NEWHURST ENERGY RECOVERY FACILITY

Air Emissions Risk Assessment

Prepared for: Biffa Waste Services Limited

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CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

APPENDICES

1.0 Introduction

1.1 Background

Biffa Waste Services Limited (Biffa) has retained SLR Consulting to prepare a variation to the Environmental Permit (EP) for the Newhurst Energy Recovery Facility (ERF) located near Shepshed in Leicestershire under the Environmental Permitting Regulations 2016 (as amended).

The Non-Technical Summary provides a full description of all the proposed variations to the EP. The key variation of relevance to this air quality assessment is the proposal to increase the total tonnage accepted from 300,000 tonnes per annum (tpa) to 350,000 tpa. This change brings the EP in line with the amended planning consent issued in 2015. The proposed variation to the capacity of the facility will result in changes to emissions to air from the stack that serves the waste incineration process. The ERF will comprise of either a one line or two line facility (total capacity 350,000 tpa) with emissions to air discharged via either one or two flues housed within a single stack.

This report presents the Air Emissions Risk Assessment undertaken in accordance with Environment Agency guidance of the proposed ERF.

1.2 Scope of Assessment

The scope of this assessment is specifically concerned with emissions from the stack; the scope incorporates:

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

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

2.0 LEGISLATION AND RELEVANT GUIDANCE

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

2.1 National Legislation

2.1.1 Air Quality Standards Regulations

The Air Quality Standards Regulations 2010 (AQSR) provide a transposition of the Air Quality Framework Directive, and transpose the Fourth Daughter Directive within the UK. The regulations include Limit Values, Target Values, Objectives, Critical Levels and Exposure Reduction Targets for the protection of human health and the environment. Those relevant to this assessment are presented within Table 2-2 below.

2.1.2 Air Quality Strategy

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

2.1.3 Local Air Quality Management

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

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

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

2.1.4 Protection of Nature Conservation Sites

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

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

[1] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, DEFRA. July 2007

[2] Department for Environment, Food and Rural Affairs (DEFRA): Local Air Quality Management Review and Assessment Technical Guidance LAQM.TG(16), 2016.

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

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

2.2 Regulation of Industrial Emissions

2.2.1 Industrial Emissions Directive

The Industrial Emissions Directive[3] (IED) recast seven existing directives including the Waste Incineration Directive (WID)[4]. Chapter IV of the IED applies to incineration and co-incineration plants (which accept waste and other fuels such as biomass) which thermally treat waste as defined in the Waste Framework Directive.

The IED defines requirements for facilities classified as waste incinerators under the IED definition including:

- operating conditions, including gas temperatures and residence times, such as 850ºC / 2 seconds;
- emission limit values for a range of substance to air and water; and
- emissions monitoring requirements.

2.2.2 Emission Limit Values to Air

The IED defines emission limit values (ELVs) for emissions to air from installations as described above. These ELVs are detailed in Table 2-4.

Table 2-1
IED Chapter IV Emission Limit Values

Pollutant	Emission Limits (mg/Nm^3) [(a)]		
	Daily average values	Half hourly averages	
		100th Percentile	97th Percentile
Continuous Monitoring			
Total Particulate Matter	10	30	10
Total Organic Carbon (TOC)	10	20	10
Hydrogen chloride (HCl)	10	60	10
Hydrogen fluoride (HF)	1	4	2
Sulphur dioxide (SO_2)	50	200	50
Oxides of nitrogen (NOx)	200	400	200
Carbon Monoxide (CO[(b)])	50	150	100
Spot sample measurements			
Group 1 metals[(c)]	0.05		

[3] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control).
[4] Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste.

Pollutant	Emission Limits (mg/Nm^3) [(a)]		
	Daily average values	Half hourly averages	
		100th Percentile	97th Percentile
Group 2 metals[(c)]	0.05		
Group 3 metals[(c)]	0.5		
Dioxins and furans[(d)]	0.0000001		

Table Notes:

a) Concentrations referenced to temperature 273 K, pressure 101.3 kPa, 11% oxygen, dry gas.

b) 150 mg/Nm^3 of combustion gas for at least 95% of all measurements determined as 10 minute averages or 100 mg/Nm^3 of combustion gas of all measurements determined as half-hourly average values taken in any 24 hour period.

c) Metal groups are as follows:

Group 1: Cadmium (Cd) and thallium (Tl)

Group 2: Mercury (Hg)

Group 3: Antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni), and vanadium (V).

d) The emission limit value refers to the total concentration of dioxins and furans calculated using the concept of toxic equivalence (TEQ).

2.2.3 Environmental Permitting

In England, the Environmental Permitting (England and Wales) Regulations 2016 (SI 2016 No.1154) transpose the IED in UK legislation. The proposed installation would be regulated by the EA under the Environmental Permitting (EP) Regulations which includes regulating emissions to air. The Environment Agency varied the permit on 12th December 2013, to give effect to the implementation of IED and bring the permit in line with changes to the EP Regulations as a result of IED.

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

Of particular relevance to the assessment of air quality impacts is the EA's '*air emission risk assessment for your environmental permit*' guidance[5] (referred to as the AERA guidance throughout this report). The purpose of this guidance is to assist operators to assess risks to the environment and human health when applying for a permit under the EP Regulations. This guidance sets out Environmental Assessment Levels (EALs) which are taken from the AQS and AQSR but also includes EALs for additional pollutants derived from occupational exposure limits (OEL) and maximum exposure levels (MEL) presented in HSE EH40[6]. Those relevant to this assessment are presented within Table 2-2 below.

2.3 Environmental Standards

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

[5] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit
[6] HSE (2011) EH40/2005 Workplace Exposure Limits.

2.3.1 Standards for Protection of Human Health

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

Table 2-2
Relevant EALs (µg/m^3)

Pollutant		Annual Standard (µg/m^3)	Short Term Standard (µg/m^3)	Ref
Nitrogen dioxide	(NO_2)	40	200 (1-hour) not to be exceeded more than 18 times per year	AQSR
Particulates	(PM_{10})	40	50 (24-hour) not to be exceeded more than 35 times per year	AQSR
Particulates	($PM_{2.5}$)	25	---	AQSR
Carbon monoxide	(CO)	---	10,000 (Max 8-hour daily mean)	AQSR
Sulphur dioxide	(SO_2)	---	266 (15-minute) not to be exceeded more than 35 times per year	AQS
Sulphur dioxide	(SO_2)	---	350 (1-hour) not to be exceeded more than 24 times per year	AQSR
Sulphur dioxide	(SO_2)	---	125 (24-hour) not to be exceeded more than 3 times per year	AQSR
Hydrogen chloride	(HCl)	---	750 (1-hour)	AERA
Hydrogen fluoride	(HF)	16 (monthly)	160 (1-hour)	AERA
Total Organic	(TOC)	5	--	AERA
Benzene	(C_6H_6)	5	--	AQSR
Ammonia	(NH_3)	180	2,500 (1-hour)	AERA
Arsenic	(As)	0.003	---	AERA
Antimony	(Sb)	5	150 (1-hour)	AERA
Cadmium	(Cd)	0.005	---	AQSR
Chromium (II and III)	(Cr)	5	150 (1-hour)	AERA
Chromium (VI)		0.0002	---	AERA
Copper	(Cu)	10	200 (1-hour)	AERA
Lead	(Pb)	0.25	---	AQS
Manganese	(Mn)	0.15	1500 (1-hour)	AERA
Mercury	(Hg)	0.25	7.5 (1-hour)	AERA
Nickel	(Ni)	0.02	--	AQSR
Vanadium	(V)	5	1 (1-hour)	AERA

The regulations[7] state that exceedances of the objectives should be assessed in relation to "the quality of the air at locations which are situated outside of buildings or other natural or man-made structures, above or

[7] The Air Quality (England) Regulations 2000 2000 No. 928

below ground, and where members of the public are regularly present". LAQM.TG(16) provides guidance on relevant exposure locations that are summarised in Table 2-3 below.

Table 2-3
Relevant Public Exposure

Averaging Period	Relevant Locations	AQO's should apply at:	AQO's don't apply at:
Annual mean	Where individuals are exposed for a cumulative period of 6 months in a year	Building facades of residential properties, schools, hospitals etc.	Facades of offices Hotels Gardens of residences Kerbside sites
24-hour mean	Where individuals may be exposed for eight hours or more in a day	As above together with hotels and gardens of residential properties	Kerbside sites where public exposure is expected to be short term
8-hour mean	Where individuals may be exposed for eight hours or more in a day	As above together with hotels and gardens of residential properties	Kerbside sites where public exposure is expected to be short term
1-hour mean	Where individuals might reasonably expected to spend one hour or longer	As above together with kerbside sites of regular access, car parks, bus stations etc.	Kerbside sites where public would not be expected to have regular access
15-minute mean	All locations where members of the public might reasonably be exposed for a period of 15-minutes or longer		-

2.3.2 Standards for the protection of Ecosystems and Vegetation

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

Critical Levels (CLe)

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

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

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

Pollutant	Concentration (µg/m^3)	Habitat and Averaging Period
		ecosystem's integrity
	20	Annual mean. For all higher plants (all other ecosystems)
Nitrogen oxides (NO_x)[(1)]	30	Annual mean (all ecosystems)
	75	Daily mean (all ecosystems)
Hydrogen fluoride (HF)	5	Daily Mean.
	0.5	Weekly Mean

Table note: 1) APIS states that *'the critical level for NO_X should only be applied where levels of SO_2 and O_3 are close to their critical levels'*.

Critical Loads (C_{Lo})

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

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

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

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

3.0 ASSESSMENT METHODOLOGY

3.1 Approach

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

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

3.2 Dispersion Modelling

3.2.1 Dispersion Model

The model used is the US American Meteorological Society and Environmental Protection Agency Regulatory Model (AERMOD v9) dispersion model. This model is commonly used for assessments of this kind and has been accepted as suitable for use by the EA on similar projects. An assessment of the sensitivity of model results to various inputs is presented in Section 7.0.

3.2.2 Model Domain / Receptors

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

- 200m x 200m at 20m grid resolution
- 500m x 500m at 50m grid resolution
- 1000m x 1000m at 100m grid resolution
- 2000m x 2000m at 200m grid resolution
- 5000m x 5000m at 500m grid resolution

In addition the modelling of discrete sensitive receptor locations as described in Section 4.1.1 was undertaken to facilitate the discussion of results.

3.2.3 Topography

AERMOD utilises digital elevation data to determine the impact of topography on dispersion from a source. Topographical data for the site has been obtained in OS digital (.ntf) format. The model was run with OS 1:50,000 scale digital height contour data. Data was processed by the AERMAP function within AERMOD to calculate terrain heights. The ground level elevations for buildings within the application site have been entered on the basis of site data.

3.2.4 Building Downwash

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

Building downwash occurs when turbulence, induced by nearby structures, causes pollutants emitted from an elevated source to be displaced and dispersed rapidly towards the ground, resulting in elevated ground level concentrations. All buildings input to the model are represented in Figure 3-1. The key building effecting downwash are buildings that have a maximum height equivalent to at least 40% of the emission height (i.e. 36m) and which are within a distance defined as five times the lesser of the height or maximum projected width of the building, these buildings are presented in Table 3-1.

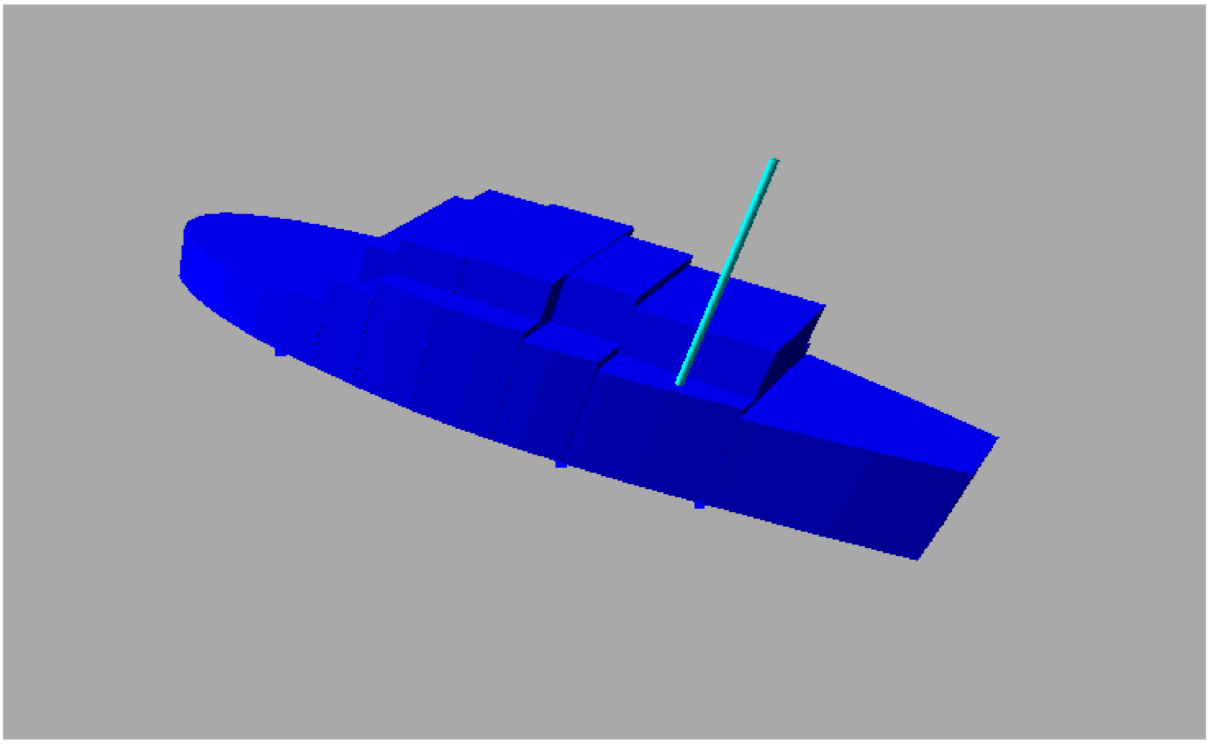

Figure 3-1
Modelled Buildings

Table 3-1
Modelled Buildings

SW x-OSGR	SW Y-OSGR	Height (m)	X Length (m)	Y Length (m)	Rotation Angle (°)
448892	317898	43.6	39	37	11.51
448884	317935	46.6	39	20	11.51
448872	317954	46.6	55	26	11.5
448867	317980	45.5	55	21	11.5
448863	318000	40.5	55	11	11.5

3.2.5 Dispersion Coefficients

The 'rural' option for dispersion coefficients was selected in accordance with AERMOD guidance[8].

3.2.6 Meteorological Data

Following consultation with the meteorological data provider, it was concluded that it was concluded that East Midlands Airport, located approximately 8.5km to the north of the application site, would provide the most complete and representative data set for purposes of this assessment. Meteorological data used in this assessment was for the period 1st January 2009 to 31st December 2013 (inclusive). This accounts for inter-year variability in meteorological conditions. From the dataset used, a total of 22 missing hours occur (i.e. representing 0.05% data loss), were recorded over the 5-year period. A windrose is presented in Figure 4-2.

The meteorological data was obtained in .met format from the data supplier and converted to the required surface and profile formats for use in AERMOD using AERMET View meteorological pre-processor. Surface characteristics were assigned for the rural surroundings as presented in Table 3-2.

Table 3-2
Applied Surface Characteristics

Zone (Start)	Zone (end)	Albedo	Bowen	Roughness
350	020	0.2517	0.975	0.1565
020	085			0.2768
085	115			0.6224
115	150			0.1498
150	245			0.094
245	300			0.3895
300	350			0.2846

3.3 Assessment of Impacts on EALs for Air Quality

3.3.1 Treatment of Model Output and Significance

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

With respect to NOx emissions the EA Air Quality Modelling and Assessment Unit (AQMAU) guidance[9] on conversion ratio for NO_x and NO_2 has been followed, i.e. a worst case scenario has been applied in that 70% of NO_x is present as NO_2 in relation to long term impacts and 35% of NOx is present as NO_2 in relation to short-term impacts.

8 EPA, AERMOD Implementation Workgroup, Aermod Implementation Guide (August 3, 2015)
9 Environment Agency, Air Quality Modelling and Assessment Unit, 'Conversion Ratios for NOx and NO_2' (no date)

Table 3-3
Model Outputs

Averaging Period	Model Output – Process Contribution (PC)	Predicted Environmental Concentration (PEC)
1 hour mean. Not to be exceeded more than 18 times a calendar year	99.79%ile of 1-hour means	PC + 2 x annual mean background
15 minute mean. Not to be exceeded more than 35 times a calendar year	99.9%ile of 1 hour means for SO_2 multiplied by 1.34	PC + 2 x annual mean background
1 hour mean. Not to be exceeded more than 24 times a calendar year	99.73%ile of 1 hour means for SO_2	PC + 2 x annual mean background
24 hour mean. Not to be exceeded more than 3 times a calendar year	99.18%ile of 24 hour means for SO_2	PC + 2 x annual mean background
24 hour mean. Not to be exceeded more than 35 times a calendar year	90.4%ile of 24 hour means for PM_{10}	PC + annual mean background
1-hour maximum	Maximum 1-hour mean	PC + 2 x annual mean background
8-hour rolling mean	Maximum 8-hour mean	PC + 2 x annual mean background
Calendar year	Annual Mean	PC + annual mean background

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

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

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

3.4 Assessment of Impacts on Vegetation and Ecosystems

In addition to the AERA guidance, the EA's Operational Instruction 66_12[10] details how the air quality impacts on ecological sites should be assessed. This guidance provides risk based screening criteria to determine whether impacts will have 'no likely significant effects (alone and in-combination)' for European sites, 'no likely damage' for SSSI's and 'no significant pollution' for other sites, as follows:

- PC <1% long-term C_{Le} and/or C_{Lo} or that the PEC <70% long-term C_{Le} and/or C_{Lo} for European sites and SSSIs;
- PC <10% short-term C_{Le} for NOx and HF (if applicable) for European sites and SSSIs;
- PC <100% long-term C_{Le} and/or C_{Lo} other conservation sites; and

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

- PC <100% short-term C_{Le} for NOx and HF (if applicable) for other conservation sites.

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

The guidance provides the following further criteria:

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

Calculation of Contribution to Critical Loads

Deposition rates were calculated using empirical methods recommended by the EA AQTAG06[11]. Dry deposition flux was calculated using the following equation:

Dry deposition flux ($\mu g/m^2/s$) = ground level concentration ($\mu g/m^3$) x deposition velocity (m/s)

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

The applied deposition velocities for the relevant chemical species are as shown in Table 3-4.

Table 3-4
Applied Deposition Velocities

Chemical Species	Recommended deposition velocity (m/s)	
NO_2	Grassland	0.0015
	Woodland	0.003
SO_2	Grassland	0.012
	Woodland	0.024
NH_3	Grassland	0.02
	Woodland	0.03
HCl	Grassland	0.025
	Woodland	0.06

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

Critical Loads - Eutrophication

The contribution to critical loads for nitrogen deposition (N) are recorded as kgN/ha/yr. The units are then converted from µg/m^2/s to units of kgN/ha/year by multiplying the dry deposition flux by standard conversion factors as summarised in Table 3-5.

Table 3-5
Applied Deposition Conversion Factors

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

Critical Loads - Acidification

The predicted deposition rates are converted to units of equivalents (keq/ha/year), which is a measure of how acidifying the chemical species can be, by dividing the dry deposition flux (kg/ha/year) by standard conversion factors as presented in Table 3-6.

Table 3-6
Applied Acidification Conversion Factors

Chemical Species	Conversion factor [kg/ha/year to keq/ha/year]
NO_2	6.84
NH_3	18.5
SO_2	9.84
HCl	8.63

Calculation of PC as a percentage of Acid Critical Load Function

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

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

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

4.0 BASELINE ENVIRONMENT

4.1 Site Setting and Sensitive Receptors

The application site is located within the Charnwood Quarry complex, on the northern edge of Charnwood forest. To the north of the application site is the A512, beyond and along which lies the town of Shepshed. To the east lies the M1, and the town centre of Loughborough situated approximately 5km to the east. There are scattered dwellings and small villages within a 5km radius of the site as well as the towns of Whitwick and Coalville located over 5km to the southwest.

There are also a number of sensitive habitats and protected sites within 10km and a Local Wildlife Site within 2km which are detailed in the section below.

4.1.1 Human Receptors

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

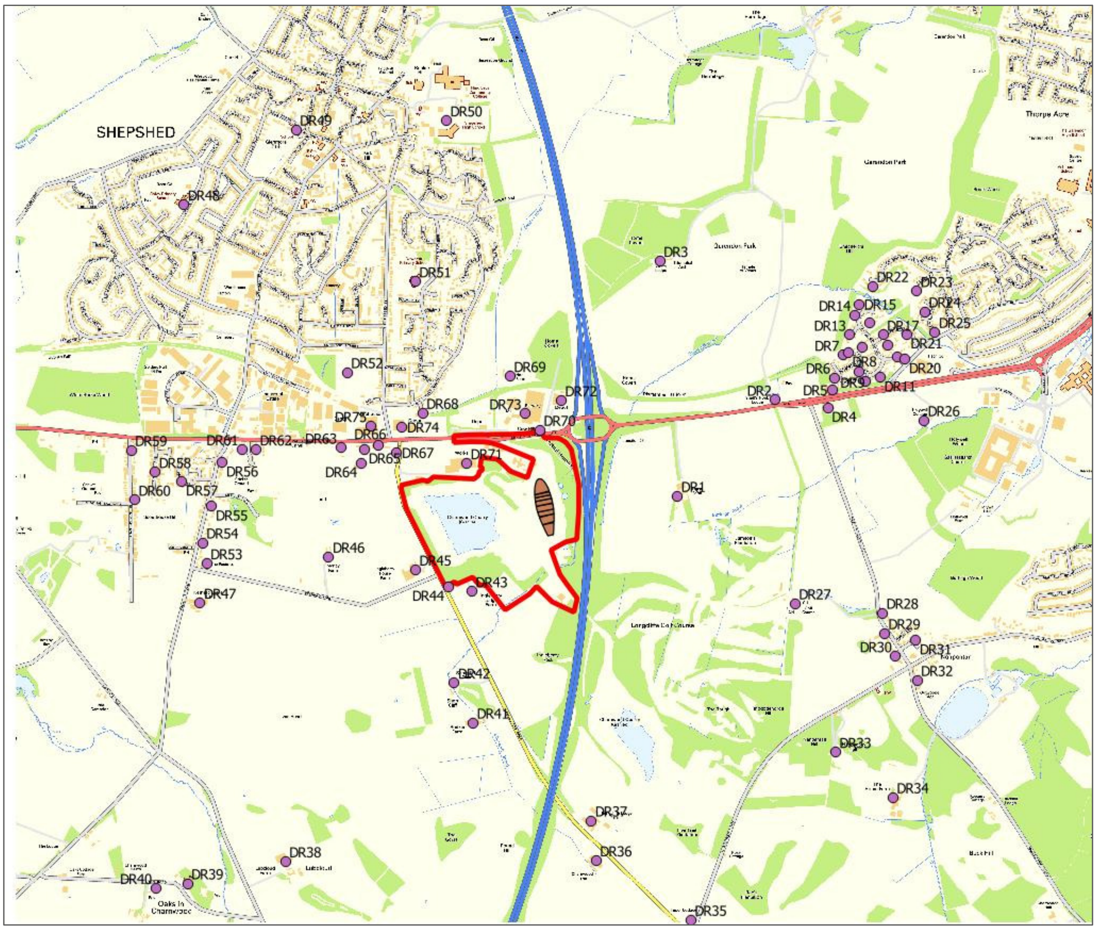

Figure 4-1
Site Setting and Modelled Receptors

4.1.2 Ecological Receptors

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

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

The sites are detailed in Table 4-1 and termed ER1 to ER14 in the assessment. Two SSSI's (Newhurst Quarry and Iveshead) are located within the screening distances however they are designated for geological interest and have therefore been excluded from the assessment.

Table 4-1
Designated Sites Requiring Assessment

Ref.	Site	Habitat Type (APIS categories)	Designation	Grid Ref
ER1	Morley Quarry	Mesotrophic Standing Waters	LNR / LWS	SK476179
ER2		Acid Grassland		
ER3		Upland Heathland		
ER4	White Horse Wood Ancient Woodland	Ancient Semi Natural Woodland	ASNW (LWS)	SK466184
ER5	Holywell Wood Ancient Woodland	Ancient Semi Natural Woodland	ASNW (LWS)	SK506182
ER6	Burleigh Wood	Ancient Semi Natural Woodland	ASNW (LWS)	SK508176
ER7	Charley Woodland	Sweet Chestnut (Mature Tree)	cLWS	SK494165
ER8	Iveshead	Upland Heathland	LWS	SK476168
ER9	Morely Lane Field	Upland Heathland	LWS	SK477179
ER10	Hermitage Estate	Woodland and Grassland	LWS	SK489201
ER11	Nanpantan Hall Wood	Woodland and Acid Grassland	LWS	SK500169
ER12	Home Farm Wood	Broadleaved Woodland	LWS	SK499166
ER13	Nanpantan Reservoir	Reservoir	LWS	SK507170
ER14	Buck Hill	Acid Grassland with woodland	LWS	SK507163
ER1	Charley Road Fields	Wet Grassland	LWS	SK473167
ER2	High Ground, Shepshed	Woodland	LWS	SK484165

4.2 Meteorological Conditions

A windrose for East Midlands Airport station for a 5 year period (hourly sequential data), providing the frequency of wind speed and direction, is presented in presented in Figure 4-2. The windrose shows winds from the south west are most frequent with winds from the south east and north east least frequent.

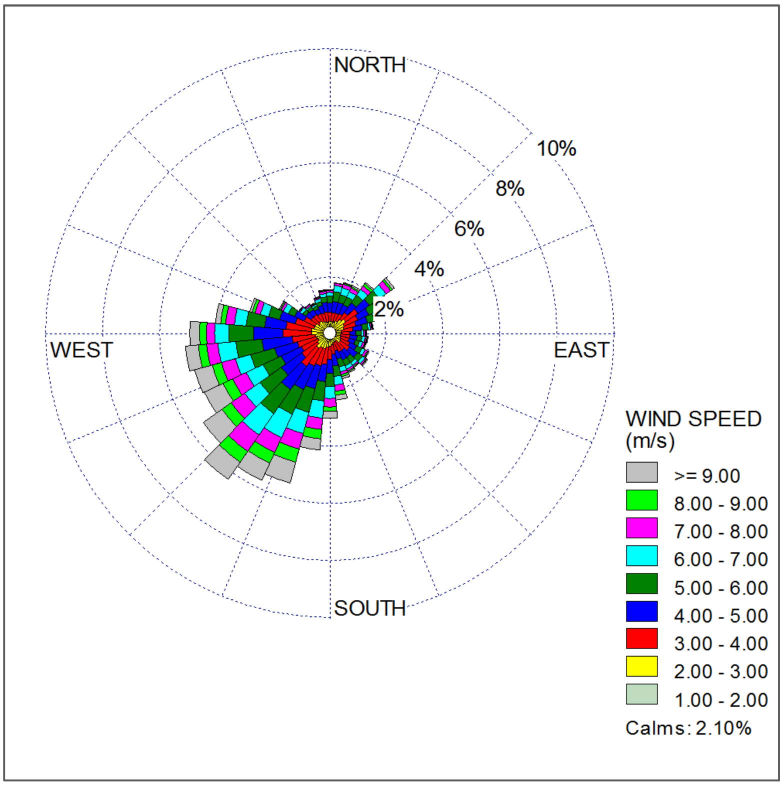

Figure 4-2
Windrose for East Midlands Airport Meteorological Station (2009-2013)

4.3 Topography

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

The area to the south of the application site comprises the northern extent of Charnwood Forest; an area of undulating topography. Approximately 1.5km to the south of the application site is Ives Head, rising to 210m AOD. To the north and east the landform is gentle and rolling towards the floodplain of the River Trent. As such terrain has been included within the dispersion modelling.

4.4 Baseline Air Quality

This section reviews the existing baseline air quality and deposition in the vicinity of the proposed installation according to monitoring and/or modelling from CBC, Defra, and APIS.

4.4.1 Local Air Quality Management and Monitoring

The site lies within CBC's area of jurisdiction with respect to LAQM, who have declared four AQMAs. The site is also close to North West Leicestershire District Council who have declared 5 AQMAs. The only AQMA within 5km is the Loughborough AQMA located 4km north east of the site for exceedances of the annual mean NO_2

AQO. The AQMA comprises a number of areas within the city. According to the latest LAQM report[12] from CBC, monitoring in the closest part of the AQMA on Epinal Way at DT3, DT4, and DT5 the annual mean concentrations are 28.6µg/m^3, 27.8µg/m^3 and 23.7µg/m^3.

According to CBC's latest LAQM report, CBC monitor NO_2 concentrations at 2 locations in the Shepshed closer to the site. The recent results are presented in Table 4-2 below.

Table 4-2
CBC NO_2 Diffusion Tube Monitoring Results

ID	Location	Type (distance to kerb)	2014 µg/m^3	2015 µg/m^3	2016 µg/m^3
DT17	Cow Hill Lodge	Roadside (~10m)	24.8	21.3	27.1
DT27	Ashby Rd Central	Roadside (~12m)	25.2	22.7	27.3

4.4.2 UK AIR Modelled Data

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

Background pollutant concentrations of NOx, NO_2, PM_{10} and $PM_{2.5}$ are based upon a 2015 base year[13] and background pollutant concentrations of CO and Benzene are based upon a 2001 base year. Projection factors for SO_2 are not provided in LAQM.TG(16) since 2001 therefore values are likely to be an over prediction. For this reason the more up-to-date APIS modelled 3 year average values (2013-2015) have been applied, for the 5km grid square containing the site the APIS background value is 2.5µg/m^3.

Mapped background concentrations were downloaded for the 9 grid squares containing the site (centred on 448500, 317500) and nearby receptors as shown in Table 4-3.

Table 4-3
Modelled 2018 Annual Mean Background Concentrations (µg/m^3)

X – NGR	Y-NGR	NO_2	PM_{10}	$PM_{2.5}$	Benzene	CO
447500	318500	13.4	18.3	11.8	0.41	162.3
448500	318500	12.9	16.5	10.9	0.41	163.6
448500	318500	16.4	18.6	11.8	0.43	166.2
447500	317500	10.0	14.6	9.9	0.40	159.2
448500	317500	11.3	19.5	10.9	0.40	160.5
448500	317500	14.6	17.1	10.9	0.41	162.7
447500	316500	9.8	13.8	9.5	0.39	156.6
448500	316500	14.9	16.6	10.8	0.38	156.6
448500	316500	11.6	14.9	10.0	0.38	157.9

[12] 2017 Air Quality Annual Status Report (ASR)
[13] Background mapping data for local authorities – http://uk-air.defra.gov.uk/data/laqm-background-home, accessed November 2017.

4.4.3 Metals

The closest location to the application site at which heavy metals have been monitored is at Beacon Hill (of a rural classification) located approximately 5km to the southeast. The site was closed in 2014. A summary of the most recent 2 years monitoring data is shown in Table 4-4.

Table 4-4
Metals Monitoring Data from Beacon Hill Station

Metal		2013 annual average (ng/m^3)	2014 annual average (ng/m^3)
Arsenic	As	0.5	0.5
Cadmium	Cd	0.1	0.1
Chromium (total)	Cr	1.0	3.5
Copper	Cu	2.7	2.2
Mercury	Hg	1.1	1.5
Manganese	Mn	2.8	1.5
Nickel	Ni	0.6	0.4
Lead	Pb	4.4	3.9
Antimony	Sb	0.9	0.4
Vanadium	V	0.7	0.5

Monitoring is not routinely undertaken for thallium or hexavalent chromium (Cr(VI)) in the UK and therefore no background data are available. The adopted approach of the EA for estimating Cr(VI) is to assume it is a fraction of total Cr, guidance[14] states that a value of 20% should be applied unless otherwise justified.

4.4.4 Hydrogen Halides

Hydrogen Chloride
Hydrogen chloride is monitored as part of the UK Acid Gases & Aerosol Network (AGANET) at Sutton Bonnington located approximately 7km north north east. The annual mean concentration of HCl from the most recent ratified data, i.e. 2014 and 2015 is 0.24µg/m^3 and 0.21µg/m^3

Hydrogen Fluoride
In 2005 The Expert Panel on Air Quality Standards (EPAQS) published a draft report entitled 'Guidelines for halogen and hydrogen halides in ambient air for protecting human health against acute irritancy effects'. The report noted that only a small number of measurements of ambient concentrations of hydrogen fluoride have been made in the UK. All of these have been made in the vicinity of three industrial plants. Many samples were below the limit of detection. However, measurable values were in the range 0.05 to 3.5µg/m^3 as approximate monthly averages.

[14] Releases from waste incinerators – Guidance on assessing group 3 metal stack emissions from incinerators. Version 4. Environment Agency, June 2016.

4.4.5 Ammonia

Ammonia is monitored at 85 sites part of the National Ammonia Monitoring Network (NAMN). The closest monitoring station is at Sutton Bonnington. The most recent ratified data shows annual mean concentration in 2015 and 2016 of 3.06µg/m^3 and 2.46µg/m^3.

The APIS modelled 3 year average value (2013-2015) for the 5km grid square containing the site is 2.45µg/m^3.

4.5 Applied Background Concentrations

The applied backgrounds are provided in Table 4-5 below.

Table 4-5
Applied Background Concentrations

Pollutant	Units	Background Concentration		Data Source
		Short Term [(a)]	Annual	
NO_2	µg/m^3	54.6	27.3	CBC Diffusion Tube Monitoring
PM_{10}	µg/m^3	19.5 (24-hr)	19.5	UK-AIR 2018 background map – highest in study area.
$PM_{2.5}$	µg/m^3	N/A	11.8	
CO	µg/m^3	332.3	166.2	
SO_2	µg/m^3	5.0	2.5	APIS Background map
HCl	µg/m^3	0.5	0.2	UK AGNET Sutton Bonnington
HF	µg/m^3	7.0	3.5	EPAQS
Benzene	µg/m^3	0.9	0.4	UK-AIR 2018 background map
Ammonia	µg/m^3	6.12	3.06	NAMN Sutton Bonnington
Cadmium	ηg/m^3	0.2	0.1	Heavy Metals Monitoring Network Beacon Hill Highest from 2013 to 2014
Mercury	ηg/m^3	3.0	1.5	
Arsenic	ηg/m^3	1.1	0.5	
Chromium (total)	ηg/m^3	7	3.5	
Copper	ηg/m^3	5.5	2.7	
Lead	ηg/m^3	8.7	4.4	
Manganese	ηg/m^3	5.7	2.8	
Nickel	ηg/m^3	1.3	0.6	
Vanadium	ηg/m^3	1.5	0.7	
Chromium VI	ηg/m^3	1.4	0.7	EA guidance

Table Note: Baseline concentrations for short-term averaging periods have been converted from annual mean in accordance with AERA guidance and LAQM.TG(16).

4.6 Critical Levels and Loads

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

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

The baseline concentrations (3-year average 2013 - 2015) of NOx, SO_2 and NH_3 are summarised in Table 4-6 below.

Table 4-6
Baseline Concentrations

Site	NO_x (µg/m^3)	SO_2 (µg/m^3)	NH_3 (µg/m^3)
ER1	21.0	2.5	2.5
ER2	21.0	2.5	2.5
ER3	21.3	2.5	2.5
ER4	26.1	2.1	2.4
ER5	26.1	2.1	2.4
ER6	23.8	2.5	2.5
ER7	20.6	2.5	2.5
ER8	21.0	2.5	2.5
ER9	32.2	2.1	2.5
ER10	20.5	2.1	2.4
ER11	23.8	2.5	2.5
ER12	20.5	2.1	2.4
ER13	20.5	2.1	2.4
ER14	20.6	2.5	2.5

4.6.1 Relevant Critical Loads

APIS was used to obtain location specific C_{Lo} of nitrogen and acid deposition and current loads (3-year average 2013 - 2015) as summarised in Table 4-7 and Table 4-8 below. The most sensitive habitat type listed on APIS has been used for the assessment and nitrogen C_{Lo} applied according to APIS guidance[15].

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

Site	APIS Habitat (most sensitive to N deposition)	C_{Lo} for Assessment (kgN/ha/yr)	Current N Load (kgN/ha/yr)
ER1	Acid Grassland	10	22.12
ER2	Dwarf Shrub Heath	10	22.12
ER3	Broadleaved, Mixed and Yew Woodland	10	36.96
ER4	Broadleaved, Mixed and Yew Woodland	10	36.26
ER5	Broadleaved, Mixed and Yew Woodland	10	36.26

15 'Indicative values within nutrient nitrogen critical load ranges for use in air pollution impact assessments' (http://www.apis.ac.uk/indicative-critical-load-values, accessed 21/11/2017)

Site	APIS Habitat (most sensitive to N deposition)	C_{Lo} for Assessment (kgN/ha/yr)	Current N Load (kgN/ha/yr)
ER6	Broadleaved, Mixed and Yew Woodland	10	36.96
ER7	Dwarf Shrub Heath	10	22.12
ER8	Dwarf Shrub Heath	10	22.12
ER9	Broadleaved, Mixed and Yew Woodland	10	36.4
ER10	Broadleaved, Mixed and Yew Woodland	10	36.26
ER11	Broadleaved, Mixed and Yew Woodland	10	36.96
ER12	Standing Open water	n/a	n/a
ER13	Broadleaved, Mixed and Yew Woodland	10	36.26
ER14	Coastal and Floodplain Grazing Marsh	20	22.12

Table 4-8
Relevant Acid Critical Loads and Baseline Deposition

Site	Habitat (most sensitive to acid deposition)	Critical Level (k_{eq}/ha/yr)			Current Load (k_{eq}/ha/yr)	
		CLmaxS	CLminN	CLmaxN	N	S
ER1	Acid Grassland	0.880	0.438	1.318	1.58	0.24
ER2	Dwarf Shrub Heath	0.880	0.714	1.594	1.58	0.24
ER3	Broadleaved, Mixed and Yew Woodland	2.594	0.142	2.736	2.64	0.29
ER4	Broadleaved, Mixed and Yew Woodland	2.604	0.142	2.746	2.59	0.3
ER5	Broadleaved, Mixed and Yew Woodland	2.604	0.142	2.746	2.59	0.3
ER6	Broadleaved, Mixed and Yew Woodland	1.525	0.357	1.882	2.64	0.29
ER7	Dwarf Shrub Heath	0.880	0.714	1.594	1.58	0.24
ER8	Dwarf Shrub Heath	0.880	0.714	1.594	1.58	0.24
ER9	Broadleaved, Mixed and Yew Woodland	2.585	0.142	2.727	2.6	0.27
ER10	Broadleaved, Mixed and Yew Woodland	1.533	0.357	1.890	2.59	0.3
ER11	Broadleaved, Mixed and Yew Woodland	1.525	0.357	1.882	2.64	0.29
ER12	Standing Open Water	n/a				
ER13	Broadleaved, Mixed and Yew Woodland	1.533	0.357	1.890	2.59	0.3
ER14	Coastal and Floodplain Grazing Marsh	None given - soil base CL is 4.0			1.58	0.24

5.0 EMISSIONS TO ATMOSPHERE

5.1 Emission Scenarios

For the purposes of the dispersion modelling assessment, to represent a precautionary (worst case) approach, it has been assumed that the plant will operate at 110% of fuel throughput, 24-hours per day for 365 days per year (i.e. 8,760 hours per year), with emission concentrations at the Permitted ELVs. In reality operational hours are likely to be less than this to allow for maintenance and emissions control would reduce emissions to below the Permitted ELVs. As such the following scenarios have been assessed:

- Normal 'daily average' emission limits
- Half-hourly emission limits; and
- Plausible abnormal emissions

5.2 Emission Parameters

The following emission parameters and process conditions were used to determine the pollutant emission rates and as input to the dispersion modelling. These are common to all scenarios assessed with variations to a number of parameters investigated in Section 7.0. The proposed ERF will be based upon either a single-flue or 2-flue (housed within a single windshield) design with mass emission rates consistent between the two designs. The main assessment has been based upon a single flue and the 2-flue design considered within Section 7.0.

Table 5-1
Emission Characteristics

Parameter	Single Flue Design
Stack Internal Diameter (m)	2.7
Stack Exhaust Height (m AGL)	90
Volume Flow (Nm^3/s) (273K, 11% O_2, dry)	89.3
Emission Temperature (^oC)	135
Oxygen Content (% O_2 dry gas)	7.99
Moisture content (% H_2O)	18.02
Actual Flow Rate (Am^3/s)	125
Emission velocity (m/s)	21.8

5.3 'Daily Average' Pollutant Emission Scenario

The pollutants emitted from the ERF stack and their emission concentration limit values, as stated in the IED are shown in Table 2-4. The emission rates are presented in Table 6-3 and have been calculated from the process conditions detailed above and the emission limits as detailed in Table 2-4. Pollutant specific issues are discussed in the sections below.

Table 5-2
'Daily Average' Pollutant Emission Rates

Parameter	Units	Emission Rate
Particulate Matter	g/s	0.89

Parameter	Units	Emission Rate
Nitrogen Dioxide	g/s	17.86
Carbon Monoxide	g/s	4.47
Sulphur Dioxide	g/s	4.47
Hydrogen Chloride	g/s	0.89
Hydrogen Fluoride	g/s	0.09
Organics (TOC)	g/s	0.89
Group 1 metals (total)	mg/s	4.47
Group 2 metal	mg/s	4.47
Group 3 metals (total)	mg/s	44.65
Dioxins and furans	ng/s	8.93
Ammonia	g/s	0.89

5.3.1 Particle Size

In air quality terms PM is classified in terms of its aerodynamic diameter; with PM_{10} relating to particles with an aerodynamic diameter of less than 10µm. Other smaller relevant fractions of particulate matter such as $PM_{2.5}$ (aerodynamic diameter less than 2.5µm) are a sub-fraction of the PM_{10} fraction i.e. PM_{10} includes $PM_{2.5}$.

For the purposes of this assessment 100% of particulate matter has been assumed to be PM_{10} and 100% to be $PM_{2.5}$. This approach ensures that a worst case scenario has been considered for the smallest particles.

5.3.2 Total Organic Carbon

There are no relevant air quality assessment levels or background for TOC. Whilst it is unlikely that any benzene would be released from the process due to the high temperature of combustion a cautious approach has been adopted by assuming all the organic carbon would be in the form of benzene in line with AERA guidance.

5.3.3 Ammonia

The plant utilises a selective-catalytic-reduction system (SCR) to abate emission of NO_x. The manufacturer information indicates very low levels of residual ammonia present; however as a precautionary approach an annual average of 10mg/Nm^3 has been applied in the assessment.

5.3.4 Metals

As shown in Table 2-3, the IED emission limits for metals are based on total emission rates for 3 different groups. Additionally, in relation to chromium, different EALs apply depending on the oxidation state of chromium. The EPAQS recommended annual mean limit of 0.2ηg/m^3 relates specifically to chromium (VI) (i.e. hexavalent chromium), with the long-term EAL of 5µg/m^3 applying to all other oxidation states of chromium.

The EA's approach to assessment of Group 3 metals[16] is based on emissions monitoring data from the UK and includes two steps. Step 1 is a screening stage and requires each metal to be modelled at 100% of the group limit and Step 2, which has been applied in this detailed assessment, requires the maximum measured value to be applied from the data presented in Table 5-3.

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[16] Releases from waste incinerators – Guidance on assessing group 3 metal stack emissions from incinerators. Version 4. Environment Agency, June 2016.

Table 5-3
EA Group 3 Metals Monitoring Data

Parameter	Measured Concentrations (mg/Nm^3)			Maximum as a % of Group 3 total	Modelled emission rate (mg/s)
	Maximum	Mean	Minimum		
Antimony	0.0115	0.0014	0.0001	2.3%	1.03
Arsenic	0.0250	0.0010	0.0002	5.0%	2.23
Chromium (II and III)	0.0920	0.0084	0.0002	18.4%	8.22
Chromium (VI)	1.3×10^{-4}	3.5×10^{-5}	2.3×10^{-6}	0.003%	0.01
Cobalt	0.0056	0.0011	0.0002	1.1%	0.49
Copper	0.0290	0.0075	0.0019	5.80	2.59
Lead	0.0503	0.0109	0.0003	10.1%	4.51
Manganese	0.0600	0.0168	0.0015	12.0%	5.36
Nickel	0.2200	0.0150	0.0025	44.0%	19.65
Vanadium	0.0060	0.0004	0.0001	1.2%	0.54

5.4 Half Hourly Emission Limits Scenario

In addition to the daily average emission limits assessed, the IED also stipulates half-hourly emission limit values with the 97th percentile at levels that mirror the daily average levels (with the exception of HF and CO), but with 100th percentile values that are elevated. As such the model scenarios include an assessment of for elevated emissions that could occur for 3% of half hourly averages as detailed in Table 2-1.

5.5 Abnormal Operating Conditions Scenario

The IED allows for elevated emissions of some pollutants for limited periods of time during ‘abnormal operating conditions’ from facilities undertaking the incineration of waste. Under such abnormal operating conditions, waste feed to the plant must be stopped and the plant is required to cease the incineration of waste as soon as practicable, within a maximum timeframe of 4 hours. Such abnormal operating conditions are only allowed to occur for 60-hours per year per line:

> *‘the waste incineration plant or waste co-incineration plant or individual furnaces being part of a waste incineration plant or waste co-incineration plant shall under no circumstances continue to incinerate waste for a period of more than 4 hours uninterrupted where emission limit values are exceeded.*
>
> *The cumulative duration of operation in such conditions over 1 year shall not exceed 60 hours.’*

UK data for plant that thermally treat residual municipal solid waste shows that the reported occurrence of abnormal operating conditions (or exceedences of permitted emission limits) is very infrequent (far below the 60-hours allowed for abnormal operating conditions under the IED).

Based on annual reports for similar operational facilities in the UK, the following are considered to be examples of abnormal operating conditions which may lead to ‘abnormal emission levels’ of pollutants:

- significant variation in waste composition (i.e. very high moisture) promoting poor combustion, leading to CO exceedences; or

- reduced efficiency of FGT injection system such as through blockages or failure of pumps leading to elevated acid gas emissions; or
- reduced efficiency of particulate filtration system due to bag failure and inadequate isolation, leading to elevated particulate emissions; or
- reduced efficiency of SNCR system as a result of blockages or failure of ammonia injection system, leading to elevated NOx emissions.

The potential impact of plausible abnormal emissions has been investigated using emission concentrations consistent with documented events for mass-burn incineration facilities in the UK and as detailed in available EA decision documents (see Table 5-4 below).

It should be noted that the definition of 'abnormal operating conditions' also encompasses periods where the continuous emission monitoring equipment is not operatively correctly and data relating to the actual emission concentrations are not available. This assessment has only used data where the concentration of continuously monitored pollutants has been quantified. Furthermore no data on flow characteristics (flow rate, temperate etc.) during these abnormal operating conditions is available, so for the purposes of this assessment the design flow characteristics have been applied to the plausible emission levels to derive an emission rate and assess impact.

Table 5-4
Plausible Abnormal Emissions

Pollutant	Permitted Emission (mg/m^3)		Plausible Abnormal Emission (mg/m^3)[(a)]	% Above Permitted Emission
	Daily Average	½ hourly max		
NO_X	200	400	600	50%
PM_{10}	10	30	150[(a)]	400%
SO_2	50	200	300	50%
CO	50	100	400	300%
HCl	10	60	600[(b)]	900%
HF	1	4	10	150%
TOC	10	20	100	400%
Group 1 Metal	0.05		0.1	100%
Group 2 Metal	0.05		0.2	300%
Group 3 Metal	0.5		1.5	200%

Table note:
a) Based upon a review of EA decision documents and annual reports for similar facilities.
b) Based upon IED
c) Based on Covanta information

6.0 PREDICTED AIR QUALITY IMPACTS

6.1 Predicted Long-term Impacts

Predicted long-term impacts are summarised in Table 6-1. The results are the maximum predicted long-term impacts and relate to the highest predicted level of impact at any location on the receptor grid and impacts at all other locations will be lower. Isopleth plots are presented in Appendix A for those PCs that are not insignificant.

The maximum ground level PC is insignificant for the majority of emissions and can be considered insignificant. For those PC's that cannot be considered insignificant the PEC does not exceed EAL.

Table 6-1
Predicted Maximum Ground Level Long-term Impacts

Pollutant	EAL (µg/m^3)	PC (µg/m^3)	PC as % EAL	PEC (µg/m^3)[(a)]	PEC as % EAL
NO_2	40	0.4	1.0%	27.7	69.3%
PM_{10}	40	0.03	0.1%	n/c	n/c
$PM_{2.5}$	25	0.03	0.1%	n/c	n/c
HF (monthly)	16	0.01	<0.1%	n/c	n/c
TOC (as Benzene)	5	0.03	0.6%	n/c	n/c
NH_3	180	0.03	<0.1%	n/c	n/c
Cadmium	0.005	0.0001	1.4%	0.0002	3.3%
Mercury	0.25	0.0001	0.1%	n/c	n/c
Antimony	5	<0.0001	<0.1%	n/c	n/c
Arsenic	0.003	0.0001	2.4%	0.0006	20.2%
Chromium (III)	5	0.0003	<0.1%	n/c	n/c
Chromium (VI)	0.0002	4E-07	0.2%	n/c	n/c
Lead	0.25	0.0001	0.1%	n/c	n/c
Manganese	0.15	0.0002	0.1%	n/c	n/c
Nickel	0.02	0.0006	3.1%	0.001	6.3%
Vanadium	5	0.00002	<0.1%	n/c	n/c

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

6.2 Predicted Short-term Impacts

Predicted short-term impacts are summarised in Table 6-2. The results presented are the maximum predicted short-term impacts and relate to the highest predicted level of impact at any location on the receptor grid and impacts at all other locations, and at all other times, will be lower. The maximum ground level PCs are insignificant for all emissions.

Table 6-2
Predicted Maximum Ground Level Short-term Impacts

Pollutant	EAL (µg/m^3)	PC (µg/m^3)	PC as % EAL
NO_2	200	7	3.3%
PM_{10}	50	0.1	0.2%
CO (8-hr)	10000	4	<0.1%
SO_2 (24-hr)	125	1	1.0%
SO_2 (1-hr)	350	3	1.0%
SO_2 (15-min)	267	13	4.8%
HCl	750	3	0.4%
HF	160	0.3	0.2%
NH_3	2500	3	0.1%
Mercury	7.5	0.02	0.2%
Antimony	150	0.002	<0.1%
Chromium (III)	150	0.03	<0.1%
Copper	200	0.01	<0.1%
Manganese	1500	0.02	<0.1%
Vanadium	1	0.004	0.2%

6.2.1 Impacts from Half Hourly Emission Limits

In addition to the daily average emission limits assessed, the IED also stipulates half-hourly emission limit values with the 97th percentile at levels above the daily average levels. The significance of the half-hourly emission limits has been investigated for NO_2, SO_2, HCl and HF that have EALs set on an hourly average period but not for EALs based on 24-hour or longer averaging periods that would not be significantly affected by the half-hourly IED emission limit. Even with the highly conservative (worst case) assumption that allowable elevated emissions coincide with the worst case meteorological conditions for dispersal over the year, the PC's are insignificant with the one exception for which PECs remains well below the EAL.

Table 6-3
Maximum Impacts using Half-hourly IED Chapter IV Limits

Pollutant	Applied Standard (µg/m^3)	PC (µg/m^3)	PC as % EAL	PEC (µg/m^3)	PEC as % EAL
NO_2	200 (1-hr 99.89%ile)	13	6.6%	n/c	n/c
SO2	350 (1-hr 99.73%ile)	13	3.8%	n/c	n/c
SO2	266 (15-min 99.9%ile)	51	19.1%	56	21.0%
HCl	750 (1-hr maximum)	20	2.7%	n/c	n/c
HF	160 (1-hr maximum)	1	0.8%	n/c	n/c

Table note: n/c = not calculated: following AERA guidance the PEC has only been calculated where the PC is 10% or above.

6.3 Impacts from Plausible Abnormal Emissions

Table 6-4 presents the potential short-term impacts from the plausible abnormal emissions scenario. Even with the highly conservative (worst case) assumption that abnormal emissions occur all year and therefore coincide with the worst case meteorological conditions for dispersal over the year, the PC's are insignificant with the two exceptions for which PECs remain well below the EAL.

Table 6-4
Predicted Maximum Ground Level Short-term Impacts (Abnormal Emissions)

Pollutant	EAL (µg/m^3)	PC (µg/m^3)	PC as % EAL	PEC (µg/m^3)	PEC as % EAL
NO_2	200 (1-hr 99.89%ile)	20	9.9%	n/c	n/c
PM_{10}	50 (24-hr 90.4%ile)	2	3.0%	n/c	n/c
CO	8-hour	28	0.3%	n/c	n/c
SO_2	350 (1-hr 99.73%ile)	20	5.7%	n/c	n/c
SO_2	266 (15-min 99.9%ile)	77	28.7%	82	30.5%
HCl	750	201	26.9%	202	26.9%
HF	160	3	2.1%	n/c	n/c
NH_3	2500	2	0.1%	n/c	n/c
Mercury	7.5	0.07	0.9%	n/c	n/c
Antimony	150	0.01	<0.1%	n/c	n/c
Chromium (III)	150	0.09	0.1%	n/c	n/c
Copper	200	0.03	<0.1%	n/c	n/c
Manganese	1500	0.06	<0.1%	n/c	n/c
Vanadium	1	0.01	0.6%	n/c	n/c

Table note: n/c = not calculated: following AERA guidance the PEC has only been calculated where the PC is 10% or above.

In order to assess the effect on long-term ground level concentrations associated with the plant operating at the identified plausible abnormal emission levels; the calculated long-term ground level concentrations have been increased pro-rata according to Table 5-4. This assumes that the plant is operating at the daily average IED emission limits for 8700 hours per year and at the plausible abnormal emission levels for 60-hours per year. Given this low frequency of occurrence, the plausible abnormal emissions are predicted to have little effect on long-term impacts as shown in Table 6-5.

Table 6-5
Predicted Maximum Ground Level Long-term Impacts (Abnormal Emissions)

Pollutant	EAL (µg/m^3)	PC (µg/m^3)	PC as % EAL	PEC (µg/m^3)	PEC as % EAL
NO_2	40	0.4	1.0%	27.7	69.3%
PM_{10}	40	0.03	0.1%	n/c	n/c
$PM_{2.5}$	25	0.03	0.1%	n/c	n/c
HF	16	0.01	0.1%	n/c	n/c

Pollutant	EAL (µg/m^3)	PC (µg/m^3)	PC as % EAL	PEC (µg/m^3)	PEC as % EAL
TOC	5	0.03	0.6%	n/c	n/c
Group 1 Metal	0.005	0.0001	1.4%	0.0002	3.3%
Group 2 Metal	0.25	0.0001	0.1%	n/c	n/c
Group 3 Metal	0.02	0.0006	3.2%	0.001	6.3%
Chromium VI	0.0002	4E-07	0.2%	n/c	n/c

Table Note:

As a worst case the assessment has been based on the metal with the highest PC in relation to its EAL, on this basis Group 1 Metal long-term impacts have been assessed against EAL for Cadmium. Group 3 Metals assessed against long term EAL for Nickel.

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

6.4 Predicted Impacts at Sensitive Ecosystems

6.4.1 Critical Levels

The predicted impacts on C_{Le} at the identified ecological sites are presented in Table 6-6 and Table 6-7. The findings are that the PC's are less than 100% of the C_{Le} at the LWS and therefore the impact is considered insignificant and will cause *'no significant pollution'*.

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

Site	PC SO_2 (µg/m^3)	PC as % C_{Le}	PC NO_x (µg/m^3)	PC as % C_{Le}	PC NH_3 (µg/m^3)	PC as % C_{Le}
ER1	0.04	0.2%	0.18	0.6%	0.009	0.3%
ER2	0.03	0.1%	0.10	0.3%	0.005	0.2%
ER3	0.10	0.5%	0.40	1.3%	0.020	0.7%
ER4	0.08	0.4%	0.30	1.0%	0.015	0.5%
ER5	0.05	0.2%	0.18	0.6%	0.009	0.3%
ER6	0.06	0.3%	0.22	0.7%	0.011	0.4%
ER7	0.05	0.2%	0.19	0.6%	0.010	0.3%
ER8	0.04	0.2%	0.17	0.6%	0.009	0.3%
ER9	0.04	0.2%	0.15	0.5%	0.007	0.2%
ER10	0.03	0.1%	0.11	0.4%	0.006	0.2%
ER11	0.04	0.2%	0.17	0.6%	0.009	0.3%
ER12	0.02	0.1%	0.08	0.3%	0.004	0.1%
ER13	0.04	0.2%	0.18	0.6%	0.009	0.3%
ER14	0.07	0.3%	0.28	0.9%	0.014	0.5%

Table 6-7
Predicted Impacts on Short-term Critical Levels

Site	PC NO_x (µg/m^3)	PC as % C_{Le}	PC HF Daily (µg/m^3)	PC as % C_{Le}	PC HF Weekly (µg/m^3)	PC as % C_{Le}
ER1	3.4	4.5%	0.02	0.3%	0.01	1.7%
ER2	2.7	3.6%	0.01	0.3%	0.01	1.4%
ER3	3.0	4.0%	0.01	0.3%	0.01	1.5%
ER4	2.7	3.6%	0.01	0.3%	0.01	1.4%
ER5	3.3	4.4%	0.02	0.3%	0.01	1.7%
ER6	4.1	5.4%	0.02	0.4%	0.01	2.1%
ER7	3.5	4.6%	0.02	0.3%	0.01	1.8%
ER8	1.8	2.4%	0.01	0.2%	<0.01	0.9%
ER9	2.2	3.0%	0.01	0.2%	0.01	1.1%
ER10	1.9	2.5%	0.01	0.2%	<0.01	1.0%
ER11	2.1	2.8%	0.01	0.2%	0.01	1.1%
ER12	1.2	1.6%	0.01	0.1%	<0.01	0.6%
ER13	3.2	4.3%	0.02	0.3%	0.01	1.6%
ER14	4.6	6.2%	0.02	0.5%	0.01	2.4%

6.4.2 Critical Loads

The predicted impact on C_{Lo}'s at the identified ecological sites for nitrogen and acid deposition are presented in Table 6-8 and Table 6-9 respectively. The findings are that the PC's are less than 100% for the LWS therefore the impact is considered insignificant and will cause *'no significant pollution'*.

Table 6-8
Predicted Impacts on Nitrogen Critical Loads

Site	PC N (kg/ha/yr)	Applied C_{Lo}	PC as % C_{L0}
ER1	0.064	10	0.6%
ER2	0.064	10	0.6%
ER3	0.062	10	0.6%
ER4	0.238	10	2.4%
ER5	0.180	10	1.8%
ER6	0.108	10	1.1%
ER7	0.081	10	0.8%
ER8	0.069	10	0.7%
ER9	0.101	10	1.0%
ER10	0.089	10	0.9%
ER11	0.066	10	0.7%
ER12	0.031	10	0.3%

Site	PC N (kg/ha/yr)	Applied C_{Lo}	PC as % C_{LO}
ER13	0.063	20	0.3%
ER14	0.165	10	1.7%

Table 6-9
Predicted Impacts on Acid Critical Loads

Site	PC N (kg/ha/yr)	PC S (kg/ha/yr)	PC as % C_{LO} (PC S + N as % CLmaxN)
ER1	0.005	0.007	0.9%
ER2	0.005	0.007	0.7%
ER3	0.004	0.009	0.5%
ER4	0.017	0.034	1.9%
ER5	0.013	0.026	1.4%
ER6	0.008	0.016	1.2%
ER7	0.006	0.009	0.9%
ER8	0.005	0.008	0.8%
ER9	0.007	0.015	0.8%
ER10	0.006	0.013	1.0%
ER11	0.005	0.010	0.8%
ER12	0.002	0.003	0.3%
ER13	0.004	0.007	0.2%
ER14	0.012	0.024	1.9%

7.0 MODEL SENSITIVITY ASSESSMENT

The sensitivity of a dispersion model is defined in the UK Atmospheric Dispersion Modelling Committee (ADMLC) guidance[17] as the differential of model output by model input. In accordance with EA guidance the following key input variables were subject to sensitivity analysis:

- meteorological data, such as different weather stations, inter-annual variation and surface characteristics;
- emission parameters;
- the receptor grid resolution; and
- treatment of terrain and buildings

The proposed ERF will be based upon either a single-flue or 2-flue (housed within a single windshield) design. The main assessment has been based upon a single flue since a common modelling approach to 2 flues within the same windshield is to model them as a single flue[18,19]. An additional sensitivity assessment has therefore been included to address the 2-flue design considering the flues as discrete emission points that are not subject to enhanced plume rise as a result of their proximity. Emission parameters applied as per Table 5-1, with the exception of diameters of 1.9m and 22.0m/s velocity for each flue.

Therefore, in order to investigate the sensitivity of the dispersion model to relation the input parameters stated above the following scenarios were investigated:

- Sensitivity 0 - Baseline, 2009 meteorological data (meteorological data that gave peak long-term impacts);
- Sensitivity 1 - increased temperature by 30ºC. All other parameters unchanged;
- Sensitivity 2 - decreased temperature by 30ºC. All other parameters unchanged;
- Sensitivity 3 - increased discharge velocity by 10%. Normalised flow (and mass emission) remains as baseline;
- Sensitivity 4 - decreased discharge velocity by 10%. Normalised flow (and mass emission) remains as baseline;
- Sensitivity 5 - Flat terrain;
- Sensitivity 6 - No buildings;
- Sensitivity 7 - Met Data Preparation: Increased Roughness (Z_0 = 1);
- Sensitivity 8 - Met Data Preparation: Decreased Roughness (Z_0 = 0.001);
- Sensitivity 9 - Met Data: Nottingham Watnall 2016 met data used;
- Sensitivity 10 - higher receptor grid resolution (closer spacing resolution doubled); and
- Sensitivity 10 – modelled as 2 separate flues.

These model sensitivity assessments for comparative purposes were assessed using a single year of meteorological data (East Midlands 2009) for all except Sensitivity 9. Inter-annual variation in the meteorological data results in annual mean NO_2 ranges from 0.5µg/m^3 to 0.4µg/m^3 and 1-hour mean (99.9%ile).

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[17] Guidelines for the Preparation of Dispersion Modelling Assessment for Compliance with Regulatory Requirements – an update to the 1995 Royal Meteorological Society guidance. UK Atmospheric Dispersion Modelling Committee (ADMLC), Version 1.4, 2004

[18] ADMS 5 User Guide Version 5 (November 2012)

[19] Source Characterization Issues for Near-Field (AERMOD) Modeling American Iron and Steel Institute Presentation at EPA's 11thModeling Conference (August 12, 2015)

The results are summarised in Table 7-1 for NO_2 annual and 1-hour (99.79%ile) means. None of the variations in the parameters investigated leads to a breach of the NO_2 EALs. The level of variation is broadly applicable to other pollutants, on the basis of which it can be concluded that the level of variation in the parameters investigated would not lead to exceedances of EALs.

Table 7-1
Model Sensitivity Assessment

Scenario	Max GLC ST NO_2 (µg/m^3)	PC as % of EAL	PEC (µg/m^3)	PEC as % of EAL	Max GLC LT NO_2 (µg/m^3)	PC % of EAL	PEC (µg/m^3)	PEC as % of EAL
0	9.5	5%	64	32%	0.5	1%	27.8	69%
1	7.9	4%	63	31%	0.4	1%	27.7	69%
2	12.5	6%	67	34%	0.5	1%	27.8	70%
3	8.4	4%	63	31%	0.4	1%	27.7	69%
4	11.1	6%	66	33%	0.5	1%	27.8	69%
5	4.4	2%	59	29%	0.5	1%	27.8	69%
6	9.5	5%	64	32%	0.5	1%	27.8	69%
7	4.4	2%	59	29%	0.8	2%	28.1	70%
8	32.5	16%	87	44%	0.5	1%	27.8	70%
9	15.1	8%	70	35%	0.4	1%	27.7	69%
10	9.8	5%	64	32%	0.5	1%	27.8	69%
11	14.1	7%	69	34%	0.7	2%	28.0	70%

8.0 Conclusions

The conclusions of the detailed atmospheric dispersion modelling assessment of the ERF combustion emissions are as follows:

- there are no predicted exceedances of short-term or long-term EALs at the point of maximum ground level impact or at relevant exposure locations for any of the scenarios assessed;
- the predicted impact on designated sensitive habitats are considered insignificant and will cause *'no significant pollution'* according to EA guidance; and
- the model sensitivity assessment shows none of the variations in the parameters investigated lead to exceedances of the EALs or any material change to the overall conclusions of the assessment.

APPENDIX A

Process Contribution Isopleths

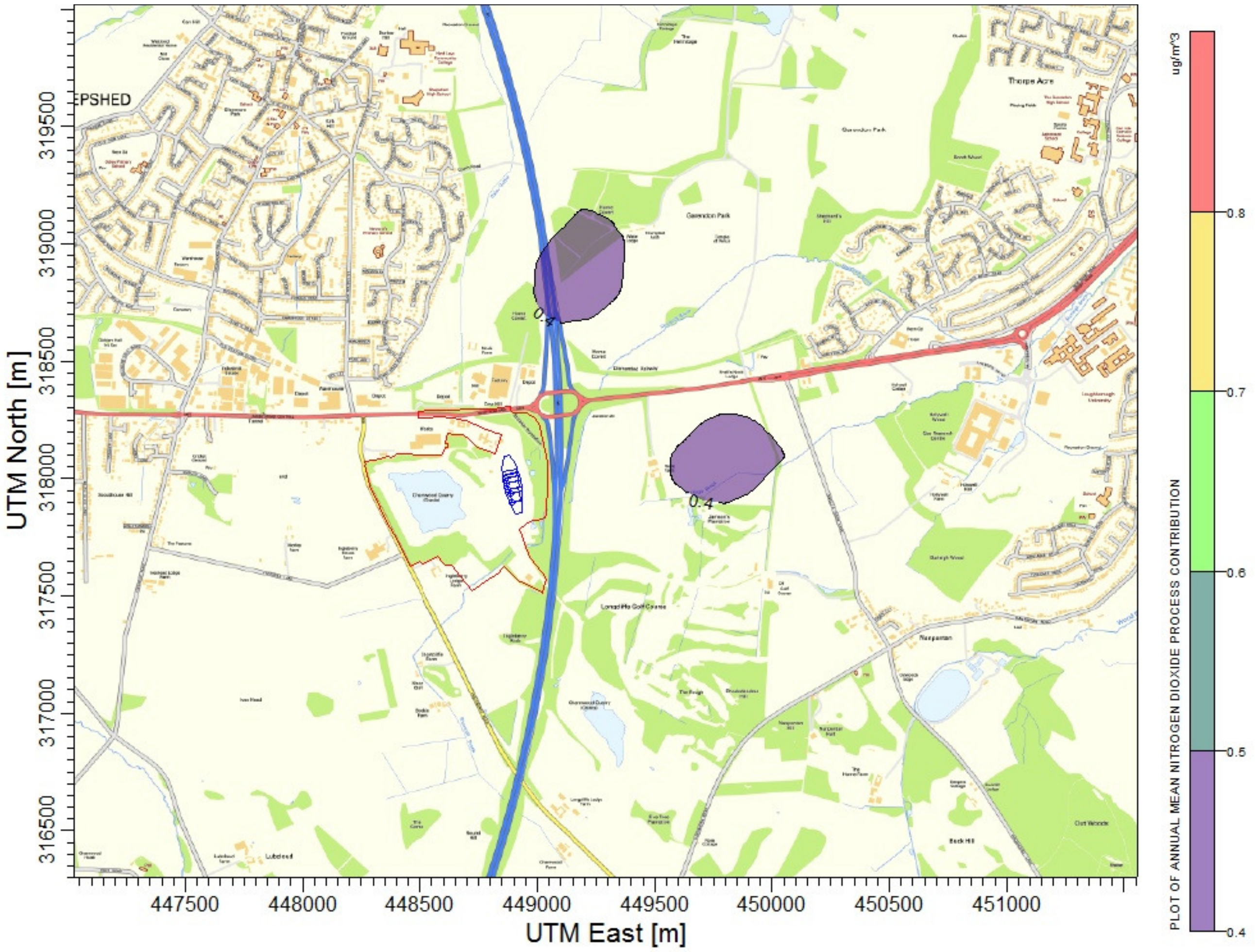

Figure A-1
Plot of NO_2 Annual Mean Process Contribution

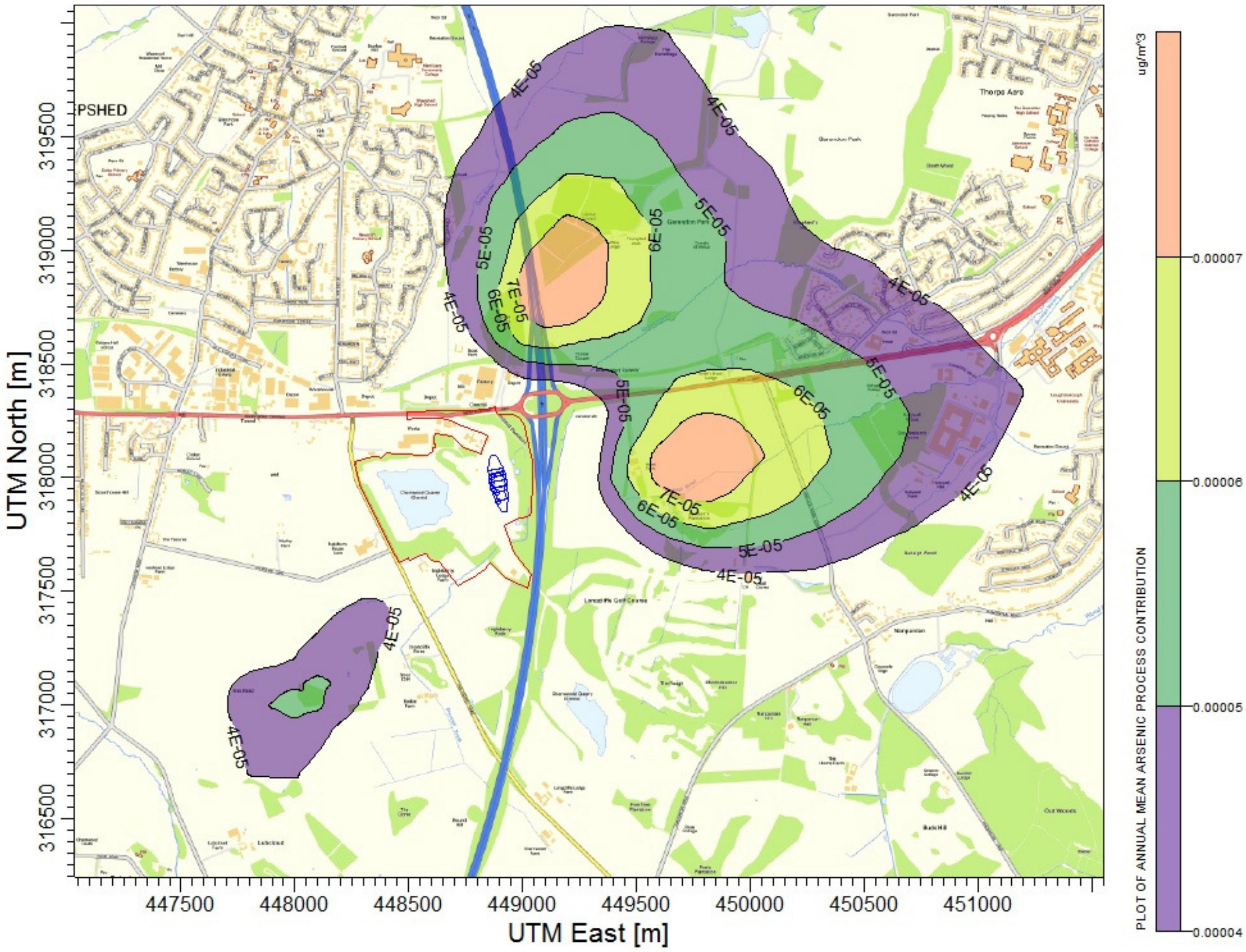

Figure A-2
Plot of Arsenic Annual Mean Process Contribution

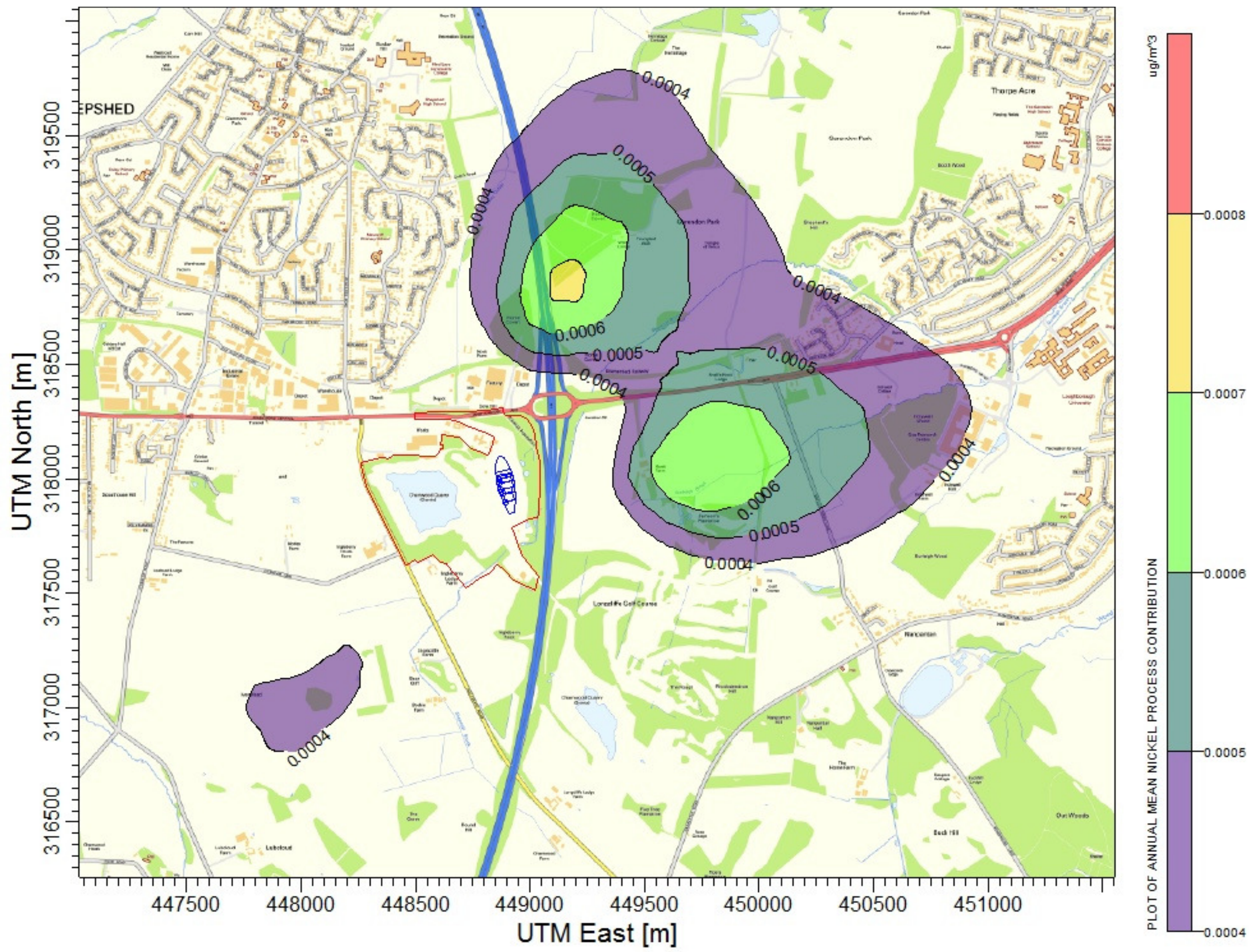

Figure A-3
Plot of Nickel Annual Mean Process Contribution

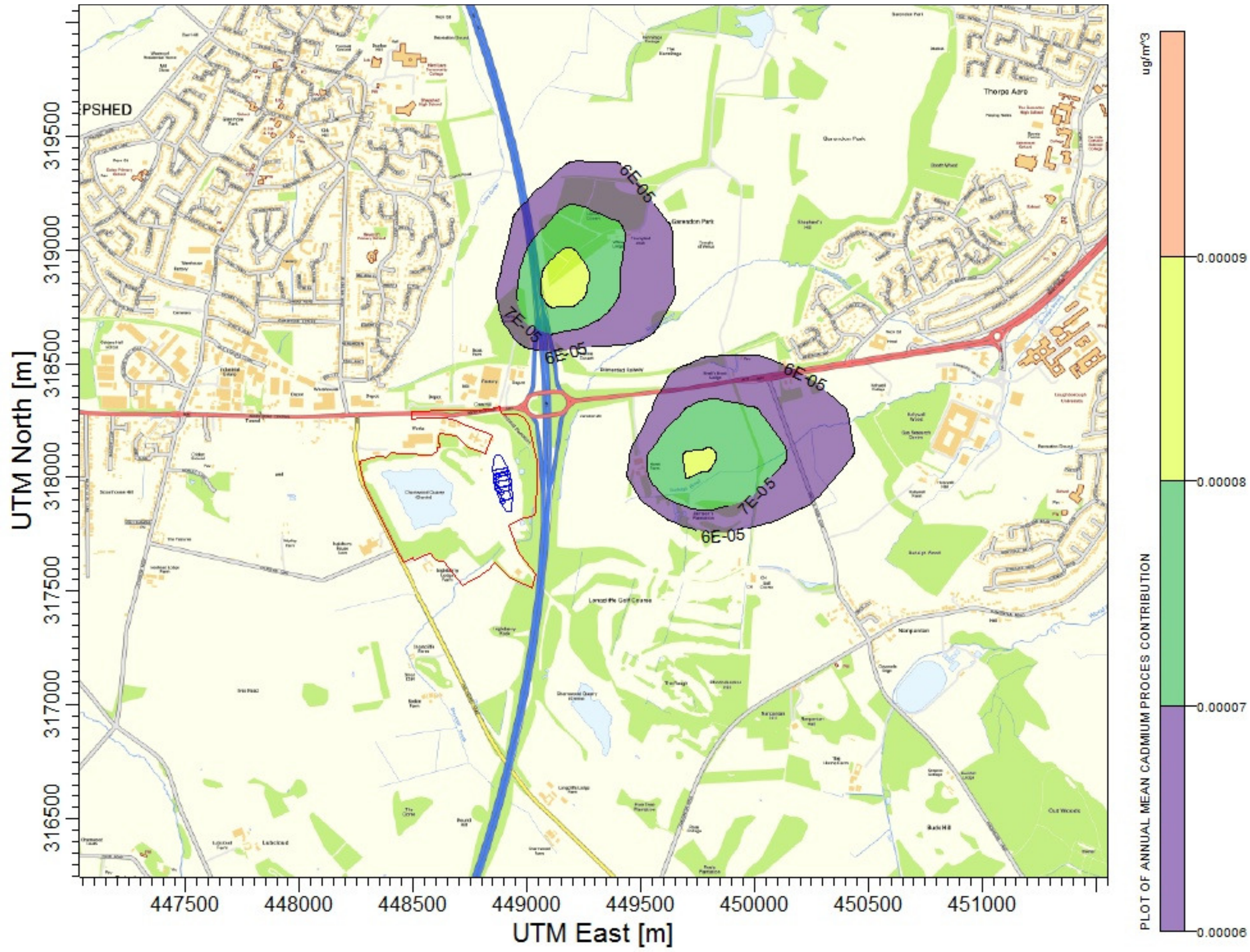

Figure A-4
Plot of Cadmium Annual Mean Process Contribution

EUROPEAN OFFICES

United Kingdom

AYLESBURY
T: +44 (0)1844 337380

BELFAST
T: +44 (0)28 9073 2493

BRADFORD-ON-AVON
T: +44 (0)1225 309400

BRISTOL
T: +44 (0)117 906 4280

CAMBRIDGE
T: + 44 (0)1223 813805

CARDIFF
T: +44 (0)29 2049 1010

CHELMSFORD
T: +44 (0)1245 392170

EDINBURGH
T: +44 (0)131 335 6830

EXETER
T: + 44 (0)1392 490152

GLASGOW
T: +44 (0)141 353 5037

GUILDFORD
T: +44 (0)1483 889800

LEEDS
T: +44 (0)113 258 0650

LONDON
T: +44 (0)203 691 5810

MAIDSTONE
T: +44 (0)1622 609242

MANCHESTER
T: +44 (0)161 872 7564

NEWCASTLE UPON TYNE
T: +44 (0)191 261 1966

NOTTINGHAM
T: +44 (0)115 964 7280

SHEFFIELD
T: +44 (0)114 245 5153

SHREWSBURY
T: +44 (0)1743 23 9250

STAFFORD
T: +44 (0)1785 241755

STIRLING
T: +44 (0)1786 239900

WORCESTER
T: +44 (0)1905 751310

Ireland

DUBLIN
T: + 353 (0)1 296 4667

France

GRENOBLE
T: +33 (0)4 76 70 93 41