FICHTNER

Consulting Engineers Limited

Rivenhall IWMF

Indaver Rivenhall Limited

Dispersion Modelling Assessment

ENGINEERING + CONSULTING

Document approval

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Management Summary

Fichtner Consulting Engineers Ltd ("Fichtner") has been engaged by Indaver to undertake a Dispersion Modelling Assessment to support the application for a variation to the Environmental Permit (EP) for the Rivenhall Integrated Waste Management Facility (herein referred to as the IWMF). The EP allows for the operation of the IWMF, which includes the following waste management activities:

- Waste incineration (CHP Plant) comprising two incineration lines;
- Paper and pulp plant (Pulp Plant);
- Wastewater Treatment Plant;
- Materials Recovery Facility (MRF);
- Mechanical and Biological Treatment Plant (MBT); and
- Anaerobic Digestion Plant (AD Plant).

Due to the complexities associated with the construction of the Rivenhall IWMF, Indaver is constructing the Rivenhall IWMF on a phased basis. The initial earthworks to create the development platform for the Rivenhall IWMF commenced in June 2021, with Phase 1 - construction of the IWMF - commencing in October 2022. Commissioning of the CHP plant is due to commence in September 2025 with handover of the CHP Plant, and commercial operation, commencing in March 2026.

Of the activities regulated within the EP there are emissions to air from the CHP Plant, the Pulp Plant, the AD gas engines, and AD biofilter, noting that the emissions from the Pulp Plant just contain moisture from the drying process and not any combustion products, and the emissions from the AD biofilter do not contain any combustion products. These all vent to atmosphere via a common stack containing a flue from each source. Therefore, the dispersion of emissions from the stack will depend upon the sourcing operating.

To allow for the phasing, as set out above, this assessment has considered the effect of the phased approach to the development of the IWMF taking into account the changes to the size of the building and the sources venting to atmosphere via the common stack.

Dispersion Modelling of Emissions

The ADMS dispersion model is routinely used for air quality assessments to the satisfaction of the Environment Agency (EA). The model uses weather data from the local area to predict the spread and movement of the exhaust gases from the stack for each hour over a five-year period. The model takes account of wind speed, wind direction, temperature, humidity and the amount of cloud cover, as all of these factors influence the dispersion of emissions. The model also takes account of the effects of buildings and terrain on the movement of air.

Dispersion modelling has been carried out for the following scenarios:

1. Permitted Facility – all sources within the IWMF operating as per the conditions of the existing EP and with the full build out of the buildings as proposed in the existing EP;
2. CHP Plant only with the full build out of the buildings as proposed in the existing EP; and
3. CHP Plant only with only the buildings associated with the delivery of the CHP Plant (i.e. the Phase 1 works).

To set up the model, it has been assumed that each plant operates for the whole year and releases emissions at the relevant emission limits values (ELVs) continuously.

The EP for the IWMF does not take into account the requirements of the Waste Incineration Best Available Techniques (BAT) Reference Document (the WI BREF). However, this will need to be accounted for before the CHP Plant is brought into operation. Therefore, for the purpose of this assessment, the ELVs applied to the CHP Plant are those which would be relevant for an “existing plant” within the WI BREF or those in the existing EP, whichever is more stringent. The ELVs for all other items of plant are those within the existing EP.

The model has been used to predict the ground level concentration of pollutants on a long-term and short-term basis across a grid of points. In addition, concentrations have been predicted at the identified sensitive receptors.

Approach and Assessment of Impact on Air Quality – Protection of Human Health

The air quality impact on human health has been assessed using a standard approach based on guidance provided by the EA. Using this approach, in relation to the Air Quality Assessment Levels (AQALs) set for the protection of human health the following can be concluded from the assessment.

1. The greatest impact on local air quality would occur if only the CHP Plant was operational and only the building constructed to allow for the CHP Plant.
2. There would generally be a lower impact with the full IWMF operating compared to the CHP Plant due to increased dispersion as a result of combining the emissions from the Pulp Plant, AD gas engines and biofilter.
3. Although the impact on local air quality would be greater with the phased approach emissions will not cause a breach of any AQAL and the total impact can be described as ‘not significant’.
4. There is no risk of exceeding an AQAL for any metal either on a long or short term basis.

Approach and Assessment of Impact on Air Quality – Protection of Ecosystems

The impact of air quality on ecology has been assessed using a standard approach based on guidance provided by the EA. Using this approach the following can be concluded from the assessment.

1. No European or UK designated receptors have been identified as requiring assessment, only six local wildlife sites.
2. At all local ecological sites, the contribution from the IWMF either when fully operational, or with a partial build out, can be screened out ‘insignificant’ as it is less than the Critical Levels and Critical Loads.

Abnormal Operations

The predicted impact on air quality associated with the identified plausible abnormal emissions from the CHP Plant. This has shown that periods of abnormal operation of the CHP Plant as permissible under the IED (Article 46) are not predicted to give rise to an unacceptable impact on air quality or the environment.

Summary and conclusions

In summary, the assessment has shown that whilst the development of only the CHP Plant would result in a slightly greater impact on local air quality the impact would not be significant. As such there should be no air quality constraint in granting a variation to the existing EP for the phased approach to the IWMF as proposed.

Contents

1 Introduction

1.1 Background

Fichtner Consulting Engineers Ltd ("Fichtner") has been engaged by Indaver to undertake a Dispersion Modelling Assessment to support the application for a variation to the Environmental Permit (EP) for the Rivenhall Integrated Waste Management Facility (IWMF). The IWMF includes a Combined Heat and Power (CHP) Plant (herein referred to as the CHP Plant) which comprises two waste incineration lines.

Full details of the proposed changes being applied for can be found in the Supporting Information document.

This assessment has considered the following scenarios:

- Permitted Facility – all sources within the IWMF operating as per the conditions of the existing EP and with the full build out of the buildings as proposed in the existing EP;
- CHP Plant only with the full build out of the buildings as proposed in the existing EP; and
- CHP Plant only with only the buildings associated with the delivery of the CHP Plant (i.e. the Phase 1 works).

The existing EP for the IWMF (EPR/FP3335YU) does not take into account the requirements of the Waste Incineration Best Available Techniques (BAT) Reference Document (the WI BREF). However, this will need to be accounted for before the CHP Plant is brought into operation. As such for the purpose of this assessment the emission limit values (ELVs) applied to the CHP Plant are those which would be relevant for an "existing plant" within the WI BREF or those in the existing EP, whichever is more stringent. For all other items of plant the ELVs from the existing EP have been applied.

When considering the impact on human health, the predicted atmospheric concentrations have been compared to the Air Quality Assessment Levels (AQALs) for the protection of human health.

When considering the impact on ecosystems the predicted atmospheric concentrations have been compared to the Critical Levels for the protection of ecosystems. In addition, deposition of emissions over a prolonged period can have nutrification and acidification impacts. An assessment of the long-term deposition of pollutants has been undertaken and the results compared to the habitat specific Critical Loads.

This assessment also includes consideration of the impact of emissions during abnormal operations of the CHP Plant as defined within the Industrial Emissions Directive (IED) (Directive 2010/75/EU) for the combustion of waste.

1.2 Structure of the report

This report has the following structure.

- National and international air quality legislation and guidance are considered in section 2.
- The residential properties and ecological receptors which are sensitive to changes in air quality associated with the IWMF and identified in section 3.
- The background levels of ambient air quality are described in section 4.
- The inputs used for the dispersion model are contained in section 5.
- Details of the sensitivity analysis carried out is presented in section 6.
- A discussion of the validity of the model and uncertainty is presented in section 7.
- The assessment methodology and results of the assessment of the impact of emissions on human health is presented in section 8.
- The assessment methodology and results of the assessment of the impact of emissions at ecological sites is presented in section 9.
- An overview of potential effect on the abnormal operations as defined within the IED are set out in section 10.
- The conclusions of the assessment are set out in section 11.
- The Appendices include illustrative figures and detailed results tables.

2 Legislation Framework and Policy

2.1 Air quality assessment levels

In the UK, Ambient Air Directive (AAD) Limit Values, Targets, and air quality standards and objectives for major pollutants are described in The Air Quality Strategy (AQS). In addition, the Environment Agency (EA) include Environmental Assessment Levels (EALs) for other pollutants in the environmental management guidance 'Air Emissions Risk Assessment for your Environmental Permit'[1] ("Air Emissions Guidance"), which are also considered. The long-term and short-term EALs from these documents have been used when the AQS does not contain relevant objectives. Standards and objectives for the protection of sensitive ecosystems and habitats are also contained within the Air Emissions Guidance and the Air Pollution Information System (APIS).

AAD Target and Limit Values, AQS Objectives, and EALs are set at levels well below those at which significant adverse health effects have been observed in the general population and in particularly sensitive groups. For the remainder of this report these are collectively referred to as AQALs. Table 1 to Table 3 summarise the air quality objectives and guidelines used in this assessment.

Table 1: Air Quality Assessment Levels (AQALs)

Pollutant	AQAL ($\mu g/m^3$)	Averaging Period	Frequency of Exceedances	Source
Nitrogen dioxide (NO_2)	200	1 hour	18 times per year (99.79th percentile)	AAD Limit Value
	40	Annual	-	AAD Limit Value
Sulphur dioxide (SO_2)	266	15 minutes	35 times per year (99.9th percentile)	AQS Objective
	350	1 hour	24 times per year (99.73rd percentile)	AAD Limit Value
	125	24 hours	3 times per year (99.18th percentile)	AAD Limit Value
Particulate matter (PM_{10})	50	24 hours	35 times per year (90.41st percentile)	AQS Objective
	40	Annual	-	AQS Objective
Particulate matter ($PM_{2.5}$)	20	Annual	-	AAD Limit Value
	10	Annual	-	Environmental Targets (fine particulate matter)

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

Pollutant	AQAL (µg/m³)	Averaging Period	Frequency of Exceedances	Source
				(England) regulations 2023
Carbon monoxide (CO)	10,000	8 hours, running	-	AAD Limit Value
	30,000	1 hour	-	Air Emissions Guidance
Hydrogen chloride (HCl)	750	1 hour		Air Emissions Guidance
Hydrogen fluoride (HF)	160	1 hour	-	Air Emissions Guidance
	16	Monthly	-	Air Emissions Guidance
Ammonia (NH_3)	2,500	1 hour	-	Air Emissions Guidance
	180	Annual	-	Air Emissions Guidance
Benzene (C_6H_6)	5	Annual	-	Air Emissions Guidance
	30	24 hours	-	Air Emissions Guidance
Polychlorinated biphenyls (PCBs)	6	1-hour	-	Air Emissions Guidance
	0.2	Annual	-	Air Emissions Guidance
Polycyclic Aromatic Hydrocarbons (PAHs)	0.00025	Annual	-	AQS Objective

Table 2: Air Quality Assessment Levels for Metals

Metal	AAD Limit / Target (ng/m³) (annual mean)	EALs (ng/m³) – EA 2023		
		Annual mean	24-hour mean	1-hour mean
Arsenic (As)	6	6	-	-
Antimony (Sb)	-	5,000	-	150,000
Cadmium (Cd)	5	-	30	-
Chromium (II & III) (Cr)	-	-	2,000	-
Chromium (VI) (Cr (VI))	-	0.25	-	-
Cobalt (Co)	-	-	-	-
Copper (Cu)	-	-	50	-

Metal	AAD Limit / Target (ng/m³) (annual mean)	EALs (ng/m³) – EA 2023		
		Annual mean	24-hour mean	1-hour mean
Lead (Pb)	500 (250 AQS Target)	-		-
Manganese (Mn)	-	150	-	1,500,000
Mercury (Hg)	-	-	60	600
Nickel (Ni)	20	-	-	700
Thallium (Tl)	-	-		-
Vanadium (V)	-	-	1,000	-

Table 3: Critical Levels for the Protection of Vegetation and Ecosystems

Pollutant	Concentration (µg/m³)	Measured as	Source
Nitrogen oxides (NOx, as NO_2)	75/200*	Daily mean	APIS
	30	Annual mean	AAD Critical Level
Sulphur dioxide (SO_2)	10	Annual mean where lichens and bryophytes are an important part of the ecosystem's integrity	Air Emissions Guidance / APIS
	20	Annual mean for all higher plants	AAD Critical Level
Hydrogen fluoride (HF)	5	Daily mean	Air Emissions Guidance / APIS
	0.5	Weekly mean	Air Emissions Guidance / APIS
Ammonia (NH_3)	1	where lichens and bryophytes are an important part of the ecosystem's integrity	APIS
	3	Annual mean for all higher plants	APIS

Notes:

**only for detailed assessments where the ozone is below the AOT40 Critical Level and sulphur dioxide is below the lower Critical Level of 10 µg/m³.*

The *AOT40 for ozone is 3,000 ppb.h (6,000 µg/m³.h) calculated from accumulated hourly ozone concentrations – AOT40 means the sum of the difference between each hourly daytime (08:00 to 20:00 Central European Time, CET) ozone concentration greater than 80 µg/m³ (40 ppb) and 80 µg/m³, for the period between 01 May and 31 July.*

In addition to the Critical Levels set out in Table 3, APIS provides habitat specific Critical Loads for nitrogen and acid deposition. Full details of the habitat specific Critical Loads can be found in Appendix B.

There are no AQALs for dioxins or dioxin-like PCBs. As there are other intake pathways besides inhalation for these substances, a separate assessment has been undertaken in which the total intake via inhalation and ingestion has been compared to the Tolerable Daily Intake (TDI). This assessment is presented in the Dioxin Pathway Intake Assessment submitted with this application.

2.2 Areas of relevant exposure

The AQALs apply only at areas of exposure relevant to the assessment level. The following table extracted from Local Authority Air Quality Technical Guidance (2022) (LAQM.TG(22)) explains where the AQALs apply.

Table 4: Guidance on Where AQALs Apply

Averaging period	AQALs should apply at:	AQALs should generally not apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
24-hour mean and 8-hour mean	All locations where the annual mean AQAL would apply, together with hotels and gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
1-hour mean	All locations where the annual mean and 24 and 8-hour mean AQALs apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might	Kerbside sites where the public would not be expected to have regular access.

Averaging period	AQALs should apply at:	AQALs should generally not apply at:
	reasonably be expected to spend one hour or longer.	
15-minute mean	All locations where members of the public might reasonably be exposed for a period of 15-minutes or longer.	

Source: Box 1.1 LAQM.TG(22)

2.3 Industrial pollution regulation

Atmospheric emissions from industrial processes are controlled in England through the Environmental Permitting Regulations (2016) (and subsequent amendments). The IWMF currently has an EP to operate. The EP includes conditions to ensure that the environmental impact of the operations is minimised. This includes conditions to prevent fugitive emissions of dust and odour beyond the boundary of the permitted activity, and limits on emissions to air.

The Industrial Emissions Directive (IED) (Directive 2010/75/EU), was adopted on 07 January 2013, and is the key European Directive which covers almost all regulation of industrial processes in the European Union (EU). Within the IED, the requirements of the relevant sector BREF (Best Available Techniques Reference documents) become binding as BAT (Best Available Techniques) guidance, as follows.

- Article 15, paragraph 2, of the IED requires that ELVs are based on best available techniques, referred to as BAT.
- Article 13 of the IED, requires that 'the Commission' develops BAT guidance documents (referred to as BREFs).
- Article 21, paragraph 3, of the IED, requires that when updated BAT conclusions are published, the Competent Authority (in England this is the EA) has up to four years to revise permits for facilities covered by that activity to comply with the requirements of the sector specific BREF.

The EA explain that ‘BAT’ means the available techniques which are the best for preventing or minimising emissions and impacts on the environment where ‘techniques’ include both the technology used and the way the installation is designed, built, maintained, operated and decommissioned.

The Waste Incineration BREF was published by the European Integrated Pollution Prevention and Control (IPPC) Bureau in December 2019, with the UK Regulators publishing the BREF Implementation Plan in September 2021. The existing EP will need to be varied to comply with the requirements of the Waste Incineration BREF prior to the CHP Plant being brought into operation. As such, for the purpose of this assessment, the emission limit values (ELVs) applied to the CHP Plant are those which would be relevant for an “existing plant” within the WI BREF or those in the existing EP, whichever is more stringent. For all other waste treatment activities the ELVs from the existing EP have been applied.

2.4 Local air quality management

In accordance with Section 82 of the Environment Act (1995) (Part IV), local authorities are required to periodically review and assess air quality within their area of jurisdiction, under the system of Local Air Quality Management (LAQM). This review and assessment of air quality involves assessing present and likely future ambient pollutant concentrations against AQALs. If it is predicted that levels at the façade of buildings where members of the public are regularly present (normally residential properties) are likely to be exceeded, then the local authority is required to declare an Air Quality Management Area (AQMA). For each AQMA, the local authority is required to produce an Air Quality Action Plan (AQAP), the objective of which is to reduce pollutant levels in pursuit of the relevant AQALs.

3 Sensitive Receptors

3.1 Human sensitive receptors

The general approach to the assessment is to evaluate the highest predicted process contribution to ground level concentrations. In addition, the predicted process contribution at a number of sensitive receptors has been evaluated. These sensitive receptors are displayed in Figure 4 of Appendix A and listed in Table 5.

These receptors are a representative sample of the residential properties, schools, hospitals, care homes (typically within 2 km of the IWMF) within the modelling domain. It is not possible to include every occupied area and as such the assessment also considers the point of maximum impact and by interpretation of plot files. These are the receptors used in the previous EP applications for the IWMF.

Table 5: Sensitive Receptors

ID	Receptor name	Location		Distance from the stack (km)
		X (m)	Y (m)	
D1	Sheepcotes Farm (Hanger No. 1)	581564.6	220328.3	0.9
D2	Wayfarers Site	582557.4	220185.4	0.3
D3	Allshot's Farm (Scrap Yard)	582892.6	220458.3	0.5
D4	Haywards	583235.7	221162.6	1.1
D5	Herons Farm	582443.0	221378.3	1.0
D6	Gosling Farm	581426.9	221380.9	1.4
D7	Curd Hall Farm	583261.7	221708.3	1.5
D8	Church (adjacent to Bradwell Hall)	581832.3	222157.9	1.8
D9	Bradwell Hall	581837.5	222319.1	2.0
D10	Rolphs Farmhouse	580675.8	220512.8	1.8
D11	Silver End / Bower Hall / Fossill Hall	581286.5	219730.6	1.3
D12	Rivenhall Pl/ Hall	581860.9	219104.3	1.4
D13	Parkgate Farm / Watchpall Cottages	582336.5	219195.2	1.2
D14	Ford Farm / Rivenhall Cottage	582697.7	218597.5	1.8
D15	Porter's Farm	583391.6	219242.0	1.5
D16	Unknown Building	583131.7	219462.9	1.2
D17	Bumby Hall / The Lodge / Polish Site (light industry)	582947.2	220115.2	0.6
D18	Footpath 8, Receptor 1 (East of Site)	582660.7	220977.1	0.6
D19	Footpath 8, Receptor 2 (East of Site)	582597.0	220688.5	0.3
D20	Footpath 8, Receptor 3 (East of Site)	582609.1	220564.0	0.2
D21	Footpath 8, Receptor 4 (East of Site)	582627.3	220497.2	0.2
D22	Footpath 8, Receptor 5 (East of Site)	582590.9	220415.2	0.1
D23	Footpath 8, Receptor 6 (East of Site)	582761.0	220217.8	0.4

ID	Receptor name	Location		Distance from the stack (km)
		X (m)	Y (m)	
D24	Footpath 8, Receptor 7 (East of Site)	583016.1	220026.5	0.7
D25	Footpath 35, Receptor 1 (North of Site)	582861.2	220843.4	0.6
D26	Footpath 35, Receptor 2 (North of Site)	582454.2	221013.5	0.6
D27	Footpath 35, Receptor 3 (North of Site)	582032.1	221162.3	0.8
D28	Footpath 31, Receptor 1 (North-west of Site)	581877.2	220958.8	0.8
D29	Footpath 31, Receptor 2 (North-west of Site)	581740.6	220764.5	0.8
D30	Footpath 31, Receptor 3 (North-west of Site)	581379.2	220548.8	1.1
D31	Footpath 7, Receptor 1 (South-east of Site)	582505.9	220117.6	0.3
D32	Footpath 7, Receptor 2 (South-east of Site)	582757.9	220066.0	0.5
D33	Footpath 7, Receptor 3 (South-east of Site)	582967.5	219959.7	0.7
D34	Footpath 7, Receptor 4 (South-east of Site)	583167.9	220372.7	0.7
D35	Footpath 7, Receptor 5 (South-east of Site)	583301.5	220725.0	0.9
D36	Elephant House (Street Sweeping)	582368.7	220189.0	0.2
D37	Green Pastures Bungalow	581249.9	221176.1	1.4
D38	Deeks Cottage	582873.4	221255.1	0.9
D39	Woodhouse Farm	582583.9	220617.9	0.2
D40	Gosling Cottage / Barn	581508.4	221305.5	1.3
D41	Felix Hall / The Close House / Park Farm	584578.8	219574.9	2.3
D42	Glazenwood House	579980.5	222134.8	3.0
D43	Bradwell Hall	580570.6	222802.9	3.0
D44	Perry Green Farm	580899.7	221973.3	2.2
D45	The Granary / Porter Farm / Rook Hall	584106.2	218964.5	2.2
D46	Grange Farm	584888.0	222222.0	3.0
D47	Coggeshall	585070.0	222839.0	3.6

3.2 Ecological sensitive receptors

A study was undertaken to identify the following sites of ecological importance in accordance with the EA's Air Emissions Guidance criteria:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), or Ramsar sites within 10 km of the IWMF; and
- Sites of Special Scientific Interest (SSSIs) within 2 km of the IWMF; and
- National Nature Reserves (NNR), Local Nature Reserves (LNRs), Local Wildlife Sites and ancient woodlands within 2 km of the IWMF.

The sensitive ecological receptors identified are presented by distance from main stack in Table 6 and are displayed in Figure 5 of Appendix A. In lieu of any citations for the site as a worst-case it has been assumed that the Critical Level for lichens and bryophytes applies at each site.

Table 6: Sensitive Ecological Receptors

ID	Name	Location		Distance from stack at closest point (km)
		X (m)	Y (m)	
European designated sites within 10 km				
	None identified			
UK designated sites (SSSIs) within 2 km				
	None identified			
Local sites				
E1	Blackwater Plantation	582771	222096	1.7
E2	Maxey's Spring	582665	219976	0.5
E3	Storey's Wood	581817	220983	0.8
E4	Upney Wood	583407	220241	1.0
E5	Link's Wood	580439	221089	2.1
E6	Park House Meadow	481075	222308	2.3

Reference should be made to Appendix B for full details of the habitats present at each site and the habitat-specific Critical Loads.

4 Baseline Air Quality

The IWMF is located within the Rivenhall Quarry, in rural Essex approximately 1.3 km to the north-east of Silver End and 2.8 km from Coggeshall. It is located within Braintree District Council. The location of the IWMF is shown in Figure 3 of Appendix A.

Within this section a review of the existing air quality has been carried out with reference to local monitoring data. Where local monitoring data is not available reference has been made to national datasets from a similar setting.

4.1 Air quality management areas

The closest AQMA to the IWMF is located in Chelmsford approximately 15 km to the south-west of the IWMF. Due to the distance to the AQMA, it is not likely that emissions from the IWMF would have any discernible impact on any designated AQMA and this has not been considered further in this assessment.

4.2 AURN and LAQM monitoring data

The UK Automatic Urban and Rural Network (AURN) is a country-wide network of air quality monitoring stations operated on behalf of the Defra. This includes automatic monitoring of oxides of nitrogen, nitrogen dioxide, sulphur dioxide, ozone, carbon monoxide and particulates. No AURN sites have been identified within 20 km of the IWMF.

In addition to the national AURN, local authorities undertake monitoring of a range of pollutants as part of the LAQM review process. A review of the monitoring undertaken by Braintree District Council has shown that they do not operate any continuous analysers, but they do monitor nitrogen dioxide using diffusion tubes. A summary of the diffusion tube monitoring within 6 km of the IWMF is presented in Table 7. The diffusion tube monitoring locations are displayed on Figure 6 within Appendix A.

Table 7: Braintree District Council Monitoring Sites within 6 km of IWMF

Site	Location		Site type	Distance (km) and bearing from IWMF
	X (m)	Y (m)		
BR12	580625	223115	Roadside	3.3 – NW
BR11	586386	219106	Roadside	4.2 – SE
BR3	583859	216497	Roadside	4.2 – S
BR9	583891	216467	Roadside	4.2 - S
BR7	577680	221964	Roadside	5.0 – NW
BR4	577800	222500	Background	5.1 – NW
BR5	582002	215111	Roadside	5.3 – S
BR22	582033	215081	Roadside	5.4 – S
BR23	582143	214630	Roadside	5.8 – S

Table 8: LAQM Diffusion Tube Monitoring – Nitrogen Dioxide

Site	Annual mean concentration (µg/m³)					
	Mapped Bg 2018	2018	2019	2020	2021	2022
BR12	9.8	25.9	27.3	20.9	22.0	22.0
BR11	10.6	23.1	22.1	17.2	18.0	19.9
BR3	14.0	46.1	45.8	37.2	33.8	33.6
BR9	14.0	40.7	35.4	26.6	27.9	33.6
BR7	11.8	29.2	27.8	21.5	19.5	24.7
BR4	11.6	16.2	16.6	12.7	13.3	13.3
BR5	15.6	40.4	39.1	32.3	30.9	33.2
BR22	15.6	-	-	44.1	18.9	20.6
BR23	19.5	-	-	28.2	24.1	-

Notes:

Data has not been published from 2023 at the time of writing this assessment. Data from 2018 to 2021 as presented in the 2022 Annual Status Report and 2022 from the Essex Air website.

Source: Braintree District Council LAQM Annual Status Report 2022 and Essex Air Website (2022 only)

As shown, the mapped background is broadly similar to the monitored nitrogen dioxide at the background site (BR4), but the concentration monitored at roadside sites is significantly higher. This is expected given the roadside setting of the diffusion tubes.

4.3 National modelling – mapped background data

In order to assist local authorities with their responsibilities under LAQM, the Department for Environment Food and Rural Affairs (Defra) provides modelled background concentrations of pollutants throughout the UK on a 1 km by 1 km grid. This model is based on known pollution sources and background measurements and is used by local authorities in lieu of suitable monitoring data. In addition, mapped atmospheric concentrations of ammonia are available from APIS. Concentrations will vary over the modelling domain area. Therefore, the maximum mapped background concentration data within 3 km of the IWMF have been downloaded along with the concentrations for the grid squares containing the IWMF. A summary is presented in Table 9.

Table 9: Mapped Background Data

Pollutant	Annual mean concentration (µg/m³)		Dataset
	At IWMF	Max within 3 km of IWMF	
Nitrogen dioxide	8.5	14.8	Defra 2018
Sulphur dioxide	3.5	3.8	Defra 2001
Particulate matter (as PM_{10})	16.7	18.0	Defra 2018
Particulate matter (as $PM_{2.5}$)	9.9	10.9	Defra 2018
Carbon monoxide	254.0	277.0	Defra 2001
Benzene	0.3	0.4	Defra 2001

Pollutant	Annual mean concentration (µg/m³)		Dataset
	At IWMF	Max within 3 km of IWMF	
Ammonia	1.7	1.8	APIS mid-year 3 year average 2019 to 2021
Note: *Concentrations of sulphur dioxide, carbon monoxide and benzene are only available in the 2001 Defra datasets.*			

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4.4 Other national monitoring networks data

Neither the Defra mapped background dataset, AURN, or LAQM include monitoring of other pollutants released from the IWMF such as hydrogen chloride, hydrogen fluoride, or VOCs. As such reference has been made to national modelling to determine a suitable baseline concentration for these pollutants.

4.4.1 Hydrogen chloride

Hydrogen chloride was measured until the end of 2015 on behalf of Defra as part of the UK Eutrophying and Acidifying Atmospheric Pollutants (UKEAP) project. This consolidates the previous Acid Deposition Monitoring Network (ADMN), and National Ammonia Monitoring Network (NAMN). Monitoring of hydrogen chloride ceased at the end of 2015 and none of the historic sites were located within 10 km of the IWMF. Prior to the cessation of the monitoring concentrations were fairly constant.

The maximum annual average monitored within the UK between 2011 and 2015 was 0.71 µg/m³. In lieu of any recent representative monitoring this has been used as the baseline concentration for this assessment as a conservative estimate.

4.4.2 Hydrogen fluoride

Baseline concentrations of hydrogen fluoride are not monitored locally or nationally, as this is not generally a pollutant of concern in terms of local air quality. However, the EPAQS report 'Guidelines for halogens and hydrogen halides in ambient air for protecting human health against acute irritancy effects' contains some estimates of baseline levels, reporting that measured concentrations have been in the range of 0.036 µg/m³ to 2.35 µg/m³.

In lieu of any local monitoring, the maximum measured baseline hydrogen fluoride concentration has been used as the baseline concentration for the purpose of this assessment as a conservative estimate.

4.4.3 Ammonia

Ammonia is also measured as part of the UKEAP project at rural background locations. There are no UKEAP monitoring locations within 10 km of the IWMF. The nearest monitoring site is at Bedingfield, 59 km to the north-east. In lieu of any local UKEAP monitoring, the maximum mapped background value from APIS within 3 km from the IWMF has been used for the purpose of this assessment (1.8 µg/m³) when considering the impact with reference to the AQALs for the protection of human health, and the maximum baseline concentration across each ecological site from APIS has been used when evaluating the impact at ecological receptors if needed.

4.4.4 Volatile Organic Compounds

As part of the Automatic and Non-Automatic Hydrocarbon Network, benzene concentrations are measured at sites co-located with the AURN across the UK. The closest monitoring site to the IWMF is Cambridge Roadside, a non-automatic monitoring site 53 km to the north-west. The measured concentration of benzene is broadly similar to the mapped background dataset. As such the maximum mapped background concentration within the 3 km of the IWMF has been used. This value is 0.4 µg/m^3.

4.4.5 Metals

In addition to the local monitoring, metals are measured as part of the Rural Metals and UK Urban/Industrial Networks (previously the Lead, Multi-Element and Industrial Metals Networks). The closest site is located in London at Chadwell St Mary. In lieu of any local monitoring, a review of monitoring from all rural sites across the UK has been carried out. This data is presented in Table 10.

Table 10: Annual Mean Metals Concentrations – Average at Rural Backgrounds Sites

Substance	Annual mean concentration (ng/m^3)						Max (as % of AQAL)
	AQAL	2019	2020	2021	2022	2022	
Cadmium	5	0.08	0.08	0.07	0.06	0.05	1.5%
Mercury	-	-	-	-	-		-
Antimony	5,000	-	-	-	-		-
Arsenic	6	0.48	0.48	0.46	0.42	0.38	8.0%
Chromium	-	0.88	0.50	0.45	0.47	0.55	-
Cobalt	-	0.04	0.03	0.03	0.04	0.03	-
Copper	-	2.03	1.60	1.57	1.71	1.43	-
Lead	250	2.83	2.39	2.38	2.22	1.82	1.1%
Manganese	150	2.14	2.06	2.08	2.29	1.79	1.5%
Nickel	20	0.44	0.33	0.38	0.47	0.31	2.3%
Vanadium	-	0.62	0.56	0.69	0.64	-	-

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In addition to the suite of metals monitored at rural background monitoring sites there would be releases of thallium, mercury and antimony from the CHP Plant within the IWMF. With reference to these pollutants:

- Thallium is not routinely monitored as part of the metals network. This assessment has considered the total impact of cadmium and thallium and has used the cadmium baseline concentration and AQAL.
- Monitoring of mercury ceased in August 2018 and from 2016 this was only carried out at two sites across the UK - London Westminster, which is an urban background site), and Runcorn

Weston Point, which is an urban industrial site. The maximum monitored concentration between 2015 and 2018 at the urban background site was 2.8 µg/m^3, and at the urban industrial site was 19 µg/m^3. In lieu of any monitoring from a rural site the concentration from the urban background site has been used. The urban industrial site is highly influenced by local industrial sources and is not representative of conditions close to the IWMF.

- Monitoring of antimony across the UK ceased at the end of 2013. The maximum monitored at any background site in 2013 was 1.30 ng/m³ at Detling. This assessment has used this value as the baseline concentration.

4.4.6 Dioxins, furans and polychlorinated biphenyl (PCBs)

Dioxins, furans and PBCs are monitored on a quarterly basis at a number of urban and rural stations in the UK as part of the Toxic Organic Micro Pollutants (TOMPs) network. There are no national monitoring locations within 10 km of the IWMF. The closest site is located in London.

A summary of dioxin and furan and PCB concentrations from all monitoring sites across the UK is presented in Table 11 and Table 12. Note that monitoring data for dioxins and furans is only available up to the end of 2016 from the UK-Air website. For PCBs, data is only available up to the end of 2018 from the UK-Air website.

Table 11: Dioxin and Furans Monitoring

Site	Annual mean concentration (fgTEQ/m³)				
	2012	2013	2014	2015	2016
Auchencorth Moss	0.13	0.86	0.01	0.01	0.13
Hazelrigg	8.75	2.02	2.61	5.27	4.59
High Muffles	4.32	0.6	1.07	0.54	2.73
London Nobel House	15.42	3.47	2.89	4.34	21.27
Manchester Law Courts	32.99	10.19	16.52	5.94	12.23
Weybourne	9.3	2.34	1.61	1.42	16.32

Source: © Crown 2024 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

Table 12: PCB Monitoring

Site	Annual mean concentration (pg/m³)				
	2014	2015	2016	2017	2018
Auchencorth Moss	23.23	24.27	25.32	19.09	12.31
Hazelrigg	25.84	41.68	52.58	33.15	22.22
High Muffles	26.11	33.43	37.76	31.63	8.86
London Nobel House	107.49	121.39	110.46	121.87	46.63
Manchester Law Courts	128.93	97.99	92.6	97.27	40.10
Weybourne	17.00	20.95	38.61	32.26	11.23

Source: © Crown 2024 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

This analysis shows that the concentrations vary significantly between sites and years. The maximum monitored concentration from the past 5 years of available monitoring data has been used as the baseline concentration within this assessment. These values are 32.99 fg/TEQ/m³ for dioxins and furans and 128.93 pg/m³ for PCBs.

4.4.7 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic Aromatic Hydrocarbons (PAHs) are monitored at a number of stations in the UK as part of the PAH network. For the purpose of this assessment, benzo(a)pyrene is considered as this is the only PAH which an AQAL has been set. The closest monitoring station to the IWMF is in London. In lieu of any local monitoring a review of monitoring from all rural sites across the UK has been carried out. This data is presented in Table 13.

Table 13: Benzo(a)pyrene

Site	AQAL (ng/m³)	Annual mean concentration (ng/m³)				
		2019	2020	2021	2022	2023
Min	0.25	0.01	0.01	0.02	0.02	0.01
Max		0.30	0.26	0.39	0.11	0.10
Average		0.09	0.08	0.11	0.06	0.04

Source: © Crown 2024 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

As shown, the average concentrations monitored are well within the AQAL, however, the maximum at any rural background site exceeds the AQAL. This is a single site at Ruarden. For the purpose of this assessment the maximum annual average concentration across all rural sites has been used (0.11 ng/m³).

4.5 Summary of baseline concentration used in assessment

In summary, there is limited local monitoring of pollutant which would be released from the IWMF. However, the IWMF is located in a rural area with no significant sources of any of these emissions, so concentrations are likely to be low and similar to background levels. A review of mapped background datasets and national monitoring has been carried out to determine suitable baseline concentrations for the purpose of this assessment. In the first instance it will be assumed that baseline concentrations are as per those set out in the following table. These are based on a mixture of monitoring at modelled data sets. Where the contribution from the IWMF cannot be screened out as 'insignificant' (see Section 8.1 for methodology), the choice of baseline concentration will be given additional consideration taking into account any local monitoring and the contribution from the other sources of emissions such as road vehicles.

Table 14: Summary of Baseline Concentrations

Pollutant	Annual mean concentration	Units	Justification
Nitrogen dioxide	14.8	µg/m³	Maximum mapped background concentration within 3 km of the Site (2018 Defra dataset)

Pollutant	Annual mean concentration	Units	Justification
Sulphur dioxide	3.8	µg/m³	Maximum mapped background concentration within 3 km of the site (2001 Defra dataset)
Particulate matter (as PM_{10})	18.0	µg/m³	Maximum mapped background concentration within 3 km of the site (2018 Defra dataset)
Particulate matter (as $PM_{2.5}$)	10.9	µg/m³	Maximum mapped background concentration within 3 km of the site (2018 Defra dataset)
Carbon monoxide	227	µg/m³	Maximum mapped background concentration within 3 km of the site (2001 Defra dataset)
Hydrogen chloride	0.71	µg/m³	Maximum monitored concentration across the UK 2011 to 2015
Hydrogen fluoride	2.35	µg/m³	Maximum measured concentration from EPAQS report
Ammonia	1.8	µg/m³	Maximum mapped background concentration from APIS 2019 to 2021 3-year average within 3 km of the site
Benzene	0.4	µg/m³	Maximum mapped background concentration within 3 km of the site (2001 Defra dataset)
Mercury	2.8	ng/m³	Maximum monitored annual mean concentration from an urban background site from 2015-2018
Cadmium	0.48	ng/m³	Average UK monitored concentration across the UK between 2019 and 2023 from a rural background site, chromium VI assumed to be 20% of total chromium in line with EA guidance
Arsenic	0.48	ng/m³	
Cobalt	0.04	ng/m³	
Copper	2.03	ng/m³	
Chromium	0.88	ng/m³	
Chromium VI	0.18	ng/m³	
Lead	2.83	ng/m³	
Manganese	2.29	ng/m³	
Nickel	0.47	ng/m³	
Vanadium	0.69	ng/m³	
Antimony	1.3	ng/m³	Detling 2013
Dioxins and furans	32.99	fg/m³	Maximum UK monitored concentration between 2012 and 2016
Polychlorinated biphenyl (PCBs)	128.93	pg/m³	Maximum UK monitored concentration between 2014 and 2018

Pollutant	Annual mean concentration	Units	Justification
Benzo(a)pyrene (PAHs)	0.11	ng/m³	Maximum average monitored concentration across all rural background sites 2019 to 2022

4.6 Baseline conditions at ecological sites

The APIS database sets out the baseline concentrations on a grid across the UK. Atmospheric concentrations of oxides of nitrogen, ammonia, acid and nitrogen deposition are provided on a 1 km x 1 km grid. Data is provided for the maximum across the ecological site. This data is the 2019 to 2021 average as presented on APIS.

Table 15: APIS Data for Ecological Sites

ID	Site	Maximum concentration (µg/m³)		
		Oxides of nitrogen	Sulphur dioxide	Ammonia
Annual mean Critical Level		**30**	**10**	**1**
E1	Blackwater Plantation	11.4	0.9	1.7
E2	Maxey's Spring	10.7	0.9	1.6
E3	Storey's Wood	10.6	0.9	1.6
E4	Upney Wood	10.6	0.9	1.7
E5	Link's Wood	10.7	0.9	1.6
E6	Park House Meadow	11.4	0.9	1.7
Notes: *Maximum across each site by extracting from APIS from the map tool.*				

Source: APIS GIS map tool release 29/11/2023

The baseline data presented in APIS shows that maximum concentrations of oxides of nitrogen and sulphur dioxide are below the annual mean Critical Level at all sites. However, baseline concentrations of ammonia exceed the Critical Level for lichens and bryophytes.

Table 16: APIS data for Ecological Sites – Deposition

ID	Site	N deposition (kgN/ha/yr)		Acid deposition (keq/ha/yr	
		Grassland	Woodland	Grassland	Woodland
E1	Blackwater Plantation	15.1	27.4	-	1.96 / 0.15
E2	Maxey's Spring	14.6	26.6	1.04 / 0.13	-
E3	Storey's Wood	15.0	27.1	-	1.92 / 0.15
E4	Upney Wood	14.9	26.9	-	1.92 / 0.15
E5	Link's Wood	15.0	27.1	-	1.93 / 0.15
E6	Park House Meadow	15.1	27.3	1.08 / 0.12	-
NOTE: *Maximum N deposition across each site by extracting from APIS from the map tool.*					

ID	Site	N deposition (kgN/ha/yr)		Acid deposition (keq/ha/yr	
		Grassland	Woodland	Grassland	Woodland
Acid deposition grid not available on APIS map from the map, so this has been determined using the search by location tool.					

Source: APIS GIS map tool release 29/11/2023

The values presented in Table 15 and Table 16 are grid square averaged values provided as a rolling 3-year mean and derived from a mixture of interpolation from measured data, and modelled data as set out in APIS. The APIS website explains that the use of a 3-year mean has been demonstrated to be a suitable time period to smooth out some of the inter-annual variations in deposition which occur due to the natural variability in annual weather patterns.

5 Modelling Methodology

5.1 Selection of model

Detailed dispersion modelling was undertaking using the model ADMS 6, developed and supplied by Cambridge Environmental Research Consultants (CERC) This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the atmospheric stability and the boundary layer height. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. The model also includes modules to take account of the effect of buildings and complex terrain.

ADMS is routinely used for modelling of emissions for environmental permitting purposes to the satisfaction of the EA. An analysis of the variation in model outputs has been undertaken and the maximum predicted concentration for each pollutant and averaging period has been used to determine the significance of any potential impacts.

The IWMF has a single stack in which the flue from each process is ducted to for release to atmosphere. The 'combine multiple flues' function has been used within ADMS to represent this. The details of the stack are provided in Table 17

Table 17: Stack Data

Item	Unit	Combined Stack
Height above surrounding ground level	m	35
Stack location	m, m	582443.88, 220419.68

5.2 Source and emissions data – CHP Plant

The source and emissions input data utilised within the modelling for the CHP Plant are presented in Table 18 to Table 19. These are presented per line and are based on operation at the design nominal case which represents a thermal input of 92 MW per line. These inputs have been used to determine the impact for the CHP Plant.

Table 18: Stack and Flue Gas Conditions – CHP Plant – Per Line

Item	Unit	CHP Plant
Internal diameter (each line)	m	2.0
Number of lines	-	2
Temperature	°C	144
Exit moisture content	% v/v	19.00
Exit oxygen content	% v/v dry	6.05
Reference oxygen content	% v/v dry	11.0
Volume at reference conditions (273.15K, dry, ref O_2)	Nm^3/h	188,265
	Nm^3/s	52.30
Volume at actual conditions	Am^3/h	238,757
	Am^3/s	66.32
Flue gas exit velocity	m/s	21.1

Table 19: Stack Emissions Data – CHP Plant – Per Line

Pollutant	Daily or periodic		Half-hourly	
	ELV (mg/Nm³, unless stated)	Release rate (g/s, unless stated)	ELV (mg/Nm³, unless stated)	Release rate (g/s, unless stated)
Oxides of nitrogen (as NO_2)	100	5.230	200	10.459
Sulphur dioxide	30	1.569	90	4.707
Carbon monoxide(1)	50	2.615	100	5.230
Total dust (PM)(2)	5	0.261	30	1.569
Hydrogen chloride	6	0.314	60	3.138
Volatile organic compounds (as TOC)	10	0.523	20	1.046
Hydrogen fluoride	1	0.052	-	-
Ammonia	10	0.523	-	-
Cadmium and thallium	0.02	1.046 mg/s	-	-
Mercury	0.02	1.046 mg/s	-	-
Other metals(3)	0.3	15.689 mg/s	-	-
Benzo(a)pyrene (PAHs)(4)	0.2 µg/Nm³	10.459 µg/s	-	-
Dioxins and furans	0.6 ng/Nm³	3.138 ng/s	-	-
PCBs(5)	0.05	0.261 mg/s	-	-

Notes:

All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.

(1) Averaging period for carbon monoxide is 95% of all 10-minute averages in any 24-hour period.

(2) As a worst-case it has been assumed that the entire dust emissions consist of either PM_{10} or $PM_{2.5}$ for comparison with the relevant AQALs.

(3) Other metals consist of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V).

(4) 0.2 µg/m³ is the maximum recorded at a UK plant (2019 Waste Incineration BREF, Figure 8.121). This is assumed to be the emission concentration for the CHP Plant.

(5) Table 3.8 of the 2006 Waste Incineration BREF states that the annual average total PCBs is less than 0.005 mg/Nm³ (dry, 11% oxygen, 273K). In lieu of other available operational data, this has been assumed to be the emission concentration for the CHP Plant.

If the CHP Plant continually operated at the half-hourly limits, the daily limits would be exceeded. The CHP Plant is designed to achieve the daily limits and as such will only operate at the short-term ELVs for short periods on rare occasions.

The contractual availability of the CHP Plant is 90.2%, or 7,900 hours per annum. However, as a conservative assumption it has been assumed that the CHP Plant continually operates at the ELVs.

5.3 Source and emissions data – AD gas engines

The AD Facility will include two 450 kWe gas engines. The principal inputs to the model with respect to the emissions to air from the AD gas engines are presented in Table 20. This source has only been modelled when considering the impact of the Permitted Facility and full build out.

Table 20: Stack and Flue Gas Conditions – AD Gas Engines – Per Unit

Item	Unit	AD gas engine
Internal diameter	m	0.3
Units	-	2
Temperature	°C	250
Exit moisture content	% v/v	14.37
Exit oxygen content	% v/v dry	6.00
Reference oxygen content	% v/v dry	5.00
Volume at reference conditions (273.15K, dry, ref O_2)	Nm^3/h	1,531
	Nm^3/s	0.43
Volume at actual conditions	Am^3/h	3,653
	Am^3/s	1.01
Flue gas exit velocity	m/s	14.4

Emissions from the AD gas engines have been assumed to comply with the ELVs in the existing EP as detailed in Table 21.

Table 21: Stack Emissions Data – AD Gas Engine – Per Line

Pollutant	Hourly average	
	ELV (mg/Nm^3, unless stated)	Release rate (g/s, unless stated)
Oxides of nitrogen (as NO2)	500	0.213
Sulphur dioxide	350	0.149
Carbon monoxide	1,400	0.595
Volatile organic compounds (as TOC)	1,000	0.425
Notes: All emissions are expressed at reference conditions of dry gas, 5% oxygen, 273.15K.		

5.4 Source and emissions data – Pulp Plant

The source and emissions input data utilised within the modelling for the Pulp Plant are presented in Table 22. This source has only been modelled when considering the impact of the Permitted Facility and full build out.

Table 22: Stack and Flue Gas Conditions – Pulp Plant

Item	Unit	Pulp Plant
Internal diameter	m	2.2
Temperature	°C	119.98
Exit moisture content	% v/v	1.85%
Exit oxygen content	% v/v dry	20.95%
Volume at actual conditions	Am^3/h	255,642
	Am^3/s	71.01
Flue gas exit velocity	m/s	18.7

The exhaust from the Pulp Plant will not include any combustion gases and as such no emissions have been included in the model. However, this source has been included to ensure the effect of emitting to atmosphere with the other sources is considered.

5.5 Source and emissions data – AD biofilter

The source and emissions input data utilised within the modelling for the AD biofilter are presented in Table 23. Noting that this source has only been modelled when considering the impact of the Permitted Facility and full build out.

Table 23: Stack and Flue Gas Conditions – AD Biofilter

Item	Unit	AD biofilter
Internal diameter	m	2.2
Temperature	°C	30.54
Volume at actual conditions	Am^3/h	61,500
	Am^3/s	17.05
Flue gas exit velocity	m/s	15.1

The air from the AD biofilter will not include any combustion gases and as such no emissions have been included in the model. However, this source has been included to ensure the effect of emitting to atmosphere with the other sources is considered.

5.6 Buildings

The presence of adjacent buildings can significantly affect the dispersion of the atmospheric emissions in various ways:

- Wind blowing around a building distorts the flow and creates zones of turbulence. The increased turbulence can cause greater plume mixing.
- The rise and trajectory of the plume may be depressed slightly by the flow distortion. This downwash leads to higher ground level concentrations closer to the stack than those which would be present without the building.

It is recommended that buildings should be included in the modelling if they are both:

- Within 5L of the stack (where L is the smaller of the building height and maximum projected width of the building); and
- Taller than 40% of the stack.

The ADMS 6 user guide also states that buildings less than one third of the stack height will not have any effect on the dispersion calculations in the model.

Within ADMS a disturbed flow field is parameterised using the buildings module where a recirculating flow region, or cavity, in the lee of the building, and a diminishing turbulent wake downwind are parameterised. Concentrations within the well mixed recirculating region are uniform and based upon the fraction of release that is entrained. The concentration at a point further downwind is the sum of the two contributions: a ground level plume from the recirculating flow region and an elevated plume from the non-entrained remain. The turbulent wake reduces plume height and increases turbulent spread. The greatest effect of the building is experienced when the wind blows along the building to the stack.

A schematic of the building layout is presented in Figure 8 of Appendix A. This shows that the IWMF is situated within an excavated area with the ground level 20 m (AOD) below the surrounding ground level. The top of the stack is 55 m above the base of the excavated area but only 35 m (AOD) above the surrounding ground level. The building has a maximum height of 60 m AOD but only 10.75 m is above the surrounding ground level of 50m AOD.

The dispersion modelling carried out to support the existing EP demonstrated that give the majority of the excavated area would be covered by the building. As such this can be represented by modelling a building with a height of 10.75 m and a stack height of 35 m – i.e. that protruding above the excavated area. In this case the building would be only 31% of height of the stack and the effect of the building would be negligible and this would not be included in the dispersion model calculations.

The proposed phasing of the IWMF would mean that not all of the building would be constructed at the same time. A building with the same height but a much smaller footprint would be constructed to allow for the CHP Plant. In this scenario the building footprint would not fill the excavated area to the same extent. This is shown schematically in Figure 8 of Appendix A. As shown, the full build out building fills much of the excavated area. However, if only the part of the building for the CHP Plant is constructed the building is 146 m shorter than the full build out.

If only part of the building is constructed for winds from the north-west and south-west the effect of the building may be underestimated in the model as the air flow would have time to follow the terrain and the flow be interrupted with a much larger building (the maximum height of 30.75 m). However, on the lee side of the building the size of the recirculating area would limited by the ground level which is raised at this side. The amount of pollutant entrained into this cavity region is a function of where the release of pollutants is in relation to the cavity region. If a building of 30.75 m is used and keeping the stack height at 35 m the cavity region represented in the model would be significantly closer to the release of pollutants than in reality. This would significantly over-estimate the building effects.

The dispersion model with emissions from only the CHP Plant has been run with the following options:

Table 24: Building Options

Scenario	Building height (m)	Stack height (m)	Length (m)	Width (m)
A – Full built out as previously modelled	10.75	35	190	260
B – CHP Plant building only	10.75	35	104	114
C – CHP Plant building 40% of the stack height above the surrounding ground level	14.00	35	104	114
D – CHP Plant building 56% of the stack height above the surrounding ground level	19.57	35	104	114
E – CHP Plant building worst case height	30.75	35	104	114
Notes: *Angle of building set to 40°* *Scenario D building height has been calculated as the ratio between the actual stack 55 m and the building 30.75 m (i.e. 56%), applied to the stack height above surrounding ground level of 35 m.*				

Scenario C has been modelled with a building height of 40% of the stack height. This is the minimum height of the building which would mean that the building effects would be accounted for in the ADMS model.

Scenario D has been modelled with a height of the building at 19.6 m. This height has been calculated by taking the ratio of the actual building height (35.75 m) to the actual stack height (55 m) – i.e. 56%. This is considered to be a conservative assumption as within the ADMS model the release height of pollutants is only 15.43 m above the building, whereas in reality the release height is 24.25 m. Therefore, the concentrations of pollutants within the model entrained into the building wake will be an overestimation of the real impacts, resulting in higher ground level concentrations.

Scenario E has been modelled as a complete worst-case, noting that the release height of pollutants is only 4.25 m above the building modelled. This is not a realistic representation of the building as in reality the stack is 24.25 m above the height of the building, and the building wake on the lee side of the building would not be as large as calculated in the model given that the height of the surrounding ground is raised by 20 m.

The maximum annual mean and 1-hour concentration of oxides of nitrogen across the modelling domain is presented in the Table 25 together with the distance and orientation from the stack that this occurs. In addition, plot files have been produced to show the difference in the distribution of emissions for the options. This analysis is based on 2020 meteorological data from Andrewsfield. This is the year which produced the greatest annual mean impacts. This has also just focussed on emissions from the CHP Plant as the modelling has demonstrated that when the other sources are included the maximum impact is lower given the additional dispersion due to the flue gas from each source combining and acting as a single source.

Table 25: Buildings Analysis

Scenario	Concentration (µg/m³)		
	Annual mean	Maximum 1-hour	99.79%ile 1-hour
A – full build out	2.34	31.56	26.94
B – Building 10.75 m above surrounding ground level	2.34	31.56	26.94
C – Building 40% of stack height	2.44	49.34	36.66
D – Building 56% of stack height	3.29	76.27	71.00
E – Worst-case	9.66	129.45	121.23
	Distance from stack peak impact (m)		
A – full build out	498	302	330
B – Building 10.75 m above surrounding ground level	498	302	330
C – Building 40% of stack height	498	222	276
D – Building 56% of stack height	356	171	171
E – Worst-case	171	136	136
	Bearing from stack peak impact (°)		
A – full build out	60	115	42
B – Building 10.75 m above surrounding ground level	60	115	42
C – Building 40% of stack height	60	95	83
D – Building 56% of stack height	67	79	79
E – Worst-case	79	122	122

The analysis of the peak impact shows that for scenario A and B the predicted impacts are the same. This is expected given that the building height is less than 40% of the stack height and therefore, the model excludes the effects of the building in both scenarios and hence in modelling terms there is no difference between the two scenarios.

Scenario E is significantly overestimating the building wake region as the emissions are released at a height of 35 m which is only 4.25 m above the top of the building wake region. Therefore, significantly more emissions are being entrained into the wake region than would actually occur. In addition, the wake region is significantly overestimated as the wake region is at a height of 30.75 m but the height of the surrounding ground is only 10.75 m below the height of the building.

Scenario D has been included to demonstrate the effect of a reduced building wake effect based on the ratio of the actual building height to actual stack height. Although the height at which pollutants are release compared to the wake region is more realistically estimated in the model, ground level impacts are likely to be overestimated. The wake region is based on a building height of 19.75 m but the surrounding ground level impedes the size of the wake as the building is only 10.75 m above the height of the surrounding ground level.

Scenario C has been included as a way of bringing in the building wake effects into the model by artificially including a building height which would mean it would be included. In this scenario, the pollutants are released 21 m above the height of the wake region, rather than 24.25 m in reality, and the wake region is a height of 14 m which slightly greater than the actual height of 10.75 m above the height of the surrounding ground level.

The annual mean plot files (Figure 9 of Appendix A) show that whilst the peak concentration differs between the scenarios the patter of distribution is similar and away from the point of maximum impact concentrations are similar in all scenarios, especially in the main populated area of Coggeshall.

The maximum 1-hour plot files (Figure 10 of Appendix A) again shows the maximum 1-hour concentration for each grid point using the full year of meteorological data. The peak impact differs between the scenarios but away from the area of the peak impacts the concentration is similar for scenarios B, C and D. The worst-case building scenario has a significantly higher peak 1-hour impact. The meteorological conditions which result in the peak 1-hour impact is when the winds are from the west.

5.6.1 Summary

This analysis has shown that the height of the building above the surrounding ground level is less than 40% of the height of the stack above the surrounding ground level is. At this height the ADMS model excludes the effect of the buildings as they are negligible. This approach is considered appropriate when considering the full build out of the building. However, in the event of a phased build out the building especially when winds are from the north-west the air flow would follow the terrain and the free-flow of air will be disturbed by the building.

Given that the building is within an excavated area and the surrounding ground level (where the areas of relevant exposure are) is 20 m above the base of the excavated area a series of option for representing the building have been considered. Within the ADMS model it is not currently possible to have a different height of the building based on different wind directions. To approximate the building effects it is considered that the most appropriate approach is to artificially increase the height of the building extruding above the excavated area so the building effects are considered in the model. This approach will overestimate the building wake effects given the height of the release of pollutants is lower than reality. This model simulates a greater concentration of pollutants being entrained into the building wake that would in reality. The modelling has shown that whilst there are differences in the maximum predicted impact as a result of how the building is approximated, further away from the area of maximum predicted impact the concentrations are broadly similar. Therefore, for the purpose of this assessment for the full build out of the building a building height of 10.75 m has been used, and for the CHP Plant only scenario a building height of 14 m (i.e. 40% of the stack height) has been used.

Table 26: Building Details

Buildings	Centre point		Height (m)	Width (m)	Length (m)	Angle (°)
	X (m)	Y (m)				
Full build out	582294.00	220473.54	10.75	190	260	40
CHP Plant only	582374.30	220464.96	14.00	104	114	40

5.7 Other inputs

Modelling has been undertaken over a grid of 5.3 km x 5.3 km with grid spacing of 53 m which is less than 1.5 times the stack height, in accordance with LAQM.TG(22) guidance. Reference should be made to Figure 7 of Appendix A for a graphical representation of the modelling domain.

Table 27: Modelling Domain

Parameter	Grid
Grid Spacing (m)	53
Grid Start X	579750
Grid Finish X	585050
Grid Start Y	217750
Grid Finish Y	223050

5.7.1 Meteorological data and surface characteristics

The impact of meteorological data has been taken into account by using meteorological data from the Andrewsfield meteorological recording station for the years 2018 – 2022 sourced from Air Pollution Services (APS) Limited. Andrewsfield is located approximately 14 km to the north-west of the IWMF. The location of the meteorological site is shown on Figure 7 of Appendix A. Wind roses for each year of meteorological data can be found in Figure 11 of Appendix A.

The minimum Monin-Obukhov length utilised in ADMS can be selected for both the dispersion site and meteorological site. This is a measure of the minimum stability of the atmosphere and can be adjusted to account for urban heat island effects which prevent the atmosphere in urban areas from ever becoming completely stable. Surface conditions surrounding the IWMF are generally rural grassland with small areas of residential similar to the Andrewsfield meteorological station. As such, the minimum Monin-Obukhov length has been set to the model default value (1 m) which is appropriate for rural areas.

The surface roughness length utilised in ADMS can additionally be selected for both the dispersion site and meteorological site. The surface roughness length is fairly constant across the modelling domain. Therefore, a value of 0.3 m has been applied which is appropriate for agricultural areas. This value is also considered representative of the land use surrounding the meteorological recording site.

A summary of the meteorological parameters used in the dispersion modelling is shown in Table 28.

Table 28: Meteorological parameters

Parameter	Dispersion Site Value (m)	Met Site Value (m)
Surface roughness length	0.3	0.3
Minimum Monin-Obukhov length	1	1

5.7.2 Terrain

It is recommended that by CERC, where gradients within 500 m of the modelling domain are greater than 1 in 10, the complex terrain module within ADMS (FLOWSTAR) should be used. No areas, other than the immediate quarry area that the IWMF is located within have been identified as having a gradient of greater than 1 in 10, the land is reasonably flat. As such the effects of terrain are minimal and this has not been considered further in this assessment.

5.7.3 Wind turbines

Wind turbines have the potential to affect the dispersion of emissions if the wind is blowing from the stack towards the turbines, or from the turbines to the stack, causing a wake. This can be accounted for within ADMS by using the wind turbines module. However, wind turbine wakes are generally dissipated within 12-15 rotor diameters, with the wind turbine effects becoming more noticeable when the stack is within a few rotor diameters of the turbine.

No wind turbines have been identified which could affect the dispersion of emissions from the stack.

5.8 Plume depletion

Within ADMS when modelling deposition an option is to include plume depletion where the concentration of pollutants in the plume reduce as the pollutants are deposited. This has not been included in the model as a conservative assumption.

5.9 Chemistry

The CHP Plant and AD gas engines will release nitric oxide (NO) and nitrogen dioxide (NO_2) which are collectively referred to as oxides of nitrogen (NOx). In the atmosphere, NO will be converted to NO_2 in a reaction with ozone (O_3) which is influenced by solar radiation. Since the AQALs are expressed in terms of NO_2, it is important to be able to assess the conversion rate of NO to NO_2.

Ground level NOx concentrations have been predicted through dispersion modelling. NO_2 concentrations reported in the results section assume 70% conversion from NOx to NO_2 for annual means and a 35% conversion for short term (hourly) concentrations, based upon the worst-case scenario specified in the EA's guidance for dispersion modelling[2] which is appropriate where the primary NO_2 to NOx ratio is less than 10%. Given the short travel time to the areas of maximum concentrations, this approach is considered conservative.

5.10 Other local point sources of emissions

No other significant point sources of emissions have been identified in the local area.

5.11 Baseline concentrations

Background concentrations for the assessment have been derived from monitoring and national mapping as summarised in Table 14. For short term averaging periods, the baseline concentration has been assumed to be twice the long-term ambient concentration following the EA recommendation within the Air Emission Guidance.

The baseline concentration set out in Table 14 has been used to define the total PEC. However, where the contribution from the IWMF cannot be screened out as insignificant additional consideration has been made of the contribution from other local sources and road sources to determine an appropriate baseline concentration for the specific receptors of concern. This has then been combined with the contribution from the IWMF to determine the PEC.

[2] https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

6 Sensitivity Analysis

The following section details the sensitivity of the model to certain input parameters. This has considered the impact of emissions from the CHP Plant (i.e. Phase 1) assuming continual operation at the ELVs. This is based on the CHP Plant only phase of the building.

6.1 Surface roughness

The sensitivity of the results to using varying surface roughness length has been considered by running the model with a variable surface roughness file and a constant surface roughness value across the modelling domain. For all sensitivity analysis the impact of changing model parameters on the maximum annual mean and short-term concentrations of oxides of nitrogen have been considered.

The following parameters have been kept constant:

- CHP Plant only operating at capacity;
- Stack height – 35 m;
- Buildings – included CHP Plant building only, height 14 m;
- Grid – 5.3 km x 5.3 km;
- Terrain file – excluded;
- Meteorological site surface roughness – 0.3 m;
- Dispersion site Monin-Obukhov length – default for rural areas;
- Meteorological site Monin-Obukhov length – default for rural areas; and
- Meteorological data used – Andrewsfield 2018.

The contribution of oxides of nitrogen emissions from the CHP Plant at the point of maximum ground level impact and the maximum impacted receptor are presented in Table 29. Where the impact is less than using the roughness value of 0.3 m this is highlighted in green, and where the impact is greater this is highlighted in yellow.

Table 29: Surface Roughness Sensitivity Analysis

Surface roughness (m)	Concentration (µg/m³)			
	Point of maximum impact – ground level		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
0.2 m	1.47	47.76	1.15	33.35
0.3 m	1.61	48.34	1.26	36.76
0.5 m	1.83	49.13	1.41	40.33
1.0 m	2.23	48.28	1.66	43.92
As % of 0.3 m surface roughness length				
0.2 m	91.2%	98.8%	91.4%	90.7%
0.3 m	100.0%	100.0%	100.0%	100.0%
0.5 m	113.8%	101.6%	112.1%	109.7%

Surface roughness (m)	Concentration (µg/m³)			
	Point of maximum impact – ground level		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
1.0 m	138.7%	99.9%	131.7%	119.5%

As shown, increasing the surface roughness leads to higher maximum annual mean ground level concentrations. However, there is very little difference in the maximum 1-hour concentration with increased surface roughness. A surface roughness value of 0.3 m is considered appropriate for the area surrounding the IWMF and has been used for the purpose of this assessment.

6.2 Operating below the design point

Dispersion modelling has been undertaken using the emission parameters based on the design nominal case for the CHP Plant. The CHP Plant will be operated as a commercial plant, so it is beneficial to operate at full capacity. If loading does fall below the design point the volumetric flow rate of the exhaust gases would reduce. The effect of this would be to decrease the quantity of pollutants emitted. The reduced volume would reduce the buoyancy of the emissions from the CHP Plant. The reduction in buoyancy, which would lead to reduced dispersion, would be more than offset by the decrease in the quantity of pollutants being emitted, so that the impact of the CHP Plant running below the design point would be reduced.

7 Model Validation and Uncertainty

In line with the EA's Air Emissions Guidance the level of uncertainty in the predictions is estimated. To do so, the results of the model validation documentation and the sensitivities have been considered, and the conservatism in the modelling has been reviewed.

7.1 Validation of ADMS model

7.1.1 Introduction

Dispersion modelling of process emission has been carried out using ADMS (version 6.0.1.0) produced by CERC.

This section of the report describes the model and explains why it is considered appropriate for modelling the impacts of the IWMF.

7.1.2 Model description

ADMS is a new generation dispersion model which characterises the atmospheric boundary layer in terms of the atmospheric stability and the boundary layer height. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. The model also includes modules to take account of the effect of buildings and complex terrain.

Within ADMS, the FLOWSTAR module is used to generate a new flow and turbulence field based on the terrain. This simulates the changes to the movement of air in the horizontal and vertical direction as a result of the terrain features in that the air flow is simulated flowing above and around raised ground. This modified flow field is then used by the model to adjust the plume height and plume spread parameters calculated by the flat terrain model. The ADMS model can also handle cases of strongly stable flow using a separate plume impingement model.

The technical specification document for the complex terrain module[3] explains that *"terrain should have no more than moderate slopes (up to 1:3) although the model is useful even when this criterion is not met (say up to 1:2)"*.

The surroundings of the IWMF are generally flat or gently sloping, with only a few areas where the gradient is greater than 1:10 and no areas where it is greater than 1:3. CERC notes that during very low wind stable conditions in hilly terrain, horizontal gradients in density can cause katabatic (downslope) winds, which may influence the background flow in deep valleys[4]. These effects are not specifically accounted for in ADMS. However, the local area does not include such valleys and as such this limitation of the model is not relevant to this project.

7.1.3 Model validation

CERC validates its models against available measured data obtained from real world situations, field campaigns and wind tunnel experiments. Validation studies are published on the CERC website[5] Not all of the validation studies are for settings similar to the study area (flat and/or gently sloping

[3] CERC, P14/01S/17 Complex Terrain Module, March 2020

[4] CERC, Note 110 Temperature Inversions in ADMS, 20 April 2017

[5] https://www.cerc.co.uk/environmental-software/model-validation.html

terrain within a rural area). There is a single validation studies that is considered to be in a location similar to the study area. This are detailed in Table 30.

Table 30: Model Validation Studies

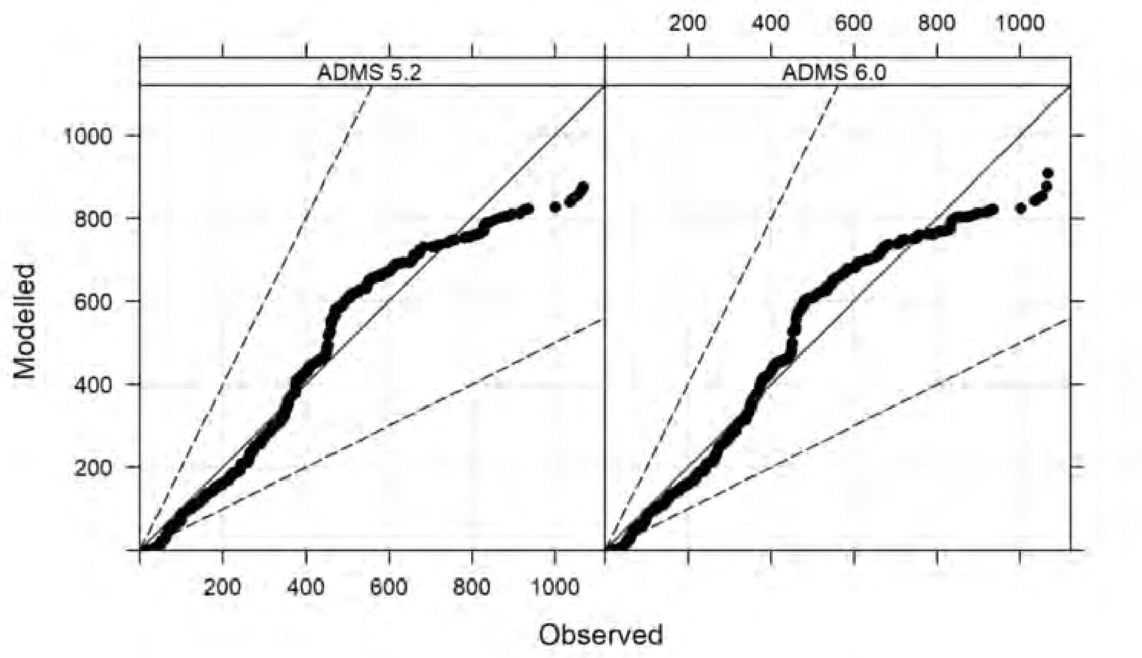
Study	Notes
Kincaid, Indianapolis and Prairie Grass experiments	Kincaid – flat farmland with lakes. Indianapolis – flat land, mixed industrial/commercial/urban. Prairie Grass experiment – ground level release, not relevant to this study.

The validation studies include scatter plots, quantile-quantile plots, and a comparison between the observed and modelled maximum.

- The scatter plots compare predicted and measured concentrations at a particular location at a particular time.
- The quantile-quantile plots compare the distribution of predicted and measured concentrations during the period having abandoned the (x,t) pairing – i.e. comparing the first highest concentration from the monitored with the first highest concentration predicted.

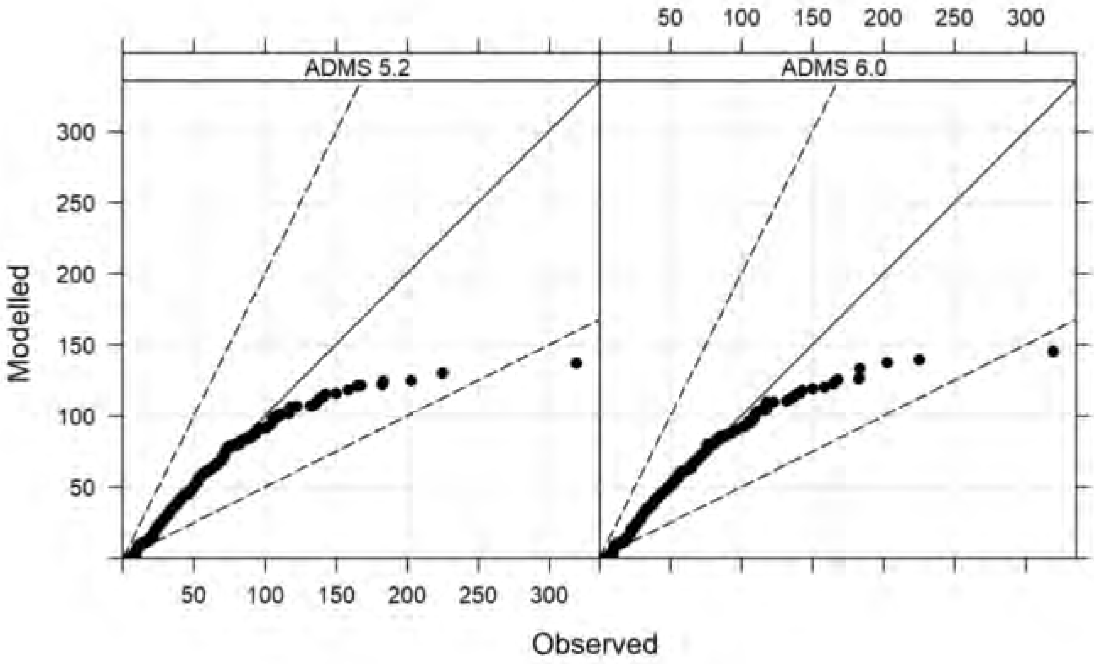
The most useful visual aid for evaluating model performance is the quantile-quantile plot which shows how the model performs across the full range of modelled and observed concentrations. The quantile-quantile plots for the validation study are shown in the following plots.

Figure 1: Quantile Plot – Indianapolis



Source: CERC, ADMS 6 Flat Terrain Validation Kincaid, Indianapolis and Prairie Grass, April 2023

Figure 2: Quantile Plot – Kincaid



Source: CERC, ADMS 6 Flat Terrain Validation Kincaid, Indianapolis and Prairie Grass, April 2023

The plots show that at the most common (median) concentrations, the modelled and observed concentrations are very similar, giving high confidence in annual mean concentrations. However, the maximum concentrations tended to be under-predicted in the Kincaid study albeit these are based on a very small sample size.

It is likely that annual mean concentrations are modelled with a high degree of accuracy. However, the extreme maximum concentrations are less certain, subject to up to potentially over 50% based on the quantile-quantile plot for the Kincaid validation study.

7.2 Uncertainty

The validation documentation shows that the levels of uncertainty in the ADMS model with respect to the peak predicted concentrations are typically within 10% of the hourly and daily concentrations, with accuracy over long time frames expected to be at least as high as this.

The sensitivity analysis in section 6 shows that varying surface roughness leads to changes limited variability in the maximum 1-hour concentration but the peak annual mean varies by up to around 20%, which is a similar order to the modelling uncertainty.

Variations in weather data are more complex and feed into the inter-annual variability discussed below.

In order to allow for modelling uncertainty, this assessment includes a number of conservative assumptions. These are explained and quantified in this section.

7.2.1 Interannual variability

The detailed results tables presented in in Appendix C to Appendix **Error! Reference source not found.** include the breakdown of the peak concentration using each year of meteorological data. The maximum predicted impact over all five years of modelled weather data of data was then used as the basis of the assessment. Table 31 provides a breakdown of the range of the predicted impacts from the CHP Plant only scenario with the build out of the CHP Plant only at the point of maximum impact for each averaging period.

Table 31: Interannual Variability

Averaging time	Impact from CHP Plant (Phase 1) as percentage of maximum	
	Minimum	Average
Annual mean	66.0%	80.1%
Max 1-hour	89.1%	95.4%
99.79%ile 1-hour	80.0%	91.1%
99.73%ile 1-hour	81.1%	91.5%
99.9%ile 15-min	79.0%	90.5%
Max 24-hour	82.7%	90.9%

For the point of maximum impact, the annual average over all five years of weather data is 80% of the highest year, and the minimum is 66% of the highest year. This suggests that using the peak year introduces a conservatism of around 20%. There is less inter-annual variability for shorter-term impacts which are reported as percentile values, where an 9-20% conservatism is introduced. For maximum hourly concentrations the average is 95% of the maximum, such that the use of the maximum over the 5 years is also likely to over-estimate the maximum hourly concentrations that occur in any given year by around 5%.

7.2.2 Plant availability

The results are based on the assumption that the CHP Plant would operate for 100% of the time. This is a very conservative assumption as the CHP Plant would be offline for periods of maintenance. Allowing for availability of the CHP Plant, the annual mean impact would be lower.

7.2.3 Emission limits

The results are based on the assumption that the CHP Plant will operate at the long term ELVs for 100% of the time. However, the CHP Plant is designed to operate below these with a safety margin.

7.2.4 Short term impacts

For short term impacts it has been assumed that the period when the CHP Plant would need to operate at the half-hourly ELV would occur on both lines concurrently for an entire hour, during the worst-case weather conditions for dispersion. This is a highly conservative assumption. In order to achieve the daily ELV, the CHP Plant will be operated to achieve the daily ELV for each hour, with only occasional emissions above this.

7.3 Overall effect on results

The conservative assumptions explained above mean that the overall impacts presented in this assessment will be overestimates.

1. Annual mean impacts are overstated by around 10% due to plant availability, by around 20% when inter-annual variability is considered and by at least 10% when allowing for operation below the emission limits. This means that, overall, the annual mean impacts in this assessment have inbuilt conservatism of at least 25-30%.
2. For short term impacts (where these are expressed as percentiles), selecting the worst case weather conditions across all five years of weather data introduces conservatism of at least 8%, and assuming operation of both lines at the short term ELVs concurrently introduces additional conservatism.
3. The validation documentation shows that the level of uncertainty in the model are on average within 10% of the hourly and daily concentrations, with accuracy over long time frames expected to be at least as high as this.
4. The sensitivity analysis presented in section 6 shows that variations in modelling assumptions leads to changes in the peak annual mean concentrations of up to 20%, but limited changes to 1-hour concentrations.

Therefore, it is considered that the results presented in this assessment are robust as the inbuilt conservatism is of a similar order to the uncertainty in the modelling.

8 Impact on Human Health

8.1 Screening criteria

The Air Emissions Guidance states that to screen out 'insignificant' process contribution (PCs):

- *the long-term PC must be less than 1% of the long-term environmental standard; and*
- *the short-term PC must be less than 10% of the short-term environmental standard.*

As part of this assessment, predicted PCs have been compared to the AQALs detailed in section 2.1.

If the above criteria are achieved, it can be concluded that it is not likely that emissions would lead to significant environmental impacts and the PCs can be screened out.

The long-term 1% PC threshold is based on the judgement that:

- it is unlikely that an emission at this level will make a significant contribution to air quality; and
- the threshold provides a substantial safety margin to protect health and the environment.

The short-term 10% PC threshold is based on the judgement that:

- spatial and temporal conditions mean that short-term PCs are transient and limited in comparison with long-term PCs; and
- the threshold provides a substantial safety margin to protect health and the environment.

For the purpose of this assessment, if the impact can be screened out as 'insignificant' at the point of maximum impact, further assessment is not required. If PCs cannot be screened out, assessment will be undertaken for the following:

- the Predicted Environmental Concentration (PEC, defined as the PC plus the background concentration) at the point of maximum impact; and
- the PC and PEC at areas of public exposure.

If the long-term PEC is below 70% of the AQAL, or the short-term PC is less than 20% of the headroom[6], it can be concluded that "there is little risk of the PEC exceeding the AQAL", and the impact can be considered 'not significant'.

For the assessment of group 3 metals, guidance taken from the EA document 'Guidance on assessing group 3 metals stack emissions from incinerators – V.4 June 2016' ('EA metals guidance') has been used. The EA metals guidance states that where the process contribution for any metal exceeds 1% of the long term or 10% of the short term environmental standard (in this case the AQAL), this is considered to have potential for significant pollution. Where the process contribution exceeds these criteria, the PEC should be compared to the AQAL. The PEC can be screened out if it is less than the AQAL. Where the impact is within these parameters it can be concluded that there is no significant risk of exceeding the AQAL.

8.2 Results

Detailed results tables for each year of weather data are provided in the following appendices:

- Appendix C – the Permitted Facility;
- Appendix D – the CHP Plant only with the full build out of the buildings; and

[6] Calculated as the AQAL minus twice the long-term background concentration.

- Appendix E – the CHP Plant only with only the buildings associated with the delivery of the CHP Plant (i.e. the Phase 1 works).

Results have been presented at the point of maximum ground level impact of emissions and are based on the following:

- Modelling domain size – 5.3 km x 5.3 km;
- Stack height – 35 m;
- Buildings – included as detailed in Table 26;
- 5 years of weather data 2018 to 2022 from Andrewsfield meteorological recording station;
- Operation at the long term ELVs for the entire year;
- Operation at the short term ELVs during the worst-case conditions for dispersion of emissions;
- Worst case conversion of NOx to nitrogen dioxide;
- The entire dust emissions consist of either PM_{10} of $PM_{2.5}$;
- The entire VOC emissions are assumed to consist entirely of benzene; and
- Cadmium and thallium are released at the combined emission limit for cadmium and thallium.

Process contributions that cannot be screened out as 'insignificant' are highlighted. Where the process contribution cannot be screened out as 'insignificant', further analysis has been undertaken.

As shown the peak impact from the IWMF is predicted to be higher when only the CHP is operating. This is because the release from the AD gas engines is at a very high temperature (250°C). Therefore, whilst there is an additional source of combustion pollutants the added buoyancy due to temperature and volume flow rate increases dispersion resulting in lower ground level impacts.

The impact on air quality is greater when only part of the building is constructed. This is expected given that the model is including building wake effects for this scenario but not for the full build out scenario.

At the point of maximum impact the impact of the following cannot be screened out as 'insignificant' for all build out scenarios and further analysis has been undertaken:

- Annual mean nitrogen dioxide impacts;
- Annual mean VOC impacts (as benzene);
- Annual mean cadmium impacts;
- Hourly mean nitrogen dioxide impacts when operating at the half-hourly ELV; and
- 15-minute sulphur dioxide impacts when operating at the half-hourly ELV.

8.2.1 Further analysis – annual mean nitrogen dioxide

There is predicted to be an increase in the maximum annual mean nitrogen dioxide impact if only the CHP is operational during the phased development of the IWMF. The maximum annual mean impact also cannot be screened out as 'insignificant' as the impact is greater than 1% of the AQAL. Table 32 provides a summary of the concentration at each of the receptors and at the point of maximum impact for each scenario. The footpath receptors have not been presented as the annual mean AQAL does not apply at these points. Figure 13 of Appendix A shows the contour plot for the maximum annual mean nitrogen dioxide impact over all five years of weather data for each scenario. The area where impacts cannot be screened out as insignificant are highlighted in yellow for the CHP Only scenario and green for the Permitted Facility. As shown, the distribution of emission is very similar for the CHP Only scenarios. However, without the operation of all sources within the IWMF there is predicted to be a greater ground level impact, and the area where impacts cannot be screened out as 'insignificant' is slightly larger. The impacts within the main areas of occupation within Coggeshall remain well below 1% of the AQAL and can be screened out as insignificant.

Figure 13 of Appendix A shows that within the area where impacts cannot be screened out as 'insignificant' there are no roads. Therefore, within the area where impacts cannot be screened out as 'insignificant' the baseline concentration is likely to be similar to the mapped background. The total PEC is predicted to be less than 70% of the AQAL. Therefore, it can be concluded that there is little risk of the PEC exceeding the annual mean AQAL for nitrogen dioxide, and the impact can be considered 'not significant'.

Table 32: Annual Mean Nitrogen Dioxide Impact (as % of AQAL) – All Scenarios

ID	Receptor	Permitted Facility	CHP Only Operating, but Full Build Out of IWMF	CHP Only Operating, but only CHP section
Point of maximum impact		3.34%	4.09%	4.27%
D1	Sheepcotes Farm (Hanger No. 1)	0.58%	0.72%	0.73%
D2	Wayfarers Site	0.26%	0.42%	0.43%
D3	Allshot's Farm (Scrap Yard)	2.01%	2.53%	2.71%
D4	Haywards	1.91%	2.19%	2.20%
D5	Herons Farm	0.38%	0.49%	0.49%
D6	Gosling Farm	0.46%	0.55%	0.56%
D7	Curd Hall Farm	0.95%	1.11%	1.11%
D8	Church (adjacent to Bradwell Hall)	0.18%	0.22%	0.22%
D9	Bradwell Hall	0.16%	0.19%	0.20%
D10	Rolphs Farmhouse	0.24%	0.28%	0.29%
D11	Silver End / Bower Hall / Fossill Hall	0.49%	0.59%	0.59%
D12	Rivenhall Pl/ Hall	0.37%	0.48%	0.48%
D13	Parkgate Farm / Watchpall Cottages	0.42%	0.53%	0.53%
D14	Ford Farm / Rivenhall Cottage	0.21%	0.27%	0.27%
D15	Porter's Farm	0.29%	0.36%	0.36%
D16	Unknown Building	0.38%	0.48%	0.48%
D17	Bumby Hall / The Lodge / Polish Site (light industry)	0.90%	1.16%	1.20%
D36	Elephant House (Street Sweeping)	0.26%	0.42%	0.42%
D37	Green Pastures Bungalow	0.46%	0.55%	0.55%

ID	Receptor	Permitted Facility	CHP Only Operating, but Full Build Out of IWMF	CHP Only Operating, but only CHP section
D38	Deeks Cottage	1.48%	1.79%	1.79%
D39	Woodhouse Farm	0.95%	1.24%	1.24%
D40	Gosling Cottage / Barn	0.50%	0.60%	0.61%
D41	Felix Hall / The Close House / Park Farm	0.32%	0.38%	0.38%
D42	Glazenwood House	0.22%	0.26%	0.27%
D43	Bradwell Hall	0.21%	0.26%	0.26%
D44	Perry Green Farm	0.29%	0.35%	0.35%
D45	The Granary / Porter Farm / Rook Hall	0.22%	0.27%	0.27%
D46	Grange Farm	0.58%	0.65%	0.65%
D47	Coggeshall	0.45%	0.50%	0.50%

8.2.2 Further analysis – annual mean VOC (as benzene)

There is predicted to be a decrease in the maximum annual mean VOCs impact if only the CHP is operational. This is due to the AD biogas engines not being operational. The ELV for VOCs for the AD biogas engines is significantly greater than for the CHP Plant. Table 33 provides a summary of the concentration at each of the receptors and at the point of maximum impact for each scenario. This is a worst-case scenario as it assumes that the entire VOC emissions consist of only benzene. The footpath receptors have not been presented as the annual mean AQAL does not apply at these points. Figure 14 of Appendix A shows the contour plot for the maximum annual mean VOC (as benzene) impact over all five years of modelled weather data for each scenario. The area where impacts cannot be screened out as insignificant are highlighted in yellow for the CHP Only scenario and green for the Permitted Facility. As shown, without the operation of all sources within the IWMF there is predicted to be a greater ground level impact, and the area where impacts cannot be screened out as ‘insignificant’ is significantly larger, than the Permitted Facility. Without the operation of the AD gas engines the impacts within the main areas of occupation within Coggeshall remain well below 1% of the AQAL and can be screened out as insignificant.

Within the area where impacts cannot be screened out as ‘insignificant’ the baseline concentration is likely to be similar to the mapped background. The total PEC is predicted to be less than 70% of the AQAL. Therefore, it can be concluded that there is little risk of the PEC exceeding the annual mean AQAL for benzene, and the impact can be considered ‘not significant’.

Table 33: Annual Mean VOC (as benzene) Impact (as % of AQAL) – All Scenarios

ID	Receptor	Permitted Facility	CHP Only Operating, but Full Build Out of IWMF	CHP Only Operating, but only CHP section
Point of maximum impact		6.66%	4.67%	4.88%

ID	Receptor	Permitted Facility	CHP Only Operating, but Full Build Out of IWMF	CHP Only Operating, but only CHP section
D1	Sheepcotes Farm (Hanger No. 1)	1.16%	0.82%	0.83%
D2	Wayfarers Site	0.52%	0.48%	0.49%
D3	Allshot's Farm (Scrap Yard)	4.00%	2.89%	3.10%
D4	Haywards	3.81%	2.51%	2.51%
D5	Herons Farm	0.75%	0.56%	0.56%
D6	Gosling Farm	0.91%	0.63%	0.63%
D7	Curd Hall Farm	1.89%	1.26%	1.26%
D8	Church (adjacent to Bradwell Hall)	0.35%	0.25%	0.26%
D9	Bradwell Hall	0.31%	0.22%	0.22%
D10	Rolphs Farmhouse	0.48%	0.32%	0.33%
D11	Silver End / Bower Hall / Fossill Hall	0.98%	0.67%	0.67%
D12	Rivenhall Pl/ Hall	0.74%	0.55%	0.55%
D13	Parkgate Farm / Watchpall Cottages	0.84%	0.61%	0.61%
D14	Ford Farm / Rivenhall Cottage	0.43%	0.30%	0.30%
D15	Porter's Farm	0.57%	0.41%	0.41%
D16	Unknown Building	0.75%	0.55%	0.55%
D17	Bumby Hall / The Lodge / Polish Site (light industry)	1.79%	1.33%	1.37%
D36	Elephant House (Street Sweeping)	0.51%	0.48%	0.48%
D37	Green Pastures Bungalow	0.91%	0.63%	0.63%
D38	Deeks Cottage	2.95%	2.04%	2.04%
D39	Woodhouse Farm	1.89%	1.41%	1.41%
D40	Gosling Cottage / Barn	0.99%	0.69%	0.69%
D41	Felix Hall / The Close House / Park Farm	0.64%	0.43%	0.43%
D42	Glazenwood House	0.44%	0.30%	0.31%
D43	Bradwell Hall	0.42%	0.30%	0.30%
D44	Perry Green Farm	0.58%	0.40%	0.40%
D45	The Granary / Porter Farm / Rook Hall	0.44%	0.30%	0.30%
D46	Grange Farm	1.16%	0.74%	0.74%
D47	Coggeshall	0.90%	0.57%	0.57%

8.2.3 Further analysis – annual mean cadmium

There is predicted to be an increase in the maximum annual mean cadmium impact if only the CHP is operational as a result of the phased development of the IWMF. The maximum annual mean impact also cannot be screened out as 'insignificant' as the impact is greater than 1% of the AQAL. Table 34 provides a summary of the concentration at each of the receptors and at the point of maximum impact for each scenario. This is a worst-case scenario as it assumes that the entire cadmium and thallium emissions consist of only cadmium. The footpath receptors have not been presented as the annual mean AQAL does not apply at these points. Figure 15 of Appendix A shows the contour plot for the maximum annual mean cadmium impact over all five years of modelled weather data for each scenario. The area where impacts cannot be screened out as insignificant are highlighted in yellow for the CHP Only scenario and green for the Permitted Facility. As shown, without the operation of all sources within the IWMF there is predicted to be a greater ground level impact, and the area where impacts cannot be screened out as 'insignificant' is slightly larger, than the Permitted Facility.

Within the area where impacts cannot be screened out as 'insignificant' the baseline concentration is likely to be similar to the rural background concentration. The total PEC is predicted to be less than 70% of the AQAL. Therefore, it can be concluded that there is little risk of the PEC exceeding the annual mean AQAL for cadmium, and the impact can be considered 'not significant'.

Table 34: Annual Mean Cadmium Impact (as % of AQAL) – All Scenarios

ID	Receptor	Permitted Facility	CHP Only Operating, but Full Build Out of IWMF	CHP Only Operating, but only CHP section
Point of maximum impact		7.33%	9.33%	9.75%
D1	Sheepcotes Farm (Hanger No. 1)	1.28%	1.64%	1.66%
D2	Wayfarers Site	0.57%	0.95%	0.97%
D3	Allshot's Farm (Scrap Yard)	4.41%	5.76%	6.18%
D4	Haywards	4.19%	5.01%	5.01%
D5	Herons Farm	0.83%	1.11%	1.11%
D6	Gosling Farm	1.00%	1.26%	1.27%
D7	Curd Hall Farm	2.08%	2.52%	2.52%
D8	Church (adjacent to Bradwell Hall)	0.39%	0.51%	0.51%
D9	Bradwell Hall	0.34%	0.44%	0.45%
D10	Rolphs Farmhouse	0.53%	0.65%	0.65%
D11	Silver End / Bower Hall / Fossill Hall	1.08%	1.34%	1.34%
D12	Rivenhall Pl/ Hall	0.81%	1.09%	1.09%
D13	Parkgate Farm / Watchpall Cottages	0.92%	1.21%	1.21%
D14	Ford Farm / Rivenhall Cottage	0.47%	0.61%	0.61%

ID	Receptor	Permitted Facility	CHP Only Operating, but Full Build Out of IWMF	CHP Only Operating, but only CHP section
D15	Porter's Farm	0.63%	0.82%	0.82%
D16	Unknown Building	0.83%	1.10%	1.10%
D17	Bumby Hall / The Lodge / Polish Site (light industry)	1.97%	2.65%	2.74%
D36	Elephant House (Street Sweeping)	0.56%	0.96%	0.96%
D37	Green Pastures Bungalow	1.01%	1.26%	1.26%
D38	Deeks Cottage	3.24%	4.07%	4.07%
D39	Woodhouse Farm	2.08%	2.82%	2.82%
D40	Gosling Cottage / Barn	1.09%	1.38%	1.38%
D41	Felix Hall / The Close House / Park Farm	0.70%	0.87%	0.86%
D42	Glazenwood House	0.48%	0.60%	0.61%
D43	Bradwell Hall	0.46%	0.59%	0.60%
D44	Perry Green Farm	0.63%	0.80%	0.81%
D45	The Granary / Porter Farm / Rook Hall	0.48%	0.61%	0.61%
D46	Grange Farm	1.28%	1.48%	1.48%
D47	Coggeshall	0.99%	1.14%	1.14%

8.2.4 Further analysis – annual mean PAHs

There is predicted to be an increase in the maximum annual mean PAH impact if only the CHP is operational as a result of the phased development of the IWMF. The maximum annual mean impact also cannot be screened out as ‘insignificant’ as the impact is greater than 1% of the AQAL. Table 35 provides a summary of the concentration at the maximum impacted receptor and at the point of maximum impact for each scenario. This is a worst-case scenario as it assumes that the entirety of the PAH emissions consist of only benzo(a)pyrene. Figure 16 of Appendix A shows the contour plot for the maximum annual mean PAH impact over all five years of modelled weather data for each scenario. The area where impacts cannot be screened out as insignificant are highlighted in yellow for the CHP Only scenario and green for the Permitted Facility. As shown, without the operation of all sources within the IWMF there is predicted to be a greater ground level impact, and the area where impacts cannot be screened out as ‘insignificant’ is slightly larger, than the Permitted Facility. However, the impacts within the main areas of occupation within Coggeshall remain well below 1% of the AQAL and can be screened out as insignificant.

Within the area where impacts cannot be screened out as ‘insignificant’ the baseline concentration is likely to be similar to the rural background concentration. The total PEC is predicted to be less than 70% of the AQAL. Therefore, it can be concluded that there is little risk of the PEC exceeding the annual mean AQAL for benzo(a)pyrene, and the impact can be considered ‘not significant’.

Table 35: Annual Mean PAH Impact (as % of AQAL) – All Scenarios

ID	Receptor	Permitted Facility	CHP Only Operating, but Full Build Out of IWMF	CHP Only Operating, but only CHP section
Point of maximum impact		1.47%	1.87%	1.95%
Maximum at a receptor (D3)		0.88%	1.15%	1.24%

8.2.5 Further analysis – daily mean cadmium

There is predicted to be an increase in the maximum daily mean cadmium impact if only the CHP is operational as a result of the phased development of the IWMF. The maximum annual mean impact also cannot be screened out as 'insignificant' as the impact is greater than 10% of the AQAL. Table 36 provides a summary of the concentration at the maximum impacted receptor and at the point of maximum impact for each scenario. This is a worst-case scenario as it assumes that the entire cadmium and thallium emissions only consist of cadmium. Figure 17 of Appendix A shows the contour plot for the maximum daily mean cadmium impact over all five years of modelled weather data for each scenario. The area where impacts cannot be screened out as insignificant are highlighted in yellow for the CHP Only scenario and green for the Permitted Facility. As shown, without the operation of all sources within the IWMF there is predicted to be a greater ground level impact, and the area where impacts cannot be screened out as 'insignificant' is slightly larger, than the Permitted Facility. However, the impacts within the main areas of occupation within Coggeshall remain well below 10% of the AQAL and can be screened out as insignificant.

Within the area where impacts cannot be screened out as 'insignificant' the baseline concentration is likely to be similar to the rural background concentration. The total PEC is predicted to be less than 70% of the AQAL and less than 20% of the headroom. Therefore, it can be concluded that there is little risk of the PEC exceeding the daily mean AQAL for cadmium, and the impact can be considered 'not significant'.

Table 36: Maximum Daily Mean Cadmium Impact (as % of AQAL) – All Scenarios

ID	Receptor	Permitted Facility	CHP Only Operating, but Full Build Out of IWMF	CHP Only Operating, but only CHP section
Point of maximum impact		10.80%	13.40%	15.03%
Maximum at a receptor (D3)		9.73%	10.16%	12.78%

8.2.6 Further analysis – hourly nitrogen dioxide

A summary of the maximum predicted impact using all five years of modelled weather data of weather data at the point of maximum impact and the maximum impacted receptor is provided in Table 37. As shown, there is predicted to an increase in the maximum 1-hour mean nitrogen dioxide impact if only the CHP is operational as a result of the phased development of the IWMF. The 1-hour impact can be screened out as insignificant when operating at the daily ELVs. However, when only part of the building is constructed and both lines of the CHP Plant operate concurrently at the half-hourly ELV during the worst-case weather conditions for dispersion the peak impact exceeds 10% of the AQAL.

Figure 18 of Appendix A shows the area where the impact cannot be screened out as 'insignificant' when both lines of the CHP Plant operate at the half-hourly ELV and this operation co-insides with the worst-case weather conditions for dispersion. As shown, this is a small area. The maximum process contribution as a percentage of the headroom is less than 20% in all instances. Therefore, although the impact cannot be screened out as 'insignificant' under the worst-case scenario there is little risk of the PEC exceeding the AQAL and the impact can be considered 'not significant'.

Table 37: 1-hour Mean Nitrogen Impact (as % of AQAL) – All Scenarios

ID	Receptor	Permitted Facility	CHP Only Operating, but Full Build Out of IWMF	CHP Only Operating, but only CHP section
Both lines operating of CHP Plant at daily ELV				
Point of maximum impact		4.62%	4.72%	6.42%
Maximum at a receptor (D3)		4.21%	4.57%	5.25%
Both lines operating of CHP Plant at half hourly ELV				
Point of maximum impact		9.05%	9.44%	12.83%
Maximum at a receptor (D3)		8.25%	9.13%	10.50%
One line operating of CHP Plant at half hourly ELV and one line at the daily ELV				
Point of maximum impact		6.83%	7.08%	9.62%
Maximum at a receptor (D3)		6.23%	6.85%	7.88%
Notes: 99.79%ile of 1-hour nitrogen dioxide concentration as a percentage of the AQAL				

8.2.7 Further analysis – 15-minute sulphur dioxide

A summary of the maximum predicted impact using all five years of modelled weather data of weather data at the point of maximum impact and the maximum impacted receptor is provided in Table 38. As shown, there is predicted to an increase in the maximum 15-minute mean sulphur dioxide impact if only the CHP is operational as a result of the phased development of the IWMF. The 15-minute impact can be screened out as insignificant when operating at the daily ELVs. However, when only part of the building is constructed and both lines of the CHP Plant operate concurrently at the half-hourly ELV during the worst-case weather conditions for dispersion the peak impact exceeds 10% of the AQAL.

Figure 19 of Appendix A shows the area where the impact cannot be screened out as 'insignificant' when both lines of the CHP Plant operate at the half-hourly ELV and this operation co-insides with the worst-case weather conditions for dispersion. As shown, this is a small area. The maximum process contribution as a percentage of the headroom is less than 20% in all instances. Therefore, although the impact cannot be screened out as 'insignificant' under the worst-case scenario there is little risk of the PEC exceeding the AQAL and the impact can be considered 'not significant'.

Table 38: 15-minute Mean Sulphur Impact (as % of AQAL) – All Scenarios

ID	Receptor	Permitted Facility	CHP Only Operating, but Full Build Out of IWMF	CHP Only Operating, but only CHP section
Both lines operating of CHP Plant at daily ELV				
Point of maximum impact		3.47%	3.30%	4.96%
Maximum at a receptor (D3)		3.10%	3.19%	3.60%
Both lines operating of CHP Plant at half hourly ELV				
Point of maximum impact		9.82%	9.89%	14.87%
Maximum at a receptor (D3)		8.77%	9.56%	10.81%
One line operating of CHP Plant at half hourly ELV and one line at the daily ELV				
Point of maximum impact		6.65%	6.59%	9.91%
Maximum at a receptor (D3)		5.93%	6.37%	7.21%
Notes: *99.9%ile of 15-minute sulphur dioxide concentration as a percentage of the AQAL*				

8.2.8 Heavy metals – at the point of maximum impact

The detailed results tables detail the predicted impact of emissions of metals for each scenario are provided in Appendix C to Appendix **Error! Reference source not found.**.

If the process contribution is greater than 1% of the AQAL when it is assumed that each metal is emitted at the total metal ELV, further analysis has been undertaken. The EA's metals guidance details the maximum monitored concentrations of Group 3 metals emitted by Municipal Waste Incinerators and Waste Wood Co-Incinerators as a percentage of the ELV for Group 3 metals. The maximum monitored emission presented in the EA's analysis has been used as a conservative assumption. This is considered highly conservative given that the monitoring shows that the maximum is an outlier, especially in the case of nickel where the maximum concentration was 0.220 mg/Nm^3, the second highest being 0.135 mg/Nm^3 (or 61% of the maximum monitored), and the third highest only 0.055 mg/Nm^3 (or 25% of the maximum monitored).

As shown, if it is assumed that the CHP Plant would perform no worse than the maximum monitored concentration from the EA metals guidance, the impact would be below 1% of the long term AQAL for all build out scenarios and for all pollutants with the exception of arsenic, chromium VI and nickel. However, the PEC is less than the annual mean AQAL for all metals.

When considering short term impacts the detailed results tables show that if it is assumed that the CHP Plant would perform no worse than maximum monitored concentration from the EA metals guidance, the process contribution is below 10% of the short term AQAL for all build out scenarios and for all pollutants with the exception of copper and nickel. However, the PEC is well below the daily and hourly AQAL for all metals.

This analysis has shown there is no risk of exceeding an AQAL for any metals either on a long-term or short-term basis as a result of emissions from the CHP Plant.

9 Impact at Ecological Receptors

9.1 Screening

The EA's Air Emissions Guidance states that to screen out impacts as 'insignificant' at European and UK statutory designated sites:

- the long-term PC must be less than 1% of the long-term environmental standard (i.e. the Critical Level or Load); and
- the short-term PC must be less than 10% of the short-term environmental standard.

If the above criteria are met, no further assessment is required. If the long-term PC exceeds 1% of the long-term environmental standard, the PEC must be calculated and compared to the standard. If the resulting PEC is less than 70% of the long-term environmental standard, the Air Emissions Guidance states that the emissions are 'insignificant' and further assessment is not required. In accordance with the guidance, calculation of the PEC for short-term standards is not required.

The EA's Air Emissions Guidance states further that to screen out impacts as 'insignificant' at local nature sites[7]:

- the long-term PC must be less than 100% of the long-term environmental standard; and
- the short-term PC must be less than 100% of the short-term environmental standard.

In accordance with the guidance, calculation of the PEC for local nature sites is not required. However, this has been calculated for completeness.

9.2 Daily mean Critical Level

The APIS baseline sulphur dioxide concentrations presented in Table 15 shows that the baseline sulphur dioxide concentrations are well below the Critical Level. The closest site which monitors ozone and sulphur dioxide concentrations is St Osyth, located approximately 30 km to the east of the IWMF. To supplement the monitoring at St Osyth a review of the monitoring of ozone from all sites across the UK has been carried out. The AO40 has been calculated and results graphed up showing where the baseline concentration exceeds the AO40 in each year in Figure 12 of Appendix A. As shown, there are locations across the UK where the AO40 exceeded the Critical Level but on average very few sites recorded exceedances of the AO40 level in the UK and these were located in the south of the UK. However, in three of the last five years the AO40 at St Osyth has exceeded the Critical Level. Therefore, it is considered that the daily mean NOx Critical Level of 75 µg/m^3 is appropriate and has been used for the purpose of this assessment.

9.3 Methodology

9.3.1 Atmospheric emissions – Critical Levels

The impact of emissions has been compared to the Critical Levels listed in Table 3. Further assessment would be undertaken where the process contribution of a particular pollutant is greater than 1% of the long term or 10% of the short-term Critical Level for European and UK designated

7 Ancient woodlands, local wildlife sites and national and local nature reserves.

sites, and where the process contribution of a particular pollutant is greater than 100% of the Critical Level for locally designated sites.

9.3.2 Deposition of emissions – Critical Loads

In addition to the Critical Levels for the protection of ecosystems, habitat specific Critical Loads for nature conservation sites at risk from acidification and nitrogen deposition (eutrophication) are outlined in APIS. In terms of acid deposition, the APIS Database contains a maximum critical load for sulphur (ClmaxS), a minimum Critical Load for nitrogen (CLminN) and a maximum Critical Load for nitrogen (ClmaxN). These components define the Critical Load function for acid deposition. Where the acid deposition flux falls within the area under the Critical Load function, no exceedances are predicted.

The APIS database does not include many of the local wildlife sites. As such the most appropriate habitat has been selected for each site. The relevant Critical Loads are presented in Appendix B.

9.3.3 Calculation methodology

9.3.3.1 Nitrogen deposition

The impact of deposition has been assessed using the methodology detailed within the Habitats Directive AQTAG 6 (March 2014). The steps to this method are as follows.

1. Determine the annual mean ground level concentrations of nitrogen dioxide and ammonia at each site.
2. Calculate the dry deposition flux ($\mu g/m^2/s$) at each site by multiplying the annual mean ground level concentration by the relevant deposition velocity presented in Table 39.
3. Convert the dry deposition flux into units of kgN/ha/yr using the conversion factors presented in Table 39.
4. Compare this result to the nitrogen deposition Critical Load.

Table 39: Deposition Factors

Pollutant	Deposition velocity (m/s)		Conversion factor ($\mu g/m^2/s$ to kg/ha/year)
	Grassland	Woodland	
Nitrogen dioxide	0.0015	0.003	96.0
Sulphur dioxide	0.0120	0.024	157.7
Ammonia	0.0200	0.030	259.7
Hydrogen chloride	0.0250	0.060	306.7

Source: AQTAG 6 (March 2014).

9.3.3.2 Acidification

Deposition of nitrogen, sulphur, hydrogen chloride and ammonia can cause acidification and should be taken into consideration when assessing the impact of the IWMF.

The steps to determine the acid deposition flux are as follows.

1. Determine the dry deposition rate in kg/ha/yr of nitrogen dioxide, sulphur, hydrogen chloride and ammonia using the methodology outlined in Section 9.3.3.

2. Apply the conversion factor for N outlined in Table 40 to the nitrogen dioxide and ammonia deposition rate in kg/ha/year to determine the total keq N/ha/year.
3. Apply the conversion factor for S to the sulphur deposition rate in kg/ha/year to determine the total keq S/ha/year.
4. Apply the conversion factor for HCl to the hydrogen chloride deposition rate in kg/ha/year to determine the dry keq Cl/ha/year.
5. Add the contribution from S to HCl and treat this sum as the total contribution from S.
6. Plot the results against the Critical Load functions.

Table 40: Conversion Factors

Pollutant	Conversion factor (kg/ha/year to keq/ha/year)
Nitrogen	Divide by 14
Sulphur	Divide by 16
Hydrogen chloride	Divide by 35.5

Source: AQTAG (March 2014)

The March 2014 version of the AQTAG 6 document states that, for installations with an HCl emission, the PC of HCl, in addition to S and N, should be considered in the acidity Critical Load assessment. The H+ from HCl should be added to the S contribution (and treated as S in APIS tool). This should include the contribution of HCl from wet deposition.

Consultation with AQMAU confirmed that the maximum of the wet or dry deposition rate for HCl should be included in the calculation. For the purpose of this analysis, it has been assumed that wet deposition of HCl is double dry deposition.

The contribution from the IWMF has been calculated using APIS formula:

Where PEC N Deposition < CLminN:

PC as % of CL function = PC S deposition / ClmaxS

Where PEC N Deposition > CLminN:

PC as % of CL function = (PC S + N deposition) / ClmaxN

9.4 Results

Detailed results tables are provided in Appendix C to Appendix E. Results have been presented at the point of maximum ground level impact of emissions from the IWMF.

Results are based on the following:

- Modelling domain size – 5.3 km x 5.3 km;
- Stack height – 35 m;
- Buildings – included as detailed in Table 26;
- 5 years of weather data 2018 to 2022 from Andrewsfield meteorological recording station;
- Operation at the long term ELVs for the entire year;
- Worst case conversion of NOx to nitrogen dioxide;
- The nitrogen deposition impacts include the contribution from nitrogen dioxide and ammonia;

- The acid deposition impacts include the contribution from nitrogen dioxide, ammonia, sulphur dioxide and hydrogen chloride;
- Wet deposition of HCl has been included in the acid S calculation as double dry deposition; and
- It has been assumed the most sensitive habitat is present at the point of maximum impact of emissions in each site.

Process contributions that cannot be screened out as 'insignificant' are highlighted. Where the process contribution cannot be screened out as 'insignificant', further analysis has been undertaken.

9.4.1 European and UK designated sites

No European or UK designated sites have been identified as requiring consideration within this assessment.

9.4.2 Local sites

As shown in Appendix D to Appendix E, as with the impact on human health, the impact at ecological sites is greater if only the CHP Plant is operating, and the impact is greater if only part of the building is constructed. However, in all instances the process contribution is not predicted to exceed the Critical Level or Load. Applying the EA's screening criteria the impact can be screened out as 'insignificant'.

10 Abnormal Operations

10.1 Background

The Environmental Permitting Regulations require that abnormal event scenarios are considered. Article 46(6) of the IED states that:

"… the waste incineration plant … shall under no circumstances continue to incinerate waste for a period of more than 4 hours uninterrupted where emission limit values are exceeded.

The cumulative duration or operation in such conditions over 1 year shall not exceed 60 hours."

Article 47 continues with:

"In the case of a breakdown, the operator shall reduce or close down operations as soon as practicable until normal operations can be restored."

The conditions detailed in Article 46(6) are considered to be "abnormal operating conditions" for the purpose of this assessment applies to the Facility.

10.2 Identification of abnormal operating conditions

The following are considered to be examples of abnormal operating conditions which may lead to 'abnormal emission levels' of pollutants:

1. Reduced efficiency of lime injection system such as through blockages or failure of fans leading to elevated acid gas emissions;
2. Complete failure of the lime injection system leading to unabated emissions of acid gases. (Note: this would require the CHP Plant to have complete failure of the bag filter system. As a plant of modern design the CHP Plant would have shut down before reaching these operating conditions);
3. Reduced efficiency of particulate filtration system due to bag failure and inadequate isolation, leading to elevated particulate emissions and metals in the particulate phase;
4. Reduced efficiency of the Selective Non-Catalytic Reduction (SNCR) system as a result of blockages or failure of ammonia injection system, leading to elevated oxides of nitrogen emissions; and
5. Complete failure of the activated carbon injection system and loss of temperature control leading to high levels of dioxin reformation and their unabated release.

10.3 CHP Plant start-up and shutdown

Start-up of the CHP Plant from cold will be conducted with clean support fuel. Waste is not introduced onto the grate unless the temperature is above the minimum requirement (850^{o}C) and other operating parameters (for example, air flow and oxygen levels) are within the range stipulated in the permit. During the warming up period the gas cleaning plant will be operational as will be the control systems and monitoring equipment.

The same is true during plant shutdown. The waste remaining on the grate is allowed to burn out, the temperature not being permitted to drop below 850^{o}C by the simultaneous introduction of clean support auxiliary fuel. After complete burnout of the waste, the burners are turned off and the plant is allowed to cool. During this period, the gas cleaning equipment, control systems and monitoring equipment will be fully operational.

It should also be noted that start-up and shutdown are infrequent events; the CHP Plant is designed to operate continuously, and ideally only close down for its annual maintenance programme.

In relation to the magnitude of dioxin emissions during plant start-up and shutdown, research has been undertaken by AEA Technology on behalf of the Environment Agency (EA). Whilst elevated emissions of dioxins (within one order of magnitude) were found during shutdown and start-up phases where the waste was not fully established on the grate, the report concluded that:

"The mass of dioxin emitted during start-up and shutdown for a 4-5 day planned outage was similar to the emission which would have occurred during normal operation in the same period. The emission during the shutdown and restart is equivalent to less than 1 % of the estimated annual emission (if operating normally all year)."

There is therefore no reason why such start-up and shutdown operations will affect the long term impact of the CHP Plant.

10.4 Plausible abnormal emission levels from the CHP Plant

The following plausible abnormal emission levels for the CHP Plant have been identified based on the performance of similar plants in the UK. The plausible abnormal emissions concentrations are presented in Table 41, where available, these have been based on measured data from a comparable facility.

Table 41: Plausible Abnormal Emissions from the CHP Plant

Pollutant	Permitted Emission Limit, (mg/Nm^3)(1)		Plausible Abnormal Emission, (mg/Nm^3)	% Above Max Permitted Emission
	Daily Average	½ hourly max		
Oxides of nitrogen	100	200	500(2)	150
Particulate matter (PM_{10})	5	30	150(3)	400
Sulphur dioxide	30	90	450(4)	400
Hydrogen chloride	6	60	900(4)	1,400
Hydrogen fluoride	1	1	20(4)	1,900
Dioxins and dioxin-like PCBs	0.06 ng/Nm^3		6 ng/Nm^3	9900(5)
PCBs	0.005 mg/Nm^3(6)		0.5 mg/Nm^3	9900(7)

Notes:

(1) All emissions expressed as Nm^3 based (dry, 0°C, 11% reference oxygen content).

(2) Taken as the upper end of the range of monitored raw flue gas after the boiler from the Waste Incineration BREF (Table 3.6)

(3) Taken from the IED maximum permitted level.

(4) Based on information presented in the Devonport Decision Document (Reference: EPR/WP3833FT).

(5) Assumes a 99% removal efficiency in lieu of any other information as set out in the Devonport Decision Document.

(6) The Waste Incineration BREF provides a range of values for PCB emissions to air from European municipal waste incineration plants. This states that the annual average total PCBs is less than 0.005 mg/Nm^3 (dry, 11% oxygen, 273K). In lieu of other available data, this has been assumed to be the emission concentration for the CHP Plant.

Pollutant	Permitted Emission Limit, (mg/Nm³)(1)		Plausible Abnormal Emission, (mg/Nm³)	% Above Max Permitted Emission
	Daily Average	½ hourly max		
(7) In lieu of any publicly available information, the plausible emissions multiplier for PCBs is assumed to be the same as for dioxins.				

A number of assumptions have been made with regard to the emissions of individual metals.

- Emission concentration of mercury has been assumed to be 100% of the ELV of 0.02 mg/m³.
- Emission concentration of cadmium has been taken as half the ELV for cadmium and thallium and compounds of 0.02 mg/m³.
- Emission concentration of heavy metals that have a short or long term EAL have been considered (antimony, arsenic, chromium, copper, lead, manganese, nickel, vanadium) and have been taken from the EA guidance document "Guidance on assessing group 3 metal stack emissions from incinerators" (version 4). This guidance summarises the existing emissions from 18 Municipal Waste Incinerators (MWIs) and Waste Wood Co-incinerators in the UK over a period between 2007 and 2015.
- The Predicted Abnormal Emission are calculated based on 30 times the emission concentration, as it is assumed that metals are in the particulate phase with the exception of mercury which would be in the vapour phase.
- The Waste Incineration BREF states that for activated carbon injections systems mercury is absorbed usually to about a 95% efficiency to result in emission to air of below 30 µg/m³ (section 4.5.6.2). Therefore, based on the WI BREF the unabated mercury emission concentration due to a failure of the carbon injection system would be 600 µg/m³. This equates to 2,900% above the modelled emission limit of 20 µg/Nm³ which was used in the main dispersion modelling.

The plausible abnormal emissions concentrations for metals are presented in Table 42.

Table 42: Predicted Abnormal Metal Emissions from the CHP Plant

Pollutant	Emission Concentrations (µg/Nm³)	Predicted Abnormal Emission (µg/Nm³)	% Above Max Permitted Emission
Antimony	11.5	345	2,900
Arsenic	25	750	2,900
Cadmium	10	300	2,900
Chromium	92	2,760	2,900
Chromium (VI)	0.13	3.9	2,900
Copper	29	870	2,900
Lead	50.3	1,509	2,900
Manganese	60	1,800	2,900
Mercury	20	600	2,900
Nickel (worst-case)	220	6,600	2,900
Vanadium	6	180	2,900

The definition of 'abnormal operating conditions' also encompasses periods where the continuous emission monitoring equipment is not operating correctly and data relating to the actual emission concentrations are not available. This assessment has only used data where the concentration of continuously monitored pollutants has been quantified. Furthermore, no data on flow characteristics (flow rate, temperature etc.) during these abnormal operating conditions is available, so for the purposes of this assessment the design flow characteristics have been applied to the plausible emission levels to derive an emission rate and assess impact.

In defining abnormal operating conditions Annex VI, Part 3 (2) notes that under no circumstances shall the total dust concentration exceed 150 mg/Nm³ expressed as a half hourly average. As such total dust has been included in this analysis. In addition, this section continues to state that the emission limits prescribed for TOC and CO in the IED must not be exceeded. As such there is no potential for the impact of emissions of TOC and CO to be greater than for normal operations. Therefore, TOC and CO have not been considered within this analysis.

10.5 Impact Resulting from Plausible Abnormal Emissions

The CHP Plant consists of two lines which operate individually. For the purpose of this analysis it has been assumed that both lines operate under abnormal operating conditions concurrently. This is a very worst case assumption.

10.5.1 Predicted short term impacts – CHP Plant only

In order to assess the effect on short term ground level concentrations associated with the CHP Plant operating at the identified abnormal emission concentration, the calculated ground level concentration has been increased pro-rata. For daily mean impacts it had been assumed that abnormal emission concentrations occur for 4 hours and emissions are at the emission limit for the remaining 20 hours. The impacts for an averaging period of one hour or less are presented in Table 43 and daily mean impacts are presented in Table 44.

This analysis is based on the CHP Plant only operating and the build out of the CHP Plant given that the greatest peak impact was predicted to occur with this build out scenario.

Table 43: Hourly and 15 Minute Mean Impacts Resulting from Plausible Abnormal Emissions – CHP Only

Pollutant	AQAL (µg/m³)	Predicted Impact – Normal Operation		Predicted Impact – Abnormal Emissions	
		Conc. µg/m³	% of AQAL	Conc. µg/m³	% of AQAL
Nitrogen dioxide	200	25.66	12.83%	64.16	32.08%
Sulphur dioxide (1-hour)	350	31.07	8.88%	155.34	44.38%
Sulphur dioxide (15-min)	266	39.54	14.87%	197.71	74.33%
Hydrogen chloride	750	30.27	4.04%	454.01	60.54%
Hydrogen fluoride	160	0.09	0.57%	1.82	11.37%
Pollutant	**AQAL (ng/m³)**	**Predicted Impact – Normal Operation**		**Predicted Impact – Abnormal Emissions**	
		Conc. ng/m³	**% of AQAL**	**Conc. ng/m³**	**% of AQAL**
Antimony	150,000	5.79	0.004%	173.59	0.12%
Manganese	1,500,000	30.19	0.002%	905.71	0.06%
Mercury	600	10.06	1.68%	301.90	50.32%
Nickel (worst-case)	600	110.70	15.81%	3,320.94	474.42%
Nickel (2nd highest)	600	67.93	9.70%	2,037.85	291.12%
Nickel (3rd highest)	600	27.67	3.95%	830.23	118.60%
Nickel (mean)	600	3.02	0.43%	90.57	12.94%
PCBs	6,000	1.13	0.02%	112.73	1.88%

Table 44: Daily Mean Impacts Resulting from Plausible Abnormal Emission – CHP Only

Pollutant	AQAL (µg/m³)	Predicted Impact – Normal Operation		Predicted Impact – Abnormal Emissions	
		Conc. µg/m³	% of AQAL	Conc. µg/m³	% of AQAL
Sulphur dioxide	125	5.55	4.44%	18.49	14.80%
Particulate matter (PM_{10})	50	0.43	0.87%	2.53	5.06%
Pollutant	**AQAL (ng/m³)**	**Predicted Impact – Normal Operation**		**Predicted Impact – Abnormal Emissions**	
		Conc. ng/m³	**% of AQAL**	**Conc. ng/m³**	**% of AQAL**
Cadmium	30	2.25	7.52%	13.15	43.84%
Chromium	2,000	20.74	1.04%	121.00	6.05%
Copper	50	6.54	13.08%	38.14	76.28%
Mercury	60	4.51	7.52%	26.30	43.84%
Vanadium	1,000	1.35	0.14%	7.89	0.79%

This is considered to be a highly conservative assessment as it assumes that the plausible abnormal emissions occur on both lines and coincide with worst case meteorological conditions. Even with these highly conservative factors, the process contribution is not predicted to exceed any of the short term AQALs with the exception of nickel, when using the three highest emission rates taken from the EA metals guidance. As discussed in section 8.2.8 the maximum monitored concentration of nickel in the EA metals guidance is an outlier. Assuming that during normal operation each line of the CHP Plant operates at the mean monitored nickel concentration from the EA metals guidance, the predicted process contribution (as a % of the applied AQAL) is less than 20%.

10.5.2 Predicted long term impacts – CHP Plant only

In order to assess the effect on long term ground level concentrations associated with both lines of the CHP Plant operating at the identified abnormal emission levels, the calculated long term ground level concentrations have been increased pro-rata as presented in Table 45 and Table 46.

This assessment assumes that the CHP Plant operates at the daily average ELVs for 8,700 hours per year and at the plausible abnormal emission levels for 60 hours per year. For hydrogen fluoride it has been assumed that the CHP Plant operates at the daily average ELVs for 660 hours and at the plausible abnormal emission levels for 60 hours – i.e. all the abnormal emissions occur in a single month.

Table 45: Long-term Impacts Resulting from Plausible Abnormal Emissions – CHP Only

Pollutant	AQAL (µg/m³)	Predicted Impact – Normal Operation		Predicted Impact – Abnormal Emissions	
		Conc. (µg/m³)	% of AQAL	Conc. (µg/m³)	% of AQAL
Nitrogen dioxide	40	1.71	4.27%	1.76	4.39%
Particulate matter (PM_{10})	40	0.12	0.30%	0.15	0.37%
Hydrogen fluoride*	16	0.09	0.57%	0.10	0.64%
Pollutant	**AQAL (ng/m³)**	**Predicted Impact – Normal Operation**		**Predicted Impact – Abnormal Emissions**	
		Conc. (ng/m³)	**% of AQAL**	**Conc. (ng/m³)**	**% of AQAL**
Antimony	5,000	0.28	0.006%	0.34	0.007%
Arsenic	6	0.61	10.15%	0.73	12.17%
Cadmium	5	0.24	4.87%	0.29	5.84%
Chromium (VI)	0.25	0.0032	1.27%	0.0038	1.52%
Lead	250	1.23	0.49%	1.47	0.59%
Manganese	150	1.46	0.97%	1.75	1.17%
Nickel (worst-case)	20	5.36	26.80%	6.43	32.13%
Nickel (2nd highest)	20	3.29	16.45%	3.94	19.71%
Nickel (3rd highest)	20	1.34	6.70%	1.61	8.03%
Nickel (mean)	20	0.37	1.83%	0.44	2.19%
PCBs	200	0.12	0.06%	0.20	0.10%
Notes:					

*All impacts annual mean with the exception of hydrogen fluoride which are a weekly mean concentration compared to the monthly mean AQAL.

The process contribution is not predicted to exceed any of the long term AQALs. The maximum predicted process contribution (as a % of the applied AQAL) is less than 33% for nickel (applying the worst-case assumption over the level of emissions), with all other pollutants lower.

10.6 Predicted Environmental Concentration – Abnormal Operations

The EA's Air Emissions Guidance includes the following method for identifying which emissions require further assessment by applying the following criteria:

- the long term process contribution is <1% of the long term environmental standard; and
- the short term process contribution is <10% of the short term environmental standard.

Where the impact of abnormal emissions is greater than the above criteria consideration of the background concentration has been made to ensure that the AQAL is not exceeded as a result of abnormal operations.

10.6.1 Predicted short term impacts

Table 46 below presents the predicted impacts of plausible abnormal operations of both lines of the CHP Plant in the short term at the point of maximum impact and the Predicted Environmental Concentration (PEC) (process contribution plus background) for those pollutants for which the impact presented in Table 3 is greater than 10%.

Table 46: Short Term PEC Resulting from Plausible Abnormal Emissions

Pollutant	AQAL (µg/m³)	Background Conc.	PC – Abnormal Emissions	PEC – Abnormal Emissions	
		µg/m³	µg/m³	µg/m³	% of AQAL
Nitrogen dioxide	200	29.60	64.16	93.76	46.88%
Sulphur dioxide (1-hour)	350	7.60	155.34	162.94	46.55%
Sulphur dioxide (15-min)	266	7.60	197.71	205.31	77.18%
Hydrogen chloride	750	1.42	454.01	455.43	60.72%
Pollutant	**AQAL (ng/m³)**	**Background Conc.**	**PC – Abnormal Emissions**	**PEC – Abnormal Emissions**	
		ng/m³	**ng/m³**	**ng/m³**	**% of AQAL**
Mercury (1-hour)	600	5.60	301.90	307.50	51.3%
Nickel (1-hour) (worst-case)	700	0.94	3320.94	3321.88	474.6%
Nickel (1-hour) (2nd highest)	700	0.94	2037.85	2038.79	291.3%
Nickel (1-hour) (3rd highest)	700	0.94	830.23	831.17	118.7%
Nickel (1-hour) (mean)	700	0.94	90.57	91.51	13.1%
Cadmium (24-hour)	30	0.96	13.15	14.11	47.0%
Copper (24-hour)	50	4.06	38.14	42.20	84.4%

Pollutant	AQAL (µg/m³)	Background Conc.	PC – Abnormal Emissions	PEC – Abnormal Emissions	
		µg/m³	µg/m³	µg/m³	% of AQAL
Mercury (24-hour)	60	5.60	26.30	31.90	53.2%

As shown, the PEC is not predicted to exceed the AQAL at the point of maximum impact for any pollutant during abnormal operations, with the exception of the worst-case scenarios for nickel. If it is assumed that during normal operation both lines of the CHP Plant operate at the mean nickel concentration monitored from an EfW Facility from the EA metals guidance the PEC is well below the AQAL.

10.6.2 Predicted long term impacts

Table 47 below presents the predicted impacts of plausible abnormal operations in the long term at the point of maximum impact, and the PEC. This assessment assumes that the CHP Plant operates at the plausible abnormal emission levels for 60 hours per year and the remaining 8,700 hours the CHP Plant operating at the ELVs.

Table 47: Long Term PEC Resulting from Plausible Abnormal Emissions

Pollutant	AQAL (µg/m³)	Background Conc.	PC – Abnormal Emissions	PEC – Abnormal Emission	
		µg/m³	µg/m³	µg/m³	% of AQAL
Nitrogen dioxide	40	14.80	1.76	16.56	41.4%
Pollutant	**AQAL (ng/m³)**	**Background Conc.**	**PC – Abnormal Emissions (1)**	**PEC – Abnormal Emission**	
		ng/m³	**ng/m³**	**ng/m³**	**% of AQAL**
Arsenic	6	0.48	0.73	1.21	20.2%
Cadmium	5	0.48	0.29	0.77	15.4%
Chromium VI	0.25	0.18	0.0038	0.18	71.9%
Manganese	150	2.29	1.75	4.04	2.7%
Nickel (worst-case)	20	0.47	6.43	6.90	34.5%
Nickel (2nd highest)	20	0.47	3.94	4.41	22.1%
Nickel (3rd highest)	20	0.47	1.61	2.08	10.4%
Nickel (mean)	20	0.47	0.44	0.91	4.5%

Note:
(1) The ground level impact has been calculated by apportioning the maximum monitored emission concentration for each metal to the total group 3 metal Process Contribution.

As shown, the PEC is not predicted to exceed the AQAL at the point of maximum impact for any pollutant during abnormal operations.

10.7 Summary

The predicted impact on air quality associated with the identified plausible abnormal emissions from the CHP Plant has been calculated by pro-rating the impact associated with normal operations by the ratio between the normal and plausible abnormal emission values. With regard to short-term impacts this is considered to be a highly conservative assessment as it assumes that the plausible abnormal emissions occur on both lines concurrently and they coincide with the worst-case meteorological conditions.

Even with these highly conservative factors, there are no predicted exceedences of any of the short term or long term AQALs associated with abnormal operations, with the exception of nickel under the worst-case emission concentrations. If it is assumed that nickel emissions during normal operation are at the mean concentration, rather than the maximum concentration monitored from an existing EfW facility which is an outlier, the predicted impact of abnormal operations does not cause am exceedence of any AQAL.

It is concluded that periods of abnormal operation of the CHP Plant as permissible under the IED (Article 46) is not predicted to give rise to an unacceptable impact on air quality or the environment.

11 Conclusions

This Dispersion Modelling Assessment has been undertaken to support an application for a variation to the EP for the IWMF to allow for a phased construction.

Of the activities within the EP there are emissions to air from the CHP Plant, the Pulp Plant, the AD gas engines, and AD biofilter, noting that the emissions from the Pulp Plant just contain moisture from the drying process and not any combustion products, and the emissions from the AD biofilter do not contain any combustion products. These all vent to atmosphere via a common stack containing a flue from each source. Therefore, the dispersion of emissions from the stack will depend upon the sourcing operating.

As part of the phasing of the IWMF it is proposed to only construct the parts of the building needed for the Phase 1 works (the CHP Plant). The presence of buildings can affect the dispersion of the emissions from the stack. Therefore, this assessment has considered the effect of the phased approach to the development of the IWMF taking into account the changes the size of the building and the sources venting to atmosphere via the common stack.

This assessment has shown that:

- There would generally be a lower impact with just the full IWMF operating compared to the CHP Plant due to increased dispersion as a result of combining the emissions from the Pulp Plant, AD gas engines and biofilter.
- Although the impact on local air quality would be greater with the phased approach emissions will not cause a breach of any AQAL and the total impact can be described as ‘not significant’.

In relation to the impact on human health:

- Although the impact on local air quality would be greater with the phased approach emissions will not cause a breach of any AQAL and the total impact can be described as ‘not significant’.
- There is no risk of exceeding an AQAL for any metal either on a long or short term basis.
- Emissions during abnormal operation of the CHP Plant, as defined under the IED, would not cause a breach of any AQAL.

In relation to the impact on ecologically sensitive sites:

- No European or UK designated receptors have been identified as requiring assessment, only six local wildlife sites.
- At all local ecological sites, the contribution from the IWMF either when fully operational, or with a partial build out, can be screened out ‘insignificant’ as it is less than the Critical Levels and Critical Loads.

In summary, the assessment has shown that whilst the development of only the CHP Plant would result in a slightly greater impact on local air quality the impact would not be significant. As such there should be no air quality constraint in granting a variation to the existing EP for the phased approach to the IWMF as proposed.

Appendices

A Figures

Legend

CCUS-HO Site Boundary

Client:	Indaver
Site:	Rivenhall
Project:	3659

Title:

Figure 3. Site Location

Drawn by: ---	Date: 18/07/2024

0 0.1 0.2 0.4 km

N

Scale: 1:10,000

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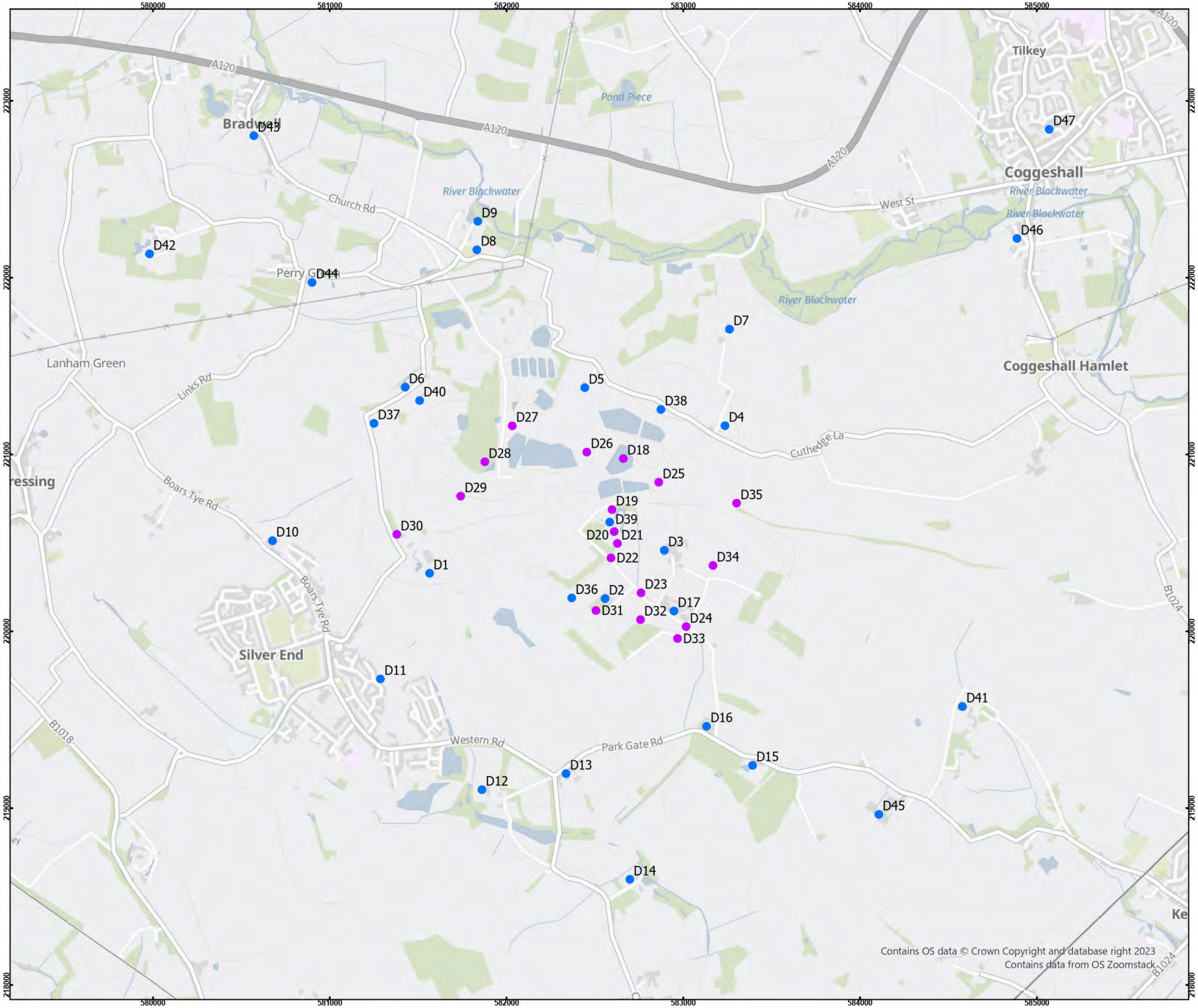
Consulting Engineers Limited

Kingsgate, Wellington Road North,
Stockport, Cheshire, SK4 1LW
Tel: 0161 476 0032
Fax: 0161 474 0618



Legend

- Human Receptors
- Footpath Receptors

Client:	Indaver
Site:	Rivenhall
Project:	3659

Title:

Figure 4. Human Sensitive Receptors

Drawn by: --- Date: 18/07/2024

Scale: 1:20,000

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Client:	Indaver
Site:	Rivenhall
Project:	3659

Title:

Figure 5. Eco Sensitive Receptors

Drawn by: --- Date: 18/07/2024

Scale: 1:20,000

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Legend

Monitoring_locations

Client:	Indaver
Site:	Rivenhall
Project:	3659
Title:	Figure 6. Monitoring Sites
Drawn by: ---	Date: 18/07/2024

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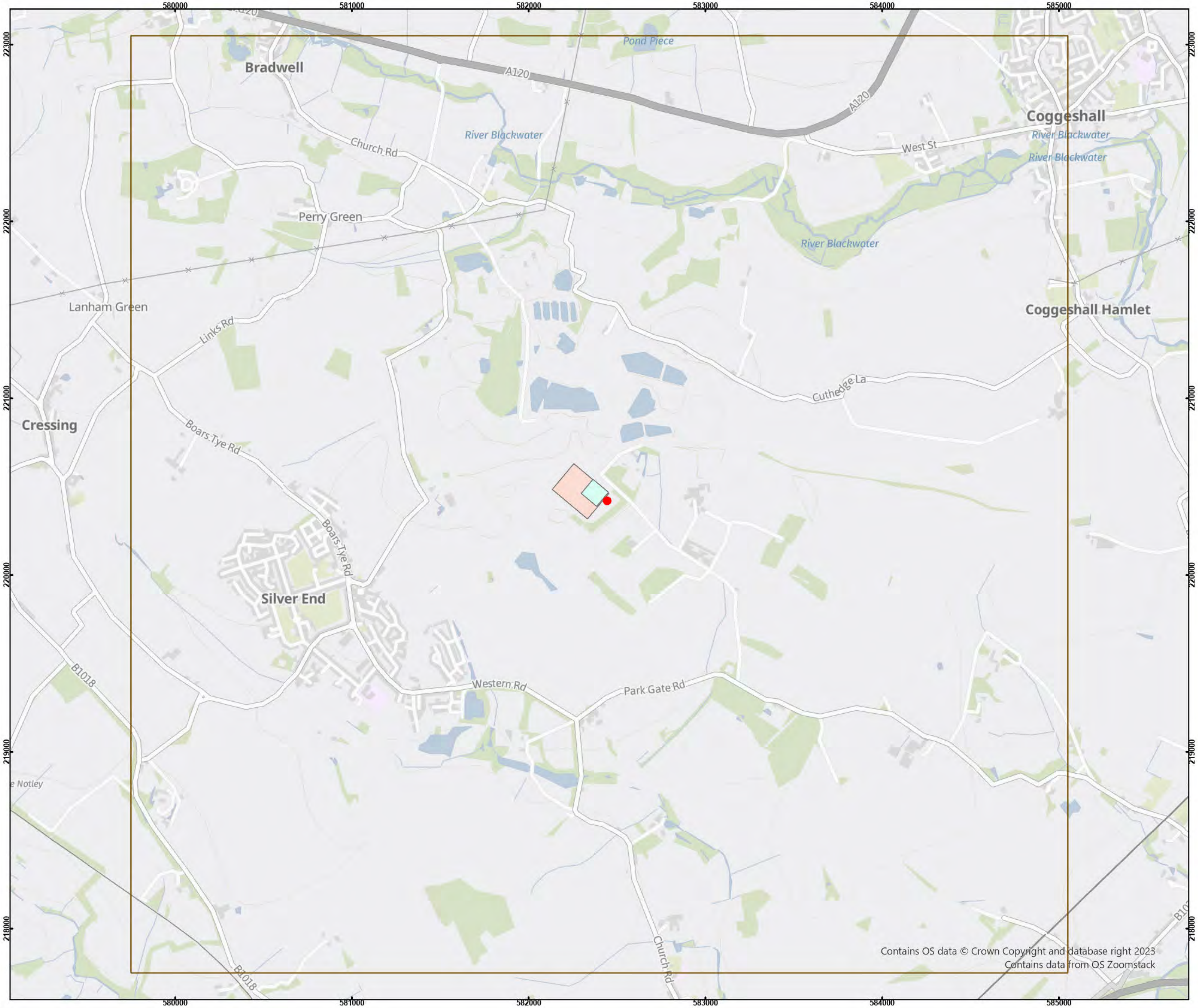

Legend

- Main Stack
- Output grid extents
- Phase 1 Building
- IWMF Building

Client:	Indaver
Site:	Rivenhall
Project:	3659
Title:	

Figure 7. Model Inputs

Drawn by: --- | Date: 18/07/2024

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Scale: 1:20,000

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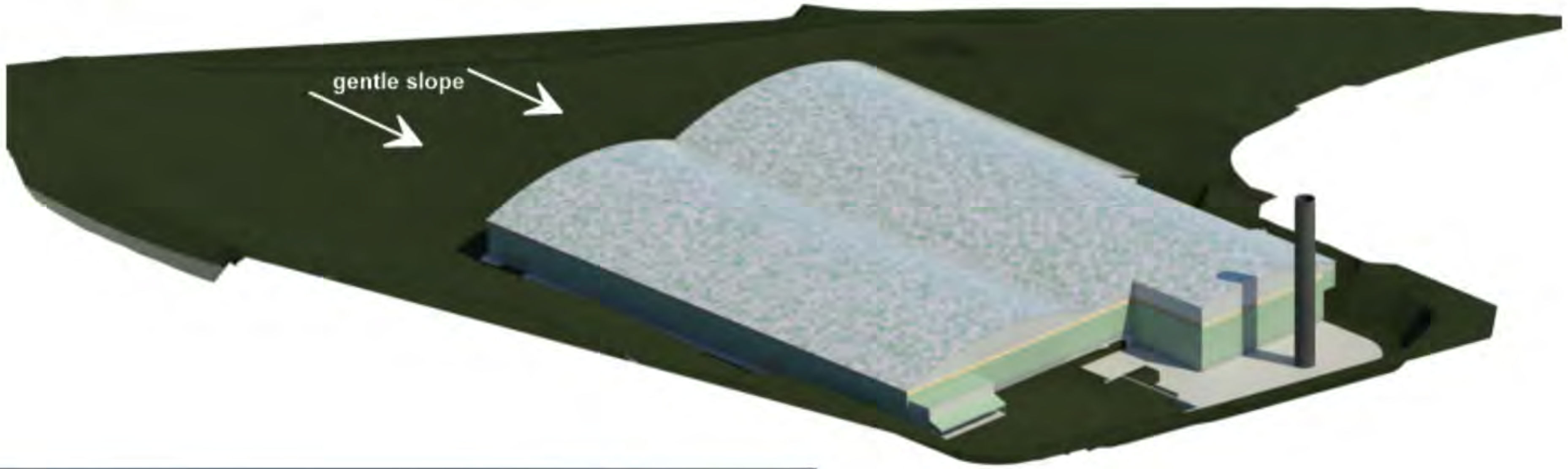

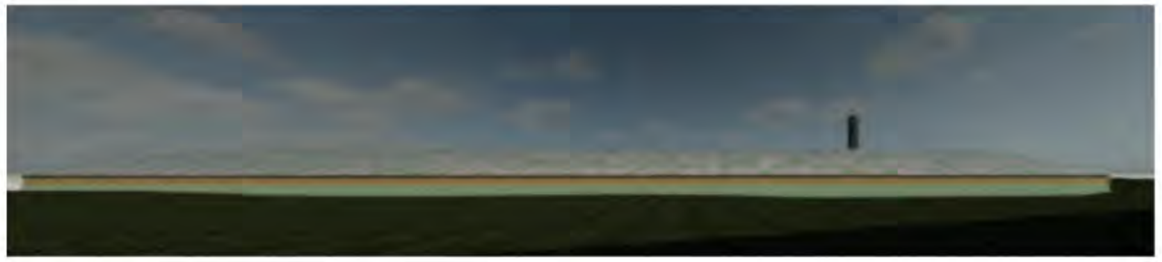

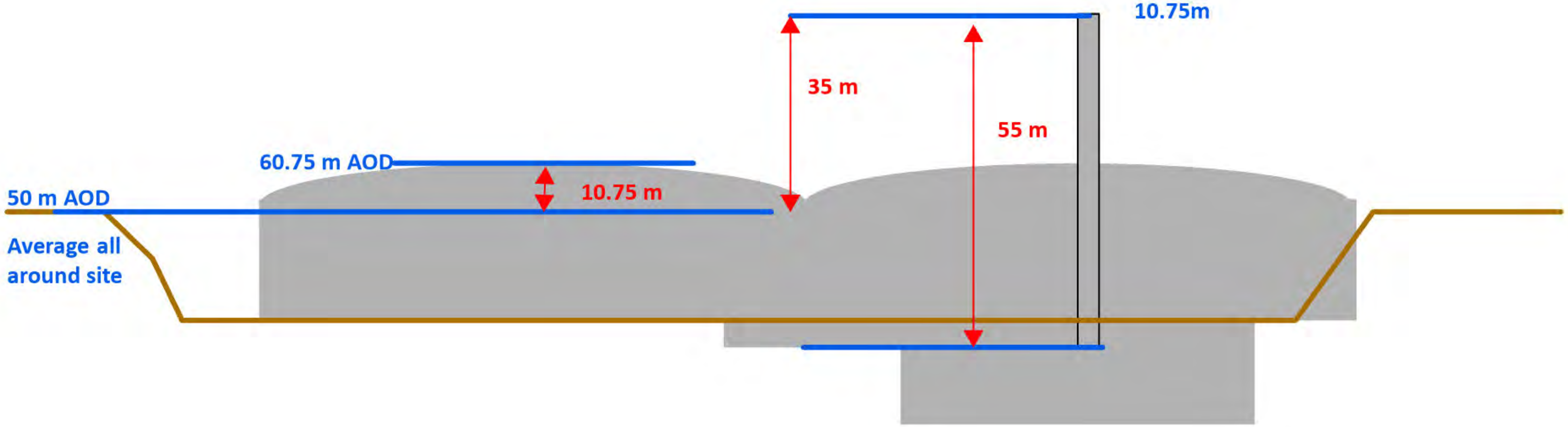

Legend

Notes:

Met data from Andrewsfield

Client:	Indaver
Site:	Rivenhall
Project:	3659

Title:

Figure 18. Building Schematic

Drawn by: --- Date: 18/07/2024

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Scale:

N

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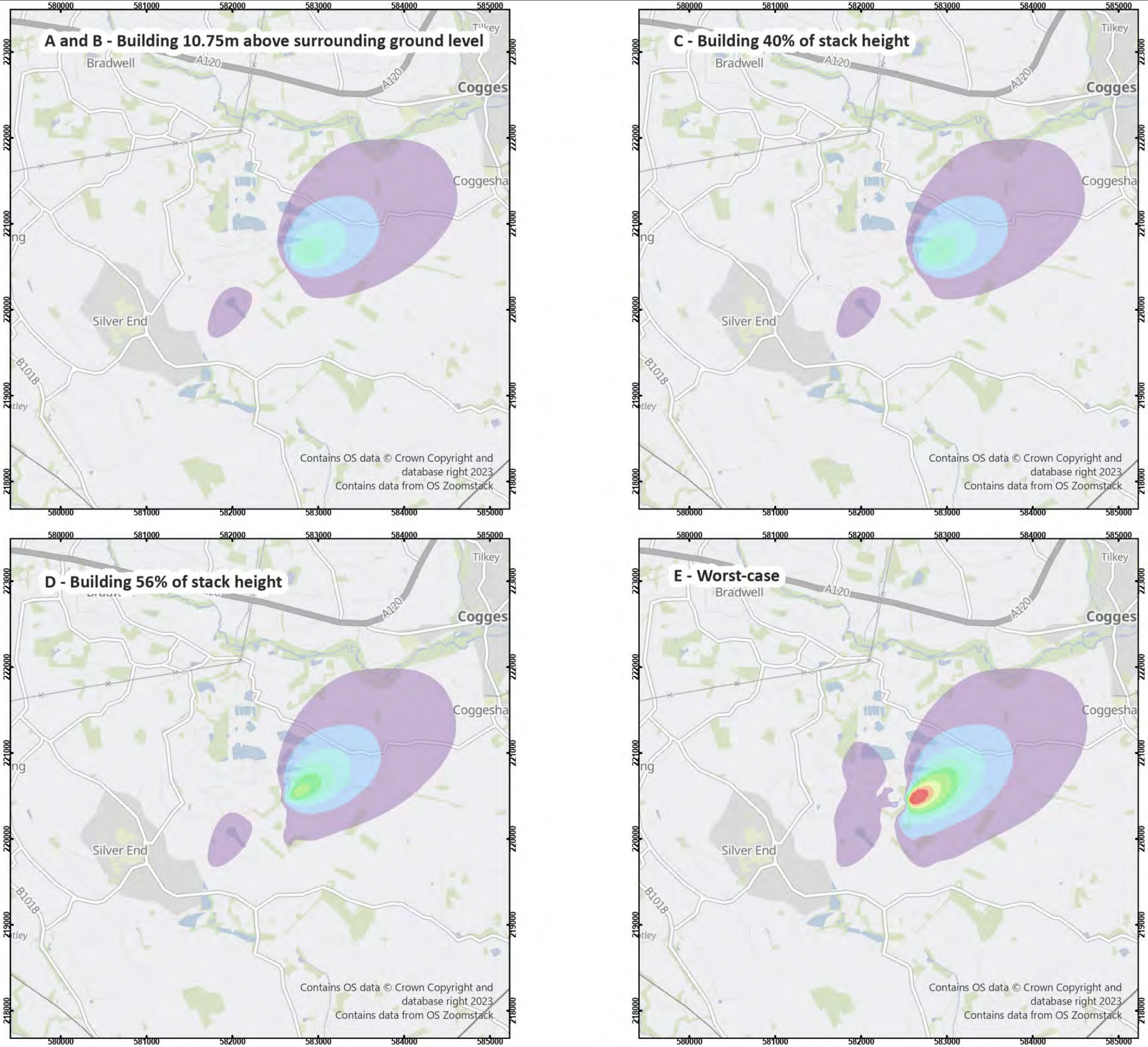

Legend

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	1.0 - 1.5
	1.5 - 2
	2.0 - 2.5
	2.5 - 3
	3.0 - 4
	4.0 - 5
	5.0 - 6
	6.0 - 7

Client:	Indaver
Site:	Rivenhall
Project:	3659

Title:

Figure 9. Annual Mean NOx Comparison

Drawn by: ---	Date: 18/07/2024

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N

Scale: 1:43,077

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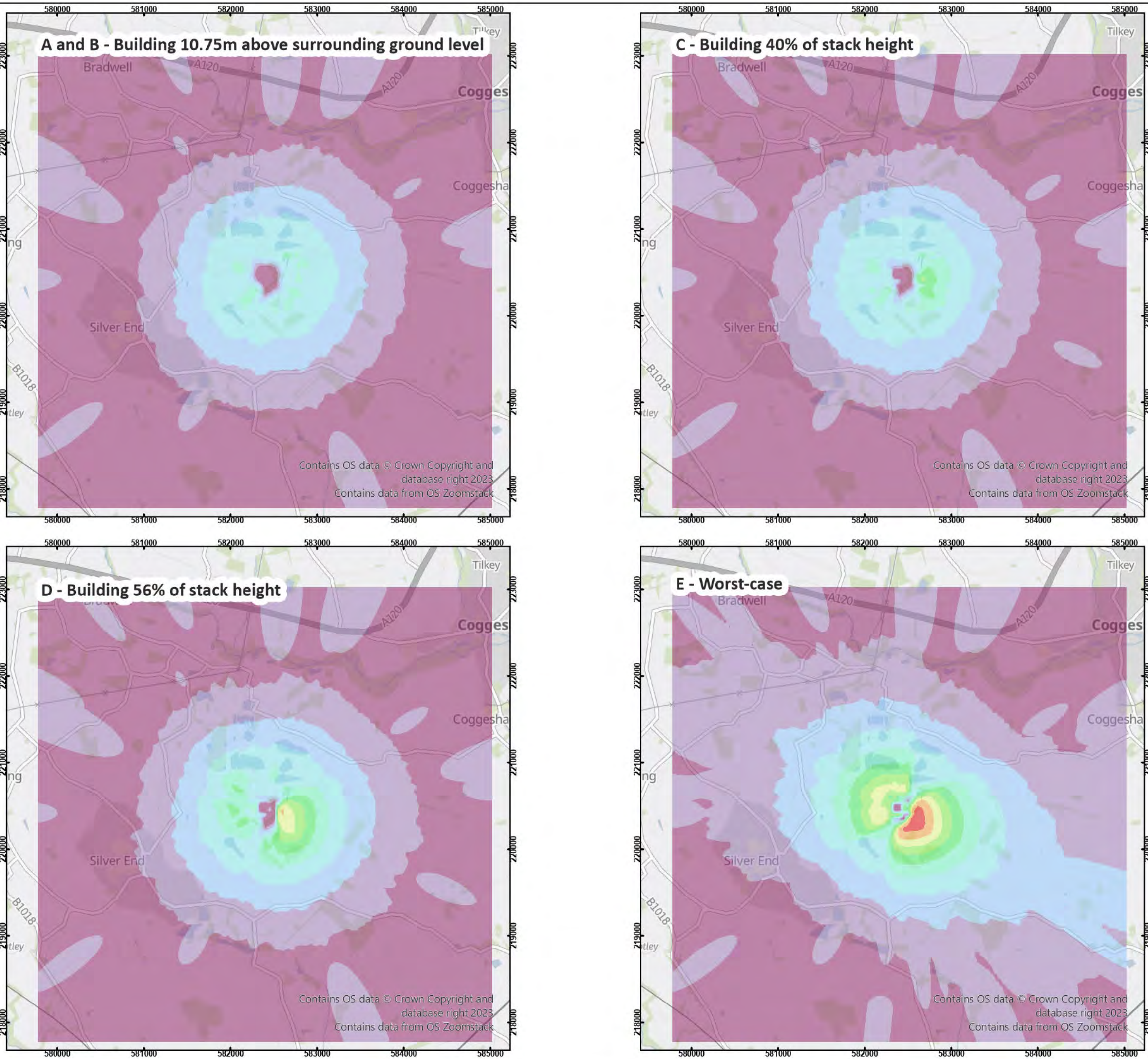
Fax: 0161 474 0618



Legend

Value

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- 10.154 - 14.722
- 14.723 - 20.814
- 20.815 - 28.429
- 28.43 - 37.059
- 37.06 - 47.212
- 47.213 - 59.396
- 59.397 - 75.133
- 75.134 - 100.008
- 100.009 - 129.452

Client:	Indaver
Site:	Rivenhall
Project:	3659

Title:

Figure 10. 1-hour NOx Comparison

Drawn by: ---	Date: 18/07/2024

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N

Scale: 1:43,077

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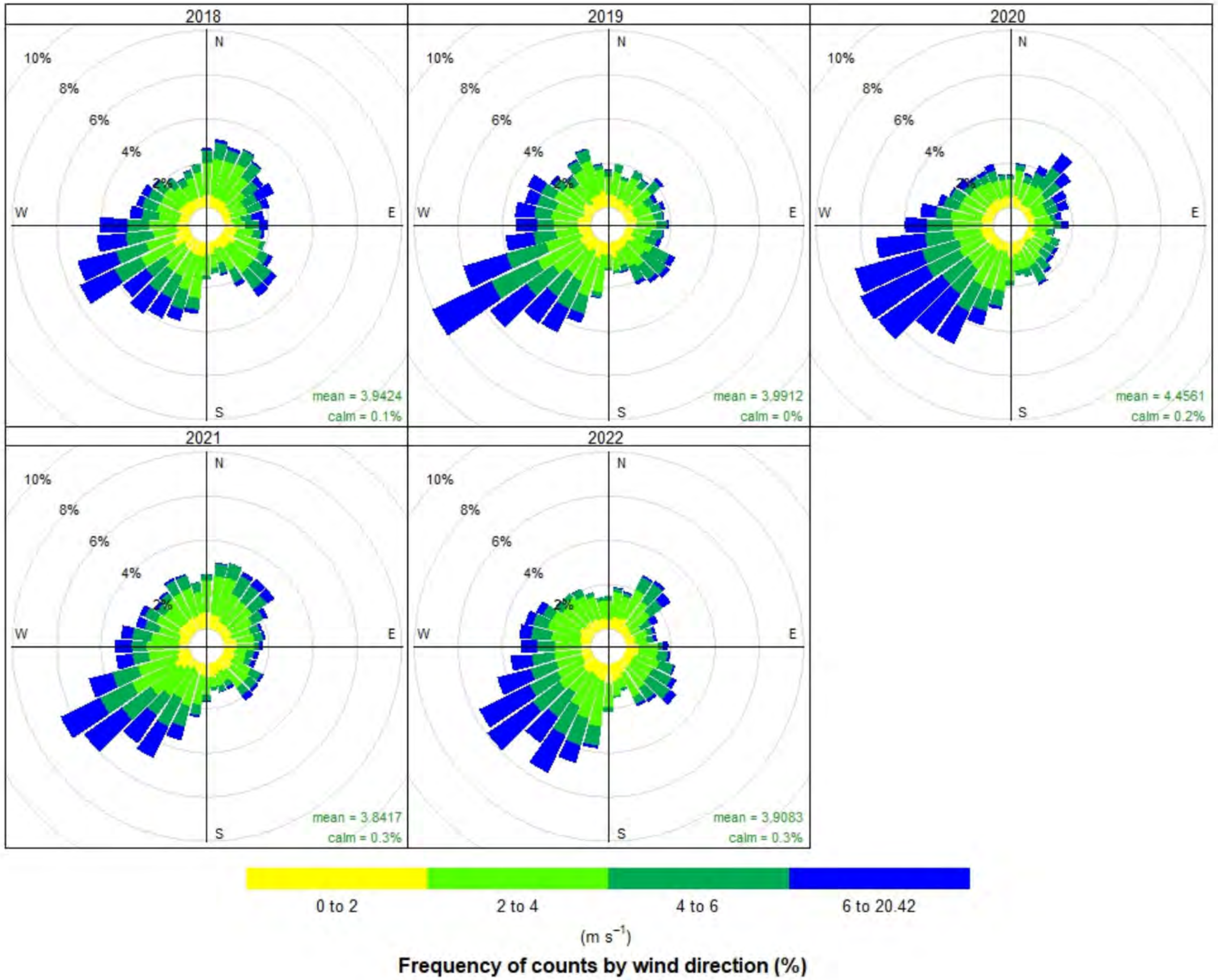
Fax: 0161 474 0618



Legend

Notes:

Met data from Andrewsfield

Client:	Indaver
Site:	Rivenhall
Project:	3659
Title:	

Figure 11. Wind Roses

Drawn by: --- Date: 18/07/2024

0 0.1 0.2 0.4 km

Scale:

N

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Tel: 0161 476 0032
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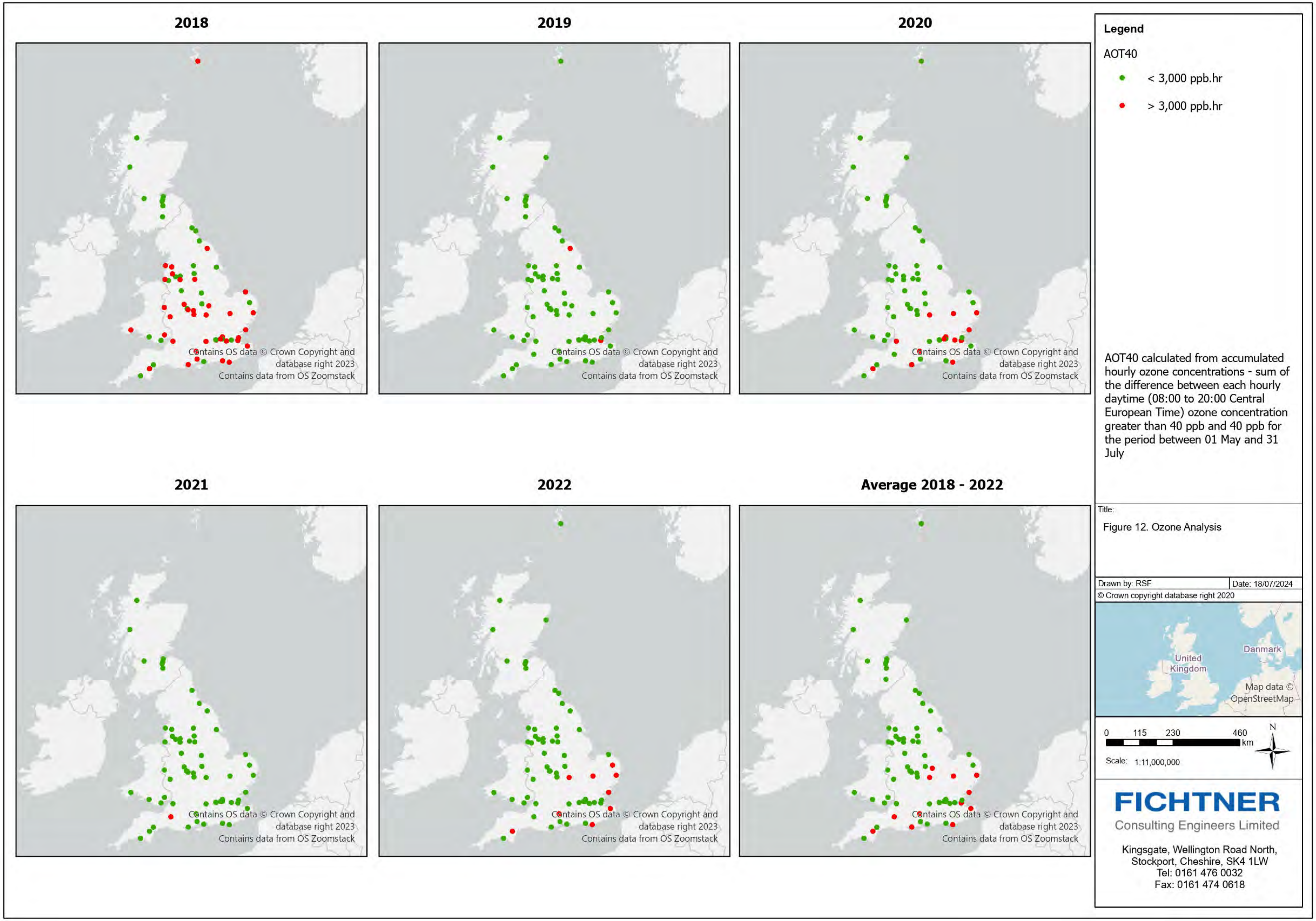
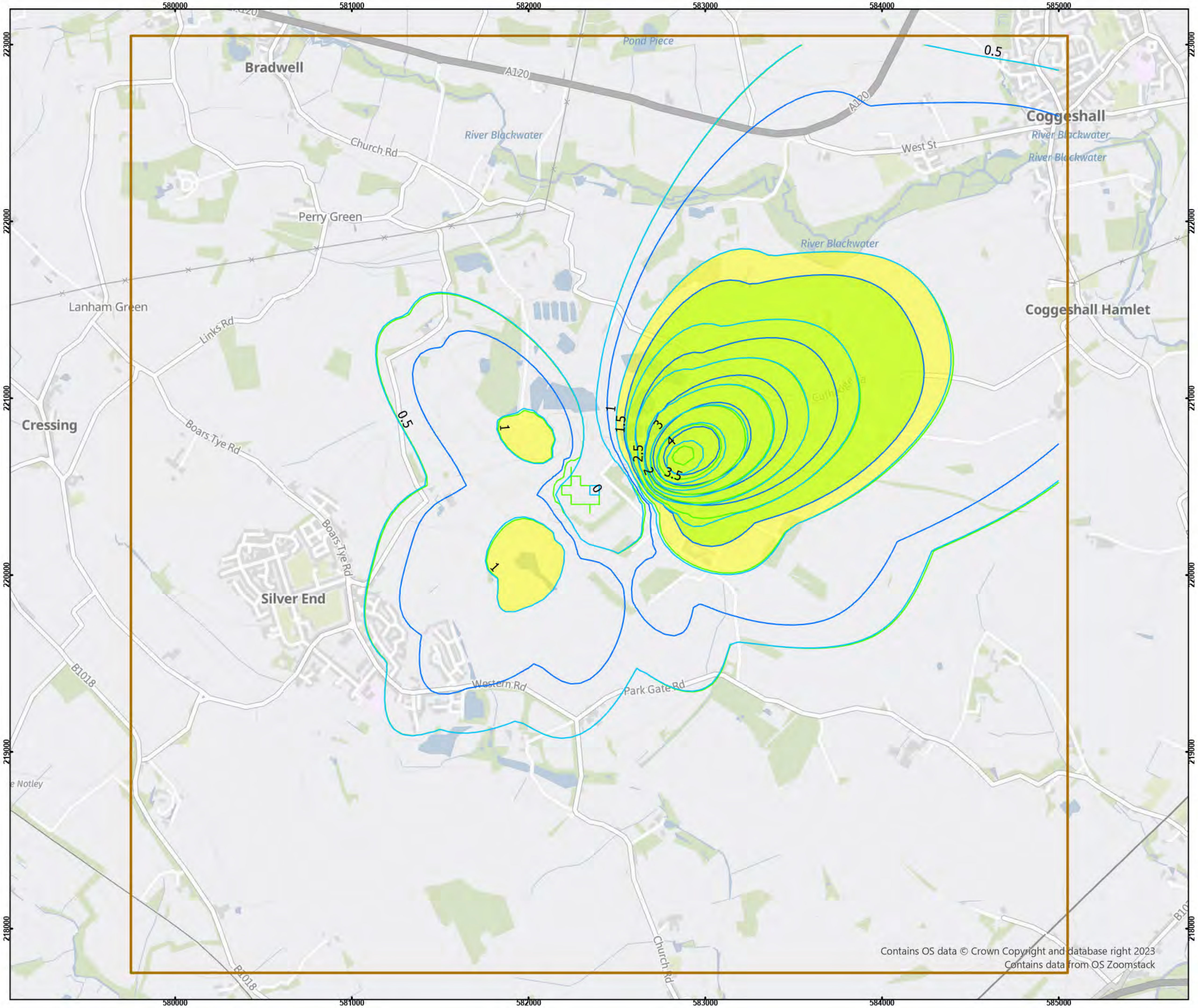


Figure 12. Ozone Analysis



Legend

- CHP Plant only - phase 1 build out
- CHP Plant only - full build out
- Permitted Facility
- Output grid extents

Notes:

Annual mean nitrogen dioxide as % of AQAL
Assumes 70% NOx to NO2 conversion rate

Client:	Indaver
Site:	Rivenhall
Project:	3659

Title:

Figure 13. Annual Mean Nitrogen Dioxide

Drawn by: --- Date: 18/07/2024

0 0.2 0.4 0.8 km

Scale: 1:20,000

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Tel: 0161 476 0032
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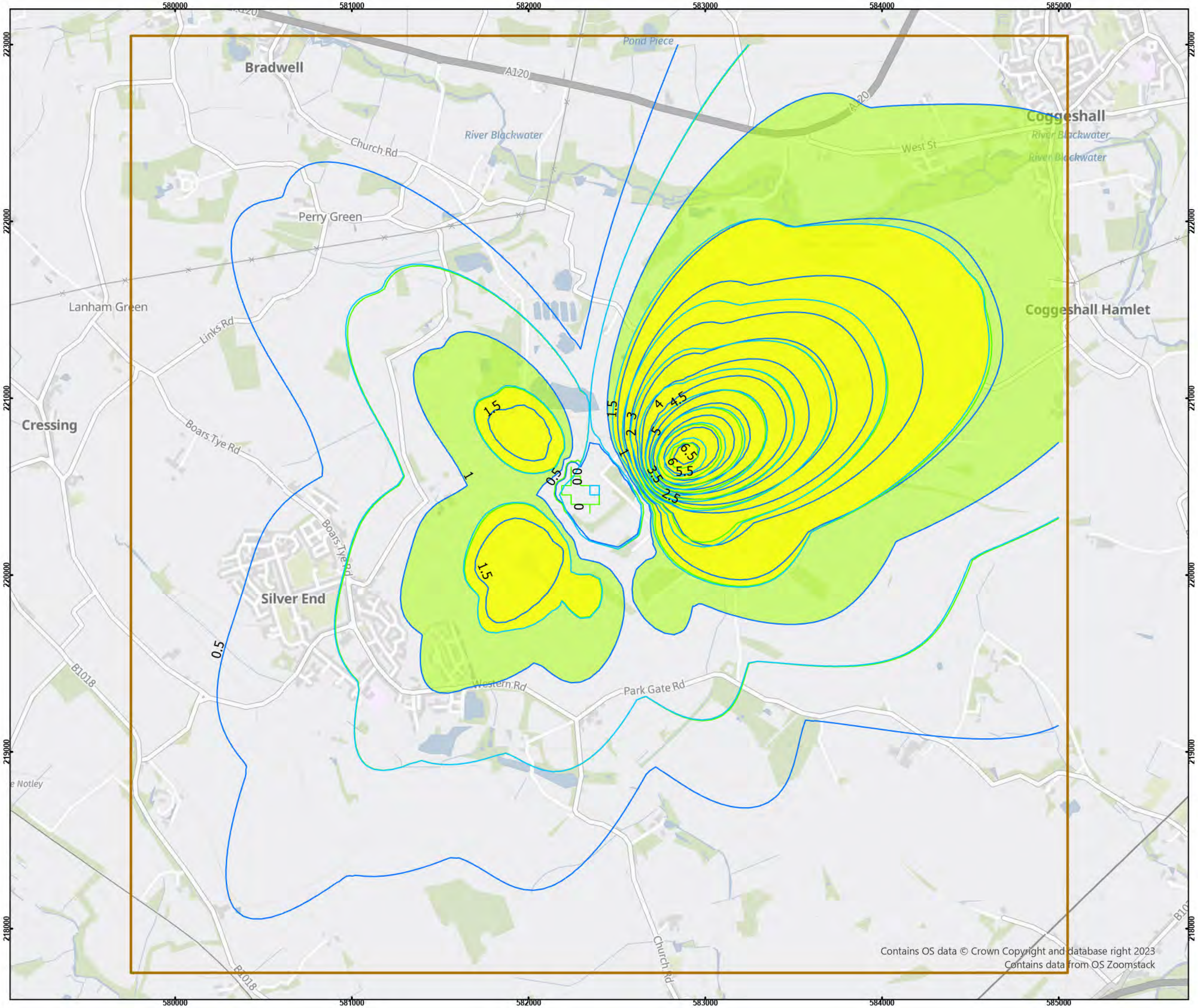

Legend

- CHP Plant only - phase 1 build out
- CHP Plant only - full build out
- Permitted Facility
- Output grid extents

Notes:

Assumes entire VOC is as benzene
Impact as % of AQAL for benzene

Client:	Indaver
Site:	Rivenhall
Project:	3659
Title:	Figure 14. Annual Mean VOCs as Benzene

Drawn by: --- Date: 18/07/2024

Braintree Coggeshall Map data © OpenStreetMap Essex Witham

0 0.2 0.4 0.8 km

N

Scale: 1:20,000

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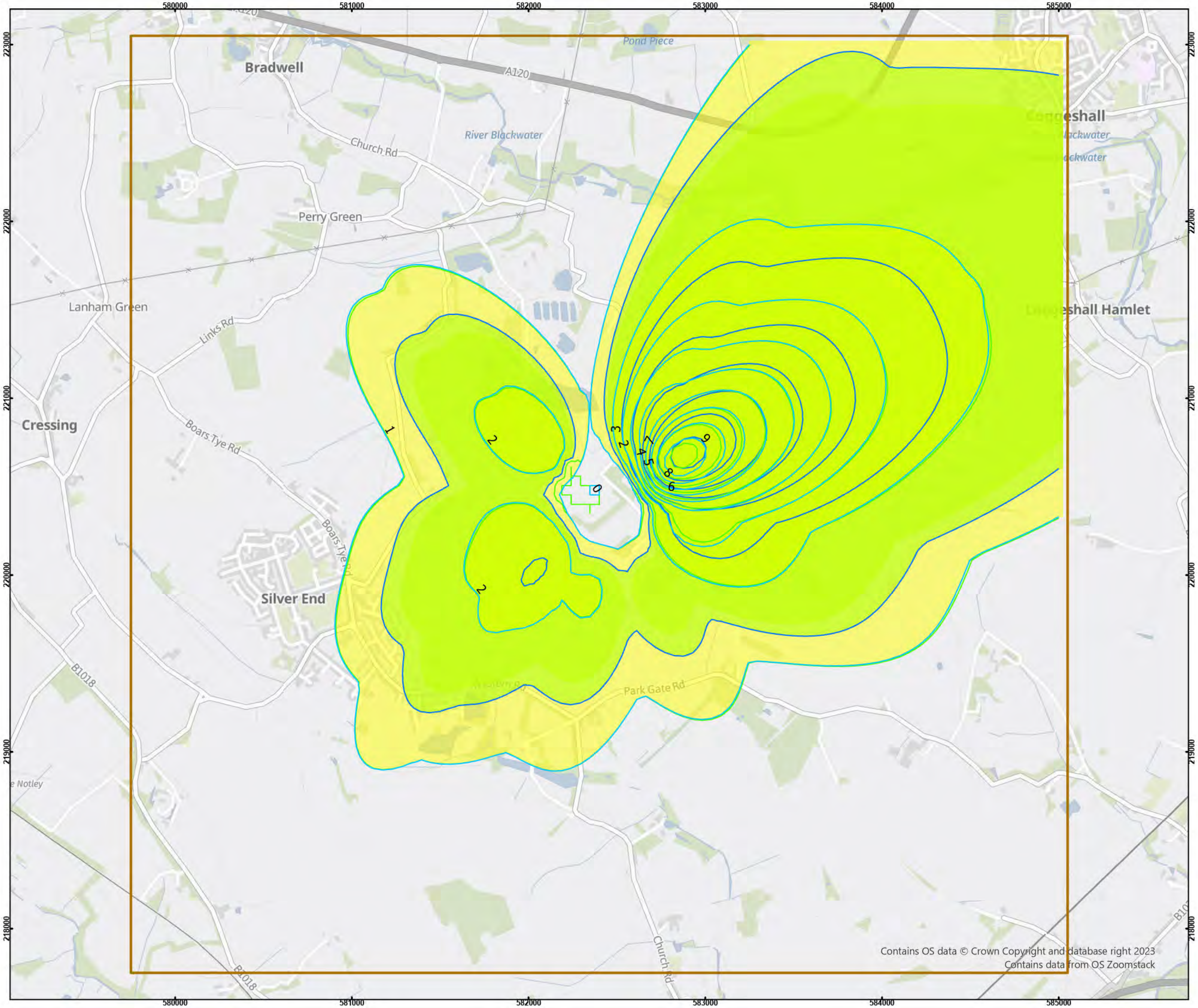

Legend

CHP Plant only - phase 1 build out

CHP Plant only - full build out

Permitted Facility

Output grid extents

Value

0.001 - 1

1.001 - 10

Value

0.001 - 1

1.001 - 10

Notes:

Assumes entire Cd and Tl is as cadmium
Impact as % of AQAL for cadmium

Client:	Indaver
Site:	Rivenhall
Project:	3659
Title:	

Figure 15. Annual Mean Cadmium

Drawn by: --- Date: 18/07/2024

0 0.2 0.4 0.8 km

Scale: 1:20,000

N

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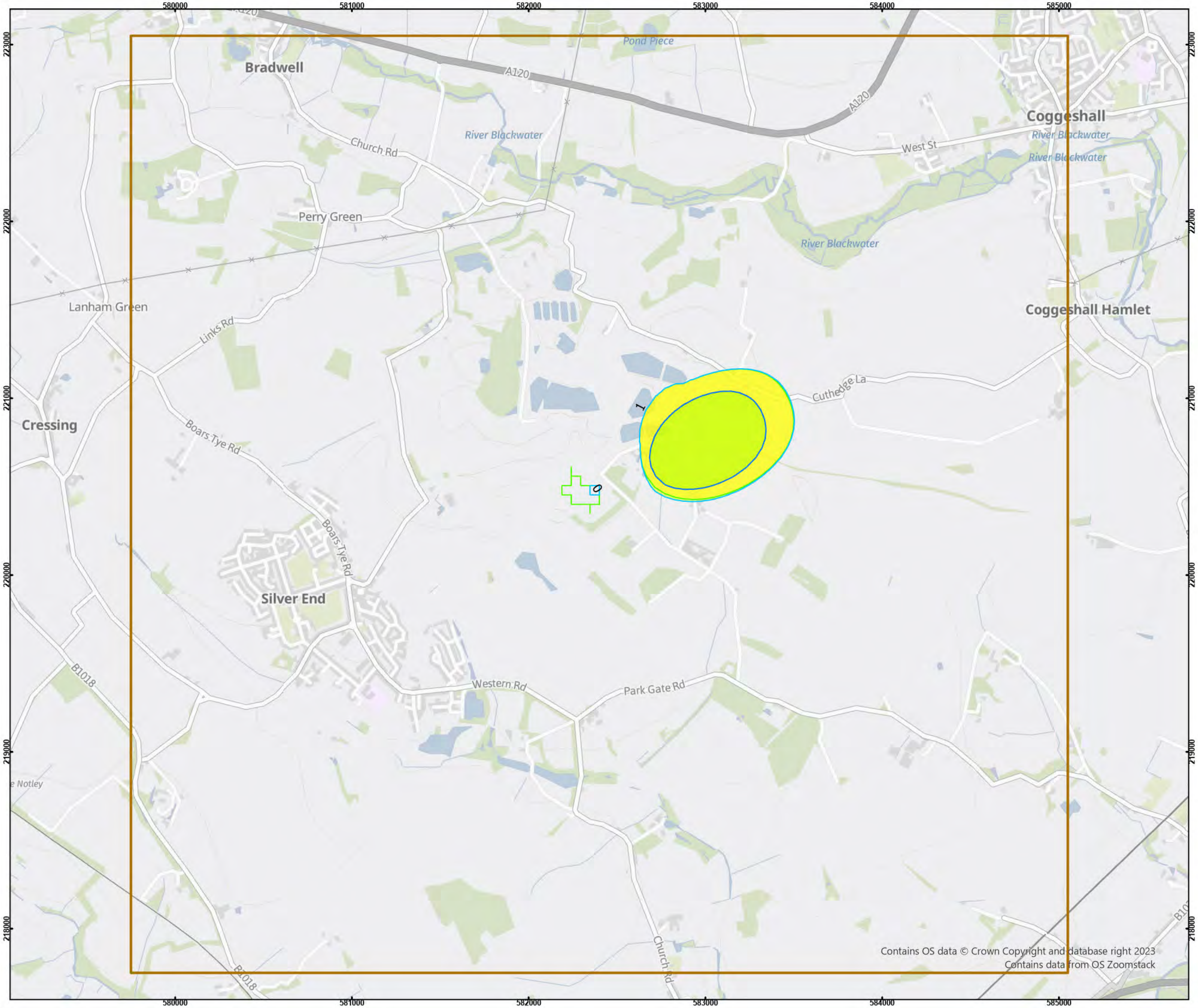

Legend

- CHP Plant only - phase 1 build out
- CHP Plant only - full build out
- Permitted Facility
- Output grid extents

Notes:

Assumes entire PAH is benzo(a)pyrene
Impact as % of AQAL for benzo(a)pyrene

Client:	Indaver
Site:	Rivenhall
Project:	3659

Title:

Figure 16. Annual Mean PAH

Drawn by: --- Date: 18/07/2024

0 0.2 0.4 0.8 km

N

Scale: 1:20,000

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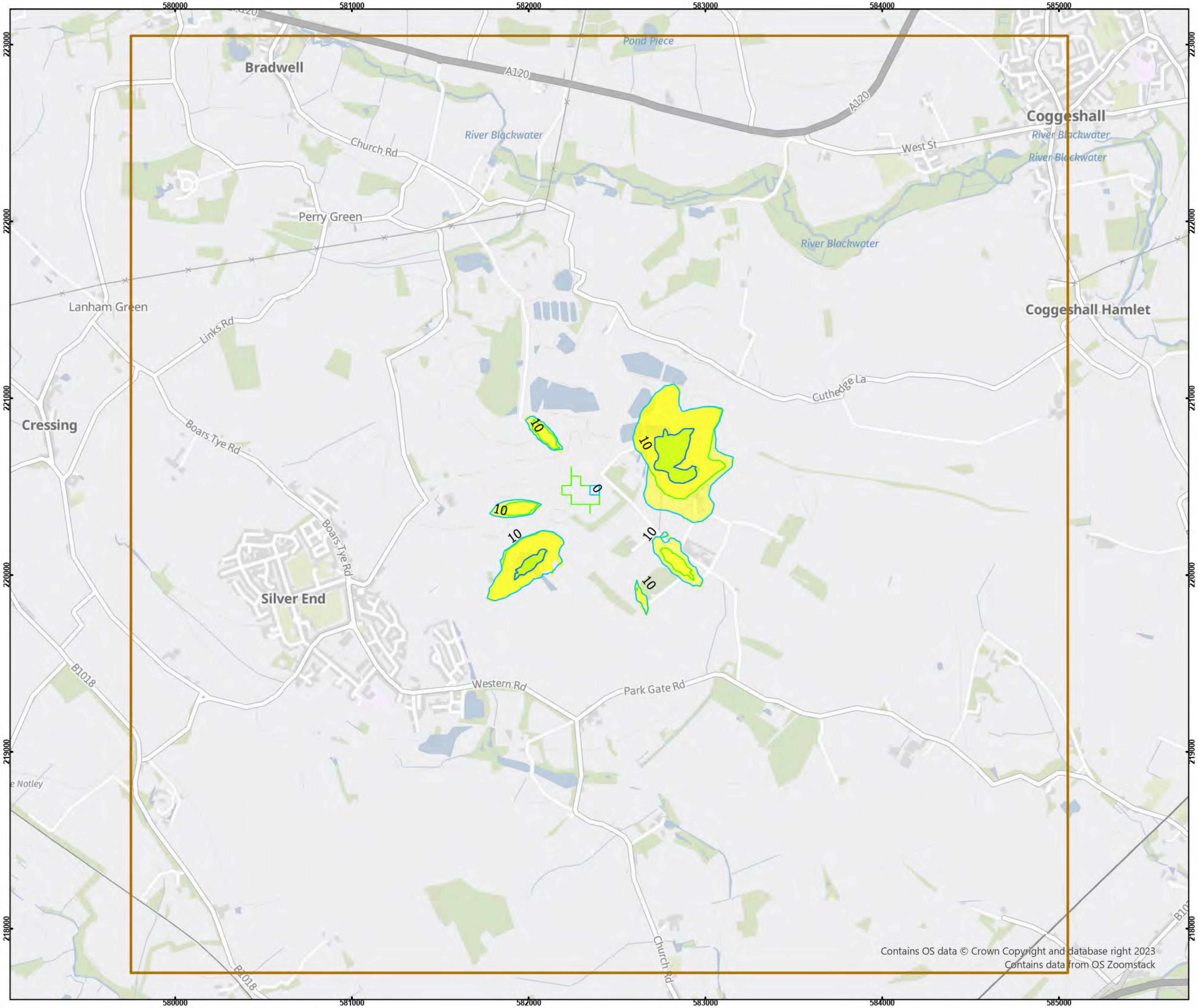

Legend

- CHP Plant only - phase 1 build out
- CHP Plant only - full build out
- Permitted Facility
- Output grid extents

Notes:

Assumes entire Cd and Tl is as cadmium
Impact as % of AQAL for cadmium

Client:	Indaver
Site:	Rivenhall
Project:	3659
Title:	

Figure 17. Daily Mean Cadmium

Drawn by: --- Date: 18/07/2024

0 0.2 0.4 0.8 km

N

Scale: 1:20,000

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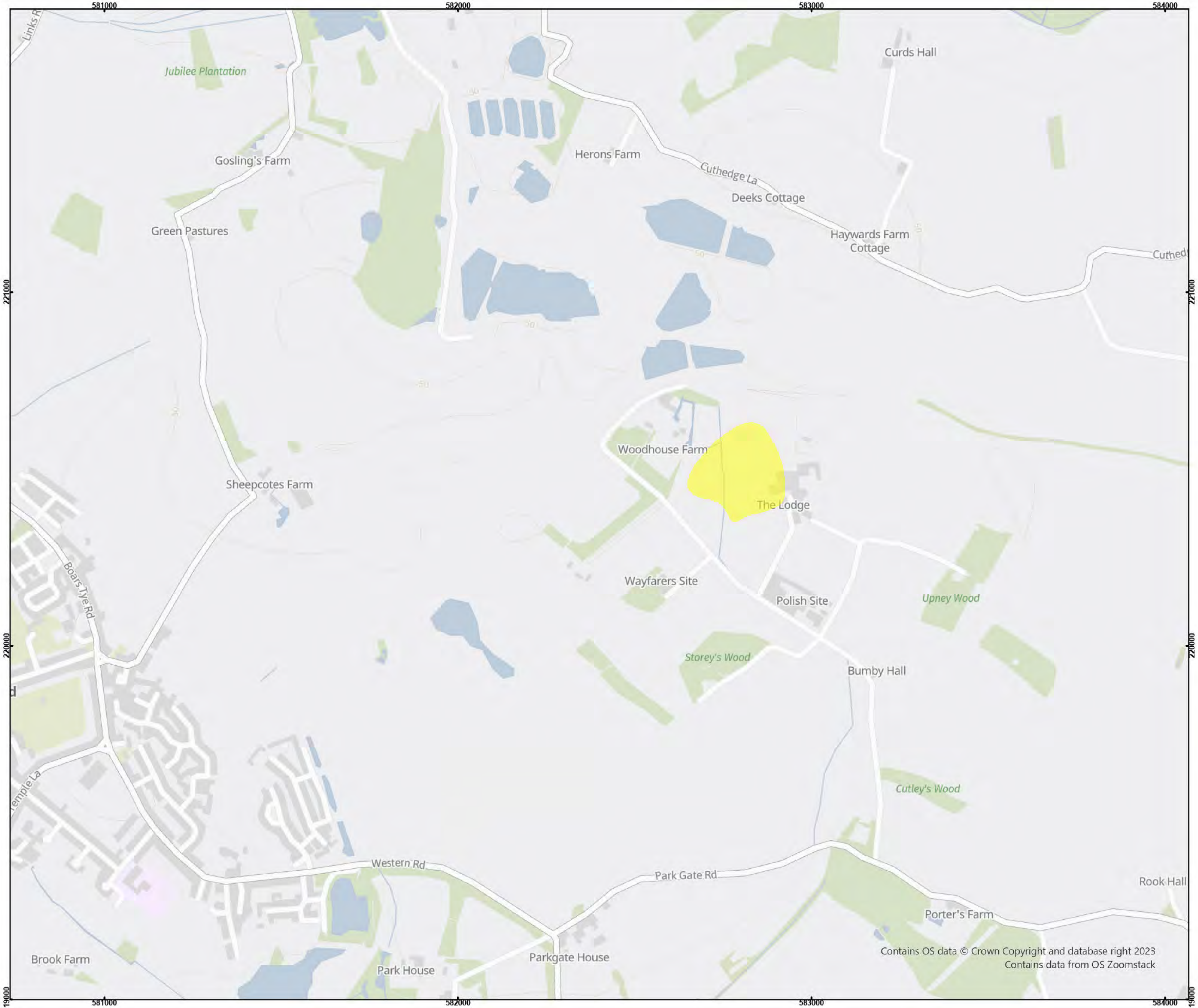
Tel: 0161 476 0032
Fax: 0161 474 0618



Legend

Output grid extents

Insignificant

Not insignificant

Notes:

99.79%ile 1-hour mean nitrogen dioxide as % of AQAL
Assumes 35% NOx to NO2 conversion rate
Assumes operation of both lines at the ST ELV

Client:	Indaver
Site:	Rivenhall
Project:	3659
Title:	Figure 18. 99.79%ile 1-hour Nitrogen Dioxide
Drawn by: ---	Date: 18/07/2024

0 0.1 0.2 0.4 km

Scale: 1:10,000

FICHTNER

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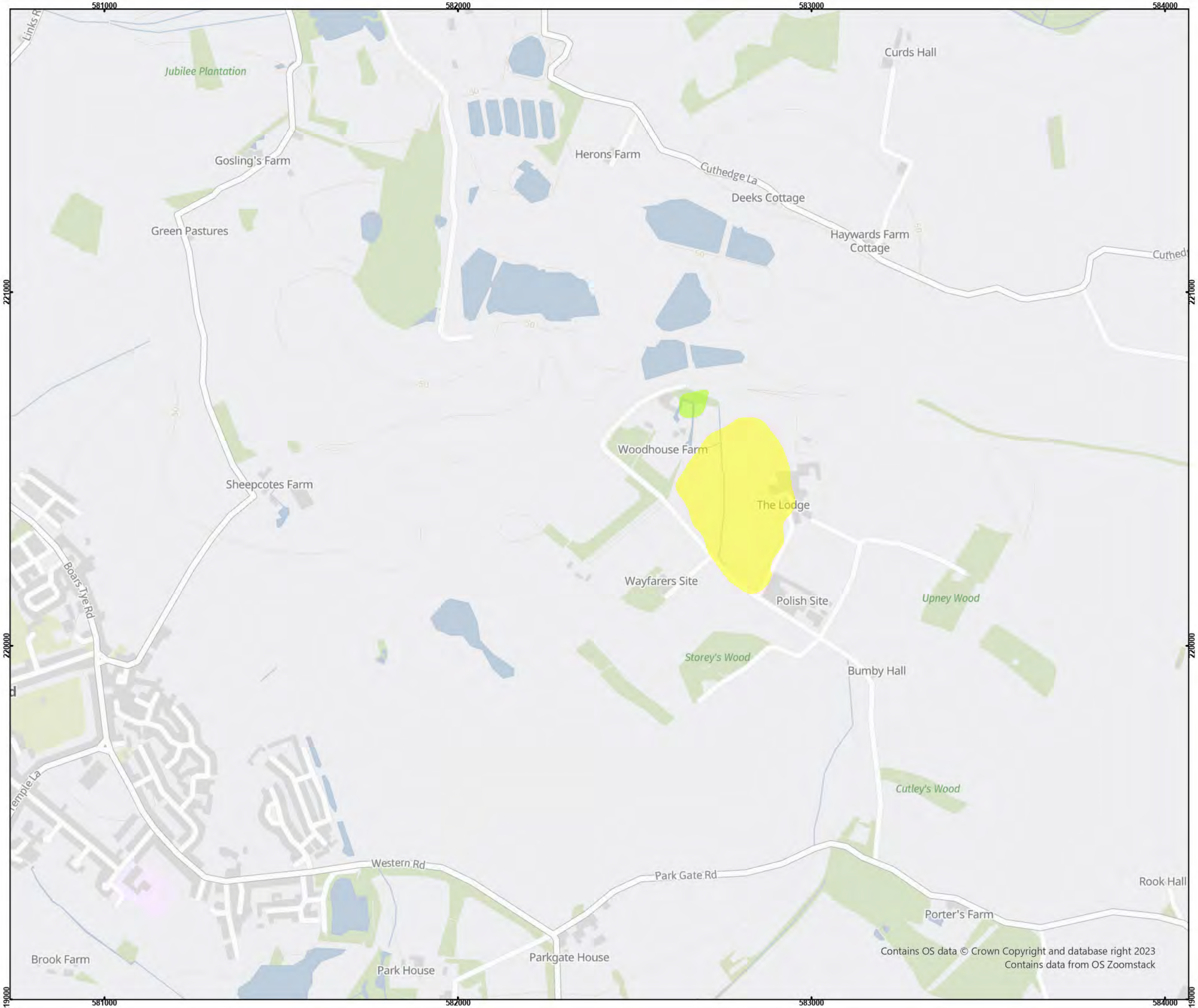
Tel: 0161 476 0032
Fax: 0161 474 0618



Legend

Output grid extents

Insignificant

Not Insignificant

Insignificant

Not Insignificant

Notes:

99.9%ile 15-minute sulphur dioxide as % of AQAL
Assumes operation of both lines at the ST ELV

Client:	Indaver
Site:	Rivenhall
Project:	3659
Title:	Figure 19. 99.9%ile 15-min Sulphur Dioxide
Drawn by: ---	Date: 18/07/2024

0 0.1 0.2 0.4 km

Scale: 1:10,000

FICHTNER
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Stockport, Cheshire, SK4 1LW
Tel: 0161 476 0032
Fax: 0161 474 0618

B APIS Critical Loads

Table 48: Nitrogen Deposition Critical Loads

ID	Site	Species/Habitat Type	NCL Class	kgN/hr/yr		
				Lower Critical Load	Upper Critical Load	Bg.
European and UK designated sites						
	None identified					
Local ecological sites						
E1	Blackwater Plantation	Broadleaved, mixed and yew woodlands	Broadleaved deciduous woodland	10	15	27.4
E2	Maxey's Spring	Calcareous grassland	Semi-dry Perennial calcareous grassland (basic meadow steppe)	10	20	14.6
E2	Maxey's Spring	Neutral grassland	Low and medium altitude hay meadows	10	20	14.6
E3	Storey's Wood	Broadleaved, mixed and yew woodlands	Broadleaved deciduous woodland	10	15	27.1
E4	Upney Wood	Broadleaved, mixed and yew woodlands	Broadleaved deciduous woodland	10	15	26.9
E5	Link's Wood	Broadleaved, mixed and yew woodlands	Broadleaved deciduous woodland	10	15	27.1
E6	Park House Meadow	Calcareous grassland	Semi-dry Perennial calcareous grassland (basic meadow steppe)	10	20	15.1
E6	Park House Meadow	Neutral grassland	Low and medium altitude hay meadows	10	20	15.1

Source: APIS

Table 49: Acid Deposition Critical Loads

ID	Site	Species/Habitat Type	Acidity Class	Lower Critical Load Function (keq/ha/yr)			Upper Critical Load Function (keq/ha/yr)			Maximum Background (keq/ha/yr) (N+S)
				CLminN	CLmaxN	CLmaxS	CLminN	CLmaxN	CLmaxS	
European and UK designated sites										
	None identified									
Local ecological sites										
E1	Blackwater Plantation	Broadleaved, mixed and yew woodlands	Broadleaved/Coniferous unmanaged woodland	0.142	1.692	1.55	-	-	-	1.96 | 0.15
E2	Maxey's Spring	Calcareous grassland	Calcareous grassland (using base cation)	1.071	5.071	4	-	-	-	1.04 | 0.13
E3	Storey's Wood	Broadleaved, mixed and yew woodlands	Broadleaved/Coniferous unmanaged woodland	0.214	10.915	10.701	-	-	-	1.92 | 0.15
E4	Upney Wood	Broadleaved, mixed and yew woodlands	Broadleaved/Coniferous unmanaged woodland	0.214	10.911	10.697	-	-	-	1.92 | 0.15
E5	Link's Wood	Broadleaved, mixed and yew woodlands	Broadleaved/Coniferous unmanaged woodland	0.357	8.63	8.273	-	-	-	1.93 | 0.15
E6	Park House Meadow	Calcareous grassland	Calcareous grassland (using base cation)	0.856	4.856	4	-	-	-	1.08 | 0.12

Source: APIS

C Detailed Results Tables – Permitted Facility

These results assume the full build out of the IWMF and the input parameters for each source as detailed in Section 5.

Table 50: Dispersion Modelling Results – PC at Point of Maximum Ground Level Impact - Daily ELVs - Permitted Facility

Pollutant	Quantity	Units	AQAL	Bg Conc.	2018	2019	2020	2021	2022	Max	Max as % of AQAL	PEC	PEC as % of AQAL
Nitrogen dioxide	Annual mean	µg/m³	40	14.8	0.85	1.17	1.34	0.93	1.03	1.34	3.34%	16.14	40.34%
	99.79th %ile of hourly means	µg/m³	200	29.6	8.11	8.71	9.23	7.97	8.22	9.23	4.62%	38.83	19.42%
Sulphur dioxide	99.18th %ile of daily means	µg/m³	125	7.6	4.00	4.02	4.45	3.73	4.14	4.45	3.56%	12.05	9.64%
	99.73rd %ile of hourly means	µg/m³	350	7.6	7.08	7.51	8.08	7.08	7.26	8.08	2.31%	15.68	4.48%
	99.9th %ile of 15 min. means	µg/m³	266	7.6	8.17	8.54	9.24	7.98	8.71	9.24	3.47%	16.84	6.33%
Particulates (PM_{10})	Annual mean	µg/m³	40	18	0.06	0.08	0.09	0.06	0.07	0.09	0.23%	18.09	45.23%
	90.41st %ile of daily means	µg/m³	50	36	0.23	0.29	0.33	0.24	0.26	0.33	0.66%	36.33	72.66%
Particulates ($PM_{2.5}$)	Annual mean	µg/m³	20	10.9	0.06	0.08	0.09	0.06	0.07	0.09	0.46%	10.99	54.96%
	Annual mean – 2040 target	µg/m³	10	10.9	0.06	0.08	0.09	0.06	0.07	0.09	0.92%	10.99	109.9%
Carbon monoxide	8 hour running mean	µg/m³	10,000	454	13.87	14.65	15.75	13.20	13.35	15.75	0.16%	469.75	4.70%
	Hourly mean	µg/m³	30,000	454	17.64	17.18	17.81	17.44	18.21	18.21	0.06%	472.21	1.57%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	1.72	1.68	1.74	1.70	1.78	1.78	0.24%	3.20	0.43%
Hydrogen fluoride	Monthly mean*	µg/m³	16	2.35	0.06	0.06	0.07	0.06	0.06	0.07	0.44%	2.42	15.12%
	Hourly mean	µg/m³	160	4.7	0.29	0.28	0.29	0.28	0.30	0.30	0.19%	5.00	3.12%
Ammonia	Annual mean	µg/m³	180	1.8	0.12	0.16	0.18	0.13	0.14	0.18	0.10%	1.98	1.10%

Pollutant	Quantity	Units	AQAL	Bg Conc.	2018	2019	2020	2021	2022	Max	Max as % of AQAL	PEC	PEC as % of AQAL
	Hourly mean	µg/m³	2,500	3.6	2.87	2.79	2.90	2.84	2.96	2.96	0.12%	6.56	0.26%
VOCs (as benzene)	Annual mean	µg/m³	5	0.4	0.21	0.29	0.33	0.23	0.26	0.33	6.66%	0.73	14.66%
	Daily mean	µg/m³	30	0.8	2.66	2.94	2.93	2.80	2.92	2.94	9.81%	3.74	12.47%
Mercury	Daily mean	ng/m³	60	5.6	2.92	3.24	3.23	3.08	3.22	3.24	5.40%	8.84	14.73%
	Hourly mean	ng/m³	600	5.6	5.74	5.59	5.79	5.67	5.92	5.92	0.99%	11.52	1.92%
Cadmium	Annual mean	ng/m³	5	0.48	0.23	0.32	0.37	0.26	0.28	0.37	7.33%	0.85	16.93%
	Daily mean	ng/m³	30	0.96	2.92	3.24	3.23	3.08	3.22	3.24	10.80%	4.20	14.00%
PaHs	Annual mean	pg/m³	250	110	2.33	3.22	3.67	2.56	2.83	3.67	1.47%	113.67	45.47%
Dioxins and Furans	Annual mean	fg/m³	-	32.99	0.70	0.96	1.10	0.77	0.85	1.10	-	34.09	-
PCBs	Annual mean	ng/m³	200	0.13	0.06	0.08	0.09	0.06	0.07	0.09	0.05%	0.22	0.11%
	Hourly mean	ng/m³	6,000	0.26	0.73	0.81	0.81	0.77	0.80	0.81	0.01%	1.07	0.02%

Note:

Assumes continuous operation of both lines of the CHP Plant at the daily ELVs, the AD gas engines at the hourly ELVs, and the contribution from the pulp plant and AD biofilter.

The maximum weekly mean hydrogen fluoride impact has been compared to the monthly mean AQAL. This is considered to be a worst-case as the monthly mean would be lower than the weekly mean.

Table 51: Dispersion Modelling Results – PC at Point of Maximum Ground Level Impact - Short-Term ELVs - Permitted Facility

Pollutant	Quantity	Units	AQAL	Bg Conc.	2018	2019	2020	2021	2022	Max	Max as % of AQAL	PEC	PEC as % of AQAL
Nitrogen dioxide	99.79th %ile of hourly means	µg/m³	200	29.6	15.91	17.08	18.10	15.62	16.12	18.10	9.05%	47.70	23.85%
Sulphur dioxide	99.73rd %ile of hourly means	µg/m³	350	7.6	20.01	21.23	22.83	20.02	20.52	22.83	6.52%	30.43	8.69%
	99.9th %ile of 15 min. means	µg/m³	266	7.6	23.09	24.14	26.12	22.56	24.62	26.12	9.82%	33.72	12.68%
Carbon monoxide	8 hour running mean	µg/m³	10,000	454	25.17	26.59	28.59	23.95	24.23	28.59	0.29%	482.59	4.83%
	Hourly mean	µg/m³	30,000	454	32.00	31.17	32.32	31.65	33.04	33.04	0.11%	487.04	1.62%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	17.24	16.79	17.41	17.05	17.80	17.80	2.37%	19.22	2.56%

Note:
Assumes continuous operation of both lines of the CHP Plant at the half-hourly ELVs, the AD gas engines at the hourly ELVs, and the contribution from the pulp plant and AD biofilter.

Table 52: Long-Term Metals Results – Point of Maximum Impact

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	6	0.48	5.50	91.65%	5.98	99.65%	8.3%	0.46	7.64%	0.94	15.64%
Antimony	5,000	1.30	5.50	0.11%	6.80	0.14%	3.8%	0.21	0.004%	1.51	0.03%
Chromium	-	0.88	5.50	-	6.38	-	30.7%	1.69	-	2.57	-
Chromium (VI)	0.25	0.18	5.50	2199.7%	5.68	2270.1%	0.043%	0.00	0.95%	0.18	71.35%
Cobalt	-	0.04	5.50	-	5.54	-	1.9%	0.10	-	0.14	-
Copper	-	2.03	5.50	-	7.53	-	9.7%	0.53	-	2.56	-
Lead	250	2.83	5.50	2.20%	8.33	3.33%	16.8%	0.92	0.37%	3.75	1.50%
Manganese	150	2.29	5.50	3.67%	7.79	5.19%	20.0%	1.10	0.73%	3.39	2.26%
Nickel	20	0.47	5.50	27.50%	5.97	29.85%	73.3%	4.03	20.16%	4.50	22.51%
Vanadium	-	0.69	5.50	-	6.19	-	2.0%	0.11	-	0.80	-

Notes:
(1) Metal as maximum percentage of the group 3 metals ELV, recalculated from the data presented in EA metals guidance document (V.4) Table A1.

Table 53: Short Term Metals Results – Point of Maximum Impact

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	-	0.96	88.82	-	89.78	-	8.3%	7.40	-	8.36	-
Antimony	150,000	2.60	88.82	0.06%	91.42	0.06%	3.8%	3.40	0.002%	6.00	0.00%
Chromium*	2,000	1.76	48.60	2.43%	50.36	2.52%	30.7%	14.90	0.75%	16.66	0.83%
Chromium (VI)	-	0.35	88.82	-	89.17	-	0.043%	0.04	-	0.39	-
Cobalt	-	0.08	88.82	-	88.90	-	1.9%	1.66	-	1.74	-
Copper*	50	4.06	48.60	97.20%	52.66	105.32%	9.7%	4.70	9.40%	8.76	17.52%
Lead	-	5.66	88.82	-	94.48	-	16.8%	14.89	-	20.55	-
Manganese	1,500,000	4.58	88.82	0.01%	93.40	0.01%	20.0%	17.76	0.001%	22.34	0.001%
Nickel	700	0.94	88.82	12.69%	89.76	12.82%	73.3%	65.14	9.31%	66.08	9.44%
Vanadium*	1,000	1.38	48.60	4.86%	49.98	5.00%	2.0%	0.97	0.10%	2.35	0.24%

Notes:

(1) Metal as maximum percentage of the group 3 metals ELV, recalculated from the data presented in EA metals guidance document (V.4) Table A1.

*All hourly mean impacts with the exception of those marked with a * which are daily mean impacts.*

Table 54: Impact at Ecological Sites - Permitted Facility

ID	Site	Oxides of nitrogen (µg/m^3)		Sulphur dioxide (µg/m^3)	Hydrogen fluoride (µg/m^3)		Ammonia (µg/m^3)
		Annual mean	Daily mean	Annual mean	Weekly mean	Daily mean	Annual mean
European and UK designated sites							
	None identified						
Local ecological sites							
E1	Blackwater Plantation	0.24	4.49	0.08	0.01	0.04	0.02
E2	Maxey's Spring	0.32	9.09	0.10	0.03	0.09	0.03
E3	Storey's Wood	0.41	9.89	0.13	0.02	0.09	0.04
E4	Upney Wood	0.50	8.10	0.16	0.03	0.08	0.05
E5	Link's Wood	0.13	2.88	0.04	0.01	0.03	0.01
E6	Park House Meadow	0.24	4.49	0.08	0.01	0.04	0.02
Notes: *Assumes continuous operation of both lines of the CHP Plant at the daily ELVs, the AD gas engines at the hourly ELVs, and the contribution from the pulp plant and AD biofilter.*							

Table 55: Impact at Ecological Sites - Permitted Facility

ID	Site	Oxides of nitrogen (% CL)		Sulphur dioxide (% CL)	Hydrogen fluoride (% CL)		Ammonia (% CL)
		Annual mean	Daily mean	Annual mean	Weekly mean	Daily mean	Annual mean
Critical level (µg/m^3)		**30**	**200**	**10**	**0.5**	**5**	**1**
European and UK designated sites							
	None identified						
Local ecological sites							
E1	Blackwater Plantation	0.81%	5.99%	0.77%	2.57%	0.86%	2.34%
E2	Maxey's Spring	1.06%	12.12%	1.00%	5.14%	1.74%	3.05%
E3	Storey's Wood	1.36%	13.18%	1.29%	4.37%	1.90%	3.92%
E4	Upney Wood	1.66%	10.80%	1.57%	5.07%	1.55%	4.77%
E5	Link's Wood	0.42%	3.84%	0.40%	1.76%	0.55%	1.21%
E6	Park House Meadow	0.47%	3.93%	0.45%	1.57%	0.57%	1.36%

Notes:

Assumes continuous operation of both lines of the CHP Plant at the daily ELVs, the AD gas engines at the hourly ELVs, and the contribution from the pulp plant and AD biofilter.

** Impacts presented as % of lower Critical Level appropriate for lower plant communities.*

Table 56: Annual Mean PC used for Deposition Analysis - Permitted Facility

ID	Site	Annual mean PC (µg/m^3)			
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia
E1	Blackwater Plantation	0.17	0.08	0.01	0.02
E2	Maxey's Spring	0.22	0.10	0.02	0.03
E3	Storey's Wood	0.29	0.13	0.02	0.04
E4	Upney Wood	0.35	0.16	0.03	0.05
E5	Link's Wood	0.09	0.04	0.01	0.01
E6	Park House Meadow	0.10	0.04	0.01	0.01

Note:

Assumes continuous operation of both lines of the CHP Plant at the daily ELVs, the AD gas engines at the hourly ELVs, and the contribution from the pulp plant and AD biofilter.

Table 57: Deposition Calculation - Grassland - Permitted Facility

ID	Site	Deposition (kg/ha/yr)				Total N Deposition (kg/ha/yr)	Acid Deposition (keq/ha/yr)	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E1	Blackwater Plantation	0.025	0.146	0.216	0.122	0.146	0.010	0.015
E2	Maxey's Spring	0.032	0.190	0.281	0.158	0.190	0.014	0.020
E3	Storey's Wood	0.041	0.244	0.361	0.204	0.245	0.017	0.025
E4	Upney Wood	0.050	0.297	0.438	0.248	0.298	0.021	0.031
E5	Link's Wood	0.013	0.076	0.112	0.063	0.076	0.005	0.008
E6	Park House Meadow	0.014	0.085	0.126	0.071	0.085	0.006	0.009

Note:

Assumes continuous operation of both lines of the CHP Plant at the daily ELVs, the AD gas engines at the hourly ELVs, and the contribution from the pulp plant and AD biofilter.

Table 58: Deposition Calculation - Woodland - Permitted Facility

ID	Site	Deposition (kg/ha/yr)				Total N Deposition (kg/ha/yr)	Acid Deposition (keq/ha/yr)	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E1	Blackwater Plantation	0.049	0.292	0.517	0.183	0.232	0.017	0.033
E2	Maxey's Spring	0.064	0.380	0.673	0.238	0.302	0.022	0.043
E3	Storey's Wood	0.082	0.489	0.866	0.306	0.388	0.028	0.055
E4	Upney Wood	0.100	0.594	1.052	0.371	0.471	0.034	0.067
E5	Link's Wood	0.025	0.151	0.268	0.094	0.120	0.009	0.017
E6	Park House Meadow	0.029	0.170	0.301	0.106	0.135	0.010	0.019

Note:
Assumes continuous operation of both lines of the CHP Plant at the daily ELVs, the AD gas engines at the hourly ELVs, and the contribution from the pulp plant and AD biofilter.

Table 59: Nitrogen Deposition - Permitted Facility

ID	Site	NCL Class	Lower CL (kgN/ha/yr)	Upper CL (kgN/ha/yr)	Background (kgN/ha/yr)	PC (kgN/ha/yr)	Process Contribution		Predicted Environmental Concentration	
							% of Lower CL or Bg	% of Upper CL	% of Lower CL	% of Upper CL
European and UK designated sites										
	None identified									
Local ecological sites										
E1	Blackwater Plantation	Broadleaved deciduous woodland	10	15	27.4	0.23	2.3%	1.5%	276.3%	184.2%
E2	Maxey's Spring	Semi-dry Perennial calcareous grassland (basic meadow steppe)	10	20	14.6	0.19	1.9%	1.0%	147.9%	74.0%
E2	Maxey's Spring	Low and medium altitude hay meadows	10	20	14.6	0.19	1.9%	1.0%	147.9%	74.0%
E3	Storey's Wood	Broadleaved deciduous woodland	10	15	27.1	0.39	3.9%	2.6%	274.9%	183.3%
E4	Upney Wood	Broadleaved deciduous woodland	10	15	26.9	0.47	4.7%	3.1%	273.7%	182.5%
E5	Link's Wood	Broadleaved deciduous woodland	10	15	27.1	0.12	1.2%	0.8%	272.2%	181.5%
E6	Park House Meadow	Semi-dry Perennial calcareous grassland (basic meadow steppe)	10	20	15.1	0.09	0.9%	0.4%	151.9%	75.9%
E6	Park House Meadow	Low and medium altitude hay meadows	10	20	15.1	0.09	0.9%	0.4%	151.9%	75.9%

Table 60: Acid Deposition - Permitted Facility

ID	Site	Acidity class	Min CL (CLmaxN)	Max CL (CLmaxN)	Background	Process Contribution				Predicted Environmental Concentration	
					N+S (kgN/ha/yr)	N (kg/ha/yr)	S (kgS/ha/yr)	% of Lower CL	% of Upper CL	% of Lower CL	% of Upper CL
European and UK designated sites											
	None identified										
Local ecological sites											
E1	Blackwater Plantation	Broadleaved/Coniferous unmanaged woodland	0.142	1.692	2.11	0.017	0.033	2.9%	-	127.6%	-
E2	Maxey's Spring	Calcareous grassland (using base cation)	1.071	5.071	1.17	0.014	0.020	0.5%	-	3.7%	-
E3	Storey's Wood	Broadleaved/Coniferous unmanaged woodland	0.214	10.915	2.07	0.028	0.055	0.8%	-	19.7%	-
E4	Upney Wood	Broadleaved/Coniferous unmanaged woodland	0.214	10.911	2.07	0.034	0.067	0.9%	-	19.9%	-
E5	Link's Wood	Broadleaved/Coniferous unmanaged woodland	0.357	8.63	2.08	0.009	0.017	0.3%	-	24.4%	-
E6	Park House Meadow	Calcareous grassland (using base cation)	0.856	4.856	1.20	0.006	0.009	0.3%	-	25.0%	-

D Detailed Results Tables – CHP Only Operating – Full Build Out

These results assume the full build out of the IWMF but only the CHP operating.

Table 61: Dispersion Modelling Results – PC at Point of Maximum Ground Level Impact - Daily ELVs – CHP Only – Full Build Out

Pollutant	Quantity	Units	AQAL	Bg Conc.	2018	2019	2020	2021	2022	Max	Max as % of AQAL	PEC	PEC as % of AQAL
Nitrogen dioxide	Annual mean	µg/m³	40	14.8	1.07	1.47	1.64	1.17	1.28	1.64	4.09%	16.44	41.09%
	99.79th %ile of hourly means	µg/m³	200	29.6	9.09	9.44	9.43	9.17	9.22	9.44	4.72%	39.04	19.52%
Sulphur dioxide	99.18th %ile of daily means	µg/m³	125	7.6	4.63	4.37	4.95	4.23	4.41	4.95	3.96%	12.55	10.04%
	99.73rd %ile of hourly means	µg/m³	350	7.6	7.68	7.93	7.97	7.75	7.83	7.97	2.28%	15.57	4.45%
	99.9th %ile of 15 min. means	µg/m³	266	7.6	8.58	8.68	8.77	8.59	8.55	8.77	3.30%	16.37	6.15%
Particulates (PM_{10})	Annual mean	µg/m³	40	18	0.08	0.10	0.12	0.08	0.09	0.12	0.29%	18.12	45.29%
	90.41st %ile of daily means	µg/m³	50	36	0.31	0.37	0.42	0.32	0.34	0.42	0.85%	36.42	72.85%
Particulates ($PM_{2.5}$)	Annual mean	µg/m³	20	10.9	0.08	0.10	0.12	0.08	0.09	0.12	0.58%	11.02	55.08%
	Annual mean – 2040 target	µg/m³	10	10.9	0.08	0.10	0.12	0.08	0.09	0.12	1.17%	11.02	110.2%
Carbon monoxide	8 hour running mean	µg/m³	10,000	454	13.25	12.91	13.42	12.50	12.49	13.42	0.13%	467.42	4.67%
	Hourly mean	µg/m³	30,000	454	16.00	17.01	15.78	16.10	16.00	17.01	0.06%	471.01	1.57%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	1.92	2.04	1.89	1.93	1.92	2.04	0.27%	3.46	0.46%
Hydrogen fluoride	Monthly mean*	µg/m³	16	2.35	0.07	0.08	0.08	0.07	0.07	0.08	0.53%	2.43	15.22%
	Hourly mean	µg/m³	160	4.7	0.32	0.34	0.31	0.32	0.32	0.34	0.21%	5.04	3.15%
Ammonia	Annual mean	µg/m³	180	1.8	0.15	0.21	0.23	0.17	0.18	0.23	0.13%	2.03	1.13%

Pollutant	Quantity	Units	AQAL	Bg Conc.	2018	2019	2020	2021	2022	Max	Max as % of AQAL	PEC	PEC as % of AQAL
	Hourly mean	µg/m³	2,500	3.6	3.19	3.40	3.15	3.21	3.19	3.40	0.14%	7.00	0.28%
VOCs (as benzene)	Annual mean	µg/m³	5	0.4	0.15	0.21	0.23	0.17	0.18	0.23	4.67%	0.63	12.67%
	Daily mean	µg/m³	30	0.8	1.76	1.81	1.93	1.86	2.01	2.01	6.71%	2.81	9.38%
Mercury	Daily mean	ng/m³	60	5.6	3.51	3.62	3.84	3.71	4.02	4.02	6.70%	9.62	16.03%
	Hourly mean	ng/m³	600	5.6	6.39	6.79	6.30	6.43	6.39	6.79	1.13%	12.39	2.07%
Cadmium	Annual mean	ng/m³	5	0.48	0.31	0.42	0.47	0.33	0.37	0.47	9.33%	0.95	18.93%
	Daily mean	ng/m³	30	0.96	3.51	3.62	3.84	3.71	4.02	4.02	13.40%	4.98	16.60%
PaHs	Annual mean	pg/m³	250	110	3.06	4.20	4.66	3.33	3.65	4.66	1.87%	114.66	45.87%
Dioxins and Furans	Annual mean	fg/m³	-	32.99	0.92	1.26	1.40	1.00	1.10	1.40	-	34.39	-
PCBs	Annual mean	ng/m³	200	0.13	0.08	0.10	0.12	0.08	0.09	0.12	0.06%	0.25	0.12%
	Hourly mean	ng/m³	6,000	0.26	0.88	0.90	0.96	0.93	1.01	1.01	0.02%	1.26	0.02%

Note:

Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.
The maximum weekly mean hydrogen fluoride impact has been compared to the monthly mean AQAL. This is considered to be a worst-case as the monthly mean would be lower than the weekly mean.

Table 62: Dispersion Modelling Results – PC at Point of Maximum Ground Level Impact - Short-Term ELVs - CHP Only – Full Build Out

Pollutant	Quantity	Units	AQAL	Bg Conc.	2018	2019	2020	2021	2022	Max	Max as % of AQAL	PEC	PEC as % of AQAL
Nitrogen dioxide	99.79th %ile of hourly means	µg/m³	200	29.6	18.18	18.89	18.85	18.34	18.44	18.89	9.44%	48.49	24.24%
Sulphur dioxide	99.73rd %ile of hourly means	µg/m³	350	7.6	23.05	23.78	23.91	23.26	23.50	23.91	6.83%	31.51	9.00%
	99.9th %ile of 15 min. means	µg/m³	266	7.6	25.75	26.05	26.30	25.76	25.64	26.30	9.89%	33.90	12.74%
Carbon monoxide	8 hour running mean	µg/m³	10,000	454	26.49	25.82	26.85	25.00	24.98	26.85	0.27%	480.85	4.81%
	Hourly mean	µg/m³	30,000	454	31.99	34.02	31.56	32.19	32.00	34.02	0.11%	488.02	1.63%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	19.21	20.43	18.95	19.33	19.21	20.43	2.72%	21.85	2.91%

Note:
Assumes continuous operation of both lines of the CHP Plant at the half-hourly ELVs.

Table 63: Long-Term Metals Results – Point of Maximum Impact - CHP Only – Full Build Out

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV [1]	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	6	0.48	6.99	116.58%	7.47	124.58%	8.3%	0.58	9.72%	1.06	17.72%
Antimony	5,000	1.30	6.99	0.14%	8.29	0.17%	3.8%	0.27	0.005%	1.57	0.03%
Chromium	-	0.88	6.99	-	7.87	-	30.7%	2.15	-	3.03	-
Chromium (VI)	0.25	0.18	6.99	2797.9%	7.17	2868.3%	0.043%	0.00	1.21%	0.18	71.61%
Cobalt	-	0.04	6.99	-	7.03	-	1.9%	0.13	-	0.17	-
Copper	-	2.03	6.99	-	9.02	-	9.7%	0.68	-	2.71	-
Lead	250	2.83	6.99	2.80%	9.82	3.93%	16.8%	1.17	0.47%	4.00	1.60%
Manganese	150	2.29	6.99	4.66%	9.28	6.19%	20.0%	1.40	0.93%	3.69	2.46%
Nickel	20	0.47	6.99	34.97%	7.46	37.32%	73.3%	5.13	25.65%	5.60	28.00%
Vanadium	-	0.69	6.99	-	7.68	-	2.0%	0.14	-	0.83	-

Notes:

[1] Metal as maximum percentage of the group 3 metals ELV, recalculated from the data presented in EA metals guidance document (V.4) Table A1.

Table 64: Short Term Metals Results – Point of Maximum Impact - CHP Only – Full Build Out

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	-	0.96	101.87	-	102.83	-	8.3%	8.49	-	9.45	-
Antimony	150000	2.60	101.87	0.07%	104.47	0.07%	3.8%	3.91	0.003%	6.51	0.004%
Chromium*	2000	1.76	60.30	3.02%	62.06	3.10%	30.7%	18.49	0.92%	20.25	1.01%
Chromium (VI)	-	0.35	101.87	-	102.23	-	0.043%	0.04	-	0.40	-
Cobalt	-	0.08	101.87	-	101.95	-	1.9%	1.90	-	1.98	-
Copper*	50	4.06	60.30	120.61%	64.36	128.73%	9.7%	5.83	11.66%	9.89	19.78%
Lead	-	5.66	101.87	-	107.53	-	16.8%	17.08	-	22.74	-
Manganese	1500000	4.58	101.87	0.01%	106.45	0.01%	20.0%	20.37	0.001%	24.95	0.002%
Nickel	700	0.94	101.87	14.55%	102.81	14.69%	73.3%	74.71	10.67%	75.65	10.81%
Vanadium*	1000	1.38	60.30	6.03%	61.68	6.17%	2.0%	1.21	0.12%	2.59	0.26%

Notes:
(1) Metal as maximum percentage of the group 3 metals ELV, recalculated from the data presented in EA metals guidance document (V.4) Table A1.
*All hourly mean impacts with the exception of those marked with a * which are daily mean impacts.*

Table 65: Impact at Ecological Sites - CHP Only – Full Build Out

ID	Site	Oxides of nitrogen (µg/m^3)		Sulphur dioxide (µg/m^3)	Hydrogen fluoride (µg/m^3)		Ammonia (µg/m^3)
		Annual mean	Daily mean	Annual mean	Weekly mean	Daily mean	Annual mean
European and UK designated sites							
	None identified						
Local ecological sites							
E1	Blackwater Plantation	0.30	5.03	0.09	0.01	0.05	0.03
E2	Maxey's Spring	0.45	11.79	0.14	0.03	0.12	0.04
E3	Storey's Wood	0.52	11.16	0.15	0.03	0.11	0.05
E4	Upney Wood	0.59	9.04	0.18	0.03	0.09	0.06
E5	Link's Wood	0.15	3.61	0.05	0.01	0.04	0.02
E6	Park House Meadow	0.30	5.03	0.09	0.01	0.05	0.03

Notes:
Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.

Table 66: Impact at Ecological Sites - CHP Only – Full Build Out

ID	Site	Oxides of nitrogen (% CL)		Sulphur dioxide (% CL)	Hydrogen fluoride (% CL)		Ammonia (% CL)
		Annual mean	Daily mean	Annual mean	Weekly mean	Daily mean	Annual mean
Critical level (µg/m^3)		**30**	**200**	**10**	**0.5**	**5**	**1**
European and UK designated sites							
	None identified						
Local ecological sites							
E1	Blackwater Plantation	0.99%	6.71%	0.89%	2.96%	1.00%	2.96%
E2	Maxey's Spring	1.50%	15.73%	1.35%	6.85%	2.35%	4.50%
E3	Storey's Wood	1.72%	14.88%	1.55%	5.85%	2.23%	5.15%
E4	Upney Wood	1.98%	12.05%	1.78%	6.03%	1.80%	5.93%
E5	Link's Wood	0.51%	4.81%	0.46%	1.96%	0.72%	1.53%
E6	Park House Meadow	0.99%	6.71%	0.89%	2.96%	1.00%	2.96%

Notes:

Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.

** Impacts presented as % of lower Critical Level appropriate for lower plant communities.*

Table 67: Annual Mean PC used for Deposition Analysis - CHP Only – Full Build Out

ID	Site	Annual mean PC (µg/m³)			
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia
E1	Blackwater Plantation	0.21	0.09	0.02	0.03
E2	Maxey's Spring	0.32	0.14	0.03	0.04
E3	Storey's Wood	0.36	0.15	0.03	0.05
E4	Upney Wood	0.42	0.18	0.04	0.06
E5	Link's Wood	0.11	0.05	0.01	0.02
E6	Park House Meadow	0.12	0.05	0.01	0.02

Note:
Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.

Table 68: Deposition Calculation - Grassland – CHP Only – Full Build Out

ID	Site	Deposition (kg/ha/yr)				Total N Deposition (kg/ha/yr)	Acid Deposition (keq/ha/yr)	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E1	Blackwater Plantation	0.030	0.168	0.272	0.154	0.184	0.013	0.018
E2	Maxey's Spring	0.045	0.256	0.414	0.234	0.279	0.020	0.028
E3	Storey's Wood	0.052	0.293	0.474	0.267	0.319	0.023	0.032
E4	Upney Wood	0.060	0.337	0.546	0.308	0.368	0.026	0.036
E5	Link's Wood	0.015	0.087	0.141	0.080	0.095	0.007	0.009
E6	Park House Meadow	0.018	0.100	0.161	0.091	0.109	0.008	0.011

Note:
Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.

Table 69: Deposition Calculation - Woodland – CHP Only – Full Build Out

ID	Site	Deposition (kg/ha/yr)				Total N Deposition (kg/ha/yr)	Acid Deposition (keq/ha/yr)	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E1	Blackwater Plantation	0.060	0.337	0.653	0.231	0.290	0.021	0.039
E2	Maxey's Spring	0.091	0.512	0.993	0.351	0.441	0.032	0.060
E3	Storey's Wood	0.104	0.586	1.137	0.401	0.505	0.036	0.069
E4	Upney Wood	0.120	0.675	1.309	0.462	0.582	0.042	0.079
E5	Link's Wood	0.031	0.174	0.338	0.119	0.150	0.011	0.020
E6	Park House Meadow	0.035	0.199	0.386	0.136	0.172	0.012	0.023

Note:
Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.

Table 70: Nitrogen Deposition - CHP Only – Full Build Out

ID	Site	NCL Class	Lower CL (kgN/ha/yr)	Upper CL (kgN/ha/yr)	Background (kgN/ha/yr)	PC (kgN/ha/yr)	Process Contribution		Predicted Environmental Concentration	
							% of Lower CL or Bg	% of Upper CL	% of Lower CL	% of Upper CL
European and UK designated sites										
	None identified									
Local ecological sites										
E1	Blackwater Plantation	Broadleaved deciduous woodland	10	15	27.4	0.29	2.9%	1.9%	276.9%	184.6%
E2	Maxey's Spring	Semi-dry Perennial calcareous grassland (basic meadow steppe)	10	20	14.6	0.28	2.8%	1.4%	148.8%	74.4%
E2	Maxey's Spring	Low and medium altitude hay meadows	10	20	14.6	0.28	2.8%	1.4%	148.8%	74.4%
E3	Storey's Wood	Broadleaved deciduous woodland	10	15	27.1	0.51	5.1%	3.4%	276.1%	184.0%
E4	Upney Wood	Broadleaved deciduous woodland	10	15	26.9	0.58	5.8%	3.9%	274.8%	183.2%
E5	Link's Wood	Broadleaved deciduous woodland	10	15	27.1	0.15	1.5%	1.0%	272.5%	181.7%
E6	Park House Meadow	Semi-dry Perennial calcareous grassland (basic meadow steppe)	10	20	15.1	0.11	1.1%	0.5%	152.1%	76.0%
E6	Park House Meadow	Low and medium altitude hay meadows	10	20	15.1	0.11	1.1%	0.5%	152.1%	76.0%

Table 71: Acid Deposition - CHP Only – Full Build Out

ID	Site	Acidity class	Min CL (CLmaxN)	Max CL (CLmaxN)	Background	Process Contribution				Predicted Environmental Concentration	
					N+S (kgN/ha/yr)	N (kg/ha/yr)	S (kgS/ha/yr)	% of Lower CL	% of Upper CL	% of Lower CL	% of Upper CL
European and UK designated sites											
	None identified										
Local ecological sites											
E1	Blackwater Plantation	Broadleaved/Coniferous unmanaged woodland	0.142	1.692	2.11	0.021	0.039	3.6%	-	128.3%	-
E2	Maxey's Spring	Calcareous grassland (using base cation)	1.071	5.071	1.17	0.020	0.028	0.7%	-	3.9%	-
E3	Storey's Wood	Broadleaved/Coniferous unmanaged woodland	0.214	10.915	2.07	0.036	0.069	1.0%	-	19.9%	-
E4	Upney Wood	Broadleaved/Coniferous unmanaged woodland	0.214	10.911	2.07	0.042	0.079	1.1%	-	20.1%	-
E5	Link's Wood	Broadleaved/Coniferous unmanaged woodland	0.357	8.63	2.08	0.011	0.020	0.4%	-	24.5%	-
E6	Park House Meadow	Calcareous grassland (using base cation)	0.856	4.856	1.20	0.008	0.011	0.4%	-	25.1%	-

E Detailed Results Tables – CHP Only Operating – CHP Build Out Only

These results assume the only the CHP Plant part of the building of the IWMF and only the CHP operating.

Table 72: Dispersion Modelling Results – PC at Point of Maximum Ground Level Impact - Daily ELVs – CHP Only – CHP Only Build Out

Pollutant	Quantity	Units	AQAL	Bg Conc.	2018	2019	2020	2021	2022	Max	Max as % of AQAL	PEC	PEC as % of AQAL
Nitrogen dioxide	Annual mean	µg/m³	40	14.8	1.13	1.52	1.71	1.19	1.31	1.71	4.27%	16.51	41.27%
	99.79th %ile of hourly means	µg/m³	200	29.6	11.81	11.37	12.83	10.26	12.16	12.83	6.42%	42.43	21.22%
Sulphur dioxide	99.18th %ile of daily means	µg/m³	125	7.6	5.20	4.69	5.55	4.28	4.58	5.55	4.44%	13.15	10.52%
	99.73rd %ile of hourly means	µg/m³	350	7.6	9.27	9.49	10.36	8.40	9.85	10.36	2.96%	17.96	5.13%
	99.9th %ile of 15 min. means	µg/m³	266	7.6	11.97	11.34	13.18	10.41	12.72	13.18	4.96%	20.78	7.81%
Particulates (PM_{10})	Annual mean	µg/m³	40	18	0.08	0.11	0.12	0.08	0.09	0.12	0.30%	18.12	45.30%
	90.41st %ile of daily means	µg/m³	50	36	0.31	0.37	0.43	0.32	0.34	0.43	0.87%	36.43	72.87%
Particulates ($PM_{2.5}$)	Annual mean	µg/m³	20	10.9	0.08	0.11	0.12	0.08	0.09	0.12	0.61%	11.02	55.11%
	Annual mean – 2040 target	µg/m³	10	10.9	0.08	0.11	0.12	0.08	0.09	0.12	1.22%	11.02	110.2%
Carbon monoxide	8 hour running mean	µg/m³	10,000	454	18.13	17.74	16.18	15.25	18.29	18.29	0.18%	472.29	4.72%
	Hourly mean	µg/m³	30,000	454	24.17	23.69	24.67	22.45	25.21	25.21	0.08%	479.21	1.60%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	2.89	2.84	2.95	2.69	3.02	3.02	0.40%	4.44	0.59%
Hydrogen fluoride	Monthly mean*	µg/m³	16	2.35	0.08	0.08	0.09	0.07	0.07	0.09	0.57%	2.44	15.26%
	Hourly mean	µg/m³	160	4.7	0.48	0.47	0.49	0.45	0.50	0.50	0.31%	5.20	3.25%
Ammonia	Annual mean	µg/m³	180	1.8	0.16	0.22	0.24	0.17	0.19	0.24	0.14%	2.04	1.14%

Pollutant	Quantity	Units	AQAL	Bg Conc.	2018	2019	2020	2021	2022	Max	Max as % of AQAL	PEC	PEC as % of AQAL
	Hourly mean	µg/m³	2,500	3.6	4.82	4.73	4.92	4.48	5.03	5.03	0.20%	8.63	0.35%
VOCs (as benzene)	Annual mean	µg/m³	5	0.4	0.16	0.22	0.24	0.17	0.19	0.24	4.88%	0.64	12.88%
	Daily mean	µg/m³	30	0.8	2.26	1.90	2.23	1.87	2.01	2.26	7.53%	3.06	10.20%
Mercury	Daily mean	ng/m³	60	5.6	4.51	3.78	4.45	3.73	4.02	4.51	7.52%	10.11	16.85%
	Hourly mean	ng/m³	600	5.6	9.65	9.46	9.85	8.96	10.06	10.06	1.68%	15.66	2.61%
Cadmium	Annual mean	ng/m³	5	0.48	0.32	0.43	0.49	0.34	0.37	0.49	9.75%	0.97	19.35%
	Daily mean	ng/m³	30	0.96	4.51	3.78	4.45	3.73	4.02	4.51	15.03%	5.47	18.23%
PaHs	Annual mean	pg/m³	250	110	3.22	4.32	4.87	3.39	3.73	4.87	1.95%	114.87	45.95%
Dioxins and Furans	Annual mean	fg/m³	-	32.99	0.96	1.30	1.46	1.02	1.12	1.46	-	34.45	-
PCBs	Annual mean	ng/m³	200	0.13	0.08	0.11	0.12	0.08	0.09	0.12	0.06%	0.25	0.13%
	Hourly mean	ng/m³	6,000	0.26	1.13	0.95	1.11	0.93	1.01	1.13	0.02%	1.39	0.02%

Note:

Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.
The maximum weekly mean hydrogen fluoride impact has been compared to the monthly mean AQAL. This is considered to be a worst-case as the monthly mean would be lower than the weekly mean.

Table 73: Dispersion Modelling Results – PC at Point of Maximum Ground Level Impact - Short-Term ELVs - CHP Only – CHP Only Build Out

Pollutant	Quantity	Units	AQAL	Bg Conc.	2018	2019	2020	2021	2022	Max	Max as % of AQAL	PEC	PEC as % of AQAL
Nitrogen dioxide	99.79th %ile of hourly means	µg/m³	200	29.6	23.62	22.74	25.66	20.53	24.31	25.66	12.83%	55.26	27.63%
Sulphur dioxide	99.73rd %ile of hourly means	µg/m³	350	7.6	27.82	28.47	31.07	25.20	29.55	31.07	8.88%	38.67	11.05%
	99.9th %ile of 15 min. means	µg/m³	266	7.6	35.91	34.01	39.54	31.22	38.16	39.54	14.87%	47.14	17.72%
Carbon monoxide	8 hour running mean	µg/m³	10,000	454	36.26	35.48	32.36	30.49	36.58	36.58	0.37%	490.58	4.91%
	Hourly mean	µg/m³	30,000	454	48.34	47.38	49.34	44.90	50.41	50.41	0.17%	504.41	1.68%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	29.02	28.44	29.62	26.96	30.27	30.27	4.04%	31.69	4.23%

Note:
Assumes continuous operation of both lines of the CHP Plant at the half-hourly ELVs.

Table 74: Long-Term Metals Results – Point of Maximum Impact - CHP Only – CHP Only – CHP Only Build Out

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV [1]	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	6	0.48	7.31	121.83%	7.79	129.83%	8.3%	0.61	10.15%	1.09	18.15%
Antimony	5,000	1.30	7.31	0.15%	8.61	0.17%	3.8%	0.28	0.006%	1.58	0.03%
Chromium	-	0.88	7.31	-	8.19	-	30.7%	2.24	-	3.12	-
Chromium (VI)	0.25	0.18	7.31	2923.8%	7.49	2994.2%	0.043%	0.00	1.27%	0.18	71.67%
Cobalt	-	0.04	7.31	-	7.35	-	1.9%	0.14	-	0.18	-
Copper	-	2.03	7.31	-	9.34	-	9.7%	0.71	-	2.74	-
Lead	250	2.83	7.31	2.92%	10.14	4.06%	16.8%	1.23	0.49%	4.06	1.62%
Manganese	150	2.29	7.31	4.87%	9.60	6.40%	20.0%	1.46	0.97%	3.75	2.50%
Nickel	20	0.47	7.31	36.55%	7.78	38.90%	73.3%	5.36	26.80%	5.83	29.15%
Vanadium	-	0.69	7.31	-	8.00	-	2.0%	0.15	-	0.84	-

Notes:
(1) Metal as maximum percentage of the group 3 metals ELV, recalculated from the data presented in EA metals guidance document (V.4) Table A1.

Table 75: Short Term Metals Results – Point of Maximum Impact - CHP Only – CHP Only – CHP Only Build Out

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV [1]	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	-	0.96	150.95	-	151.91	-	8.3%	12.58	-	13.54	-
Antimony	150000	2.60	150.95	0.10%	153.55	0.10%	3.8%	5.79	0.004%	8.39	0.006%
Chromium*	2000	1.76	67.64	3.38%	69.40	3.47%	30.7%	20.74	1.04%	22.50	1.13%
Chromium (VI)	-	0.35	150.95	-	151.30	-	0.043%	0.07	-	0.42	-
Cobalt	-	0.08	150.95	-	151.03	-	1.9%	2.82	-	2.90	-
Copper*	50	4.06	67.64	135.28%	71.70	143.40%	9.7%	6.54	13.08%	10.60	21.20%
Lead	-	5.66	150.95	-	156.61	-	16.8%	25.31	-	30.97	-
Manganese	1500000	4.58	150.95	0.01%	155.53	0.01%	20.0%	30.19	0.002%	34.77	0.002%
Nickel	700	0.94	150.95	21.56%	151.89	21.70%	73.3%	110.70	15.81%	111.64	15.95%
Vanadium*	1000	1.38	67.64	6.76%	69.02	6.90%	2.0%	1.35	0.14%	2.73	0.27%

Notes:

[1] Metal as maximum percentage of the group 3 metals ELV, recalculated from the data presented in EA metals guidance document (V.4) Table A1.

*All hourly mean impacts with the exception of those marked with a * which are daily mean impacts.*

Table 76: Impact at Ecological Sites - CHP Only – CHP Only – CHP Only Build Out

ID	Site	Oxides of nitrogen (µg/m³)		Sulphur dioxide (µg/m³)	Hydrogen fluoride (µg/m³)		Ammonia (µg/m³)
		Annual mean	Daily mean	Annual mean	Weekly mean	Daily mean	Annual mean
European and UK designated sites							
	None identified						
Local ecological sites							
E1	Blackwater Plantation	0.30	5.04	0.09	0.01	0.05	0.03
E2	Maxey's Spring	0.46	12.21	0.14	0.04	0.12	0.05
E3	Storey's Wood	0.52	11.55	0.16	0.03	0.12	0.05
E4	Upney Wood	0.60	9.23	0.18	0.03	0.09	0.06
E5	Link's Wood	0.16	3.65	0.05	0.01	0.04	0.02
E6	Park House Meadow	0.30	5.04	0.09	0.01	0.05	0.03
Notes: *Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.*							

Table 77: Impact at Ecological Sites - CHP Only – CHP Only – CHP Only Build Out

ID	Site	Oxides of nitrogen (% CL)		Sulphur dioxide (% CL)	Hydrogen fluoride (% CL)		Ammonia (% CL)
		Annual mean	Daily mean	Annual mean	Weekly mean	Daily mean	Annual mean
Critical level (µg/m^3)		**30**	**75**	**10**	**0.5**	**5**	**1**
European and UK designated sites							
	None identified						
Local ecological sites							
E1	Blackwater Plantation	0.99%	6.72%	0.89%	2.96%	1.01%	2.96%
E2	Maxey's Spring	1.52%	16.28%	1.37%	7.19%	2.44%	4.54%
E3	Storey's Wood	1.73%	15.40%	1.56%	5.93%	2.31%	5.18%
E4	Upney Wood	2.00%	12.31%	1.80%	6.09%	1.84%	5.98%
E5	Link's Wood	0.52%	4.87%	0.47%	1.98%	0.73%	1.55%
E6	Park House Meadow	0.99%	6.72%	0.89%	2.96%	1.01%	2.96%

Notes:
Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.
** Impacts presented as % of lower Critical Level appropriate for lower plant communities.*

Table 78: Annual Mean PC used for Deposition Analysis - CHP Only – CHP Only – CHP Only Build Out

ID	Site	Annual mean PC (µg/m³)			
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia
E1	Blackwater Plantation	0.21	0.09	0.02	0.03
E2	Maxey's Spring	0.32	0.14	0.03	0.05
E3	Storey's Wood	0.36	0.16	0.03	0.05
E4	Upney Wood	0.42	0.18	0.04	0.06
E5	Link's Wood	0.11	0.05	0.01	0.02
E6	Park House Meadow	0.12	0.05	0.01	0.02

Note:
Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.

Table 79: Deposition Calculation - Grassland – CHP Only – CHP Only – CHP Only Build Out

ID	Site	Deposition (kg/ha/yr)				Total N Deposition (kg/ha/yr)	Acid Deposition (keq/ha/yr)	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E1	Blackwater Plantation	0.030	0.169	0.273	0.154	0.184	0.013	0.018
E2	Maxey's Spring	0.046	0.258	0.418	0.236	0.282	0.020	0.028
E3	Storey's Wood	0.052	0.295	0.477	0.269	0.321	0.023	0.032
E4	Upney Wood	0.060	0.340	0.550	0.311	0.371	0.026	0.037
E5	Link's Wood	0.016	0.088	0.143	0.081	0.096	0.007	0.010
E6	Park House Meadow	0.018	0.101	0.163	0.092	0.110	0.008	0.011

Note:
Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.

Table 80: Deposition Calculation - Woodland – CHP Only – CHP Only – CHP Only Build Out

ID	Site	Deposition (kg/ha/yr)				Total N Deposition (kg/ha/yr)	Acid Deposition (keq/ha/yr)	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E1	Blackwater Plantation	0.060	0.337	0.655	0.231	0.291	0.021	0.040
E2	Maxey's Spring	0.092	0.517	1.003	0.354	0.446	0.032	0.061
E3	Storey's Wood	0.105	0.589	1.144	0.404	0.508	0.036	0.069
E4	Upney Wood	0.121	0.680	1.320	0.466	0.587	0.042	0.080
E5	Link's Wood	0.031	0.176	0.342	0.121	0.152	0.011	0.021
E6	Park House Meadow	0.036	0.202	0.391	0.138	0.174	0.012	0.024

Note:
Assumes continuous operation of both lines of the CHP Plant at the daily ELVs.

Table 81: Nitrogen Deposition - CHP Only – CHP Only Build Out

ID	Site	NCL Class	Lower CL (kgN/ha/yr)	Upper CL (kgN/ha/yr)	Background (kgN/ha/yr)	PC (kgN/ha/yr)	Process Contribution		Predicted Environmental Concentration	
							% of Lower CL or Bg	% of Upper CL	% of Lower CL	% of Upper CL
European and UK designated sites										
	None identified									
Local ecological sites										
E1	Blackwater Plantation	Broadleaved deciduous woodland	10	15	27.4	0.29	2.9%	1.9%	276.9%	184.6%
E2	Maxey's Spring	Semi-dry Perennial calcareous grassland (basic meadow steppe)	10	20	14.6	0.28	2.8%	1.4%	148.8%	74.4%
E2	Maxey's Spring	Low and medium altitude hay meadows	10	20	14.6	0.28	2.8%	1.4%	148.8%	74.4%
E3	Storey's Wood	Broadleaved deciduous woodland	10	15	27.1	0.51	5.1%	3.4%	276.1%	184.1%
E4	Upney Wood	Broadleaved deciduous woodland	10	15	26.9	0.59	5.9%	3.9%	274.9%	183.2%
E5	Link's Wood	Broadleaved deciduous woodland	10	15	27.1	0.15	1.5%	1.0%	272.5%	181.7%
E6	Park House Meadow	Semi-dry Perennial calcareous grassland (basic meadow steppe)	10	20	15.1	0.11	1.1%	0.5%	152.1%	76.0%
E6	Park House Meadow	Low and medium altitude hay meadows	10	20	15.1	0.11	1.1%	0.5%	152.1%	76.0%

Table 82: Acid Deposition - CHP Only – CHP Only Build Out

ID	Site	Acidity class	Min CL (CLmaxN)	Max CL (CLmaxN)	Background	Process Contribution				Predicted Environmental Concentration	
					N+S (kgN/ha/yr)	N (kg/ha/yr)	S (kgS/ha/yr)	% of Lower CL	% of Upper CL	% of Lower CL	% of Upper CL
European and UK designated sites											
	None identified										
Local ecological sites											
E1	Blackwater Plantation	Broadleaved/Coniferous unmanaged woodland	0.142	1.692	2.11	0.021	0.040	3.6%	-	128.3%	-
E2	Maxey's Spring	Calcareous grassland (using base cation)	1.071	5.071	1.17	0.020	0.028	0.7%	-	3.9%	-
E3	Storey's Wood	Broadleaved/Coniferous unmanaged woodland	0.214	10.915	2.07	0.036	0.069	1.0%	-	19.9%	-
E4	Upney Wood	Broadleaved/Coniferous unmanaged woodland	0.214	10.911	2.07	0.042	0.080	1.1%	-	20.1%	-
E5	Link's Wood	Broadleaved/Coniferous unmanaged woodland	0.357	8.63	2.08	0.011	0.021	0.4%	-	24.5%	-
E6	Park House Meadow	Calcareous grassland (using base cation)	0.856	4.856	1.20	0.008	0.011	0.4%	-	25.1%	-

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