WILTON HYDROTHERMAL UPGRADING FACILITY ENVIRONMENTAL PERMIT APPLICATION

Air Emissions Risk Assessment

Prepared for: ReNew Wilton Ltd

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BASIS OF REPORT

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1.0 Introduction

1.1 Background

ReNew Wilton Ltd (ReNew Wilton) has instructed SLR Consulting Limited (SLR) to prepare a bespoke Environmental Permit (EP) application for the Wilton Hydrothermal Upgrading Facility in Redcar, Wilton Centre, Redcar, Teesside, TS10 4RG (the "site").

This report presents the Air Emissions Risk Assessment (AERA) undertaken in accordance with Environment Agency guidance and forms Section 5 of the application.

The Non-Technical Summary provided in Section 1 of the application gives a full description of the EP application and the facility. The key details of relevance to this air quality assessment are that the facility will comprise:

- production of hydrocarbon chemicals (light naphtha to heavy wax residues) from the hydrothermal treatment of end life plastics and production of process gas (similar to refinery gas).
- The process gas is utilised in:
    - high pressure supercritical steam generating boiler with a selective catalytic reduction (SCR – ammonia or urea based nitrogen oxides (NOx) control) that discharges treated flue gases at 18m; and
    - low pressure steam generating boiler that discharges flue gases at 5m.
- An enclosed flare 12m high designed for plant start up and emergency over pressure protection of the low pressure system. At the same location, a conventional open flare for extreme emergency operations protecting the high pressure system from over pressurisation (discharging at 13m).

The boilers will also be able to operate using natural gas. Once fully operational it is the intent that all of the process gas produced will be used to power the process, supplemented by natural gas as required.

1.2 Scope of Assessment

The scope of this assessment is specifically concerned with emissions from the stacks. The scope incorporates:

- a review of relevant legislation and guidance;
- a review of baseline conditions at the site and potential for cumulative effects with other local emitters;
- quantification of pollutant emissions to air;
- prediction of the impact of emissions to air using atmospheric dispersion modelling techniques;
- consideration of model uncertainties and sensitivities; and
- assessment of the significance of these predicted impacts on air quality.

The objective of the assessment is to determine the potential effect of emissions from the proposed facility on the air quality environment by comparison to relevant guidelines for the protection of human health and the environment (i.e. protected sensitive habitats).

2.0 LEGISLATION AND RELEVANT GUIDANCE

The following legislation and guidance relates to the assessment of potential air quality impacts from the installation.

2.1 National Legislation

2.1.1 Air Quality Standards Regulations

The Air Quality Standards Regulations 2010 (the AQSR) transpose the Air Quality Directive (2008/50/EC) and Fourth Daughter Directive (2004/107/EC) into UK legislation. The regulations include Limit Values, Target Values, Objectives, Critical Levels and Exposure Reduction Targets for the protection of human health and the environment. Those relevant to this assessment are presented within Table 2-2.

2.1.2 Air Quality Strategy

The Air Quality Strategy[1] (AQS) sets out a comprehensive strategic framework within which air quality policy will be taken forward in the short to medium term, and the roles that the Government, industry, Environment Agency (EA), local government, business, individuals and transport have in protecting and improving air quality. The AQS contains Air Quality Objectives (AQOs) for the protection of both human health and vegetation (ecosystems). Those relevant to this assessment are presented within Table 2-2.

2.1.3 Local Air Quality Management

Section 82 of the Environment Act 1995 (Part IV) requires local authorities to periodically review and assess the quality of air within their administrative area. The reviews have to consider the present and future air quality and whether any AQALs prescribed in regulations are being achieved or are likely to be achieved in the future.

Where any of the prescribed standards are not likely to be achieved the authority concerned must designate an Air Quality Management Area (AQMA). For each AQMA the local authority has a duty to draw up an Air Quality Action Plan (AQAP) setting out the measures the authority intends to introduce to deliver improvements in local air quality in pursuit of the standards. As such, Local Authorities (LAs), have formal powers to control air quality through a combination of LAQM and by use of their wider planning policies.

Defra has published technical guidance for use by local authorities in their LAQM work[2]. This guidance, referred to in this report as LAQM.TG(16), has been used where appropriate in the assessment presented here.

2.1.4 Protection of Nature Conservation Sites

Sites of nature conservation importance at a European, national and local level, are provided environmental protection from developments, including from atmospheric emissions.

The Conservation of Habitats and Species Regulations 2010 introduces the precautionary principle for protected areas, i.e. that projects can only be permitted to proceed; having ascertained that there will be no adverse effect on the integrity of the designated site. It requires an assessment to determine if significant effects (alone or in combination) are likely, followed by an 'appropriate assessment' by the competent authority, if necessary.

Similarly, the Countryside and Rights of Way (CRoW) Act 2000 provides protection to Sites of Special Scientific Interest (SSSIs) to ensure that developments are not likely to cause them damage.

[1] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, DEFRA. July 2007
[2] Department for Environment, Food and Rural Affairs (DEFRA): Local Air Quality Management Review and Assessment Technical Guidance LAQM.TG(16), 2016.

Locally important sites (such as National Nature Reserves (NNR), Local Nature Reserves (LNR), Local Wildlife Sites (LWS) or Sites of Importance for Nature Conservation (SINCs) and Ancient Woodland (AW)) are also protected by legislation to ensure that developments do not cause significant pollution.

2.2 Regulation of Industrial Emissions

2.2.1 Medium Combustion Plant Directive

The Medium Combustion Plant Directive[3] (MCPD) regulates pollutant emissions from the combustion of fuels in plants with a rated thermal input equal to or greater than 1 Megawatt thermal (MWth) and less than 50 MWth.

Due to the low thermal input of the two gas fired boillers (each less than 2MW) with significantly less than 3t/h of combusted fuel, the combustion plants at the site falls under the MCPD regulations. The flare stack is used for emergency and overpressure flaring is exempt from emissions compliance under the MCPD.

2.2.2 Emission Limit Values to Air

As mentioned above, the combustion plant at the site will be regulated under MCPD. Table 2-1 presents the applicale ELVs for the combustion plant.

Table 2-1
MCPD Emission Limit Values

Pollutant	Emission Limits (mg/Nm^3) [(a)]	
	Natural gas	Gaseous Fuels other than natural gas
Sulphur dioxide (SO_2)	N/A	35
Oxides of nitrogen (NOx)	100	200

Table Notes:

a) Concentrations referenced to temperature 273 K, pressure 101.3 kPa, 3% oxygen, dry gas.

2.2.3 Environmental Permitting

In England, the Environmental Permitting (England and Wales) Regulations (2018) transpose the MCPD in UK legislation. The proposed installation would be regulated by the EA under the Environmental Permitting (EP) Regulations which includes regulating emissions to air.

Guidance Notes produced by Defra provide a framework for regulation of installations and additional Technical Guidance Notes produced by the EA are used to provide the basis for Environmental Permit conditions as regards releases to air and mitigation measures.

Of particular relevance to the assessment of air quality impacts is the EA's '*air emission risk assessment for your environmental permit*' guidance[4] (referred to as the AERA guidance throughout this report). The purpose of this guidance is to assist operators to assess risks to the environment and human health when applying for a permit under the EP Regulations. This guidance sets out Environmental Assessment Levels (EALs) which are taken from the AQS and AQSR but also includes EALs for additional pollutants derived from occupational exposure limits

[3] Directive 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants.
[4] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

(OEL) and maximum exposure levels (MEL) presented in HSE EH40[5]. Those relevant to this assessment are presented within Table 2-2 below.

2.3 Environmental Standards

The environmental standards for air, taken from the legislation and guidance outlined above, for the protection of human health and sensitive ecological receptors are presented in the sections below.

2.3.1 Standards for Protection of Human Health

The standards applied in this assessment, taken from the AQSR, AQS and AERA guidance are set out in Table 2-2 below.

Table 2-2
Relevant Standards (µg/m^3)

Pollutant		Annual Standard (µg/m^3)	Short Term Standard (µg/m^3)	Ref
Nitrogen dioxide	(NO_2)	40	200 (1-hour) not to be exceeded more than 18 times per year	AQSR
Sulphur dioxide	(SO_2)	---	266 (15-minute) not to be exceeded more than 35 times per year	AQS
			350 (1-hour) not to be exceeded more than 24 times per year	AQSR
			125 (24-hour) not to be exceeded more than 3 times per year	AQSR
Ammonia	(NH_3)	180	2,500 (1-hour)	AERA

The regulations[6] state that exceedances of the objectives should be assessed in relation to "the quality of the air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present". LAQM.TG(16) provides guidance on relevant exposure locations that are summarised in Table 2-3 below.

Table 2-3
Relevant Public Exposure

Averaging Period	Relevant Locations	AQO's should apply at:	AQO's don't apply at:
Annual mean	Where individuals are exposed for a cumulative period of 6 months in a year	Building facades of residential properties, schools, hospitals etc.	Facades of offices Hotels Gardens of residences Kerbside sites

[5] HSE (2011) EH40/2005 Workplace Exposure Limits.
[6] The Air Quality (England) Regulations 2000 No. 928

Averaging Period	Relevant Locations	AQO's should apply at:	AQO's don't apply at:
24-hour mean	Where individuals may be exposed for eight hours or more in a day	As above together with hotels and gardens of residential properties	Kerbside sites where public exposure is expected to be short term
8-hour mean	Where individuals may be exposed for eight hours or more in a day	As above together with hotels and gardens of residential properties	Kerbside sites where public exposure is expected to be short term
1-hour mean	Where individuals might reasonably expected to spend one hour or longer	As above together with kerbside sites of regular access, car parks, bus stations etc.	Kerbside sites where public would not be expected to have regular access
15-minute mean	All locations where members of the public might reasonably be exposed for a period of 15-minutes or longer		-

2.3.2 Standards for the protection of Ecosystems and Vegetation

Environmental Quality Standards exist for nature conservation sites known as Critical Levels (for airborne concentrations) and Critical Loads (for deposition of nitrogen or acid forming compounds).

Critical Levels (CLe)

CLe's are a quantitative estimate of exposure to one or more airborne pollutants in gaseous form, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. CLe's for the protection of vegetation and ecosystems are specified within relevant European air quality directives and corresponding UK air quality regulations (see Table 2-4).

Table 2-4
Critical Levels for the Protection of Vegetation and Ecosystems

Pollutant	Concentration ($\mu g/m^3$)	Habitat and Averaging Period
Ammonia (NH_3)	1	Annual mean. Sensitive lichen communities & bryophytes and ecosystems where lichens & bryophytes are an important part of the ecosystem's integrity
	3	Annual mean. For all higher plants (all other ecosystems)
Sulphur dioxide (SO_2)	10	Annual mean. Sensitive lichen communities & bryophytes and ecosystems where lichens & bryophytes are an important part of the ecosystem's integrity
	20	Annual mean. For all higher plants (all other ecosystems)
Nitrogen oxides (NO_x)	30	Annual mean (all ecosystems)
	75	Daily mean (all ecosystems)

Critical Loads (C_{Lo})

C_{Lo}'s are a quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. C_{Lo}'s are set for the deposition of various substances to sensitive ecosystems. In relation to combustion emissions, C_{Lo}'s for eutrophication and acidification are relevant which can occur via both wet and dry deposition, however on a local scale only dry (direct deposition) is considered significant.

Empirical C_{Lo}'s for eutrophication (derived from a range of experimental studies) are assigned based on different habitats, including grassland ecosystems, mire, bog and fen habitats, freshwaters, heathland ecosystems, coastal and marine habitats, and forest habitats and can be obtained from the UK Air Pollution Information System (APIS) website[7].

C_{Lo}'s for acidification have been set in the UK using an empirical approach for non-woodland habitats on a 1km grid square based upon the mineralogy and chemistry of the dominant soil series present in the grid square, and the simple mass balance (SMB) equation for both managed and unmanaged woodland habitats.

The C_{Lo}'s relevant to this assessment are presented in Section 4.6.

[7] http://www.apis.ac.uk/srcl Accessed November 2019.

3.0 ASSESSMENT METHODOLOGY

3.1 Approach

The assessment has been undertaken as a 'detailed assessment' using dispersion modelling. The assessment incorporates:

- identification of sensitive receptors and compilation of the existing air quality baseline;
- quantification of emissions from the installation;
- atmospheric dispersion modelling to determine process contribution to ground level concentrations and calculate deposition rates; and
- assessment of impacts by comparison to standards for protection of human health and ecological receptors.

3.2 Dispersion Modelling

3.2.1 Dispersion Model

The model used is the US American Meteorological Society and Environmental Protection Agency Regulatory Model (AERMOD[8]) dispersion model. This model is commonly used for assessments of this kind and has been accepted as suitable for use by the EA on similar projects.

3.2.2 Model Domain / Receptors

The modelling has been undertaken using a receptor grid across an Ordnance Survey map of the study area. Pollutant exposure isopleths are generated by interpolation between receptor points and superimposed onto the map. This method allows the maximum ground level concentration outside the site boundary to be assessed. A receptor grid was applied as follows:

- 100m x 100m at 20m grid resolution;
- 2000m x 2000m at 50m grid resolution;
- 4000m x 4000m at 100m grid resolution;
- 8000m x 8000m at 200m grid resolution; and
- 12000m x 12000m at 500m grid resolution

In addition, the modelling of discrete sensitive receptor locations as described in Section 4.1 was undertaken to facilitate the discussion of results.

3.2.3 Topography

The presence of elevated terrain can significantly affect the dispersion of pollutants and the resulting ground level concentration in a number of ways. Elevated terrain reduces the distance between the plume centre line and the ground level, thereby increasing ground level concentrations. Elevated terrain can also increase turbulence and, hence, plume mixing with the effect of increasing concentrations near to a source and reducing concentrations further away.

AERMOD utilises digital elevation data to determine the impact of topography on dispersion from a source. Topography was incorporated within the modelling using 30m resolution Shuttle Radar Topography Mission (SRTM) terrain data files. Data was processed by the AERMAP function within AERMOD to calculate terrain heights.

[8] Software used: Lakes AERMOD View, (Executable Aermod_19191)

3.2.4 Building Downwash

The integrated Building Profile Input Programme (BPIP) module within AERMOD was used to assess the potential impact of building downwash upon predicted dispersion characteristics.

Building downwash occurs when turbulence, induced by nearby structures, causes pollutants emitted from an elevated source to be displaced and dispersed rapidly towards the ground, resulting in elevated ground level concentrations. All buildings input to the model are represented in Figure 3-1. The key building effecting downwash are buildings that have a maximum height equivalent to at least 40% of the emission height and which are within a distance defined as five times the lesser of the height or maximum projected width of the building. The structures modelled are presented in Figure 3-1.

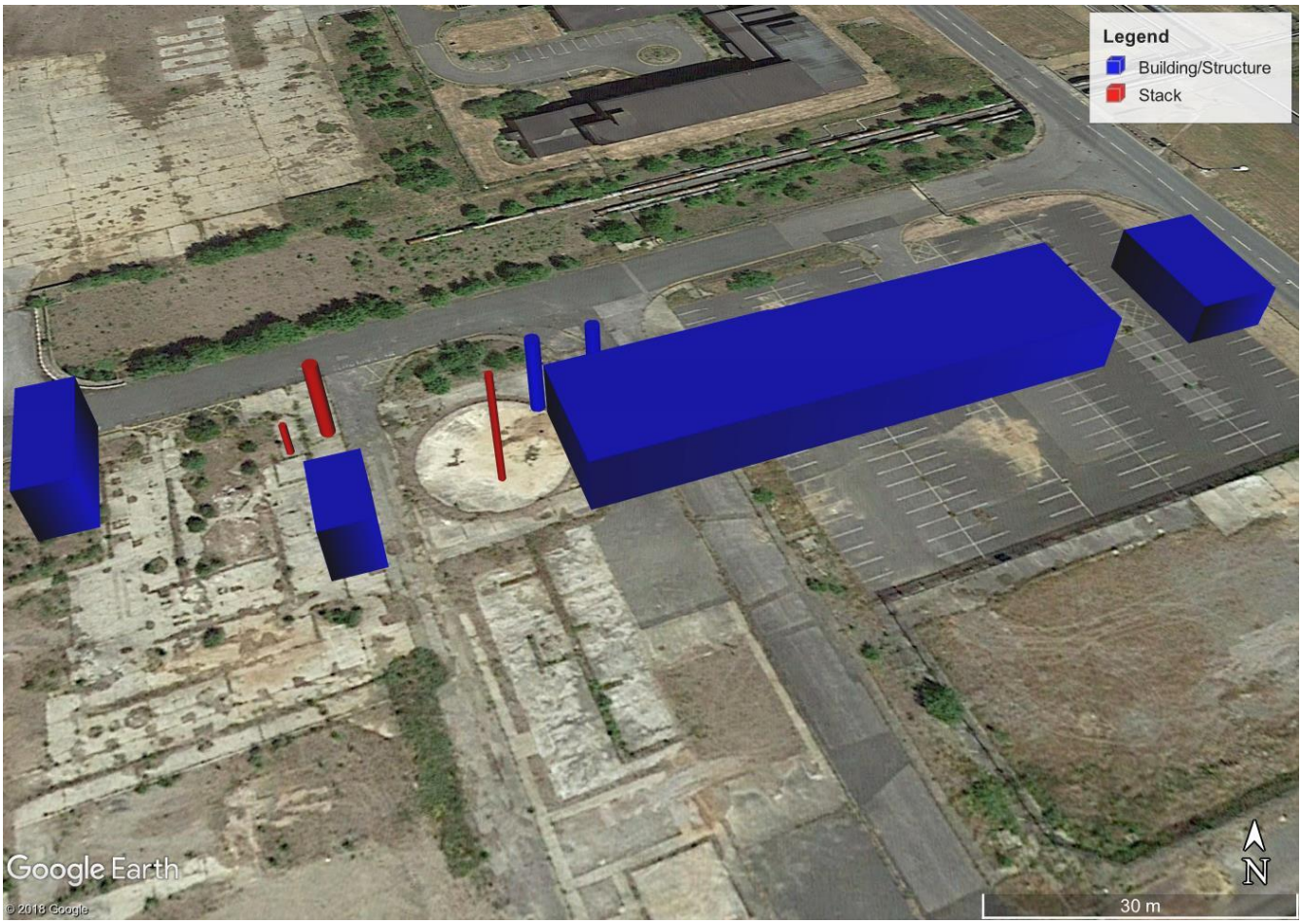

Figure 3-1
Modelled Buildings

3.2.5 Dispersion Coefficients

The 'urban' option for dispersion coefficients was selected in accordance with AERMOD guidance[9], using a population equivalent of 60,000 to reflect the estimated population of the nearby urban areas of Redcar, South bank, Teesville and Eston.

[9] EPA, AERMOD Implementation Workgroup, Aermod Implementation Guide (August, 2019).

3.2.6 Meteorological Data

Following consultation with the meteorological data provider, it was concluded that Teesside International Airport, located approximately 20km to the west of the site, would provide the most complete and representative meteorological data set for purposes of this assessment. Meteorological data used in this assessment was for the years 2016 to 2018 (inclusive). This accounts for inter-year variability in meteorological conditions. From the dataset used, a total of 893 missing hours occur (i.e. representing 3.4% data loss), were recorded over the 3-year period. A windrose is presented in Figure 4-3.

The meteorological data was obtained in .met format from the data supplier and converted to the required surface and profile formats for use in AERMOD using AERMET View meteorological pre-processor. Surface characteristics were assigned for the rural surroundings as presented in Table 3-1.

Table 3-1
Applied Surface Characteristics

Zone (Start)	Zone (end)	Albedo	Bowen	Roughness
10	90	0.273	0.817	0.04
90	305			0.07
305	10			0.16

3.3 Assessment of Impacts on Standards for Air Quality

3.3.1 Treatment of Model Output and Significance

The assessment of impacts against the standards as defined in Section 2.3 was undertaken using model outputs as described in Table 3-2 below.

With respect to NOx emissions the EA Air Quality Modelling and Assessment Unit (AQMAU) guidance[10] on conversion ratio for NO_x and NO_2 has been followed, i.e. a worst case scenario has been applied in that 70% of NO_x is present as NO_2 in relation to long term impacts and 35% of NOx is present as NO_2 in relation to short-term impacts.

Table 3-2
Model Outputs

Averaging Period	Model Output – Process Contribution (PC)	Predicted Environmental Concentration (PEC)
1 hour mean. Not to be exceeded more than 18 times a calendar year	99.79%ile of 1-hour means	PC + 2 x annual mean background
15 minute mean. Not to be exceeded more than 35 times a calendar year	99.9%ile of 1 hour means for SO_2 multiplied by 1.34	PC + 2 x annual mean background
1 hour mean. Not to be exceeded more than 24 times a calendar year	99.73%ile of 1 hour means for SO_2	PC + 2 x annual mean background

[10] Environment Agency, Air Quality Modelling and Assessment Unit, 'Conversion Ratios for NOx and NO_2' (no date)

Averaging Period	Model Output – Process Contribution (PC)	Predicted Environmental Concentration (PEC)
24 hour mean. Not to be exceeded more than 3 times a calendar year	99.18%ile of 24 hour means for SO_2	PC + 2 x annual mean background
1-hour maximum	Maximum 1-hour mean	PC + 2 x annual mean background
Calendar year	Annual Mean	PC + annual mean background

In accordance with AERA guidance, the impact is considered to be insignificant or negligible if:

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

For process contributions that cannot be considered insignificant further assessment has been undertaken and the Predicted Environmental Concentration (PEC: PC + existing background pollutant concentration) determined for comparison as a percentage of the relevant EAL.

3.4 Assessment of Impacts on Vegetation and Ecosystems

In addition to the AERA guidance, the EA's Operational Instruction 66_12[11] details how the air quality impacts on ecological sites should be assessed. This guidance provides risk based screening criteria to determine whether impacts will have 'no likely significant effects (alone and in-combination)' for European sites, 'no likely damage' for SSSI's and 'no significant pollution' for other sites, as follows:

- PC does not exceed 1% long-term C_{Le} and/or C_{Lo} or that the PEC <70% long-term C_{Le} and/or C_{Lo} for European sites and SSSIs;
- PC does not exceed 10% short-term C_{Le} for NOx and HF (if applicable) for European sites and SSSIs;
- PC does not exceed 100% long-term C_{Le} and/or C_{Lo} other conservation sites; and
- PC does not exceed 100% short-term C_{Le} for NOx and HF (if applicable) for other conservation sites.

Where impacts cannot be classified as resulting in 'no likely significant effect', more detailed assessment may be required depending on the sensitivity of the feature in accordance with EAs Operational Instruction 67_12 ('*Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation'*). This can require the consideration of the potential for in-combination effects, the actual distribution of sensitive features within the site, and local factors (such as the water table).

The guidance provides the following further criteria:

- if the PEC<100% of the appropriate limit it can be assumed there will be no adverse effect;
- if the background is below the limit, but a small PC leads to an exceedance – decision based on local considerations;
- if the background is currently above the limit and the additional PC will cause a small increase – decision based on local considerations;
- if the background is below the limit, but a significant PC leads to an exceedance – cannot conclude no adverse effect; and

[11] NRW/EA Working Instruction 66_12 - Simple assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation

- if the background is currently above the limit and the additional PC is large - cannot conclude no adverse effect.

Calculation of Contribution to Critical Loads

Deposition rates were calculated using empirical methods recommended by the EA AQTAG06[12]. Dry deposition flux was calculated using the following equation:

Dry deposition flux (µg/m^2/s) = ground level concentration (µg/m^3) x deposition velocity (m/s)

Wet deposition occurs via the incorporation of the pollutant into water droplets which are then removed in rain or snow, and is not considered significant over short distances (AQTAG06) compared with dry deposition and therefore for the purposes of this assessment, wet deposition has not been considered.

The applied deposition velocities for the relevant chemical species are as shown in Table 3-3.

Table 3-3
Applied Deposition Velocities

Chemical Species	Recommended deposition velocity (m/s)	
NO_2	Grassland	0.0015
	Woodland	0.003
SO_2	Grassland	0.012
	Woodland	0.024
NH_3	Grassland	0.02
	Woodland	0.03

Critical Loads - Eutrophication

The contribution to critical loads for nitrogen deposition (N) are recorded as kgN/ha/yr. The units are converted from µg/m^2/s to units of kgN/ha/year by multiplying the dry deposition flux by standard conversion factors as summarised in Table 3-4.

Table 3-4
Applied Deposition Conversion Factors

Chemical Species	Conversion factor [µg/m^2/s to kgN/ha/year]	
NO_2	of N:	95.9
NH_3	of N:	260

Critical Loads - Acidification

The predicted deposition rates are converted to units of equivalents (keq/ha/year), which is a measure of how acidifying the chemical species can be, by multiplying the dry deposition flux (µg/m^2/s) by standard conversion factors as presented in Table 3-5.

[12] AQTAG06 – Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air. Environment Agency, March 2014 version.

Table 3-5
Applied Acidification Conversion Factors

Chemical Species	Conversion factor [kg/ha/year to keq/ha/year]
NO_2	6.84
NH_3	18.5
SO_2	9.84

Calculation of PC as a percentage of Acid Critical Load Function

The calculation of the process contribution of N, S and Cl to the critical load function has been carried out according to the guidance on APIS, which is as follows:

> *'The potential impacts of additional sulphur and/or nitrogen deposition from a source are partly determined by PEC, because only if PEC of nitrogen deposition is greater than CLminN will the additional nitrogen deposition from the source contribute to acidity. Consequently, if PEC is less that CLminN only the acidifying affects of sulphur from the process need to be considered:*
>
> *Where PEC N Deposition < CLminN*
>
> *PC as % CL function = (PC S deposition/CLmaxS)*100*
>
> *Where PEC is greater than CLminN (the majority of cases), the combined inputs of sulphur and nitrogen need to be considered. In such cases, the total acidity input should be calculated as a proportion of the CLmaxN.*
>
> *Where PEC N Deposition > CLminN*
>
> *PC as %CL function = ((PC of S+N deposition)/CLmaxN)*100'*

The predicted dry N, sulphur (S) and chlorine (Cl) deposition (k_{eq}/ha/year) are summed to determine total acid deposition.

4.0 BASELINE ENVIRONMENT

4.1 Site Setting and Sensitive Receptors

The site is located within the borough of Redcar and Cleveland at National Grid Reference (NGR) NZ 56795 20911. The site is approximately 7.5km east of Middlesborough city centre in an industrial area. The closest residential areas in the surrounding environment are Lazenby (approximately 1.0km to the south), Grangetown (approximately 1.2km to the west), Teesville (approximately 1.5km south-west), and Redcar (approximately 3.0km to the north east).

A number of sensitive receptors have been identified, presented in Section 4.1.1 and Section 4.1.2 below.

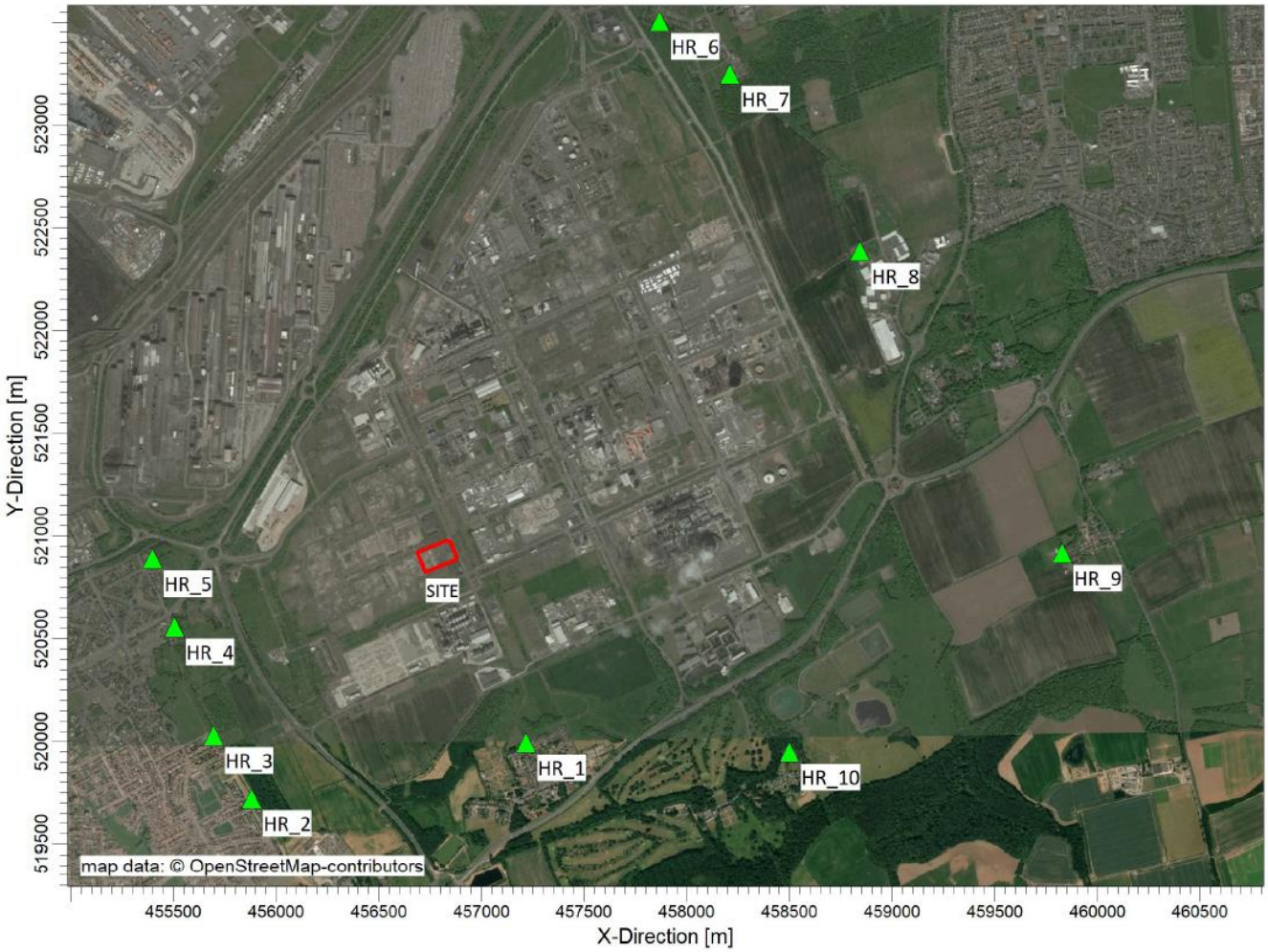

Figure 4-1
Site Setting and Modelled Human Receptors

4.1.1 Human Receptors

According to LAQM.TG(16), air quality standards should only apply to locations where members of the public may be reasonably likely to be exposed to air pollution for the duration of the relevant standard as summarised in Table 2-3. The dispersion modelling has been completed using a receptor grid, as such the impact concentration has been assessed at all potential exposure locations surrounding the site. Ten discrete sensitive receptors have been modelled (shown in Figure 4-1 and listed in Table 4-1) representing the closest human

locations (relevant to annual mean exposure). The receptor grid allows the maximum ground level impact to be assessed including potential short-term exposure locations.

Table 4-1
Assessed Annual Mean Exposure Locations

Reference	Classification	NGR X	NGR Y
HR1	Residential	457218	519993
HR2	Residential	455880	519721
HR3	Residential	455695	520028
HR4	Residential	455504	520558
HR5	Residential	455399	520891
HR6	Residential	457867	523503
HR7	Residential	458211	523248
HR8	Residential	458842	522385
HR9	Residential	459829	520917
HR10	Residential	458499	519947

4.1.2 Ecological Receptors

The EA AERA guidance states that ecological habitats should be screened against relevant standards if they are located within the following set distances from the facility:

- SPAs, SACs or Ramsar sites within 10km of the installation; and
- SSSIs, NNRs, LNRs, local wildlife sites (LWS or SINCs) and ancient woodland within 2km of the location of the installation.

The sites identified using the EA screening service are detailed in Table 4-2 and presented in Figure 4-1.

Table 4-2
Designated Sites Requiring Assessment

Ref.	Site (Designation)	Habitat Type (APIS categories)
ER1	Wilton Wood (Ancient Woodland)	Broadleaved deciduous woodland
ER2	Teesmouth and Cleveland Coast (Ramsar/SPA/SSSI)	Supralittoral sediment
ER3	North York Moors (SPA/SAC/SSSI)	Blanket bogs

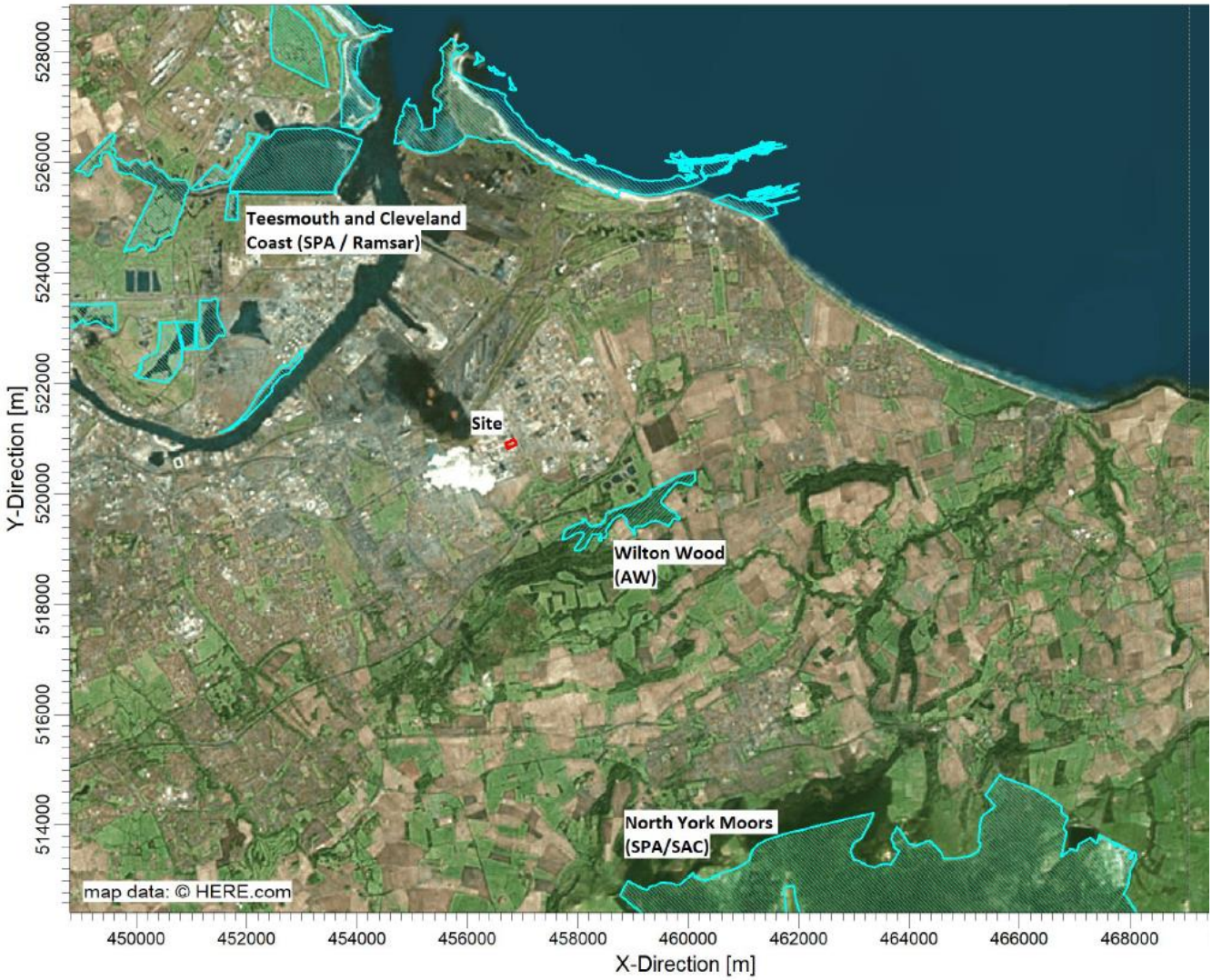

Figure 4-2
Site Setting and Modelled Human and Ecological Receptors

4.2 Meteorological Conditions

A windrose for Teesside International Airport station for a 3 year period (hourly sequential data), providing the frequency of wind speed and direction, is presented in presented in Figure 4-3. The windrose shows winds from the south and south-west are most frequent with winds from the east least frequent.

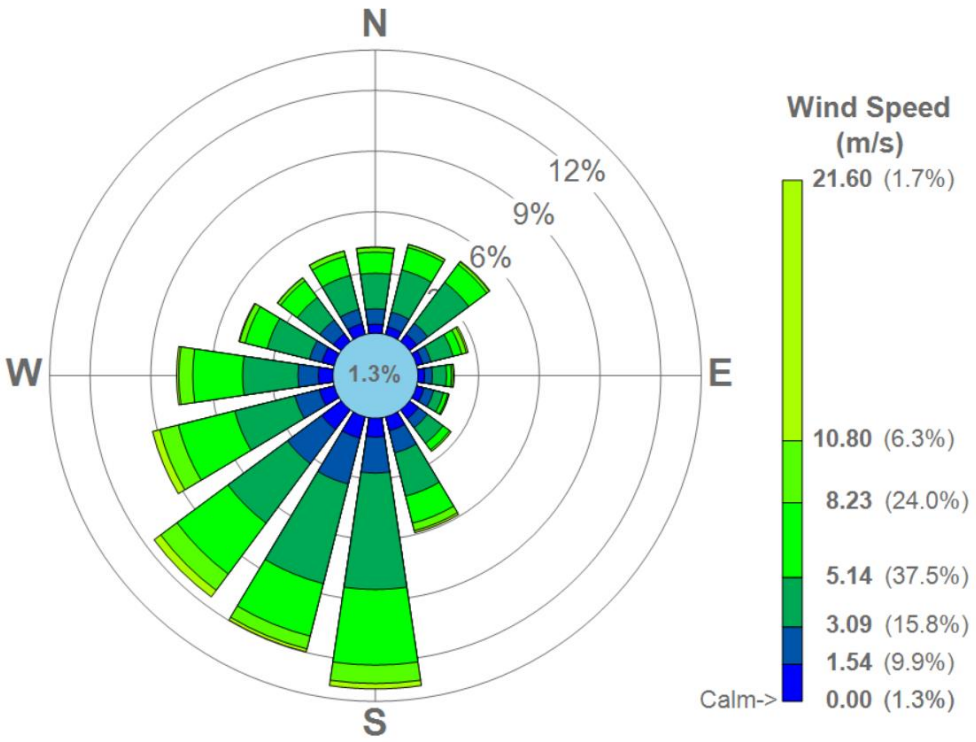

Figure 4-3
Windrose for Teesside International Airport Meteorological Station (2016-18)

4.3 Topography

The site lies on a flat area at approximately 15m AOD south of the mouth of the River Tees. Within approximately 1.5km of the site, the surrounding topography is relatively flat. To south the terrain rises with hill tops up to 240m AOD at approximately 2.5km distance. The local topography is illustrated in Figure 4-4.

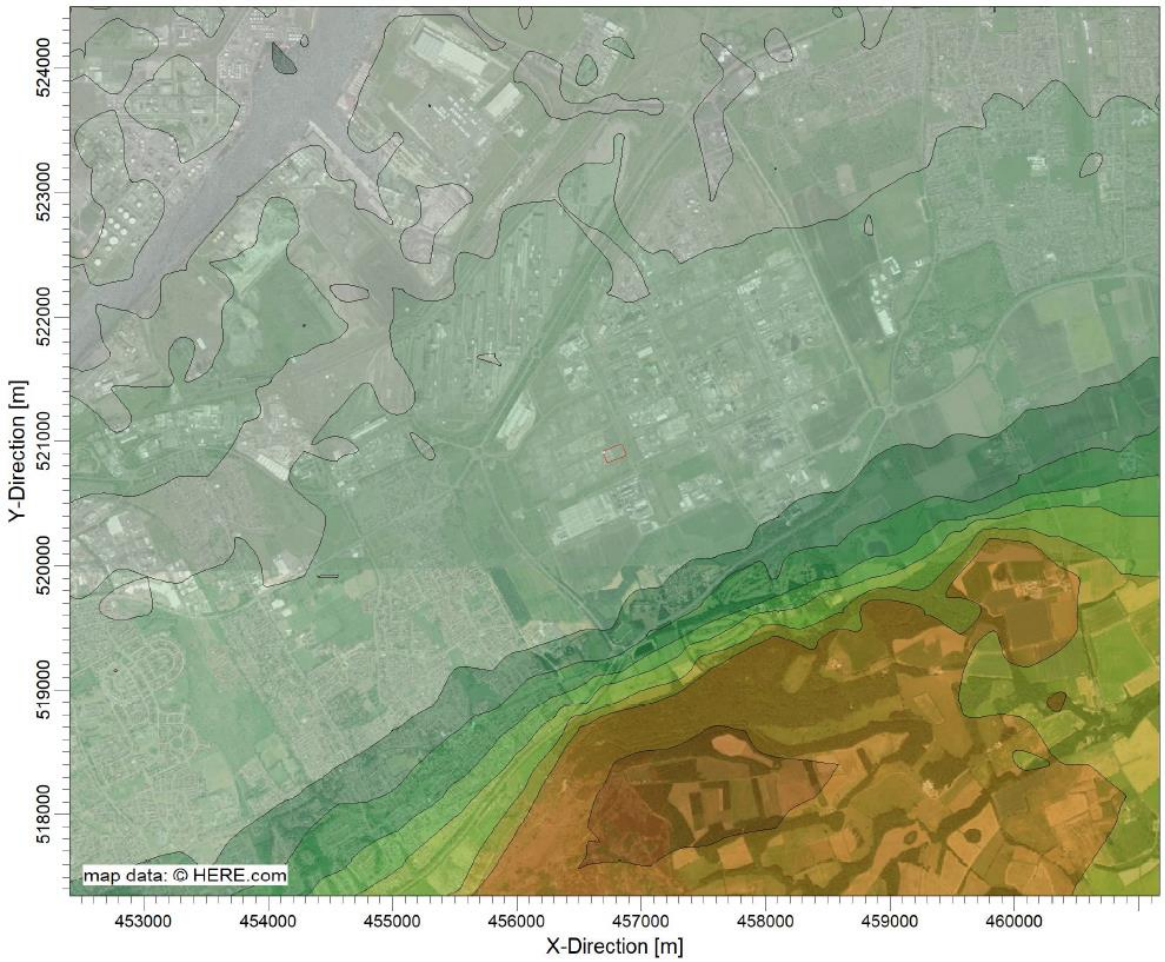

Figure 4-4
Local Topography

4.4 Baseline Air Quality

This section reviews the existing baseline air quality and deposition in the vicinity of the proposed installation according to monitoring and/or modelling from Redcar and Cleveland Borough Council (RCBC), Defra, and APIS.

4.4.1 Local Air Quality Management and Monitoring

The site lies within the area of jurisdiction of RCBC, with respect to LAQM no AQMAs have been declared.

RCBC's latest LAQM report[13] has been reviewed for monitoring data close to the site (within approximately 2km) based upon the ground level impacts from both background and roadside locations. The recent results are presented in Table 4-3 below; the locations are presented in Figure 4-5. The monitoring shows that background NO_2 concentrations range between 10 and 29.8µg/m^3. The NO_2 AQAL was not exceeded at any of the monitoring locations investigated.

[13] Redcar and Cleveland Borough Council, 2019 Air Quality Annual Status Report (ASR), (June 2019)

Table 4-3
RCBC NO_2 Monitoring Results

ID	Location	Type of monitoring	Location type	Distance to kerb (m)	Distance to Relevant exposure (m)	2017 µg/m^3	2018 µg/m^3
AM1	Dormanstown	Automatic	Suburban	150	1	12.0	10.0
R17	Dormanstown	Diff. tube	Suburban	150	1	13.9	17.9
R18	Dormanstown	Diff. tube	Suburban	150	1	14.2	17.3
R19	Dormanstown	Diff. tube	Suburban	150	1	14.8	17.5
R26	South Bank, Trunk Road	Diff. tube	Roadside	11	42	19.8	24.7
R27	West Lane, Grangetown	Diff. tube	Roadside	1	42	25.5	29.8
R40	Keilder Close	Diff. tube	Roadside	3.2	0.8	-	16.5
R41	Mersey Road	Diff. tube	Roadside	3.7	17	-	20.2
R42	Primrose Court	Diff. tube	Roadside	9.6	0	-	16.6
R43	Normanby Road	Diff. tube	Roadside	11.6	0	-	16.1
R44	Normanby Road	Diff. tube	Roadside	7.9	0	-	15.7

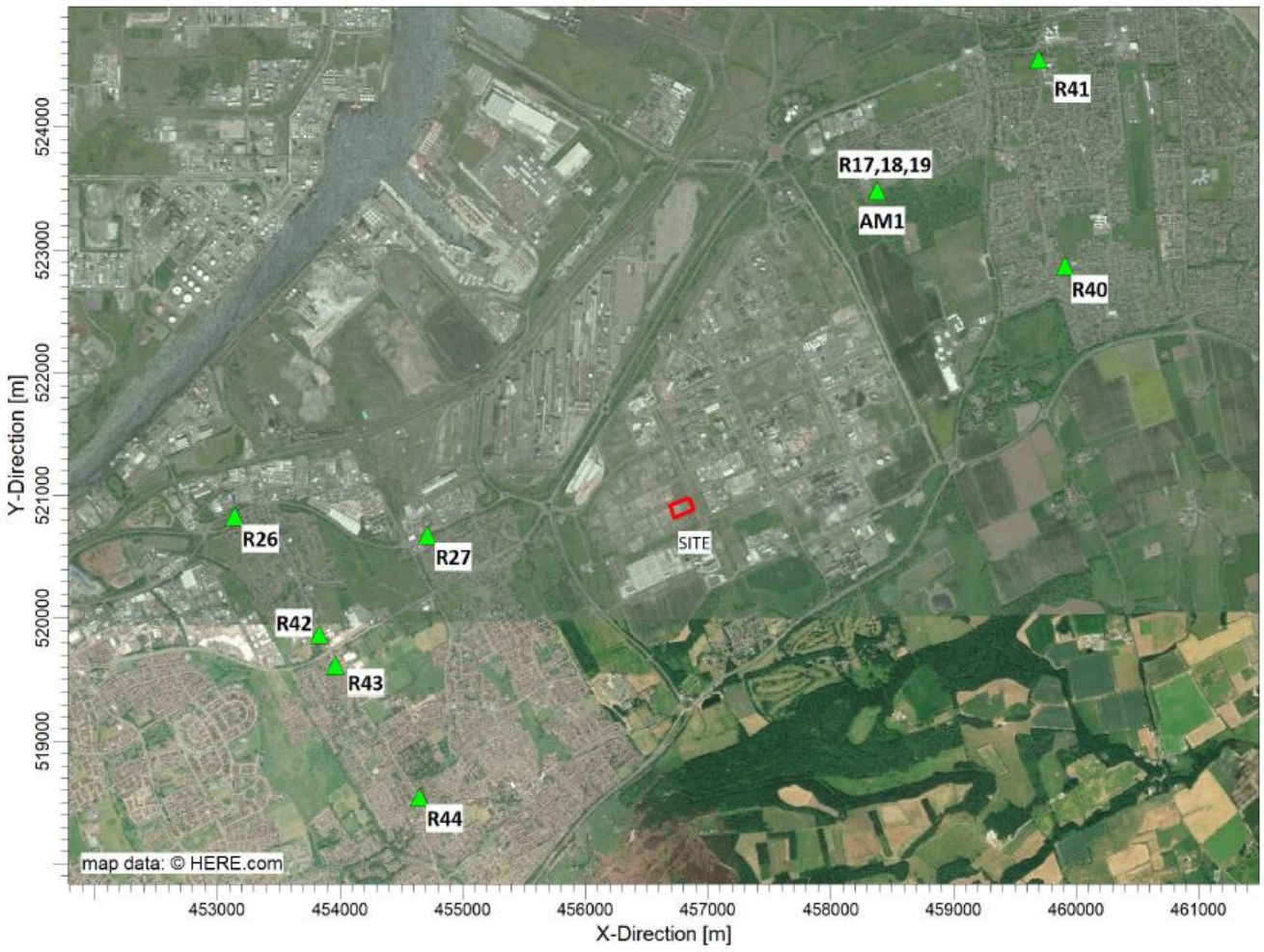

Figure 4-5
Local NO_2 Diffusion Tube Monitoring Locations

4.4.2 UK AIR Modelled Data

Background pollutant concentration data on a 1km x 1km spatial resolution is provided by Defra through the UK AIR website and is routinely used to support LAQM and Air Quality Assessments.

Background pollutant concentrations of NO_2 are based upon a 2017 base year[14]. Projection factors for SO_2 are not provided in LAQM.TG(16) since 2001 therefore values are likely to be an over prediction. For this reason the more up-to-date APIS modelled 3 year average values (2015-2017) have been applied, for the two 5km grid squares which containing the site and the human receptors, the two APIS background values are 4.07 and 1.35µg/m^3. To provide a conservative approach, the value of 5.15µg/m^3 has been adopted as the annual mean SO_2 concentrations for all human receptors.

The mapped background concentrations for the 9 grid squares containing the site (centred on x456795,y520909) and nearby receptors for 2019 are shown in Table 4-4. The NO_2 background monitoring data shows reasonable agreement with the 2017 predicted concentrations.

[14] Background mapping data for local authorities – https://uk-air.defra.gov.uk/data/laqm-background-home, accessed November 2019.

Table 4-4
Modelled 2019 Annual Mean Background Concentrations (µg/m^3)

X – NGR	Y-NGR	NO_2
457500	519500	12.4
455500	519500	13.9
455500	520500	15.5
457500	523500	15.6
458500	523500	15.2
458500	522500	14.1
459500	520500	11.0
458500	519500	10.8
456500	520500	14.6

4.4.3 Ammonia

Ammonia is monitored at 85 sites as part of the National Ammonia Monitoring Network (NAMN). The closest monitoring station is at High Muffles located approximately 30km southeast of the site. The most recent ratified data shows average annual mean concentration of 0.89 µg/m^3.

The APIS modelled 3 year average values (2015-2017) for the 5km grid square containing the site and the human receptors are 2.43 and 1.39µg/m^3. To provide a conservative approach, the value of 2.43µg/m^3 has been adopted as the annual mean NH_3 concentrations for all human receptors.

4.5 Applied Background Concentrations

The applied backgrounds are provided in Table 4-5 below. Baseline concentrations for short-term averaging periods have been converted from annual mean in accordance with AERA guidance and LAQM.TG16.

Table 4-5
Applied Background Concentrations

Pollutant	Background Concentration (µg/m^3)		Data Source
	Short Term [a]	Annual	
NO_2	39.9	19.9	RCBC Diffusion Tube Monitoring – average roadside
SO_2	8.14	4.07	APIS modelled 3 year average value (2015-2017)
Ammonia	2.78	1.39	APIS modelled 3 year average value (2015-2017)
(a) Short term is double the annual mean			

4.6 Critical Levels and Loads

APIS is a support tool for assessment of potential effects of air pollutants on habitats and species developed in partnership by the UK conservation agencies and regulatory agencies and the Centre for Ecology and Hydrology. APIS[15] has been used to provide information on:

- identification of whether the habitats present are sensitive;
- critical levels and current baseline levels (Table 4-6); and
- critical loads and current loads (Table 4-7 and Table 4-8).

The baseline concentrations (3-year average 2013 - 2015) of NOx, SO_2 and NH_3 are summarised in Table 4-6 below. Note that a potential extension of the Teesmouth and Cleveland Coast SAC is proposed as well as a designation of SSSI over the majority of the proposed SAC. As no formal decision has been published at the time of writing, and baseline data is not available, the extension has not been considered as part of this assessment.

Table 4-6
Maximum Baseline Concentrations

Site	NO_x (µg/m^3)	SO_2 (µg/m^3)	NH_3 (µg/m^3)
Wilton Wood (Ancient Woodland)	15.1	1.35	2.43
Teesmouth and Cleveland Coast (Ramsar/SPA)	46.4	5.15	2.25
North York Moors (SPA/SAC/SSSI)	10.1	1.19	2.16

4.6.1 Relevant Critical Loads

APIS was used to obtain location specific C_{Lo} of nitrogen and acid deposition and current loads (3-year average 2015 - 2017) as summarised in Table 4-7 and Table 4-8 below. The most sensitive habitat type listed on APIS has been used for the assessment and nitrogen C_{Lo} applied according to APIS guidance[16].

Table 4-7
Relevant N Critical Loads (kgN/ha/yr)

Site	APIS Habitat (most sensitive to N deposition)	C_{Lo} for Assessment (kgN/ha/yr)	Current N Load (kgN/ha/yr)
ER1	Broadleaved deciduous woodland	10	34.6
ER2	Supralittoral sediment	8	17.8
ER3	Blanket bogs	5	21.6

[15] At the time of writing the APIS baseline data utilised was 2015-2017 averages.
[16] 'Indicative values within nutrient nitrogen critical load ranges for use in air pollution impact assessments' (http://www.apis.ac.uk/indicative-critical-load-values)

Table 4-8
Relevant Acid Critical Loads and Baseline Deposition

Site	Habitat (most sensitive to acid deposition)	Critical Level (k_{eq}/ha/yr)			Current Load (k_{eq}/ha/yr)	
		CLmaxS	CLminN	CLmaxN	N	S
ER1	Broadleaved deciduous woodland	2.439	0.357	2.796	2.5	0.3
ER2	Supralittoral sediment	1.560	0.223	1.998	1.3	0.4
ER3	Blanket bogs	0.150	0.178	0.471	1.5	0.4

5.0 EMISSIONS TO ATMOSPHERE

5.1 Emission Scenario

The boilers will be regulated under the MCPD due their low thermal input (<2MW). The boilers will be fired on natural gas during start-up but will convert to process gas in normal operation. An assessment has been undertaken to assess the impacts under this regulatory scenario, assuming the boilers are fired on process gas (to account to worst case emissions scenario).

For the purposes of the dispersion modelling assessment, to represent a precautionary (worst case) approach, it has been assumed that the plant will operate at maximum throughput, 24-hours per day for 365 days per year (i.e. 8,760 hours per year), with emission concentrations at the Permitted ELVs. In reality operational hours are likely to be less than this to allow for maintenance.

5.2 Emission Parameters

The following emission parameters and process conditions were used to determine the pollutant emission rates and inputs to the dispersion modelling.

Table 5-1
Emission Characteristics

Parameter	High Pressure (HP) Boiler	Low Pressure (LP) Boiler	Flare
Stack Location (NGR x/y)	456752/520913	456724/520917	456728/520921
Stack Internal Diameter (m)	0.3	0.2	2.0
Stack Exhaust Height (m AGL)	18	5	12
Emission Temperature (°C)	350	240	850
Oxygen Content (% O_2 dry gas)	2.9	2.9	2.9
Moisture content (% H_2O)	14.8	14.8	14.8
Actual Flow Rate (Am^3/s) (wet, at stack conditions)	1.7	0.7	5.3
Emission velocity (m/s)	24	23	2
Volume Flow (Nm^3/s) (273K, 3% O_2, dry)	0.64	0.33	1.11

5.3 Emission Rates

Table 5-2 shows the calculated release to atmosphere if the combustion systems discharge at the maximum allowable concentration levels detailed in the MCPD when when burning process gas (worst case). The plant utilises a selective-catalytic-reduction system (SCR) to abate emission of NOx from the high pressure steam generator. The manufacturer information indicates very low levels of residual ammonia present; however as a precautionary approach an annual average of 15mg/Nm^3 has been considered in the assessment.

Table 5-2
Pollutant Emission Rates

Pollutant	Emission Rate (g/s) (process gas)		
	HP Boiler	LP Boiler	Flare
Oxides of nitrogen (NOx)	0.127	0.067	0.173
Sulphur dioxide (SO_2)	0.022	0.012	0.030
Ammonia (NH_3)	0.010	n/a	n/a

5.4 Other potential emissions

The following paragraphs discuss other potential emissions associated with site activities.

5.4.1 Particles

Both fuels fired on the combustion plant are clean gas products with neglibible particle concentration/ability to form particles. Particles emission from the process will be primarilaly those of the ambient air used in the combustion process.

5.4.2 Total Organic Carbon

Combustion temperatures in the process are such that very low levels of TOC will occur in the emissions from the combustion processes.

5.4.3 PCBs

Combustion temperatures in the process are such that very low levels of PCBs will occur in the emissions from the combustion processes. An example of process gas analysis is included in Appendix B. The laboratory report illustrates low levels of chlorine and sulphur in the expected process gas.

5.4.4 Metals

Solid metals are not expected to get past the upstream distillation column. Cleaning of the plastic prior to processing means that metals such as mercury and cadmium are negibible in the process gas.

6.0 PREDICTED AIR QUALITY IMPACTS

6.1 Predicted long term and short term impacts

Predicted long-term and short-term impacts are summarised in Table 6-1 (isopleths for NO_2 are presented in Appendix A). The results presented are the maximum predicted impacts and relate to the highest predicted level of impact at any location on the receptor grid and impacts at all other locations, and at all other times, will be lower. The maximum ground level PCs are insignificant for all emissions.

Table 6-1
Predicted Maximum Ground Level Impacts

Pollutant	Standard (µg/m^3)	PC (µg/m^3)	PC as % Standard	PEC (µg/m^3)[(a)]	PEC as % Standard
NO_2 (annual)	40	1.90	4.8%	21.8	54.6
NO_2-(1-hr)	200	16.6	8.3%	n/c	n/c
SO_2 (24-hr)	125	2.75	2.2%	n/c	n/c
SO_2 (1-hr)	350	8.32	2.4%	n/c	n/c
SO_2 (15-min)	266	11.7	4.4%	n/c	n/c
NH_3 (annual)	180	0.09	0.1%	n/c	n/c
NH_3 (1-hr)	2500	0.91	<0.1%	n/c	n/c

Table note: n/c = not calculated: following AERA guidance the PEC has only been calculated where the long-term PC is 1% or above.

6.2 Predicted Impacts at Sensitive Ecosystems

6.2.1 Critical Levels

The predicted impacts on C_{Le} at the identified ecological sites are presented in Table 6-2 and

Table 6-3. The findings are that the PC's are less than 1% of the long-term C_{Le} and less than 10% of the short-term C_{Le} at the SPA/SAC/Ramsar sites and therefore the impact is considered insignificant and will cause *'no likely significant effect''*. In addition the PC is less than 100% of the C_{Le} at the AW and therefore the impact is considered insignificant and will cause *'no significant pollution'*.

Table 6-2
Predicted Impacts on Long-term Critical Levels

Site	PC SO_2 ($\mu g/m^3$)	PC as % C_{Le}	PC NO_x ($\mu g/m^3$)	PC as % C_{Le}	PC NH_3 ($\mu g/m^3$)	PC as % C_{Le}
ER1	0.01	<0.1%	0.04	0.1%	0.001	0.08%
ER2	0.01	<0.1%	0.05	0.2%	0.001	0.04%
ER3	<0.01	<0.1%	<0.01	<0.1%	<0.001	0.01%

Table 6-3
Predicted Impacts on Short-term Critical Levels

Site	PC NO_x Daily ($\mu g/m^3$)	PC as % C_{Le}	PC NH_3 Daily ($\mu g/m^3$)	PC as % C_{Le}
ER1	0.75	1.0%	1.26	1.7%
ER2	0.57	0.8%	1.09	1.5%
ER3	0.06	0.1%	0.13	0.2%

6.2.2 Critical Loads

The predicted impact on C_{Lo}'s at the identified ecological sites for nitrogen and acid deposition are presented in Table 6-4 and Table 6.5. The findings are that the PC's are less than 1% of the C_{Lo} at the SPA/SAC/Ramsar sites and therefore the impact is considered insignificant and will cause *'no likely significant effect''*. In addition the PC is less than 100% of the C_{Lo} at the AW and therefore the impact is considered insignificant and will cause *'no significant pollution'*.

Table 6-4
Predicted Impacts on Nitrogen Critical Loads

Site	PC N (kg/ha/yr)	Applied C_{Lo}	PC as % C_{L0}
ER1	0.014	10	0.1%
ER2	0.012	8	0.1%
ER3	0.001	5	<0.1%

Table 6-5
Predicted Impacts on Acid Critical Loads

Site	PC N (kg/ha/yr)	PC S (kg/ha/yr)	Applied C_{Lo} CLmaxN (kg/ha/yr)	PC as % C_{L0} (PC S + N as % CLmaxN)
ER1	0.004	0.002	2.796	0.2%
ER2	<0.001	0.002	1.998	0.1%
ER3	<0.001	<0.0014	0.471	<0.1%

7.0 CONCLUSIONS

The conclusions of the detailed atmospheric dispersion modelling assessment of the facility's combustion emissions are as follows:

- there are no predicted exceedances of short-term or long-term standards at the point of maximum ground level impact or at relevant exposure locations; and

- the predicted impact on designated sensitive habitats are considered insignificant and will cause *'no likely significant effect''* on the SPA/SAC/Ramsar and *'no significant pollution'*on the AW according to EA/Natural England guidance.

APPENDIX A

Process Contribution Isopleths

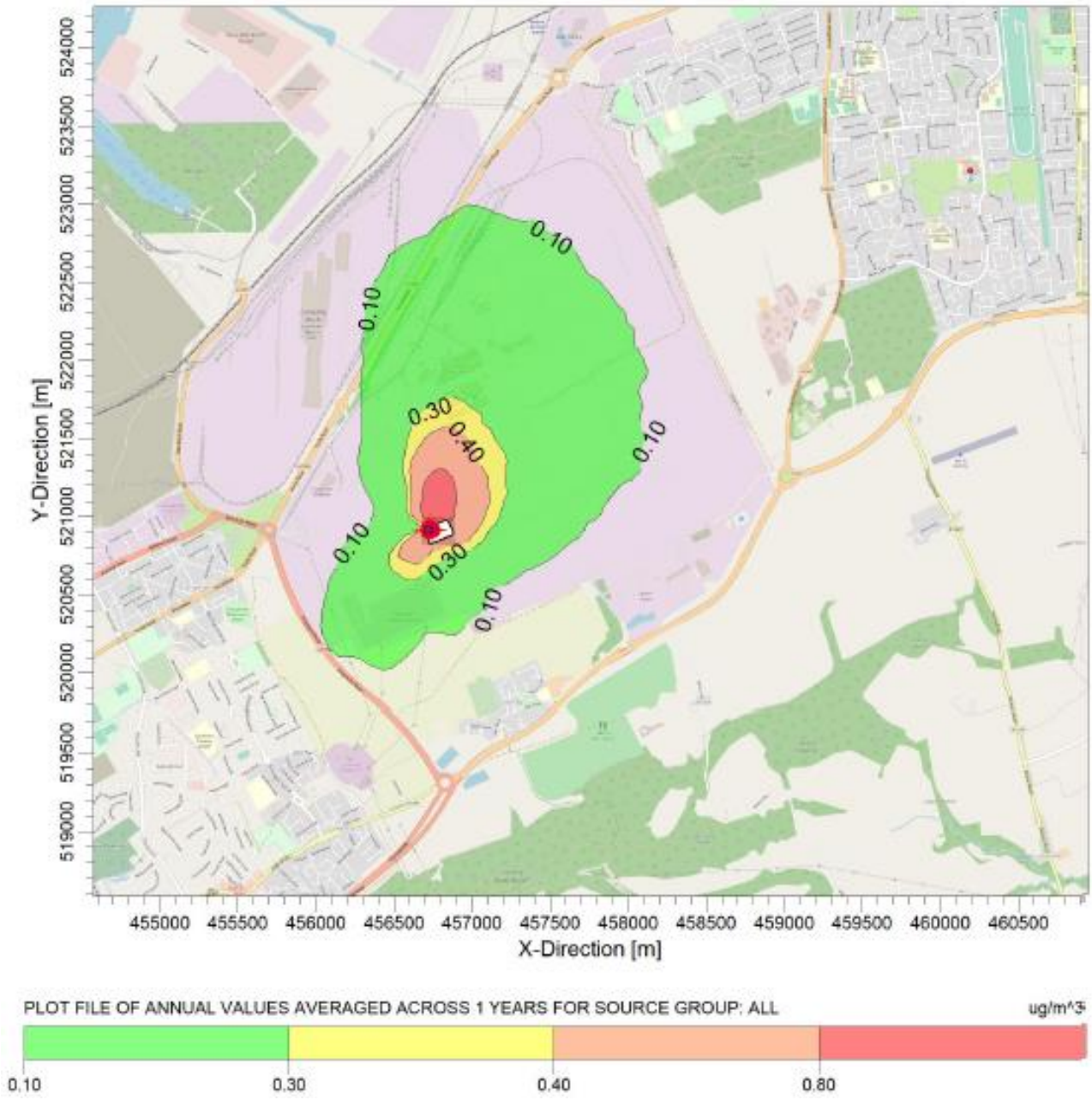

Figure A-1
Plot of NO_2 Annual Mean Process Contribution

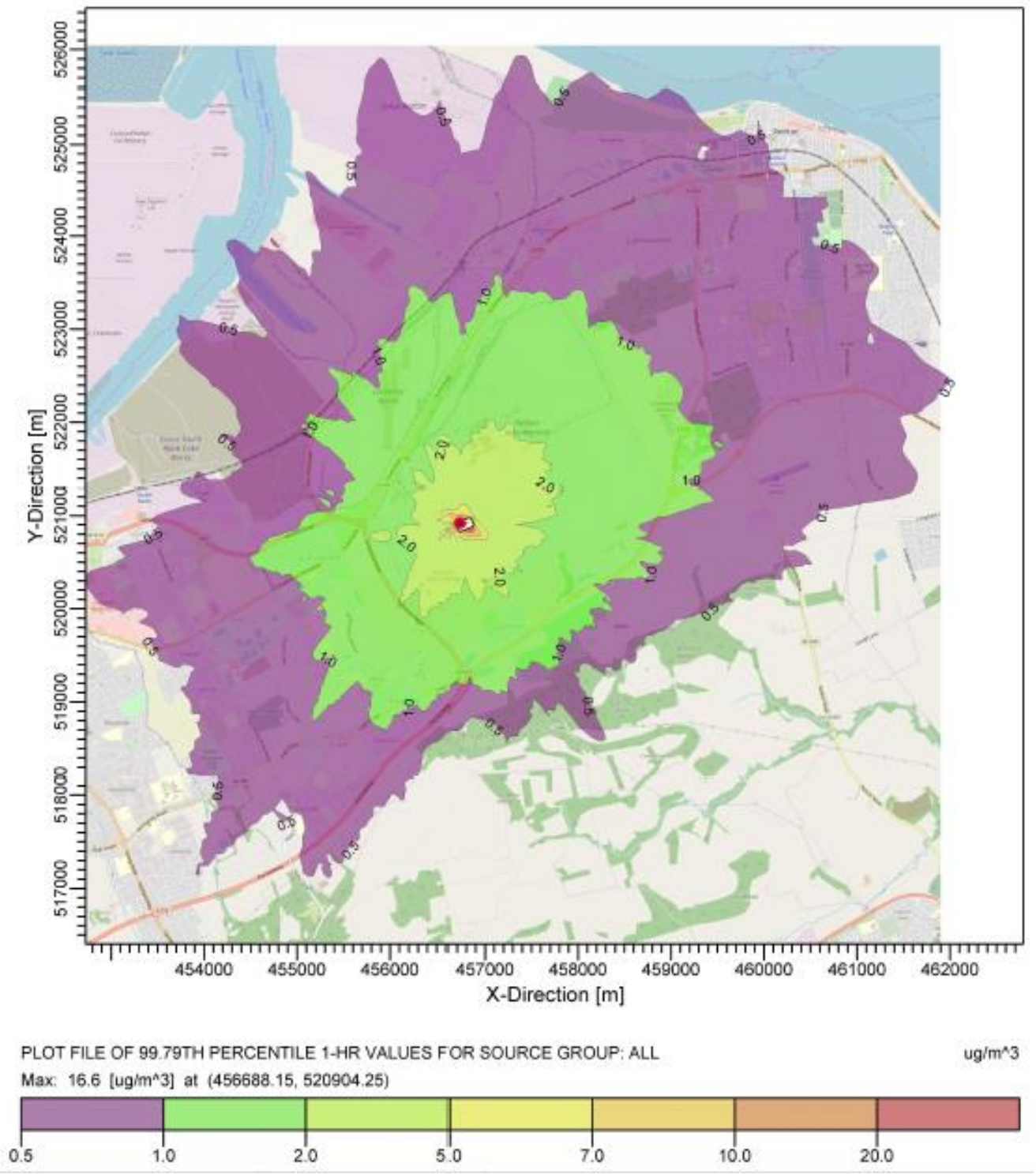

Figure A-2
Plot of NO_2 Hourly Mean Process Contribution (99.79th Percentile)

APPENDIX B

Process Gas Analysis

Laboratory analysis report provided separately

Process Gas Analysis

Analytical Results

Table 1

Permanent (GC-TCD) examination of process gas

	PG 20180412
Analyte	**Concentration (%v/v)**
Hydrogen	4.5%
Carbon dioxide	6.4%
Oxygen	0.077
Nitrogen	0.5
Argon	<0.02
Carbon monoxide	<0.02

Table 2

Hydrocarbon gases (GC-FID) examination of process gas

	PG 20180412
Analyte	**Concentration (%v/v)**
Methane	19
Ethylene	0.60
Ethane	19
Propylene	5.7
Propane	21
Iso-butylene	4.1
1-butene	3.4
Iso-butane	4.3
Butane	0.60
Cyclobutene	0.40

	PG 20180412
Analyte	**Concentration (%v/v)**
Pentane	7.9
Hexane	2.2
Heptane	0.2
Octanes	0.2
Nonanes	<0.1
Decanes	<0.1

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