Net Zero Teesside – Environmental Statement

Planning Inspectorate Reference: EN010103

Volume III – Appendices

Appendix 8B: Air Quality – Operational Assessment

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (as amended)

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8B. Air Quality – Operational Phase

8.1 Introduction

Overview

8.1.1 This Technical Appendix supports Chapter 8: Air Quality, of the Environmental Statement (ES) (ES Volume I, Document Ref. 6.2) and describes the additional details for the dispersion modelling of point source emissions from the Proposed Development once operational.

8.1.2 This assessment considers the likely significant effects on air quality as a result of the CCGT and the carbon capture plant for the Proposed Development. For more details about the Proposed Development, refer to Chapter 4: Proposed Development (ES Volume I, Document Ref. 6.2).

8.1.3 Emissions associated with the operational Proposed Development have the potential to affect human health and sensitive ecosystems, if not appropriately managed. This Technical Appendix identifies and proposes measures to address the potential impacts and effects of the Proposed Development on air quality during its operational phase.

8.1.4 The magnitude of air quality impacts at sensitive human and ecological receptors has been quantified for pollutants emitted from the main stack associated with the Proposed Development. The impact of emissions on sensitive ecological receptors has been considered in the context of relevant critical levels and critical loads for designated and non-designated ecological sites.

8.1.5 The assessment has considered emissions from the Proposed Development during normal operational conditions. Non routine emissions, such as those which may occur during the commissioning process or other short-term events would typically only occur on an infrequent basis, would be detected by the process control system and rectified within a short time period and the plant operation will be tightly regulated by the Environment Agency through the Environmental Permit required for the operation of the Proposed Development. For this reason, no detailed consideration of impacts associated with non-routine or emergency events has been included in this assessment.

8.1.6 Annex A of this Appendix provides a sensitivity analysis of the model input parameters.

8.1.7 Annex B of this Appendix provides an assessment of visible plumes from the absorber stack, and also from the preferred cooling technology for the Proposed Development.

8.1.8 Annex C of this Appendix details the cumulative impacts of the Proposed Development and other proposed developments that are considered likely to have cumulative impacts.

8.2 Scope

Operational Traffic Emissions

8.2.1 No assessment of operational traffic emissions has been made, as the numbers of additional vehicles associated with the operational phase of the Proposed Development are below the DMRB and IAQM screening criteria for requiring such assessment. In addition, the predicted impacts for the construction phase traffic emissions showed that the effect of additional construction traffic was not significant at all receptors. The number of additional vehicles for the operational phase is well below the numbers assessed for the construction phase and therefore it is considered that the effect of operational traffic is also not significant, and that there will therefore be no in-combination effects with the operational traffic and operation Proposed Development.

Combustion Plant and Carbon Capture Emissions

8.2.2 The assessment has considered the impact of operational process emissions on local air quality, under normal operating conditions, with the CCGT operational and the flue gas being abated by the carbon capture plant, operating for 8,760 hours per year, as this represents the worst case for annual average impacts. The assessment considers impacts in the earliest year in which the Proposed Development is due to commence operation, 2026.

8.2.3 The Study Area for the operational Proposed Development point source emissions extends up to 15 km from the Low Carbon Power Station within the PCC Site, in order to assess the potential impacts on ecological receptors, in line with the Environment Agency risk assessment methodology (Defra and Environment Agency, 2016):

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), Ramsar sites and Sites of Special Scientific Interest (SSSIs) within 15 km; and
- Local Nature Sites (including ancient woodlands, Local Wildlife Sites (LWS) and National and Local Nature Reserves (NNR and LNR)) within 2 km.

8.2.4 In terms of human health receptors, impacts from the operational Proposed Development become negligible well within approximately 2 km and therefore sensitive receptors for the human health impacts only are concentrated within a 2 km Study Area.

8.2.5 The dispersion of emissions has been predicted using the latest version of the atmospheric dispersion model ADMS (currently version 5.2.2). The results are presented in both tabular format within this Appendix and as contours of predicted ground level process contributions (PCs) overlaid on mapping of the surrounding area, see Figures 8.5 – 8.9 (ES Volume II, Document Ref. 6.3).

8.2.6 The dispersion modelling assessment has concentrated on the combustion emissions associated with the operation of the CCGT plant of oxides of nitrogen (NO_x) and carbon monoxide (CO) with consideration also of the impacts from ammonia (NH_3) slip (from the Selective Catalytic Reduction NO_x abatement system). In addition, emissions of amines and their potential degradation products from the carbon capture plant have also been assessed.

8.2.7 Emissions from Large Combustion Plant (LCP) are currently governed by the Industrial Emissions Directive (IED Directive 2010/75/EU), which contains measures relating to the control of emissions, including setting limits on emissions to air from LCP and requires operators to monitor and report emissions.

8.2.8 The Proposed Development would be regulated under the IED and in accordance with the LCP Best Available Technique (BAT) Reference document (BRef). The current LCP BRef and associated BAT conclusion document was issued in 2017. The recommendations of the LCP BRef are enforceable through Environmental Permits and the Environment Agency would set specific emission limits in the Environmental Permit issued to the Proposed Development, based on the BAT-associated emission levels (BAT-AELs). There are currently no BAT-AELs relating to the carbon capture process itself, and the EA is currently drafting BAT guidance for carbon capture plants. Emissions from the carbon capture process are therefore based on levels that can be met by plant licensors that need to be achieved to prevent significant adverse effects on receptors.

8.2.9 A comparison has been made between predicted model output concentrations (process contributions), and short-term and long-term Air Quality Assessment Levels (AQALs) as detailed in Chapter 8: Air Quality (ES Volume I, Document Ref. 6.2).

Cumulative Impacts

8.2.10 Cumulative impacts from existing sources of pollution in the area are accounted for in the adoption of site-specific background pollutant concentrations from archive sources and a programme of project-specific baseline air quality monitoring in close proximity to the Proposed Development site.

8.2.11 It is recognised, however, that there is a potential impact on local air quality from emission sources which have either received or are about to receive planning permission but have yet to come into operation.

8.2.12 The full list of short-listed cumulative schemes to be considered for the Proposed Development are detailed within Chapter 24: Cumulative and Combined Effects (ES Volume I, Document Ref. 6.2), and those that are relevant for consideration due to their potential cumulative operational air quality impacts are:

- Redcar Energy Centre, Energy Recovery Facility (R/2020/0411/FFM) (adjacent to the west);
- Grangetown Prairie, Energy Recovery Centre (R/2019/0767/OOM) (approximately 4km Southwest);

- Land at Teesport, Tees Dock Road, Grangetown, Biomass Power Station (R/2008/0671/EA) (approximately 3km Southwest);
- Teesside Combined Cycle Power Plant (PINS Ref. EN010082, 2019) (approximately 5km South);
- Land to the South of Tofts Road West, Graythorp, Hartlepool, Energy Recovery Centre (H/2019/0275) (approximately 5km Northwest)
- Land at Grid Reference 450674, 521428 Port Clarence Road Port Clarence, Renewable Energy Plant (14/1106/EIS) (approximately 7km Southwest).

8.2.13 Given the distance of a number of these developments from the Proposed Development, it is considered that the cumulative impacts will not be significant, for example the Port Clarence development. In addition, the prevailing wind direction for the area would mean that significant cumulative impacts with the Land to the South of Tofts Road West would be unlikely.

8.2.14 It is recognised that there are five developments planned by Teesworks on the south bank of the Tees, however it is not considered that any of these would have any point source emissions leading to cumulative operational impacts.

8.2.15 The greatest potential for cumulative impacts is from the proposed adjacent Redcar Energy Centre, and therefore these have been specifically considered in this assessment. Cumulative impacts are assessed and discussed in Annex B of this Appendix.

Sources of Information

8.2.16 The information that has been used within this assessment includes pertinent information from:

- Chapter 4: Proposed Development (ES Volume I, Document Ref. 6.2);
- Data on emissions to atmosphere from the process, taken from IED limits, BAT-AEL values and data provided by technology licensors;
- Details on the proposed site layout;
- Ordnance Survey mapping;
- Baseline air quality data from project specific monitoring, published sources and Local Authorities; and
- Meteorological data supplied by ADM Ltd.

8.3 Methodology

Dispersion Model Selection

8.3.1 The assessment of emissions from the Proposed Development has been undertaken using the advanced dispersion model ADMS (version V5.2.2), supplied by Cambridge Environmental Research Consultants Limited (CERC). ADMS is a modern dispersion model that has an extensive published validation history for use in the UK. This model has been extensively used throughout the UK to demonstrate regulatory compliance.

Modelled Scenarios

8.3.2 The dispersion modelling undertaken for the assessment of emissions from the operational Proposed Development main absorber stack includes:

- Modelling of maximum ground-level impacts at a range of release heights, between 80 m and 120 m, in order to evaluate the effect of increasing effective release height on dispersion;
- Reporting of impacts at identified human health and sensitive ecological receptors, from the carbon capture absorber stack at a release height of 115 m above ground level, as the main reported assessment;
- The absorber stack location has not been finalised therefore, four assessment scenarios have been modelled, with the absorber stack separately assessed as being located at four corners of a defined area of the Site to align with the Works Plan location of the carbon capture plant, with the worst case results being reported;
- Emissions from the CCGT HRSG stack have not been assessed, as it is considered that this will lead to lower impacts than emission from the carbon capture absorber (detailed in para 8.3.5 – 8.3.6) and;
- Modelling of impacts on a variable resolution receptor grid and at discrete sensitive human receptors for all pollutants emitted from the absorber stack.

Model Inputs

8.3.3 The general model conditions used in the assessment are summarised in Table 8B-1. Other more detailed data used to model the dispersion of emissions is considered below.

Table 8B-1: General ADMS 5 Model Inputs

Variable	Input
Surface roughness at source	0.3 m
Surface roughness at meteorological site	0.3 m
Receptors	Selected discrete receptors (as Tables 8B-4 and 8B-5)
	Nested receptor grid, with variable spacing
Receptor location	X,Y co-ordinates determined by GIS
	z = 1.5 m for residential receptors
	z = 0 m (ground level) for ecological receptors
Source location	X,Y co-ordinates of the four corners of a defined area of the Site to align with the Works Plan location of the carbon capture plant, determined by GIS
Emissions	IED emission limits, BAT-AEL values and data provided by Amine Solvent Licensors

Variable	Input
Sources	1 x Carbon Capture Plant Absorber Stack
Meteorological data	5 years of meteorological data, Durham Tees Valley Meteorological Station (2015 - 2019)
Terrain data	Not required
Buildings that may cause building downwash effects	Absorber Tower

Emissions Data

8.3.4 During normal operation, the carbon capture plant absorber stack would be the primary source of emissions from both the combustion and carbon capture processes associated with the Proposed Development.

8.3.5 In addition, there would be a stack associated with the Proposed Developments CCGT plant, which would only be operational when the Proposed Development is operating in an unabated mode (i.e. combustion emissions only, with no carbon capture taking place).

8.3.6 The combustion emissions (NO_x and CO, including NH_3 from the SCR) associated with these two modes of operation would be subject to the same emission limits and therefore the associated release rates would be comparable. The unabated emissions from the CCGT plant only however would be released at a higher temperature (~100 ºC) compared with the carbon capture process, which is likely to be between 35 - 60 ºC depending on whether reheat is applied or not. At higher stack temperatures the thermal buoyancy is improved, and consequentially the dispersion, resulting in a level of impact for the unabated CCGT operation that is no worse than for the carbon capture mode of operation. The CCGT stack would be sized appropriate to ensure that this is the case.

8.3.7 When the plant is operating with carbon capture, the treated flue gas mainly comprises nitrogen, oxygen and water vapour making up 99% of emissions, although there are trace emissions of amines and potentially their degradation compounds (nitrosamines and nitramines, collectively referred to as N-amines). The carbon capture mode of operation therefore has been assessed as representing the worst-case mode of operation in terms of the resulting predicted impacts for the ES, due to the additional species emitted and the lower release temperature resulting in reduced thermal buoyancy of the release.

8.3.8 The main reported emissions for the Proposed Development have been modelled at a carbon capture plant absorber stack height of 115 m above finished ground level, with an internal stack diameter of 6.6 m. It is considered that 115m is the stack height that would result in not significant impacts at human health and ecological receptors, with the current model input parameters and therefore has been used in the assessment.

8.3.9 In line with the Rochdale Envelope approach, the carbon capture plant absorber stack has been modelled in each of the four corners of the

Proposed Development site that is allocated for the carbon capture plant, as the exact position of the absorber stack within this area has not been finalised. The worst-case results from all stack locations modelled are therefore reported in this assessment.

8.3.10 In addition, plant design parameters such as the release temperature, have also to be finalised and therefore these have been modelled at the lower and upper end of the proposed range, with the worst-case results again being reported in the assessment.

8.3.11 The physical properties of assessed emission sources, as represented within the model, are shown in Table 8B-2. The position of the stack and the buildings included within the model are illustrated in Figure 8.4: Model Visualisation (ES Volume II, Document Ref. 6.3).

Table 8B-2: Emissions Inventory

Parameter	Unit	Carbon absorber stack
Stack position	(NGR) m	Assessed at: NW corner 456808, 525487 NE corner 457046, 525393 SW corner 456758, 525359 SE corner 456995, 525265
Stack release height (above ground level)	m	115
Effective internal stack diameter	m	6.6
Flue temperature	°C	35 and 60
Flue H_2O content	%	5.5
Flue O_2 content (dry)	%	11.9
Stack gas exit velocity	m/s	24.8
Stack flow (actual)	Am^3/s	848
Stack flow at reference conditions (STP, dry)	Nm^3/s	1,084 – 1,002 (depending on the release temperature)

8.3.12 The modelled pollutant emission rates (in grams per second (g/s)) have been calculated by multiplying the emission concentration by the volumetric flow rate at normalised reference conditions. The emission limits assumed to apply to the Proposed Development are shown in Table 8B-3.

8.3.13 In order to optimise the rate of carbon capture, emission concentrations of NOx are required to be within the BAT-AEL range provided in the Large Combustion Plant BRef (10 - 30 mg/Nm3 as a yearly average). That said, the proposed CCGT plant can achieve efficiencies in excess of 55%, and the BRef allows for a correction factor to be applied to the upper end of the BAT-AELs to allow for a higher NO_x emission where high efficiencies can be achieved.

8.3.14 NO_x emissions have therefore been modelled at a corrected rate of 34 mg/Nm^3, which is considered to be the maximum NO_x concentrations that could be released. Whilst it is recognised that some additional NO_x may be formed in the carbon capture plant itself, there would also be control of NO_x through the proposed SCR unit and removal of further NO_x from the CCP through reaction with amine. The use of the corrected LCP BAT-AEL on exit from the absorber stack therefore is considered to represent a worst-case NO_x emission; in practice the emission is likely to be considerably lower than this concentration.

8.3.15 A NO_x abatement system such as Selective Catalytic Reduction (SCR) would be required to achieve the required NO_x concentration at the inlet of the carbon capture plant. SCR reduces NO_x concentrations by spraying urea (or other forms of NH_3) into the flue gas and therefore have the potential to result in 'ammonia slip' with a resulting emission of ammonia. Emissions of NH_3 have therefore also been included in the assessment. In addition, depending on the amine solution used, ammonia can result as a degradation product during the carbon capture process itself. As there is uncertainty in the level of potential ammonia emission, the design of the CCP may include provision for an acid wash to remove ammonia from the absorber stack gas if required. Emissions of NH_3 have therefore been assessed at a range of concentrations (2 – 3 mg/Nm^3) in order to provide some flexibility for detailed design. The worst-case results are presented in the assessment.

8.3.16 The carbon capture process is likely to utilise a proprietary amine solvent to remove the carbon dioxide from the combustion emission. Emissions of 'amine slip' can therefore also result, and this has also been modelled at the maximum emission concentrations provided by any of the Licensors being considered for the design of the Proposed Development.

8.3.17 There are a number of licensors with proprietary amine solutions available for use in carbon capture systems, however at this stage of the development the final licensor has not been selected. Each licensor's proprietary amine solution is likely to contain a different amine or mix of amines and therefore in order to consider this in the assessment, the potential amine release has been assessed at the maximum concentration provided by all the potential licensors and has been assessed as monoethanolamine (MEA).

8.3.18 It is also known that some amines can potentially degrade into nitrosamines and nitramines (collectively referred to as N-amines) both during the carbon capture process itself and also in the environment following release, and therefore this has also been considered in this assessment. Depending on the amine solvent, other degradation products, such as acetaldehyde, formaldehyde and acetic acid may be formed during the carbon capture process, and therefore these have also been included in the assessment at the maximum value obtained from all the Licensors under consideration.

8.3.19 Due to the complexity of the N-amines atmospheric degradation processes that occur following release, the assessment of N-amines is described in Technical Appendix 8C: Air Quality Amine Degradation Assessment (ES Volume III, Document Ref.6.4)).

8.3.20 The assessment has assumed that the Proposed Development would operate at continuous design load (8,760 hours per year). No time-based variation in emissions have therefore been accounted for within the model.

Table 8B-3: Emission Concentrations and the Assessed Emission Rates

Pollutant	Carbon absorber stack 35°C Model		Carbon absorber stack 60°C Model	
	Emission concentration (mg/m^3)	Emission rate (g/s)	Emission concentration (mg/m^3)	Emission rate (g/s)
Oxides of Nitrogen ((NO_X (as NO_2))	34.0	36.8	34.0	34.1
Carbon Monoxide (CO)	100	108.4	100	100.2
Ammonia (NH_3)	2.0	2.2	3.0	3.0
Amines	5.5	6.0	5.5	5.5
Acetaldehyde	5.3	5.7	5.3	5.3
Formaldehyde	0.5	0.5	0.5	0.5
Ketones	5	5.4	5	5.0
Acetic Acid	1.2	1.3	1.2	1.2

Modelled Domain – Discrete Receptors

Sensitive Human Receptors

8.3.21 The modelling has predicted concentrations of the modelled pollutants relevant to human health at discrete air quality sensitive receptors, as listed in Table 8B-4. The locations of these receptors are also shown in Figure 8.1: Air Quality Study Area Human Health (ES Volume II, Document Ref. 6.3). The receptors are selected to be representative of residential dwellings, recreational areas and schools in the area around the Proposed Development. (OR = Operational Receptor).

Table 8B-4: Human Receptor Locations

Receptor reference	Receptor description	Grid reference		Distance and direction from the operational site
		X	Y	
OR1	Houses at Warrenby	457950	525045	750 m east
OR2	Cleveland Golf Links	458090	525550	880 m northeast
OR3	South Gare Fisherman's Association	455680	527395	2.5 km northwest
OR4	Marine Club	455550	527345	2.5 km northwest
OR5	Caravan Park	458675	525415	1.4 km east
OR6	Houses at Dormanstown	457895	523735	1.5 km southeast
OR7	Houses at Coatham	458900	525060	1.7 km east
OR8	Dormanstown Primary School	458250	523585	1.8 km southeast
OR9	Coatham C of E School	459195	524980	2 km east
OR10	South Tees Development Site	456640	525880	Adjacent west

Sensitive Ecological Receptors

8.3.22 In accordance with the Environmental Agency's air emissions risk assessment guidance, the impacts associated with emissions from the Proposed Development on statutory sensitive ecological sites has been quantified. The assessment considers European designated sites (Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites) and Sites of Special Scientific Interest (SSSIs) within 15 km of the operational Proposed Development, as recommended by the EA's risk assessment guidance for "large emitters". The most notable of these sites is the Teesmouth and Cleveland Coast Ramsar, SPA and SSSI, which is adjacent to the Proposed Development site.

8.3.23 In additional, Local Wildlife Sites (LWSs) within 2km of the Proposed Development have also been included in the assessment.

8.3.24 Ground-level concentrations of the modelled pollutants relevant to sensitive ecological receptors have been predicted at locations listed in Table 8B-5 and the locations of these receptors are shown in Figure 8.2: Air Quality Study Area Ecological (ES Volume II, Document Ref. 6.3)). The location reported for each ecology site is the point closest to the Proposed Development, taken to be representative of the worst case.

Table 8B-5: Ecological Receptor Locations

Receptor identification	Ecology site	Grid reference		Distance and direction from the operational site
		X	Y	
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	457714	525773	500 m north
E2	North York Moors SPA, SAC and SSSI	463315	514190	11.9 km southeast
E3	Northumbria Coast SPA and Ramsar	448259	537470	14.6 km northwest
E4	Durham Coast SSSI and SAC	449520	536190	12.9 km northwest
E5	Lovell Hill Pools SSSI	459860	519100	6.3 km southeast
E6	Saltburn Gill SSSI	467000	521265	10 km southeast
E7	Coatham Marsh LWS	457860	524990	650m east
E9	Eston Pumping Station LWS	456370	523890	1.1 km southwest

N.B. E8 receptor represents Wilton Woods, which is only applicable to the construction traffic air assessment.

Modelled Domain – Receptor Grid

8.3.25 Emissions from the Proposed Development have also been modelled on a receptor grid of variable spacing, in order to determine:

- The location and magnitude of maximum ground level impacts; and
- To enable the generation of pollutant isopleth plots.

8.3.26 The dispersion model output has been reported at specific receptors and as a nested grid of values. The inner grid extends 500 m at a resolution of 25 m x 25 m. The middle grid extends from 500 m to 5,000 m at a resolution of 50 m x 50 m. The outer grid extends from 5,000 m to 15,000 m at a resolution of 250 m x 250 m. Details of the receptor grid are summarised in Table 8B-6.

Table 8B-6: Modelled Domain, Receptor Grid

Grid spacing (m)	Dimensions (km)	Number of nodes in each direction	National grid reference of south west corner
25	1 x 1	41	456551, 524770
50	10 x 10	201	452051, 520270
250	30 x 30	121	442051, 510270

Meteorological Data

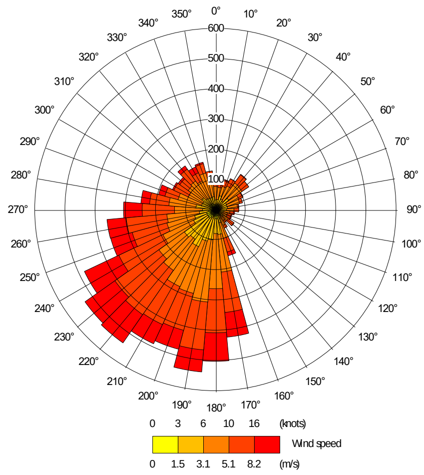
8.3.27 Actual measured hourly-sequential meteorological data is available for input into dispersion models, and it is important to select data as representative as possible for the site that will be modelled. This is usually achieved by selecting a meteorological station as close to the site as possible, although other stations may be used if the local terrain and conditions vary considerably, or if the station does not provide sufficient data.

8.3.28 The meteorological site that was selected for the assessment is Durham Tees Valley Airport, located approximately 22 km southwest of the Proposed Development Site, at a flat airfield in a principally agricultural area, and therefore a surface roughness of 0.3 m (representative of an agricultural area) has been selected for the meteorological site within the model.

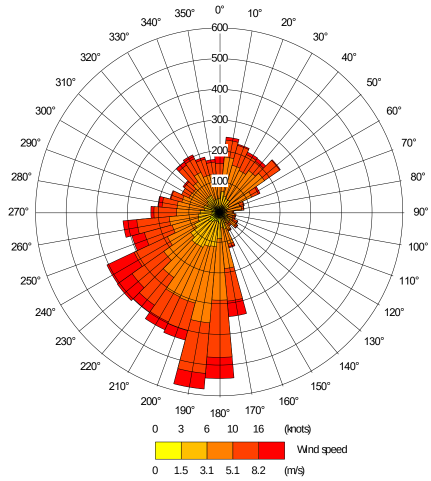
8.3.29 The modelling for this assessment has utilised 5 years of meteorological data for the period 2015 – 2019. Wind roses for each of the years within this period are shown in Figure 8B-2.

Diagram 8B- 1: Wind Roses for Durham Tees Valley Airport, 2015 To 2019

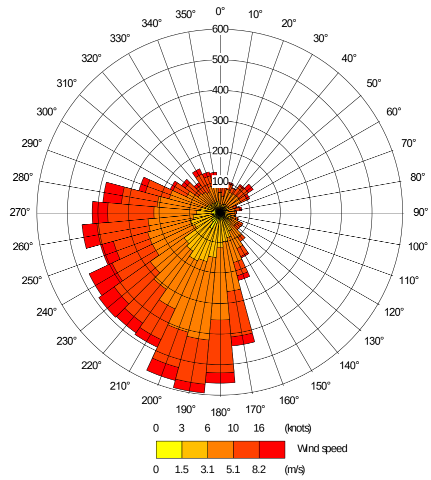
2015



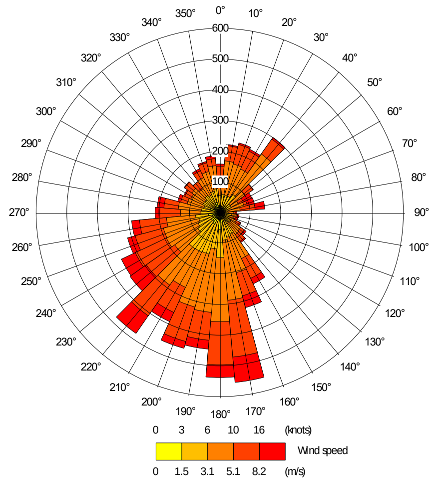
2016



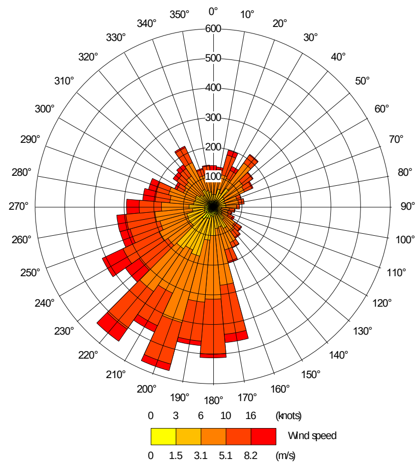
2017



2018



2019



Building Downwash Effects

8.3.30 The buildings that make up the Proposed Development have the potential to affect the dispersion of emissions from the operational process stack. The ADMS buildings effect module has therefore been used to incorporate building downwash effects as part of the model set up. Buildings greater than one third of the range of stack heights modelled have been included within the modelling assessment. Model sensitivity testing showed that the only building to affect the predicted impacts from the carbon capture plant absorber stack, was the absorber building itself.

8.3.31 The absorber building has been included in the model in all four corners of the PCC Site, as described above for the stack location. The modelled locations are shown in Table 8B-7 and a plan showing the building layout used in the ADMS simulation is illustrated in Figure 8.4: Model Visualisation (ES Volume II, Document Ref. 6.3). The dimensions of the absorber are the maximum measurements that could potentially be required (as defined in the Rochdale Envelope) and have been provided by the Design Engineers.

Table 8B-7: Buildings Incorporated into the Modelling Assessment

Building	Building centre grid reference (x,y)	Height (m)	Length (m)	Width (m)	Angle (o)
CC Absorber Tower	NW corner 456808, 525487	80	35	25	112
	NE corner 457046, 525393				
	SW corner 456758, 525359				
	SE corner 456995, 525265				

8.3.32 The immediate local area downwind of the Proposed Development is flat and undeveloped land followed by the coast and the North Sea. Upwind of the Proposed Development Site is dominated by industrial land uses and relatively flat. The Site is adjacent to the River Tees Estuary to the west. A surface roughness of 0.3 m, corresponding to the minimum value associated with the terrain type, has therefore been selected to represent the local terrain.

8.3.33 Site-specific terrain data has not been used in the model, as there are no potentially significant changes in gradient within the Study Area.

NO_X to NO_2 Conversion

8.3.34 Emissions of nitrogen oxides from industrial point sources are typically dominated by nitric oxide (NO), with emissions from combustion sources typically in the ratio of nitric oxide to nitrogen dioxide of 9:1. However, it is nitrogen dioxide that has specified environmental standards due to its potential impact on human health. In the ambient air, nitric oxide is oxidised to nitrogen dioxide by the ozone present, and the rate of oxidation is dependent on the relative concentrations of nitric oxide and ozone in the ambient air.

8.3.35 For the purposes of detailed modelling, and in accordance with Environment Agency technical guidance it is assumed that 70% of nitric oxide emitted from the stack is oxidised to nitrogen dioxide in the long term and 35% of the emitted nitric oxide is oxidised to nitrogen dioxide in the local vicinity of the site in the short-term.

Calculation of Deposition at Sensitive Ecological Receptors

8.3.36 The deposition of nutrient nitrogen and acid at sensitive ecological receptors has been calculated, using the modelled process contribution predicted at the receptor points. The deposition rates are determined using conversion rates and factors contained within Environment Agency guidance, which account for variations deposition mechanisms in different types of habitat.

8.3.37 The conversion rates and factors used in the assessment are detailed in Table 8B-8 and Table 8B-9.

Table 8B-8: Conversion Factors – Calculation of Nutrient Nitrogen Deposition

Pollutant	Deposition velocity grassland (m/s)	Deposition velocity woodland (m/s)	Conversion factor (μg/m^3/s to kg/ha/yr)
NO_X as NO_2	0.0015	0.003	96
NH_3	0.02	0.03	259.7

Table 8B-9: Conversion Factors – Calculation of Acid Deposition

Pollutant	Deposition velocity grassland (m/s)	Deposition velocity woodland (m/s)	Conversion factor (μg/m^3/s to keq/ha/yr)
NO_2	0.0015	0.003	6.84
NH_3	0.02	0.03	18.5

Specialised Model Treatments

8.3.38 Emissions have been modelled such that they are not subject to dry and wet deposition or depleted through chemical reactions. The assumption of continuity of mass is likely to result in an over-estimation of impacts at receptors, and therefore is considered to be conservative.

8.4 Baseline Air Quality

Overview

8.4.1 This section presents the information used to evaluate the background and baseline ambient air quality in the area surrounding the Proposed Development. The following steps have been taken in the determination of background values. Where appropriate, the study focuses on data gathered in the vicinity of the site:

- Identification of Air Quality Management Areas;
- Review of Redcar and Cleveland Borough Council (RCBC) ambient monitoring data;
- Review of data from Defra's background mapping database;
- AECOM monitoring undertaken in the area around the application site; and

- Review of background data and site relevant critical loads from the APIS website.

Air Quality Management Areas

8.4.2 Redcar and Cleveland Borough Council (RCBC) and Stockton on Tees Borough Council (STBC) have not declared any AQMAs within their administrative area, and there are no AQMAs declared by other Local Authorities within the Study Area.

Local Authority Ambient NO_x and NO_2 Monitoring Data

Redcar And Cleveland Borough Council

8.4.3 RCBC currently operate one automatic monitoring site, located at Dormanstown Primary School, approximately 1.5 km to the south east of the operational Proposed Development. The site was chosen in order to monitor roadside and industrial emissions. Data for 2019 was available at the time of writing with annual concentrations of NO_x and NO_2 of 13.0 µg/m^3 and 9 µg/m^3 respectively.

8.4.4 In addition, NO_x diffusion tube monitoring is carried out at 16 locations within the borough. The nearest NO_2 diffusion tubes are again located at Dormanstown Primary School. At the time of writing, the most recent monitoring data available from RCBC diffusion tube monitoring is for 2018 and the average measured annual NO_2 concentration was 16.4 µg/m^3.

8.4.5 All monitoring locations within the Study Area are below the annual mean nitrogen dioxide objective of 40µg/m^3 in 2018.

Defra Background Data

8.4.6 Defra's 2018-based background maps are available at a 1x1 km resolution for the UK for the year 2018 and are projected forward to the year 2030. These projections of pollution concentrations across England are available for NO_2 and NO_x.

8.4.7 Background concentrations from the Defra 2018-based background maps are presented for the year 2018 in Table 8B-10 taken for the grid square in which the operational Proposed Development is located (456500, 525500) for NO_x and NO_2. Background concentrations for CO are not available for the most recent Defra maps, but data for 2001-based background concentrations are available and this has been adjusted for 2018 using the Defra published year adjustment factors.

8.4.8 Data for 2018 has been presented, as the typical trend shown in the Defra background mapping is that over the projected time period, concentrations of NO_2 and NO_x are shown to be decreasing. This corresponds to a reduction overtime of vehicle emissions as newer, cleaner vehicles replace older ones. Therefore, assuming no reduction occurs until the opening year of the Proposed Development (2026), is considered to represent a conservative approach.

8.4.9 A review of the background map concentrations over the Study Area for human health receptors shows that the concentration presented in Table 8B-10 for the Site location is also representative of the background concentrations at the receptor locations (the average NO_2 concentration in the grid squares with identified receptors was 14.7 µg/m^3).

Table 8B-10: Defra Background Concentrations (NGR 456500, 525500)

Pollutant	Background concentration (µg/m^3)
NO_X	20.5
NO_2	14.7
CO	110.9

AECOM Monitoring Data

8.4.10 A diffusion tube monitoring survey of the Study Area commenced in December 2019, in order to gather data on the ambient concentrations of NO_2 at representative human health and ecological receptor locations. Due to the National Lockdown, the diffusion tube monitoring survey ceased in March 2020. The data collected relevant to the Operational assessment are shown in Table 8B-11.

Table 8B-11: AECOM Nitrogen Dioxide Diffusion Tube Monitoring

Site ID	Monitoring location	Site type	Grid reference		2020 Annual mean concentration (µg/m^3)
			X	Y	
DT3	North-west corner of Coatham Marshes	Urban background	459068	524863	14.4
DT9	Woodlands Drive in Eston	Urban Background	455142	517500	11.9
DT10	Garsbeck Way in Ormesby	Urban Background	453906	517392	8.8

8.4.11 The monitoring tube data suggests that the urban background monitoring sites have comparable or lower NO_2 concentrations that the Defra data, and therefore it was considered appropriate to use the Defra data for the assessment, as a worst case.

Ecological Site Background Data

8.4.12 The NO_X and NH_3 background concentrations are available from the APIS website for designated SAC, SPA and SSSI sites. The average concentrations present at the relevant habitat receptor sites are presented in Table 8B12.

Table 8B-12: APIS Background Data NO_x And NH_3

Receptor I.D.	Ecology site	NOx ($\mu g/m^3$)	Ammonia ($\mu g/m^3$)
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	19.43	0.89
E2	North York Moors SPA, SAC and SSSI	8.32	1.24
E3	Northumbria Coast SPA and Ramsar	9.46	1.56
E4	Durham Coast SAC and SSSI	10.57	1.56
E5	Lovell Hill Pools SSSI	13.22	2.04
E6	Saltburn Gill SSSI	9.45	1.15
E7	Coatham Marsh LWS	26.89	1.42
E9	Eston Pumping Station LWS	22.40	1.42

8.4.13 In addition, the APIS website provides information on the relevant critical loads for the assessment of depositional impacts, as well as background nitrogen deposition and acid deposition loads. This data has been presented in Table 8B-13.

Table 8B-13: APIS Background Deposition Information

Receptor I.D.	Ecology site	N-Deposition	Acid Deposition	
		(kg N/ha/yr)	(keq N/ha/yr)	(keq S/ha/yr)
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	10.50	0.75	0.25
E2	North York Moors SPA, SAC and SSSI	18.06	1.29	0.21
E3	Northumbria Coast SPA and Ramsar	14.70	1.05	0.15
E4	Durham Coast SAC and SSSI	14.70	1.05	0.15
E5	Lovell Hill Pools SSSI	No information available on relevant critical loads for assessment		
E6	Saltburn Gill SSSI	19.74	0.89	0.15
E7	Coatham Marsh LWS	14.14	1.01	0.23
E9	Eston Pumping Station LWS	14.14	1.01	0.23

8.5 Summary of Background Air Quality

8.5.1 For human health receptors, the background concentrations for nitrogen dioxide and CO has been taken from the Defra background mapping, as presented in Table 8-10. Although the diffusion tube data for Dormanstown indicates slightly higher NO_2 concentrations, it is considered that as the Defra data and the automatic monitoring data at the same location show good correlation, this is most appropriate for use in the assessment.

8.5.2 The background NO_x and NH_3 concentrations for ecological receptors were sourced from APIS using the specific location for the relevant ecological receptor, as detailed in Table 8B-12.

8.5.3 There is little data on background amine concentrations in the UK and therefore background concentrations have been assumed to be zero as a worst case for the purpose of this assessment.

8.5.4 Where no short-term concentrations are available, short-term background concentrations have been calculated by multiplying the selected annual mean background concentration by a factor of two, in accordance with the Environment Agency Risk Assessment methodology.

8.5.5 In order to represent a conservative approach, it has been assumed that background concentrations would not decrease in future years. Therefore, the current background concentrations have been assumed to apply to the projected opening year of 2026.

8.6 Operational Emissions Modelling Results

Evaluation of Stack Height

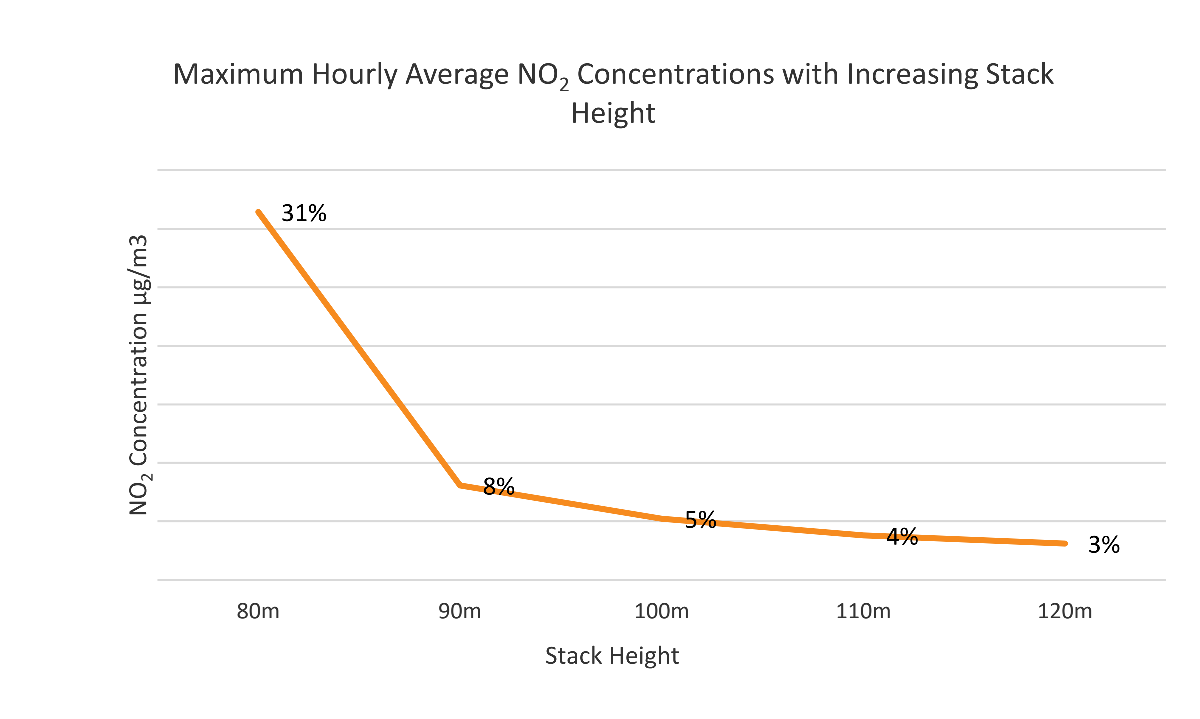
8.6.1 The selection of an appropriate stack release height requires a number of factors to be taken into account, the most important of which is the need to balance a release height sufficient to achieve adequate dispersion of pollutants against other constraints such as the visual impact of tall stacks.

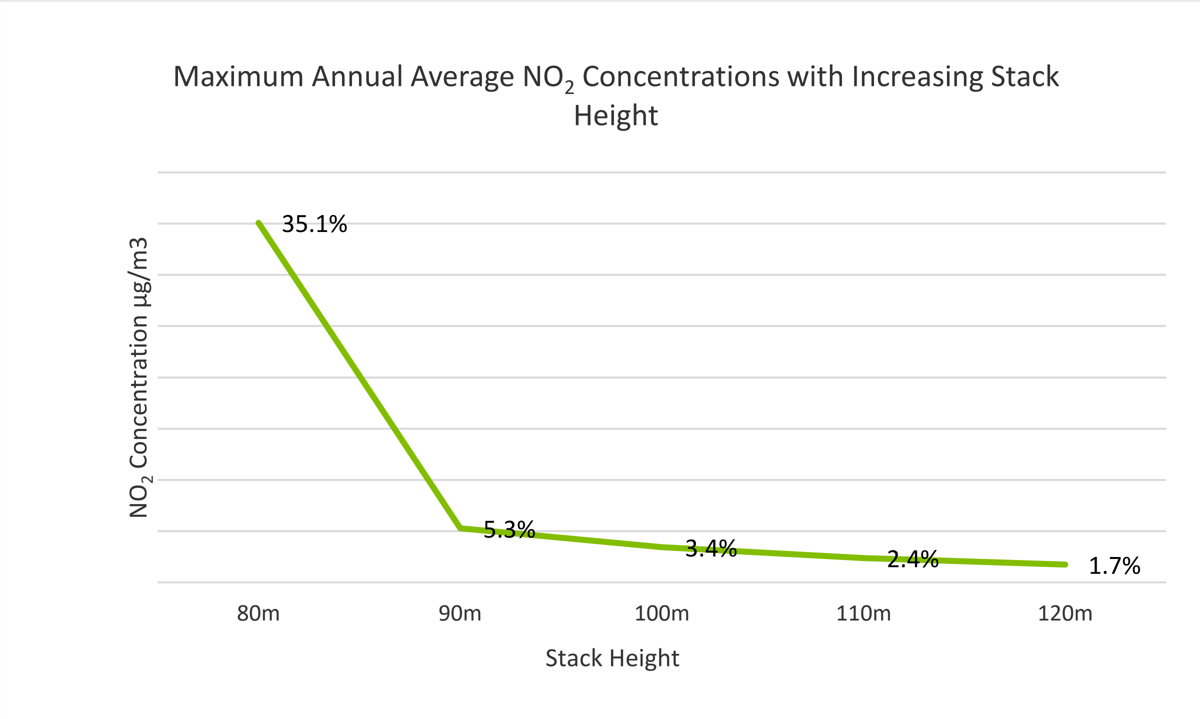
8.6.2 Emissions from the main carbon capture stacks have been modelled at heights between 80 m and 120 m, at 10 m increments. Graphs, showing the predicted ground level concentrations for the annual mean and maximum 1-hour NO_2 concentrations are presented in Diagram 8B- 22. The purpose of the graphs is to evaluate the optimum release height in terms of the dispersion of pollutants which would occur, against the visual constraints of further increases in release height, with the ‘elbow’ of the resulting curve showing where the reductions in ground level concentrations become disproportionate to the increasing height.

8.6.3 Analysis of the curves shows that the benefit of incremental increases in release heights after 90 m become less pronounced although at heights above 100 m, the air quality benefit of increasing release height further is reduced, with this levelling out after 110m.

8.6.4 Although the graph suggests that a stack height of 90 – 100 m represents the optimum stack height for maximum ground level concentrations of NO2, following further analysis of the results, especially those at the habitat receptors, it has been concluded that an 115 m stack is more appropriate for ensuring that impacts of atmospheric pollutants at these receptors can be considered to be acceptable. The reported results are therefore based on a 115 m stack.

Diagram 8B- 2: Predicted Maximum Process Contribution to Ground Level NO_2 Concentrations at Stack Release Heights of 80 m – 120 m





Human Health Receptor Results

Nitrogen dioxide emissions

8.6.5 The predicted change in annual mean NO_2 concentrations that would occur during the operation of the Proposed Development, at the identified human health receptors, are presented in Table 8B-14. The results presented represents the highest (worst case) result from all five years of the meteorological data used in the model.

8.6.6 The maximum predicted annual mean NO_2 concentration that occurs anywhere within the Study Area as a result of the Proposed Development is 0.81 µg/m^3, and this occurs at the coast at Coatham, just to the north of the operational Proposed Development, in the vicinity of the Cleveland Links Golf Course. The annual mean NO_2 predicted environmental concentration (i.e. the process contribution and the existing background concentration) is 15.5 µg/m^3 and therefore is below the annual mean NO_2 AQAL of 40 µg/m^3. NO_2 emissions from the Proposed Development are therefore not predicted to lead to a risk of the annual mean AQALs being exceeded anywhere within the Study Area.

8.6.7 The discrete receptor most affected by long term emissions from the Proposed Development is receptor OR2 the Cleveland Links Golf Course, with a predicted annual mean NO_2 concentration as a result of the Proposed Development of 0.60 µg/m^3, representing 1.5% of the AQAL.

8.6.8 The significance of the predicted change in annual mean NO_2 concentrations in planning terms is discussed in Chapter 8: Air Quality (ES Volume I, Document Ref. 6.2).

Table 8B-14: Predicted Change in Annual Mean NO_2 Concentrations

Receptor	AQAL (µg/m3)	Predicted Concentration (PC) (µg/m^3)	PC/AQAL %	Background Concentration (BC) (µg/m^3)	Predicted Environmental Concentration (PEC) (µg/m^3)	PEC/ AQAL %
Max anywhere	40	0.81	2.0%	14.7	15.5	39%
OR1		0.31	0.8%		15.0	38%
OR2		0.60	1.5%		15.3	38%
OR3		0.20	0.5%		14.9	37%
OR4		0.16	0.4%		14.9	37%
OR5		0.48	1.2%		15.2	38%
OR6		0.17	0.4%		14.9	37%
OR7		0.37	0.9%		15.1	38%
OR8		0.16	0.4%		14.9	37%
OR9		0.32	0.8%		15.1	38%
OR10		0.12	0.3%		14.9	38%

PC = Process Contribution, AQAL = Air Quality Assessment Level, BC = Background Concentration, PEC = Predicted Environmental Concentration

8.6.9 The maximum predicted hourly mean NO_2 concentration (as the 99.79th percentile of hourly averages) that occurs anywhere within the Study Area as a result of the Proposed Development is 7.0 µg/m^3, and this occurs again just to the north of the operational Proposed Development, and also to a small area to the south of the operational Proposed Development. The predicted environmental concentration (i.e. the process contribution and the existing background concentration) is 36.4 µg/m^3 and therefore is well below the hourly mean NO_2 AQAL of 200 µg/m^3. NO_2 emissions from the Proposed Development are therefore not predicted to lead to a risk of the hourly mean air quality standard being exceeded anywhere within the Study Area.

8.6.10 The discrete receptor most affected by short term emissions from the Proposed Development is receptor OR2 Cleveland Links Golf Course, with a predicted hourly mean NO_2 concentration as a result of the Proposed Development of 6.4 µg/m^3.

Table 8B-15: Predicted Change in Hourly Mean NO_2 Concentrations (as the 99.79th Percentile of Hourly Averages

Receptor	AQAL (µg/m^3)	PC (µg/m^3)	PC/AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %
Max anywhere	200	7.0	3%	29.5	36.4	18%
OR1		5.4	3%		34.9	17%
OR2		6.4	3%		35.9	18%
OR3		4.1	2%		33.5	17%
OR4		3.8	2%		33.3	17%
OR5		5.1	3%		34.6	17%
OR6		4.6	2%		34.1	17%
OR7		4.6	2%		34.0	17%
OR8		4.1	2%		33.5	17%
OR9		3.9	2%		33.4	17%
OR10		4.6	2%		34.0	17%

PC = Process Contribution, AQAL = Air Quality Assessment Level, BC = Background Concentration, PEC = Predicted Environmental Concentration

Carbon monoxide emissions

8.6.11 The maximum hourly and 8 hour running mean predicted concentrations that occur anywhere as a result of the Proposed Development represent less than 1% of the relevant AQALs and therefore can be considered to be insignificant/ negligible at all receptor locations. In addition, in combination with the background concentrations in the Study Area, the predicted environmental concentration remains less than 1% of the relevant AQALs for both averaging periods. The results at individual receptors have therefore not been presented.

Ammonia emissions

8.6.12 The annual and hourly average predicted concentrations of ammonia that occur anywhere as a result of the Proposed Development represent less than 1% of the relevant AQALs and therefore can be considered to be insignificant/ negligible at all receptor locations. In addition, in combination with the background concentrations in the Study Area, the predicted environmental concentration remains less than 1% of the relevant AQALs for both averaging periods. The results at individual receptors have therefore not been presented.

Amine emissions

8.6.13 The annual average predicted concentration of amines that occurs anywhere as a result of the Proposed Development represent less than 1% of the relevant AQAL at all locations and therefore can be considered to be insignificant/ negligible.

8.6.14 The hourly average concentrations at the maximum impacted location is 4.9 µg/m^3, representing 1.2% of the AQALs. The results at other receptors are shown in Table 8B-16.

Table 8B-16: Predicted Change in Hourly Average Amine Concentrations

Receptor	AQAL (µg/m^3)	PC (µg/m^3)	PC/AQAL %
Max anywhere	400	4.6	1.2%
OR1		3.6	0.9%
OR2		3.7	0.9%
OR3		3.0	0.8%
OR4		3.1	0.8%
OR5		3.3	0.8%
OR6		2.8	0.7%
OR7		2.6	0.6%
OR8		2.8	0.7%
OR9		2.5	0.6%
OR10		4.2	1.0%

Amine degradation products

8.6.15 The annual average and hourly predicted concentrations of acetaldehyde, formaldehyde and acetic acid that occur anywhere as a result of the Proposed Development, represent less than 0.1% of the relevant AQALs at all locations and therefore can be considered to be insignificant/ negligible.

Ecological Receptors Results

8.6.16 The results of the dispersion modelling of predicted impacts on sensitive ecological receptors are presented in Table 8B-17 to Table 8B-20. The tables set out the predicted PC to atmospheric concentrations of NO_x and NH_3 and also nutrient nitrogen and acid deposition.

8.6.17 Specific significance criteria relating to impacts on sensitive designated ecological receptors are set out within the Environmental Agency air emissions risk assessment guidance. The impact of stack emissions can be regarded as insignificant at sites with statutory designations if:

- The long-term PC is less than 1% of the critical level, or if greater than 1% then the PEC is less than 70% of the critical level.
- The short-term PC is less than 10% of the critical level.

8.6.18 The impact of stack emissions can be regarded as insignificant at sites of local importance if:

- The long-term PC is less than 100% of the critical level.
- The short-term PC is less than 100% of the critical level

8.6.19 The effect of atmospheric NO_x concentrations, nitrogen deposition rates and acid deposition rates on the modelled receptor locations have been considered in detail in the Habitats Regulations Assessment Report (Document Ref. 5.13) submitted with the Application. Further discussion on the significance of the impact on sensitive ecological receptors is provided in Chapter 12: Terrestrial Ecology and Nature Conservation (ES Volume I, Document Ref. 6.2).

Oxides of nitrogen emissions – Critical Levels

8.6.20 The assessment results show that the predicted annual average and daily average NO_x impacts are below the criteria for insignificance at five of the eight receptors.

8.6.21 PCs of more than 1% of the long-term critical level and 10% of the daily critical level for NO_x occur at the adjacent Teesmouth and Cleveland Coast SPA, SSSI and Ramsar, the Coatham Marsh LWS and also the Eston Pumping Station LWS.

8.6.22 The annual average PEC at the Teesmouth and Cleveland Coast site is 67% of the annual average critical level and 60% of the daily average critical level respectively. The annual average value is therefore just under 70% of the critical level threshold for insignificance. There is also no exceedance of the daily average critical level predicted.

8.6.23 Annual average impacts at the Coatham Marsh LWS represent 1.2% of the critical level and therefore only just over the 1% threshold for insignificance. The background NO_x concentration at the site represents 90% of the critical level without the contribution from the Proposed Development, and therefore the PEC represents 91% of the annual critical level. This is just below the level of insignificance for LWSs. The daily PC represents 9.2% of the critical level, and therefore is insignificant.

8.6.24 Due to the worst-case assumptions used in the assessment, it is considered that the predicted impacts are conservative and that an exceedance of the critical level is unlikely to occur as a result of the emissions from the operational development.

Ammonia – Critical Levels

8.6.25 The assessment results show that the predicted annual average NH_3 impacts are below the criteria for insignificance (<1% of the critical level) at seven of the eight receptors, and therefore can be considered insignificant. The predicted annual average NH_3 impacts at the Teesmouth and Cleveland coast receptor are slightly over the threshold of insignificance at 1.5% of the critical level, however in combination with the background concentration it represents only 32% of the critical level and therefore can be considered to be not significant.

Nitrogen deposition – Critical Loads

8.6.26 The Environment Agency and Natural England have agreed that depositional impacts that are below 1% of the relevant critical load for a site can be regarded as insignificant. Guidance from the Institute of Air Quality Management clarifies that the 1% threshold is not intended to be precise to a set number of decimal places but to the nearest whole number (paragraph 5.5.2.6 of Institute of Air Quality Management, 2020[1]). Further interpretation of the significance of the depositional results is provided in Chapter 12: Terrestrial Ecology and Nature Conservation (ES Volume I, Document Ref. 6.2).

[1] Institute of Air Quality Management (2020). *A Guide to the Assessment of Air Quality Impacts on Designated Nature Conservation Sites, Version 1.1* [Online]. Available from: https://iaqm.co.uk/text/guidance/air-quality-impacts-on-nature-sites-2020.pdf

Table 8B-17: NO_x Dispersion Modelling Results for Ecological Receptors

Receptor ID	Site Name	Annual average (µg/m³)						24 hour average (µg/m³)					
		CL	PC (µg/m³)	PC % of CL	BC (µg/m³)	PEC (µg/m³)	PEC % of CL	Critical level (CL)	PC (µg/m³)	PC % of CL	BC (µg/m³)	PEC (µg/m³)	PEC % of CL
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	30	0.8	2.6%	19.43	20.20	67%	75	15.5	20.7%	29.15	44.6	60%
E2	North York Moors SPA, SAC and SSSI		0.06	0.2%	8.32	8.38	28%		1.0	1.3%	12.48	13.48	18%
E3	Northumbria Coast SPA and Ramsar		0.04	0.1%	9.46	9.50	32%		0.8	1.0%	14.19	14.95	20%
E4	Durham Coast SAC and SSSI		0.05	0.2%	10.57	10.62	35%		0.7	0.9%	15.86	16.56	22%
E5	Lovell Hill Pools SSSI		0.11	0.4%	13.22	13.33	44%		1.7	2.3%	19.83	21.55	29%
E6	Saltburn Gill SSSI		0.06	0.2%	9.45	9.51	32%		0.8	1.1%	14.18	14.97	20%
E7	Coatham Marsh LWS		0.36	1.2%	26.89	27.25	91%		6.9	9.2%	40.34	47.23	63%
E9	Eston Pumping Station LWS		0.46	1.5%	22.40	22.86	76%		8.6	11.4%	33.60	42.16	56%

CL = Critical Level, PC = Process Contribution, BC = Background Concentration (assumed to be 1.5 times the annual average for daily concentrations), PEC = Predicted Environmental Concentration

Table 8B-18: Dispersion Modelling Results for Ecological Receptors – NH_3

Receptor ID	Site Name	Annual Average (µg/m³)					
		CL (µg/m³)	PC	PC % of CL	BC (µg/m³)	PEC (µg/m³)	PEC % of CL
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	3	0.06	2.0%	0.89	0.95	32%
E2	North York Moors SPA, SAC and SSSI		0.004	0.1%	1.24	1.24	41%
E3	Northumbria Coast SPA and Ramsar		0.003	0.1%	1.56	1.56	52%
E4	Durham Coast SAC		0.003	0.1%	1.56	1.56	52%
E5	Lovell Hill Pools SSSI		0.01	0.2%	2.04	2.05	68%
E6	Saltburn Gill SSSI		0.005	0.2%	1.15	1.15	38%
E7	Coatham Marsh LWS		0.02	0.7%	1.42	1.44	48%
E8	Eston Pumping Station LWS		0.03	0.9%	1.42	1.45	48%

CL = Critical Level, PC = Process Contribution, BC = Background Concentration, PEC = Predicted Environmental Concentration

Table 8B-19: Dispersion Modelling Results for Ecological Receptors – Nutrient Nitrogen Deposition (Kg/Ha/Yr)

Receptor ID	Site name	Background nitrogen deposition (kg N/ha/yr)	Most stringent Critical Load class applicable for the site	Lower value of applicable Critical Load range	PC (kg N/ha/yr)	PC % Critical Load	PEC (μg/m³)	PEC % Critical Load
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	10.5	Coastal stable dune grassland (calcareous type)	10	0.39	3.9%	10.9	109%
E2	North York Moors SPA, SAC and SSSI	18.1	Dry Heath	10	0.03	0.3%	18.5	181%
E3	Northumbria Coast SPA and Ramsar	14.7	Coastal stable dune grassland (acid type)	8	0.02	0.2%	14.7	184%
E4	Durham Coast SAC and SSSI	14.7	Sub-atlantic semi-dry calcareous grassland	15	0.02	0.2%	14.7	98%
E5	Lovell Hill Pools SSSI	No comparable habitat with established critical load for estimate available.						
E6	Saltburn Gill SSSI	19.7	Broad-leaved, mixed and yew woodland	15	0.05	0.3%	19.8	132%
E7	Coatham Marsh LWS	14.1	Sub-atlantic semi-dry calcareous grassland	15	0.15	1.0%	14.3	95%
E9	Eston Pumping Station LWS	14.1	Sub-atlantic semi-dry calcareous grassland	15	0.19	0.9%	14.3	72%

Table 8B-20: Dispersion Modelling Results for Ecological Receptors – Acid Deposition N (Keq/Ha/Yr)

Receptor ID	Site name	Acid deposition (keq/ha/yr)2				PC acid deposition (keq/ha/yr)3		
		Critical Load4	Baseline	Lowest Critical Load class applicable	Baseline % of Critical Load	PC	PC % of Critical Load	PEC% of Critical Load
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	Min CL Min N 0.856 Min CL Max N 4.856 Min CL Max S 4.00	N: 0.75 S: 0.25	Calcareous grassland	6.3%	0.025	0%	6.3%
E2	North York Moors SPA, SAC and SSSI	Min CL Min N 0.499 Min CL Max N 0.792 Min CL Max S 0.150	N: 1.29 S: 0.21	Dwarf shrub heath	189.4%	0.002	0%	189.4%
E3	Northumbria Coast SPA and Ramsar	Min CL Min N 0.223 Min CL Max N 0.786 Min CL Max S 0.420	N: 1.05 S: 0.15	Acid grassland	152.7%	0.001	0%	152.7%
E4	Durham Coast SAC and SSSI	Min CL Min N 0.223 Min CL Max N 1.03	N: 1.05 S: 0.15	Acid grassland	116.5%	0.001	0%	116.5%

[2] Acid Deposition Critical Loads
[3] Process Contribution and Process Environmental Contribution as percentages of the relevant Critical Load have been calculated using the Min CL Max N
[4] Critical Load (as obtained from APIS, July 2018)

Receptor ID	Site name	Acid deposition (keq/ha/yr)2				PC acid deposition (keq/ha/yr)3		
		Critical Load4	Baseline	Lowest Critical Load class applicable	Baseline % of Critical Load	PC	PC % of Critical Load	PEC% of Critical Load
		Min CL Max S 0.81						
E5	Lovell Hill Pools SSSI	No critical loads assigned for the features present.						
E6	Saltburn Gill SSSI	Min CL Min N 0.142 Min CL Max N 2.639 Min CL Max S 2.448	N: 0.89 S: 0.15	Unmanaged Broadleafed/Coniferous Woodland	39.4%	0.004	0%	39.4%
E7	Coatham Marsh LWS	Min CL Min N 1.07 Min CL Max N 5.071 Min CL Max S 4.00	N: 1.01 S: 0.23	Calcareous grassland	5.8%	0.017	0%	5.8%
E9	Eston Pumping Station	Min CL Min N 1.07 Min CL Max N 5.071 Min CL Max S 4.00	N: 1.01 S: 0.23	Calcareous grassland	5.8%	0.022	0%	5.8%

8.7 Assessment of Limitations and Assumptions

8.7.1 This section outlines the potential limitations associated with the dispersion modelling assessment. Where assumptions have been made, this is also detailed here.

8.7.2 The greatest uncertainty associated with any dispersion modelling assessment arises through the inherent uncertainty of the dispersion modelling process itself. Nevertheless, the use of dispersion modelling is a widely applied and accepted approach for the prediction of impacts from industrial sources.

8.7.3 In order to minimise the likelihood of under-estimating the PC to ground level concentrations from the main stack, the following conservative assumptions have been made within the assessment:

- The operational Proposed Development has been assumed to operate on a continuous basis i.e. for 8,760 hour per year, although in practice the plant would require routine maintenance periods;
- The modelling predictions are based on the use of five full years of meteorological data from Durham Tees Valley Airport meteorological station for the years 2015 to 2019 inclusive, with the highest result being reported for all years assessed; This is considered to be conservative. Additional regional data supplied by the clients indicate the wind speeds at the location could be higher and the direction less scattered leading to narrower zone of emission contaminants.
- The largest possible building sizes within the Rochdale Envelope have been included in the assessment; therefore the stack height represents the highest required to achieve the impacts presented in this assessment;
- The stack has been located in all four corners of the PCC site, and the worst-case receptor results reported; and
- Emission concentrations for the process are calculated based on the use of IED limits, BAT-AEL concentrations, or maximum envisaged emission rates from licensors; in practice annual average rates would be below this to enable continued compliance with environmental permit requirements.

8.7.4 The following assumptions have been made in the preparation of the assessment:

- 70% NO_x to NO_2 conversion rate has been assumed in predicting the long-term process contribution, and 35% for the short-term process contribution respectively;
- Emissions of ammonia may need to be controlled through the use of an acid wash stage after the water wash. This process uses sulphuric acid to remove the ammonia from the flue gas~~; this may be required~~ and is being considered as a mitigation method to meet the proposed ELVs so as to not give rise to unacceptable nitrogen deposition effects. It may also further reduce the release of amine from the stack, thereby reducing the formation of amine degradation products.

- Another measure that helps improve dispersion from the stack is the use of reheat to raise the stack gas temperature from around 35°C to around 60°C.
- The air assessment has assessed both the use of acid wash and the use of reheat to gain an understanding of the benefits from the use of either mitigation approach The assessment presents the worst case results for either option, which is dependent on the individual receptor locations; the decision as to which control technique is used will be made later in the design stage and will be subject to licensor design and guarantees.

8.8 Conclusions

8.8.1 This report has assessed the impact on local air quality of the operation of the Proposed Development. The assessment has used the dispersion model ADMS to predict the increases in pollutant species released from the operational Development to the local Study Area.

8.8.2 Emissions from the main stack would result in small increases in ground-level concentrations of the modelled pollutants. Taking into account available information on background concentrations within the modelled domain, predicted operational concentrations of the modelled pollutants would be within current environmental standards for the protection of human health.

8.8.3 The modelling of impacts at designated ecological sites (SACs / Ramsar / SPAs and SSSIs) has predicted that emissions would give rise to no significant impacts with regard to increases in atmospheric concentrations of NO_x and NH_3, however depositional impacts of nutrient nitrogen are above the insignificance threshold at the Teesmouth and Cleveland Coast SPA. Further interpretation and discussion of these impacts is provided in the Habitats Regulations Assessment Report (Document Ref. 5.13).

8.8.4 Modelling of the combined impacts of emissions from the Proposed Development and other cumulative developments (Annex B), has shown that the combined impacts on local pollutant concentrations would result in no significant effects.

Annex A: Sensitivity Testing Of Model Inputs

The maximum predicted concentrations of NO_2 at the worst-affected human health receptors and NO_x at the worst-affected statutory designated ecological receptor associated with the variable input parameters, are presented in Table A1 as the percentage of maximum reported values in Tables 8B-14, 8B-15 and 8B-17 above.

Table A1: Point Source Dispersion Model Sensitivity Analysis

Model Input Variable	Human Health Receptors		Ecological Receptors	
	Short-term	Long-term	Short-term	Long-term
Meteorological data (5-year min-max)	95%	59%	31%	61%
Stack and absorber position	91%	85%	85%	75%
Surface roughness representation (0.5m)	100%	108%	106%	115%
Surface roughness representation (0.2m)	98%	94	97%	90%

The main uncertainty associated with the model is considered to be the meteorological data, with a NO_2 process contribution variation of 95% in the hourly mean NO_2 results; this is equivalent to an overall uncertainty at the worst-affected receptor of -0.3 µg/m^3 (or -20.1% of the relevant AQAL).

The annual average NO_2 process contribution varies by 59%, equivalent to an overall uncertainty at the worst-affected receptor of -0.25 µg/m^3 (or -0.6% of the relevant AQAL).

The position of the absorber and stack as a less marked effect on the predicted process contributions than the meteorological data.

The surface roughness representation in the main model has been assessed at 0.3m, representative of the maximum surface roughness associated with agricultural land. The surface roughness has been varied and it was found that a higher surface roughness (0.5m), on the whole resulted in higher impacts at the worst case receptor, however for receptors further away from the source, the impacts would be reduced over those reported in the main assessment.

The lower surface roughness of 0.2 m resulted in lower impacts.

Annex B: Assessment of Visible Plumes from absorber stack and cooling towers

Absorber Emission

Due to the initial water content of the emission from the absorber stack, and the relatively low temperature of the release, there is potential for the plume released from the stack to be visible. The ADMS module can assess the potential for visible plumes to form, based on the initial water content of the release, and the humidity of the ambient air.

The plume from the stack is described as being “visible” when liquid water is present in the plume above a critical threshold of 0.002kg/kg.

The original version of the Environment Agency H1 Risk Assessment Guidance published in 2003 included a methodology for the assessment of the impacts of visible plumes, however this guidance is now outdated. An assessment has therefore been carried out so that the outputs can be reported and discussed in the Chapter 17: Landscape and Visual Chapter (ES Volume I, Document Ref. 6.2).

The ADMS model set up is identical to that used for the main assessment of pollutant emission, except for the selection of plume visibility in the model set-up and the input of initial water content in the plume. The initial water vapour mixing ratio of the plume is 0.030 kg/kg (mass of water vapour per unit mass of dry release at the stack). ADMS 5 defines the plume to be ‘visible’ at a particular downwind distance if the ambient humidity at the plume centreline is below 98%, above which it is considered the plume would be indistinguishable from clouds. All other model inputs are identical to those detailed for the main assessment.

The results from the model are shown in Table B1 assuming an emission at 35°C, and in Table B2 assuming an emission at 60°C. The results show that the 35°C emission would lead to the worst-case visible plumes, with plumes being visible for up to 40% of the time. The plume would only be longer than 115 metres (i.e. the height of the stack) for approximately 4% of the time.

Table B1: Summary of Visible Plumes for a 35°C Release

Met Year	Percentage of Time Plume is Visible	Longest Visible Plume Length	Average Visible Plume Length (m)	Percentage of Time There is a Visible Plume Over 115m
2015	31%	781m	21m	2%
2016	38%	716m	16m	3%
2017	33%	675m	15m	3%
2018	40%	713m	20m	4%
2019	39%	629m	17m	3%

Table B2: Summary of Visible Plumes for a 60°C Release

Met Year	Percentage of Time Plume is Visible	Longest Visible Plume Length (m)	Average Visible Plume Length (m)	Percentage of Time There is a Visible Plume Over 115m
2015	<1%	232m	<1m	0.1%
2016	<1%	229m	<1m	0.1%
2017	<1%	217m	<1m	0.1%
2018	1%	406m	<1m	0.2%
2019	<1%	172m	<1m	0.1%

Cooling Towers

In addition to the potential for visible plumes to occur from the absorber stack, there is also potential for visible plumes to occur from the mechanical draft cooling towers. The current plant design shows 22 cooling cells positioned in 2 banks of 11 cells. The potential for visible plumes to occur from the cooling cells has therefore been modelled as per the information shown in Table B3.

Table B3: Cooling Cell Visible Plume Model Inputs

Parameter	Wet Cooling System
Number of vents	22
Release height (m)	25
Vent diameter (m)	12
Flow rate per vent	700 kg/s
Water ratio (kg/kg, dry)	0.0112
Temperature (°C)	Ambient

The results for the cooling tower modelling are shown in Table B4. Although the results indicate that a short visible plume may be present for the majority of the time once the Proposed Development becomes operational, the amount of time that the visible plume is predicted to exceed the boundary of the Low Carbon Electricity Generating Station site (taken as being an arbitrary 100m for the assessment) is less than 1%.

Table B4: Cooling Cell Visible Plumes

Met Year	Percentage of Time Plume is Visible	Longest Visible Plume Length (m)	Average Visible Plume Length (m)	Percentage of Time There is a Visible Plume Over 100m
2015	85%	205	10	0.5%
2016	82%	255	12	0.4%
2017	84%	353	11	0.8%
2018	81%	515	15	1.1%
2019	82%	255	13	0.8%

Annex C: Assessment of Cumulative Impacts

Introduction

This Annex provides an assessment of the operational cumulative impacts from the Proposed Development and other industrial emission sources in the vicinity of the Site.

Cumulative impacts from existing sources of pollution in the area are accounted for in the adoption of site-specific background pollutant concentrations from archive sources and a programme of project-specific baseline air quality monitoring in close proximity to the Proposed Development site.

It is recognised, however, that there is a potential impact on local air quality from emission sources which have either received or are about to receive planning permission but have yet to come into operation. Those that are relevant for consideration due to their potential operational air quality impacts are:

- Redcar Energy Centre, Energy Recovery Facility (R/2020/0411/FFM) (adjacent to the west);
- Grangetown Prairie, Energy Recovery Centre (R/2019/0767/OOM) (approximately 4km Southwest);
- Land at Teesport, Tees Dock Road, Grangetown, Biomass Power Station (R/2008/0671/EA) (approximately 3km Southwest);
- Teesside Combined Cycle Power Plant (CCPP) (DCO Reference 2019) (approximately 5km South);
- Land to the South of Tofts Road West, Graythorp, Hartlepool, Energy Recovery Centre (H/2019/0275) (approximately 5km Northwest)
- Land at Grid Reference 450674, 521428 Port Clarence Road Port Clarence, Renewable Energy Plant (14/1106/EIS) (approximately 7km Southwest).

It is recognised that there are a number of developments planned for the adjacent STDC site, however it is not considered that any of these developments will have cumulative point source emissions, and therefore have not been included in this assessment.

Given the distance of a number of these developments from the Proposed Development, it is considered that the cumulative impacts will not be significant, such as the Port Clarence development. In addition, the prevailing wind direction for the area would mean that significant cumulative impacts with the Land to the South of Tofts Road West would be unlikely.

Therefore, the cumulative assessment carried has utilised the same ADMS model as the main assessment for the Proposed Development presented above, and has included emission sources for:

- Redcar Energy Centre;
- Grangetown Prairie;
- Land at Teesport; and
- Teesside CCPP.

Information on the emissions from these sources has been derived from the available Planning Applications, and has been included in the ADMS model. Due to the nature of these emissions, the cumulative assessment has only included emissions of NO_x, CO and NH_3, as these are the only pollutant species common to all the cumulative schemes.

Model Inputs

All cumulative model schemes have been assumed to run continuously at full output, therefore providing a worst-case assessment of the potential cumulative impact. The model inputs for the Proposed Development are as described in Tables 8B-2 and 8B-3, and those for the cumulative schemes are shown in Table C1.

Table C1: Emission Inventory for the Cumulative Schemes

Parameter	Redcar Energy Centre	Grangetown Prairie	Land at Teesport	Teesside CCPP
No. Stacks	2	1	1	2
Stack Location NGR x, y	455890, 526032, 455895, 526030	454592, 521251	454124,523184	Not stated (estimated at: 456454,520437 456513, 520466)
Stack Height (m)	80	70	95	75
Stack diameter (m)	2.3	3.48	5.2	8
Stack Temperature (°C)	140	140	95	72.4
Actual Flow Rate (Am^3/s)	79.1	142.5	541.5	928
Stack Velocity (m/s)	19.1	15	25.5	18.5
Normalised Flow Rate (Nm^3/s)[1]	55.4	80.7	323	744
NO_x Emission Concentration (mg/Nm^3)	120[2]	120[2]	150	30[3]
NO_x Release Rate (g/s)	6.7	9.7	48.5	22.3
CO Emission Concentration (mg/Nm^3)	50	50	100	30
CO Release Rate (g/s)	2.8	4.0	32.3	22.3
NH_3 Emission Concentration (mg/Nm^3)	10[2]	10[2]	10	Not released
NH_3 Release Rate (g/s)	0.55	0.81	3.2	Not released

[1] STP, dry gas and the relevant O_2 correction factor applied for the process.

[2] Modelled at the BAT-AEL for Waste Incineration Plant

[3] Not assessed in the CCPP DCO, but assumed to be indicative BAT as in LCP BATc

The buildings for each of the cumulative schemes, that may affect the dispersion of the emissions from the stacks have been included in the model run for the assessment of cumulative impacts. The buildings included in the model are shown in Table C2.

Table C2: Buildings for Inclusion in the Cumulative Scheme Model

Cumulative Scheme	Building	Grid Reference	Height (m)	Length (m)	Width (m)	Angle (°)
Redcar Energy Centre	Boiler Hall	455863, 525961	49	25	63	112
Grangetown Prairie	Main Building	454568, 521275	45	25	63	75
Land at Teesport	Main Boiler	454125, 523104	55	45	45	90
Teesport CCPP	HRSG 1	456467, 520407	45	30	26	65
	HRSG 2	456528, 520434	45	30	26	65

Cumulative Assessment Results – Human Health Receptors

Nitrogen dioxide emissions

The results of cumulative assessment for NO_2 at human health receptors are shown in Tables C3 and C4 for annual average and hourly average impacts respectively.

Table C3: Predicted Change in Annual Mean NO_2 Concentrations

Receptor	AQAL (µg/m^3)	Predicted Concentration (PC) (µg/m^3)	PC/AQAL %	Background Concentration (BC) (µg/m3)	Predicted Environmental Concentration (PEC) (µg/m^3)	PEC/ AQAL %
Max anywhere	40	1.56	3.9%	14.7	16.3	41%
OR1		0.93	2.3%		15.7	39%
OR2		1.33	3.3%		16.1	40%
OR3		1.18	2.9%		15.9	40%
OR4		1.10	2.7%		15.8	39%
OR5		1.13	2.8%		15.9	40%
OR6		0.94	2.3%		15.7	39%
OR7		0.94	2.4%		15.7	39%
OR8		0.89	2.2%		15.6	39%
OR9		0.87	2.2%		15.6	39%
OR10		1.05	2.6%		15.8	39%

PC = Process Contribution, AQAL = Air Quality Assessment Level, BC = Background Concentration, PEC = Predicted Environmental Concentration

The maximum predicted annual mean NO_2 concentration that occurs anywhere as a result of the cumulative impacts is 1.6 µg/m^3, which represents 3.9% of the AQAL. In combination with the background concentration of NO_2, the impact represents 40.8% of the AQAL, and therefore is well below the annual AQAL. It is therefore considered that the cumulative impact of NO_2 emissions from the developments assessed is negligible adverse.

The maximum predicted hourly mean NO_2 concentration (as the 99.79th percentile of hourly averages) that occurs anywhere as a result of the cumulative impacts is 15.7 μg/m^3, which represents 7.9% of the AQAL, and therefore can be considered insignificant in accordance with the significance criteria.

Table C4: Predicted Change in Hourly Mean NO_2 Concentrations (as the 99.79th Percentile of Hourly Averages

Receptor	AQAL (μg/m^3)	PC (μg/m^3)	PC/AQAL %	BC (μg/m^3)	PEC (μg/m^3)	PEC/ AQAL %
Max anywhere	200	15.7	8%	29.5	45.2	23%
OR1		6.2	3%		35.7	18%
OR2		6.7	3%		36.1	18%
OR3		6.1	3%		35.6	18%
OR4		5.9	3%		35.4	18%
OR5		5.5	3%		35.0	17%
OR6		4.7	2%		34.2	17%
OR7		5.4	3%		34.8	17%
OR8		4.6	2%		34.1	17%
OR9		4.7	2%		34.2	17%
OR10		5.7	3%		35.1	18%

PC = Process Contribution, AQAL = Air Quality Assessment Level, BC = Background Concentration, PEC = Predicted Environmental Concentration

Carbon monoxide emissions

The maximum hourly and 8 hour running mean predicted concentrations that occur anywhere as a result of the Cumulative impacts represent less than 1% of the hourly AQAL and 3% of the 8-hour AQAL. This is below the 10% threshold for short term impacts and therefore can be considered insignificant. It is therefore considered that the cumulative impact of CO emissions from the developments assessed is negligible adverse.

Ammonia emissions

The annual and hourly average predicted concentrations of ammonia that occur anywhere as a result of the cumulative schemes still represent less than 1% of the relevant AQALs and therefore can be considered to be insignificant/ negligible at all receptor locations. It is therefore considered that the cumulative impact of NH_3 emissions on human health receptors from the developments assessed is negligible adverse.

Cumulative Assessment Results – Ecological Receptors

Oxides of nitrogen emissions – Critical Levels

The cumulative assessment results show that the predicted annual average NO_x impacts are below the criteria for insignificance at three sites, and a further two sites are only just over the threshold for insignificance. The remaining three sites are the Teesmouth and Cleveland Coast SPA, Coatham Marsh LWS and also the Eston

Pumping Station LWS. Both the LWS sites have impacts that remain <100% of the critical level when the background concentrations are taken into consideration. The cumulative impacts at the Teesmouth SPA are 72% of the critical level when the background concentration is also taken into consideration, and therefore remains well below the critical level.

The daily average NO_x impacts are below the criteria for insignificance at seven of the eight receptors. The remaining site is again the Teesmouth and Cleveland Coast SPA which has cumulative impacts that represent 21% of the critical level, however when the background concentration is taken into consideration, the impacts represent 60% of the critical level, and therefore remains well below the critical level.

Ammonia – Critical Levels

The assessment results show that the predicted cumulative annual average NH_3 impacts over the criteria for insignificance (<1% of the critical level) at only three of the eight receptors. The predicted annual average NH_3 impacts at the Teesmouth and Cleveland are 4.1% of the critical level, however in combination with the background concentration it represents only 34% of the critical level and therefore can be considered to be not significant.

Nitrogen deposition – Critical Loads

The Environment Agency and Natural England have agreed that depositional impacts that are below 1% of the relevant critical load for a site can be regarded as insignificant. Further interpretation of the significance of the depositional results is provided in Chapter 12: Terrestrial Ecology and Nature Conservation (ES Volume I, Document Ref. 6.2).

Table C5: NO_x Dispersion Modelling Results for Ecological Receptors

Receptor ID	Site Name	Annual average (µg/m³)						24 hour average (µg/m³)					
		CL	PC (µg/m³)	PC % of CL	BC (µg/m³)	PEC (µg/m³)	PEC % of CL	Critical level (CL)	PC (µg/m3)	PC % of CL	BC (µg/m³)	PEC (µg/m³)	PEC % of CL
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	30	2.3	7.6%	19.43	21.7	72%	75	15.6	20.8%	29.15	44.7	60%
E2	North York Moors SPA, SAC and SSSI		0.23	0.8%	8.32	8.6	29%		3.2	4.3%	12.48	15.7	21%
E3	Northumbria Coast SPA and Ramsar		0.23	0.8%	9.46	9.7	32%		2.5	3.4%	14.19	16.7	22%
E4	Durham Coast SAC and SSSI		0.29	1.0%	10.57	10.9	36%		2.6	3.5%	15.86	18.5	25%
E5	Lovell Hill Pools SSSI		0.47	1.6%	13.22	13.7	46%		4.9	6.6%	19.83	24.8	33%
E6	Saltburn Gill SSSI		0.39	1.3%	9.45	9.8	33%		3.0	4.0%	14.18	17.2	23%
E7	Coatham Marsh LWS		1.31	4.4%	26.89	28.2	94%		7.7	10.3%	40.3	48.1	64%
E9	Eston Pumping Station LWS		1.77	5.9%	22.40	24.2	81%		6.8	9.1%	33.60	40.4	54%

CL = Critical Level, PC = Process Contribution, BC = Background Concentration (assumed to be 1.5 times the annual average for daily concentrations), PEC = Predicted Environmental Concentration

Table C6: Dispersion Modelling Results for Ecological Receptors – NH_3

Receptor ID	Site Name	Annual Average (µg/m³)					
		CL (µg/m³)	PC	PC % of CL	BC (µg/m³)	PEC (µg/m³)	PEC % of CL
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	3	0.12	4.1%	0.89	1.0	34%
E2	North York Moors SPA, SAC and SSSI		0.01	0.3%	1.24	1.2	42%
E3	Northumbria Coast SPA and Ramsar		0.01	0.4%	1.56	1.6	52%
E4	Durham Coast SAC		0.01	0.4%	1.56	1.6	52%
E5	Lovell Hill Pools SSSI		0.02	0.6%	2.04	2.1	69%
E6	Saltburn Gill SSSI		0.01	0.5%	1.15	1.2	39%
E7	Coatham Marsh LWS		0.05	1.7%	1.42	1.5	49%
E8	Eston Pumping Station LWS		0.07	2.4%	1.42	1.5	50%

CL = Critical Level, PC = Process Contribution, BC = Background Concentration, PEC = Predicted Environmental Concentration

Table C7: Dispersion Modelling Results for Ecological Receptors – Nutrient Nitrogen Deposition (Kg/Ha/Yr)

Receptor ID	Site name	Background nitrogen deposition (kg N/ha/yr)	Most stringent Critical Load class applicable for the site	Lower value of applicable Critical Load range	PC (kg N/ha/yr)	PC % Critical Load	PEC (µg/m^3)	PEC % Critical Load
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	10.5	Coastal stable dune grassland (calcareous type)	10	0.86	8.6%	11.4	114%
E2	North York Moors SPA, SAC and SSSI	18.1	Dry Heath	10	0.07	0.7%	18.1	181%
E3	Northumbria Coast SPA and Ramsar	14.7	Coastal stable dune grassland (acid type)	8	0.08	1.0%	14.8	185%
E4	Durham Coast SAC and SSSI	14.7	Sub-atlantic semi-dry calcareous grassland	15	0.10	0.6%	14.8	99%
E5	Lovell Hill Pools SSSI	No comparable habitat with established critical load for estimate available.						
E6	Saltburn Gill SSSI	19.7	Broad-leaved, mixed and yew woodland	15	0.19	1.3%	19.9	133%
E7	Coatham Marsh LWS	14.1	Sub-atlantic semi-dry calcareous grassland	15	0.39	2.6%	14.5	97%
E9	Eston Pumping Station LWS	14.1	Sub-atlantic semi-dry calcareous grassland	15	0.55	2.7%	14.7	73%

Table C8: Dispersion Modelling Results for Ecological Receptors – Acid Deposition N (Keq/Ha/Yr)

Receptor ID	Site name	Acid deposition (keq/ha/yr)5				PC acid deposition (keq/ha/yr)6		
		Critical Load7	Baseline	Lowest Critical Load class applicable	Baseline % of Critical Load	PC	PC % of Critical Load	PEC% of Critical Load
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	Min CL Min N 0.856 Min CL Max N 4.86 Min CL Max S 4.00	N: 0.75 S: 0.25	Calcareous grassland	6.3%	0.061	1.2%	6.3%
E2	North York Moors SPA, SAC and SSSI	Min CL Min N 0.499 Min CL Max N 0.792 Min CL Max S 0.150	N: 1.29 S: 0.21	Dwarf shrub heath	189.4%	0.005	1.3%	190.7%
E3	Northumbria Coast SPA and Ramsar	Min CL Min N 0.223 Min CL Max N 0.786 Min CL Max S 0.420	N: 1.05 S: 0.15	Acid grassland	152.7%	0.006	1.3%	153.9%
E4	Durham Coast SAC and SSSI	Min CL Min N 0.223 Min CL Max N 1.03 Min CL Max S 0.81	N: 1.05 S: 0.15	Acid grassland	116.5%	0.007	1.0%	117.5%

[5] Acid Deposition Critical Loads
[6] Process Contribution and Process Environmental Contribution as percentages of the relevant Critical Load have been calculated using the Min CL Max N
[7] Critical Load (as obtained from APIS, April 2021)

Receptor ID	Site name	Acid deposition (keq/ha/yr)5				PC acid deposition (keq/ha/yr)6		
		Critical Load7	Baseline	Lowest Critical Load class applicable	Baseline % of Critical Load	PC	PC % of Critical Load	PEC% of Critical Load
E5	Lovell Hill Pools SSSI	No critical loads assigned for the features present.						
E6	Saltburn Gill SSSI	Min CL Min N 0.142 Min CL Max N 2.639 Min CL Max S 2.448	N: 0.89 S: 0.15	Unmanaged Broadleafed/Coniferous Woodland	39.4%	0.014	0.4%	39.8%
E7	Coatham Marsh LWS	Min CL Min N 1.07 Min CL Max N 5.071 Min CL Max S 4.00	N: 1.01 S: 0.23	Calcareous grassland	5.8%	0.047	0%	5.8%
E9	Eston Pumping Station	Min CL Min N 1.07 Min CL Max N 5.071 Min CL Max S 4.00	N: 1.01 S: 0.23	Calcareous grassland	5.8%	0.065	1.4%	7.2%