiler would operate simultaneously and continuously at maximum load all year. This is a conservative assumption as, in practice, the assessed combustion plant will have periods of shut-down and maintenance and may not always operate at maximum load.

Protected conservation areas

For critical levels, the results indicate that at the assessed local nature sites, the respective annual mean NOx and SO_2 PCs are less than 100% of the long-term environmental standard and their impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2021a).

For the 24-hour mean critical level for NOx, the results indicate that at the assessed local nature sites, the short-term NOx PCs are less than 100% of the short-term environmental standard for protected conservation areas and the impact can also be described as 'insignificant'.

For acid deposition and nutrient nitrogen deposition, the results indicate that at the assessed local nature sites, the respective PCs are less than 100% of the long-term environmental standard for protected conservation areas and the impact can be described as 'insignificant'.

Summary

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

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8. Figures

Figure 1: Approximate site fenceline, modelled stack locations and modelled buildings

Figure 2: Extent of modelled grid and sensitive human receptor locations

Figure 3: Assessed protected conservation areas

Figure 4: Annual mean nitrogen dioxide process contributions, 2019 meteorological data

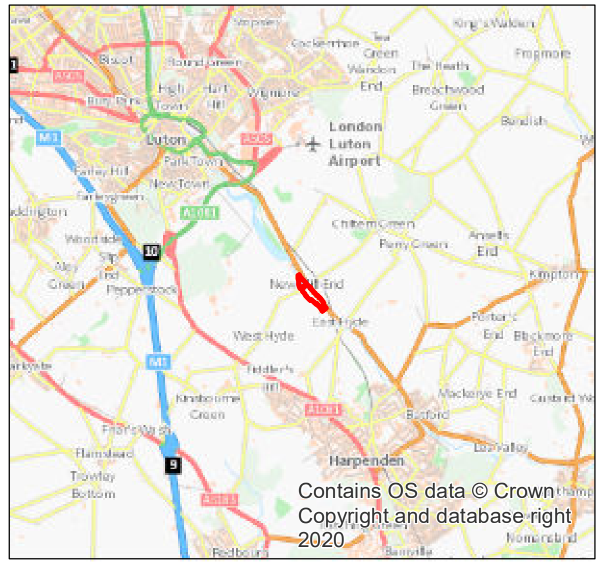
Figure 5: 1-hour mean (99.79th percentile) nitrogen dioxide process contributions, 2016 meteorological data

Figure 6: 1-hour mean (99.73rd percentile) sulphur dioxide process contributions, 2018 meteorological data

Figure 7: 15-minute mean (99.9th percentile) sulphur dioxide process contributions, 2016 meteorological data

Legend

- Approximate site fenceline
- Modelled stack locations
- Modelled buildings



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Drawing Title

APPROXIMATE SITE FENCELINE, MODELLED STACK LOCATIONS AND MODELLED BUILDINGS

Drawing Status

FINAL

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FIGURE 1

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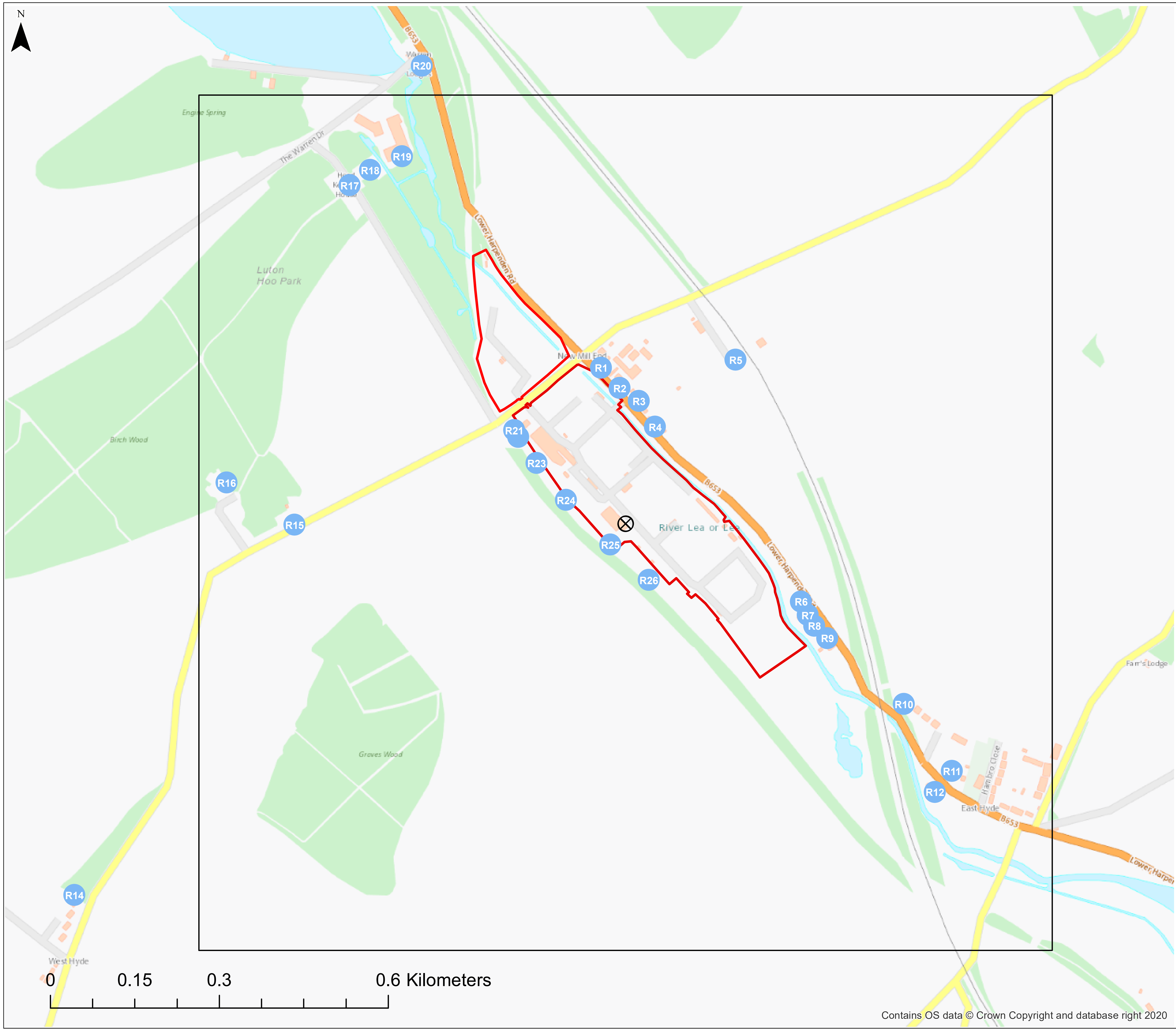
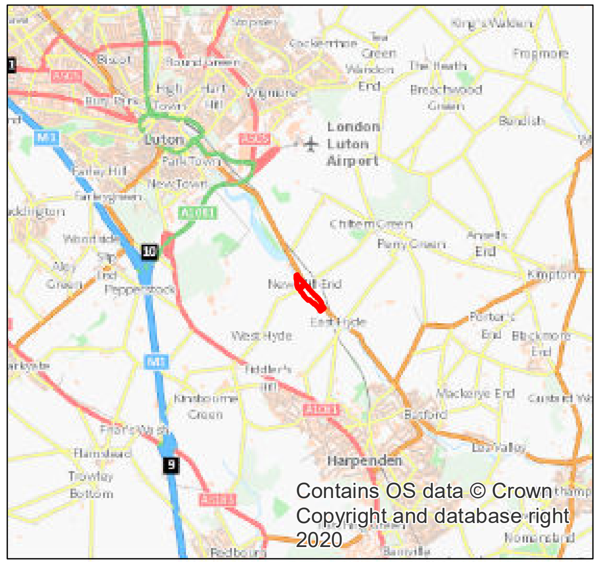


Legend

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



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Drawing Title
EXTENT OF MODELLED GRID AND SENSITIVE HUMAN RECEPTOR LOCATIONS

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FIGURE 2

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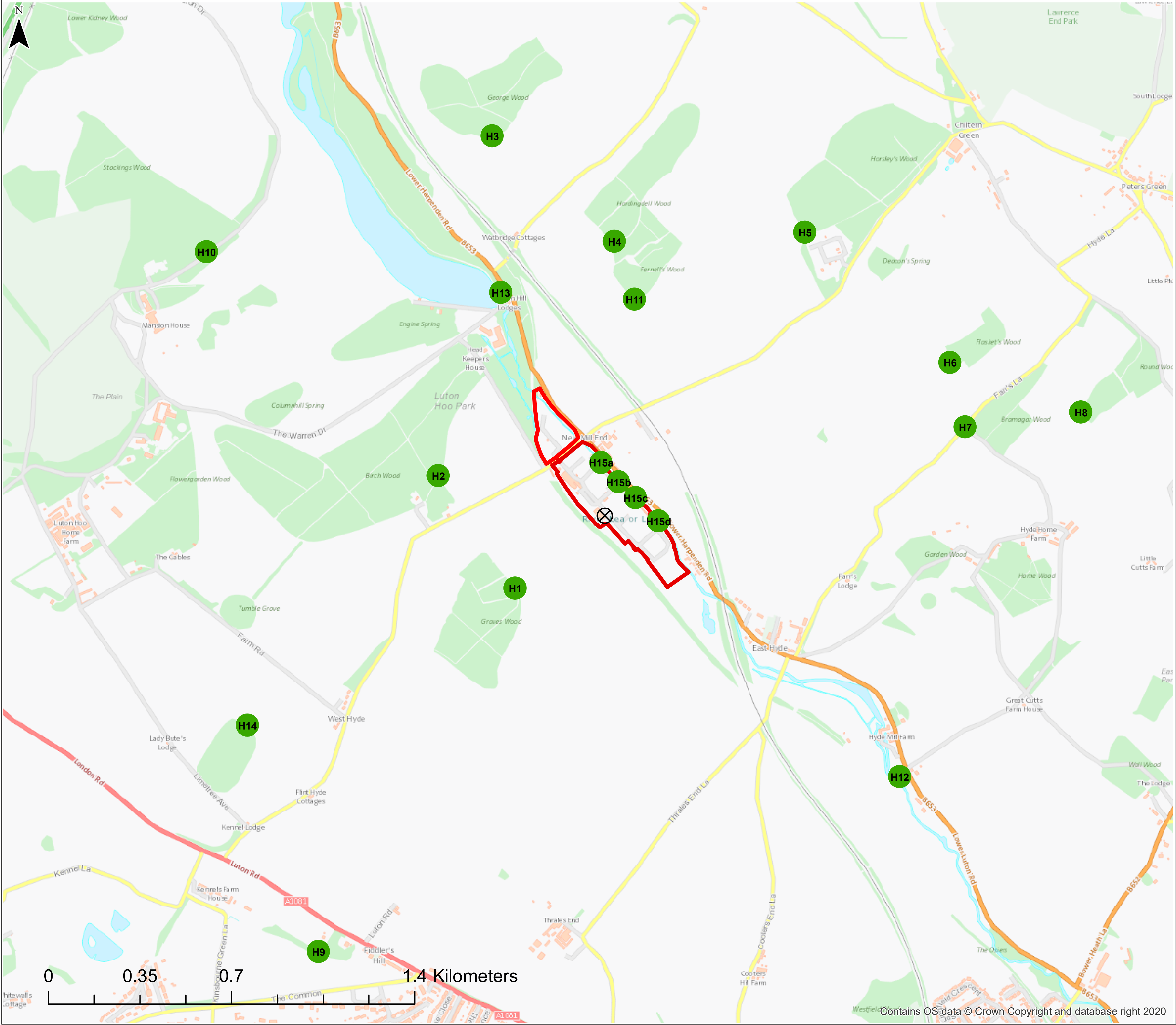

Legend

- Approximate site fenceline
- Modelled stack locations
- H1 Protected conservation area location

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Drawing Title

ASSESSED PROTECTED CONSERVATION AREAS

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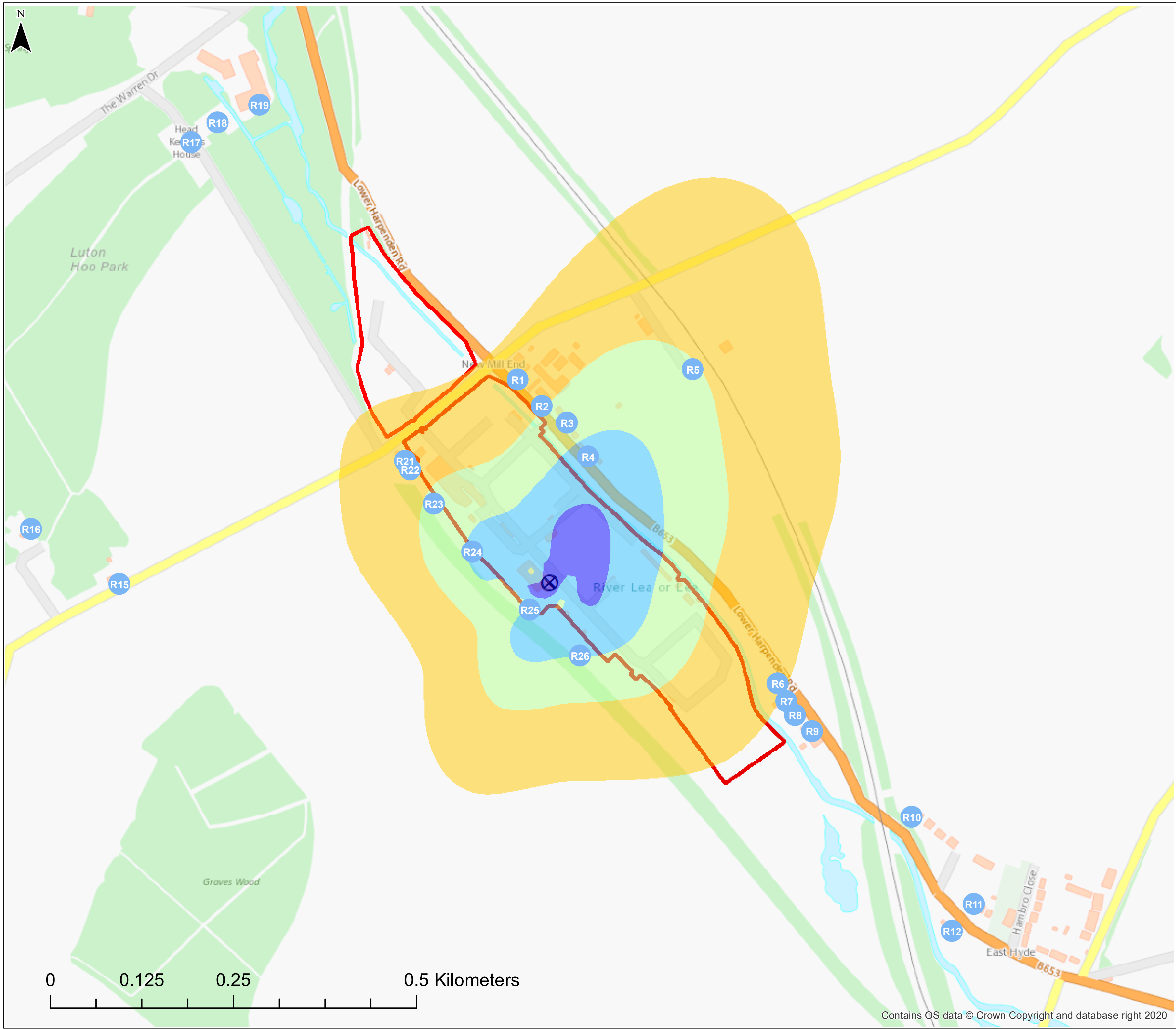

Legend

- Approximate site fenceline
- Modelled stack locations
- Sensitive human receptor locations

Annual mean nitrogen dioxide process contributions (µg/m³)

- 0 - 0.6
- 0.6 - 1.3
- 1.3 - 2.6
- 2.6 - 6.6
- 6.6 - 20.1

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Drawing Title

ANNUAL MEAN NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2019 METEOROLOGICAL DATA

Drawing Status

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FIGURE 4

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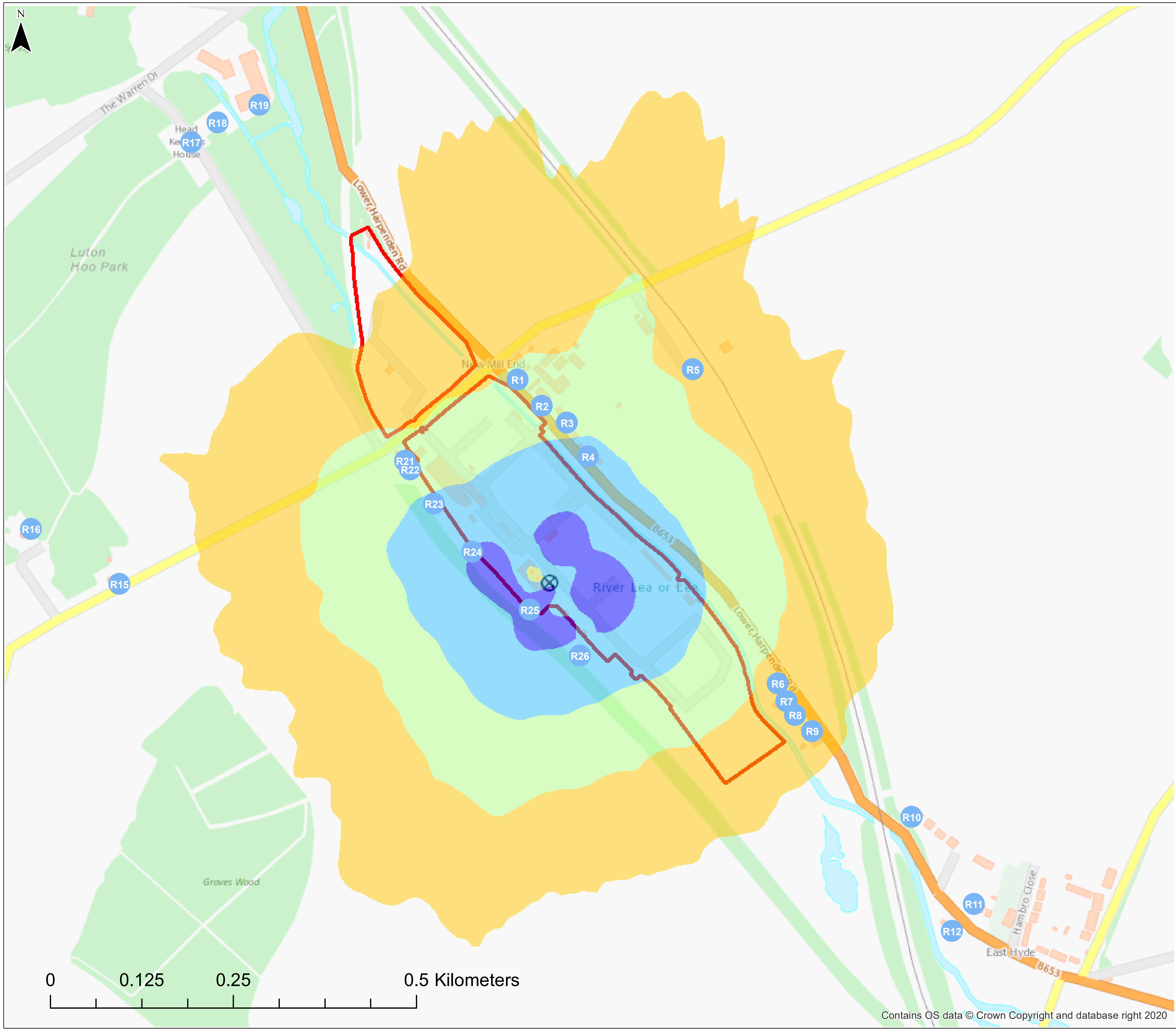

Legend

- Approximate site fenceline
- Modelled stack locations
- Sensitive human receptor locations

1-hour mean (99.79th percentile) nitrogen dioxide process contributions

- 0 - 5
- 5 - 8
- 8 - 14
- 14 - 30
- 30 - 53

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Drawing Title

1-HOUR MEAN (99.79th PERCENTILE) NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2016 METEOROLOGICAL DATA

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Drawing Number

FIGURE 5

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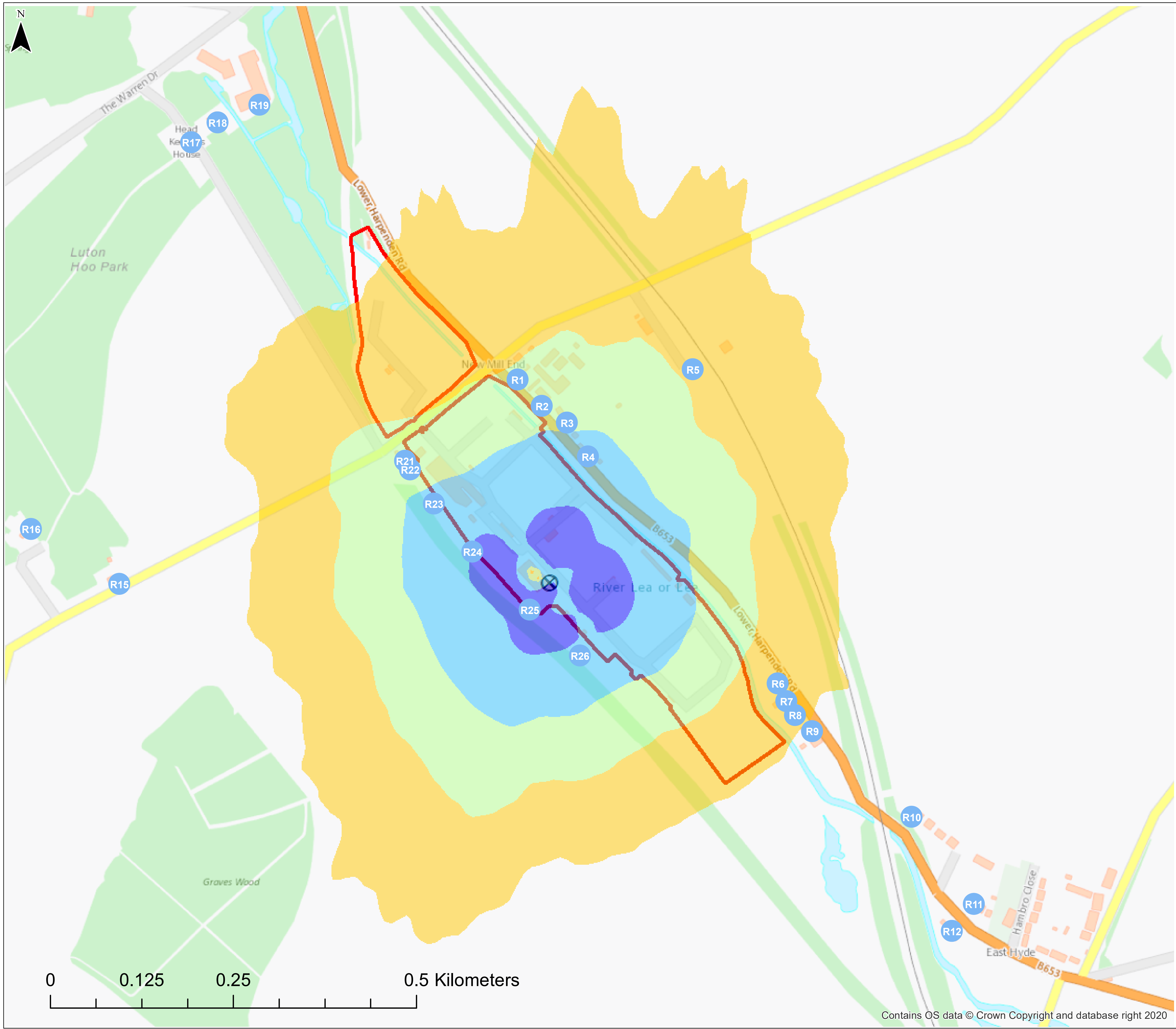

Legend

- Approximate site fenceline
- Modelled stack locations
- Sensitive human receptor locations

1-hour mean (99.73rd percentile) sulphur dioxide process contributions

- 0 - 8
- 8 - 13
- 13 - 22
- 22 - 47
- 47 - 84

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Drawing Title

1-HOUR MEAN (99.73rd PERCENTILE) SULPHUR DIOXIDE PROCESS CONTRIBUTIONS, 2018 METEOROLOGICAL DATA

Drawing Status

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FIGURE 6

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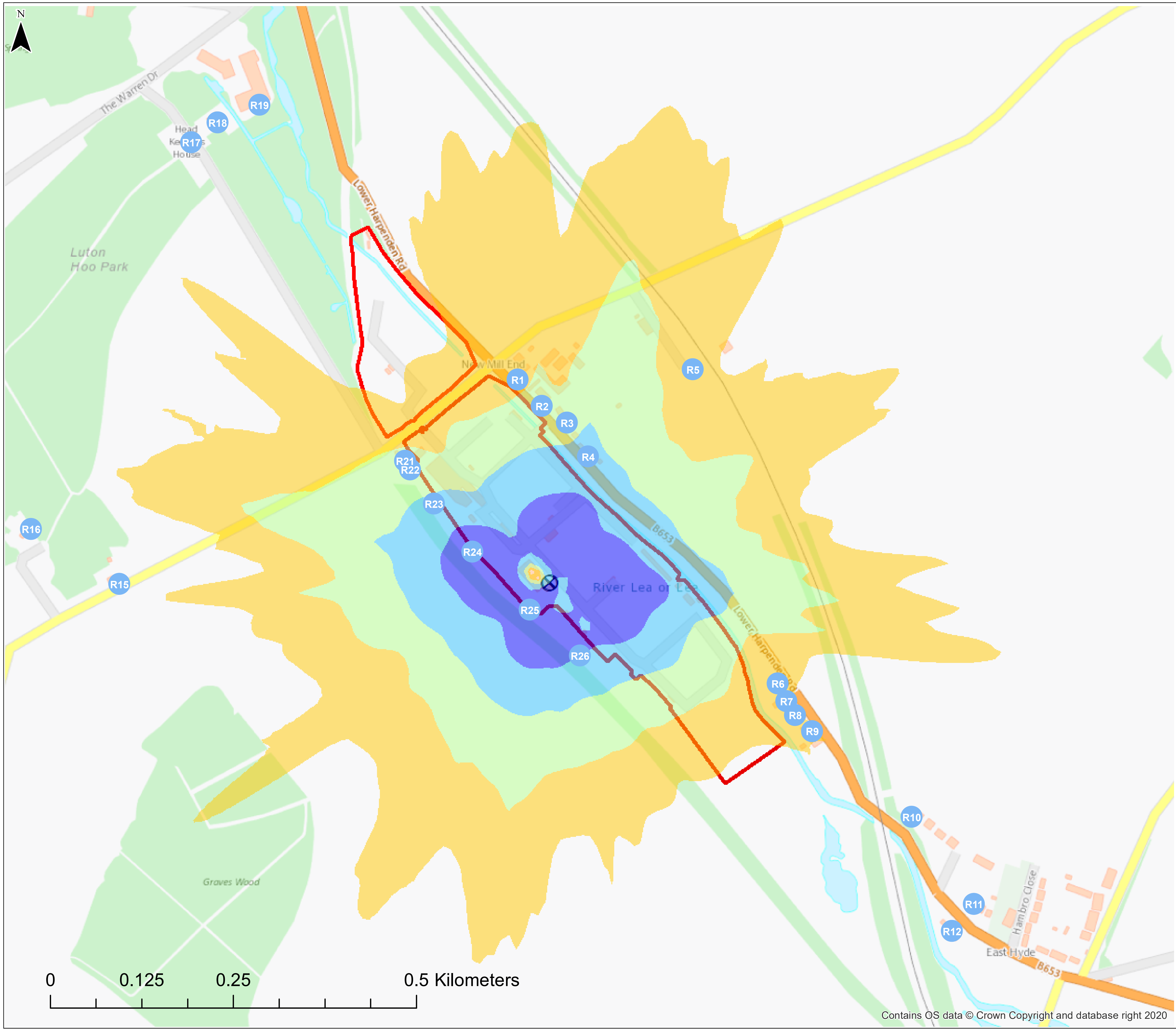

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Drawing Title
15-MINUTE MEAN (99.9th PERCENTILE) SULPHUR DIOXIDE PROCESS CONTRIBUTIONS, 2016 METEOROLOGICAL DATA

Drawing Status
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Drawing Number
FIGURE 7

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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. Emission limits as set out in the MCPD[2] for existing combustion plant are also presented in Table A.1 where relevant.

Table A.1: Dispersion modelling parameters

Parameters	Unit	CAT CHP engine (1.4 MW_{th})	Strebel boiler (1.1 MW_{th})
Modelled fuel	-	Biogas	Biogas
Emission point	-	A1	A2
Assessed annual operational hours	Hours	8,760	8,760
Stack location	m	E 512171 N 217811[2]	E 512172 N 217811[2]
Stack height	m	11.70	11.70
Stack diameter	m	0.25	0.35
Flue gas temperature	°C	174	152
Efflux velocity	m/s	36.0	12.2
Moisture content of exhaust gas	%	9.1	8.1
Oxygen content of exhaust gas (dry)	%	7.9	6.4
Volumetric flow rate (actual)	m^3/s	1.769	1.173
Volumetric flow rate (normal)[1]	Nm^3/s	2.163	0.560
NOx emission concentration[1,]	mg/Nm^3	241 (190 after 1st January 2030)	250 (250 after 1st January 2030)
NOx emission rate	g/s	0.522	0.140
CO emission concentration[1]	mg/Nm^3	557	100
CO emission rate	g/s	1.204	0.056
PM_{10} / $PM_{2.5}$ emission concentration[1]	mg/Nm^3	2.7	5
PM_{10} / $PM_{2.5}$ emission rate	g/s	0.006	0.003
SO_2 emission concentration[1]	mg/Nm^3	130 (60 after 1st January 2030)	200
SO_2 emission rate	g/s	0.281	0.112
TVOC emission concentration[1]	mg/Nm^3	649	1,126
TVOC emission rate	g/s	1.405	0.631

Note 1: Normalised flows and concentrations presented at 273 K, 101.3 kPa, dry gas and oxygen content of 15% (CHP engine) or 3% (boiler).
Note 2: Due to the close proximity of the CHP engine stack and boiler stack, 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
Building 1 - Boiler house / CHP engine housing[1]	Rectangular	40.70	21.70	11.10	138	512150	217820
Building 2 - Boiler house / CHP engine housing	Rectangular	10.10	8.10	11.10	48	512169	217805
Tank 1 - Primary digester	Circular	13.30	-	14.40	-	512196	217782
Tank 2 - Primary digester	Circular	12.99	-	14.40	-	512208	217769
Tank 3 - Primary digester	Circular	12.99	-	14.40	-	512220	217756
Tank 4	Circular	4.50	-	5.30	-	512185	217792
Tank 5	Circular	4.40	-	4.15	-	512175	217785

Note 1: Modelled as main building in ADMS.

A.2.2 Other Model Inputs

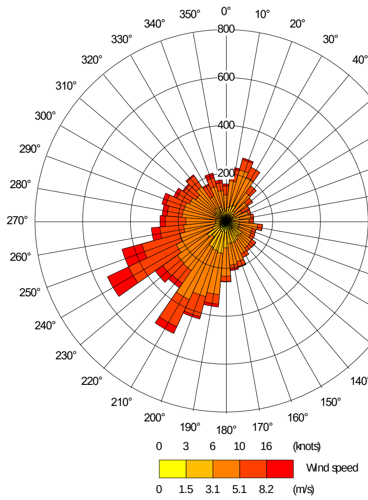
Table A.3: Other model inputs applied

Parameter	Value used	Comments
Surface roughness length for dispersion site	0.4 m	This is appropriate for the dispersion site where the local land-use ranges from parkland to open suburbia. 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	0.7 m	This is appropriate for an area where the local land-is relatively built up such as at Luton Airport.
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	Luton Airport meteorological station, 2016 - 2020	Luton Airport meteorological station is located approximately 3.1 km north-northeast of the site and is considered the closest most representative meteorological monitoring station to the site.
Combined flue option	Yes	As the CHP engine stack and boiler stack are in close proximity, an aai file was used in the model to represent the effects of a single plume.

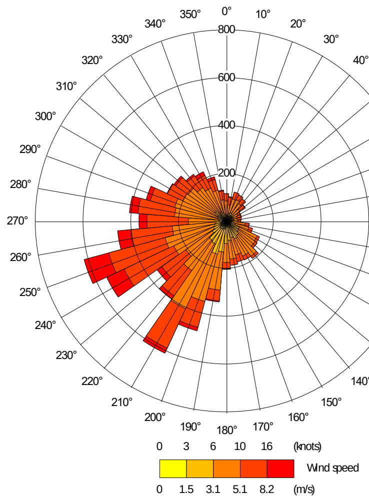
A.2.3 Meteorological Data – Wind Roses

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

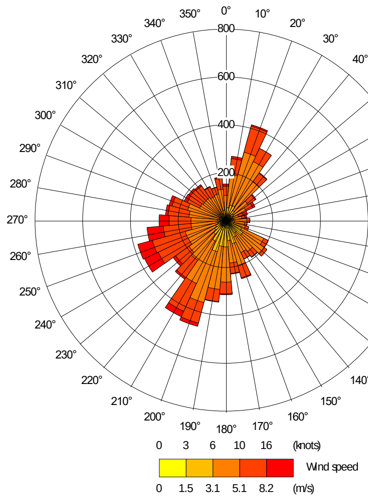
Luton Airport meteorological station, 2016



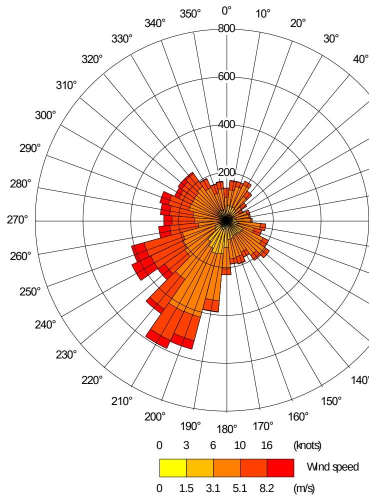
Luton Airport meteorological station, 2017



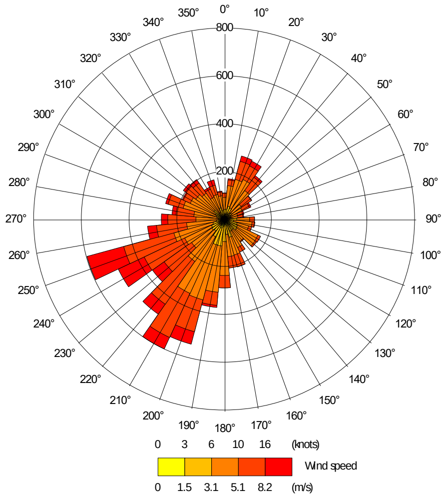
Luton Airport meteorological station, 2018



Luton Airport meteorological station, 2019



Luton Airport meteorological station, 2020



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	511421	512921	151	10
Northing	217061	218561	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 15 protected conservation areas within the required study area were assessed. The receptor locations are shown in Figure 1 and Figure 2 and further details of the receptor locations are provided in Table A.5 and Table A.6.

Table A.5: Assessed sensitive human receptor locations

Receptor	Description	Grid reference		Distance from CHP engine stack (km)	Direction from CHP engine stack
		Easting	Northing		
R1	Residential property on Lower Harpenden Road	512128	218087	0.28	N
R2	Residential property on Lower Harpenden Road	512161	218051	0.24	N
R3	Residential property on Lower Harpenden Road	512195	218028	0.22	N
R4	Residential property on Lower Harpenden Road	512224	217982	0.18	NNE
R5	Residential property on Chiltern Green Road	512367	218101	0.35	NE
R6	Residential property on Lower Harpenden Road	512483	217672	0.34	ESE
R7	Residential property on Lower Harpenden Road	512495	217648	0.36	ESE
R8	Residential property on Lower Harpenden Road	512507	217629	0.38	ESE
R9	Residential property on Lower Harpenden Road	512530	217607	0.41	ESE
R10	Residential property on Southern Rise	512666	217490	0.59	ESE
R11	Residential property on Lower Harpenden Road	512751	217371	0.73	SE
R12	Residential property on Lower Harpenden Road	512721	217334	0.73	SE
R13	Residential property on Thrales End Lane	511962	216337	1.49	S
R14	Residential property on Farm Road	511193	217151	1.18	SW
R15	Residential property on West Hyde Road	511584	217808	0.59	W
R16	Residential property on West Hyde Road	511463	217883	0.71	W
R17	Residential property on The Warren Drive	511682	218411	0.77	NW
R18	Residential property on The Warren Drive	511718	218438	0.77	NW
R19	Residential property on The Warren Drive	511775	218462	0.76	NNW
R20	Residential property on The Warren Drive	511810	218623	0.89	NNW
R21	Residential property on Lower Harpenden Road	511974	217976	0.26	NW
R22	Residential property on Lower Harpenden Road	511981	217964	0.24	NW
R23	PRoW	512014	217918	0.19	NW
R24	PRoW	512066	217852	0.11	WNW
R25	PRoW	512144	217773	0.05	SW
R26	PRoW	512213	217710	0.11	SSE

Table A.6: Assessed protected conservation area locations

Receptor	Description	Grid reference		Distance from CHP engine stack (km)	Direction from CHP engine stack
		Easting	Northing		
H1	Graves Wood AW & CWS (LWS)	511829	217533	0.44	SW
H2	Birch Wood AW & Luton Hoo Park CWS (LWS)	511535	217963	0.65	WNW
H3	George Wood AW & CWS (LWS)	511742	219262	1.51	NNW
H4	Hardingdell Woods AW	512209	218859	1.05	N
H5	Horselys Wood AW & Chiltern Green CWS (LWS)	512937	218893	1.33	NE
H6	Flaskets Wood AW & CWS (LWS)	513491	218396	1.44	ENE
H7	Bramagar Wood AW & CWS (LWS)	513550	218149	1.42	ENE
H8	Round Wood AW CWS (LWS)	513992	218206	1.86	ENE
H9	Kinsbourne Green Grassland LWS	511078	216143	1.99	SSW
H10	Stockings Wood[1]	510650	218819	1.82	WNW
H11	Hardingdell and Fernell's Woods CWS (LWS)	512286	218637	0.83	N
H12	Luton Hoo Park South[1]	513300	216812	1.51	SE
H13	River Lea Pastures, N. of Harpenden LWS & East Hyde Riverside CWS (LWS)	511775	218663	0.94	NNW
H14	Circus Wood[1]	510806	217008	1.58	WSW
H15a	River Lea CWS	512158	218013	0.20	N
H15b		512224	217939	0.14	NNE
H15c		512290	217878	0.14	ENE
H15d		512377	217789	0.21	E

Note 1: Unable to identify correct name of LWS. The name of the LWS is based on the geographic areas they inhabit or are adjacent too.

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 NO_x 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, 2021b). 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, 2021a), 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 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 (z_o) 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 boiler were assumed to operate simultaneously for 8,760 hours each calendar year but in practice, the CHP engine and boiler will have periods of shut-down and maintenance and may not always operate at maximum load.
- 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 each assessed protected conservation area is present at the specific modelled location.

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, 2021). Information on the deposition critical loads for each habitat site was also obtained from the APIS database using the Site Relevant Critical Load function.

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

Dry deposition flux (µg/m^2/s) = ground level concentration (µg/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 µg/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

µg/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

µg/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 (µg/m³)	Maximum 8-hour running mean					Maximum 1-hour mean				
		EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	301	10,000	47.9	349	0.5%	3.5%	30,000	51.2	353	0.2%	1.2%
R2	301		52.4	354	0.5%	3.5%		68.7	370	0.2%	1.2%
R3	301		54.7	356	0.5%	3.6%		72.7	374	0.2%	1.2%
R4	301		78.9	380	0.8%	3.8%		95.9	396	0.3%	1.3%
R5	301		34.7	336	0.3%	3.4%		46.8	348	0.2%	1.2%
R6	301		36.1	337	0.4%	3.4%		69.4	370	0.2%	1.2%
R7	301		35.0	336	0.4%	3.4%		64.5	365	0.2%	1.2%
R8	301		35.6	336	0.4%	3.4%		60.9	361	0.2%	1.2%
R9	301		34.4	335	0.3%	3.4%		55.8	356	0.2%	1.2%
R10	301		24.6	325	0.2%	3.3%		37.2	338	0.1%	1.1%
R11	301		23.6	324	0.2%	3.2%		27.8	328	0.1%	1.1%
R12	301		26.2	327	0.3%	3.3%		27.1	328	0.1%	1.1%
R13	320		7.7	328	0.1%	3.3%		11.3	332	0.0%	1.1%
R14	309		9.2	318	0.1%	3.2%		16.8	325	0.1%	1.1%
R15	309		17.8	326	0.2%	3.3%		39.4	348	0.1%	1.2%
R16	309		27.8	336	0.3%	3.4%		32.6	341	0.1%	1.1%
R17	317		13.6	330	0.1%	3.3%		24.6	341	0.1%	1.1%
R18	317		13.0	330	0.1%	3.3%		23.8	340	0.1%	1.1%
R19	317		14.2	331	0.1%	3.3%		23.9	341	0.1%	1.1%
R20	317		11.2	328	0.1%	3.3%		20.4	337	0.1%	1.1%
R21	309		55.5	364	0.6%	3.6%		62.4	371	0.2%	1.2%
R22	309		61.5	370	0.6%	3.7%		70.0	379	0.2%	1.3%
R23	301		84.1	385	0.8%	3.8%		107.7	408	0.4%	1.4%
R24	301		153.3	454	1.5%	4.5%		199.0	500	0.7%	1.7%
R25	301		183.6	484	1.8%	4.8%		188.0	489	0.6%	1.6%
R26	301		132.9	434	1.3%	4.3%		147.4	448	0.5%	1.5%

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	11.9	40	1.0	12.9	2.5%	32.2%	200	23.8	8.7	32.5	4.3%	16.2%
R2	11.9		1.4	13.3	3.5%	33.2%		23.8	11.1	34.9	5.5%	17.4%
R3	11.9		1.9	13.8	4.7%	34.5%		23.8	12.5	36.3	6.3%	18.1%
R4	10.9		3.3	14.3	8.3%	35.6%		21.8	16.8	38.7	8.4%	19.3%
R5	11.9		1.4	13.3	3.4%	33.1%		23.8	8.0	31.8	4.0%	15.9%
R6	10.9		0.8	11.8	2.1%	29.4%		21.8	7.4	29.2	3.7%	14.6%
R7	10.9		0.7	11.7	1.9%	29.2%		21.8	6.6	28.5	3.3%	14.2%
R8	10.9		0.7	11.6	1.7%	29.0%		21.8	6.3	28.2	3.2%	14.1%
R9	10.9		0.6	11.5	1.5%	28.8%		21.8	5.7	27.5	2.9%	13.8%
R10	10.9		0.3	11.2	0.8%	28.1%		21.8	3.7	25.5	1.8%	12.7%
R11	10.9		0.2	11.1	0.6%	27.9%		21.8	2.8	24.7	1.4%	12.3%
R12	10.9		0.2	11.1	0.5%	27.8%		21.8	2.9	24.7	1.4%	12.4%
R13	10.8		0.1	10.9	0.2%	27.2%		21.6	1.3	22.9	0.6%	11.4%
R14	10.6		0.1	10.7	0.1%	26.7%		21.2	1.4	22.6	0.7%	11.3%
R15	10.6		0.2	10.8	0.4%	26.9%		21.2	3.8	25.0	1.9%	12.5%
R16	10.6		0.1	10.7	0.3%	26.8%		21.2	3.0	24.2	1.5%	12.1%
R17	11.4		0.2	11.5	0.4%	28.9%		22.8	2.9	25.7	1.5%	12.8%
R18	11.4		0.2	11.5	0.4%	28.9%		22.8	2.9	25.7	1.5%	12.8%
R19	11.4		0.2	11.5	0.4%	28.9%		22.8	3.0	25.7	1.5%	12.9%
R20	11.4		0.1	11.5	0.4%	28.8%		22.8	3.1	25.9	1.6%	13.0%
R21	10.6		0.9	11.5	2.3%	28.9%		21.2	10.3	31.5	5.2%	15.8%
R22	10.6		1.0	11.6	2.5%	29.0%		21.2	11.1	32.3	5.6%	16.2%
R23	10.9		1.5	12.4	3.7%	31.0%		21.8	16.1	37.9	8.0%	19.0%
R24	10.9		2.9	13.8	7.2%	34.5%		21.8	31.3	53.1	15.6%	26.6%
R25	10.9		6.9	17.8	17.3%	44.6%		21.8	34.1	56.0	17.1%	28.0%
R26	10.9		2.8	13.8	7.1%	34.4%		21.8	24.5	46.4	12.3%	23.2%

Table C.3: Results of detailed assessment at human receptor locations for 24-hour 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	7.1	125	6.9	14.0	5.5%	11.2%	350	7.1	14.4	21.5	4.1%	6.1%
R2	7.1		8.7	15.9	7.0%	12.7%		7.1	18.3	25.5	5.2%	7.3%
R3	7.1		10.3	17.5	8.3%	14.0%		7.1	20.9	28.0	6.0%	8.0%
R4	6.9		14.2	21.1	11.3%	16.9%		6.9	27.9	34.9	8.0%	10.0%
R5	7.1		5.2	12.3	4.2%	9.9%		7.1	12.6	19.7	3.6%	5.6%
R6	6.9		4.6	11.5	3.7%	9.2%		6.9	11.5	18.4	3.3%	5.3%
R7	6.9		4.1	11.0	3.3%	8.8%		6.9	11.0	17.9	3.1%	5.1%
R8	6.9		3.6	10.5	2.9%	8.4%		6.9	10.4	17.3	3.0%	5.0%
R9	6.9		3.1	10.1	2.5%	8.1%		6.9	9.3	16.2	2.6%	4.6%
R10	6.9		1.8	8.8	1.5%	7.0%		6.9	6.0	12.9	1.7%	3.7%
R11	6.9		1.4	8.4	1.1%	6.7%		6.9	4.5	11.5	1.3%	3.3%
R12	6.9		1.5	8.5	1.2%	6.8%		6.9	4.7	11.6	1.3%	3.3%
R13	6.8		0.5	7.3	0.4%	5.9%		6.8	1.9	8.8	0.6%	2.5%
R14	6.6		0.6	7.2	0.5%	5.8%		6.6	2.2	8.8	0.6%	2.5%
R15	6.6		1.8	8.4	1.5%	6.8%		6.6	5.9	12.5	1.7%	3.6%
R16	6.6		1.5	8.1	1.2%	6.5%		6.6	4.6	11.2	1.3%	3.2%
R17	7.0		1.5	8.5	1.2%	6.8%		7.0	4.8	11.8	1.4%	3.4%
R18	7.0		1.5	8.5	1.2%	6.8%		7.0	4.8	11.8	1.4%	3.4%
R19	7.0		1.5	8.5	1.2%	6.8%		7.0	4.6	11.7	1.3%	3.3%
R20	7.0		1.4	8.4	1.1%	6.7%		7.0	5.0	12.0	1.4%	3.4%
R21	6.6		8.9	15.5	7.1%	12.4%		6.6	17.0	23.6	4.9%	6.7%
R22	6.6		9.4	16.0	7.5%	12.8%		6.6	17.5	24.1	5.0%	6.9%
R23	6.9		12.5	19.5	10.0%	15.6%		6.9	26.0	33.0	7.4%	9.4%
R24	6.9		28.6	35.5	22.9%	28.4%		6.9	50.4	57.3	14.4%	16.4%
R25	6.9		43.0	49.9	34.4%	39.9%		6.9	57.7	64.7	16.5%	18.5%
R26	6.9		20.8	27.7	16.6%	22.2%		6.9	40.7	47.7	11.6%	13.6%

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	7.1	266	18.8	25.9	7.1%	9.7%
R2	7.1		22.7	29.8	8.5%	11.2%
R3	7.1		25.3	32.5	9.5%	12.2%
R4	6.9		34.4	41.3	12.9%	15.5%
R5	7.1		19.7	26.9	7.4%	10.1%
R6	6.9		17.2	24.1	6.5%	9.1%
R7	6.9		14.4	21.4	5.4%	8.0%
R8	6.9		14.7	21.7	5.5%	8.2%
R9	6.9		15.5	22.4	5.8%	8.4%
R10	6.9		10.7	17.7	4.0%	6.6%
R11	6.9		10.4	17.3	3.9%	6.5%
R12	6.9		10.0	17.0	3.8%	6.4%
R13	6.8		4.6	11.4	1.7%	4.3%
R14	6.6		7.0	13.6	2.6%	5.1%
R15	6.6		11.9	18.5	4.5%	6.9%
R16	6.6		8.5	15.1	3.2%	5.7%
R17	7.0		9.3	16.3	3.5%	6.1%
R18	7.0		9.2	16.3	3.5%	6.1%
R19	7.0		10.3	17.3	3.9%	6.5%
R20	7.0		9.5	16.5	3.6%	6.2%
R21	6.6		22.4	29.0	8.4%	10.9%
R22	6.6		24.0	30.6	9.0%	11.5%
R23	6.9		33.2	40.1	12.5%	15.1%
R24	6.9		60.5	67.4	22.7%	25.3%
R25	6.9		60.1	67.0	22.6%	25.2%
R26	6.9		46.7	53.7	17.6%	20.2%

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	15.1	40	0.02	15.1	0.0%	37.9%	50	30.3	0.07	30.3	0.1%	60.6%
R2	15.1		0.03	15.2	0.1%	37.9%		30.3	0.09	30.3	0.2%	60.7%
R3	15.1		0.04	15.2	0.1%	37.9%		30.3	0.12	30.4	0.2%	60.8%
R4	15.1		0.06	15.2	0.2%	37.9%		30.2	0.19	30.4	0.4%	60.7%
R5	15.1		0.03	15.2	0.1%	37.9%		30.3	0.07	30.3	0.1%	60.7%
R6	15.1		0.02	15.1	0.0%	37.8%		30.2	0.05	30.2	0.1%	60.5%
R7	15.1		0.01	15.1	0.0%	37.8%		30.2	0.04	30.2	0.1%	60.5%
R8	15.1		0.01	15.1	0.0%	37.8%		30.2	0.04	30.2	0.1%	60.4%
R9	15.1		0.01	15.1	0.0%	37.8%		30.2	0.04	30.2	0.1%	60.4%
R10	15.1		0.01	15.1	0.0%	37.7%		30.2	0.02	30.2	0.0%	60.4%
R11	15.1		0.00	15.1	0.0%	37.7%		30.2	0.02	30.2	0.0%	60.4%
R12	15.1		0.00	15.1	0.0%	37.7%		30.2	0.02	30.2	0.0%	60.4%
R13	15.7		0.00	15.7	0.0%	39.2%		31.4	0.01	31.4	0.0%	62.8%
R14	15.2		0.00	15.2	0.0%	37.9%		30.3	0.00	30.3	0.0%	60.6%
R15	15.2		0.00	15.2	0.0%	37.9%		30.3	0.01	30.3	0.0%	60.7%
R16	15.2		0.00	15.2	0.0%	37.9%		30.3	0.01	30.3	0.0%	60.7%
R17	14.1		0.00	14.1	0.0%	35.3%		28.3	0.01	28.3	0.0%	56.6%
R18	14.1		0.00	14.1	0.0%	35.3%		28.3	0.01	28.3	0.0%	56.6%
R19	14.1		0.00	14.1	0.0%	35.3%		28.3	0.01	28.3	0.0%	56.6%
R20	14.1		0.00	14.1	0.0%	35.3%		28.3	0.01	28.3	0.0%	56.6%
R21	15.2		0.02	15.2	0.0%	37.9%		30.3	0.08	30.4	0.2%	60.8%
R22	15.2		0.02	15.2	0.0%	37.9%		30.3	0.09	30.4	0.2%	60.8%
R23	15.1		0.03	15.1	0.1%	37.8%		30.2	0.12	30.3	0.2%	60.6%
R24	15.1		0.06	15.1	0.1%	37.9%		30.2	0.26	30.4	0.5%	60.9%
R25	15.1		0.13	15.2	0.3%	38.1%		30.2	0.61	30.8	1.2%	61.6%
R26	15.1		0.05	15.1	0.1%	37.9%		30.2	0.21	30.4	0.4%	60.8%

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	9.5	25	0.02	9.5	0.1%	38.1%
R2	9.5		0.03	9.5	0.1%	38.1%
R3	9.5		0.04	9.5	0.1%	38.1%
R4	9.5		0.06	9.6	0.3%	38.3%
R5	9.5		0.03	9.5	0.1%	38.1%
R6	9.5		0.02	9.5	0.1%	38.1%
R7	9.5		0.01	9.5	0.1%	38.1%
R8	9.5		0.01	9.5	0.1%	38.1%
R9	9.5		0.01	9.5	0.0%	38.1%
R10	9.5		0.01	9.5	0.0%	38.1%
R11	9.5		0.00	9.5	0.0%	38.1%
R12	9.5		0.00	9.5	0.0%	38.1%
R13	9.6		0.00	9.6	0.0%	38.5%
R14	9.5		0.00	9.5	0.0%	37.9%
R15	9.5		0.00	9.5	0.0%	37.9%
R16	9.5		0.00	9.5	0.0%	37.9%
R17	9.3		0.00	9.3	0.0%	37.1%
R18	9.3		0.00	9.3	0.0%	37.1%
R19	9.3		0.00	9.3	0.0%	37.1%
R20	9.3		0.00	9.3	0.0%	37.1%
R21	9.5		0.02	9.5	0.1%	37.9%
R22	9.5		0.02	9.5	0.1%	37.9%
R23	9.5		0.03	9.5	0.1%	38.2%
R24	9.5		0.06	9.6	0.2%	38.3%
R25	9.5		0.13	9.7	0.5%	38.6%
R26	9.5		0.05	9.6	0.2%	38.3%

Table C.7: Results of detailed assessment at sensitive human receptor locations for annual mean and maximum 1-hour mean TVOC predicted concentrations

Receptor ID	Annual mean						100th percentile of 1-hour mean					
	Baseline air quality level	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	n/a		4.3	n/a			n/a		82.8	n/a		
R2			6.1						110.9			
R3			8.3						117.5			
R4			14.6						154.9			
R5			6.0						75.6			
R6			3.7						112.2			
R7			3.3						104.2			
R8			2.9						98.3			
R9			2.6						90.2			
R10			1.4						60.1			
R11			1.0						44.9			
R12			0.9						43.9			
R13			0.3						18.3			
R14			0.2						27.2			
R15			0.7						63.6			
R16			0.5						52.6			
R17			0.7						39.7			
R18			0.7						38.5			
R19			0.7						38.7			
R20			0.6						33.0			
R21			4.1						100.8			
R22			4.5						113.2			
R23			6.4						174.0			
R24			12.7						321.5			
R25			30.3						303.7			
R26			12.4						238.2			