FICHTNER
Consulting Engineers Limited

AXIS
NORTH BECK ENERGY CENTRE
APPENDIX 8.2 EMISSIONS MODELLING

Fichtner Consulting Engineers Limited
Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW, United Kingdom
t: +44 (0)161 476 0032 f: +44 (0)161 474 0618 www.fichtner.co.uk

AXIS
NORTH BECK ENERGY CENTRE
APPENDIX 8.2 EMISSIONS MODELLING

Original Document Production & Approval Record				
NAME		SIGNATURE	POSITION	DATE
Prepared by:	Stuart Nock	[signature]	Environmental Scientist	22/12/2017
Checked by:	Rosalind Flavell	[signature]	Associate Senior Consultant	04/01/2018
Approved by:	Stephen Othen	[signature]	Technical Director	04/01/2018

Document Revision Record				
ISSUE NO.	DATE	DETAILS OF REVISIONS	PREPARED BY	CHECKED BY
1	15/12/17	For comment	RSF	SMO
2	18/12/17	Final	RSF	SMO
3	22/12/17	Updated ecological section	RSF	SMO
4	04/01/17	Final	RSF	SMO

TABLE OF CONTENTS

TABLE OF CONTENTS III

1 Introduction 1

2 Process Emissions Dispersion Modelling Methodology 2

2.1 Selection of model 2

2.2 Source and emissions data 2

2.3 Other inputs 4

2.3.1 Modelling domain 4

2.3.2 Meteorological data and surface characteristics 4

2.3.3 Buildings 5

2.3.4 Terrain 5

2.4 Chemistry 6

2.5 Baseline concentrations 6

2.5.1 Final stages of development 6

2.5.2 Developments in receipt of planning consent 7

2.6 Sensitivity analysis – surface roughness 8

2.7 Sensitivity analysis – operating below the design ooint 9

3 Road Emissions Dispersion Modelling Methodology 10

3.1 Traffic generation rates 10

3.2 Methodology 10

4 Dispersion Modelling Results 12

4.1 Annual mean nitrogen dioxide process contribution 15

4.1.1 Nitrogen dioxide impacts at local AQMAs 19

4.2 Sulphur dioxide 19

4.3 Annual mean PM 19

4.4 Annual mean VOCs 19

4.5 Annual mean cadmium 21

4.6 Heavy metals 22

4.7 Impact at ecological receptors 25

4.7.1 Atmospheric emissions - Critical Levels 25

4.7.2 Deposition of emissions - Critical Loads 27

4.7.3 Deposition of emissions - Critical Loads - methodology 27

4.7.4 Deposition of emissions - Critical Loads - results 28

5 Effect of the Finalisation of the BREF 34

5.1 Background 34

5.2 Effect at the point of maximum impact 35

5.3 Effect on Predicted Impacts at Ecological Sites 38

6 Plume Visibility 39

6.1 Base assumptions 39

6.2 Plume visibility results 39

APPENDIX A – CUMULATIVE DEVELOPMENTS – MODEL INPUTS 42

1 Introduction

This Appendix sets out the approach taken to modelling emissions. This includes those from the main stack of the Proposed Development and the road traffic emissions. This includes all model inputs and justifications where appropriate. Finally, this Appendix presents the results of the modelling.

2 Process Emissions Dispersion Modelling Methodology

2.1 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 Environment Agency and Local Authorities. An analysis of the variation in model outputs has been undertaken and the maximum predicted concentration for each pollutant and averaging period has been used to determine the significance of any potential impacts.

2.2 Source and emissions data

The principal inputs to the model with respect to the emissions to air from the proposed energy recovery facility are presented in Table 2.1 and Table 2.2.

Table 2.1 : Stack Source Data

Item	Unit	Value
Stack Data		
Height	m	90.0
Internal diameter – effective diameter	m	3.3
Location	m, m	520638, 414600
Flue Gas Conditions		
Temperature	°C	140
Exit moisture content	% v/v	16.15%
Exit oxygen content	% v/v dry	8.0%
Reference oxygen content	% v/v dry	11.00%
Volume at reference conditions (dry, ref O_2)	Nm^3/s	124.91
Volume at actual conditions	Am^3/s	173.12
Flue gas exit velocity	m/s	20.24

Notes:
The facility will operate two independent incinerator lines. The data in this table is for the combined emissions from both lines.

Table 2.2 : Stack Emissions Data – IED Limits				
Pollutant	**Daily or Periodic ELV**	**Half-hourly ELV**	**Daily or Periodic ELV**	**Half-hourly ELV**
	Conc. (mg/Nm³)		**Release Rate (g/s)**	
Oxides of nitrogen (as NO_2)	200	400	10.702	21.404
Sulphur dioxide	50	200	2.675	10.702
Carbon monoxide	50	150*	2.675	8.026
Fine Particulate Matter (PM)	10	30	0.535	1.605
Hydrogen chloride	10	60	0.535	3.211
Volatile organic compounds (as TOC)	10	20	0.535	1.070
Hydrogen fluoride	1	4	0.054	0.214
Ammonia	10	20	0.535	1.070
Cadmium and thallium	0.05	-	0.003	-
Mercury	0.05	-	0.003	-
Other metals	0.5	-	0.027	-
Benzo(a)pyrene (PaHs)	0.21 µg/Nm³	-	11.23 µg/s	-
Dioxins and furans	0.1 ng/Nm³	-	5.35 ng/s	-
PCBs	5.0 µg/Nm³	-	267.54 µg/s	-

NOTES:

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

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

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.

The highest recorded emission concentration of B[a]P from the EA's public register was 0.105 ug/m³, or 0.000105 mg/m³ (dry, 11% oxygen, 273K). This has been multiplied by a safety factor of two (i.e. to give 0.21 ug/m³), which is assumed to be the emission concentration for the Proposed Development.

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

The Waste Incineration BREF provides a range of values for PCB emissions to air from European municipal waste incineration plants. This states that the annual average total PCBs is less than 0.005 mg/Nm3 (dry, 11% oxygen, 273K). In lieu of other available data, this has been assumed to be the emission concentration for the Proposed Development.

Emissions from the energy recovery facility have been assumed to comply with the limits prescribed within Annex VI Part 3 of the Industrial Emissions Directive (IED) for waste incineration plants. It should be noted that if the energy recovery 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 shorter term limits for short periods on rare occasions.

Also, the energy recovery facility is designed to operate at full capacity and is not anticipated to have significant changes in loading. Therefore, it is appropriate to base the assessment on the design point of the system.

2.3 Other inputs

2.3.1 Modelling domain

Modelling has been undertaken over a 9 km x 9 km grid with a spatial resolution of 90m. In addition, a wider grid was considered for ecological impacts to visualise the impact across a wider area incorporating all ecological sites within 10km. In both instances, the maximum grid spacing in each direction is less than 1.5 times the stack height, in accordance with the Environment Agency's modelling rule of thumb. Reference should be made to Figure 8.7 [Dispersion Model Inputs] for a graphical representation of the modelling domains used. The extent of the modelling domain is detailed in Table 2.3.

Table 2.3: Modelling Domain

Grid Quantity	Standard Modelling Domain	Extended Modelling Domain for Ecological Impacts
Grid spacing (m)	90	90
Grid points	101	250
Grid Start X (m)	516100	509395
Grid Finish X (m)	525100	531805
Grid Start Y (m)	410100	403395
Grid Finish Y (m)	419100	425805

2.3.2 Meteorological data and surface characteristics

The impact of meteorological data was taken into account by using weather data from the Humberside Airport meteorological recording station for the years 2012 – 2016. Humberside Airport is approximately 12.5km to the west of the Proposed Development.

The period 2012 to 2016 was chosen as this was the most recent full set of data available at the time of starting the air quality modelling. The Environment Agency recommends that 5 years of data are used to take into account inter-annual fluctuations in weather conditions. Wind roses for each year can be found in Figure 8.8 [Wind Roses].

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 0.2m for the meteorological site, which is appropriate for the rural, open agricultural areas surrounding the airport. The dispersion modelling domain encompasses a variety of terrain, including agricultural land, suburban, industrial and water. Therefore, spatially varying surface roughness has been used in the model. The parameters of the surface roughness are detailed in Table 2.4. The sensitivity of the modelling to the choice of surface roughness has been considered later in this Technical Appendix. Reference should be made to Figure 8.7 [Dispersion Model Inputs] for a graphical representation of the surface roughness file.

Table 2.4: Spatially Varying Surface Roughness	
Identified surface type	**Modelled surface roughness length (m)**
Agricultural	0.3
Suburban	0.5
Industrial	0.5
Water	0.0001

2.3.3 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 Environment Agency 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 height.

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

A review of the site layout has been undertaken and the details of the applicable buildings are presented in Table 2.5. For completeness, details of all buildings are provided, although only those of height greater than one third of the stack height will have an effect on dispersion. A site plan showing which buildings have been included in the model is presented in Figure 8.9 [Buildings Modelled].

Table 2.5: Building Details						
Buildings	**Centre Point**		**Height (m)**	**Width (m)**	**Length (m)**	**Angle (°C)**
	X (m)	**Y (m)**				
Boiler House	520722	414663	48.0	55.0	45.5	53.0
Flue Gas Turbine Hall	520673	414626	48.0	55.0	78.0	53.0
Bunker	520759	414691	48.0	76.1	45.5	53.0
Waste Reception	520793	414712	26.6	83.7	35.0	53.0
Turbine Hall	520747	414627	24.0	32.0	40.0	53.0
ACC	520679	414567	20.0	26.0	74.0	53.0

2.3.4 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 need not be taken into account in the modelling.

2.4 Chemistry

The Proposed Development 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 air quality objectives 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 Environment Agency methodology. Given the short travel time to the areas of maximum concentrations, this approach is considered conservative.

2.5 Baseline concentrations

Applying the IAQM magnitude of change criteria set out in Chapter 8, if the annual mean contribution from the Proposed Development is less than 0.5% of the AQAL, the magnitude of change can be described as negligible irrespective of baseline concentrations. The contribution from the Proposed Development should include the emissions from the process, together with those associated with the increase in vehicle movements.

If the annual mean contribution from the Proposed Development is greater than 0.5% of the AQAL, then consideration of the future baseline concentration is needed in order to define the magnitude of change.

There are two sources of baseline concentrations; existing monitoring and mapped background data. The monitoring data will include the contribution from all existing sources whilst the mapped background dataset will include the contribution from all existing major point sources and wider background sources.

The future baseline should include all existing processes and those which are consented and would be operational when the Proposed Development would be online.

Appendix A of this report includes the model input information for each of the developments listed below. These are all displayed on Figure 8.10 [Other Local Developments].

2.5.1 Final stages of development

A review of the local area has shown that there are a number of developments locally which release similar pollutants as the Proposed Development, have been granted planning permission and a permit to operate, are in the process of being built and which will be operational by the time the Proposed Development is online or have only been operating for a short period. These projects will add pollution to the baseline concentrations, so it may not be wholly appropriate to only rely upon monitoring or mapped background data to define the future baseline concentration. The projects identified are:

- The UKPR Queens Road Power Plant – a Short Term Operating Reserve (STOR) Facility which was granted approval by North East Lincolnshire Council on 19 May 2016 (ref: DM/0246/16/FUL), and for which the Environment Agency granted an Environmental Permit to operate on 16 June 2014 (ref: EPR/VP3032EZ). The Environmental Permit limits the operation of this plant to no more than 500 hours per year. As such, no emission limits are set out in the Environmental Permit. However, the Air Quality Assessment assumed that there would be emissions of oxides of nitrogen and carbon monoxide. Therefore, the emission concentrations set out in the Air Quality Assessment have been used in this assessment and the annual mean output factored by the maximum allowable hours of operation. This is operated by UKPR and referred to as the "UKPR Queens Road STOR Facility".

- The UKPR Kings Road Power Plant – a STOR Facility for which the Environment Agency granted an Environmental Permit to operate on 07 February 2017 (ref: EPR/PP3339YQ). The Environmental Permit limits the operation of this plant to no more than 1,500 hours per year. This development is permitted to release emissions of oxides of nitrogen but no limit is set for carbon monoxide. Therefore, the emission concentrations set out in the Air Quality Assessment have been used in this assessment and the annual mean output factored by the maximum allowable hours of operation. This is operated by UKPR and referred to as the "UKPR Kings Road STOR Facility".
- The AMP Queens Road Power Plant – a STOR Facility which was granted approval by North East Lincolnshire Council on 02 November 2016 (ref: DM/0802/16/FUL). It is not clear whether this plant has been given an Environmental Permit to operate to date. However, the plant is currently under construction so it is expected that the Environmental Permit is currently being finalised. The Air Quality Assessment for the planning application assumed the Facility would be operational for no more than 2,000 hours per year. This development will be permitted to release emissions of oxides of nitrogen and carbon monoxide. The emission concentrations set out in the Air Quality Assessment have been used in this assessment and the annual mean output factored by the maximum allowable hours of operation. This is operated by AMP Energy Services Limited and referred to as the "AMP Queens Road STOR Facility".

In addition to the above local developments it is noted that the North Killingholme Power Project (a gas fired CCGT) was granted approval by the Secretary of State on 11 September 2014 under the North Killingholme (Generating Station) Order 2014, and the Environment Agency granted an Environmental Permit to operate on 10 August 2017 (ref: EPR/FP3838EB). This development is permitted to release emissions of oxides of nitrogen and carbon monoxide. Although this is located approximately 7km to the north-east of the Proposed Development, this is a large-scale plant and would have far wider reaching impacts than the immediate surroundings. As it is expected that this plant would be operational at the same time of the Proposed Development, it has also been considered in this assessment.

2.5.2 Developments in receipt of planning consent

A review of the local area has shown that there are a number of developments locally which release similar pollutants as the Proposed Development, and have been granted planning permission, but do not currently have a permit to operate. These will need to apply to the Environment Agency for an Environmental Permit. These projects have the potential to add pollution to the future baseline concentrations. The projects identified are those set out in Chapter 2.0 of the Environmental Statement:

- A 49MW Biomass CHP Facility which was granted approval by North East Lincolnshire Council in April 2014 (ref: DC/999/11/IMM). This would release emissions of oxides of nitrogen, sulphur dioxide, carbon monoxide, and particulate matter. Although this has been granted planning permission it is highly unlikely that this project would go ahead due to the change in financial subsidies available. However, since the planning permission has been saved in perpetuity it has been included in this assessment in the very unlikely case that the project went ahead. When modelling, the limits set out in the Air Quality Assessment have been used. This is referred to as the "Real Ventures Immingham Biomass CHP Facility".

- A food waste energy processing plant which was granted approval by North East Lincolnshire Council in February 2007 (ref: DM/1004/13FUL). This would release emissions of the same suite of pollutants as the Proposed Development. Although this has been granted planning permission, due to various issues with the technology and finances, the project has not gone further. However, the planning permission has been saved in perpetuity so it has been included in the assessment. When modelling, the limits set out in the Air Quality Assessment have been used. This is referred to as the "Kiln Lane Option A".
- Planning permission for a waste-type to energy pyrolysis plant in the disused Immingham Rail freight terminal, including a STOR Facility, was approved by North East Lincolnshire Council on 04 December 2017 (ref: DM/0333/17/FUL). This would release emissions of the same suite of pollutants as the Proposed Development. To date, an Environmental Permit has not been granted by the Environment Agency. This project is on the same piece of land as the Kiln Lane Industrial Estate Food Waste Energy Processing Plant (Kiln Lane Option A). Therefore, when considering the future baseline, it has been assumed that either this or the Kiln Lane Option A will be progressed, noting that it is most likely that this project would be developed. When modelling, the limits set out in the Air Quality Assessment have been used. This is referred to as the "Kiln Lane Option B".
- Planning permission to develop a renewable power facility at Plot Q on the Kiln Lane Industrial Estate was approved by North East Lincolnshire Council in April 2016 (ref: DM/0848/14/FUL). To date, an Environmental Permit to operate has not been granted by the Environment Agency. Unfortunately, there is very limited information available on the planning portal to define the inputs for the dispersion model. The scale of this plant is very small and, as such, it is not considered likely that this would have significant impacts. This has not been specifically modelled in this assessment.

As detailed above, for the site on Kiln Lane there are two planning permissions which could be brought forward, options A and B. It is most likely that option B will be brought forward. Despite this, the impact of both options has been determined. As expected, Option B has the greatest impact on local air quality. Therefore, when considering the future baseline this has been quantified, based on Kiln Lane Option B operating.

2.6 Sensitivity analysis – surface roughness

The sensitivity of the results to using spatially varying surface roughness length has been considered by running the model for two scenarios:

- Constant roughness length of 0.3m across the dispersion modelling domain, suitable for agricultural areas; and
- A spatially varying roughness length across the modelling domain, as detailed in Table 2.4 and Figure 8.7 [Dispersion Model Inputs].

The following parameters were kept constant:

- Stack height – 90 m;
- Buildings – included; and
- Meteorological data year – 2015.

The contribution of the energy recovery facility to the ground level concentration of the emissions of oxides of nitrogen at the point of maximum impact are presented in Table 2.6.

Table 2.6: Surface Roughness Sensitivity Analysis		
Surface roughness	**Max annual mean NOx process contribution**	**Max 1-hour mean NOx process contribution**
Constant 0.3m	2.9	25.08
Spatially varying roughness	2.94	24.99

As shown, varying surface roughness values leads to slightly higher process contributions on an annual mean and short term basis. Therefore, spatially varying surface roughness has been included in the dispersion modelling. This is appropriate, given the differences between the roughness values across the modelling domain.

2.7 Sensitivity analysis – operating below the design ooint

Dispersion modelling has been undertaken based on the emission parameters based on the design point for the energy recovery facility and the maximum capacity. The energy recovery facility is 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 on 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.

3 Road Emissions Dispersion Modelling Methodology

3.1 Traffic generation rates

Operation phase traffic data has been provided for the local road network for the following scenarios:

- Scenario 1: 2023 Baseline; and
- Scenario 2: 2023 Baseline + Proposed Development Traffic.

The traffic is routed such that LDVs (staff and visitors) arrive and depart to the west along Queens Road, while HGVs arrive and depart to the east along Queens Road towards the A180 via Laporte Road and Kiln Lane, away from local sensitive residential receptors as shown on Figure 8.4.

Table 3.1 shows a summary of the average daily weekday traffic flows for the above scenarios, and for the development impact (i.e. Scenario 2 – Scenario 1).

Table 3.1 – Operational Phase Traffic

Scenario	Road link							
	Site Access		Queens Road West		Queens Road East		Laporte Road	
	LDVs	HGVs	LDVs	HGVs	LDVs	HGVs	LDVs	HGVs
2023 Baseline	0	0	2455	1036	2455	1036	1638	1052
2023 Baseline + Proposed Development	98	252	2553	1036	2455	1288	1638	1304
Development traffic	98	252	98	0	0	252	0	252

As shown, the maximum change in vehicle movements as a result of the operation of the Proposed Development is anticipated to be approximately 252 HGV movements per day and 98 LDV movements per day on a weekday, occurring on separate road links.

The increased vehicle movements along Queens Road west of the site access are less than the IAQM screening criteria for locations not within or adjacent to an AQMA. Therefore, road vehicle emissions associated with the operational phase of the Proposed Development along Queens Road West are not expected to cause a significant change and the significance of effect is deemed to be negligible.

Along Queens Road to the east of the site access, although there is no increase in LDV movements, the increase in HGV movements exceeds the IAQM criteria. As shown on Figure 8.4, there are no sensitive human receptors within 200m to the affected roads (Queens Road East, Laporte Road and Kiln Lane). However, there are two local non-designated ecological habitat sites within 200m of these roads: the Immingham Dock Reedbed and Laporte Road Brownfield Site.

3.2 Methodology

In order to assess the impact of the operational phase traffic on the two ecological habitat sites, dispersion modelling has been undertaken using the ADMS-Roads model.

The maximum impact using the same five years of meteorological data as used for the process emissions modelling. As roads more than 200m from the ecological habitat sites are unlikely to contribute significantly to pollutant concentrations, only Queens Road East and Laporte Road have been included in the model. Vehicles have been modelled at the following speeds:

- Queens Road East: LDVs: 48kph, HGVs: 20kph; and
- Laporte Road: LDVs: 64kph, HGVs: 48kph.

The impact at the closest point to the road within each ecological site has been assessed. The location of the receptor point used to represent each ecological site is presented in Table 3.2.

Table 3.2 – Ecological Receptors for Operational Phase Traffic Modelling

Ecological Site	Modelled Receptor Location		Distance from road centreline (m)
	X(m)	Y(m)	
Immingham Dock Reedbed	520675	415314	60
Laporte Road Brownfield Site	521440	414816	10

A screening approach has been taken to the modelling, using the following conservative assumptions:

- Development-generated traffic continues at weekday levels throughout the 7-day week. This is highly conservative, as development-generated traffic is expected to be significantly lower at weekends.
- Vehicle emissions do not vary throughout the day. This is conservative as the majority of development-generated traffic occurs during daylight hours, when conditions are typically more conducive to dispersion of pollutants from road traffic.
- Maximum daily mean NOx contributions from road traffic and the process emissions have been assumed to occur under the same meteorological conditions; in reality, the worst-case meteorological conditions will differ for stack emissions and road traffic emissions.
- Vehicle emission factors for 2015 have been used, i.e. it is assumed that there is no improvement in vehicle emissions from 2015 levels by 2023.
- The highest mapped background concentration for oxides of nitrogen across both ecological sites has been used.

The contribution from road traffic emissions to airborne concentrations of NOx, nutrient nitrogen deposition and acid deposition has been calculated and compared to the relevant Critical Levels and Critical Loads, along with the combined impact of road traffic emissions and process emissions. The results are presented in Section 4.7 of this technical appendix.

4 Dispersion Modelling Results

Table 4.1 presents the results of the dispersion modelling of process emissions from the energy recovery facility at the point of maximum impact. This is the maximum predicted concentration based on the following:

- Modelling domain size – 9.0km at 90m resolution;
- Buildings – included;
- Stack height – 90m;
- 5 years of weather data 2012 to 2016 from Humberside Airport meteorological recording station;
- Operation at the long term ELVs set out in the IED for 100% of the year;
- Operation at the short term ELVs set out in the IED during the worst-case conditions for dispersion of emissions;
- Environment Agency's worst case conversion of NOx to NO_2;
- 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 monitoring contained in Appendix 8.1 [Baseline Review]. Where the process contribution is less than 0.5% of the long term and less than 9.5% of the short term AQAL, the magnitude of change of the impact can be described as 'negligible' irrespective of baseline concentrations. If either of these criteria are exceeded, further analysis has been undertaken.

Table 4.1: Dispersion Modelling Results – Point of Maximum Impact													
Pollutant	Quantity	Units	AQAL	Bg Conc.	Process Contribution (PC) at Point of Greatest Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2012	2013	2014	2015	2016	Max			
Nitrogen dioxide	Annual mean	µg/m³	40	31.5	1.35	1.40	1.48	2.06	1.40	2.06	5.15%	33.60	84.00%
	99.79th%ile of hourly means(1)	µg/m³	200	63.1	19.07	19.26	19.27	19.45	19.01	19.45	9.73%	82.53	41.27%
Sulphur dioxide	99.18th%ile of daily means	µg/m³	125	33.4	3.92	3.62	4.41	4.67	3.34	4.67	3.73%	38.07	30.45%
	99.73rd%ile of hourly means(1)	µg/m³	350	33.4	27.12	27.25	27.30	27.76	27.07	27.76	7.93%	61.16	17.48%
	99.9th%ile of 15 min. means(1)	µg/m³	266	33.4	30.02	30.40	30.40	30.51	29.94	30.51	11.47%	63.91	24.03%
PM_{10}s	Annual mean	µg/m³	40	20.4	0.10	0.10	0.11	0.15	0.10	0.15	0.37%	20.52	51.29%
	90.41th%ile of daily means	µg/m³	50	40.7(2)	0.32	0.34	0.34	0.44	0.34	0.44	0.87%	41.18	82.35%
$PM_{2.5}$s	Annual mean	µg/m³	25	15.3	0.10	0.10	0.11	0.15	0.10	0.15	0.59%	15.42	61.67%
Carbon monoxide	8 hour running mean(1)	µg/m³	10,000	648.0	19.71	22.72	19.36	20.78	20.03	22.72	0.23%	670.72	6.71%
Hydrogen chloride	Hourly mean(1)	µg/m³	750	1.4	10.21	10.91	11.97	9.90	10.92	11.97	1.60%	13.39	1.78%
Hydrogen fluoride	Annual mean	µg/m³	16	2.4	0.01	0.01	0.01	0.01	0.01	0.01	0.09%	2.36	14.78%
	Hourly mean(1)	µg/m³	160	4.7	0.68	0.73	0.80	0.66	0.73	0.80	0.50%	5.50	3.44%
Ammonia	Annual mean	µg/m³	180	2.9	0.10	0.10	0.11	0.15	0.10	0.15	0.08%	3.07	1.70%
	Hourly mean	µg/m³	2,500	5.8	1.70	1.82	1.99	1.65	1.82	1.99	0.08%	7.83	0.31%
VOCs (as benzene)	Annual mean	µg/m³	5	1.2	0.10	0.10	0.11	0.15	0.10	0.15	2.94%	1.34	26.74%
	Hourly mean	µg/m³	195	2.4	3.40	3.64	3.99	3.30	3.64	3.99	2.05%	6.37	3.27%

Table 4.1: Dispersion Modelling Results – Point of Maximum Impact													
Pollutant	**Quantity**	**Units**	**AQAL**	**Bg Conc.**	**Process Contribution (PC) at Point of Greatest Impact**						**Max as % of AQAL**	**PEC (PC +Bg)**	**PEC as % of AQAL**
					2012	**2013**	**2014**	**2015**	**2016**	**Max**			
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.2	0.10	0.10	0.11	0.15	0.10	0.15	6.54%	0.34	14.99%
Mercury	Annual mean	ng/m³	250	20.0	0.48	0.50	0.53	0.74	0.50	0.74	0.29%	20.75	8.30%
	Hourly mean	ng/m³	7500	40.0	8.51	9.09	9.97	8.25	9.10	9.97	0.13%	49.99	0.67%
Cadmium	Annual mean	ng/m³	5	0.8	0.24	0.25	0.26	0.37	0.25	0.37	7.36%	1.20	23.96%
	Hourly mean	ng/m³	-	1.7	4.26	4.55	4.99	4.12	4.55	4.99	-	6.65	-
Dioxins	Annual mean	fg/m³	-	33.0	0.97	1.00	1.06	1.47	1.00	1.47	-	34.47	-
PCBs	Annual mean	ng/m³	250	3.9	1.02	1.05	1.11	1.55	1.05	1.55	0.62%	5.42	2.17%
	Hourly mean	ng/m³	6000	254.9	0.05	0.05	0.05	0.07	0.05	0.07	0.00%	254.99	4.25%
PAHs	Annual mean	pg/m³	200	127.5	0.85	0.91	1.00	0.82	0.91	1.00	0.50%	128.46	64.23%
Other metals	Annual mean	ng/m³	-	-	4.83	5.01	5.29	7.36	5.01	7.36	See metals assessment		
	Hourly mean	ng/m³	-	-	85.12	90.91	99.71	82.47	90.98	99.71			

Notes:

(1) *Assumes both lines operate at the short term ELV concurrently.*

(2) Assumes background to be twice the annual mean background concentration noting that this is conservative and LAQM guidance recommends using the annual mean background concentration. The PEC with the annual mean concentration is predicted to be 52.1%.

All assessment is based on the maximum process contribution using all 5 years of weather data.

As shown, the process contribution is greater than 0.5% of the long term and greater than 10% of the short term AQAL at the point of maximum impact for the following pollutants and therefore the magnitude of change cannot be screened out as 'negligible', irrespective of baseline concentrations:

- Annual mean nitrogen dioxide;
- 15-minute sulphur dioxide;
- Annual mean VOCs; and
- Annual mean cadmium

Therefore, further analysis of the likely future baseline concentrations has been undertaken to define the magnitude of change. For all other pollutants and averaging periods, the magnitude of change can be screened out as 'negligible' irrespective of baseline concentrations.

It is noted that road vehicles associated with the Proposed Development are also sources of nitrogen dioxide and particulate matter emissions. Therefore, for these pollutants the magnitude of change should consider the contribution from both process emissions and road vehicle exhaust emissions. The following sections define the magnitude of change for those pollutants listed above, for which the process contribution cannot be screened out as negligible, irrespective of baseline concentrations and those pollutants which are also emitted from road vehicles.

4.1 Annual mean nitrogen dioxide process contribution

The annual mean nitrogen dioxide process contribution from process emissions from the energy recovery facility is predicted to be 5.15% of the AQAL at the point of maximum impact. However, this does not include any contribution from road traffic.

As discussed in the ES chapter, the additional contribution from road traffic is not expected to be significant. Figure 8.11 [HGV Routing and AQ Impact] shows the routing of the HGVs. As shown, there are no residential properties where the impact of process emissions is greater than 0.5% of the AQAL and is within 200m of the HGV route. Therefore, the contribution from HGVs is not expected to be a significant contributor to the overall impact at any residential receptor and only the contribution from the Energy Recovery Facility has been considered.

The annual mean nitrogen dioxide process contribution as a percentage of the AQAL is presented in Figure 8.12 [Annual Mean Nitrogen Dioxide]. As shown, the peak concentration is predicted to occur approximately 900km to the north east of the energy recovery facility. This is not in an area where residential receptors have been identified and the long term AQALs apply. Figure 8.13 [Annual Mean Nitrogen Dioxide] shows that at all residential properties the impact is between 0.5% and 1% of the AQAL. Applying the Environment Agency screening criteria, the impact can be screened out as 'insignificant', as the impact at all residential properties is less than 1% of the annual mean AQAL.

Table 4.2 details the impact of annual mean nitrogen dioxide contributions from the process emissions at the identified sensitive human receptor locations.

Table 4.2: Annual Mean Nitrogen Dioxide Impact at Identified Sensitive Receptors			
Receptor		Process Concentration	
		µg/m³	as % of AQAL
R1	Queens Road, Immingham	0.13	0.33%
R2	Chestnut Avenue, Immingham	0.19	0.48%
R3	N Moss Ln, Stallingborough	0.14	0.35%
R4	Brickpit Farm, S Marsh Rd, Stallingborough	0.14	0.35%
R5	S Marsh Rd, Stallingborough	0.14	0.35%
R6	Church Ln, Stallingborough	0.15	0.37%
R7	Keelby Rd, Stallingborough	0.16	0.41%
R8	Mauxhall Farm, Immingham Rd, Stallborough	0.28	0.70%
R9	Havenmere Residential Care Home	0.19	0.49%
R10	Stark Lincolnshire and Goole Hospitals	0.18	0.45%
R11	Canon Peter Hall Church of England Primary School	0.19	0.49%
R12	Eastfield Primary School	0.27	0.67%
R13	Oasis Academy Immingham	0.20	0.49%

As shown the impact is less than 0.5% of the AQAL at all but two of the specific receptor locations considered in the assessment.

As noted in Section 2.5, the future baseline concentration should include the contribution from the existing sources, those currently in the final stages of development, and those with planning consent. Each of the identified projects have been included in the model. This has needed to be undertaken as most of the applications lacked any plot files to show the spatial distribution of emissions. For each of the STOR Facilities, the annual mean impact has been determined by running the model for all hours and then factoring the output by the allowable number of hours of operation. The plot file showing the impact of each of these other developments is provided in Figure 8.13 [Annual Mean NO2 PEC Analysis]. As shown the STOR Facilities make the most significant contribution. However, impacts are limited to small areas close to each facility, away from areas of relevant exposure due to the short stack heights for these types of plant.

The plot files have been investigated to determine the likely future baseline concentration and how this varies across the local area.

Figure 8.13 [Annual Mean NO2 PEC Analysis] shows that where the contribution of the Proposed Development is between 2 and 5% of the AQAL, the contribution from other sources is a maximum of 10% of the AQAL. In this area the mapped background concentration is 53% of the AQAL. The mapped background includes the contribution from the other sources not modelled in the local area. The PEC (modelled processes, mapped background and Proposed Development) is predicted to be well below 75% of the AQAL.

Where the contribution of the Proposed Development is between 0.5 and 1.5% of the AQAL, the contribution from other sources is a maximum of 10% of the AQAL over a small area. In this area the mapped background concentration is ~50% of the AQAL. The PEC (modelled processes, mapped background and Proposed Development) is predicted to be well below 75% of the AQAL.

Where the contribution of the Proposed Development is between 0.5 and 1.0% of the AQAL and there are residential properties, the contribution from other sources is a maximum of 2% of the AQAL. In this area the mapped background concentration is ~45% of the AQAL. Therefore, the PEC (modelled processes, mapped background and Proposed Development) is predicted to be well below 75% of the AQAL.

For completeness, the contribution from each source has been calculated at each receptor. This analysis is provided in Table 4.3. As shown, the total PEC for both Kiln Lane development options is predicted to be less than 75% of the AQAL. Therefore, the magnitude of change is described as negligible at all areas considered.

Table 4.3: Annual Mean Nitrogen Dioxide Impact at Identified Sensitive Receptors								
Receptor	Concentration as % of AQAL							
	Mapped Background	Final Stages of Development	Obtained Planning Permission – Option A	Obtained Planning Permission – Option B	Proposed Development	PEC - only including Final Stage Developments	PEC – all consented schemes – Option A	PEC – all consented schemes – Option B
R1	48.4	3.6	0.5	1.7	0.33	52.3	52.8	54.0
R2	50.9	1.0	0.6	0.9	0.48	52.3	52.9	53.2
R3	37.9	0.3	0.2	0.5	0.35	38.5	38.7	39.1
R4	39.5	0.2	0.2	0.4	0.35	40.1	40.3	40.6
R5	39.5	0.2	0.2	0.4	0.35	40.0	40.3	40.4
R6	32.4	0.3	0.2	0.4	0.38	33.1	33.3	33.5
R7	35.1	0.3	0.3	0.4	0.40	35.8	36.0	36.2
R8	37.5	0.5	0.4	0.8	0.70	38.7	39.0	39.4
R9	42.2	0.7	0.5	0.7	0.48	43.4	43.9	44.1
R10	42.2	0.7	0.5	0.7	0.45	43.3	43.8	44.0
R11	42.2	0.7	0.5	0.7	0.48	43.4	43.8	44.0
R12	42.2	0.6	0.4	0.6	0.68	43.5	43.9	44.1
R13	42.2	0.6	0.4	0.6	0.50	43.3	43.8	43.9

4.1.1 Nitrogen dioxide impacts at local AQMAs

The closest AQMA locally is designated due to concern over annual mean nitrogen dioxide concentrations is over 8km to the north of the Proposed Development, and is north of the River Humber (as shown on Figure 8.5 [AQMAs]). As shown on Figure 8.12 [Annual Mean Nitrogen Dioxide], the impact is well below 0.5% of the AQAL, and therefore the magnitude of change within the AQMAs is described as negligible.

4.2 Sulphur dioxide

The analysis presented in Table 4.1 assumes that each line operates at the half hourly ELV during the worst case weather conditions for dispersion. This is highly unlikely as each line will be independent. Despite this, Figure 8.14 [15-minute Sulphur Dioxide] shows that the area where impacts are predicted to be greater than 10% of the AQAL includes a number of workplaces but no residential properties. The following table looks at the effect of other operating scenarios.

Table 4.4: 15-min Sulphur Dioxide Analysis

Scenario	99.9%ile 15-minute Sulphur Dioxide Concentration as % of AQAL
Both lines operate at the IED half hourly ELV	11.5%
Once line operates at the daily IED ELV and the other at the half-hourly IED ELV	8.6%
Both lines operate at the daily ELV	2.9%

As shown, it is only if it is assumed that both lines concurrently operate at the half hourly ELV during the worst-case weather conditions for dispersion that the peak concentration greater than 10% of the AQAL. This is not considered to be a significant impact.

4.3 Annual mean PM

The impact of process emissions at the point of maximum impact is less than 0.5% of the AQAL, assuming that the entire PM emissions consist of PM10 or PM2.5s and the magnitude of change can be described as negligible, irrespective of baseline concentration. As noted when discussing the impact of annual mean nitrogen dioxide, the impact of process and vehicle emissions should be considered in combination. However, there are no residential receptors within 200m of any of the roads used by HDVs. Therefore the contribution from HGVs is not expected to be a significant contributor to the overall impact at any residential receptor and only the contribution from the energy recovery facility has been considered.

4.4 Annual mean VOCs

There are two VOCs for which an AQAL has been set; 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 process contribution from the Proposed Development is predicted to be 2.94% of the AQAL for benzene, and 6.54% of the AQAL for 1,3-butadiene. The annual mean VOC process contributions as a percentage of the AQAL for benzene and 1,3-butadiene are presented in Figures 8.15 and 8.16 respectively.

As noted in Section 2.5, the future baseline concentration should include the contribution from the existing sources, those currently in the final stages of development and those with planning consent. Each of the identified projects have been included in the model. This has needed to be undertaken as most of the applications lacked any plot files to show the spatial distribution of emissions. None of the projects in the final stages of development were identified as releasing VOCs. The only developments in receipt of planning which will potentially release VOCs are:

- Kiln Lane Option A – the Food Waste Energy Processing Plant; and
- Kiln Lane Option B - the Kiln Lane Pyrolysis plant.

As explained, these are located on the same site so only one option will progress, rather than both plants at the same time. Both of these plants will be required to meet the requirements of the IED for the incineration of waste, like the Proposed Development. This will include an emission limit for TOC. The exact speciation is unknown and it is highly unlikely that this will only consist of benzene or 1,3-butadiene. However, as a conservative assumption it has been assumed that the entire TOC emissions from these plants consist of only benzene or 1,3-butadiene.

As with annual mean nitrogen dioxide, the plot files have been investigated to determine the likely future baseline concentration and how this varies across the local area.

Figure 17 [Benzene PEC Analysis] shows that where the contribution of the Proposed Development is between 2 and 5% of the AQAL, the contribution from other sources is a maximum of 1% of the AQAL. In this area the mapped background concentration is 9% of the AQAL. The mapped background includes the contribution from the other sources not modelled in the local area. The PEC (modelled processes, mapped background and Proposed Development) is predicted to be well below 75% of the AQAL. Where the contribution of the Proposed Development is between 0.5 and 1.5% of the AQAL, the contribution from other sources is a maximum of 2% of the AQAL. In this area the mapped background concentration is ~9% of the AQAL. The PEC (modelled processes, mapped background and Proposed Development) is predicted to be well below 75% of the AQAL. Therefore, the magnitude of change is described as negligible at all areas considered.

Figure 8.18 [1,3-butadiene PEC Analysis] shows that where the contribution of the Proposed Development is between 2 and 5% of the AQAL, the contribution from other sources is a maximum of 4% of the AQAL. In this area the mapped background concentration is 6% of the AQAL. The mapped background includes the contribution from the other sources not modelled in the local area. The PEC (modelled processes, mapped background and Proposed Development) is predicted to be well below 75% of the AQAL. Where the contribution of the Proposed Development is between 0.5 and 1.5% of the AQAL, the contribution from other sources is a maximum of 3% of the AQAL. In this area the mapped background concentration is ~6% of the AQAL. The PEC (modelled processes, mapped background and Proposed Development) is predicted to be well below 75% of the AQAL. Therefore, the magnitude of change is described as negligible at all areas considered.

This is a worst-case analysis as it assumes that there would be no reduction in baseline concentrations and it assumes that the Proposed Development and the Kiln Lane plant will operate at the maximum throughput, at the emission limits for the entire year and that the entire VOC emissions consist either of only benzene or 1,3-butadiene.

4.5 Annual mean cadmium

The annual mean cadmium process contribution from the Proposed Development is predicted to be 7.36% of the AQAL. However, this assumes that the entire cadmium and thallium emissions consist of only cadmium. This is extremely conservative as monitoring from facilities processing a similar fuel has indicated concentrations of cadmium are usually about 14%of the IED ELV. Table 4.5 provides an estimate of the process contribution for a range of scenarios for the point of maximum impact, and the maximum impacted sensitive receptor location. Figure 8.19 [Annual Mean Cadmium – Screening], Figure 8.20 [Annual Mean Cadmium – Worst Case] and Figure 8.21 [Annual Mean Cadmium – Typical] also show the spatial distribution of emissions for each scenario.

Table 4.5: Annual Mean Cadmium Analysis

Scenario	Cadmium as % of ELV	Process Contribution (as % of AQAL)	
		Point of Maximum Impact	Maximum Impacted Receptor
Screening	100%	7.4%	1.0%
Worst-case	50%	3.7%	0.5%
Typical	14%	1.0%	0.1%
*Notes: * Negligible – irrespective of baseline concentrations*			

In the 'screening scenario' it is assumed that the entire cadmium and thallium emissions consist of only cadmium, which is a highly conservative assumption. As shown, the screening scenario predicts the PC to be 7.36% of the AQAL at the point of maximum impact. The plot files show that if it is assumed that emissions are similar to a typical plant then the impact is less than 0.5% of the AQAL at all areas where the annual mean AQAL applies. Therefore the magnitude of change can be described as negligible, irrespective of baseline concentrations. For completeness Table 4.6 provides further details of the impact of annual mean cadmium contributions from the process emissions at the identified sensitive human receptor locations, for the 'screening', 'worst case' and 'typical' scenarios.

Table 4.6: Annual Mean Cadmium Impact at Identified Sensitive Receptors

Receptor		Process Contribution (as % of AQAL)		
		Screening	Worst-case	Typical
R1	Queens Road, Immingham	0.5%	0.2%	0.1%
R2	Chestnut Avenue, Immingham	0.7%	0.3%	0.1%
R3	N Moss Ln, Stallingborough	0.5%	0.2%	0.1%
R4	Brickpit Farm, S Marsh Rd, Stallingborough	0.5%	0.3%	0.1%
R5	S Marsh Rd, Stallingborough	0.5%	0.2%	0.1%
R6	Church Ln, Stallingborough	0.5%	0.3%	0.1%
R7	Keelby Rd, Stallingborough	0.6%	0.3%	0.1%
R8	Mauxhall Farm, Immingham Rd, Stallborough	1.0%	0.5%	0.1%
R9	Havenmere Residential Care Home	0.7%	0.3%	0.1%
R10	Stark Lincolnshire and Goole Hospitals	0.6%	0.3%	0.1%

Table 4.6: Annual Mean Cadmium Impact at Identified Sensitive Receptors				
Receptor		Process Contribution (as % of AQAL)		
		Screening	Worst-case	Typical
R11	Canon Peter Hall Church of England Primary School	0.7%	0.3%	0.1%
R12	Eastfield Primary School	1.0%	0.5%	0.1%
R13	Oasis Academy Immingham	0.7%	0.4%	0.1%
*Notes: * Negligible – irrespective of baseline concentrations*				

4.6 Heavy metals

The Environment Agency guidance document 'Guidance on assessing group 3 metals stack emissions from incinerators – V.4 June 2016' ('Environment Agency metals guidance') states that where the PC 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 PC exceeds these criteria the PEC should be compared to the environmental standard. The PEC can be screened out where the PEC is less than the environmental standard. Where the impact is within these parameters it can be concluded that there is no risk of exceeding the AQAL and as such the magnitude of change and significance of effect is considered 'negligible'.

Table 4.7 and Table 4.8 detail the PC and PEC assuming that each metal is released at the combined long and short-term metal ELVs set out in the IED respectively. If the PC is greater than 1% of the AQAL, when it is assumed that each metal is emitted at the total metal ELV, further analysis has been undertaken assuming the release is no greater than the maximum monitored at an existing waste facility. The Environment Agency metals guidance 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. We have used the maximum monitored emission presented in the Environment Agency's analysis as a conservative assumption.

Table 4.7: Metals Impact – Point of Maximum Impact – Annual Mean							
Metal	AQAL (ng/m³)	Background Concentration (ng/m³)	Assuming each metal emitted at 100% of the group ELV		Maximum monitored emissions (as % of ELV)	Assuming operation no worse than a currently operating Facility	
			PC as % of AQAL	PEC as % of AQAL		PC as % of AQAL	PEC as % of AQAL
Arsenic	3	0.81	245.3%	272.3%	5.00%	12.3%	39.3%
Antimony	5,000	0.78	0.15%	0.16%	2.30%	0.0034%	0.02%
Chromium	5,000	12.00	0.15%	0.39%	18.40%	0.03%	0.27%
Chromium (VI)	0.2	2.40	3680.2%	4880.2%	0.026%	0.96%	1201.0%
Cobalt	-	0.62	-	-	1.12%	-	-
Copper	10,000	19.30	0.07%	0.27%	5.80%	0.004%	0.20%
Lead	250	22.00	2.94%	11.7%	10.06%	0.30%	9.10%
Manganese	150	28.31	4.91%	23.8%	12.00%	0.59%	19.5%
Nickel	20	8.65	36.8%	80.1%	44.00%	16.2%	59.4%
Vanadium	5,000	2.66	0.15%	0.20%	1.20%	0.002%	0.05%

Table 4.8: Metals Impact – Point of Maximum Impact – Maximum 1-hour							
Metal	**AQAL (ng/m^3)**	**Background Concentration (ng/m^3)**	**Assuming each metal emitted at 100% of the group ELV**		**Maximum monitored emissions (as % of ELV)**	**Assuming operation no worse than a currently operating Facility**	
			PC as % of AQAL	**PEC as % of AQAL**		**PC as % of AQAL**	**PEC as % of AQAL**
Arsenic	-	1.62	-	-	5.00%	-	-
Antimony	150,000	1.56	0.07%	0.07%	2.30%	0.002%	0.003%
Chromium	150,000	24.00	0.07%	0.08%	18.40%	0.012%	0.028%
Chromium (VI)	-	4.80	-	-	0.026%	-	-
Cobalt	-	1.24	-	-	1.12%	-	-
Copper	200,000	38.60	0.05%	0.07%	5.80%	0.003%	0.022%
Lead	-	44.00	-	-	10.06%	-	-
Manganese	1,500,000	56.62	0.01%	0.01%	12.00%	0.001%	0.005%
Nickel	-	17.30	-	-	44.00%	-	-
Vanadium	1000	5.32	10.0%	10.5%	1.20%	0.12%	0.65%

As shown, if it is assumed that the entire emissions of metals consist of only one metal, the impact is generally 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. The PEC is only predicted to exceed the long term AQAL for arsenic and chromium (VI) using this worst-case screening assumption. If it is assumed that the Proposed Development would perform no worse than a currently operating facility, the process contribution is below 1% of the long term and 10% of the short term AQAL for all pollutants with the exception of arsenic and nickel. However, the PECs for arsenic and nickel are well below the AQALs and therefore it can be concluded that there is no risk of exceeding the AQAL for metals, and the magnitude of change in emissions of metals is considered 'negligible'.

It is noted that the PEC does not specifically include the modelled contribution of arsenic and nickel from the other consented but not yet operational sites which would be additional sources of these pollutants in the local area. However, the PEC is sufficiently below the AQAL that the risk of exceeding the AQAL even with the other developments is not likely.

4.7 Impact at ecological receptors

4.7.1 Atmospheric emissions - Critical Levels

The impact of emissions from the Proposed Development has been compared to the Critical Levels listed in Chapter 8.0 [Air Quality] Table 8.3 [Critical Levels for the Protection of Ecosystems]. In accordance with the stated assessment methodology, further assessment would be undertaken where the PC of a particular pollutant is greater than 1% of the long term or 10% of the short term Critical Level for designated sites, and where the PC of a particular pollutant is greater than 100% of the Critical Level for non-designated sites. The process contribution has been calculated based on the maximum predicted, using all 5-years of weather data. Owing to the short distance between the Proposed Development and the Humber Estuary, plot files have been generated to show the distribution of emissions across the local area. These results are presented in Table 4.9 and supported by the following figures:

Figure 8.22 - Annual Mean NOx Process Contribution as % of Critical Level

Figure 8.23 - Daily Mean NOx Process Contribution as % of Critical Level

Figure 8.24 - Annual Mean SO2 Process Contribution as % of Critical Level

Figure 8.25 - Weekly Mean HF Process Contribution as % of Critical Level

Figure 8.26 - Daily Mean HF Process Contribution as % of Critical Level

Figure 8.27 - Annual Mean NH3 Process Contribution as % of Critical Level

Figure 8.35 - Annual Mean NOx – PEC Analysis

Figure 8.36 - Annual Mean SO2 – PEC Analysis

Table 4.9: Impact of Emissions at Humber Estuary

Scenario	Concentration as % of Critical Level					
	NOx		SO_2	HF		NH_3
	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean
Max at any point in Humber Estuary [(1)]	9.2%	25.5%	3.5%	11.2%	1.9%	4.6%
APIS mapped background	129%	51.6% [(2)]	13.6%	-	-	30.3%
Contribution from other projects	<14%	-	<2%	-	-	-[(3)]

Table 4.9: Impact of Emissions at Humber Estuary						
Scenario	Concentration as % of Critical Level					
	NOx		SO_2	HF		NH_3
	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean
Total PEC	152%	-	19%	-	-	34.9%

NOTES:
(1) calculated by post processing the model output to find the maximum at any point within the modelling domain which is within the Humber Estuary.
(2) calculated as 1x annual mean background as per LAQM.TG(16).
(3) None of the other sources identified as releasing NH3.

Table 4.10: Impact of Emissions at Non Designated Ecological Sites – Impact as % of Critical Level						
Site	NOx		SO_2	HF		NH_3
	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean
Laporte Road brownfield site	2.2%	9.0%	0.8%	4.1%	1.1%	1.9%
Immingham Dock reedbed	1.4%	9.9%	0.5%	4.3%	1.2%	1.1%
North Moss Lane meadow	0.5%	4.6%	0.2%	1.9%	0.6%	0.4%

As shown, at all the identified local non-statutory designated ecological receptors the impact of process emissions from the energy recovery facility is well below the relevant Critical Level for all pollutants. At the Humber Estuary the maximum impact cannot be screened out from further analysis as the process contribution is greater than 1% of the long term and 10% of the short term Critical Level. The significance of this impact is discussed in Chapter 6.0 of the ES and Technical Appendix 6.2.

It is noted that the routing for HGVs passes within 200m of the Immingham Dock Reedbed and Laporte Road Brownfield Site. Therefore, for these sites, the additional contribution from the HGVs along this route has been considered to determine the maximum impact from the in-combination of process and traffic emissions. This analysis is shown in the following table.

Table 4.11 – Impact of Operational Phase Traffic Emissions at Ecological Sites – NOx Impact as % of Critical Level				
Site	Annual Mean NOx		Daily Mean NOx	
	Road Traffic	Road Traffic + Process Emissions	Road Traffic	Road Traffic + Process Emissions
Laporte Road brownfield site	3.9%	6.1%	3.6%	12.6%
Immingham Dock reedbed	0.6%	2.0%	1.2%	11.1%

As shown, the combined impact of process and traffic emissions is less than the Critical Level.

4.7.2 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 the Air Pollution Information System (APIS).

An assessment has been made for each habitat feature identified in APIS for the specific site. The search by location tool has been used to identify the feature habitats, and then the search by location tool to find the habitat specific Critical Load for the specific points assessed within the designated sites. If the impact of process emissions upon nitrogen or acid deposition is greater than 1% of the Critical Load, further assessment has been undertaken.

APIS does not include site specific Critical Loads for non-designated sites. In lieu of this, the search by location function of APIS has been used. The Critical Loads using this function are based on a broad habitat type and location.

4.7.3 Deposition of emissions - Critical Loads - methodology

The APIS Database contains a maximum critical load for sulphur (CLmax), a minimum critical load for nitrogen (CLminN) and a maximum critical load for nitrogen (CLmaxN). These components define the Critical Load function. Where the acid deposition flux falls within the area under the critical load function, no exceedences are predicted.

A search has been undertaken for each of the ecological receptors. Each site has a number of habitats, each with different Critical Loads.

The impact of deposition of nitrogen has been assessed using the methodology detailed within the Habitats Directive AQTAG 6 (March 2014). The steps to this method are as follows:

- Determine the annual mean ground level concentrations of nitrogen dioxide and ammonia at each site.
- Calculate the dry deposition flux ($\mu g/m^2/s$) at each site by multiplying the annual mean ground level concentration by the relevant deposition velocity presented in the following table.
- Convert the dry deposition flux into units of kgN/ha/yr using the conversion factors presented in the Table 4.12.
- Compare this result to the nitrogen deposition Critical Load.

Table 4.12: Deposition Factors

Pollutant	Deposition Velocity		Conversion Factor ($\mu g/m^3$ to kg/ha/yr)	Conversion Factor (kg/ha/yr to keq/ha/yr)
	Grassland	Woodland		
Nitrogen dioxide	0.0015	0.003	96.0	Divide by 14
Sulphur dioxide	0.0120	0.024	157.7	Divide by 16
Ammonia	0.0200	0.030	259.7	-
Hydrogen chloride	0.0250	0.060	306.7	Divide by 35.5

The impact of acid deposition has been assessed using the methodology detailed within the Habitats Directive AQTAG 6 (March 2014). The steps to this method are as follows:

- Determine the dry deposition rate in kg/ha/yr of nitrogen, sulphur, hydrogen chloride and ammonia using the methodology outlined above.
- Apply the conversion factor for N to the nitrogen and ammonia deposition rate in kg/ha/year to determine the total keq N/ha/year.
- Apply the conversion factor for S to the sulphur deposition rate in kg/ha/year to determine the total keq S/ha/year.
- Apply the conversion factor for HCl to the hydrogen chloride deposition rate in kg/ha/year to determine the dry keq Cl/ha/year.
- Apply the conversion factor for HCl to the hydrogen chloride deposition rate in kg/ha/year to determine the wet keq Cl/ha/year.
- Add the contribution from S to HCl dry and wet and treat this sum as the total contribution from S.
- Plot the results against the Critical Load functions.

The March 2014 version of the AQTAG 6 document states that, for installations with an HCl emission, the process contribution of HCl, in addition to S and N, should be considered in the acidity Critical Load assessment. The H+ from HCl should be added to the S contribution (and treated as S in the APIS tool). This should include the contribution of HCl from wet deposition.

Consultation with AQMAU confirmed that the maximum of the wet or dry deposition rate for HCl should be included in the calculation. The wet deposition of HCl has been calculated as two times the dry deposition rate in lieu of any precipitation data in the meteorological data file.

The process contribution has been calculated using the APIS formula:

Where PEC N Deposition < CLminN:

- *PC as % of CL function = PC S deposition / CLmaxS*

Where PEC N Deposition > CLminN:

- *PC as % of CL function = (PC S + N deposition) / CLmaxN*

4.7.4 Deposition of emissions - Critical Loads - results

Table 4.13, Table 4.14 and Table 4.16 detail the results and calculated deposition rates as a result of emissions from the Proposed Development.

Table 4.13: Annual Mean Process Contribution used for Deposition Analysis

Site	Annual Mean Process Contribution (ng/m^3)			
	NO_2	SO_2	HCl	NH_3
European designated sites (within 10km) and UK designated sites (within 2km)				
Humber Estuary	1.93	0.69	0.14	0.14
Max in the area identified as coastal saltmarsh	0.48	0.17	0.034	0.034
Locally non-statutory designated sites (within 2km)				
Laporte Road brownfield site	0.78	0.28	0.06	0.06
Immingham Dock reedbed	0.47	0.17	0.03	0.03
North Moss Lane meadow	0.16	0.06	0.01	0.01

Table 4.14: Nitrogen Deposition Impact of Emissions at Humber Estuary											
Site	NCL Class	Deposition Velocity	CL (kgN/ha/yr)		PC N Dep (kgN/ha/yr)	PC as % of Lower CL	PC as % of Upper CL	Max Bg N Dep (kgN/ha/yr)	PEC N Dep (kgN/ha/yr)	PEC as % of Lower CL	PEC as % of Upper CL
			Lower CL	Upper CL							
European designated sites (within 10km) and UK designated sites (within 2km)											
Humber Estuary	Coastal saltmarsh	Grassland	20	30	0.245	1.22%	0.82%	14.42	14.665	73.32%	48.88%
NOTES: Maximum impact in the area identified as coastal saltmarsh and APIS mapped background concentration for the appropriate grid square. The plot file is shown in Figure 8.32 – N Deposition as % of Critical Load – Process Contribution from EfW Facility											

Table 4.15: Nitrogen Deposition Impact of Emissions at Identified Non-Designated Ecological Receptors					
Site	NCL Class	Deposition Velocity	CL (kgN/ha/yr)	PC N Dep (kgN/ha/yr)	PC as % of Lower CL
Laporte Road brownfield site	Inland dune pioneer grasslands	Grassland	8	0.402	5.02%
Immingham Dock reedbed	Rich Fens	Grassland	15	0.244	1.63%
North Moss Lane meadow	Low and medium altitude hay meadows	Grassland	20	0.082	0.41%

Table 4.16: Acid Deposition Impact of Emissions at Ecologically Designated Sites											
Site	Acidity Class	Deposition Velocity	CL (KeqN or S/ha/yr)			Max Bg Acid Dep (KeqN or S/ha/yr)		PC (KeqN or S/ha/yr)		PC as % of CLmin	PEC as % of CLmin
			MinN	MaxN	MaxS	N	S	N	S		
European designated sites (within 10km) and UK designated sites (within 2km)											
Humber Estuary	No features sensitive to acid deposition identified within 10km of the Proposed Development as discussed in Appendix 6.2										
Locally non-designated sites (within 2km)											
Laporte Road brownfield site	Acid Grassland	Grassland	0.438	4.538	4.1	1.11	0.42	0.029	0.057	1.89%	35.60%
Immingham Dock reedbed	N/A	Grassland	N/A	N/A	N/A	N/A	N/A	0.017	0.035	-	-
North Moss Lane meadow	Acid Grassland	Grassland	0.438	4.538	4.1	1.11	0.42	0.006	0.012	0.38%	34.10%

As shown, at all the identified local non-statutory designated ecological receptors the impact of emissions from the Proposed Development is well below Critical Load for all pollutants.

At the Humber Estuary, the process contribution cannot be screened out from further analysis. Further analysis of the likelihood of significant effects has been considered in Chapter 6.0 and Appendix 6.2.

Again, the combined impact of traffic and process emissions on deposition at the Immingham Dock Reedbed and Laporte Road Brownfield Site has been considered. As shown the combined impact is less than the Critical Level.

Table 4.17 – Impact of Operational Phase Traffic Emissions at Ecological Sites – Nutrient Nitrogen Deposition Impact as % of Critical Load

Site	NCL Class	Deposition Velocity	CL (kgN/ha/yr)	Road Traffic N Dep (kgN/ha/yr)	Road Traffic N Dep as % of CL	Road Traffic + Process Emissions N Dep as % of CL
Laporte Road Brownfield Site	Inland dune pioneer grasslands	Grassland	8	0.084	1.04%	6.06%
Immingham Dock Reedbed	Rich Fens	Grassland	15	0.013	0.09%	1.72%

Table 4.18 – Impact of Operational Phase Traffic Emissions at Ecological Sites – Acid Deposition Impact as % of Critical Load

Site	Acidity Class	Deposition Velocity	CL (KeqN or S/ha/yr)			Road Traffic Acid Dep (keqN/ha/yr)	Road Traffic Acid Dep as % of CL	Road Traffic + Process Emissions Acid Dep as % of CL
			MinN	MaxN	MaxS			
Immingham Dock Reedbed	N/A	Grassland	N/A	N/A	N/A	0.001	N/A	N/A
Laporte Road Brownfield Site	Acid Grassland	Grassland	0.438	4.538	4.1	0.006	0.93%	2.82%

5 Effect of the Finalisation of the BREF

5.1 Background

The 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 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 BREF's).
- Article 21, paragraph 3, of the IED, requires that when updated BAT conclusions are published, the Competent Authority (in England this is the Environment Agency) 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 Draft Waste incineration BREF was published by the European IPPC Bureau in May 2017. The BREF is currently being consulted on prior to its formal adoption - expected Q2 2018. Upon adoption of the final BREF, the Environment Agency will be required to review and implement conditions within all permits which require operators to comply with the requirements set out in the BREF. This will include the Proposed Development. As currently drafted, the BREF will introduce BAT Associated Emission Levels (AELs) which are more stringent than the ELVs currently set out in the IED.

The assessment contained in Section 4 assumed that the energy recovery facility will need to comply with the ELVs set out in Annex VI Part 3 of the IED for waste incineration plants. The following table summarises the changes to the allowable pollutant emission concentrations, as currently drafted (Draft 1 May 2017) for a ‘new plant’. As shown, it is expected that the BAT AELs will be lower than the IED ELVs for most pollutants. It should be noted that the Draft BREF only mentions short term AELs for mercury.

Table 5.1 : Comparison IED ELVs and Draft BREF BAT AELs				
Pollutant	**IED - ELV**		**Draft BREF – BAT AEL**	
	Daily or Periodic	**Half-hourly**	**Daily or Periodic**	**Half-hourly**
Conc. (mg/Nm^3)				
Oxides of nitrogen (as NO_2)	200	400	120	-
Sulphur dioxide	50	200	30	-
Carbon monoxide	50	150*	50	-
Fine Particulate Matter (PM)	10	30	5	-
Hydrogen chloride	10	60	6	-
Volatile organic compounds (as TOC)	10	20	10	-
Hydrogen fluoride	1	4	1	-
Ammonia	10	20	10	-
Cadmium and thallium	0.05	-	0.02	-
Mercury	0.05	-	0.02	0.04
Other metals	0.5	-	0.3	-
Conc. ($ng I-TEQ/Nm^3$)				
Dioxins and furans	0.1	-	0.04	-
Dioxin and furans and dioxin like PCBs	0.1	-	0.06	-

NOTES:
** Averaging period for carbon monoxide is 95% of all 10-minute averages in any 24-hour period.*
All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.
There is no mention of short term BAT AELs for any pollutant other than mercury.

5.2 Effect at the point of maximum impact

The following table provides a summary of the effect of energy recovery facility being permitted with limits set out in the Environmental Permit, based on the BAT AELs. As shown, the annual mean impact is reduced but the conclusion of the assessment will remain the same in that the same pollutants can be screened out as negligible.

Table 5.2: Analysis of Effect of the BREF								
Pollutant	**Quantity**	**Units**	**AQAL**	**IED ELVs**		**BAT AELs**		**Change in Impact (% of Impact at IED ELV**
				PC	**Max as % of AQAL**	**PC**	**Max as % of AQAL**	
Nitrogen dioxide	Annual mean	µg/m³	40	2.06	5.15%	1.24	3.09%	-40%
	99.79th%ile of hourly means(1)	µg/m³	200	19.45	9.73%	19.45	9.73%	No change
Sulphur dioxide	99.18th%ile of daily means	µg/m³	125	4.67	3.73%	2.80	2.24%	-40%
	99.73rd%ile of hourly means(1)	µg/m³	350	27.76	7.93%	27.76	7.93%	No change
	99.9th%ile of 15 min. means(1)	µg/m³	266	30.51	11.47%	30.51	11.47%	No change
PM_{10}s	Annual mean	µg/m³	40	0.15	0.37%	0.07	0.18%	-50%
	90.41st%ile of daily means	µg/m³	50	0.44	0.87%	0.22	0.44%	-50%
$PM_{2.5}$s	Annual mean	µg/m³	25	0.15	0.59%	0.07	0.29%	-50%
Carbon monoxide	8 hour running mean(1)	µg/m³	10,000	22.72	0.23%	22.72	0.23%	No change
Hydrogen chloride	Hourly mean(1)	µg/m³	750	11.97	1.60%	7.18	0.96%	-40%
Hydrogen fluoride	Annual mean	µg/m³	16	0.01	0.09%	0.01	0.09%	No change
	Hourly mean(1)	µg/m³	160	0.80	0.50%	0.80	0.50%	No change
Ammonia	Annual mean	µg/m³	180	0.15	0.08%	0.15	0.08%	No change
	Hourly mean	µg/m³	2,500	1.99	0.08%	1.99	0.08%	No change
VOCs (as benzene)	Annual mean	µg/m³	5	0.15	2.94%	0.15	2.94%	No change
	Hourly mean	µg/m³	195	3.99	2.05%	3.99	2.05%	No change
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.15	6.54%	0.15	6.54%	No change

Table 5.2: Analysis of Effect of the BREF								
Pollutant	Quantity	Units	AQAL	IED ELVs		BAT AELs		Change in Impact (% of Impact at IED ELV
				PC	Max as % of AQAL	PC	Max as % of AQAL	
Mercury	Annual mean	ng/m3	250	0.74	0.29%	0.29	0.12%	-60%
	Hourly mean	ng/m3	7500	9.97	0.13%	7.98	0.11%	-20%
Cadmium	Annual mean	ng/m3	5	0.37	7.36%	0.15	2.94%	-60%
	Hourly mean	ng/m3	-	4.99	-	1.99	-	-60%

5.3 Effect on Predicted Impacts at Ecological Sites

As shown, the implementation of the BREF as currently drafted will introduce BAT AELs which are lower than the current ELVs set in the IED. The impacts presented in Section 4.7 are based on operation of the energy recovery facility at the IED ELVs. The effect on the impacts for each pollutant is as follows:

- Annual mean NOx impacts will be reduced by 40%
- Daily mean NOx impacts will be reduced by 40%
- Annual mean SO_2 impacts will be reduced by 40%
- Daily HF impacts will remain the same
- Weekly HF impacts will remain the same
- Annual NH_3 impacts will remain the same
- Annual N Deposition impacts will be reduced by 14%
- Annual Acid N Deposition impacts will be reduced by 14% and acid S deposition impacts will be reduced by 34%

For each pollutant and averaging period plot files have been produced to show this effect.

Table 5.3: Impact of Emissions at Ecological Sites – Impact as % of Critical Level – BAT AELs

Site	NOx		SO_2	HF		NH_3
	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean
European designated sites (within 10km) and UK designated sites (within 2km)						
Max at any point in Humber Estuary (1)	5.5%	15.3%	2.1%	No change		
Locally non-statutory designated sites (within 2km)						
Laporte Road brownfield site	1.3%	5.4%	0.5%	No change		
Immingham Dock reedbed	0.8%	6.0%	0.3%			
North Moss Lane meadow	0.3%	2.8%	0.1%			

NOTES:
(1) calculated by post processing the model output to find the maximum at any point within the modelling domain which is within the Humber Estuary.

This analysis is supported by the following figures:

Figure 8.29 – Annual Mean NOx – Effect of BREF

Figure 8.30 – Daily Mean NOx – Effect of BREF

Figure 8.31 – Annual Mean SO2 – Effect of BREF

Figure 8.32 – N Deposition as % of Critical Load – Effect of BREF

6 Plume Visibility

6.1 Base assumptions

The plume visibility assessment has been undertaken using the moisture content of 16.2% by volume, or 0.116 kg water per kg dry gas, and gas exit temperature of 140°C.

6.2 Plume visibility results

Table 6.1 details the plume visibility results during daylight hours.

Table 6.1: Plume Visibility Results

Weather Data Year	Percentage of daylight hours the plume is visible	Furthest distance from stack a plume is visible (m)	Percentage of time there is a visible plume extending beyond site boundary
2012	22.3%	516	8.7%
2013	24.4%	641	12.1%
2014	15.7%	489	7.0%
2015	17.6%	545	6.8%
2016	20.5%	545	7.6%

The furthest distance from the stack that visible plume is predicted to exist is no more than 650m, as illustrated in Figure 8.34, which means that the visible plume would not extend above the nearest residential receptors. Using the EA significance criteria detailed in Chapter 8 [Air Quality] Table 8.14 [Summary of Qualitative Plume Visibility Impacts], as the plume length exceeds the distance to the site boundary for more than 5% of the year, the visual impact of the plume is "medium". However, this does not extent above any residential properties.

To assist with the visual impact assessment, further details of the breakdown of the last distance that a plume is visible from the stack and the number which exceed from set distances from the stack has been provided in the following tables. This shows that, on average, visible plumes are predicted to occur for 20.1% of daylight hours, and are predicted to extend beyond the site boundary for an average of 8.4% of daylight hours. The actual maximum distance a visible plume extends from the stack is 641m. The breakdown shows that the majority of visible plumes dissipate within 100m of the stack.

Table 6.2: All Plumes Visible During Daylight Hours						
	2012	**2013**	**2014**	**2015**	**2015**	**Average**
Total number of visible plumes during daylight hours.	957	1053	677	753	885	865
% of daylight hours with visible plume predicted to occur.	22.3%	24.4%	15.7%	17.6%	20.5%	20.1%
Total number of visible plumes predicted to extend beyond site boundary during daylight hours.	374	521	303	289	328	363
% of daylight hours a visible plume is predicted to extend beyond site boundary during daylight hours.	8.7%	12.1%	7.0%	6.8%	7.6%	8.4%
Longest visible length of a plume during daylight hours (m).	511	633	476	539	535	539
Furthest distance from stack a plume is visible during daylight hours (m).	516	641	489	545	545	547

Table 6.3: All Plumes Visible During Daylight Hours						
	2012	**2013**	**2014**	**2015**	**2015**	**Average**
Number of visible plumes in daylight hours						
>20m length	858	965	602	688	779	778
>50m length	611	675	454	492	553	557
>100m length	340	341	272	282	306	308
>200m length	116	107	86	94	104	101
% of daylight hours a plume is visible						
>20m length	20.0%	22.4%	14.0%	16.1%	18.0%	18.1%
>50m length	14.2%	15.6%	10.6%	11.5%	12.8%	12.9%
>100m length	7.9%	7.9%	6.3%	6.6%	7.1%	7.2%
>200m length	2.7%	2.5%	2.0%	2.2%	2.4%	2.4%
% of visible plumes of length						
>20m	89.7%	91.6%	88.9%	91.4%	88.0%	89.9%
>50m	63.8%	64.1%	67.1%	65.3%	62.5%	64.6%
>100m	35.5%	32.4%	40.2%	37.5%	34.6%	36.0%
>200m	12.1%	10.2%	12.7%	12.5%	11.8%	11.8%

Table 6.4: Breakdown of visible plumes by the distance from stack that the plume is last visible						
	2012	**2013**	**2014**	**2015**	**2015**	**Average**
Number of visible plumes in daylight hours						
>20m length	942	1030	661	736	867	847
>50m length	729	794	553	587	671	667
>100m length	401	405	324	332	368	366
>200m length	134	116	96	101	120	113
% of daylight hours a plume is visible						
>20m length	22.0%	23.9%	15.4%	17.2%	20.0%	19.7%
>50m length	17.0%	18.4%	12.9%	13.7%	15.5%	15.5%
>100m length	9.3%	9.4%	7.5%	7.8%	8.5%	8.5%
>200m length	3.1%	2.7%	2.2%	2.4%	2.8%	2.6%
% of visible plumes of length						
>20m	98.4%	97.8%	97.6%	97.7%	98.0%	97.9%
>50m	76.2%	75.4%	81.7%	78.0%	75.8%	77.4%
>100m	41.9%	38.5%	47.9%	44.1%	41.6%	42.8%
>200m	14.0%	11.0%	14.2%	13.4%	13.6%	13.2%

Appendix A – Cumulative Developments – Model Inputs

Other Sources Considered in the Analysis							
Plant	**Location**		**Stack Height (m)**	**Diameter (m)**	**Temperature (°C)**	**Velocity (m/s)**	**Main Building**
	X	**Y**					
UKPR Queens Road	*		13	0.4	390	47.67	UKPR Queens Road
UKPR Kings Road	*		12	0.4	390	47.67	UKPR Kings Road
AMP Queens Road	*		7	0.3	388	79.14	AMP1
Killingholme CCGT	515724.0	419658.0	80	6.2	87.6	25.1	KCCGT Turbine Hall
Immingham Biomass CHP Facility	519460.0	415837.0	77	2.6	145	16.1	C2 Boiler House
Kiln Lane Option A	520595.0	414330.0	40	1.7	152	22.1	C3/C4 Main Building
Kiln Lane Option B - Pelletiser	520624.9	414333.7	14.5	0.4	107	24.8	C3/C4 Main Building
Kiln Lane Option B - Refiner	520625.7	414349.3	14.5	0.3	120	19.9	C3/C4 Main Building
Kiln Lane Option B - Pyrolyser	520756.6	414422.0	14.5	0.9	35	14.8	C3/C4 Main Building
Kiln Lane Option B - Flue Gas	520624.3	414394.4	14.5	0.4	22.5	26.9	C3/C4 Main Building
Kiln Lane Option B - STOR	*		12	0.25	442	84.9	Proposed Development FGT

NOTES:
* multiple sources see later table for details of location

Other Sources Considered in the Analysis – Emission Concentration Modelled										
Plant	Release Rate (g/s)						Release Rate (mg/s)			Release Rate (pg/s)
	NOx	CO	PM	SO2	VOC	HCl	HF	Cd or Hg	Other Metals	Dioxins
UKPR Queens Road	0.450	1.790	-	-	-	-	-	-	-	-
UKPR Kings Road	0.450	1.790	-	-	-	-	-	-	-	-
AMP Queens Road	0.561	1.120	-	-	-	-	-	-	-	-
Killingholme CCGT	34.2	61.7	-	-	-	-	-	-	-	-
Immingham Biomass CHP Facility	9.980	9.980	0.998	9.980	-	-	-	-	-	-
Kiln Lane Option A	2.44	0.122	0.122	0.61	0.122	0.122	12.2	0.61	6.1	1.22
Kiln Lane Option B - Pelletiser	-	-	0.003	-	-	-	-	-	-	-
Kiln Lane Option B - Refiner	-	-	0.005	-	-	-	-	-	-	-
Kiln Lane Option B – Tyre Prep	-	-	0.080	-	-	-	-	-	-	-
Kiln Lane Option B - Flue Gas	0.62	0.15	0.03	0.15	0.03	0.03	3.0	0.15	1.5	0.3
Kiln Lane Option B - STOR	0.28	1.55	-	-	1.11	-	-	-	-	-

NOTES:
* multiple sources see later table for details of location

STOR Stack Locations		
Plant	Location	
	X	Y
UKPR Queens Road 1	520299.0	414732.0
UKPR Queens Road 2	520301.0	414728.0
UKPR Queens Road 3	520303.0	414723.0
UKPR Queens Road 4	520306.0	414718.0
UKPR Queens Road 5	520308.0	414714.0
UKPR Queens Road 6	520310.0	414709.0
UKPR Queens Road 7	520288.0	414699.0
UKPR Queens Road 8	520286.0	414704.0
UKPR Queens Road 9	520284.0	414708.0
UKPR Queens Road 10	520282.0	414713.0
UKPR Queens Road 11	520279.0	414717.0
UKPR Queens Road 12	520277.0	414722.0
UKPR Kings Road 1	519591.0	414727.0
UKPR Kings Road 2	519594.0	414730.0
UKPR Kings Road 3	519599.0	414733.0
UKPR Kings Road 4	519603.0	414736.0
UKPR Kings Road 5	519607.0	414739.0
UKPR Kings Road 6	519611.0	414742.0
UKPR Kings Road 7	519616.0	414744.0
UKPR Kings Road 8	519619.0	414747.0
UKPR Kings Road 9	519624.0	414750.0
UKPR Kings Road 10	519628.0	414753.0
UKPR Kings Road 11	519632.0	414756.0
UKPR Kings Road 12	519636.0	414759.0
AMP Queens Road 1	520624.0	414845.0
AMP Queens Road 2	520628.0	414840.0
AMP Queens Road 3	520631.0	414834.0
AMP Queens Road 4	520634.0	414829.0
AMP Queens Road 5	520643.0	414852.0
AMP Queens Road 6	520649.0	414856.0
AMP Queens Road 7	520654.0	414859.0
AMP Queens Road 8	520659.0	414862.0
AMP Queens Road 9	520664.0	414865.0
AMP Queens Road 10	520669.0	414868.0
AMP Queens Road 11	520703.0	414879.0

STOR Stack Locations		
Plant	Location	
	X	Y
AMP Queens Road 12	520706.0	414874.0
Kiln Lane Option B STOR 1	520874.24	414613.2
Kiln Lane Option B STOR 2	520871.21	414609.6
Kiln Lane Option B STOR 3	520868.55	414606.8
Kiln Lane Option B STOR 4	520865.68	414603.5
Kiln Lane Option B STOR 5	520863.36	414600.6
Kiln Lane Option B STOR 6	520860.65	414597.4
Kiln Lane Option B STOR 7	520857.69	414593.9
Kiln Lane Option B STOR 8	520854.75	414590.6
Kiln Lane Option B STOR 9	520851.89	414587.2
Kiln Lane Option B STOR 10	520849.25	414584.2
Kiln Lane Option B STOR 11	520846.19	414580.8
Kiln Lane Option B STOR 12	520842.91	414577.4
Kiln Lane Option B STOR 13	520892.82	414599
Kiln Lane Option B STOR 14	520889.7	414595.3
Kiln Lane Option B STOR 15	520886.63	414591.9
Kiln Lane Option B STOR 16	520883.78	414588.4
Kiln Lane Option B STOR 17	520881.14	414585.3
Kiln Lane Option B STOR 18	520878.4	414582.1
Kiln Lane Option B STOR 19	520875.28	414578.9
Kiln Lane Option B STOR 20	520872.67	414575.6
Kiln Lane Option B STOR 21	520869.97	414572.4
Kiln Lane Option B STOR 22	520867.21	414569.2
Kiln Lane Option B STOR 23	520864.37	414566
Kiln Lane Option B STOR 24	520860.78	414562.5

FICHTNER

Consulting Engineers Limited

Fichtner Consulting Engineers Limited
Kingsgate (Floor 3), Wellington Road North, Stockport, Cheshire, SK4 1LW, United Kingdom
t: +44 (0)161 476 0032 f: +44 (0)161 474 0618 www.fichtner.co.uk