FICHTNER

Consulting Engineers Limited

Redcar Energy Centre

Low Carbon Limited

Dispersion Modelling Assessment

ENGINEERING CONSULTING

Document approval

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Management Summary

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

1) Dispersion Modelling of Emissions

The ADMS dispersion model is routinely used for air quality assessments to the satisfaction of the Environment Agency (EA). The model uses weather data from the local area to predict the spread and movement of the exhaust gases from the stack for each hour over a five-year period. The model takes account of wind speed, wind direction, temperature, humidity and the amount of cloud cover, as all of these factors influence the dispersion of emissions. The model also takes account of the effects of buildings and terrain on the movement of air. To set up the model, it has been assumed that the Facility operates for the whole year and releases emissions at the emission limits compliant with the BAT-AELs set out in the Waste Incineration BREF for new plants, with the exception of oxides of nitrogen for which an emission limit lower than the upper end of the BAT-AEL range is being applied for in line with the EA's position statement on the implementation of the BREF for new plants in the England. The model has been used to predict the ground level concentration of pollutants on a long-term and short-term basis across a grid of points. In addition, concentrations have been predicted at the identified sensitive receptors.

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

The air quality impact of the Facility on human health has been assessed using a standard approach based on guidance provided by the EA. Using this approach, in relation to the Air Quality Assessment Levels (AQALs) set for the protection of human health the following can be concluded from the assessment.

1. Emissions from the operation of the Facility will not cause a breach of any AQAL.
2. The overall impact of long-term process emissions associated with the operation of the Facility can be considered 'insignificant' and 'not significant' in accordance with the EA's screening criteria at the point of maximum impact and at all identified human sensitive receptors.
3. The overall impact of short-term process emissions associated with the operation of the Facility can be screened out as 'not significant' in accordance with the EA's screening criteria at all areas of relevant exposure and at all identified human sensitive receptors.
4. The EA's approach to assessing the impact of metals has been used which considers the risk of exceeding the AQAL based on the existing background levels and contribution from the Facility. Using this approach, it has been determined that where the PEC exceeds the AQAL for heavy metals, it is due to high background concentrations rather than contributions from the Facility and the impact of emissions from the Facility is not significant.

3) Approach and Assessment of Impact on Air Quality – Protection of Ecosystems

The impact of air quality on ecology has been assessed using a standard approach based on guidance provided by the EA. Using this approach, in relation to the Critical Level and Critical Loads set for the protection of ecology it can be concluded that all of the impacts at ecological features can be screened out as insignificant except for nitrogen deposition at coastal sand dune habitats in the Teesmouth and Cleveland Coast SPA/Ramsar. The significance of this effect has been considered in the Environmental Statement submitted with the approved planning application for the Facility, which concludes that the effect is 'not significant'.

4) Summary and Conclusions

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

Contents

1 Introduction

1.1 Background

Fichtner Consulting Engineers Ltd ('Fichtner') has been engaged by Low Carbon Limited to undertake a Dispersion Modelling Assessment to support the application for an Environmental Permit (EP) for the Redcar Energy Centre (the 'Facility').

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

When considering the impact on human health, the predicted atmospheric concentrations have been compared to the Air Quality Assessment Levels (AQALs) for the protection of human health. It is noted that for some pollutants such as metals and dioxins they have the potential to accumulate within the environment. A separate Dioxin Pathway Intake Assessment has been undertaken to assess the pathway intake of these pollutants and impacts compared to the Tolerable Daily Intakes (TDIs).

When considering the impact on ecosystems the predicted atmospheric concentrations have been compared to the Critical Levels for the protection of ecosystems. It is noted that deposition of emissions over a prolonged period can have nutrification and acidification impacts. An assessment of the long-term deposition of pollutants has been undertaken and the results compared to the habitat specific Critical Loads.

1.2 Structure of the report

This report has the following structure.

- Air quality legislation and guidance are considered in section 2.
- The assessment criteria used are described in section 3.
- The background levels of ambient air quality are described in section 4.
- The residential properties and ecological receptors which are sensitive to changes in air quality associated with the operation of the Facility and identified in section 5.
- The inputs used for the dispersion model are contained in section 6.
- Details of the sensitivity analysis carried out is presented in section 7.
- The assessment methodology and results of the assessment of the impact of emissions on human health is presented in section 8.
- The assessment methodology and results of the assessment of the impact of emissions at ecological sites is presented in section 9.
- The analysis of the cumulative impact with other local sources is detailed in section 10.
- The conclusions of the assessment are set out in section 11.
- The Appendices include illustrative figures and detailed results tables.

2 Legislation Framework and Policy

2.1 Air quality assessment levels

In the UK, AAD Limit Values, Targets, and air quality standards and objectives for major pollutants are described in The Air Quality Strategy (AQS). In addition, the EA include Environmental Assessment Levels (EALs) for other pollutants in the environmental management guidance 'Air Emissions Risk Assessment for your Environmental Permit'[1] ("Air Emissions Guidance"), which are also considered. The long-term and short-term EALs from these documents have been used when the AQS does not contain relevant objectives. Standards and objectives for the protection of sensitive ecosystems and habitats are also contained within the Air Emissions Guidance and the Air Pollution Information System (APIS)[2].

The Environment Act (2021) introduces a duty on the government to set a legally binding target for $PM_{2.5}$. To date this has not yet been set. The Department for the Environment Food and Rural Affairs (Defra) fact sheet[3] sets out that:

"The government is committed to evidence-based policy making, and will consider the World Health Organisation's (WHO's) annual mean guideline level for $PM_{2.5}$ when setting the target, alongside independent expert advice, evidence and analysis on a diversity of factors – from the health benefits of reducing $PM_{2.5}$, to the practical feasibility and economic viability of taking different actions.

It would be irresponsible to set a target without giving consideration to its achievability and the measures required to deliver on that target.

The target level and achievement date will be developed during the target setting process and will follow in secondary legislation."

The WHO set an annual mean $PM_{2.5}$ guideline value of 10 µg/m³ in 2005, which was updated to 5 µg/m³ in 2021. It is possible that the Secretary of State will set targets at either of the WHO recommendations or set an independently determined target. Whilst neither the 2005 nor 2021 WHO guideline values are currently legally binding, the impact of the Facility against these guideline values has been considered in this assessment due to the requirement within the Environment Act to set a legally binding target for $PM_{2.5}$.

AAD Target and Limit Values, AQS Objectives, and EALs are collectively referred to as Air Quality Assessment Levels (AQALs) for the remainder of this report. Table 1 to Table 3 summarise the AQALs used in this assessment.

Table 1: Air Quality Assessment Levels (AQALs)

Pollutant	Limit Value (µg/m³)	Averaging Period	Frequency of Exceedances	Source
Nitrogen dioxide	200	1 hour	18 times per year (99.79th percentile)	AQS Objective
	40	Annual	-	AQS Objective

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

[2] www.apis.ac.uk

[3] DEEFRA Policy paper 10 March 2020: Air quality factsheet (part 4) - https://www.gov.uk/government/publications/environment-bill-2020/10-march-2020-air-quality-factsheet-part-4

Pollutant	Limit Value (µg/m³)	Averaging Period	Frequency of Exceedances	Source
Sulphur dioxide	266	15 minutes	35 times per year (99.9th percentile)	AQS Objective
	350	1 hour	24 times per year (99.73rd percentile)	AQS Objective
	125	24 hours	3 times per year (99.18th percentile)	AQS Objective
Particulate matter (PM_{10})	50	24 hours	35 times per year (90.41st percentile)	AQS Objective
	40	Annual	-	AQS Objective
Particulate matter ($PM_{2.5}$)	25	Annual	-	AQS Target Value
	10	Annual	-	WHO 2005 Guideline
	5	Annual	-	WHO 2021 Guideline
Carbon monoxide	10,000	8 hours, running	-	AQS Objective
	30,000	1 hour		Air Emissions Guidance
Hydrogen chloride	750	1 hour	-	Air Emissions Guidance
Hydrogen fluoride	160	1 hour	-	Air Emissions Guidance
	16	Annual	-	Air Emissions Guidance
Ammonia	2,500	1 hour	-	Air Emissions Guidance
	180	Annual	-	Air Emissions Guidance
Lead	0.25	Annual	-	AQS Objective
Benzene	5.00	Annual	-	AQS Objective
	30	24 hours	-	Air Emissions Guidance
1,3-butadiene	2.25	Annual, running	-	AQS Objective
PCBs	6	1-hour	-	Air Emissions Guidance
	0.2	Annual	-	Air Emissions Guidance
PAHs	0.00025	Annual	-	AQS Objective

Table 2: Air Quality Assessment Levels for Metals

Pollutant	AQAL (ng/m³)	Averaging Period	Source
Cadmium	-	1 hour	-
	5	Annual	AAD Target Value
Mercury	7,500	1 hour	Air Emissions Guidance
	250	Annual	Air Emissions Guidance
Antimony	150,000	1 hour	Air Emissions Guidance

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

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

Pollutant	Concentration (µg/m³)	Measured as	Source
Nitrogen oxides (as nitrogen dioxide)	75	Daily mean	APIS
	200		WHO(1)
	30	Annual mean	AAD Critical Level
Sulphur dioxide	10	Annual mean For the protection of lichens and bryophytes	Air Emissions Guidance / APIS
	20	Annual mean for all higher plants	AAD Critical Level
Hydrogen fluoride	5	Daily mean	Air Emissions Guidance / APIS
	0.5	Weekly mean	Air Emissions Guidance / APIS
Ammonia	1	Annual mean For the protection of lichens and bryophytes	APIS
	3	Annual mean for all higher plants	APIS
Note:			

Pollutant	Concentration ($\mu g/m^3$)	Measured as	Source
Note: *(1) the Institute of Air Quality Management (IAQM) consider it most appropriate to use 200 $\mu g/m^3$ as the short term Critical Level.*			

The WHO Guidelines include a short term (24-hour) average NOx Critical Level of 75 $\mu g/m^3$. However, the CD Rom version of the guidelines[4] expands upon the justification for this level. This shows that experimental evidence exists that the Critical Level reduces from around 200 to 75 $\mu g/m^3$ when in combination with ozone or sulphur dioxide above their Critical Levels. Given the low ozone and sulphur dioxide levels in the UK the IAQM consider it most appropriate to use 200 $\mu g/m^3$ as the short-term Critical Level. As such, when carrying out this assessment the daily Critical Level of 75 $\mu g/m^3$ has been used as an initial screening level, and where a potentially significant impact cannot be screened out, consideration has also been given to the impact with reference to the much higher Critical Level of 200 $\mu g/m^3$.

In addition to the Critical Levels set out in the table above, provides habitat specific Critical Loads for nitrogen and acid deposition. Full details of the habitat specific Critical Loads can be found in Appendix B.

2.2 Areas of relevant exposure

The AQALs apply only at areas of exposure relevant to the assessment level. The following table extracted from Local Authority Air Quality Technical Guidance TG16 (LAQM.TG(16)), most recently updated in February 2021, explains where the AQALs apply.

Table 4: Guidance on Where AQALs Apply

Averaging period	AQALs should apply at:	AQALs should generally not apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
24-hour mean and 8-hour mean	All locations where the annual mean AQAL would apply, together with hotels. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.

[4] WHO Guidelines CD Rom version

Averaging period	AQALs should apply at:	AQALs should generally not apply at:
1-hour mean	All locations where the annual mean and 24 and 8-hour mean AQALs apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.
15-minute mean	All locations where members of the public might reasonably be exposed for a period of 15-minutes or longer.	

Source: Box 1.1 LAQM.TG(16)

2.3 Industrial pollution regulation

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

- Article 15, paragraph 2, of the IED requires that Emission Limit Values (ELVs) are based on best available techniques, referred to as BAT.
- Article 13 of the IED, requires that 'the Commission' develops BAT guidance documents (referred to as BREFs).
- Article 21, paragraph 3, of the IED, requires that when updated BAT conclusions are published, the Competent Authority (in England this is the EA) has up to four years to revise permits for facilities covered by that activity to comply with the requirements of the sector specific BREF.

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

2.4 Local air quality management

In accordance with Section 82 of the Environment Act (1995) (Part IV), local authorities are required to periodically review and assess air quality within their area of jurisdiction, under the system of

Local Air Quality Management (LAQM). This review and assessment of air quality involves assessing present and likely future ambient pollutant concentrations against AQALs. If it is predicted that levels at the façade of buildings where members of the public are regularly present (normally residential properties) are likely to be exceeded, then the local authority is required to declare an AQMA. For each AQMA, the local authority is required to produce an AQAP, the objective of which is to reduce pollutant levels in pursuit of the relevant AQALs.

3 Assessment Criteria

3.1 Human health

The Air Emissions Guidance states that to screen out 'insignificant' PCs:

- *the long-term PC must be less than 1% of the long-term environmental standard; and*
- *the short-term PC must be less than 10% of the short-term environmental standard.*

As part of this assessment, predicted PCs have been compared to the AQALs detailed in section 2.1.

If the above criteria are achieved, it can be concluded that it is not likely that emissions would lead to significant environmental impacts and the PCs can be screened out.

The long-term 1% PC threshold is based on the judgement that:

- it is unlikely that an emission at this level will make a significant contribution to air quality; and
- the threshold provides a substantial safety margin to protect health and the environment.

The short-term 10% PC threshold is based on the judgement that:

- spatial and temporal conditions mean that short-term PCs are transient and limited in comparison with long-term PCs; and
- the threshold provides a substantial safety margin to protect health and the environment.

For the purpose of this assessment, if the impact can be screened out as 'insignificant' at the point of maximum impact, further assessment is not required. If PCs cannot be screened out, assessment will be undertaken for the following:

- the Predicted Environmental Concentration (PEC, defined as the PC plus the background concentration) at the point of maximum impact; and
- the PC and PEC at areas of public exposure.

If the long-term PEC is below 70% of the AQAL, or the short-term PC is less than 20% of the headroom[5], it can be concluded that "there is little risk of the PEC exceeding the AQAL", and the impact can be considered 'not significant'.

For the assessment of group 3 metals, guidance taken from the EA document 'Guidance on assessing group 3 metals stack emissions from incinerators – V.4 June 2016' ('EA metals guidance') has been used. The EA metals guidance states that where the process contribution for any metal exceeds 1% of the long term or 10% of the short term environmental standard (in this case the AQAL), this is considered to have potential for significant pollution. Where the process contribution exceeds these criteria, the PEC should be compared to the AQAL. The PEC can be screened out if is less than the AQAL. Where the impact is within these parameters it can be concluded that there is no significant risk of exceeding the AQAL.

3.2 Ecology

The Air Emissions Guidance states that to screen out impacts as 'insignificant' at European and UK statutory designated sites:

- the long-term PC must be less than 1% of the long-term environmental standard (i.e., the Critical Level or Load); and

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

- the short-term PC must be less than 10% of the short-term environmental standard.

If the above criteria are met, no further assessment is required. If the long-term PC exceeds 1% of the long-term environmental standard, the PEC must be calculated and compared to the standard. If the resulting PEC is less than 70% of the long-term environmental standard, the Air Emissions Guidance states that the emissions are 'insignificant' and further assessment is not required. In accordance with the guidance, calculation of the PEC for short-term standards is not required.

The Air Emissions Guidance states further that to screen out impacts as 'insignificant' at local nature sites[6]:

- the long-term PC must be less than 100% of the long-term environmental standard; and
- the short-term PC must be less than 100% of the short-term environmental standard.

In accordance with the guidance, calculation of the PEC for local nature sites is not required.

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

4 Baseline Air Quality

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

The Facility is located within the northern section of the South Tees Development Corporation regeneration area within the RBT zone. It is located within 0.5 km of the estuary of the River Tees to the north-west, and around 4.5 km west of Redcar town centre. It is within the Redcar and Cleveland Brough Council (RCBC) local authority area.

4.1 Air quality review and assessment

The closest AQMA to the Facility is in Staithes, approximately 24 km to the southeast. Due to the distance from the Facility it is considered that the impact of the Facility emissions within this AQMA and all other AQMAs will be negligible. Therefore, the impact on AQMAs has been excluded from the assessment.

4.2 National modelling – mapped background data

In order to assist local authorities with their responsibilities under LAQM, the Defra provides modelled background concentrations of pollutants throughout the UK on a 1 km by 1 km grid. This model is based on known pollution sources and background measurements and is used by local authorities in lieu of suitable monitoring data. In addition, mapped atmospheric concentrations of ammonia are available from Defra throughout the UK on a 5 km by 5 km grid. Concentrations will vary over the modelling domain area. Therefore, the maximum mapped background concentration within the modelling domain (i.e., within 5 km) has been downloaded along with the concentrations for the grid squares containing the Facility. A summary is presented in Table 5. The mapped background concentrations are well below the relevant AQALs.

Table 5: Mapped Background Data

Pollutant	Annual Mean AQAL (µg/m³)	Concentration (µg/m³)		Dataset
		At Facility	Max Within 5 km of Facility	
Nitrogen dioxide	40	17.16	28.68	Defra 2018 Dataset
Particulate matter (PM_{10})	40	10.15	14.19	Defra 2018 Dataset
Particulate matter ($PM_{2.5}$)	20	6.87	8.82	Defra 2018 Dataset
Carbon monoxide	-	244	331	Defra 2001 Dataset
Sulphur dioxide	-	9.10	34.30	Defra 2001 Dataset
Benzene	5	0.36	0.70	Defra 2001 Dataset
1,3-butadiene	2.25	0.15	0.32	Defra 2001 Dataset
Ammonia	180	0.56	1.55	CEH 2014 Dataset

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Defra has not updated the mapped background datasets for carbon monoxide, sulphur dioxide, benzene and 1,3-butadeine since those produced for a base year of 2001. Defra provides factors for adjusting these pollutants to later years. The factors were published in 2003 and result in reduced concentrations in later years. As a conservative measure the 2001 mapped background concentrations have been presented; however, due to a decline in local industry and shipping, it is anticipated that concentrations of pollutants in the area, in particular sulphur dioxide, have decreased substantially since 2001.

4.3 AURN and LAQM monitoring data

Monitoring locations are broadly classified into 'roadside' and 'background' locations. 'Background' locations, which may be urban, suburban, rural or industrial, are typically sited so that no single pollutant source is dominant and are intended to be representative of background concentrations over several square kilometres. 'Roadside' sites are dominated by road traffic emissions and only representative of concentrations in the immediate vicinity of the analyser. This analysis has considered background sites within 5 km, and roadside sites within 2 km, of the Facility.

The UK Automatic Urban and Rural Network (AURN) is a country-wide network of air quality monitoring stations operated on behalf of Defra. The closest site to the Facility is the Middlesbrough urban industrial site, located approximately 8.4 km to the west. Due to the distance from the Facility, concentrations at this site have not been considered.

In addition to the national AURN, local authorities undertake monitoring of a range of pollutants as part of the LAQM review process. Local monitoring is undertaken RCBC. The neighbouring local authorities do not operate any monitoring locations within 5 km of the Facility.

Data from the most recent Annual Status Report (ASR) published by RCBC in 2021 shows that no roadside monitoring has been undertaken within 2 km of the Facility. There are three background (suburban) type monitoring locations within 5 km of the Facility, one of which is the Redcar Dormanstown automatic monitoring site. This site is co-located with nitrogen dioxide diffusion tubes in triplicate. The most recent 5 years of monitoring results provided in Table 6. Little weight is given to monitoring undertaken in 2020 due to the effect of the Covid-19 pandemic.

Table 6: Local Authority Monitoring Data

Ref	Distance from stack (km)	Annual Mean Concentration (µg/m³)					
		2018 Mapped Bg	2016	2017	2018	2019	2020
Background monitoring – nitrogen dioxide							
RD(1)	3.6	14.7	11.0	12.0	10.0	9.0	9.0
R17- R19(2)	3.6	14.7	13.2	14.8	17.5	15.2	13.2
R48	3.7	12.4	-	-	-	17.7	15.0
R52	4.6	13.2	-	-	-	-	11.8
Background monitoring – PM_{10}							
RD(1)	3.6	11.4	12.7	12.0	12.0	14.0	13.0
Background monitoring – $PM_{2.5}$							
RD(1)	3.6	7.4	8.9	8.4	8.4	9.8	9.1
Note: *(1) RD = Redcar Dormanstown, an automatic monitoring site.* *(2) R17 – R19 are co-located in triplicate with the Redcar Dormanstown automatic site.*							

Source: RCBC 2021 Air Quality Annual Status Report

As shown, no exceedance of any AQAL has been measured. The monitored concentrations at background sites (i.e., away from significant road sources) are generally in line with the mapped background concentrations, although concentrations in excess of the mapped background have been measured in at least one of the last five years at most sites, indicating that the mapped background may underestimate actual background concentrations.

As shown, there is limited local monitoring data available, and the closest monitoring location is more than 3.5 km from the Facility. For the pollutants for which monitoring data is available, the monitored concentrations are lower than the maximum mapped background concentrations within 5 km as presented in Table 5. As such, the maximum mapped background concentrations have been used as the baseline background concentrations for the assessment.

4.4 National monitoring data

4.4.1 Hydrogen chloride

Hydrogen chloride is measured on behalf of Defra as part of the UK Eutrophying and Acidifying Atmospheric Pollutants (UKEAP) project. This consolidates the previous Acid Deposition Monitoring Network (ADMN), and National Ammonia Monitoring Network (NAMN). There are no monitoring locations within 10 km of the Facility. A summary of data from all UK monitoring sites is presented in Table 7. The UK ceased monitoring of hydrogen chloride at the end of 2015.

Table 7:National Monitoring – Hydrogen Chloride

Site Type	Quantity	AQAL	Annual Mean Concentration (µg/m³)				
			2012	2013	2014	2015	2016
All	Min	-	0.11	0.15	0.10	0.12	-
	Max		0.49	0.50	0.54	0.71	-
	Average		0.27	0.31	0.26	0.24	-

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In lieu of any local monitoring, the UK maximum from the national monitoring network will be used as the baseline concentration for the assessment.

4.4.2 Hydrogen fluoride

Baseline concentrations of hydrogen fluoride are not measured locally or nationally since this pollutant is not generally of concern in terms of local air quality. However, the EPAQS report 'Guidelines for halogens and hydrogen halides in ambient air for protecting human health against acute irritancy effects' contains some estimates of baseline levels, reporting that measured concentrations have been in the range of 0.036 µg/m^3 to 2.35 µg/m^3.

In lieu of any local monitoring, the maximum measured baseline hydrogen fluoride concentration (2.35 µg/m³) will be used as the baseline concentration for the assessment as a conservative estimate.

4.4.3 Ammonia

Ammonia is also measured as part of the UKEAP project. There are no UKEAP monitoring locations within 10 km of the Facility. In lieu of any representative monitoring data, the maximum mapped background concentrations within the modelling domain presented in Table 5 (1.55 µg/m³) has been used as the baseline concentration for the assessment for human health. For the assessment of ecological impacts, site-specific data has been obtained from the Air Pollution Information System (APIS) website[7] where required. This data is presented in section 9.2.

4.4.4 Volatile Organic Compounds

As part of the Automatic and Non-Automatic Hydrocarbon Network, benzene concentrations are measured at sites co-located with the AURN across the UK. In 2007, due to low monitored concentrations of 1,3-butadiene at non-automatic sites, Defra took the decision to cease non-automatic monitoring of 1,3-butadiene. There are no automatic 1,3-butadiene monitors within 10 km of the Facility.

In lieu of any local monitoring of benzene and 1,3-butadiene, the maximum mapped background concentrations within the modelling domain (0.70 µg/m³ for benzene and 0.32 µg/m³ for 1,3-butadiene, as presented in Table 5) have been used as the baseline concentrations for the assessment.

4.4.5 Metals

Metals are measured as part of the Rural Metals and UK Urban/Industrial Networks (previously the Lead, Multi-Element and Industrial Metals Networks). Monitoring of metals was undertaken at the Redcar Normanby site until the end of 2013. This site is located approximately 9 km south-west of the Facility, with no other monitoring sites located within 100 km of the Facility. Therefore, it is considered that the historical monitoring data from Redcar Normanby is most representative of the conditions in the vicinity of the Facility. The most recent monitoring data from Redcar Normanby is presented in Table 8.

Table 8: Metals Monitoring – Redcar Normanby

Substance	AQAL (ng/m³)	Annual Mean Concentration (ng/m³) - 2013	as % of AQAL
Arsenic	6	0.39	6.50%
Cadmium	5	0.12	2.40%
Chromium	5,000	1.60	0.03%
Cobalt	-	0.03	-
Copper	10,000	2.20	0.02%
Lead	250	4.30	1.72%
Manganese	150	4.10	2.73%
Nickel	20	0.51	2.55%
Vanadium	5,000	0.65	0.01%

Source: © Crown 2021 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL)

As shown, the monitored concentrations are well below the respective AQALs.

There are also AQALs for antimony and mercury. However, these metals were not monitored at Redcar Normanby. Monitoring of antimony across the UK ceased at the end of 2013. The maximum

[7] www.apis.ac.uk

monitored at any background site in 2013 was 1.30 ng/m³ at Detling, which has been used as the baseline concentration for the assessment. This value is only 0.026% of the annual mean AQAL of 5,000 ng/m³.

Mercury was widely monitored across the UK until the end of 2013 (and was monitored in the PM_{10} fraction at Redcar Normanby, although this excludes gaseous mercury). The maximum monitored at any urban or rural background site in 2013 was 2.10 ng/m³ at Cockley Beck, which has been used as the baseline concentration for the assessment. This value is only 0.84% of the annual mean AQAL of 250 ng/m³.

4.4.6 Dioxins, furans and polychlorinated biphenyl (PCBs)

Dioxins, furans and PCBs are monitored on a quarterly basis at a number of urban and rural stations in the UK as part of the Toxic Organic Micro Pollutants (TOMPs) network. There are no monitoring locations within 10 km of the Facility.

A summary of dioxin and furan and PCB concentrations from all monitoring sites across the UK is presented in Table 9 and Table 10. Monitoring data is only available up to the end of 2016 for dioxins and the end of 2018 for PCBs.

Table 9: TOMPS – Dioxin and Furans Monitoring

Site	Annual Mean Concentration (fgTEQ/m³)				
	2012	2013	2014	2015	2016
Auchencorth Moss	0.13	0.86	0.01	0.01	0.13
Hazelrigg	8.75	2.02	2.61	5.27	4.59
High Muffles	4.32	0.60	1.07	0.54	2.73
London Nobel House	15.42	3.47	2.89	4.34	21.27
Manchester Law Courts	32.99	10.19	16.52	5.94	12.23
Weybourne	9.30	2.34	1.61	1.42	16.32

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Table 10: TOMPS – PCB Monitoring

Site	Annual Mean Concentration (pg/m³)				
	2014	2015	2016	2017	2018
Auchencorth Moss	23.23	24.27	25.32	19.09	12.31
Hazelrigg	25.84	41.68	52.58	33.15	22.22
High Muffles	26.11	33.43	37.76	31.63	8.86
London Nobel House	107.49	121.39	110.46	121.87	46.63
Manchester Law Courts	128.93	97.99	92.60	97.27	40.10
Weybourne	17.00	20.95	38.61	32.26	11.23

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As shown, the concentrations vary significantly between sites and years. As no site is located in close proximity to the Facility, the maximum monitored concentrations (32.99 fg/TEQ/m³ for dioxins and furans and 128.93 pg/m³ for PCBs) have been used as the baseline concentrations for the assessment.

4.4.7 Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAHs) are monitored as part of the PAH network. For the purpose of this assessment, benzo(a)pyrene is considered as this is the only PAH for which an AQAL has been set. The closest monitoring site is at Middlesbrough, an urban background site approximately 8.4 km to the west of the Facility. A summary of benzo(a)pyrene concentrations from Middlesbrough and all background monitoring sites within the UK is presented in the following table.

Table 11: National Benzo(a)pyrene Monitoring

Site	Quantity	AQAL	Annual Mean Concentration (ng/m³)				
			2016	2017	2018	2019	2020
Middlesbrough	-	0.25	0.19	0.14	0.17	0.18	0.13
All UK Background Monitoring	Minimum	0.25	0.02	0.01	0.02	0.01	0.01
	Maximum	0.25	1.30	0.86	0.74	0.83	0.55
	Average	0.25	0.27	0.20	0.18	0.22	0.16

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The concentrations measured at Middlesbrough are at the lower end of the range monitored at background sites across the UK. As conservative estimate, the maximum monitored concentration from any UK background site (1.30 ng/m³ – 2016) has been used for this assessment, noting that this exceeds the AQAL.

4.5 Summary

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

Table 12: Summary of Baseline Concentrations

Pollutant	Annual Mean	Units	Source
Nitrogen dioxide	28.68	µg/m³	Maximum mapped background concentration from across the modelling grid – Defra 2018 dataset
Sulphur dioxide	34.30	µg/m³	Maximum mapped background concentration from across the modelling grid – Defra 2001 dataset
Particulate matter (as PM_{10})	14.19	µg/m³	Maximum mapped background concentration from across the modelling grid – Defra 2018 dataset
Particulate matter (as $PM_{2.5}$)	8.82	µg/m³	Maximum mapped background concentration from across the modelling grid – Defra 2018 dataset

Pollutant	Annual Mean	Units	Source
Carbon monoxide	331	µg/m³	Maximum mapped background concentration from across the modelling grid – Defra 2001 dataset
Benzene	0.70	µg/m³	Maximum mapped background concentration from across the modelling grid – Defra 2001 dataset
1,3-butadiene	0.32	µg/m³	Maximum mapped background concentration from across the modelling grid – Defra 2001 dataset
Ammonia	1.55	µg/m³	Maximum mapped background concentration from across the modelling grid – CEH 2014 dataset
Hydrogen chloride	0.71	µg/m³	Maximum monitored concentration across the UK 2011 to 2015
Hydrogen fluoride	2.35	µg/m³	Maximum measured concentration from EPAQS report
Mercury	2.10	ng/m³	Maximum monitored at a UK background site in 2013
Antimony	1.30	ng/m³	Maximum monitored at a UK background site in 2013
Arsenic	0.39	ng/m³	Maximum monitored at Redcar Normanby in 2013
Cadmium	0.12	ng/m³	
Chromium	1.60	ng/m³	
Cobalt	0.03	ng/m³	
Copper	2.20	ng/m³	
Lead	4.30	ng/m³	
Manganese	4.10	ng/m³	
Nickel	0.51	ng/m³	
Vanadium	0.65	ng/m³	
PaHs	1.30	ng/m³	Maximum monitored at a UK background site, 2016 - 2020
Dioxins and Furans	32.99	fg ITEQ /m³	Maximum monitored across the UK 2012 to 2016
PCBs	128.93	pg/m³	Maximum monitored across the UK 2014 to 2018

5 Sensitive Receptors

5.1 Human sensitive receptors

The general approach to the assessment is to evaluate the highest predicted process contribution to ground level concentrations. In addition, the predicted process contribution at a number of sensitive receptors has been evaluated. These sensitive receptors are displayed in Figure 1 of Appendix A and listed in Table 13. The Facility is located in an area that was formerly dominated by heavy industry. The closest human sensitive receptors are industrial and commercial, with no high sensitivity residential receptors in close proximity. The same receptor points that were identified in air quality assessment submitted with the planning application for the Facility have been included in this assessment. These comprise a mix of residential, commercial and industrial properties.

Table 13: Human Sensitive Receptors

ID	Name	Receptor Type	Location		Distance from stack (m)
			X (m)	Y (m)	
R1	Tesco DC	Industrial	455521	524198	1,870
R2	Intertek	Commercial	454076	524732	2,234
R3	Hartlepool Power Station	Industrial	452988	526955	3,048
R4	Frutarom UK	Commercial	453507	527302	2,703
R5	Birkbrow Motors	Commercial	457837	523976	2,829
R6	Broadway West	Residential	458050	523878	3,048
R7	York Road	Residential	458903	525055	3,164
R8	Northumbrian Water	Industrial	456751	524385	1,856
R9	Redcar Bulk Terminal	Commercial	454849	525945	1,048
R10	Paddy's Hole	Commercial	455616	527344	1,342
R11	Broadway East	Residential	458776	524150	3,442
R12	Tod Point Road	Residential	457942	525050	2,272

5.2 Ecological sensitive receptors

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

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

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

Table 14: Ecological Sensitive Receptors

ID	Site	Desig-nation(1)	Closest point to Facility		Distance from stacks at closest point (km)	Lichens/ bryo-phytes present
			X (m)	Y (m)		
European and UK Designated Sites						
E1	Teesmouth and Cleveland Coast	Ramsar/ SPA/SSSI	455734	526280	0.3	No
Local Nature Sites						
E2	Teesmouth	NNR	454390	526915	1.7	No

The maximum process contribution at ground level within each site has been assessed.

Reference should be made to Appendix B for full details of the habitats present at each site and the habitat-specific Critical Loads.

6 Dispersion Modelling Methodology

6.1 Selection of model

Detailed dispersion modelling was undertaken using the model ADMS 5.2, developed and supplied by Cambridge Environmental Research Consultants (CERC) This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the atmospheric stability and the boundary layer height. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. The model also includes modules to take account of the effect of buildings and complex terrain.

ADMS is routinely used for modelling of emissions for planning and environmental permitting purposes to the satisfaction of the EA and local authorities. The maximum predicted concentration for each pollutant and averaging period has been used to determine the significance of any potential impacts.

6.2 Source and emissions data

6.2.1 Main stacks

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

Table 15: Stack Source Data

Item	Unit	Value
Stack Data		
Height	m	80 - See Stack Height Analysis (section 7.1)
Internal diameter (each flue)	m	2.30
Location – stack 1	m, m	455890, 526032
Location – stack 2	m, m	455895, 526030
Flue Gas Conditions		
Temperature	°C	140
Exit moisture content	% v/v	17.8%
	kg/kg	0.130
Exit oxygen content	% v/v dry	8.1%
Reference oxygen content	% v/v dry	11%
Volume at reference conditions (dry, ref O_2) – both flues combined	Nm^3/h	398,880
	Nm^3/s	110.80
Volume at actual conditions – both flues combined	Am^3/h	569,520
	Am^3/s	158.20
Flue gas exit velocity	m/s	19.04

Table 16: Stack Emissions Data – Both Flues Combined

Pollutant	Daily or Periodic	Half-hourly	Daily or Periodic	Half-hourly
	Conc. (mg/Nm^3)		Release Rate (g/s)	
Oxides of nitrogen (as NO_2)	100	400	11.080	44.32
Sulphur dioxide	30	200	3.324	22.16
Carbon monoxide	50	150(1)	5.540	16.62
Fine particulate matter (PM)(2)	5	30	0.554	3.324
Hydrogen chloride	6	60	0.665	6.648
Volatile organic compounds (as TOC)	10	20	1.108	2.216
Hydrogen fluoride	1	4	0.111	0.222
Ammonia	10	-	1.108	-
Cadmium and thallium	0.02	-	2.216 mg/s	-
Mercury	0.02	-	2.216 mg/s	-
Other metals(3)	0.3	-	33.24 mg/s	-
Benzo(a)pyrene (PAHs)(4)	0.2 $\mu g/Nm^3$	-	22.16 µg/s	-
Dioxins, furans and dioxin-like PCBs	0.06 ng/Nm^3	-	6.648 ng/s	-
PCBs(5)	5.0 $\mu g/Nm^3$	-	0.554 mg/s	-

Notes:

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

(1) Averaging period for carbon monoxide is 95% of all 10-minute averages in any 24-hour period.

(2) As a worst-case it has been assumed that the entire PM emissions consist of either PM_{10} or $PM_{2.5}$ for comparison with the relevant AQALs.

(3) Other metals consist of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V).

(4) Figure 8.121 of the 2019 WI BREF shows that the maximum recorded at a UK plant was 0.2 $\mu g/m^3$. This is assumed to be the emission concentration for the Facility.

(5) Table 3.8 of the 2006 WI BREF states that the annual average total PCBs was less than 0.005 mg/Nm^3 (dry, 11% oxygen, 273K). In lieu of other available operational data, this has been assumed to be the emission concentration for the Facility.

If the Facility continually operated at the half-hourly limits, the daily limits would be exceeded. The Facility is designed to achieve the daily limits and as such will only operate at the short term limits for short periods on rare occasions. The impact of the Facility operating at the short-term limits is presented in section 8.

6.2.2 Emergency diesel generator

The proposed design for the Facility includes an emergency diesel generator (EDG) to enable safe shut-down of the ERF in the event of a loss in grid connection. The EDG would only be expected to operate for short periods (i.e., approximately half an hour per week, totalling less than50 hours per year) for testing purposes. It is expected that the EDG will have a capacity of around 10 MWth. The location of the EDG is yet to be confirmed but is likely to be close to the main ERF buildings.

Emissions from the EDG will, as a minimum standard, comply with the emission limit for oxides of nitrogen specified in “TA-Luft 2g” of 2,000 mg/Nm³ (273.15K, dry, 5% O_2), equivalent to 742 mg/Nm³ at 15% O_2. Based on the combustion of 10 MWth of diesel fuel and assuming emissions at 742 mg/Nm³ at 15% O_2, the EDG will release approximately 6.38 g/s of oxides of nitrogen. The impact of emissions from the EDG is considered insignificant for the following reasons:

1. The hours of operation will be very limited. The EDG will run for less than 50 hours per year, typically for up to half an hour per week for testing or for up to 4 hours in an emergency shutdown situation. Such an emergency shutdown situation is anticipated to be extremely rare.
2. The EDG will have an appropriate stack height, likely 8 – 12 m. Due to the relatively short stack, the maximum ground-level impact will occur in close proximity to the stack, likely within 100 m. The area around the Facility is industrial in nature so no high-sensitivity human receptors will be significantly affected by emissions from the EDG.
3. The closest ecological receptor, the Teesmouth and Cleveland Coast SPA/Ramsar/SSSI, lies within 130 m of the Installation boundary, but more than 300 m from the likely location of the EDG. Due to the distance between the EDG and the Teesmouth and Cleveland Coast SPA/Ramsar/SSSI, no significant impact on ecological features is anticipated.
4. The emission rate of oxides of nitrogen from the EDG (6.38 g/s) is significantly less than from the ERF (11.08 g/s at the daily average ELV, 44.32 g/s at the half-hourly ELV). Although the stack height will be shorter, due to the lower oxides of nitrogen release rate and limited number of operational hours (see point 1), emissions from the EDG will not significantly add to nitrogen deposition at Teesmouth and Cleveland Coast SPA/Ramsar/SSSI.

As such, emissions from the EDG will not be significant and have not been considered further in this assessment.

6.3 Other inputs

6.3.1 Meteorological data and surface characteristics

The impact of meteorological data used in the assessment has been taken from Durham Tees Valley Airport meteorological recording station for the years 2015 – 2019. Durham Tees Valley Airport is located approximately 23 km to the southwest of the Facility and is the closest and most representative meteorological station available. The data was provided by ADM Limited.

The period 2015 to 2019 was chosen to align with the dispersion modelling undertaken to support the planning application for the Facility. The EA recommends that 5 years of data are used to take into account inter-annual fluctuations in weather conditions. Wind roses for each year are presented in Figure 3.

The minimum Monin-Obukhov length can be selected in ADMS for both the dispersion site and the meteorological site. This is a measure of the minimum stability of the atmosphere and can be adjusted to account for urban heat island effects which prevent the atmosphere in urban areas from ever becoming completely stable. The minimum Monin-Obukhov length has been set to 10 m for both the dispersion site and for the meteorological site. The value of 10 m is recommended by CERC for small towns <50,000 inhabitants and is considered appropriate for the surroundings of the meteorological site. The surroundings of the dispersion site are uninhabited, but currently comprise a mix of industry and open land. Therefore, a value of 10 m is also considered appropriate for the surroundings of the dispersion site.

The surface roughness length can be selected in ADMS for both the dispersion site and the meteorological site. The surface roughness has been set to 0.2 m for the meteorological site, which is appropriate for the relatively open surroundings of Durham Tees Valley Airport. The surface roughness length varies widely across the modelling domain, from very low values over the Tees estuary to much higher values over built up areas. To account for the varying surface roughness length a spatially-varying surface roughness file has been generated and used as a model input. The land-use class for each point in the file has been extracted from the CORINE Land Cover database[8] and cross-referenced with the most likely surface roughness length value[9].

The parameters for the spatially-varying surface roughness file are shown in Table 17 and a visual representation provided in Figure 4.

Table 17: Spatially Varying Surface Roughness File Parameters

Parameter	Value
Grid spacing (m)	50
Grid points	205 x 205
Grid Start X (m)	450775
Grid Finish X (m)	461025
Grid Start Y (m)	520875
Grid Finish Y (m)	531125

Table 18: Surface Roughness Lengths Used for Different Land Use Classes

Land Use Classification	Corine 2018 Land Use Codes	Surface Roughness Length (m)
Continuous urban fabric	111	1.2
Forest	311, 312	0.75
Green urban areas	141	0.6
Discontinuous urban fabric, industrial or commercial units(1), sport and leisure facilities, port areas	112, 121, 142, 123	0.5
Agricultural land with areas of natural vegetation	243	0.3
Road and rail networks and associated land	122	0.075
Non-irrigated arable land, inland marshes	211, 411	0.05
Pastures, moors and heathland, natural grasslands	231, 322, 321	0.03
Salt marshes, sparsely vegetated areas, mineral extraction sites	421, 333, 131	0.005
Intertidal flats	423	0.0005
Water(2)	523, 512, 511	0.0001

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

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

Land Use Classification	Corine 2018 Land Use Codes	Surface Roughness Length (m)
Notes: *(1) The area between the A1085 and A1053 covered by the British Steel site was misclassified as 'Road and rail networks and associated land'. This area was considered to be industrial or commercial units with a roughness length of 0.5 m.* *(2) The 'most likely' value for water is given as zero. ADMS cannot model a surface roughness length of zero, so areas of water have been assigned a roughness length of 0.0001 m which is the value recommended by CERC for 'sea'.*		

A summary of the meteorological parameters used in the dispersion modelling is shown in Table 19

Table 19: Meteorological parameters

Parameter	Dispersion Site Value (m)	Met Site Value (m)
Surface roughness length	Variable	0.2
Minimum Monin-Obukhov length	10	10

The sensitivity of the modelling results to the choice of surface roughness has been considered in section 7.

6.3.2 Modelling domain

Modelling has been undertaken using a 9 x 9 km grid of points with a spatial resolution of 90 m. The grid resolution is fine enough to accurately capture the highest modelled concentrations from the 80 m tall stacks. Reference should be made to Figure 5 for a graphical representation of the modelling domain used. The extent of the modelling domain is detailed in Table 20.

Table 20: Modelling Domain

Grid Quantity	Value
Grid spacing (m)	90
Grid points	101 x 101
Grid Start X (m)	451400
Grid Finish X (m)	460400
Grid Start Y (m)	521500
Grid Finish Y (m)	530500

6.3.3 Terrain

It is recommended that, where gradients within 500 m of the modelling domain are greater than 1 in 10, the complex terrain module within ADMS (FLOWSTAR) should be used. A review of the local area has deemed that the effect of terrain should be taken into account in the modelling.

A terrain file large enough to cover the output grid of points was created using Ordnance Survey Terrain 50 data. The parameters of the terrain files used are outlined in Table 21. Reference should be made to Figure 6 for a graphical representation of the terrain file used.

Table 21: Terrain File Parameters

Parameter	Value
Grid spacing (m)	50
Grid points	205 x 205
Grid Start X (m)	450775
Grid Finish X (m)	461025
Grid Start Y (m)	520875
Grid Finish Y (m)	531125

6.3.4 Buildings

The presence of adjacent buildings can significantly affect the dispersion of the atmospheric emissions in various ways:

- Wind blowing around a building distorts the flow and creates zones of turbulence. The increased turbulence can cause greater plume mixing.
- The rise and trajectory of the plume may be depressed slightly by the flow distortion. This downwash leads to higher ground level concentrations closer to the stack than those which would be present without the building.

The EA recommends that buildings should be included in the modelling if they are both:

- Within 5L of the stack (where L is the smaller of the building height and maximum projected width of the building); and
- Taller than 40% of the stack.

The ADMS 5.2 user guide also states that buildings less than one third of the stack height will not have any effect on the dispersion calculations in the model.

A review of the site layout has been undertaken and the details of the buildings included in the model are presented in Table 22. The buildings have been modelled at the height of the highest point of the structure. A site plan showing which buildings have been included in the model is presented in Figure 7.

Table 22: Building Details

Buildings	Centre Point		Height (m)	Width (m)	Length (m)	Angle (°)
	X (m)	Y (m)				
Boiler House (1)	455863	525961	49	68	25	20
Bunker 1	455851	525933	40	77	37	20
Bunker 2	455872	525980	40	47	15	20
Tipping Hall	455838	525901	24	58	34	20
Turbine Hall	455925	525997	2	24	49	20

Note:
(1) Selected as the main building for the Facility

6.4 Chemistry

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

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

6.5 Baseline concentrations

Background concentrations for the assessment have been derived from monitoring and national mapping as presented in section 3. For short term averaging periods, the background concentration has been assumed to be twice the long term ambient concentration following the Air Emissions Guidance methodology.

7 Sensitivity Analysis

7.1 Stack height assessment

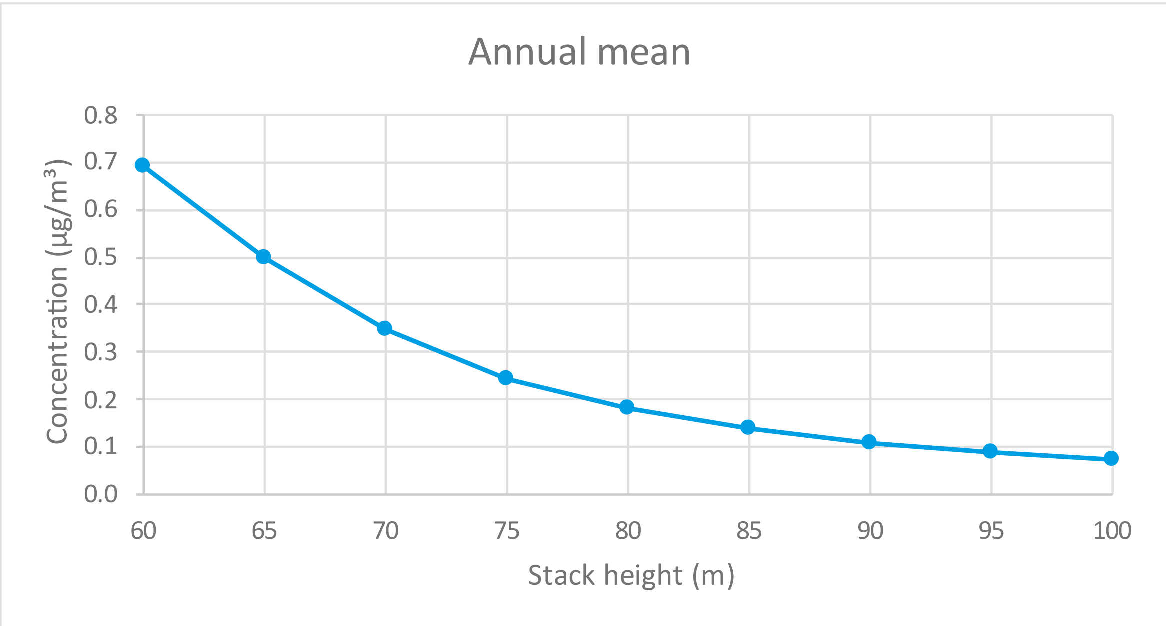
When determining a suitable stack height, it is best practice to identify the stack height where the rate of reduction in maximum ground level concentration with increased height slows down. This can be identified on a graph as a step change in the slope. A range of stack heights from 60 m to 100 m (at 5 m increments) has been considered.

To ensure that the highest concentrations are adequately captured, the model has been run with a 3 x 3 km grid out output points at a resolution of 30 m. The surface roughness and terrain files have been scaled appropriately and run at 32 x 32 resolution.

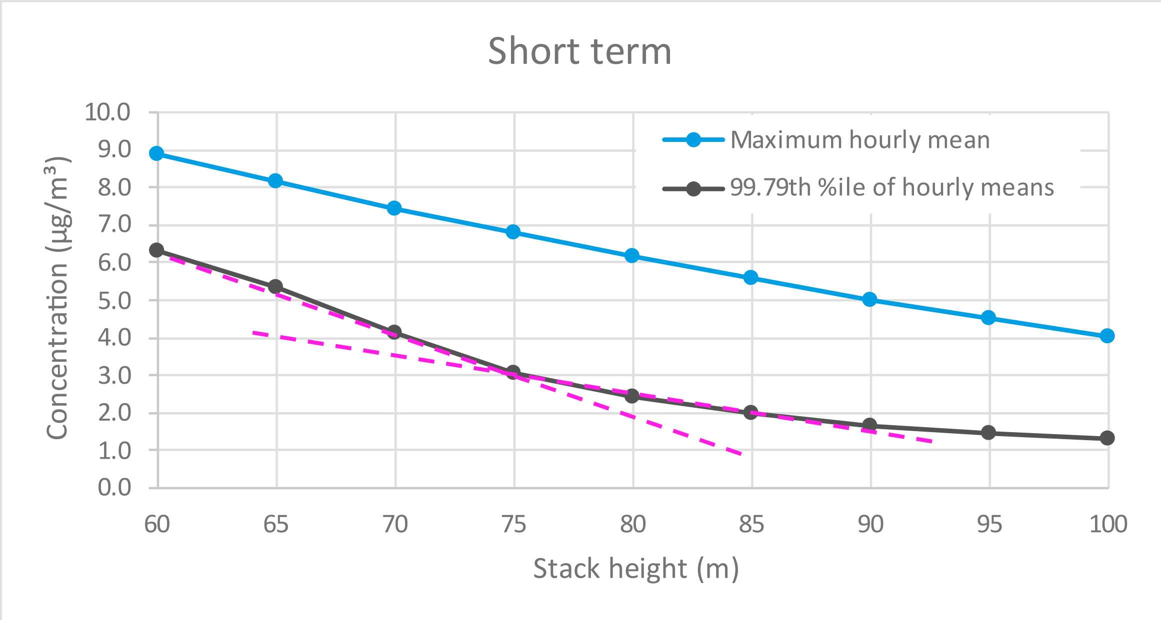
The following parameters were kept constant for each stack height:

- Buildings – included;
- Grid size – 3 x 3 km at 30 m resolution;
- Dispersion site surface roughness value – variable at 32 x 32 resolution;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – 10 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Terrain – included at 32 x 32 resolution; and
- Meteorological data used – Durham Tees Valley Airport 2015 to 2019.

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



Graph 1 – Annual Mean Stack Height Analysis



Graph 2 – Short-Term Stack Height Analysis

For annual mean concentrations there is no clear step change in the angle of the slope, but rather a general flattening of the slope is observed as the stack height is increased.

There is little change in the angle of the slope for maximum hourly mean concentrations. For the 99.79th percentile of hourly mean concentrations (which has been selected for its relevance to the short-term AQAL for nitrogen dioxide), there is a slight change in slope at a stack height of 75 m, as shown by the magenta lines. On this basis the minimum stack height recommend is 75 m. The Air Quality Assessment submitted with the planning application was based on a stack height of 80 m, and the stack height being proposed as part of the EP application remains at 80 m.

With an 80 m high stack, at the point of maximum impact, and assuming operation at the emission limits set out in Table 16:

- all annual mean impacts on human health at areas of relevant exposure can be screened out as 'not significant' when the PEC is considered;
- all short term impacts on human health can be screened out as 'insignificant' if it is assumed that the plant operates at the daily BAT-AELs; and
- short-term impacts on nitrogen dioxide and sulphur dioxide cannot be screened out as 'insignificant' at the point of maximum impact if it is assumed that both lines of the Facility operate at the short-term ELVs during the worst case weather conditions for dispersion. However, further analysis (presented in section 8.6) shows that there is no risk of exceedance of any AQAL;
- Certain impacts on ecological receptors cannot be screened out as 'insignificant'. However, further analysis (presented in section 9) shows that no significant effects are predicted.

Therefore, a stack height of 80 m provides adequate dispersion of pollutants from the Facility, and the remainder of this assessment has been undertaken for a stack height of 80 m.

7.2 Surface roughness

The sensitivity of the results to using spatially varying surface roughness length has been considered by running the model with a variety of surface roughness lengths for the dispersion site. For all sensitivity analyses the impact of changing model parameters on the maximum annual mean and short-term concentrations of oxides of nitrogen have been considered.

The following parameters were kept constant:

- Stack height – 80 m
- Buildings – included;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – 10 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Terrain – included at 64 x 64 resolution; and
- Meteorological data used – Durham Tees Valley Airport 2015.

The contribution of the Facility to the ground level concentration of oxides of nitrogen at the point of maximum impact and at the maximum impacted human receptor is presented in Table 23.

Table 23: Surface Roughness Sensitivity Analysis

Surface roughness (m)	Oxides of Nitrogen PC (µg/m³)		
	Annual Mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
Varying	**2.05**	**27.26**	**30.67**
0.1	1.59	25.72	26.63
0.2	1.74	25.22	26.26
0.3	1.85	24.89	26.51
0.5	2.02	24.88	27.14
0.7	2.15	24.70	31.42
Maximum impacted receptor			
Varying	**0.69**	**10.55**	**14.27**
0.1	0.46	10.46	14.00
0.2	0.54	10.32	13.26
0.3	0.59	10.17	12.88
0.5	0.64	9.95	13.80
0.7	0.68	9.78	13.66

As shown, increasing the surface roughness value leads to greater annual mean concentrations at the point of maximum impact and at the maximum impacted receptor. Using the spatially varying surface roughness file leads to annual mean concentrations similar to a fixed surface roughness of 0.5 – 0.7 m.

Short-term concentrations are not particularly sensitive to the choice of surface roughness length. The spatially varying surface roughness file leads to maximum short-term concentrations at the upper end of those predicted using fixed surface roughness lengths.

The spatially varying surface roughness length was selected for the model as this was considered the most accurate representation of the different land use types in the modelling domain.

7.3 Building parameters

The sensitivity of the results to the effect of buildings has been considered by running the model with and without the buildings presented in Table 22.

The following parameters were kept constant:

- Stack height – 80 m
- Dispersion site surface roughness – variable at 64 x 64 resolution;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – 10 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Terrain – included at 64 x 64 resolution; and
- Meteorological data used – Durham Tees Valley Airport 2015.

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

Table 24: Effect of Buildings

Scenario used in model	Oxides of Nitrogen PC (µg/m³)		
	Annual Mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
Including buildings	**2.05**	**27.26**	**30.67**
Excluding buildings	0.82	19.41	30.39
Maximum impacted receptor			
Including buildings	**0.69**	**10.55**	**14.27**
Excluding buildings	0.57	10.46	14.45

As shown, modelling the presence of buildings results in higher annual mean and short-term concentrations at the point of maximum impact, but has little effect at the maximum impacted receptor. Buildings have been included in the dispersion model as this represents a realistic approach.

7.4 Terrain

The sensitivity of the results to the effect of terrain has been considered by running the model with and without the terrain file.

The following parameters were kept constant:

- Stack height – 80 m
- Dispersion site surface roughness – variable at 64 x 64 resolution;

- Buildings – included;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – 10 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Meteorological data used – Durham Tees Valley Airport 2015.

The contribution of the Facility to the ground level concentration of oxides of nitrogen at the point of maximum impact and at the maximum impacted human receptor is presented in Table 25 for each scenario.

Table 25: Effect of Terrain

Scenario used in model	Oxides of Nitrogen PC (µg/m³)		
	Annual Mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
Including terrain	**2.05**	**27.26**	**30.67**
Excluding terrain	1.75	27.02	30.86
Maximum impacted receptor			
Including terrain	**0.69**	**10.55**	**14.27**
Excluding terrain	0.65	11.32	14.65

As shown, modelling the effects of terrain results in higher annual mean concentrations at the point of maximum impact, but has little effect on short term concentrations, or concentrations at the maximum impacted receptor. Terrain effects have been included in the dispersion model as this represents a realistic approach and is the recommended approach given the level of terrain variances in the area.

7.5 Grid resolution

The sensitivity of the results to the grid resolution used has been considered by running the model with a grid resolution of 90 m (see Table 20) and with a grid resolution of 25 m. The resolution of 25 m has been chosen as this is not a divisor of 90 m, so the grid points will not be substantially duplicated which would reduce the value of the sensitivity analysis.

The following parameters were kept constant:

- Stack height – 80 m
- Dispersion site surface roughness – variable at 64 x 64 resolution;
- Buildings – included;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – 10 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Meteorological data used – Durham Tees Valley Airport 2015.

The contribution of the Facility to the ground level concentration of oxides of nitrogen at the point of maximum impact is presented in Table 25 for each scenario.

Table 26: Effect of Grid Resolution.

Grid resolution used in model (m)	Oxides of Nitrogen PC (µg/m³)		
	Annual Mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
90 m	**2.05**	**27.26**	**30.67**
25 m	2.09	27.42	31.14

As shown, a grid resolution of 25 m captures very slightly higher annual mean and short-term concentrations, but the difference is less than 2% and will not affect any conclusions. Therefore, an output grid resolution of 90 m is sufficiently fine to accurately capture the maximum predicted concentrations. That the grid resolution does not affect the impacts at the specific receptor points.

7.6 Operating below the design point

Dispersion modelling has been undertaken using the emission parameters based on the design point for the Facility. The Facility will be operated as a commercial plant, so it is beneficial to operate at full capacity. If loading does fall below the design point the volumetric flow rate and the exit velocity of the exhaust gases would reduce. The effect of this would be to decrease the quantity of pollutants emitted but also to reduce the buoyancy of the plume due to momentum. The reduction in buoyancy, which would lead to reduced dispersion, would be more than offset by the decrease in the amount of pollutants being emitted, so that the impact of the plant when running below the design point would be reduced.

8 Impact on human health

Table 27 and Table 28 present the results of the dispersion modelling of process emissions from the Facility at the point of maximum impact. This is a summary of the maximum impact over 5 years. Results are presented as the maximum predicted concentration based on the following:

- Modelling domain size – a 9 x 9 km grid with a spatial resolution of 90 m;
- Buildings – included;
- Stack height – 80 m;
- 5 years of weather data 2015 to 2019 from Durham Tees Valley Airport meteorological recording station;
- Dispersion site surface roughness value – variable at 32 x 32 resolution;
- Meteorological site surface roughness value – 0.2 m
- Dispersion and meteorological site Monin-Obukhov length – 10 m
- Terrain – included at 32 x 32 resolution
- Assumes operation of both lines at the long term ELVs for 100% of the year;
- Assumes operation of both lines at the short term ELVs during the worst-case conditions for dispersion of emissions (Table 28 only);
- EA's worst case 70% long-term and 35% short-term conversion of NOx to nitrogen dioxide;
- The entire VOC emissions are assumed to consist of either benzene or 1,3-butadiene; and
- Cadmium is released at the combined emission limit for cadmium and thallium.

The baseline concentration is taken from the review of baseline conditions contained in section 3.

Process contributions that cannot be screened out as 'insignificant' are highlighted. Where the process contribution cannot be screened out as 'insignificant', further analysis has been undertaken.

Table 27: Dispersion Modelling Results – Point of Maximum Impact - Operation at Daily ELVs

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2015	2016	2017	2018	2019	Max			
Nitrogen dioxide	Annual mean	µg/m³	40	28.68	1.44	1.28	1.23	1.07	1.13	1.44	**3.59%**	30.12	75.29%
	99.79th%ile of hourly means	µg/m³	200	57.36	9.54	9.48	9.38	9.35	9.33	9.54	4.77%	66.90	33.45%
Sulphur dioxide	99.18th%ile of daily means	µg/m³	125	68.6	4.89	4.05	3.64	3.73	3.73	4.89	3.91%	73.49	58.79%
	99.73rd%ile of hourly means	µg/m³	350	68.6	8.02	8.01	7.99	7.90	7.96	8.02	2.29%	76.62	21.89%
	99.9th%ile of 15 min. means	µg/m³	266	68.6	8.85	8.72	8.84	8.62	8.71	8.85	3.33%	77.45	29.12%
PM_{10}	Annual mean	µg/m³	40	14.19	0.10	0.09	0.09	0.08	0.08	0.10	0.26%	14.29	35.73%
	90.41st%ile of daily means	µg/m³	50	28.38	0.33	0.34	0.30	0.25	0.28	0.34	0.67%	28.72	57.43%
$PM_{2.5}$	Annual mean	µg/m³	20	8.82	0.10	0.09	0.09	0.08	0.08	0.10	0.51%	8.92	44.61%
Carbon monoxide	8 hour running mean	µg/m³	10,000	662	12.44	12.09	12.50	12.38	12.36	12.50	0.13%	674.50	6.75%
	Hourly mean	µg/m³	30,000	662	15.34	17.78	27.87	16.72	14.86	27.87	0.09%	689.87	2.30%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	1.84	2.13	3.34	2.00	1.78	3.34	0.45%	4.76	0.63%
Hydrogen fluoride	Annual mean	µg/m³	16	2.35	0.02	0.02	0.02	0.02	0.02	0.02	0.13%	2.37	14.82%
	Hourly mean	µg/m³	160	4.7	0.31	0.36	0.56	0.33	0.30	0.56	0.35%	5.26	3.29%
Ammonia	Annual mean	µg/m³	180	1.55	0.21	0.18	0.18	0.15	0.16	0.21	0.11%	1.76	0.98%
	Hourly mean	µg/m³	2,500	3.1	3.07	3.56	5.57	3.34	2.97	5.57	0.22%	8.67	0.35%
VOCs (as benzene)	Annual mean	µg/m³	5	0.7	0.21	0.18	0.18	0.15	0.16	0.21	**4.11%**	0.91	18.11%

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2015	2016	2017	2018	2019	Max			
	Daily mean	µg/m³	30	0.7	1.97	1.65	1.44	1.63	1.45	1.97	6.56%	2.67	8.89%
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.32	0.21	0.18	0.18	0.15	0.16	0.21	**9.13%**	0.53	23.35%
Mercury	Annual mean	ng/m³	250	2.1	0.41	0.37	0.35	0.31	0.32	0.41	0.16%	2.51	1.00%
	Hourly mean	ng/m³	7500	4.2	6.13	7.11	11.15	6.69	5.95	11.15	0.15%	15.35	0.20%
Cadmium	Annual mean	ng/m³	5	0.12	0.41	0.37	0.35	0.31	0.32	0.41	**8.21%**	0.53	10.61%
	Hourly mean	ng/m³	-	0.24	6.13	7.11	11.15	6.69	5.95	11.15	-	11.39	-
PAHs	Annual mean	pg/m³	250	1300	4.11	3.67	3.51	3.06	3.22	4.11	**1.64%**	1304.11	**521.64%**
Dioxins	Annual mean	fg/m³	-	32.99	1.23	1.10	1.05	0.92	0.97	1.23	-	34.22	-
PCBs	Annual mean	ng/m³	200	0.12893	0.10	0.09	0.09	0.08	0.08	0.10	0.05%	0.23	0.12%
	Hourly mean	ng/m³	6000	0.25786	1.53	1.78	2.79	1.67	1.49	2.79	0.05%	3.05	0.05%
Other metals	Annual mean	ng/m³	-	-	6.16	5.51	5.26	4.59	4.83	6.16	See metals assessment – Section 8.7		
	Hourly mean	ng/m³	-	-	92.02	106.65	167.24	100.33	89.18	167.24			

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

Table 28: Dispersion Modelling Results – Point of Maximum Impact - Short-Term ELVs

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC (PC) at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2015	2016	2017	2018	2019	Max			
Nitrogen dioxide	99.79th%ile of hourly means	µg/m³	200	57.36	38.16	37.92	37.53	37.41	37.34	38.16	**19.08%**	95.52	47.76%
Sulphur dioxide	99.73rd%ile of hourly means	µg/m³	350	68.6	53.50	53.38	53.29	52.67	53.06	53.50	**15.28%**	122.10	34.88%
	99.9th%ile of 15 min. means	µg/m³	266	68.6	58.99	58.16	58.94	57.48	58.09	58.99	**22.18%**	127.59	47.97%
Carbon monoxide	8 hour running mean	µg/m³	10000	662	37.33	36.26	37.51	37.13	37.07	37.51	0.38%	699.51	7.00%
	Hourly mean	µg/m³	30000	662	46.01	53.33	83.62	50.16	44.59	83.62	0.28%	745.62	2.49%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	18.38	21.31	33.41	20.04	17.82	33.41	4.45%	34.83	4.64%
Hydrogen fluoride	Hourly mean	µg/m³	160	4.7	1.23	1.42	2.23	1.34	1.19	2.23	1.39%	6.93	4.33%

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

As shown, at the point of maximum impact, all PCs are less than 10% of the short-term AQAL and less than 1% of the annual mean AQAL and can be screened out as 'insignificant' irrespective of the PEC in accordance with The Air Emissions Guidance, with the exception of the following pollutants:

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

Further analysis of impacts at specific receptor locations has been undertaken to define the magnitude of change for annual mean impacts, and the impact at areas of relevant exposure has been analysed using plot files to determine the magnitude of change for short-term impacts.

In addition, consideration has been given to the impact of the Facility on concentrations of $PM_{2.5}$ at receptor locations with reference to the WHO guideline values for $PM_{2.5}$ due to the commitment within the Environment Act for the UK Government to introduce a more stringent AQAL for $PM_{2.5}$.

8.1 Further analysis – annual mean nitrogen dioxide

The annual mean nitrogen dioxide PC from the Facility is predicted to be 3.59% of the AQAL at the point of maximum impact. Table 29 details the impact of annual mean nitrogen dioxide contributions from process emissions at the identified sensitive human receptor locations. PCs greater than 1% of the AQAL are highlighted. Figure 8 shows the spatial distribution of emissions.

Table 29: Annual Mean Nitrogen Dioxide Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.15	0.39%	28.83	72.09%
R2	0.11	0.29%	28.79	71.99%
R3	0.03	0.07%	28.71	71.77%
R4	0.03	0.08%	28.71	71.78%
R5	0.05	0.14%	28.73	71.84%
R6	0.05	0.13%	28.73	71.83%
R7	0.09	0.22%	28.77	71.92%
R8	0.08	0.19%	28.76	71.89%
R9	0.08	0.21%	28.76	71.91%
R10	0.55	**1.37%**	29.23	73.07%
R11	0.05	0.11%	28.73	71.81%
R12	0.08	0.21%	28.76	71.91%

The PC at all identified sensitive receptors except for R10 is less than 1% of the AQAL and can be screened out as 'insignificant'. However, as detailed in Table 13, R10 is a 'commercial' receptor and in accordance with the criteria detailed in Table 4, the annual mean AQAL does not apply at this location.

As shown in Figure 8, the area in which the PC is predicted to exceed 1% of the AQAL does not contain any residential areas, schools, hospitals, or care homes and as such the impact at all areas of relevant exposure can be screened out as 'insignificant'.

8.2 Further analysis – annual mean $PM_{2.5}$

The annual mean $PM_{2.5}$ PC from the Facility is predicted to be less than 1% of the AQAL at the point of maximum impact, and so is considered 'insignificant'. This is based on the AQAL of 20 µg/m³ as set by the AQS Target. As detailed in section 2.1, the Environment Act will introduce a requirement for a new legally-binding limit on annual mean concentrations of $PM_{2.5}$. The recommended value during the various committee stages of the Environment Act was 10 µg/m³, which is the WHO 2005 guideline value. An updated guideline of 5 µg/m³ was published by the WHO in September 2021. Although these guideline values are not currently legally binding in the UK, the impact of the Facility has been assessed against the WHO guideline values for completeness.

The PC from the Facility at the point of maximum impact is predicted to be 1.03% of the WHO 2005 guideline value and 2.05% of the WHO 2021 guideline value. This conservatively assumes that the entire PM emissions consists of only $PM_{2.5}$. Based on the dispersion modelling results, $PM_{2.5}$ could be emitted at up to 48% of the total PM ELV and the maximum impact would be less than 1% of the WHO 2021 guideline value. Although the actual fraction of $PM_{2.5}$ will not be known until operational, monitoring from other facilities has shown that emissions of $PM_{2.5}$ make up only a small proportion of the total dust emissions (and well below 48%).

The PC at receptor locations (assuming that the entire PM emissions consist of only $PM_{2.5}$) is presented in Table 30. Figure 9 shows the spatial distribution of emissions with reference to the WHO 2021 guideline values, which is the most stringent assessment criterion used.

Table 30: Annual Mean $PM_{2.5}$ Impact at Identified Sensitive Receptors – WHO Guideline Values

Receptor	PC			
	µg/m³	% of AQAL	% of WHO 2005 Guideline Value	% of WHO 2021 Guideline Value
R1	0.011	0.06%	0.11%	0.22%
R2	0.008	0.04%	0.08%	0.16%
R3	0.002	0.01%	0.02%	0.04%
R4	0.002	0.01%	0.02%	0.05%
R5	0.004	0.02%	0.04%	0.08%
R6	0.004	0.02%	0.04%	0.07%
R7	0.006	0.03%	0.06%	0.12%
R8	0.006	0.03%	0.06%	0.11%
R9	0.006	0.03%	0.06%	0.12%
R10	0.039	0.20%	0.39%	0.78%
R11	0.003	0.02%	0.03%	0.07%

Receptor	PC			
	µg/m³	% of AQAL	% of WHO 2005 Guideline Value	% of WHO 2021 Guideline Value
R12	0.006	0.03%	0.06%	0.12%

As shown, the impact at all receptor locations is less than 1% of the AQAL and of the 2005 and 2021 WHO guideline values and is therefore 'insignificant'.

8.3 Further analysis - VOCs (as 1,3-butadiene)

There are two VOCs for which an AQAL has been set in the AQS: benzene and 1,3-butadiene. For the purpose of this analysis it has been assumed that the entire VOC emissions consist of only benzene or 1,3-butadiene. This is a highly conservative assumption as it does not take into account the speciation of VOCs in the emissions and the modelling does not take into account the volatile nature of the compounds.

The PC from the Facility is predicted to be 4.11% of the AQAL for benzene and 9.13% of the AQAL for 1,3-butadiene at the point of maximum impact. Table 31 and Table 32 detail the impact of annual mean benzene and 1,3-butadiene contributions from process emissions at the identified sensitive human receptor locations. PCs greater than 1% of the AQAL are highlighted. Figure 10 and Figure 11 show the spatial distribution of emissions.

Table 31: Annual Mean VOCs (as Benzene) Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.022	0.44%	0.72	14.44%
R2	0.016	0.33%	0.72	14.33%
R3	0.004	0.07%	0.70	14.07%
R4	0.005	0.09%	0.70	14.09%
R5	0.008	0.16%	0.71	14.16%
R6	0.007	0.14%	0.71	14.14%
R7	0.012	0.25%	0.71	14.25%
R8	0.011	0.22%	0.71	14.22%
R9	0.012	0.24%	0.71	14.24%
R10	0.078	**1.57%**	0.78	15.57%
R11	0.007	0.13%	0.71	14.13%
R12	0.012	0.24%	0.71	14.24%

Table 32: Annual Mean VOCs (as 1,3-Butadiene) Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.022	0.98%	0.34	15.20%

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R2	0.016	0.73%	0.34	14.95%
R3	0.004	0.17%	0.32	14.39%
R4	0.005	0.21%	0.32	14.43%
R5	0.008	0.35%	0.33	14.57%
R6	0.007	0.32%	0.33	14.54%
R7	0.012	0.55%	0.33	14.77%
R8	0.011	0.49%	0.33	14.71%
R9	0.012	0.53%	0.33	14.75%
R10	0.078	**3.49%**	0.40	17.71%
R11	0.007	0.29%	0.33	14.51%
R12	0.012	0.52%	0.33	14.75%

As shown, the PCs at all receptors are less than 1% of the AQAL and are considered ‘insignificant’, except at R10. However, R10 is a ‘commercial’ receptor so the annual mean AQAL does not apply at this location. In addition, the PECs for both pollutants are well below 70% of the AQAL, so the impact at receptor locations is ‘not significant’ regardless of the sensitivity of the receptor.

8.4 Further analysis – annual mean cadmium

The annual mean cadmium PC from the Facility is predicted to be 8.21% of the AQAL the point of maximum impact. However, this assumes that the entire cadmium and thallium emissions consist of only cadmium. The WI BREF shows that the average concentration recorded from UK plants equipped with bag filters was 1.6 µg/Nm^3 (or 8% of the ELV of 0.02 mg/Nm^3), the highest recorded concentration of cadmium and thallium was 14 µg/Nm^3 (or 70% of the ELV of 0.02 mg/Nm^3) and only three lines recorded concentrations higher than 10 µg/Nm^3 (or 50% of the ELV of 0.02 mg/Nm^3).

Table 33 shows the annual mean cadmium PC at the identified sensitive human receptor locations, for cadmium emitted at 100%, 50% and 8% of the ELV, referred to as the ‘screening’, ‘worst case’ and ‘typical’ scenarios. PCs greater than 1% of the AQAL are highlighted. Figure 12 shows the spatial distribution of emissions assuming cadmium is emitted at 100% of the combined cadmium and thallium emission limit.

Table 33: Annual Mean Cadmium Impact at Identified Sensitive Receptors

Receptor	PC					
	Screening		Worst-case		Typical	
	ng/m³	% AQAL	ng/m³	% AQAL	ng/m³	% AQAL
Pt of max impact	0.411	**8.21%**	0.205	**4.11%**	0.033	0.66%
R1	0.044	0.88%	0.022	0.44%	0.004	0.07%
R2	0.033	0.66%	0.016	0.33%	0.003	0.05%
R3	0.007	0.15%	0.004	0.07%	0.001	0.01%

Receptor	PC					
	Screening		Worst-case		Typical	
	ng/m³	% AQAL	ng/m³	% AQAL	ng/m³	% AQAL
R4	0.009	0.19%	0.005	0.09%	0.001	0.02%
R5	0.016	0.31%	0.008	0.16%	0.001	0.02%
R6	0.014	0.29%	0.007	0.14%	0.001	0.02%
R7	0.025	0.49%	0.012	0.25%	0.002	0.04%
R8	0.022	0.44%	0.011	0.22%	0.002	0.04%
R9	0.024	0.48%	0.012	0.24%	0.002	0.04%
R10	0.157	**3.14%**	0.078	**1.57%**	0.013	0.25%
R11	0.013	0.26%	0.007	0.13%	0.001	0.02%
R12	0.024	0.47%	0.012	0.24%	0.002	0.04%

Even under the screening scenario, the impact only exceeds 1% of the AQAL at R10, which is a 'commercial' receptor at which the annual mean AQAL does not apply. In addition, when the baseline concentration of 0.12 µg/m³ is included, the maximum PEC at any receptor is 0.28 µg/m³ which is 5.67% of the AQAL and therefore 'not significant'.

Under the more realistic assumption that cadmium emissions are typical for an operational UK Facility, the impact at the point of maximum impact and at all receptor locations is well below 1% of the AQAL and can be screened out as 'insignificant'.

8.5 Further analysis – annual mean PAHs

The annual mean PAHs (as BaP) PC from the Facility is predicted to be 1.64% of the AQAL. However, this assumes that BaP is emitted at the highest concentration recorded at a UK plant, as reported in the WI BREF, which is a highly conservative assumption.

Table 33 shows the annual mean PAH PC at the identified sensitive human receptor locations. PCs greater than 1% of the AQAL are highlighted. Figure 13 shows the spatial distribution of emissions.

Table 34: Annual Mean PAHs (as BaP) Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	pg/m³	as % of AQAL	pg/m³	as % of AQAL
R1	0.44	0.18%	1300.44	520.18%
R2	0.33	0.13%	1300.33	520.13%
R3	0.07	0.03%	1300.07	520.03%
R4	0.09	0.04%	1300.09	520.04%
R5	0.16	0.06%	1300.16	520.06%
R6	0.14	0.06%	1300.14	520.06%
R7	0.25	0.10%	1300.25	520.10%
R8	0.22	0.09%	1300.22	520.09%
R9	0.24	0.10%	1300.24	520.10%

Receptor	PC		PEC	
	pg/m³	as % of AQAL	pg/m³	as % of AQAL
R10	1.57	0.63%	1301.57	520.63%
R11	0.13	0.05%	1300.13	520.05%
R12	0.24	0.09%	1300.24	520.09%

Although the PEC is predicted to exceed the AQAL, this is based on the assumption that the baseline concentration is 1.3 ng/m^3 (or 520% of the AQAL), which is the highest annual average monitored at any UK background site from 2016 - 2020. Whilst the assumed baseline exceeds the AQAL, the PC at all receptor locations is well below 1% of the AQAL and can be screened out as 'insignificant'.

8.6 Short-term impacts

Impacts greater than 10% of the short-term AQAL are predicted to for the following pollutants and averaging periods, but only if both lines of the Facility operate concurrently at the half-hourly ELVs during the worst-case weather conditions for dispersion:

- 99.79th percentile of hourly mean nitrogen dioxide;
- 99.9th percentile of 15-minute mean sulphur dioxide; and
- 99.73rd percentile of hourly mean sulphur dioxide.

Both lines operate independently and would only operate at the short-term ELVs for short periods. This analysis does not account for the probability that both would operate concurrently at the half-hourly ELV.

The following plot files have been produced to assist with the assessment of short term impacts on concentrations of nitrogen dioxide and sulphur dioxide:

- Figure 14 [99.79%ile of Hourly Mean Nitrogen Dioxide];
- Figure 15 [99.73%ile of Hourly Mean Sulphur Dioxide]; and
- Figure 16 [99.9%ile of 15-Minute Mean Sulphur Dioxide].

Impacts greater than 10% of the AQAL extend across areas where the public may be exposed for an hour or more. Therefore, consideration has been given to the headroom and the PEC to determine the risk of exceedance of an AQAL.

For both nitrogen dioxide and sulphur dioxide, in the first instance a high baseline concentration (the maximum mapped background from within 5 km) has been assumed. There are no significant local sources in the area where the impacts exceed 10% of the AQAL that would be likely to lead to the actual baseline concentrations being higher than the mapped background concentrations. Therefore, the assumed baseline concentrations are considered appropriately conservative. Table 35 presents the maximum predicted impact as a percentage of the AQAL and percentage of the headroom for the relevant pollutants and averaging periods, assuming both lines operate at the half-hourly ELV during the worst-case weather conditions for dispersion. PCs greater than 20% of the headroom are highlighted.

Table 35: Short-term Impacts

Pollutant and statistic	PC			PEC	
	µg/m³	as % of AQAL	as % of headroom	µg/m³	as % of AQAL
99.79 %ile of hourly mean nitrogen dioxide	38.16	19.08%	26.75%	95.52	47.76%
99.73 %ile of hourly mean sulphur dioxide	53.50	15.28%	19.01%	122.10	34.88%
99.9 %ile of 15-minute mean sulphur dioxide	58.99	22.18%	29.89%	127.59	47.97%

The hourly mean sulphur dioxide PC is less than 20% of the headroom so the impact is considered to be 'not significant'. For 15-minute mean sulphur dioxide and hourly mean nitrogen dioxide, the PC is between 25 – 30% of the headroom. However, even with the assumed high baseline concentrations (see section 4), the assumption that the short-term baseline is twice the annual mean baseline, and the assumption that both lines operate at the half-hourly ELVs during the worst-case weather conditions for dispersion, detailed modelling has shown that the PEC will be less than 50% of the AQAL.

Furthermore, it is highly unlikely that both lines will operate at the half-hourly ELVs during the worst-case weather conditions for dispersion. If only one line was to operate at the half-hourly ELV while the other operated at the daily ELV, the maximum PC is predicted to be 17.2% of the headroom for 15-minute sulphur dioxide and 16.7% of the headroom for hourly mean nitrogen dioxide. As this is less than 20% of the headroom for both pollutants, the impact of one line operating at the half-hourly ELV, whilst the other operates at the daily ELV, is 'not significant'.

Based on the above, the risk of exceedance of an AQAL is considered negligible and the impact is not significant.

8.7 Heavy metals – at the point of maximum impact

Table 36 and Table 37 detail the PC and PEC assuming that each metal is released at the combined long-term metal ELVs set out in the WI BREF. If the PC is greater than 1% of the long-term or 10% of the short-term AQAL and the PEC exceeds the AQAL when it is assumed that each metal is emitted at the total metal ELV, further analysis has been undertaken. The EA's metals guidance[10] details the maximum monitored concentrations of group 3 metals emitted by municipal waste incinerators and waste wood co-incinerators as a percentage of the group ELV. It has been assumed that emissions of metals from the Facility are no greater than the maximum monitored emission presented in the EA's analysis has been used as a conservative assumption for this further analysis. The results are shown in Table 36 and Table 37.

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

Table 36: Long-Term Metals Results – Point of Maximum Impact

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	6	0.39	6.16	**102.66%**	6.55	**109.16%**	8.3%	0.51	**8.55%**	0.90	15.05%
Antimony	5,000	1.30	6.16	0.12%	7.46	0.15%	3.8%	0.24	0.005%	1.54	0.03%
Chromium	5,000	1.60	6.16	0.12%	7.76	0.16%	30.7%	1.89	0.04%	3.49	0.07%
Chromium (VI)	0.25	0.32	6.16	**2463.8%**	6.48	**2591.8%**	0.043%	0.003	**1.07%**	0.32	**129.07%**
Cobalt	-	0.03	6.16	-	6.19	-	1.9%	0.11	-	0.14	-
Copper	10,000	2.20	6.16	0.06%	8.36	0.08%	9.7%	0.60	0.006%	2.80	0.03%
Lead	250	4.30	6.16	**2.46%**	10.46	4.18%	16.8%	1.03	0.41%	5.33	2.13%
Manganese	150	4.10	6.16	**4.11%**	10.26	6.84%	20.0%	1.23	0.82%	5.33	3.55%
Nickel	20	0.51	6.16	**30.80%**	6.67	33.35%	73.3%	4.52	**22.58%**	5.03	25.13%
Vanadium	5,000	0.65	6.16	0.12%	6.81	0.14%	2.0%	0.12	0.002%	0.77	0.02%

Notes:
(1) Metal as maximum percentage of the group 3 BAT-AEL, recalculated from the data presented in EA's metals guidance document (V.4) Table A1.

Table 37: Short-Term Metals Results – Point of Maximum Impact

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV [1]	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	-	0.78	167.24	-	168.02	-	8.3%	13.94	-	14.72	-
Antimony	150,000	2.60	167.24	0.11%	169.84	0.11%	3.8%	6.41	0.004%	9.01	0.01%
Chromium	150,000	3.20	167.24	0.11%	170.44	0.11%	30.7%	51.29	0.03%	54.49	0.04%
Chromium (VI)	-	0.64	167.24	-	167.88	-	0.043%	0.07	-	0.71	-
Cobalt	-	0.06	167.24	-	167.30	-	1.9%	3.12	-	3.18	-
Copper	200,000	4.40	167.24	0.08%	171.64	0.09%	9.7%	16.17	0.008%	20.57	0.01%
Lead	-	8.60	167.24	-	175.84	-	16.8%	28.04	-	36.64	-
Manganese	1,500,000	8.20	167.24	0.01%	175.44	0.01%	20.0%	33.45	0.002%	41.65	0.003%
Nickel	-	1.02	167.24	-	168.26	-	73.3%	122.64	-	123.66	-
Vanadium	1,000	1.30	167.24	**16.72%**	168.54	16.85%	2.0%	3.34	0.334%	4.64	0.46%

Notes:
(1) Metal as maximum percentage of the group 3 BAT-AEL, recalculated from the data as presented in EA's metals guidance document (V.4) Table A1.

As shown in Table 36 and Table 37, if it is assumed that the entire emissions of metals consist of only one metal, the impact is less than 1% of the long-term and less than 10% of the short-term AQAL, with the exception of annual mean impacts of arsenic, chromium (VI), lead, manganese and nickel, and short-term vanadium. The PEC is only predicted to exceed the AQALs for annual mean arsenic and chromium (VI) using this worst-case screening assumption. If it is assumed that the Facility would emit metals at the maximum concentration from the EA's metals guidance document, the PC is below 1% of the long term and 10% of the short term AQAL for all pollutants with the exception of annual mean arsenic, chromium (VI) and nickel. However, the annual mean PEC is well below the AQAL for both arsenic and nickel. Therefore, the impact of emissions of these metals can be screened out and is considered to be not significant.

The impact of chromium (VI) at the point of maximum impact slightly exceeds the 1% annual mean screening criterion, and the PEC exceeds the AQAL. The point of maximum impact is uninhabited. The maximum concentration at a receptor location is 0.41% of the AQAL and is screened out as 'insignificant'. Nonetheless, as the PC at the point of maximum impact exceeds 1% of the AQAL, further analysis of the chromium (VI) impact has been undertaken.

Concentrations of chromium (VI) are not widely monitored across the UK and monitoring is not undertaken in the vicinity of the Facility. Therefore, background chromium (VI) has conservatively been assumed to be 20% of total chromium, in accordance with the EA's metals guidance. Furthermore, the PC has been assessed assuming that the Facility operates at the maximum monitored concentration of chromium (VI) reported in the metals guidance. If it is assumed that the Facility operates at the mean concentration from the metals guidance rather than the maximum, the impact would be 0.29% of the AQAL and would be screened out as 'insignificant'. Therefore, it is considered that the impact on concentrations of chromium (VI) is not significant.

9 Impact at ecological receptors

9.1 Methodology

9.1.1 Atmospheric emissions – Critical Levels

The impact of emissions from the Facility has been compared to the Critical Levels listed in Table 3. For the purpose of the assessment of impacts at ecological sites, the mapped background dataset from APIS has been used. If the PC is than 1% of the long-term or 10% of the short-term Critical Level further consideration will be made to the baseline concentrations.

9.1.2 Deposition of emissions – Critical Loads

In addition to the Critical Levels for the protection of ecosystems, habitat specific Critical Loads for nature conservation sites at risk from acidification and nitrogen deposition (eutrophication) are outlined in APIS.

An assessment has been made for the relevant habitat features identified in APIS for the specific site. The site-specific features tool has been used to identify the feature habitats.

The lowest Critical Loads listed anywhere in each designated site would typically be used to ensure a robust screening assessment. As there are only two designated sites within the relevant screening distances from the Facility, the screening stage has been omitted and the relevant Critical Loads have been determined as follows:

- The most sensitive habitat present within the Teesmouth and Cleveland Coast SSSI/SPA/Ramsar is the coastal sand dune habitat. The report 'Air Quality Impacts on Designated Habitat Sites' prepared by RPS[11] ("the RPS Air Quality Habitats Report"), submitted as part of the Environmental Statement (ES) to support the planning application for the Facility, used a nitrogen Critical Load range of 10-15 kgN/ha/yr for calcareous dunes, which has been accepted by Natural England in their consultation response to the planning application. The bird species for which the site has been designated are not sensitive to the effect of acid deposition on the habitats present.
- Saltmarsh habitats within the Teesmouth and Cleveland Coast SSSI/SPA/Ramsar and the Teesmouth NNR are also sensitive to nitrogen deposition, so the impact on saltmarsh habitats has also been assessed. The Priority Habitat Inventory (PHI) provided by the UK Government under the Open Government Licence shows that the closest area of saltmarsh lies approximately 2 km east of the Facility. The maximum impact in areas of saltmarsh has been assessed.

The relevant Critical Loads and background levels of deposition are presented in Appendix B. If the impact of process emissions from the Facility is greater than 1% of the Critical Load, further assessment has been undertaken.

[11] RPS, Air Quality Impacts on Designated Habitat Sites, Redcar Energy Centre Environmental Statement, July 2020

9.1.2.1 Nitrogen deposition – eutrophication

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

9.1.2.2 Acidification

No habitats or species have been identified within the designated sites which are sensitive to acid deposition. Therefore, the effects of acidification have not been considered further in this assessment.

9.1.3 Calculation methodology – nitrogen deposition

The impact of deposition has been assessed using the methodology detailed within the Habitats Directive AQTAG06[12] (March 2014). The steps to this method are as follows.

1. Determine the annual mean ground level concentrations of nitrogen dioxide and ammonia at each site.
2. Calculate the dry deposition flux (µg/m^2/s) at each site by multiplying the annual mean ground level concentration by the relevant deposition velocity presented in Table 38.
3. Convert the dry deposition flux into units of kgN/ha/yr using the conversion factors presented in Table 38.
4. Compare this result to the nitrogen deposition Critical Load.

Table 38: Deposition Factors

Pollutant	Deposition Velocity (m/s)		Conversion Factor (µg/m^2/s to kg/ha/year)
	Grassland	Woodland	
Nitrogen dioxide	0.0015	0.003	96.0
Ammonia	0.0200	0.030	259.7

9.2 Results - atmospheric emissions - Critical Levels

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

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

Table 39: Process Contribution at Designated Ecological Sites

Site	NOx		SO_2	HF		NH_3
	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean
Process Contribution as µg/m³						
Teesmouth and Cleveland Coast SPA/Ramsar/SSSI	2.05	16.92	0.62	0.08	0.17	0.21
Teesmouth NNR	0.14	3.53	0.04	0.02	0.04	0.01
Process Contribution as % of Critical Level						
Teesmouth and Cleveland Coast SPA/Ramsar/SSSI	**6.84%**	**22.56%**	**3.08%**	16.17%	3.38%	**6.84%**
Teesmouth NNR	0.46%	4.70%	0.21%	3.14%	0.71%	0.46%
Note: *(1) The lower annual mean Critical Levels of 10 µg/m³ for sulphur dioxide and 1 µg/m³ for ammonia for the protection of lichens and bryophytes have been applied at the North York Moors SAC.*						

At all designated sites the PC is less than 1% of the long-term or 10% of the short-term Critical Level and can be screened out as 'insignificant' for all pollutants considered, except for annual mean oxides of nitrogen, sulphur dioxide and ammonia and daily mean oxides of nitrogen at the Teesmouth and Cleveland Coast SPA/Ramsar/SSSI.

Exceedances of the screening criteria do not automatically mean that the impact is significant but do require further analysis to determine the significance of effect.

The background concentration of oxides of nitrogen, sulphur dioxide and ammonia have been extracted from APIS across the area of the Teesmouth and Cleveland Coast SPA/Ramsar/SSSI where the PC cannot be screened out as 'insignificant' and further analysis has been undertaken.

9.2.1 Oxides of nitrogen

9.2.1.1 Annual mean

Figure 17 shows the area where the impact exceeds 1% of the Critical Level, along with the 'main habitat' as taken from the PHI. The maximum background concentration in this area is 49.1 µg/m³ (near the mouth of the River Tees, with industrial and shipping sources contributing). However, 'mud flats' is the only PHI priority habitat in the area where the background concentration exceeds the Critical Level and the impact of the Facility exceeds 1% of the Critical Level. This habitat is not sensitive to effects of airborne oxides of nitrogen, so has not been considered further.

The only other sensitive habitat listed in the area where the impact exceeds 1% of the Critical Level is 'coastal sand dunes'. The maximum background concentration where this habitat is present is 26.22 µg/m³. When the maximum PC of 2.05 µg/m³ is included, the maximum PEC is 28.27 µg/m³, which is 94.2% of the Critical Level.

The PC exceeds 1% of the Critical Level and the PEC exceeds 70% of the Critical level so that the impact of the Facility cannot be screened out as 'insignificant' or 'not significant. However, detailed modelling has shown that no exceedance of the Critical Level is predicted. Therefore, no significant effect is anticipated.

9.2.1.2 Daily mean

Figure 18 shows the area where the impact exceeds 10% of the Critical Level of 75 µg/m³. The maximum daily mean PC is predicted to be 16.92 µg/m³, which is 22.56% of the Critical Level of 75 µg/m³. However, as noted in section 2.1, the WHO and IAQM recommend the use of a higher Critical Level of 200 µg/m³ when sulphur dioxide and ozone are below their respective Critical Levels, as they tend to be in the UK. As discussed in section 9.2.2 the maximum PEC for sulphur dioxide is only 27.1% of the Critical Level.

Regarding ozone, the applicable Critical Level is an AOT40 of 3,000 ppb.h for agricultural crops and herbaceous natural vegetation. The AOT40 is defined as the accumulated concentration above 40 parts per billion during daylight hours during the growing season (May to July). As such, an annual average baseline concentration would not inform the assessment. Therefore, the average AOT40 has been calculated for 2016 - 2020 for the closest AURN site which monitors ozone, the Middlesbrough urban industrial site (~8 km southwest).

The average AOT40 from 2016 – 2020 is 884 ppb.h (29.5% of the Critical Level). Therefore, it is considered unlikely that the ozone concentration exceeds the Critical Level in the vicinity of the Facility, so the use of the higher short-term Critical Level for oxides of nitrogen of 200 µg/m³ is appropriate for this assessment.

The PC of 16.92 µg/m³ is only 8.46% of the higher Critical Level of 200 µg/m³. Based on the higher Critical Level, the impact of the Facility can be screened out as 'insignificant'.

9.2.2 Sulphur dioxide

Figure 19 shows the area where the impact exceeds 1% of the Critical Level. The maximum background concentration of sulphur dioxide anywhere withing the Teesmouth and Cleveland Coast SPA/Ramsar/SSSI is 4.8 µg/m³, or 24.0% of the Critical Level of 20 µg/m³. If it is assumed that this is the baseline concentration at the point of maximum impact, the PEC is 5.42 µg/m³ which is 27.1% of the Critical Level. As the PEC is well below 70% of the Critical Level the impact can be considered 'not significant'.

9.2.3 Ammonia

Figure 20 shows the area where the impact exceeds 1% of the Critical Level, along with the 'main habitat' as taken from the PHI. The maximum background concentration of ammonia in the area where the PC cannot be screened out and sensitive habitats are present (i.e., excluding mudflats) is 0.89 µg/m³, or 29.7% of the Critical Level of 3 µg/m³ set for the protection of higher plants. When the PC is included, the PEC remains well below 70% of the Critical Level, so the PEC is screened out as 'not significant'.

9.3 Results - deposition of emissions - Critical Loads

Appendix C presents the results at each of the identified statutory designated ecological receptors.

As shown in Appendix C, at all designated sites the PC is less than 1% of the Critical Load and can be screened out as 'insignificant' for all pollutants considered, except for nitrogen deposition on coastal sand dune habitats within the Teesmouth and Cleveland Coast SPA/Ramsar. The maximum nitrogen deposition PC on coastal sand dunes is a maximum of 12.73% of the lower Critical Load of 10 kgN/ha/yr and the PEC is 117.7% of the Critical Load. Figure 21 shows the distribution of nitrogen deposition resulting from emissions from the Facility.

The RPS Air Quality Habitats Report submitted with the planning application considered the impact of the Facility on the coastal sand dune habitat. This assessment was based on the previous design of the Facility, including operation at the ELVs specified in chapter 4 of the IED. The BAT-AEL for oxides of nitrogen that the Facility will have to comply with is lower than the IED ELV, so total nitrogen deposition is predicted to be lower than the value of 1.64 kgN/ha/yr (16.4% of the Critical Load) presented in the RPS Air Quality Habitats Report. The effect of this impact on the sand dune habitats was assessed in chapter 7 of the ES submitted with the planning application. The conclusion of the assessment was that emissions from the Facility would not have a significant effect on the Teesmouth and Cleveland Coast designated site. This conclusion was accepted by Natural England (NE) in the consultation response to the planning application (NE ref: 325067). As the impact of the Facility operating at the BAT-AELs will be less than operation at the IED ELVs as assessed in the planning application, the conclusion that there will no significant effect on the Teesmouth and Cleveland Coast designated site remains applicable.

10 Cumulative Analysis

This section details the point source emitters to be considered in the cumulative assessment. A search of the EA's public register has been undertaken to identify any permitted installations within 3 km of the stacks of Facility which include point-source emissions and have been granted an EP to operate or become operational for the first time after 2019. Emissions from installations operational prior to this will typically be captured in the baseline pollution mapping and monitoring considered in section 4. The search distance of 3 km is considered appropriate for the following reasons:

1. The annual mean PCs from the Facility for all pollutants have been shown to be 'insignificant' at all areas of relevant exposure. Any change in the PEC due to emissions from cumulative sources will not change this conclusion;
2. Although the short-term PCs of nitrogen dioxide and sulphur dioxide from the Facility cannot be screened out as 'insignificant' at areas of relevant exposure, the areas where the impact cannot be screened out is limited to relatively close proximity to the Facility (generally less than 1.5 km from the stacks, except to the north-east over the North Sea). This will also be the case for short-term emissions from any cumulative sources. Therefore, sources further than 3 km from the stacks of the Facility have negligible potential to cause a significant short-term in-combination impact.

No installations which have been granted an EP to operate or become operational for the first time after 2019 have been identified within the 3 km screening distance. Based on the above, the potential for a significant in-combination effect on human health has been screened out.

10.1 Ecological receptors

The Air Emissions guidance states that:

> *"For SPAs, SACs and Ramsar sites, you need to consider the 'in combination' (combined) impact of all permissions, plans or projects that affect the site."*

An assessment of the in-combination impact of the Facility with other relevant plans and projects on the Teesmouth and Cleveland Coast SPA/Ramsar has been undertaken. Due to the sensitivity of ecological features in the Teesmouth and Cleveland Coast SPA/Ramsar, this assessment has considered the potential for in-combination effects due to other plans and projects that lie further than 3 km from the Facility.

To identify the relevant plans and projects, a review of the ES submitted with the planning application for the Facility (planning ref: R/2020/0411/FFM) has been undertaken. The plans and projects explicitly modelled in the cumulative impact assessment are:

- the Tees Renewable Energy Plant (planning ref: R/2008/0671/EA);
- the Teesside Combined Cycle Power Plant (planning ref: R/2017/0119/DCO); and
- the Tees Valley Energy Recovery Facility (planning ref: R/2019/0767/OOM).

These schemes result in a PEC above the lower end of the critical load range for sand dune habitats. However, it was concluded in Chapter 7 of the ES (Ecology and Ornithology) and accepted by Natural England in their consultation response dated September 2020, that this would not result in adverse impacts on the integrity of the Teesmouth and Cleveland Coast SPA/Ramsar.

The dispersion modelling undertaken to support the conclusions of Chapter 7 of the ES conservatively assumed that the Facility would operate at the ELVs set out in the IED. However, the Facility will operate with emissions no higher than the upper end of the BAT-AEL ranges detailed in

Table 16, which are lower than the IED ELVs. Therefore, the impact of emissions from the Facility as assessed in this Dispersion Modelling Assessment is less than that presented in the ES. As such, it remains the case that there will be no adverse impacts on the integrity of the Teesmouth and Cleveland Coast SPA/Ramsar, either due to the operation of the Facility alone or in-combination with other plans and projects.

11 Conclusions

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

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

The primary conclusions of the assessment are presented below.

1. In relation to the impact on human health:
    a. Emissions from the operation of the Facility will not cause a breach of any AQAL.
    b. The overall impact of long-term process emissions associated with the operation of the Facility can be considered 'insignificant' or 'not significant' in accordance with EA screening criteria at the point of maximum impact and at all identified human sensitive receptors.
    c. The overall impact of short-term process emissions associated with the operation of the Facility can be screened out as 'not significant' in accordance with EA screening criteria at all areas of relevant exposure and at all identified human sensitive receptors.
    d. The EA's approach to assessing the impact of metals has been used which considers the risk of exceeding the AQAL based on the existing background levels and contribution from the Facility. Using this approach, it has been determined that where the PEC exceeds the AQAL for heavy metals, it is due to the assumed high background concentration rather than contributions from the Facility, and the impact of emissions from the Facility is not significant
    e. A cumulative assessment including other consented point source emissions has been undertaken. The inclusion of these cumulative sources does not change any of the conclusions regarding human health.
2. In relation to the impact on ecologically sensitive sites:
    a. All of the impacts at ecological features can be screened out as 'insignificant' except for nitrogen deposition at coastal sand dune habitats in the Teesmouth and Cleveland Coast SPA/Ramsar.
    b. The significance of effect has been considered in the ES submitted with the planning application for the Facility, which concludes that the effect of the operation of the Facility is 'not significant', either alone or in-combination with other plans and projects.
3. In summary, the assessment has shown that the operation of the Facility will not cause a breach of any AQAL, and the overall impact of process emissions can be screened out as 'not significant' at the point of maximum impact and at all sensitive receptor locations. As such, there should be no air quality constraint in granting an EP to operate the Facility.

Appendices

A Figures

Figure 1: Human Sensitive Receptors

<Click here to insert figure>

Figure 2: Ecological Sensitive Receptors

<Click here to insert figure>

Figure 3: Durham Tees Valley Wind Roses 2015 - 2019

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Figure 4: Spatially Varying Surface Roughness File

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Figure 5: Modelling Domain

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Figure 6: Terrain File

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Figure 7: Buildings Modelled

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Figure 8: Annual Mean Nitrogen Dioxide

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Figure 9: Annual Mean $PM_{2.5}$

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Figure 10: Annual Mean VOCs as Benzene

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Figure 11: Annual Mean VOCs as 1,3-Butadiene

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Figure 12: Annual Mean Cadmium – Typical

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Figure 13: Annual Mean PAHs

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Figure 14: 99.79th Percentile of Hourly Mean Nitrogen Dioxide

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Figure 15: 99.73rd Percentile of Hourly Mean Sulphur Dioxide

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Figure 16: 99.9th Percentile of 15-Minute Mean Sulphur Dioxide

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Figure 17: Annual Mean Oxides of Nitrogen

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Figure 18: Daily Mean Oxides of Nitrogen

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Figure 19: Annual Mean Sulphur Dioxide

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Figure 20: Annual Mean Ammonia

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Figure 21: Nitrogen Deposition

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B APIS Critical Loads

Table 40: Nitrogen Deposition Critical Loads

Site	Habitat	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Background (kgN/ha/yr)(1)
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Coastal stable dune grasslands - calcareous type	10	15	10.50
	Saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	20	30	14.98
Teesmouth NNR	Saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	20	30	14.98

Note:

(1) Background deposition rates selected for closest part of each designated site to the Facility at which each habitat is present, as determined using the Priority Habitat Inventory.

Table 41: Acid Deposition Critical Loads

Site	Species/Habitat Type	Acidity Class	Critical Load Function (keq/ha/yr)			Maximum Background (keq/ha/yr)	
			CLminN	CLmaxN	CLmaxS	N	S
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	No species sensitive to effects of acid deposition(1)	N/A	-	-	-	-	-
Teesmouth NNR	Saltmarsh	Habitat not sensitive	-	-	-	-	-

Note:

(1) With the exception of the great cormorant which is sensitive to the effects of acid deposition on the broad habitat ‘standing open water and canals’. However, there is no acidity critical load defined for this habitat type, so it has been excluded from the assessment.

C Deposition Analysis at Ecological Sites

Table 42: Annual Mean PC used for Deposition Analysis

Site	Habitat	Annual Mean PC (µg/m³)	
		Nitrogen Dioxide	Ammonia
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	1.44	0.21
	Saltmarsh	0.06	0.01
Teesmouth NNR	Saltmarsh	0.06	0.01

Table 43: Deposition Calculation

Site	Habitat	Deposition Velocity	Deposition (kg/ha/yr)		N Deposition (kgN/ha/yr)
			NO_2	NH_3	
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	0.21	1.07	1.27
	Saltmarsh	Grassland	0.01	0.05	0.06
Teesmouth NNR	Saltmarsh	Grassland	0.01	0.05	0.06

Table 44: Detailed Results – Nitrogen Deposition

Site	NCL Class	Deposition Velocity	PC			PEC		
			PC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL	PEC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL
European and UK Statutory Designated Sites								
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	1.27	**12.73%**	**8.49%**	11.8	**117.7%**	**78.5%**
	Saltmarsh	Grassland	0.06	0.28%	0.19%	15.0	75.2%	50.1%
Teesmouth NNR	Saltmarsh	Grassland	0.06	0.28%	0.19%	15.0	75.2%	50.1%

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