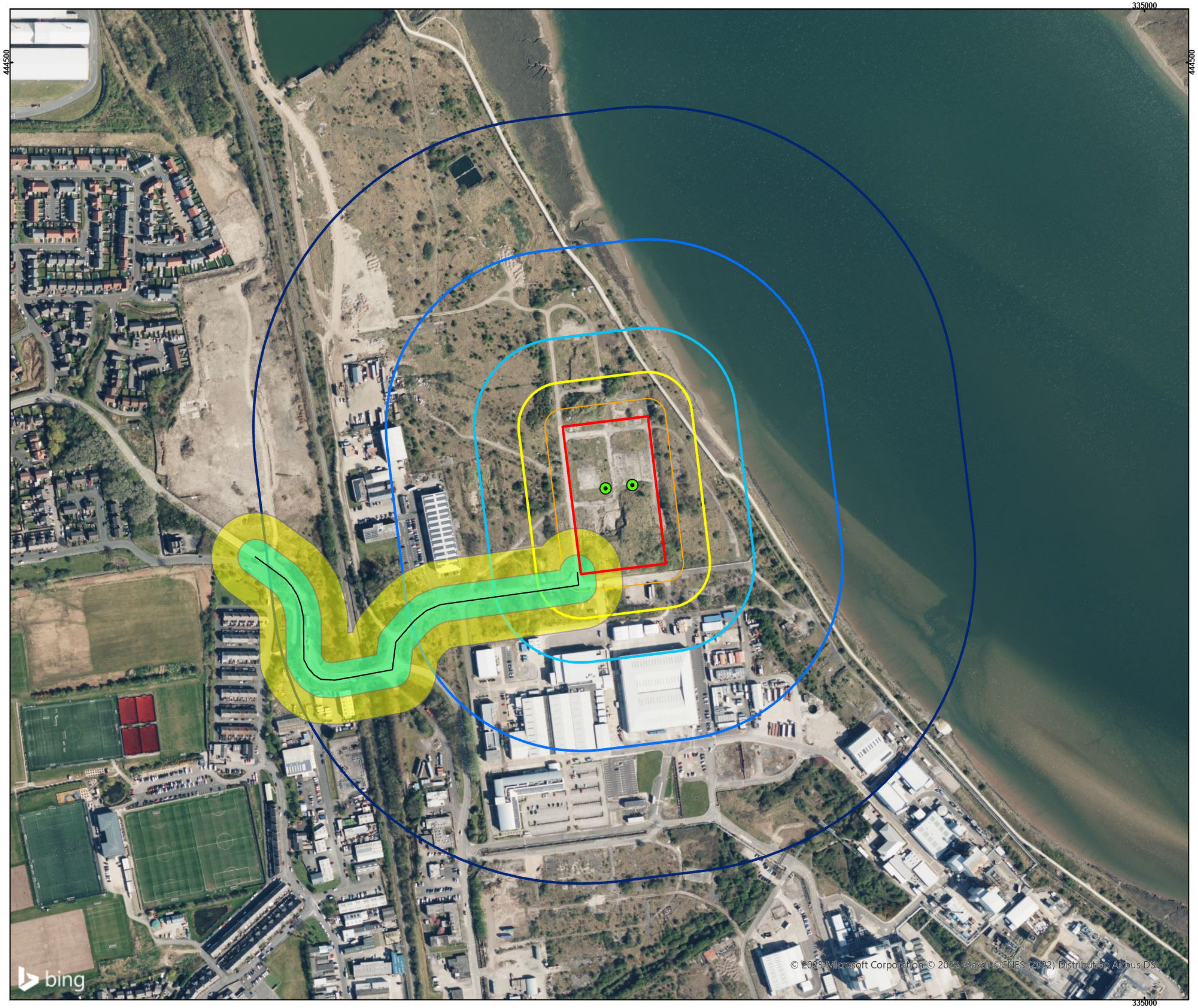


Legend

- Stack Locations
- Site Boundary
- 500m Site Access Route
- 20m Site Access Route Buffer
- 50m Site Access Route Buffer

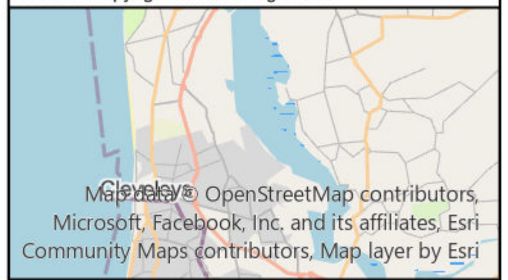
Distance (m)

- 20
- 50
- 100
- 200
- 350

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	

Figure 8.1 Construction Screening Zones

Drawn by: MJC	Date: 20/01/2023



0 0.04 0.08 0.16 km

Scale: 1:4,000

N

FICHTNER

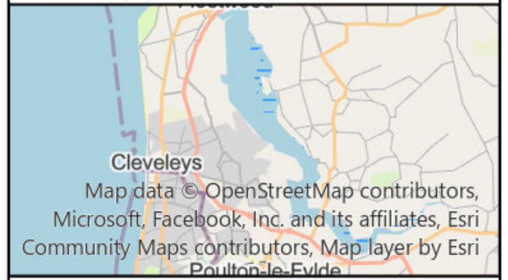
Consulting Engineers Limited

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

Legend

- Stack Locations
- Site Boundary
- Human Sensitive Receptors
- LAQM Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	Figure 8.2 Human Sensitive Receptors
Drawn by: MJC	Date: 20/01/2023



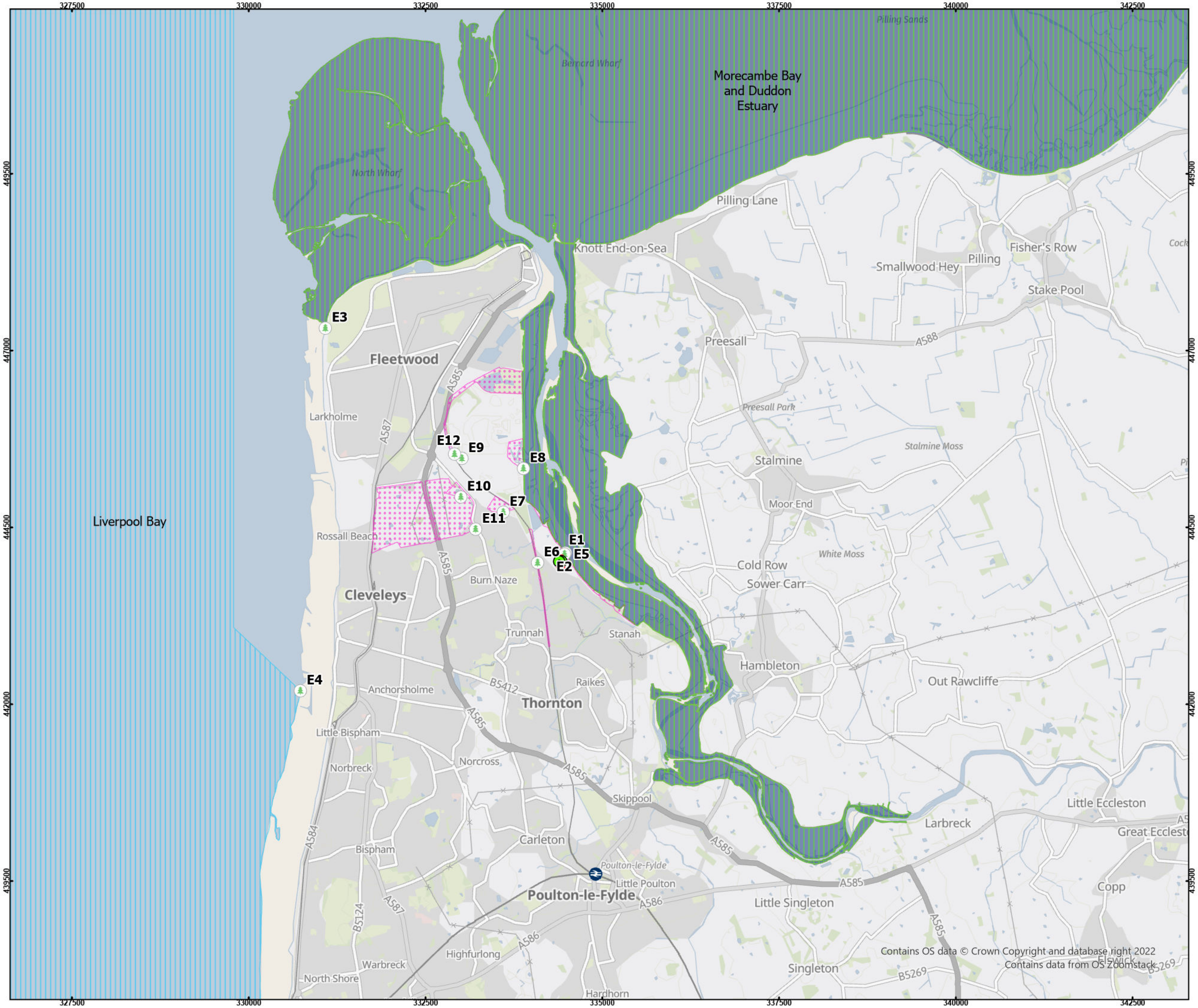
0 0.1 0.2 0.4 km

Scale: 1:10,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Discrete Ecological Receptor Points
- Liverpool Bay SPA
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 8.3 Ecological Sensitive Receptors

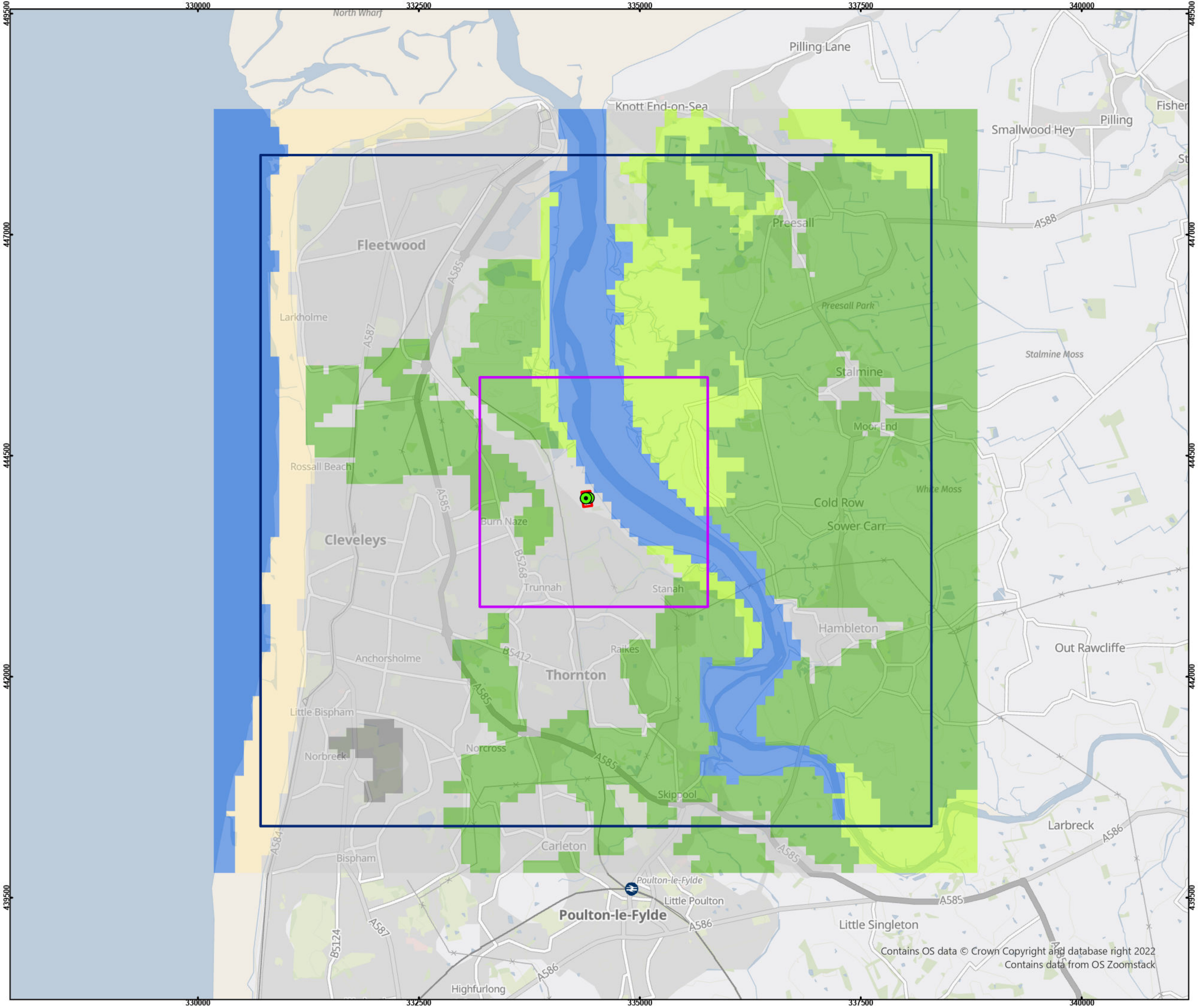
Drawn by: MJC | Date: 20/01/2023

0 0.5 1 2 km

Scale: 1:50,000

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Fine Grid Extent
- Wide Grid Extent

Surface Roughness Length (m)

- 0.0001
- 0.0005
- 0.03
- 0.05
- 0.5
- 0.6

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	

Figure 8.4 Dispersion Model Inputs

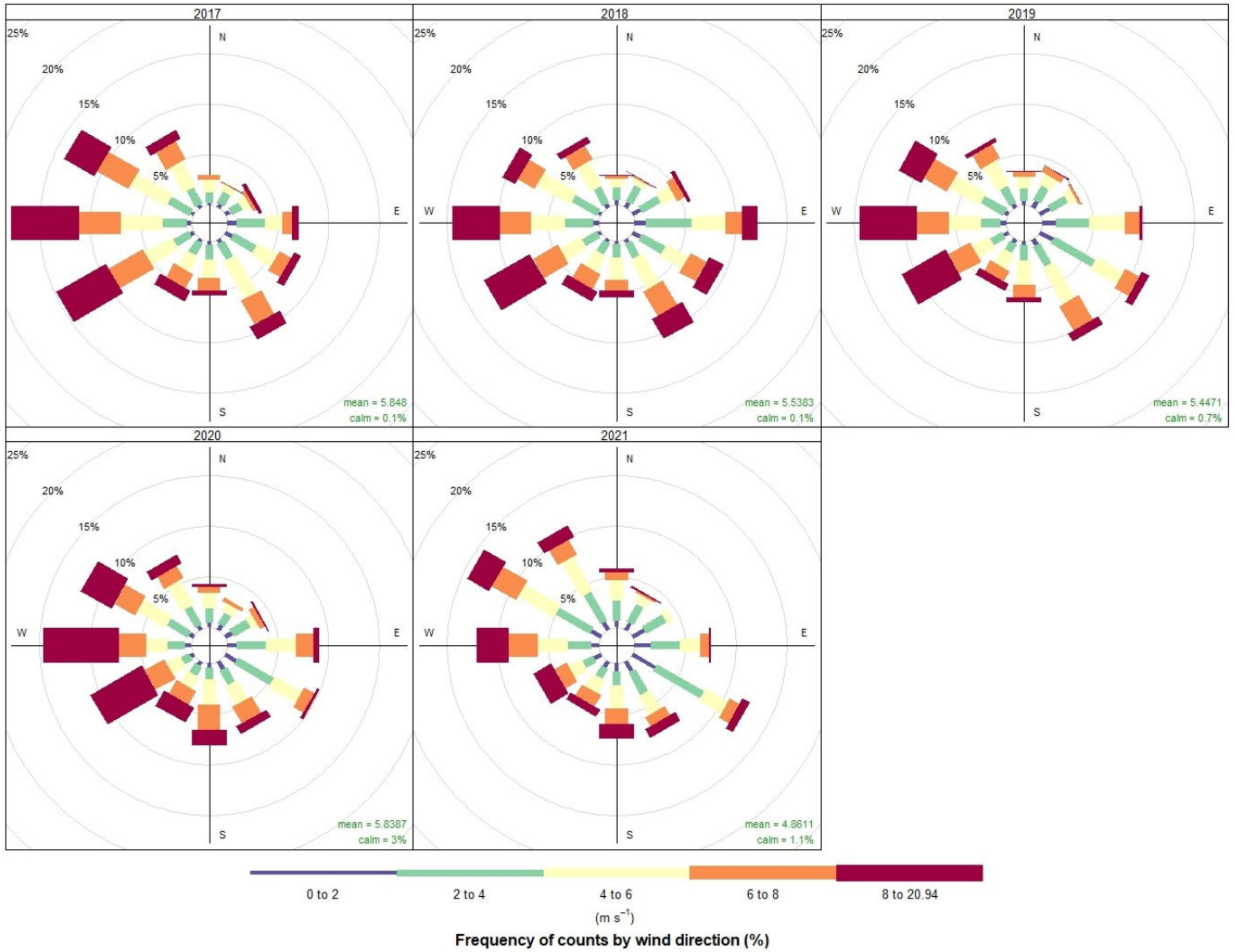
Drawn by: MJC | Date: 20/01/2023

0 0.4 0.8 1.6 km

Scale: 1:40,000

N

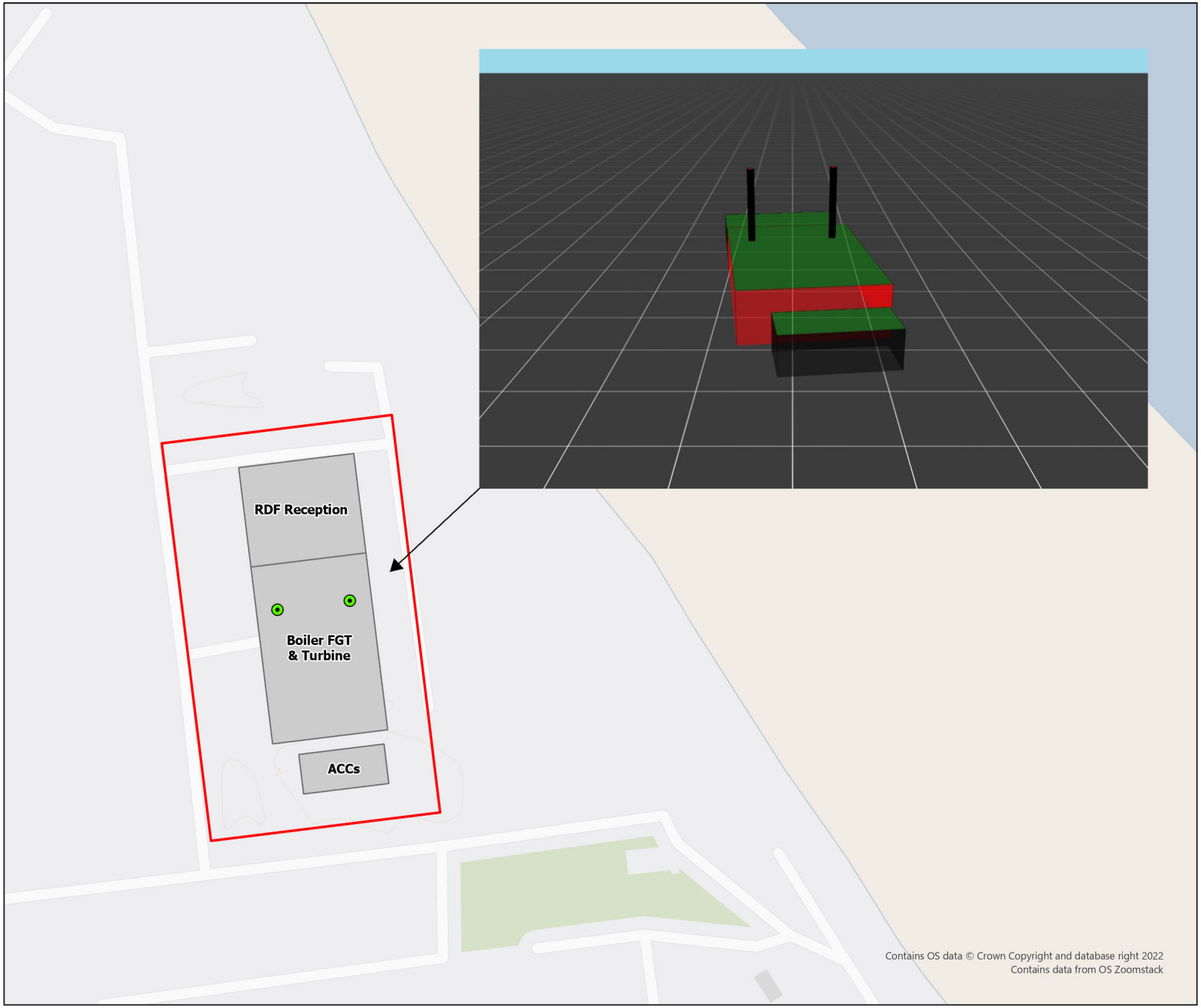
FICHTNER
Consulting Engineers Limited
Kingsgate, Wellington Road North,
Stockport, Cheshire, SK4 1LW
Tel: 0161 476 0032
Fax: 0161 474 0618



Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	Figure 8.5 Meteorlogical Data (Windroses)
Drawn by: MJC	Date: 20/01/2023

FICHTNER
Consulting Engineers Limited

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



Legend

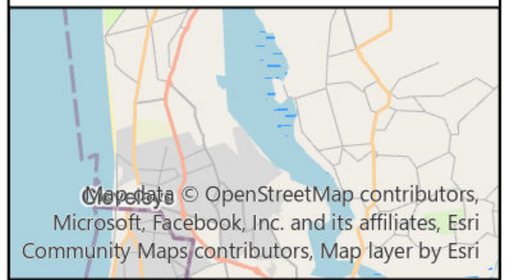
- Stack Locations
- Buildings
- Site Boundary

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 8.6 Buildings Modelled

Drawn by: MJC | Date: 20/01/2023



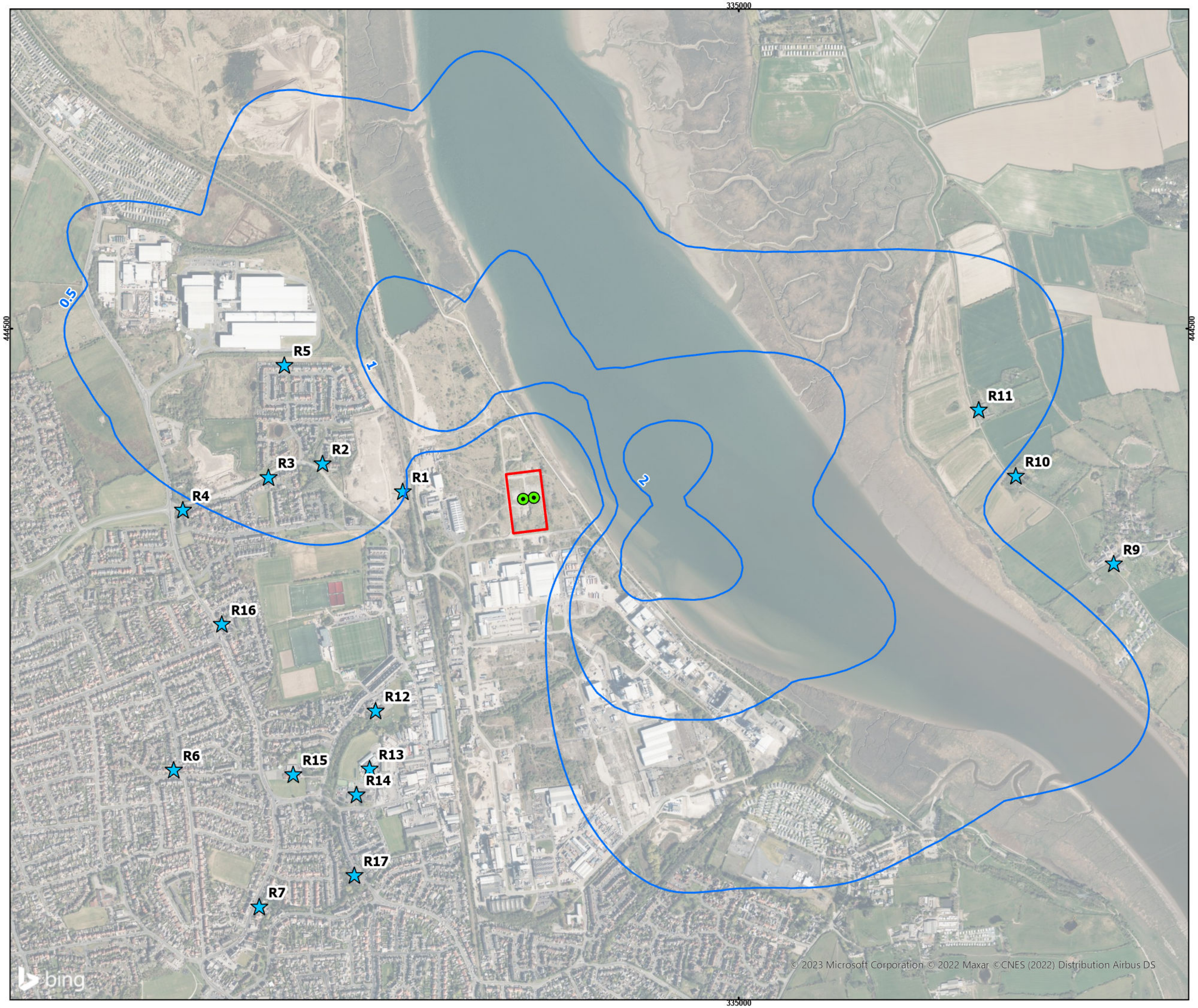
0 0.01 0.03 0.06 km

Scale: 1:1,500

N

FICHTNER
Consulting Engineers Limited

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



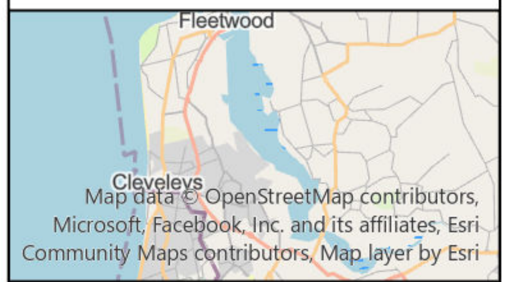
Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean Nitrogen Dioxide (% of AQAL)
- Human Sensitive Receptors

Notes: Assumed 70% conversion of oxides of nitrogen to nitrogen dioxide

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	Figure 8.7 Annual Mean Nitrogen Dioxide

Drawn by: MJC | Date: 20/01/2023



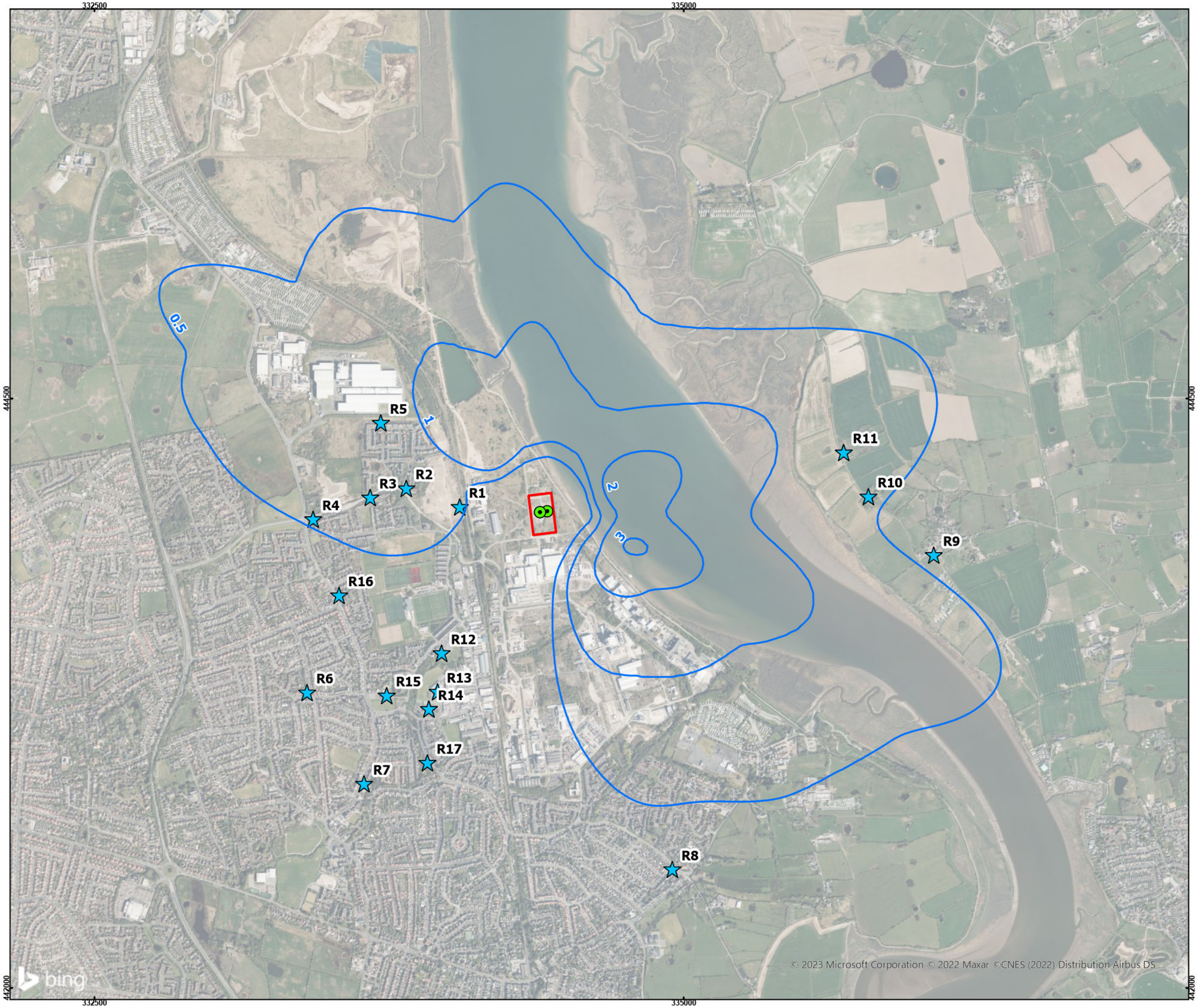
0 0.1 0.2 0.4 km

Scale: 1:10,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean VOCs as Benzene (% of AQAL)
- Human Sensitive Receptors

Notes:
- Assumed that all VOCs are emitted as benzene

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 8.8 Annual Mean VOCs as Benzene

Drawn by: MJC | Date: 20/01/2023

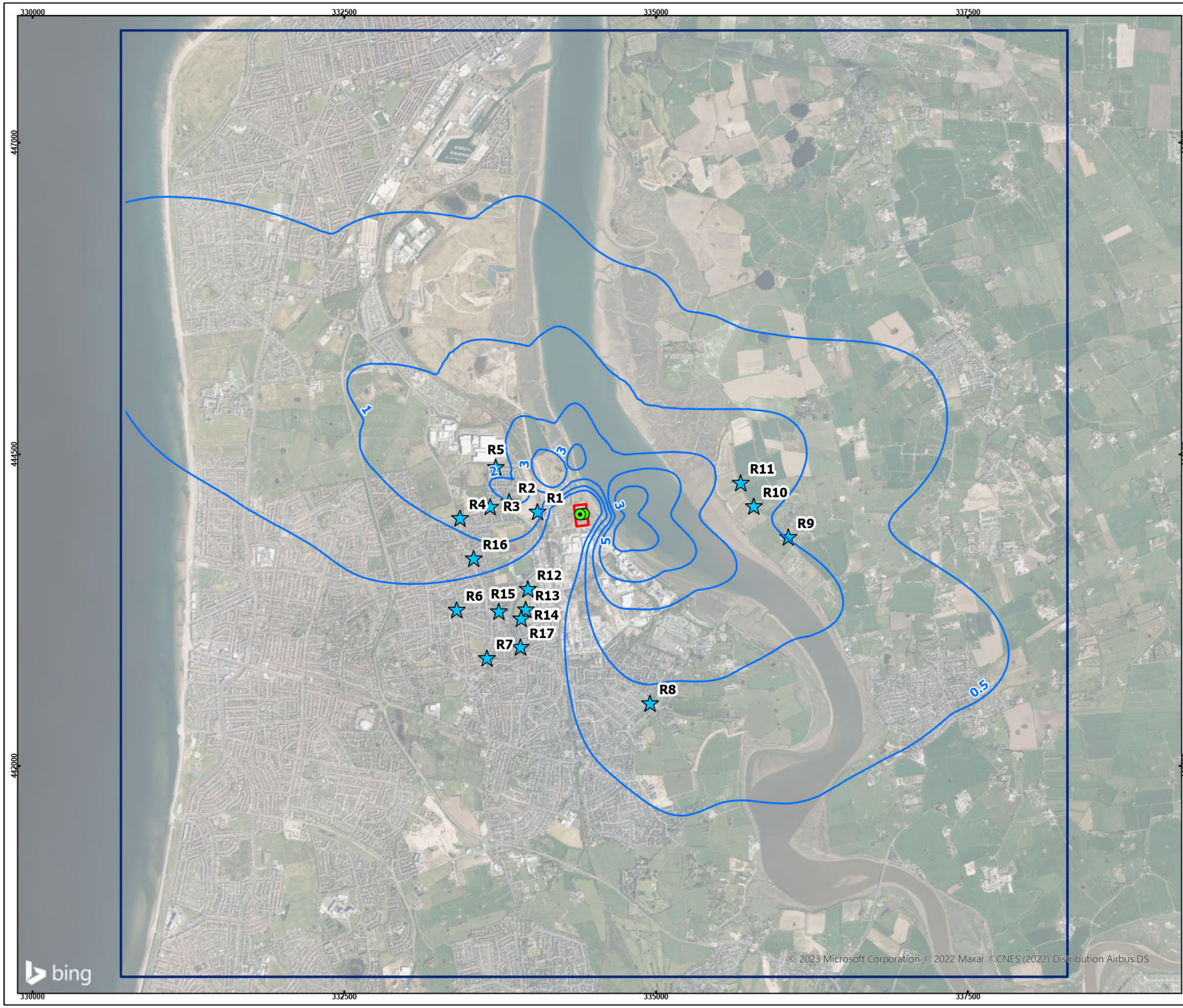
0 0.15 0.3 0.6 km

N

Scale: 1:15,000

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean VOCs as 1,3-Butadiene (% of AQAL)
- Human Sensitive Receptors

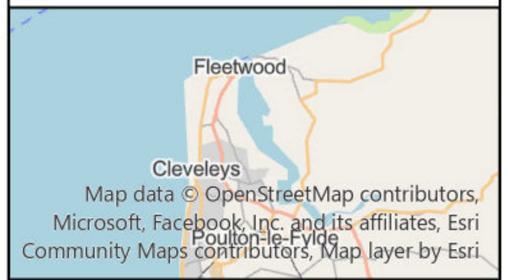
Notes:
- Assumed that all VOCs are emitted as 1,3-butadiene

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 8.9 Annual Mean VOCs as 1,3-Butadiene

Drawn by: MJC	Date: 20/01/2023



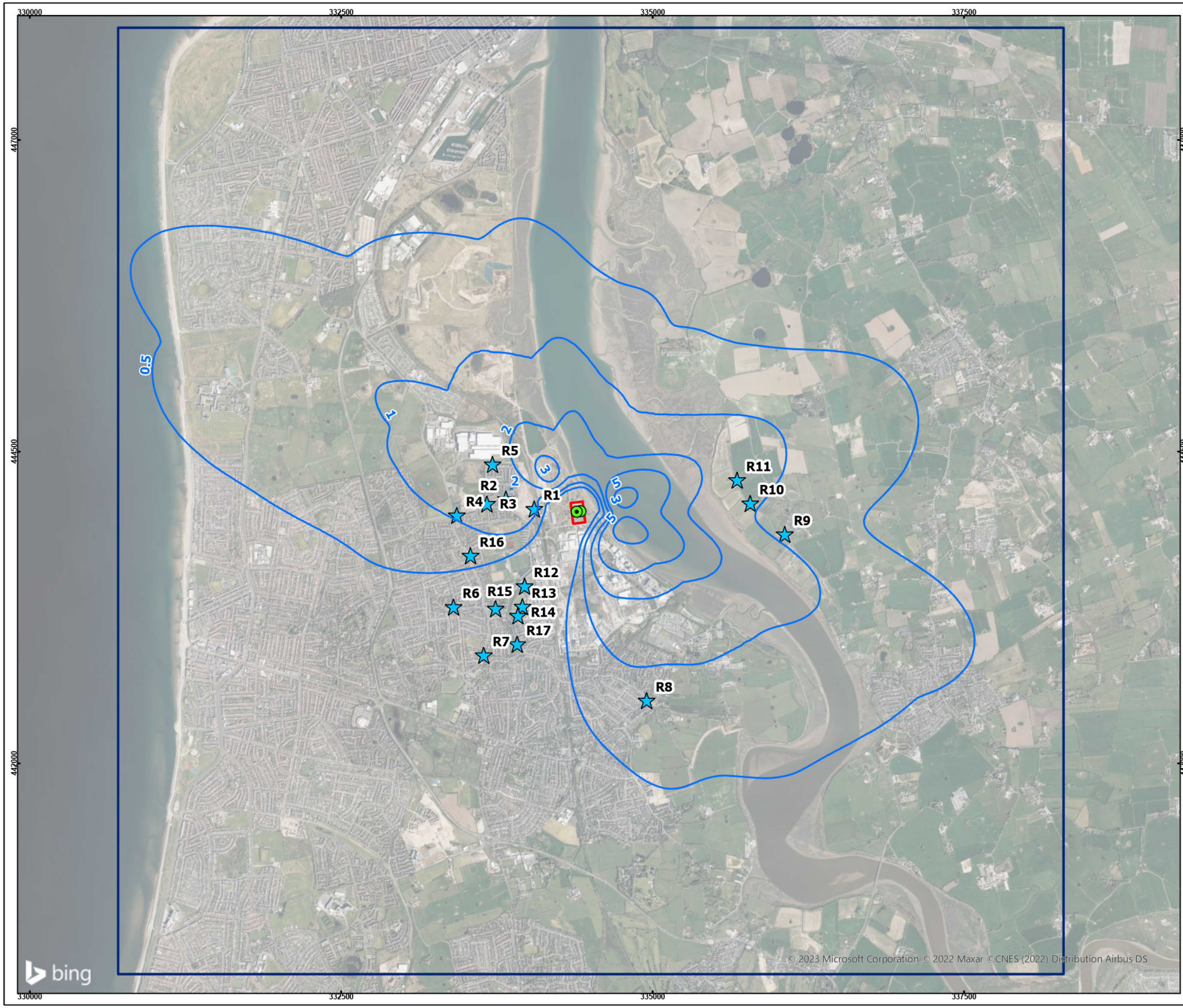
0 0.28 0.55 1.1 km

N

Scale: 1:28,000

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean Cadmium - Screening (% of AQAL)
- Human Sensitive Receptors

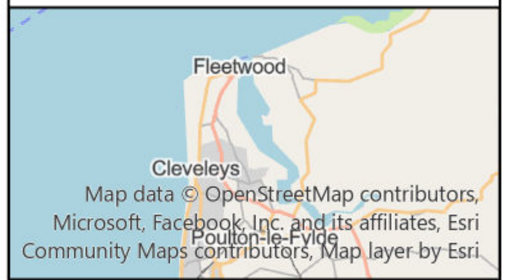
Notes:
- Assumed that cadmium is emitted at the combined cadmium and thallium ELV

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 8.10 Annual Mean Cadmium - Screening

Drawn by: MJC	Date: 20/01/2023



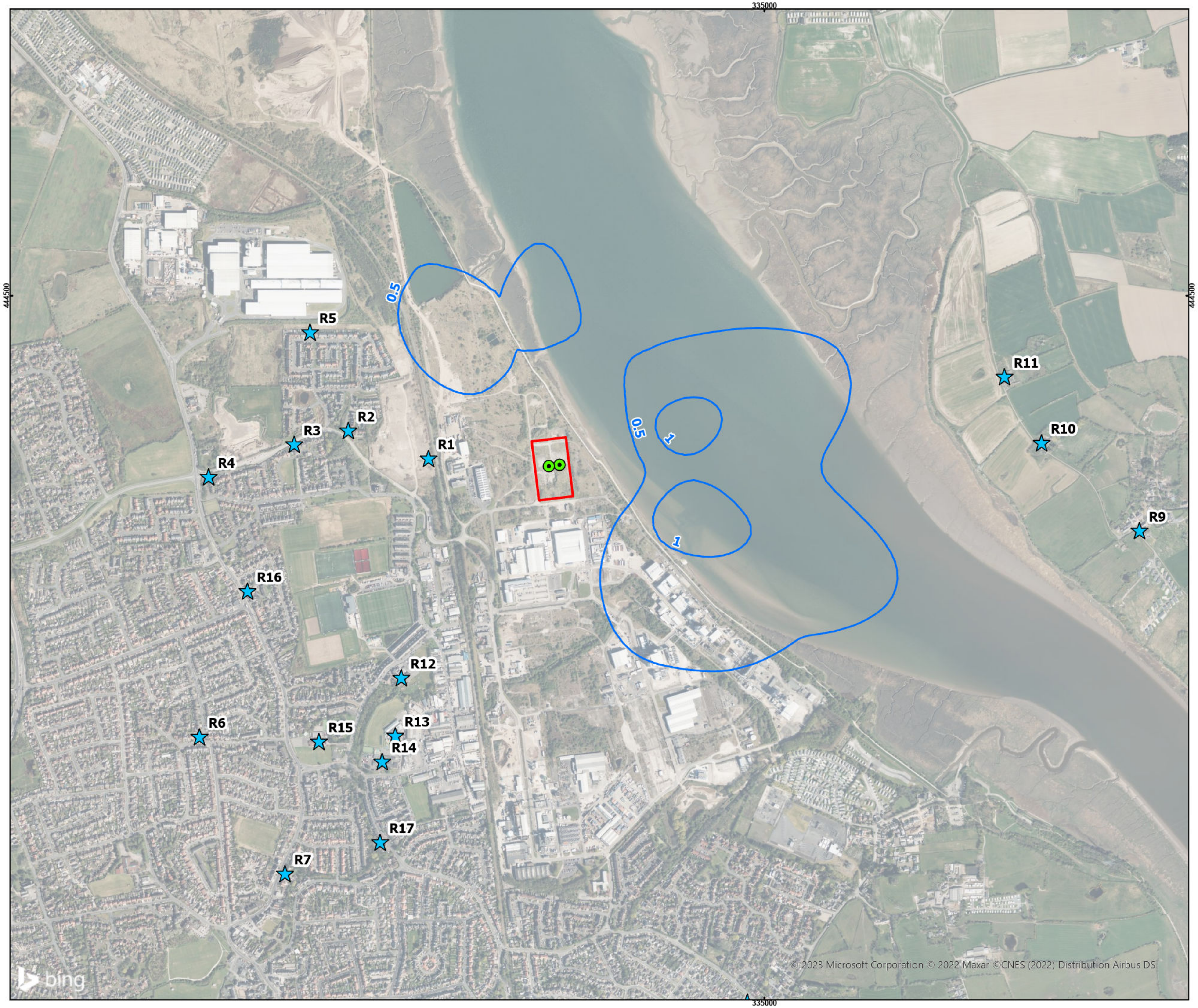
0 0.28 0.55 1.1 km

N

Scale: 1:28,000

FICHTNER
Consulting Engineers Limited

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



Legend

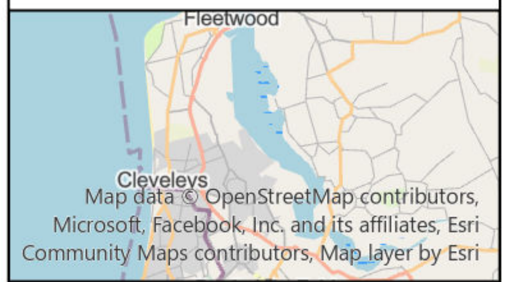
- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean PAHs (% of AQAL)
- Human Sensitive Receptors

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 8.11 Annual Mean PAHs

Drawn by: MJC | Date: 20/01/2023



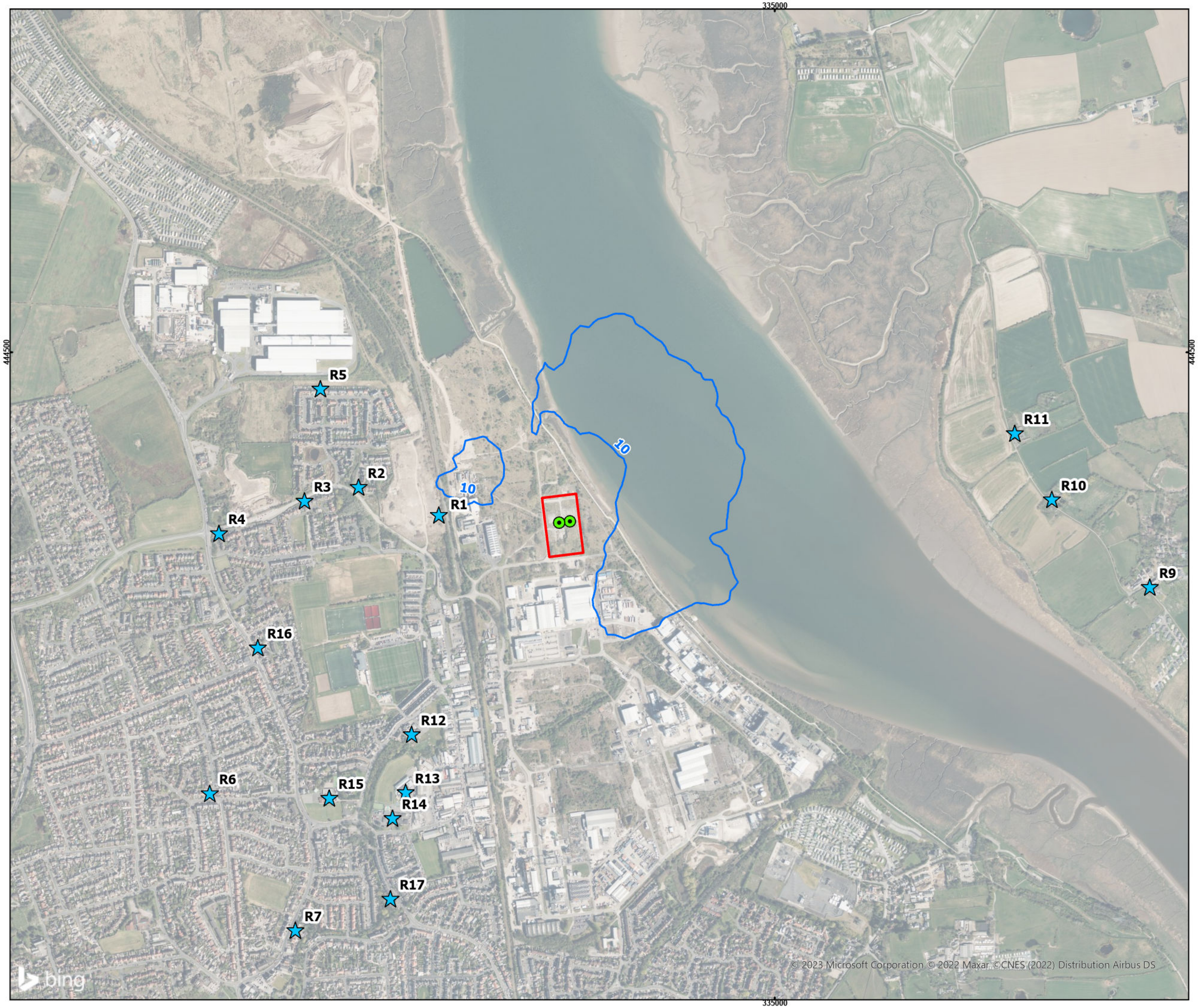
0 0.1 0.2 0.4 km

N

Scale: 1:10,000

FICHTNER
Consulting Engineers Limited

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

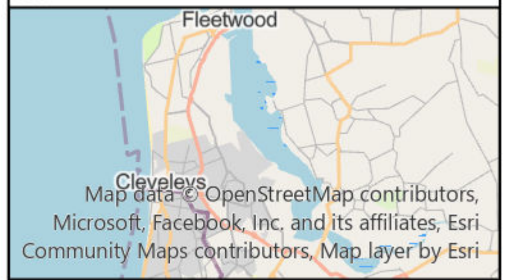


Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Hourly Mean Nitrogen Dioxide (% of AQAL)
- Human Sensitive Receptors

Notes:
- Assumed 35% conversion of oxides of nitrogen to nitrogen dioxide
- Assumed both lines operate concurrently at the short term ELVs

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	Figure 8.12 Hourly Mean Nitrogen Dioxide
Drawn by: MJC	Date: 20/01/2023
351	



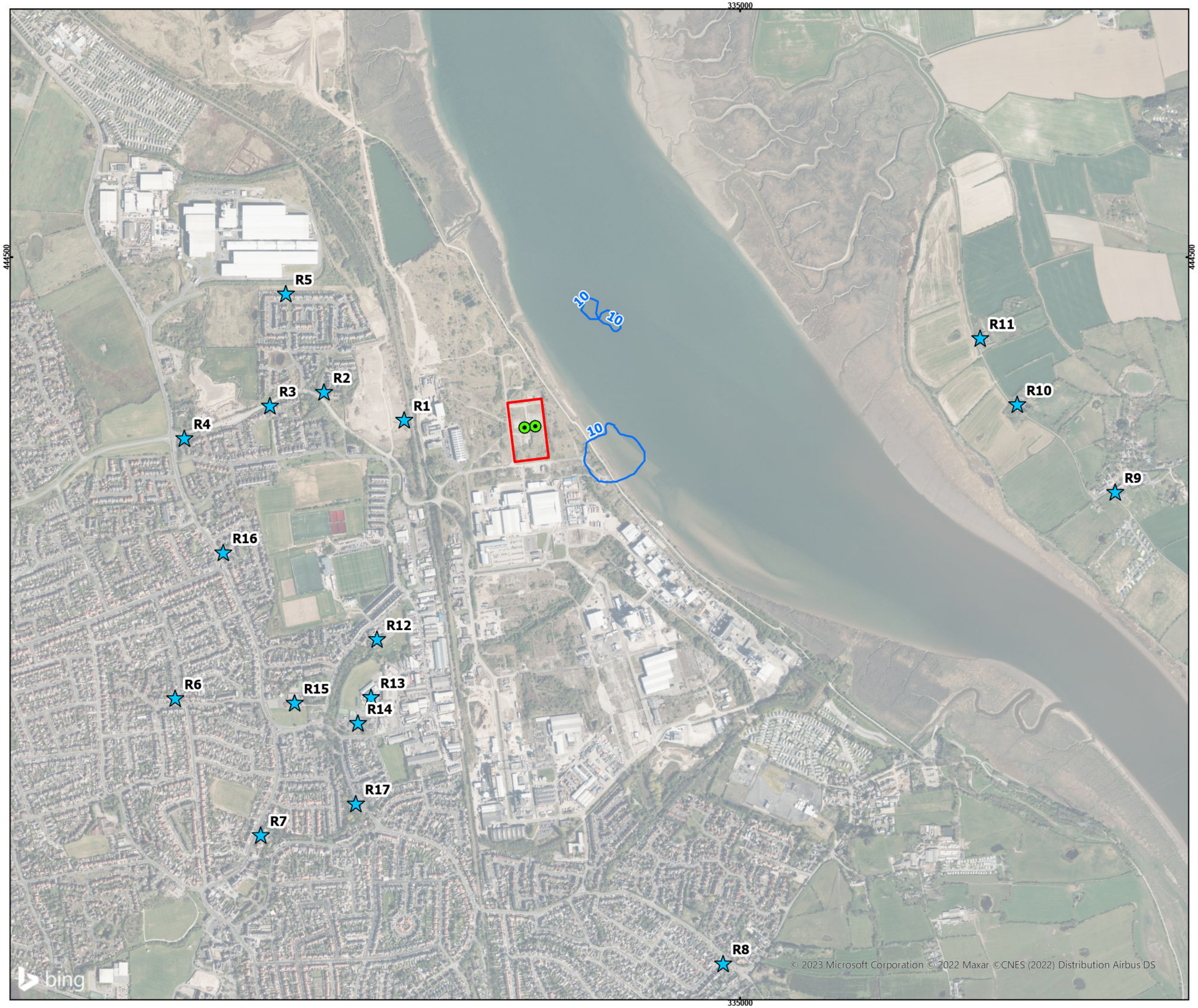
0 0.1 0.2 0.4 km

Scale: 1:10,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Hourly Mean Sulphur Dioxide (% of AQAL)
- Human Sensitive Receptors

Notes:
- Assumed both lines operate concurrently at the short term ELVs

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	Figure 8.13 Hourly Mean Sulphur Dioxide

Drawn by: MJC	Date: 20/01/2023
12	

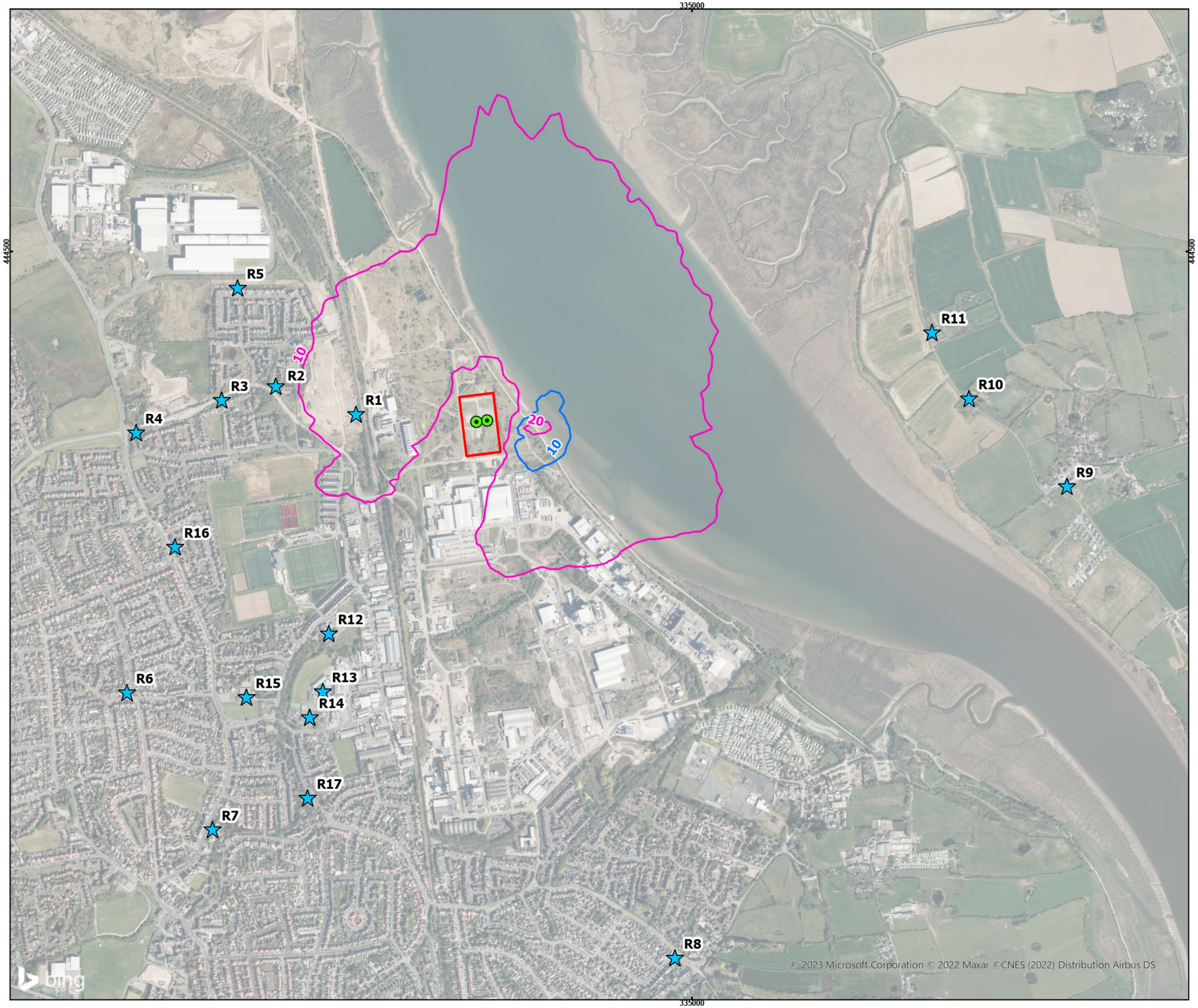
0 0.1 0.2 0.4 km

N

Scale: 1:10,000

FICHTNER
Consulting Engineers Limited

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



Legend

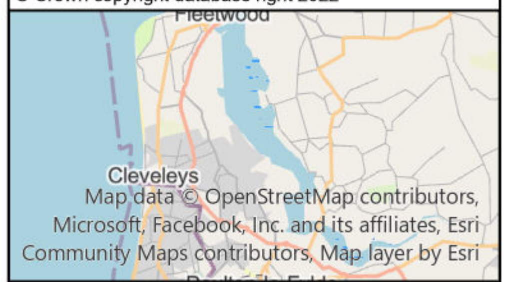
- Stack Locations
- Site Boundary
- Modelling Domain
- 15-Minute Mean Sulphur Dioxide (% of AQAL) - one line at short term ELV, one line at daily ELV
- 15-Minute Mean Sulphur Dioxide (% of AQAL) - both lines at short term ELV
- Human Sensitive Receptors

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 8.14 15-Minute Mean Sulphur Dioxide

Drawn by: MJC	Date: 20/01/2023



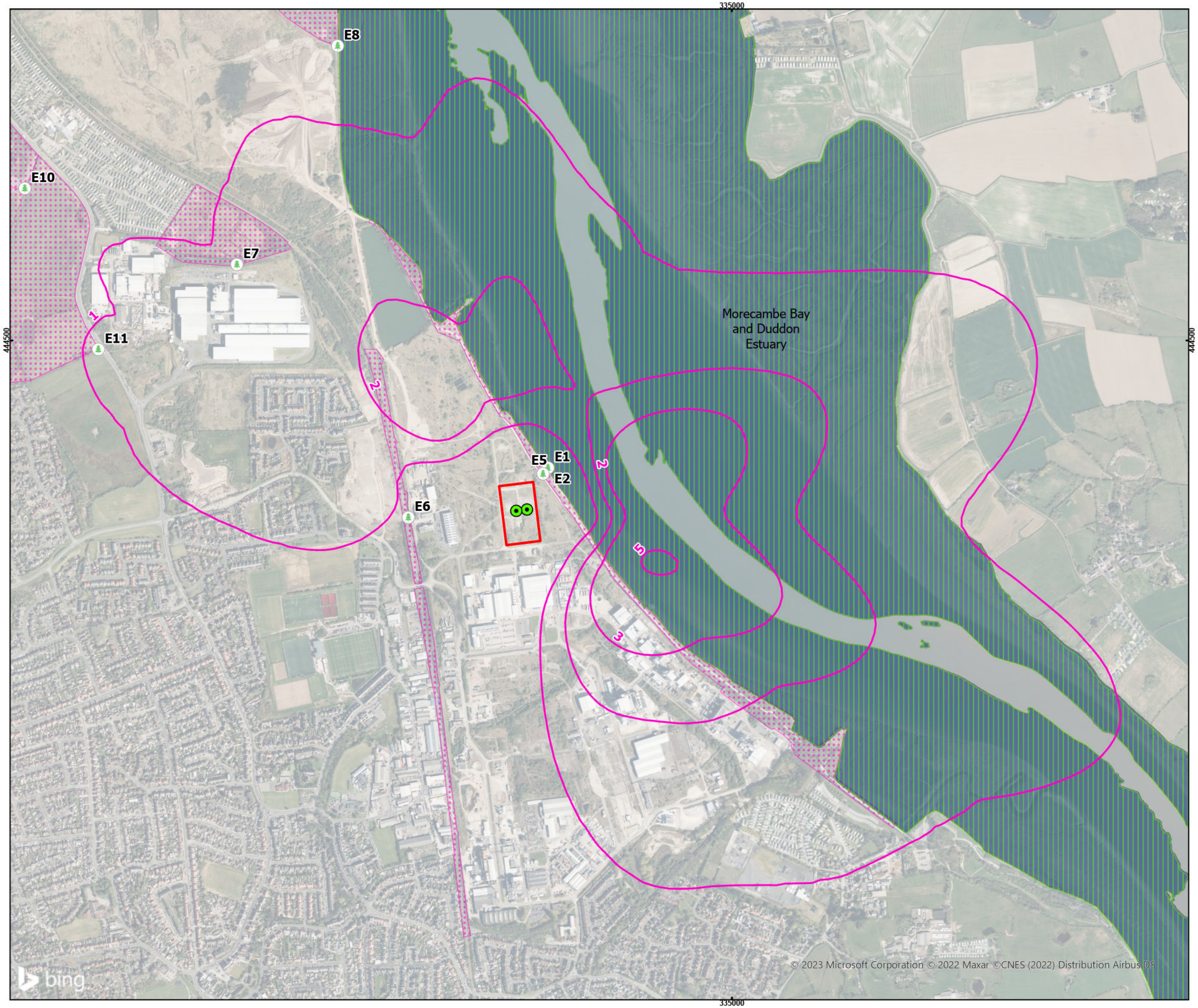
0 0.1 0.2 0.4 km

N

Scale: 1:10,000

FICHTNER
Consulting Engineers Limited

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



Legend

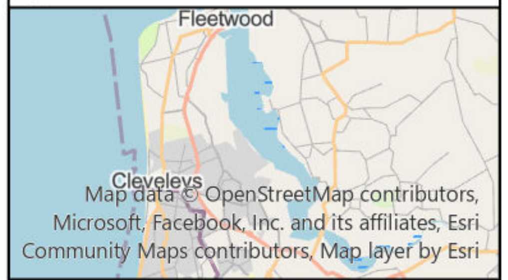
- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean Oxides of Nitrogen (% of Critical Level)
- Discrete Ecological Receptor Points
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 8.15 Annual Mean Oxides of Nitrogen

Drawn by: MJC	Date: 20/01/2023
321	



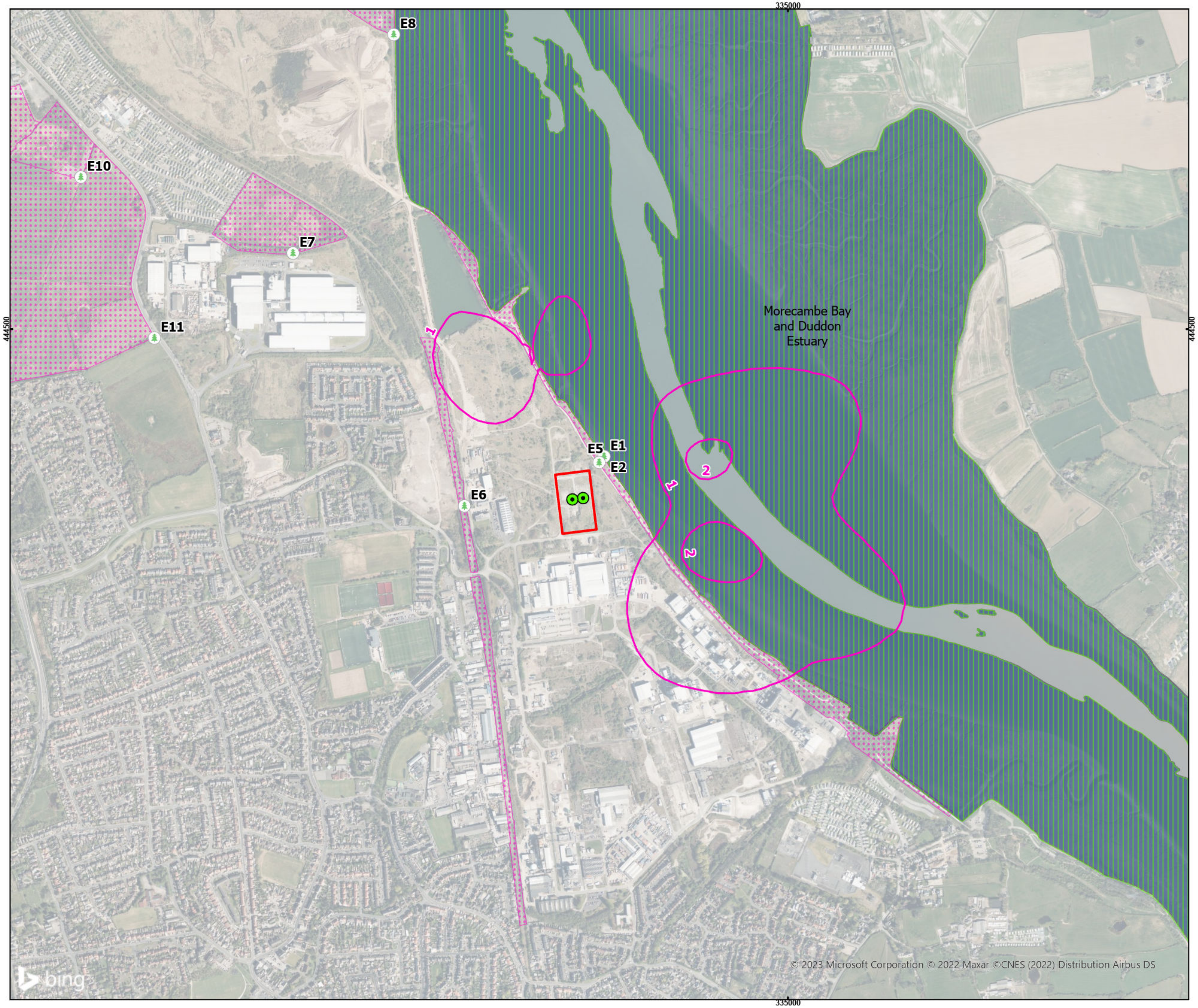
0 0.1 0.2 0.4 km

Scale: 1:10,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

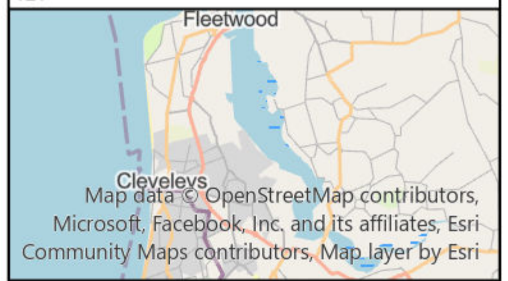
- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean Sulphur Dioxide (% of Critical Level)
- Discrete Ecological Receptor Points
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 8.16 Annual Mean Sulphur Dioxide

Drawn by: MJC	Date: 20/01/2023
321	



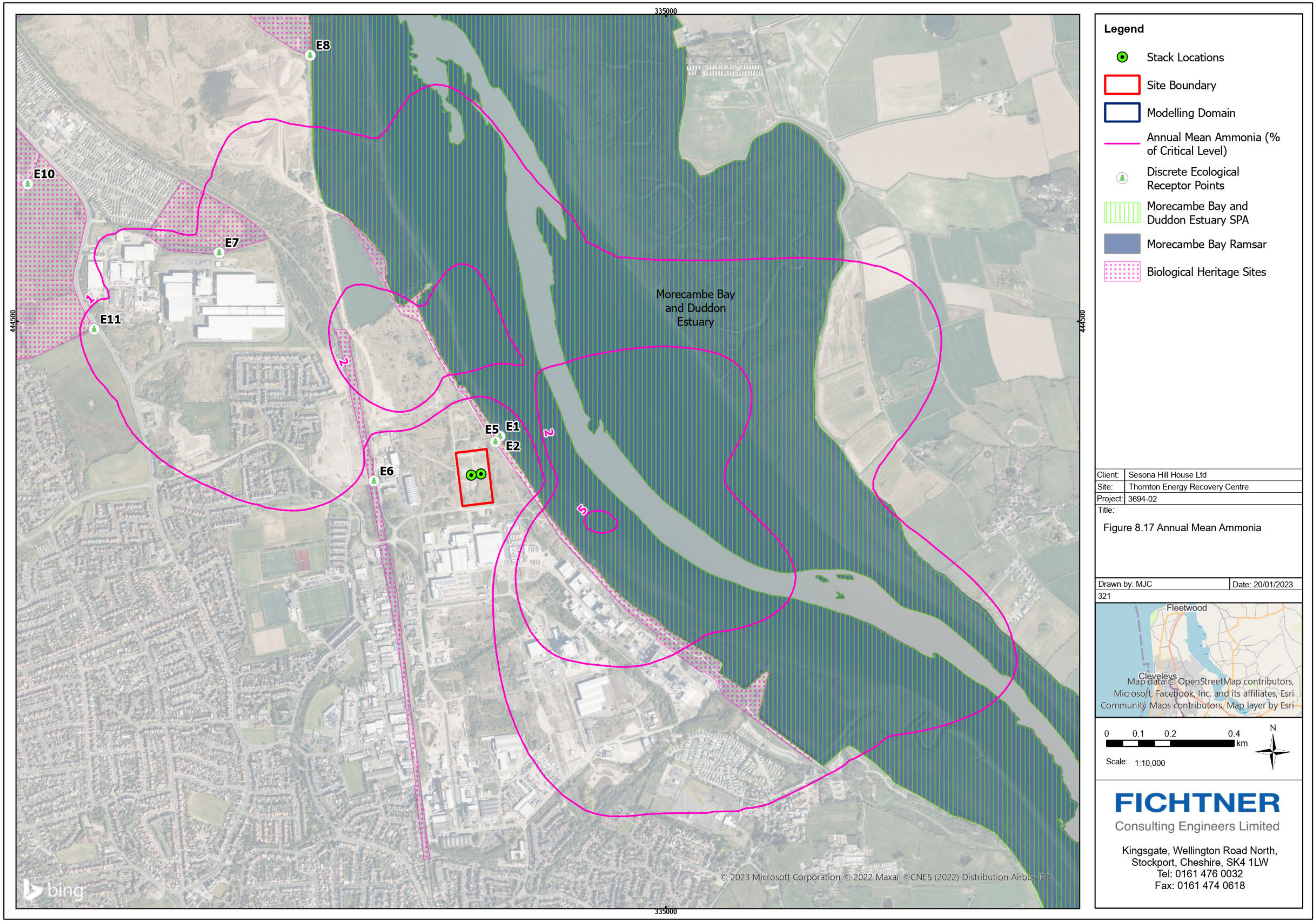
0 0.1 0.2 0.4 km

Scale: 1:10,000

N

FICHTNER
Consulting Engineers Limited

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



Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

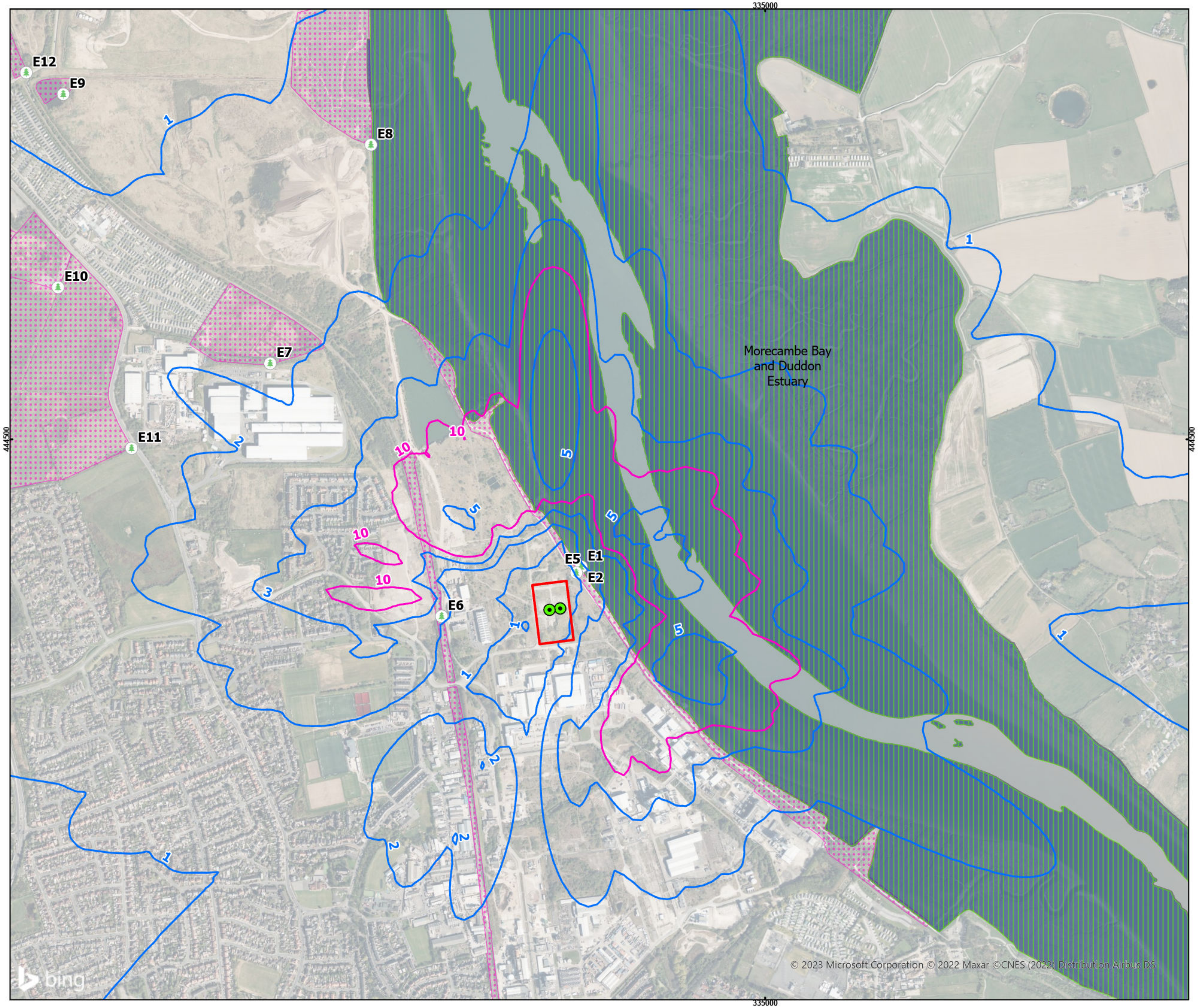
Figure 8.17 Annual Mean Ammonia

Drawn by: MJC | Date: 20/01/2023

321

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Daily Mean Oxides of Nitrogen (% of CL75)
- Daily Mean Oxides of Nitrogen (% of CL200)
- Discrete Ecological Receptor Points
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Notes:
- Only PC as % of 75 µg/m³ Critical Level is presented as PC as % of 200 µg/m³ Critical Level screens out as insignificant (<10%)

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	Figure 8.18 Daily Mean Oxides of Nitrogen

Drawn by: MJC | Date: 20/01/2023

231

Fleetwood

Map data © OpenStreetMap contributors, Microsoft, Facebook, Inc. and its affiliates, Esri Community Maps contributors, Map layer by Esri

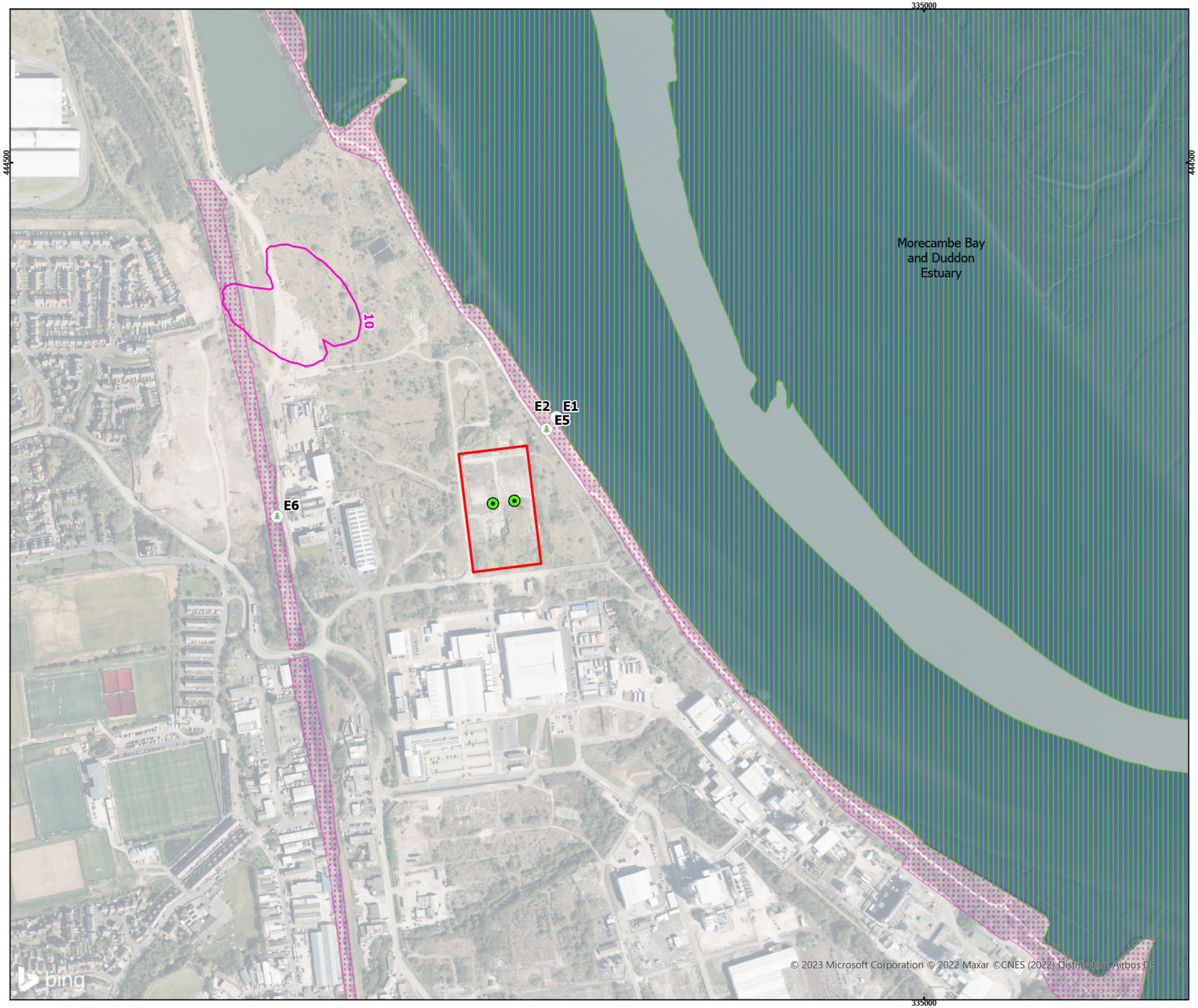
0 0.1 0.2 0.4 km

Scale: 1:10,000

N

FICHTNER
Consulting Engineers Limited

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



Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

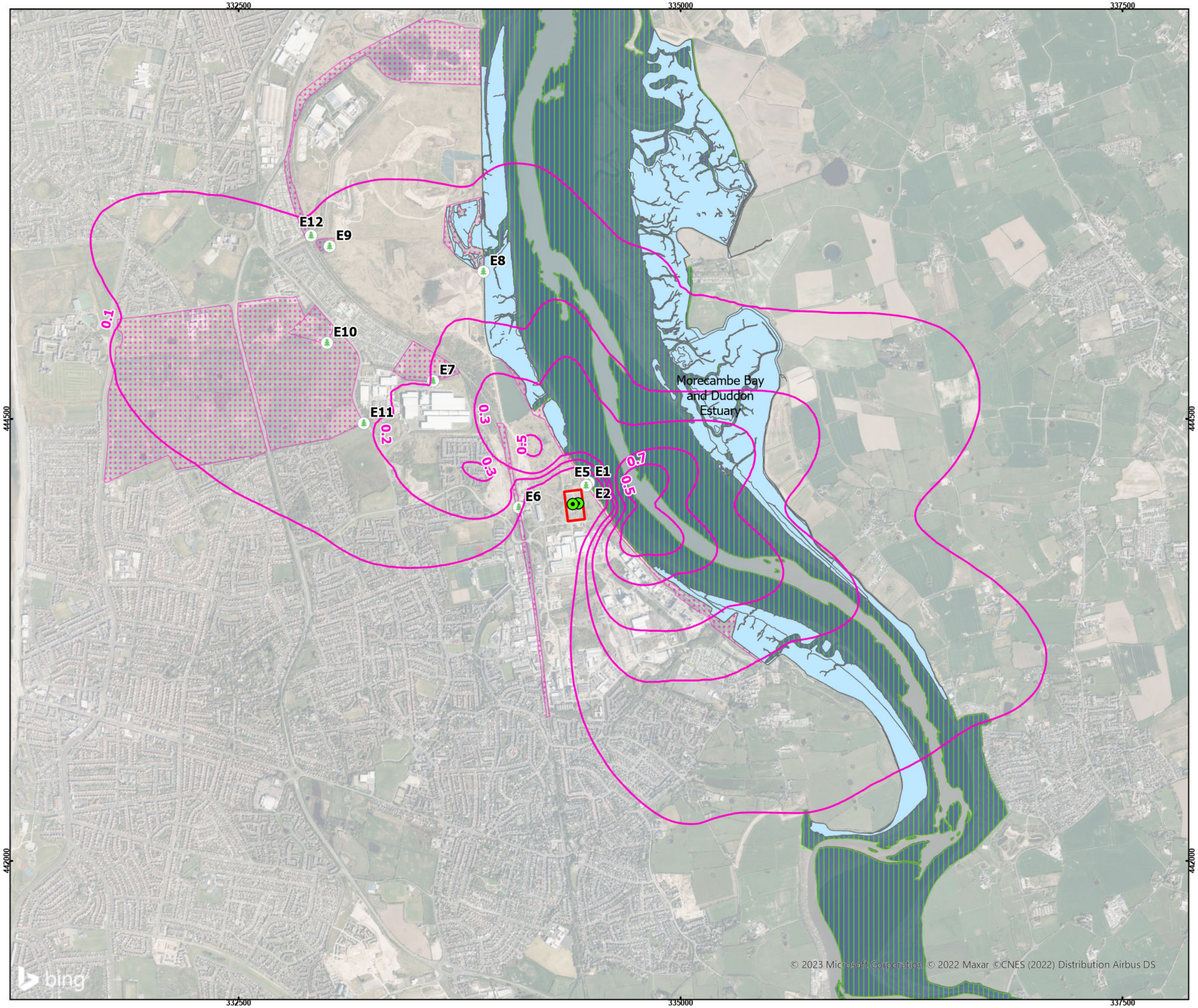
Figure 8.19 Weekly Mean Hydrogen Fluoride

Drawn by: MJC | Date: 20/01/2023

321

FICHTNER Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Nitrogen Deposition (kgN/ha/yr)
- Discrete Ecological Receptor Points
- Coastal Saltmarsh
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	Figure 8.20 Nitrogen Deposition

Drawn by: MJC | Date: 20/01/2023

321

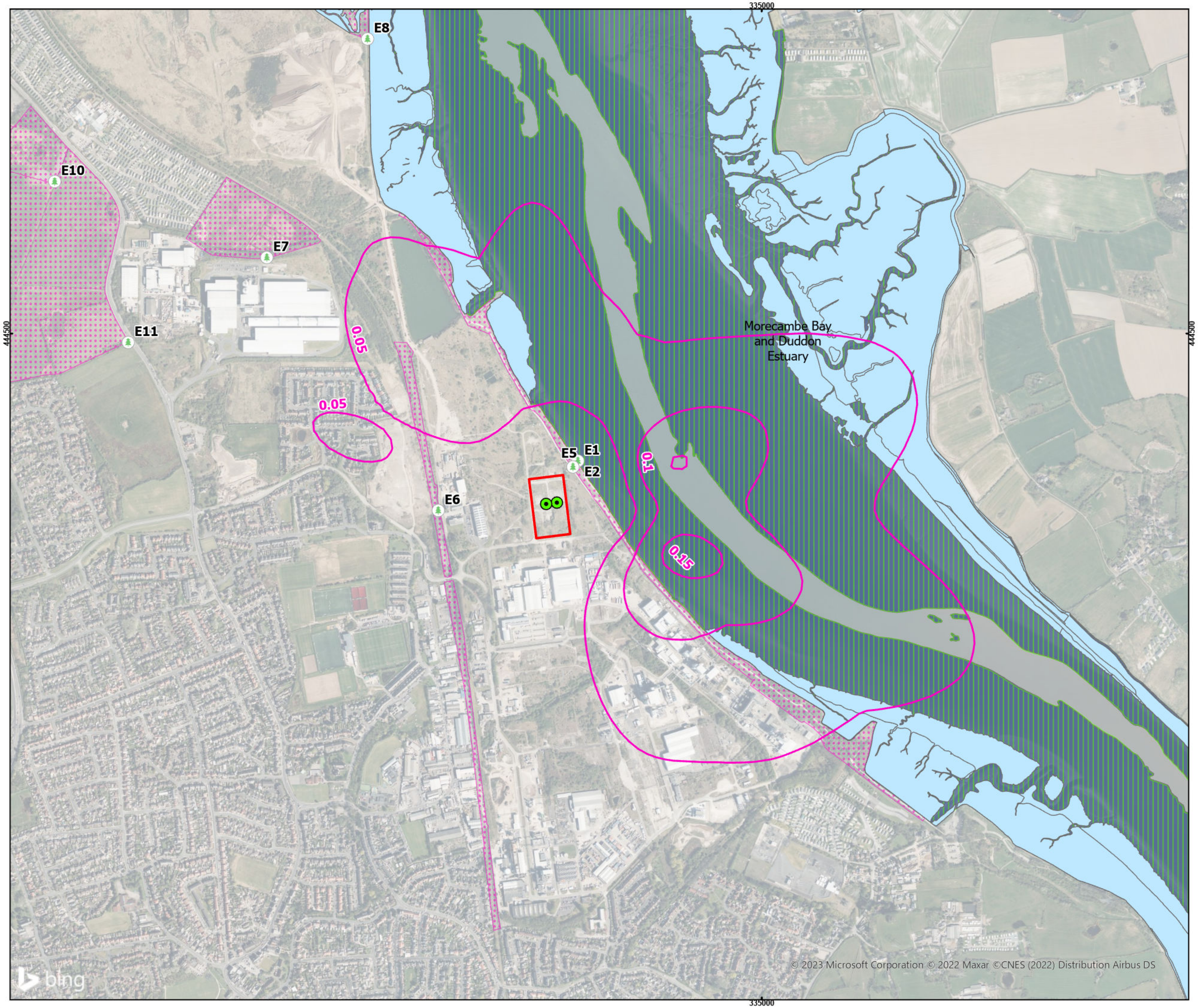
0 0.2 0.4 0.8 km

Scale: 1:20,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Acid Deposition (keq/ha/yr)
- Discrete Ecological Receptor Points
- Coastal Saltmarsh
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	Figure 8.21 Acid Deposition

Drawn by: MJC | Date: 20/01/2023

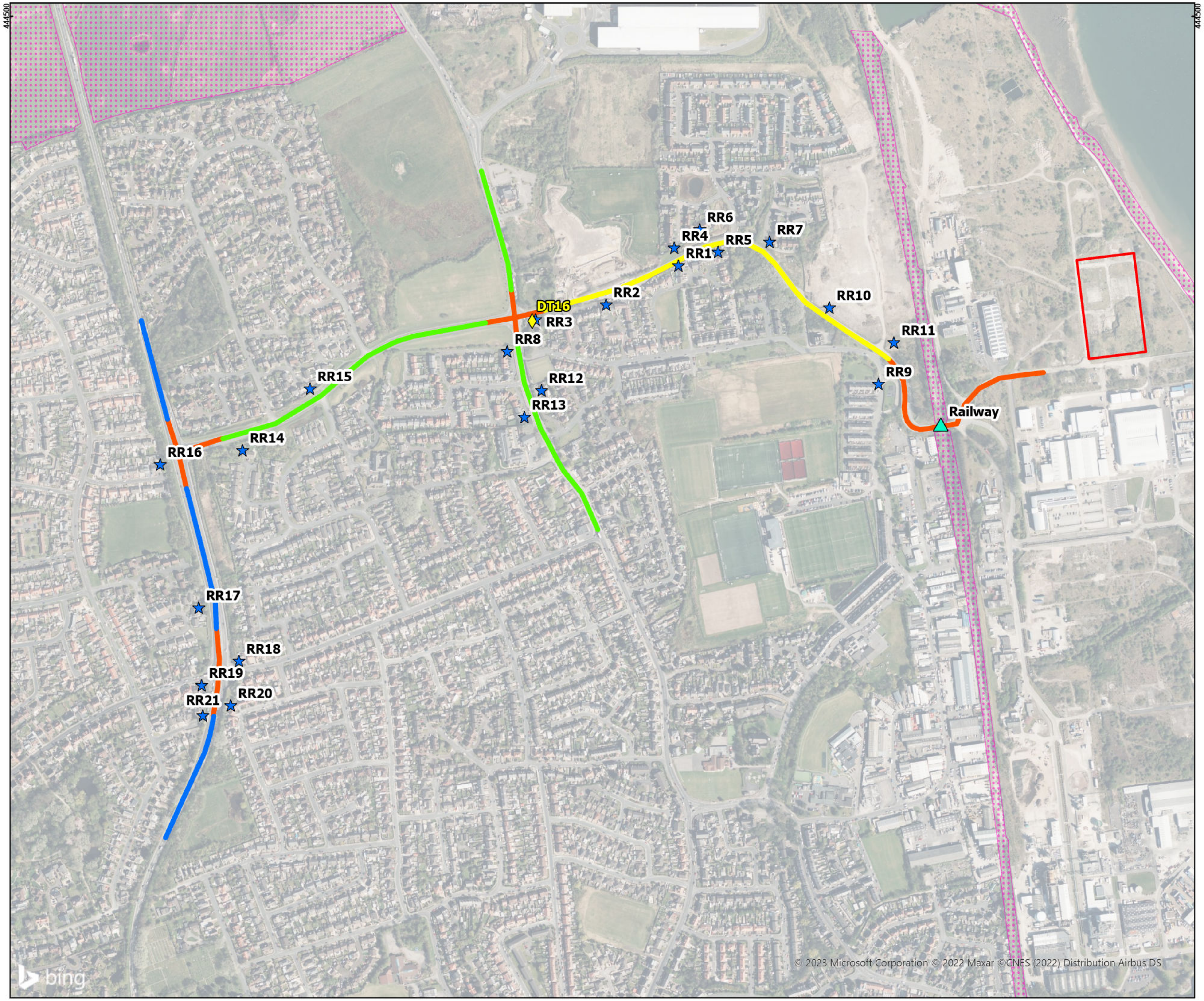
231

0 0.1 0.2 0.4 km

Scale: 1:10,000

N

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



Legend

- Site Boundary
- Monitoring Location for Verification
- Vehicle Emissions Sensitive Receptors
- Roadside Ecological Receptor Point
- 64 kph
- 48 kph
- 32 kph
- 20 kph
- Biological Heritage Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	

Figure 8.22 Vehicle Emissions Modelling

Drawn by: MJC | Date: 20/01/2023

Scale: 1:6,000

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

FICHTNER

Consulting Engineers Limited

Sesona Hill House Ltd

Abnormal Emissions Assessment

ENGINEERING + CONSULTING

Document approval

	Name	Signature	Position	Date
Prepared by:	Matt Clegg		Environmental Scientist	20/12/2022
Checked by:	Stuart Nock		Associate Senior Consultant	20/12/2022

Document revision record

Revision no	Date	Details of revisions	Prepared by	Checked by
0	20/12/2022	First issue	MJC	SMN

Contents

1 Introduction

Fichtner Consulting Engineers Ltd (Fichtner) has been engaged to undertake an Abnormal Emissions Assessment to support the Environmental Permit (EP) application for the proposed Thornton Energy Recovery Centre (the Facility). The Environmental Permitting Regulations require that abnormal event scenarios are considered.

Article 46(6) of the Industrial Emissions Directive (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.

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 (with the exception of hydrogen chloride);
2. Complete failure of the lime injection system leading to unabated emissions of hydrogen chloride. (Note: this would require the plant to have complete failure of the bag filter system. As a plant of modern design the 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.

As a modern design, it is anticipated that the Facility will be operated to a high degree of compliance. Therefore, the identification of plausible abnormal emission levels has been based primarily on the data obtained from modern plants. Where actual data is not available, worst case conservative assumptions have been made.

2.1 Plant start-up and shutdown

Start-up of the Facility from cold will be conducted with clean support fuel (low sulphur light fuel oil). 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 Facility 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 Facility.

3 Plausible Abnormal Emission Levels

The following plausible abnormal emission levels for the Facility have been identified based on the performance of similar plants in the UK. The plausible abnormal emissions concentrations are presented in Table 1, where available, these have been based on measured data from a comparable Facility.

Table 1: Plausible Abnormal Emissions from an EfW

Pollutant	Permitted Emission Limit, (mg/Nm³)(1)		Plausible Abnormal Emission, (mg/Nm³)	% Above Max Permitted Emission
	Daily Average	½ hourly max		
Oxides of nitrogen	120	400	500(2)	25
Particulate matter (PM_{10})	5	30	150(3)	400
Sulphur dioxide	30	200	450(4)	125
Hydrogen chloride	6	60	900(4)	1,400
Hydrogen fluoride	1	4	20(4)	400
Dioxins and dioxin-like PCBs	0.06 ng/Nm³		6 ng/Nm³	9900(5)
PCBs	0.005 mg/Nm³(6)		0.5 mg/Nm³	9900(7)

NOTES:

(1) All emissions expressed as Nm³ 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/Nm³ (dry, 11% oxygen, 273K). In lieu of other available data, this has been assumed to be the emission concentration for the Facility.

(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 Best Available Techniques Associated Emission Level (BAT-AEL) concentration of 0.02mg/m³.
- Emission concentration of cadmium has been taken as half of the BAT-AEL concentration for cadmium and thallium and compounds of 0.02mg/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 where it has been assumed there is a 99% removal efficiency.

The plausible abnormal emissions concentrations for metals are presented in Table 2.

Table 2: Predicted Abnormal Metal Emissions from an EfW

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	2,000	9,900
Nickel	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 those presented in the AQA. Therefore, TOC and CO have not been considered within this abnormal emissions assessment.

4 Impact Resulting from Plausible Abnormal Emissions

The Facility 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.

4.1 Predicted short term impacts

In order to assess the effect on short term ground level concentrations associated with the Facility operating at the identified abnormal emission concentration, the calculated ground level concentration has been increased pro-rata as presented in Table 3.

Table 3: Short-term Impacts Resulting from Plausible Abnormal Emissions

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	30.34	15.17%	37.93	18.96%
Particulate matter (PM_{10})	50	0.26	0.51%	7.66	15.32%
Sulphur dioxide (24-hour)	125	2.92	2.34%	43.83	35.06%
Sulphur dioxide (1-hour)	350	40.78	11.65%	91.75	26.21%
Sulphur dioxide (15-min)	266	57.30	21.54%	128.92	48.46%
Hydrogen chloride	750	44.92	5.99%	673.82	89.84%
Hydrogen fluoride	160	2.99	1.87%	14.96	9.35%
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	8.60	0.01%	258.01	0.17%
Chromium	150,000	68.80	0.05%	2,064.08	1.38%
Copper	200,000	21.69	0.01%	650.63	0.33%
Manganese	1,500,000	44.87	0.00%	1,346.14	0.09%
Mercury	7,500	14.96	0.20%	1,495.71	19.94%
Vanadium (daily mean)	1,000	0.81	0.08%	24.17	2.42%
PCBs	6,000	3.74	0.06%	373.93	6.23%

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. The maximum predicted process contribution (as a % of the applied AQAL) is less than 90% for hydrogen chloride with all other pollutants lower.

4.2 Predicted long term impacts

In order to assess the effect on long term ground level concentrations associated with the Facility operating at the identified abnormal emission levels, the calculated long term ground level concentrations have been increased pro-rata as presented in Table 4 and Table 5.

This assessment assumes that the Facility operates at the daily average BAT-AELs for 8,700 hours per year and at the plausible abnormal emission levels for 60 hours per year.

Table 4: Long-term Impacts Resulting from Plausible Abnormal Emissions

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	1.09	2.72%	1.12	2.79%
Particulate matter (PM_{10})	40	0.08	0.19%	0.09	0.23%
Hydrogen fluoride	16	0.016	0.10%	0.018	0.11%
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	0.18	0.004%	0.21	0.004%
Arsenic	6	0.39	6.47%	0.47	7.75%
Cadmium	5	0.16	3.10%	0.19	3.72%
Chromium	5,000	1.43	0.03%	1.71	0.03%
Chromium (VI)	0.25	0.0020	0.81%	0.0024	0.97%
Copper	10,000	0.45	0.00%	0.54	0.01%
Lead	250	0.78	0.31%	0.94	0.37%
Manganese	150	0.93	0.62%	1.12	0.74%
Mercury	250	0.31	0.12%	0.52	0.21%
Nickel	20	3.41	17.07%	4.09	20.46%
PCBs	200	0.08	0.04%	0.13	0.07%

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 21% for nickel, with all other pollutants lower.

There is no AQAL for dioxins and dioxin-like PCBs against which the impact can be assessed. Therefore, to assess the impact of dioxins and dioxin-like PCBs, the increase in concentration at the point of maximum impact has been assessed. As can be seen from the results presented in Table 5, the impact of abnormal emissions is to increase in the maximum ground level concentration by 67.81%.

Table 5: Long Term Impacts from Predicted Dioxin Emissions

Pollutant	Predicted Impact – Normal Operation	Predicted Impact –Abnormal Emissions	
	fg/m³	fg/m³	% increase
Dioxins and dioxin like PCBs	0.93	1.56	67.81%

Based on the results of the Dioxin Pathway Intake Assessment (DPIA), the highest dose of dioxins and dioxin-like PCBs is predicted to be 5.52% of the TDI. This is based on the ingestion and inhalation of dioxins and dioxin-like PCBs by a child agricultural receptor at the point of maximum impact. Assuming the impact of abnormal operations, it is calculated that the process contribution at this receptor will be (5.52% x 1.6781) = 9.26% of the UK TDI for dioxins and dioxin-like PCBs. Existing sources contribute 90.65% of the TDI, and therefore the total exposure will be 99.91% of the TDI.

In addition, the DPIA considers the impact of the ingestion of dioxins and dioxin-like PCBs by an infant being breast fed by an adult agricultural receptor at the point of maximum impact. The impact is predicted to be 33.25% of the UK TDI for dioxins and dioxin-like PCBs. There are no other significant pathways for infant receptors. Assuming the impact of abnormal operations, the impact at this receptor will be (33.25% x 1.6781) = 55.80% of the UK TDI for dioxins and dioxin-like PCBs.

Based on the conservative assumptions used within the modelling, there will be no exceedences of the TDI for dioxins and dioxin-like PCBs.

5 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.

5.1 Background concentrations

Appendix A outlines the values for the annual average background concentrations that have been used to evaluate the impact of the Facility. These are as presented in the Air Quality Assessment submitted with the EP application.

5.2 Predicted short term impacts

Table 6 below presents the predicted impacts of plausible abnormal operations 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 6: 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	31.4	37.93	69.33	34.66%
Particulate matter (PM_{10})	50	22.3	7.66	29.96	59.92%
Sulphur dioxide (24-hour)	125	13.9	43.83	57.75	46.20%
Sulphur dioxide (1-hour)	350	13.9	91.75	105.67	30.19%
Sulphur dioxide (15-min)	266	13.9	128.92	142.84	53.70%
Hydrogen chloride	750	1.4	673.82	675.24	90.03%
Pollutant	**AQAL (ng/m³)**	**Background Conc.**	**PC – Abnormal Emissions**	**PEC – Abnormal Emissions**	
		ng/m³	**ng/m³**	**ng/m³**	**% of AQAL**
Mercury	7,500	6	1495.7	1501.3	20.02%

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

5.3 Predicted long term impacts

Table 7 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 Facility operates at the BAT-AELs for 8,700 hours per year and at the plausible abnormal emission levels for 60 hours per year.

Table 7: 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	15.7	1.12	16.82	42.04%
Pollutant	**AQAL (ng/m³)**	**Background Conc.**	**PC – Abnormal Emissions (1)**	**PEC – Abnormal Emission**	
		ng/m³	**ng/m³**	**ng/m³**	**% of AQAL**
Arsenic	6	1.1	0.47	1.57	26.08%
Cadmium	5	0.4	0.19	0.54	10.72%
Nickel	20	2.2	4.09	6.29	31.46%
(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.

6 Summary

An assessment of the impact on air quality associated with abnormal operating conditions from the Facility has identified plausible abnormal emissions based on a review of monitoring data from operational facilities of a similar type in the UK. Notwithstanding the low frequency of occurrence of such abnormal operating conditions identified by the review, the potential impact on air quality has been assessed.

The predicted impact on air quality associated with the identified plausible abnormal emissions 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 air quality limits associated with abnormal operations. The maximum predicted short term process contribution (as % of the applied AQAL) is less than 90%; and the maximum predicted long term process contribution (as % of the applied AQAL) is less than 21%. Abnormal emissions from the Facility will not cause any exceedences of any AQAL. In addition, there will not be any exceedences of the TDI for dioxins.

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

Appendices

A Background Concentrations

Summary of Background Concentrations			
Pollutant	**Annual Mean Concentration**	**Units**	**Justification**
Nitrogen dioxide	15.70	µg/m³	Maximum monitored concentration from suburban or urban background LAQM within 5 km of Site.
Particulate matter (PM_{10})	11.15	µg/m³	
Sulphur dioxide	6.96	µg/m³	Maximum mapped background concentration from within 5 km of Site- DEFRA 2001 dataset.
Hydrogen chloride	0.71	µg/m³	
Hydrogen fluoride	2.35	µg/m³	
Mercury	2.80	ng/m³	Maximum annual concentration averaged across all urban background sites across the UK 2017 to 2021.
Cadmium	0.35	ng/m³	
Arsenic	1.10	ng/m³	
Nickel	2.20	ng/m³	

ENGINEERING + CONSULTING

FICHTNER
Consulting Engineers Limited

Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW,
United Kingdom

t: +44 (0)161 476 0032
f: +44 (0)161 474 0618

www.fichtner.co.uk

FICHTNER
Consulting Engineers Limited

Thornton Energy Recovery Centre

Sesona Hill House Ltd

Greenhouse Gas Assessment

ENGINEERING + CONSULTING

Document approval

	Name	Signature	Position	Date
Prepared by:	Katie Hampton		Environmental Consultant	16/01/2023
Checked by:	James Sturman		Lead Consultant	16/01/2023

Document revision record

Revision no	Date	Details of revisions	Prepared by	Checked by
00	12/12/2022	For Client	KLH	JRS
01	21/12/2022	Updated following Client comments	KLH	JRS
02	16/01/2023	Update Applicant name	KLH	JRS

Contents

1 Introduction

Sesona Hill House Ltd (Sesona) is applying to the Environment Agency (EA) under the Environmental Permitting Regulations (EPRs) for an Environmental Permit (EP) to operate the Thornton Energy Recovery Centre (the Facility). The Facility will incinerate incoming non-hazardous refuse derived fuel (RDF). The Facility will be located at the Hillhouse Business Park, Thornton-Cleveleys, Lancashire.

1.1 Background

The aim of this report is to assess the impact of greenhouse gas emissions as a result of the operation of the Facility.

A quantitative assessment of greenhouse gas emissions from the operation of the Facility has been undertaken as required by the Environment Agency (EA) for power generating activities. Greenhouse gas emissions from the Facility have also been considered in relation to other forms of power generation in the UK. The assessment does not consider the avoidance of emissions from the disposal of the waste in a landfill, or from any other alternative methods of waste treatment.

The EA guidance titled '*Assess the impact of air emissions on global warming*' requires an application for a bespoke environmental permit to identify:

- direct greenhouse gas emissions; and
- indirect greenhouse gas emissions (from heat or power imported to the site).

The application should then calculate the total carbon impact associated with the activity.

The assessment calculates the quantity of emissions of CO_2 from the Facility and also other greenhouse gases released (for example N_2O) as a CO_2 equivalent.

Power generated through energy recovery from waste/RDF displaces electricity that would have otherwise been sourced from conventional power stations. Therefore, the net change in carbon dioxide emissions has been calculated as a result of combusting incoming RDF to generate electricity rather than generating electricity by conventional means (based on the average UK power mix).

2 Assumptions

The Facility will use a moving grate as the combustion technology, consisting of a twin-stream design. The main design assumptions are set out in Table 1.

Table 1: Assumptions

Parameter	Unit	Value
Operating hours	hours	7,900
Annual capacity	tpa	100,000
NCV	MJ/kg	10.11
Carbon content[(a)]	%	26.41
Percentage of carbon which is biogenic[(a)]	%	58.91
Electrical generation	MWe	9.284
Parasitic load	MWe	1.5
Thermal capacity	MWth	35.6
Auxiliary burner fuel	-	Fuel oil
Auxiliary burner capacity	MWth	21.3 (approx. 60% of thermal capacity of Facility)
Start-up/shutdowns each year	-	2
Start-up/shutdown duration	hours	17
Start-up/shutdown periods each year	hours	34
Periods of non-availability each year	hours per annum	826
Parasitic load during periods of non-availability	MWe	0.3 (approx. 20% of operational parasitic load)
(a) Source: Carbon Assessment submitted to support the planning application.		

In addition, for the purposes of this assessment, the following additional assumptions have been applied:

1. Nitrous oxide is emitted from the process at a rate of 4 kg/TJ waste[1].
2. As stated in Environment Agency Guidance Note H1, the combustion of fuel oil has emissions of 0.25 t CO_2eq/MWh.

[1] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 2, Table 2.2: Default emissions factors for stationary combustion in the energy industries, Municipal Wastes (non-biomass fraction)

3 Displaced Power

Power generated from the combustion of incoming RDF within the Facility will displace alternative forms of power generation. Table 3-1 shows the energy sources for UK electricity generation, with their associated carbon intensities. It is important to consider which of these energy sources would be displaced by the power generated by the Facility.

Table 2: UK electricity supply characteristics[2]

Energy Source	Proportion of UK Supply (%)	Carbon emissions during operation (gCO_2/kWh)
Coal	3.8	1002
Natural Gas	38.5	372
Nuclear	16.1	0
Renewables	38.7	0
Other	2.9	795

The current UK energy strategy uses nuclear power stations to operate as baseload stations, run with relatively constant output over a daily and annual basis, with limited ability to ramp up and down in capacity to accommodate fluctuations in demand. Power supplied from existing nuclear power stations is relatively low in marginal cost and has the benefit of extremely low CO_2 emissions.

Wind and solar plants also have very low marginal operating costs and, in many cases, are supported by subsidies. This means that they will run when there is sufficient wind or sun, and their operation will be unaffected by the operation of the Facility. It is considered that the operation of the Facility will have little or no effect on how nuclear, wind or solar plants operate when taking into account market realities (such as the phase-out of nuclear plants and the generous subsidies often associated with the development of wind and solar plants).

Combined cycle gas turbines (CCGTs) are the primary flexible electricity source. Since wind and solar are intermittent, with the electricity supplied varying from essentially zero (on still nights) to more than 19.9 GW and 9.6 GW respectively for wind and solar (peak generation records to date at the time of writing), CCGTs supply a variable amount of power. However, records show that there are only very limited periods when CCGTs are not operational and providing power to the grid.

Gas engines, diesel engines and open cycle gas turbines also make a small contribution to the grid. These are mainly used to provide balancing services and to balance intermittent supplies. As they are more carbon intensive than CCGTs, it is more conservative to ignore these for the purposes of this assessment.

The Defra document '*Energy from Waste – A guide to the debate 2014*' provides support for the use of CCGT as a comparator for electricity generated from the combustion of waste. Footnote 29 on Page 21 of the document states that:

> *'A gas fired power station (Combined Cycle Gas Turbine – CCGT) is a reasonable comparator as this is the most likely technology if you wanted to build a new power station today.'*

Therefore, for the purposes of this assessment it is assumed that power from the Facility will displace power which would otherwise be generated in a CCGT, and that the CO_2 emissions from a CCGT power station are equivalent to 372 g/kWh (refer to Table 2).

[2] Department of Energy and Climate Change. UK Fuel Mix Disclosure data table (1 April 2021 to 31 March 2022). At the time of writing, this was the most up-to-date table available.

It is acknowledged that the UK government has set a target which '*will require the UK to bring all greenhouse gas emissions to net zero by 2050*'. Taking this into consideration, in the future, it is anticipated that the power which the Facility will generate will displace other forms of power generation, including renewable energy power stations. However, at this stage, the mix of generation capacity which could be added in the future to the grid that could be displaced is uncertain (so the carbon intensity of future displaced generation cannot be accurately quantified). Therefore, it has been assumed that the Facility will displace a gas fired power station, as this is considered to be a reasonable comparator.

The following assumptions regarding the energy outputs from the Facility have been made.

- The Facility will generate 9.284 MWe of electricity with a net output of 7.784 MWe, giving a gross and net electrical efficiency of approximately 26% and 22% respectively.
- There will be no heat export from the Facility. However, as noted in the Heat Investigation Study (Appendix G of the Supporting Information), a number of potential heat users have been identified.

On this basis:

- The Facility will generate approximately 73,344 MWh of power per annum. Of the power generated, approximately 61,494 MWh per annum will be available for export. This will displace a total of approximately 22,900 tonnes of carbon dioxide equivalent.

4 Emissions from the Facility

The Facility will release emissions of carbon dioxide and their equivalents (other greenhouse gases such as nitrous oxide) from the combustion of RDF. Furthermore, during periods when it is not generating power, the Facility will have a parasitic load which will require power to be imported from the grid.

In addition, during start-up, auxiliary burners will be used to raise the temperature within the boiler to ≥850°C before starting to feed RDF into the combustion chamber, as required by the Industrial Emissions Directive (IED). The burners will also be used to maintain the temperature within the boiler above 850°C when needed, as required by the IED. During shutdown, the auxiliary burners will be used to ensure complete burn-out of the RDF. The combustion of auxiliary fuel will release carbon dioxide.

4.1 Emissions from the incineration of incoming RDF

The Facility will export 615 kW of power per tonne of incoming RDF.

The carbon dioxide equivalent emissions from the incineration of incoming RDF would be 968 kg per tonne of RDF, of which approximately 398 kg per tonne of RDF will be from non-biogenic sources.

The total carbon dioxide equivalent emissions from fossil fuels (excluding the combustion of fuel oil) will be approximately 39,800 tonnes per annum.

4.2 Emissions of nitrous oxide

The Facility will release approximately 4.04 tonnes of nitrous oxide per annum. Nitrous oxide has a Global Warming Potential (GWP) of 310 carbon dioxide equivalents.

The total carbon dioxide equivalent emissions from emissions of nitrous oxide will be approximately 1,250 tonnes per annum.

4.3 Electricity import

During periods of start-up and shutdown, the Facility will have an electrical demand of approximately 51 MWh electricity; and during periods of non-availability an electrical demand of approximately 248 MWh electricity. On this basis, the Facility will consume approximately 299 MWh of electricity per annum. It should be noted that this is a conservative assumption, as in reality, each stream of the plant will have annual maintenance outages broadly in sequence, and therefore, imported electricity would be replaced with reduced electrical export from the RDF incineration process.

As stated in Environment Agency Guidance Note H1, the import of electricity from public supply should be assumed to have emissions of 0.166 tCO_2e/MWh. Therefore, the operation of the Facility is anticipated to result in the release of approximately 50 tonnes per annum of carbon dioxide equivalent from the import of electricity.

4.4 Emissions from auxiliary firing

For the purposes of this assessment, it is conservatively assumed that the auxiliary burners will consume approximately 700 MWh of fuel oil per annum. This will be equivalent to a total of approximately 200 tonnes per annum of carbon dioxide equivalent from the combustion of fuel oil for auxiliary firing.

4.5 Summary

The operation of the Facility will lead to the release of approximately:

- 39,800 tonnes per annum of carbon dioxide equivalent from the incineration of the non-biogenic component of the incoming RDF;
- 1,250 tonnes per annum of carbon dioxide equivalent from nitrous oxide from the incineration of incoming RDF;
- 50 tonnes per annum of carbon dioxide equivalent from imported electricity which is used for the incineration of incoming RDF; and
- 200 tonnes per annum of carbon dioxide equivalent from the combustion of fuel oil for auxiliary firing in the Facility.

Therefore, in total it is predicted that the operation of the Facility will result in the release of approximately 41,300 tonnes per annum of carbon dioxide.

5 Conclusions

The information presented within this assessment is summarised in Table 3.

Table 3: Greenhouse gas assessment summary

Process	GWP (tonnes CO_2 equivalent)	
Parameter	**Released**	**Saving/Offset**
CO_2 emissions derived from fossil fuels (a)	39,800	
N_2O from the process (ammonia) (b)	1,250	
Indirect CO_2 emissions (imported electricity) (c)	50	
Direct CO_2 emissions (auxiliary fuel) (d)	200	
Total released (e=a+b+c+d)	**41,300**	
Energy recovered (electricity) (f)		22,900
Energy recovered (heat) (g)		-
Total offset (h=f+g)		**22,900**
Net GWP (j=e-h)	**18,400**	

To conclude, the operation of the Facility will result in an increase in the emissions of carbon dioxide released from the generation of power from the incineration of RDF, compared to generating the equivalent power in a conventional CCGT power station.

As stated previously, this assessment methodology does not consider the avoidance of emissions from the disposal of the waste in a landfill, or from any other alternative methods of waste treatment. In addition, this assessment does not consider the carbon savings available from the potential to export heat from the Facility. This assessment only considers the direct and indirect carbon emissions as a result of the operation of the Facility, including carbon offset as a result of recovered energy as electricity, as required by the EA in support of an application for a bespoke EP – refer to section 1.1.

As set out in the Heat Investigation Study (Appendix G of the application), there are a number of opportunities for the export of heat to potential heat-users within the local area. If it is assumed that this heat would otherwise be generated from the combustion of fossil fuels, exporting heat to these potential heat users will further off-set carbon emissions from the Facility.

ENGINEERING CONSULTING

FICHTNER

Consulting Engineers Limited

Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW,
United Kingdom

t: +44 (0)161 476 0032
f: +44 (0)161 474 0618

www.fichtner.co.uk

FICHTNER

Consulting Engineers Limited

Thornton Energy Recovery Centre

Sesona Hill House Ltd

Dioxin Pathway Intake Assessment

ENGINEERING CONSULTING

Document approval

	Name	Signature	Position	Date
Prepared by:	Stuart Nock		Associate Senior Environmental Consultant	12/12/2022
Checked by:	Rosalind Flavell		Senior Environmental Consultant	12/12/2022

Document revision record

Revision no	Date	Details of revisions	Prepared by	Checked by
0	12/12/2022	First Issue	SMN	RSF
1	14/12/2022	Final version	SMN	RSF

Contents

1 Introduction

Fichtner Consulting Engineers Ltd (Fichtner) has been engaged to undertake a Dioxin Pathway Intake Assessment to support the Environmental Permit (EP) application for the proposed Thornton Energy Recovery Centre (the Facility).

As the fuel combusted at the Facility will be sourced from waste, the limits on emissions to air will be based on those outlined in Chapter IV and Annex VI of the Industrial Emissions Directive (IED) (2010/75/EU) for waste incineration and co-incineration plants. This will include limits on emissions of dioxins and furans (collectively referred to as "dioxins" for the purpose of this assessment).

The Waste Incineration BREF was published by the European Integrated Pollution Prevention and Control (IPPC) Bureau in December 2019. The Environment Agency will be required to implement conditions within all permits requiring operators to comply with the requirements set out in the BREF within four years of the publication date. This will include the Facility. The Waste Incineration BREF has introduced BAT-AELs (BAT Associated Emission Levels) which are more stringent than those currently set out in the IED for some pollutants. The Facility would be designed to meet the requirements of the Waste Incineration BREF for a new plant. Therefore, it has been assumed that the emissions from the Facility would comply with the BAT-AEL for dioxins and dioxin-like PCBs set out in the Waste Incineration BREF for new plants.

The advice from health specialists such as the UK Health Security Agency (formerly the Health Protection Agency, "HPA") is that the damage to health from emissions from incineration and co-incineration plants is likely to be very small, and probably not detectable. Nevertheless, the specific effects on human health of the Facility have been considered and are presented in this report. This includes a review of published literature on the health effects of energy recovery facilities, and a quantitative assessment of the effect of the Facility.

For most substances released from the Facility, the most significant effects on human health will arise by inhalation. However, for dioxins and dioxin-like polychlorinated biphenyls (PCBs) which accumulate in the environment, inhalation is only one of the potential exposure routes.

For dioxins and dioxin-like PCBs the health assessment criteria are expressed as the total intake from ingestion and inhalation. Therefore, this assessment considers exposure routes other than just inhalation.

2 Literature review

The HPA, whose role was taken over by Public Health England (PHE) and more recently by the UK Health Security Agency, published a note RCE-13 "The Impact on Health of Emissions to Air from Municipal Waste Incinerators", in 2009[1]. The summary states:

> *"While it is not possible to rule out adverse health effects from modern, well-regulated municipal waste incinerators with complete certainty, any potential damage to the health of those living close-by is likely to be very small, if detectable"*

PHE commissioned further research in 2012, while continuing to state that the conclusions of RCE-13 remain applicable. These studies were commissioned from the Small Area Health Statistics Unit, which is based at Imperial College London and Kings College London. The methodology and results of the studies have been published in a series of papers in scientific journals. The three most recent papers, known as Ghosh et al (2018)[2], Freni-Sterrantino et al (2019)[3] and Parkes et al (2019)[4], are the most relevant.

These studies considered whether living near a municipal waste incinerator (MWI) is linked with adverse reproductive and infant health outcomes. These outcomes were studied as they are considered more sensitive to the accumulation of pollutants in the environment than other potential markers such as lifetime cancer rates.

Ghosh et al (2018) concluded that:

> *"This large national study found no evidence for increased risk of a range of birth outcomes, including birth weight, preterm delivery and infant mortality, in relation to either MWI emissions or living near an MWI operating to the current EU waste incinerator regulations in Great Britain."*

Freni-Sterrantino et al (2019) concluded that:

> *"we did not find an association between the opening of a new MWI and changes in infant mortality trends or sex ratio at birth for 10 and 4 km buffers, using distance as proxy of exposure, after taking into account temporal trends in comparator areas and potential confounding factors."*

The objective of Parkes et al (2019) was as follows: *"To conduct a national investigation into the risk of congenital anomalies in babies born to mothers living within 10 km of an MWI associated with: i) modelled concentrations of PM_{10} as a proxy for MWI emissions more generally and; ii) proximity of residential postcode to nearest MWI, in areas in England and Scotland that are covered by a congenital anomaly register."* Under objective (i), which related congenital anomalies to modelled concentrations and so would be considered the more representative approach, the study

[1] https://www.gov.uk/government/publications/municipal-waste-incinerators-emissions-impact-on-health

[2] Ghosh RE, Freni Sterrantino A, Douglas P, Parkes B, Fecht D, de Hoogh K, Fuller G, Gulliver J, Font A, Smith RB, Blangiardo M, Elliott P, Toledano MB, Hansell AL. (2018) Fetal growth, stillbirth, infant mortality and other birth outcomes near UK municipal waste incinerators; retrospective population based cohort and case-control study. Environment International.

[3] Freni-Sterrantino, A; Ghosh, RE; Fecht, D; Toledano, MB; Elliott, P; Hansell, AL; Blangiardo, M. (2019) Bayesian spatial modelling for quasi-experimental designs: An interrupted time series study of the opening of Municipal Waste Incinerators in relation to infant mortality and sex ratio. Environment International. 128 106-115

[4] Parkes B, Hansell A.L., Ghosh R.E, Douglas P., Fecht D., Wellesley D., Kurinczuk J.J., Rankin J., de Hoogh K., Fuller G.W, Elliot P., and Toledano M.B. "Risk of congenital anomalies near municipal waste incinerators in England and Scotland: Retrospective population-based cohort study". Environment International (Parkes et al).

found no association with congenital abnormalities. Under objective (ii), there was a small excess risk, but the paper's authors note that this may be due to residual confounding.

The Imperial College website includes Frequently Asked Questions on this study. One of these is "Does the study show that MWIs are causing increased congenital anomalies in populations living nearby?" The answer is as follows.

> *"No. The study does not say that the small excess risks associated with congenital heart disease and genital anomalies in proximity to MWIs are caused by those MWIs, as these results may be explained by residual confounding factors i.e., other influences which it was not possible to take into account in the study. This possible explanation is supported further by the fact that the study found no increased risk in congenital anomalies due to exposure to emissions from incinerators."*

These three recent papers consider facilities in the UK, operating under the same regulatory regime which would apply to the Facility and operating to the current standards of the IED. The papers found no conclusive evidence of an association of waste incineration facilities with the health outcomes considered. Given that the Facility would actually operate to tighter standards, as it would be subject to the reduced emissions limits from the Waste Incineration BREF, the conclusions are directly relevant and support PHE's position statement that "*any potential damage to the health of those living close-by is likely to be very small, if detectable".*

Therefore, it can be concluded that the effect of emissions from the Facility of pollutants that accumulate in the environment would not be significant. Nonetheless, a quantitative assessment of the effect of emissions from the Facility has been undertaken and is presented in the following sections.

3 Issue Identification

3.1 Issue

The key issue for consideration is the release of substances to atmosphere from the Facility which have the potential to harm human health. Details of the dispersion modelling can be found in the Dispersion Modelling Assessment submitted with the EP application.

The Facility will be designed to meet the BAT-AELs outlined in the Waste Incineration BREF. Limits have been set for pollutants known to be produced during the combustion of municipal waste which have the potential to impact upon the local environment either on human health or ecological receptors. Dioxins and dioxin-like PCBs can accumulate in the environment, which means that inhalation is only one of the potential exposure routes. The health assessment criterion is expressed as the total intake from ingestion and inhalation. Pathway modelling considering the intake from inhalation and ingestion has been carried out using the software "Industrial Risk Assessment Program-Human Health" (IRAP-h View – Version 5.1, "IRAP"). In addition, a review of published literature on the health effects of energy recovery facilities has been undertaken.

3.2 Chemicals of Potential Concern (COPC)

The following substances have been considered COPCs for the purpose of this assessment:

- PCDD/Fs (individual congeners), i.e., dioxins; and
- Dioxin-like PCBs;

This risk assessment investigates the potential for long term health effect of these COPCs through other routes than just inhalation.

4 Assessment Criteria

IRAP calculates the total exposure through each of the different pathways so that a dose from inhalation and ingestion can be calculated for each receptor. By default, these doses are then used to calculate a cancer risk, using the United States Environment Protection Agency's (USEPA)'s approach. However, this assessment applies the approach set out in the Environment Agency's document "Human Health Toxicological Assessment of Contaminants in Soil", ref SC050021 (2009).

For the COPCs considered, which have a threshold level for toxicity, a Tolerable Daily Intake (TDI) is defined. This is "an estimate of the amount of a contaminant, expressed on a bodyweight basis, which can be ingested daily over a lifetime without appreciable health risk." A Mean Daily Intake (MDI) is also defined, which is the typical intake from background sources (including dietary intake) across the UK. In order to assess the impact of the Facility, the predicted intake of a substance due to emissions from the Facility is added to the MDI and compared with the TDI.

The following table outlines the MDIs (the typical intake from existing background sources) and TDIs for dioxins and dioxin-like PCBs. These figures are defined in the "Contaminants in soil: updated collation of toxicology data and intake values for humans: dioxins, furans and dioxin-like PCBs"(Environment Agency 2009).

Table 1: Intake of Dioxins and Dioxin-Like PCBs

Item	Units	Intake	
		70 kg adult	20 kg child
Tolerable Daily Intake (TDI)	pg WHO-TEQ/kg bw/day	2.0	
Mean Daily Intake (MDI)	pg WHO-TEQ/kg bw/day	0.7	1.8
	% of TDI	35.00%	90.65%

To allow comparison with the TDI for dioxins, intake values for each dioxin are multiplied by a factor known as the WHO-TEF. A full list of the WHO-TEF values for each dioxin is provided in Table 7.

The TDI has been set at a level which can be ingested daily over a lifetime without appreciable health risk. Therefore, if the total exposure is less than the TDI, it can be concluded that the impact of the Facility is not significant.

5 Conceptual Site Model

5.1 Conceptual site model

IRAP, created by Lakes Environmental, is based on the USEPA Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities[5]. This Protocol is a development of the approach defined by Her Majesties Inspectorate on Pollution (HMIP) in the UK in 1996[6], taking account of further research since that date. The exposure pathways included in the IRAP model are shown in Table 2.

Exposure to gaseous contaminants has the potential to occur by direct inhalation or vapour phase transfer to plants. In addition, exposure to particulate phase contaminants may occur via indirect pathways following the deposition of particles to soil. These pathways include:

- ingestion of soil and dust;
- uptake of contaminants from soil into the food-chain (through home-grown produce and crops); and
- direct deposition of particles onto above ground crops.

The pathways through which inhalation and ingestion occur and the receptors that have been considered to be impacted via each pathway are shown in the table below.

Table 2: Pathways Considered

Pathway	Residential	Agricultural
Direct inhalation	Yes	Yes
Ingestion of soil	Yes	Yes
Ingestion of home-grown produce	Yes	Yes
Ingestion of drinking water	Yes	Yes
Ingestion of eggs from home-grown chickens	-	Yes
Ingestion of home-grown poultry	-	Yes
Ingestion of home-grown beef	-	Yes
Ingestion of home-grown pork	-	Yes
Ingestion of home-grown milk	-	Yes
Ingestion of breast milk (infants only)	Yes	Yes

Some households may keep chickens and consume eggs and potentially the birds. The impact on these households is considered to be between the impact at an agricultural receptor and a standard resident receptor. The approach used considers an agricultural receptor at the point of maximum impact as a complete worst case.

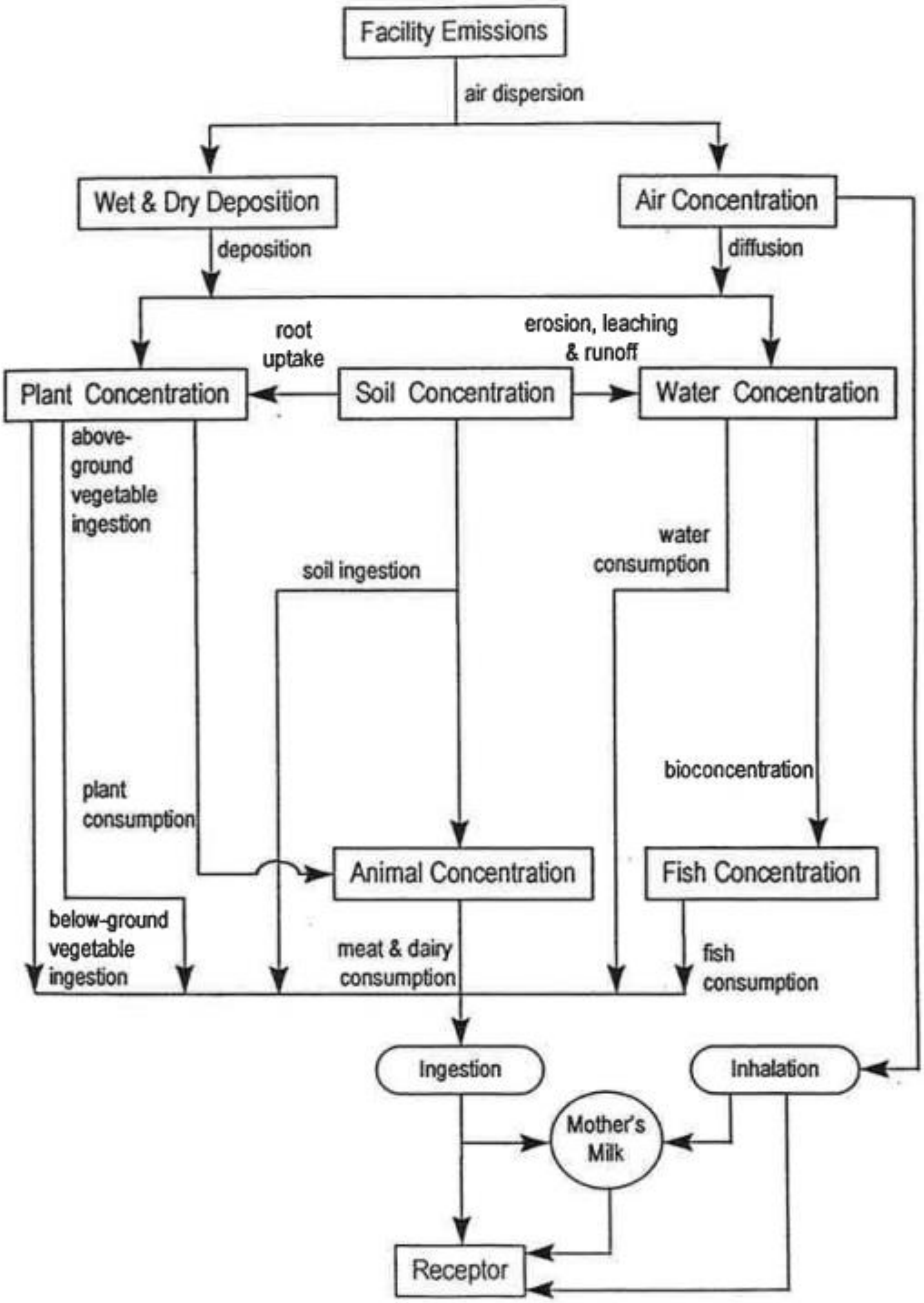
As shown in Figure 1, the pathway from the ingestion of mother's milk in infants is considered within the assessment. The IRAP model calculates the amount of dioxins entering the mother's milk and being passed on to the infants. IRAP does not include data on individual PCBs, but it does include data for take-up and accumulation rates within the food chain for two groups of PCBs,

[5] USEPA (2005) Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

[6] HMIP (1996) Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes.

known as Aroclor 1254 and Aroclor 1016. IRAP does not include these when determining the intake via mother's milk. Therefore, a safety factor of 1.5 has been applied to the dioxin and dioxin-like PCBs emission rate when considering the impact of the intake via mother's milk. The impacts are then compared against the TDI.

Figure 1: Conceptual Site Model – Exposure Pathways



5.2 Pathways excluded from assessment

The intake of dioxins via dermal absorption, groundwater and surface water exposure, and fish consumption pathways is very limited and as such these pathways are excluded from this assessment. The justification for excluding these pathways is highlighted in the following sections.

5.2.1 Dermal absorption

Both the HMIP and the USEPA note that the contribution from dermal exposure to soils impacted from thermal treatment facilities is typically a very minor pathway and is typically very small relative to contributions resulting from exposures via the food chain.

The USEPA[7] provide an example from the risk assessment conducted for the Waste Technologies, Inc. hazardous thermal treatment in East Liverpool, Ohio. This indicated that for an adult subsistence farmer in an area with high exposures, the risk resulting from soil ingestion and dermal contact was 50-fold less than the risk from any other pathway and 300-fold less than the total estimated risk.

The HMIP document[8] provides a screening calculation using conservative assumptions, which states that the intake via dermal absorption is 30 times lower than the intake via inhalation, which is itself a minor contributor to the total risk.

As such the pathway from dermal absorption is deemed to be an insignificant risk and has been excluded from this assessment.

5.2.2 Groundwater

Exposure via groundwater can only occur if the groundwater is contaminated and consumed untreated by an individual.

The USEPA[9] have concluded that the build-up of dioxins in the aquifer over realistic travel times relevant to human exposure was predicted to be so small as to be essentially zero.

As such the pathway from groundwater is deemed to be an insignificant risk and has been excluded from this assessment.

5.2.3 Surface water

A possible pathway is via deposition of emissions directly onto surface water – i.e., local drinking water supplies or rainwater storage tanks.

Surface water generally goes through several treatment steps and as such any contaminants would be removed from the water before consumption. Run off to rainwater tanks may not go through the same treatment. However, rainwater tanks have a very small surface area and as such the potential for deposition and build-up of COPCs is limited. As such, the pathway from contaminated surface water is deemed to be an insignificant risk and has been excluded from this assessment.

[7] USEPA (2005) Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

[8] HMIP (1996) Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes.

[9] USEPA (2005) Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

5.2.4 Fish consumption

The consumption of locally caught fish has been excluded from the assessment. Whilst fish makes up a proportion of the UK diet, it is not likely that this would be sourced wide-scale from close proximity to the Facility.

A review of the local waterbodies has been undertaken to see if there are any game fishing lakes in the local area[10]. The closest game fishing lake is the Fylde Trout Fishery, located approximately 10 km south-east of the Facility. Due to the distance from the Facility, it is considered that the impact at the fishery will be imperceptible. In addition, the likelihood of persons sources a large proportion of their diet from a trout fishery is very low. Game fishing may also take place along rivers, estuaries and the sea in the local area. However, the accumulation of pollutants in river systems is not of significant concern, as any pollutants will be washed downstream rather than accumulating, and accumulation in estuaries and seas will be diluted by tidal action. Therefore, the fish consumption pathway has been excluded from this assessment.

[10] Locations Map, http://www.fisharound.net/where-to-fish/locations-map

6 Sensitive Receptors

This assessment considers the possible effects on human health at key receptors, where humans are likely to be exposed to the greatest impact from the Facility, and at the point of maximum impact of annual mean emissions.

For the purposes of this assessment, receptor locations have been categorised as ‘residential’ or ‘agricultural’. Residential receptors represent a known place of residence that is occupied within the study area. Agricultural receptors represent a farm holding or area land of horticultural interest.

The specific receptors identified in the Dispersion Modelling Assessment have been considered in this assessment. An additional receptor has been included at the point of maximum impact. This point lies in the River Wyre so neither inhabited nor in agricultural use. However, this point has been included to demonstrate the theoretical maximum impact of the Facility. The sensitive receptors assessed are listed in Table 3. Reference should be made to Annex B which shows the location of these receptors with respect to the Facility.

Table 3: Sensitive Receptors

ID	Receptor Name	Location		Type of Receptor
		X	Y	
MAX	Point of maximum impact	334800	443875	Agricultural / Residential
R1	Land at Bourne Road	334050	444040	Residential
R2	240 Bourne Rd	333823	444119	Residential
R3	23 Bourne Rd	333670	444080	Residential
R4	20 Rose Fold	333428	443988	Residential
R5	Hawthorn Drive	333715	444397	Residential
R6	52 Holmes Road	333402	443253	Residential
R7	122 Fleetwood Road North	333644	442866	Residential
R8	1 Woodfield Road	334952	442503	Residential
R9	Staynall Lane	336061	443836	Agricultural
R10	Carters Farm	335784	444084	Agricultural
R11	Burrows Farm	335679	444271	Agricultural
R12	Thornton Primary School	333973	443420	Residential
R13	Red Marsh Special School	333956	443256	Residential
R14	Great Arley School	333919	443183	Residential
R15	Sacred Heart Catholic Primary School	333740	443240	Residential
R16	Westport House Care Home	333538	443665	Residential
R17	Thornton Lodge Care Home	333913	442955	Residential

7 IRAP Model Assumptions and Inputs

The following section details the user defined assumptions used within the IRAP model and provides justifications where appropriate.

7.1 Concentrations in soil

The concentration of each chemical in the soil is calculated from the deposition results of the air quality modelling for vapour phase and particle phase deposition. The critical variables in calculating the accumulation of pollutants in the soil are as follows:

- the lifetime of the Facility is taken as 30 years; and
- the soil mixing depth is taken as 2 cm in general and 30 cm for produce.

The split between the solid and vapour phase for the substance considered depends on the specific physical properties of each chemical.

In order to assess the amount of substance which is lost from the soil each year through volatilisation, leaching and surface run-off, a soil loss constant is calculated. The rates for leaching and surface runoff are taken as constant, while the rate for volatilisation is calculated from the physical properties of each substance.

7.2 Concentrations in plants

The concentrations in plants are determined by considering direct deposition and air-to-plant transfer for above ground produce, and root uptake for above ground and below ground produce.

The calculation takes account of the different types of plant. For example, uptake of substances through the roots will differ for below ground and above ground vegetables, and deposition onto plants will be more significant for above ground vegetables.

7.3 Concentrations in animals

The concentrations in animals are calculated from the concentrations in plants, assumed consumption rates and bio-concentration factors. These vary for different animals and different substances, since the transfer of chemicals between the plants consumed and animal tissue varies.

It is also assumed that 100% of the plant materials eaten by animals is grown on soil contaminated by emission sources. This is likely to be a highly pessimistic assumption for UK farming practice.

7.4 Concentrations in humans

7.4.1 Intake via inhalation

This is calculated from inhalation rates of typical adults and children and atmospheric concentrations. The inhalation rates used for adults and children are:

- adults – 20 m^3/day; and
- children – 7.2 m^3/day.

These are as specified within the Environment Agency's document "Human Health Toxicological Assessment of Contaminants in Soil". The calculation also takes account of time spent outside, since most people spend most of their time indoors.

7.4.2 Intake via soil ingestion

This calculation allows for the ingestion of soil and takes account of different exposure frequencies. It allows for ingestion of soil attached to unwashed vegetables, unintended ingestion when farming or gardening and, for children, ingestion of soil when playing.

7.4.3 Ingestion of food

The calculation of exposure due to ingestion of food draws on the calculations of concentrations in animals and plants and takes account of different ingestion rates for the various food groups by different age groups.

For most people, locally-produced food is only a fraction of their diet and so exposure factors are applied to allow for this.

7.4.4 Breast milk ingestion

For infants, the primary route of exposure is through breast milk. The calculation draws on the exposure calculation for adults and then allows for the transfer of chemicals in breast milk to an infant who is exclusively breast-fed.

The only pathway considered for dioxins for a breast feeding infant is through breast milk. The modelled scenario consists of the accumulation of pollutants in the food chain up to an adult receptor, the accumulation of pollutants in breast milk and finally the consumption of breast milk by an infant.

The assumptions used were:

- Exposure duration of infant to breast milk — 1 year
- Proportion of ingested dioxin that is stored in fat — 0.9
- Proportion of mother's weight that is stored in fat — 0.3
- Fraction of fat in breast milk — 0.04
- Fraction of ingested contaminant that is absorbed — 0.9
- Half-life of dioxins in adults — 2,555 days
- Ingestion rate of breast milk — 0.688 kg/day
- Safety factor on total dioxin intake to account for PCBs — 1.5

7.5 Estimation of COPC concentration in media

The IRAP-h model uses a database of physical and chemical parameters to calculate the COPC concentrations through each of the different pathways identified. The base physical and chemical parameters have been used in this assessment.

Weather data has been obtained for the period 2017 to 2021 from the Blackpool Airport weather station, as used within the Dispersion Modelling Assessment. This provides the annual average precipitation which can be used to calculate the general IRAP-h input parameters, as presented in Table 4.

Table 4: Site-Specific Properties

Input Variable	Assumption	Value (cm/year)
Annual average evapotranspiration	70% of annual average precipitation	69.08
Annual average irrigation	0% of annual average precipitation	0.00
Annual average precipitation	100% of annual average precipitation	98.69
Annual average runoff	10% of annual average precipitation	9.87

The average wind speed was taken as 5.51 m/s, calculated from the average of the five years of weather data from Blackpool Airport.

A number of assumptions have been made with regard to the deposition of the different phases. These are summarised in the following table.

Table 5: Deposition Assumptions

Deposition Phase	Dry Deposition Velocities (m/s)	Ratio Dry deposition to Wet deposition	
		Dry Deposition	Wet Deposition
Vapour	0.005	1.0	2.0
Particle	0.010	1.0	2.0
Bound particle	0.010	1.0	2.0

These deposition assumptions have been applied to the annual mean concentrations predicted using the dispersion modelling, to generate the inputs needed for the IRAP modelling. For details of the dispersion modelling methodology please refer to the Dispersion Modelling Assessment.

7.6 Modelled emissions

For the purpose of this assessment it is assumed that the Facility operates at the BAT-AEL for dioxin and dioxin-like PCBs within the Waste Incineration BREF for its entire operational life. In reality, the Facility will be shut down for periods of maintenance and will typically operate below the emission limits prescribed in the permit.

The following tables present the emissions rates of each COPC modelled and the associated emission concentrations which have been used to derive the emission rate.

Table 6: COPC Emissions Modelled

COPC	Split of congeners for a release of 1 ng I-TEQ/Nm^3 (1)	Emission conc. (ng/Nm^3)(2)	Emission rate (ng/s) (3)
Sum I-TEQ dioxins(4)	-	0.04 ng I-TEQ/Nm^3	-
2,3,7,8-TCDD	0.031	0.0012	0.030
1,2,3,7,8-PeCDD	0.245	0.0098	0.234
1,2,3,4,7,8-HxCDD	0.287	0.0115	0.274
1,2,3,6,7,8-HxCDD	0.258	0.0103	0.246

COPC	Split of congeners for a release of 1 ng I-TEQ/Nm^3 (1)	Emission conc. (ng/Nm^3) (2)	Emission rate (ng/s) (3)
1,2,3,7,8,9-HxCDD	0.205	0.0082	0.196
1,2,3,4,6,7,8-HpCDD	1.704	0.0681	1.625
OCDD	4.042	0.1616	3.855
2,3,7,8-TCDF	0.277	0.0111	0.264
1,2,3,7,8-PCDF	0.277	0.0111	0.264
2,3,4,7,8-PCDF	0.535	0.0214	0.510
1,2,3,4,7,8-HxCDF	2.179	0.0871	2.078
1,2,3,6,7,8-HxCDF	0.807	0.0323	0.770
1,2,3,7,8,9-HxCDF	0.042	0.0017	0.040
2,3,4,6,7,8-HxCDF	0.871	0.0348	0.831
1,2,3,4,6,7,8-HpCDF	4.395	0.1757	4.192
1,2,3,4,7,8,9-HpCDF	0.429	0.0172	0.409
OCDF	3.566	0.1426	3.401
Total dioxins	20.150	0.8057	19.218
Dioxin-like PCBs	-	0.0092	0.219

Notes:

(1) Split of the congeners taken from Table 7.2a from the HMIP document.

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

(3) Emission release rate calculated by multiplying the normalised volumetric flow rate by the emission concentration.

(4) The Waste Incineration BREF includes an emission limit for dioxins of 0.04 ng I-TEQ/Nm^3, or a combined limit of 0.06 ng I-TEQ/Nm for dioxins when dioxin-like PCBs are included. As this assessment considers dioxin-like PCBs separately, the lower limit of 0.04 ng I-TEQ/Nm^3 for dioxins has been used.

A number of points should be noted for the two groups of COPCs:

1. **Dioxins**

The split of the different dioxins and furans is based on split of congeners for a release of 1 ng I-TEQ/Nm^3 as presented in in Table 6. This data is taken from Table 7.2a from the HMIP document "Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes".

To determine the emission rates, this split of the different dioxins has been multiplied by normalised volumetric flow rate to determine the release rate of each congener.

2. **Dioxin-like PCBs**

There are a total of 209 PCBs, which act in a similar manner to dioxins, are generally found in complex mixtures and also have TEFs.

The UK Environment Agency has advised that 44 measurements of dioxin like PCBs have been taken at 24 MWIs between 2008 and 2010. The following data summarises the measurements, all at 11% reference oxygen content:

- Maximum = 9.2 x 10^{-3} ng[TEQ]/m³
- Mean = 2.6 x 10^{-3} ng[TEQ]/m³
- Minimum = 5.6 x 10^{-5} ng[TEQ]/m³

For the purpose of this assessment, the maximum monitored PCB concentration has been used which has been converted to an emission rate using the volumetric flow.

The IRAP software, and the HHRAP database which underpins it, does not include any data on individual PCBs, but it does include data for take-up and accumulation rates within the food chain for two groups of PCBs, known as Aroclor 1254 and Aroclor 1016. Each Aroclor is based on a fixed composition of PCBs. Since we are not aware of any data on the specification of PCBs within incinerator or co-incinerator emissions, as a worst-case assumption it has been assumed that PCB emissions consist entirely of each of the two Aroclor compositions and the maximum impact of either composition has been presented.

As shown in Table 1, the MDI and TDI for dioxins and dioxin-like PCBs is given in pg WHO-TEQ/kg bw/day. However, the split of congeners shown in Table 6 which are used to calculate the release rate of each dioxin are based on the I-TEFs listed in Annex VI Part II of the IED. To determine the total intake TEQ for comparison with the TDI, the output of the IRAP model has been multiplied by the relevant WHO-TEFs. The I-TEFs and WHO-TEFs are shown in Table 7.

Table 7: Toxic Equivalency Factors for Dioxins and Furans

Congener	IED I-TEQ Multiplier	2005 WHO-TEF Multiplier
2,3,7,8-TCDD	1	1
1,2,3,7,8-PeCDD	0.5	1
1,2,3,4,7,8-HxCDD	0.1	0.1
1,2,3,6,7,8-HxCDD	0.1	0.1
1,2,3,7,8,9-HxCDD	0.1	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.01
OCDD	0.001	0.0003
2,3,7,8-TCDF	0.1	0.1
1,2,3,7,8-PCDF	0.5	0.3
2,3,4,7,8-PCDF	0.05	0.03
1,2,3,4,7,8-HxCDF	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1
1,2,3,4,6,7,8-HpCDF	0.01	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.01
OCDF	0.001	0.0003

Source: Contaminants in soil: updated collation of toxicological data and intake values for humans, Dioxins, furans and dioxin-like PCBs (Science report: SC050021/TOX 12), Environment Agency, 2009

8 Results

8.1 Assessment against TDI - point of maximum impact

The following tables present the impact of emissions of dioxins and dioxin-like PCBs from the Facility at the point of maximum impact of emissions from the Facility for an 'agricultural' receptor. As explained in section 2, this receptor type assumes the direct inhalation, and ingestion from soil, drinking water, and home-grown eggs and meat, beef, pork, and milk. This assumes that the person lives at the point of maximum impact and consumes home-grown produce etc. This is considered to be a worst-case scenario. Reference should be made to the figure contained in Annex B for the location of the point in relation to the Facility.

Table 8: Impact Analysis – Dioxins and Dioxin-Like PCBs – Point of Maximum Impact

Receptor Type	MDI (% of TDI)	Process Contribution (% of TDI)	Overall (% of TDI)
Adult			
Agricultural	35.00%	3.91%	38.91%
Residential	35.00%	0.09%	35.09%
Child			
Agricultural	90.65%	5.52%	96.17%
Residential	90.65%	0.28%	90.93%

The TDI is an estimate of the amount of a contaminant, expressed on a bodyweight basis, which can be ingested daily over a lifetime without appreciable health risk. As shown in Table 8, at the point of maximum impact the overall impact (including the contribution from existing dietary intake) is less than the TDI for dioxins and dioxin-like PCBs. Therefore, there would not be an appreciable health risk based on the emission of these pollutants.

8.2 Breast milk exposure

The total accumulation of dioxins in an infant resulting from emissions from the Facility, considering the breast milk pathway and based on an adult agricultural receptor at the point of maximum impact of emission from the Facility feeding an infant, is 0.665 pg WHO-TEQ / kg-bw / day which is 33.2% of the TDI. For a residential-type receptor this is 0.013 pg WHO-TEQ / kg-bw / day, which is only 0.63% of the TDI.

There are no ingestion pathways besides breast milk ingestion for an infant receptor. As the process contribution is less than the TDI, it is considered that the Facility will not increase the health risks from the accumulation of dioxins in infants significantly.

8.3 Maximum impact at a receptor

The following tables outline the impact of emissions from the Facility at the most affected receptor (i.e., the receptor with the greatest combined impact from ingestion and inhalation of emissions from the Facility) (R11 – Burrows Farm). This receptor has been classified as an agricultural receptor, which is conservative as it assumes that a significant proportion of the diet of the receptor is sourced from the receptor point assessed, including meat and milk products. In reality, people in the UK tend to source their diet from a wide geographical area.

Table 9: Impact Analysis – Dioxins and Dioxin-Like PCBs – Maximum Impacted Receptor

Receptor Type	MDI (% of TDI)	Process Contribution (% of TDI)	Overall (% of TDI)
Adult			
Agricultural	35.00%	0.88%	35.88%
Child			
Agricultural	90.65%	1.25%	91.90%

As shown, for the most impacted receptor the overall impact (including the contribution from existing dietary intake) is less than the TDI for dioxins and dioxin-like PCBs. Therefore, there would not be an appreciable health risk based on the emission of these pollutants.

In addition, the total accumulation of dioxins in an infant, resulting from emissions from the Facility considering the breast milk pathway and based on an adult agricultural receptor at R9 feeding an infant, is 0.155 pg WHO-TEQ / kg-bw / day which is 7.5% of the TDI. Therefore, as the process contribution is less than the TDI, it is considered that the Facility will not increase the health risks from the accumulation of dioxins in infants significantly.

Detailed results for all identified receptor locations are presented in Annex A. As shown, the predicted impact at all other receptor locations is considerably lower than for the maximum impacted receptor.

8.4 Uncertainty and sensitivity analysis

To account for uncertainty in the modelling the impact on human health was assessed for a receptor at the point of maximum impact.

To account for uncertainty in the dietary intake of a person, both residential and agricultural receptors have been assessed. The agricultural receptor is assumed to consume a greater proportion of home grown produce, which has the potential to be contaminated by the COPCs released, than for a residential receptor. In addition, the agricultural receptor includes the pathway from consuming animals grazed on land contaminated by the emission source. This assumes that 100% of the plant materials eaten by the animals is grown on soil contaminated by emission sources.

The agricultural receptor at the point of maximum impact is considered the upper maximum of the impact of the Facility.

The IRAP software, and the HHRAP database which underpins it, does not include any data on individual PCBs, but it does include data for take-up and accumulation rates within the food chain for two groups of PCBs, known as Aroclor 1254 and Aroclor 1016. Each Aroclor is based on a fixed composition of PCBs. Since we are not aware of any data on the specification of PCBs within incinerator or co-incinerator emissions, as a worst-case assumption it has been assumed that PCB emissions consist entirely of each of the two Aroclor compositions and the maximum impact of either composition has been presented.

IRAP does not include these Aroclors (which are being used as a proxy for dioxin-like PCBs) when determining the intake via mother's milk. Therefore, a safety factor of 1.5 has been applied to the dioxin and dioxin-like PCBs emission rate when considering the impact of the intake via mother's milk.

8.5 Upset process conditions

Article 46(6) of the IED (Directive 2010/75/EU) 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 "Upset Operating Conditions". As identified these periods are short term events which can only occur for a maximum of 60 hours per year.

Start-up of the Facility from cold will be conducted with clean support fuel (low sulphur light fuel oil). During start-up waste will not be introduced onto the grate unless the temperature within the oxidation zone is above the 850ºC as required by Article 50, paragraph 4(a) of the IED. During start-up, the flue gas treatment plant will be operational as will be the combustion control systems and emissions monitoring equipment.

The same is true during plant shutdown where waste will cease to be introduced to the grate. The waste remaining on the grate will be combusted, the temperature not being permitted to drop below 850°C through the combustion of clean support auxiliary fuel. During this period the flue gas treatment equipment is fully operational, as will be the control systems and monitoring equipment. After complete combustion of the waste, the auxiliary burners will be turned off and the plant will be allowed to cool.

Start-up and shutdown are infrequent events. The Facility is designed to operate continuously, and ideally only shutdown 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[11]. Whilst elevated emissions of dioxins (within one order of magnitude) were found during shutdown and start-up phases where the fuel was not fully established in the combustion chamber, 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 or upset operating conditions will affect the long term impact of the Facility.

11 AEA Technology (2012) Review of research into health effects of Energy from Waste facilities.

9 Conclusions

This Dioxin Pathway Intake Assessment has been undertaken based on the following conservative assumptions:

- the Facility will operate continually at the BAT-AEL for dioxin and dioxin-like PCBs for a new plant, i.e., at the maximum concentrations which it is expected that the Facility will be permitted to operate at; and
- the hypothetical maximum impacted receptor (an agricultural receptor at the point of maximum impact) only ingests food and drink sourced from the area with the maximum contribution from the Facility.

The results of the assessment show that, for the hypothetical maximum impacted receptor (an agricultural child receptor at the point of maximum impact of emissions from the Facility), the combined intake from the Facility and the existing MDI intake of dioxins and dioxin-like PBCs via inhalation and ingestion is below the TDI. In addition, the ingestion of dioxins by an infant being breast fed by an agricultural receptor at the point of maximum impact of emissions from the Facility is less than the TDI. The impact at identified receptor locations is much lower. Therefore, there would not be an appreciable health risk based on the emission of dioxins and dioxin-like PCBs.

In conclusion, the impact of emissions of dioxins and dioxin-like PCBs from the Facility on human health is predicted to be not significant.

Annexes

A Detailed Results Tables

Table 10: Comparison with Total Dioxin and Dioxin-Like PCBs TDI Limits for Adult Receptors

Receptor	Total Inhalation, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total Ingestion, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total uptake, (pg WHO-TEQ kg^{-1} bw day^{-1})	Comparison (% of TDI)
MDI (% of TDI)				**35.00%**
Point of maximum impact - agricultural	2.25E-04	7.80E-02	7.82E-02	38.910%
Point of maximum impact - residential	2.25E-04	1.56E-03	1.78E-03	35.089%
R1 Land at Bourne Road	4.39E-05	3.05E-04	3.49E-04	35.017%
R2 240 Bourne Rd	6.48E-05	4.49E-04	5.14E-04	35.026%
R3 23 Bourne Rd	5.69E-05	3.94E-04	4.51E-04	35.023%
R4 20 Rose Fold	3.86E-05	2.68E-04	3.06E-04	35.015%
R5 Hawthorn Drive	5.93E-05	4.11E-04	4.70E-04	35.023%
R6 52 Holmes Road	1.26E-05	8.71E-05	9.96E-05	35.005%
R7 122 Fleetwood Road North	1.20E-05	8.31E-05	9.51E-05	35.005%
R8 1 Woodfield Road	2.87E-05	1.99E-04	2.27E-04	35.011%
R9 Staynall Lane	3.18E-05	1.11E-02	1.11E-02	35.554%
R10 Carters Farm	3.95E-05	1.37E-02	1.38E-02	35.688%
R11 Burrows Farm	5.08E-05	1.76E-02	1.77E-02	35.884%
R12 Thornton Primary School	1.55E-05	1.07E-04	1.23E-04	35.006%
R13 Red Marsh Special School	1.49E-05	1.03E-04	1.18E-04	35.006%
R14 Great Arley School	1.43E-05	9.94E-05	1.14E-04	35.006%
R15 Sacred Heart Catholic Primary School	1.27E-05	8.79E-05	1.01E-04	35.005%
R16 Westport House Care Home	2.36E-05	1.64E-04	1.88E-04	35.009%
R17 Thornton Lodge Care Home	1.21E-05	8.38E-05	9.59E-05	35.005%

Table 11: Comparison with Total Dioxin and Dioxin-Like PCBs TDI Limits for Child Receptors

Receptor	Total Inhalation, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total Ingestion, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total uptake, (pg WHO-TEQ kg^{-1} bw day^{-1})	Comparison (% of TDI)
MDI (% of TDI)				**90.65%**
Point of maximum impact - agricultural	2.83E-04	1.10E-01	1.10E-01	96.171%
Point of maximum impact - residential	2.83E-04	5.27E-03	5.55E-03	90.927%
R1 Land at Bourne Road	5.54E-05	1.03E-03	1.09E-03	90.704%
R2 240 Bourne Rd	8.17E-05	1.52E-03	1.60E-03	90.730%
R3 23 Bourne Rd	7.16E-05	1.33E-03	1.41E-03	90.720%
R4 20 Rose Fold	4.86E-05	9.05E-04	9.54E-04	90.698%
R5 Hawthorn Drive	7.47E-05	1.39E-03	1.46E-03	90.723%
R6 52 Holmes Road	1.58E-05	2.95E-04	3.11E-04	90.666%
R7 122 Fleetwood Road North	1.51E-05	2.81E-04	2.96E-04	90.665%
R8 1 Woodfield Road	3.61E-05	6.73E-04	7.09E-04	90.685%
R9 Staynall Lane	4.01E-05	1.56E-02	1.57E-02	91.433%
R10 Carters Farm	4.98E-05	1.94E-02	1.94E-02	91.621%
R11 Burrows Farm	6.40E-05	2.49E-02	2.50E-02	91.899%
R12 Thornton Primary School	1.95E-05	3.64E-04	3.83E-04	90.669%
R13 Red Marsh Special School	1.88E-05	3.50E-04	3.68E-04	90.668%
R14 Great Arley School	1.81E-05	3.37E-04	3.55E-04	90.668%
R15 Sacred Heart Catholic Primary School	1.60E-05	2.98E-04	3.14E-04	90.666%
R16 Westport House Care Home	2.98E-05	5.55E-04	5.85E-04	90.679%
R17 Thornton Lodge Care Home	1.52E-05	2.83E-04	2.99E-04	90.665%

B Location of Sensitive Receptors

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	

Figure 2 Sensitive Receptors

Drawn by: MJC | Date: 26/01/2023

FICHTNER
Consulting Engineers Limited

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

ENGINEERING CONSULTING

FICHTNER

Consulting Engineers Limited

Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW,
United Kingdom

t: +44 (0)161 476 0032
f: +44 (0)161 474 0618

www.fichtner.co.uk

FICHTNER

Consulting Engineers Limited

Thornton Energy Recovery Centre

Sesona Hill House Ltd

Dispersion Modelling Assessment

ENGINEERING + CONSULTING

Document approval

	Name	Signature	Position	Date
Prepared by:	Stuart Nock		Associate Senior Environmental Consultant	12/12/2022
Checked by:	Rosalind Flavell		Senior Consultant	12/12/2022

Document revision record

Revision no	Date	Details of revisions	Prepared by	Checked by
0	12/12/2022	First issue	SMN	RSF
1	14/12/2022	Final version	SMN	RSF

Management Summary

Fichtner Consulting Engineers Ltd (Fichtner) has been engaged by Sesona Hill House Limited to undertake a Dispersion Modelling Assessment to support the application for an Environmental Permit (EP) for the Thornton Energy Recovery Centre (the Facility). Full details of the Facility can be found in the Supporting Information document submitted with this application.

1) 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. To set up the model, it has been assumed that the Facility operates for the whole year and releases emissions at the emission limits compliant with the BAT-AELs set out in the Waste Incineration BREF for new plants, with the exception of oxides of nitrogen for which an emission limit lower than the upper end of the BAT-AEL range is being applied for in line with the EA's position statement on the implementation of the BREF for new plants in the England. 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.

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

The air quality impact of the Facility 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. Emissions from the operation of the Facility will not cause a breach of any AQAL.
2. The overall impact of long-term process emissions associated with the operation of the Facility can be considered 'insignificant' and 'not significant' in accordance with the EA's screening criteria at the point of maximum impact and at all identified human sensitive receptors.
3. The overall impact of short-term process emissions associated with the operation of the Facility can be screened out as 'not significant' in accordance with the EA's screening criteria, or is well below the AQAL with no risk of a significant impact, at all areas of relevant exposure and at all identified human sensitive receptors.

3) 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, in relation to the Critical Level and Critical Loads set for the protection of ecology it can be concluded that all of the impacts at ecological features can be screened out as 'insignificant'urham or 'not significant' except for ammonia and nitrogen deposition impacts at the Wyre Estuary SSSI and Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar site. Further analysis undertaken by the project ecologist has concluded no significant effects are likely

4) Summary and Conclusions

The assessment has shown that emissions from the Facility would not result in a breach of any AQAL and would not have a significant impact on local air quality, the general population or the local community, either alone or in-combination with other plans and projects. As such, there should be no air quality constraint in granting an EP to operate.

Contents

1 Introduction

1.1 Background

Fichtner Consulting Engineers Ltd (Fichtner) has been engaged by Sesona Hill House Limited to undertake a Dispersion Modelling Assessment to support the application for an Environmental Permit (EP) for the Thornton Energy Recovery Centre (the Facility).

This report sets out the approach taken to modelling emissions from the stacks of the Facility. This includes all model inputs and justifications where appropriate. Finally, this report presents the results of the modelling.

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. It is noted that for some pollutants such as metals and dioxins they have the potential to accumulate within the environment. A separate Dioxin Pathway Intake Assessment has been undertaken to assess the pathway intake of these pollutants and impacts compared to the Tolerable Daily Intakes (TDIs).

When considering the impact on ecosystems the predicted atmospheric concentrations have been compared to the Critical Levels for the protection of ecosystems. It is noted that 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.

No developments have been identified which could give rise to likely significant cumulative environmental effects when considering process emissions from the Facility.

1.2 Structure of the report

This report has the following structure.

- Air quality legislation and guidance are considered in section 2.
- The assessment criteria used are described in section 3.
- The baseline levels of ambient air quality are described in section 4.
- The residential properties and ecological receptors which are sensitive to changes in air quality associated with the operation of the Facility and identified in section 5.
- The inputs used for the dispersion model are contained in section 6
- Details of the sensitivity analysis carried out 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.
- The conclusions of the assessment are set out in section 10.
- 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 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. The sources for each of the values can be found in the preceding sections.

Table 1: Air Quality Assessment Levels (AQALs)

Pollutant	AQAL (µg/m³)	Averaging Period	Frequency of Exceedances	Source
Nitrogen dioxide	200	1 hour	18 times per year (99.79th percentile)	AAD Limit Value
	40	Annual	-	AAD Limit Value
Sulphur dioxide	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	-	AQS Target
	10	Annual	-	WHO 2005 Air Quality Guideline (AQG)
	5	Annual	-	WHO 2021 AQG

[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
Carbon monoxide	10,000	8 hours, running	-	AAD Limit Value
	30,000	1 hour	-	Air Emissions Guidance
Hydrogen chloride	750	1 hour		Air Emissions Guidance
Hydrogen fluoride	160	1 hour	-	Air Emissions Guidance
	16	Annual	-	Air Emissions Guidance
Ammonia	2,500	1 hour	-	Air Emissions Guidance
	180	Annual	-	Air Emissions Guidance
Benzene	5	Annual	-	Air Emissions Guidance
	30	24 hours	-	Air Emissions Guidance
1,3-butadiene	2.25	Annual, running	-	AQS Objective
PCBs	6	1-hour	-	Air Emissions Guidance
	0.2	Annual	-	Air Emissions Guidance
PAHs	0.00025	Annual	-	AQS Objective

Table 2: Air Quality Assessment Levels for Metals

Pollutant	AQAL (ng/m³)	Averaging Period	Source
Cadmium	-	1 hour	-
	5	Annual	AAD Target Value
Mercury	7,500	1 hour	Air Emissions Guidance
	250	Annual	Air Emissions Guidance
Antimony	150,000	1 hour	Air Emissions Guidance
	5,000	Annual	Air Emissions Guidance
Arsenic	-	1 hour	-
	6	Annual	Air Emissions Guidance
Chromium (II & III)	150,000	1 hour	Air Emissions Guidance
	5,000	Annual	Air Emissions Guidance
Chromium (VI)	-	1 hour	-
	0.25	Annual	Air Emissions Guidance
Copper	200,000	1 hour	Air Emissions Guidance
	10,000	Annual	Air Emissions Guidance
Lead	-	1 hour	-
	250	Annual	AQS Target
Manganese	1,500,000	1 hour	Air Emissions Guidance
	150	Annual	Air Emissions Guidance

Pollutant	AQAL (ng/m³)	Averaging Period	Source
Nickel	-	1 hour	-
	20	Annual	AAD Limit
Vanadium	1,000	24 hours	Air Emissions Guidance

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

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

Note:
**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 the table above, provides habitat specific Critical Loads for nitrogen and acid deposition. Full details of the habitat specific Critical Loads can be found in Appendix B.

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))[2] 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. 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 reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

Source: Local Air Quality Management Technical Guidance (TG22), Defra, August 2022

[2] Department for Environment, Food and Rural Affairs, Local Air Quality Management Technical Guidance (TG22), August 2022, available at: https://laqm.defra.gov.uk/wp-content/uploads/2022/08/LAQM-TG22-August-22-v1.0.pdf

2.3 Industrial pollution regulation

The Industrial Emissions Directive (IED) (Directive 2010/75/EU), adopted on 7th January 2013, is the key European Directive which covers almost all regulation of industrial processes in the EU. Within the IED, the requirements of the relevant sector Best Available Techniques Reference Document (BREF) become binding as BAT guidance, as follows.

- Article 15, paragraph 2, of the IED requires that Emission Limit Values (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 Waste incineration (WI) BREF was adopted by the European IPPC Bureau in December 2019. The EA is required to review and implement conditions within all permits which require operators to comply with the requirements set out in the WI BREF. The WI BREF introduces BAT-Associated Emission Limits (BAT-AELs) which are more stringent than the ELVs currently set out in the IED. It has been assumed that emissions from the Facility will comply with the upper end of the BAT-AEL range for each pollutant, except where otherwise stated.

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 AQMA. For each AQMA, the local authority is required to produce an AQAP, the objective of which is to reduce pollutant levels in pursuit of the relevant AQALs.

3 Assessment Criteria

3.1 Human health

The Air Emissions Guidance states that to screen out 'insignificant' 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[3], 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 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.

3.2 Ecology

The 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

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

- 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 Air Emissions Guidance states further that to screen out impacts as 'insignificant' at local nature sites[4]:

- 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.

[4] Ancient woodlands, local wildlife sites and national and local nature reserves.

4 Baseline Air Quality

This section presents a review of the baseline air quality and defines appropriate baseline concentrations to be used within this assessment.

The Facility is located in the Hillhouse Business Park, Thornton-Cleveleys, Lancashire, within the administrative area of Wyre Borough Council (WBC).

4.1 Air quality review and assessment

The closest AQMA to the Facility is the Chapel Street AQMA in Poulton-le-Fylde, approximately 5 km to the south. Due to the distance from the Facility it is considered that the impact of the Facility emissions within this AQMA and all other AQMAs will be negligible. Therefore, the impact on AQMAs has been excluded from the assessment.

4.2 National modelling – mapped background data

In order to assist local authorities with their responsibilities under Local Air Quality Management, the Department for Environment Food and Rural Affairs (DEFRA) provides modelled background concentrations of pollutants across 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. Mapped background concentrations have been downloaded for the grid squares containing the Site and immediate surroundings. In addition, mapped atmospheric concentrations of ammonia are available from DEFRA via the National Environment Research Council (NERC) Centre for Ecology and Hydrology (CEH) throughout the UK.

The mapped background data is calibrated against monitoring data. For instance, the 2018 mapped background concentrations are based on 2018 meteorological data and are calibrated against monitoring undertaken in 2018. As a conservative approach where mapped background data is used the concentration for the year against which the data was validated has been used. This eliminates any potential uncertainties over anticipated trends in future background concentrations.

Concentrations will vary over the modelling domain area. Therefore, the maximum mapped background concentration from within 5 km of the Site has been calculated, as presented in Table 5, together with the concentration at the Site.

Table 5: Mapped Background Data

Pollutant	Annual mean concentration (µg/m³)		Dataset
	At Site	Max within 5 km of Site	
Nitrogen dioxide	6.99	11.38	DEFRA 2018 Dataset
Oxides of nitrogen	8.93	15.15	DEFRA 2018 Dataset
Sulphur dioxide	-	6.96	DEFRA 2001 Dataset
Particulate matter (as PM_{10})	9.06	11.15	DEFRA 2018 Dataset
Particulate matter (as $PM_{2.5}$)	6.26	8.27	DEFRA 2018 Dataset
Carbon monoxide	-	306	DEFRA 2001 Dataset
Benzene	-	0.54	DEFRA 2001 Dataset
1,3-butadiene	-	0.18	DEFRA 2001 Dataset

Pollutant	Annual mean concentration (µg/m³)		Dataset
	At Site	Max within 5 km of Site	
Ammonia	1.03	3.45	DEFRA (CEH) 2014
Note: 2001 mapped background concentrations were not available for the grid square containing the Site.			

Source: © Crown 2022 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

4.3 AURN and LAQM monitoring data

Monitoring locations are broadly classified into 'roadside' and 'background' locations. 'Background' locations are typically sited so that no single pollutant source is dominant and are intended to be representative of background concentrations over several square kilometres. 'Roadside' sites are dominated by road traffic emissions and only representative of concentrations in the immediate vicinity of the analyser. This analysis has considered background sites within 5 km and roadside sites within 2 km of the Facility, i.e. within the area most likely experience the greatest impact of emissions from the Facility.

The UK Automatic Urban and Rural Network (AURN) is a country-wide network of air quality monitoring stations operated on behalf of DEFRA. This includes automatic monitoring of nitrogen dioxide and particulate matter. In addition, non-automatic (diffusion tube) monitoring of benzene is co-located with a number of AURN sites.

The nearest AURN monitoring station is Blackpool Marton, an urban background site located 9.27 km south of the Site. As there are no AURN sites within 5 km of the Site, AURN monitoring has not been considered further in this analysis.

Wyre Council does not have any continuous monitoring sites within their jurisdiction however, they do undertake non-automatic (diffusion tube) monitoring for nitrogen dioxide at various sites across the district. Thirteen of these sites are within 5 km of the Site.

A summary of monitoring data from the non-automatic (diffusion tube) background-type monitoring sites within 5 km of the Site and roadside-type sites within 2 km of the Site is provided in Table 6. The latest available data (2016 -2020) has been taken from the 2021 Wyre Council Local Air Quality Monitoring (LAQM) Annual Status Report (September 2021).

Table 6: Summary of non-automatic monitoring data within 5 km of the Site

ID	Distance from Site (km)	2018 Mapped Bg (µg/m³)	Annual mean concentration (µg/m³)				
			2016	2017	2018	2019	2020
Background/Suburban Monitoring							
U1 – U3	4.2	9.7	10.1	9.5	10.2	9.0	6.4
7	3.7	9.4	15.7	14.8	14.8	13.3	10.5
11	2.7	9.3	20.2	19.1	20.0	17.9	14.1
16	1.0	8.8	15.2	14.3	15.7	13.4	11.0
Roadside Monitoring							
L	2.0	9.1	21.7	20.1	21.4	19.7	14.8
15.1 – 15.3	1.1	8.8	28.6	28.6	28.4	27.7	22.9

Source: Wyre Council 2021 LQAM Annual Status Report (September 2021) and © Crown 2022 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

Concentrations at the roadside sites are considerably higher than the mapped background concentrations due to emissions from nearby traffic and are only representative of air quality for the immediate area of the diffusion tube. Therefore, the data from the diffusion tubes at roadside sites are not considered to be representative of the general background conditions.

One monitor within 5 km of the Site is classed as an urban background site (U1 – U3) whilst the other three monitors are classed as suburban. Monitored concentrations at these sites are typically slightly higher than the mapped background, with the exception of monitoring location 11. However, this monitor is located 10 m from a major road (A575 Amounderness Way) and in a setting more like a roadside monitoring site. Therefore, it has not been considered further in this assessment.

Of the remaining background and suburban monitors, the maximum measured annual average concentration (15.7 µg/m³) has been taken as a conservative estimate of the baseline nitrogen dioxide concentration for the air quality assessment for locations away from major road sources. The choice of baseline concentrations will be considered further if the impact of the Facility cannot be screened out as 'insignificant'.

4.4 National monitoring data

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 Site. 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 measured locally or nationally, since these are not generally 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 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 Site. The nearest monitoring site is Myerscough located 16 km to the east. In lieu of any local UKEAP monitoring, the maximum mapped background value from within 5 km of the Site has been used for the purpose of this assessment as set out in Table 5. This value is 3.45 µg/m³.

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. In 2007, due to low monitored concentrations of 1,3-butadiene at non-automatic sites, DEFRA took the decision to cease non-automatic monitoring of 1,3-butadiene. There are no monitoring locations within 10 km of the Site. The nearest background monitoring site is Liverpool Speke 61 km to the south.

In lieu of any local monitoring of benzene or 1,3-butadiene, the maximum mapped background concentrations within the modelling domain (0.54 µg/m³ for benzene and 0.18 µg/m³ for 1,3-butadiene, as presented in Table 5) will be used as the baseline concentrations.

4.4.5 Metals

Metals are measured as part of the Rural Metals and UK Urban/Industrial Networks (previously the Lead, Multi-Element and Industrial Metals Networks). There are no metals monitoring locations within 10 km of the Site. The nearest monitoring site is Cockley Beck, a rural background site 58 km to the north. Due to its rural nature and distance from the Site, it is not considered representative of the urban and light industrial conditions at the Site. A summary of the maximum annual data across all UK urban and rural background monitoring sites is presented in the following table.

Table 7: Metals Monitoring Maximum of all Background Sites – Urban and Rural

Substance	Annual mean concentration (ng/m³)						Max (as % of AQAL)
	AQAL	2017	2018	2019	2020	2021	
Cadmium	5	0.22	0.26	0.35	0.23	0.25	7.0%
Mercury	250	2.70	2.80	-	-	-	1.1%
Antimony	5,000	-	-	-	-	-	-
Arsenic	6	1.10	0.93	0.92	1.00	0.88	18.3%
Chromium	5,000	3.60	5.80	4.20	3.70	4.80	0.12%
Cobalt	-	0.20	0.18	0.15	0.16	0.16	-
Copper	10,000	16.00	15.00	15.00	10.00	10.00	0.16%
Lead	250	12.00	20.00	11.00	7.80	15.00	8.0%
Manganese	150	8.30	9.70	7.80	10.00	7.60	6.7%
Nickel	20	1.70	2.20	1.80	1.70	2.20	11.0%
Vanadium	5,000	1.20	1.70	1.50	3.00	3.00	0.06%

Notes:
Excludes data from Sheffield Tinsley and Swansea Coedgwilym – although classified as urban background sites, these are located close to large industrial sources of metals and as such has high levels of these pollutants far greater than those monitored at other sites.

Source: © Crown 2022 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

As shown, the concentrations monitored between 2017 and 2021 were significantly lower than the AQALs at all monitoring sites considered.

The area surrounding the Site is a mixture of rural, suburban and the adjacent light industrial area. The processes undertaken in the industrial area are chemical processes including the production of polymer and plastics generation. As these processes do not involve industrial levels of metal emissions, it is deemed appropriate to use the maximum metal concentration across all urban and rural background sites (excluding Sheffield Tinsley and Swansea Coedgwilym, which are close to significant sources of metals) from between 2017 and 2021 as the baseline concentration within this assessment, in lieu of any representative local monitoring.

No data is available for antimony as monitoring of this metal across the UK ceased at the end of 2014. The maximum monitored at any rural background site in 2014 was 0.68 ng/m³, which will be used as the baseline concentration for the AQA. This value is only 0.014% of the annual mean AQAL of 5,000 ng/m³.

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 monitoring locations within 10 km of the Site. The closest site is Hazelrigg 20 km to the northeast.

A summary of dioxin and furan and PCB concentrations from all monitoring sites across the UK is presented in Table 8 and Table 9. 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 8:TOMPS – 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 2020 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

Table 9:TOMPS – 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	40.1
Weybourne	17	20.95	38.61	32.26	11.23

Source: © Crown 2020 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

As shown, the concentrations vary significantly between sites and years. As there are no monitoring sites located within close proximity of the Site or any mapped background datasets, the maximum monitored concentration from the past 5 years has been used as the background concentration within this assessment. These values are 32.99 fg/TEQ/m^3 for dioxins and furans and 128.93 pg/m^3 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. There are no monitoring locations within 10 km of the Site. The closest site is Hazelrigg, a rural background monitor, located 20 km to the north.

For the purpose of this assessment, benzo(a)pyrene is considered as this is the only PAH which an AQAL has been set. A summary of benzo(a)pyrene concentrations from all urban background monitoring sites within the UK is presented in Table 10.

Table 10: National Monitoring - Benzo(a)pyrene

Site Type	Quantity	AQAL (ng/m^3)	Annual mean concentration (ng/m^3)				
			2017	2018	2019	2020	2021
All Urban Background	Min	0.25	0.05	0.06	0.06	0.04	0.05
	Max		0.86	0.74	0.83	0.55	0.68
	Average		0.24	0.21	0.26	0.19	0.21

Source: © Crown 2020 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

As shown the monitored concentration exceeds the AQAL at a number of urban background sites. The AQAL goes beyond the requirement of the European Directive (Commission Decision 2004/107/EC) which sets a target value of 1 ng/m^3. None of the background sites exceed this value between 2017 and 2021.

Concentrations vary by location, with lower concentrations typically measured in England compared to other parts of the UK. The urban background values monitored in England are presented in Table 11.

Table 11: National Monitoring - Benzo(a)pyrene (England Only)

Site Type	Quantity	AQAL (ng/m^3)	Annual mean concentration (ng/m^3)				
			2017	2018	2019	2020	2021
All Urban Background	Min	0.25	0.10	0.09	0.12	0.09	0.10
	Max		0.19	0.21	0.50	0.21	0.21
	Average		0.16	0.16	0.22	0.14	0.16

Source: © Crown 2020 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

The data from across England shows that the maximum at any urban background site exceeded the AQAL in just one year (2019), and the average of all background sites was also highest in 2019 at 0.22 ng/m^3. In lieu of any local monitoring of PAHs or any mapped background datasets, the average of urban background sites across England in 2019 has been used. The choice of background concentration will be investigated further if the process contribution cannot be screened out as 'insignificant'.

4.5 Summary

The preceding sections have provided a review of the baseline local and national monitoring data and national modelled background concentrations. Table 12 presents the values for the annual baseline concentrations that will be used to evaluate the impact of the Facility. Further consideration will be given to the baseline concentrations at specific receptor locations if the predicted impact of emissions of a given pollutant from the Facility cannot be screened out as insignificant.

Table 12: Summary of Baseline Concentrations

Pollutant	Concentration	Units	Justification
Nitrogen dioxide	15.70	µg/m^3	Maximum monitored concentration from suburban or urban background LAQM within 5 km of Site.
Sulphur dioxide	6.96	µg/m^3	Maximum mapped background concentration from within 5 km of Site- DEFRA 2001 dataset.
Particulate matter (as PM_{10})	11.15	µg/m^3	Maximum mapped background concentration from within 5 km of Site- DEFRA 2018 dataset.
Particulate matter (as $PM_{2.5}$)	8.27	µg/m^3	Maximum mapped background concentration from within 5 km of Site- DEFRA 2018 dataset.
Carbon monoxide	306	µg/m^3	Maximum mapped background concentration from within 5 km of Site- DEFRA 2001 dataset.
Benzene	0.54	µg/m^3	Maximum mapped background concentration from within 5 km of Site- DEFRA 2001 dataset.
1,3-butadiene	0.18	µg/m^3	Maximum mapped background concentration from within 5 km of Site- DEFRA 2001 dataset.
Ammonia	3.45	µg/m^3	Maximum mapped background concentration from within 5 km of Site- DEFRA (CEH) 2014 dataset.
Hydrogen chloride	0.71	µg/m^3	Maximum monitored concentration across the UK 2012 to 2015
Hydrogen fluoride	2.35	µg/m^3	Maximum measured concentration from EPAQS report
Cadmium	0.35	ng/m^3	Maximum annual concentration averaged across all urban background sites across the UK 2017 to 2021 (except Antimony), excluding Sheffield Tinsley and Swansea Coedgwilym. Antinomy: Maximum monitored at a UK rural background site in 2014.
Mercury	2.80	ng/m^3	
Antimony	0.68	ng/m^3	
Arsenic	1.10	ng/m^3	
Chromium	5.80	ng/m^3	
Cobalt	0.20	ng/m^3	
Copper	16.00	ng/m^3	
Lead	20.00	ng/m^3	
Manganese	10.00	ng/m^3	
Nickel	2.20	ng/m^3	
Vanadium	3.00	ng/m^3	

Pollutant	Concentration	Units	Justification
Dioxins and Furans	32.99	fgTEQ/m^3	Maximum monitored concentration across all UK sites 2012 to 2016
PCBs	128.93	pg/m^3	Maximum monitored concentration across all UK sites 2014 to 2018
PaHs	0.22	ng/m^3	Average of annual concentrations across all background sites across England in 2019

5 Sensitive Receptors

As part of this assessment, the predicted Process Contribution (PC) at the point of maximum impact and a number of sensitive receptors has been evaluated.

5.1 Human sensitive receptors

The human sensitive receptors identified for assessment are displayed in Figure 1 and listed in Table 13. These represent the residential properties with the greatest risk of experiencing a significant effect from the operation of the Facility, along with the closest schools and care homes to the Facility. No hospitals have been identified within several kilometres of the Facility.

Table 13: Human Sensitive Receptors

ID	Name	Location		Distance from ERF stacks (km)
		x	y	
R1	Land at Bourne Road	334050	444040	0.34
R2	240 Bourne Rd	333823	444119	0.58
R3	23 Bourne Rd	333670	444080	0.72
R4	20 Rose Fold	333428	443988	0.96
R5	Hawthorn Drive	333715	444397	0.77
R6	52 Holmes Road	333402	443253	1.25
R7	122 Fleetwood Road North	333644	442866	1.37
R8	1 Woodfield Road	334952	442503	1.62
R9	Staynall Lane	336061	443836	1.68
R10	Carters Farm	335784	444084	1.40
R11	Burrows Farm	335679	444271	1.31
R12	Thornton Primary School	333973	443420	0.73
R13	Red Marsh Special School	333956	443256	0.88
R14	Great Arley School	333919	443183	0.96
R15	Sacred Heart Catholic Primary School	333740	443240	1.01
R16	Westport House Care Home	333538	443665	0.92
R17	Thornton Lodge Care Home	333913	442955	1.17

5.2 Ecological sensitive receptors

A study was undertaken to identify the following sites of ecological importance in accordance with the following screening distances laid out in the Air Emissions Guidance:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), or Ramsar sites within 10 km of the Site;
- Sites of Special Scientific Interest (SSSIs) within 2 km of the Site; and
- National Nature Reserves (NNR), Local Nature Reserves (LNRs), local wildlife sites and ancient woodlands within 2 km of the Site. There are collectively referred to as local nature sites.

The sensitive ecological receptors identified as a result of the study are displayed in Figure 2 and are listed in Table 14. A review of the citation and APIS website for each site has been undertaken to determine if lichens or bryophytes are an important part of the ecosystem's integrity. If lichens or bryophytes are present, the more stringent Critical Level has been applied as part of the assessment.

Table 14: Ecological Sensitive Receptors

ID	Site	Desig-nation[1]	Closest point to Site		Distance from stacks at closest point (km)	Lichens / bryo-phytes present
			X	Y		
European and UK Designated Sites						
E1	Wyre Estuary	SSSI	334480	444140	0.15	No
E2	Morecambe Bay and Duddon Estuary	SPA/ Ramsar	334480	444140	0.15	No
E3	Morecambe Bay	SAC	331083	447317	4.67	No
E4	Liverpool Bay	SPA	330750	442190	4.07	No
Local nature sites						
E5	ICI Hillhouse Estuary Banks	BHS[1]	334466	444123	0.13	No
E6	Fleetwood Railway Branch Line Trunnah to Burn Naze	BHS	334085	444000	0.31	No
E7	Burglars Alley Field	BHS	333600	444715	1.05	No
E8	Jameson Road Saltmarsh	BHS	333885	445333	1.41	No
E9	ICI Hillhouse International Pool	BHS	333015	445476	2.00	No
E10	Rossall Lane Wood and Pasture	BHS	333000	444930	1.66	No
E11	Fleetwood Farm Fields	BHS	333208	444475	1.27	No
E12	Fleetwood Marsh Industrial lands	BHS	332910	445537	2.12	No

Note:
(1) BHS = Biological Habitat Site

For sites which are close to the Facility or cover a wide area, the maximum process contribution at ground level within each site has been assessed. This has been done for all European and UK designated sites except Liverpool Bay SAC, and all local nature sites except ICI Hillhouse International Pool and Fleetwood Marsh Industrial lands. The impact at these sites has been assessed at the receptor points listed in Table 14.

6 Dispersion Modelling Methodology

6.1 Selection of model

Detailed dispersion modelling was undertaken using the model ADMS 5.2, 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 planning and Environmental Permitting purposes to the satisfaction of the Environment Agency and Local Authorities. The maximum predicted concentration for each pollutant and averaging period has been used to determine the significance of any potential impacts.

6.2 Emission limits

The Industrial Emissions Directive (IED) (Directive 2010/75/EU), adopted on 7th January 2013, is the key European Directive which covers almost all regulation of industrial processes in the EU. Within the IED, the requirements of the relevant sector BREF become binding as BAT guidance, as follows.

- Article 15, paragraph 2, of the IED requires that Emission Limit Values (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 Environment Agency) 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 Waste Incineration BREF was published by the European Integrated Pollution Prevention and Control (IPPC) Bureau in December 2019. The Environment Agency is required to implement conditions within all permits requiring operators to comply with the requirements set out in the BREF within four years of the publication date. This will include the Facility. The Waste Incineration BREF has introduced BAT-AELs (BAT Associated Emission Levels) which are more stringent than those currently set out in the IED for some pollutants.

The Facility will be designed to meet the requirements of the Waste Incineration BREF for a new plant. Therefore, this assessment has been undertaken assuming that the emissions from the Facility will comply with the BAT-AELs set out in the Waste Incineration BREF for new plants. For the remainder of this assessment the anticipated emission limits, which are the BAT-AELs or the emission limits from the IED, are referred to as Emission Limit Values (ELVs).

6.3 Source and emissions data

The principal inputs to the model with respect to the emissions to air from the stacks of the Facility are presented in Table 15 and Table 16.

Table 15: Stack Source Data

Item	Unit	Value
Stack Data		
Height	m	45 - See Stack Height Analysis (section 6.4)
Internal diameter (each stack)	m	1.24
Location – stack 1	m, m	334390.0, 444018.0
Location – stack 2	m, m	334420.6, 444022.0
Flue Gas Conditions		
Temperature(1)	°C	110
Exit moisture content	% v/v	7%
	kg/kg	0.045
Exit oxygen content	% v/v dry	11%
Reference oxygen content	% v/v dry	11%
Volume at reference conditions (dry, ref O_2)	Nm^3/h	42,933
	Nm^3/s	11.93
Volume at actual conditions	Am^3/h	64,755
	Am^3/s	17.99
Flue gas exit velocity	m/s	15

Note:
All flue gas data provided by the technology provider.
(1) The temperature of the flue gas assumes the Facility operates with heat recovery, as this is the most conservative scenario.

Table 16: Stack Emissions Data

Pollutant	Daily or Periodic	Half-hourly	Daily or Periodic	Half-hourly
	Conc. (mg/Nm^3)		Release Rate (g/s) – Each Line	
Oxides of nitrogen (as NO_2)	100	400	1.193	4.533
Sulphur dioxide	30	200	0.358	2.267
Carbon monoxide(1)	50	150(2)	0.596	1.700
Fine particulate matter (PM)(2)	5	30	0.060	0.340
Hydrogen chloride	6	60	0.072	0.680
Volatile organic compounds (as TOC)	10	20	0.119	0.227
Hydrogen fluoride	1	4	0.012	0.045
Ammonia	10	-	0.119	-
Cadmium and thallium	0.02	-	0.239 mg/s	-
Mercury	0.02	-	0.239 mg/s	-

Pollutant	Daily or Periodic	Half-hourly	Daily or Periodic	Half-hourly
	Conc. (mg/Nm³)		Release Rate (g/s) – Each Line	
Other metals(3)	0.3	-	3.578 mg/s	-
Benzo(a)pyrene (PaHs)(4)	0.2 µg/Nm³	-	2.385 µg/s	-
Dioxins, furans and dioxin-like PCBs	0.06 ng/Nm³	-	0.716 ng/s	-
PCBs(5)	5.0 µg/Nm³	-	59.63 µg/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 PM 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) Figure 8.121 of the 2019 Waste Incineration BREF shows that the maximum recorded at a UK plant was 0.2 µg/m³. This is assumed to be the emission concentration for the Facility.

(5) The 2006 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/Nm³ (dry, 11% oxygen, 273K). In lieu of other available operational data, this has been assumed to be the emission concentration for the Facility.

The Facility is designed to operate at full capacity and is not anticipated to have significant changes in loading. Therefore, it is appropriate to base the assessment on the design point of the system.

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

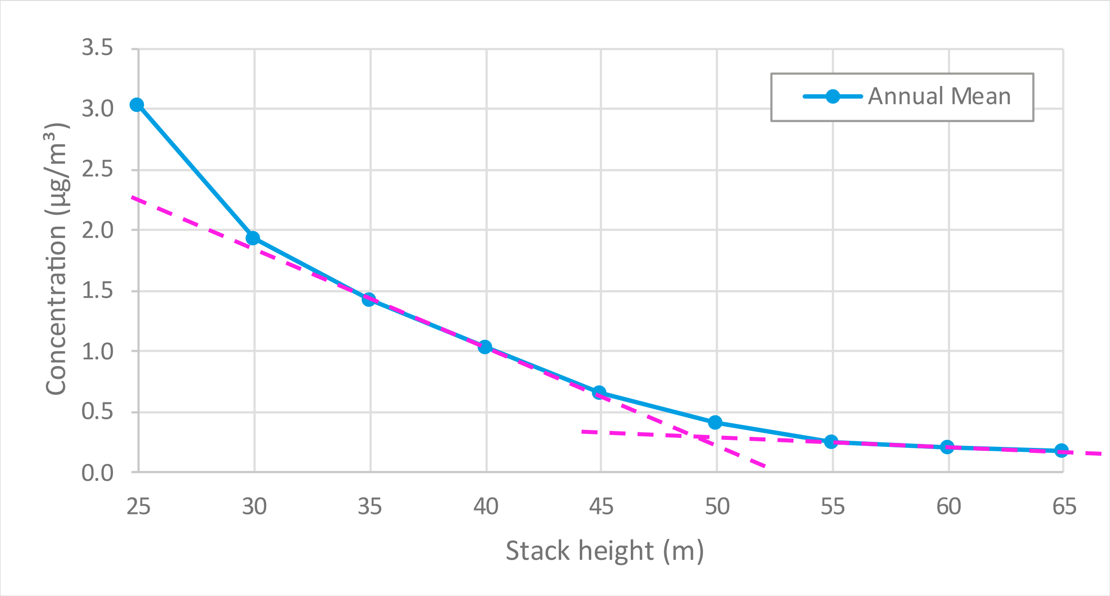
6.4 Stack height justification

When determining a suitable stack height, it is best practice to identify the stack height where the rate of reduction in maximum ground level concentration with increased height slows down. This can be identified on a graph as a step change in the slope. A range of stack heights from 25 m to 65 m has been considered.

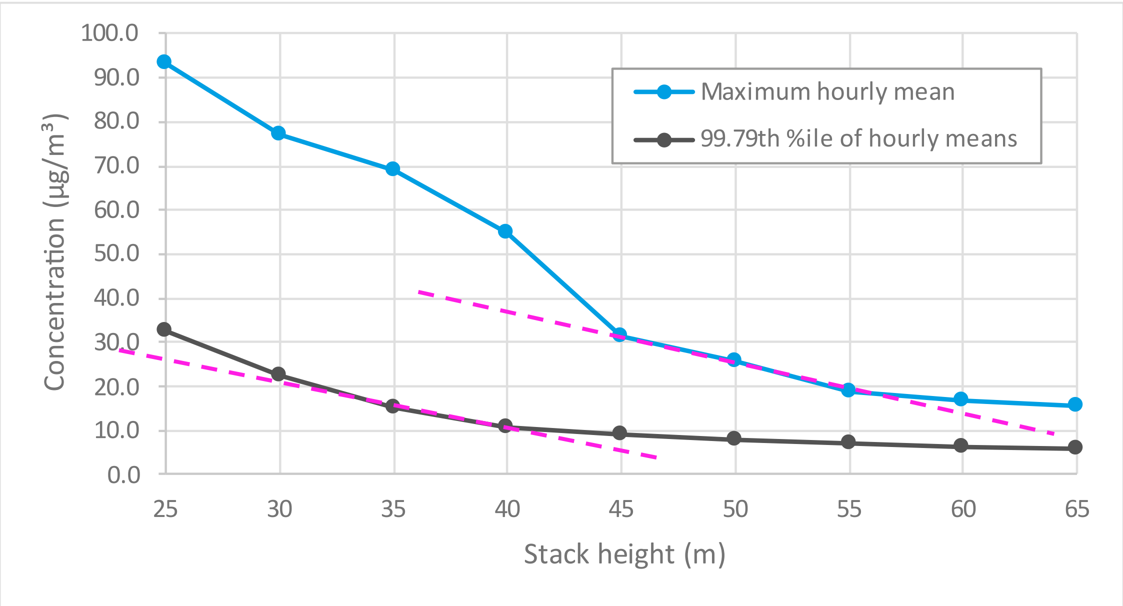
The following parameters were kept constant:

- Buildings – included;
- Dispersion site surface roughness value – varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.3 m;
- Dispersion site Monin-Obukhov length – 1 m;
- Meteorological site Monin-Obukhov length – 1 m; and
- Meteorological data used – Blackpool Airport 2017 to 2021.

The following graphs show the ground level concentration at the point of maximum impact for a range of stack heights for the Facility, for a nominal 1 g/s release rate.



Graph 1 – Annual Mean Stack Height Analysis



Graph 2 – Short-Term Stack Height Analysis

Analysis of the graphs shows that for annual mean concentrations there are no large step changes in the angle of the slope, although the graph is linear for stack heights above 55 m, and mainly linear for stack heights between 30 - 45 m (as indicated by the magenta lines). This shows that there is minimal benefit to ground level annual mean concentrations from increasing the stack height beyond 55 m. For stack heights of 45 – 55 m there is some benefit from increasing the stack height. The point of maximum impact occurs in the Wyre Estuary (but not in the area where sensitive habitats are located), so the effect of increasing the stack height at areas of human exposure is minimal.

For the 99.79th percentile of hourly mean concentrations (which has been selected for its relevance to the short-term AQAL for nitrogen dioxide), there is a slight change in slope at a stack height of 40 m, again indicated by the magenta line. For maximum hourly concentrations, there is a significant decrease in concentrations at a stack height of 45 m.

The choice of appropriate stack height should be weighted more towards annual mean impacts due to the greater potential for significant air quality impacts over longer timescales. Graph 1 shows that a stack height of 45 m is appropriate based on annual mean impacts, and this choice of stack height is supported by the change in slope of maximum hourly concentrations at 45 m.

Overall, it is considered that a stack height of 45 m is appropriate to provides adequate dispersion of pollutants from the Facility, and the remainder of this assessment has been undertaken for a stack height of 45 m.

6.5 Other inputs

6.5.1 Modelling domain

Modelling has been undertaken using a nested grid of points; a 2.5 km x 2.5 km grid with a spatial resolution of 25 m nested within a 7.5 km x 7.5 km grid with a spatial resolution of 75 m. The high resolution of the finest grid has been chosen to ensure that the gridded output accurately captures the highest modelled concentrations. Reference to Figure 3 should be made to for a graphical representation of the modelling domain used. The extent of the modelling domain is detailed in Table 17.

Table 17: Modelling Domain

Grid Quantity	Fine Grid	Wide Grid
Grid spacing (m)	25	75
Grid points	101	101
Grid Start X (m)	333250	330750
Grid Finish X (m)	335750	338250
Grid Start Y (m)	442850	440350
Grid Finish Y (m)	445350	447850

6.5.2 Meteorological data and surface characteristics

The dispersion modelling has been undertaken using weather data from the Blackpool Airport meteorological recording station. Blackpool Airport is approximately 13 km to the south of the Facility and is the closest and most representative meteorological station available.

The Environment Agency recommends that 5 years of data are used to take into account inter-annual fluctuations in weather conditions. The period 2017 – 2021 has been used as this is the most recent 5 year period available at the time the dispersion modelling was undertaken. Wind roses for each year are presented in Figure 4.

The minimum Monin-Obukhov length can be selected in ADMS for both the dispersion site and the 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. The minimum Monin-Obukhov length has been set to 30 m for the dispersion site, which is recommended by CERC for “mixed urban/industrial” areas such as the setting of the Facility. The minimum Monin-Obukhov length has been set to 10 m for the meteorological site which is recommended by CERC for “small towns <50,000 [population]”, and is considered appropriate for the mix of suburbs, sea and semi-rural areas surrounding the meteorological site.

The surface roughness length utilised in ADMS can also be selected for both the dispersion site and meteorological site. There is considerable variation in surface roughness across the 7.5 x 7.5 km modelling domain, ranging from open water to built-up urban areas. To account for the varying surface roughness length a spatially-varying surface roughness file has been used as a model input. The land-use class for each point in the file has been extracted from the CORINE Land Cover database[5] and cross-referenced with the most likely surface roughness length value[6].

A surface roughness length of 0.3 m has been selected for Blackpool Airport. CERC recommends that this value is the maximum value suitable for “agricultural areas” and is considered representative of the mix of land uses around the meteorological station.

The parameters for the spatially-varying surface roughness file are shown in Table 18 and a visual representation provided in Figure 3.

Table 18: Spatially Varying Surface Roughness File Parameters

Parameter	Value
Grid spacing (m)	50
Grid points	112 x 112
Modelled resolution	64 x 64
Grid Start X (m)	425375
Grid Finish X (m)	430925
Grid Start Y (m)	294475
Grid Finish Y (m)	300025

Table 19: Surface Roughness Lengths Used for Different Land Use Classes

Land Use Classification	Corine 2018 Land Use Codes	Surface Roughness Length (m)
Green urban areas	141	0.6
Discontinuous urban fabric, industrial or commercial units, port areas, sport and leisure facilities	112, 121, 123, 142	0.5
Non-irrigated arable land, salt marshes	211, 421	0.05
Pastures	231	0.03
Intertidal flats	423	0.0005
Water[(1)]	522, 523	0.0001
Note:		

5 https://land.copernicus.eu/pan-european/corine-land-cover

6 Taken from “Roughness length classification of Corine Land Cover classes”, Megajoule Consultants, 2007.

Land Use Classification	Corine 2018 Land Use Codes	Surface Roughness Length (m)
[1] *The 'most likely' value for water is given as zero. ADMS cannot model a surface roughness length of zero, so areas of water have been assigned a roughness length of 0.0001 m which is the value recommended by CERC for 'sea'.*		

A summary of the meteorological parameters used in the dispersion modelling is shown in Table 20

Table 20: Meteorological parameters

Parameter	Dispersion Site Value (m)	Met Site Value (m)
Surface roughness length	Spatially varying	0.3
Minimum Monin-Obukhov length	30	10

The sensitivity of the modelling results to the choice of surface roughness has been considered in Section 7.1.

6.5.3 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.

The Environment Agency recommends 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 5.2 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.

A review of the site layout has been undertaken and the details of the applicable buildings which may affect dispersion from the Facility are presented in Table 21. The buildings have been modelled at the height of the highest point of the structure. A site plan showing which buildings have been included in the model is presented in Figure 5.

Table 21: Building Details

Buildings	Centre Point		Height (m)	Length (m)	Width (m)	Angle (°)
	X (m)	Y (m)				
Boiler FGT & Turbine[1]	334407.7	444002.2	18.0	48.6	75.0	83.0
RDF Reception	334400.6	444060.0	13.6	48.6	42.0	83.0
ACCs	334418.0	443951.5	12.8	36.0	16.7	83.0

Buildings	Centre Point		Height (m)	Length (m)	Width (m)	Angle (°)
	X (m)	Y (m)				
Note: *(1) Selected as the main building for the Facility*						

6.5.4 Terrain

It is recommended that, 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. A review of the local area has deemed that there are no gradients greater than 1 in 10 in the modelling domain. A sensitivity analysis has been undertaken to determine the effect of terrain (see section 7.2). This confirms that terrain has a negligible effect on dispersion. Therefore, terrain effects have not been included in the model.

6.6 Chemistry

The Facility will release nitric oxide (NO) and nitrogen dioxide (NO_2) which are collectively referred to as NOx. In the atmosphere, nitric oxide will be converted to nitrogen dioxide in a reaction with ozone which is influenced by solar radiation. Since the air quality objectives are expressed in terms of nitrogen dioxide, it is important to be able to assess the conversion rate of nitric oxide to nitrogen dioxide.

Ground level NOx concentrations have been predicted through dispersion modelling. Nitrogen dioxide concentrations reported in the results section assume 70% conversion from NOx to nitrogen dioxide for annual means and a 35% conversion for short term (hourly) concentrations, based upon the worst-case scenario in the Environment Agency methodology. Given the short travel time to the areas of maximum concentrations, this approach is considered conservative.

6.7 Baseline concentrations

Background concentrations for the assessment have been derived from monitoring and national mapping as presented in section 4. For short term averaging periods, the background concentration has been assumed to be twice the long term ambient concentration following the Air Emissions Guidance methodology.

7 Sensitivity Analysis

7.1 Surface roughness

The sensitivity of the results to using spatially varying surface roughness length has been considered by running the model with a variety of surface roughness lengths for the dispersion site. For all sensitivity analyses 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 were kept constant:

- Stack height – 45 m
- Buildings – included;
- Meteorological site surface roughness – 0.3 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Blackpool Airport 2017.

The contribution of the process emissions from the Facility to the ground level concentration of oxides of nitrogen at the point of maximum impact and at the maximum impacted human receptor is presented in Table 22.

Table 22: Surface Roughness Sensitivity Analysis

Surface roughness (m)	Oxides of nitrogen PC					
	Annual mean		99.79%ile of 1-hour mean		Max 1-hour mean	
	Conc. (µg/m³)	% change from varying	Conc. (µg/m³)	% change from varying	Conc. (µg/m³)	% change from varying
Point of maximum impact						
Varying	**1.55**	-	**17.74**	-	**74.85**	-
0.1	1.31	-15.3%	15.31	-13.7%	33.07	-55.8%
0.3	1.61	3.8%	16.49	-7.0%	33.31	-55.5%
0.5	1.80	15.6%	17.07	-3.8%	34.67	-53.7%
0.7	1.96	26.0%	17.97	1.3%	36.56	-51.1%
Maximum impacted receptor						
Varying	**0.35**	-	**10.26**	-	**15.28**	-
0.1	0.40	13.6%	11.80	15.1%	15.64	2.3%
0.3	0.41	15.5%	12.90	25.8%	15.23	-0.4%
0.5	0.41	16.3%	13.28	29.5%	14.78	-3.3%
0.7	0.44	25.0%	13.38	30.5%	14.86	-2.8%

Increasing the surface roughness value leads to greater annual mean and short-term concentrations at the point of maximum impact. The use of the spatially varying surface roughness file results in annual mean impacts similar to a constant surface roughness length of 0.3 m. The maximum hourly concentrations are much higher for the spatially varying surface roughness file, in comparison to the use of a constant surface roughness length.

At the maximum impacted receptor location the spatially varying surface roughness length results in lower concentrations than the use of a constant surface roughness length, except for maximum hourly concentrations where there is little effect.

Due to the sensitivity of the results to the choice of surface roughness length it is considered appropriate to use the spatially varying surface roughness file in the main model runs as this most accurately represents the variations in land use and surface roughness around the Facility.

7.2 Terrain

The sensitivity of the results to the effect of terrain has been considered by running the model with and without a complex terrain file, which has the same points as the spatially varying surface roughness file shown in Table 18 and was run at 64 x 64 resolution.

The following parameters have been kept constant:

- Stack height – 45 m;
- Grid – nested;
- Buildings – included;
- Dispersion site surface roughness – spatially varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.3 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Blackpool Airport 2017.

The contributions of the process emissions from the Facility to the ground level concentration of oxides of nitrogen at the point of maximum predicted concentration and maximum impacted receptor are presented in Table 23 for each scenario.

Table 23: Effect of Terrain

Scenario used in model	Oxides of nitrogen PC (µg/m³)		
	Annual mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
Excluding terrain	**1.55**	**17.74**	**74.85**
Including terrain	1.29	17.14	71.58
% change	-17.2%	-3.4%	-4.4%
Maximum impacted receptor			
Excluding terrain	**0.35**	**10.26**	**15.28**
Including terrain	0.33	9.96	15.72
% change	-5.1%	-2.9%	2.9%

Modelling the effect of terrain results in lower annual mean concentrations at the point of maximum impact, but there is little change in short term concentrations, or in annual mean and short-term concentrations at the maximum impacted receptor. As the surroundings of the Facility are mainly flat, terrain effects have been excluded.

7.3 Building parameters

The sensitivity of the results to the effect of buildings has been considered by running the model with and without the buildings presented in Table 21.

The following parameters were kept constant:

- Stack height – 45 m;
- Grid – nested;
- Terrain – excluded;
- Dispersion site surface roughness – spatially varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.3 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Blackpool Airport 2017.

The contribution of the process emissions from the Facility to the ground level concentration of oxides of nitrogen at the point of maximum impact and at the maximum impacted human receptor is presented in Table 24 for each scenario.

Table 24: Effect of Buildings

Scenario used in model	Oxides of nitrogen PC (µg/m³)		
	Annual mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
Including buildings	**1.55**	**17.74**	**74.85**
Excluding buildings	0.92	17.27	42.29
% change	-40.6%	-2.7%	-43.5%
Maximum impacted receptor			
Including buildings	**0.35**	**10.26**	**15.28**
Excluding buildings	0.34	8.51	16.15
% change	-3.1%	-17.0%	5.7%

Modelling the presence of buildings results in significantly higher annual mean and maximum hourly mean concentrations at the point of maximum impact, although there is litter effect at the 99.79th percentile of hourly means. The opposite effect is evident at receptors, with the 99.79th percentile of hourly means being higher when building effects are modelled but only a small effect on annual mean and maximum hourly mean concentrations. Buildings have been included in the dispersion model as this is a realistic approach.

7.4 Grid resolution

The sensitivity of the results to the choice of grid resolution has been considered by running the model with the 25 m nested grid resolution detailed in Table 17, and with a finer grid of 15 m resolution.

The following parameters were kept constant:

- Stack height – 45 m;
- Buildings – included;
- Terrain – excluded;
- Dispersion site surface roughness – spatially varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.3 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Blackpool Airport 2017.

The contribution of the process emissions from the Facility to the ground level concentration of oxides of nitrogen at the point of maximum impact is presented in Table 24 for each scenario.

Table 25: Effect of Grid Resolution

Scenario used in model	Oxides of nitrogen PC (µg/m³)		
	Annual mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
25 m grid	**1.55**	**17.74**	**74.85**
15 m grid	1.55	17.78	103.95
% change	0.1%	0.2%	38.9%

Modelling a finer grid of 15 m resolution results in a negligible change in maximum annual mean and short-term concentrations, except for maximum 1-hour means where the 15 m grid captures higher concentrations. However, due to the very limited geographical extent of these impacts (i.e., higher impacts are predicted to occur between the grid points that are only 25 m apart), which occur just to the south-east of the Site boundary where there is no relevant exposure, and noting that these conditions occur for only one hour of the modelled weather data, it is considered that no potentially significant effects would be missed with a grid resolution of 25 m. Therefore, the 25 m resolution is considered fine enough to accurately represent process emissions from the Facility. The choice of grid resolution does not affect the results at individual receptor points.

7.5 Sensitivity analysis – operating below the design point

Dispersion modelling has been undertaken using the emission parameters based on the design point for the Facility. The Facility 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 and the exit velocity of the exhaust gases would reduce. The effect of this would be to decrease the quantity of pollutants emitted but also to reduce the buoyancy of the plume due to momentum. The reduction in buoyancy, which would lead to reduced dispersion, would be more than offset by the decrease in the amount of pollutants being emitted, so that the impact of the plant when running below the design point would be reduced.

8 Impact on Human Health

8.1 At the point of maximum impact

Table 26 and Table 27 present the results of the dispersion modelling of process emissions from the Facility at the point of maximum impact. This is the maximum predicted concentration based on the following:

- Modelling domain size – a nested grid of points; a 2.5 km x 2.5 km grid with a spatial resolution of 25 m nested within a 7.5 km x 7.5 km grid with a spatial resolution of 75 m;
- Buildings – included;
- Stack height – 45 m;
- 5 years of weather data 2017 to 2021 from Blackpool Airport meteorological recording station;
- Operation at the long term ELVs for 100% of the year;
- Operation at the short term ELVs during the worst-case conditions for dispersion of emissions (Table 27 only);
- Environment Agency's worst case 70% conversion of oxides of nitrogen to nitrogen dioxide;
- The entire VOC emissions are assumed to consist of either benzene or 1,3-butadiene; and
- Cadmium is released at the combined emission limit for cadmium and thallium.

The baseline concentration is taken from the review of baseline monitoring contained in section 4.

Impacts that cannot be screened out as 'insignificant' are highlighted. Where the impact cannot be screened out as 'insignificant', further analysis has been undertaken.

Table 26: Dispersion Modelling Results – Point of Maximum Impact - Operation at Daily ELVs

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2017	2018	2019	2020	2021	Max			
Nitrogen dioxide	Annual mean	µg/m³	40	15.70	1.09	0.84	0.92	0.90	0.88	1.09	**2.72%**	16.79	41.97%
	99.79th %ile of hourly means	µg/m³	200	31.40	6.21	6.28	6.61	7.03	7.59	7.59	3.79%	38.99	19.49%
Sulphur dioxide	99.18th %ile of daily means	µg/m³	125	13.92	2.85	2.78	2.84	2.92	2.53	2.92	2.34%	16.84	13.47%
	99.73rd %ile of hourly means	µg/m³	350	13.92	5.28	5.32	5.28	5.44	6.12	6.12	1.75%	20.04	5.72%
	99.9th %ile of 15 min. means	µg/m³	266	13.92	6.53	7.08	7.46	7.60	8.59	8.59	3.23%	22.51	8.46%
PM_{10}	Annual mean	µg/m³	40	11.15	0.08	0.06	0.07	0.06	0.06	0.08	0.19%	11.23	28.07%
	90.41st %ile of daily means	µg/m³	50	22.30	0.26	0.19	0.22	0.22	0.20	0.26	0.51%	22.56	45.11%
$PM_{2.5}$	Annual mean	µg/m³	20	8.27	0.08	0.06	0.07	0.06	0.06	0.08	0.39%	8.35	41.74%
Carbon monoxide	8 hour running mean	µg/m³	10,000	612	8.42	8.18	9.10	9.80	8.07	9.80	0.10%	621.80	6.22%
	Hourly mean	µg/m³	30,000	612	37.39	23.67	29.72	35.67	32.46	37.39	0.12%	649.39	2.16%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	4.49	2.84	3.57	4.29	3.90	4.49	0.60%	5.91	0.79%
Hydrogen fluoride	Annual mean	µg/m³	16	2.35	0.02	0.01	0.01	0.01	0.01	0.02	0.10%	2.37	14.78%
	Hourly mean	µg/m³	160	4.70	0.75	0.47	0.59	0.71	0.65	0.75	0.47%	5.45	3.40%
Ammonia	Annual mean	µg/m³	180	3.45	0.16	0.12	0.13	0.13	0.13	0.16	0.09%	3.61	2.00%
	Hourly mean	µg/m³	2,500	6.90	7.48	4.73	5.94	7.13	6.49	7.48	0.30%	14.38	0.58%
VOCs (as benzene)	Annual mean	µg/m³	5	0.54	0.16	0.12	0.13	0.13	0.13	0.16	**3.10%**	0.70	13.90%

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2017	2018	2019	2020	2021	Max			
	Daily mean	µg/m³	30	1.08	1.14	1.34	1.11	1.20	1.11	1.34	4.48%	2.42	8.08%
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.18	0.16	0.12	0.13	0.13	0.13	0.16	**6.90%**	0.34	14.90%
Mercury	Annual mean	ng/m³	250	2.80	0.31	0.24	0.26	0.26	0.25	0.31	0.12%	3.11	1.24%
	Hourly mean	ng/m³	7,500	5.60	14.96	9.47	11.89	14.27	12.98	14.96	0.20%	20.56	0.27%
Cadmium	Annual mean	ng/m³	5	0.35	0.31	0.24	0.26	0.26	0.25	0.31	**6.21%**	0.66	13.21%
PAHs	Annual mean	pg/m³	250	220	3.10	2.40	2.64	2.57	2.51	3.10	**1.24%**	223.10	89.24%
Dioxins, furans and dioxin-like PCBs	Annual mean	fg/m³	-	32.99	0.93	0.72	0.79	0.77	0.75	0.93	-	33.92	-
PCBs	Annual mean	ng/m³	200	0.13	0.08	0.06	0.07	0.06	0.06	0.08	0.04%	0.21	0.10%
	Hourly mean	ng/m³	6,000	0.26	3.74	2.37	2.97	3.57	3.25	3.74	0.06%	4.00	0.07%
Other metals	Annual mean	ng/m³	-	-	4.66	3.60	3.95	3.85	3.76	4.66	See metals assessment – Section 8.2.6		
	Daily mean	ng/m³	-	-	34.20	40.29	33.17	36.03	33.38	40.29			
	Hourly mean	ng/m³	-	-	224.36	142.01	178.34	214.02	194.73	224.36			

Note:
All assessment is based on the maximum PC using all 5 years of weather data.

Table 27: Dispersion Modelling Results – Point of Maximum Impact - Short-Term ELVs

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2017	2018	2019	2020	2021	Max			
Nitrogen dioxide	99.79th%ile of hourly means	µg/m³	200	31.40	24.84	25.10	26.42	28.11	30.34	30.34	**15.17%**	61.74	30.87%
Sulphur dioxide	99.73rd%ile of hourly means	µg/m³	350	13.92	35.22	35.44	35.23	36.27	40.78	40.78	**11.65%**	54.70	15.63%
	99.9th%ile of 15 min. means	µg/m³	266	13.92	43.52	47.19	49.72	50.68	57.30	57.30	**21.54%**	71.22	26.77%
Carbon monoxide	8 hour running mean	µg/m³	10,000	612	25.27	24.53	27.29	29.39	24.22	29.39	0.29%	641.39	6.41%
	Hourly mean	µg/m³	30,000	612	112.18	71.01	89.17	107.01	97.37	112.18	0.37%	724.18	2.41%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	44.92	28.43	35.71	42.85	38.99	44.92	5.99%	46.34	6.18%
Hydrogen fluoride	Hourly mean	µg/m³	160	4.70	2.99	1.89	2.38	2.85	2.60	2.99	1.87%	7.69	4.81%

Note:
All assessment is based on the maximum PC using all 5 years of weather data and operation of both lines at the short-term ELVs

As shown, at the point of maximum impact the contribution of the process emissions from the Facility is less than 10% of the short-term AQAL and less than 1% of the annual mean AQAL and can be screened out as 'insignificant', with the exception of the following:

- Annual mean nitrogen dioxide impacts;
- Annual mean VOCs as benzene and 1,3-butadiene impacts;
- Annual mean cadmium impacts;
- Annual mean PAHs impacts;
- 99.79th percentile of hourly mean nitrogen dioxide impacts;
- 99.73rd percentile of hourly mean sulphur dioxide impacts; and
- 99.9th percentile of 15-minute mean sulphur dioxide impacts.

Further assessment of these impacts has been undertaken.

8.2 Further assessment

8.2.1 Annual mean nitrogen dioxide

The contribution of the process emissions from the Facility to annual mean nitrogen dioxide concentrations is predicted to be 2.72% of the AQAL at the point of maximum impact. Table 28 details the impact of annual mean nitrogen dioxide contributions from process emissions at the identified sensitive human receptor locations. PCs greater than 1% of the AQAL are highlighted. Figure 6 shows the spatial distribution of emissions.

Baseline concentrations of nitrogen dioxide are likely to vary across the modelling domain. On review of the available air quality monitoring data presented in section 4 it is considered that the maximum baseline concentration at any of these receptors or areas of relevant exposure is likely to be no higher than the maximum recorded over the last five years at the monitoring location at Rose Fold (15.7 µg/m³). This has been used as the baseline concentration to calculate the PEC.

Table 28: Annual Mean Nitrogen Dioxide Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.21	0.53%	15.91	39.78%
R2	0.31	0.78%	16.01	40.03%
R3	0.28	0.69%	15.98	39.94%
R4	0.19	0.47%	15.89	39.72%
R5	0.29	0.72%	15.99	39.97%
R6	0.06	0.15%	15.76	39.40%
R7	0.06	0.15%	15.76	39.40%
R8	0.14	0.35%	15.84	39.60%
R9	0.15	0.39%	15.85	39.64%
R10	0.19	0.48%	15.89	39.73%
R11	0.25	0.61%	15.95	39.86%
R12	0.08	0.19%	15.78	39.44%

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R13	0.07	0.18%	15.77	39.43%
R14	0.07	0.17%	15.77	39.42%
R15	0.06	0.15%	15.76	39.40%
R16	0.11	0.29%	15.81	39.54%
R17	0.06	0.15%	15.76	39.40%

The PC at all receptor locations is less than 1% of the AQAL. As shown in Figure 6, there are no areas of relevant exposure with regard to the annual mean AQAL where the PC exceeds 1% of the AQAL. Therefore, the impact at all receptor locations and all areas of relevant exposure is screened out as 'insignificant'.

8.2.2 Annual mean VOCs

There are two VOCs for which an AQAL has been set: benzene and 1,3-butadiene. For the purpose of this analysis, it has been assumed that the entire VOC emissions consist of only benzene or 1,3-butadiene. This is a highly conservative assumption as it does not take into account the speciation of VOCs in the emissions and the modelling does not take into account the volatile nature of the compounds. The contribution of the process emissions from the Facility to annual mean VOC concentrations is predicted to be 3.10% of the AQAL for benzene and 6.90% of the AQAL for 1,3-butadient at the point of maximum impact.

Table 29 and Table 30 detail the impact of annual mean benzene and 1,3-butadiene contributions from process emissions at the identified sensitive human receptor locations. PCs greater than 0.5% of the AQAL are highlighted. Figure 7 and Figure 8 show the spatial distribution of emissions of VOCs as benzene and 1,3-butadiene respectively.

Table 29: Annual Mean VOCs (as Benzene) Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.030	0.61%	0.57	11.41%
R2	0.045	0.90%	0.58	11.70%
R3	0.039	0.79%	0.58	11.59%
R4	0.027	0.53%	0.57	11.33%
R5	0.041	0.82%	0.58	11.62%
R6	0.009	0.17%	0.55	10.97%
R7	0.008	0.17%	0.55	10.97%
R8	0.020	0.40%	0.56	11.20%
R9	0.022	0.44%	0.56	11.24%
R10	0.027	0.55%	0.57	11.35%
R11	0.035	0.70%	0.58	11.50%
R12	0.011	0.21%	0.55	11.01%

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R13	0.010	0.21%	0.55	11.01%
R14	0.010	0.20%	0.55	11.00%
R15	0.009	0.18%	0.55	10.98%
R16	0.016	0.33%	0.56	11.13%
R17	0.008	0.17%	0.55	10.97%

Table 30: Annual Mean VOCs (as 1,3-Butadiene) Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.030	**1.35%**	0.21	9.35%
R2	0.045	**1.99%**	0.22	9.99%
R3	0.039	**1.75%**	0.22	9.75%
R4	0.027	**1.19%**	0.21	9.19%
R5	0.041	**1.82%**	0.22	9.82%
R6	0.009	0.39%	0.19	8.39%
R7	0.008	0.37%	0.19	8.37%
R8	0.020	0.88%	0.20	8.88%
R9	0.022	0.98%	0.20	8.98%
R10	0.027	**1.21%**	0.21	9.21%
R11	0.035	**1.56%**	0.22	9.56%
R12	0.011	0.48%	0.19	8.48%
R13	0.010	0.46%	0.19	8.46%
R14	0.010	0.44%	0.19	8.44%
R15	0.009	0.39%	0.19	8.39%
R16	0.016	0.73%	0.20	8.73%
R17	0.008	0.37%	0.19	8.37%

The PC of benzene at all receptor locations is less than 1% of the AQAL. As shown in Figure 7, the area where the PC exceeds 1% of the AQAL includes no existing areas of relevant exposure, but does include a small section of the housing development north of Bourne Road which is under construction. For 1,3-butadiene the PC exceeds 1% of the AQAL over a larger area, as shown in Figure 8, inclding at several of the identified receptor locations. However, for both benzene and 1,3-butadiene the PEC is well below 70% of the AQAL at the point of maximum impact and all areas of relevant exposure, so the impact is 'not significant'.

8.2.3 Annual mean cadmium

The contribution of the process emissions from the Facility to annual mean cadmium concentrations is predicted to be 6.21% of the AQAL. However, this assumes that the entire cadmium and thallium emissions consist of only cadmium. Data submitted by UK plants to the European Waste Incineration BREF working group in 2017 shows that the average cadmium concentration recorded from UK plants equipped with bag filters was 1.6 µg/Nm³ (or 3.2% of the ELV of 0.02 mg/Nm³), the highest recorded concentration of cadmium and thallium was 14 µg/Nm³ (or 70% of the ELV) and only three lines recorded concentrations higher than 10 µg/Nm³ (or 50% of the ELV of 0.02 mg/Nm³).

Table 31 shows the annual mean cadmium PC at the identified sensitive human receptor locations, for cadmium emitted at 100%, 50% and 8% of the ELV, referred to as the 'screening', 'worst case' and 'typical' scenarios. PCs greater than 0.5% of the AQAL are highlighted. Figure 9 shows the spatial distribution of emissions assuming cadmium is emitted at 100% of the combined cadmium and thallium emission limit.

Table 31: Annual Mean Cadmium Impact at Identified Sensitive Receptors

Receptor	PC (as % of AQAL)					
	Screening		Worst-case		Typical	
	ng/m³	% AQAL	ng/m³	% AQAL	ng/m³	% AQAL
Pt of max impact	0.310	**6.21%**	0.155	**3.10%**	0.025	0.50%
R1	0.061	**1.21%**	0.030	0.61%	0.005	0.10%
R2	0.090	**1.79%**	0.045	0.90%	0.007	0.14%
R3	0.079	**1.57%**	0.039	0.79%	0.006	0.13%
R4	0.053	**1.07%**	0.027	0.53%	0.004	0.09%
R5	0.082	**1.64%**	0.041	0.82%	0.007	0.13%
R6	0.017	0.35%	0.009	0.17%	0.001	0.03%
R7	0.017	0.33%	0.008	0.17%	0.001	0.03%
R8	0.040	0.79%	0.020	0.40%	0.003	0.06%
R9	0.044	0.88%	0.022	0.44%	0.004	0.07%
R10	0.055	**1.09%**	0.027	0.54%	0.004	0.09%
R11	0.070	**1.40%**	0.035	0.70%	0.006	0.11%
R12	0.021	0.43%	0.011	0.21%	0.002	0.03%
R13	0.021	0.41%	0.010	0.21%	0.002	0.03%
R14	0.020	0.40%	0.010	0.20%	0.002	0.03%
R15	0.018	0.35%	0.009	0.18%	0.001	0.03%
R16	0.033	0.65%	0.016	0.33%	0.003	0.05%
R17	0.017	0.33%	0.008	0.17%	0.001	0.03%

When the baseline concentration of 0.35 ng/m³ is taken into account, the PEC at the point of maximum impact under the 'screening' scenario is 13.21% of the AQAL. The impact at some receptor locations cannot be screened out as 'insignificant' in this scenario. However, as the PEC is well below 70% of the AQAL, the impact is 'not significant'. Furthermore, Table 31 shows that under the 'typical' emissions scenario, the PC at the point of maximum impact is less than 1% of the AQAL and is screened out as 'insignificant'.

8.2.4 Annual mean PAHs

The contribution of the process emissions from the Facility to annual mean PAH concentrations is predicted to be 1.24% of the AQAL for benzo[a]pyrene at the point of maximum impact. Table 32 details the impact of annual mean PAH contributions from process emissions at the identified sensitive human receptor locations. PCs greater than 1% of the AQAL are highlighted. Figure 10 shows the spatial distribution of emissions.

Table 32: Annual Mean PAH Impact at Identified Sensitive Receptors

Receptor	PC		PEC(1)	
	pg/m³	as % of AQAL	pg/m³	as % of AQAL
R1	0.61	0.24%	220.61	88.24%
R2	0.90	0.36%	220.90	88.36%
R3	0.79	0.31%	220.79	88.31%
R4	0.53	0.21%	220.53	88.21%
R5	0.82	0.33%	220.82	88.33%
R6	0.17	0.07%	220.17	88.07%
R7	0.17	0.07%	220.17	88.07%
R5	0.40	0.16%	220.40	88.16%
R6	0.44	0.18%	220.44	88.18%
R7	0.55	0.22%	220.55	88.22%
R5	0.70	0.28%	220.70	88.28%
R6	0.21	0.09%	220.21	88.09%
R7	0.21	0.08%	220.21	88.08%
R5	0.20	0.08%	220.20	88.08%
R6	0.18	0.07%	220.18	88.07%
R7	0.33	0.13%	220.33	88.13%
R8	0.17	0.07%	220.17	88.07%

Note:
(1) Includes contribution from the Biomass CHP Plant.

As shown in Table 32, the PC at all receptor locations is less than 1% of the AQAL and is screened out as 'insignificant'. Figure 10 shows that there are no areas of relevant exposure where the PC exceeds 1% of the AQAL. Therefore, the impact at all receptor locations and all areas of relevant exposure is screened out as 'insignificant'.

8.2.5 Short-term impacts

The impact of the process emissions from the Facility operating at the short-term ELVs exceeds 10% of the AQAL for the 99.79th percentile of hourly mean nitrogen dioxide, 99.73rd percentile of hourly mean sulphur dioxide and the 99.9th percentile of 15-minute mean sulphur dioxide. The maximum PCs are predicted to be 15.17%, 11.65% and 21.54% of the respective AQALs. These impacts are only predicted to occur in the very unlikely case that both lines are operating at the maximum permitted short-term ELV during the worst-case weather conditions for dispersion.

The PCs as percentage of the headroom are presented in Table 33.

Table 33: Further Assessment – Short-Term Impacts

Pollutant	Quantity	Units	AQAL	Bg Conc.	Max PC	As % of AQAL	As % of headroom
Nitrogen dioxide	99.79th%ile of hourly means	µg/m³	200	31.40	30.34	**15.17%**	18.00%
Sulphur dioxide	99.73rd%ile of hourly means	µg/m³	350	13.92	40.78	**11.65%**	12.13%
	99.9th%ile of 15 min. means	µg/m³	266	13.92	57.30	**21.54%**	**22.73%**

When the baseline concentrations are taken into account, assuming that the short-term baseline concentration is twice the long-term concentration, the PC is less than 20% of the headroom for hourly mean nitrogen dioxide and hourly mean sulphur dioxide. Therefore, the impact on hourly mean concentrations of these pollutants is 'not significant'. The PC for 15-minute mean sulphur dioxide is more than 20% of the AQAL and cannot be screened out as 'not significant'.

Further analysis of the impacts has been undertaken with reference to Figure 11, Figure 12, and Figure 13, which respectively show the spatial distribution of the hourly mean nitrogen dioxide, hourly mean sulphur dioxide and 15-minute mean sulphur dioxide PC from the Facility.

8.2.5.1 Hourly mean nitrogen dioxide

As shown in Figure 11, the PC is less than 10% of the AQAL at all identified sensitive receptors. At other areas of relevant exposure, such as sections of the Hillhouse Business Park and the Wyre Way footpath, the PC exceeds 10% of the AQAL; as such, the impacts at areas of relevant exposure cannot be screened out as 'insignificant'.

The area where the PC exceeds 10% of the AQAL does not include any busy roads, which would result in local elevated baseline concentrations. Furthermore, the National Atmospheric Emissions Inventory (NAEI) UK Emissions Interactive Map[7] shows that the closest existing point sources of oxides of nitrogen are at the Vinnolit and AGC Chemicals facilities, approximately 1 km to the south, and a set of landfill gas engines located around 2 km to the north. Figure 11 shows that the areas of relevant exposure where the PC exceeds 1% of the AQAL are no more than around 300 m from the Facility, so these point sources will not significantly affect the baseline concentration. As such, the assumed baseline is applicable, the PC is less than 20% of the headroom, and the impact is 'not significant'.

Furthermore, If the Facility were to operate with one line at the half-hourly ELV and the other at the daily ELV, the maximum impact would be approximately 9.48% of the AQAL. This is approximate as the exact result depends which line is operating at the half-hourly ELV. Therefore, under this scenario the impact would be described as 'insignificant'.

[7] https://naei.beis.gov.uk/emissionsapp/

8.2.5.2 Hourly mean sulphur dioxide

As shown in Figure 12, the PC is less than 10% of the AQAL at all identified sensitive receptors. There is a small area where the PC exceeds 10% of the AQAL but this is limited to a short stretch of the Wyre Way footpath. The same point sources as listed in section 8.2.5.1 also emit sulphur dioxide, except for the landfill gas engines. However, due to the location of the exceedance of the 10% screening threshold, it is considered that these point sources will not significantly affect the baseline concentration, so the PC is less than 20% of the headroom and the impact is 'not significant'.

Furthermore, with one line operating at the half-hourly ELV and the other at the daily ELV, the maximum impact would be approximately 6.70% of the AQAL and would be described as 'insignificant'.

8.2.5.3 15-minute mean sulphur dioxide

As shown in Figure 13, the PC is less than 10% of the AQAL at all identified sensitive receptors, except at receptor R1. The area where the PC exceeds 10% extends across sections of the Hillhouse Business Park and the Wyre Way footpaths, and pavements and residential receptors on Bourne Road, Edward Street, and Birch Lane. As with hourly mean sulphur dioxide, Figure 13 shows that impacts at areas of relevant exposure that that cannot be screened out as 'insignificant' are limited to within around 500 m of the Facility, so these point sources will not significantly affect the baseline concentration. As such, although the maximum PC is not less than 20% of the headroom, the modelled PEC of 26.77% of the AQAL demonstrates that there is no risk of an exceedance of the AQAL, so no significant effects are predicted.

Furthermore, with one line operating at the half-hourly ELV and the other at the daily ELV, the maximum impact would be approximately 12.39% of the AQAL. Although this cannot be screened out as 'insignificant', this PC is 13.1% of the headroom so is 'not significant'.

8.2.6 Heavy metals – at the point of maximum impact

Table 34 and Table 35 detail the impact of process emissions from the Facility and the PEC assuming that each metal is released at the combined long- and short-term metal ELVs respectively. If the PC is greater than 1% of the long-term or 10% of the short-term AQAL and the PEC exceeds the AQAL when it is assumed that each metal is emitted at the total metal ELV, further analysis has been undertaken assuming the release of each metal is no greater than the maximum reported in the Environment Agency metals guidance[8].

[8] Guidance on Assessing group 3 metal stack emissions from incinerators, Environment Agency, 2016

Table 34: 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	1.10	4.66	**77.60%**	5.76	95.93%	8.3%	0.39	**6.47%**	1.49	24.80%
Antimony	5,000	0.68	4.66	0.09%	5.34	0.11%	3.8%	0.18	<0.00%	0.86	0.02%
Chromium	5,000	5.80	4.66	0.09%	10.46	0.21%	30.7%	1.43	0.03%	7.23	0.14%
Chromium (VI)	0.25	1.16	4.66	**1862.3%**	5.82	**2326.3%**	0.043%	0.00	0.81%	1.16	464.81%
Cobalt	-	0.20	4.66	-	4.86	-	1.9%	0.09	-	0.29	-
Copper	10,000	16.00	4.66	0.05%	20.66	0.21%	9.7%	0.45	0.005%	16.45	0.16%
Lead	250	20.00	4.66	**1.86%**	24.66	9.86%	16.8%	0.78	0.31%	20.78	8.31%
Manganese	150	10.00	4.66	**3.10%**	14.66	9.77%	20.0%	0.93	0.62%	10.93	7.29%
Nickel	20	2.20	4.66	**23.28%**	6.86	34.28%	73.3%	3.41	**17.07%**	5.61	28.07%
Vanadium	-	6.00	4.66	-	10.66	-	2.0%	0.09	-	6.09	-

Notes:

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

Table 35: 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	-	2.20	224.36	-	226.56	-	8.3%	18.70	-	20.90	-
Antimony	150,000	1.36	224.36	0.15%	225.72	0.15%	3.8%	8.60	0.006%	9.96	0.01%
Chromium	150,000	11.60	224.36	0.15%	235.96	0.16%	30.7%	68.80	0.05%	80.40	0.05%
Chromium (VI)	-	2.32	224.36	-	226.68	-	0.043%	0.10	-	2.42	-
Cobalt	-	0.40	224.36	-	224.76	-	1.9%	4.19	-	4.59	-
Copper	200,000	32.00	224.36	0.11%	256.36	0.13%	9.7%	21.69	0.011%	53.69	0.03%
Lead	-	40.00	224.36	-	264.36	-	16.8%	37.62	-	77.62	-
Manganese	1,500,000	20.00	224.36	0.01%	244.36	0.02%	20.0%	44.87	0.003%	64.87	0.004%
Nickel	-	4.40	224.36	-	228.76	-	73.3%	164.53	-	168.93	-
Vanadium (24-hour mean)	1,000	6.00	40.29	4.03%	46.29	4.63%	2.0%	0.81	0.081%	6.81	0.68%

Notes:

All impacts maximum 1-hour PC with the exception of vanadium which is the maximum 24-hour PC.

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

As shown in Table 34 and Table 35, if it is assumed that the entire emissions of metals consist of only one metal, the impact of process emissions from the Facility is less than 1% of the long-term and less than 10% of the short-term AQAL, with the exception of annual mean impacts of arsenic, chromium (VI), lead, manganese and nickel. The PEC is only predicted to exceed the long-term AQAL for chromium (VI) using this worst-case screening assumption. If it is assumed that process emissions from the Facility are the maximum values reported in the Environment Agency's metals guidance, the PC is below 1% of the long term and 10% of the short term AQAL for all pollutants with the exception of annual mean arsenic and nickel. However, the annual mean PEC is well below the AQAL for both arsenic and nickel. Therefore, the impact of emissions of metals can be screened out and is considered to be 'insignificant'.

Although the PC for chromium (VI) is less than 1% if it is assumed that emissions are at the maximum value reported in the EA metals guidance, the PEC is still predicted to exceed the AQAL. This is due to the high baseline concentration, which is assumed to be 20% of total chromium in lieu of any site-specific monitoring of chromium (VI), in accordance with the Environment Agency's metals guidance. Due to the conservative assumptions, first that the baseline concentration of total chromium is the maximum annual concentration averaged across all urban background sites in the UK from 2017 to 2021 (as detailed in section 4), and that chromium (VI) is 20% of total chromium, it is unlikely that the PEC of chromium (VI) exceeds the AQAL.

9. Impact at Ecological Receptors

This section provides an assessment of the impact of emissions at the ecological receptors identified in Section 5.2.

9.1 Methodology

9.1.1 Atmospheric emissions – Critical Levels

The impact of process emissions from the Facility has been compared to the Critical Levels listed in Table 3 and the results are presented in Section 9.2.

For the purpose of the ecological assessment, the mapped background dataset from APIS has been used. If the PC is than 1% of the long-term or 10% of the short-term Critical Level further consideration will be made to the baseline concentrations.

9.1.2 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.

A review of the sensitivity of the habitats in each designated site has been undertaken by Argus Ecology and is presented in Appendix D. The nitrogen and acid deposition Critical Loads and background levels of deposition appropriate to each habitat are presented in Appendix B.

The location of each habitat requiring assessment in each European and UK designated site has been determined using Natural England's Priority Habitat Inventory map and the maximum PC in the relevant habitat has been used for comparison with the Critical Loads. If the impact of process emissions from the Facility upon nitrogen or acid deposition is greater than 1% of the Critical Load, further assessment has been undertaken.

9.1.3 Nitrogen deposition – eutrophication

Appendix B summarises the Critical Loads for nitrogen deposition and background deposition rates as detailed in APIS for each identified receptor. The impact has been assessed against these Critical Loads for nitrogen deposition.

9.1.4 Acidification

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. Where the acid deposition flux falls within the area under the Critical Load function, no exceedances are predicted.

Appendix B summaries the Critical Loads for acidification and background deposition rates as detailed in APIS for each identified habitat. The impact has been assessed against these Critical Load functions. Where a Critical Load function for acid deposition is not available but the habitat is listed as sensitive to acid deposition, the total nitrogen and sulphur deposition has been presented and compared with the background concentration.

9.1.5 Calculation methodology

9.1.5.1 nitrogen deposition

The impact of deposition has been assessed using the methodology detailed within the Habitats Directive AQTAG06[9] (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 (µg/m^2/s) at each site by multiplying the annual mean ground level concentration by the relevant deposition velocity presented in Table 36.
3. Convert the dry deposition flux into units of kgN/ha/yr using the conversion factors presented in Table 36.
4. Compare this result to the nitrogen deposition Critical Load.

Table 36: Deposition Factors

Pollutant	Deposition Velocity (m/s)		Conversion Factor (µg/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

9.1.5.2 Acidification

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

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

1. Determine the dry deposition rate in kg/ha/yr of nitrogen, sulphur, hydrogen chloride and ammonia using the methodology outlined in Section 9.1.5.
2. Apply the conversion factor for N outlined in Table 36 to the nitrogen 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 37: Conversion Factors

Pollutant	Conversion Factor (kg/ha/year to keq/ha/year)
Nitrogen	Divide by 14
Sulphur	Divide by 16

[9] Air Quality Advisory Group, AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air, March 2014

Pollutant	Conversion Factor (kg/ha/year to keq/ha/year)
Hydrogen chloride	Divide by 35.5

The March 2014 version of the AQTAG06 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 process emissions from the Facility 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

9.2 Results – atmospheric emissions - Critical Levels

The impact of process emissions from the Facility has been compared to the Critical Levels and the results are presented in Table 38 and Table 39. If the PC of a particular pollutant is greater than 1% of the long-term or 10% of the short-term Critical Level at a European or UK designated site, or 100% of the long- or short-term Critical Level at a local nature site, further assessment would be undertaken. The PC has been calculated based on the maximum predicted in each designated site using all five years of weather data. This assumes operation at the daily ELVs as set out in Table 16.

Table 38: Process Contribution at Designated Ecological Sites – µg/m³

Site		NOx	SO_2		HF	NH_3
	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean
European designated sites (within 10 km) and UK designated sites (within 2 km)						
Wyre Estuary SSSI	1.55	13.44	0.466	0.048	0.134	0.155
Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	1.55	13.44	0.466	0.048	0.134	0.155
Morecambe Bay SAC	0.08	0.84	0.024	0.004	0.008	0.008
Liverpool Bay SPA	0.04	0.75	0.012	0.003	0.007	0.004
Local nature sites (within 2 km)						
ICI Hillhouse Estuary Banks BHS	1.22	9.54	0.366	0.046	0.095	0.122
Fleetwood Railway Branch Line Trunnah to Burn Naze BHS	0.67	8.72	0.202	0.052	0.087	0.067
Burglars Alley Field BHS	0.39	4.03	0.117	0.024	0.040	0.039
Jameson Road Saltmarsh BHS	0.24	2.77	0.071	0.011	0.028	0.024
ICI Hillhouse International Pool BHS	0.18	1.61	0.054	0.009	0.016	0.018
Rossall Lane Wood and Pasture BHS	0.27	3.02	0.081	0.011	0.030	0.027
Fleetwood Farm Fields BHS	0.31	3.54	0.093	0.017	0.035	0.031
Fleetwood Marsh Industrial Lands	0.17	1.51	0.052	0.009	0.015	0.017

Table 39: Process Contribution at Designated Ecological Sites – as % of Critical Level

Site	NOx		SO_2	HF		NH_3
	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean
European designated sites (within 10 km) and UK designated sites (within 2 km)						
Wyre Estuary SSSI	**5.18%**	**17.92%**	**2.33%**	9.70%	2.69%	**5.17%**
Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	**5.18%**	**17.92%**	**2.33%**	9.70%	2.69%	**5.17%**
Morecambe Bay SAC	0.27%	1.12%	0.24%	0.75%	0.17%	0.80%
Liverpool Bay SPA	0.13%	0.99%	0.06%	0.69%	0.15%	0.13%
Local nature sites (within 2 km)						
ICI Hillhouse Estuary Banks BHS	4.06%	12.72%	1.83%	9.26%	1.91%	4.06%
Fleetwood Railway Branch Line Trunnah to Burn Naze BHS	2.24%	11.63%	1.01%	10.38%	1.74%	2.24%
Burglars Alley Field BHS	1.29%	5.37%	0.58%	4.71%	0.80%	1.29%
Jameson Road Saltmarsh BHS	0.79%	3.70%	0.36%	2.25%	0.55%	0.79%
ICI Hillhouse International Pool BHS	0.60%	2.15%	0.27%	1.88%	0.32%	0.60%
Rossall Lane Wood and Pasture BHS	0.90%	4.02%	0.40%	2.17%	0.60%	0.90%
Fleetwood Farm Fields BHS	1.03%	4.71%	0.46%	3.45%	0.71%	1.03%
Fleetwood Marsh Industrial Lands	0.58%	2.01%	0.26%	1.72%	0.30%	0.58%

Notes:
As shown in Table 14 the higher Critical Levels of 20 µg/m³ for sulphur dioxide and 3 µg/m³ for ammonia have been applied at all sites, with the exception of Morecambe Bay SAC where the lower Critical Levels of 10 µg/m³ for sulphur dioxide and 1 µg/m³ for ammonia apply.

As shown in Table 39, at all designated sites the PC from the Facility is less than the screening and can be screened out as 'insignificant' for all pollutants considered, with the exception of the following pollutants at the Wyre Estuary SSSI and Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar site:

- Annual mean oxides of nitrogen;
- Daily mean oxides of nitrogen;
- Annual mean sulphur dioxide; and
- Annual mean ammonia;
- The following Illustrative plot files of impacts that cannot be screened out as 'insignificant' have been produced:
- Figure 14 [Annual Mean Oxides of Nitrogen];
- Figure 15 [Annual Mean Sulphur Dioxide];
- Figure 16 [Annual Mean Ammonia]; and
- Figure 17 [Daily Mean Oxides of Nitrogen].

Exceedances of the screening criteria do not automatically result in a significant effect but do require further analysis to determine the significance of effect. For annual mean impacts, the PEC has been calculated for each site, taking the background concentrations for the grid square where the maximum PC occurs in each site, to determine the potential for a significant effect.

Table 40: Impact at Designated Ecological Sites – Further Analysis of Annual Mean Impacts

Site	Facility (µg/m³)	Background (µg/m³	PEC	
			(µg/m³)	% of CL
Annual Mean Oxides of Nitrogen				
Wyre Estuary SSSI	1.55	12.5	14.05	46.84%
Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	1.55	12.5	14.05	46.84%
Annual Mean Ammonia				
Wyre Estuary SSSI	0.16	2.3	2.46	**81.84%**
Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.16	2.3	2.46	**81.84%**
Annual Mean Sulphur Dioxide				
Wyre Estuary SSSI	0.47	1.4	1.87	9.33%
Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.47	1.4	1.87	9.33%

As shown, at all ecological sites considered the PEC is below 70% of the Critical Level for annual mean oxides of nitrogen and sulphur dioxide, so the impact can be screened out as 'not significant' and the significance of effect is therefore 'negligible'. For ammonia the PEC is greater than 70% but less than 100% of the Critical Level. This impact cannot be screened out as 'not significant', and further analysis has been undertaken by Argus Ecology and presented in Appendix D, which has concluded no significant effects are likely.

The daily mean oxides of nitrogen PC exceeds 10% of the Critical Level of 75 µg/m³. The distribution of emissions is shown on Figure 17. Given the relatively low background concentrations (a maximum annual mean of 12.5 µg/m³), the highest PEC would be 38.44 µg/m³ (taking the short-term background to be twice the long-term background, in accordance with Environment Agency guidance). This is well below the Critical Level. Furthermore, as detailed in Table 3, the lower Critical Level is only applicable if sulphur dioxide and ozone are below their respective Critical Levels. A higher Critical Level of 200 µg/m³ is applicable if sulphur dioxide and ozone levels are below their respective Critical Levels. As shown in Table 40, the annual mean PEC of sulphur dioxide of 1.4 µg/m³ is well below the lower Critical Level of 10 µg/m³.

The Critical Level for ozone is an AOT40 of 3,000 ppb.h (6,000 µg/m³.h). The AOT is defined as the sum of the difference between each hourly daytime (08:00 to 20:00 CET) ozone concentration greater than 80 µg/m³ (40 ppb) and 80 µg/m³, for the period between 01 May and 31 July, i.e., the cumulative hourly exceedances of 40 ppb during daylight hours across the growing season. The closest AURN ozone monitoring station is at Blackpool Marton, an urban background site approximately 18 km south.

Due to large variations in AOT40 between years, the average over the most recent 5 years has been considered. The AOT40 over the last 5 years of monitoring data has been calculated and is presented in Table 41.

Table 41: Ozone AOT40

Site	AOT40 (ppb.h)					
	2017	2018	2019	2020	2021	Average
Blackpool Marton	1,299	4,864	1,379	1,916	1,282	2,148

The average AOT40 over the last 5 years is 2,148 ppb.h which is 71.6% of the Critical Level of 3,000 ppb.h. As such, it is considered that the higher daily mean NOx Critical Level of 200 µg/m³ is applicable. The maximum change in daily mean NOx concentrations as a result of process emissions from the Facility at any ecological receptor is 13.44 µg/m³, which is 6.7% of the higher Critical Level of 200 µg/m³. As such, the daily mean impact of oxides of nitrogen is less than 10% of the Critical Level and can be screened out as 'insignificant'.

9.3 Results - deposition of emissions - Critical Loads

Appendix C presents the results at each of the identified statutory designated ecological receptors. As shown, at all designated sites the contribution from process emissions from the Facility is less than the screening criteria and can be screened out as 'insignificant' at all designated sites considered, with the exception of:

- Nitrogen deposition impacts on saltmarsh habitats atthe Wyre Estuary SSSI and Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar; and

- Acid deposition impacts on grassland habitats at the Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar.

The following Illustrative plot files of impacts that cannot be screened out as 'insignificant' have been produced:

- Figure 18 [Nitrogen Deposition]; and
- Figure 19 [Acid Deposition].

Baseline nitrogen deposition already exceeds the Critical Loads, so the nitrogen deposition impacts cannot be screened out based on PEC. However, the PEC for acid deposition is well below 70% of the Critical Level for the impacts detailed above. Therefore, acid deposition impacts can be screened out as 'not significant'.

Further discussion of the impact of nitrogen deposition is presented in Appendix D. This has concluded that nitrogen deposition due to emissions from the Facility will not have a significant effect on the identified ecological sites.

10 Conclusions

This Dispersion Modelling Assessment has been undertaken to support an application for an EP for the Facility. This has been undertaken based on the assumption that the Facility will operate continually at the emission limits compliant with the BAT-AELs set out in the WI BREF for new plants, with the exception of oxides of nitrogen for which an emission limit lower than the upper end of the BAT-AEL range is being applied for.

This assessment has included a review of baseline pollution levels, dispersion modelling of emissions and quantification of the impact of these emissions on local air quality.

The primary conclusions of the assessment are presented below.

1. In relation to the impact on human health:
    a. Emissions from the operation of the Facility will not cause a breach of any AQAL.
    b. The overall impact of long-term process emissions associated with the operation of the Facility can be considered 'insignificant' or 'not significant' in accordance with EA screening criteria at the point of maximum impact and at all identified human sensitive receptors.
    c. The overall impact of short-term process emissions associated with the operation of the Facility can be screened out as 'not significant' in accordance with EA screening criteria at all areas of relevant exposure and at all identified human sensitive receptors, except for 15-minute mean sulphur dioxide. Detailed modelling has shown that the 15-minute mean PEC will remain well below the AQAL, so no significant effects are predicted.
2. In relation to the impact on ecologically sensitive sites, all can be screened out as 'insignificant' or 'not significant', except for ammonia and nitrogen deposition impacts at the Wyre Estuary SSSI and Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar site. Further analysis undertaken by the project ecologist has concluded no significant effects are likely

In summary, the assessment has shown that the operation of the Facility will not cause a breach of any AQAL, and the overall impact of process emissions can be screened out as 'not significant' at the point of maximum impact and at all sensitive receptor locations. As such, there should be no air quality constraint in granting an EP to operate the Facility.

Appendices

A Figures

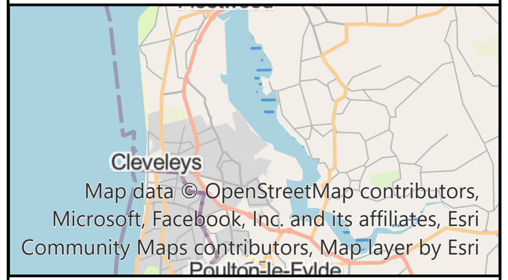
Legend

- Stack Locations
- Site Boundary
- Human Sensitive Receptors
- LAQM Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	

Figure 1: Human Sensitive Receptors

Drawn by: MJC	Date: 12/12/2022



0 0.1 0.2 0.4 km

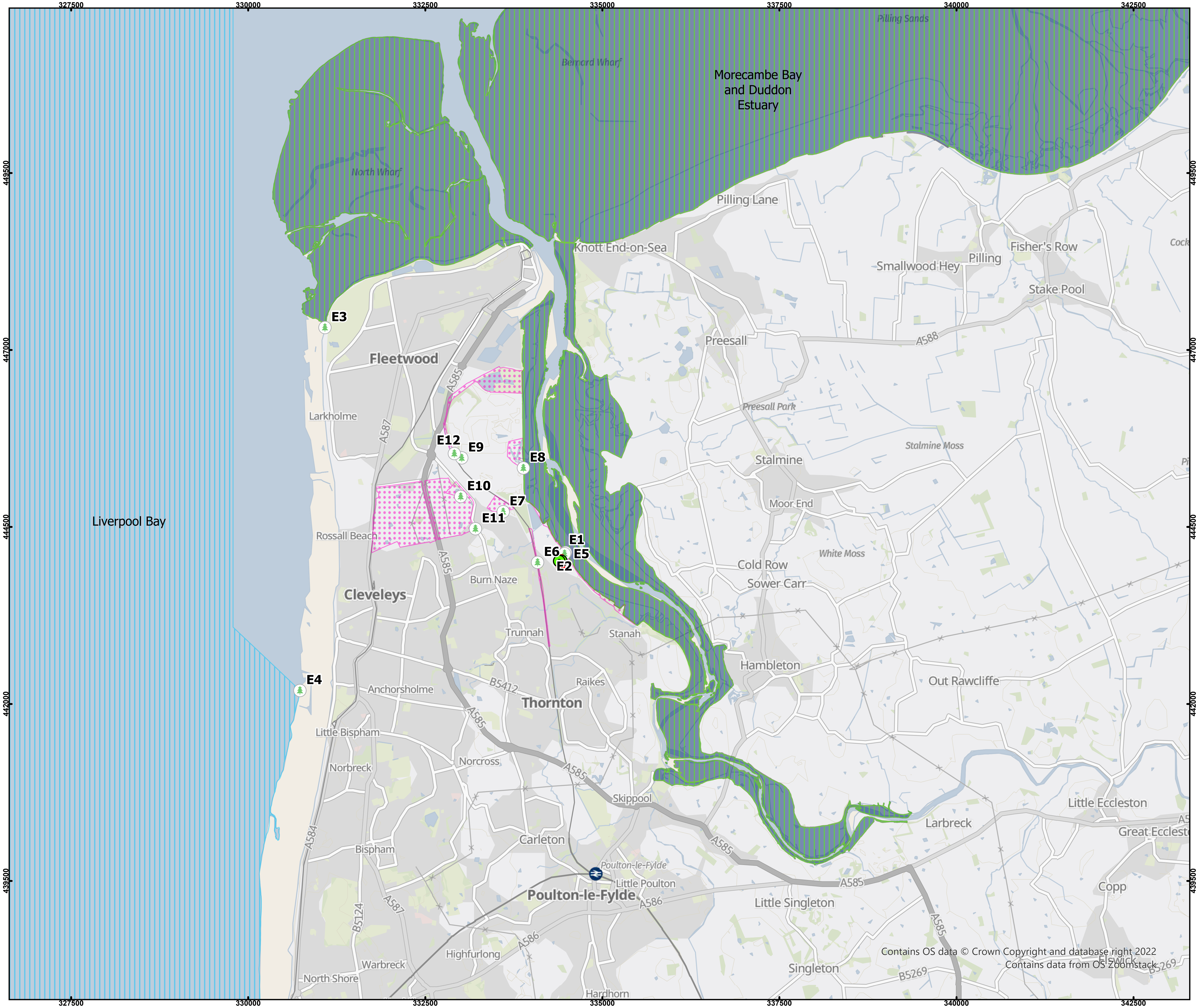
N

Scale: 1:10,000

FICHTNER

Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Discrete Ecological Receptor Points
- Liverpool Bay SPA
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	

Figure 2: Ecological Sensitive Receptors

Drawn by: MJC | Date: 12/12/2022

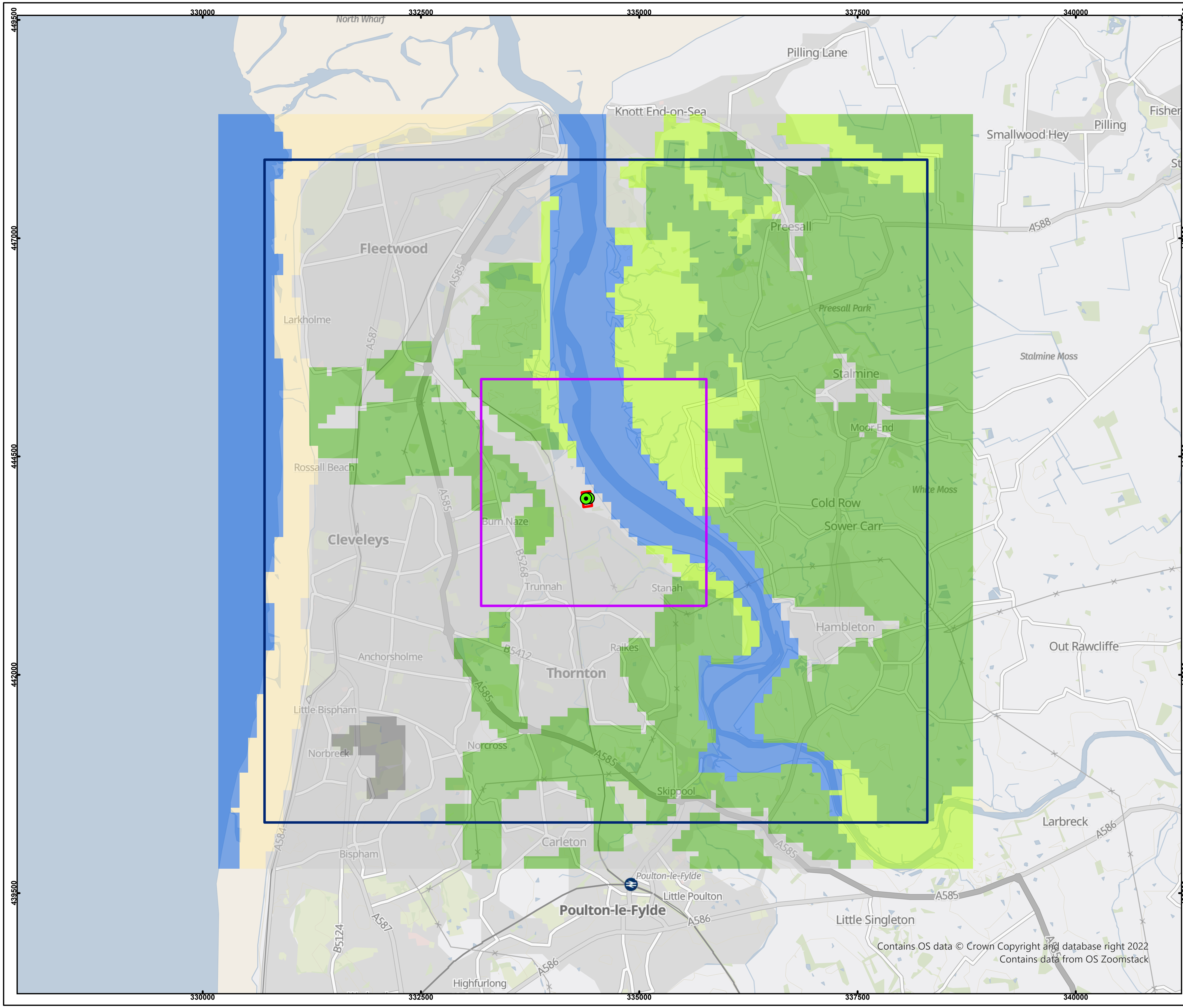
0 0.5 1 2 km

N

Scale: 1:50,000

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Fine Grid Extent
- Wide Grid Extent

Surface Roughness Length (m)

- 0.0001
- 0.0005
- 0.03
- 0.05
- 0.5
- 0.6

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	

Figure 3: Dispersion Model Inputs

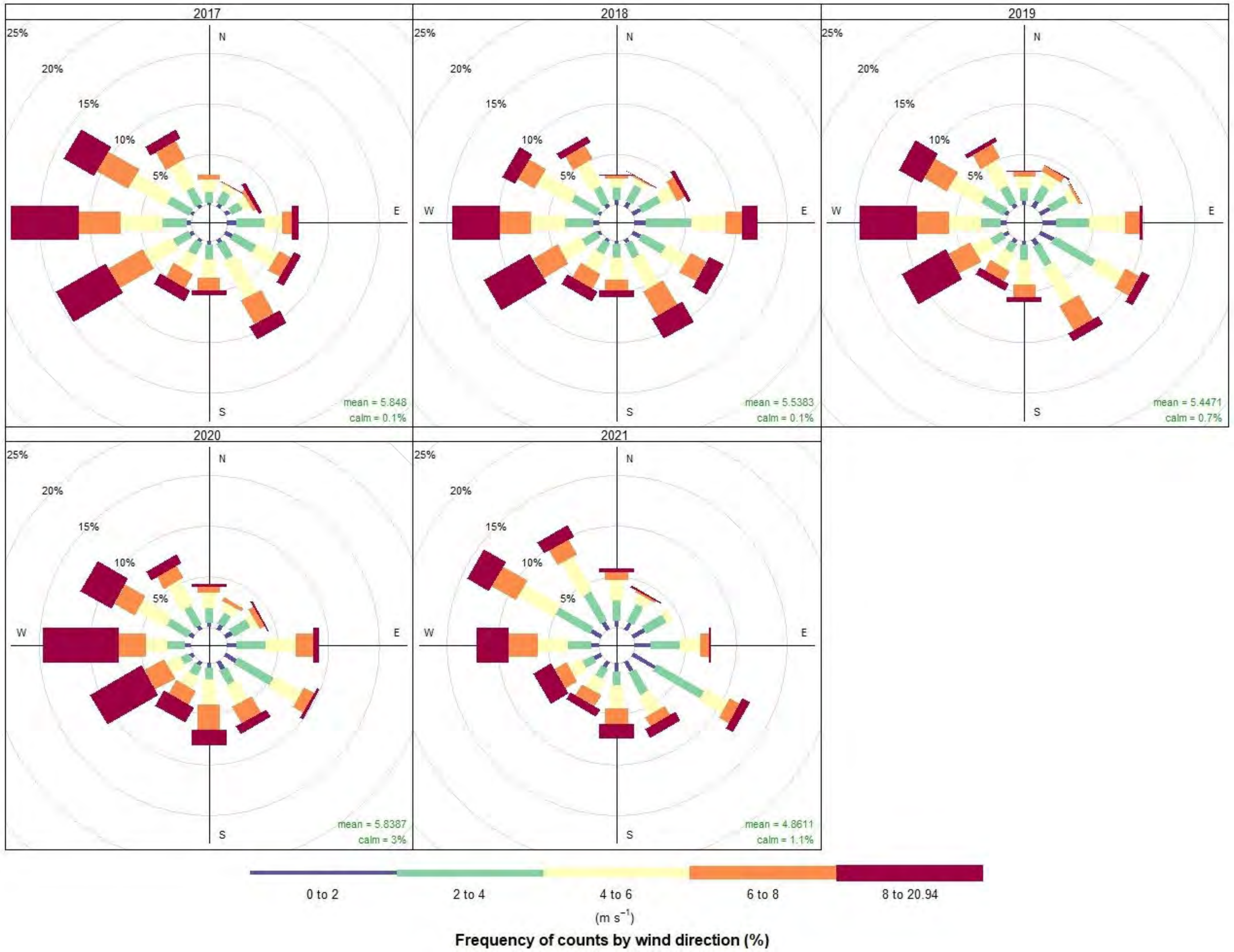
Drawn by: MJC | Date: 12/12/2022

0 0.4 0.8 1.6 km

Scale: 1:40,000

FICHTNER
Consulting Engineers Limited

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



Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

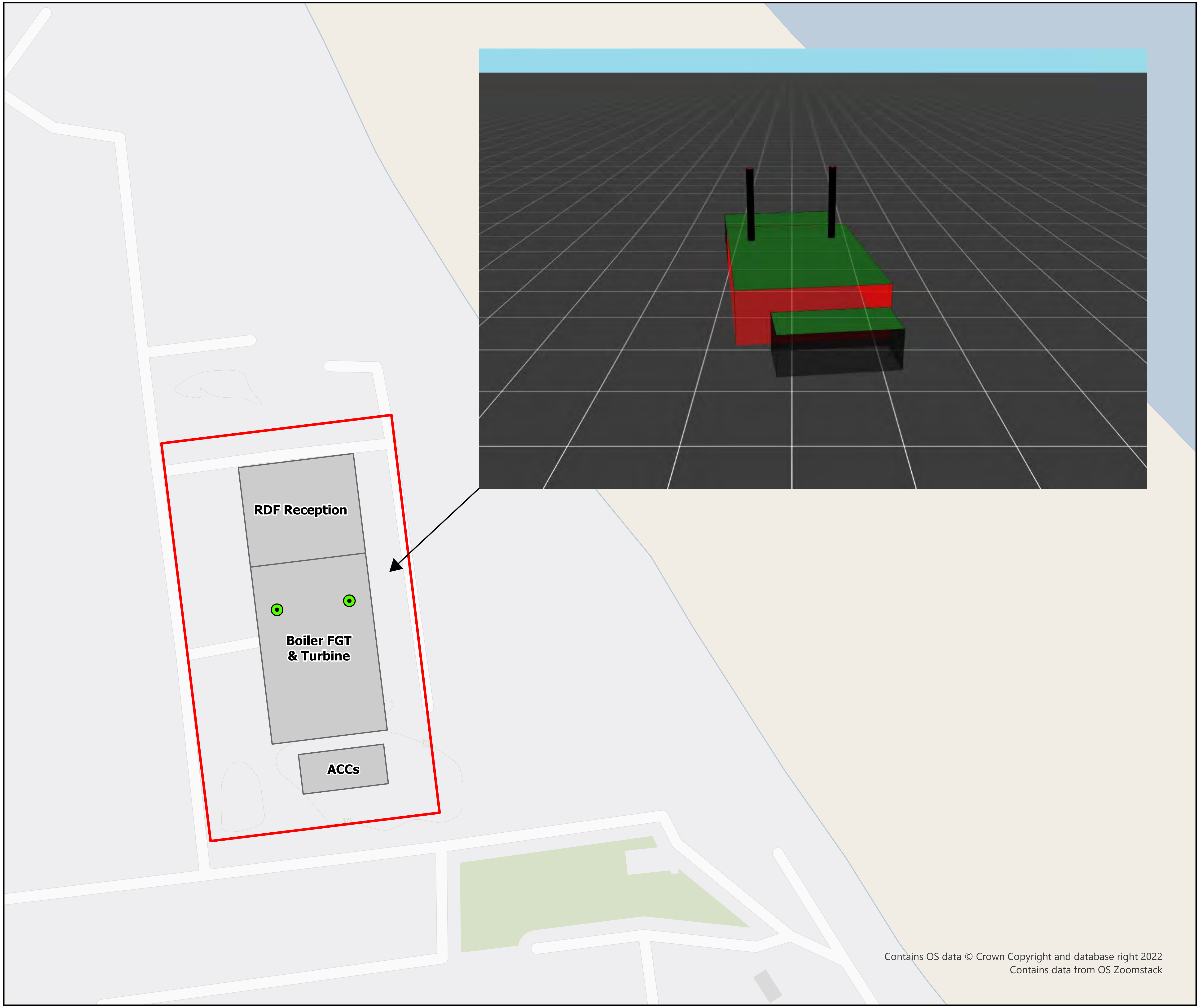
Figure 4: Meteorological Data (Windroses)

Drawn by: MJC	Date: 12/12/2022

FICHTNER

Consulting Engineers Limited

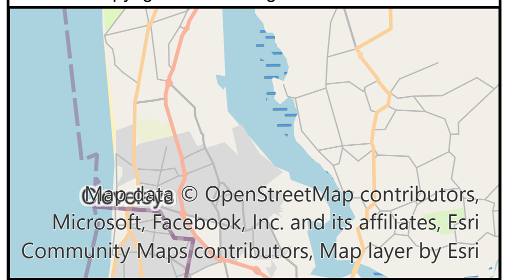
Kingsgate, Wellington Road North,
Stockport, Cheshire, SK4 1LW
Tel: 0161 476 0032
Fax: 0161 474 0618



Legend

- Stack Locations
- Buildings
- Site Boundary

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	Figure 5: Buildings Modelled
Drawn by: MJC	Date: 12/12/2022



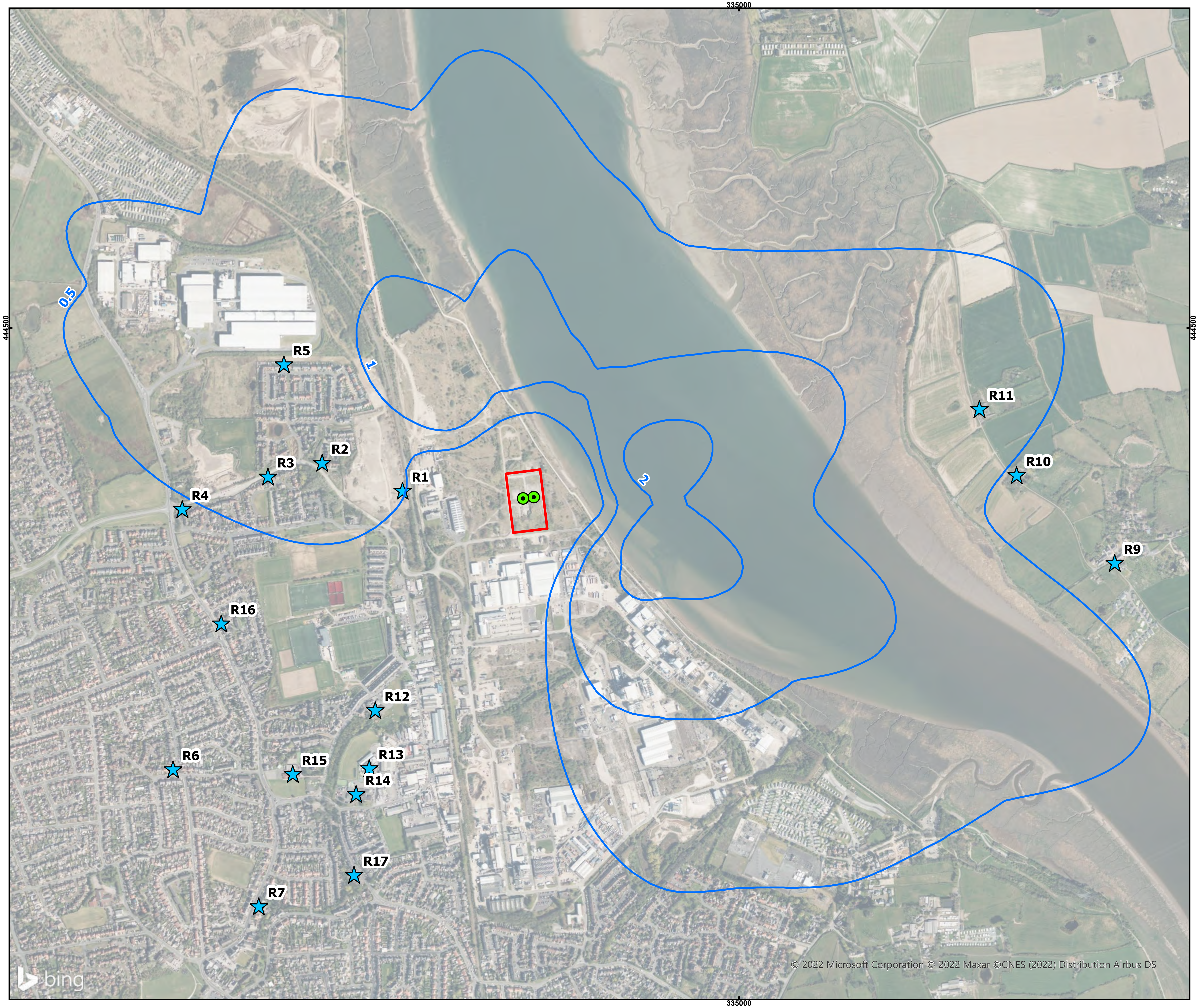
0 0.01 0.03 0.06 km

Scale: 1:1,500

N

FICHTNER
Consulting Engineers Limited

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

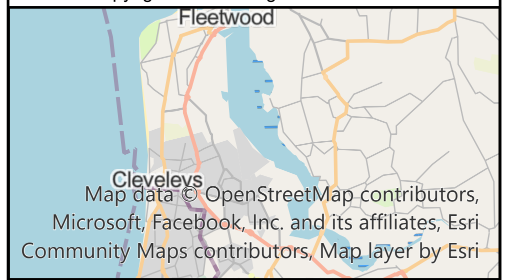


Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean Nitrogen Dioxide (% of AQAL)
- Human Sensitive Receptors

Notes: Assumed 70% conversion of oxides of nitrogen to nitrogen dioxide

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	Figure 6: Annual Mean Nitrogen Dioxide
Drawn by: MJC	Date: 12/12/2022



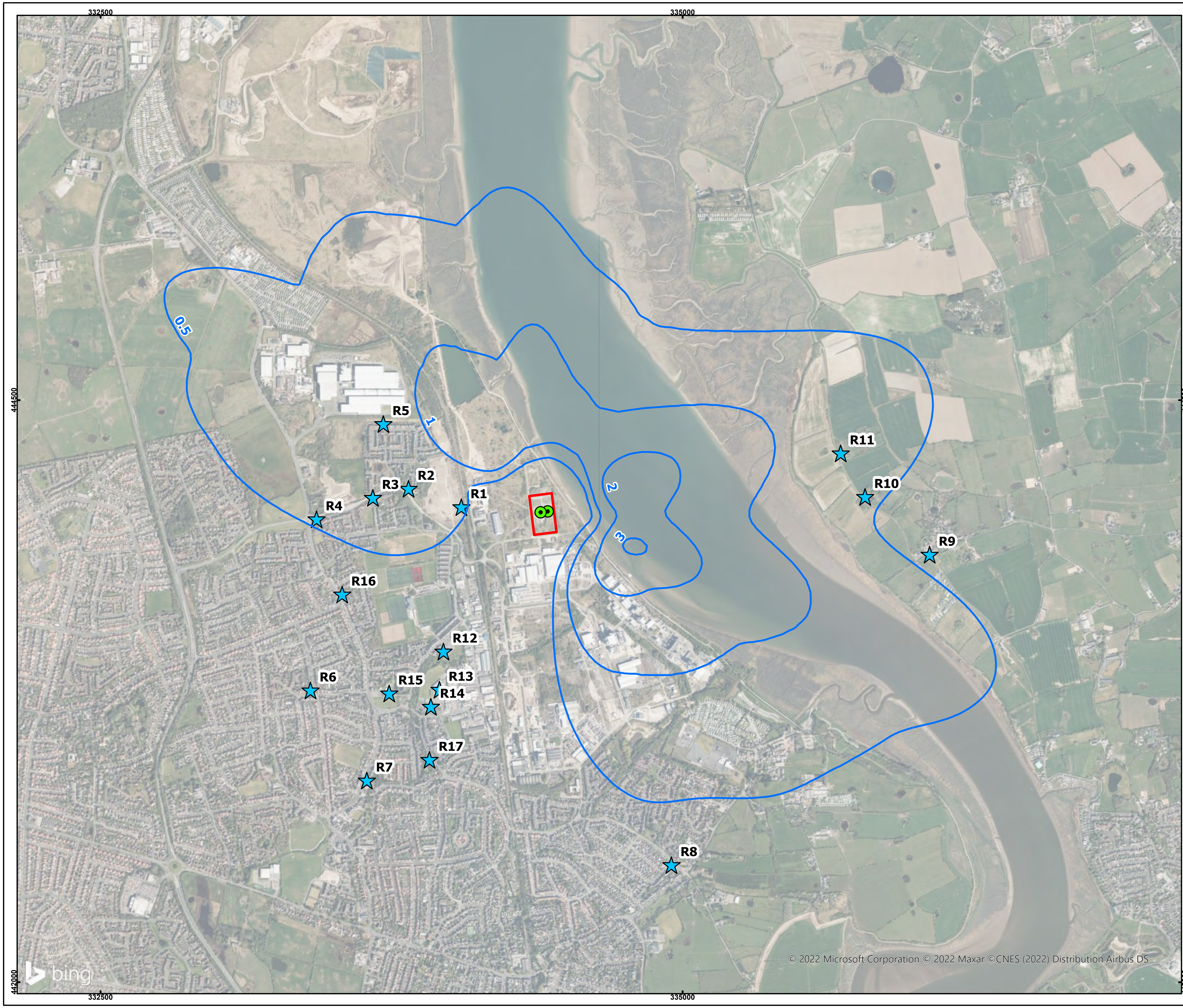
0 0.1 0.2 0.4 km

Scale: 1:10,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean VOCs as Benzene (% of AQAL)
- Human Sensitive Receptors

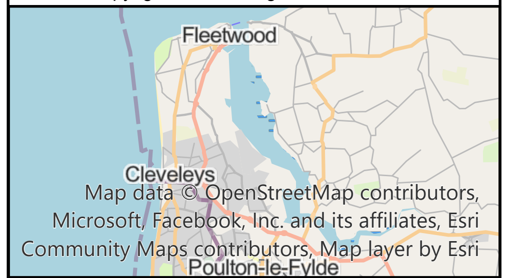
Notes:
- Assumed that all VOCs are emitted as benzene

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 7: Annual Mean VOCs as Benzene

Drawn by: MJC | Date: 12/12/2022



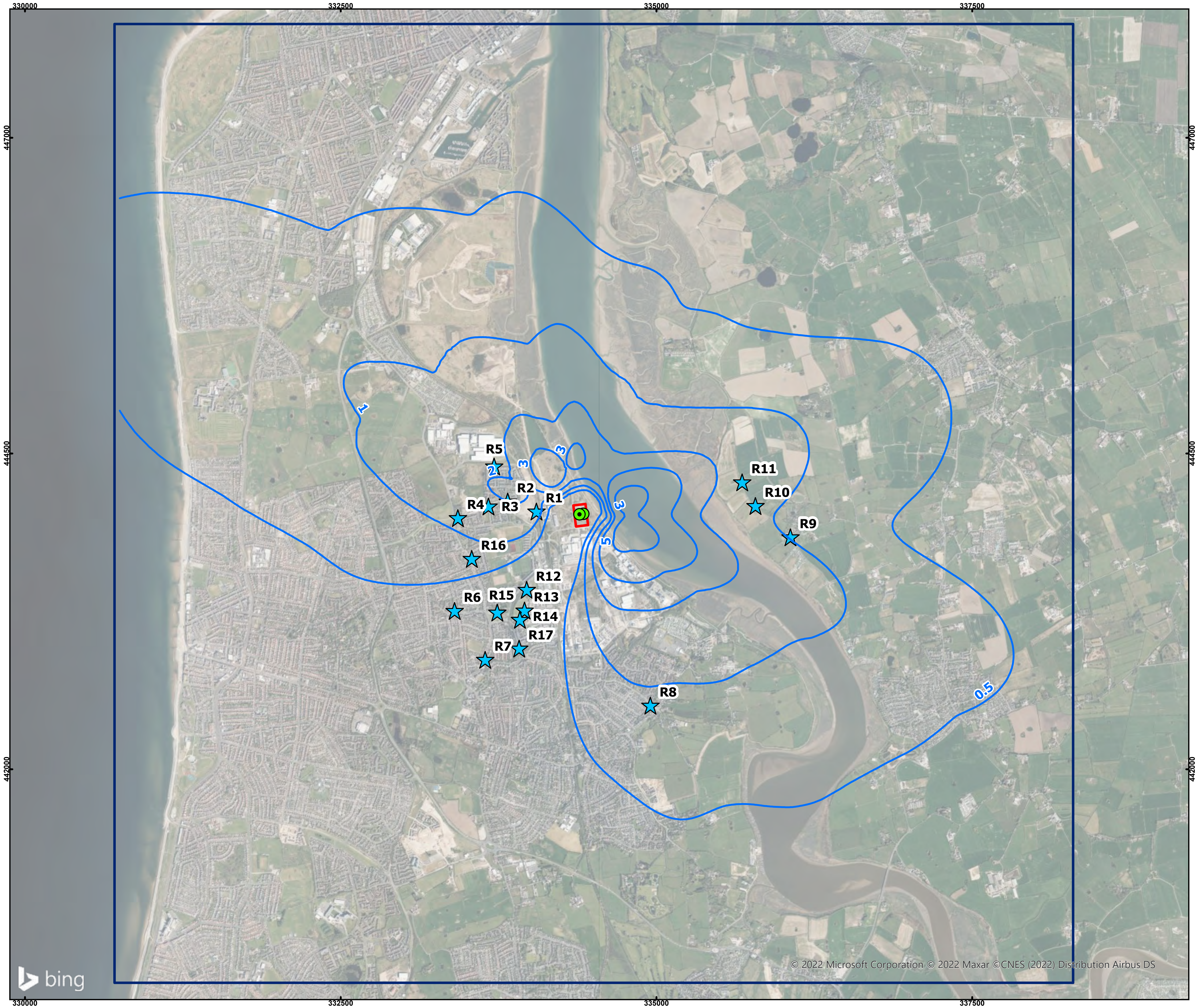
0 0.15 0.3 0.6 km

Scale: 1:15,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean VOCs as 1,3-Butadiene (% of AQAL)
- Human Sensitive Receptors

Notes:
- Assumed that all VOCs are emitted as 1,3-butadiene

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	Figure 8: Annual Mean VOCs as 1,3-Butadiene

Drawn by: MJC | Date: 12/12/2022

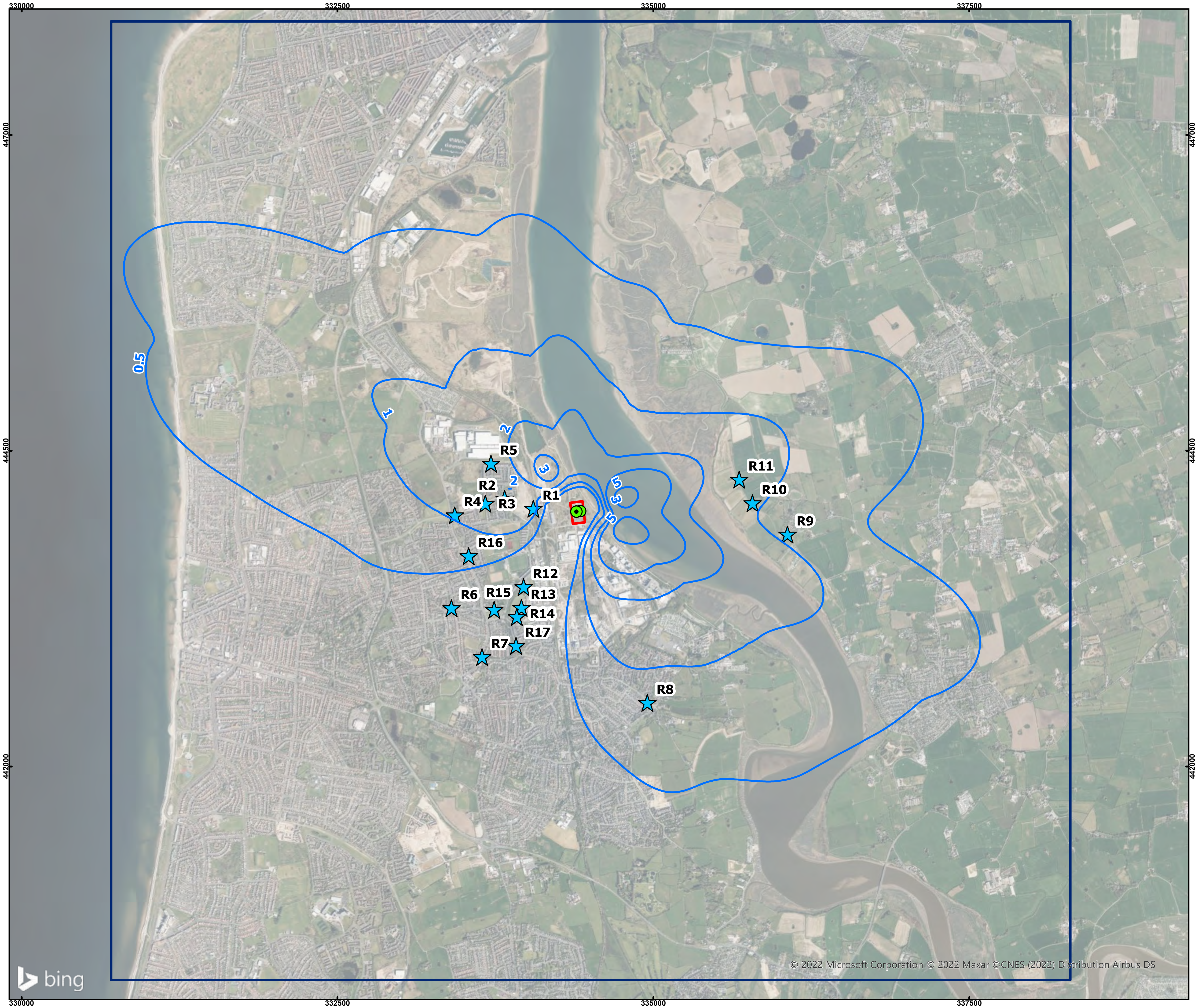
0 0.28 0.55 1.1 km

Scale: 1:28,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean Cadmium - Screening (% of AQAL)
- Human Sensitive Receptors

Notes:
- Assumed that cadmium is emitted at the combined cadmium and thallium ELV

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 9: Annual Mean Cadmium - Screening

Drawn by: MJC | Date: 12/12/2022

0 0.28 0.55 1.1 km

N

Scale: 1:28,000

FICHTNER
Consulting Engineers Limited

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

335000

444500

444500

335000

Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean PAHs (% of AQAL)
- Human Sensitive Receptors

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 10: Annual Mean PAHs

Drawn by: MJC | Date: 12/12/2022

0 0.1 0.2 0.4 km

N

Scale: 1:10,000

FICHTNER

Consulting Engineers Limited

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

Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Hourly Mean Nitrogen Dioxide (% of AQAL)
- Human Sensitive Receptors

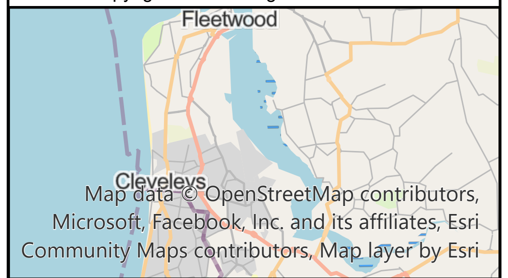
Notes:
- Assumed 35% conversion of oxides of nitrogen to nitrogen dioxide
- Assumed both lines operate concurrently at the short term ELVs

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 11: Hourly Mean Nitrogen Dioxide

Drawn by: MJC | Date: 12/12/2022

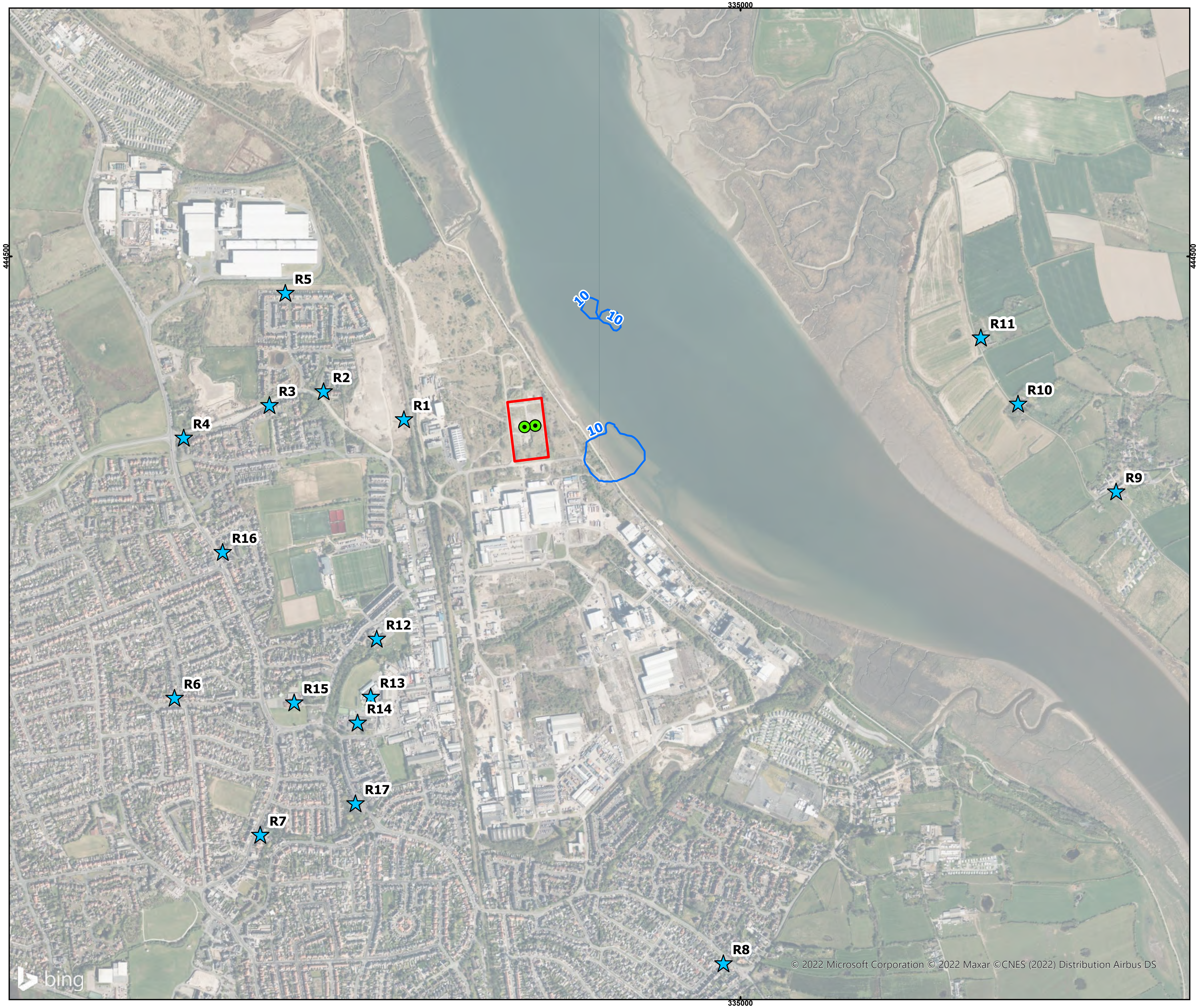


0 0.1 0.2 0.4 km

Scale: 1:10,000

N

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



Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Hourly Mean Sulphur Dioxide (% of AQAL)
- Human Sensitive Receptors

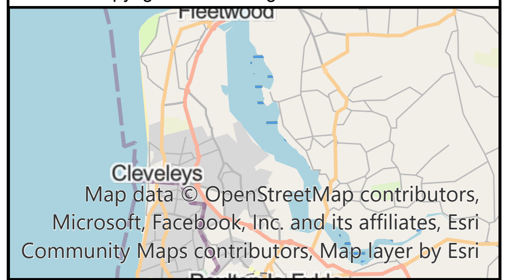
Notes:
- Assumed both lines operate concurrently at the short term ELVs

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 12: Hourly Mean Sulphur Dioxide

Drawn by: MJC	Date: 12/12/2022



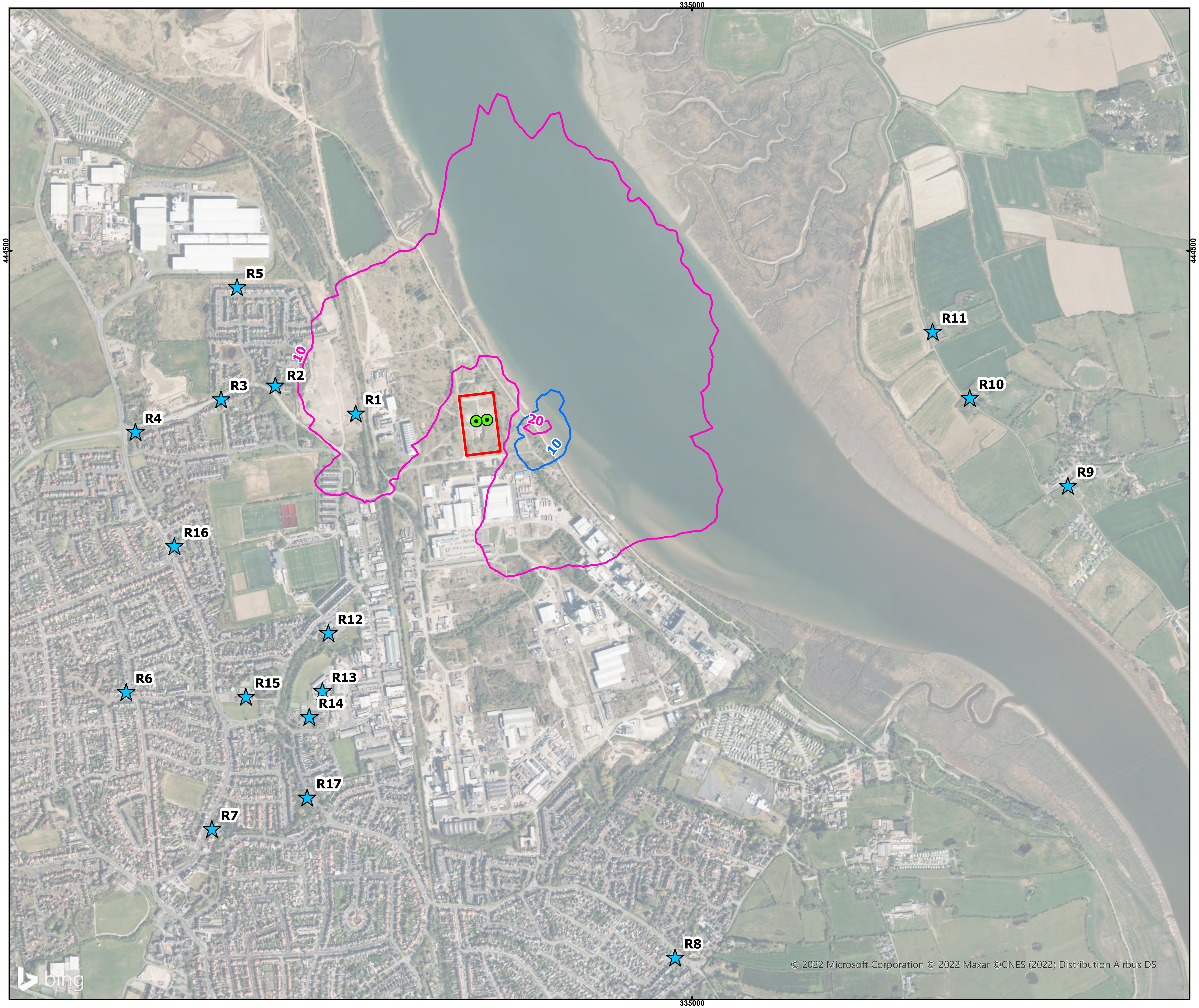
0 0.1 0.2 0.4 km

Scale: 1:10,000

N

FICHTNER
Consulting Engineers Limited

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



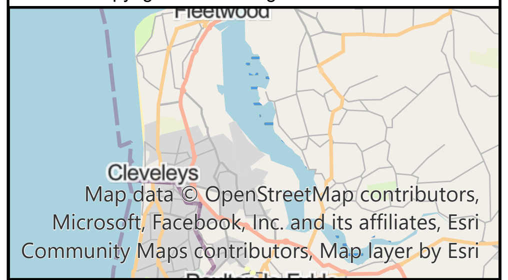
Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- 15-Minute Mean Sulphur Dioxide (% of AQAL) - one line at short term ELV, one line at daily ELV
- 15-Minute Mean Sulphur Dioxide (% of AQAL) - both lines at short term ELV
- Human Sensitive Receptors

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	

Figure 13: 15-Minute Mean Sulphur Dioxide

Drawn by: MJC | Date: 12/12/2022



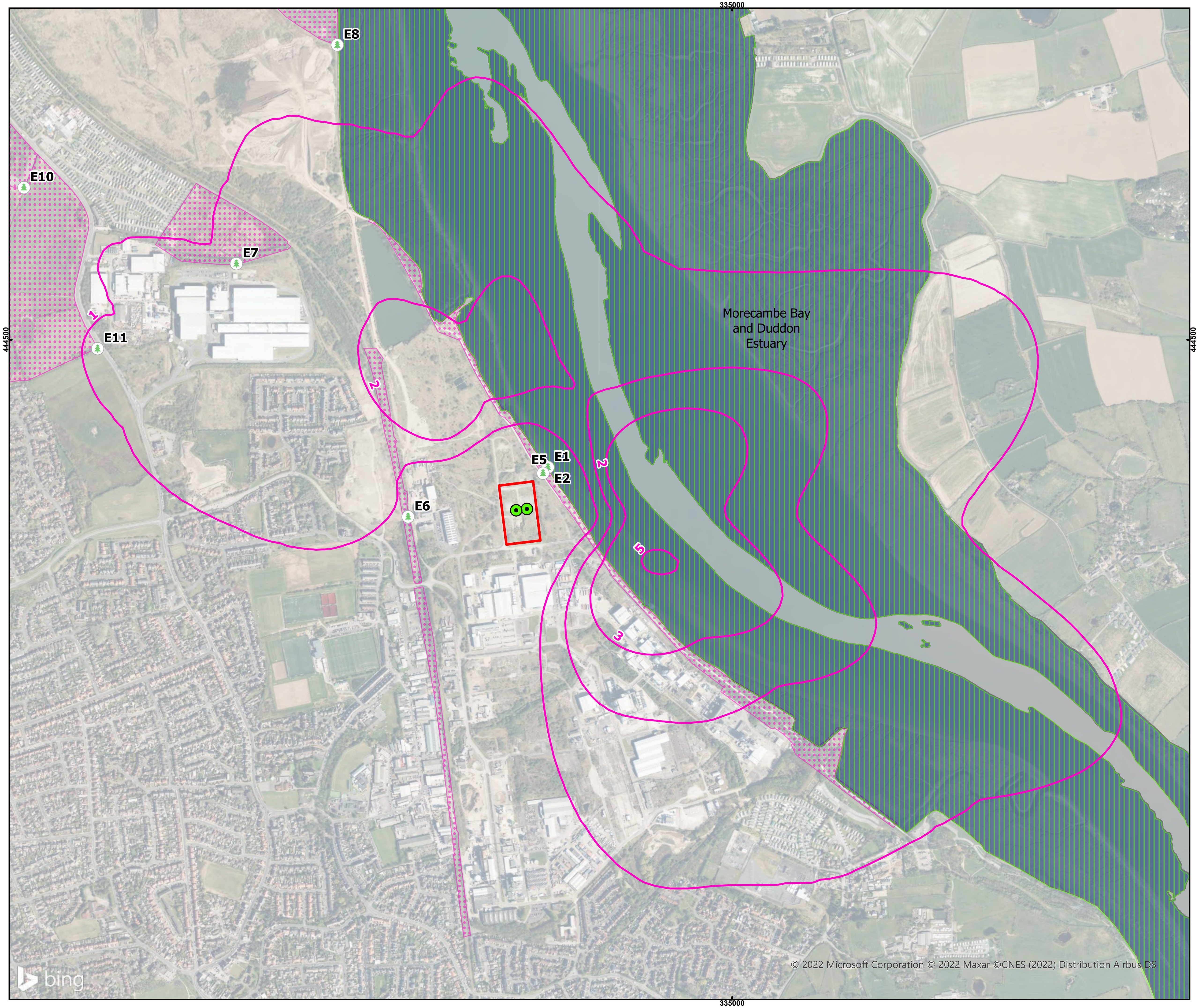
0 0.1 0.2 0.4 km

Scale: 1:10,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

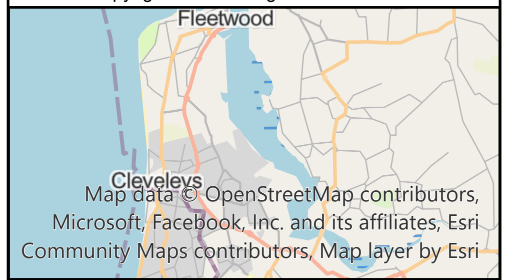
- Stack Locations
- Annual Mean Oxides of Nitrogen (% of Critical Level)
- Site Boundary
- Modelling Domain
- Discrete Ecological Receptor Points
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 14: Annual Mean Oxides of Nitrogen

Drawn by: MJC | Date: 12/12/2022



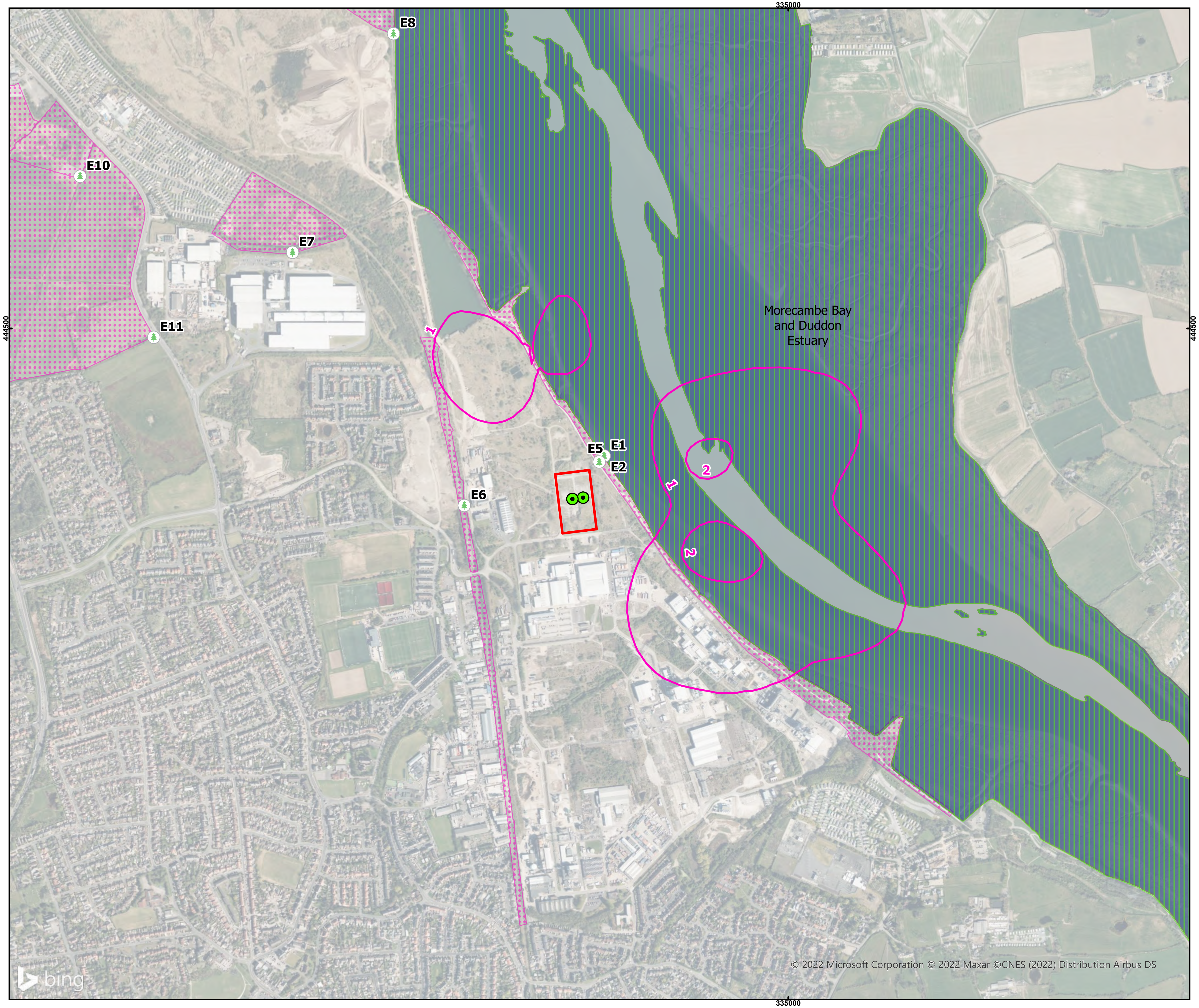
0 0.1 0.2 0.4 km

Scale: 1:10,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

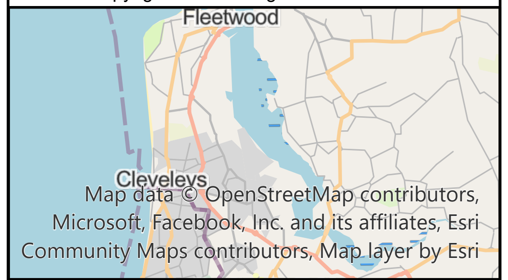
- Stack Locations
- Site Boundary
- Modelling Domain
- Annual Mean Sulphur Dioxide (% of Critical Level)
- Discrete Ecological Receptor Points
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 15: Annual Mean Sulphur Dioxide

Drawn by: MJC | Date: 12/12/2022



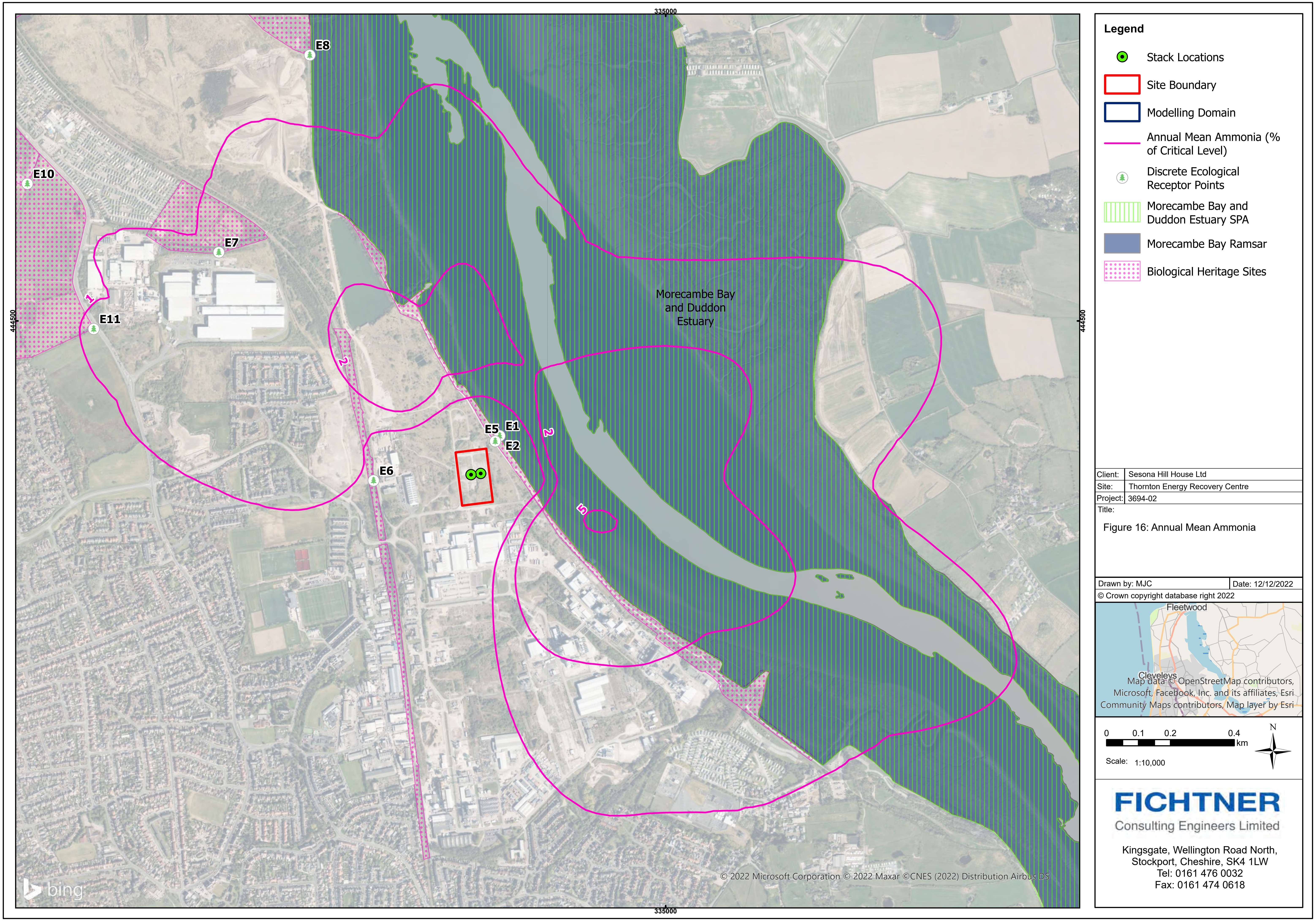
0 0.1 0.2 0.4 km

Scale: 1:10,000

N

FICHTNER
Consulting Engineers Limited

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



335000
444500
E8
E10
E7
E11
E5
E1
E2
E6
1
2
5
Morecambe Bay and Duddon Estuary
© 2022 Microsoft Corporation © 2022 Maxar ©CNES (2022) Distribution Airbus DS
bing
Legend
Stack Locations
Site Boundary
Modelling Domain
Annual Mean Ammonia (% of Critical Level)
Discrete Ecological Receptor Points
Morecambe Bay and Duddon Estuary SPA
Morecambe Bay Ramsar
Biological Heritage Sites
Client: Sesona Hill House Ltd
Site: Thornton Energy Recovery Centre
Project: 3694-02
Title:
Figure 16: Annual Mean Ammonia
Drawn by: MJC
Date: 12/12/2022
© Crown copyright database right 2022
Fleetwood
Cleveleys
Map data © OpenStreetMap contributors, Microsoft, Facebook, Inc. and its affiliates, Esri Community Maps contributors, Map layer by Esri
0 0.1 0.2 0.4 km
N
Scale: 1:10,000
FICHTNER
Consulting Engineers Limited
Kingsgate, Wellington Road North, Stockport, Cheshire, SK4 1LW
Tel: 0161 476 0032
Fax: 0161 474 0618

Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Daily Mean Oxides of Nitrogen (% of CL75)
- Discrete Ecological Receptor Points
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Notes:
- Only PC as % of 75 µg/m³ Critical Level is presented as PC as % of 200 µg/m³ Critical Level screens out as insignificant (<10%)

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 17: Daily Mean Oxides of Nitrogen

Drawn by: MJC	Date: 12/12/2022

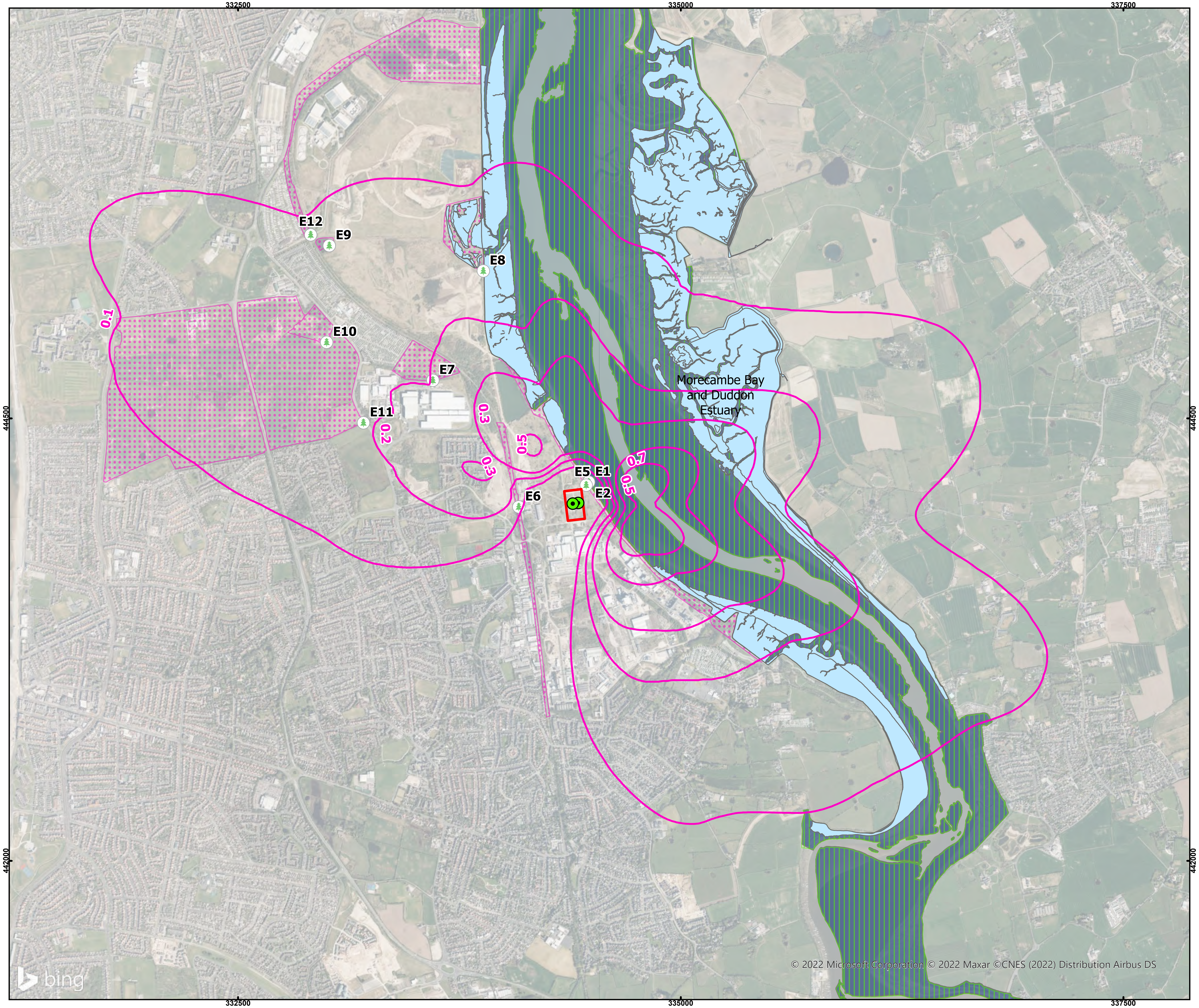
0 0.1 0.2 0.4 km

N

Scale: 1:10,000

FICHTNER
Consulting Engineers Limited

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



Legend

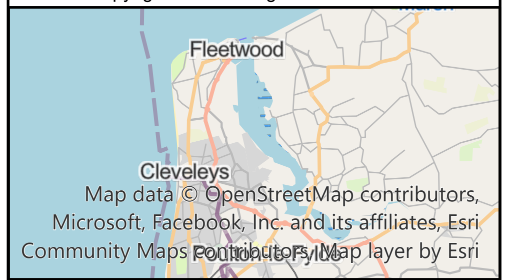
- Stack Locations
- Site Boundary
- Modelling Domain
- Nitrogen Deposition (kgN/ha/yr)
- Discrete Ecological Receptor Points
- Coastal Saltmarsh
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02

Title:

Figure 18: Nitrogen Deposition

Drawn by: MJC | Date: 12/12/2022



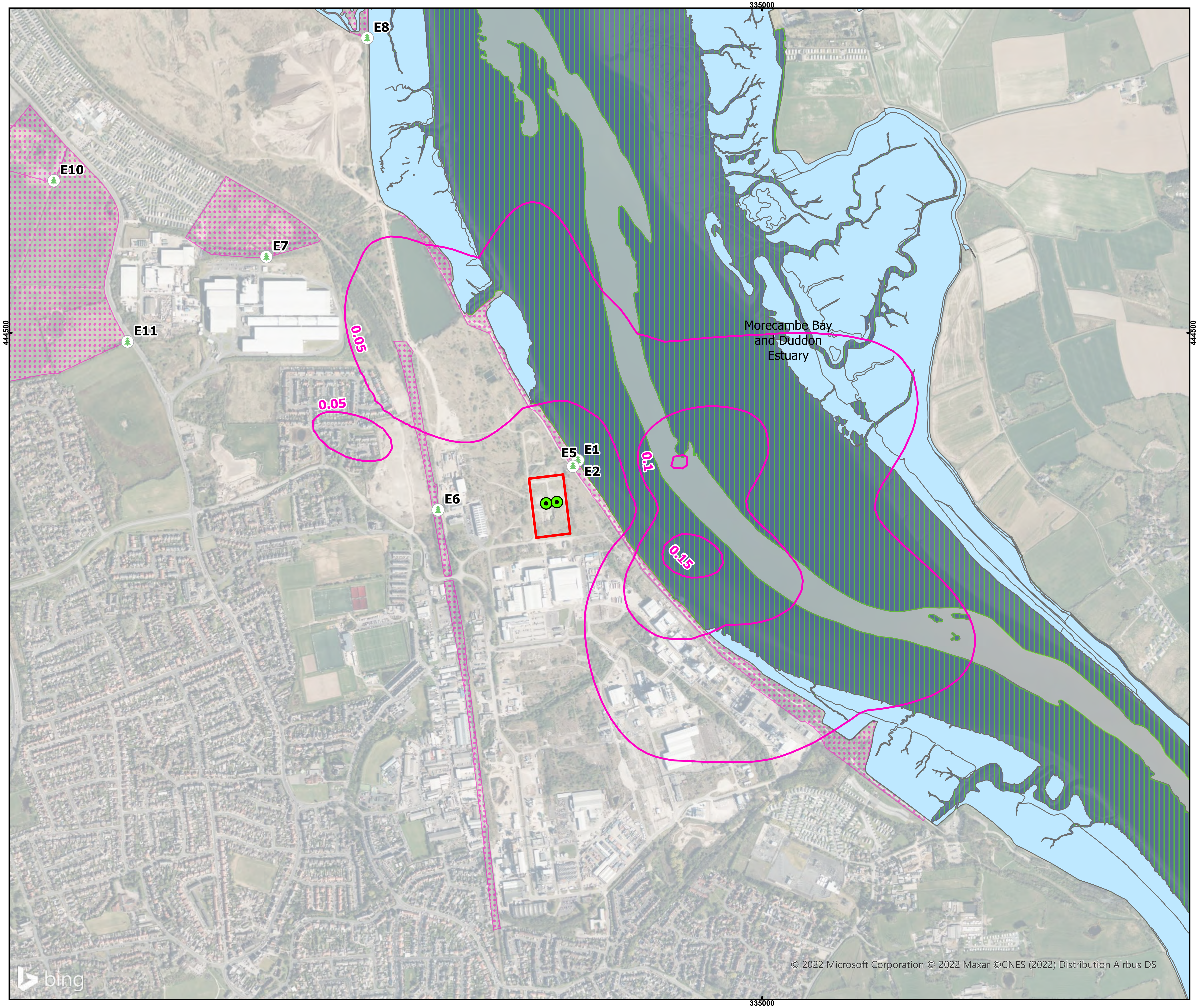
0 0.2 0.4 0.8 km

N

Scale: 1:20,000

FICHTNER
Consulting Engineers Limited

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



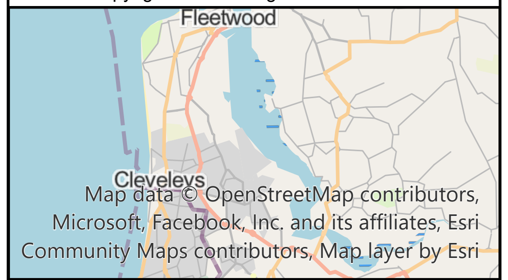
Legend

- Stack Locations
- Site Boundary
- Modelling Domain
- Acid Deposition (keq/ha/yr)
- Discrete Ecological Receptor Points
- Coastal Saltmarsh
- Morecambe Bay and Duddon Estuary SPA
- Morecambe Bay Ramsar
- Biological Heritage Sites

Client:	Sesona Hill House Ltd
Site:	Thornton Energy Recovery Centre
Project:	3694-02
Title:	

Figure 19: Acid Deposition

Drawn by: MJC	Date: 12/12/2022



0 0.1 0.2 0.4 km

N

Scale: 1:10,000

FICHTNER
Consulting Engineers Limited

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

B APIS Critical Loads

Table 42: Nitrogen Deposition Critical Loads

Site	Species/Habitat Type	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Maximum Background (kgN/ha/yr)
European and UK Statutory Designated Sites					
Wyre Estuary SSSI	Saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	20	30	19.6
Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	Saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	20	30	19.6
Morecambe Bay SAC	Coastal stable dune grasslands; shifting coastal dunes	Coastal stable dune grasslands - acid type	8	10	19.3
Liverpool Bay SPA	No habitats sensitive to nitrogen deposition	-	-	-	-
Local nature sites					
ICI Hillhouse Estuary Banks BHS	Saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	20	30	19.6
Fleetwood Railway Branch Line Trunnah to Burn Naze BHS	Neutral and acid grassland	Non-Mediterranean dry acid and neutral closed grassland	10	15	19.6
Burglars Alley Field BHS	Saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	20	30	19.3
Jameson Road Saltmarsh BHS	Saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	20	30	19.7
ICI Hillhouse International Pool BHS	Geolittoral wetlands and meadows: saline and brackish reed rush and sedge stands	Pioneer, low-mid, mid-upper saltmarshes	20	30	19.7

Site	Species/Habitat Type	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Maximum Background (kgN/ha/yr)
Rossall Lane Wood and Pasture BHS	Grassland	Moist and wet oligotrophic grassland	15	25	19.3
Fleetwood Farm Fields BHS	Improved grassland	Not sensitive	-	-	-
Fleetwood Marsh Industrial lands	Grassland	Low and medium altitude hay meadows	20	30	18.7

Table 43: Acid Deposition Critical Loads

Site	Species/Habitat Type	Acidity Class	Critical Load Function (keq/ha/yr)			Maximum Background (keq/ha/yr)	
			CLminN	CLmaxN	CLmaxS	N	S
European and UK Statutory Designated Sites							
Wyre Estuary SSSI	No sensitive habitats	-	-	-	-	-	-
Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	Neutral Grassland	Calcareous Grassland	1.071	5.071	4	1.26	0.16
Morecambe Bay SAC	Coastal stable dune grasslands; shifting coastal dunes	Acid grassland	0.223	4.283	4.06	1.39	0.17
Liverpool Bay SPA	No sensitive habitats	-	-	-	-	-	-
Local nature sites							
ICI Hillhouse Estuary Banks BHS	Neutral Grassland	Calcareous Grassland	1.071	5.071	4	1.26	0.16
Fleetwood Railway Branch Line Trunnah to Burn Naze BHS	Acid grassland	Acid grassland	0.438	4.498	4.06	1.26	0.16
Burglars Alley Field BHS	Neutral Grassland	Calcareous Grassland	1.071	5.071	4	1.26	0.16
Jameson Road Saltmarsh BHS	Saltmarsh	Not sensitive	-	-	-	-	-
ICI Hillhouse International Pool BHS	Neutral Grassland	Calcareous Grassland	1.071	5.071	4	1.26	0.16
Rossall Lane Wood and Pasture BHS	Acid grassland	Acid grassland	0.438	4.498	4.06	1.26	0.16
Fleetwood Farm Fields BHS	Improved grassland	Not sensitive	-	-	-	-	-
Fleetwood Marsh Industrial lands	Neutral Grassland	Calcareous Grassland	1.071	5.071	4	1.41	0.17

C Deposition Analysis at Ecological Sites

Table 44: Annual Mean PC used for Deposition Analysis

Site	Annual Mean PC (µg/m³)			
	Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia
European and UK Statutory Designated Sites				
Wyre Estuary SSSI	0.647	0.277	0.055	0.092
Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.647	0.277	0.055	0.092
Morecambe Bay SAC	0.056	0.024	0.005	0.008
Liverpool Bay SPA	0.028	0.012	0.002	0.004
Local nature sites				
ICI Hillhouse Estuary Banks BHS	0.851	0.365	0.073	0.122
Fleetwood Railway Branch Line Trunnah to Burn Naze BHS	0.471	0.202	0.040	0.067
Burglars Alley Field BHS	0.272	0.117	0.023	0.039
Jameson Road Saltmarsh BHS	0.166	0.071	0.014	0.024
ICI Hillhouse International Pool BHS	0.126	0.054	0.011	0.018
Rossall Lane Wood and Pasture BHS	0.188	0.081	0.016	0.027
Fleetwood Farm Fields BHS	0.216	0.093	0.019	0.031
Fleetwood Marsh Industrial lands	0.121	0.052	0.010	0.017

Table 45: Deposition Calculation

Site	Deposition Velocity	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
		NO_2	SO_2	HCl	NH_3		N	S
European and UK Statutory Designated Sites								
Wyre Estuary SSSI	Grassland	0.093	0.525	0.851	0.480	0.573	0.041	0.057
Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	Grassland	0.093	0.525	0.851	0.480	0.573	0.041	0.057
Morecambe Bay SAC	Grassland	0.008	0.046	0.074	0.042	0.050	0.004	0.005
Liverpool Bay SPA	Grassland	0.004	0.023	0.037	0.021	0.025	0.002	0.002
Local nature sites								
ICI Hillhouse Estuary Banks BHS	Grassland	0.123	0.691	1.119	0.631	0.754	0.054	0.075
Fleetwood Railway Branch Line Trunnah to Burn Naze BHS	Grassland	0.068	0.382	0.619	0.349	0.417	0.030	0.041
Burglars Alley Field BHS	Grassland	0.039	0.220	0.357	0.201	0.241	0.017	0.024
Jameson Road Saltmarsh BHS	Grassland	0.024	0.135	0.218	0.123	0.147	0.010	0.015
ICI Hillhouse International Pool BHS	Grassland	0.018	0.102	0.166	0.093	0.112	0.008	0.011
Rossall Lane Wood and Pasture BHS	Grassland	0.027	0.153	0.248	0.140	0.167	0.012	0.017
Fleetwood Farm Fields BHS	Grassland	0.031	0.175	0.284	0.160	0.192	0.014	0.019
Fleetwood Marsh Industrial lands	Grassland	0.017	0.098	0.159	0.090	0.107	0.008	0.011

Table 46: Detailed Results – Nitrogen Deposition

Site	NCL Class	Deposition Velocity	PC			PEC		
			PC N dep kgN/ha/yr	% of Lower CL	% of Upper CL	PEC N dep kgN/ha/yr	% of Lower CL	% of Upper CL
European and UK Statutory Designated Sites								
Wyre Estuary SSSI	Pioneer, low-mid, mid-upper saltmarshes	Grassland	0.57	**2.87%**	**1.91%**	20.2	**100.9%**	67.2%
Morecambe Bay and Duddon Estuary SPA/ Morecambe Bay Ramsar	Pioneer, low-mid, mid-upper saltmarshes	Grassland	0.57	**2.87%**	**1.91%**	20.2	**100.9%**	67.2%
Morecambe Bay SAC	Coastal stable dune grasslands - acid type	Grassland	0.05	0.62%	0.50%	19.3	241.9%	193.5%
Liverpool Bay SPA	Not sensitive	N/A	0.02	-	-	-	-	-
Local nature sites								
ICI Hillhouse Estuary Banks BHS	Pioneer, low-mid, mid-upper saltmarshes	Grassland	0.76	3.78%	-	20.4	101.8%	-
Fleetwood Railway Branch Line Trunnah to Burn Naze BHS	Closed Non-Mediterranean dry acid and neutral grassland)	Grassland	0.42	4.17%	-	20.0	200.2%	-
Burglars Alley Field BHS	Pioneer, low-mid, mid-upper saltmarshes	Grassland	0.24	1.20%	-	19.5	97.7%	-
Jameson Road Saltmarsh BHS	Pioneer, low-mid, mid-upper saltmarshes	Grassland	0.15	0.73%	-	19.8	99.2%	-
ICI Hillhouse International Pool BHS	Pioneer, low-mid, mid-upper saltmarshes	Grassland	0.11	0.56%	-	19.8	99.1%	-

Site	NCL Class	Deposition Velocity	PC			PEC		
			PC N dep kgN/ha/yr	% of Lower CL	% of Upper CL	PEC N dep kgN/ha/yr	% of Lower CL	% of Upper CL
Rossall Lane Wood and Pasture BHS	Moist and wet oligotrophic grassland	Grassland	0.17	1.11%	-	19.5	129.8%	-
Fleetwood Farm Fields BHS	Not sensitive	N/A	0.19	-	-	-	-	-
Fleetwood Marsh Industrial lands	Low and medium altitude hay meadows	Grassland	0.11	0.54%	-	18.8	94.0%	-

Table 47: Detailed Results – Acid Deposition – Facility

Site	Acidity Class	Deposition Velocity	PC			PEC		
			N keq/ ha/yr	S keq/ ha/yr	% of CL Function	N keq/ ha/yr	S keq/ ha/yr	% of CL Function
European and UK Statutory Designated Sites								
Wyre Estuary SSSI	No sensitive habitats	N/A	-	-	-	-	-	-
Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	Calcareous Grassland	Grassland	0.069	0.095	**3.24%**	1.32	0.25	30.9%
Morecambe Bay SAC	Acid grassland	Grassland	0.004	0.005	0.20%	1.39	0.17	36.6%
Liverpool Bay SPA	No sensitive habitats	N/A	-	-	-	-	-	-
Locally Designated Sites								
ICI Hillhouse Estuary Banks Biological Heritage Site (BHS)	Calcareous Grassland	Grassland	0.054	0.075	2.54%	1.31	0.23	30.5%
Fleetwood Railway Branch Line Trunnah to Burn Naze BHS	Acid grassland	Grassland	0.030	0.041	1.58%	1.29	0.20	33.2%
Burglars Alley Field BHS	Calcareous Grassland	Grassland	0.017	0.024	0.81%	1.28	0.18	28.8%
Jameson Road Saltmarsh BHS	Not sensitive	N/A	-	-	-	-	-	-
ICI Hillhouse International Pool BHS	Calcareous Grassland	Grassland	0.008	0.011	0.38%	1.27	0.17	28.4%
Rossall Lane Wood and Pasture BHS	Acid grassland	Grassland	0.012	0.017	0.63%	1.27	0.18	32.2%
Fleetwood Farm Fields BHS	Not sensitive	N/A	-	-	-	-	-	-
Fleetwood Marsh Industrial lands	Calcareous Grassland	Grassland	0.01	0.01	0.36%	1.42	0.18	31.5%

D Ecological Interpretation of AQA

Thornton Energy Recovery Centre

Ecological Interpretation of Air Quality Assessment

Prepared for Axis PED

Kevin Barry Honour MSc MCIEEM

Version 1.0 / Ref. K22-002

03/11/2022

Unit 14 The Greenhouse Greencroft Industrial Park
Annfield Plain County Durham DH9 7XN

Thornton Energy Recovery Centre

Ecological Interpretation of Air Quality Assessment

Report Reference	Ref. K22-002
Date	03/11/2022
Date of survey/s	n/a

Issue	Prepared by	Status	Date
V1	Kevin Barry Honour MSc MCIEEM	DRAFT	03/11/2022
V2		FINAL	13/12/2022

The author of this report subscribes to the Chartered Institute of Ecology and Environmental Managements (CIEEM) code of professional conduct in their work.

This report has been prepared in accordance with CIEEM's Guidelines for Ecological Report Writing.

Unit 14 The Greenhouse Greencroft Industrial Park
Annfield Plain County Durham DH9 7XN

Contents

1 Introduction

This document provides an ecological interpretation of the Air Quality Assessment (AQA) undertaken by Fichtner Consulting Engineers for Thornton Energy Recovery Centre (TERC; the 'Proposed Development'), located at Hillhouse Business Park, Thornton-Cleveleys, Lancashire.

The aim of the assessment is to provide further ecological interpretation of the results of the AQA, focussing on any effects on sensitive ecological receptors which cannot be screened out as insignificant, in accordance with Environment Agency (EA) and Institute of Air Quality Management (IAQM) criteria.

This analysis is based on dispersion and deposition modelling undertaken by Fichtner Consulting Engineers, and reported in the Emissions Modelling Assessment (Appendix 8.3 to the ES). It focusses on potential ecological effects at sensitive receptors where exceedances of the identified screening thresholds are predicted. In these cases, further ecological assessment has been undertaken to:

- Confirm sensitivity of qualifying and notified features;
- Assess potential effects by comparing dispersion and deposition model plots with the spatial distribution of sensitive habitats; and
- Provide an informed ecological opinion on the likelihood of significant effects or significant harm.

2 Scope and Methodology

2.1 Scope of Assessment

Geographic Scope of Assessment

The geographic scope of assessment is based on EA guidance. The following screening distances were applied:

- 10km from emission source for Habitat (European / Natura 2000) sites, including Special Areas of Conservation (SAC) and Special Protection Areas (SPA), and Ramsar sites;
- 2km from emission source for National Nature Reserves (NNR) and Sites of Special Scientific Interest (SSSIs); and
- 2km from emission source for Local Nature Reserves (LNR), Local Wildlife Sites (LWS) and ancient woodlands.

Screening Thresholds

Screening thresholds used in Appendix 8.3 for statutory designated sites are based on EA guidance, and can be summarised as follows:

- For Ramsar, Natura 2000 sites and SSSIs, predicted process contributions (PCs) below 1% of the relevant long-term (annual) Critical Level and Critical Load or 10% of the relevant short-term (24-hour) Critical Level are screened out.
- For Ramsar, European sites and SSSIs, PCs above 1%, where the predicted environmental concentration (PEC; PC plus background) is <70% of the Critical Level and Critical Load are screened out.

For Natura 2000 sites the 1% PC has been regarded as a *de minimis* threshold, below which effects can be considered inconsequential. The English and Welsh agencies which make up the Air Quality Technical Advisory Group (AQTAG) clarified that projects below the 1% PC do not have to be considered in an in-combination assessment[1], although this has been subject to further revision (with respect in particular to cumulative vehicle emissions) through UK and European case law.

[1] Environment Agency (2015). *AQTAG position. In-combination guidance and assessment*. Response to PINS, March 2015.

For permitting purposes, the EA advise that a 100% PC can be used for locally designated sites and ancient woodlands; however, for planning application purposes a 1% threshold has been applied, in accordance with the advice set out below.

IAQM Guidance on Scope

The Institute of Air Quality Management (IAQM) published guidance on the assessment of air quality impacts on designated sites in June 2019 and revised in May 2020[2]. This confirmed the use of the 1% long-term / 10% short-term thresholds for industrial point source emissions, with some important clarifications:

- '*The 1% screening criterion is not a threshold of harm and exceeding this threshold does not, of itself, imply damage to a habitat*' (IAQM 2020, para. 5.5.1.8);
- The 70% PEC threshold '*was intended to be a trigger for detailed dispersion modelling. It is not intended to be a damage threshold.*' (5.5.3.2);
- The 100% threshold for locally designated sites and ancient woodlands used in permit applications purposes may be inappropriate in a planning context, failing to provide adequate protection (5.5.2.2).

IAQM guidance does not suggest a threshold for consideration of effects on locally designated sites, and there is no established practice for treatment of locally designated sites in the ecological interpretation of air quality assessments. In order to take the guidance into account, predicted impacts in excess of the 1% long-term threshold have been identified and highlighted in this report, and the sensitivity of component habitats to air quality effects considered in greater detail. However, the interpretation of impact significance reflects the lower degree of policy protection of locally designated sites.

Receptors and Impacts Considered in Assessment

<u>European / Internationally Designated Sites</u>

Morecambe Bay and Duddon Estuary Special Protection Area (SPA) and **Morecambe Bay Ramsar Site** have contiguous boundaries and are located ca.32m north west of the Proposed Development site from the nearest boundary. The SPA and Ramsar site

[2] Holman et al (2020). *A guide to the assessment of air quality impacts on designated nature conservation sites* – version 1.1, Institute of Air Quality Management, London.

extend north to include the extensive intertidal and other coastal habitats within Morecambe Bay.

Morecambe Bay Special Area of Conservation (SAC)

Morecambe Bay is a marine SAC, including subtidal, intertidal and coastal habitats. It is located 4.3km from the Site boundary at its nearest point, on the coast at Fleetwood.

Shell Flat and Lune Deep SPA

Shell Flat and Lune Deep is a marine Special Protection Area, comprising two discrete areas offshore from the Fylde coast. The nearest is located a minimum distance of 7.90km from the Site boundary.

Liverpool Bay SPA

Liverpool Bay SPA is a marine SPA, taking in subtidal coastal and offshore areas to the south of Morecambe Bay. It is located 4.05km from the Site boundary at its nearest point, on the coast at Cleveleys.

UK Designated Sites

Wyre Estuary SSSI is located ca.32m east of the Site boundary at its nearest point. It is contiguous in this section with the boundaries of the SPA and Ramsar Site in this area, taking in intertidal habitats within Morecambe Bay.

Wyre - Lune Marine Conservation Zone (MCZ) takes in intertidal and fluvial habitats within the Wyre Estuary, extending north to encompass intertidal and marine habitats within Morecambe Bay, as well as the Lune estuary.

Note that the **Lune Estuary SSSI** is not considered in terms of its SSSI notified features as it is located more than 2km from the Proposed Development, but forms part of the SAC, SPA and Ramsar site.

Locally Designated Sites

The following locally designated Biological Heritage Sites (BHS) have been considered in the assessment:

- ICI Hillhouse Estuary Banks;
- Fleetwood Railway Branch Line, Trunnah to Burn Naze;
- Burglars Alley Field;
- Jameson Road Saltmarsh;

- Rossall Lane Wood and Pasture;
- Fleetwood Farm Fields;
- ICI Hillhouse International Pool; and
- Fleetwood Marsh Industrial Lands.

There are no ancient woodland sites within 2km or more of the Proposed Development.

2.2 Assessment Methodology

Data Search

Information including the Citations, notified natural features and condition of SSSIs were sourced from the Natural England website. Digital boundary data for the designated sites obtained from Natural England and from Lancashire Environmental Records Network (LERN) were overlain on an OS Vector Map backdrop layer using QGIS 3.2 (see Figures 1-2 and Figure 4 below).

The Air Pollution Information System (APIS) website's GIS Tool for site-relevant Critical Loads was used to provide an initial assessment of the sensitivity of statutory designated sites to pollutant impacts. This provides habitat-specific critical loads for nitrogen and acid deposition, as well as setting out recommended Critical Levels for long-term (annual mean) oxides of nitrogen (NOx), ammonia (NH_3) and sulphur dioxide (SO_2).[3]

Identification of Appropriate Habitats and Environmental Quality Standards

In order to assess whether potentially significant ecological effects are likely to occur, the vulnerability of component habitats is assessed for each of the qualifying features of the designated sites. For many habitats these can be expressed in terms of Critical Loads for nitrogen and acid deposition, and Critical Levels for short and long-term ground-level atmospheric concentrations of other pollutants.

Critical Levels are normally set at a single level for the protection of the most sensitive features of all habitats, although lower levels are used when particularly sensitive features (e.g. important lichen or bryophyte communities) are present. The appropriate level to use was based on published information (e.g. Natural England citations) about the SSSI (e.g. whether lichens or bryophytes were identified as

[3] https://www.apis.ac.uk/app

important components of notified features) and other site-specific information such as surveys and management plans; APIS also identifies whether lichens and bryophytes are present, but this is based on the habitat present and is not necessarily site-specific.

Critical Loads for nitrogen and acid deposition are set as a range with lower and upper limits. The APIS website recommends the appropriate Critical Load for different habitats to be used for environmental assessment purposes; this has been followed in the assessment, unless a different limit is justified in terms of published evidence or advice, or on the basis of the field survey. APIS sets Critical Loads for habitats based on the EUNIS (European Nature Information System) classification (Strachan, 2015[4]); however, Site-relevant Critical Loads for qualifying features of particular designated sites also give Broad Habitats, and in some cases, relevant NVC (National Vegetation Classification) plant communities. Notified habitat features in SSSIs are normally expressed in terms of NVC communities, while qualifying features of SACs are expressed in terms of Habitats Directive Annex I habitats. This can lead to anomalies in the way APIS treats what is essentially the same habitat in different sites (e.g. alder woodland (W7) NVC community is given a minimum Critical Load of 10kg N/ha/yr for SSSIs, but the equivalent EUNIS / Annex I habitat is considered not to be vulnerable to atmospheric nitrogen deposition). Where necessary, translation between NVC and EUNIS to ensure the correct quality standard is applied has been undertaken with reference to Strachan (2015).

Assessment of Effect Magnitude and Significance

There are no currently accepted thresholds for assessing the magnitude of air quality effects on ecological receptors. Neither CIEEM or IAQM (2020) guidance provide any characterisation of effect magnitude or ecological significance thresholds. In the absence of guidance for ecological receptors, Environmental Protection UK (EPUK, 2010)[5] advice can be applied with caution; although this was developed for assessment of nitrogen dioxide and particulate emissions on human health in a development control context, it provides a useful descriptor to express impact magnitude as a percentage of the relevant assessment level (see Table 2.2 below). This has now been superseded by revised advice, which is now explicitly reserved for application in a human health assessment context.

---

[4] Strachan, I.M. (2015). *Manual of terrestrial EUNIS habitats in Scotland*. Scottish Natural Heritage Commissioned Report No. 766.
[5] Environmental Protection UK (2010). *Development Control: Planning For Air Quality (2010 Update)*. EPUK, April 2010.

Table A8.5.2: EPUK (2010) Guidance on Impact Magnitude

Magnitude of Change	Annual Mean Value Increase / Decrease (as Percentage of Assessment Level)
Large	>10%
Medium	5 – 10%
Small	1 – 5%
Imperceptible	<1%

With respect to assessing **significance** of ecological effects, it is important to note that the 1% screening threshold is not an effect threshold. The magnitude of impact which might result in a significant ecological effect is likely to depend on baseline conditions and sensitivity of the receiving environment.

CIEEM (2016[6]) define a significant ecological effect as *"an impact on the integrity of a defined site or ecosystem and/or the conservation status of habitats or species within a given geographical area"*. The guidelines do not favour a matrix approach to the assessment of significance, because these can downplay impacts on features of local importance, and the ecological meaning of the resulting terms is often poorly defined. Instead, significance is defined at the geographic scale at which it occurs.

With respect to assessing whether it is possible to conclude no adverse effect on site integrity (European site) and to conclude no damage (SSSIs) in a permitting context in England and Wales, Environment Agency (EA) guidance[7] distinguished between circumstances when:

- the background concentration is less than the appropriate environmental criterion but a small process contribution leads to an exceedance; or
- the background concentration is currently exceeding the appropriate environmental criterion and the new process contribution will cause an additional **small** increase; and

[6] CIEEM (2016). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd edition*. Chartered Institute of Ecology and Environmental Management, Winchester

[7] Environment Agency (2012). *Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation*. Operational Instruction 67_12, Issued 08/05/12

- the background concentration is less than the appropriate environmental criterion, but the process contribution is significant (*i.e. of higher magnitude*) and leads to an exceedance; or
- the background concentration is more than the appropriate environmental criterion, and the process contribution is **large.**

In the first two circumstances, the EA recommend that a decision is based on local circumstances, based on factors set out in guidance (such as spatial disposition of sensitive habitats relative to predicted effects); in the latter two circumstances, the EA state that it is not possible to conclude no adverse effect. The EA go on distinguish between the varying level of legal and policy protection applied to European sites relative to SSSIs. For European sites (SACs, SPAs and Ramsar sites) the key policy test is 'no likely significant effect', which is best understood as 'no possible significant effect according to best available scientific knowledge'. For SSSIs, the EA refer to 'operations likely to damage' a SSSI.

Habitat Condition

The significance of an effect can also be related to the condition of the receiving environment. Natural England use 'Common Standards Monitoring' to assess the conservation status of both qualifying features of European sites and notified features of their component SSSI. Site condition provides important context to the assessment of air quality impacts, taking into account the effect of baseline conditions, including unregulated activities and existing operational consents. Condition is assessed at the level of the individual SSSI Units; the boundaries of these and the most recent condition assessments are shown on Figure 3, for both Wyre Estuary SSSI and Lune Estuary SSSI.

3 Sensitivity of Statutory and Locally Designated Sites

3.1 Morecambe Bay and Duddon Estuary SPA / Morecambe Bay Ramsar Site

SPA Qualifying Features

The SPA is classified for the occurrence of a range of breeding, migratory and wintering species, comprising the following:

Bar-tailed godwit*, Limosa lapponica* - A157, non-breeding
Black-tailed godwit, *Limosa limosa islandica* - A616, non-breeding
Common tern, *Sterna hirundo* - A193, breeding
Curlew, *Numenius arquata* - A160, non-breeding
Dunlin, *Calidris alpina alpina* - A672, non-breeding
Golden plover*, Pluvialis apricaria* - A140, non-breeding
Grey plover, *Pluvialis squatarola* - A141, non-breeding
Herring gull, *Larus argentatus* - A184, breeding
Knot, *Calidris canutus* - A143, non-breeding
Lesser black-backed gull, *Larus fuscus* - A183, breeding
Lesser black-backed gull, *Larus fuscus* - A183, non-breeding
Little egret, *Egretta garzetta* - A026, non-breeding
Little tern, *Sterna albifrons* - A195, breeding
Mediterranean gull, *Larus melanocephalus* - A176, non-breeding
Oystercatcher, *Haematopus ostralegus* - A130, non-breeding
Pink-footed goose, *Anser brachyrhynchus* - A040, non-breeding
Pintail, *Anas acuta* - A054, non-breeding
Redshank, *Tringa totanus* - A162, non-breeding
Ringed plover, *Charadrius hiaticula* - A137, non-breeding
Ruff, *Philomachus pugnax* - A151, non-breeding
Sanderling, *Calidris alba* - A144, non-breeding
Sandwich tern, *Sterna sandvicensis* - A191, breeding
Seabird assemblage
Shelduck, *Tadorna tadorna* - A048, non-breeding
Turnstone, *Arenaria interpres* - A169, non-breeding
Waterbird assemblage
Whooper swan, *Cygnus cygnus* - A038-B, non-breeding

Sensitivity to Air Quality Impacts

The potential sensitivity to air quality impacts of SPA qualifying species depends on effects on their supporting habitat, which may reduce the suitability of the habitat to support the species in question. APIS assign the following Critical Loads for nitrogen and acid deposition to supporting habitats of the above species, summarised in the table below:

Table 3.1: Sensitivity of Qualifying Species (from APIS)

Qualifying feature	Supporting habitat (with EUNIS code)	Critical Load (N deposition (kg N/ha/yr))	Critical Load (acid deposition keq/ha/yr)	Considered sensitive to air quality impacts?
Sandwich tern, common tern, little tern	B1.4; B1.3 Coastal stable dune grasslands; shifting coastal dunes	8 -10 (B1.4 acid type); 10-15 (B1.4 calcareous type); 10 - 20 (B1.3)	0.643	Yes
Pintail, dunlin, sanderling, ringed plover, knot, bar-tailed godwit, redshank, grey plover, oystercatcher, little egret, pink-footed goose, shelduck	A2.54; A2.55; A2.53 Pioneer, low-mid, mid-upper saltmarshes	20 - 30	0.643	No
Mediterranean gull, curlew	A2.54; A2.55; A2.53 Pioneer, low-mid, mid-upper saltmarshes	20 - 30	0.643	Yes
Golden plover	E2.2, A2.54; A2.55; A2.53 low and medium altitude hay meadows; Pioneer, low-mid, mid-upper saltmarshes	20 - 30	4.856	Yes
Ruff	E2.2, A2.54; A2.55; A2.53 low and medium altitude hay meadows; Pioneer, low-mid, mid-upper saltmarshes	20 - 30	4.856	No
Whooper swan	Standing open water and canals; improved grassland	n/a	No CL	Site-specific (depending on N or P limitation)
Herring gull, lesser black-backed gull,	Supralittoral rock	n/a	Not sensitive	No

Appropriate Critical Loads and Levels for Screening Purposes

Nitrogen Deposition

The SSSI Unit information indicates that all Units within 10km of the Proposed Development support littoral sediment broad habitat (intertidal mud and saltmarsh communities), with no coastal dune habitats supporting tern colonies within this range. Data published by Natural England to inform the site's classification indicates that these are located much further north, within the Duddon Estuary and on Walney Island[8].

The appropriate Critical Load for nitrogen deposition is therefore the range of 20 - 30kg N/ha/yr for saltmarsh habitats, with the lower figure being recommended by APIS for upper saltmarsh habitats. Since saltmarshes typically exhibit a transition depending on the frequency of tidal inundation, it can be assumed that upper saltmarsh habitats are present in most areas, and the lower **20kg N/ha/yr** value is appropriate for screening purposes.

Acid Deposition

As discussed above, the relevant habitat for consideration of deposition impacts within 10km of the Proposed Development is saltmarsh. This is not regarded by APIS as sensitive to acid deposition, and it is therefore arguable that an acid deposition Critical Load is not relevant to proximal supporting habitats of SPA qualifying features.

Ammonia Levels

None of the supporting habitats of SPA qualifying species are regarded as having an elevated sensitivity to atmospheric ammonia levels, therefore the long-term annual mean Critical Level for protection of ecosystems of **3µg/m^3** is appropriate.

8 Natural England (2016). *Departmental Brief: Morecambe Bay and Duddon Estuary potential Special Protection Area (pSPA).* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492891/morecambe-duddon-departmental-brief.pdf

3.2 Morecambe Bay SAC

SAC Qualifying Features

Morecambe Bay SAC is designated for the occurrence of the following qualifying features:

- H1130 Estuaries
- H1140 Mudflats and sandflats not covered by seawater at low tide
- H1160 Large shallow inlets and bays
- H1220 Perennial vegetation of stony banks
- H1310 Salicornia and other annuals colonizing mud and sand
- H1330 Atlantic salt meadows (Glauco-Puccinellietalia maritimae)
- H2120 Shifting dunes along the shoreline with Ammophila arenaria ('white dunes')
- H2130 Fixed coastal dunes with herbaceous vegetation ('grey dunes')" * Priority feature
- H2190 Humid dune slacks

Annex I habitats present as a qualifying feature, but not a primary reason for selection:

- H1110 Sandbanks which are slightly covered by sea water all the time
- H1150 Coastal lagoons * Priority feature
- H1170 Reefs
- H2110 Embryonic shifting dunes
- H2150 Atlantic decalcified fixed dunes (Calluno-Ulicetea) * Priority feature
- H2170 Dunes with Salix repens ssp. argentea (Salicion arenariae)

Annex II species that are a primary reason for selection:

- S1166 Great crested newt *Triturus cristatus*

Sensitivity of Qualifying Features to Air Quality Impacts

APIS assign the following Critical Loads for nitrogen and acid deposition to qualifying habitats of the SAC, summarised in order of sensitivity to nitrogen deposition in the table overleaf.

Table 3.2: Sensitivity of Morecambe Bay SAC Qualifying Features (APIS)

Qualifying feature (Annex I habitat)	EUNIS habitat	Critical Load (N deposition (kg N/ha/yr))	Critical Load (acid deposition keq/ha/yr)	Considered sensitive to air quality impacts?
Fixed coastal dunes with herbaceous vegetation (H2130)	B1.4 Coastal stable dune grassland	8 - 10 (acid type) 10 - 15 (calcareous type)	*0.643 / 4.856**	Yes
Perennial vegetation of stony banks (H1220)	B1.4 and other habitats		*0.643**	Yes
Humid dune slacks (H2190) Dunes with Salix repens ssp. argentea (H2170)	B1.8 Moist to wet dune slacks	10 - 15 (acid type) 15 - 20 (calcareous type)	*0.643 / 4.856**	Yes
Embryonic shifting dunes (H2110) Shifting dunes along the shoreline with Ammophila arenaria (H2120)	B1.3 Shifting coastal dunes	10 - 15	Not sensitive	Yes
Atlantic decalcified fixed dunes (H2150)	B1.5 Coastal dune heaths	10 - 20	*1.029**	Yes
Estuaries (H1130) Coastal lagoons (H1150) Salicornia and other annuals colonising mud and sand (H1310) Atlantic salt meadows (H1330)	A2.54; A2.55; A2.53 Pioneer, low-mid, mid-upper saltmarshes	20 - 30	Not sensitive	Yes
Mudflats and sandflats not covered by water at high tide (H1140)	A2.1 - A2.4 Littoral sediment	No comparable habitat with critical load	Not sensitive	Yes
Great crested newt (S1166)	C1 Surface standing waters	No critical load - seek site-specific advice	No critical load	Yes
Sandbanks slightly covered by seawater at all times (H1110) Large shallow inlets and bays (H1160) Reefs (H1170)	A5 Sublittoral sediment; A3-A4 Infralittoral / circalittoral rock and other hard substrata	Not sensitive to eutrophication	Not sensitive	No

(* - see comments below regarding acid deposition to dune habitats)

Appropriate Critical Loads and Levels for Screening Purposes

<u>Nitrogen Deposition</u>

Based on SSSI Unit descriptions for one of the SAC's component SSSIs (Unit 1 of Wyre Estuary), the nearest area of sensitive habitat is an area of coastal dunes located to the north of Fleetwood, around 4.3 - 4.5km from the Site boundary. The Unit description describes these as an area of embryo and mobile dunes (Annex I habitats H2110 and

H2120) with a small area of fixed coastal dunes (H2130). There is no indication from the habitat description that these have an acidic character, and therefore a minimum Critical Load of **10kg N/ha/yr** is appropriate and sufficiently precautionary.

Saltmarsh habitats are considered above in the context of supporting habitat within the Morecambe Bay and Lune Estuary SPA, with the same Critical Load applied for upper saltmarsh habitat of **20kg N/ha/yr**.

Acid Deposition

Most of the habitats within 10km of the Site boundary are not sensitive to acid deposition. The small area of fixed coastal dunes north of Fleetwood has a Critical Load of 0.643 keq H^+/ha/yr applied by APIS for acid-type dunes, but **4.856 keq H^+/ha/yr** is more appropriate for the habitats on this site, using APIS Check by Location Function. Note that one component of the sand dune habitat (embryonic shifting dunes) is not considered by APIS to be vulnerable to acid deposition.

Ammonia Levels

None of the SSSI notified features are regarded as having an elevated sensitivity to atmospheric ammonia levels, therefore the long-term annual mean Critical Level for protection of ecosystems of **3µg/m³** is appropriate.

3.3 Shell Flat and Lune Deep SAC

SAC Qualifying Features

Shell Flat and Lune Deep SPA is designated for the occurrence of the following features[9]:

- H1110 Sandbanks which are slightly covered by sea water all the time
- H1170 Reefs

Sensitivity of Qualifying Features to Air Quality Impacts

APIS report that neither qualifying feature is regarded as sensitive to air quality impacts[10], including nitrogen and acid deposition or ambient concentrations of oxides of nitrogen, sulphur dioxide, ammonia or hydrogen fluoride.

[9] https://sac.jncc.gov.uk/site/UK0030376
[10] https://www.apis.ac.uk/srcl/select-feature?site=UK0030376&SiteType=SAC&submit=Next

3.4 Liverpool Bay SPA

SPA Qualifying Features

Liverpool Bay SPA is classified for the occurrence of the following qualifying species[11]:

- red-throated diver *Gavia immer* (non-breeding);
- little gull *Hydrocoloeus minutus* (non-breeding);
- common scoter *Melanitta nigra* (non-breeding);
- waterbird assemblage (non-breeding);
- little tern *Sternula albifrons* (breeding); and
- common tern *Sterna vulgaris* (breeding).

The waterbird assemblage qualifying feature consists of the above four non-breeding species, together with red-breasted merganser *Mergus serrator* and cormorant *Phalacrocorax carbo*.

Sensitivity of Qualifying Features to Air Quality Impacts

The key habitat association of non-breeding species is sublittoral sediment (i.e. marine habitats). APIS does not regard this supporting habitat as sensitive to air quality impacts[12].

Supporting habitat of the two breeding tern species is regarded by APIS as potentially sensitive to air quality impacts; however, the nearest colonies are well outside the 10km screening radius. The nearest little tern colonies are well to the north at Walney Island (Morecambe Bay and Duddon Estuary SPA), and south at Dee Estuary, Wales (Dee Estuary SPA)[13]. The nearest common tern colonies are at Ribble and Alt Estuary SPA and Dee Estuary SPA to the south[14].

[11] https://jncc.gov.uk/our-work/liverpool-bay-spa/
[12] https://www.apis.ac.uk/srcl/select-feature?site=UK9020294&SiteType=SPA&submit=Next
[13] Parsons, M., Lawson, J., Lewis, M., Lawrence, R. & Kuepfer, A. (2015). Quantifying foraging areas of little tern around its breeding colony SPA during chick-rearing. *JNCC Report No. 548.* Joint Nature Conservation Committee, Peterborough.
[14] Wilson L. J., Black J., Brewer, M. J., Potts, J. M., Kuepfer, A., Win I., Kober K., Bingham C., Mavor R. & Webb A. 2014. Quantifying usage of the marine environment by terns *Sterna* sp. around their breeding colony SPAs. *JNCC Report No. 500.*

3.5 Wyre Estuary SSSI

Notified Features

Wyre Estuary SSSI is notified for the occurrence of the following features[15]:

- wintering black-tailed godwit, turnstone and teal;
- saltmarsh vegetation, comprising a range of plant communities from pioneer, low-mid and mid-upper marsh habitats;
- Freshwater and brackish swamp, tall-herb fen and reedbed communities;
- Mobile dune and strandline communities; and
- Gorse - bramble (*Ulex europaeus - Rubus fruticosus*) scrub.

Sensitivity to Air Quality Impacts

APIS assign the following Critical Loads for nitrogen and acid deposition to notified habitats and supporting habitats of notified species, summarised in the table below:

Table 3.2: Sensitivity of SSSI Notified Features

Notified feature	EUNIS habitat	Critical Load (N deposition (kg N/ha/yr))	Critical Load (acid deposition keq/ha/yr)	Considered sensitive to air quality impacts?
Ammophila arenaria mobile dune community (NVC SD6)	B1.3 Shifting coastal dunes	10 - 20	No critical load - seek site-specific advice	Yes
Ulex europeaeus - Rubus fruticosus scrub (W23)	G1 Broadleaved deciduous woodland [*APIS classification inaccurate - see below*]	10 - 20	1.694	Yes
Phragmites australis swamp and reed-beds (S4)	D4.1 Rich fens [*APIS classification inaccurate - see below*]	15 - 30	Not sensitive	Yes
Saltmarsh habitats (SM6, SM8-10, SM12-16, SM18, SM24, SM28; Black-tailed godwit	A2.54; A2.55; A2.53 Pioneer, low-mid, mid-upper saltmarshes	20 - 30	No critical load - seek site-specific advice; not sensitive	Yes

15 https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S2000199&SiteName=Wyre+Estuary&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

Notified feature	EUNIS habitat	Critical Load (N deposition (kg N/ha/yr))	Critical Load (acid deposition keq/ha/yr)	Considered sensitive to air quality impacts?
Teal; turnstone	A2.54; A2.55; A2.53 Pioneer, low-mid, mid-upper saltmarshes	20 - 30	Not sensitive	No
Honkenya peploides - Cakile maritima strand-line community (SD2)	B1.1 Sand beach driftlines [*not classified by APIS*]	No critical load - seek site-specific advice	No critical load - seek site-specific advice	Not assessed
Phalaris arundinacea tall-herb fen (S28); *Bolboschoenus* (Scirpus) *maritimus* swamp (S21)	D5.1 Reedbeds without free-standing water; A2.53D Geolittoral wetlands and meadows: saline and brackish reed, rush and sedge stands [*not classified by APIS*]	Not sensitive to eutrophication	Not sensitive	No

Appropriate Critical Loads and Levels for Screening Purposes

<u>Nitrogen Deposition</u>

Based on SSSI Unit descriptions, the nearest area of mobile dunes is in Unit 1; this is located to the north of Fleetwood, a minimum of 4.3km from the boundary of the Proposed Development. All of the Units within 2km of the Proposed Development are described as containing littoral sediment broad habitat (saltmarsh and intertidal mud).

The location of *Ulex europaeus* - *Rubus fruticosus* (gorse - bramble) scrub is unclear from the SSSI Unit descriptions, and it is not mentioned in the Site Citation, nor is it defined as a Monitoring Feature by Natural England. For these reasons it is unlikely to be regarded as a notified feature of the SSSI - this plant community is not normally regarded as a feature of high conservation interest unless it functions as supporting habitat for a notified species, which is not the case here. In addition, APIS misclassify this habitat as broadleaved woodland (EUNIS G1 Level 2 habitat), when in accordance with Strachan (2015) it falls within the F3 Level 2 habitat (temperate and Mediterranean - montane scrub) as Level 4 habitat F3.15 *Ulex europaeus* thickets. APIS do not assign an indicative critical load value to this habitat[16], but the 10-20kg range given for woodland is likely to be over-precautionary.

[16] https://www.apis.ac.uk/indicative-critical-load-values

Reedbed habitat is noted in the SSSI Unit descriptions in Unit 20; this is likely to be at the eastern side of the Unit at the upper part of the saltmarsh, just over 1.0km from the Proposed Development. It is also noted in Units 10 and 13, located 3.8km and over 5km respectively to the south-east of the Proposed Development. APIS assign a recommended Critical Load for screening and environmental assessment purposes of 15kg N/ha/yr for rich fen habitat (EUNIS D4.1). However, reference to Strachan (2015) indicates that reedbeds of brackish habitats should be classed within A2.53D (Geolittoral wetlands and meadows: saline and brackish reed, rush and sedge stands). This forms part of the A2.53 mid-upper saltmarsh habitat, with a recommended Critical Load of **20kg N/ha/yr**. This is therefore the correct Critical Load to apply to this habitat, together with the other upper saltmarsh habitats in proximal parts of the SSSI to the Proposed Development.

<u>Acid Deposition</u>

Ulex europeaus - Rubus fruticosus scrub is the only habitat regarded as sensitive to acid deposition in the SSSI, with a minCLmaxN value of 1.694 keq H^+ /ha/yr. Given its questionable status as a SSSI notified feature, this could be regarded as over-precautionary, but could be used for screening purposes.

<u>Ammonia Levels</u>

None of the SSSI notified features are regarded as having an elevated sensitivity to atmospheric ammonia levels, therefore the long-term annual mean Critical Level for protection of ecosystems of **3µg/m^3** is appropriate.

3.6 Wyre Lune Marine Conservation Zone

Protected Features

Wyre Lune MCZ was designated for the protection of one feature, smelt (*Osmerus eperlanus*).

Sensitivity

The smelt is a migratory fish which has suffered significant population declines. It shoals in lower estuaries and migrates to freshwater for spawning (DEFRA, 2019[17]). It is regarded as being sensitive to pollution and an indicator of good water quality.

[17] DEFRA (2019). *Wyre - Lune Marine Conservation Zone Factsheet.* 31 May 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/915506/mcz-wyre-lune-2019.pdf

Emissions to the water environment are consequently of much greater significance, and they cannot therefore be regarded as sensitive to atmospheric emissions.

3.7 Relevant SSSI Unit Condition

Figure 3 shows all of the SSSI Units within 10km of the Proposed Development are regarded as being in Favourable condition. These include Units which are components of Wyre Estuary SSSI and Lune Estuary SSSI, and which also form part of Morecambe Bay and Duddon Estuary SPA, and Morecambe Bay SAC.

3.8 Sensitivity of Biological Heritage Sites

Site Features

The reasons for designation of Biological Heritage Sites (BHS) within 2km of the Proposed Development are given in the table below.

Table 3.3: Features of Biological Heritage Sites

Site Name	Site ID	Feature codes	Features
Fleetwood Marsh Industrial Lands	34NW06	(Av7) , (Ff2) , (Ff4)? , (Hm1)	Habitat mosaics, flowering plants and ferns, birds
Rossall Lane Wood and Pasture	34NW07	(Ff4a) , (In2)	Flowering plants and ferns, other invertebrates
Jameson Road Saltmarsh	34NW08	(Co1) , (Ff2)	Coastal, flowering plants and ferns
Fleetwood Railway Branch Line, Trunnah to Burn Naze	34SW05	(Ar2) , (Ff4a)	Artificial habitats, flowering plants and ferns
ICI Hillhouse Estuary Banks	34SW06	(Ar1) , (Ff4a) , (Ff4b)	Artificial habitats, flowering plants and ferns
Fleetwood Farm Fields	34SWW1	(AvW) , (Ff4a)?	Birds, flowering plants and ferns
Burglars Alley Field	34SW08	(Co1) , (Le4)? , (Le5)? , (Ma1a)	Coastal, mammals
ICI Hillhouse International Pool	34NW05	(Ff4)? , (Po1)	Ponds, flowering plants and ferns

Appropriate Critical Loads and Levels for Screening Purposes

<u>Nitrogen Deposition</u>

With the aid of more detailed descriptions supplied by LERN, these features have been translated where possible to EUNIS habitats to allow assignment of appropriate Critical Loads for nitrogen deposition.

Fleetwood Marsh Industrial Lands supports a wide range of habitats. The most sensitive for nitrogen deposition fall within the definitions of E2.2 (low and medium altitude hay meadows) and A2.53D Geolittoral wetlands and meadows: saline and brackish reed, rush and sedge stands, both with a Critical Load of **20kg N/ha/yr**.

Rossall Lane Wood and Pasture

This site supports wet woodland habitats, which are usually regarded as not sensitive to nitrogen deposition. Other habitats include E3 wet grassland; based on reported species composition, this is probably E3.4 (moist and wet eutrophic and mesotrophic grassland), where the 20kg N/ha/yr Critical Load for neutral grassland would be appropriate. However, use of the EUNIS E3.51 moist and wet oligotrophic grassland Critical Load of **15kg N/ha/yr** would be precautionary for screening purposes.

Jameson Road Saltmarsh

This site is designated for the occurrence of saltmarsh habitat containing an uncommon species (lax-flowered sea lavender) The Critical Load for A2.53 mid-upper saltmarshes of **20kg N/ha/yr** is appropriate for screening purposes.

Fleetwood Railway Branch Line, Trunnah to Burn Naze

A variety of habitats occur on this site, some of which have low sensitivity to air quality impacts. The most sensitive is neutral and acid grassland habitat E1.7 (Closed Non-Mediterranean dry acid and neutral grassland) which has a Critical Load of **10kg N/ha/yr**.

ICI Hillhouse Estuary Banks

This includes two habitats: species rich grassland (E2.2) and upper saltmarsh transition (A2.53) which both have a Critical Load of **20kg N/ha/yr**.

Fleetwood Farm Fields

This site supports agricultural fields which have ornithological interest for wintering waterbirds. Their suitability for birds is dependent on management; the relevant EUNIS habitat, E2.6 Agriculturally improved grassland is **not sensitive to atmospheric nitrogen deposition**.

Burglars Alley Field

This site supports Upper saltmarsh transition (A2.53) vegetation with a Critical Load of **20kg N/ha/yr**.

ICI Hillhouse International Pool is described as a brackish water pool with a notable submerged aquatic flora and a range of marginal species. The closest EUNIS community with a Critical Load for nitrogen deposition is A2.53D Geolittoral wetlands and meadows: saline and brackish reed, rush and sedge stands. This has a Critical Load equivalent to that of upper saltmarsh of **20kg N/ha/yr**.

Acid Deposition

Using the APIS Search by Grid Reference function on a central grid reference for relevant broad habitats returns the Critical Loads for acid deposition (all are CLmaxN values) set out in Table 3.4 below. Note that on some sites the feature with the highest sensitivity to nitrogen deposition may not be sensitive to acid deposition. Fleetwood Marsh Industrial Lands, ICI Hillhouse Estuary Banks and Burglars Alley Field all support neutral grassland habitats, which are more sensitive than coastal saltmarsh broad habitat.

Table 3.4: Acid Deposition Critical Loads for Biological Heritage Sites

Site Name	Grid ref.	Broad habitat	Critical Load (keq H^+/ha/yr)
Fleetwood Marsh Industrial Lands	333720, 446590	Neutral grassland	5.071
Rossall Lane Wood and Pasture	332930, 445020	Acid grassland	4.498
Jameson Road Saltmarsh	333790, 445550	Coastal saltmarsh	No comparable CL class; soil base empirical CL is 4.00
Fleetwood Railway Branch Line, Trunnah to Burn Naze	334120, 443775	Acid grassland	4.498
ICI Hillhouse Estuary Banks	334470, 444120	Neutral grassland	5.071
Fleetwood Farm Fields	332820, 444730	Improved grassland	Not sensitive to acidity
Burglars Alley Field	333550, 444800	Neutral grassland	5.071
ICI Hillhouse International Pool	332990, 445490	Coastal saltmarsh	No comparable CL class; soil base empirical CL is 4.00

Ammonia Levels

None of the BHS descriptions mentions bryophytes or lichens as reasons for site designation. The habitats responsible for designation are generally not regarded as likely to support important bryophyte or lichen communities. It is therefore acceptable to use the **3µg/m³** annual mean Critical Level for ammonia on all sites.

4 Assessment of Predicted Air Quality Impacts

4.1 Dispersion and Deposition Modelling Results

Impacts above Screening Thresholds

The following table lists predicted exceedances of 1% screening thresholds, in circumstances where the predicted environmental concentration (PEC) or deposition rate exceeds 70% of the relevant environmental quality standard (EQS (critical level or critical load)). These are based on modelled values reported in tables 32, 40 and 41 of Appendix 8.3 of the AQA.

Table 4.1: Predicted Impacts

Site	Pollutant	Critical Load / Level (EQS)	PC (% of EQS)	Background (% EQS)	PEC (% EQS)
European / internationally designated sites					
Morecambe Bay and Duddon Estuary SPA / Ramsar Site	NH_3	3µg/m³ annual mean	0.155µg/m³ (5.17%)	2.3µg/m³ (76.7%)	2.46µg/m³ (81.84%)
Morecambe Bay and Duddon Estuary SPA / Ramsar Site	N dep.	20kg N/ha/yr	0.57kg N/ha/yr (2.87%)	19.6kg N/ha/yr (98.0%)	20.2kg N/ha/yr (**100.9%**)
Nationally designated sites					
Wyre Estuary SSSI	NH_3	3µg/m³ annual mean	0.155µg/m³⁺ (5.17%)	2.3µg/m³ (76.7%)	2.46µg/m³ (81.84%)
Wyre Estuary SSSI	N dep.	20kg N/ha/yr	0.57kg N/ha/yr (2.87%)	19.6kg N/ha/yr (98.0%)	20.2kg N/ha/yr (**100.9%**)
Non-statutory locally designated sites					
ICI Hillhouse Estuary Banks BHS	NH_3	3µg/m³ annual mean	0.122µg/m³ (4.06%)	2.3µg/m³ (76.7%)	2.42µg/m³ (80.73%)
Fleetwood Railway Branch Line BHS	NH_3	3µg/m³ annual mean	0.067µg/m³ (2.24%)	2.3µg/m³ (76.7%)	2.37µg/m³ (78.91%)
Burglars Alley Field BHS	NH_3	3µg/m³ annual mean	0.039µg/m³ (1.29%)	2.3µg/m³ (76.7%)	2.34µg/m³ (77.96%)
Fleetwood Farm Fields BHS	NH_3	3µg/m³ annual mean	0.031µg/m³ (1.03%)	2.3µg/m³ (76.7%)	2.33µg/m³ (77.70%)

Site	Pollutant	Critical Load / Level (EQS)	PC (% of EQS)	Background (% EQS)	PEC (% EQS)
Fleetwood Railway Branch Line BHS	HF	0.5µg/m^3 weekly mean	0.052µg/m^3 (10.38%)	-	-
ICI Hillhouse Estuary Banks BHS	N dep.	20kg N/ha/yr	0.76kg N/ha/yr (3.78%)	19.6kg N/ha/yr (98.0%)	20.4kg N/ha/yr (**101.8%**)
Fleetwood Railway Branch Line BHS	N dep.	10kg N/ha/yr	0.42kg N/ha/yr (4.17%)	19.6kg N/ha/yr **(196.0%)**	20.0kg N/ha/yr **(200.2%)**
Burglars Alley Field BHS	N dep.	20kg N/ha/yr	0.24kg N/ha/yr (1.20%)	19.3kg N/ha/yr (96.5%)	19.5kg N/ha/yr (97.7%)
Rossall Lane Wood and Pasture BHS	N dep.	15kg N/ha/yr	0.17kg N/ha/yr (1.11%)	19.3kg N/ha/yr **(128.7%)**	19.5kg N/ha/yr **(129.8%)**

Other Predicted Impacts

Oxides of Nitrogen

The AQA predicts a number of exceedances of the 1% screening threshold for long-term (annual mean) oxides of nitrogen levels. In all cases the PEC remains well below 70% of the 30µg/m^3 Critical Level for long-term NOx.

For short-term (daily mean) NOx, given low SO_2 and O_3 levels, the 200µg/m^3 Critical Level is appropriate for this area. The PC on all sites remains below the 10% screening threshold for short-term NOx.

Sulphur Dioxide

The AQA predicts a number of exceedances of the 1% screening threshold for long-term (annual mean) sulphur dioxide levels. In all cases the PEC remains below 10% of the 20µg/m^3 Critical Level for protection of forests and natural vegetation.

4.2 Predicted Impacts on Morecambe Bay and Duddon Estuary SPA / Ramsar Site

Ammonia Levels

Impact Magnitude

A medium magnitude increase in annual mean ammonia levels is predicted over a small area of saltmarsh habitat in close proximity to the Proposed Development, with a smaller magnitude increase extending over a wider area of the Wyre Estuary saltmarsh.

Potential Effects

The PEC remains below the Critical Level for protection of ecosystems, and there is therefore no risk of any effect as a consequence of the Proposed Development, based on current baseline levels.

Recent and Future Trends

There is some evidence for a long-term decline of around 6% in ammonia levels in the UK, based on a published analysis of UK National Ammonia Monitoring Network data from 1998-2014 (Tang *et al*, 2018[18]). This is complicated by changes in atmospheric chemistry (lower SO_2 levels) resulting in lower reactivity and longer atmospheric residence times.

Emissions data published by the UK government[19] shows a stable or increasing contribution from agricultural sources from 2010 - 2020, which accounted for 87% of total emissions in 2020. Despite increased ammonia generation from catalytic reduction of vehicle NOx emissions, road transport emissions showed a 65% reduction from 2010 - 2020.

Under the Convention on Long Range Transboundary Air Pollution (CLRTAP) and National Emissions Ceiling Regulations (NECR), the UK is required to reduce ammonia emissions by 16 per cent compared to emissions in 2005 by 2030. If emission reductions of this magnitude are achieved, it is very likely that this will be reflected in lower background levels. When longer term trends and future legal and policy commitments are taken into account, it is very unlikely that the relevant Critical Level for the SPA will be exceeded during the lifetime of the Proposed Development.

Nitrogen Deposition Rates

Impact Magnitude

A low magnitude increase in nitrogen deposition rates is predicted for areas of saltmarsh habitat in relatively close proximity to the Proposed Development. This will lead to the Critical Load for upper saltmarsh habitat being very slightly exceeded, based on 2019 background deposition rates.

[18] Tang, Y. S., Braban, C. F., Dragosits, U., Dore, A. J., Simmons, I., van Dijk, N., Poskitt, J., Dos Santos Pereira, G., Keenan, P. O., Conolly, C., Vincent, K., Smith, R. I., Heal, M. R., and Sutton, M. A. (2018) Drivers for spatial, temporal and long-term trends in atmospheric ammonia and ammonium in the UK, *Atmospheric Chemistry and Physics*, **18**, 705–733, https://doi.org/10.5194/acp-18-705-2018

[19] https://www.gov.uk/government/statistics/emissions-of-air-pollutants/emissions-of-air-pollutants-in-the-uk-ammonia-nh3

The PEC is not predicted to exceed the Critical Load for lower saltmarsh habitat of 30kg N/ha/yr, and in fact remains lower than 70%.

Potential Effects

The predicted impact is an example of a circumstance where the background concentration is less than the appropriate environmental criterion, but a small process contribution leads to an exceedance. Environment Agency advice in these circumstances suggests that a decision on whether an adverse effect is likely is based on local circumstances, and further assessment is undertaken; it is not necessary to automatically conclude that a likely significant effect would occur.

In this case the magnitude of predicted exceedance (0.9% / <0.18kg N/ha/yr) is extremely small, and likely to be well below the level of annual variation in deposition rates caused by factors such as changes in quantity of wet deposition.

In determining whether an ecological effect may occur, and whether this would be significant, it is important to remember that a critical load does not denote a damage threshold. IAQM (2020) defines critical load thus: '*Deposition flux of an air pollutant below which significant harmful effects on sensitive ecosystems do not occur, according to present knowledge*'. Predicted deposition rates are therefore at (or very slightly above) those at which harmful effects **do not occur**.

The contribution of atmospheric nitrogen inputs to saltmarsh vegetation also needs to be seen in the context of tidal contributions, when marshes are periodically inundated. Critical loads for nitrogen deposition to saltmarsh habitats were reviewed in a Natural Resources Wales report (Stevens *et al.*, 2013[20]). This study notes that saltmarsh systems have high levels of total nitrogen, and experience large inputs and outputs through surface water, which are significantly larger than the defined critical load range of 20-30kg N/ha/yr. They note that despite these large nutrient fluxes, they are still regarded as nitrogen-limited, and can still exhibit changes due to the effects of excess N deposition, such as in vegetation growth and the rate of succession. They note that impacts could be different in lower marsh communities, where growth is likely to be stimulated, while upper marsh communities may suffer a loss of species diversity. In terms of implications for critical loads, they refer to a study which suggests that

[20] Stevens, C., Jones, L., Rowe, E., Dale, S., Payne, R., Hall, J., Evans, C., Caporn, S., Sheppard, L., Menichino, N., Emmett, B. (2013). *Review of the effectiveness of on-site habitat management to reduce atmospheric nitrogen deposition impacts on terrestrial habitats*. CCW Science Series Report No: 1037 (part A), 186pp, CCW, Bangor

nutrient inputs would have to be significantly higher than defined critical loads for any responses to occur (Boorman & Hezelden, 2012[21]).

Boorman & Hezelden (2012) reviewed the types and range of nutrient nitrogen inputs likely to be taken up by a saltmarsh as a consequence of tidal flows. With respect to seawater inputs, they referred to the following estimated inputs:

Table 4.2: Estimated Nitrogen Inputs to Saltmarsh from Tidal Flows

Form of nitrogen	Mean estimated input	Input range
Particulate N	87 kg N/ha/yr	10 - 240 kg N/ha/yr
Dissolved organic N	74 kg N/ha/yr	10 - 310 kg N/ha/yr
Ammoniacal N	29 kg N/ha/yr	4 – 48 kg N/ha/yr
Nitrate N	16 kg N/ha/yr	6 - 27 kg N/ha/yr

They also noted that the pool of nitrogen in saltmarshes (most of which is in the soil) can be 5 – 30x greater than these inputs.

Although this study concludes that atmospheric nitrogen deposition could still have an impact on saltmarsh communities, particularly upper marsh vegetation, the above figures give some indication of the relatively greater magnitude of inputs from water.

A further consideration is the nutrient status of the water environment in the relevant estuary. In estuaries and coastal waters subject to high nutrient loadings, excessive macro-algal growth may occur on intertidal sediments; this is an issue with sites such as Tees Estuary and the Solent, which are subject to nutrient neutrality regulations. Although nutrient loadings in the Morecambe Bay area in excess of Water Framework Directive (WFD) and OSPAR thresholds are recorded, phosphate inputs have reduced significantly (Greenwood *et al*, 2019[22]). Natural England report in the *Supplementary Advice for Conservation Objectives* (SACOs) for the SPA that the risk of eutrophication across the site has been assessed as low[23]. This assessment is reported as using the Environment Agency's Weight of Evidence approach, which takes into account

[21] Boorman, L.A. and Hazelden, J. (2012). *Impacts of additional aerial inputs of nitrogen to salt marsh and transitional habitats*. CCW Science Report No: 995, pp44, Countryside Council for Wales, Bangor, Wales
[22] Greenwood N., Devlin M.J., Best M., Fronkova L., Graves C.A., Milligan A., Barry J., van Leeuwen S.M. (2019). Utilizing Eutrophication Assessment Directives From Transitional to Marine Systems in the Thames Estuary and Liverpool Bay, UK. *Frontiers in Marine Science*, **6**: 116.
[23] https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9020326&SiteName=Morecambe+Bay&SiteNameDisplay=Morecambe+Bay+and+Duddon+Estuary+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=25

assessments of the Water Framework Directive (WFD) opportunistic macroalgae and phytoplankton quality elements using the respective assessment tools.

Recent and Future Trends

The Centre for Ecology and Hydrology (CEH) *Trends Report 2021* (Rowe *et al*, 2021)[24] reports a 16% reduction in the percentage area of habitats subject to nitrogen Critical Load exceedance between 1996 - 2018. A breakdown by habitats shows a very low proportion of saltmarsh habitats are subject to exceedance, estimated at 1.1% of total area for the 2017-19 period.

This significant downward trend reflects a decreasing trend in NOx emissions due to closure of coal-fired power stations and reduction in vehicle emissions. UK Government statistics report an annual average decline of 4.6% between 1990 and 2020.[25] While sources of reduced N (NHx) have not shown the same rate of decline, there is a high degree of confidence that the PEC for nitrogen deposition will continue to decline during the lifetime of the Proposed Development, driven by ongoing changes to vehicle emission factors. It is therefore very likely that the PEC will decline and remain below the Critical Load for nitrogen deposition to saltmarsh. Taking other factors into account, including the small area of Critical Load exceedance at Morecambe Bay and Duddon Estuary SPA, the assessed low risk of eutrophication from tidal inputs, and the relatively small contribution of atmospheric inputs to the nitrogen budget of saltmarsh habitats, it can be concluded with a high degree of confidence that there would be no likely significant effect on this SPA supporting habitat.

4.3 Predicted Impacts on Wyre Estuary SSSI

Impacts on Saltmarsh Habitats

The location and relevant notified features of Wyre Estuary SSSI in the vicinity of the Proposed Development are essentially the same as for Morecambe Bay and Lune Estuary SPA. The key differences are:

- Saltmarsh habitats are notified features in their own right in the SSSI, rather than supporting habitats of SPA qualifying bird species. As such, a change in species

[24] Rowe EC, Sawicka K, Tomlinson S, Levy P, Banin LF, Martín Hernandez C & Fitch A (2021) *Trends Report 2021: Trends in critical load and critical level exceedances in the UK*. Report to Defra under Contract AQ0849, UKCEH project 07617. https://uk-air.defra.gov.uk/library/reports?report_id=1020
[25] https://www.gov.uk/government/statistics/emissions-of-air-pollutants/emissions-of-air-pollutants-in-the-uk-nitrogen-oxides-nox

composition which did not result in a change in its functional utility for birds could be regarded as a negative effect; and

- The test for significance is different for a SSSI and slightly less precautionary than a European site, determining whether it is an *operation likely to damage* a SSSI rather than an initial assessment of likely significant effect.

The assessment of no likely significant effect set out above for the SPA does not rely on an assessment of the likelihood of indirect effects on bird populations; it is therefore valid to apply it to the SSSI. It can therefore be safely concluded that there would be no likely risk of damage as a consequence of the Proposed Development.

Impacts on Sand Dune Habitats

As set out in section 3, the most sensitive part of the SSSI to atmospheric nitrogen deposition is the sand dune habitat located on the coastline to the north and north-west of Fleetwood, within Unit 1. The predicted impact on this area (see Appendix 8.3) is a PC of 0.05kg N/ha/yr, equivalent to 0.5% of the 10kg N/ha/yr Critical Load. This can therefore be screened out as not likely to damage the SSSI sand dune notified feature.

4.4 Predicted Impacts on Morecambe Bay SAC

No impacts in excess of screening thresholds have been identified within Morecambe Bay SAC. The most sensitive habitat subject to the highest nitrogen deposition rate is the sand dune habitat to the north of Fleetwood, within Unit 1 of Wyre Estuary SSSI.

In the absence of any in-combination effects (see below), a PC of 0.5% of the Critical Load would not have a likely significant effect on the SAC.

4.5 Predicted Impacts on Other Statutory Designated Sites

No impacts are predicted on Shell Flat and Lune Deep SAC, Liverpool Bay SPA, or Wyre Lune MCZ as a consequence of emissions to air from the Proposed Development.

4.6 Predicted Impacts on Locally Designated Sites

ICI Hillhouse Estuary Banks BHS

The AQA predicts a low magnitude increase in ammonia levels, which remain below the Critical Level. A low magnitude increase in nitrogen deposition rates is predicted to saltmarsh habitats, causing a low magnitude exceedance (101.8%) of the Critical Load.

For the reasons set out above in relation to similar habitat in the adjoining Morecambe Bay and Lune Estuary SPA / Wyre Estuary SSSI, there is no risk of a significant effect on this habitat as a consequence of the Proposed Development.

Fleetwood Railway Branch Line BHS

Background nitrogen deposition rates in the most sensitive habitat (acid grassland) are currently well in excess of the lower Critical Load of 10kg N/ha/yr. A low magnitude increase in nitrogen deposition rate is predicted, resulting in a PEC of just over 200% of the lower Critical Load. The relatively high baseline values may have resulted in some changes in species composition, for example by favouring more competitive species, although this may be complicated by local factors such as very nutrient-poor soils derived from railway ballast and imported spoil. In respect of the Proposed Development impact, such as small magnitude increase in deposition rates are very unlikely to have a measurable negative effect, or significantly delay the return to favourable condition as a response to falling background rates.

In the context of the policy protection afforded to non-statutory designated sites, this is therefore a low magnitude, non-significant impact on the BHS.

No impacts of nitrogen deposition are predicted on less sensitive components of the site such as neutral grassland and scrub. No exceedance of the Critical Level for ammonia is predicted.

Section 9.2.2 of Appendix 8.3 [Emissions Modelling] also considers the combined impact of process and vehicle emissions at the BHS. At the roadside the ammonia impact is predicted to be lower than the maximum impact within the BHS due to stack emissions alone, which occurs well to the north of the road. For oxides of nitrogen the roadside impact is slightly higher than the maximum of stack emissions alone, but no exceedance of the Critical Level is predicted. Therefore, the combined impact of vehicle and stack emissions results in a low magnitude, non-significant impact on the BHS.

An increase in weekly mean Hydrogen Fluoride (HF) levels of 0.052µg/m^3 is predicted; this is 10.38% of the 0.5µg/m^3 weekly mean Critical Level, and exceeds the 10% screening threshold for short-term values. Exceedance of this value could affect the most sensitive components of the grassland ecosystem, which on this site are likely to include *Hypericum* (St. John's-wort) species[26] such as *Hypericum perforatum*.

[26] https://www.apis.ac.uk/node/1132

Exceedance can result in visible injury symptoms, but ecosystem level effects (e.g., changes in the species composition or structure of plant communities) are less certain.

HF background levels are not monitored or modelled in the UK, but emissions information is available from the National Atmospheric Emissions Inventory (NAEI)[27]. This shows a 93% drop in emissions from 1990 - 2020 due to the decline in coal combustion. Given this clear declining trend, it is less likely that the Proposed Development would contribute to an exceedance of the Critical Level on this site.

Other industrial processes such as brickmaking, aluminium smelting and glassworks act as point sources for HF emissions and can result in local elevation of background levels. The absence of such sources locally further reduces risks of exceedance as a consequence of the Proposed Development.

Burglars Alley Field BHS

The AQA predicts low magnitude increases in ammonia levels and nitrogen deposition rates, taking the PEC above 70%, but remaining below the respective Critical Levels and Critical Loads. In the context of stable or declining background levels and deposition rates, no effect is predicted on the most sensitive habitat (neutral grassland) within this site.

Rossall Lane Wood and Pasture BHS

Background nitrogen deposition rates in the most sensitive habitat (moist and wet oligotrophic grassland) are currently in excess of the lower Critical Load of 15kg N/ha/yr. A low magnitude increase (1.11%) in nitrogen deposition rate is predicted, resulting in a PEC of 129.8% of the lower Critical Load.

An increase of this magnitude is very unlikely to have a measurable effect on the plant community, or significantly delay its return to favourable condition in the context of declining nitrogen deposition rates. In addition, the identification of critical load exceedance is based on a precautionary allocation of habitats based on the BHS site description to the most sensitive plant community. Having regard for this precautionary assumption and having regard to the policy protection afforded to non-statutory designated sites, this is a low magnitude, non-significant impact on the BHS.

Other BHS Sites

[27] https://naei.beis.gov.uk/overview/pollutants?pollutant_id=112

At Jameson Road Saltmarsh, ICI Hillhouse International Pool, and Fleetwood Marsh Industrial Lands BHS, the PEC for nitrogen deposition is predicted to remain below the Critical Load for the most sensitive component habitat. In the context of declining deposition rates, no negative effects are predicted.

No exceedance of ammonia Critical Levels are predicted at any BHS site.

4.7 In-combination Effects

No in-combination effects have been identified in the EIA which require consideration in the AQA. European and internationally designated sites, including Morecambe Bay and Lune Estuary SPA, and Morecambe Bay SAC are not thought to be subject to multiple development pressures which would trigger the need for a more detailed in-combination assessment.

5 Conclusions

An assessment of habitat sensitivity to air quality impacts identified the most sensitive features in statutory and locally designated sites within the relevant zone of influence of the Proposed Development.

The AQA identified a number of exceedances of screening thresholds for ammonia levels and nitrogen deposition rates at statutory and locally designated sites. Further ecological assessment was undertaken of these.

Low magnitude impacts on saltmarsh habitat were identified at Morecambe Bay and Lune Estuary SPA / Ramsar Site, and the contiguous Wyre Estuary SSSI. No likely significant effects were identified on the SPA / Ramsar Site, and a conclusion of no likely significant harm was made with respect to the SSSI.

Impacts below screening thresholds were identified on sand dune habitat at Morecambe Bay SAC and the contiguous Unit 1 of Wyre Estuary SSSI. No risk of any significant effects were identified.

No in-combination effects have been identified on European and internationally designated sites, which would require consideration of lower magnitude air quality impacts.

A low-magnitude increase in nitrogen deposition rates is predicted at two locally designated sites, in circumstances where the Critical Load is already exceeded. These are not considered likely to result in a measurable effect, or delay their return to favourable condition in the context of declining nitrogen deposition rates.

.

Appendix 1: Figures

Fig.1: Statutory Designated Sites

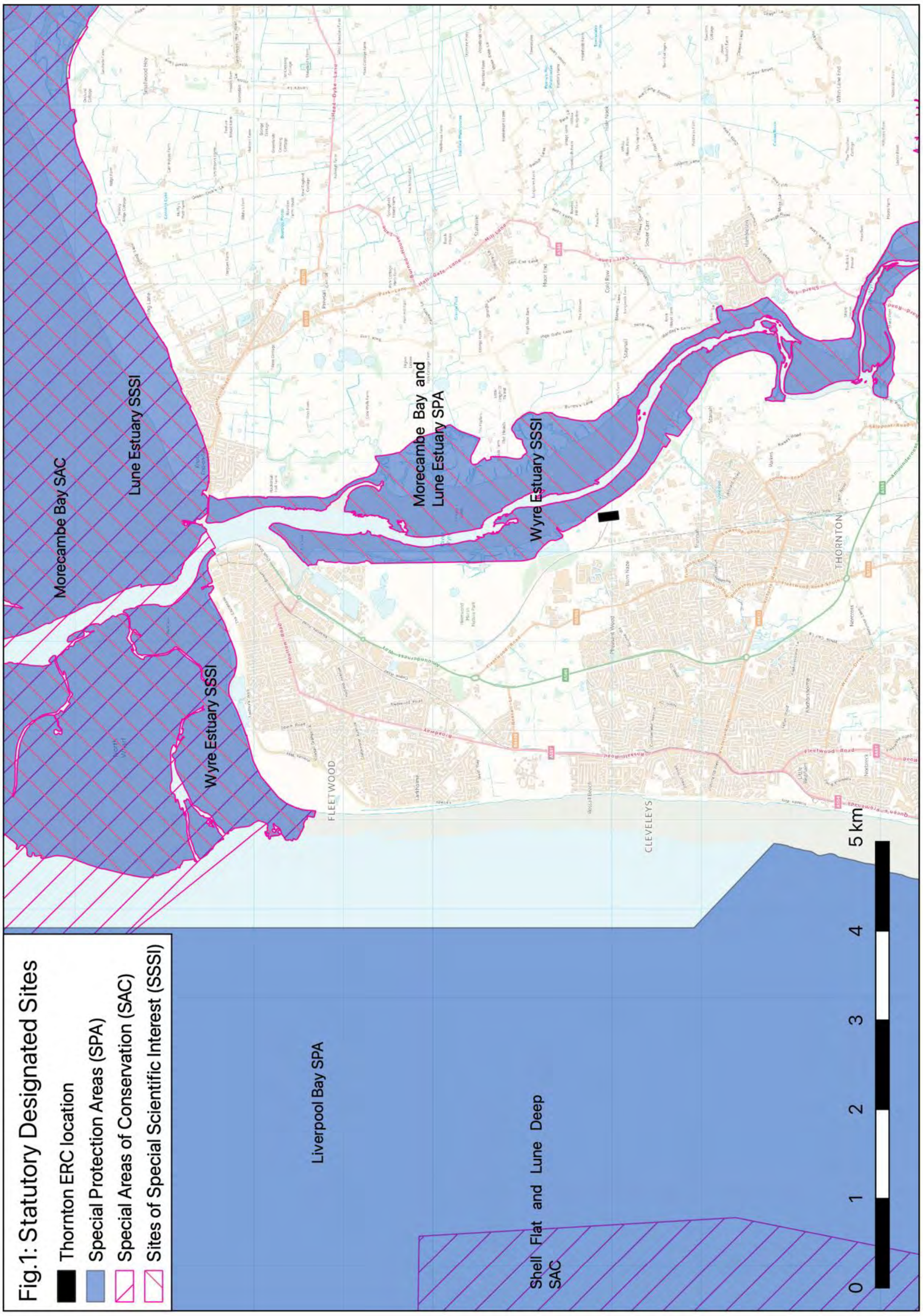


Fig. 2: Marine Conservation Zone

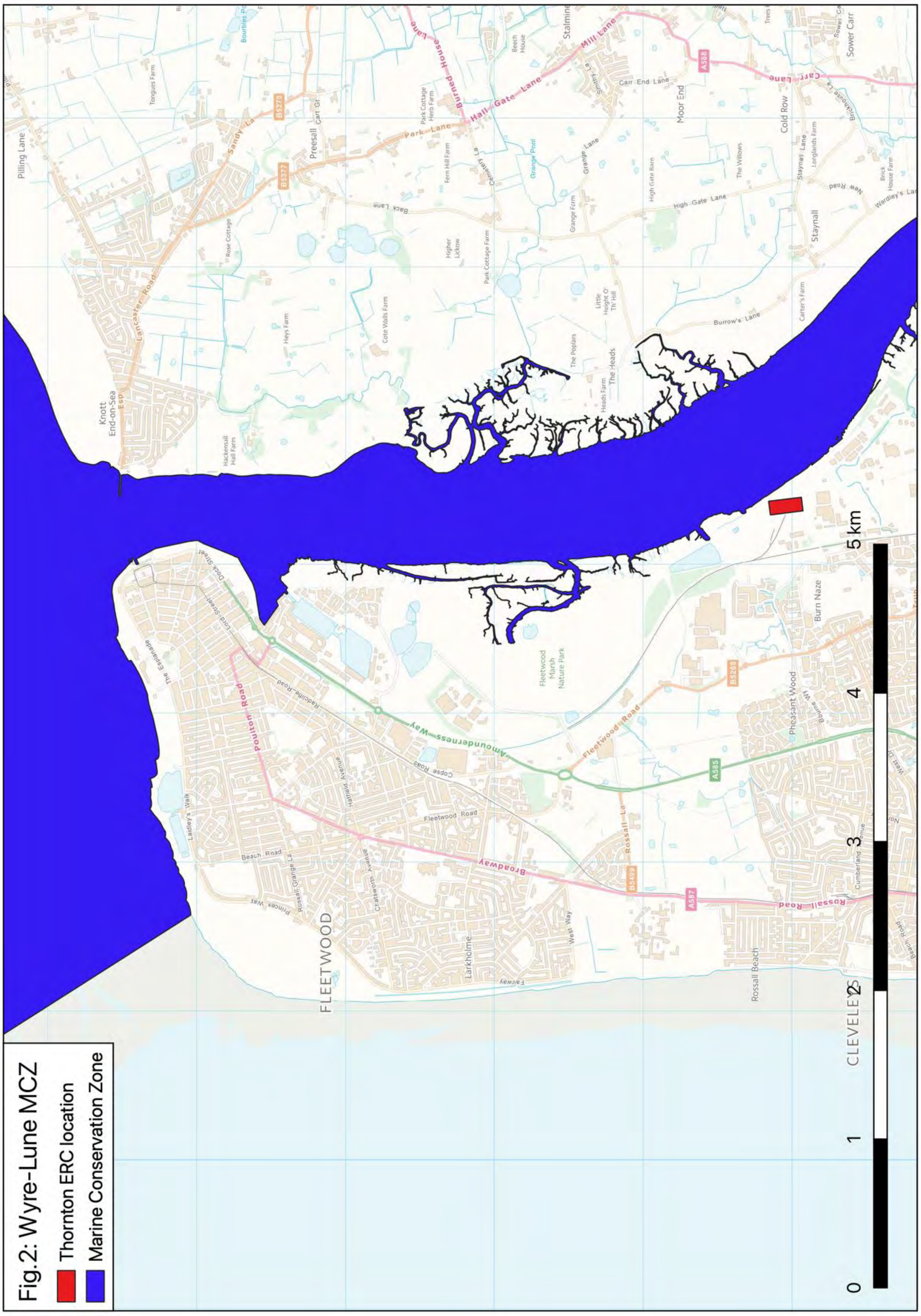


Fig. 3: SSSI Unit Condition

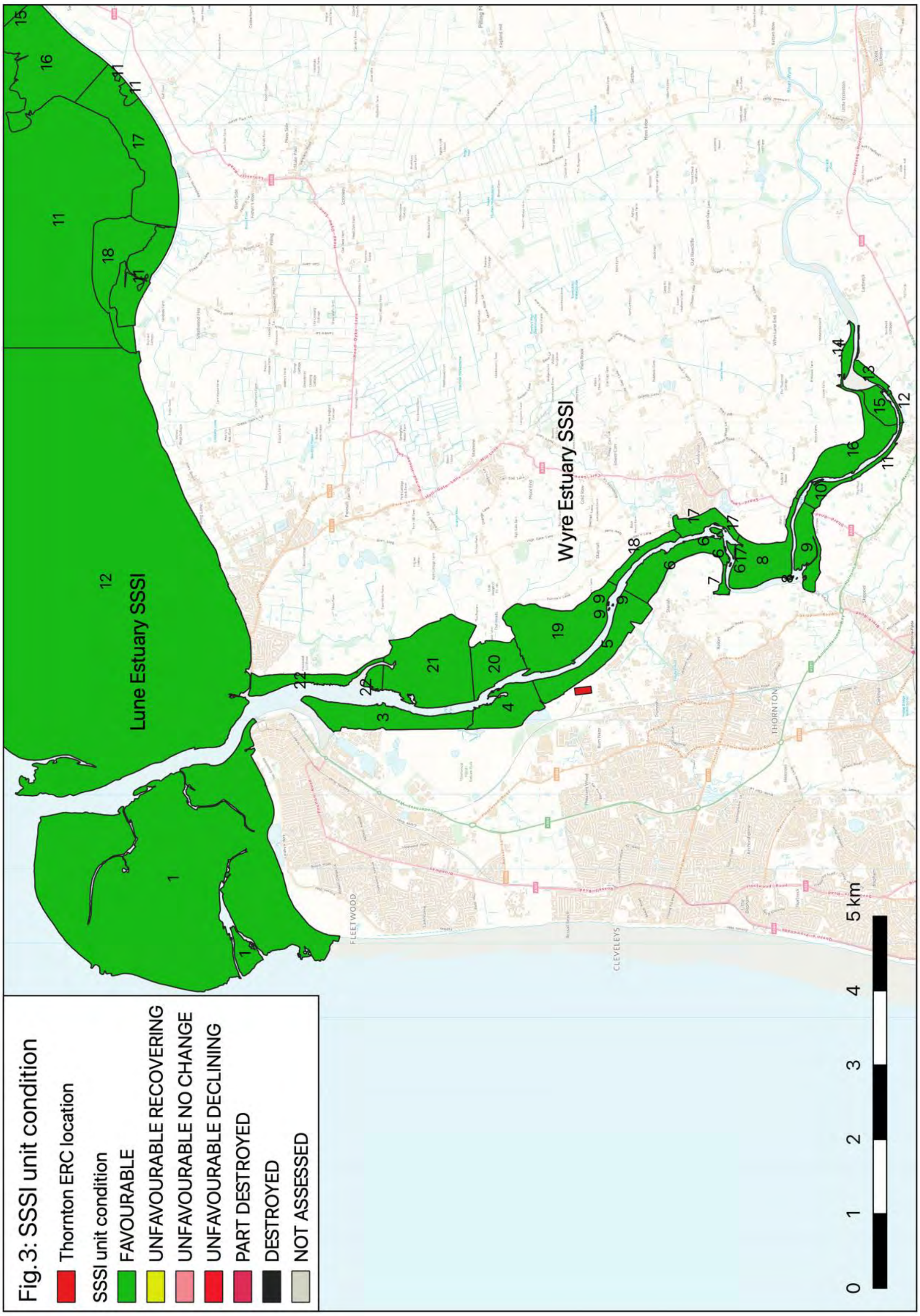
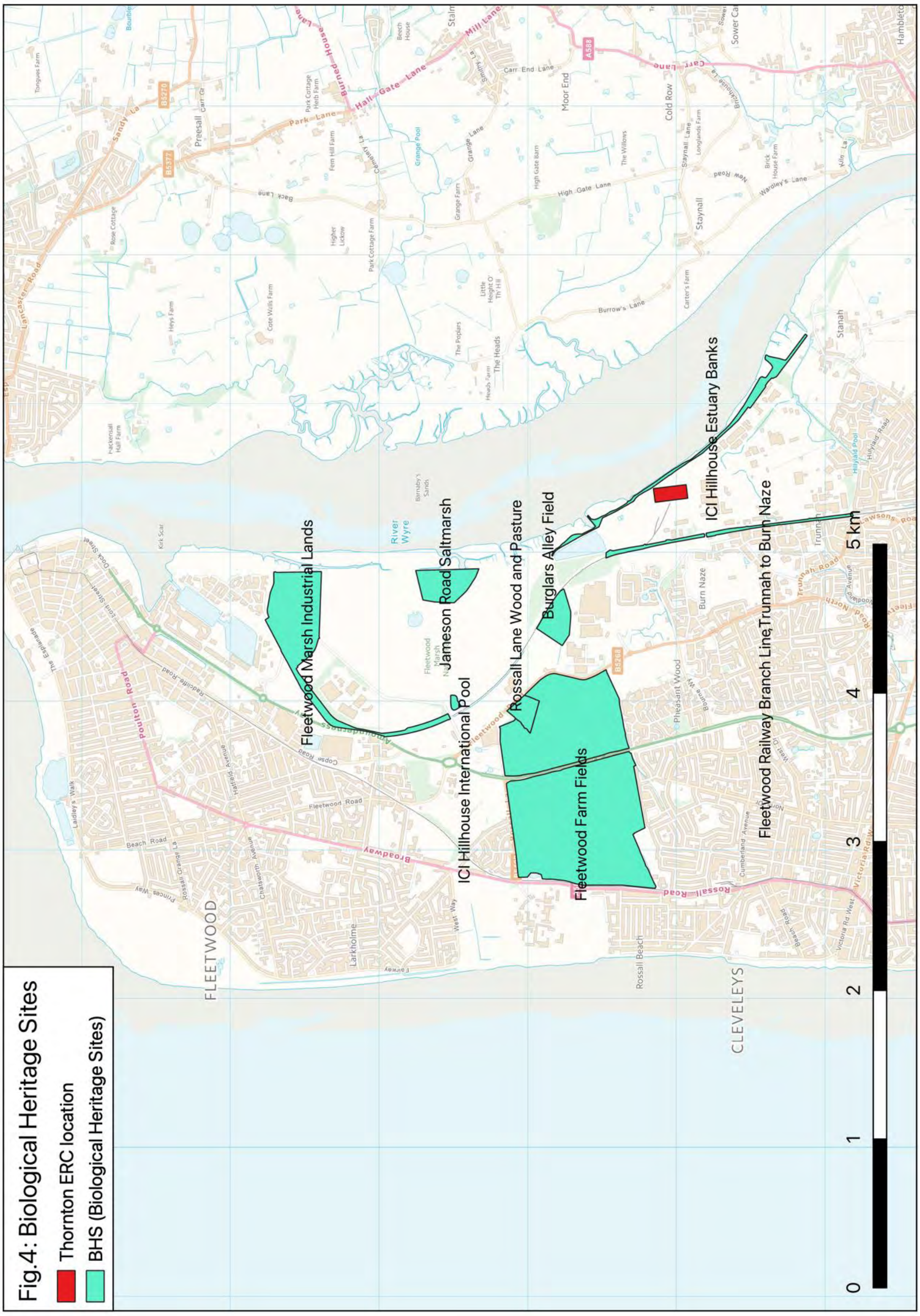


Fig. 4: Biological Heritage Sites



ENGINEERING CONSULTING

FICHTNER
Consulting Engineers Limited

Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW,
United Kingdom

t: +44 (0)161 476 0032
f: +44 (0)161 474 0618

www.fichtner.co.uk