AIR DISPERSION MODELLING ASSESSMENT OF RELEASES FROM THE PROPOSED ENERGY RECOVERY FACILITY AT TEES VALLEY

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ACRONYMS / TERMS USED IN THIS REPORT

AAD	Ambient Air Directive
ADMS	Atmospheric Dispersion Modelling System
APIS	Air Pollution Information System
AQAL	Air Quality Assessment Level
AQDD	Air Quality Daughter Directive
AQMA	Air Quality Management Area
AQMAU	Air Quality Modelling Assessment Unit
AQO	Air Quality Objective
AQS	Air Quality Standard
As	Arsenic
ASR	Annual Status Report
B[a]P	Benzo[a]Pyrene
BAT	Best Available Techniques
BAT-AEL	Best Available Techniques–Associated Emission Level
Bref	Best Available Techniques Reference Document
BSG	BSG Ecology
Cd	Cadmium
CERC	Cambridge Environmental Research Consultants
CO	Carbon monoxide
Co	Cobalt
CrIII	Chromium III
CrVI	Chromium VI
cSAC	Candidate Special Areas of Conservation
Cu	Copper
DAS	Discretionary Advice Service
DEFRA	Department for Environment, Food and Rural Affairs
DT	Diffusion Tube
EA	Environment Agency
ECL	Environmental Compliance Ltd
ELV	Emission Limit Value
EP	Environmental Permit
EPAQS	Expert Panel on Air Quality Standards
EPR	Environmental Permitting Regulations
EPUK	Environmental Protection UK
ERF	Energy Recovery Facility
FCC	FCC Waste Services (UK) Limited
GLC	Ground Level Concentration
HCl	Hydrogen Chloride
HF	Hydrogen Fluoride
Hg	Mercury
HZI	Hitachi Zosen Inova
IAQM	Institute of Air Quality Management
IED	Industrial Emissions Directive
LNR	Local Nature Reserve
Met Data	Meteorological Data
Met Office	Meteorological Office
Met Station	Meteorological Station

ACRONYMS / TERMS USED IN THIS REPORT (cont.)

Met Year	Meteorological Year
Mn	Manganese
N	Nitrogen
NE	Natural England
NH_3	Ammonia
Ni	Nickel
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NRW	Natural Resources Wales
NWP	Numerical Weather Prediction
PAH	Polyaromatic Hydrocarbons
Pb	Lead
PC	Process Contribution
PCB	Polychlorinated Biphenyls
PEC	Predicted Environmental Concentration
PM_{10}	Particulate Matter (with a diameter of 10 µm or less)
$PM_{2.5}$	Particulate Matter (with a diameter of 2.5 µm or less)
Ramsar	Ramsar Convention on Wetlands of International Importance
RCBC	Redcar and Cleveland Borough Council
REC	Redcar Energy Centre
S	Sulphur
SAC	Special Areas of Conservation
Sb	Antimony
SEPA	Scottish Environment Protection Agency
sHRA	Shadow Habitats Regulation Assessment
SO_2	Sulphur Dioxide
SPA	Special Protection Areas
SSSI	Site of Special Scientific Interest
Tl	Thallium
The Installation	Tees Valley Energy Recovery Centre
V	Vanadium
VOC	Volatile Organic Compounds
WHO	World Health Organisation

1. INTRODUCTION

1.1. The Study

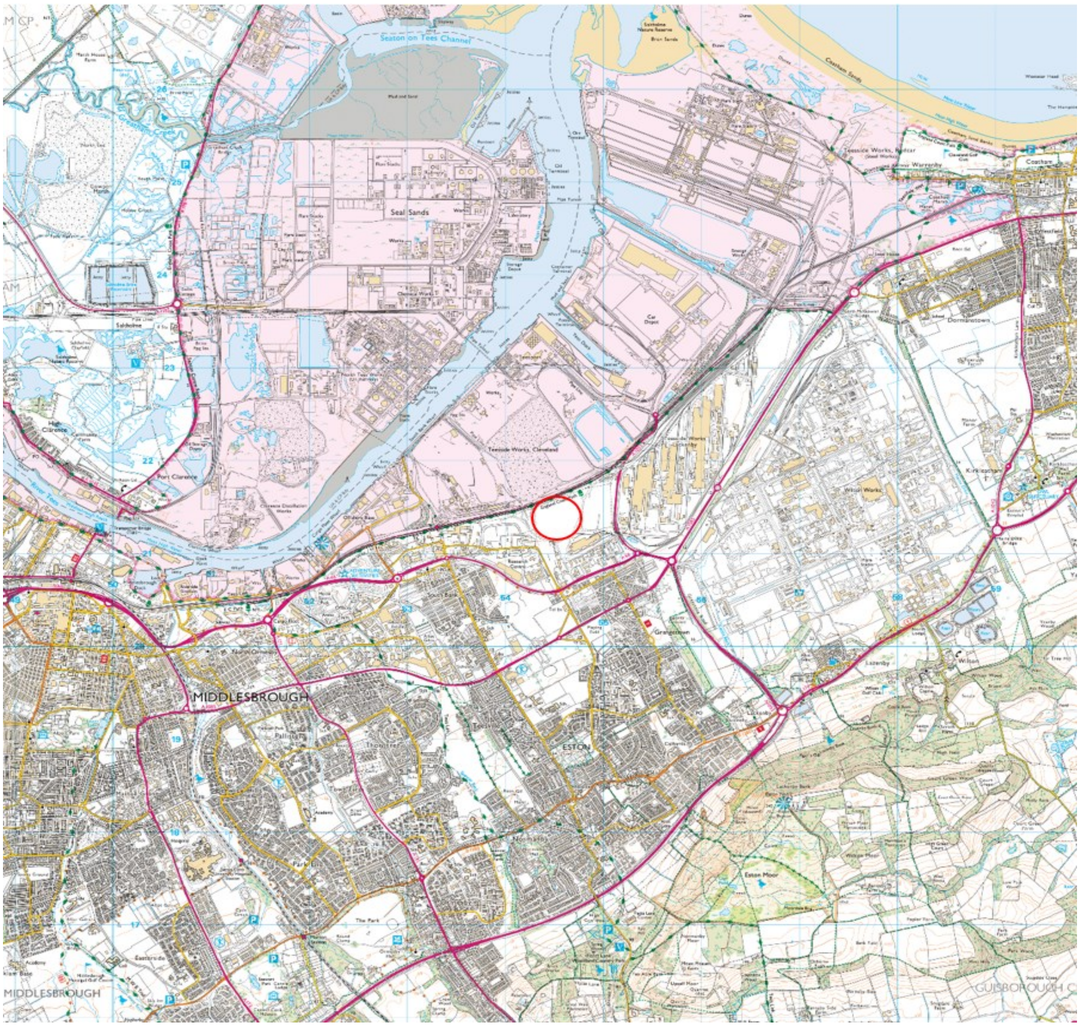
1.1.1. Environmental Compliance Ltd ("ECL") were commissioned by FCC Waste Services (UK) Limited ("FCC") to undertake an air quality assessment of releases from the proposed Energy Recovery Facility ("ERF") at Tees Valley ("the Installation"), in Grangetown, Redcar, in support of both a Planning Application to the Local Authority and an Environmental Permit ("EP") Application to the Environment Agency ("EA").

1.1.2. The study was conducted to determine the impact of emissions to air from the proposed Installation on both human health and local environmentally sensitive sites.

1.1.3. The study was undertaken using the ADMS modelling package, which is one of the models recognised as being suitable for this type of study.

1.1.4. The approximate site location is shown on the Site Location Map, outlined in red, which is presented as Figure 1.

Figure 1: Site Location Map



1.2. Objectives of the Study

1.2.1. The objectives of this study are as follows:

- to determine suitable discharge stack heights for the two emission points associated with the proposed Installation's twin lines, by undertaking a stack height screening assessment;
- to determine the maximum ground level concentrations ("GLCs") arising from the emission of pollutants from the Installation's two discharge stacks; the pollutants are assumed to be released from the Installation at the upper end of the Emission Limit Values ("ELVs") defined in the Best Available Techniques ("BAT") Reference Document ("Bref") for Waste Incineration[1] (i.e., the BAT-associated emission levels ("BAT-AELs") will be used). Annex VI of the Industrial Emissions Directive ("IED")[2] - *Technical provisions relating to waste incineration plants and waste co-incineration plants* will also be referred to. Maximum GLCs have been determined with the plant operating normally and abnormally;
- to assess the impact of emissions from the Installation's two discharge stacks on existing local air quality in relation to human health at a range of potentially sensitive receptors by comparison with relevant air quality standards ("AQSs").
- to assess the impact of emissions from the Installation's two discharge stacks on potentially sensitive ecological receptors and compare these to the Critical Levels set for the protection of Ecosystems.
- to predict deposition rates of acids and nutrient nitrogen from the modelled emissions and compare these with relevant Critical Loads at a range of sensitive habitat sites;
- to assess plume visibility;
- to assess abnormal emissions as detailed in IED; and
- to assess any cumulative impacts.

1.3. Scope of the Study

1.3.1. The first part of the study comprised a screening assessment to determine a suitable height for the Installation's two discharge stacks. The impact of the Installation on human health and sensitive habitats was assessed for a range of stack heights between 45m and 110m.

1.3.2. The main study determined the maximum predicted GLCs of the following pollutants:

- nitrogen oxides (NO_x and NO_2);
- total fine particles (PM_{10} and $PM_{2.5}$);
- carbon monoxide;
- gaseous and vaporous organic substances ("VOCs"), expressed as total organic carbon and assumed to comprise entirely of benzene (this is in accordance with the EA's guidance when grouping air emissions[3], which says where characterisation of VOCs has not been undertaken, treat all VOCs as benzene);

[1] *Best Available Techniques (BAT) Reference Document for Waste Incineration* (published December 2019). Available online via: https://eippcb.jrc.ec.europa.eu/sites/default/files/2020-01/JRC118637_WI_Bref_2019_published_0.pdf
[2] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast)
[3] *Air emissions risk assessment for your environmental permit*: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

- sulphur dioxide;
- hydrogen chloride;
- hydrogen fluoride;
- ammonia;
- mercury and its compounds;
- cadmium and thallium and their compounds;
- antimony, arsenic, chromium, cobalt, copper, lead, manganese, nickel, vanadium and their compounds (note for ease of reporting, this group of nine metals and their compounds are hereinafter referred to as "Group 3 metals and their compounds";
- dioxins and furans;
- polychlorinated biphenyls and
- PAH, as benzo[a]pyrene (the AQS for PAH is expressed as benzo[a]pyrene, and, accordingly, for the purposes of the assessment, all PAH are assumed to be present as benzo[a]pyrene).

1.3.3. Modelling was carried out using the upper end of the BAT-AELs outlined for New Plant; as specified in the BAT conclusions of the Bref document on waste incineration (published December 2019).

1.3.4. As requested by the EA, where short-term half-hourly ELVs are specified in the guidance (i.e., in Annex VI of the IED), these have also been used. It has been considered that, by assessing the impact of abnormal releases, this will help to ensure the assessment is as conservative as possible. The Daily BAT-AELs were used for the pollutants in which half-hourly ELVs have not been assigned.

1.3.5. The effects of prevailing meteorological conditions, building downwash effects, local terrain and existing ambient air quality were also taken into account.

1.3.6. The maximum predicted pollutant ground level concentrations ("GLCs") - also known as the process contributions ("PCs") - for each of the releases were compared with the relevant AQSs.

1.3.7. The predicted environmental concentrations ("PECs") - the sum of the pollutant PC and the existing pollutant background concentration from other sources - were also compared to the relevant standards. Results are presented as the maximum predicted GLC and the maximum sensitive receptor GLC.

1.3.8. The maximum predicted annual mean GLCs of NO_x, sulphur dioxide ("SO_2"), hydrogen fluoride ("HF") and ammonia ("NH_3") were compared with the Critical Levels for the Protection of Ecosystems or Vegetation detailed in the Environment Agency's online guidance[4].

1.3.9. The maximum predicted pollutant GLCs at sixteen human receptors were also compared to the relevant AQSs. There are currently no declared Air Quality Management Areas ("AQMAs") in Redcar and Cleveland Borough Council ("RCBC"). Consequently, the assessment of impact on AQMAs is not required.

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

1.3.10. Using ADMS, the rates of deposition for acids (nitrogen and sulphur, as kilo-equivalents) and nutrient nitrogen were predicted for all relevant habitat sites. These rates were then compared to the appropriate critical loads for the type and location of each habitat.

1.3.11. Abnormal operating conditions were also considered in the study to take account of short-term abnormal conditions permitted under Article 46(6) of the IED.

1.3.12. Cumulative impacts were also considered as part of the study where data was made publicly available. Of the surrounding existing and proposed developments that were acknowledged as being potentially relevant for inclusion in the model, information was only readily available for Redcar Energy Centre ("REC").

1.3.13. REC, which will be situated at land formerly occupied by Redcar Bulk Terminal (approximately 4.8km to the north of the Installation), is due to be commissioned circa 2024 to 2025. Consequently, the emissions arising from the two stacks associated with its two process lines will be incorporated into the cumulative impact assessment undertaken as part of this study. This will be carried out making use of the emissions data disclosed in the air quality chapter submitted as part of the planning application documentation for REC.

2. METHOD STATEMENT

2.1. Choice of Model

2.1.1. The UK-ADMS model was developed jointly by Cambridge Environmental Research Consultants ("CERC"), Her Majesty's Inspectorate of Pollution (the EA's predecessor body), the Meteorological Office and National Power, with sponsorship from the UK Government and a number of commercial organisations. UK-ADMS is a computer-based model of dispersion from both point and non-point sources in the atmosphere and is one of the modelling packages that are suitable for this type of study. The current version is ADMS 5.2 (model version 5.2.4.0).

2.1.2. ADMS 5.2 has been validated against a number of data sets in order to assess various configurations of the model such as flat or complex terrain, line/area/volume sources, buildings, dry deposition fluctuations and visible plumes. The model results have been compared to observational data or other model results if available.

2.1.3. ADMS 5.2 is a new generation Gaussian plume air dispersion model, which means that the atmospheric boundary layer properties are characterised by two parameters:

- the boundary layer depth, and
- the Monin-Obukhov length,

rather than in terms of the single parameter Pasquill-Gifford class.

2.1.4. Dispersion under convective meteorological conditions uses a skewed Gaussian concentration distribution (shown by validation studies to be a better representation than a symmetrical Gaussian expression).

2.1.5. ADMS 5.2 is therefore considered to be suitable for use in this assessment.

2.2. Key Assumptions

2.2.1. The study will be undertaken on the basis of a worst-case scenario. Consequently, the following assumptions have been made:

- the release concentrations of the pollutants will be at the permitted ELVs on a 24-hourly basis, 365 days of the year; in practice, when the plant is operating, the release concentrations will be below the ELVs, and, for most pollutants, considerably so; furthermore, taking shutdowns for planned maintenance into account, the plant will not operate for 365 days;
- the highest predicted pollutant GLCs for the six years of meteorological data for each averaging period (annual mean, hourly, etc.) have been used;
- concentrations of NO_2 in the emissions have been calculated assuming a long-term 70% NO_X to NO_2 conversion rate, and a short-term 35% NO_X to NO_2 as referenced in AQTAG06[5];
- all of the particulate releases will be present as $PM_{2.5}$ and also as PM_{10}; this enables direct comparison with the particle AQSs, which are expressed in terms of $PM_{2.5}$

[5] AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air (April 2014);

and PM_{10}; in practice, this will not be the case as some of the particles present will be larger than PM_{10}; and
- maximum predicted GLCs at any location, irrespective of whether a sensitive receptor is characteristic of public exposure, are compared against the relevant AQSs for each pollutant; in addition, the predicted maximum sensitive receptor GLC has also been assessed.

2.3. Sensitive Human Receptors

2.3.1. In addition to predicting concentrations over a 4km by 4km grid, there are sixteen potentially sensitive human receptors considered in the assessment (up to a distance of 1.8km from the main stacks). Details of these receptors are provided in Table 1 and a visual representation as Figure 2. All receptors are assumed to be at ground level.

Table 1: Potentially Sensitive Human Receptors

ADMS Ref.	Name	Easting (X)	Northing (Y)	Distance from Source (m)	Heading (degrees)
HSR1	Industrial activity off John Boyle Road	453979	521277	422	252
HSR2	Industrial activity off Stapylton Street	454699	520909	594	147
HSR3	Industrial activity off Eston Road	454299	520815	600	188
HSR4	Residential properties off Cheetham Street	454963	520759	875	138
HSR5	Residential properties off Elgin Avenue	454538	520528	896	170
HSR6	Residential properties off Passfield Crescent	453847	520674	908	216
HSR7	Golden Boy Green Community Centre	453574	520682	1085	228
HSR8	Residential properties off Lawson Close	453902	520378	1137	205
HSR9	Industrial activity NNW of Site	453756	522499	1255	330
HSR10	Grangetown Primary School	455105	520341	1292	146
HSR11	Large car park off Tees Dock Road	455114	522527	1337	33
HSR12	Saint Peter's Catholic College	453817	520136	1392	204
HSR13	Tesco Extra store entrance	454155	519997	1431	189
HSR14	Industrial activity off Tees Dock Road	454411	523108	1698	1
HSR15	Industrial activity ENE of Site	456030	521841	1706	75
HSR16	Allotments South Garden	453212	520097	1757	222

Notes to Table 1

(a) Distances are measured as the crow flies from the defined point of the receptor to the 'Source'. The 'Source' is the approximate halfway location between the two emission points associated with the incinerator – location coordinates: 454379 (X), 521410 (Y).

Figure 2: Location of the Potentially Sensitive Human Receptors Considered for the Assessment

Notes to Figure 2

The red circle is the approximate location of the proposed emission points (Line 1 and Line 2) at the Installation;

The neon green squares with the red outline and yellow highlighted annotations are the locations of the potentially sensitive human receptor locations specified in Table 1; and

The darker green shapes represent the buildings layout considered in the modelling assessment (refer to Section 2.16., for further details).

2.4. Sensitive Ecological Receptors

2.4.1. The impact of emissions to air on vegetation and ecosystems from the Installation has been assessed for the following sensitive environmental receptors within 10km of the proposed discharge stack:

- Special Areas of Conservation ("SACs") and candidate SACs ("cSACs") designated under the EC Habitats Directive[6];
- Special Protection Areas ("SPAs") and potential SPAs designated under the EC Birds Directive[7];
- SACs and SPAs are included in an EU-wide network of protected sites called Natura 2000[8]. The EC Habitats Directive and Wild Birds Directive have been transposed into UK law by the Habitats Regulations[9].
- Ramsar Sites designated under the Convention on Wetlands of International Importance[10];

2.4.2. In addition, the impact of emissions to air on vegetation and ecosystems from the Installation has been assessed for the following sensitive environmental receptors within 2km of the discharge stack:

- Sites of Special Scientific Interest ("SSSI") established by the 1981 Wildlife and Countryside Act;
- Ancient woodland; and
- local nature sites (ancient woodland, local wildlife sites and national and local nature reserves).

2.4.3. For dispersion modelling purposes, the specified habitat coordinates are a precautionary approach, and are those located at the boundary of the protected site / priority habitat approximately closest in distance to the proposed Installation. All receptors are assumed to be at ground level. The details of the habitat sites are provided in Table 2, and a visual representation provided in Figure 3.

[6] Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora
[7] Council Directive 79/409/EEC on the conservation of wild birds
[8] www.natura.org
[9] The Conservation (Natural Habitats, &c.) Regulations 1994. The Conservation (Natural Habitats, &c.) (Amendment) Regulations 1997 (Statutory Instrument 1997 No. 3055), The Conservation (Natural Habitats, &c.) (Amendment) (England) Regulations 2000 (Statutory Instrument 2000 No. 192)
[10] The Convention of Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, Iran,1971)

Table 2: Ecological Receptors Considered for the Assessment

ADMS Ref.	Name [a]	Designation [a]	Easting (X) [a]	Northing (Y) [a]	Distance from Source [b] (m)	Heading (degrees)
NYM1	North York Moors	SAC, SPA	458895	512978	9565	152
TCC1	Teesmouth and Cleveland Coast [c]	SPA, SSSI	453277	522462	1524	314
TCC2			454760	523212	1842	12
TCC3			454282	523483	2075	357
TCC4			452203	521269	2181	266
TCC5		SPA, Ramsar	453002	522482	1745	308
TCC6			452430	521870	2003	283
TCC7			451970	521355	2410	269
TCC8			454304	524213	2804	358
TCC9			455670	524302	3167	24
TCC10			450882	522960	3825	294
TCC11			453572	525627	4294	349
TCC12			451681	525099	4570	324
TCC13			456614	525978	5085	26
TCC14 [d]		SSSI	453880	526160	4776	354

Notes to Table 2

(a) The ecological sites included were identified using the Multi-Agency Geographic Information System for the Countryside ("MAGIC") portal and via the EA's pre-application advice Nature and Heritage Conservation Screening Report (reference EPR/ZP3309LW/A001).

(b) Distances are measured as the crow flies from the approximate nearest point of the boundary of the ecological receptor / priority habitat location to the 'Source'. The 'Source' is the approximate halfway location between the two emission points associated with the incinerator – location coordinates: 454379 (X), 521410 (Y).

(c) Please note that, as the Teesmouth and Cleveland Coast ecological site covers a large area and is broken up into many different segments, depending on the designation and coastal priority habitat, to account for any variations to the predicted PCs with changing meteorological effects – multiple boundary points have been selected in numerous compass directions from the proposed Installation.

(d) TCC14 was retrospectively added following discussions with Natural England to further assess the predicted impact of aerial emissions on the Seal Sands peninsula (specifically the SSSI).

Figure 3: Location of the Potentially Sensitive Ecological Receptors Considered for the Assessment

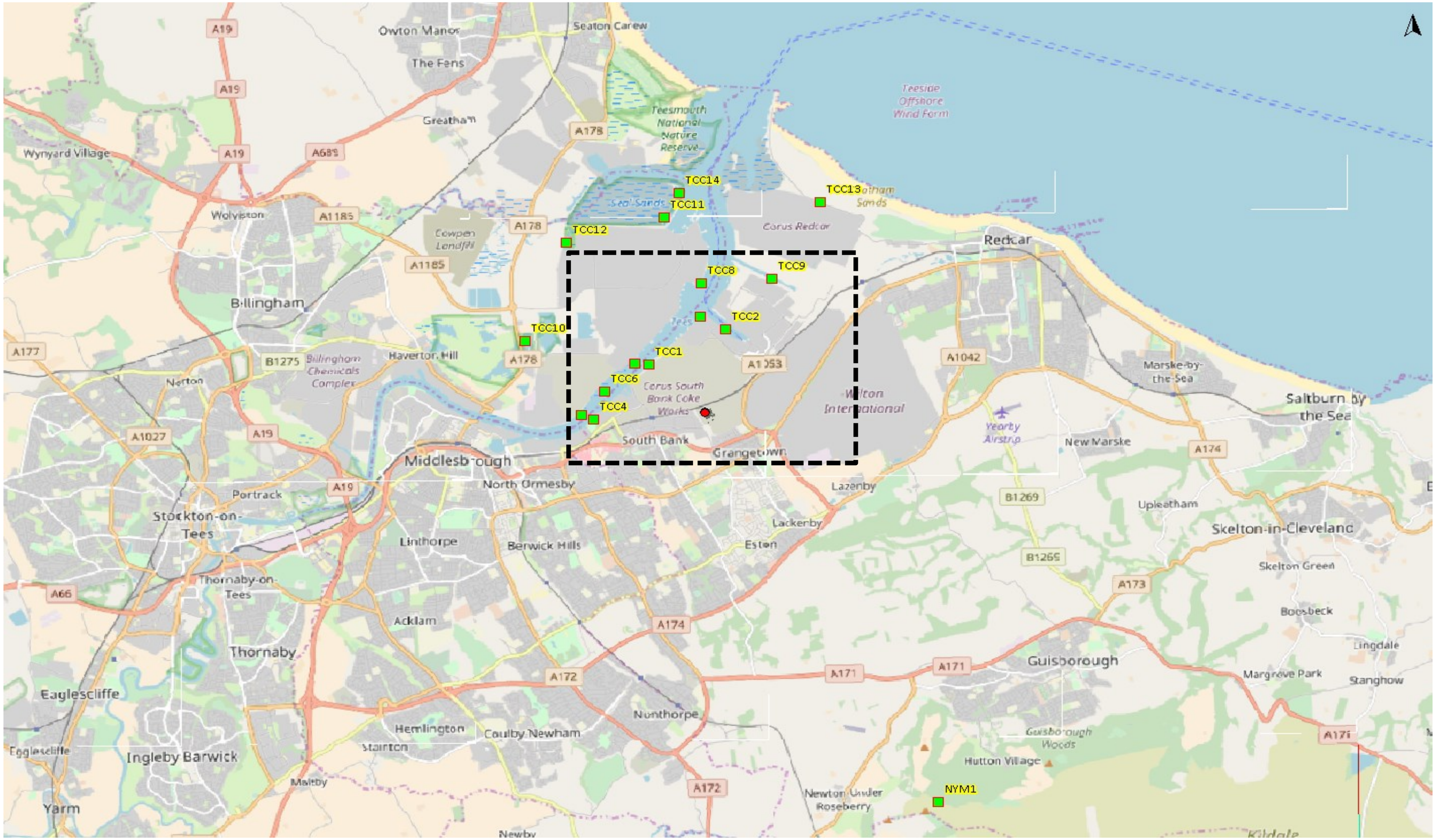


Figure 3: Location of the Potentially Sensitive Ecological Receptors Considered for the Assessment (cont.)

Notes to Figure 3

The red circle is the approximate location of the proposed emission points (Line 1 and Line 2) at the Installation;

The neon green squares with the red outline and yellow highlighted annotations are the locations of the ecological receptor locations specified in Table 2; and

The darker green shapes represent the buildings layout considered in the modelling assessment (refer to Section 2.16., for further details)

2.5. Air Quality Standards for the Protection of Human Health

2.5.1. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland[11] details Air Quality Strategy Objectives for a range of pollutants, including a number that are directly relevant to this study. In addition, the Regulatory Authorities must ensure that the proposals do not exceed Ambient Air Direction ("AAD") limit values.

2.5.2. The 4th Air Quality Daughter Directive[12] ("AQDD") details Target Values for arsenic, cadmium and nickel. The Expert Panel on Air Quality Standards ("EPAQS"), which advises the UK Government on air quality, has set recommended Guideline Values for arsenic, chromium VI and nickel; the EPAQS Guideline Value for nickel is the same as the AQDD Target Value, but the EPAQS Guideline Value for arsenic is half that of the AQDD value. The lowest of these values have been taken into account in this study.

2.5.3. In the case of hydrogen chloride, hydrogen fluoride, chromium (VI) and arsenic, EPAQS has set recommended Guideline Values which have been taken into account in this study. Environmental Quality Standards ("EQSs") have been assigned by the EA (by the use of the EA's EQS) to a number of the other pollutants assessed in the modelling study; these are detailed (where assigned) in the EA's online guidance; these have been derived from a variety of published UK and international sources (including the World Health Organisation ("WHO")).

2.5.4. In this report, the generic term Air Quality Standard ("AQS") is used to refer to any of the above values. The various AQSs - Air Quality Objectives, Target Values, EPAQS Guideline Values and EALs - are intended to be used as guidelines for the protection of human health and the management of local air quality. The values relevant to this study are detailed in Table 3.

[11] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1), July 2007

[12] Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air, 15th December 2004.

Table 3: Air Quality Standards for the Protection of Human Health

Pollutant	Averaging Period	AQS ($\mu g/m^3$)	Comments
Nitrogen Dioxide (NO_2)	annual	40	UK Air Quality Objective ("AQO") and Ambient Air Directive ("AAD") Limit
	1-hour	200	UK AQO and AAD Limit, not to be exceeded more than 18 times per annum, equivalent to the 99.79th percentile of 1-hour means
Sulphur Dioxide (SO_2)	24-hour	125	UK AQO, not to be exceeded more than 3 times per annum, equivalent to the 99.18th percentile of 24-hour means
	1-hour	350	UK AQO, not to be exceeded more than 24 times per annum, equivalent to the 99.73rd percentile of 1-hour means
	15-minute	266	UK AQO, not to be exceeded more than 35 times per annum, equivalent to the 99.90th percentile of 15-minute means
Particulate Matter, as PM_{10}	annual	40	UK AQO
	24-hour	50	UK AQO, not to be exceeded more than 35 times per annum, equivalent to the 90.41st percentile of 24 hour means
Particulate Matter, as $PM_{2.5}$	annual	20	AAD Limit
Carbon Monoxide (CO)	8-hour	10,000	UK AQO and AAD Limit
VOC (as benzene)	Annual	5	AAD Limit and AQS Objective
Ammonia	Annual	180	EAL derived from long-term occupational exposure limits
	1-hour	2,500	EAL derived from long-term occupational exposure limits as no short-term limit exists
Hydrogen chloride	1-hour	750	EPAQS Guideline Value
Hydrogen Fluoride (HF)	Annual	16	EPAQS Guideline Values
	1-hour	160	

Table 3: Air Quality Standards for the Protection of Human Health (Cont.)

Pollutant	Averaging Period	AQS ($\mu g/m^3$)	Comments
Antimony (Sb)	annual	5	EAL derived from long-term occupational exposure limits
	1-hour	150	EAL derived from long-term occupational exposure limits as no short-term limit exists
Arsenic (As)	annual	0.003	EPAQS Guideline Value
Cadmium (Cd)	annual	0.005	AQDD Target Value/EPAQS Guideline Value
Chromium III (CrIII)	annual	5	EAL derived from long-term occupational exposure limits
	1-hour	150	EAL derived from long-term occupational exposure limits as no short-term limit exists
Chromium VI (Cr VI)	annual	0.0002	EPAQS Guideline Value
Cobalt (Co)	annual	0.2	EAL derived from long-term occupational exposure limits
	1-hour	6	EAL derived from short-term occupational exposure limits
Copper (Cu)	annual	10	EAL derived from short-term occupational exposure limits
	1-hour	200	EAL derived from long-term occupational exposure limits
Lead (Pb)	annual	0.25	UK AQO
Manganese (Mn)	annual	1	WHO Guideline Value
	1-hour	1,500	EAL derived from long-term occupational exposure limits as no short-term limit exists
Mercury (Hg)	annual	0.25	EAL derived from long-term occupational exposure limits
	1-hour	7.5	EAL derived from long-term occupational exposure limits as no short-term limit exists

Table 3: Air Quality Standards for the Protection of Human Health (Cont.)

Pollutant	Averaging Period	AQS ($\mu g/m^3$)	Comments
Nickel (Ni)	annual	0.02	AQDD Target Value/EPAQS Guideline Value
Thallium (Tl)	Annual	1	EAL derived from long-term occupational exposure limits
	1-hour	30	EAL derived from short-term occupational exposure limits
Vanadium (V)	annual	5	EAL derived from long-term occupational exposure limits
	24-hour	1	WHO Guideline Value
PAH (as Benzo[a]pyrene)	annual	0.00025	UK AQO
PCBs	annual	0.2	EAL
	1-hour	6	EAL
Dioxins and Furans	No Standard Applies		

2.6. Assessment Criteria for the Protection of Sensitive Habitat Sites and Ecosystems - Critical Levels

2.6.1. Critical levels are thresholds of airborne pollutant concentrations above which damage may be sustained to sensitive plants and animals. High concentrations of pollutants in ambient air directly cause harm to leaves and needles of forests and other plant communities. Oxidised nitrogen can have both a toxic effect on vegetation and an impact on nutrient nitrogen.

2.6.2. The 2008 Air Quality Directive[13] set limit values for the protection of vegetation and ecosystems and these have been adopted by the Air Quality Strategy but are not currently set in Regulations. The current objectives are summarised in Table 4.

[13] Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe, 21st May 2008

Table 4: Assessment Criteria for the Protection of Sensitive Habitats and Ecosystems

Pollutant	Averaging Period	Critical Level (µg/m³)	Comments
Nitrogen Oxides (as NO_2)	annual	30	Air Quality Objective
	daily	75	(a)
Sulphur Dioxide (SO_2)	annual	10	Sensitive lichen communities & bryophytes and ecosystems where lichens & bryophytes are an important part of the ecosystem's integrity (a)
	annual	20	Air Quality Objective
	winter mean	20	Air Quality Objective
Ammonia (NH_3)	annual	1	Sensitive lichen communities & bryophytes and ecosystems where lichens & bryophytes are an important part of the ecosystem's integrity (b)
	annual	3	All other ecosystems (b)
Hydrogen Fluoride (HF)	daily	5	(c)
	weekly	0.5	(c)

Notes to Table 4
(a) WHO (2000) Air Quality Guidelines for Europe; 2nd Edition. WHO Regional Publications, European Series, No. 91.
(b) UN Economic & Social Council, Executive Body for the Convention on Long-Range Transboundary Air Pollution, ECE/EB.AIR/WG.5/2007/3.
(c) Mc Cune, DC (1969a): Fluoride criteria for vegetation reflect the diversity of the plant kingdom. In a symposium: The technical significance of air quality standards. Environmental Science & Technology. 3: 720-735.

2.7. Assessment Criteria for the Protection of Sensitive Habitat Sites and Ecosystems - Critical Loads

2.7.1. Critical Loads are defined as:
"a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"[14].

2.7.2. Critical loads for nutrient nitrogen are set under the Convention on Long-Range Transboundary Air Pollution based on empirical evidence, mainly observations from experiments and gradient studies. Critical loads[15] are assigned to habitat classes of the European Nature Information System[16] in units of kgN/ha/yr.

2.7.3. Predicted NO_x deposition rates in units of $\mu g\ m^{-2}\ s^{-1}$ are converted to units of kg/ha/yr as nitrogen for direct comparison with critical loads as follows:

$$kgN/ha/yr = \mu g/m^2/s \times (14/46)^{17} \times 315.36^{18}$$

[14] From http://www.unece.org/env/lrtap/WorkingGroups/wge/definitions.htm
[15] From http://www.apis.ac.uk/overview/issues/overview_Cloadslevels.htm
[16] See http://eunis.eea.europa.eu/ for details
[17] Ratio of atomic weight of nitrogen to molecular weight of nitrogen dioxide
[18] Conversion factor from µg/m² to kg/ha.

2.7.4. Exceedance of critical loads for nitrogen deposition can result in significant terrestrial and freshwater impacts due to changes in species composition, reduction in species richness, increase in nitrate leaching, increases in plant production, changes in algal productivity and increases in the rate of succession[19].

2.7.5. In the UK, an empirical approach is applied to critical loads for acidity for non-woodland habitats; and the simple mass balance equation is applied to both managed and unmanaged woodland habitats. For freshwater ecosystems, national critical load maps are currently based on the First-order Acidity Balance model. All of these methods provide critical loads for systems at steady-state[15] in units of keq/ha/yr.

2.7.6. The unit kiloequivalent (keq) is the molar equivalent of potential acidity resulting from sulphur or oxidised and reduced nitrogen. Predicted acid deposition rates in units of $\mu g/m^2/s$ are converted to units of keq/ha/yr) as hydrogen for direct comparison with critical loads as follows:

- nitrogen from NO_x (keq) $=([NO_x]\mu g/m^2/s \times (14/46) \times 315.36) \div 14$[20]
- sulphur (keq) $=([SO_2]\mu g/m^2/s \times (32/64) \times 315.36) \div 16$[21].

2.7.7. Emissions of ammonia ("NH_3") and hydrogen chloride ("HCl") from the Installation will also contribute to the total acidification rate.

2.7.8. Exceedance of the critical loads for acid deposition can result in significant terrestrial and freshwater impacts due to leaching and subsequent increase in availability of potentially toxic metal ions.

2.7.9. Table 5 list the site-specific critical loads for nutrient nitrogen deposition and acid deposition. Features are as indicated on the Air Pollution Information System ("APIS") website (for SAC's) or directly from the SSSI citation. Where a primary feature identified in the SSSI citation was not listed on the APIS website, an equivalent feature was used to derive critical loads as indicated in the Habitats Table on the APIS website[22]. The Critical Load values for acidification were based on the grid reference for the ecological receptor as stated in Table 2.

2.7.10. A summary of site-specific baseline nutrient nitrogen and acid deposition rates, as provided by APIS, is also presented in Table 5. Again, the specific deposition rates for each ecological receptor have been obtained from the same point as listed in Table 2, i.e., the closest grid square to the point of the site used in the assessment.

[19] From http://www.apis.ac.uk/overview/issues/overview_Cloadslevels.htm#_Toc279788052
[20] 14kg nitrogen/ha/yr = 1keq nitrogen/ha/yr
[21] 16kg sulphur/ha/yr= 1keq sulphur/ha/yr
[22] http:/www.apis.ac.uk/habitat_table.html

Table 5: Critical Loads for Deposition

ADMS Receptor Reference	Site Name and Designation	Habitat Interest and Habitat Feature	Nutrient Nitrogen - Empirical Critical Load (kgN/ha/yr)		Acid Deposition (keq/ha/yr)		
			Lower Critical Load (N)	Upper Critical Load (N)	CL MinN	CL MaxN	CL MaxS
NYM1	North York Moors - SAC	Blanket Bogs - Raised and blanket bogs	5	10	0.321	0.504	0.183
		Northern Atlantic wet heaths with Erica tetralix - Erica tetralix dominated wet heath	10	20	0.499	0.792	0.15
		European dry heaths - Dry heaths	10	20	0.499	0.792	0.15
NYM1	North York Moors - SPA	European Golden Plover - Reproducing - Montane habitats	5	10	0.178	0.471	0.15
		European Golden Plover - Reproducing - Bogs	5	10	0.321	0.504	0.183
		European Golden Plover - Reproducing - Dwarf shrub heath	10	20	0.499	0.792	0.15
		Merlin - Reproducing - Dwarf shrub heath	10	20	0.499	0.792	0.15
TCC1 – TCC13 [(a)]	Teesmouth and Cleveland Coast - SPA	Sandwich Tern - Concentration - Supralittoral sediment - Coastal stable dune grasslands (acid type)	8	10	0.223	1.998	1.56
		Sandwich Tern - Concentration - Supralittoral sediment - Shifting coastal dunes	10	20	Species not sensitive due to acidity impacts on broad habitat		

Table 5: Critical Loads for Deposition (cont.)

ADMS Receptor Reference	Site Name and Designation	Habitat Interest and Habitat Feature	Nutrient Nitrogen - Empirical Critical Load (kgN/ha/yr)		Acidity Critical Loads (keq/ha/yr)		
			Lower Critical Load (N)	Upper Critical Load (N)	CL MinN	CL MaxN	CL MaxS
TCC1 – TCC13 [(a)]	Teesmouth and Cleveland Coast - SPA (cont.)	Sandwich Tern - Concentration - Supralittoral sediment - Coastal stable dune grasslands (calcareous type)	10	15	0.856	4.856	4
		Little Tern - Reproducing - Supralittoral sediment - Coastal stable dune grasslands (acid type)	8	10	0.223	1.998	1.56
		Little Tern - Reproducing - Supralittoral sediment - Shifting coastal dunes	10	20	Species not sensitive due to acidity impacts on broad habitat		
		Little Tern - Reproducing - Supralittoral sediment - Coastal stable dune grasslands (calcareous type)	10	15	0.856	4.856	4
		Common Shelduck - Wintering - Littoral sediment - Pioneer, low-mid, mid-upper saltmarshes	20	30	Species not sensitive due to acidity impacts on broad habitat		
		Eurasian teal - Wintering - Littoral sediment - Pioneer, low-mid, mid-upper saltmarshes	20	30	Species not sensitive to acidity impacts		
		Eurasian teal - Wintering - Standing open water and canals	No comparable habitat with established critical load estimates available				
		Red Knot - Wintering - Littoral sediment - Pioneer, low-mid, mid-upper saltmarshes	20	30	Habitat / species not sensitive due to acidity impacts on broad habitat		

Table 5: Critical Loads for Deposition (cont.)

ADMS Receptor Reference	Site Name and Designation	Habitat Interest and Habitat Feature	Nutrient Nitrogen - Empirical Critical Load (kgN/ha/yr)		Acidity Critical Loads (keq/ha/yr)		
			Lower Critical Load (N)	Upper Critical Load (N)	CL MinN	CL MaxN	CL MaxS
TCC1 – TCC13 [a]	Teesmouth and Cleveland Coast – SPA (cont.)	Sanderling - Wintering - Littoral sediment - Pioneer, low-mid, mid-upper saltmarshes	20	30	Habitat / species not sensitive due to acidity impacts on broad habitat		
		Common Redshank - Concentration - Littoral sediment - Pioneer, low-mid, mid-upper saltmarshes	20	30	Habitat / species not sensitive due to acidity impacts on broad habitat		
		Great Cormorant - Wintering - Standing open water and canals	No comparable habitat with established critical load estimates available		No values given by APIS		
		Northern Shoveler - Wintering - Standing open water and canals			Species not sensitive due to acidity impacts on broad habitat		
TCC1 – TCC4 & TCC14	Teesmouth and Cleveland Coast – SSSI	Supralittoral sediment (Ammophila arenaria - arrhenatherum elatius dune grassland)	8	15	No information currently published by APIS		
		Supralittoral sediment (Ammophila arenaria - Festuca rubra semi-fixed dune community)	8	15			
		Supralittoral sediment (Festuca rubra - Galium verum fixed dune grassland)	8	15			
		Supralittoral sediment (Phleum arenarium - Arenaria serpyllifolia dune annual community)	8	15			

Table 5: Critical Loads for Deposition (cont.)

ADMS Receptor Reference	Site Name and Designation	Habitat Interest and Habitat Feature	Nutrient Nitrogen - Empirical Critical Load (kgN/ha/yr)		Acidity Critical Loads (keq/ha/yr)		
			Lower Critical Load (N)	Upper Critical Load (N)	CL MinN	CL MaxN	CL MaxS
TCC1 – TCC4 & TCC14	Teesmouth and Cleveland Coast – SSSI (cont.)	Supralittoral sediment (Ammophila arenaria mobile dune community)	10	20	No information currently published by APIS		
		Supralittoral sediment (Elymus farctus ssp. Boreali-atlanticus foredune community)	10	20			
		Supralittoral sediment (Leymus arenarius mobile dune community)	10	20			
		Supralittoral sediment (Salix repens - Holcus Lanatus dune slack community)	10	20			
		Littoral sediment (Annual Salicornia Saltmarsh)	20	30			
		Littoral sediment (Elytrigia atherica saltmarsh)	20	30			
		Littoral sediment (Elytrigia repens saltmarsh)	20	30			
		Littoral sediment (Puccinellia maritima saltmarsh, Limonium vulgare - Armeria maritima sub-community)	20	30			
		Littoral sediment (Puccinellia maritima saltmarsh, Puccinellia maritima dominant sub-community)	20	30			
		Littoral sediment (Suaeda Maritima Saltmarsh)	20	30			

Table 5: Critical Loads for Deposition (cont.)

ADMS Receptor Reference	Site Name and Designation	Habitat Interest and Habitat Feature	Nutrient Nitrogen - Empirical Critical Load (kgN/ha/yr)		Acidity Critical Loads (keq/ha/yr)		
			Lower Critical Load (N)	Upper Critical Load (N)	CL MinN	CL MaxN	CL MaxS
TCC1 – TCC4 & TCC14	Teesmouth and Cleveland Coast – SSSI (cont.)	Littoral sediment (Transitional low marsh vegetation with Puccinellia maritima, annual Salicornia species and Suaeda maritima.)	20	30	No information currently published by APIS		
		Supralittoral sediment (Honkenya peploides - Cakile maritima strandline community)	Not assessed for this feature				
		Coastal stable dune grasslands (calcareous type)	10	15			
		Sterna albifrons - Little Tern / Common Tern / Sandwich Tern – Bird – Breeding – Supralittoral sediment (acidic type)	8	10			
		Calidris alba – Sanderling – Bird – Nonbreeding – Littoral sediment	20	30			
		Calidris canutus - Knot– Bird – Nonbreeding – Littoral sediment	20	30			
		Charadrius hiaticula - Ringed Plover – Bird – Nonbreeding – Littoral sediment	20	30			
		Philomachus pugnax – Ruff – Bird – Nonbreeding – Neutral grassland and Littoral sediment	20	30			
		Recurvirostra avosetta – Avocet – Bird – Breeding – Littoral sediment	20	30			

Table 5: Critical Loads for Deposition (cont.)

ADMS Receptor Reference	Site Name and Designation	Habitat Interest and Habitat Feature	Nutrient Nitrogen - Empirical Critical Load (kgN/ha/yr)		Acidity Critical Loads (keq/ha/yr)		
			Lower Critical Load (N)	Upper Critical Load (N)	CL MinN	CL MaxN	CL MaxS
TCC1 – TCC4 & TCC14	Teesmouth and Cleveland Coast – SSSI (cont.)	Tadorna tadorna – Shelduck – Bird – Nonbreeding – Littoral sediment	20	30	No information currently published by APIS		
		Tringa totanus - Redshank – Bird – Nonbreeding – Littoral sediment	20	30			
		>20,000 Non-breeding waterbirds - >20,000 Non-Breeding Waterbirds – Standing open water and canals	No comparable habitat with established critical load estimates available				
		Anas clypeata – Shoveler – Bird – Nonbreeding – Standing open water and canals					
		Anas strepera – Gadwall – Bird – Nonbreeding – Standing open water and canals					
		Calidris maritima - Purple Sandpiper – Bird – Nonbreeding – Littoral rock	Species' broad habitat not sensitive to Nitrogen				
		Phoca vitulina - Common Seal – Inshore sublittoral rock					
TCC5 – TCC13 [(a)]	Teesmouth and Cleveland Coast - Ramsar [(b)]	Coastal stable dune grasslands (calcareous type)	10	15	0.856	4.856	4.00

Notes to Table 5

(a) Please note that, as the Teesmouth and Cleveland Coast ecological site covers a large area and is broken up into many different segments, depending on the designation / coastal priority habitat, to account for any variations to the predicted PCs with changing meteorological effects – multiple boundary points have been selected in numerous compass directions from the proposed Installation.

(b) APIS does not provide data for the Ramsar site – however, as the Ramsar site is noted for the same bird species as the SPA, it is reasonable to assume that the site should be treated in the same way. Consequently, and in the interest of being conservative, the SPA habitat interest and feature with the lowest lower critical load assigned to it, has been selected.

2.8. Habitat Site Specific Baseline Concentrations and Deposition Rates

2.8.1. Airborne NO_X, SO_2 and NH_3 Concentrations

2.8.1.1. A summary of site-specific baseline concentrations of NO_X, SO_2 and NH_3, as provided by APIS, is presented in Table 6. Background concentrations for each ecological receptor have been obtained at the same point as listed in Table 2 i.e., the closest grid square to the point of the site used in the assessment.

Table 6: Baseline Concentrations of NO_X, SO_2 and NH_3

ADMS Receptor Reference	Name and Designation(s)	Background Concentration [(a)]			
		NO_X (µg/m³)		SO_2 (µg/m³)	NH_3 (µg/m³)
		Annual Mean	24 Hour Mean [(b)]	Annual Mean	Annual Mean
NYM1	North York Moors – SAC, SPA	8.67	10.23	0.91	1.95
TCC1	Teesmouth and Cleveland Coast – SPA, SSSI [(c)]	25.65	30.27	3.05	1.6
TCC2		35.78	42.22		
TCC3					
TCC4		28.89	34.09		
TCC5	Teesmouth and Cleveland Coast – SPA and Ramsar [(c)]	25.65	30.27	3.05	1.6
TCC6		28.89	34.09		
TCC7		27.59	32.56		
TCC8		49.1	57.94		
TCC9		27.93	32.96	3.89	1.42
TCC10		21.62	25.51	3.05	1.6
TCC11		41.45	48.91	2.38	1.71
TCC12		19.51	23.02	2.38	1.71
TCC13		21.52	25.39	0 [(d)]	0.89
TCC14	Teesmouth and Cleveland Coast – SSSI [(c)]	24.14	28.49	2.38	1.71

Notes to Table 6

(a) Background concentrations for the relevant ecological habitats have been taken from the APIS website for the closest grid square to the site (data year: 2017-2019).

(b) The 24-hour mean baseline concentration is twice the annual mean multiplied by a factor of 0.59, in accordance with the H1 guidance.

(c) Please note that, as the Teesmouth and Cleveland Coast ecological site covers a large area and is broken up into many different segments, depending on the designation and coastal priority habitat, to account for any variations to the predicted PCs with changing meteorological effects – multiple boundary points have been selected in numerous compass directions from the proposed Installation.

(d) With APIS reporting a concentration of 0 µg/m³, it is suspected this value is erroneous. In the interest of being conservative the SO_2 value from TCC11 (i.e., the receptor closest in distance to TCC13) of 2.38 µg/m³ will be used for calculating the SO_2 PECs for TCC13.

2.8.2. Nutrient Nitrogen and Acid Deposition

1.8.2.3. A summary of site-specific baseline nutrient nitrogen and acid deposition rates, as provided by APIS, is presented in Table 7. Again, the specific deposition rates for each ecological receptor have been obtained from the same point as listed in Table 2, i.e., the closest grid square to the point of the site used in the assessment.

Table 7: Background Nutrient Nitrogen and Acid Deposition

ADMS Receptor Reference	Name and Designation(s)	Nutrient Nitrogen Background (kgN/ha/yr) [(a)]	Acid Deposition Background - (keq/ha/yr) [(b)]		
			Total	Nitrogen	Sulphur
NYM1	North York Moors – SAC, SPA	14.98	1.46	1.36	0.18
TCC1	Teesmouth and Cleveland Coast – SPA, SSSI [(c)]	8.96	1.19	1.03	0.2
TCC2					
TCC3					
TCC4					
TCC5	Teesmouth and Cleveland Coast – SPA and Ramsar [(c)]				
TCC6					
TCC7					
TCC8					
TCC9		8.4	1.2	1.01	0.23
TCC10		8.96	1.19	1.03	0.2
TCC11		10.78	1.31	1.07	0.28
TCC12		10.78	1.31	1.07	0.28
TCC13		9.1	0.95	0.75	0.25
TCC14	Teesmouth and Cleveland Coast – SSSI [(c)]	10.78	1.31	1.07	0.28

Notes to Table 7

(a) Background concentrations for nutrient nitrogen deposition have been taken from the APIS website (specifically the *APIS GIS map tool*) for the relevant grid square. The concentrations provided are the grid averages, with 2018 selected as the midyear for all sites with the exception of TCC13 (with 2016 being the latest available midyear).

(b) Background concentrations for acid deposition have been taken from the APIS website for the closest grid square to the site (data year: 2017-2019).

(c) Please note that, as the Teesmouth and Cleveland Coast ecological site covers a large area and is broken up into many different segments, depending on the designation, to account for any variations to the predicted PCs with changing meteorological effects – multiple boundary points have been selected in numerous compass directions from the proposed Installation.

2.9. Deposition Parameters - Sensitive Habitats

2.9.1. Deposition of nitrogen and acids at designated habitats sites was also included in the assessment. This focused on sites within 10km of the Installation as detailed in Section 2.4.3. The pollutant deposition rates are presented in Table 8. These parameters are detailed in AQTAG06. Since woodland sites have a greater surface area, higher deposition velocities are adopted for these sites.

2.9.2. For acidification impacts, the deposition of oxides of nitrogen, ammonia, sulphur dioxide and hydrogen chloride are considered. For nutrient nitrogen, the deposition of the oxides of nitrogen and ammonia are included.

Table 8: Acid/Nitrogen Deposition Parameters [a]

Pollutant	Dry Deposition Velocity for Grassland (m/s)	Dry Deposition Velocity for Woodland (m/s)
Sulphur Dioxide	0.012	0.024
Oxides of Nitrogen (as NO_2)	0.0015	0.003
Ammonia	0.02	0.03
Hydrogen Chloride	0.025	0.06

Note to Table 8
(a) As detailed in AQTAG06.

2.10. Background Air Quality

2.10.1. Background air quality data has been obtained for all pollutants, where relevant, so that the PECs can be calculated. Where background concentrations were needed, the source and concentrations used are discussed in the relevant sections of this report.

2.11. Stack Emission Parameters

2.11.1. The stack emission parameters used in the study are presented in Table 9 for the two main stacks (designated A1 and A2). Emissions parameters were provided by Hitachi Zosen Inova ("HZI").

Table 9: Stack Emission Parameters

Parameter	Line 1 (A1)	Line 2 (A2)
Stack Height (m)	TBC (45-110m)	TBC (45-110m)
Stack Exit Diameter (m)	1.90	1.90
Stack Gas Discharge Velocity (actual) (m/s)	18.44	18.44
Stack Gas Discharge Temperature (°C)	135	135
Stack Centre Coordinates	454379 (X) 521412 (Y)	454381 (X) 521408 (Y)
Oxygen Concentration in Stack Emission (%)	5.9	5.9
Moisture Concentration in Stack Emission (%)	20.4	20.4
Actual Volumetric Flowrate (m^3/s)	52.28	52.28
Normalised Volumetric Flowrate (Nm^3/s) [a]	42.19	42.19

Notes to Table 9
(a) Referenced to 273K, 1 atm, dry and 11% O_2.

2.11.2. The ELVs assumed for each pollutant and the pollutant mass emission rate for the study are presented in Table 10a for the daily ELVs. Similarly, Tables 10b and 10c display the pollutants where ELVs have been assigned for abnormal emissions – both for half-hourly emission limits and for abnormal operating conditions, respectively. These are the assumed ELVs used for the modelling assessment.

Table 10a: Pollutant Emission Rates – Daily ELVs

Pollutant	ELV [(a)] [(b)] (mg/Nm^3)	A1 & A2 (g/s)
NO_x as NO_2 [(c)]	100	4.22
SO_2	30	1.27
CO	50	2.11
PM_{10} [(d)]	5	0.211
$PM_{2.5}$ [(d)]	5	0.211
VOCs (as Benzene)	10	0.422
HCl	6	0.253
HF	1	0.0422
Cd/Tl	0.02	0.000844
Hg	0.02	0.000844
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V	0.3	0.0127
NH_3	10	0.422
Dioxins and Furans	0.00000004	0.00000000169
PAH (as benzo[a]pyrene) [(e)]	0.0001	0.0000422
PCBs	0.00000008	0.00000000337

Notes to Table 10a

(a) Concentrations are at reference conditions i.e., 273K, 1 atmosphere, 11% oxygen, dry.

(b) Unless stated otherwise, the BAT-AELs have been used (new plant, high end).

(c) A lower NO_x BAT-AEL of 100 mg/Nm^3 is being proposed (as opposed to the high end BAT-AEL for NO_x of 120 mg/Nm^3) to improve the Installation's NO_x emissions. It has been considered that this, in turn, should reduce the environmental impact associated with the Installation's NO_x emissions, as well as helping to future proof the plant.

(d) It has been assumed that all particulate matter can be present as PM_{10} or $PM_{2.5}$.

(e) There is no ELV for B[a]P. Consequently, an appropriate ELV for the purposes of the modelling study was required. The BREF for the waste incineration sector quotes emission levels for B[a]P ranging from 0.004ng/Nm^3 to 1µg/Nm^3. Actual emissions testing from another plant (FCC Millerhill) using the same HZI technology gave results of between 0.0147 µg/m^3 and 0.0179 µg/m^3. As the BREF document uses data from older as well as more modern incineration plant, it is considered that a limit of 1 µg/Nm^3 would be overly conservative and would not provide realistic results. It is also approximately 70 times that of the actual emissions observed. Consequently, for the purposes of this modelling study a value of 0.1 µg/Nm^3 has been used for emissions of B[a]P. This is still some 7 times greater than the actual emissions observed, however still retains a degree of conservatism for the assessment.

Table 10b: Pollutant Emission Rates – Half-Hourly Emission Limits

Pollutant	ELV [(a)] [(b)] (mg/Nm^3)	A1 & A2 (g/s)
NO_x as NO_2	400	16.9
SO_2	200	8.44
PM_{10}	30	1.27

Table 10b: Pollutant Emission Rates – Half-Hourly Emission Limits (cont.)

Pollutant	ELV [(a) (b)] (mg/Nm^3)	A1 & A2 (g/s)
VOCs (as Benzene)	20	0.844
HCl	60	2.53
HF	4	0.169

Notes to Table 10b
(a) Concentrations are at reference conditions i.e., 273K, 1 atmosphere, 11% oxygen, dry.
(b) Half-hourly emission limits as prescribed in Annex VI of the IED.

Table 10c: Pollutant Emission Rates – Abnormal Releases

Pollutant	ELV [(a) (b)] (mg/Nm^3)	A1 & A2 (g/s)
NOx as NO_2 – Long-term	102.05	4.31
NOx as NO_2 – Short-term	400	16.87
SO_2	200	8.44
CO	100	4.22
PM_{10} – Long-term	5.99	0.253
PM_{10} – Short-term	29.2	1.23
HCl	60	2.53
HF (annual)	1.02	0.0431
HF – Short-term	4	0.169

Notes to Table 10c
(a) Concentrations are at reference conditions i.e., 273K, 1 atmosphere, 11% oxygen, dry.
(b) ELVs as per Article (6) of the IED – when taking account of short-term abnormal operating conditions.

2.12. Meteorological (Met) Data

2.12.1. ADMS has a meteorological pre-processing capability, which calculates the required boundary layer parameters from a variety of data. Meteorological data ("met data") can be utilised in its sequentially analysed form, which estimates the pattern of dispersion through 10° sectors from the source or as raw data.

2.12.2. The Meteorological Office ("Met Office") were contacted to query the location of the nearest appropriate meteorological station ("met station") for the purposes of providing data for an air dispersion modelling assessment utilising ADMS.

2.12.3. The met station option presented by the Met Office was Loftus, which is located approximately 19 km to the east of the Installation. Further to pre-application discussions with the EA, the EA's Air Quality Modelling and Assessment Unit ("AQMAU") commented that Loftus met station is in a hilly environment, compared to the relatively flat topography in the vicinity of the proposed Installation, and therefore might not provide representative met data. Taking this into consideration, a years' worth of site-specific Numerical Weather

Prediction ("NWP") data has also been used in the modelling study to allow for sensitivity testing and comparisons between observed met data and modelled met data.

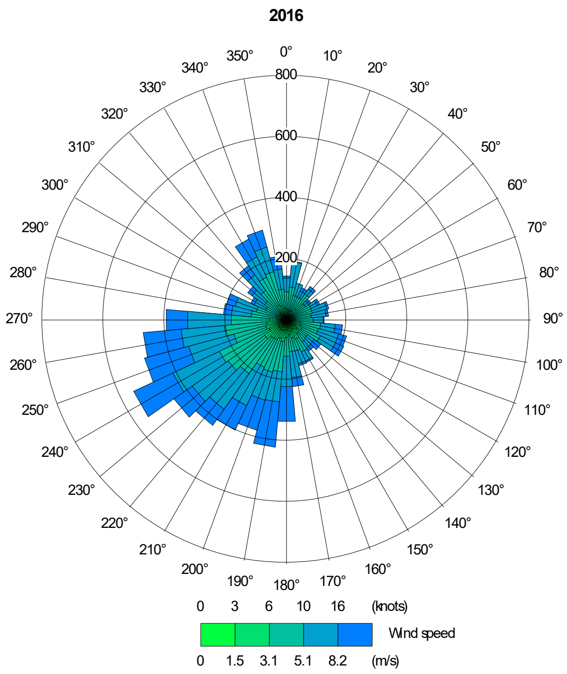
2.12.4. Consequently, the assessment utilises five years (2016 – 2020, inclusive) of observed data from Loftus met station and one year (2020) of modelled (NWP) data (all hourly sequentially analysed in sectors of 10°).

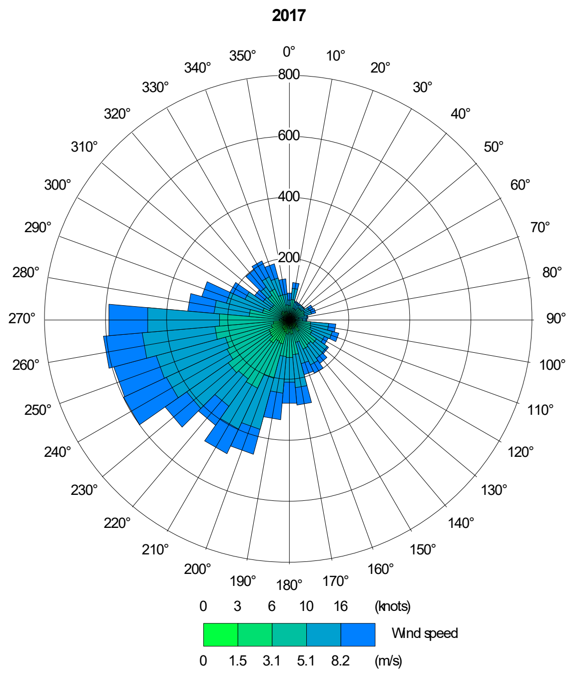
2.12.5. Over the five years (43,848 hours) of meteorological data used from Loftus, ADMS reported that 17 hours were calm, 263 hours contained inadequate data and 394 hours were non-calm met data lines with a wind speed less than the minimum value (0.75 m/s). These represent 0.04%, 0.60% and 0.90% of the data, respectively.

2.12.6. Of the one year (8,784 hours) of 2020 NWP data, ADMS reported that 0 hours were calm, 0 hours contained inadequate data and 211 hours were non-calm met data lines with a wind speed less than the minimum value (0.75 m/s). The non-calm met data lines represent 2.40% of the data, with the remaining 97.60% of the met data used.

2.12.7. Wind roses for the data are presented as Figure 4.

Figure 4: Wind Roses - Met Years 2016-2020 (Loftus) + 2020 NWP





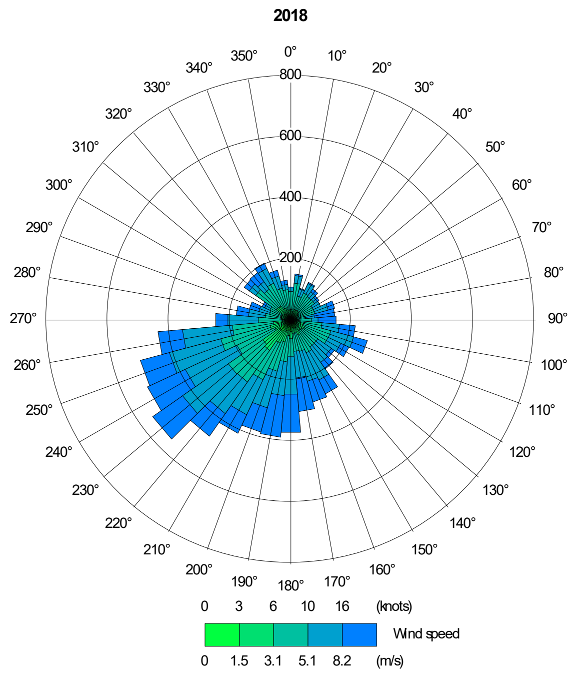
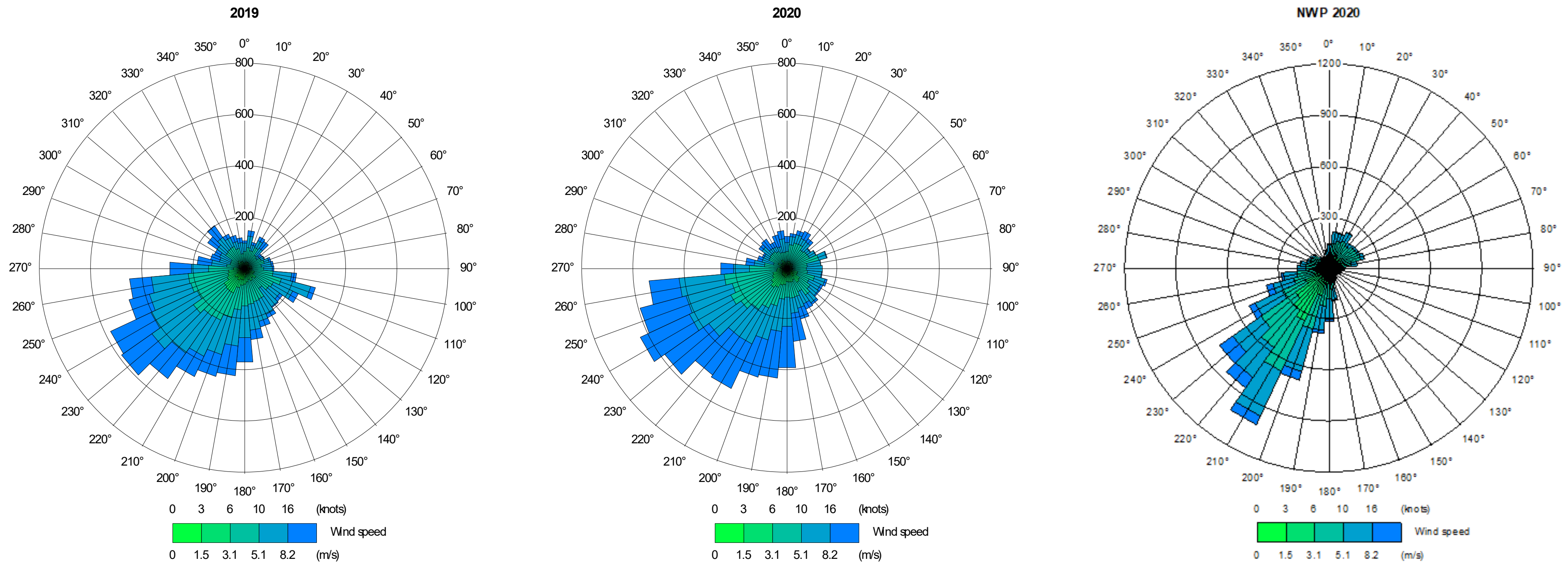


Figure 4: Wind Roses - Met Years 2016-2020 (Loftus) + 2020 NWP (cont.)



2.12.8. It is apparent, from the wind roses shown in Figure 4, that the prevailing winds are predominantly south-westerly for all the met data considered.

2.12.9. The wind rose for the NWP data, compared to the observed data from Loftus recording station, appears to demonstrate a more significant and focused south-westerly wind. Differences in the prevailing wind direction, as well as the other meteorological effects accounted for, will have an impact on dispersion modelling. Consequently, all six years of met data will be used in the modelling assessment and impacts will be based on the worst case met year regardless of observed or NWP.

2.13. Surface Albedo

2.13.1. The surface albedo is the ratio of reflected to incident shortwave solar radiation at the surface of the earth[23]. ADMS allows the user to set this value between 0 and 1. A value of 0.40-0.95 would be considered representative of snow-covered ground where a large proportion of the light is reflected, soils from 0.05-0.40, agricultural crops 0.18-0.25, and grass would be 0.16 – 0.26 depending on length[24]. A value of 0.23 is an average value for non-snow-covered surfaces and is the default value used in the model. This value is considered appropriate for the rural setting of the dispersion site.

2.14. Priestley-Taylor Parameter

2.14.1. The Priestly Taylor parameter is a parameter representing the surface moisture available for evaporation[27]. This parameter must be set between 0 and 3 where 0 would be classed as dry bare earth, 0.45 as dry grassland, 1 as moist grassland and a value of 3 is suggested for a saturated forest surrounded by forest[25]. The value of 1 was considered to be appropriate for the rural setting of the dispersion site.

2.15. Minimum Monin-Obukhov Length

2.15.1. The Monin-Obukhov length provides a measure of the stability of the atmosphere. For example, in urban areas the air is affected by heat generated from buildings and traffic which prevents the atmosphere from becoming stable. In rural areas the atmosphere would be more stable. The minimum Monin-Obukhov length can be set between 1 and 200m. Typical values would be[27]:

- large conurbations >1 million = 100m;
- cities and large towns = 30m;
- mixed urban/industrial = 30m;
- small towns <50,000 = 10m; and
- rural areas = 1m.

[23] ADMS5 User Guide, CERC, V5, Nov 2012
[24] TR Oke, Buondary Layer Climates, 2nd Edition 1987
[25] J P Lhomme, A Theorestivl Basis for the Priestley-Taylor Coefficient, February 1997.

2.15.2. A value of 30m was used as this value is considered appropriate for the combination of residential and industrial land use experienced in the vicinity of the dispersion site.

2.16. Buildings Data

2.16.1. The building parameters utilised for the study are detailed in Table 11 and a plan view is provided as Figure 5.

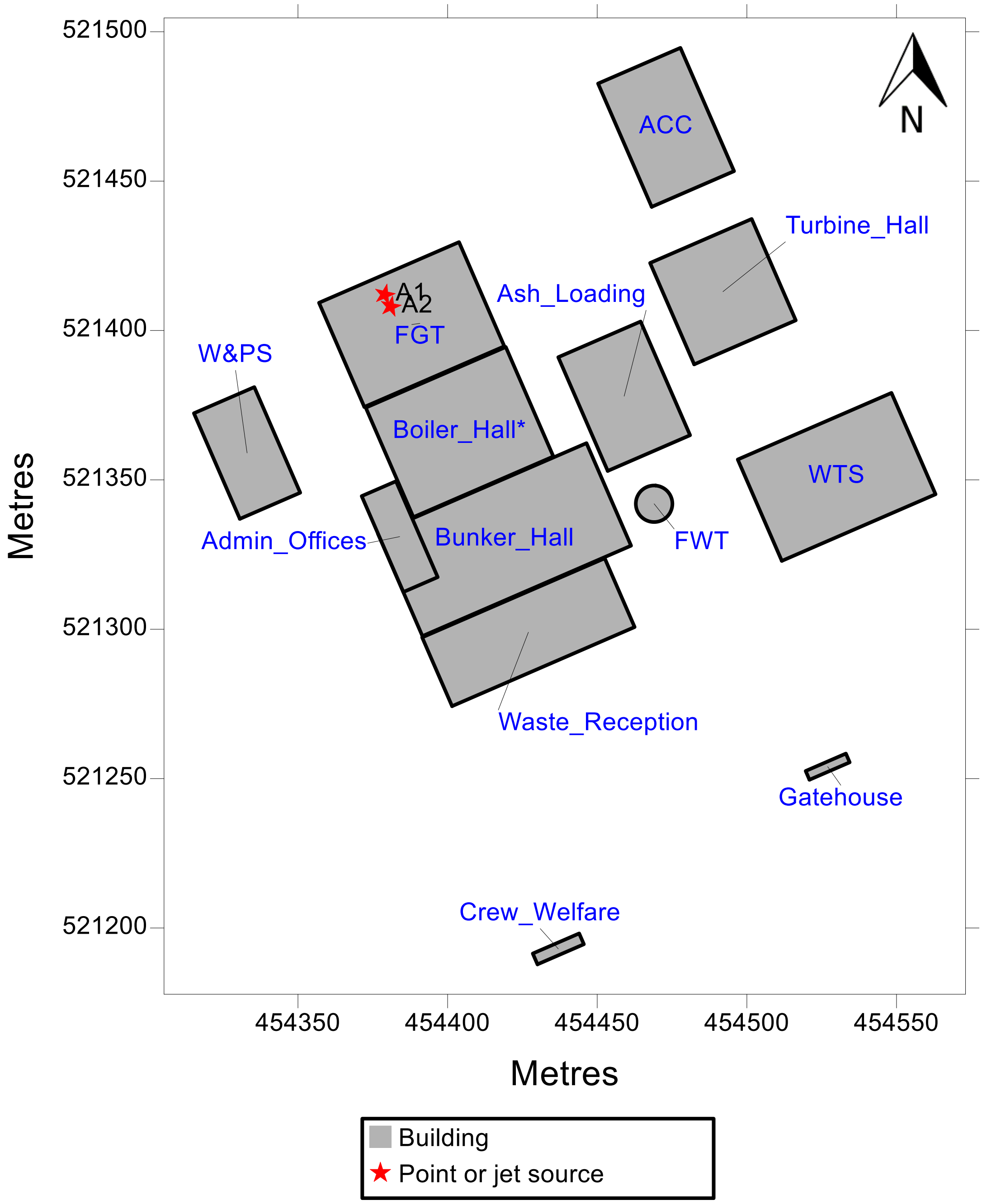
Table 11: On-Site Building Parameters

Building	X [a]	Y [a]	Angle (°) [b]	Height (m) [c]	Length/ Diameter (m) [c]	Width (m) [c]
Boiler Hall	454403	521366	-23.5°	46.00	39.96	51.00
FGT	454388	521402	-23.5°	32.95	38.02	51.00
Bunker Hall	454419	521330	-23.5°	40.15	37.43	76.00
Waste Reception	454427	521299	-23.5°	21.65	25.10	66.50
Admin Offices	454384	521331	-23.5°	40.15	35.00	12.50
Ash Loading	454459	521378	-23.5°	16.00	41.50	30.00
Turbine Hall	454492	521413	-23.5°	27.00	37.00	37.00
Air Cooled Condensers (ACC)	454473	521468	-23.5°	24.25	45.00	30.00
Waste Transfer Station (WTS)	454530	521351	-23.5°	11.00	37.00	56.00
Workshop and Parts Store (W&PS)	454333	521359	-23.5°	11.00	38.54	22.00
Gatehouse	454527	521254	-23.5°	4.25	3.20	14.65
Crew Welfare	454437	521193	-23.5°	3.98	3.95	16.90
Fire Water Tank (FWT)	454469	521342	n/a	12.05	12.23	
Boiler Hall	454404	521366	-23.5°	46.00	39.96	51.00
FGT	454388	521402	-23.5°	32.95	38.02	51.00
Bunker Hall	454419	521330	-23.5°	40.15	37.43	76.00
Waste Reception	454427	521299	-23.5°	21.65	25.10	66.50
Admin Offices	454384	521331	-23.5°	40.15	35.00	12.50

Notes to Table 11

(a) X(m), Y(m) denote the grid reference coordinates of the centre of the building.
(b) Angle denotes the angle between north and the side designated as length in the ADMS model.
(c) Building dimensions confirmed by Garry Stewart Design Associates Limited (GSDA).

Figure 5: Buildings Layout – Plan View



2.17. Terrain Data – Grid Resolution

2.17.1. ADMS has a terrain pre-processing capability, which calculates the required boundary layer parameters from a variety of data. Three terrain files were created for the purposes of this study by compiling the data from the relevant Ordnance Survey tiles and using an ADMS terrain grid resolution of 64 x 64.

2.17.2. Terrain File One - Firstly, for modelling the pollutant PCs from the Installation at the maximum point of impact and at sensitive receptors up to a distance of 5.5km from A1 and A2 (i.e., all potentially sensitive human receptors specified in Table 1 of Section 2.3., and all ecological sites specified in Table 2 of Section 2.4., bar NYM1 – North York Moors SAC / SPA), terrain data was used for an area 5.5km north by 5km east, south and west. For ease of reference, this terrain file will be referred to as 'terrain file one'.

2.17.3. Terrain File Two - Secondly, for modelling the relevant pollutant PCs from the Installation on ecological receptor NYM1, terrain data was used for an area 5.5km north, 5.5km east, 9km south and 0.75km west of the proposed emission points A1 and A2. For ease of reference, this terrain file will be referred to as 'terrain file two'.

2.17.4. Terrain File Three – Thirdly, for modelling the relevant pollutant PCs arising from the simultaneous operation of the Installation and REC (i.e., to account for any cumulative impacts) at both the maximum point of impact and at potentially sensitive human and ecological receptor locations, terrain data was used for an area 5km north, east and west and 11.5km south of the approximate centre point between the Installation and REC (i.e., 454945 (X), 523669 (Y)). For ease of reference, this terrain file will be referred to as 'terrain file three'.

2.17.5. Figures 6, 7 and 8 show visual representations of terrain files one to three, respectively. The location of the Installation's stacks are shown by the red circle in Figures 6 and 7. In Figure 8 the locations of the Installation and REC are shown by the annotated red circles. The arrows on each figure represent north, with north off set.

Figure 6: Terrain File One

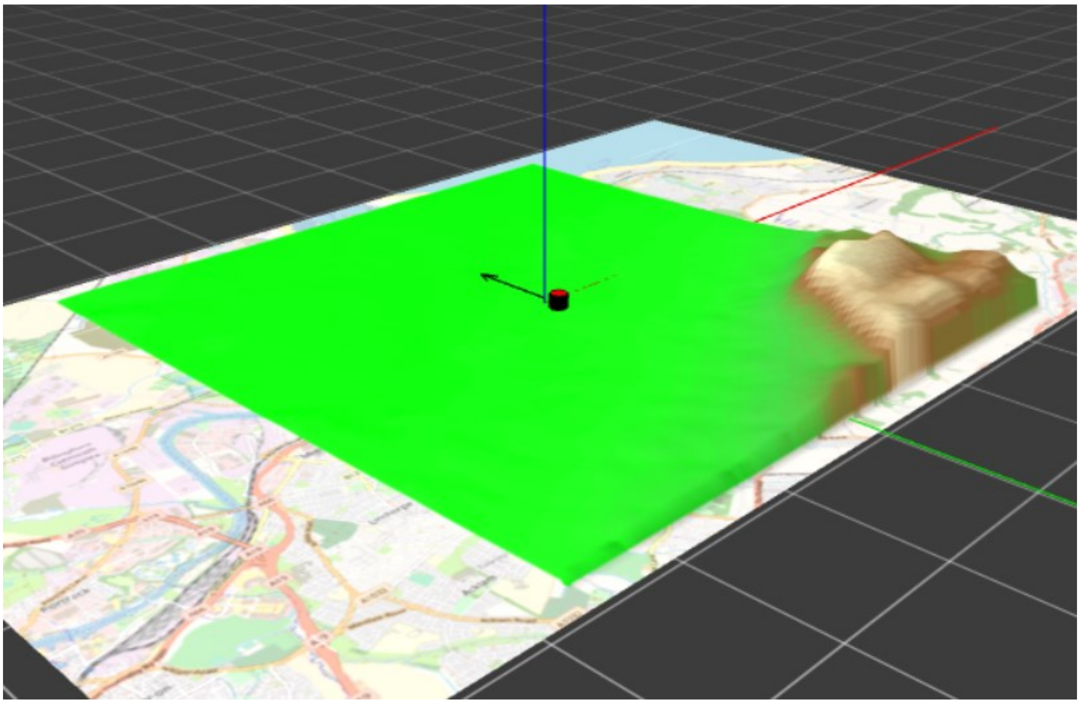


Figure 7: Terrain File Two

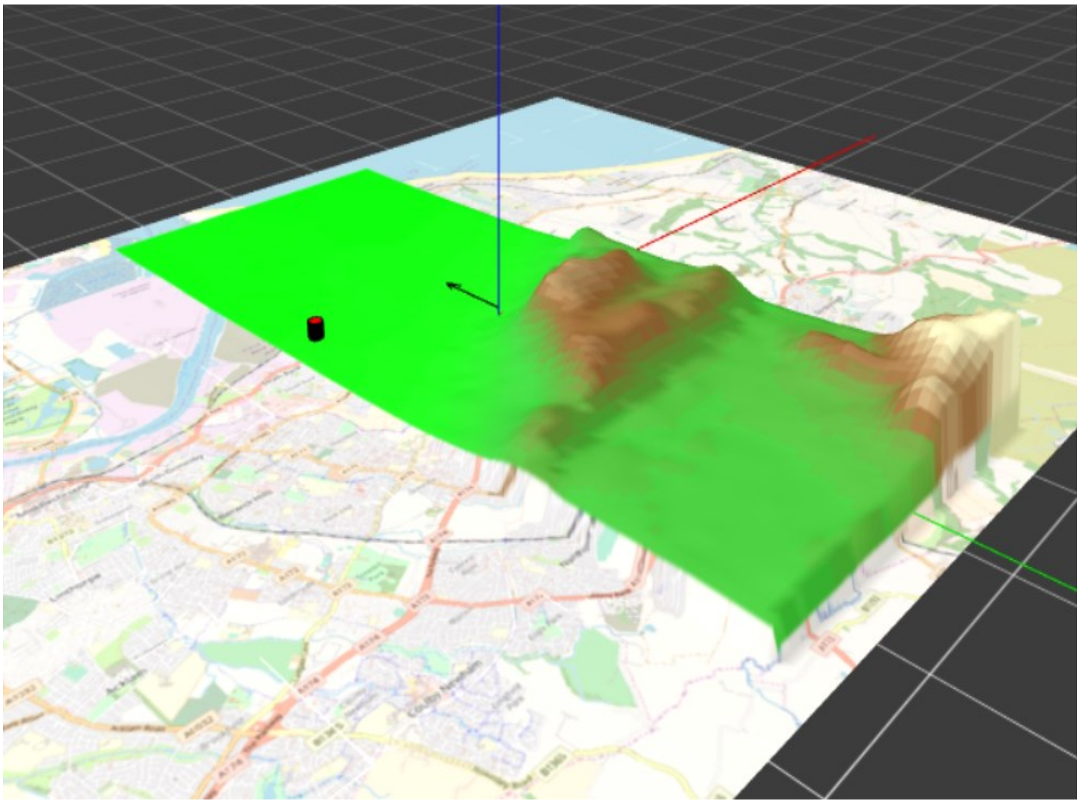
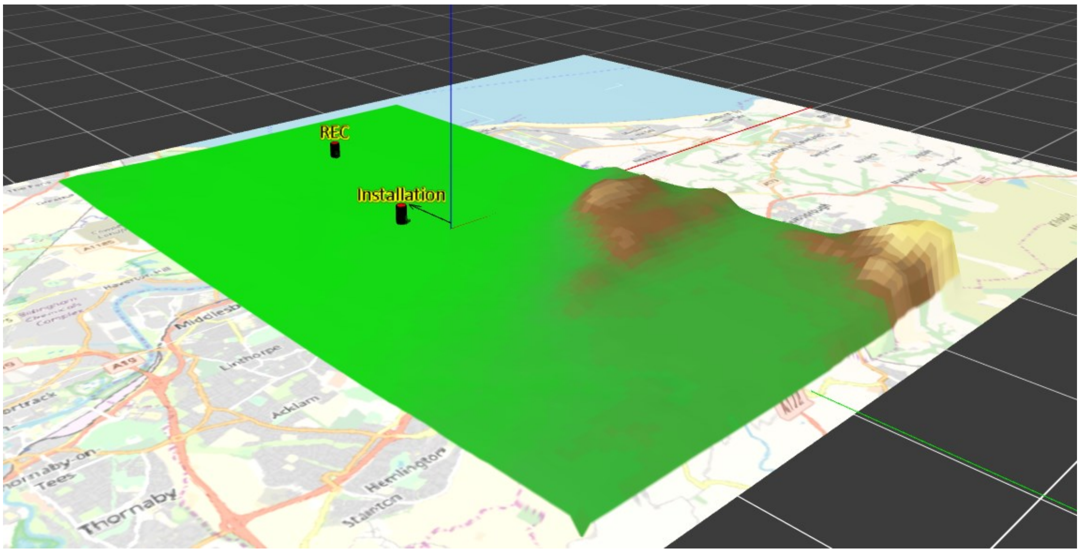


Figure 8: Terrain File Three



2.18. Roughness Length

2.18.1. The surface nature of the terrain is defined in terms of Roughness Length (Z_o). The roughness length is dependent on the type of terrain and its physical properties. The ADMS model gives values to various types of terrain, for example, agricultural areas are classed as 0.2-0.3m, parkland and open suburbia is classed as 0.5m and cities and woodlands are classed as 1.0m.

2.18.2. Based on a review of the terrain, the most appropriate surface roughness was considered to be 0.5m and was used for the 'Dispersion site' (indicative of parkland and open suburbia e.g. a combination of residential and industrial land use is experienced in the vicinity of the dispersion site) and a value of 0.3m was used for the 'met measurement site' (indicative of agricultural crops). The met measurement site is located in a corner of a field in Loftus and is encapsulated by agricultural land. From a review of Google Earth satellite and street view imagery, the higher surface roughness value for agricultural areas (i.e., 'agricultural areas max' (0.3m)) was selected to account for periods in which there is substantial crop growth.

2.18.3. When the model was run with the NWP data the roughness length was again set to 0.5m for both the dispersion site and the met site.

2.19. Model Output Parameters

2.19.1. The ADMS model calculates the likely pollutant GLCs at locations within a definable grid system pre-determined by a user. Output grids may be determined in terms of a Cartesian or Polar coordinate system. For the purposes of this study the Cartesian system was used.

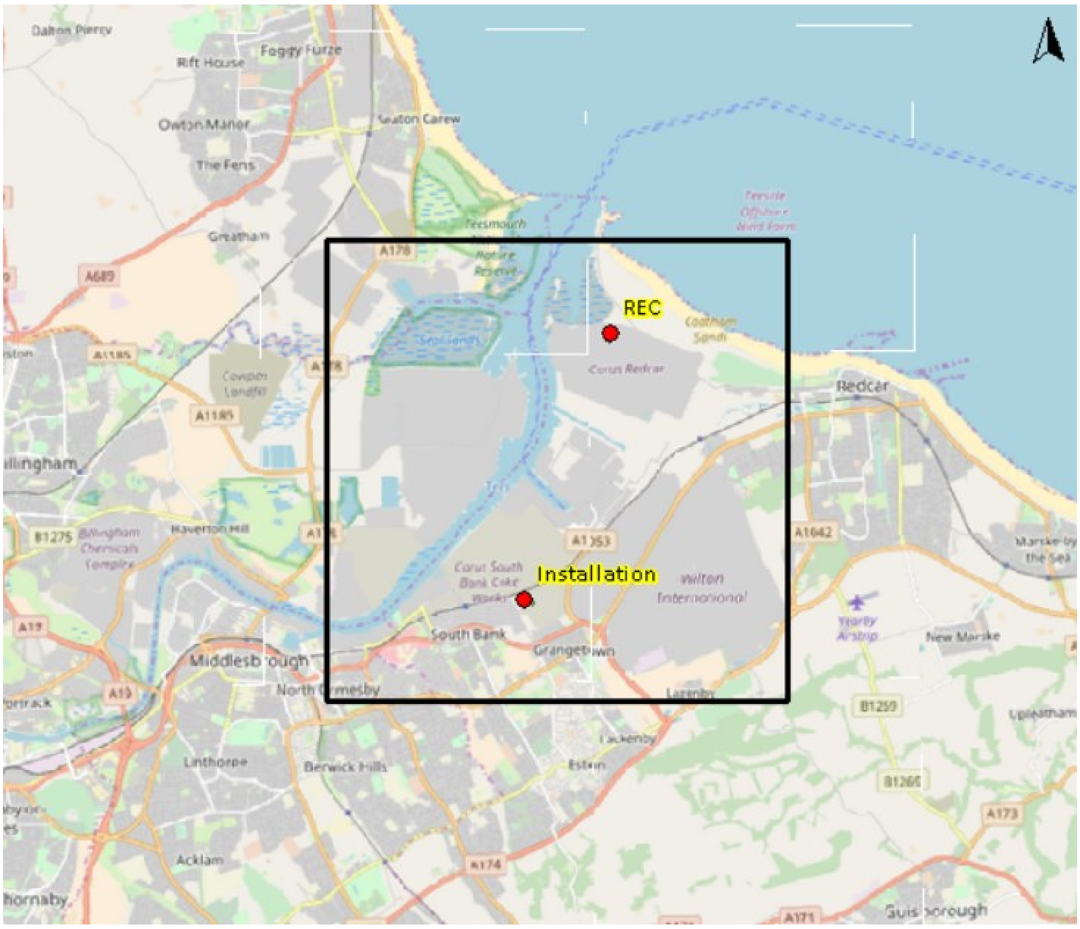
2.19.2. A Cartesian grid is constructed with reference to an initial origin, which is taken to be the bottom left corner of the grid. The lines of the grid are inserted at regular pre-defined increments in both northerly and easterly directions. Pollutant GLCs are calculated at the intersection of these grid lines; they are calculated in this manner primarily to aid in the generation of pollutant contours.

2.19.3. For assessing the maximum point of impact from the Installation, a grid sizing of 4km x 4km was utilised in order to capture values of the predicted pollutant GLCs arising from the model. The grid coordinates were X = 452379 to 456379 and Y = 519410 to 523410, with 101 nodes along each axis i.e., a grid spacing of 40m. The extent of the output grid is outlined in black on Figure 9.

2.19.4. For assessing the maximum point of impact from the cumulative scenario (i.e., the Installation and REC both operating simultaneously), a grid sizing of 8km x 8km was utilised in order to capture values of the predicted pollutant GLCs arising from the model. The grid coordinates were X = 450945 to 458945 and Y = 519669 to 527669, with 201 nodes along each axis i.e., a grid spacing of 40m. The extent of the output grid is outlined in black on Figure 10.

Figure 9: Extent of Output File for Maximum GLC – Installation Only

Figure 10: Extent of Output File for Maximum GLC – Cumulative Impact



2.19.5. For assessing the impact of emissions on human health the grid references of each were included as specified points within the ADMS model. Also, for assessing ecological sites, the grid reference of the ecological sites' boundary closest to the stack location was used.

2.20. Scenarios Modelled

2.20.1. The modelling study assessed the following scenarios:

- emissions from the Installation for all pollutants at the maximum GLC for a range of stack heights. The results of the stack height screening assessment informed the stack height to adopt for the remaining following scenarios;
- emissions from the Installation for all pollutants at the potentially sensitive human receptor locations;
- emissions from the Installation for NO_x, SO_2, NH_3 and HF at the ecological habitat sites;
- modelled deposition rates (acid and nitrogen) at the ecological habitat sites;
- plume visibility from the Installation;
- abnormal emissions from the Installation, as detailed in IED; and
- cumulative impacts of the emissions associated with the Installation and REC operating simultaneously.

2.21. Assessment of Significance of Impact Guidelines – Maximum GLC and Human Receptors

2.21.1. Both the EA online guidance and IAQM[26] guidance has been used for the purposes of significance assessment, and this guidance details the guidelines upon which the assessment of the significance of impact can be established.

2.21.2. In the first instance, the EA online guidance indicates that PCs can be considered insignificant if:

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

2.21.3. As outlined in the EA online guidance, there are no criteria to determine whether:

- PCs are significant; and
- PECs are insignificant or significant.

2.21.4. Consequently, significance will be judged based on the site-specific circumstances and on the EPUK and IAQM methodology as described in Sections 2.21.5 to 2.21.12.

Long-Term Impacts

2.21.5. If the PCs exceed the long-term criteria outlined in the EA online guidance, the potential long-term effects on human receptors from the operation of the two scrubber stacks will be assessed in accordance with the latest guidance produced by EPUK and IAQM in January 2017.

2.21.6. The guidance provides a basis for a consistent approach that could be used by all parties to professionally judge the overall significance of the air quality effects based on the severity of air quality impacts.

2.21.7. The following rationale is used in determining the severity of the air quality impacts at individual human receptors:

- the effects are provided as a percentage of the AQAL;
- the absolute concentrations are also considered in terms of the AQAL and are divided into categories for long-term concentrations. The categories are based on the sensitivity of the individual receptor in terms of harmful potential. The degree of potential to change increases as absolute concentrations are close to or above the AQAL;
- severity of the effect is described as qualitative descriptors; negligible, slight, moderate or substantial by taking into account in combination the harm potential and air quality effect. This means that a small increase at a receptor which is already close to or above the AQAL will have higher severity compared to a relatively large change at a receptor which is significantly below the AQAL, >75% AQAL;
- the effects can be adverse when the air quality concentration increases or beneficial when the concentration decreases as a result of development; and
- the judgement of overall significance of the effects is then based on severity of effects on all the individual receptors considered.

[26] IAQM guidance, January 2017 (Land-Use Planning & Development Control: Planning for Air Quality')

2.21.8. The impact descriptors for individual receptors are presented in Table 12.

Table 12: Impact Descriptors for Individual Receptors – Long-Term Concentrations

Long-term average concentration at receptor in assessment year	% Change in concentration relative to AQAL			
	1	2-5	6-10	>10
≤75% of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
≥ 110% of AQAL	Moderate	Substantial	Substantial	Substantial

Short-Term Impacts

2.21.9. As stated in EPUK / IAQM guidance, January 2017 (Land-Use Planning & Development Control: Planning for Air Quality') in Section 6.36, Page 27: *"For any point source, some consideration must also be given to the impacts resulting from short term, peak concentrations of those pollutants that can affect health through inhalation. The Environment Agency uses a threshold criterion of 10% of the short term AQAL as a screening criterion for the maximum short-term impact. This is a reasonable value to take and this guidance also adopts this as a basis for defining an impact that is sufficiently small in magnitude to be regarded as having an insignificant effect. Background concentrations are less important in determining the severity of impact for short term concentrations, not least because the peak concentrations attributable to the source and the background are not additive."*

2.21.10. Short-term concentrations, in the context laid out in the IAQM guidance, are those averaged over periods of an hour or less. These exposures would be regarded as acute and occur when a plume from an elevated source affects airborne concentrations experienced by a receptor over an hour or less.

2.21.11. The IAQM guidance offers the following severity of impact descriptors for peak short-term concentrations from an elevated source:

- 11-20% of the relevant AQAL – the magnitude can be regarded as 'small';
- 21-50% of the relevant AQAL – the magnitude can be regarded as 'medium'; and
- 51% or more of the relevant AQAL – the magnitude can be regarded as 'large'.

2.21.12. It is argued that this approach is intended to be a streamlined and pragmatic assessment procedure that avoids undue complexity.

2.22. Assessment of Significance of Impact Guidelines – Ecological Receptors, Critical Levels and/or Loads

2.22.1. EA Operational Instruction 67_12[27] states that a detailed assessment is required where modelling predicts that the long-term PC is greater than:

- 1% for European sites and SSSIs; or
- 100% for NNR, LNR, LWS and ancient woodlands.

And, the PEC is greater than:

- 70% for European sites and SSSIs; or
- 100% for NNR, LNR, LWS and ancient woodlands.

2.22.2. For short-term emissions, modelling is required at European site and SSSI's where the PC is greater than 10% of the critical level, or 100% for NNR, LNR, LWS and ancient woodland.

2.22.3. Following detailed assessment, if the PEC is less than 100% of the appropriate environmental criterion, then it can be assumed there will be no adverse effect for European Sites and SSSI's.

2.22.4. However, for NNR, LNR, LWS or ancient woodland, if the PC is less than 100% of the appropriate environmental criterion, then it can be assumed there will be no significant pollution.

2.23. Assessment of Significance Guidelines for Trace Metals

2.23.1. For the Group 3 metals there is an additional guideline indicated in the EA Guidance for Group 3 metals (see below) that states that the environmental standard is unlikely to be exceeded if:

- the long-term and short-term PEC is <100% of the long-term and short-term environmental standard (as appropriate)

(where the short-term PEC is the sum of the short-term PC and twice the long-term pollutant background concentration).

2.23.2. For trace metals, Annex VI of the IED assigns ELVs for three groups. Group 1 comprises cadmium (Cd) and thallium (Tl), Group 2 comprises mercury (Hg) and Group 3 comprises antimony (Sb), arsenic (As), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), lead (Pb), nickel (Ni) and vanadium (V). The ELVs are the total for the combined emissions, and it would not be reasonable to assume that each metal emits at the maximum ELV for the group. In this regard, the EA has provided guidance on the steps required for assessing the impact of such metal emissions, namely Releases from Waste Incinerators[28].

2.23.3. Step 1 of the guidance is to assume that all emissions are at the maximum ELV for the group. For example, all of the Group 3 metals would be assumed to be emitted at a concentration of 0.3mg/Nm^3 (i.e., as per the BAT-AEL).

[27] EA Operational Instruction 67_12 Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation, V2, 27.3.15

[28] Releases from Waste Incinerators, Environment Agency, V4

2.23.4. Where the release is considered potentially significant, Step 2 of the guidance allows the applicant to use the maximum emissions data listed in Appendix A of the guidance to revise predictions and consider each pollutant as a percentage of the Group 3 ELVs.

2.24. NO_x to NO_2 conversion Rates

2.24.1. EA online guidance states that emissions of NO_x should be recorded as NO_2 as follows:

- for the long-term PCs and PECs, assume 100% of the emissions of NO_x convert to NO_2; and
- for the short-term PCs and PECs assume 50% of the emissions of NO_x convert to NO_2.

2.24.2. However, further to detailed discussion with both NRW and the EA on previous studies, a long-term 70% NO to NO_2 conversion rate, and a short-term 35% NO to NO_2 as required by guidance on NO_X and NO_2 Conversion Ratios as referenced in AQTAG06 should be used in all detailed modelling assessments. The conversion rates, as provided in section 2.24.1., should only be used for screening assessments.

3. ASSESSMENT OF AIR QUALITY IMPACTS AT THE MAXIMUM GROUND LEVEL CONCENTRATIONS

3.1. Model Setup

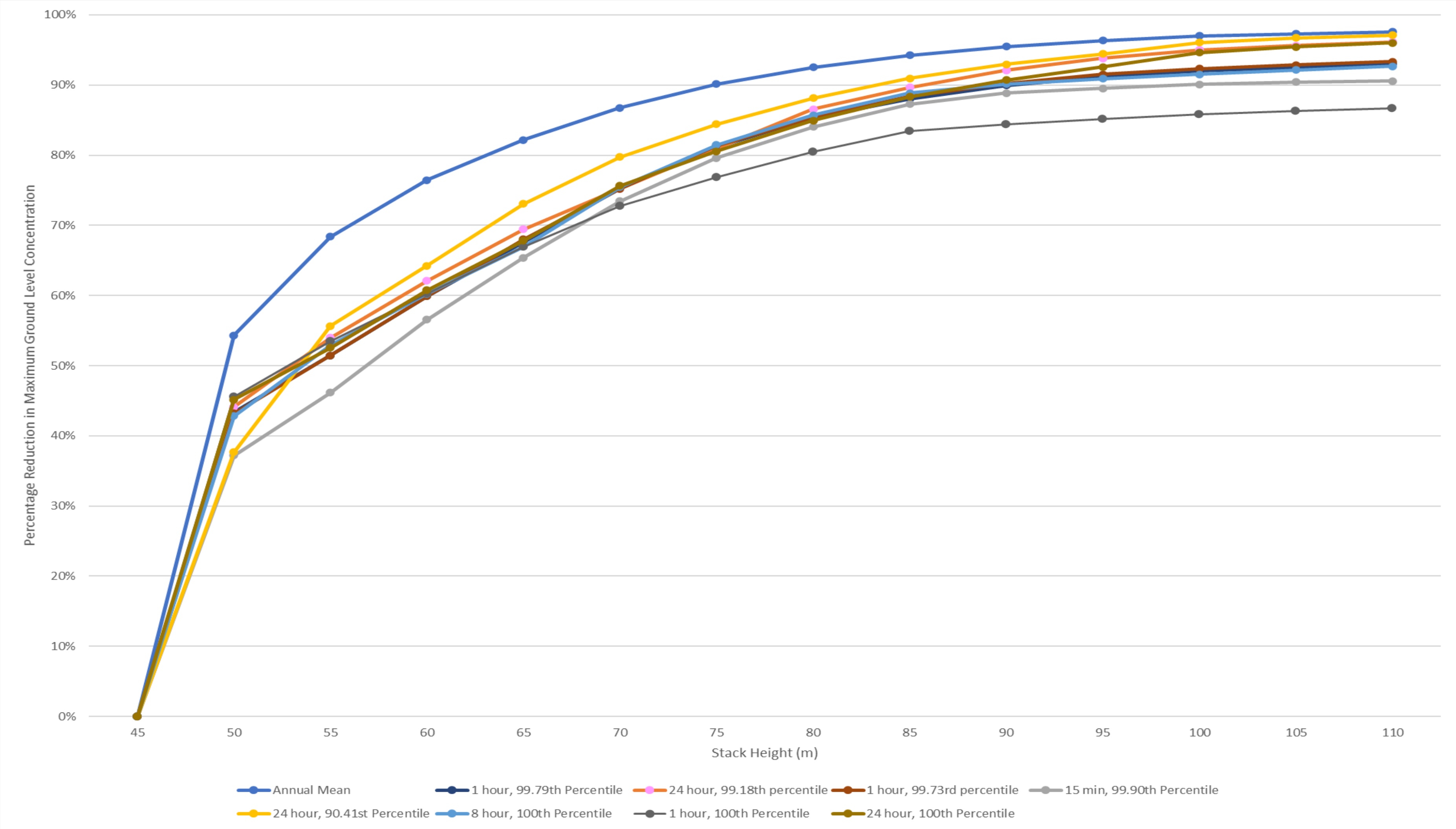
3.1.1. This assessment considered the effect of stack height on all relevant averaging periods required to complete the main modelling assessment. For the screening study, the modelling was undertaken with the following settings:

- buildings effects were included;
- the modelled grid was as specified in Section 2.19.3;
- complex terrain was included (Terrain File One - see Section 2.17);
- emission rates for pollutants were as outlined in Table 10a of Section 2.11.;
- NO_x to NO_2 conversion rates were taken into account (refer to Section 2.24.);
- stack heights from 45m – 110m were considered;
- a surface roughness of 0.5m was used for the dispersion site and 0.3m for the met measurement site (a value of 0.5m was used for the dispersion site and met measurement site when using the 2020 NWP met data);
- 5 years of hourly sequential meteorological data from Loftus recording station for the period 2016 – 2020 (inclusive) and 2020 NWP data was used;
- only the maximum GLC was considered for the stack height screening.

3.2. Identification of Appropriate Stack Heights

3.2.1. A graph summarising the results of the stack height screening assessment, for the worst case met year for each pollutant and averaging period, is presented as Figure 11.

Figure 11: Effect of Stack Height on Ground Level Concentrations



3.2.2. Figure 11 clearly indicate that increasing the stack heights has the effect of decreasing the modelled maximum ground level concentrations (GLCs), for all of the averaging periods considered. There is a substantial reduction in GLCs up to 70m, (for most percentiles at least a 70% reduction). However, at heights of 85m and greater it is evident that reductions in GLCs, for all averaging periods, start to level off and therefore do not offer much more environmental benefit.

3.2.3. In order to determine the optimum stack heights for the Installation's A1 and A2 emission points, and the impact of the emissions on the environment, all modelled stack heights and pollutants will be assessed for impact at maximum GLC. This will help to further assess the significance of the emissions arising from A1 and A2 in accordance with the criteria (see Section 2.21.)

3.3. Comparison of Maximum Predicted Pollutant Ground Level Concentrations with Air Quality Standards

3.3.1. The predicted PCs for each of the pollutants considered in the assessment at the maximum point of impact have been extracted and are presented in Table 13. The data is based on the worst case met data year. It should be noted that the location of the maximum impact may not be in an area where there is a relevant public exposure.

3.3.2. Maximum concentrations are considered potentially significant if the long-term prediction is greater than 1% of the long-term AQS. For short-term predictions, a potentially significant concentration would be greater than 10% of the short-term AQS. In Table 13, any PCs that are above these significance criteria are indicated in bold type.

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m^3)	AQS (µg/m^3)	PC as a % of AQS
NO_2 (annual mean)	45	2018	**13.28**	40	**33.19%**
	50	NWP 2020	**6.06**		**15.16%**
	55	NWP 2020	**4.20**		**10.49%**
	60	2020	**3.13**		**7.82%**
	65	2020	**2.37**		**5.91%**
	70	2020	**1.76**		**4.40%**
	75	2020	**1.31**		**3.27%**
	80	2020	**0.99**		**2.47%**
	85	2020	**0.77**		**1.91%**
	90	2020	**0.60**		**1.51%**
	95	2020	**0.49**		**1.21%**
	100	NWP 2020	0.39		0.99%
	105	NWP 2020	0.36		0.89%
	110	NWP 2020	0.32		0.81%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
NO_2 (1 hour, 99.79th percentile)	45	2018	**51.87**	200	**25.94%**
	50	2019	**29.40**		**14.70%**
	55	2017	**25.18**		**12.59%**
	60	2018	**20.80**		**10.40%**
	65	2016	16.82		8.41%
	70	2016	12.83		6.42%
	75	2019	9.80		4.90%
	80	2019	7.60		3.80%
	85	2018	6.21		3.11%
	90	2018	5.21		2.61%
	95	2018	4.58		2.29%
	100	2018	4.16		2.08%
	105	2018	3.88		1.94%
	110	2018	3.64		1.82%
SO_2 (24 hour, 99.18th percentile)	45	2018	**32.60**	125	**26.08%**
	50	2016	**18.22**		**14.57%**
	55	2018	**15.01**		**12.00%**
	60	2018	12.36		9.89%
	65	2016	9.96		7.97%
	70	2016	8.09		6.47%
	75	2016	6.20		4.96%
	80	2016	4.38		3.51%
	85	2016	3.36		2.69%
	90	2016	2.58		2.06%
	95	2016	2.02		1.62%
	100	2016	1.63		1.31%
	105	2016	1.42		1.14%
	110	2016	1.26		1.01%
SO_2 (1 hour, (99.73rd percentile)	45	2018	**44.35**	350	**12.67%**
	50	2017	25.19		7.20%
	55	2017	21.53		6.15%
	60	2017	17.78		5.08%
	65	2018	14.19		4.05%
	70	2019	11.00		3.14%
	75	2019	8.29		2.37%
	80	2019	6.51		1.86%
	85	2018	5.14		1.47%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m^3)	AQS (µg/m^3)	PC as a % of AQS
SO_2 (1 hour, (99.73rd percentile)	90	2018	4.36	350	1.25%
	95	2018	3.76		1.07%
	100	2018	3.39		0.97%
	105	2018	3.17		0.91%
	110	2018	2.96		0.85%
SO_2 (15min, 99.90th Percentile)	45	2018	**45.42**	266	**17.07%**
	50	2017	**28.53**		**10.72%**
	55	2017	24.45		9.19%
	60	2017	19.74		7.42%
	65	2019	15.72		5.91%
	70	2016	12.07		4.54%
	75	2018	9.27		3.49%
	80	2018	7.25		2.72%
	85	2018	5.79		2.18%
	90	2018	5.06		1.90%
	95	2018	4.75		1.79%
	100	NWP 2020	4.50		1.69%
	105	NWP 2020	4.35		1.64%
	110	NWP 2020	4.27		1.61%
PM_{10} (annual mean)	45	2018	**0.95**	40	**2.37%**
	50	NWP 2020	**0.43**		**1.08%**
	55	NWP 2020	0.30		0.75%
	60	2020	0.22		0.56%
	65	2020	0.17		0.42%
	70	2020	0.13		0.31%
	75	2020	0.09		0.23%
	80	2020	0.07		0.18%
	85	2020	0.05		0.14%
	90	2020	0.04		0.11%
	95	2020	0.03		0.09%
	100	NWP 2020	0.03		0.07%
	105	NWP 2020	0.03		0.06%
	110	NWP 2020	0.02		0.06%
PM_{10} (24 hour, 90.41st Percentile)	45	2020	2.50	50	4.99%
	50	NWP 2020	1.55		3.11%
	55	2020	1.11		2.21%
	60	2020	0.89		1.79%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
PM_{10} (24 hour, 90.41st Percentile)	65	2020	0.67	50	1.34%
	70	2020	0.51		1.01%
	75	2020	0.39		0.78%
	80	2020	0.30		0.59%
	85	2020	0.23		0.45%
	90	2020	0.18		0.35%
	95	2020	0.14		0.28%
	100	2020	0.10		0.20%
	105	2020	0.08		0.16%
	110	NWP 2020	0.07		0.14%
$PM_{2.5}$ (annual mean)	45	2018	**0.95**	20	**4.74%**
	50	NWP 2020	**0.43**		**2.17%**
	55	NWP 2020	**0.30**		**1.50%**
	60	2020	**0.22**		**1.12%**
	65	2020	0.17		0.85%
	70	2020	0.13		0.63%
	75	2020	0.09		0.47%
	80	2020	0.07		0.35%
	85	2020	0.05		0.27%
	90	2020	0.04		0.22%
	95	2020	0.03		0.17%
	100	NWP 2020	0.03		0.14%
	105	NWP 2020	0.03		0.13%
	110	NWP 2020	0.02		0.12%
CO (8 hour, 100th percentile)	45	2018	72.61	10,000	0.73%
	50	2016	41.52		0.42%
	55	2016	34.22		0.34%
	60	2016	28.87		0.29%
	65	2016	23.98		0.24%
	70	2016	17.82		0.18%
	75	2016	13.46		0.13%
	80	2019	10.37		0.10%
	85	2017	8.10		0.08%
	90	2018	7.16		0.07%
	95	2018	6.62		0.07%
	100	2018	6.15		0.06%
	105	2018	5.71		0.06%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m^3)	AQS (µg/m^3)	PC as a % of AQS
CO (8 hour, 100th percentile)	110	2018	5.33	10,000	0.05%
VOC (annual mean)	45	2018	**1.90**	5	**37.93%**
	50	NWP 2020	**0.866**		**17.32%**
	55	NWP 2020	**0.599**		**11.99%**
	60	2020	**0.447**		**8.93%**
	65	2020	**0.338**		**6.76%**
	70	2020	**0.251**		**5.02%**
	75	2020	**0.187**		**3.73%**
	80	2020	**0.141**		**2.83%**
	85	2020	**0.109**		**2.19%**
	90	2020	**0.0861**		**1.72%**
	95	2020	**0.0694**		**1.39%**
	100	NWP 2020	**0.0564**		**1.13%**
	105	NWP 2020	**0.0510**		**1.02%**
	110	NWP 2020	0.0462		0.92%
NH_3 (annual mean)	45	2018	**1.90**	180	**1.05%**
	50	NWP 2020	0.866		0.48%
	55	NWP 2020	0.599		0.33%
	60	2020	0.447		0.25%
	65	2020	0.338		0.19%
	70	2020	0.251		0.14%
	75	2020	0.187		0.10%
	80	2020	0.141		0.08%
	85	2020	0.109		0.06%
	90	2020	0.0861		0.05%
	95	2020	0.0694		0.04%
	100	NWP 2020	0.0564		0.03%
	105	NWP 2020	0.0510		0.03%
	110	NWP 2020	0.0462		0.03%
NH_3 (1-hour)	45	2018	16.39	2,500	0.66%
	50	2018	8.93		0.36%
	55	2018	7.63		0.31%
	60	NWP 2020	6.52		0.26%
	65	NWP 2020	5.41		0.22%
	70	2020	4.47		0.18%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
NH_3 (1-hour)	75	2020	3.80	2,500	0.15%
	80	2020	3.20		0.13%
	85	NWP 2020	2.72		0.11%
	90	2018	2.56		0.10%
	95	2018	2.43		0.10%
	100	2019	2.32		0.09%
	105	2018	2.24		0.09%
	110	NWP 2020	2.19		0.09%
HCl (1-hour)	45	2018	9.83	750	1.31%
	50	2018	5.35		0.71%
	55	2018	4.57		0.61%
	60	NWP 2020	3.91		0.52%
	65	NWP 2020	3.25		0.43%
	70	2020	2.68		0.36%
	75	2020	2.28		0.30%
	80	2020	1.92		0.26%
	85	NWP 2020	1.63		0.22%
	90	2018	1.53		0.20%
	95	2018	1.46		0.19%
	100	2019	1.39		0.19%
	105	2018	1.34		0.18%
	110	NWP 2020	1.31		0.17%
HF (annual mean)	45	2018	**0.190**	16	**1.19%**
	50	NWP 2020	0.0866		0.54%
	55	NWP 2020	0.0599		0.37%
	60	2020	0.0447		0.28%
	65	2020	0.0338		0.21%
	70	2020	0.0251		0.16%
	75	2020	0.0187		0.12%
	80	2020	0.0141		0.09%
	85	2020	0.0109		0.07%
	90	2020	0.00861		0.05%
	95	2020	0.00694		0.04%
	100	NWP 2020	0.00564		0.04%
	105	NWP 2020	0.00510		0.03%
	110	NWP 2020	0.00462		0.03%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
HF (1-hour)	45	2018	1.64	160	1.02%
	50	2018	0.89		0.56%
	55	2018	0.76		0.48%
	60	NWP 2020	0.65		0.41%
	65	NWP 2020	0.54		0.34%
	70	2020	0.45		0.28%
	75	2020	0.38		0.24%
	80	2020	0.32		0.20%
	85	NWP 2020	0.27		0.17%
	90	2018	0.26		0.16%
	95	2018	0.24		0.15%
	100	2019	0.23		0.15%
	105	2018	0.22		0.14%
	110	NWP 2020	0.22		0.14%
Sb (annual mean)	45	2018	**0.057**	5	**1.14%**
	50	NWP 2020	0.026		0.52%
	55	NWP 2020	0.018		0.36%
	60	2020	0.013		0.27%
	65	2020	0.010		0.20%
	70	2020	0.0076		0.15%
	75	2020	0.0056		0.11%
	80	2020	0.0043		0.09%
	85	2020	0.0033		0.07%
	90	2020	0.0026		0.05%
	95	2020	0.0021		0.04%
	100	NWP 2020	0.0017		0.03%
	105	NWP 2020	0.0015		0.03%
	110	NWP 2020	0.0014		0.03%
Sb (1-hour)	45	2018	0.493	150	0.33%
	50	2018	0.269		0.18%
	55	2018	0.230		0.15%
	60	NWP 2020	0.196		0.13%
	65	NWP 2020	0.163		0.11%
	70	2020	0.135		0.09%
	75	2020	0.114		0.08%
	80	2020	0.0964		0.06%
	85	NWP 2020	0.0819		0.05%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
Sb (1-hour)	90	2018	0.0769	150	0.05%
	95	2018	0.0731		0.05%
	100	2019	0.0699		0.05%
	105	2018	0.0674		0.04%
	110	NWP 2020	0.0659		0.04%
As (annual mean)	45	2018	**0.0571**	0.003	**1902.53%**
	50	NWP 2020	**0.0261**		**868.93%**
	55	NWP 2020	**0.0180**		**601.20%**
	60	2020	**0.0134**		**448.00%**
	65	2020	**0.0102**		**339.07%**
	70	2020	**0.00756**		**251.97%**
	75	2020	**0.00562**		**187.23%**
	80	2020	**0.00425**		**141.78%**
	85	2020	**0.00329**		**109.69%**
	90	2020	**0.00259**		**86.35%**
	95	2020	**0.00209**		**69.61%**
	100	NWP 2020	**0.00170**		**56.56%**
	105	NWP 2020	**0.00153**		**51.14%**
	110	NWP 2020	**0.00139**		**46.33%**
Cd (annual mean)	45	2018	**0.00379**	0.005	**75.86%**
	50	NWP 2020	**0.00173**		**34.65%**
	55	NWP 2020	**0.00120**		**23.97%**
	60	2020	**0.000893**		**17.86%**
	65	2020	**0.000676**		**13.52%**
	70	2020	**0.000502**		**10.05%**
	75	2020	0.000373		7.47%
	80	2020	0.000283		5.65%
	85	2020	0.000219		4.37%
	90	2020	0.000172		3.44%
	95	2020	0.000139		2.78%
	100	NWP 2020	0.000113		2.26%
	105	NWP 2020	0.000102		2.04%
	110	NWP 2020	0.0000924		1.85%
Cr (annual mean)	45	2018	**0.0571**	5	**1.14%**
	50	NWP 2020	0.0261		0.52%
	55	NWP 2020	0.0180		0.36%
	60	2020	0.0134		0.27%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
Cr (annual mean)	65	2020	0.0102	5	0.20%
	70	2020	0.00756		0.15%
	75	2020	0.00562		0.11%
	80	2020	0.00425		0.09%
	85	2020	0.00329		0.07%
	90	2020	0.00259		0.05%
	95	2020	0.00209		0.04%
	100	NWP 2020	0.00170		0.03%
	105	NWP 2020	0.00153		0.03%
	110	NWP 2020	0.00139		0.03%
Cr (1-hour)	45	2018	0.493	150	0.33%
	50	2018	0.269		0.18%
	55	2018	0.230		0.15%
	60	NWP 2020	0.196		0.13%
	65	NWP 2020	0.163		0.11%
	70	2020	0.135		0.09%
	75	2020	0.114		0.08%
	80	2020	0.0964		0.06%
	85	NWP 2020	0.0819		0.05%
	90	2018	0.0769		0.05%
	95	2018	0.0731		0.05%
	100	2019	0.0699		0.05%
	105	2018	0.0674		0.04%
	110	NWP 2020	0.0659		0.04%
Cr(VI) (annual mean)	45	2018	**0.0571**	0.0002	**28538.00%**
	50	NWP 2020	**0.0261**		**13034.00%**
	55	NWP 2020	**0.0180**		**9018.00%**
	60	2020	**0.0134**		**6720.00%**
	65	2020	**0.0102**		**5086.00%**
	70	2020	**0.00756**		**3779.60%**
	75	2020	**0.00562**		**2808.50%**
	80	2020	**0.00425**		**2126.65%**
	85	2020	**0.00329**		**1645.30%**
	90	2020	**0.00259**		**1295.20%**
	95	2020	**0.00209**		**1044.20%**
	100	NWP 2020	**0.00170**		**848.35%**
	105	NWP 2020	**0.00153**		**767.05%**

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
Cr(VI) (annual mean)	110	NWP 2020	**0.00139**	0.0002	**695.00%**
Co (annual mean)	45	2018	**0.0571**	0.2	**28.54%**
	50	NWP 2020	**0.0261**		**13.03%**
	55	NWP 2020	**0.0180**		**9.02%**
	60	2020	**0.0134**		**6.72%**
	65	2020	**0.0102**		**5.09%**
	70	2020	**0.00756**		**3.78%**
	75	2020	**0.00562**		**2.81%**
	80	2020	**0.00425**		**2.13%**
	85	2020	**0.00329**		**1.65%**
	90	2020	**0.00259**		**1.30%**
	95	2020	**0.00209**		**1.04%**
	100	NWP 2020	0.00170		0.85%
	105	NWP 2020	0.00153		0.77%
	110	NWP 2020	0.00139		0.70%
Co (1-hour)	45	2018	0.493	6	8.22%
	50	2018	0.269		4.48%
	55	2018	0.230		3.83%
	60	NWP 2020	0.196		3.27%
	65	NWP 2020	0.163		2.72%
	70	2020	0.135		2.24%
	75	2020	0.114		1.90%
	80	2020	0.0964		1.61%
	85	NWP 2020	0.0819		1.37%
	90	2018	0.0769		1.28%
	95	2018	0.0731		1.22%
	100	2019	0.0699		1.17%
	105	2018	0.0674		1.12%
	110	NWP 2020	0.0659		1.10%
Cu (annual mean)	45	2018	0.0571	10	0.57%
	50	NWP 2020	0.0261		0.26%
	55	NWP 2020	0.0180		0.18%
	60	2020	0.0134		0.13%
	65	2020	0.0102		0.10%
	70	2020	0.00756		0.08%
	75	2020	0.00562		0.06%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
Cu (annual mean)	80	2020	0.00425	10	0.04%
	85	2020	0.00329		0.03%
	90	2020	0.00259		0.03%
	95	2020	0.00209		0.02%
	100	NWP 2020	0.00170		0.02%
	105	NWP 2020	0.00153		0.02%
	110	NWP 2020	0.00139		0.01%
Cu (1-hour)	45	2018	0.493	200	0.25%
	50	2018	0.269		0.13%
	55	2018	0.230		0.11%
	60	NWP 2020	0.196		0.10%
	65	NWP 2020	0.163		0.08%
	70	2020	0.135		0.07%
	75	2020	0.114		0.06%
	80	2020	0.0964		0.05%
	85	NWP 2020	0.0819		0.04%
	90	2018	0.0769		0.04%
	95	2018	0.0731		0.04%
	100	2019	0.0699		0.03%
	105	2018	0.0674		0.03%
	110	NWP 2020	0.0659		0.03%
Pb (annual mean)	45	2018	**0.0571**	0.25	**22.83%**
	50	NWP 2020	**0.0261**		**10.43%**
	55	NWP 2020	**0.0180**		**7.21%**
	60	2020	**0.0134**		**5.38%**
	65	2020	**0.0102**		**4.07%**
	70	2020	**0.00756**		**3.02%**
	75	2020	**0.00562**		**2.25%**
	80	2020	**0.00425**		**1.70%**
	85	2020	**0.00329**		**1.32%**
	90	2020	**0.00259**		**1.04%**
	95	2020	0.00209		0.84%
	100	NWP 2020	0.00170		0.68%
	105	NWP 2020	0.00153		0.61%
	110	NWP 2020	0.00139		0.56%
Mn (annual mean)	45	2018	**0.0571**	1	**5.71%**
	50	NWP 2020	**0.0261**		**2.61%**

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
Mn (annual mean)	55	NWP 2020	**0.0180**	1	**1.80%**
	60	2020	**0.0134**		**1.34%**
	65	2020	**0.0102**		**1.02%**
	70	2020	0.00756		0.76%
	75	2020	0.00562		0.56%
	80	2020	0.00425		0.43%
	85	2020	0.00329		0.33%
	90	2020	0.00259		0.26%
	95	2020	0.00209		0.21%
	100	NWP 2020	0.00170		0.17%
	105	NWP 2020	0.00153		0.15%
	110	NWP 2020	0.00139		0.14%
Mn (1-hour)	45	2018	0.493	1,500	0.03%
	50	2018	0.269		0.02%
	55	2018	0.230		0.02%
	60	NWP 2020	0.196		0.01%
	65	NWP 2020	0.163		0.01%
	70	2020	0.135		0.01%
	75	2020	0.114		0.01%
	80	2020	0.0964		0.01%
	85	NWP 2020	0.0819		0.01%
	90	2018	0.0769		0.01%
	95	2018	0.0731		0.005%
	100	2019	0.0699		0.005%
	105	2018	0.0674		0.004%
	110	NWP 2020	0.0659		0.004%
Hg (annual mean)	45	2018	**0.00379**	0.25	**1.52%**
	50	NWP 2020	0.00173		0.69%
	55	NWP 2020	0.00120		0.48%
	60	2020	0.000893		0.36%
	65	2020	0.000676		0.27%
	70	2020	0.000502		0.20%
	75	2020	0.000373		0.15%
	80	2020	0.000283		0.11%
	85	2020	0.000219		0.09%
	90	2020	0.000172		0.07%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
Hg (annual mean)	95	2020	0.000139	0.25	0.06%
	100	NWP 2020	0.000113		0.05%
	105	NWP 2020	0.000102		0.04%
	110	NWP 2020	0.0000924		0.04%
Hg (1-hour)	45	2018	0.0328	7.5	0.44%
	50	2018	0.0179		0.24%
	55	2018	0.0153		0.20%
	60	NWP 2020	0.0130		0.17%
	65	NWP 2020	0.0108		0.14%
	70	2020	0.00894		0.12%
	75	2020	0.00759		0.10%
	80	2020	0.00641		0.09%
	85	NWP 2020	0.00544		0.07%
	90	2018	0.00511		0.07%
	95	2018	0.00486		0.06%
	100	2019	0.00465		0.06%
	105	2018	0.00448		0.06%
	110	NWP 2020	0.00438		0.06%
Ni (annual mean)	45	2018	0.0571	0.02	**285.38%**
	50	NWP 2020	0.0261		**130.34%**
	55	NWP 2020	0.0180		**90.18%**
	60	2020	0.0134		**67.20%**
	65	2020	0.0102		**50.86%**
	70	2020	0.00756		**37.80%**
	75	2020	0.00562		**28.09%**
	80	2020	0.00425		**21.27%**
	85	2020	0.00329		**16.45%**
	90	2020	0.00259		**12.95%**
	95	2020	0.00209		**10.44%**
	100	NWP 2020	0.00170		**8.48%**
	105	NWP 2020	0.00153		**7.67%**
	110	NWP 2020	0.00139		**6.95%**
Tl (annual mean)	45	2018	0.00379	1	0.38%
	50	NWP 2020	0.00173		0.17%
	55	NWP 2020	0.00120		0.12%
	60	2020	0.000893		0.09%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
Tl (annual mean)	65	2020	0.000676	1	0.07%
	70	2020	0.000502		0.05%
	75	2020	0.000373		0.04%
	80	2020	0.000283		0.03%
	85	2020	0.000219		0.02%
	90	2020	0.000172		0.02%
	95	2020	0.000139		0.01%
	100	NWP 2020	0.000113		0.01%
	105	NWP 2020	0.000102		0.01%
	110	NWP 2020	0.0000924		0.01%
Tl (1-hour)	45	2018	0.0328	30	0.11%
	50	2018	0.0179		0.06%
	55	2018	0.0153		0.05%
	60	NWP 2020	0.0130		0.04%
	65	NWP 2020	0.0108		0.04%
	70	2020	0.00894		0.03%
	75	2020	0.00759		0.03%
	80	2020	0.00641		0.02%
	85	NWP 2020	0.00544		0.02%
	90	2018	0.00511		0.02%
	95	2018	0.00486		0.02%
	100	2019	0.00465		0.02%
	105	2018	0.00448		0.01%
	110	NWP 2020	0.00438		0.01%
V (annual mean)	45	2018	0.0571	5	1.14%
	50	NWP 2020	0.0261		0.52%
	55	NWP 2020	0.0180		0.36%
	60	2020	0.0134		0.27%
	65	2020	0.0102		0.20%
	70	2020	0.00756		0.15%
	75	2020	0.00562		0.11%
	80	2020	0.00425		0.09%
	85	2020	0.00329		0.07%
	90	2020	0.00259		0.05%
	95	2020	0.00209		0.04%
	100	NWP 2020	0.00170		0.03%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
V (annual mean)	105	NWP 2020	0.00153	5	0.03%
	110	NWP 2020	0.00139		0.03%
V (24-hour)	45	2018	0.366	1	**36.60%**
	50	2017	0.201		**20.07%**
	55	2017	0.174		**17.36%**
	60	2016	0.144		**14.36%**
	65	2016	0.118		**11.78%**
	70	2016	0.0891		8.91%
	75	2016	0.0712		7.12%
	80	2016	0.0552		5.52%
	85	2016	0.0428		4.28%
	90	2016	0.0340		3.40%
	95	2016	0.0273		2.73%
	100	2018	0.0197		1.97%
	105	2018	0.0167		1.67%
	110	2016	0.0147		1.47%
PAH (as B[a]P) (annual mean)	45	2018	**0.000190**	0.00025	**75.86%**
	50	NWP 2020	**0.0000866**		**34.65%**
	55	NWP 2020	**0.0000599**		**23.97%**
	60	2020	**0.0000447**		**17.86%**
	65	2020	**0.0000338**		**13.52%**
	70	2020	**0.0000251**		**10.05%**
	75	2020	**0.0000187**		**7.47%**
	80	2020	**0.0000141**		**5.65%**
	85	2020	**0.0000109**		**4.37%**
	90	2020	**0.00000861**		**3.44%**
	95	2020	**0.00000694**		**2.78%**
	100	NWP 2020	**0.00000564**		**2.26%**
	105	NWP 2020	**0.00000510**		**2.04%**
	110	NWP 2020	**0.00000462**		**1.85%**
PCBs (annual mean)	45	2018	0.0000000151	0.2	0.00001%
	50	NWP 2020	0.00000000692		0.000003%
	55	NWP 2020	0.00000000479		0.000002%
	60	2020	0.00000000357		0.000002%
	65	2020	0.00000000270		0.000001%
	70	2020	0.00000000201		0.000001%

Table 13: Comparison of Predicted Maximum Ground Level PCs with AQSs (cont.)

Pollutant	Stack Height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS
PCBs (annual mean)	75	2020	0.00000000149	0.2	0.000001%
	80	2020	0.00000000113		0.000001%
	85	2020	0.000000000873		0.0000004%
	90	2020	0.000000000687		0.0000003%
	95	2020	0.000000000554		0.0000003%
	100	NWP 2020	0.000000000450		0.0000002%
	105	NWP 2020	0.000000000407		0.0000002%
	110	NWP 2020	0.000000000369		0.0000002%
PCBs (1-hour)	45	2018	0.000000131	6	0.000002%
	50	2018	0.0000000713		0.000001%
	55	2018	0.0000000609		0.000001%
	60	NWP 2020	0.0000000520		0.000001%
	65	NWP 2020	0.0000000432		0.000001%
	70	2020	0.0000000357		0.000001%
	75	2020	0.0000000303		0.000001%
	80	2020	0.0000000256		0.0000004%
	85	NWP 2020	0.0000000217		0.0000004%
	90	2018	0.0000000204		0.0000003%
	95	2018	0.0000000194		0.0000003%
	100	2019	0.0000000186		0.0000003%
	105	2018	0.0000000179		0.0000003%
	110	NWP 2020	0.0000000175		0.0000003%
Dioxins and Furans	45	2018	0.00000000760	No Standard Applies	
	50	NWP 2020	0.00000000347		
	55	NWP 2020	0.00000000240		
	60	2020	0.00000000179		
	65	2020	0.00000000135		
	70	2020	0.00000000101		
	75	2020	0.000000000747		
	80	2020	0.000000000566		
	85	2020	0.000000000438		
	90	2020	0.000000000345		
	95	2020	0.000000000278		
	100	NWP 2020	0.000000000226		
	105	NWP 2020	0.000000000204		
	110	NWP 2020	0.000000000185		

3.3.3. It can be seen from the data in Table 13, that the impact of the Installation varies depending on the pollutant considered. However, the stack height screening study demonstrated that there is significant environmental benefit of stack heights which are 85m or higher (see Section 3.2.1). Therefore, for stack heights of 85m and above, the potentially significant impacts are for long-term (annual):

- NO_2,
- VOC (as benzene),
- As,
- Cr(VI),
- Co,
- Pb,
- Ni, and
- PAH (as B[a]P)

3.3.4. It is important to note that the metals, at this step of the assessment, have each been modelled at their respective ELVs (see Section 2.11. of this report).

3.3.5. However, it would not be reasonable to assume that each Group 3 metal emits at the maximum ELV for the group. In this regard, the EA has provided guidance on the steps required for assessing the impact of metals emissions (see Section 2.23. of this report). If any of the Group 3 metals exceed 1% of a long-term standard, then the PEC should be compared against the AQS. If the PEC is greater than 100% of the AQS then case specific screening is required. Consequently, background concentrations for As, Cr(VI), Co, Pb and Ni are required.

3.4. Background Air Concentrations of Group 3 Metals

3.4.1. Monitoring of trace elements has been undertaken by DEFRA since 1976. Currently, monitoring of twelve metals is carried out at locations throughout the UK, predominantly in urban locations. In addition, concentrations of As and Ni are monitored at a further ten rural locations.

3.4.2. The closest location to the Installation is the urban industrial site at Scunthorpe Low Santon (492936 (X), 411943 (Y)) approximately 116km to the south-southeast of the Installation. Although this is some distance from the site, it is classed as an urban industrial monitoring site, and therefore is considered to be appropriate to be used in the assessment.

3.4.3. For CrVI, it has been assumed that the background concentration is 20% of the total Cr concentration (as indicated in the EPAQS report *Guidelines for metals and metalloids in ambient air for the protection of human health*, May 2009).

3.4.4. Background concentrations for 2019 are provided in Table 14.

Table 14: Annual Mean Trace Metal Concentrations

Metal	Annual Mean Concentration ($\mu g/m^3$)
Arsenic (As)	0.000788
Total Chromium (Cr)	0.00374
Hexavalent Chromium (Cr VI)	0.000749
Cobalt (Co)	0.000177
Lead (Pb)	0.0154
Nickel (Ni)	0.00124

Notes to Table 14

(a) Cr VI assumed to be 20% of total Cr

3.5. Step 1 and 2 Screening of Group 3 Metals

3.5.1. Using the background concentrations in Table 14, PECs for the potentially significant Group 3 metals are provided in Table 15. Any PECs greater than 100% of the AQS are highlighted in bold.

Table 15: PECs of Group 3 Metals – Step 1 Screening

Pollutant	Stack height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS	Background Concentration (µg/m³)	Maximum PEC (µg/m³)	PEC as a % of AQS
As (annual mean)	85	2020	**0.00329**	0.003	**109.69%**	0.000788	**0.00408**	**136%**
	90	2020	**0.00259**		**86.35%**		**0.00338**	**113%**
	95	2020	**0.00209**		**69.61%**		0.00288	96%
	100	NWP 2020	**0.00170**		**56.56%**		0.00248	83%
	105	NWP 2020	**0.00153**		**51.14%**		0.00232	77%
	110	NWP 2020	**0.00139**		**46.33%**		0.00218	73%
Cr(VI) (annual mean)	85	2020	**0.00329**	0.0002	**1645.30%**	0.000749	**0.00404**	**2020%**
	90	2020	**0.00259**		**1295.20%**		**0.00334**	**1669%**
	95	2020	**0.00209**		**1044.20%**		**0.00284**	**1418%**
	100	NWP 2020	**0.00170**		**848.35%**		**0.00245**	**1223%**
	105	NWP 2020	**0.00153**		**767.05%**		**0.00228**	**1141%**
	110	NWP 2020	**0.00139**		**695.00%**		**0.00214**	**1069%**
Co (annual mean)	85	2020	**0.00329**	0.2	**1.65%**	0.000177	0.00347	1.7%
	90	2020	**0.00259**		**1.30%**		0.00277	1.4%
	95	2020	**0.00209**		**1.04%**		0.00227	1.1%
	100	NWP 2020	0.00170		0.85%		0.00187	0.9%
	105	NWP 2020	0.00153		0.77%		0.00171	0.9%
	110	NWP 2020	0.00139		0.70%		0.00157	0.8%

Table 15: PECs of Group 3 Metals – Step 1 Screening (cont.)

Pollutant	Stack height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS	Background Concentration (µg/m³)	Maximum PEC (µg/m³)	PEC as a % of AQS
Pb (annual mean)	85	2020	**0.00329**	0.25	**1.32%**	0.0154	0.0186	7.5%
	90	2020	**0.00259**		**1.04%**		0.0179	7.2%
	95	2020	0.00209		0.84%		0.0174	7.0%
	100	NWP 2020	0.00170		0.68%		0.0170	6.8%
	105	NWP 2020	0.00153		0.61%		0.0169	6.8%
	110	NWP 2020	0.00139		0.56%		0.0167	6.7%
Ni (annual mean)	85	2020	**0.00329**	0.02	**16.45%**	0.00124	0.00453	23%
	90	2020	**0.00259**		**12.95%**		0.00383	19%
	95	2020	**0.00209**		**10.44%**		0.00332	17%
	100	NWP 2020	0.00170		**8.48%**		0.00293	15%
	105	NWP 2020	0.00153		**7.67%**		0.00277	14%
	110	NWP 2020	0.00139		**6.95%**		0.00263	13%

3.5.2. The data in Table 15 indicates that, although for the majority of pollutants the PECs can be screened out, further screening is required for long-term As at stack heights of 85m and 90m and for Cr(VI) at all stack heights listed.

3.5.3. Step 2 screening indicates that where the PC exceeds 1% of the long-term standard, the maximum emissions data in Appendix A of the EA's Group 3 metals assessment guidance can be used to revise the predictions, and the PEC then compared against the AQS. The guidance states that As comprises 5% of the Group 3 metals, and Cr(VI) 0.03%. Consequently, the emission rates for each have been recalculated based on these percentages. The results of the assessment may be found in Table 16.

Table 16: PECs of Group 3 Metals – Step 2 Screening

Pollutant	Stack height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS	Background Concentration (µg/m³)	Maximum PEC (µg/m³)	PEC as a % of AQS
As (annual mean)	85	2020	**0.000164**	0.003	**5.47%**	0.000788	0.000952	32%
	90	2020	**0.000129**		**4.30%**		0.000917	31%
Cr(VI) (annual mean)	85	2020	0.000000985	0.0002	0.49%	N/A – PCs all screen out (i.e., they are all less than 1% of the AQS)		
	90	2020	0.000000775		0.39%			
	95	2020	0.000000625		0.31%			
	100	NWP 2020	0.000000435		0.22%			
	105	NWP 2020	0.000000374		0.19%			
	110	NWP 2020	0.000000338		0.17%			

3.5.4. The data in Table 16 indicates that the PECs for As can be screened out. In addition, the PCs for Cr(VI) all screen out. Consequently, no further assessment is required for the metals.

3.5.5. The long-term impacts of NO_2, VOC and PAH still requires further assessment. The next stage of the Step 2 impact significance screening process is to compare the long-term pollutant PECs with the criteria outlined in Section 2.21. of this report. Consequently, the background concentrations of the pollutants are required.

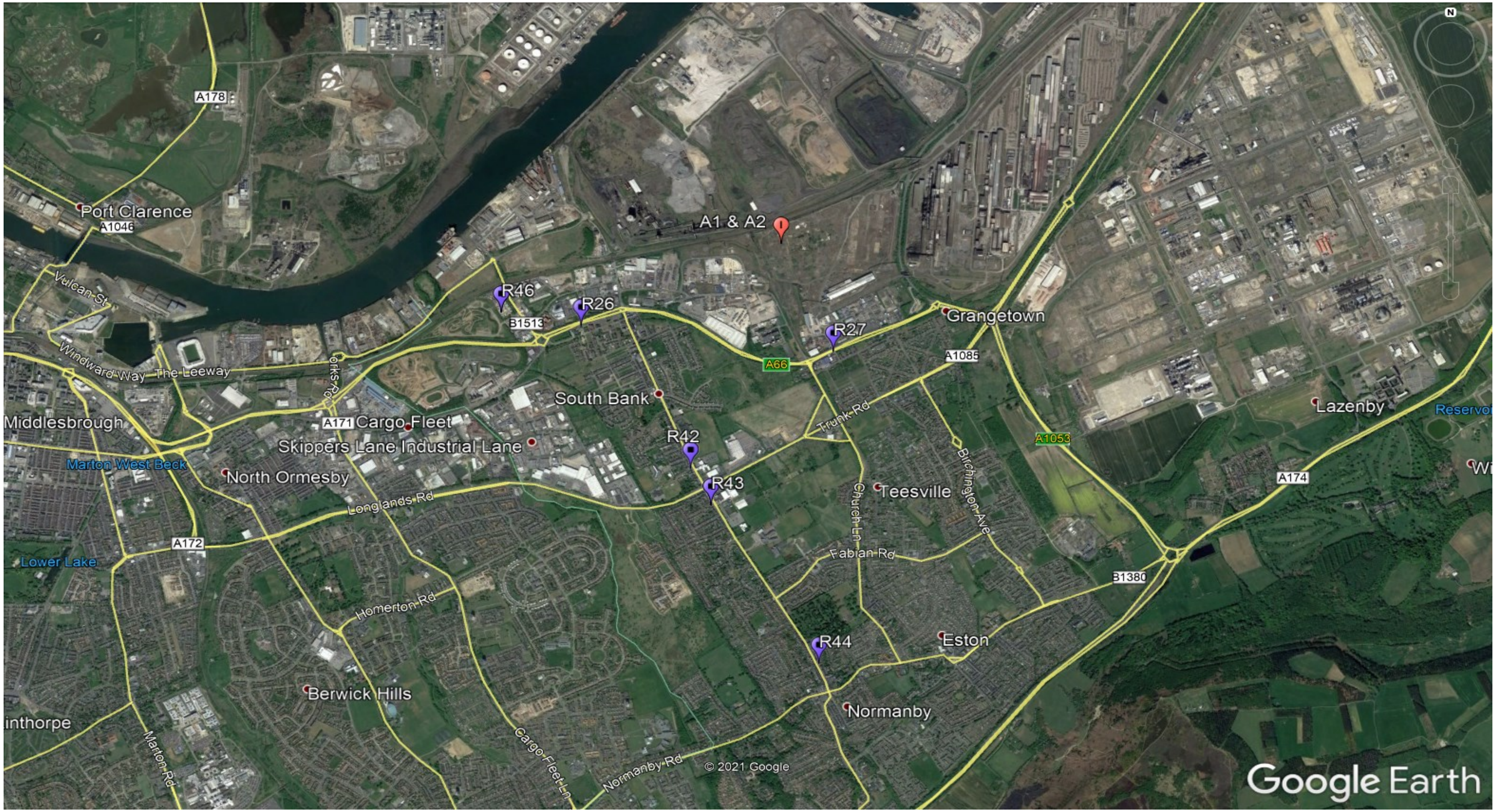
3.6. Background Concentrations of NO_2, VOC and PAH

Nitrogen Dioxide (NO_2)

3.6.1. RCBC undertake automatic and diffusion tube ("DT") monitoring for NO_2 throughout the county. Of these sites monitoring locations within a 3km radius of the Installation were considered.

3.6.2. The details of the specific DTs considered are shown on Figure 12 and the results of the monitoring are provided in Table 17.

Figure 12: Diffusion Tube Monitoring Locations



Notes to Figure 12

The red pin represents the approximate location of the A1 and A2 emissions points at the Installation; and
The blue pins represent the approximate locations of the DTs (refer to Table 17 for further details).

Table 17: Nearest DT Monitoring Site Locations to the Installation

ID / Name [(a)]	NO_2 Conc. (µg/m³) 2019 [(a)] *	NO_2 Conc. (µg/m³) 2020 [(b)] **	Eastings (X) [(a)]	Northings (Y) [(a)]	Distance from Source (m) [(b)]	Heading (degrees)
R27	24.8	21.0	454712	520678	804	156
R26	19.5	17.7	453142	520836	1364	245
R42	13.9	n/a	453834	519869	1635	199
R46	16.1	14.0	452644	520921	1803	254
R43	15.2	n/a	453964	519621	1837	193
R44	12.9	n/a	454648	518546	2877	175

Notes to Table 17

(a) Information obtained online from RCBC's 2020 Air Quality Annual Status Report ("ASR") (a copy of which may be found as Appendix I of this report).

(b) Information obtained online from RCBC's 2021 Air Quality ASR. Available online via: https://www.redcar-cleveland.gov.uk/resident/environmental-protection/air-quality/Documents/Air%20Quality%20Report.pdf.

(c) Distances are measured as the crow flies from the coordinates of the DT to the 'Source'. The 'Source' is the approximate halfway location between the two emission points associated with the incinerator – location coordinates: 454379 (X), 521410 (Y).

* RCBC applied a national bias adjustment factor of 0.87 to the 2019 monitoring data.

** RCBC applied a national bias adjustment factor of 0.82 to the 2020 monitoring data.

n/a: data not available.

3.6.3. It is worth noting that, as a result of the lockdown restrictions and societal behavioural changes resulting from the COVID-19 pandemic there have been implications to air quality at local, regional and national scales. The reduced activity experienced (particularly in regard to vehicle movements and their subsequent emissions) was most notable during the first national lockdown, which saw vehicle traffic reductions of up to 70% across the UK by mid-April (2020), relative to pre COVID-19 levels (Department for Transport data)[29].

3.6.4. RCBC have stated that there were no identifiable impacts as a consequence of COVID-19 upon air quality within Redcar and Cleveland. Although air quality monitoring was able to continue during the 2020 reporting year, it is apparent that there were less DT monitoring sites compared to the 2019 reporting year. Consequently, in the interest of a conservative assessment, NO_2 concentrations from 2019 will therefore be used for the purposes of PEC calculations.

3.6.5. In addition to monitored data, DEFRA modelled background maps are also available. These background pollution maps are at a resolution of 1x1km and are modelled each year under DEFRA's Modelling of Ambient Air Quality contract. Table 18 displays the nearest mapped NO_2 locations to the point of maximum GLC, for the stack heights assessed, and their concentrations for the year 2019 (the latest available year at the time of writing).

[29] Refer to Appendix F of the 2021 ASR report for further details.

Table 18: Nearest DEFRA Background NO_2 Data to the Point of Maximum GLC

Stack Height (m)	UK Grid Code [(a)]	2019 Annual Mean NO_2 Concentration ($\mu g/m^3$) [(a)]	Easting Coordinate of Max GLC (X)	Northing Coordinate of Max GLC (Y)	Distance from Max GLC [(b)] (m)	Heading (degrees)
85m	537285	13.78	454419	521930	438	169
90m	536595	16.20	454459	522050	452	5
95m	536595	16.20	454459	522130	372	6
100m	536596	16.27	455059	522450	444	84
105m	536596	16.27	455099	522490	401	89
110m	536596	16.27	455139	522530	362	95

Notes to Table 18

(a) Information from the latest (2019) DEFRA background pollution maps, available via: https://uk-air.defra.gov.uk/data/pcm-data.
(b) Distances are measured as the crow flies from the coordinates of the DEFRA grid square to the occurrence of the maximum GLC.

3.6.6. It can be seen from the data in Table 18, compared to the data in Table 17, that the DEFRA modelled NO_2 concentrations are similar in value to the majority of the DTs considered (for the year 2019) and closer to the Installation overall with the exception of R27 which has a higher concentration. Consequently, this location will be used to ensure a conservative assessment.

Volatile Organic Compounds (as Benzene)

3.6.7. As there is no suitable measured data for VOC as benzene, the DEFRA mapped data will be used. Table 19 displays the nearest mapped benzene locations to the point of maximum GLC, for the stack heights assessed, and their concentrations for the year 2019.

Table 19: Nearest DEFRA Background Benzene Data to the Point of Maximum GLC

Stack Height (m)	UK Grid Code [(a)]	2019 Annual Mean Benzene Concentration ($\mu g/m^3$) [(a)]	Easting Coordinate of Max GLC (X)	Northing Coordinate of Max GLC (Y)	Distance from Max GLC [(b)] (m)	Heading (degrees)
85m	537285	0.326	454419	521930	438	169
90m	536595	0.355	454459	522050	452	5
95m	536595	0.355	454459	522130	372	6
100m	536596	0.358	455059	522450	444	84
105m	536596	0.358	455099	522490	401	89
110m	536596	0.358	455139	522530	362	95

Notes to Table 19

(a) Information from the latest (2019) DEFRA background pollution maps, available via: https://uk-air.defra.gov.uk/data/pcm-data.
(b) Distances are measured as the crow flies from the coordinates of the DEFRA grid square to the occurrence of the maximum GLC.

3.6.8. For the purposes of calculating the VOC PECs, the closest DEFRA modelled data to the location of the maximum VOC GLCs, for the stack heights assessed, will be used.

PAH (as Benzo[a]pyrene)

3.6.9. Monitoring of PAH has been undertaken by DEFRA since 1991. Currently, the network consists of over 30 PAH measurement sites across England, Wales, Scotland and Northern Ireland measuring ambient concentrations of PAH in UK atmosphere[30].

3.6.10. The closest location to the Installation is the urban industrial site at Middlesbrough (450471 (X), 519621 (Y)), situated approximately 4.3km to the west-southwest of the Installation. The 2019 annual average PAH (as Benzo[a]pyrene, solid phase) concentration at this monitoring location was 0.000206 µg/m^3 and will therefore be used for the calculation of the PAH PECs.

3.7. Step 2 Screening of Remaining Pollutants

3.7.1. Using the background data discussed in section 3.6., PECs will now be calculated for the long-term impacts of NO_2, VOC and PAH. The criteria used to determine the significance of the impact of PECs is provided in Section 2.22 of this report. Table 20 displays the PEC assessment, with any potentially significant PCs indicated in bold.

[30] https://uk-air.defra.gov.uk/networks/network-info?view=pah.

Table 20: Long-term impacts of NO_2, VOC and PAH – Step 2 Screening

Pollutant	Stack height (m)	Worst Case Met Year	Maximum PC (µg/m³)	AQS (µg/m³)	PC as a % of AQS	Background Concentration (µg/m³)	Maximum PEC (µg/m³)	PEC as a % of AQS	Impact Descriptor
NO_2 (annual mean)	85	2020	**0.765**	40	**1.91%**	24.8	25.57	64%	Negligible
	90	2020	**0.603**		**1.51%**		25.40	64%	Negligible
	95	2020	**0.486**		**1.21%**		25.29	63%	Negligible
	100	NWP 2020	0.395		0.99%		25.19	63%	Screens out at Step 1
	105	NWP 2020	0.357		0.89%		25.16	63%	Screens out at Step 1
	110	NWP 2020	0.323		0.81%		25.12	63%	Screens out at Step 1
VOC (annual mean)	85	2020	**0.109**	5	**2.19%**	0.326	0.435	9%	Negligible
	90	2020	**0.0861**		**1.72%**	0.355	0.441	9%	Negligible
	95	2020	**0.0694**		**1.39%**	0.355	0.424	8%	Negligible
	100	NWP 2020	**0.0564**		**1.13%**	0.358	0.414	8%	Negligible
	105	NWP 2020	**0.0510**		**1.02%**	0.358	0.409	8%	Negligible
	110	NWP 2020	**0.0462**		0.92%	0.358	0.404	8%	Screens out at Step 1
PAH (as B[a]P) (annual mean)	85	2020	**0.0000109**	0.00025	**4.37%**	0.000206	0.000217	87%	Slight
	90	2020	**0.00000861**		**3.44%**		0.000215	86%	Slight
	95	2020	**0.00000694**		**2.78%**		0.000213	85%	Slight
	100	NWP 2020	**0.00000564**		**2.26%**		0.000212	85%	Slight
	105	NWP 2020	**0.00000510**		**2.04%**		0.000211	85%	Slight
	110	NWP 2020	**0.00000462**		**1.85%**		0.000211	84%	Negligible

3.7.2. The data in Table 20 indicates that, for annual NO_2, the impact on the environment can be classed as 'negligible' for stack heights of 85m to 95m (inclusive) and screens out at stack heights of 100m and taller. For VOC the impact on the environment can be classed as 'negligible' for stack heights of 85m to 105m (inclusive) and screens out at stack heights of 110m. For PAH (as B[a]P) the impact on the environment can be classed as 'slight' for stack heights of 85m to 105m (inclusive) and 'negligible' for stack heights of 110m.

3.7.3. Consequently, stack heights of 85m and taller are regarded as suitable heights. However, taking the overall results of the stack height screening assessment at the maximum point of impact into account, it has been considered that stack heights (for both A1 and A2) of 90m will provide slightly greater environmental protection (compared to stack heights of 85m and shorter) and should therefore allow for more flexibility when factoring in periods of abnormal emissions, as well as when accounting for any cumulative impacts (refer to Sections 8 and 9, respectively, for further details).

3.8. Proposed Stack Height

3.8.1. Based on the results of the stack height screening assessment detailed in the sections above, 90m discharge stack heights are proposed and will be used from this point forward.

3.9. Isopleths

3.9.1. Isopleths have been prepared for every pollutant with an AQS (with the exception of annual and 1-hour PCBs, as it has been considered that the predicted PCs for these pollutants are infinitesimal (refer to Table 13 for details) for the worst-case met year. These are provided as Figures 13-32.

3.9.2. The blue contour lines (as shown in Figures 13, 21 and 31 for annual NO_2, VOC and PAH (as B[a]P), respectively)) represent the extent to which the predicted PCs are 1% of the relevant AQS for these pollutants.

Figure 13: NO_2 - Annual Mean – Met Year 2020

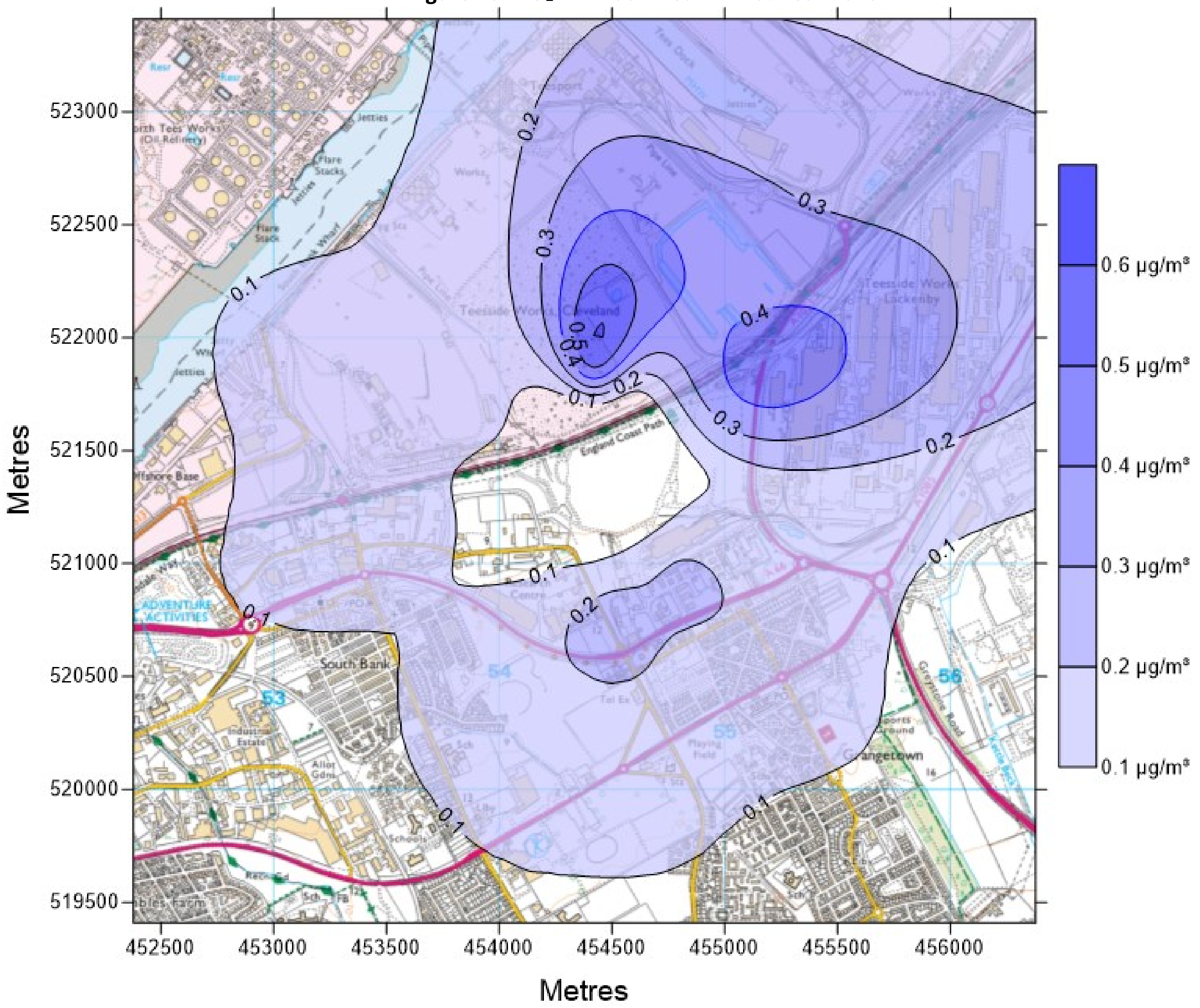


Figure 14: NO_2 - 99.79th Percentile – Met Year 2018

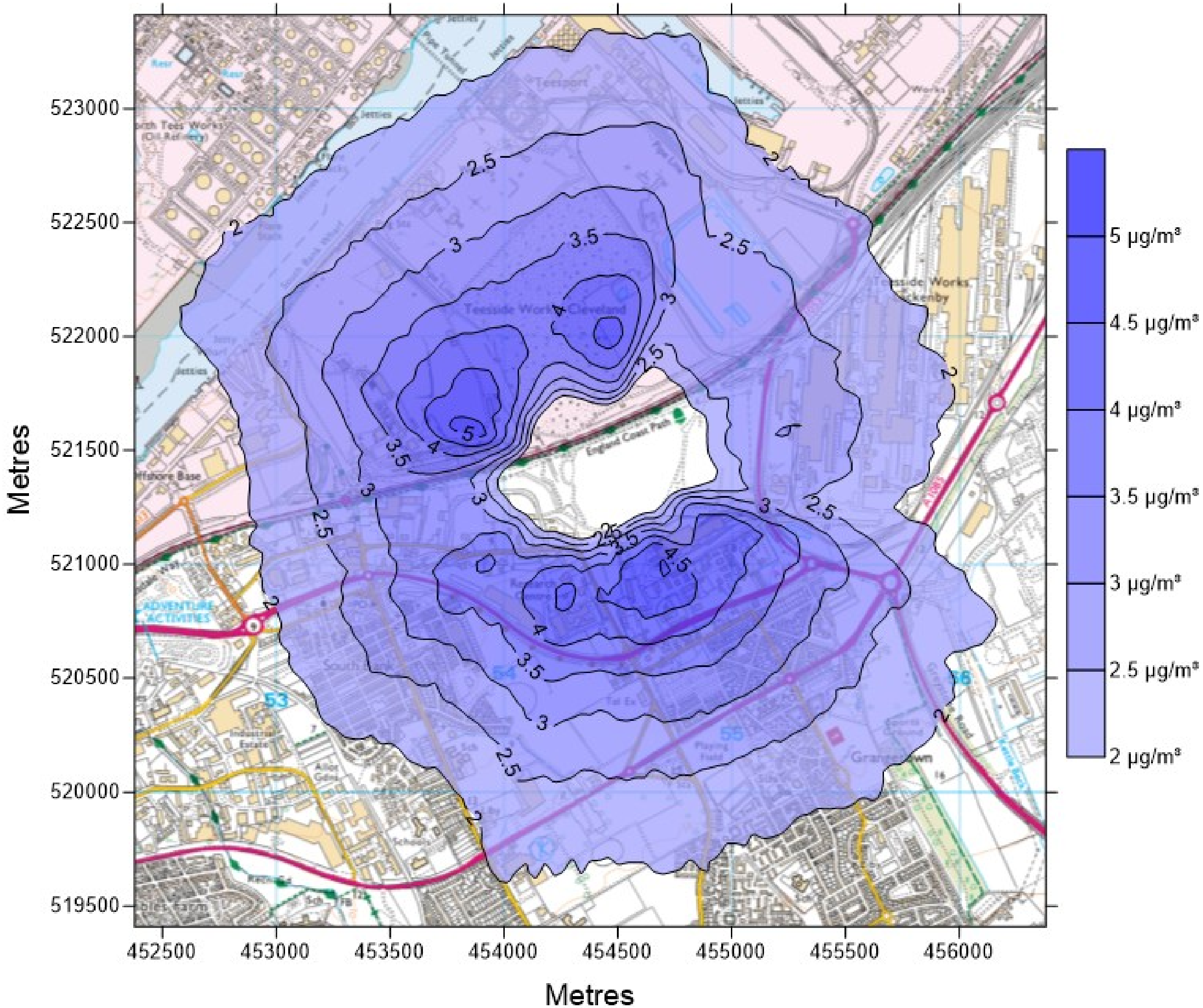


Figure 15: SO_2 - 99.18th Percentile – Met Year 2016

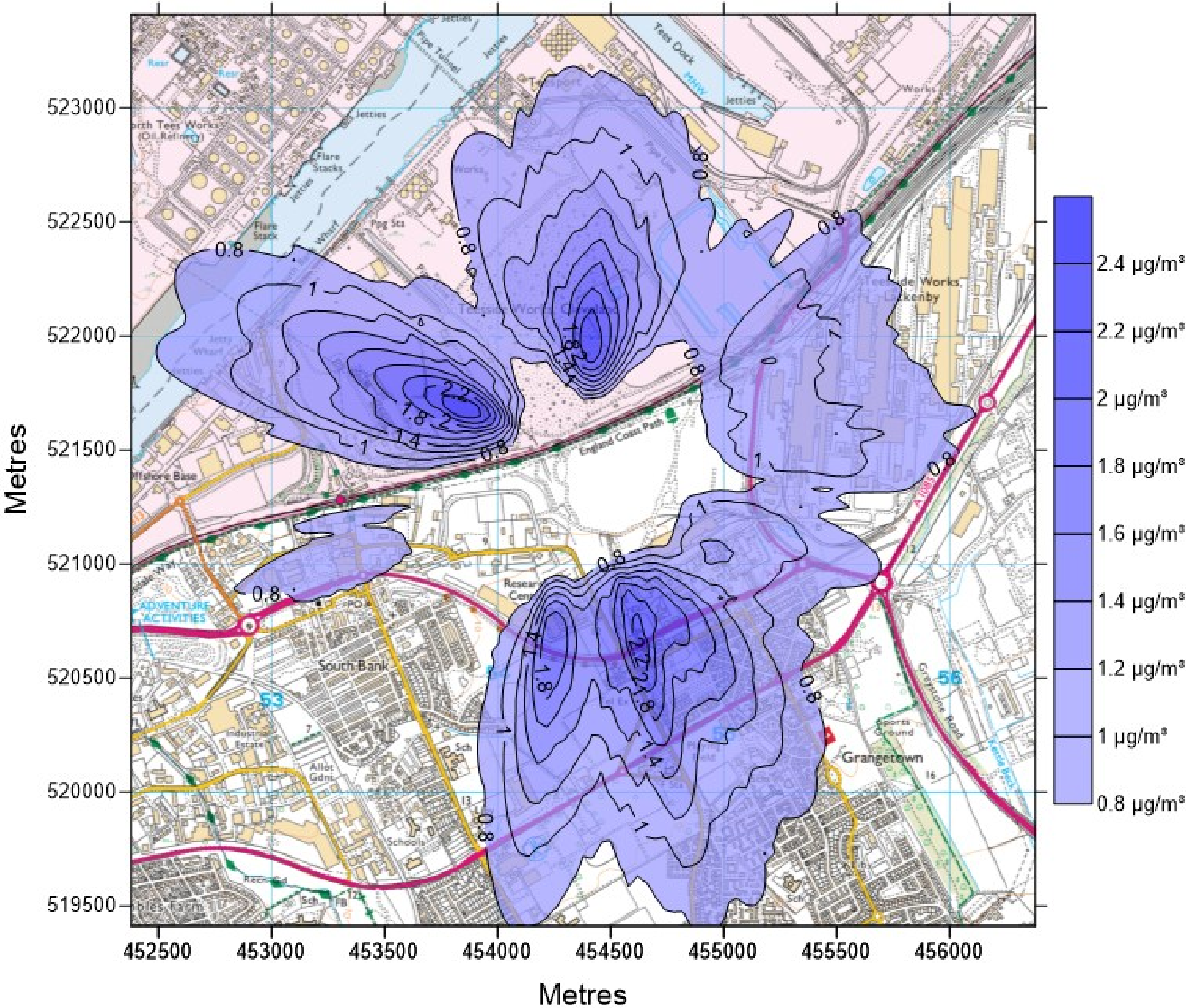


Figure 16: SO_2 - 99.73rd Percentile – Met Year 2018

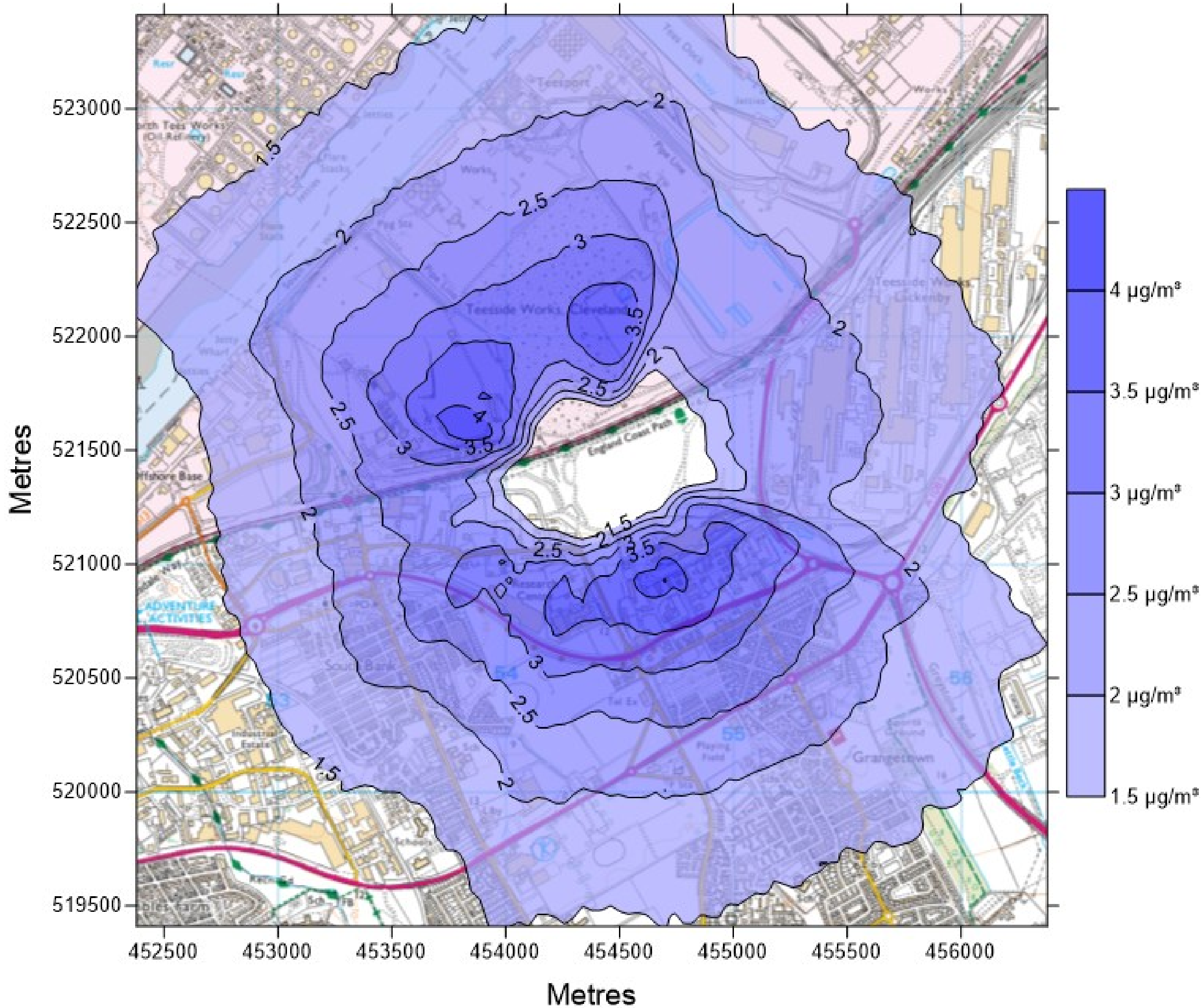


Figure 17: SO_2 - 99.90th Percentile – Met Year 2018

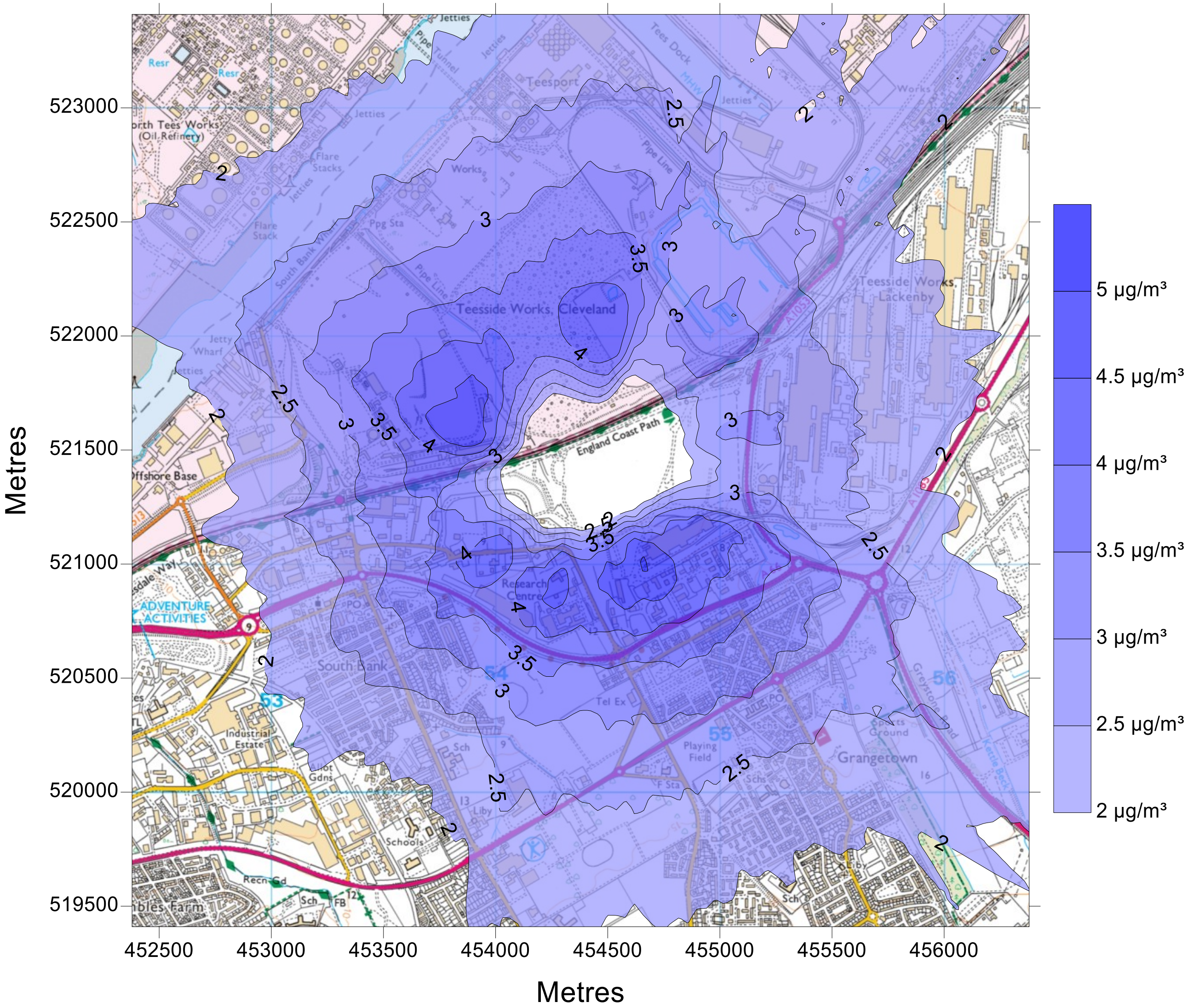


Figure 18: PM_{10} and $PM_{2.5}$ - Annual Mean – Met Year 2020

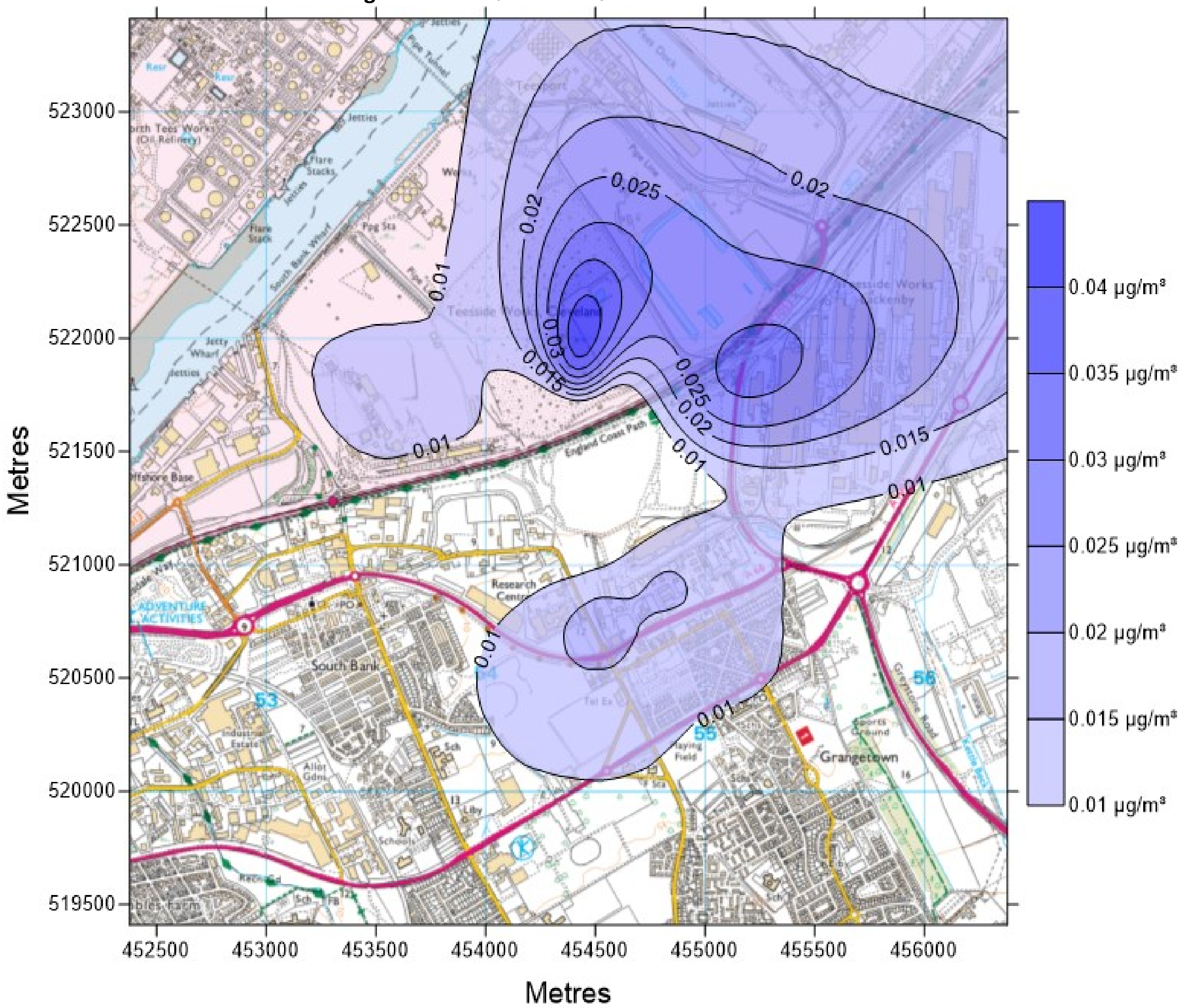


Figure 19: PM$_{10}$ - 90.41st Percentile – Met Year 2020

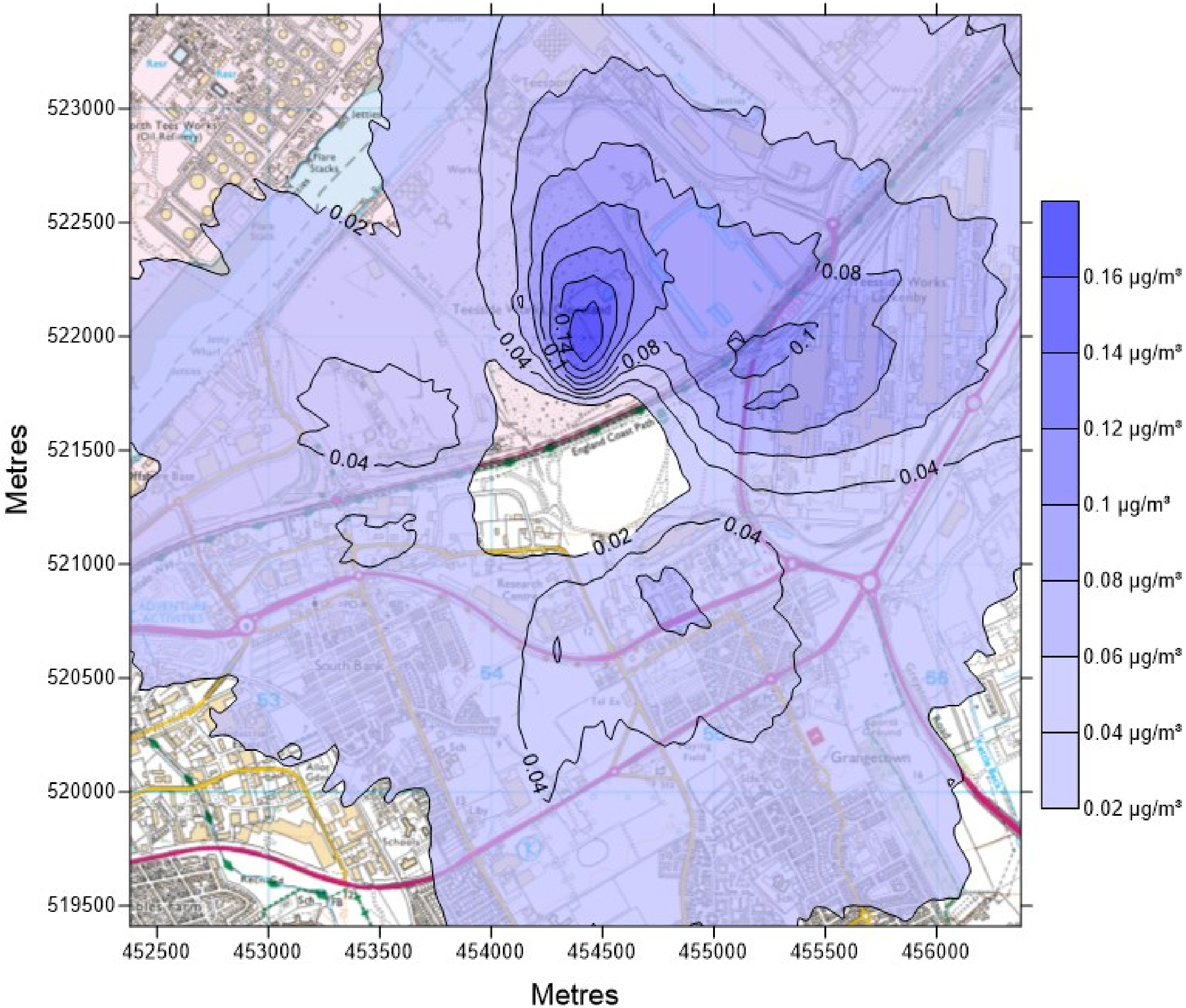


Figure 20: CO - 100th Percentile – Met Year 2018

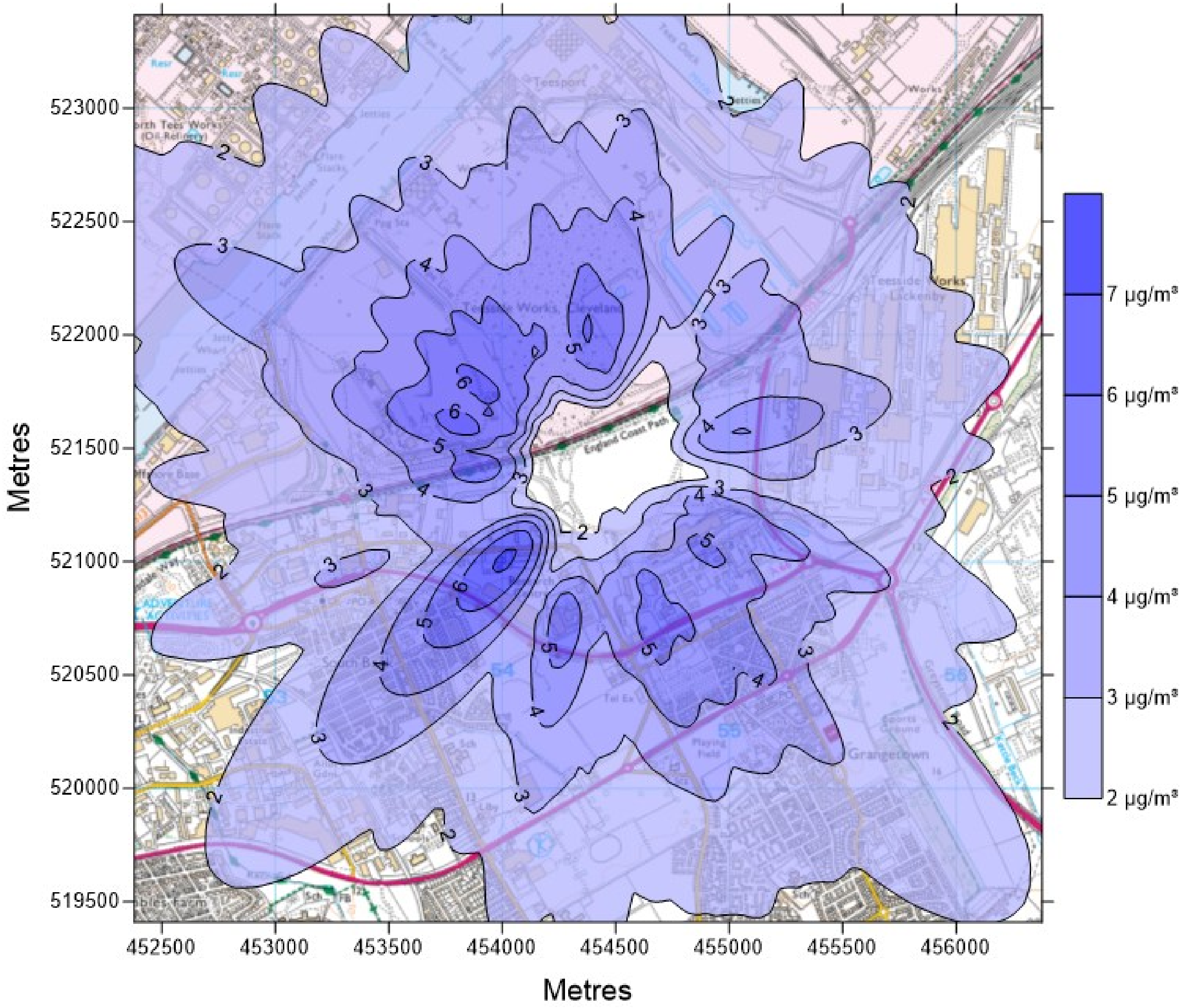


Figure 21: VOC - Annual Mean – Met Year 2020