MAKING COMPLEX EASY

Air Quality Assessment

Project Peaking Plant

Saltholme North, Stockton-on-Tees

For Statera Energy Limited

www.rpsgroup.com

Quality Management

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Executive Summary

This Air Quality Assessment has been undertaken to accompany the environmental permit application for the proposed Saltholme North gas-fired electricity generating facility in Stockton-on-Tees. The facility would generate 49.99 MW of electricity during peak periods of demand thereby reducing grid instability. All electricity will be fed directly into the local Distributed Network Operator network.

The Application Site is located within the administrative area of Stockton-on-Tees Borough Council (SoTBC). SoTBC has not currently designated any Air Quality Management Areas (AQMAs) and local air quality is generally good.

This assessment predicts that ground-level pollutant concentrations will be within acceptable levels at sensitive human health receptors and will not give rise to any significant adverse effects. Cumulative effects with the Salthome South facility at sensitive human health receptors are also considered to be not significant.

The cumulative impacts at nature conservation sites have been considered and any potentially significant impacts have been passed to the project's ecologist to allow the significance of the likely effect to be determined within the Habitats Regulations Assessment.

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1 Introduction

1.1 This report details the air quality assessment undertaken to accompany the environmental permit application for the proposed installation of the Saltholme North gas-fired electricity generating facility in Stockton-on-Tees. The facility would generate 49.99 MW of electrical output during peak periods of demand, thereby reducing grid instability. All electricity will be fed directly into the local Distributed Network Operator network.

1.2 The Application Site is located within the administrative area of Stockton-on-Tees Borough Council (SoTBC). SoTBC has not currently designated any Air Quality Management Areas (AQMAs) and local air quality is generally good.

1.3 This air quality assessment covers an evaluation of the impacts of the stack emissions on the local area.

1.4 This report begins by setting out the policy and legislative context for the assessment. The methods and criteria used to assess potential air quality effects have then been described. The baseline air quality conditions have been established taking into account Defra estimates and local authority documents. The results of the assessment of air quality impacts have been presented. A conclusion has been drawn on the significance of the residual operational-phase effects.

2 Policy and Legislative Context

Ambient Air Quality Legislation and National Policy

The Ambient Air Quality Directive and Air Quality Standards Regulations

2.1 The 2008 Ambient Air Quality Directive (2008/50/EC) [1] aims to protect human health and the environment by avoiding, reducing or preventing harmful concentrations of air pollutants; it sets legally binding concentration-based limit values, as well as target values. There are also information and alert thresholds for reporting purposes. These are to be achieved for the main air pollutants: particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO), lead (Pb) and benzene. This Directive replaced most of the previous EU air quality legislation and in England was transposed into domestic law by the Air Quality Standards Regulations 2010 [2], which in addition incorporates the 4th Air Quality Daughter Directive (2004/107/EC) that sets targets for ambient air concentrations of certain toxic heavy metals (arsenic, cadmium and nickel) and polycyclic aromatic hydrocarbons (PAHs). Member states must comply with the limit values (which are legally binding on the Secretary of State) and the Government and devolved administrations operate various national ambient air quality monitoring networks to measure compliance and develop plans to meet the limit values.

UK Air Quality Strategy

2.2 The Environment Act 1995 established the requirement for the Government and the devolved administrations to produce a National Air Quality Strategy (AQS) for improving ambient air quality, the first being published in 1997 and having been revised several times since, with the latest published in 2007 [3]. The Strategy sets UK air quality standards♦ and objectives# for the pollutants in the Air Quality Standards Regulations plus 1,3-butadiene and recognises that action at national, regional and local level may be needed, depending on the scale and nature of the air quality problem. There is no legal requirement to meet objectives set within the UK AQS except where equivalent limit values are set within the EU Directives.

2.3 The 1995 Environment Act also established the UK system of Local Air Quality Management (LAQM), that requires local authorities to go through a process of review and assessment of air

♦ Standards are concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. Standards, as the benchmarks for setting objectives, are set purely with regard to scientific evidence and medical evidence on the effects of the particular pollutant on health, or on the wider environment, as minimum or zero risk levels.

Objectives are policy targets expressed as a concentration that should be achieved, all the time or for a percentage of time, by a certain date.

quality in their areas, identifying places where objectives are not likely to be met, then declaring Air Quality Management Areas (AQMAs) and putting in place Air Quality Action Plans to improve air quality. These plans also contribute, at local level, to the achievement of EU limit values.

2.4 For the purposes of this assessment, the limit values set out in the Air Quality Standards Regulations 2010 and the objective levels specified under the current UK AQS have been used.

2.5 In addition, the assessment has considered the ammonia (NH_3) impacts from the Selective Catalytic Reduction (SCR) technology used to abate emissions. As there are no limit values or objectives in the Air Quality Standards (England) Regulations 2010 or the current UK AQS, impacts have been compared with the Environment Agency' Air Quality Assessment Level (AQAL).

2.6 The limit values and objectives relevant to this assessment are summarised in Table 2.1.

Table 2.1 Summary of Relevant Air Quality Limit Values and Objectives

Pollutant	Averaging Period	Objectives/ Limit Values	Not to be Exceeded More Than
Nitrogen Dioxide (NO_2)	1 hour	200 $\mu g.m^{-3}$	18 times per calendar year
	Annual	40 $\mu g.m^{-3}$	-
Ammonia (NH_3)	1 hour	2,500 $\mu g.m^{-3}$	0 times per calendar year
	Annual	180 $\mu g.m^{-3}$	-

2.7 In July 2017, Defra published the *'UK plan for tackling roadside nitrogen dioxide concentrations'.* This describes the Government's plan for bringing roads with NO_2 concentrations above the EU Limit Value back into compliance within the shortest possible time. In January 2018, the High Court found the plan to be unlawful in certain respects and the UK Government was directed to urgently prepare a Supplement to the 2017 plan. In the interim, the High Court directed that the 2017 plan should remain in force whilst the Supplement is produced, in order to avoid any delay in its implementation.

Environmental Permitting Regulations

2.8 Directive 2010/75/EU concerning Industrial Emissions ("the IED") [4] applies an integrated environmental approach to the regulation of certain industrial activities. The Environmental Permitting Regulations (EPR) 2010 as amended in 2013 [5] implement the IED relating to installations in England and Wales. The EPR define activities that require the operator to obtain an Environmental Permit from the Environment Agency (EA). The Proposed Development will be regulated by the Environment Agency through a substantial variation to the existing Environmental Permit.

2.9 The intention of the regulatory system is to ensure that Best Available Techniques (BAT), required by the IED, are used to prevent or minimise the effects of an activity on the environment, having regard to the effects of emissions to air, land and water via a single permitting process.

2.10 To gain a permit, operators have to demonstrate in their applications, in a systematic way, that the techniques they are using or are proposing to use are the BAT for their installation and meet certain other requirements taking account of relevant local factors.

2.11 The essence of BAT is that the techniques selected to protect the environment should achieve a high degree of protection of people and the environment taken as a whole. Indicative BAT standards are laid out in national guidance and where relevant, should be applied unless a different standard can be justified for a particular installation. The EA is legally obliged to go beyond BAT requirements where EU Air Quality Limit Values may be exceeded by an existing operator.

2.12 The EA removed their detailed guidance, Horizontal Guidance Note EPR H1 [6], for undertaking risk assessments on 1 February 2016. This has been replaced with on-line risk assessment guidance [7]. As the guidance is intended for risk assessments, it primarily relates to the process for screening out impacts.

3 Assessment Methodology

Approach

3.1 This air quality assessment covers the key elements listed below:

- Establishing the background Ambient Concentration (AC) from consideration of Air Quality Review & Assessment findings and assessment of existing local air quality through a review of available air quality monitoring and Defra background map data in the vicinity of the proposed site.
- Quantitative assessment of the operational effects on local air quality from stack emissions utilising a "new generation" Gaussian dispersion model, ADMS 5. Assessment of Process Contributions (PC) from the facility in isolation, and assessment of resultant Predicted Environmental Concentrations (PEC), taking into account cumulative impacts through incorporation of the AC.

3.2 Air quality guidance advises that the organisation engaged in assessing the overall risks should hold relevant qualifications and/or extensive experience in undertaking air quality assessments. The RPS air quality team members involved at various stages of this assessment have professional affiliations that include Member of the Institute of Air Quality Management, Chartered Chemist, Chartered Scientist, Chartered Environmentalist and Member of the Royal Society of Chemistry and have the required academic qualifications for these professional bodies. In addition, the Director responsible for authorising this deliverable has over 15 years' experience.

Summary of Key Pollutants Considered

3.3 The key pollutant emissions associated with combustion processes are oxides of nitrogen (NO_x), CO, SO_2, volatile organic compounds (VOCs), water and other pollutants in trace quantities. However for gas-fired spark-ignition engines, the pollutant of local concern is NOx.

3.4 The gas engines will comply with 'Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)' (referred to hereafter as the IED). For gas engines, the IED provides a limit for emissions-at-source of NO_x of 75 $mg.Nm^{-3}$.

3.5 Emissions of total NO_x from combustion sources comprise nitric oxide (NO) and NO_2. The NO oxidises in the atmosphere to form NO_2. The assessment of operational impacts therefore focuses on changes in NO_2 concentrations at ground level receptors.

3.6 SCR will be used to reduce NO_2 emissions. The assessment has also included an assessment of ammonia (NH_3) slip from the SCR.

3.7 The technology suppliers have advised that there are no other significant pollutant emissions.

Pollutant Concentrations

3.8 In urban areas, pollutant concentrations are primarily determined by the balance between pollutant emissions that increase concentrations, and the ability of the atmosphere to reduce and remove pollutants by dispersion, advection, reaction and deposition. An atmospheric dispersion model is used as a practical way to simulate these complex processes; such a model requires a range of input data, which can include emissions rates, meteorological data and local topographical information. The model used and the input data relevant to this assessment are described in the following sub-sections.

3.9 The atmospheric pollutant concentrations in an urban area depend not only on local sources at a street scale, but also on the background pollutant level made up of the local urban-wide background, together with regional pollution and pollution from more remote sources brought in on the incoming air mass. This background contribution needs to be added to the fraction from the modelled sources, and is usually obtained from measurements or estimates of urban background concentrations for the area in locations that are not directly affected by local emissions sources. Background pollution levels are described in detail in Section 4.

Dispersion Model Selection

3.10 A number of commercially available dispersion models are able to predict ground level concentrations arising from emissions to atmosphere from elevated point sources. Modelling for this study has been undertaken using ADMS 5, a version of the ADMS (Atmospheric Dispersion Modelling System) developed by Cambridge Environmental Research Consultants (CERC) that models a wide range of buoyant and passive releases to atmosphere either individually or in combination. The model calculates the mean concentration over flat terrain and also allows for the effect of plume rise, complex terrain, buildings and deposition. Dispersion models predict atmospheric concentrations within a set level of confidence and there can be variations in results between models under certain conditions; the ADMS 5 model has been formally validated and is widely used in the UK and internationally for regulatory purposes.

3.11 ADMS comprises a number of individual modules each representing one of the processes contributing to dispersion or an aspect of data input and output. Amongst the features of ADMS are:

- An up-to-date dispersion model in which the boundary layer structure is characterised by the height of the boundary layer and the Monin-Obukhov length, a length scale dependent on the friction velocity and the heat flux at the surface. This approach allows the vertical structure of the boundary layer, and hence concentrations, to be calculated more accurately than does the use of Pasquill-Gifford stability categories, which were used in many previous models (e.g. ISCST3). The restriction implied by the Pasquill-Gifford approach that the dispersion parameters are independent of height is avoided. In ADMS the concentration distribution is Gaussian in stable and neutral conditions, but the vertical distribution is non-

Gaussian in convective conditions, to take account of the skewed structure of the vertical component of turbulence;

- A number of complex modules including the effects of plume rise, complex terrain, coastlines, concentration fluctuations and buildings; and
- A facility to calculate long-term averages of hourly mean concentration, dry and wet deposition fluxes and radioactivity, and percentiles of hourly mean concentrations, from either statistical meteorological data or hourly average data.

Model Inputs

Meteorological Data

3.12 The most important meteorological parameters governing the atmospheric dispersion of pollutants are wind direction, wind speed and atmospheric stability as described below:

- Wind direction determines the sector of the compass into which the plume is dispersed;
- Wind speed affects the distance that the plume travels over time and can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise; and
- Atmospheric stability is a measure of the turbulence of the air, and particularly of its vertical motion. It therefore affects the spread of the plume as it travels away from the source. New generation dispersion models, including ADMS, use a parameter known as the Monin-Obukhov length that, together with the wind speed, describes the stability of the atmosphere.

3.13 For meteorological data to be suitable for dispersion modelling purposes, a number of meteorological parameters need to be measured on an hourly basis. These parameters include wind speed, wind direction, cloud cover and temperature. There are only a limited number of sites where the required meteorological measurements are made.

3.14 The year of meteorological data that is used for a modelling assessment can have a significant effect on source contribution concentrations. Dispersion model simulations have been performed using three years of data from Durham Tees Valley Airport, between 2013 and 2015.

3.15 Wind roses have been produced for each of the years of meteorological data used in this assessment and are presented in Figure 1.

Stack Parameters and Emissions Rates used in the Model

3.16 The Proposed Development comprises four engines, each with its own flue stack, located as shown in Figure 2. The emissions characteristics for each stack modelled are provided in Table 3.1. The NO_X and NH_3 mass emission rates are summarised in Table 3.2.

Table 3.1: Stack Characteristics (per Stack)

Parameter	Unit	Value
Stack height	m	15
Number of stacks	-	4
Internal diameter	m	1.3
Efflux velocity	$m.s^{-1}$	23.6
Efflux temperature	^{o}C	288
Actual volumetric flow	$Am^3.s^{-1}$	31.3
Oxygen by (dry) volume	%	12.9
Water by volume	%	9.2
Normalised volumetric flow (dry, 0^0C, 15% O_2)	$Nm^3.s^{-1}$	18.71
NO_X Emission Concentration (dry, 0^0C, 15% O_2)*	$mg.Nm^{-3}$	30
NH_3 Emission Concentration (dry, 0^0C, 15% O_2)	$mg.Nm^{-3}$	5

*The emission concentration complies with the IED limit of 75 mg Nm^{-3} (dry, 0^oC, 15% O_2) for natural gas engines.

Table 3.2: Mass Emissions (per Stack) of Released Pollutants

Pollutants	Mass Emission Rate ($g.s^{-1}$)
NO_x	0.561
NH_3	0.09

Time Varying Emissions

3.17 The gas engines will only operate during peak demand. For the purposes of assessing the air quality impacts, modelling has been undertaken for a worst-case scenario assuming that the gas engines operate for 3,500 hours per year which represents the largest total number of operational hours considered as part of this assessment.

Surface Roughness

3.18 The roughness of the terrain over which a plume passes can have a significant effect on dispersion by altering the velocity profile with height, and the degree of atmospheric turbulence. This is accounted for by a parameter called the surface roughness length.

3.19 A surface roughness length of 0.5 m has been used within the model to represent the average surface characteristics across the study area.

Building Wake Effects

3.20 The movement of air over and around buildings generates areas of flow circulation, which can lead to increased ground level concentrations in the building wakes. Where building heights are greater than about 30 - 40% of the stack height, downwash effects can be significant. The dominant structure is the engine hall, within which the engines will be housed (i.e. with the greatest dimensions likely to promote turbulence), and the ventilation outlet structures extending from the roof of the engine hall. The building dimensions are listed in Table 3.3.

Table 3.3: Dimensions of Buildings Included Within the Dispersion Model

Building	National Grid Reference of Building Centre	Height (m)	Length/Width (m)	Angle (º) from North
Engine enclosures	448946, 523890	9.5	26.5, 35	79
Radiators	448972, 523898	6.6	10.5, 29	79

Stack Height Determination

3.21 Gas is a clean-burning fuel; nevertheless, there is a need to discharge the flue gases through an elevated stack to allow dispersion and dilution of the residual combustion emissions. The stack needs to be of sufficient height to ensure that pollutant concentrations are acceptable by the time they reach ground level. The stack also needs to be high enough to ensure that releases are not within the aerodynamic influence of nearby buildings, or else wake effects can quickly bring the undiluted plume down to the ground.

3.22 A stack height determination has been undertaken to establish the height at which there is minimal additional environmental benefit associated with the cost of further increasing the stack. As set out above, the EA removed their detailed guidance, Horizontal Guidance Note EPR H1 [6], for undertaking risk assessments on 1 February 2016; however, the approach used here by RPS is consistent with that EA guidance, which required the identification of "*an option that gives acceptable environmental performance but balances costs and benefits of implementing it*."

3.23 The stack height determination has focused on identifying the stack height required to overcome the wake effects of nearby buildings. This involved running a series of atmospheric dispersion modelling simulations to predict the ground-level concentrations with the stack at different heights: starting at 11 metres and extending up in 1 metre increments, until a height of 20 metres was reached. The results of the stack height determination are provided in Appendix A.

Model Outputs

Receptors

3.24 The air quality assessment predicts the impacts at locations that could be sensitive to any changes. Such sensitive receptors should be selected where the public is regularly present and likely to be exposed over the averaging period of the objective. LAQM.TG16 [8] provides examples of exposure locations and these are summarised in Table 3.4.

Table 3.4: Example of Where Air Quality Objectives Apply

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

3.25 Modelling of point source impacts has been undertaken using a grid of 3 km by 3 km centred on the stacks, with a grid spacing of 30 m.

3.26 In addition, the effects of the proposed development have been assessed at the façades of local existing receptors. All human receptors have been modelled at a height of 1.5 m, representative of typical head height. The locations of these discrete receptors are listed in Table 3.5 and illustrated in Figure 2.

Table 3.5: Modelled Sensitive Receptors

Description	Receptor Type	National Grid Reference		Approx. distance (km) and bearing from Application Site
		X (m)	Y (m)	
Tuck In Cafe	Business/ Commercial	448151	524339	0.9 NW
Cowpen Ln 1	Residential	448277	524718	1.1 NW
Cowpen Ln 2	Residential	447994	524658	1.2 NW
RSPB	Parkland	450279	523124	1.5 SE
Industrial 1	Light Industrial	448909	522895	1.0 S

Description	Receptor Type	National Grid Reference		Approx. distance (km) and bearing from Application Site
		X (m)	Y (m)	
Lime Tree Cl 1	Residential	449150	522462	1.5 S
Technology Centre	Business/ Commercial	447529	523454	1.5 SW
Industrial 2	Light Industrial	448089	523491	1.0 SW

Note: Receptors have been modelled at 1.5m above ground level, representative of typical head height

3.27 The AQS NO_2 objectives for all the different averaging periods apply at the façades of the modelled sensitive receptors.

3.28 The impacts at nature conservation sites are considered in Appendix C.

NO_x to NO_2 Relationship

3.29 The NO_x emissions will typically comprise approximately 90-95% nitrogen monoxide (NO) and 5-10% nitrogen dioxide (NO_2) at the point of release. The NO oxidises in the atmosphere in the presence of sunlight, ozone and volatile organic compounds to form NO_2, which is the principal concern in terms of environmental health effects.

3.30 There are various techniques available for estimating the proportion of NO_x converted to NO_2 by the time it has reached receptors which depends on the distance and hence travel time between the source and receptor. The methods used in this assessment are discussed below.

NO_x to NO_2 Assumptions for Annual-Mean Calculations

3.31 Total conversion (i.e. 100%) of NO to NO_2 is sometimes used for the estimation of the absolute upper limit of the annual mean NO_2. This technique is based on the assumption that all NO emitted is converted to NO_2 before it reaches ground level. However, in reality the conversion is an equilibrium reaction and even at ambient concentrations a proportion of NO_X remains in the form of NO. Total conversion is, therefore, an unrealistic assumption, particularly in the near field [9]. While this approach is useful for screening assessments, it is not appropriate for detailed assessments.

3.32 Historically, the Environment Agency has recommended that for a ‘worst-case scenario’, a 70% conversion of NO to NO_2 should be considered for calculation of annual average concentrations. If a breach of the annual average NO_2 objective/limit value occurs, the Environment Agency requires a more detailed assessment to be carried out with operators asked to justify the use of percentages lower than 70%.

3.33 Following the withdrawal of the Environment Agency’s H1 guidance document, there is no longer an explicit recommendation; however, for the purposes of this detailed assessment, a 70% conversion of NO to NO_2 has been assumed for annual average NO_2 concentrations in line with the Environment Agency’s historic recommendations.

NOx to NO_2 Assumptions for Hourly-Mean Calculations

3.34 An assumed conversion of 35% follows the Environment Agency's recommendations [10] for the calculation of 'worst-case scenario' short-term NO_2 concentrations.

Modelling of Long-term and Short-term Emissions

3.35 Long-term (annual-mean) NO_2 has been modelled for comparison with the relevant annual mean objectives.

3.36 For short-term NO_2, the objective is for the hourly-mean concentration not to exceed 200 $\mu g.m^{-3}$ more than 18 times per calendar year. As there are 8,760 hours in a non-leap year, the hourly-mean concentration would need to be below 200 $\mu g.m^{-3}$ in 8,742 hours, i.e. 99.79% of the time. Therefore, the 99.79th percentile of hourly NO_2 has been modelled.

Cumulative Impacts

3.37 Cumulative air quality impacts with the Saltholme South gas-fired facility have been considered for human health and ecological receptors within Appendices B and C, respectively.

Significance Criteria

3.38 As discussed in Section 2, the on-line EA guidance is for risk assessments and provides details for screening out substances for detailed assessment. In particular, it states that:

"To screen out a PC for any substance so that you don't need to do any further assessment of it, the PC must meet both of the following criteria:

- *the short-term PC is less than 10% of the short-term environmental standard*
- *the long-term PC is less than 1% of the long-term environmental standard*

If you meet both of these criteria you don't need to do any further assessment of the substance.

If you don't meet them you need to carry out a second stage of screening to determine the impact of the PEC."

3.39 It continues by stating that:

"You must do detailed modelling for any PECs not screened out as insignificant."

3.40 It then states that further action may be required where:

- *"your PCs could cause a PEC to exceed an environmental standard (unless the PC is very small compared to other contributors – if you think this is the case contact the Environment Agency)*
- *the PEC is already exceeding an environmental standard"*

3.41 On that basis, the results of the detailed modelling presented in this report have been used as follows:

- *The impacts are not considered significant if the short-term PC is less than 10 % of the short-term Air Quality Assessment Level (AQAL);*

- *The impacts are not considered significant if the long-term PC is less than 1 % of the long-term AQAL; and*
- *The impacts are not considered significant if the PEC is below the AQAL*.

3.42 The Air Quality Assessment Level refers to the AQS air quality objective and the EU limit value.

Uncertainty

3.43 All air quality assessment tools, whether models or monitoring measurements, have a degree of uncertainty associated with the results. The choices that the practitioner makes in setting-up the model, choosing the input data, and selecting the baseline monitoring data will decide whether the final predicted impact should be considered a central estimate, or an estimate tending towards the upper bounds of the uncertainty range (i.e. tending towards worst-case).

3.44 The atmospheric dispersion model itself contributes some of this uncertainty, due to it being a simplified version of the real situation: it uses a sophisticated set of mathematical equations to approximate the complex physical and chemical atmospheric processes taking place as a pollutant is released and as it travels to a receptor. The predictive ability of even the best model is limited by how well the turbulent nature of the atmosphere can be represented.

3.45 Each of the data inputs for the model, listed earlier, will also have some uncertainty associated with them. Where it has been necessary to make assumptions, these have mainly been made towards the upper end of the range informed by an analysis of relevant, available data to achieve an assessment that has a conservative bias overall. Where no significant effects are predicted, based on conservative assumptions, there is no need to revisit these assumptions, although the opportunity exists to do so.

3.46 The main components of uncertainty in the total predicted concentrations, made up of the background concentration and the modelled fraction, include those summarised in Table 3.6.

Table 3.6: Approaches to Dealing with Uncertainty used Within the Assessment

Concentration	Source of Uncertainty	Approach to Dealing with Uncertainty	Comments
Background Concentration	Characterisation of future baseline air quality (i.e. the air quality conditions in the future assuming that the development does not proceed)	The future background concentration used in the assessment is the same as the current background concentration and no reduction has been assumed. This is a conservative assumption as, in reality, background concentrations are likely to reduce over time as cleaner vehicle technologies form an increasing proportion of the fleet.	The background concentration is the major proportion of the total predicted concentration. The conservative assumptions adopted ensure that the background concentration used within the model contribute to the result being towards the top of the uncertainty range, rather than a central estimate.
Model Input/Output Data	Meteorological Data	Uncertainties arise from any differences between the conditions at the met station and the development site, and between the historical met years and the future years. These have been minimised by using meteorological data collated at a representative measuring site. The model has been run for three full years of meteorological conditions.	The modelled fraction is likely to contribute to the result being between a central estimate and the top of the uncertainty range.
	Receptors	The model has been run for a grid of receptors. In addition, receptor locations have been identified where concentrations are highest or where the greatest changes are expected.	

3.47 The analysis of the component uncertainties indicates that, overall, the predicted total concentration is likely to be towards the top of the uncertainty range (i.e. the worst case) rather than being a central estimate. The actual concentrations that will be found when the development is operational are unlikely to be higher than those presented within this report and are more likely to be lower.

4 Baseline Air Quality Conditions

Overview

4.1 The background concentration often represents a large proportion of the total pollution concentration, so it is important that the background concentration selected for the assessment is realistic. For this assessment, the background air quality has been characterised by drawing on information from the Defra maps [11], which show estimated pollutant concentrations across the UK in 1 km grid squares.

Review and Assessment Process

4.2 SoTBC has not currently designated any Air Quality Management Areas (AQMAs) and local air quality is generally good.

Defra Mapped Concentration Estimates

4.3 Defra's total annual-mean NO_2 concentration estimate has been collected for the 1 km grid square, centred on the study area, and is provided in Table 4.1.

Table 4.1: Defra Mapped Annual-Mean Background NO_2 Concentration Estimate

Pollutant	Data Source	Annual-mean Concentration (µg.m^{-3})
NO_2	Defra (2017)	14

4.4 A short-term NO_2 concentration has been derived as double the long-term concentrations.

4.5 Historically the view has been that traffic-related NO_2 concentrations in the UK would reduce over time, due to the progressive introduction of improved vehicle technologies and increasingly stringent limits on emissions. However, the results of recent monitoring across the UK suggest that background annual-mean NO_2 concentrations have not decreased in line with expectations.

4.6 To ensure that the assessment presents conservative results, no reduction in the background has been applied for future years.

5 Assessment of Operational-Phase Air Quality Impacts

Results of Stack Emissions Modelling

Short-term NO_2 Impacts

5.1 Table 5.1 summarises the highest predicted short-term Process Contribution (PC) for NO_2 anywhere across the modelled grid for the 4 stacks (Note: the PEC is the PC added to the background Ambient Concentration (AC)).

Table 5.1: Highest Predicted Short-term Process Contribution (μg.m^{-3}) for NO_2

Averaging period (Pollutant)	AQAL (μg.m^{-3})	Max PC (μg.m^{-3})	Max PC as % of AQAL	Potentially Significant? Yes/No	AC (μg.m^{-3})	PEC (μg.m^{-3})	Significant? Yes/No
1 hour 99.79th percentile (NO_2)	200	43.2	22	Yes	28	71	No

5.2 The results show that the maximum short-term PC anywhere across the modelling grid is 22% of the relevant Air Quality Assessment Level (AQAL). The maximum short-term PEC is below the AQAL. As such, the short-term NO_2 impacts based on modelling across the grid are not considered to be significant.

5.3 It is useful to see the geographical extent of the short-term impact: Figure 3 shows the contour plot of 99.79th percentile hourly-mean NO_2 PCs for 2013. This illustrates that the highest predicted concentration is not at a location where the public would be exposed.

5.4 Dispersion modelling has also been undertaken to predict the PCs from the proposed facility at discrete receptors around the application site, as shown in Figure 2. Table 5.2 summarises the short-term, predicted PCs at the discrete sensitive receptors.

Table 5.2: Short-term Predicted NO_2 Concentrations ($\mu g.m^{-3}$) at Sensitive Receptors

Receptors	Receptor Type	Process Contribution (1 hour 99.79th percentile $\mu g.m^{-3}$)	Process Contribution as % of AQAL	PEC ($\mu g.m^{-3}$)
Tuck In Cafe	Business/ Commercial	1.9	1	29.9
Cowpen Ln 1	Residential	1.7	1	29.7
Cowpen Ln 2	Residential	1.5	1	29.5
RSPB	Parkland	1.4	1	29.4
Industrial 1	Light Industrial	1.8	1	29.8
Lime Tree Cl 1	Residential	1.2	1	29.2
Technology Centre	Business/ Commercial	1.3	1	29.3
Industrial 2	Light Industrial	2.0	1	30.0

AQAL for 1 hour 99.79th percentile (NO_2) is 200 $\mu g.m^{-3}$

5.5 The results show that the highest PC as a percentage of the AQAL at any discrete receptors is 1%. As the PC is less than 10% of the AQAL, the impacts are considered not significant. Furthermore, when the PC is added to the AC, the maximum PEC is 30.0 $\mu g.m^{-3}$, approximately 15% of the AQAL. This indicates that there is considerable head-room between the PEC and the AQAL.

Short-term NH_3 Impacts

5.6 The 100th percentile hourly-mean process contribution for NH_3 is 1.1 $\mu g.m^{-3}$ at Industrial 2. This is less than 1% of the AQAL of 2,500 $\mu g.m^{-3}$. On this basis, the short-term impacts at all receptors are not considered to be significant, regardless of the background concentration.

Long-term NO_2 Impacts

5.7 Table 5.3 summarises the highest long-term Predicted Environmental Concentration (PEC) anywhere across the modelled grid.

Table 5.3: Highest Long-term Predicted Environmental Concentrations

Averaging period (Pollutant)	AQAL ($\mu g.m^{-3}$)	AC ($\mu g.m^{-3}$)	Max PC ($\mu g.m^{-3}$)	Change as % of AQAL	Potentially Significant? Yes/No	Max PEC ($\mu g.m^{-3}$)	Max PEC as % of AQAL	Significant? Yes/No
Annual mean (NO_2)	40	14	2.2	6	Yes	16.2	41	No

5.8 The maximum long-term PC is more than 1% of the AQAL and the impacts are considered to be potentially significant. The maximum long-term PEC is well below the AQAL. As such, the long-term NO_2 impacts based on modelling across the grid are not considered to be significant. Figure 4 shows the contour plot of annual-mean NO_2 PECs for 2013. This illustrates that the highest predicted concentration is not at a location where the public would be exposed.

5.9 Table 5.4 summarises the long-term maximum PC and PEC values at the selected discrete sensitive receptors, noting that the annual-mean objective applies only at the residential receptors listed below.

Table 5.4: Long-term Predicted NO_2 Concentrations ($\mu g.m^{-3}$) at Sensitive Receptors

Receptors	Receptor Type	Process Contribution (Annual mean)	Process Contribution as % of AQAL	Predicted Environmental Concentration ($\mu g.m^{-3}$)
Tuck In Cafe	Business/ Commercial	0.03	0	14.0
Cowpen Ln 1	Residential	0.04	0	14.0
Cowpen Ln 2	Residential	0.03	0	14.0
RSPB	Parkland	0.03	0	14.0
Industrial 1	Light Industrial	0.05	0	14.0
Lime Tree Cl 1	Residential	0.02	0	14.0
Technology Centre	Business/ Commercial	0.04	0	14.0
Industrial 2	Light Industrial	0.07	0	14.1

AQAL for annual-mean NO_2 is 40 $\mu g.m^{-3}$

5.10 The predicted process contributions is less than 1 % of the annual-mean limit value of 40 $\mu g.m^{-3}$ at all of the discrete receptors. On this basis, the long-term impacts are not considered to be significant.

Long-term NH_3 Impacts

5.11 The highest predicted annual-mean process contribution for NH_3 is 0.02 $\mu g.m^{-3}$ at Industrial 2. This is less than 1% of the AQAL of 180 $\mu g.m^{-3}$. On this basis, the long-term impacts at all receptors are not considered to be significant, regardless of the background concentration.

Significance of Effects

5.12 As set out in Section 3, it is generally considered good practice that, where possible, an assessment should communicate effects both numerically and descriptively. Professional judgement by a competent, suitably qualified professional is required to establish the significance associated with the consequence of the impacts.

5.13 Based on the predicted concentrations, the effects are deemed to be not significant, with no predicted exceedences of any objectives or standards at the point of maximum impact or at modelled discrete receptors.

Sensitivity and Uncertainty

5.14 Section 3 provided an analysis of the sources of uncertainty in the results of the assessment. The conclusion of that analysis was that, overall, the predicted total concentration is likely to be towards the top of the uncertainty range rather than being a central estimate. The actual concentrations that will be found when the development is operational are unlikely to be higher than those presented within this report and are more likely to be lower.

5.15 The impacts at existing receptors are shown to be not significant even for this conservative scenario. Consequently, further sensitivity analysis has not been undertaken and, in practice, the impacts at sensitive receptors are likely to be lower than those reported in this conservative assessment.

6 Mitigation

Operational Phase

6.1 Predicted concentrations of pollutants from the operational phase of the proposed facility have been demonstrated by the assessment to meet the relevant air quality standards and objectives at human health receptors. On that basis, no additional mitigation is proposed.

7 Conclusions

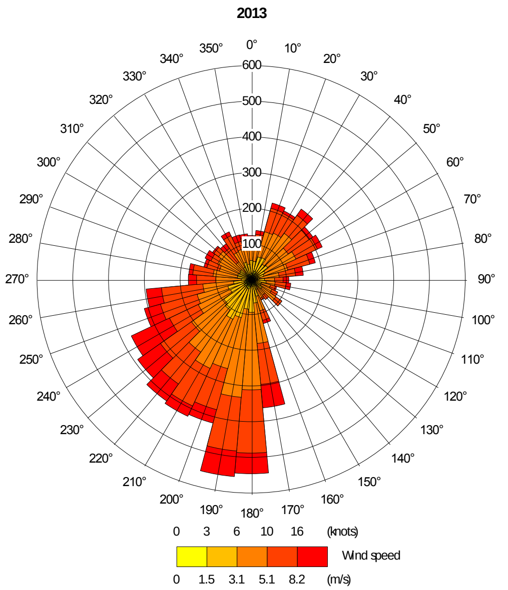
7.1 This assessment has considered the air quality impacts during the operational phase of the Saltholme North gas-fired electricity generating facility in Stockton-on-Tees.

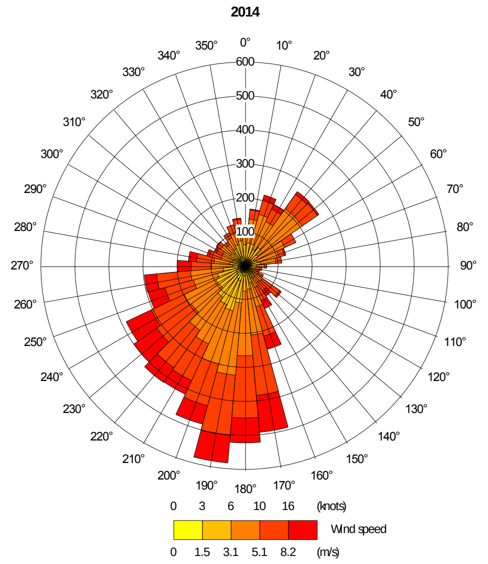
7.2 The operational effects of NO_2 emissions from the facility's stacks have been predicted using best practice approaches. The assessment has been undertaken based on a number of worst-case assumptions, including using the worst-case meteorological conditions and modelling the stack emissions for 3,500 hours. The results show that with the gas engines operational, the predicted concentrations are below the relevant air quality standards and the impacts are not considered to be significant.

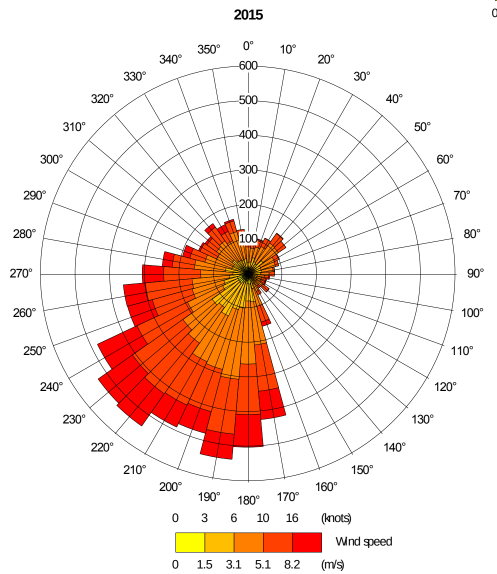
7.3 Cumulative air quality impacts with the Saltholme South gas-fired electricity generating facility are predicted to not result in any significant adverse effects.

7.4 Using professional judgement and experience of similar projects, the resulting air quality effect of the proposed development is considered to be 'not significant' overall.

Figures







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Project: Saltholme North Peaking Plant	
Job Ref: JAR10459	
File location: N/A	
Date: 21/08/2018	**Rev: 0**
Drawn: RC	**Checked: FP**

Figure 1: Wind Roses – Durham Tees Valley Airport (2013 – 2015)

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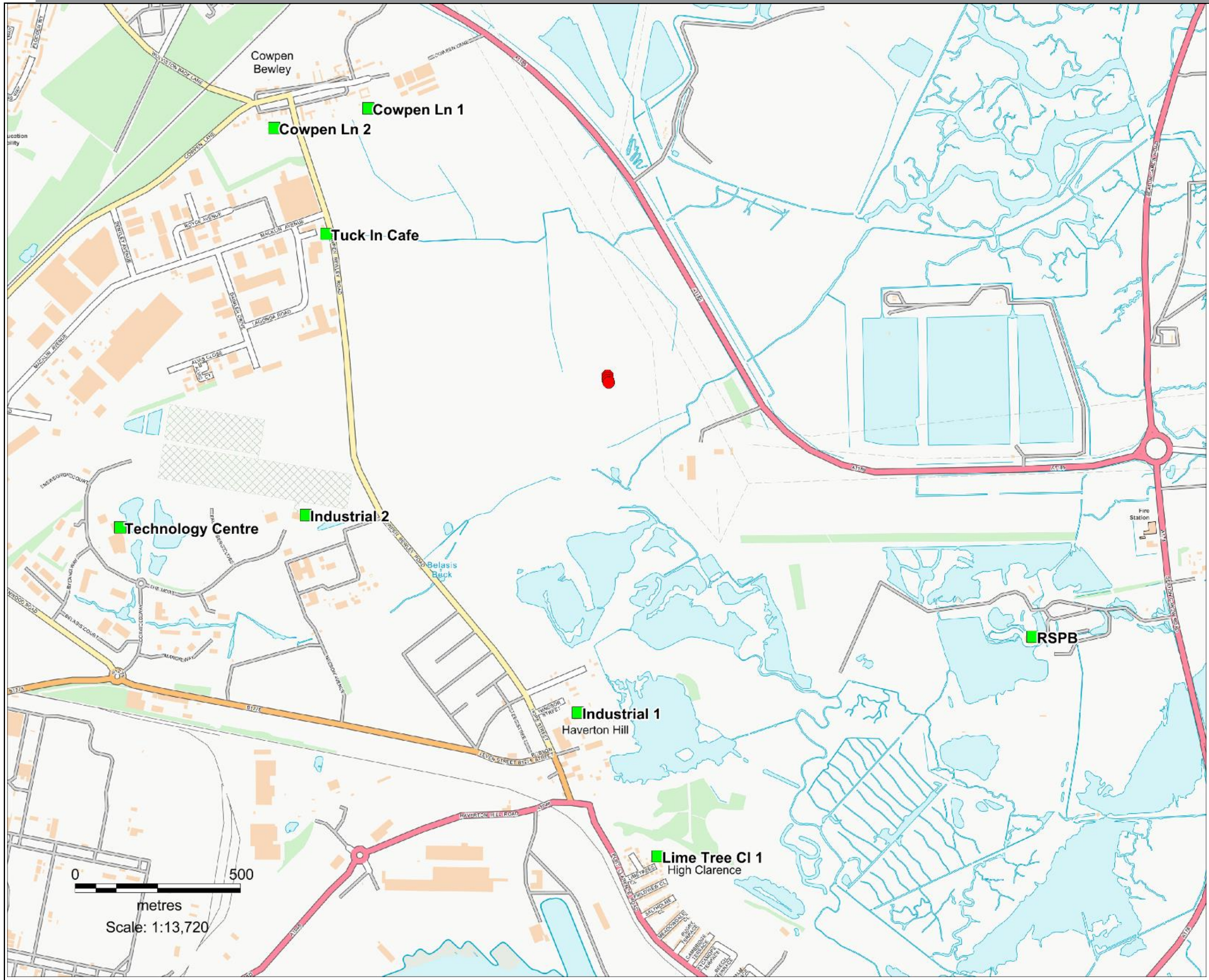

Legend

- Modelled Stacks
- Sensitive Receptors

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Figure 2: Site and Receptors Modelled

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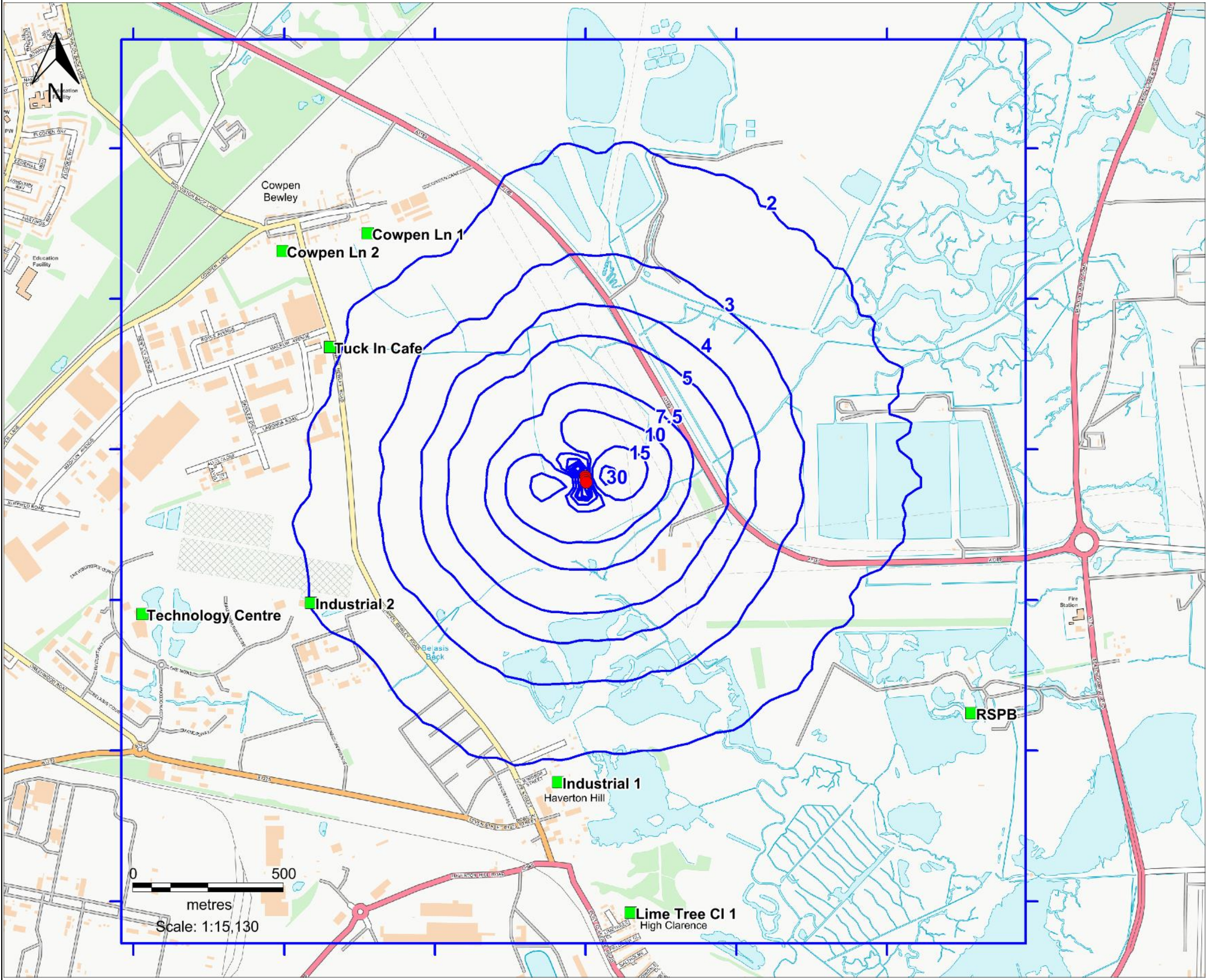

Legend

Sensitive Receptors

Stacks Modelled

PC

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Figure 3: 99.79th Percentile Hourly-mean NO_2 Process Contributions ($\mu g.m^{-3}$) for 2013

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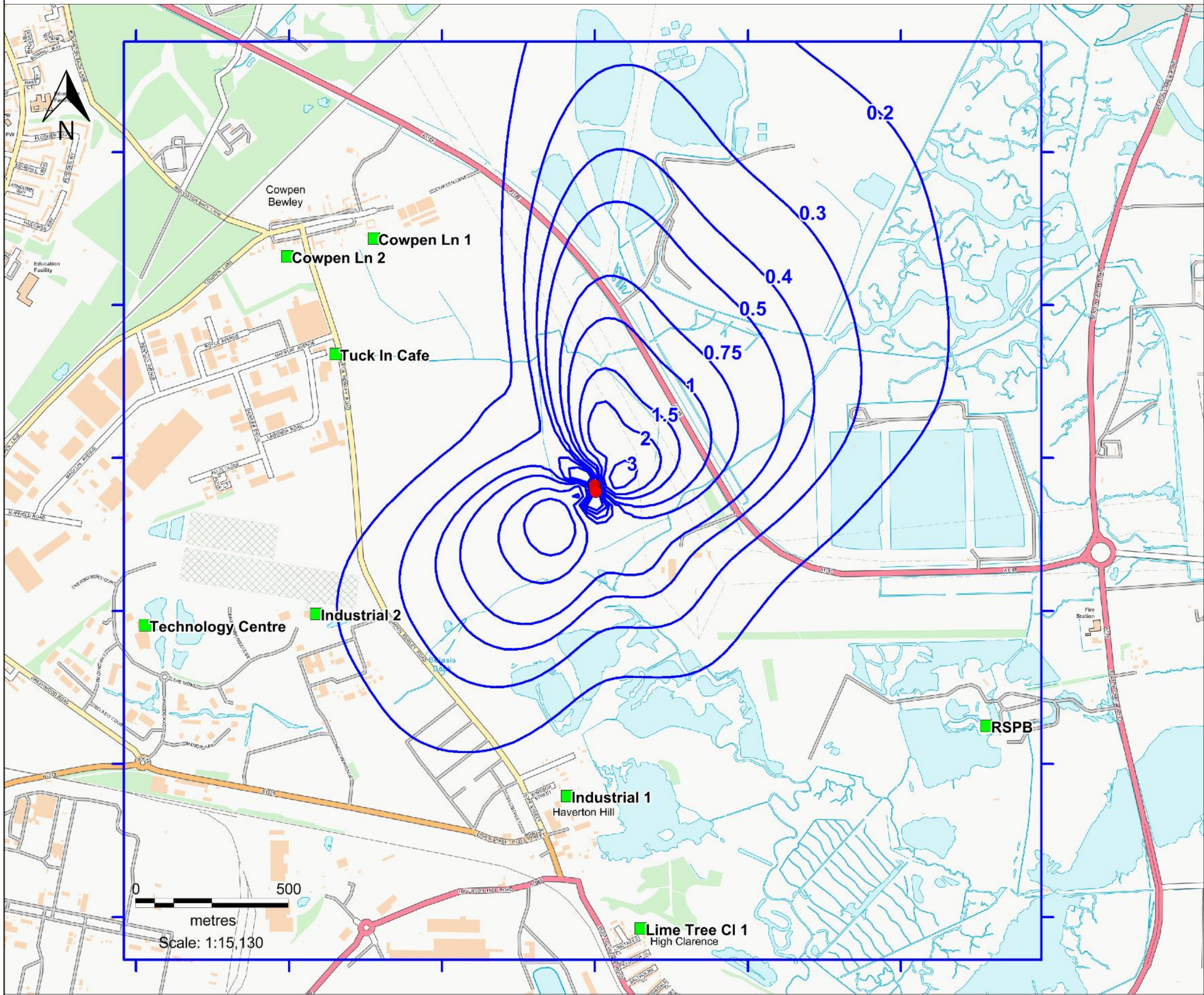

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Figure 4: Annual-mean NO_2 Predicted Environmental Concentrations ($\mu g.m^{-3}$) for 2013

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Appendices

Appendix A: Stack Height Determination

A.1 A stack height determination has been undertaken to establish the height at which there is minimal additional environmental benefit associated with the cost of further increasing the stack. The Environment Agency removed their detailed guidance, Horizontal Guidance Note EPR H1 [12], for undertaking risk assessments on 1 February 2016; however, the approach used here by RPS is consistent with that EA guidance which required the identification of *"an option that gives acceptable environmental performance but balances costs and benefits of implementing it."*

A.2 The emissions data used in the stack height determination are summarised in Section 3 of the report. Simulations have been run using ADMS 5 to determine what stack height is required to provide adequate dispersion/dilution and to overcome local building wake effects.

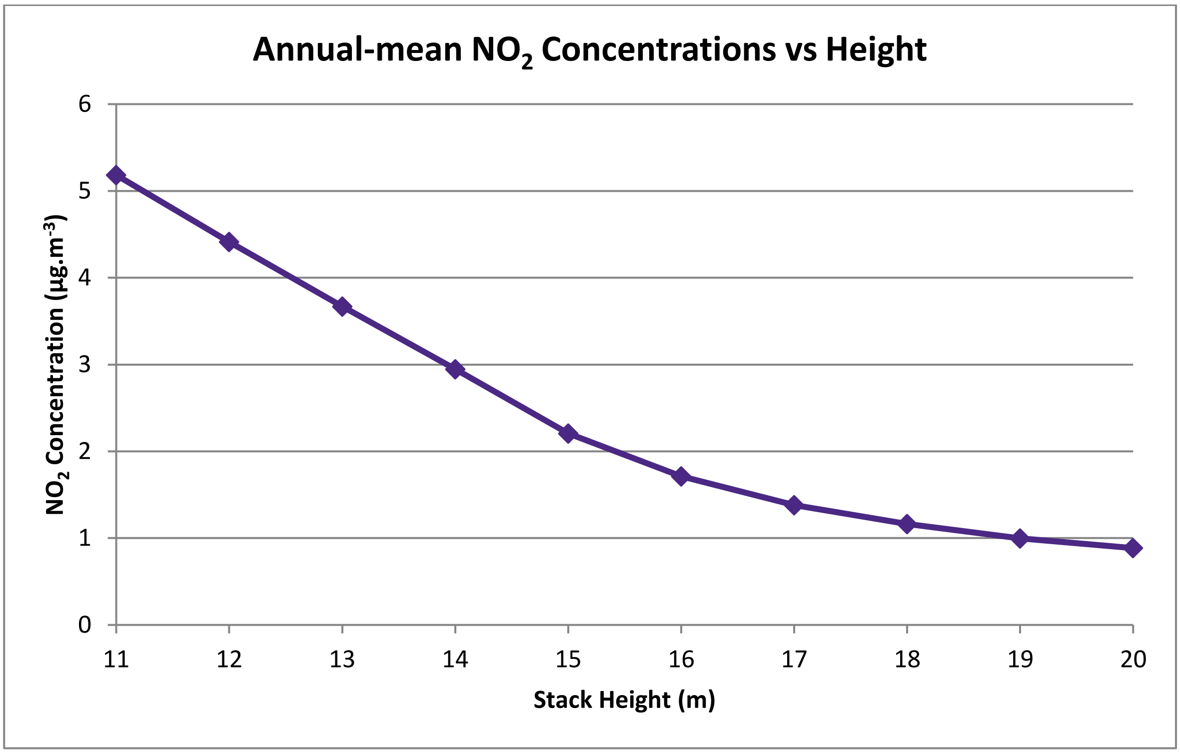
A.3 The stack height determination considers ground level concentrations over the averaging periods relevant to the air quality assessment, together with the full range of all likely meteorological conditions through the use of three years of hourly sequential meteorological data from Durham Tees Valley Airport. The model was run for a range of stack heights between 11 m to 20 m at 1 m intervals.

A.4 The dispersion modelling for the purposes of stack height determination assumed a domain of 3 km by 3 km centred on the proposed development and with a grid spacing of 30 m. Results have been reported initially for the location where the highest concentration is predicted and subsequently at the nearest sensitive receptor locations identified in the study area. This is considered a robust and conservative approach.

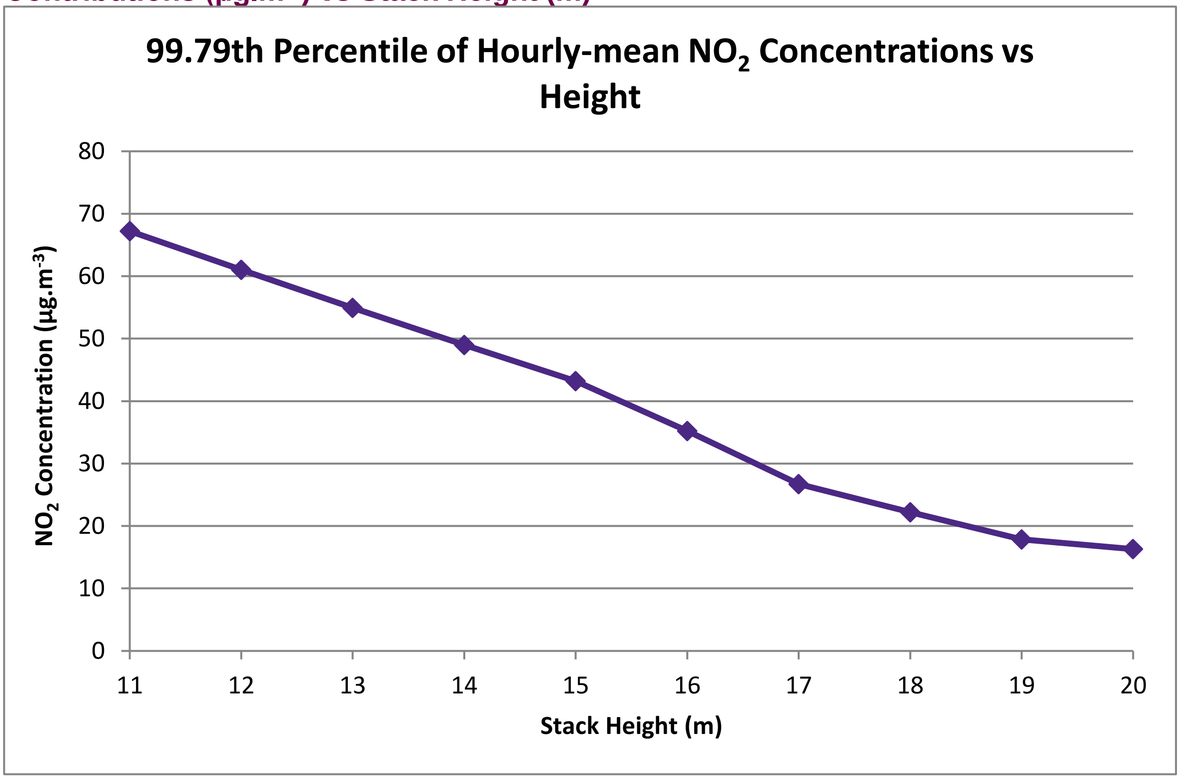
A.5 The stack height modelling results have been analysed in two stages:

A.6 Stage 1 - The maximum predicted annual-mean and 99.79th percentile of hourly-mean NO_2 process contributions have been plotted against height to determine if there is a height at which no benefit is gained from increases in stack heights. The maximum predicted annual-mean process contribution and the maximum predicted 99.79th percentile of hourly-mean process contributions are compared with the stack heights modelled in Graphs A.1 and A.2 below.

Graph A.1 – Maximum Predicted Annual-mean NO_2 Process Contributions (µg.m^{-3}) vs Stack Height (m)



Graph A.2 – Maximum Predicted 99.79th Percentile of Hourly-mean NO_2 Process Contributions (µg.m^{-3}) vs Stack Height (m)



A.7 Neither of the graphs show the ground-level Process Contribution levelling off within the range of heights considered. The graphs indicate that the point at which there are no further potential benefits in increasing the stack height, is beyond 20 m height.

A.8 Stage 2 – Noting that the maximum predicted ground level concentration occurs in close proximity to the site, where no members of the public would be exposed, the lowest height at which the maximum long and short-term NO_2 impacts at sensitive receptors are 'not significant' has been determined.

Stack Height Determination Results

A.9 The maximum long and short-term impacts at sensitive receptors, for each height, are set out in Table A.1 and Table A.2 respectively.

Table A.1 Maximum Impacts at Sensitive Receptors – Long-term NO_2

Height (m)	Annual Mean PC (µg.m^{-3})	Annual- mean PC as %AQAL	Annual-mean PEC (µg.m^{-3})
11	0.1	0	14.1
12	0.1	0	14.1
13	0.1	0	14.1
14	0.1	0	14.1
15	0.1	0	14.1
16	0.1	0	14.1
17	0.1	0	14.1
18	0.1	0	14.1
19	0.1	0	14.1
20	0.1	0	14.1

The AQAL for annual-mean NO_2 is 40 µg.m^{-3}.

Table A.2 Maximum Impacts at Sensitive Receptors – Short-term NO_2

Height (m)	99.79th Percentile of Hourly-mean PCs (µg.m^{-3})	99.79th Percentile of Hourly-mean PC as %AQAL	99.79th Percentile of Hourly-mean PEC (µg.m^{-3})	99.79th Percentile of Hourly-mean PEC as % of AQAL
11	2.1	1	30.1	15
12	2.1	1	30.1	15
13	2.1	1	30.1	15
14	2.1	1	30.0	15
15	2.0	1	30.0	15
16	2.0	1	30.0	15
17	2.0	1	30.0	15
18	1.9	1	29.9	15
19	1.9	1	29.9	15
20	1.9	1	29.9	15

The AQAL for 99.79th hourly-mean NO_2 is 200 µg.m^{-3}.

A.10 For the long-term impacts, the maximum PEC falls well below the AQAL of 40 µg.m^{-3} at all heights from 11 to 20 m. The long-term effects can be considered 'not significant' at all heights.

A.11 For the short-term impacts, the maximum PEC at the sensitive receptors is 15% of the AQAL of 200 µg.m^{-3} at all heights and the impacts are considered ‘not significant’.

Conclusion

A.12 The impacts are considered to be not significant at all stack heights modelled. The modelling undertaken in this report assumes a 15 m high stack.

Appendix B: Cumulative Impacts

B.1 This appendix presents the results of an assessment of the cumulative impacts of the Saltholme North and South gas-fired electricity generating facilities at selected sensitive receptors and across the modelled grid. The Saltholme South facility is the subject of a separate application.

Results of Stack Emissions Modelling

Short-term NO_2 Impacts

B.2 Table B.1 summarises the highest cumulative short-term PC anywhere across the modelled grid.

Table B.1: Highest Predicted Short-term Process Contribution ($\mu g.m^{-3}$) for NO_2

Averaging period (Pollutant)	AQAL ($\mu g.m^{-3}$)	Max Cumulative PC ($\mu g.m^{-3}$)	Max Cumulative PC as % of AQAL	Potentially Significant? Yes/No	AC ($\mu g.m^{-3}$)	PEC ($\mu g.m^{-3}$)	Significant? Yes/No
1 hour 99.79th percentile (NO_2)	200	85.9	43	Yes	28	113.9	No

B.3 The results show that the maximum short-term PC anywhere across the modelling grid is 43% of the relevant Air Quality Assessment Level (AQAL). The maximum short-term PEC is below the AQAL. As such, the short-term NO_2 impacts based on modelling across the grid are not considered to be significant.

B.4 Dispersion modelling has also been undertaken to predict the PCs from both facilities at discrete receptors around the application site. Table B.2 summarises the short-term, predicted PCs at the discrete sensitive receptors.

Table B.2: Highest Short-term Process Contribution ($\mu g.m^{-3}$) for NO_2 at Sensitive Receptors

Receptors	Receptor Type	Short-term PC Saltholme North (1 hour 99.79th percentile) ($\mu g.m^{-3}$)	Short-term PC Saltholme South (1 hour 99.79th percentile) ($\mu g.m^{-3}$)	Cumulative PC (1 hour 99.79th percentile) ($\mu g.m^{-3}$)	Cumulative PC as % of AQAL	PEC ($\mu g.m^{-3}$)
Tuck In Cafe	Business/ Commercial	1.9	1.8	3.7	2	31.7
Cowpen Ln 1	Residential	1.7	1.6	3.2	2	31.2
Cowpen Ln 2	Residential	1.5	1.4	2.9	1	30.9
RSPB	Parkland	1.4	1.4	2.8	1	30.8
Industrial 1	Light Industrial	1.8	2.0	3.8	2	31.8
Lime Tree Cl 1	Residential	1.2	1.5	2.7	1	30.7
Technology Centre	Business/ Commercial	1.3	1.3	2.6	1	30.6
Industrial 2	Light Industrial	2.0	2.0	4.0	2	32.0

AQAL for 1 hour 99.79th percentile (NO_2) is 200 $\mu g.m^{-3}$

B.5 The results show that the highest PC as a percentage of the AQAL at any discrete receptors is 2%. When the PC is added to the AC, the maximum PEC is 31.7 µg.m^{-3}, with considerable head-room between the PEC and the AQAL of 200 µg.m^{-3}. On that basis, the short-term impacts are not considered to be significant.

Long-term NO_2 Impacts

B.6 Table B.3 summarises the highest long-term PEC anywhere across the modelled grid. (Note: the PEC is the PC added to the AC).

Table B.3: Highest Long-term Predicted Environmental Concentrations

Averaging period (Pollutant)	AQAL (µg.m^{-3})	AC (µg.m^{-3})	Max Cumulative PC (µg.m^{-3})	Change as % of AQAL	Potentially Significant? Yes/No	Max PEC (µg.m^{-3})	Max PEC as % of AQAL	Significant? Yes/No
Annual mean (NO_2)	40	14	4.6	11	Yes	18.6	46	No

B.7 The maximum long-term cumulative PC is more than 1% of the AQAL and the impacts are considered to be potentially significant. The maximum long-term PEC is well below the AQAL of 40 µg.m^{-3}. As such, the long-term NO_2 impacts based on modelling across the grid are not considered to be significant.

B.8 Table B.4 summarises the long-term maximum PC and PEC values at the selected discrete sensitive receptors, noting that the annual-mean objective only applies at the residential receptors listed below.

Table B.4: Long-term Predicted NO_2 Concentrations (µg.m^{-3}) at Sensitive Receptors

Receptors	Receptor Type	Annual-mean PC Saltholme North (µg.m^{-3})	Annual-mean PC Saltholme South (µg.m^{-3})	Cumulative annual-mean PC (µg.m^{-3})	Cumulative PC as % of AQAL	Cumulative PEC (µg.m^{-3})
Tuck In Cafe	Business/ Commercial	0.03	0.03	0.06	0	14.1
Cowpen Ln 1	Residential	0.04	0.04	0.07	0	14.1
Cowpen Ln 2	Residential	0.03	0.03	0.05	0	14.0
RSPB	Parkland	0.03	0.03	0.06	0	14.1
Industrial 1	Light Industrial	0.05	0.05	0.10	0	14.1
Lime Tree Cl 1	Residential	0.02	0.03	0.05	0	14.0
Technology Centre	Business/ Commercial	0.04	0.03	0.07	0	14.1
Industrial 2	Light Industrial	0.07	0.07	0.14	0	14.1

AQAL for annual-mean NO_2 is 40 µg.m^{-3}

B.9 The predicted cumulative process contributions are less than 1% of the annual-mean limit value of 40 µg.m^{-3} at all receptors. Furthermore, the total predicted environmental concentrations are well below the AQAL. On this basis, the long-term impacts are not considered to be significant.

Appendix C: Impacts on Habitat Sites

C.1 The EA guidance on 'Screening for protected conservation areas' [13] requires identification of:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or Ramsar sites *within 10 km of the Proposed Development; and*
- *Sites of Special Scientific Interest (SSSIs) and Local Nature sites (ancient woods, local wildlife sites and national and local nature reserves) within 2 km of the Proposed Development.*

C.2 During consultation with Natural England and the Environment Agency [14, 15] for a previous Air Quality Assessment Addendum (dated 05/12/2018), it was agreed that air quality impacts on the following habitat sites would be assessed:

- *An assessment of impacts on all Special Protection Areas (SPAs), Ramsar sites and Special Areas of Conservation (SACs) within 15 km of the application sites.*
- *An assessment of impacts on Teesmouth and Cleveland Coast Site of Special Scientific Interest (SSSI).*
- *An assessment of impacts on Teesmouth and Cleveland Coast potential Special Protection Area (pSPA).*

C.3 Additionally, it was agreed that the assessment would use of meteorological data collated at Durham Tees Airport (wind roses are provided in Figure 1) and include cumulative impacts taking into account the results in the air quality assessments for the following schemes:

- *Teesside Renewable Energy Plant* (REP);
- Billingham Reach Energy from Waste Plant; and
- Tees Combined Cycle Power Plant (CCPP).

C.4 As such, this assessment considers the cumulative impact of both facilities on NO_X and ammonia (NH_3) concentrations, nutrient nitrogen deposition and acid deposition at the following sites:

- Teesmouth & Cleveland Coast SPA, Ramsar, SSSI & pSPA sites;
- Northumbria Coast SPA & Ramsar site;
- North York Moors SPA;
- Durham Coast SAC;
- North York Moors SPA.

C.5 The nature sites have been modelled as gridded receptors with 70 m spacing, to allow the maximum process contribution to be predicted.

Critical Levels

C.6 Critical levels are maximum atmospheric concentrations of pollutants for the protection of vegetation and ecosystems and are specified within relevant European air quality directives and corresponding UK air quality regulations. PCs and PECs of NO_x have been calculated for comparison with the 30 $\mu g.m^{-3}$ annual-mean critical level. Similarly, the PCs and PECs for NH_3 have been compared against the relevant critical level for NH_3, which ranged from 1 to 3 $\mu g.m^{-3}$

at the habitat sites. Background NO_x and NH_3 concentrations at each designated site have been derived from the UK Air Pollution Information System (APIS) database [16].

Critical Loads

C.7 Critical loads refer to the quantity of pollutant deposited, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge.

Critical Loads – Nutrient Nitrogen Deposition

C.8 Percentage contributions to nutrient nitrogen deposition have been derived from the results of the ADMS dispersion modelling. Deposition rates have been calculated using empirical methods recommended by the EA, as follows:

C.9 The dry deposition fluxes of NO_2 and NH_3 ($\mu g.m^{-2}.s^{-1}$) have been calculated by multiplying the ground level NO_2 and NH_3 concentrations ($\mu g.m^{-3}$) by their deposition velocities. In this case, the habitats at the identified sites are all low level, mostly comprising grassland and saltmarshes, and the deposition velocities provided by the EA guidance for short habitats would be most appropriate. The deposition velocities for short habitats are 0.0015 and 0.02 $m.s^{-1}$ for NO_2 and NH_3, respectively.

C.10 Wet deposition in the near field is not significant compared with dry deposition for N [17] and therefore for the purposes of this assessment, wet deposition has not been considered.

C.11 The deposition flux of N in units of $kg.ha^{-1}.year^{-1}$ has been calculated from the dry deposition fluxes of NO_2 and NH_3 in units of $\mu g.m^{-2}.s^{-1}$, by multiplying the dry deposition fluxes by the standard conversion factors of 96 for NO_2 and 259.7 for NH_3. The total N deposition flux has then been calculated as the sum of the contribution from both pollutants.

C.12 Predicted contributions to nitrogen deposition have been calculated and compared with the relevant critical load range for the habitat types associated with the designated site. These have been derived from the APIS database.

Critical Loads – Acidification

C.13 The acid deposition rate, in equivalents $keq.ha^{-1}.year^{-1}$, has been calculated by multiplying the total N deposition flux ($kg.ha^{-1}.year^{-1}$) by a conversion factor of 0.071428. This takes into account the degree to which a chemical species is acidifying, calculated as the proportion of N within the molecule.

C.14 Predicted contributions to acid deposition have been calculated and compared with the minimum critical load function for the habitat types associated with each designated site as derived from the APIS database.

Significance Criteria

C.15 The PC and PEC of NO_x and NH_3 and N/acid deposition have been compared against the relevant critical level/load for the relevant habitat type/interest feature. Based on current Environment Agency guidelines [18] and the Institute of Air Quality Management [19].

C.16 The following criteria have been used to determine if the impacts are significant:

- If the long-term PC does not exceed 1% of relevant critical level/load the emission is considered not significant; and

- If the long-term PC exceeds 1% but the resulting PEC is below 100% of the relevant critical level/load, the emission is not considered significant;
- If the short-term PC does not exceed 10% of the relevant critical level/load the emission is considered not significant; and
- If the short -term PC exceeds 10% but the resulting PEC is below 100% of the relevant critical level/load, the emission is not considered significant.

C.17 Where potentially significant impacts have been identified, the impacts have been passed to the project's ecologist to allow the significance of the likely effect to be determined.

Results

C.18 The ambient NOx concentrations and existing deposition rates have been obtained from APIS. The highest deposition rates have been obtained taking into account the various habitats across the sites. The lowest critical loads for nitrogen deposition and the nitrogen component for acid deposition have been also obtained from APIS. These are provided in Table C.1.

C.19 The predicted annual-mean NOx and NH_3 concentrations are compared with the critical levels in Table C.2 and C.3. The maximum 24-hour mean NO_X concentrations are compared with the critical levels in Table C.4. The predicted nutrient N deposition rate is compared with the critical load in Table C.5. The predicted acid deposition rates are compared with the critical load function in Table C.6.

Table C.1 Background Concentrations and Critical Loads

Designation	Site Name	Interest Feature	Background				Critical Load	
			NOx (µg.m^{-3})	NH_3 (µg.m^{-3})	Average Nitrogen Deposition Rate (kgN.ha^{-1}.yr^{-1})	Average Acid Deposition Nitrogen (keq.ha^{-1}.yr^{-1})	Minimum Nitrogen Deposition Range for Habitats (kgN.ha^{-1}.yr^{-1})	Acid Deposition - Critical Load Function (keq.ha^{-1}.yr^{-1})
SPA / Ramsar	Teesmouth & Cleveland Coast	Sterna sandvicensis (Western Europe/Western Africa) - Sandwich tern	26.05	0.99	11.7	0.84	8 – 10	1.998
		Sterna albifrons (Eastern Atlantic - breeding) - Little tern			11.7	0.84	8 – 10	1.998
		Tadorna tadorna (North-western Europe) - Common shelduck			11.7	0.84	20 – 30	ND
		Anas crecca (North-western Europe) - Eurasian teal			11.7	0.84	20 – 30	1.998
		Anas clypeata (North-western/Central Europe) - Northern shoveler			11.7	0.84	20 – 30	1.998
		Calidris canutus (North-eastern Canada/Greenland/Iceland/ North-western Europe) - Red knot			11.7	0.84	20 – 30	ND
		Calidris alba (Eastern Atlantic/Western & Southern Africa - wintering) - Sanderling			11.7	0.84	20 – 30	ND
		Tringa totanus (Eastern Atlantic - wintering) - Common redshank			11.7	0.84	20 – 30	1.998

Designation	Site Name	Interest Feature	Background				Critical Load	
			NOx (µg.m^{-3})	NH_3 (µg.m^{-3})	Average Nitrogen Deposition Rate (kgN.ha^{-1}.yr^{-1})	Average Acid Deposition Nitrogen (keq.ha^{-1}.yr^{-1})	Minimum Nitrogen Deposition Range for Habitats (kgN.ha^{-1}.yr^{-1})	Acid Deposition - Critical Load Function (keq.ha^{-1}.yr^{-1})
	Northumbria Coast	Sterna albifrons (Eastern Atlantic - breeding) - Little tern (A195)	10.1	0.7	11.21	0.8	8 – 10	0.786
		Arenaria interpres (Western Palearctic - wintering) - Ruddy turnstone (A169)			11.21	0.8	20 – 30	4.856
		Calidris maritima (Eastern Atlantic - wintering) - Purple sandpiper (A148)			11.21	0.8	NS	NS
SPA	North York Moors	Pluvialis apricaria [North-western Europe - breeding] - European golden plover (A140)	7.49	1.13	19.02	1.36	5 – 10	0.471
		Falco columbarius - Merlin (A098)			19.02	1.36	10 – 20	0.792
SSSI	Teesmouth & Cleveland Coast SSSI*	Various	19.99	0.99	13.8	0.99	20 – 30	1.998
pSPA	Teesmouth & Cleveland Coast	Various	26.05	0.99	11.7	0.84	8 – 10	1.998
SAC	Durham Coast SAC	Vegetated sea cliffs of the Atlantic and Baltic Coasts (H1230)	15.85	1.68	13.0	NS	ND	NS
	North York Moors SAC	Blanket bogs (* if active bog) (H7130)	7.49	2.16	19.02	1.36	5 – 10	0.54
		Northern Atlantic wet heaths with Erica tetralix (H4010)			19.02	1.36	10 – 20	0.792

Designation	Site Name	Interest Feature	Background				Critical Load	
			NOx ($\mu g.m^{-3}$)	NH_3 ($\mu g.m^{-3}$)	Average Nitrogen Deposition Rate ($kgN.ha^{-1}.yr^{-1}$)	Average Acid Deposition Nitrogen ($keq.ha^{-1}.yr^{-1}$)	Minimum Nitrogen Deposition Range for Habitats ($kgN.ha^{-1}.yr^{-1}$)	Acid Deposition - Critical Load Function ($keq.ha^{-1}.yr^{-1}$)
		European dry heaths (H4030)			19.02	1.36	10 – 20	0.792

Note: Data sourced from APIS, NS = Not sensitive, ND = No data

Table C.2 Predicted Annual-Mean NO_x Concentrations at Designated Habitat Sites

Designation	Site Name	CL ($\mu g.m^{-3}$)	AC ($\mu g.m^{-3}$)	Teesside REP PC ($\mu g.m^{-3}$)*	Tees CCPP PC ($\mu g.m^{-3}$)**	Billingham Reach PC ($\mu g.m^{-3}$)***	Saltholme North + Saltholme South PC ($\mu g.m^{-3}$)	Cumulative PEC ($\mu g.m^{-3}$)	Saltholme North + Saltholme South PC/CL (%)	Cumulative PEC/CL (%)
SPA / Ramsar	Teesmouth & Cleveland Coast	30	26.05	0.76	0.31	0.62	0.38	28.11	1	94
	Northumbria Coast		10.1	0.76	0.31	0.62	0.01	11.80	0	39
SPA	North York Moors		7.49	0.76	0.31	0.62	0.00	9.18	0	31
SSSI	Teesmouth & Cleveland Coast SSSI		19.99	0.76	0.31	0.62	0.89	22.56	**3**	75
pSPA	Teesmouth & Cleveland Coast		26.05	0.76	0.31	0.62	0.89	28.62	**3**	95
SAC	Durham Coast SAC		15.85	0.76	0.31	0.62	0.01	17.55	0	59
	North York Moors SAC		7.49	0.76	0.31	0.62	0.00	9.18	0	31

Note: Data sourced from APIS, NS = Not sensitive, ND = No data
*Maximum predicted annual-mean NO_X concentration presented in Air Quality Environmental Impact Assessment Addendum (REC, April 2015)
** Maximum predicted annual-mean NO_X concentration presented in Tees CCPP Project, Volume 1 – Chapter 7 (Sembcorp Utilities UK, May 2018)
*** Maximum predicted annual-mean NO_X concentration presented in Billingham Reach ES Addendum, Chapter 7 (Tees Eco Energy Limited, August 2016)

Table C.3 Predicted Annual-Mean NH_3 Concentrations at Designated Habitat Sites

Designation	Site Name	CL (µg.m^{-3})	AC (µg.m^{-3})	Teesside REP PC (µg.m^{-3})*	Tees CCPP PC (µg.m^{-3})**	Billingham Reach PC (µg.m^{-3})***	Saltholme North + Saltholme South PC (µg.m^{-3})	Cumulative PEC (µg.m^{-3})	Saltholme North + Saltholme South PC/CL (%)	Cumulative PEC/CL (%)
SPA / Ramsar	Teesmouth & Cleveland Coast	3	0.99	0.02	0	0.31	0.06	11.38	**2**	46
	Northumbria Coast		0.70	0.02	0	0.31	0.00	1.03	0	34
SPA	North York Moors		1.13	0.02	0	0.31	0.00	1.46	0	49
SSSI	Teesmouth & Cleveland Coast SSSI		0.99	0.02	0	0.31	0.14	1.46	**5**	49
pSPA	Teesmouth & Cleveland Coast		0.99	0.02	0	0.31	0.14	1.46	**5**	49
SAC	Durham Coast SAC	ND	1.68	0.02	0	0.31	0.00	2.01	ND	ND
	North York Moors SAC	1	2.16	0.02	0	0.31	0.00	2.49	0	249

Note: Data sourced from APIS, NS = Not sensitive, ND = No data
*Maximum predicted annual-mean NH_3 concentration presented in Air Quality Environmental Impact Assessment Addendum (REC, April 2015)
**No NH_3 emissions predicted from the Tees CCPP Project, Volume 1 – Chapter 7 (Sembcorp Utilities UK, May 2018)
*** Maximum predicted annual-mean NH_3 concentration presented in Billingham Reach ES Addendum, Chapter 7 (Tees Eco Energy Limited, August 2016)

Table C.4 Predicted Maximum 24-Hour NOx Concentrations at Designated Habitat Sites

Designation	Site Name	CL ($\mu g.m^{-3}$)	AC ($\mu g.m^{-3}$)	Teesside REP PC ($\mu g.m^{-3}$)*	Tees CCPP PC ($\mu g.m^{-3}$)**	Billingham Reach PC ($\mu g.m^{-3}$)***	Saltholme North + Saltholme South PC ($\mu g.m^{-3}$)	Cumulative PEC ($\mu g.m^{-3}$)	Saltholme North + Saltholme South PC/CL (%)	Cumulative PEC/CL (%)
SPA / Ramsar	Teesmouth & Cleveland Coast	75	52.10	6.21	9.19	3.98	14.86	86.34	**20**	**115**
	Northumbria Coast		20.20	6.21	9.19	3.98	0.64	40.23	1	54
SPA	North York Moors		14.98	6.21	9.19	3.98	0.22	34.58	0	46
SSSI	Teesmouth & Cleveland Coast SSSI		39.98	6.21	9.19	3.98	43.39	102.75	**58**	**137**
pSPA	Teesmouth & Cleveland Coast		52.10	6.21	9.19	3.98	43.39	114.87	**58**	**153**
SAC	Durham Coast SAC		31.70	6.21	9.19	3.98	0.65	51.74	1	69
	North York Moors SAC		14.98	6.21	9.19	3.98	0.22	34.58	0	46

Note: APIS provides a single value for the NO_X background concentration. The PEC and PEC/CL(%) are provided for a doubled background concentration.
*Maximum predicted daily-mean NO_X concentration presented in Air Quality Environmental Impact Assessment Addendum (REC, April 2015)
** Maximum predicted daily-mean NO_X concentration presented in Tees CCPP Project, Volume 1 – Chapter 7 (Sembcorp Utilities UK, May 2018)
*** Maximum predicted daily-mean NO_X concentration presented in Billingham Reach ES Addendum, Chapter 7 (Tees Eco Energy Limited, August 2016)

Table C.5 Predicted Nutrient N Deposition at Designated Habitat Sites

Designation	Site Name	Interest Feature	Min CL (kgN.ha-1.yr-1)	AC (kgN.ha-1.yr-1)	Teesside REP PC (kgN.ha-1.yr-1)*	Tees CCPP PC (kgN.ha-1.yr-1)**	Billingham Reach PC (kgN.ha-1.yr-1)***	Saltholme North + Saltholme South PC (kgN.ha-1.yr-1)			PEC (kgN.ha-1.yr-1)	Salthome N+S PC/min CL (%)	PEC/min CL (%)
								From NO_x	From NH_3	Total			
SPA / Ramsar	Teesmouth & Cleveland Coast	Sterna sandvicensis (Western Europe/Western Africa) - Sandwich tern	8	11.7	0.14	0.09	0.22	0.04	0.29	0.33	12.48	**4**	**156**
		Sterna albifrons (Eastern Atlantic - breeding) - Little tern	8	11.7	0.14	0.09	0.22	0.04	0.29	0.33	12.48	**4**	**156**
		Tadorna tadorna (North-western Europe) - Common shelduck	20	11.7	0.14	0.09	0.22	0.04	0.29	0.33	12.48	**2**	62
		Anas crecca (North-western Europe) - Eurasian teal	20	11.7	0.14	0.09	0.22	0.04	0.29	0.33	12.48	**2**	62
		Anas clypeata (North-western/Central Europe) - Northern shoveler	20	11.7	0.14	0.09	0.22	0.04	0.29	0.33	12.48	**2**	62
		Calidris canutus (North-eastern Canada/Greenland/Iceland/North-western Europe) - Red knot	20	11.7	0.14	0.09	0.22	0.04	0.29	0.33	12.48	**2**	62

Designation	Site Name	Interest Feature	Min CL (kgN.ha-1.yr-1)	AC (kgN.ha-1.yr-1)	Teesside REP PC (kgN.ha-1.yr-1)*	Tees CCPP PC (kgN.ha-1.yr-1)**	Billingham Reach PC (kgN.ha-1.yr-1)***	Saltholme North + Saltholme South PC (kgN.ha-1.yr-1)			PEC (kgN.ha-1.yr-1)	Salthome N+S PC/min CL (%)	PEC/min CL (%)
								From NO_x	From NH_3	Total			
		Calidris alba (Eastern Atlantic/Western & Southern Africa - wintering) - Sanderling	20	11.7	0.14	0.09	0.22	0.04	0.29	0.33	12.48	**2**	62
		Tringa totanus (Eastern Atlantic - wintering) - Common redshank	20	11.7	0.14	0.09	0.22	0.04	0.29	0.33	12.48	**2**	62
	Northumbria Coast	Sterna albifrons (Eastern Atlantic - breeding) - Little tern (A195)	8	11.2	0.14	0.09	0.22	<0.005	<0.005	<0.005	11.67	0	**146**
	Northumbria Coast	Arenaria interpres (Western Palearctic - wintering) - Ruddy turnstone (A169)	20	11.2	0.14	0.09	0.22	<0.005	<0.005	<0.005	11.67	0	58
SPA	North York Moors	Pluvialis apricaria [North-western Europe - breeding] - European golden plover (A140)	5	19.0	0.14	0.09	0.22	<0.005	<0.005	<0.005	19.48	0	**390**
SPA	North York Moors	Falco columbarius - Merlin (A098)	10	19.0	0.14	0.09	0.22	<0.005	<0.005	<0.005	19.48	0	**195**
SSSI	Teesmouth & Cleveland Coast SSSI	Various	20	13.8	0.14	0.09	0.22	0.09	0.69	0.78	15.04	**4**	75

Designation	Site Name	Interest Feature	Min CL (kgN.ha-1.yr-1)	AC (kgN.ha-1.yr-1)	Teesside REP PC (kgN.ha-1.yr-1)*	Tees CCPP PC (kgN.ha-1.yr-1)**	Billingham Reach PC (kgN.ha-1.yr-1)***	Saltholme North + Saltholme South PC (kgN.ha-1.yr-1)			PEC (kgN.ha-1.yr-1)	Salthome N+S PC/min CL (%)	PEC/min CL (%)
								From NO_x	From NH_3	Total			
pSPA	Teesmouth & Cleveland Coast	Various	8	11.7	0.14	0.09	0.22	0.09	0.69	0.78	12.94	**10**	**162**
SAC	North York Moors SAC	Blanket bogs (if active bog) (H7130)	5	19.0	0.14	0.09	0.22	<0.005	<0.005	<0.005	19.48	0	**390**
		Northern Atlantic wet heaths with Erica tetralix (H4010)	10	19.0	0.14	0.09	0.22	<0.005	<0.005	<0.005	19.48	0	**195**
		European dry heaths (H4030)	10	19.0	0.14	0.09	0.22	<0.005	<0.005	<0.005	19.48	0	**195**

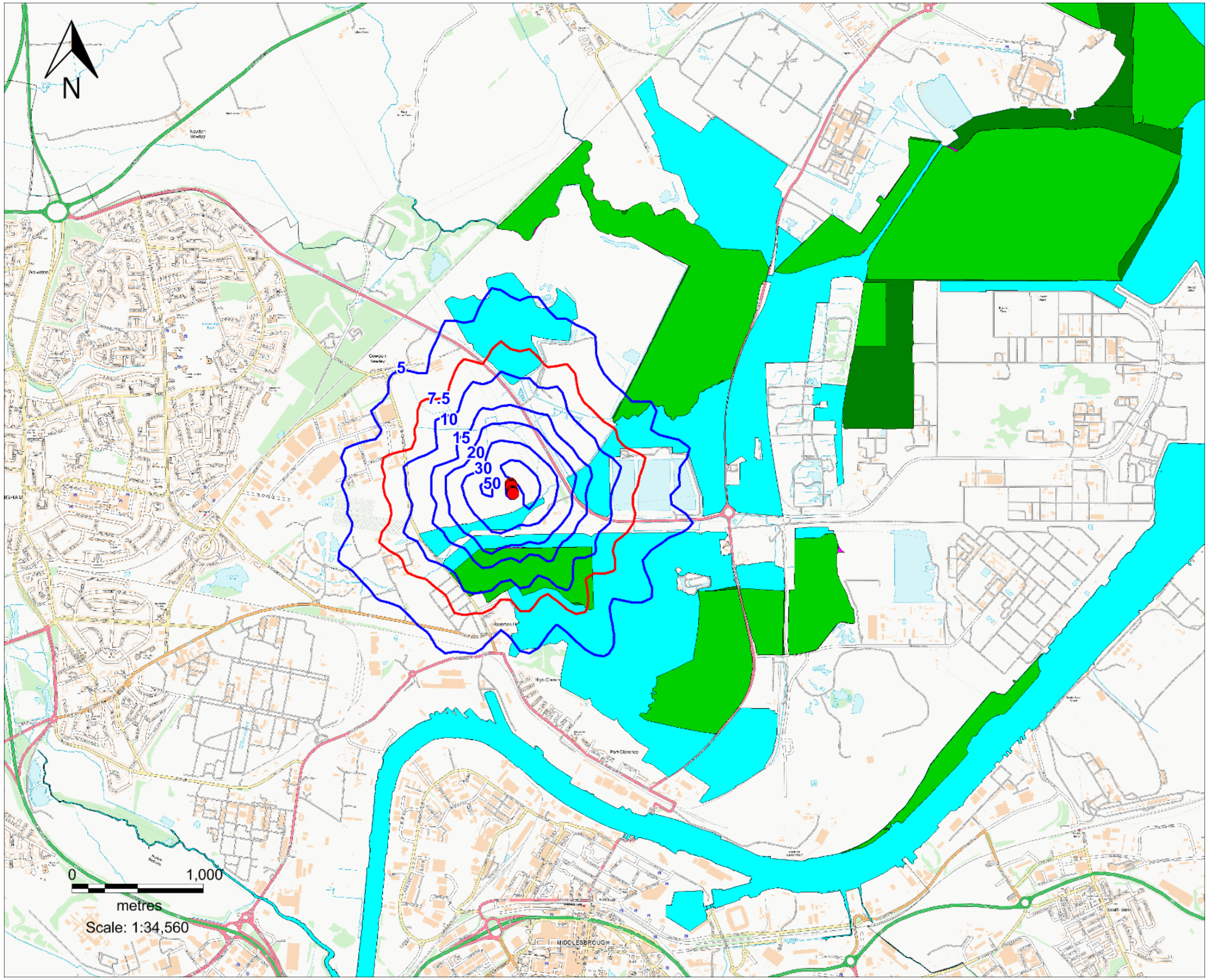
Note: As advised by APIS, for sites with high precipitation, the upper bound of the critical load range should be used
*Maximum predicted N deposition rate presented in Air Quality Environmental Impact Assessment Addendum (REC, April 2015)
** Maximum predicted N deposition rate presented in Tees CCPP Project, Volume 1 – Chapter 7 (Sembcorp Utilities UK, May 2018)
*** Maximum predicted N deposition rate presented in Billingham Reach ES Addendum, Chapter 7 (Tees Eco Energy Limited, August 2016)

Table C.6 Predicted Acid Deposition at Designated Habitat Sites

Designation	Site Name	Interest Feature	Critical Load CLmaxN (keq.ha^{-1}.yr^{-1})	AC (keq.ha^{-1}.yr^{-1})	Teesside REP PC (keq.ha^{-1}.yr^{-1})*	Tees CCPP PC (keq.ha^{-1}.yr^{-1})**	Billingham Reach PC (keq.ha^{-1}.yr^{-1})***	Saltholme North + Saltholme South PC (keq.ha^{-1}.yr^{-1})	PEC (keq.ha^{-1}.yr^{-1})	Salthome N+S PC/min CL (%)	PEC/ CL (%)
SPA / Ramsar	Teesmouth & Cleveland Coast	Sterna sandvicensis (Western Europe/Western Africa) - Sandwich tern	1.998	0.84	0.03	0.0061	0.04	0.02	0.94	1	47
		Sterna albifrons (Eastern Atlantic - breeding) - Little tern	1.998	0.84	0.03	0.01	0.04	0.94	0.94	1	47
		Anas crecca (North-western Europe) - Eurasian teal	1.998	0.84	0.03	0.01	0.04	0.94	0.94	1	47
		Anas clypeata (North-western/Central Europe) - Northern shoveler	1.998	0.84	0.03	0.01	0.04	0.94	0.94	1	47
		Tringa totanus (Eastern Atlantic - wintering) - Common redshank	1.998	0.84	0.03	0.01	0.04	0.94	0.94	1	47
	Northumbria Coast	Sterna albifrons (Eastern Atlantic - breeding) - Little tern (A195)	0.786	0.8	0.03	0.01	0.04	<0.005	0.87	0	**111**
		Arenaria interpres (Western Palearctic - wintering) - Ruddy turnstone (A169)	4.856	0.8	0.03	0.01	0.04	<0.005	0.87	0	18
SPA	North York Moors	Pluvialis apricaria [North-western Europe - breeding] - European golden plover (A140)	0.471	1.36	0.03	0.01	0.04	<0.005	1.43	0	**304**

Designation	Site Name	Interest Feature	Critical Load CLmaxN (keq.ha^{-1}.yr^{-1})	AC (keq.ha^{-1}.yr^{-1})	Teesside REP PC (keq.ha^{-1}.yr^{-1})*	Tees CCPP PC (keq.ha^{-1}.yr^{-1})**	Billingham Reach PC (keq.ha^{-1}.yr^{-1})***	Saltholme North + Saltholme South PC (keq.ha^{-1}.yr^{-1})	PEC (keq.ha^{-1}.yr^{-1})	Salthome N+S PC/min CL (%)	PEC/ CL (%)
		Falco columbarius - Merlin (A098)	0.792	1.36	0.03	0.01	0.04	<0.005	1.43	0	**181**
SSSI	Teesmouth & Cleveland Coast SSSI	Various	1.998	0.99	0.03	0.01	0.04	0.06	1.12	**3**	56
pSPA	Teesmouth & Cleveland Coast	Various	1.998	0.84	0.03	0.01	0.04	0.06	0.97	**3**	48
SAC	North York Moors SAC	Blanket bogs (if active bog) (H7130)	0.54	1.36	0.03	0.01	0.04	<0.005	1.43	0	**265**
		Northern Atlantic wet heaths with Erica tetralix (H4010)	0.792	1.36	0.03	0.01	0.04	<0.005	1.43	0	**181**
		European dry heaths (H4030)	0.792	1.36	0.03	0.01	0.04	<0.005	1.43	0	**181**

Note: CLF = Critical Load Function
*Maximum predicted acid deposition rate presented in Air Quality Environmental Impact Assessment Addendum (REC, April 2015)
** Maximum predicted acid deposition rate presented in Tees CCPP Project, Volume 1 – Chapter 7 (Sembcorp Utilities UK, May 2018)
*** Maximum predicted acid deposition rate presented in Billingham Reach ES Addendum, Chapter 7 (Tees Eco Energy Limited, August 2016)



Stacks
PC = 10 Percent of CL
Contour: Daily Mean NOx PC
Special Protection Area
Site of Special Scientific Interest
Potential Special Protection Area

Notes
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Project: Saltholme – Air Quality Impacts on Habitat Sites

Job Ref: JAR10459

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Figure C.1: Daily-Mean NO_X PC ($\mu g.m^{-3}$)

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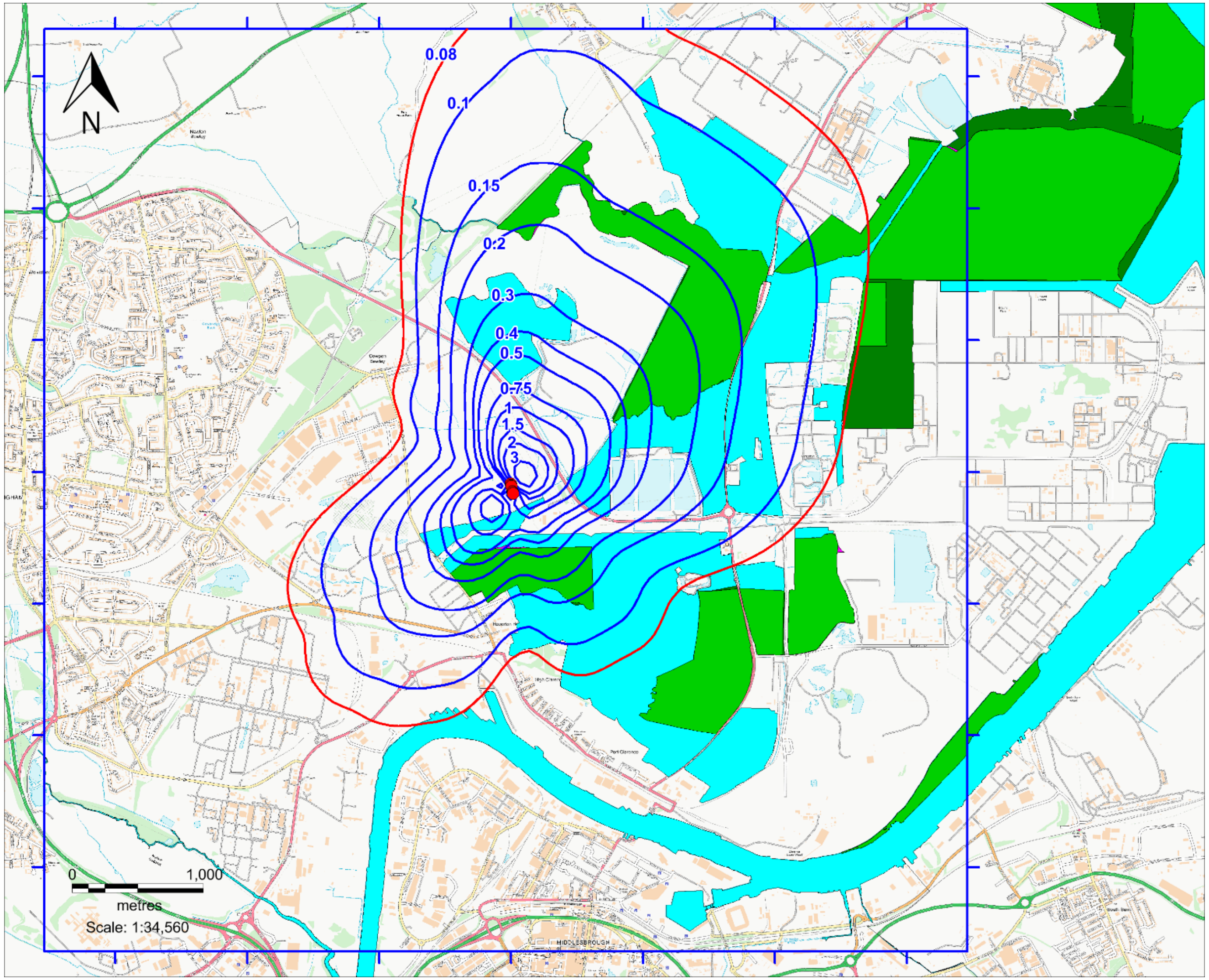

Stacks
PC = 1 Percent of Min CL
Contour: Nutrient Nitrogen Deposition PC
Special Protection Area
Site of Special Scientific Interest
Potential Special Protection Area

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Figure C.2: Nutrient N Deposition PC	

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Interpretation of Results

Annual-mean NOx

C.20 The maximum annual-mean NO_X PC is above 1% of the critical level at three habitat sites. However, the PECs are below the critical level. As such, the emissions are not considered to be significant.

Daily-mean NOx

C.21 The maximum daily-mean NOx PC is above 10% of the critical level at Teesmouth & Cleveland Coast SPA/Ramsar site, SSSI and pSPA. The PECs across parts of these sites exceed the critical level of 75 $\mu g.m^{-3}$ and the emissions are considered to be potentially significant. Consequently, these impacts have been passed to the project's ecologist, and a statement on the likely significance of effect has been provided within the Habitats Regulations Assessment (HRA).

Annual-mean NH_3

C.22 The maximum annual-mean NH_3 PC is above 1% of the critical level at three habitat sites. However, the PECs are below the critical level. As such, the emissions are not considered to be significant.

Nutrient N Deposition

C.23 The maximum nitrogen deposition PC exceeds 1% of the critical load range at the Teesmouth & Cleveland Coast SPA/Ramsar site, SSSI and pSPA. The PECs across parts of these sites exceed the minimum critical load for some interest features and the emissions are considered to be potentially significant. Consequently, these impacts have been passed to the project's ecologist, and a statement on the likely significance of effect has been provided within the HRA.

Acid Deposition

C.24 The maximum acid deposition PC exceeds 1% of the critical load function at the Teesmouth & Cleveland Coast SSSI and pSPA. However, the PECs at these sites do not exceed the minimum critical loads. On that basis, the emissions are not considered to be significant.

Significance of Daily-Mean NO_X and Nutrient N Deposition

Daily-mean NOx

C.25 Figure C.1 presents the contour plot of the predicted daily-mean NO_X PC from the Saltholme facilities. The areas of the Teesmouth & Cleveland Coast habitat sites where the PC exceeds 10% of the critical level are shown. This figure and the full set of air quality impacts have been passed to the project's ecologist, and a statement on the significance of the likely effect for Daily-Mean NOx is included within the HRA.

Nutrient N Deposition

C.26 Figure C.2 presents the contour plot of the cumulative nutrient nitrogen PC predicted from the Saltholme facilities, which shows the areas of the Teesmouth & Cleveland Coast habitat sites where the PC is potentially significant. These impacts have been passed to the Project's ecologist and a statement on the significance of the likely effect for nutrient nitrogen deposition is included within the HRA.

Appendix D: BAT Sensitivity Test

D.1 As part of the Best Available Techniques (BAT) assessment, consideration has been given to a scenario in which the stacks are aggregated. This report provides the results of a stack height determination assuming that the flues serving the four engines are routed through one stack. The impacts from the stacks at the height so determined have been compared with the impacts predicted in the original assessment, which assumed that the four engine flues would each have their own stack.

Approach

D.2 As in the original assessment, the determination of the appropriate stack height for a one-stack scenario was performed by identifying the height required to meet relevant air quality assessment levels (AQALs) and overcome the wake effects of nearby buildings. A series of atmospheric dispersion modelling simulations have been used to predict the ground-level concentrations for two stacks at a range of heights: starting at 11 metres and extending up in 1 metre increments, until a height of 20 metres is reached.

Model Inputs

Stack Parameters and Emissions Rates used in the Model

D.3 The stack characteristics modelled in the original assessment and the stack characteristics modelled for this sensitivity test are provided in Table D.1.

Table D.1: Stack Characteristics

Parameter	Unit	Value Used in Original Assessment – Each Stack	Value Used in Sensitivity Test – Each Stack
Stack height	m	15	15
Number of stacks	-	4	1
Grid reference	-	-	449000, 523901
Internal diameter	m	1.3	2.6
Efflux velocity	$m.s^{-1}$	23.6	23.6
Efflux temperature	^{o}C	288	288
Actual volumetric flow	$Am^3.s^{-1}$	31.3	125.2
Oxygen by (dry) volume	%	12.9	12.9
Water by volume	%	9.2	9.2
Normalised volumetric flow (dry, 0^0C, 15% O_2)	$Nm^3.s^{-1}$	18.71	74.84
NO_X Emission Concentration (dry, 0^0C, 15% O_2)*	$mg.Nm^{-3}$	30	30
NH_3 Emission Concentration (dry, 0^0C, 15% O_2)	$mg.Nm^{-3}$	5	5

D.4 The NO_x mass emission rates for the original assessment and this sensitivity test are provided in Table D.2.

Table D.2: Stack Emissions

Pollutants	Mass Emission Rate ($g.s^{-1}$)	Emission Rate Used in Sensitivity Test – Stack 1 (g.s-1)
NO_x	0.561	2.245

Model Inputs

D.5 All other model inputs are the same as in the modelling for the main assessment to allow a comparison of the results. In particular:

- Modelling has been undertaken for a worst-case scenario assuming that the gas engines operate for 3,500 hours per year.
- A surface roughness length of 0.5 m has been used within the model to represent the average surface characteristics across the study area.
- The buildings and structures listed in Table 3.3 have been included within the model.

Model Outputs

D.6 Pollutant concentrations have been predicted over a domain of 3 km by 3 km centred on the Plant and with a grid spacing of 30 m. Results have been reported for the location where the highest concentration is predicted. This is considered a robust and conservative approach.

D.7 In addition, the effects of the facility have been assessed at the façades of local existing receptors, listed in Table 3.5. All human receptors have been modelled at a height of 1.5 m, representative of typical head height. The locations of these discrete receptors are listed in Table 3.5 and illustrated in Figure 2.

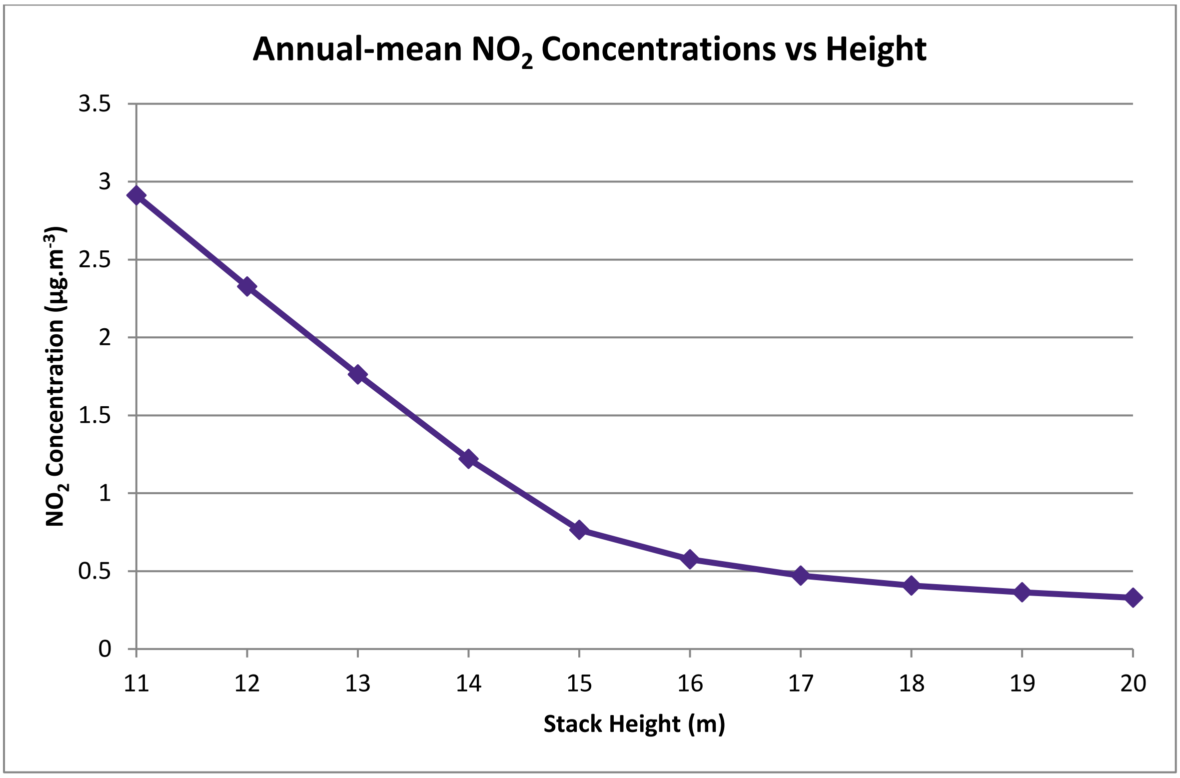
Stack Height Determination

Results of Stack Emissions Modelling

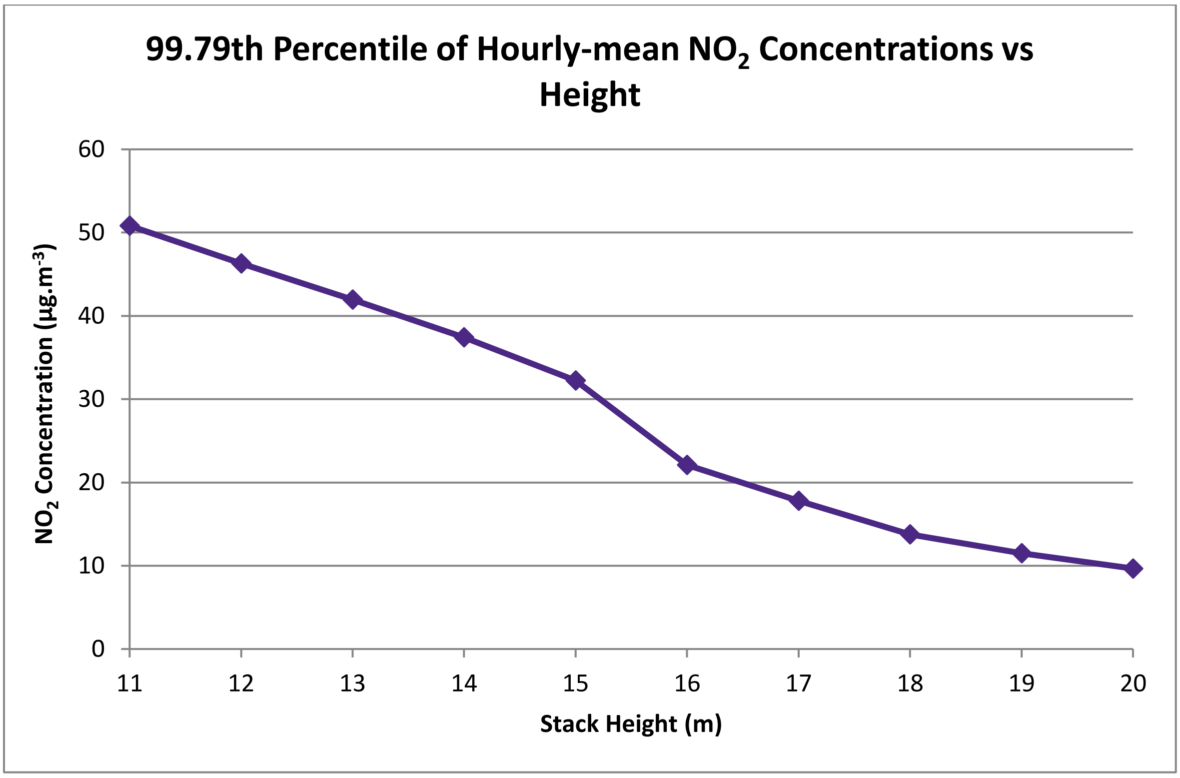
D.8 The stack height modelling results have been analysed in two stages:

D.9 Stage 1 - The maximum predicted annual-mean and 99.79th percentile of hourly-mean NO_2 process contributions have been plotted against height to determine if there is a height at which no benefit is gained from increases in stack heights. The maximum predicted annual-mean process contribution and the maximum predicted 99.79th percentile of hourly-mean process contributions are compared with the stack heights modelled in Graphs D.1 and D.2 below.

Graph D.1 – Maximum Predicted Annual-mean NO_2 Process Contributions (µg.m[-3]) vs Stack Height (m)



Graph A.2 – Maximum Predicted 99.79th Percentile of Hourly-mean NO_2 Process Contributions ($\mu g.m^{-3}$) vs Stack Height (m)



D.10 Neither of the graphs show the ground-level Process Contribution levelling off within the range of heights considered. The graphs indicate that the point at which there are no further potential benefits in increasing the stack height, is beyond 20 m height.

D.11 Stage 2 – Noting that the maximum predicted ground level concentration occurs in close proximity to the site, where no members of the public would be exposed, the lowest height at which the maximum long and short-term NO_2 impacts at sensitive receptors are 'not significant' has been determined.

Stack Height Determination Results

D.12 The maximum long and short-term impacts at sensitive receptors, for each height, are set out in Table D.3 and Table D.4 respectively.

Table D.3 Maximum Impacts at Sensitive Receptors – Long-term NO_2

Height (m)	Annual Mean PC ($\mu g.m^{-3}$)	Annual- mean PC as %AQAL	Annual Mean PEC ($\mu g.m^{-3}$)
11	0.04	0	14.0
12	0.04	0	14.0
13	0.04	0	14.0

Height (m)	Annual Mean PC (µg.m^{-3})	Annual- mean PC as %AQAL	Annual Mean PEC (µg.m^{-3})
14	0.04	0	14.0
15	0.04	0	14.0
16	0.04	0	14.0
17	0.04	0	14.0
18	0.04	0	14.0
19	0.04	0	14.0
20	0.04	0	14.0

The AQAL for annual-mean NO_2 is 40 µg.m^{-3}.

Table D.4 Maximum Impacts at Sensitive Receptors – Short-term NO_2

Height (m)	99.79th Percentile of Hourly-mean PCs (µg.m^{-3})	99.79th Percentile of Hourly-mean PC as %AQAL	99.79th Percentile of Hourly-mean PEC (µg.m^{-3})	99.79th Percentile of Hourly-mean PEC as % of AQAL
11	1.2	1	29.2	15
12	1.2	1	29.2	15
13	1.2	1	29.2	15
14	1.2	1	29.2	15
15	1.2	1	29.2	15
16	1.2	1	29.2	15
17	1.2	1	29.1	15
18	1.1	1	29.1	15
19	1.1	1	29.1	15
20	1.1	1	29.1	15

The AQAL for 99.79th hourly-mean NO_2 is 200 µg.m^{-3}.

D.13 For the long-term impacts, the PEC is well below the AQAL of 40 µg.m^{-3} at all heights considered.

D.14 For the short-term impacts, the maximum PEC at the sensitive receptors is 15% of the AQAL of 200 µg.m^{-3} at all heights and the impacts are considered ‘not significant’.

Conclusion

D.15 The impacts are negligible at all stack heights modelled. The results of the modelling that follows assume a 15 m high stack.

Comparison with Original Results

Results of Stack Emissions Modelling

Short-term NO_2 Impacts

D.16 Table D.5 summarises the highest predicted short-term Process Contribution (PC) for NO_2 anywhere across the modelled grid for the four 15 m stacks as presented in the main assessment.

Table D.5: Highest Predicted Short-term Process Contribution (μg.m^{-3}) for NO_2 – 4 x 15 m Stacks

Averaging period (Pollutant)	AQAL (μg.m^{-3})	Max PC (μg.m^{-3})	Max PC as % of AQAL	Potentially Significant? Yes/No	AC (μg.m^{-3})	PEC (μg.m^{-3})	Significant? Yes/No
1 hour 99.79th percentile (NO_2)	200	43.2	22	Yes	28	71.2	No

The Ambient Concentration is twice the annual-mean NO_2 concentration of 14 μg.m^{-3}

D.17 Table D.6 summarises the highest predicted short-term Process Contribution (PC) for NO_2 anywhere across the modelled grid for emission from the four units combined and released via one 15 m high stack.

Table D.6: Highest Predicted Short-term Process Contribution (μg.m^{-3}) for NO_2 – 1 x 15 m Stack

Averaging period (Pollutant)	AQAL (μg.m^{-3})	Max PC (μg.m^{-3})	Max PC as % of AQAL	Potentially Significant? Yes/No	AC (μg.m^{-3})	PEC (μg.m^{-3})	Significant? Yes/No
1 hour 99.79th percentile (NO_2)	200	32.2	16	Yes	28	60.2	No

The Ambient Concentration is twice the annual-mean NO_2 concentration of 14 μg.m^{-3}

D.18 The maximum PC for the 15 m one-stack scenario falls below the maximum PC for the four 15 m stacks. In both cases, the results show that the maximum short-term PC anywhere across the modelling grid is above 10% of the relevant AQAL; however, when the PC is added to the AC, the maximum short-term PEC is below the AQAL. As such, the short-term NO_2 impacts are considered to be 'not significant'.

D.19 Comparison of Tables D.5 and D.6 shows that there is a 9 μg.m^{-3} decrease in the maximum PEC for the aggregated stack option compared with the chosen stack option. Although this is a slight improvement on the chosen option with individual stacks, the maximum predicted short-term impacts are considered to be not significant for both stack options.

Long-term NO_2 Impacts

D.20 Table D.7 summarises the highest long-term PEC anywhere across the modelled grid for four 15 m stacks as presented in the main assessment.

Table D.7: Highest Long-term Predicted Environmental Concentrations – 4 x 15 m Stacks

Averaging period (Pollutant)	AQAL ($\mu g.m^{-3}$)	AC ($\mu g.m^{-3}$)	Max PC ($\mu g.m^{-3}$)	Change as % of AQAL	Potentially Significant? Yes/No	Max PEC ($\mu g.m^{-3}$)	Max PEC as % of AQAL	Significant? Yes/No
Annual mean (NO_2)	40	14	2.2	6	Yes	16.2	41	No

D.21 Table D.8 summarises the highest long-term PEC anywhere across the modelled grid for one 15 m stack.

Table D.8: Highest Long-term Predicted Environmental Concentrations – 1 x 15 m Stacks

Averaging period (Pollutant)	AQAL ($\mu g.m^{-3}$)	AC ($\mu g.m^{-3}$)	Max PC ($\mu g.m^{-3}$)	Change as % of AQAL	Potentially Significant? Yes/No	Max PEC ($\mu g.m^{-3}$)	Max PEC as % of AQAL	Significant? Yes/No
Annual mean (NO_2)	40	14	0.8	2	Yes	14.8	37	No

D.22 The maximum PC for the aggregate stack scenario at 15 m is 1.4 $\mu g.m^{-3}$ lower than the maximum PC for the four 15 m stacks. In both cases, the results show that the maximum long-term PC anywhere across the modelling grid is above 1% of the relevant AQAL; however, when the PC is added to the AC, the maximum long-term PEC is below the AQAL. As such, the long-term NO_2 impacts are considered to be 'not significant'.

D.23 Comparison of Tables D.7 and D.8 shows that there is a slight decrease in the maximum PEC for the aggregated stack option compared with the chosen option; however, the maximum predicted long-term impacts are already considered to be significant for the original proposal with individual stacks.

Summary

D.24 In conclusion, this analysis has shown that the potential aggregation of stacks (compared with the chosen 4-stack option) will have slight beneficial effect on both the predicted short term and long term air quality impacts; however, both stack options are likely to result in impacts that are 'not significant' at human health receptors.

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6 Environment Agency (2010) Environmental Permitting Regulations (EPR) – H1 Environmental Risk Assessment

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8 Defra (2016) Local Air Quality Management Technical Guidance, 2016 (LAQM.TG16)

9 Environment Agency (2007) Review of methods for NO to NO2 conversion in plumes at short ranges

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14 Email from Ellen Bekker (Natural England) to Rosemary Challen (RPS) dated 31/10/18

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17 Approaches to modelling local nitrogen deposition and concentrations in the context of Natura 2000 - Topic 4

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