EMISSIONS MODELLING ASSESSMENT - WHITWICK MANOR AD PLANT

STL Energy Limited

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Document History:

Version	Issue date	Author	Checked	Description
1.0	21/03/2022	DY		Draft for client comment
1.1	09/08/2022	DY		Submitted to LPA with planning application
1.2	24/04/2023	DY		Inclusion of River Wye SAC in assessment. Minor revision to discrete receptor co-ordinates and additional of further discrete receptor points. Update to critical loads based on revised information on APIS website. Updated pollutant background concentrations to include data for 2023. Model runs using updated AERMOD source code.
1.3	06/09/2023	DY		Critical loads for acid and nitrogen deposition updated in accordance with recent APIS database update

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1 Introduction

1.1 Background and Context of Assessment

1.1.1 An emissions modelling assessment has been undertaken in support of a planning and permit application being submitted for an Anaerobic Digestion (AD) Plant to be located at Whitwick Manor, Herefordshire. The assessment has been undertaken to predict the potential air quality impacts at sensitive receptor locations as a result of residual emissions from the flare, two Combined Heat and Power (CHP) units and two back-up boilers to be used at the site.

1.2 Site Location and Layout

1.2.1 The site is located at Whitwick Manor, Herefordshire. A layout plan is included within Appendix I.

1.3 Proposed Activities and Environmental Context

1.3.1 The proposals are for the operation of an AD plant which will utilise up to 176,000 tonnes/annum of agricultural feedstocks, including poultry manure, apple pomace, digestate and liquid wastes from agriculture/food manufacturing to produce various outputs, including digestate and biogas. Much of the biogas will be upgraded and exported to the grid. Some of the biogas will be used to power two CHP engines to produce power and heat for site operations. These will be supplemented by two back up boilers which will be used during periods of maintenance. A gas flare will be used to deal with any excess biogas or situations where there is a risk of excess pressure building up in the system. An Environmental Permit (EP) is required for the operation under the Environmental Permitting (England and Wales) Regulations 2016 ("the regulations").

1.3.2 The operation of the process will have the potential to create airborne emissions and subsequent impacts upon the surrounding environment. Potential long term and short term air quality impacts associated with the CHP units, back up boilers and flare have been quantified within this report through prediction of resulting ground level pollutant concentrations which have been compared to the relevant Air Quality Limit Values (AQLVs), Air Quality Standards (AQS), Environmental Assessment Levels (EALs) and critical levels/loads.

2 Air Quality Standards

2.1 Air Quality Limit Values

2.1.1 The tables below contain the AQLVs and Objectives which are relevant to this assessment. These have been obtained from the Air Quality Standards Regulations 2010 (as amended) and government permitting risk assessment guidance website.

Table 2.1 - Air Quality Limit Values

Pollutant	Measured As	Purpose	Air Quality Limit Values
Nitrogen Dioxide (NO_2)	Annual mean	Protection of human health	40µg.m^{-3}
	1-hour mean	Protection of human health	200µg.m^{-3} (not to be exceeded more than 18 times per calendar year)
Sulphur dioxide (SO_2)	1-hour mean	Protection of human health	350µg.m^{-3} (not to be exceeded more than 24 times per calendar year)
	24-hour mean	Protection of human health	125µg.m^{-3} (not to be exceeded more than 3 times per calendar year)
Carbon monoxide (CO)	Maximum running daily 8-hour mean	Protection of human health	10,000µg.m^{-3}
Benzene	Annual mean	Protection of human health	5µg.m^{-3}

Table 2.2 - Ambient Air Directive Target Values and UK Air Quality Strategy Objectives

Pollutant	Measured As	Purpose	Ambient Air Directive Target Values and UK Air Quality Strategy Objectives
SO_2	15-minute mean	Protection of human health	266µg.m^{-3} (not to be exceeded more than 35 times per calendar year)

2.2 Environmental Assessment Levels

2.2.1 A list of short and long-term EALs relevant to this assessment are presented in the table below. These have been obtained from the government website[1].

Table 2.3 - Environmental Assessment Levels

Substance	EALs		
	Long Term Annual Limit (µg.m^{-3})	Short Term Hourly Limit (µg.m^{-3})	24-Hour Mean (µg.m^{-3})
CO	-	30,000	-
Benzene	-	-	30

2.3 Critical Levels for Protection of Vegetation and Ecosystems

2.3.1 Table 2.4 contains critical levels for the protection of vegetation at nature conservation sites, obtained from permitting risk assessment guidance on the government permitting risk assessment website.

Table 2.4 - Critical Levels for the Protection of Vegetation

Pollutant	EALs	
	Concentration (µg.m^{-3})	Measured As
Nitrogen oxide (NO_x, expressed as NO_2	30	Annual mean
	75	Daily mean
SO_2	20 (10µg.m^{-3} where lichens or bryophytes are present)	Annual mean

2.4 Critical Loads for Protection of Vegetation and Ecosystems

2.4.1 Critical loads are assigned for nitrogen and acid deposition at sensitive ecological sites, above which it is suggested harmful effects on vegetation may occur. Permitting risk assessment guidance requires potential impacts to be considered at any Sites of Special Scientific Interest (SSSI) within 2km of a site, any Special Areas of Conservation (SAC), Special

[1] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Protection Areas (SPAs) or Ramsar sites within 10km of a site and any local nature sites, such as ancient woodland areas, Local Nature Reserves and Local Wildlife Sites within 2km of a site. For SSSI/SPA/Ramsar/SAC, the APIS website outlines site specific critical loads for nitrogen and acid deposition. There are some local nature sites within 2km of the site, such as ancient woodland areas and Local Wildlife Sites. However, no site specific information is available on critical loads for local nature sites. Therefore, the tables below contain worst case critical loads for local nature sites. For acid deposition, these were obtained from the APIS website for the grid square containing each receptor. It should be noted that for each grid square, critical loads are presented for a range of habitats, which will not all necessarily be present at each site. The lowest critical loads for all habitats in each grid square was assigned to provide a highly precautionary assessment. For nitrogen deposition, a precautionary approach has been used for local nature sites, with an assumed critical load of 3 kg $N.ha^{-1}.Year^{-1}$

Table 2.5 – Worst Case Critical Loads for Nitrogen Deposition

Site	Worst Case Critical Load for Nitrogen Deposition (Kg $N.ha^{-1}.Year^{-1}$)
All local nature sites within 2km (Receptors R19 to 38)	3
River Wye SAC (Receptors (Receptors R39 to R83)	5

Table 2.6 – Worst Case Critical Loads for Acid Deposition

Site	Worst Case Critical Load for Acid Deposition ($keq.ha^{-1}.Year^{-1}$)	
	CLMinN	CLMaxN
Receptors R19 to R28	0.142	0.498
Receptors R29 to R34	0.142	0.498
Receptors R35 and R36	0.142	0.497
Receptor 37	0.142	0.499
Receptor 38	0.142	0.509
River Wye SAC (Receptors R39 to R83)	0.142	0.487

3 Baseline Position

3.1 Air Quality Across Herefordshire

3.1.1 Local Authorities (LAs) are required to undertake a review and assessment of air quality within their area of jurisdiction under Section 82 of part IV of the Environment Act (1995). For areas where AQLVs are not expected to be achieved, the LA is obligated to undertake detailed assessment, involving modelling of pollutant emissions. Subsequently, if AQLVs are not predicted to be met, the LA must declare an Air Quality Management Area (AQMA). The latest DEFRA technical guidance on Air Quality Management, Technical Guidance for Local Air Quality Management 2016 (LAQM.TG(16)), directs that an Annual Status report must be submitted by each LA by 30th June of each year.

3.1.2 The latest air quality progress report available on the Herefordshire Council (HC) website is the 2020 ASR.[2] There are two AQMAs declared in Herefordshire at present. These are declared for NO_2 as follows:

- Hereford AQMA – The A49(T) corridor in Hereford, extending from Holmer Road in the North to Belmont Road in the South and extending East along New Market/Blue School Street and West along Eign Street as far as Barton Yard; and
- Bargates Leominster AQMA – An area encompassing the junction between the A44 Bargates and B4361 Dishley Street/Cursneh Road in Leominster.

3.1.3 The above AQMAs are all located several kilometres from the proposed site. As such, they have not been considered further in this assessment since no impacts are predicted on the AQMAs given the distance from the site.

[2] 2020 Air Quality ASR, HC, April 2021.

3.2 Air Quality Monitoring Data

3.2.1 Continuous Monitoring

3.2.1.1 The Automatic Urban and Rural Network (AURN) is a network of air pollution monitoring stations across the UK, managed and co-ordinated by Bureau Veritas on behalf of DEFRA. The main purpose of the network is to enable the government to assess air quality at different locations to aid with the implementation of suitable policy measures for protection of human health.

3.2.1.2 The closest AURN monitoring station to the proposed site is Leominster. This is a suburban background monitoring location situated at least 17km from the site. With consideration to the proximity of this monitoring location to the proposed site and the nature of the location, which is situated close to an urban environment, it was not considered that it would provide a suitably representative source of background monitoring data for use in this assessment. Therefore, it was not considered further for this purpose.

3.2.1.3 HC maintain a continuous monitoring location on Victoria Street, Hereford. However, this is a roadside monitoring location, located within a major urban environment, approximately 12km from the site. Given the distance from the site and nature of the monitoring location, it was not considered this would provide a suitable source of background data for use in this assessment. Therefore, it was not considered further for this purpose.

3.2.2 Nitrogen Dioxide Diffusion Tube Monitoring

3.2.2.1 NO_2 diffusion tubes are deployed at numerous locations throughout the HC area. However, these are all located several kilometres from the site and mostly comprise roadside/urban background locations. Given the distance from the site, it was not considered that these would provide a suitable source of background data for use in this assessment. Therefore, they were not considered further for this purpose.

3.3 Background Pollutant Mapping

3.3.1 The DEFRA website contains background pollutant mapping data for NO_x, NO_2, CO, SO_2 and benzene on a 1km by 1km grid square basis across the UK. This data is routinely used for assessing background pollutant concentrations where no suitably representative air pollution monitoring data exists. The archive is maintained by AEA on behalf of DEFRA. NO_x and NO_2 data is available for each grid square for the years 2018 to 2030. Background mapping of CO, SO_2 and benzene is only available for 2001. Future year predictions of CO and benzene have been calculated using the appropriate year adjustment factors contained on the DEFRA website. The annual mean concentration for SO_2 has been calculated as 75% of the 2001 mapped concentration, in accordance with previous LAQM guidance. The table below contains background pollutant concentrations for the grid square containing the site.

Table 3.1 - Background Pollutant Mapping Data for Grid Square 360500, 245500

Pollutant	2023 Annual Mean Concentration ($\mu g.m^{-3}$) within Grid Square Containing Site
NO_x	5.25
NO_2	4.22
CO	88.4
SO_2	1.06
Benzene	0.11

3.4 Summary of Background Data Used in Assessment

3.4.1 The table below summarises the background data used within this assessment. In lieu of any suitably representative monitoring data in the vicinity of the site, DEFRA mapped background data has been used to derive suitable background concentrations for use in the assessment. Short term background concentrations have been calculated using the following factors, based on government guidance and is an approach which has been accepted by the EA previously:

- 24-hour mean background concentration – derived by applying factor of 0.59 to hourly mean background concentration;
- 8-hour mean background concentration – derived by applying factor of 0.7 to hourly mean background concentration;
- 1-hour mean background concentration – assumed to be twice annual mean background concentration; and,
- 15-minute mean background concentration – derived by applying factor of 1.34 to hourly mean background concentration.

Table 3.2 - Summary of Background Data Used in Assessment

	Background Pollutant Concentrations					
Pollutant	**Annual Mean ($\mu g.m^{-3}$)**	**1-Hour Mean ($\mu g.m^{-3}$)(a)**	**24-Hour Mean ($\mu g.m^{-3}$)(b)**	**8-Hour Mean ($\mu g.m^{-3}$)(c)**	**15-Minute Mean ($\mu g.m^{-3}$)(d)**	**Source of Annual Mean Background Data**
NOx	5.25	N/A	6.2	N/A	N/A	DEFRA Mapped Background Data
NO2	4.22	8.44	N/A	N/A	N/A	DEFRA Mapped Background Data
SO2	1.06	2.12	1.25	N/A	2.84	DEFRA Mapped Background Data
CO	88.4	176.79	N/A	141.44	N/A	DEFRA Mapped Background Data
Benzene	0.11	N/A	0.13	N/A	N/A	DEFRA Mapped Background Data

3.5 Sensitive Receptors

3.5.1 The table below outlines the nearest receptors to the proposed AD plant. The human receptor locations identified are the closest human receptors to the proposed site which are representative of relevant worst case long term exposure locations. In order to provide a highly precautionary, conservative assessment, the maximum modelled pollutant concentrations surrounding the plant have been used to assess potential worst case short term impacts at human receptor locations. This assumes that a human receptor would be present at the location of the maximum point of impact surrounding the plant for the relevant averaging time of each short term AQLV/EAL/AQS, which is highly unlikely to be the case in reality. Relevant ecological receptors have also been included. Given the large geographical extent of some ecological receptors, multiple receptor points were assigned for some receptors to ensure the maximum point of impact was captured.

Table 3.3 - Sensitive Receptors

Receptor Identifier	Receptor Description	National Grid Reference (m)	
		X	Y
R1	Residential property at Whitwick Manor	360946	245711.5
R2	Residential property at Whitwick Manor	360961.3	245703.1
R3	Residential property at Whitwick Manor	360992.9	245701.4
R4	Residential property at Whitwick Manor	361082.1	245901
R5	Residential property at Whitwick Manor	361110	245886.8
R6	The Lodge	361225.9	245877.5
R7	Upper Mitchell's Cottages	361351.4	245702.3
R8	Lower Mitchell's Cottages	361387.5	245380.3
R9	Residential property off A417	361551.9	245140
R10	Residential property off A4103	361518.4	244939.1
R11	The Conifers	361385.3	244885.5
R12	Residential property off A4103	361209.1	244828.1
R13	Wharf House	360761.8	244293.5
R14	Residential property at Boundary Land	359730.1	245606.9
R15	Residential property	359951	246022.9
R16	Residential property at Woods End	360519.4	246341.6
R17	Gardeners Cottage	361312.7	246558.5
R18	The Coach House	361476.4	246496.2
R19	Ancient Replanted Woodland/Local Wildlife Site	360777.6	246073.9
R20	Ancient Replanted Woodland/Local Wildlife Site	360650.7	246169.1
R21	Ancient Replanted Woodland/Local Wildlife Site	360681.7	246142.3
R22	Ancient Replanted Woodland/Local Wildlife Site	360731.6	246106.1
R23	Ancient Replanted Woodland/Local Wildlife Site	360822.2	246050.1
R24	Ancient Replanted Woodland/Local Wildlife Site	360914.7	246016.3
R25	Ancient Replanted Woodland/Local Wildlife Site	361106.7	245940.2
R26	Ancient Replanted Woodland/Local Wildlife Site	361137.1	245919.6

Receptor Identifier	Receptor Description	National Grid Reference (m)	
		X	Y
R27	Ancient Replanted Woodland/Local Wildlife Site	361014.1	246000
R28	Ancient Replanted Woodland/Local Wildlife Site	361168.3	245902.9
R29	Ash Coppice Ancient Woodland/Local Wildlife Site	360341.9	245319.9
R30	Ash Coppice Ancient Woodland/Local Wildlife Site	360329	245321.8
R31	Ash Coppice Ancient Woodland/Local Wildlife Site	360296.9	245324.7
R32	Ash Coppice Ancient Woodland/Local Wildlife Site	360207.1	245326.2
R33	Ash Coppice Ancient Woodland/Local Wildlife Site	360356.3	245304.3
R34	Ash Coppice Ancient Woodland/Local Wildlife Site	360254.6	245324.9
R35	Ash Bed Ancient Woodland	359125.9	246318.5
R36	Long Coppice Ancient Woodland	359976.4	246887.8
R37	Local Wildlife Site	362202	246139
R38	Local Wildlife Site	359468	244190
R39	River Wye SAC	353283.5	244593.4
R40	River Wye SAC	353289.7	244505.7
R41	River Wye SAC	353334.4	244358
R42	River Wye SAC	353324.8	244216.2
R43	River Wye SAC	353363.1	244139.5
R44	River Wye SAC	353333	243978.4
R45	River Wye SAC	353325.1	243860.6
R46	River Wye SAC	353426	243648.5
R47	River Wye SAC	353487.7	243506.3
R48	River Wye SAC	353408.4	243322.3
R49	River Wye SAC	353485.4	243029.8
R50	River Wye SAC	354769.6	240680.3
R51	River Wye SAC	353265.7	241870.7
R52	River Wye SAC	353210.2	241751.5
R53	River Wye SAC	353126.9	241346.4
R54	River Wye SAC	353269.5	241145.1
R55	River Wye SAC	353348.6	241054.2
R56	River Wye SAC	353512.2	240973.3

Receptor Identifier	Receptor Description	National Grid Reference (m)	
		X	Y
R57	River Wye SAC	353920.8	240693.5
R58	River Wye SAC	353490.9	242815.9
R59	River Wye SAC	353441.6	242634.6
R60	River Wye SAC	353399.7	242481
R61	River Wye SAC	355052.9	240426.4
R62	River Wye SAC	355123.3	240221.5
R63	River Wye SAC	353120.9	241561.1
R64	River Wye SAC	355312	239930.9
R65	River Wye SAC	355443.5	239643.3
R66	River Wye SAC	355657.4	239516
R67	River Wye SAC	355657.6	239327
R68	River Wye SAC	355785.3	239093.3
R69	River Wye SAC	355896.9	238968.3
R70	River Wye SAC	352905.1	244712.1
R71	River Wye SAC	352869.6	244915.1
R72	River Wye SAC	352856.3	245050.1
R73	River Wye SAC	352866	245179.7
R74	River Wye SAC	352798.2	245358.2
R75	River Wye SAC	352743.4	245414.1
R76	River Wye SAC	353066.2	244535.7
R77	River Wye SAC	352258.1	245488.2
R78	River Wye SAC	352039.7	245624.8
R79	River Wye SAC	351668.6	247489.9
R80	River Wye SAC	351819.8	247662.9
R81	River Wye SAC	351821.7	247931.6
R82	River Wye SAC	353318.7	250750.9
R83	River Wye SAC	353724.3	251122

4 Modelling Methodology

4.1 Model Description

4.1.1 The potential air quality impacts associated with residual emissions arising from the process have been quantified using AERMOD, which is a steady state, next generation, dispersion model. AERMOD was developed jointly by the American Meteorological Society (AMS) and the United States (US) Environmental Protection Agency (EPA) Regulatory Model Improvement Committee. AERMOD is a development from the Industrial Source Complex (ISC) 3 dispersion model and incorporates improved dispersion algorithms and pre-processors to integrate the impact of meteorology and topography within the modelling output, and is approved for use in the UK by the EA. The version of AERMOD that has been used for this current assessment is Lakes Environmental ISC-AERMOD View Version 11.2.0. The model has been run using the most recent version of the AERMOD executable file, 22112. In order to improve model run times, Lakes Environmental have produced an equivalent source code to 22112, known as AERMOD parallel which enables the model to be run over multiple processors. The model was run using Lakes Environmental AERMOD MPI 22112.

4.2 Model Inputs

4.2.1 Emission Source Process Parameters

4.2.1.1 Reference should be made to Appendix I for a graphical representation of the site layout showing the flare, CHP and backup boiler flue locations. The tables below contain expected process parameters for the emission points, which is based on information provided by the technology provider.

Table 4.1 - Expected Emission Source Process Parameters – Proposed Flare

Process Parameter	Value
Flare NGR (X,Y)	360462.014, 245590.864
Exhaust internal diameter (m)	2.436
Flare height (m)	8.293

Process Parameter	Value
Expected Exhaust efflux velocity ($m.s^{-1}$)	11.5
Expected Exhaust volumetric flowrate ($m^3.s^{-1}$)	53.6
Expected Exhaust volumetric flowrate, normalised to reference conditions, 3%O_2 dry gas, 273K, 101.3Kpa ($Nm^3.s^{-1}$)	4.14
Expected stack efflux temperature (K)	1273
Expected oxygen content of exhaust gas (dry basis) (v/v, %)	14.07
Expected moisture content of exhaust gas (v/v, %)	6.53
Expected absolute stack pressure (KPa)	101.3

Table 4.2 - Expected Emission Source Process Parameters for CHP Exhausts

Process Parameter for Each CHP Exhaust	Value
Stack NGRs (X,Y)	CHP 1 = 360531.772, 245699.903 CHP 2 = 360536.674, 245703.628
Exhaust internal diameter (m)	0.325
Stack height (m)	7
Expected Exhaust efflux velocity ($m.s^{-1}$)	24.59
Expected Exhaust volumetric flowrate ($m^3.s^{-1}$)	2.04
Expected Exhaust volumetric flowrate, normalised to following reference conditions: 5%O_2 dry gas, 273.15K, 101.3Kpa ($Nm^3.s^{-1}$)	0.8
Expected Exhaust volumetric flowrate, normalised to following reference conditions: 15%O_2 dry gas, 273.15K, 101.3Kpa ($Nm^3.s^{-1}$)	2.14
Expected Exhaust volumetric flowrate, normalised to following reference conditions: 273.15K, 101.3Kpa ($Nm^3.s^{-1}$)	1.33
Expected stack efflux temperature (K)	418
Expected oxygen content of exhaust gas (dry basis) (v/v, %)	10.33
Expected moisture content of exhaust gas (v/v, %)	9.71
Expected absolute stack pressure (KPa)	101.3

Table 4.3 - Expected Emission Source Process Parameters for Backup Boiler Exhausts

Process Parameter for Each Boiler Exhaust	Value
Stack NGR (X,Y)	Backup Boiler 1 = 360510.583, 245713.65 Backup Boiler 2 = 360514.431, 245716.555
Exhaust internal diameter (m)	0.35
Stack height (m)	6.5
Expected Exhaust efflux velocity ($m.s^{-1}$)	1.8

Process Parameter for Each Boiler Exhaust	Value
Expected Exhaust volumetric flowrate ($m^3.s^{-1}$)	0.173
Expected Exhaust volumetric flowrate, normalised to following reference conditions: 3%O_2 dry gas, 273.15K, 101.3Kpa ($Nm^3.s^{-1}$)	0.094
Expected Exhaust volumetric flowrate, normalised to following reference conditions: 273.15K, 101.3Kpa ($Nm^3.s^{-1}$)	0.097
Expected stack efflux temperature (K)	488
Expected oxygen content of exhaust gas (dry basis) (v/v, %)	3.5
Expected moisture content of exhaust gas (v/v, %)	0.1
Expected absolute stack pressure (KPa)	101.3

4.2.2 Pollutant Emissions

4.2.2.1 There will be a number of potential pollutant emissions as a result of operation of the gas flare, CHP plant and backup boilers. The flare will be required to meet emission limits in accordance with EA Guidance on monitoring of enclosed landfill gas flares. These are summarised in the table below. These were used to determine worst case emission rates for the flare, as outlined within the same table.

Table 4.4 – Flare Pollutant Emission Rates

Pollutant	Maximum Emission Concentrations Normalised to 273K, 101.3KPa, dry gas, 3% O_2 ($mg.Nm^{-3}$)	Pollutant Emission Rates ($g.s^{-1}$)
NO_x	150	0.62
Total Volatile Organic Carbon (TVOC)	10	0.041
CO	50	0.207

4.2.2.2 Given that the rated thermal input of each CHP unit is greater than 1MW, they will be required to comply with emission limits within the Medium Combustion Plant Directive (MCPD). The MCPD contains emission limits for NO_x and SO_2. These are outlined within the table below. Additional limits will also apply for CO, Total Volatile Organic Compounds (TVOC) including methane and non-methane VOCs. The plant will include substantial abatement for VOCs with the biogas subject to carbon filtration. The subsequent combustion within the CHP units or boilers will provide further destruction of volatile compounds. As such, the maximum emission concentration presented in the tables below for non-methane VOCs for the boilers and CHP units are considered to provide a conservative estimate of residual concentrations.

Table 4.5 – CHP Pollutant Emission Rates

Pollutant	Maximum Emission Concentrations Normalised to 273.15K, 101.3KPa, dry gas, 15% O_2 (mg.Nm^{-3})	Maximum Emission Concentrations Normalised to 273.15K, 101.3KPa, dry gas, 5% O_2 (mg.Nm^{-3})	Maximum Emission Concentrations Normalised to 273, 101.3KPa, (mg.Nm^{-3})	Pollutant Emission Rates (g.s^{-1})
NO_x	190	-	-	0.407
SO_2	40	-	-	0.086
CO	-	1400	-	1.124
Total VOC (Including Methane)	-	1000	-	0.803
Total Non Methane VOCs	-	-	10	0.0133

Table 4.6 – Backup Boilers Pollutant Emission Rates

Pollutant	Maximum Emission Concentrations Normalised to 273.15K, 101.3KPa, dry gas, 3% O_2 (mg.Nm^{-3})	Maximum Emission Concentrations Normalised to 273, 101.3KPa, (mg.Nm^{-3})	Pollutant Emission Rates (g.s^{-1})
NO_x	500	-	0.047
SO_2	350	-	0.033
CO	1400	-	0.132
Total VOC (Including Methane)	1000	-	0.094
Total Non Methane VOCs	-	10	0.00097

4.2.2.3 There are no ambient air quality guideline values for TVOC. In accordance with the relevant guidance, it has been assumed that total non-methane VOC emissions consist entirely of benzene and modelled concentrations have subsequently been compared to the EAL and

AQLV for benzene. This presents a worst case assessment since it is highly unlikely that total VOC emissions would consist entirely of benzene.

4.2.2.4 Nitric oxide (NO) and NO_2 are normally measured as oxides of NO_x, but when comparing against health based standards, NO_x is usually expressed as it's individual components. NO is oxidised to NO_2 in the presence of ozone. In order to provide a conservative estimate of resulting NO_2 concentrations, it has been assumed that 35% of modelled NO_x concentrations are present as NO_2 for short-term hourly-mean concentrations and 70% present as NO_2 for long term concentrations. This provides a worst case scenario, in accordance with EA guidance.

4.2.3 Building Downwash

4.2.3.1 Significant on-site buildings and structures were digitised within the model based on site layout and elevation information provided by the site operator. In accordance with government guidance, significant structures within a distance of 5L of the emission sources have been included, where L is defined as the lesser of the maximum projected building width and height. As the closest buildings to the emission points, these would be expected to have an influence on pollutant dispersion. Table 4.7 contains information on buildings/structures included within the model. Reference should be made to Appendix I for a plan showing building/structure locations and orientation. The integrated Building Profile Input Programme (BPIP) module within AERMOD was used to assess the potential impact of building downwash upon predicted dispersion characteristics. Building downwash occurs when turbulence, induced by nearby structures, causes pollutants emitted from an elevated source to be displaced and dispersed rapidly towards the ground, resulting in elevated ground level concentrations. All buildings and structures were input into the BPIP processor.

Table 4.7 - Building Inputs

Structure	Length and Width (m)	Diameter (m) Circular Structures	Max Height (m)
Feedstock/Water Storage Tanks	-	33.96	14.6
Digester Tank 1	-	33.96	14.6
Digester Tank 2	-	33.96	14.6

Structure	Length and Width (m)	Diameter (m) Circular Structures	Max Height (m)
Secondary Tank 1	-	33.96	14.6
Secondary Tank 2	-	33.96	14.6
Digester Tank 3	-	33.96	14.6
Storage Tank	-	33.96	14.6
Digester Tank 4	-	33.96	14.6
Pasteuriser Tank	-	15.96	14.6
Hydrolyser Tank	-	15.96	14.6
Ammonia Recovery Tank	-	15.96	14.6
Manure Storage Clamps	70 x 59.5	-	14.94
Silage Clamp 1	70 x 30	-	7.1
Silage Clamp 2	70 x 58	-	7.1
Nitrogen and Phosphate Recovery Tanks	42 x 8	-	12
Dry Ice Plant and Control Room	12 x 24.73	-	7.47
Biomethane Plant 1	12.15 x 2.4	-	3.04
Biomethane Plant 2	2.6 x 13.7	-	3.04
Biomethane Plant 3	3.5 x 8	-	3.04
Biomethane Plant 4	2.71 x 15.9	-	3.04
Biomethane Plant 5	2.17 x 3.4		3.04
CHP 1	3 x 12.5	-	5.1
CHP 2	3 x 12.5	-	5.1
CO2 Building	15 x 24.73	-	7.81
Chiller Unit No 1	7.99 x 3.6	-	6.5
Backup Boilers	12.19 x 2.5	-	2.5
NEF Unit	8.5 x 3.5	-	2.55
Compressor Unit	5.3 x 2.8	-	2.35

Structure	Length and Width (m)	Diameter (m) Circular Structures	Max Height (m)
Propane Tanks	4.4 x 14.4	-	2.14
Office and Welfare Building	18.72 x 6.89	-	6.94
Separator/Centrifuge	22.18 x 13.6	-	9.6
Chiller Unit No 2	5.11 x 2	-	6.5
Chiller Unit No 3	5.11 x 2	-	6.5
CO2 Tanks	2.5 x 21	-	7.51

4.2.4 Meteorological Data

4.2.4.1 Meteorological data used in this assessment was from Hereford/Credenhill with missing cloud cover data from Pershore. Hereford meteorological station is located approximately 16km to the West-South-West of the proposed site and it is considered that it provides suitable data for use in this assessment. Previous DEFRA guidance stated met stations within 30km of a study site to be suitable for use in dispersion modelling assessments.

4.2.4.2 Reference should be made to Appendix III for wind roses showing wind speed and direction frequency at Hereford between 2017 and 2021.

4.2.4.3 Five years of sequential meteorological data observed between 2017 and 2021 were used within the assessment. Data was supplied by ADM Ltd, an established distributor of met data within the UK. The data provided by ADM Ltd was in ADMS format. This was converted to the required format required by AERMET using the ADMS UK to SAMSON converter, which is a tool within the AERMET processor. The AERMET processor within AERMOD was used to process the data to be site specific. US EPA guidance on processing met data for use within AERMOD states that land use up to 1km upwind from a site should be considered when determining surface roughness characteristics, whilst for Bowen ratio and albedo, land use types within a 10km by 10km area centred over the site should be considered[3]. AERMOD guidance states that albedo and Bowen ratio should be calculated as the arithmetic and geometric mean respectively of land use types over the 10km by 10km grid, not weighted by direction or distance. The Land Use Creator and AERSURFACE tool within AERMET was used to calculate the appropriate land-use characteristics, which are contained in the following table.

Table 4.8 - Parameters for Surface Roughness, Albedo and Bowen Ratio

Parameter	Directional Sector	Value
Surface Roughness	0-30°	0.087
	30-60°	0.087
	60-90°	0.088
	90-120°	0.088
	120-150°	0.088
	150-180°	0.088
	180-210°	0.087
	210-240°	0.087
	240-270°	0.088
	270-300°	0.088
	300-330°	0.088
	330-360°	0.087
Albedo	All	0.18
Bowen Ratio	All	0.56

4.2.5 Assessment Area

4.2.5.1 Two uniform cartesian receptors grid were used to define the modelling domain. This included a high resolution grid, extended over a 3000m by 3000m area with a spacing of 20m in X and Y direction, centred over the emission source locations. An additional uniform Cartesian receptor grid was extended over a 20,000m by 20,000m area with a grid spacing

3 AERMOD Implementation Guide, USEPA, August 2015.

of 200m in X and Y direction, centred over the emission source locations. This ensured the maximum point of impact could be captured. In addition, the discrete receptors identified previously were included within the model as cartesian receptors. All human receptor heights were set to 1.5m above ground level, representative of typical breathing height. All ecological receptor heights were set to ground level (0.0m).

4.2.6 Terrain Data

4.2.6.1 Topographical features can have a significant impact on pollutant dispersion. Given that the gradient of the land between the site and receptors exceeds a gradient of 10% in places, terrain data was included in the model, in accordance with the relevant guidance[4]. The terrain data used was Ordnance Survey Terrain 5 data, which is 1:10,000 scale data, contoured at 5m vertical intervals. The digital terrain data was processed in AERMAP, the inbuilt terrain processor within AERMOD. This then applied elevation data to all sources, buildings and receptors within the modelling domain.

4.2.7 Model Scenarios

4.2.7.1 The scenarios modelled are contained within Table 4.9.

4.2.7.2 The flare is to be installed for safety purposes, to be used during start up, maintenance and in the event that excess gas arises. It is anticipated that this would be used for <1% of the year cumulatively. As such, the flare emission source was only included within the model for short term model scenarios, including 1-hour, 8-hour and 24-hour mean scenarios.

4.2.7.3 The backup boilers will be used during periods of CHP down time such as during routine maintenance. As such, these emission sources were only included within the model for short

[4] LAQM.TG(16), DEFRA, 2016.

term model scenarios, including 15-minute mean, 1-hour mean, 8-hour mean and 24-hour mean scenarios.

4.2.7.4 It was assumed that the flare, back up boilers and CHP units could all operate simultaneously when assessing short term impacts. This will not be the case in reality, therefore, this has provided an overestimation of potential short term impacts. Short term AQLVs for SO_2 and NO_2 are based on a number of allowable exceedences of the relevant AQLV each calendar year. As such, it is appropriate to model equivalent percentiles for each pollutant/scenario when assessing potential short term impacts, as outlined in the table below.

Table 4.9 – Modelled Scenarios

Pollutant	Modelled Scenarios
NO_x	Annual mean, maximum 24-hour mean across five years of met data
NO_2	Annual mean, 99.8th percentile of 1-hour mean concentrations, each individual met data year.
TVOC (as benzene)	Maximum 24-hour mean concentration across five years of met data
CO	Maximum 8-hour rolling mean concentration, each individual year of met data.
SO_2	Annual mean, 99.2nd percentile of 24-hour mean concentrations, 99.7th percentile of 1-hour mean concentrations, 99.9th percentile of 15-minute mean concentrations, each individual met data year

4.3 Assessment of Potential Impacts

4.3.1 Methodology for Assessment of Potential Impacts at Human Receptors and Nationally and Internationally Designated Ecological Receptors

4.3.1.1 In order to assess potential impacts at human receptors and nationally and internationally designated ecological receptor locations, reference has been made to the permitting air emissions risk assessment guidance on the government website.[5]

4.3.1.2 The government guidance indicates that potential impacts from a process can be considered insignificant if the following screening criteria are met:

- The long term process contribution (PC) is <1% of the long term environmental standard; and/or,
- The short term PC is <10% of the short term environmental standard.

4.3.1.3 The guidance also indicates that more detailed assessment of emissions (modelling) for a process may be required if the following criteria are met:

- The long term PC + background concentration is >70% of the long term environmental standard; and/or
- The short term process contribution is >20% (Short term environmental standard minus twice annual mean background concentration).

4.3.1.4 If any of the criteria above are met for both short and long term modelled concentrations, it can be concluded that potential impacts will be acceptable and there is no requirement for further assessment, in accordance with the relevant guidance. If the above criteria are exceeded, the Predicted Environmental Concentration (PEC) is then compared to the

5 https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.

relevant environmental standard. If the modelling shows that the relevant standard will be met at receptor locations confidence will be high that a breach of the standard will be unlikely, especially given the conservative assumptions which have been used throughout the assessment.

4.3.2 Methodology for Assessment of Potential Impacts at Local Nature Sites

4.3.2.1 In accordance with government permitting risk assessment guidance, potential impacts on local nature sites, such as Local Wildlife Sites and ancient woodland areas, can be screened out as insignificant if the PC is <100% of the critical level/load for relevant pollutants.

4.3.3 Assessment of Potential Impacts on Critical Loads for Nitrogen and Acid Deposition at Ecological Receptors

4.3.3.1 The methodology for assessing potential impacts on critical loads accords with the section above. However, it should be noted that a range of critical loads are assigned for each ecological receptor.

4.3.3.2 In order to ensure a worst case assessment of potential impacts in terms of nitrogen deposition, the lower end of the critical load range was assumed in each case.

4.3.3.3 In terms of assessing potential impacts on critical loads for acid deposition, the APIS website provides specific guidance as follows, which has been followed for assessing impacts on critical loads for acid deposition associated with the proposed development:

"The potential impacts of additional sulphur and/or nitrogen deposition from a source are partly determined by PEC, because only if PEC of nitrogen deposition is greater than CLminN will the additional nitrogen deposition from the source contribute to acidity. Consequently, if PEC is less that CLminN only the acidifying affects of sulphur from the process need to be considered."

Where PEC N Deposition < CLminN
*PC as % CL function = (PC S deposition/CLmaxS)*100*

Where PEC is greater than CLminN (the majority of cases), the combined inputs of sulphur and nitrogen need to be considered. In such cases, the total acidity input should be calculated as a proportion of the CLmaxN.

Where PEC N Deposition > CLminN
*PC as %CL function = ((PC of S+N deposition)/CLmaxN)*100"*

4.4 Model Verification and Uncertainty

4.4.1 It was not possible to verify model results as the plant is not yet operational.

4.4.2 There can be a significant degree in uncertainty in predications made by any atmospheric dispersion model, which needs to be considered when assessing results. Such uncertainty can arise as a result of model limitations, uncertainty in input data, including emissions estimates, meteorological data used and background pollutant concentrations used in the assessment.

4.4.3 AERMOD is a commonly used model produced by the US EPA and is approved for use in the UK by the EA. The model is well validated and the US EPA present the results of the model validation exercises undertaken on their website. These verify the output of the model in comparison to observed data for a number of scenarios, to ensure predictions are as accurate as possible. The model input code is periodically updated by the US EPA to resolve bugs and errors and to improve the output to take account of latest knowledge. The latest AERMOD model executable file has been used to run the model for the purpose of this assessment.

4.4.4 In addition to the choice of model, the following methods used in the assessment ensures that confidence can be high that potential impacts have not been underestimated:

- Worst case modelled concentrations across 5 years of meteorological data used in assessment;
- Assumption that the CHP plant will be operational for 100% of each year when modelling annual mean concentrations;

- Assumption that CHP plant, flare and backup boilers could all operate simultaneously when modelling short term pollutant concentrations and that these could operate in any given hour during each year;
- Where possible, estimation of existing background pollutant concentrations has been conservative;
- Worst case assumption made for NO_x to NO_2 conversion;
- Worst case assumption that TVOC emissions consist entirely of benzene;
- Emission rates based on the assumption that the plant will emit at the maximum permitted level, 24-hours per day, 365 days per year;
- Worst case assumptions made for receptor locations; and,
- Worst case assumptions on critical loads for nitrogen and acid deposition at ecological receptor locations.

5 Model Results

5.1 Maximum Modelled Pollutant Concentrations

5.1.1 The tables below contain the maximum modelled pollutant concentrations within the modelling domain and at sensitive receptor concentrations, with comparison to the relevant AQLVs, AQS, EALs and critical levels for each pollutant and scenario. Maximum modelled concentrations from the five years of sequential data have been used to undertake assessment of potential impacts.

5.1.2 Pollutant contour profiles are included within Appendix V. These are presented for the worst case assessment year for each pollutant and scenario.

Table 5.1 – Modelled Annual Mean NO_2 Concentrations at Receptor Locations

Receptor	Modelled PC to Annual Mean NO_2 Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum Predicted Environmental Concentration (PEC) ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2017	2018	2019	2020	2021			
R1	2.42360	1.98124	2.03606	1.96794	1.89098	6.06	6.64	16.61
R2	2.35871	1.95686	1.99718	1.88412	1.90474	5.90	6.58	16.45
R3	2.20155	1.83152	1.86753	1.75285	1.79517	5.50	6.42	16.05
R4	1.37932	0.98029	1.13009	1.30265	1.04533	3.45	5.60	14.00
R5	1.35168	0.95030	1.08616	1.22121	1.02743	3.38	5.57	13.93
R6	1.05604	0.74029	0.83082	0.91005	0.78983	2.64	5.28	13.19
R7	0.80614	0.63734	0.66458	0.63771	0.64144	2.02	5.03	12.57
R8	1.40688	1.13799	1.05890	0.99507	1.41544	3.54	5.64	14.09
R9	0.76340	0.52629	0.56820	0.56614	0.72877	1.91	4.98	12.46
R10	0.45485	0.29886	0.32281	0.29468	0.42958	1.14	4.67	11.69
R11	0.35234	0.25978	0.29172	0.30271	0.36922	0.92	4.59	11.47
R12	0.21279	0.25280	0.20751	0.24897	0.26280	0.66	4.48	11.21
R13	0.05266	0.07088	0.07771	0.06481	0.08168	0.20	4.30	10.75
R14	0.29189	0.39713	0.43726	0.26824	0.39300	1.09	4.66	11.64
R15	0.16213	0.21054	0.16435	0.11274	0.11992	0.53	4.43	11.08
R16	0.19993	0.22737	0.20088	0.26273	0.21372	0.66	4.48	11.21
R17	0.16018	0.15716	0.14594	0.20063	0.13478	0.50	4.42	11.05
R18	0.18533	0.17095	0.19431	0.22938	0.12503	0.57	4.45	11.12

Table 5.2 – Modelled 99.8th Percentile of 1-Hour Mean NO_2 Concentrations at Receptor Locations

Receptor	Modelled PC to 99.8th Percentile of 1-Hour Mean NO_2 Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2017	2018	2019	2020	2021			
R1	31.55285	32.76239	31.54411	30.11809	31.24121	16.38	41.20	20.60
R2	31.16128	32.24493	31.25629	30.43814	31.66360	16.12	40.68	20.34
R3	30.47892	31.90402	30.76871	30.04192	31.32240	15.95	40.34	20.17
R4	21.21317	21.92007	23.42913	21.03751	23.17972	11.71	31.87	15.93
R5	20.53451	19.83983	19.57552	18.90862	21.86484	10.93	30.30	15.15
R6	15.97585	17.10028	16.55046	15.97440	17.91636	8.96	26.36	13.18
R7	13.33894	13.36426	14.12365	14.43441	13.58880	7.22	22.87	11.44
R8	33.38612	32.55255	32.15837	33.77219	33.31473	16.89	42.21	21.11
R9	28.17587	26.30489	27.94315	28.26294	29.15282	14.58	37.59	18.80
R10	23.64335	22.76833	20.30021	19.76630	24.45058	12.23	32.89	16.45
R11	24.17163	21.65538	24.02968	22.97179	24.83262	12.42	33.27	16.64
R12	13.36434	20.14493	14.08660	17.16152	17.94607	10.07	28.58	14.29
R13	2.94965	4.00544	4.00713	3.84372	4.43388	2.22	12.87	6.44
R14	14.41157	18.41929	19.34009	15.13264	19.25599	9.67	27.78	13.89
R15	8.64777	8.62453	8.60729	8.17303	8.19014	4.32	17.09	8.54
R16	9.31166	10.14108	9.99299	10.67267	9.46836	5.34	19.11	9.56
R17	10.12388	9.98017	9.99834	10.25007	9.92418	5.13	18.69	9.35
R18	9.02325	8.68182	9.08446	9.13117	8.54961	4.57	17.57	8.79
Maximum Point of Impact	93.26014	93.04646	94.99114	88.23912	91.38328	47.50	103.43	51.72

Table 5.3 – Modelled 99.2nd Percentile of 24-Hour Mean SO_2 Concentrations at Receptor Locations

Receptor	Modelled PC to 99.2nd Percentile of 24-Hour Mean SO_2 Concentrations (µg.m^{-3})					Maximum PC to AQLV (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to AQLV (%)
	2017	2018	2019	2020	2021			
R1	5.93945	5.79505	5.96113	5.40133	5.26934	4.77	7.21	5.77
R2	5.82593	5.59131	5.46202	5.20102	5.1115	4.66	7.08	5.66
R3	5.61816	5.38824	5.15284	5.01895	4.95532	4.49	6.87	5.49
R4	4.76125	4.42093	4.13805	4.56693	6.29539	5.04	7.55	6.04
R5	4.53085	4.23086	4.29855	4.0301	4.97208	3.98	6.22	4.98
R6	3.49005	3.38851	3.3387	2.91728	3.36364	2.79	4.74	3.79
R7	2.57227	2.3969	2.2929	2.09103	2.25314	2.06	3.82	3.06
R8	4.51627	3.75767	3.20307	3.76967	4.13694	3.61	5.77	4.61
R9	3.19112	2.16053	2.29627	2.67856	2.66526	2.55	4.44	3.55
R10	1.8653	1.53544	1.8967	1.48101	2.14089	1.71	3.39	2.71
R11	1.62219	1.46972	1.8012	1.84438	2.06916	1.66	3.32	2.66
R12	1.56294	2.28611	1.70254	1.53549	1.59351	1.83	3.54	2.83
R13	0.40273	0.49428	0.58295	0.49841	0.72683	0.58	1.98	1.58
R14	1.53169	2.16916	1.92546	1.48353	2.55009	2.04	3.80	3.04
R15	1.82039	2.27638	1.26234	1.4391	1.3473	1.82	3.53	2.82
R16	2.28433	2.2663	2.69638	3.22927	3.22593	2.58	4.48	3.58
R17	1.89037	1.59667	1.45505	1.71978	1.76829	1.51	3.14	2.51
R18	1.69514	1.44124	1.98243	1.86823	1.62173	1.59	3.23	2.59
Maximum Point of Impact	41.71115	56.76114	35.69607	55.29793	54.62827	45.41	58.01	46.41

Table 5.4 – Modelled 99.7th Percentile of 1-Hour Mean SO_2 Concentrations at Receptor Locations

Receptor	Modelled PC to 99.7th Percentile of 1-Hour Mean SO_2 Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2017	2018	2019	2020	2021			
R1	34.72997	35.19908	35.02693	33.30207	35.18136	10.06	37.32	10.66
R2	34.06836	34.3547	34.35907	32.58925	34.40821	9.83	36.53	10.44
R3	34.07407	34.5158	34.87016	32.57148	34.96519	9.99	37.09	10.60
R4	27.99637	27.65761	30.24365	28.13794	31.06619	8.88	33.19	9.48
R5	28.47437	24.75117	27.10098	25.68952	28.9706	8.28	31.09	8.88
R6	22.4372	23.05351	22.9983	22.51032	23.52764	6.72	25.65	7.33
R7	17.96059	17.93668	17.82816	17.26152	18.37184	5.25	20.49	5.85
R8	27.25842	26.11855	26.38921	26.24471	27.32791	7.81	29.45	8.41
R9	22.92774	20.76545	23.00878	22.52314	24.89794	7.11	27.02	7.72
R10	20.26829	16.14972	15.73424	14.26092	21.5808	6.17	23.70	6.77
R11	19.61644	12.70124	17.38533	18.07301	20.62465	5.89	22.74	6.50
R12	9.46863	16.09699	10.34802	12.74388	11.77314	4.60	18.22	5.20
R13	2.36136	3.05724	2.82904	3.99137	3.35627	1.14	6.11	1.75
R14	10.2962	11.16873	13.08877	9.50226	12.51974	3.74	15.21	4.35
R15	13.53211	11.68204	13.07108	11.88041	12.15866	3.87	15.65	4.47
R16	14.46793	14.84481	14.72618	14.23718	13.87744	4.24	16.96	4.85
R17	17.44739	15.45315	15.60736	16.41144	14.72219	4.98	19.57	5.59
R18	14.87274	14.58476	16.67898	16.24351	14.92413	4.77	18.80	5.37
Maximum Point of Impact	95.86206	101.72144	102.6934	104.835	105.07884	30.02	107.20	30.63

Table 5.5 – Modelled 99.9th Percentile of 15-Minute Mean SO_2 Concentrations at Receptor Locations

Receptor	Modelled PC to 99.9th Percentile of 15-Minute Mean SO_2 Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQS (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to AQS (%)
	2017	2018	2019	2020	2021			
R1	50.94230	51.38038	51.05600	50.26357	50.64254	19.32	54.22	20.38
R2	50.28863	51.53797	50.61409	48.68141	50.95189	19.38	54.38	20.44
R3	50.05309	51.87908	50.77497	48.85959	51.28570	19.50	54.72	20.57
R4	41.49807	43.06973	43.39357	41.11454	44.07402	16.57	46.91	17.64
R5	41.49463	41.80326	41.06498	40.16146	41.36715	15.72	44.64	16.78
R6	33.25144	33.70444	33.25784	33.85483	33.79997	12.73	36.69	13.80
R7	26.71858	26.62979	26.97029	26.68377	26.92226	10.14	29.81	11.21
R8	40.31480	39.92521	38.51817	40.65323	40.12219	15.28	43.49	16.35
R9	35.23892	34.69197	34.44540	34.25291	35.21177	13.25	38.08	14.32
R10	34.01456	32.03671	29.63533	31.79047	33.33325	12.79	36.85	13.86
R11	32.53436	31.87581	32.66422	33.29523	32.65865	12.52	36.14	13.58
R12	24.64721	31.21384	26.36360	32.35005	33.29436	12.52	36.13	13.58
R13	6.20244	7.25181	7.65790	8.76100	9.21408	3.46	12.05	4.53
R14	19.84519	25.02778	24.72959	23.57768	25.28473	9.51	28.12	10.57
R15	21.90111	21.62188	22.39258	21.95046	22.02770	8.42	25.23	9.49
R16	24.13069	25.58138	24.78574	25.57352	23.21613	9.62	28.42	10.68
R17	25.80437	25.72884	26.04881	26.30692	25.28547	9.89	29.15	10.96
R18	23.77551	22.71445	24.12371	23.99060	23.33974	9.07	26.96	10.14
Maximum Point of Impact	153.53331	155.04383	154.51157	156.31946	154.43137	58.77	159.16	59.83

Table 5.6 – Modelled Annual Mean Benzene Concentrations at Receptor Locations

Receptor	Modelled PC to Annual Mean Benzene Concentrations (µg.m^{-3})					Maximum PC to AQLV (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to AQLV (%)
	2017	2018	2019	2020	2021			
R1	0.11314	0.09249	0.09505	0.09187	0.08828	2.26	0.22	4.46
R2	0.11011	0.09135	0.09323	0.08796	0.08892	2.20	0.22	4.40
R3	0.10278	0.0855	0.08718	0.08183	0.0838	2.06	0.21	4.26
R4	0.06439	0.04576	0.05276	0.06081	0.0488	1.29	0.17	3.49
R5	0.0631	0.04436	0.05071	0.05701	0.04796	1.26	0.17	3.46
R6	0.0493	0.03456	0.03879	0.04248	0.03687	0.99	0.16	3.19
R7	0.03763	0.02975	0.03102	0.02977	0.02994	0.75	0.15	2.95
R8	0.06568	0.05312	0.04943	0.04645	0.06608	1.32	0.18	3.52
R9	0.03564	0.02457	0.02653	0.02643	0.03402	0.71	0.15	2.91
R10	0.02123	0.01395	0.01507	0.01376	0.02005	0.42	0.13	2.62
R11	0.01645	0.01213	0.01362	0.01413	0.01724	0.34	0.13	2.54
R12	0.00993	0.0118	0.00969	0.01162	0.01227	0.25	0.12	2.45
R13	0.00246	0.00331	0.00363	0.00303	0.00381	0.08	0.11	2.28
R14	0.01363	0.01854	0.02041	0.01252	0.01835	0.41	0.13	2.61
R15	0.00757	0.00983	0.00767	0.00526	0.0056	0.20	0.12	2.40
R16	0.00933	0.01061	0.00938	0.01227	0.00998	0.25	0.12	2.45
R17	0.00748	0.00734	0.00681	0.00937	0.00629	0.19	0.12	2.39
R18	0.00865	0.00798	0.00907	0.01071	0.00584	0.21	0.12	2.41

Table 5.7 – Maximum Modelled 24-Hour Mean Benzene Concentrations at Receptor Locations

Receptor	Maximum Modelled PC to 24-Hour Mean Benzene Concentrations (µg.m^{-3})	Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL (%)
R1	0.63909	2.13	0.77	2.56
R2	0.62021	2.07	0.75	2.50
R3	0.58618	1.95	0.72	2.39
R4	0.51631	1.72	0.65	2.15
R5	0.48764	1.63	0.62	2.06
R6	0.40496	1.35	0.53	1.78
R7	0.27095	0.90	0.40	1.34
R8	0.62071	2.07	0.75	2.50
R9	0.64068	2.14	0.77	2.57
R10	0.36151	1.21	0.49	1.64
R11	0.26968	0.90	0.40	1.33
R12	0.25117	0.84	0.38	1.27
R13	0.08979	0.30	0.22	0.73
R14	0.37867	1.26	0.51	1.70
R15	0.39782	1.33	0.53	1.76
R16	0.47293	1.58	0.60	2.01
R17	0.19981	0.67	0.33	1.10
R18	0.15705	0.52	0.29	0.96
Maximum Point of Impact	5.78221	19.27	5.91	19.71

Table 5.8 – Maximum Modelled 8-Hour Rolling Mean CO Concentrations at Receptor Locations

Receptor	Maximum Modelled PC to Rolling 8-Hour Mean CO Concentrations (µg.m^{-3})					Maximum PC to AQLV (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to AQLV (%)
	2017	2018	2019	2020	2021			
R1	111.30292	110.1396	144.1664	90.68384	105.61843	1.44	285.61	2.86
R2	105.27873	119.03062	140.2272	98.47369	104.46439	1.40	281.67	2.82
R3	101.70888	116.23318	135.9028	98.00161	103.61564	1.36	277.34	2.77
R4	73.11382	79.22253	79.88362	94.39127	78.46174	0.94	235.83	2.36
R5	66.77488	70.46275	79.61741	89.81567	75.49774	0.90	231.26	2.31
R6	52.50396	65.19381	61.80767	65.70566	67.0538	0.67	208.49	2.08
R7	42.7681	45.0202	50.21529	40.48388	44.76311	0.50	191.66	1.92
R8	140.67252	109.82649	109.1102	122.5944	171.73991	1.72	313.18	3.13
R9	144.62085	62.67875	74.72062	97.3595	111.17538	1.45	286.06	2.86
R10	51.3072	57.37676	47.90688	64.25845	75.2523	0.75	216.69	2.17
R11	58.28123	54.49722	48.55165	55.17905	64.37142	0.64	205.81	2.06
R12	35.37232	61.70107	44.18303	58.85006	55.23131	0.62	203.14	2.03
R13	13.38066	15.20178	16.48367	15.81341	22.99412	0.23	164.43	1.64
R14	51.24817	85.26033	50.4369	49.13254	60.91581	0.85	226.70	2.27
R15	50.36406	56.65719	43.38237	28.66719	28.42567	0.57	198.10	1.98
R16	38.5479	43.31542	47.83595	62.02036	50.03553	0.62	203.46	2.03
R17	54.0932	34.26837	27.0455	33.62707	44.65012	0.54	195.53	1.96
R18	29.9844	31.69716	38.13268	29.81138	29.04852	0.38	179.57	1.80
Maximum Point of Impact	638.30603	655.92944	609.955	669.48	594.68567	6.69	810.92	8.11

Table 5.9 – Maximum Modelled 1-Hour Mean CO Concentrations at Receptor Locations

Receptor	Maximum Modelled PC to 1-Hour Mean CO Concentrations (µg.m^{-3})	Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL (%)
R1	294.72329	0.98	471.51	1.57
R2	288.4245	0.96	465.21	1.55
R3	286.65851	0.96	463.45	1.54
R4	202.86999	0.68	379.66	1.27
R5	198.00952	0.66	374.80	1.25
R6	159.77322	0.53	336.56	1.12
R7	165.58942	0.55	342.38	1.14
R8	298.72279	1.00	475.51	1.59
R9	254.26833	0.85	431.06	1.44
R10	241.83419	0.81	418.62	1.40
R11	256.82478	0.86	433.61	1.45
R12	264.00006	0.88	440.79	1.47
R13	65.07834	0.22	241.87	0.81
R14	206.64695	0.69	383.44	1.28
R15	99.09539	0.33	275.89	0.92
R16	123.27635	0.41	300.07	1.00
R17	103.88182	0.35	280.67	0.94
R18	89.41353	0.30	266.20	0.89
Maximum Point of Impact	1045.89625	3.49	1222.69	4.08

Table 5.10 – Modelled Annual Mean NO_x Concentrations at Receptor Locations

Receptor	Modelled PC to Annual Mean NO_x Concentrations ($\mu g.m^{-3}$)					Maximum PC to Critical Level (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to Critical Level (%)
	2017	2018	2019	2020	2021			
R19 – R28	1.66032	1.18788	1.46969	1.63895	1.25205	5.53	6.91	23.03
R29 – R34	0.60764	1.30203	0.74531	1.08953	1.16294	4.34	6.55	21.84
R35	0.08184	0.10938	0.09198	0.05888	0.05845	0.36	5.36	17.86
R36	0.15335	0.15527	0.11028	0.13643	0.1519	0.52	5.41	18.02
R37	0.38568	0.25905	0.29472	0.33174	0.28065	1.29	5.64	18.79
R38	0.08217	0.1935	0.11052	0.14844	0.17631	0.65	5.44	18.15
R39 – R83	0.03389	0.0503	0.04946	0.04587	0.05224	0.17	5.30	17.67

Table 5.11 – Maximum Modelled 24-Hour Mean NO_x Concentrations at Receptor Locations

Receptor	Maximum Modelled PC to 24-Hour Mean NO_x Concentrations ($\mu g.m^{-3}$)	Maximum PC to Critical Level (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to Critical Level (%)
R19 – R28	22.737	30.32	28.94	38.58
R29 – R34	20.48187	27.31	26.68	35.58
R35	5.4199	7.23	11.62	15.49
R36	4.50567	6.01	10.71	14.27
R37	3.85527	5.14	10.06	13.41
R38	3.97649	5.30	10.18	13.57
R39 – R83	1.75673	2.34	7.96	10.61

Table 5.12 – Modelled Annual Mean SO_2 Concentrations at Receptor Locations

Receptor	Modelled PC to Annual Mean SO_2 Concentrations (µg.m^{-3})					Maximum PC to Critical Level (%)	Maximum Predicted Environmental Concentration (PEC) (µg.m^{-3})	Contribution of PEC to Critical Level (%)
	2017	2018	2019	2020	2021			
R19 – R28	0.3492	0.24983	0.3091	0.3447	0.26333	3.49	1.41	14.09
R29 – R34	0.1278	0.27384	0.15675	0.22915	0.24459	2.74	1.33	13.34
R35	0.01721	0.02301	0.01935	0.01238	0.01229	0.23	1.08	10.83
R36	0.03225	0.03266	0.02319	0.02869	0.03195	0.33	1.09	10.93
R37	0.08112	0.05448	0.06199	0.06977	0.05903	0.81	1.14	11.41
R38	0.01728	0.0407	0.02324	0.03122	0.03708	0.41	1.10	11.01
R39 – R83	0.00713	0.01058	0.0104	0.00965	0.01099	0.11	1.07	10.71

5.2 Assessment of Potential Impacts at Human Receptors

5.2.1 Nitrogen Dioxide

5.2.1.1 The modelled PEC for annual mean NO_2 concentrations is <70% of the AQLV at all relevant receptor locations. As such, impacts are concluded to be insignificant, in accordance with the relevant guidance. Furthermore, no exceedence of the annual mean AQLV is predicted at any relevant receptor location. Although the maximum modelled PC to 99.8th percentile of 1-hour mean concentrations is >10% of the AQLV at several receptor locations, the PEC is significantly below the AQLV at all locations surrounding the plant, the PEC at the maximum point of impact being 51.72% of the AQLV. As such, a breach of the short term AQLV is highly unlikely. Therefore, potential impacts are predicted to be insignificant. Confidence in this prediction is high given the highly conservative assumptions used in the assessment.

5.2.2 Sulphur Dioxide

5.2.2.1 The modelled PC to 99.2nd percentile of 24-hour mean concentrations and 99.7th percentile of 1-hour mean concentrations is <10% of the AQLV at receptors R1 to R18. As such, impacts are predicted to be insignificant at these locations. Although the PC exceeds 10% of the AQLV at the maximum point of impact for both of these scenarios, the PEC is substantially below the AQLV for both scenarios, the PEC being 46.41% of the 24-hour mean AQLV and 30.63% of the 1-hour mean AQLV. Although the PC to 99.9th percentile of 15-minute mean concentrations exceeds 10% of the AQS at several receptor locations, the PEC at the maximum point of impact is 59.83% of the AQS. Given the above, a breach of the short term AQLVs/AQS for SO_2 is highly unlikely. Therefore, potential impacts are predicted to be insignificant. Confidence in this prediction is high given the highly conservative assumptions used in the assessment.

5.2.3 Benzene

5.2.3.1 The modelled PEC for annual mean benzene concentration is <70% of the AQLV at all relevant receptor locations. As such, impacts are concluded to be insignificant, in accordance with the relevant guidance. Furthermore, no exceedence of the annual mean AQLV for benzene is predicted at any relevant receptor location. Although the modelled PC exceeds 10% of the 24-hour mean EAL for benzene at the maximum point of impact, the PEC is significantly below the EAL at all locations surrounding the plant, the PEC at the maximum point of impact being 19.71% of the EAL and 19.36% of the EAL minus twice annual mean background concentration. Therefore, potential impacts are predicted to be insignificant, in accordance with the relevant guidance. Confidence in this prediction is high given the highly conservative assumptions used in the assessment.

5.2.4 Carbon Monoxide

5.2.4.1 The maximum modelled PC to rolling 8-hour maximum mean and 1-hour mean CO concentration is <10% of the AQLV and EAL respectively at all locations surrounding the plant. As such, impacts are concluded to be insignificant, in accordance with the relevant guidance. Furthermore, no exceedence of the AQLV/EAL is predicted at any relevant receptor location. Therefore, no significant impacts are predicted.

5.3 Assessment of Potential Impacts at Sensitive Ecological Receptors

5.3.1 Critical Levels

5.3.1.1 The modelled PC is less than 100% of the critical level for annual mean and 24-hour mean NO_x concentrations and annual mean SO_2 concentrations at receptors R19 to R38. As such, potential impacts on local nature sites are predicted to be insignificant, in accordance with the relevant guidance. At receptors R39 to R83 (River Wye SAC), the modelled PC is less than 1% of the critical level for annual mean NO_x concentrations and less than 10% of the critical level for 24-hour mean NO_x concentrations. As such, impacts are not predicted to be significant at the River Wye SAC, in accordance with the relevant guidance.

5.3.2 Nitrogen Deposition

5.3.2.1 The maximum PC to nitrogen deposition has been calculated from the predicted annual mean NO_x concentrations, in accordance with the relevant guidance. Nitrogen deposition arising as a result of resulting annual mean NO_x concentrations has been calculated using the following formula:

$$F = \left(\frac{Vd \times C \times 10000}{1000000000}\right) \times 0.3 \times 31536000$$

Where: F = deposition flux (Kg N $ha^{-1}Year^{-1}$)

V_d = nitrogen dry deposition velocity, assumed to be $0.003 m.s^{-1}$

C = predicted annual mean NO_x concentration ($\mu g.m^{-3}$)

10000 = conversion from m^2 to hectares (ha)

1000000000 = conversion from µg to Kg

0.30 = fraction of NO_2 that is N

31536000 = conversion from seconds to year

5.3.2.2 Calculated annual nitrogen deposition at relevant receptors is presented in the table below. As the PC is <100% of the worst case critical load at local nature sites (R19 to R38) and <1% of the critical load at River Wye SAC (R39 to R83), impacts are predicted to be insignificant at all relevant ecological receptors and there is no requirement for further assessment in accordance with government permitting risk assessment guidance.

Table 5.13 - Calculated Annual Nitrogen Deposition at Ecological Receptors

Receptor	Maximum Modelled Annual Mean NO_x Concentration ($\mu g.m^{-3}$)	Calculated PC to Annual Nitrogen Deposition (Kg $N.ha^{-1}.Year^{-1}$) Based on Modelled Annual Mean NO_x Concentration	Percentage Contribution to Worst Case Critical Load for Annual Nitrogen Deposition (%)
R19 – R28	1.66032	0.471239	15.71
R29 – R34	1.30203	0.369547	12.32
R35	0.10938	0.031045	1.03
R36	0.15527	0.044069	1.47

Receptor	Maximum Modelled Annual Mean NO_x Concentration ($\mu g.m^{-3}$)	Calculated PC to Annual Nitrogen Deposition ($Kg\ N.ha^{-1}.Year^{-1}$) Based on Modelled Annual Mean NO_x Concentration	Percentage Contribution to Worst Case Critical Load for Annual Nitrogen Deposition (%)
R37	0.38568	0.109465	3.65
R38	0.1935	0.05492	1.83
R39 – R83	0.05224	0.014827	0.30

5.3.3 Acid Deposition

5.3.3.1 The potential PC to acid deposition across relevant ecological sites can be calculated by converting nitrogen and sulphur deposition predictions to kiloequivalents ($keq.ha^{-1}.Year^{-1}$) using the following assumptions, obtained from the APIS website:

- 1 keq N $ha^{-1}.Year^{-1}$ is equal to 14kg N $ha^{-1}.Year^{-1}$; and,
- 1keq S $ha^{-1}.Year^{-1}$ is equal to 16kg S $ha^{-1}.Year^{-1}$

5.3.3.2 Potential sulphur deposition across ecological sites was calculated in a similar fashion to nitrogen deposition, using the following equation and assumptions:

$$F = \frac{Vd \times C \times 10000}{1000000000} \times 0.50 \times 31536000$$

Where: F = deposition flux (Kg S $ha^{-1}Year^{-1}$)

V_d = sulphur dry deposition velocity, assumed to be $0.024 m.s^{-1}$

C = predicted annual mean SO_2 concentration ($\mu g.m^{-3}$)

10000 = conversion from m^2 to hectares (ha)

1000000000 = conversion from µg to Kg

0.5 = fraction of SO_2 that is S

31536000 = conversion from seconds to year

5.3.3.3 Based upon the above, the following table summarises annual nitrogen and sulphur deposition, total PC to annual acid deposition at ecological receptors due to nitrogen and sulphur and percentage contribution to critical load function for nitrogen (CLmaxN). As is shown, the total PC to acid deposition is predicted to be less than 100% of the relevant critical load function at all local nature sites (R19 to R38) and less than 1% of the relevant critical load function at River Wye SAC (R39 to R83). As such, potential impacts are predicted to be insignificant, in accordance with the relevant guidance.

Table 5.14 - Calculated Acid Deposition at Ecological Receptors

Receptor	Calculated PC to Annual Nitrogen Deposition (Kg N.ha^{-1}.Year^{-1}) Based on Modelled Annual Mean NO_x Concentration	Calculated PC to Annual Sulphur Deposition (Kg N.ha^{-1}.Year^{-1}) Based on Modelled Annual Mean SO_2 Concentration	Total PC to Annual Acid Deposition Due to Nitrogen and Sulphur (keq.ha^{-1}. Year^{-1})	Percentage Contribution to CLMaxN (%)
R19 – R28	0.03366	0.082593	0.116253	23.34
R29 – R34	0.026396	0.064769	0.091165	18.31
R35	0.002217	0.005442	0.00766	1.54
R36	0.003148	0.007725	0.010873	2.19
R37	0.007819	0.019187	0.027005	5.41
R38	0.003923	0.009626	0.013549	2.66
R39 – R83	0.001059	0.002599	0.003658	0.75

6 Conclusions

6.1 An assessment of potential air quality impacts has been undertaken for the proposed operation of an AD plant at Whitwick Manor, Herefordshire. Modelling has been undertaken using AERMOD to quantify potential resulting long and short-term pollutant concentrations at surrounding receptor locations as a result of operation of the proposed plant. A series of highly conservative assumptions have been made within the report, resulting in a highly precautionary assessment.

6.2 No exceedences of long and short term AQLVs/EALs have been predicted for NO_2, CO, and benzene at any relevant receptor location surrounding the plant, with the PEC significantly below relevant EAL/AQLV at all relevant receptor locations. Given the highly conservative assumptions used in the assessment, confidence is therefore high that potential impacts will not be significant.

6.3 The modelled PC to critical levels for NO_x and SO_2 and critical loads for annual nitrogen and acid deposition at relevant has been predicted to be <100% at local nature sites and <1% at the River Wye SAC. As such, potential impacts on relevant ecological receptors are not predicted to be significant.

6.4 Given the above, the model results have demonstrated that the proposals will not generate any significant adverse impacts on local air quality at relevant human and ecological receptor locations. Confidence in this prediction is high, given the conservative assumptions made within the assessment.

Appendix I

Site Plans

Key

1. Digester Tank 1
2. Digester Tank 2
3. Feed Stock/Water Storage Tank
4. Secondary Tank 1
5. Pasteuriser Tank
6. Hydrolyser Tank
7. Ammonia Recover Tank
8. Pump Room
9. Feeders
10. Vehicle Turning
11. Open Feed Stock Storage Clamps
12. Covered Feed Stock Storage Clamps
13. Open Feed Stock Storage Clamps
14. Process Containers & Tank
15. Secondary Tank 2
16. Digester Tank 3
17. Storage Tank
18. Digester Tank 4
19. 6 x Nitrogen & Phosphate Bunded Recovery Tanks
20. Control Room
21. Solids Recovery Separator & Centrifuge
22. Flare
23. Dry Ice Plant & Control Room
24. 4 x CO2 Tanks
25. CO2 Plant
26. Bio Methane Plant
27. 2 x CHP's
28. 6 x Propane Tanks
29. Chiller Units
30. 2 x Back up Boilers
31. NEF Unit
32. Compressor Unit
33. Office & Welfare Building
34. Weighbridge
35. Storm Water Lagoon
36. Process Water Lagoon
37. Reed Beds
38. Grain Store
39. Site Access
40. Gas Pipe to Grid
41. Tank Bund
42. Phosphate stripping and polishing tanks
43. Wash down & wheel wash area

0m 10m 50m 100m 150m

Rev No.	Revision Note.	Date	Drawn	Checked
A	Pre App Drawings	12.11.19	AW	AW
B	Wetlands system added to the site	01.04.20	AW	AW
C	Grain Store updated	02.10.20	CJB	AW
D	Red line site amended	07.09.22	AW	AW
E	Grain store and storage building revised	28.03.23	AW	AW

NUMBER - REV - CLIENT - PROJECT
01113-00 - E - N Layton - Whitwick Manor

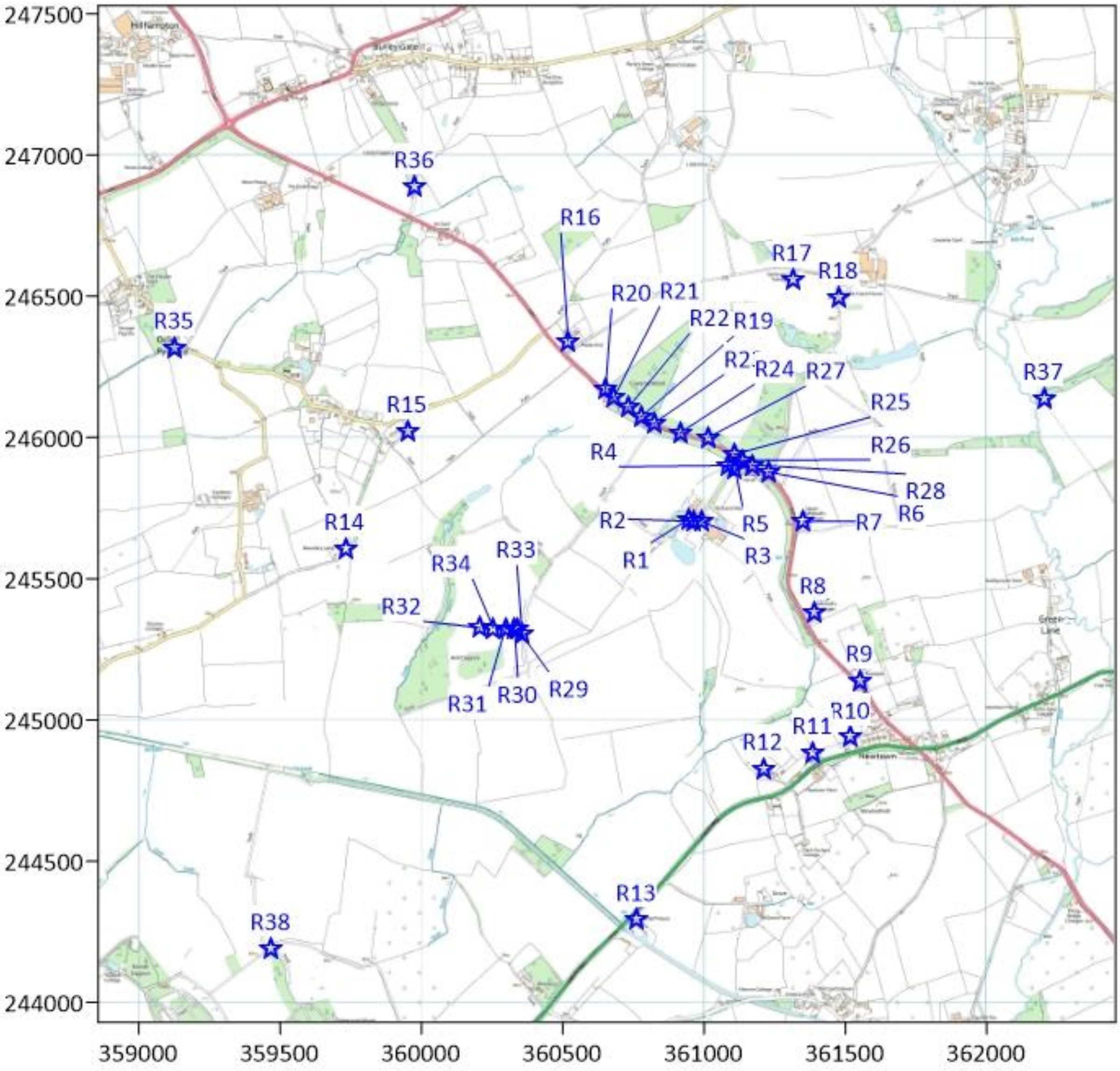
TITLE
Site Plan

DATE	SHEET	SCALE
08.08.22	02	1:1000
DRN BY AW	CHK BY AW	PAPER SIZE A1

BOURNE VALLEY ASSOCIATES
ANDOVER LANE FARM
FABERSTOWN
ANDOVER
HAMPSHIRE
SP11 9PE
Tel: 01264 850159
Email: info@bournevalley.co.uk

Appendix II

Sensitive Receptor Locations



Appendix II Figure 1 - Sensitive Receptors

☆ Receptor Location	Oaktree Environmental Ltd Lime House 2 Road Two Winsford Cheshire CW7 3QZ
R1 Receptor Identifier	

N.B - Map contains Ordnance Survey data

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Appendix III

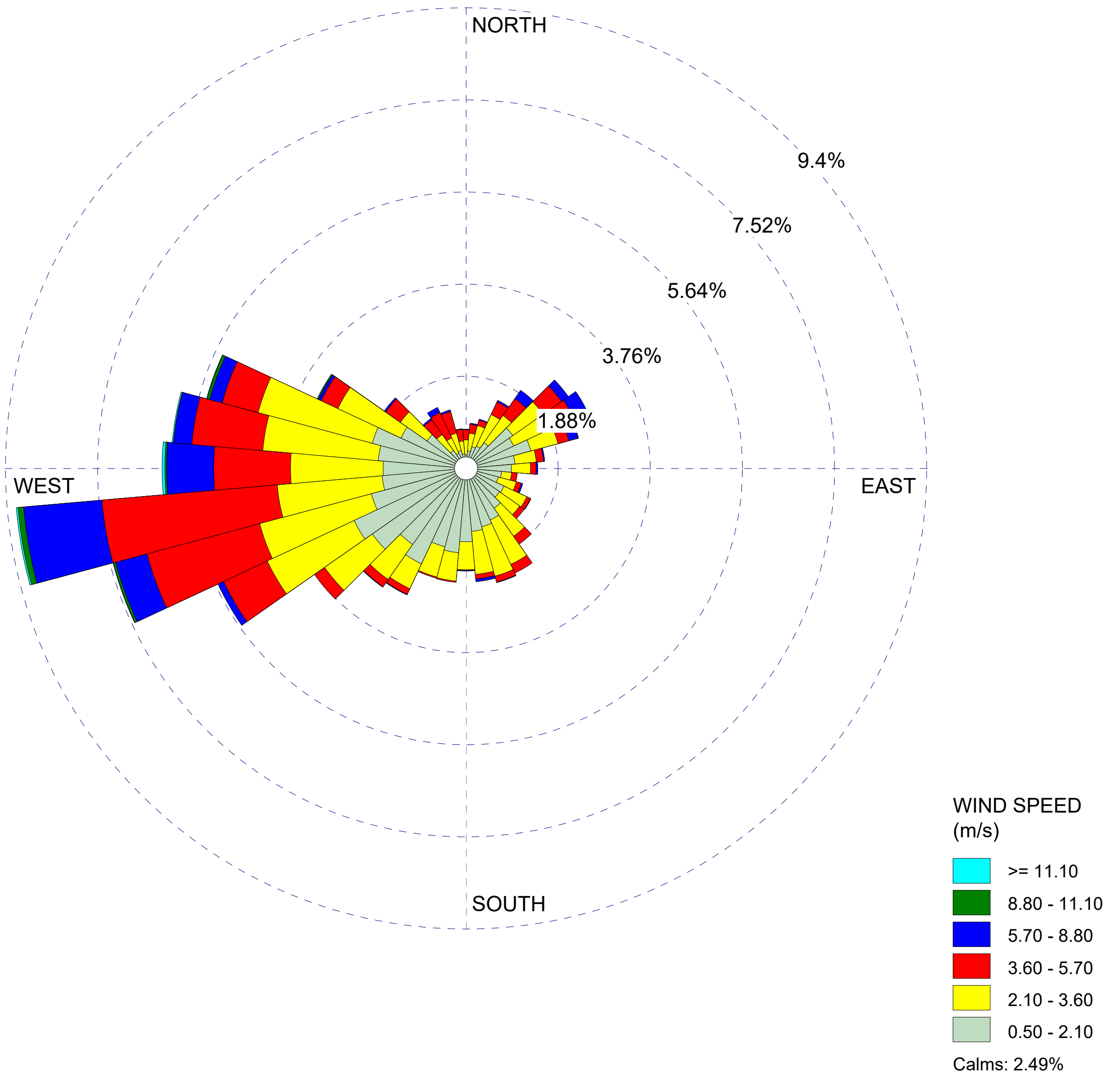
Hereford/Credenhill Wind Roses

WIND ROSE PLOT:

Wind Speed Direction and Frequency at Hereford During 2017

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:

Start Date: 01/01/2017 - 00:00
End Date: 31/12/2017 - 23:59

COMPANY NAME:

MODELER:

CALM WINDS:

2.49%

TOTAL COUNT:

8739 hrs.

AVG. WIND SPEED:

2.37 m/s

DATE:

28/04/2023

PROJECT NO.:

2102

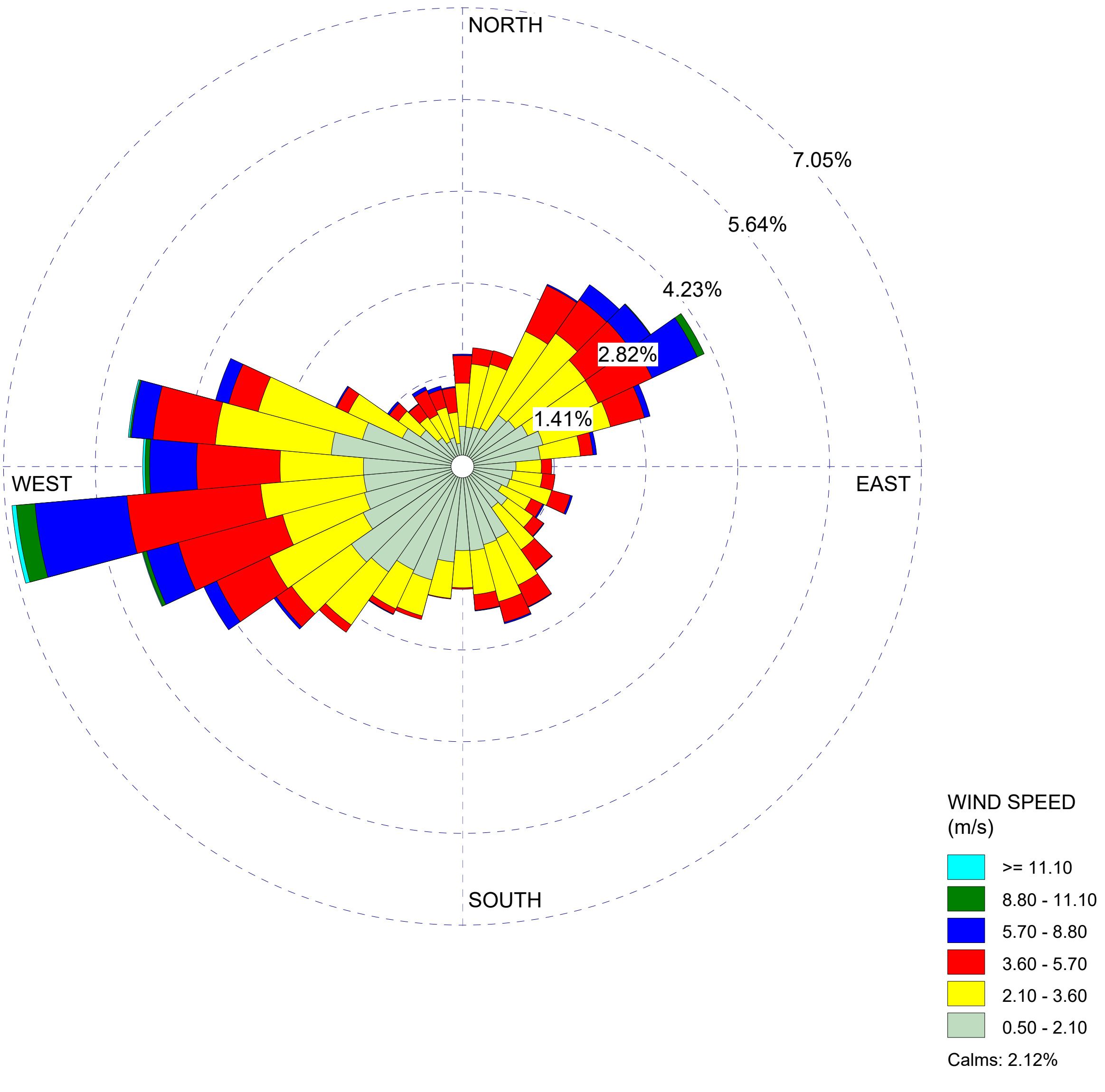
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Wind Speed Direction and Frequency at Hereford During 2018

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:

Start Date: 01/01/2018 - 00:00
End Date: 31/12/2018 - 23:00

COMPANY NAME:

MODELER:

CALM WINDS:

2.12%

TOTAL COUNT:

8549 hrs.

AVG. WIND SPEED:

2.42 m/s

DATE:

11/04/2022

PROJECT NO.:

2102

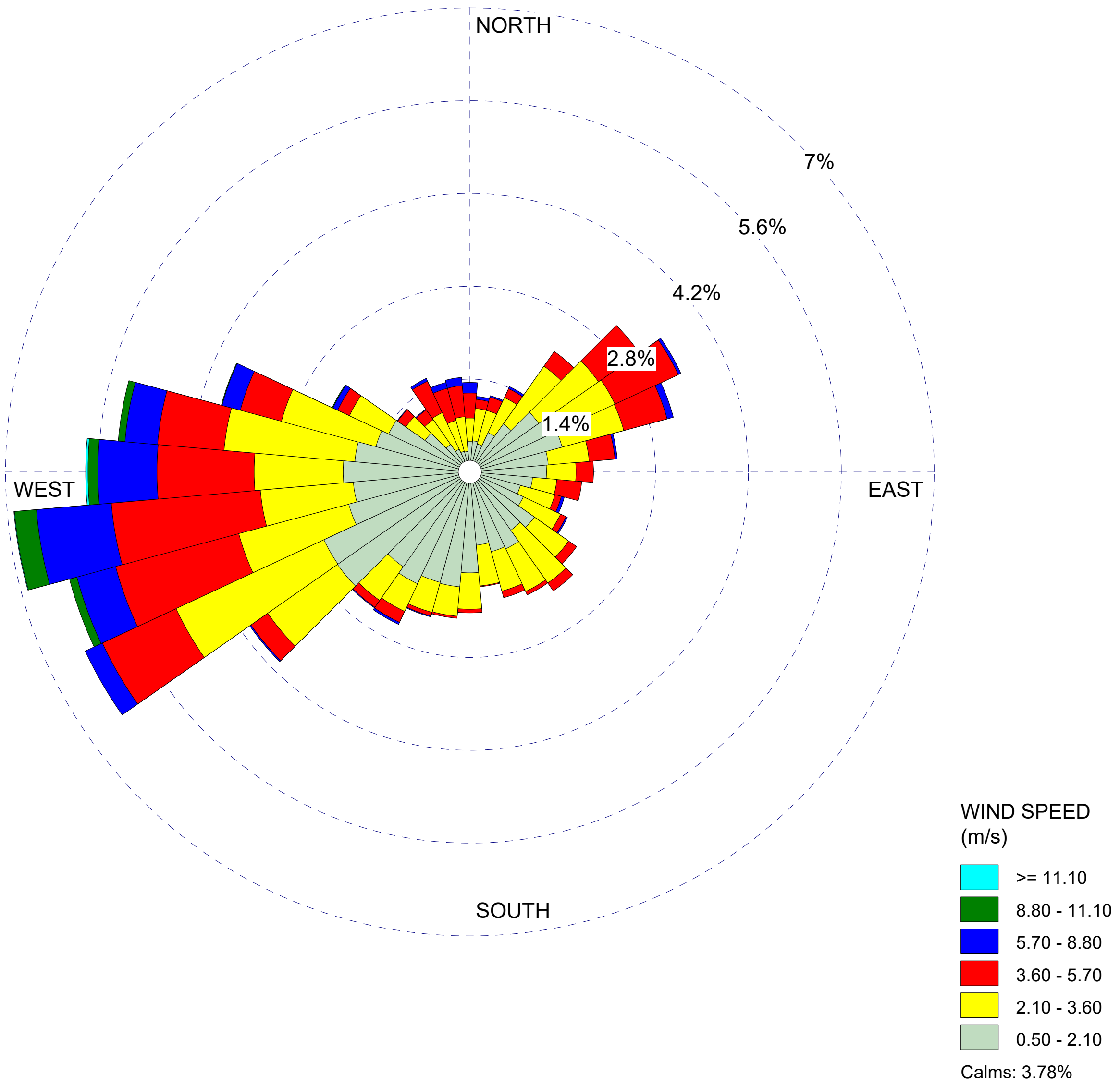
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Wind Speed Direction and Frequency at Hereford During 2019

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 01/01/2019 - 00:00 **End Date: 31/12/2019 - 23:00**	MODELER:	
	CALM WINDS: **3.78%**	TOTAL COUNT: **8665 hrs.**	
	AVG. WIND SPEED: **2.28 m/s**	DATE: **11/04/2022**	PROJECT NO.: **2102**

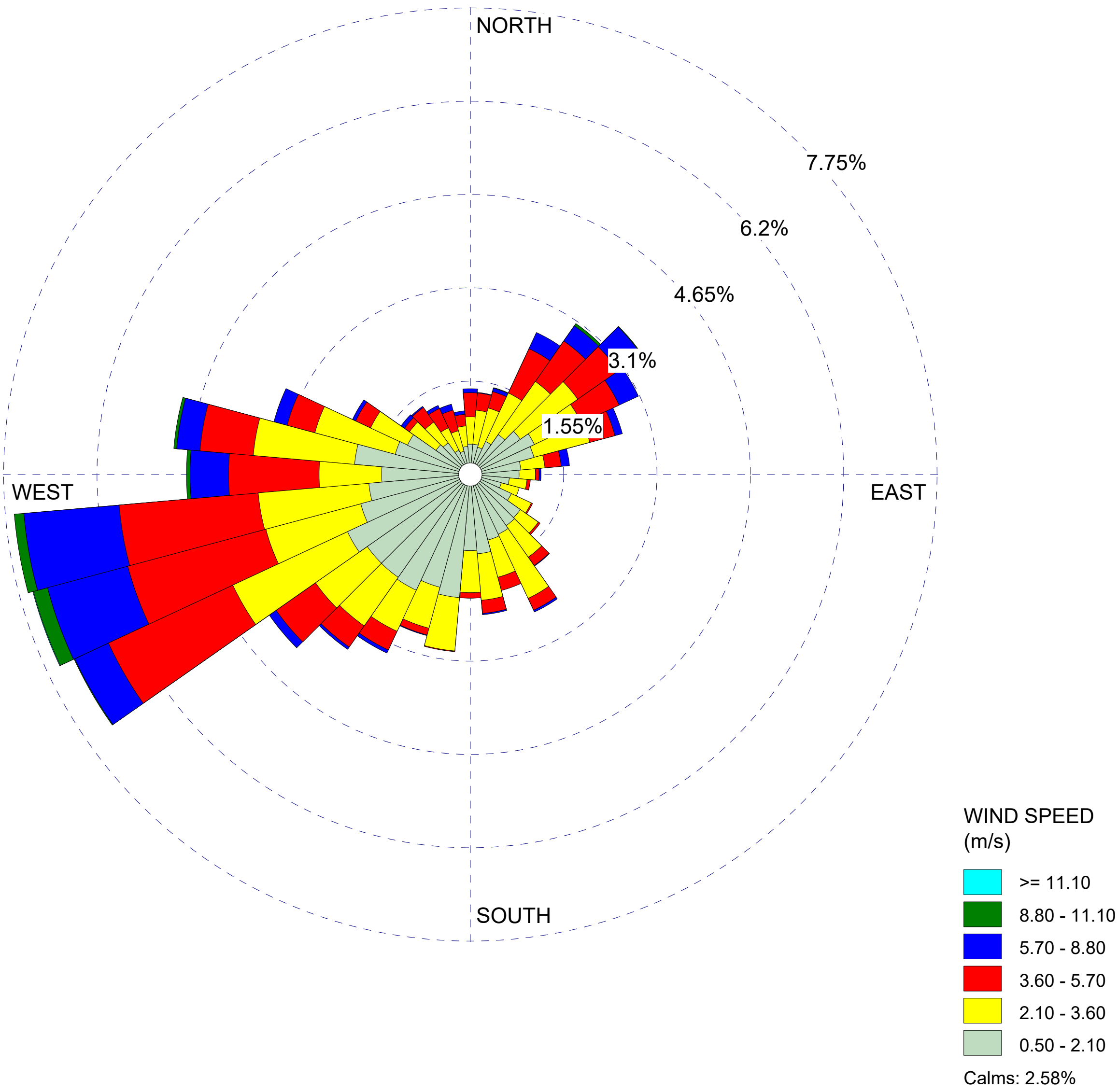
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Wind Speed Direction and Frequency at Hereford During 2020

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: **Start Date: 01/01/2020 - 00:00** **End Date: 31/12/2020 - 23:00**	COMPANY NAME:	
		MODELER:	
	CALM WINDS: **2.58%**	TOTAL COUNT: **8784 hrs.**	
	AVG. WIND SPEED: **2.50 m/s**	DATE: **11/04/2022**	PROJECT NO.: **2102**

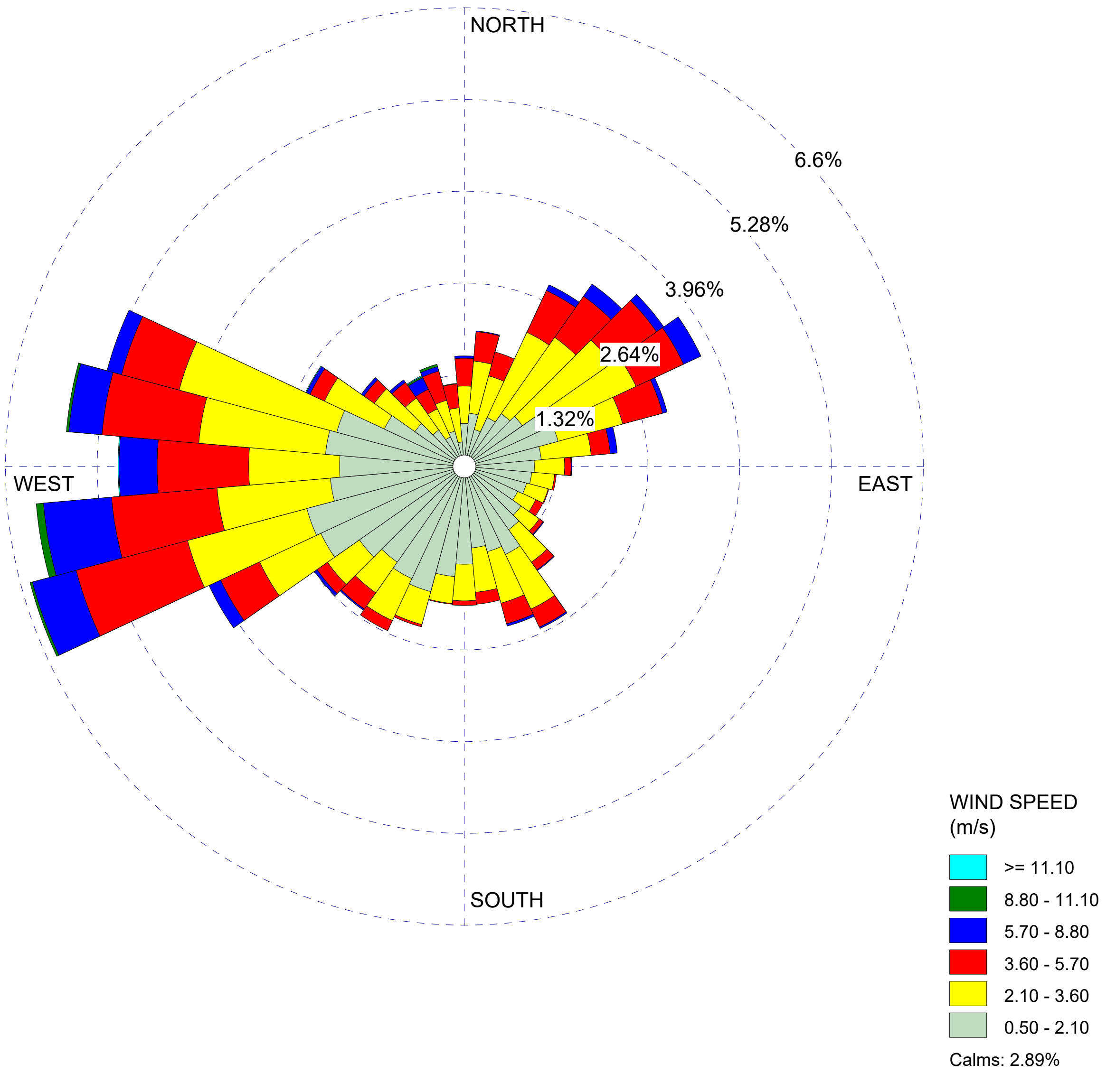
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Wind Speed Direction and Frequency at Hereford During 2021

DISPLAY:

Wind Speed
Direction (blowing from)

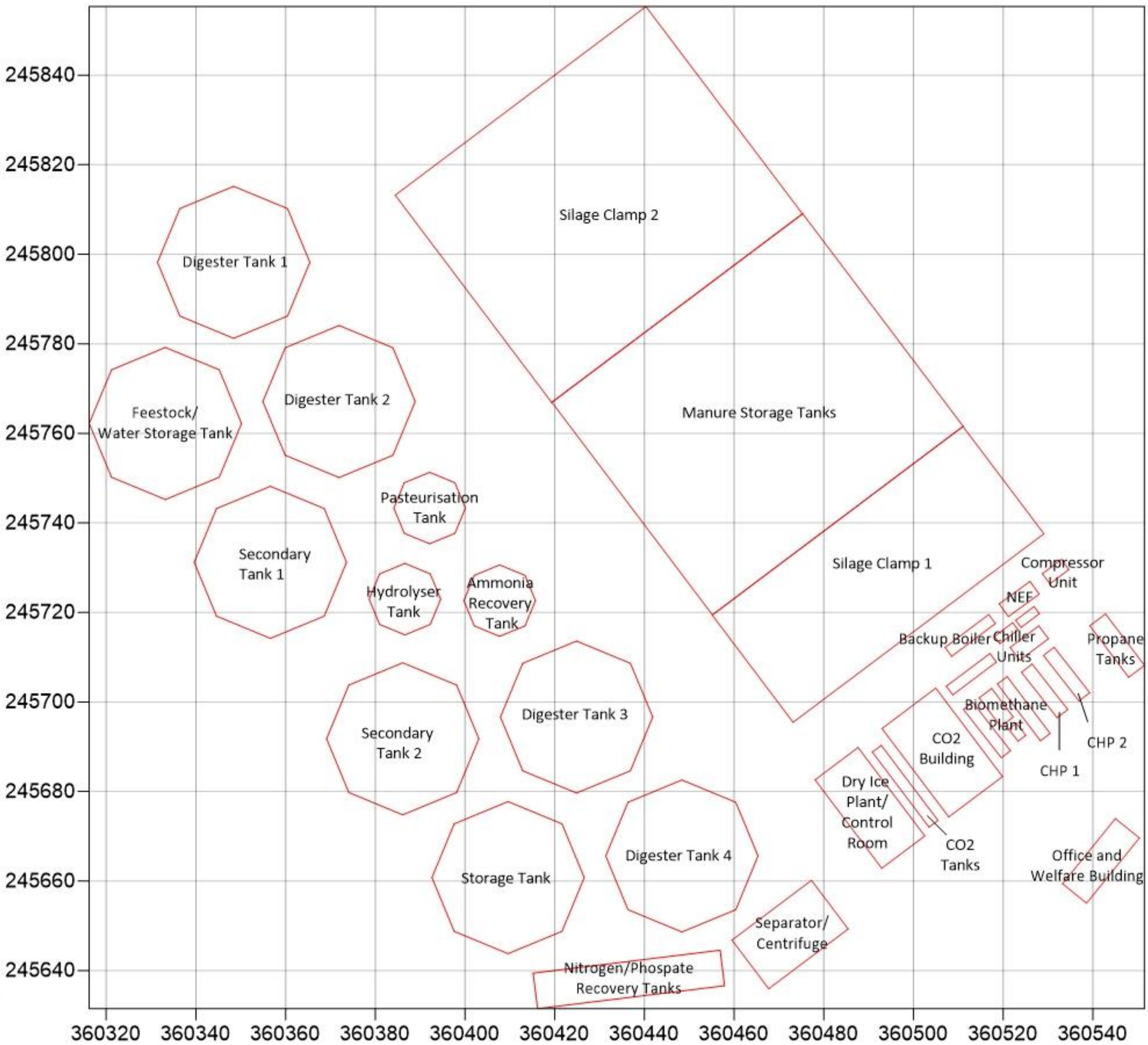


COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 01/01/2021 - 00:00 **End Date: 31/12/2021 - 23:00**	MODELER:	
	CALM WINDS: **2.89%**	TOTAL COUNT: **8667 hrs.**	
	AVG. WIND SPEED: **2.23 m/s**	DATE: **11/04/2022**	PROJECT NO.: **2102**

WRPLOT View - Lakes Environmental Software

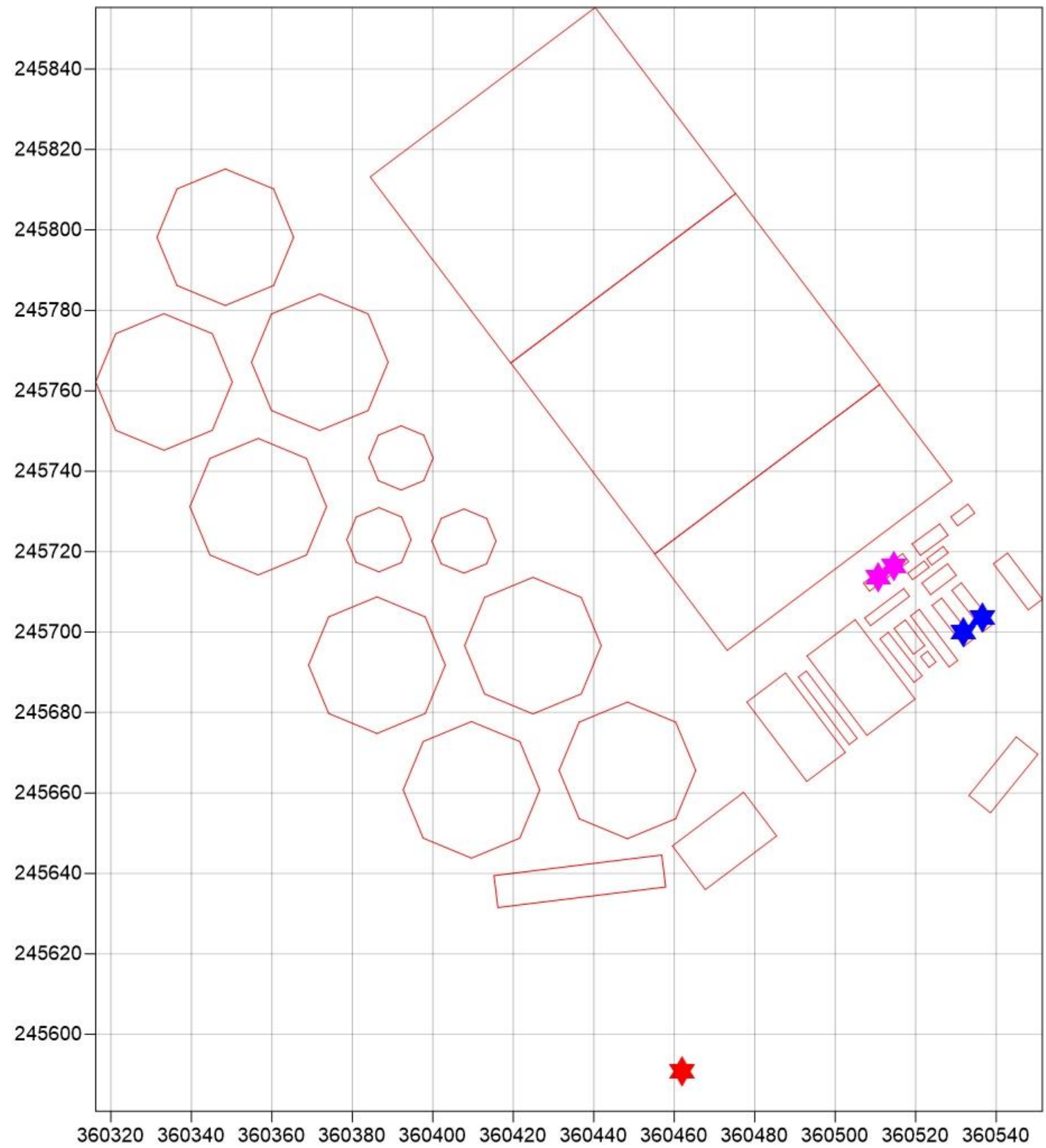
Appendix IV

Structures and Point Sources Digitised Within Model



Appendix IV Figure 1 - Buildings and Structures Digitised Within Model

Oaktree Environmental Ltd
Lime House
2 Road Two
Winsford
Cheshire
CW7 3QZ



Appendix IV Figure 2 - Point Source Emission Locations

Flare

CHP Stacks

Backup Boiler Stacks

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Appendix V

Pollutant Contour Profiles

(N.B scales may not be linear)

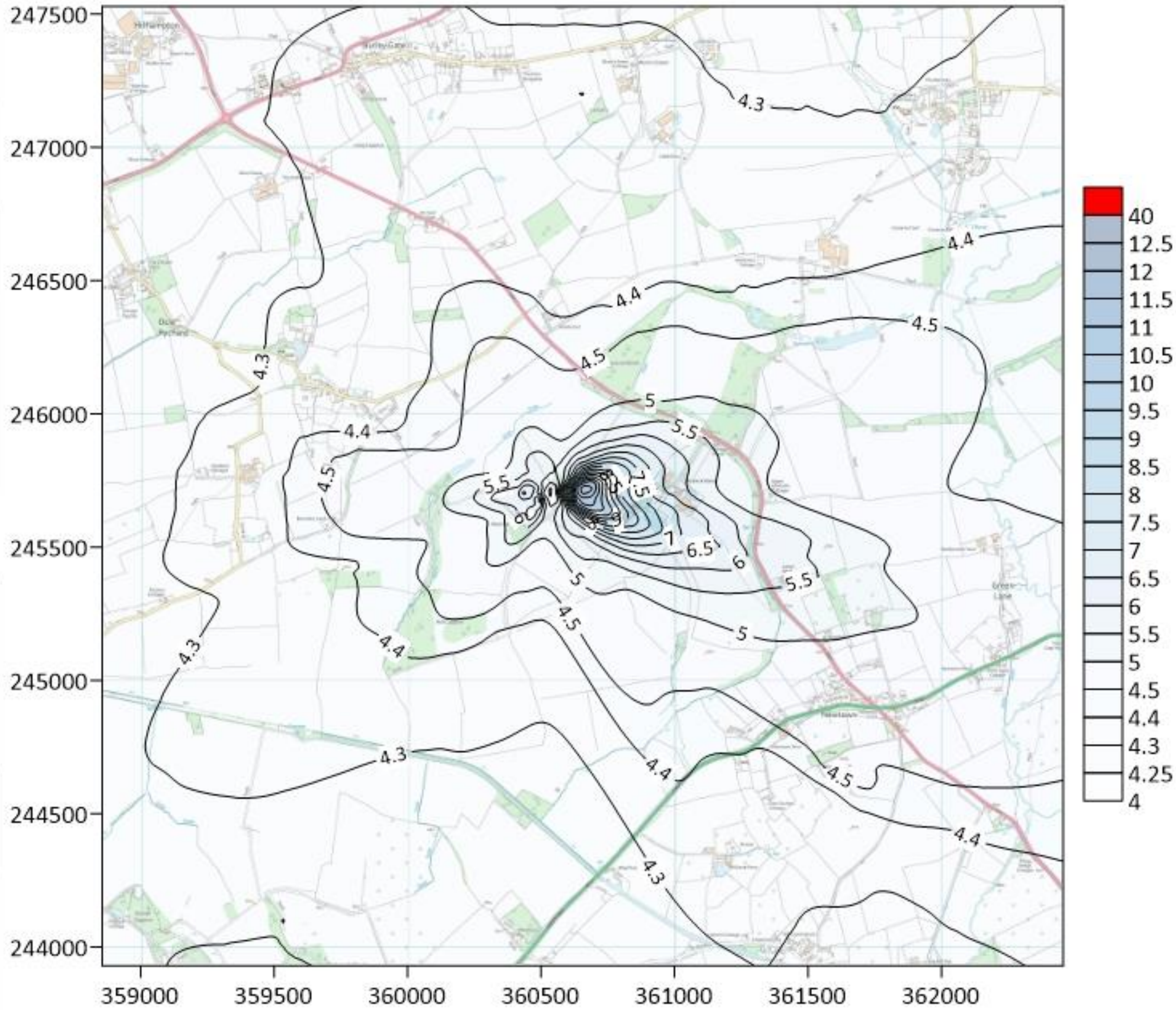

Figure V Figure 1 - Predicted annual mean nitrogen dioxide concentrations (μg.m^{-3}) based upon 2017 meteorological data

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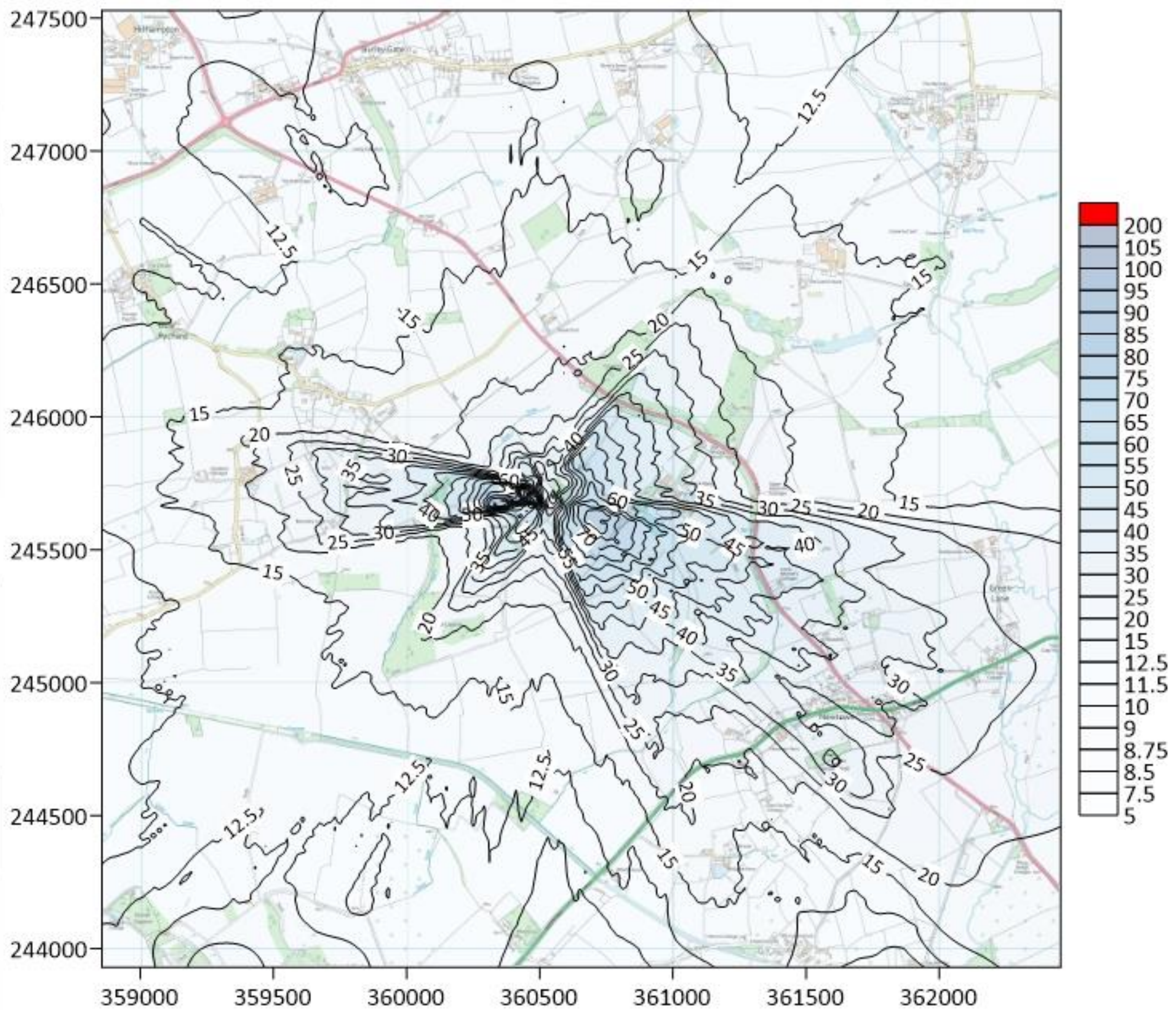

Figure V Figure 2 - Predicted 99.8th percentile of 1-hour mean nitrogen dioxide concentrations ($\mu g.m^{-3}$) based upon 2019 meteorological data

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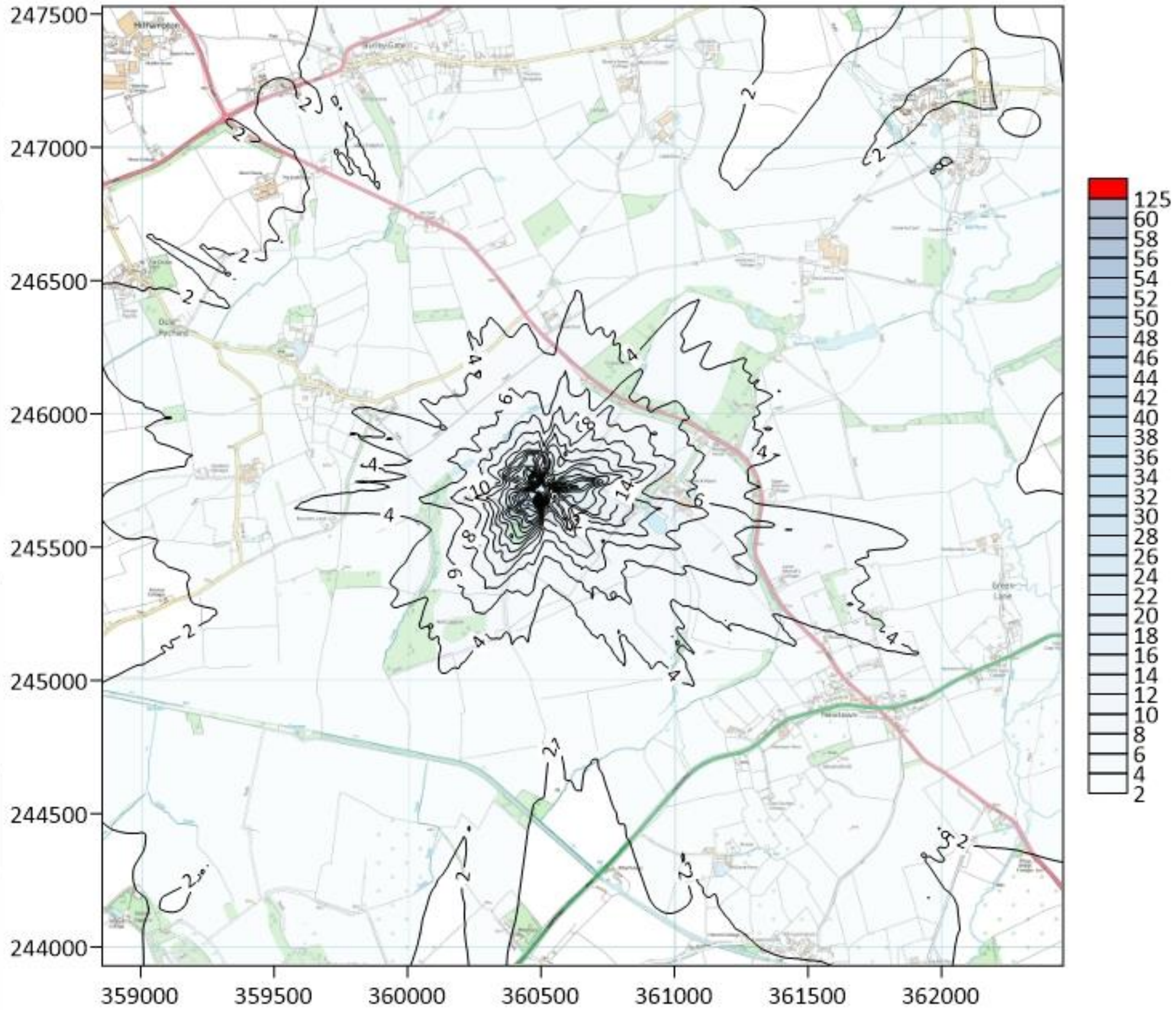

Figure V Figure 3 - Predicted 99.2nd percentile of 24-hour mean sulphur dioxide concentrations (µg.m^{-3}) based upon 2018 meteorological data

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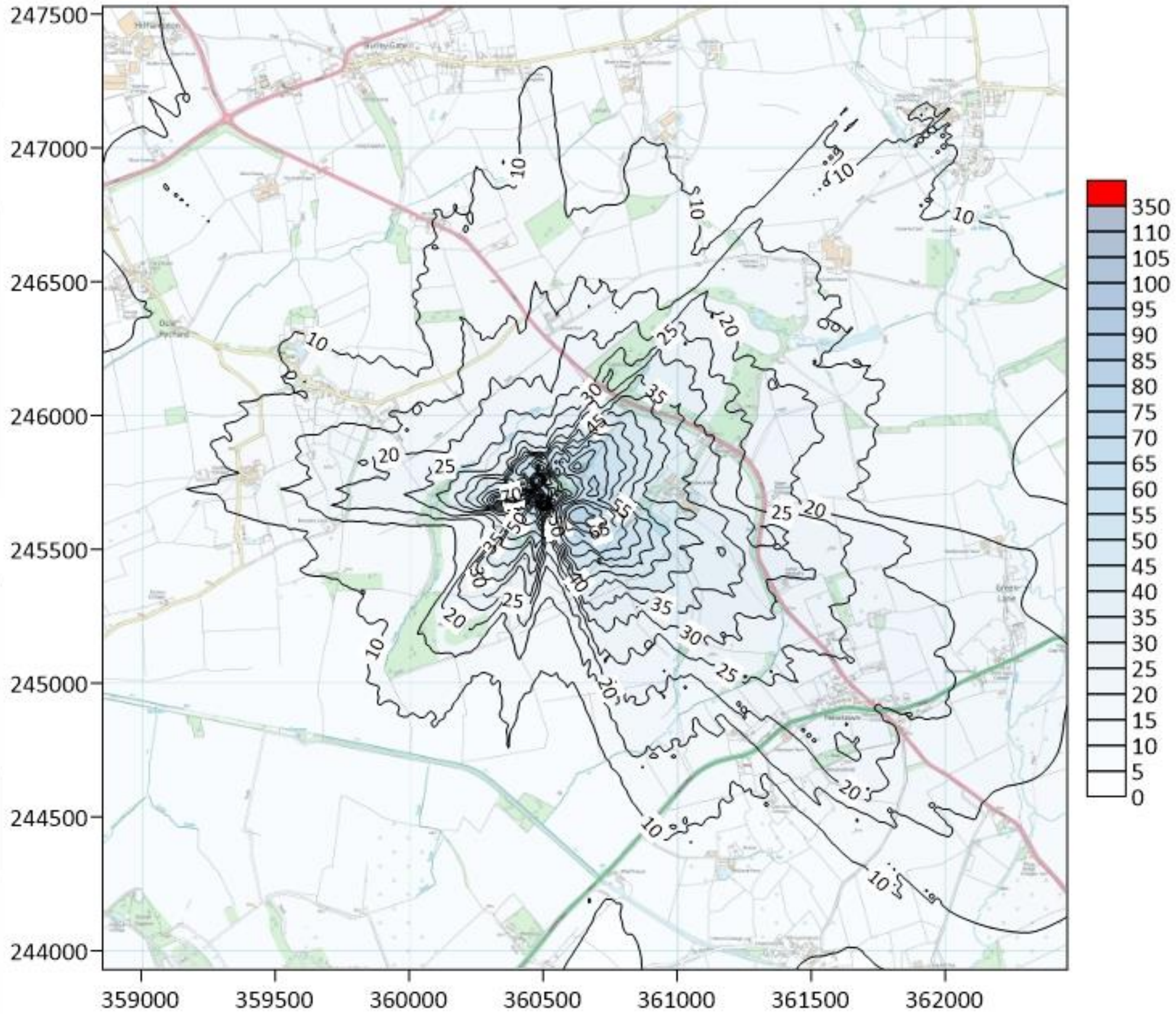

Figure V Figure 4 - Predicted 99.7th percentile of 1-hour mean sulphur dioxide concentrations (μg.m^{-3}) based upon 2021 meteorological data

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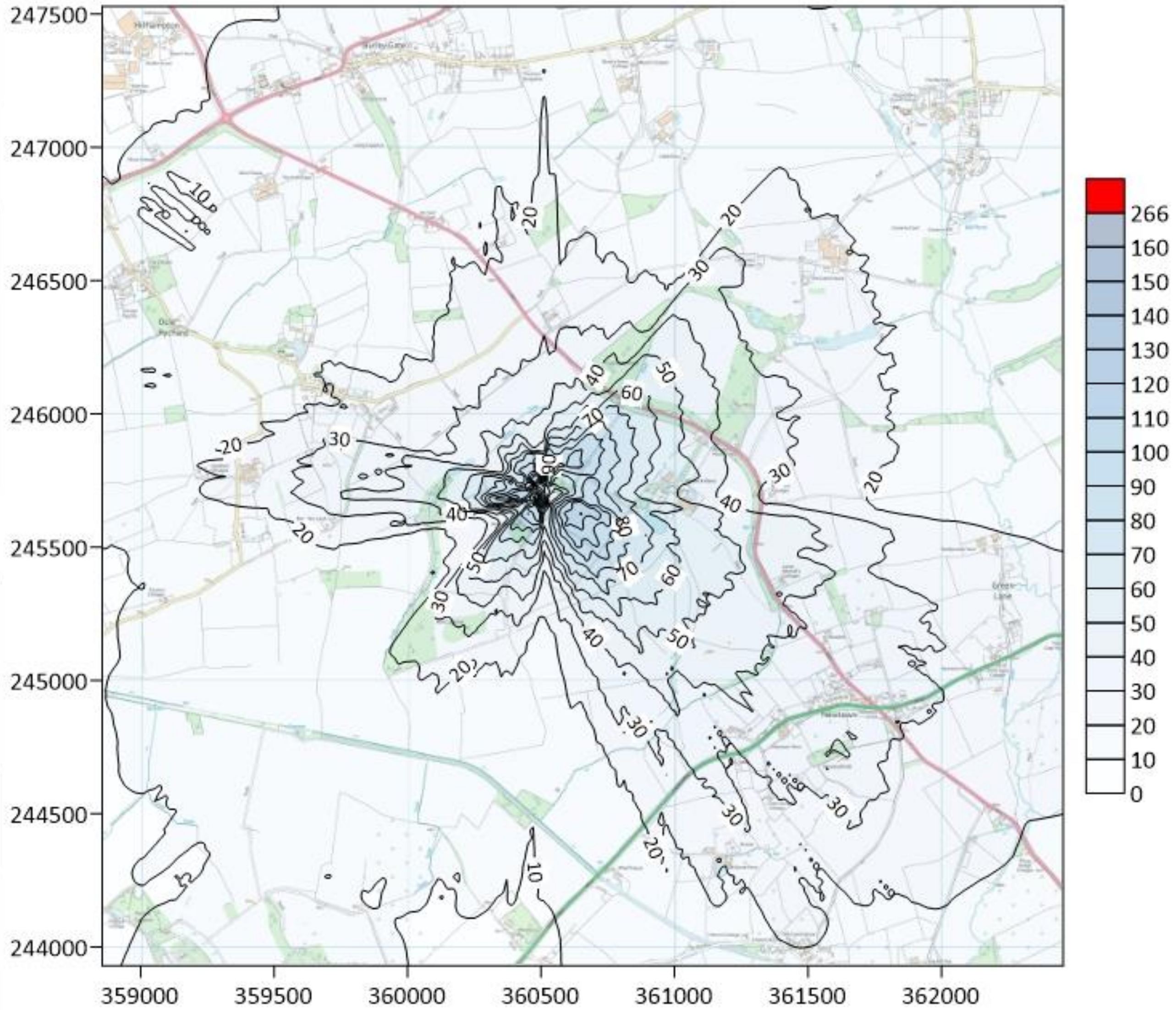

Figure V Figure 5 - Predicted 99.9th percentile of 15-minute mean sulphur dioxide concentrations ($\mu g.m^{-3}$) based upon 2020 meteorological data

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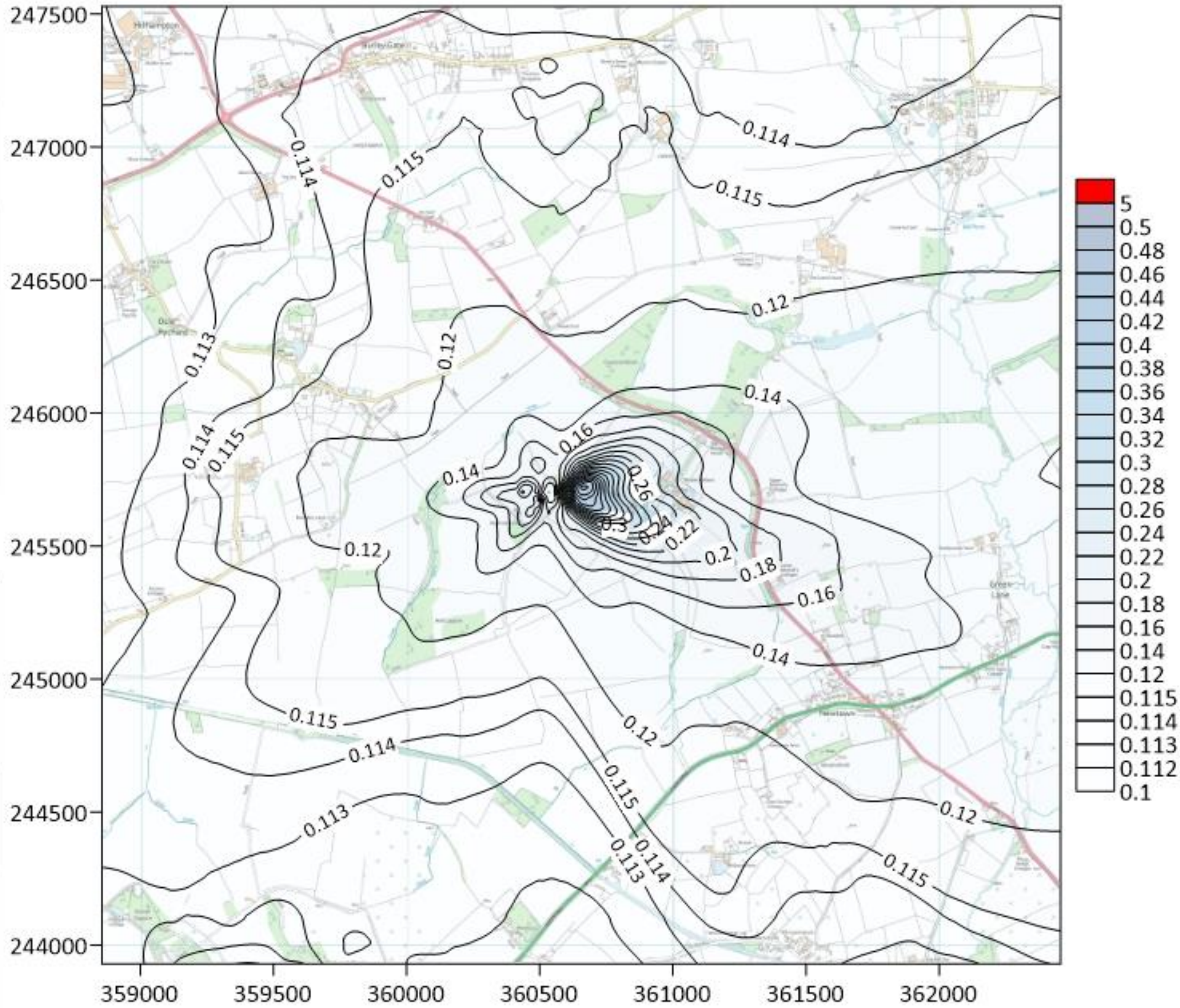

Figure V Figure 6 - Predicted annual mean benzene concentrations ($\mu g.m^{-3}$) based upon 2017 meteorological data

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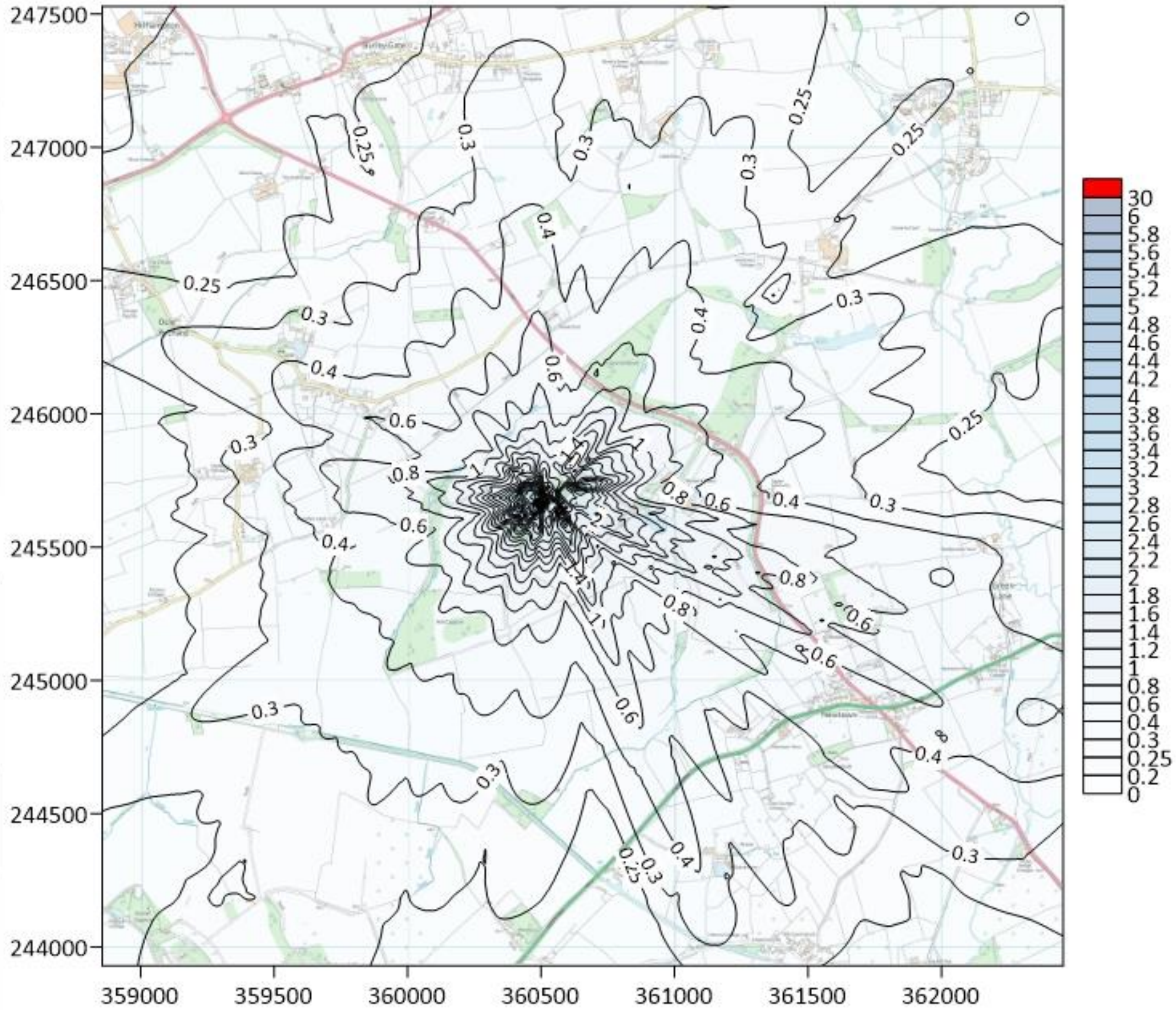

Figure V Figure 7 - Maximum modelled 24 mean benzene concentrations ($\mu g.m^{-3}$)

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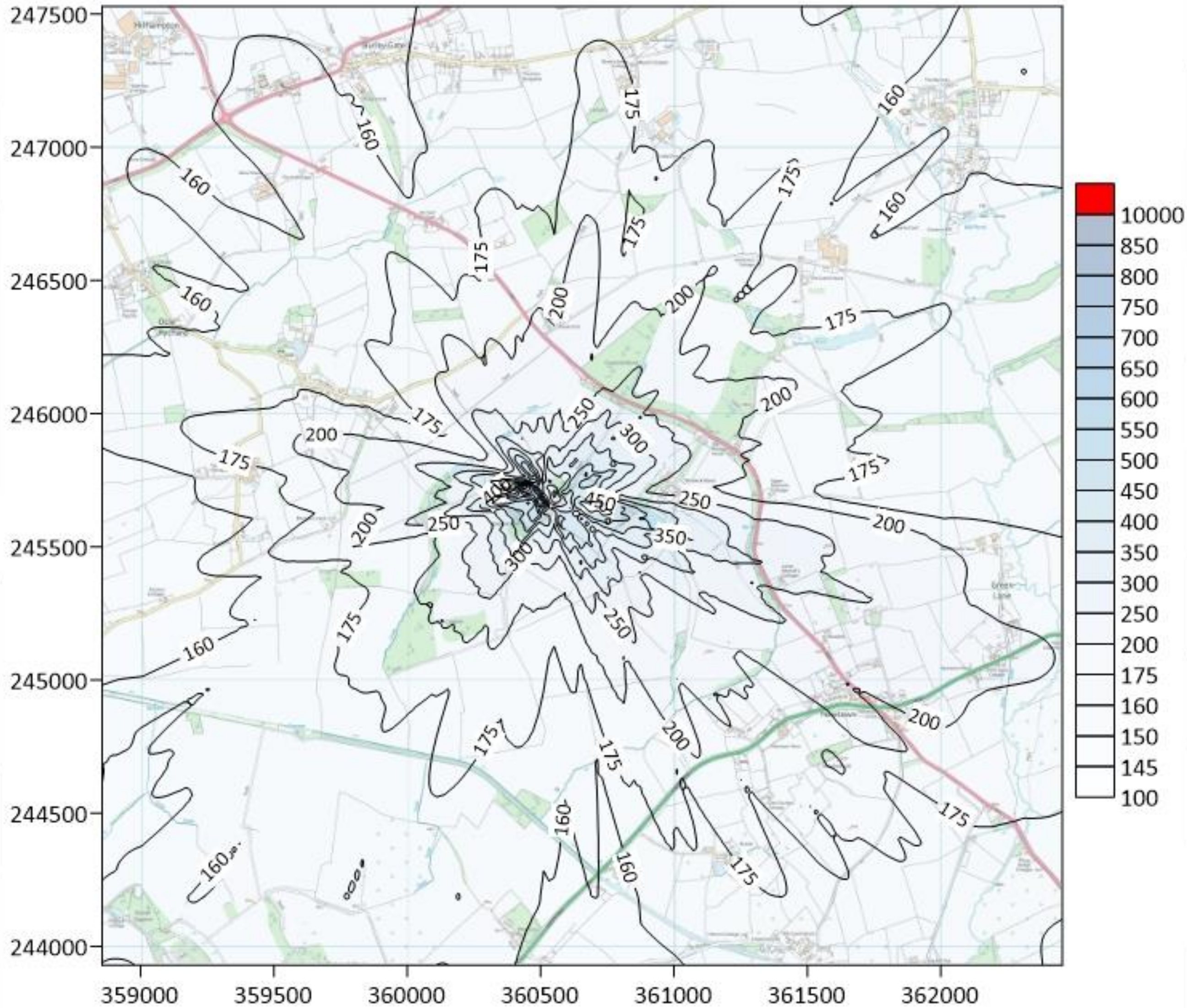

Figure V Figure 8 - Predicted rolling maximum 8 hour mean CO concentrations (μg.m^{-3}) based on 2020 meteorological data

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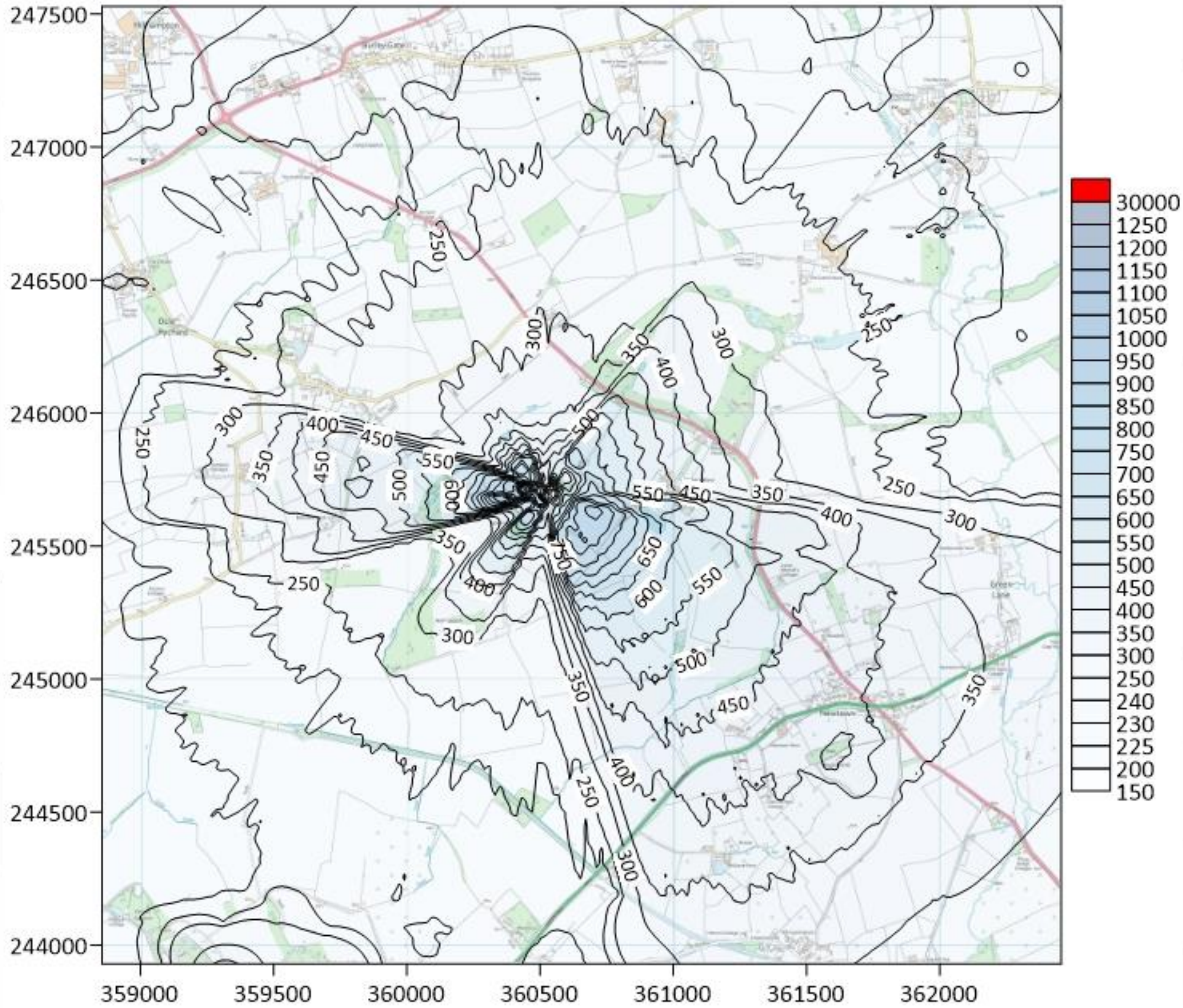

Figure V Figure 9 Maximum modelled 1 hour mean CO concentrations ($\mu g.m^{-3}$)

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