8 Air Quality

8.1 Introduction

The Ringaskiddy Resource Recovery Centre will have one furnace and flue gas cleaning line. The line will have a moving grate furnace with a state-of-the-art flue gas cleaning system.

The combustion of waste produces a number of emissions, the discharges of which are regulated by the EU Directive on Industrial Emissions (IED) (2010/75/EU). The emissions to atmosphere which have been regulated are:

- Nitrogen Dioxide (NO_2)
- Sulphur Dioxide (SO_2)
- Total Dust (although there is no regulated Total Dust standard, standards exist for PM_{10} and $PM_{2.5}$ (particulate matter less than 10 and 2.5 microns respectively))
- Carbon Monoxide (CO)
- Total Organic Carbon (TOC)
- Hydrogen Fluoride (HF) and Hydrogen Chloride (HCl)
- Dioxins/Furans (PCDD/PCDFs)
- Cadmium (Cd) & Thallium (Tl)
- Mercury (Hg)
- and the sum of Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni) and Vanadium (V).

The impact of the pollutants outlined above have been assessed in this chapter of the EIS in addition to any potential construction phase emissions.

In addition, Polycyclic Aromatic Hydrocarbons (PAHs) have been assessed as incineration is a potential emission source for this group of compounds.

The scope of the evaluation of the potential impacts on air quality arising from the proposed development consists of the following components:

- Review of maximum emission levels and other relevant information needed for the modelling study;
- Review of construction phase potential emissions;
- Identification of the significant substances which are released from the facility;
- Review of background ambient air quality in the vicinity of the facility including an extensive baseline survey which was carried out in the region of the proposed Ringaskiddy Resource Recovery Centre facility over the period August 2014 to July 2015. This supplements the extensive baseline surveys undertaken in November 2006 to February 2007 and from April 2008 to July 2008;
- Air dispersion modelling of significant substances released from the facility;

- Particulate deposition modelling of Dioxins & Furans, Polycyclic Aromatic Hydrocarbons (PAHs) and heavy metals released from the facility;
- Identification of predicted ground level concentrations of released substances at the facility boundary and at sensitive receptors in the immediate environment;
- The potential cumulative impacts of the proposed development on air quality in combination with other relevant planned or permitted development in the area;
- Evaluation of the significance of these predicted concentrations, including consideration as to whether ground level concentrations are likely to exceed the applicable stringent ambient air quality standards and guidelines.

8.1.1 Modelling Under Maximum & Abnormal Operating Conditions

In order to assess the potential impact from the proposed facility under maximum and abnormal operations, a conservative approach was adopted that is designed to “over-predict” ground level concentrations. This cautious or conservative approach will ensure that an over-estimation of impacts will occur and that the resultant emission standards adopted are stringent in their protection of ambient air quality. The approach incorporated several conservative assumptions regarding operating conditions at the proposed facility. This approach incorporated the following features:

- For the maximum operating scenario, it has been assumed that the emission point is continuously operating at its maximum operating volume flow. This will over-estimate the actual mass emissions from the facility.
- For the maximum operating scenario, it has been assumed that the emission point is operating at its maximum emission concentration for 24-hrs/day over the course of the full year.
- Abnormal operating emissions were obtained from the process engineer and are pessimistically assumed to occur as outlined below:
    - NO_X - 400 mg/m^3 for 3% of the year (11 days per annum)
    - SO_2 - 200 mg/m^3 for 3% of the year (11 days per annum)
    - Total Dust - 30 mg/m^3 for 3% of the year (11 days per annum)
    - TOC - 30 mg/m^3 for 3% of the year (11 days per annum)
    - HCl - 60 mg/m^3 for 3% of the year (11 days per annum)
    - HF - 4 mg/m^3 for 3% of the year (11 days per annum)
    - CO - 200 mg/m^3 for 5% of the year (18 days per annum)
    - Dioxins & Furans - 0.5 ng/m^3 for 3% of the year (11 days per annum)
    - Heavy Metals (other than Hg, Cd & Tl) - 30 mg/m^3 for 3% of the year (11 days per annum)
    - Cd & Tl - 0.2 mg/m^3 for 3% of the year (11 days per annum)
    - Hg - 1 mg/m^3 for 3% of the year (11 days per annum)

As a result of these conservative assumptions, there will be an over-estimation of the emissions from the facility and the impact of the proposed facility on human health and the surrounding environment.

8.2 Methodology

8.2.1 Modelling Study Methodology

The air dispersion modelling input data consists of detailed information on the physical environment (including building dimensions and terrain features), design details from all emission points on-site and a full year of worst-case meteorological data. Using this input data, the model predicts ambient ground level concentrations beyond the site boundary for each hour of the modelled meteorological year. The model post-processes the data to identify the location of the maximum ambient ground level concentration in the applicable format for comparison with the relevant limit values. This maximum concentration is then added to the existing background concentration to give the maximum predicted ambient concentration. The maximum ambient concentration is then compared with the relevant ambient air quality standard for the protection of human health to assess the significance of the releases from the site.

In the absence of detailed guidance in Ireland, the selection of appropriate modelling methodology has followed the guidance from the USEPA which has issued detailed and comprehensive guidance on the selection and use of air quality models(1-3).

Based on guidance from the USEPA, the most appropriate regulatory model for the current application is the AERMOD model (Version 15181). The model is applicable in both simple and complex terrain, urban or rural locations and for all averaging periods(3). The terrain data for the region of the facility was obtained from the US Jet Propulsion Laboratory Shuttle RADAR Topography Mission (SRTM) at 1 arc-second (30m) resolution and imported into the model using the AERMOD terrain pre-processor AERMAP (see Figure 8.2). An overview of the model is outlined in Appendix 8.2.

The selection of the urban/rural classification is based on the land use procedure of Auer(4) as recommended by the USEPA(1). An examination of the land-use type around the site indicated that the rural boundary layer was appropriate.

The AERMOD model is capable of modelling most meteorological conditions likely to be encountered in the region. However, unusual meteorological conditions may occur infrequently, which may not be modelled adequately using AERMOD. One such condition is fumigation which occurs when a plume is emitted into a stable layer of air which subsequently mixes to ground level through either convective transfer of heat from the surface or because of advection to less stable surroundings(1). A recommended air dispersion model is CALPUFF(1) (full details are outlined in Appendix 8.1).

8.2.2 Meteorological Considerations

Meteorological data is an important input into the air dispersion model. The local airflow pattern will be influenced by the geographical location. Important features will be the location of hills and valleys or land-water-air interfaces and whether the site is located in simple or complex terrain.

The selection of the appropriate meteorological data has followed the guidance issued by the USEPA(1). A primary requirement is that the data used should have a data capture of greater than 90% for all parameters. One synoptic meteorological station operated by Met Éireann was identified near the site – Cork Airport. Data collection of greater than 90% for all parameters is required for air dispersion modelling. Cork Airport fulfils this requirement.

Cork Airport meteorological station is in a region of gentle rolling terrain and is 12 km from the site. The meteorological data used in the appraisal (2010 - 2014) is the most recent data which is available for this station. The final issue relates to the exposure of the meteorological monitoring site and specifically relating to the surface characteristics of the station compared to the site of the proposed facility. Cork Airport is 12km from the coast and located in an area of mainly agricultural land with urban characteristics to the north of the airport. In contrast, Ringaskiddy is in a coastal area with a range of surface characteristics including water, agricultural and urban within a few kilometres of the site. Thus, some differences in surface characteristics are apparent between the meteorological station at Cork Airport and the site location. In order to ascertain the likely significance of the difference in surface characteristics, a sensitivity study was conducted as shown in Appendix 8.5. Secondly, a weather station was installed on-site which measured wind speed, wind direction, temperature and relative humidity over the period starting in October 2006 and finished at the end of December 2007. This station allowed the similarities and differences between Cork Airport and the proposed site to be identified. The on-site meteorological data was used in the AERMOD modelling study and in the CALPUFF modelling study as detailed in Section 8.12 of Appendix 8.1.

The windrose from Cork Airport for the years 2010 - 2014 is shown in Figure 8.3 with detailed data outlined in Appendix 8.2. The windrose indicates the prevailing wind speed and direction over the five-year period. The prevailing wind direction is generally from the S-NW direction, with generally moderate wind speeds, averaging around 5 m/s.

8.2.3 Background Concentrations

The ambient concentrations detailed in the following sections include both the emissions from the site and the ambient background concentration for that substance. Background concentrations have been derived from a conservative analysis of the existing background air quality and an analysis of cumulative sources in the region in the absence of the development. A detailed baseline air quality assessment (Section 8.3 of Appendix 8.1) was carried out to assess background levels of those pollutants, which are likely to be released from the site. Appropriate background values have been outlined in Table 8.1. In arriving at the combined annual background concentration, cognisance has been taken of the accuracy of the approach and the degree of double counting inherent in the assessment. In relation to NO_2, PM_{10}, $PM_{2.5}$ and benzene, the baseline monitoring programme took into account both the existing traffic levels and existing industrial sources. However, some increases in traffic levels will occur due to the additional development which has been incorporated into the final combined background levels. Again, in recognition of the various inaccuracies in this approach, the values have been rounded accordingly. A similar approach has been adopted for the other pollutants. In addition, modelling of cumulative sources has been undertaken with the impact of the cumulative sources added to the background concentration. The cumulative sources modelled were Janssen

Biologics, Hovione Cork, GSK Ireland, ESB Aghada, Novartis Ringaskiddy Ltd, Pfizer Ireland Pharmaceuticals and BGE Whitegate.

In order to obtain the predicted environmental concentration (PEC), background data was added to the process emissions. In relation to the annual averages, the ambient background concentration was added directly to the process concentration. However, in relation to the short-term peak concentrations, concentrations due to emissions from elevated sources cannot be combined in the same way. Guidance from the UK DEFRA[5] advises that for NO_2, SO_2 and PM_{10} an estimate of the maximum combined pollutant concentration can be obtained as shown below:

NO_2 - The 99.8th%ile of total 1-hour NO_2 is equal to the minimum of either A or B below:

a) 99.8th%ile hourly background total oxidant (O_3 & NO_2) + 0.05 x (99.8th%ile process contribution NOx)

b) The maximum of either:

99.8th% process contribution NOx + 2 x (annual mean background NO_2)

or

99.8th% hourly background NO_2 + 2 x (annual mean process contribution NO_x)

PM_{10} - The 90.4th%ile of total 24-hour mean PM_{10} is equal to the maximum of either A or B below:

a) 90.4th%ile of 24-hour mean background PM_{10} + annual mean process contribution PM_{10}

b) 90.4th%ile 24-hour mean process contribution PM_{10} + annual mean background PM_{10}

SO_2 - The 99.7th%ile of total 1-hour SO_2 is equal to the maximum of either A or B below:

a) 99.7th%ile hourly background SO_2 + (2 x annual mean process contribution SO_2)

b) 99.7th%ile hourly process contribution SO_2 + (2 x annual mean background contribution SO_2)

SO_2 - The 99.2th%ile of total 24-hour SO_2 is equal to the maximum of either A or B below:

a) 99.2th%ile of 24-hour mean background SO_2 + (2 x annual mean process contribution SO_2)

b) 99.2th%ile 24-hour mean process contribution SO_2 + (2 x annual mean background contribution SO_2).

8.2.4 Cumulative Appraisal

As the region around Ringaskiddy is partly industrialised and thus has several other potentially significant sources of pollutants, a detailed cumulative appraisal has been carried out using the methodology outlined by the USEPA. The impact of nearby sources (Janssen Biologics, Hovione Cork, GSK Ireland, ESB Aghada, Novartis Ringaskiddy Ltd, Pfizer Ireland Pharmaceuticals and BGE Whitegate) has been examined where interactions between the plume of the point source under consideration and those of nearby sources can occur. These include:

1) the area of maximum impact of the point source,
2) the area of maximum impact of nearby sources,
3) the area where all sources combine to cause maximum impact on air quality[1].

Background concentrations for the area, based on natural, minor and distant major sources need also to be taken into account in the modelling procedure. A major baseline monitoring programme (see Section 8.3) was undertaken over several months which, in conjunction with other available baseline data, was used to determine worst-case background concentrations in the region (see **Table 8.1**). Full detail of the cumulative impact assessment and associated results can be seen in Appendix 8.4.

Air modelling of road emissions associated with the project have also been undertaken and added to the existing worst-case background pollutant levels. Cumulative impacts due to the Port of Cork expansion project have been included in both the “do-nothing” and “do-something” scenario.

DePuy Ireland, which is located approximately 400m south of the proposed facility, has recently constructed a wind turbine onsite with a diameter of 101m. A wind turbine, when in operation, has the potential to interact with the plume as the plume passes the region of the turbine. The implications of this have been studied recently by Fletcher and Brown[6]. The study found that there was a small increase in relative concentration in the plume of the order of 5 – 20% over a distance of 1 to 2 turbine diameters downwind of the turbine. Thereafter, concentrations in the plume where seen to fall rapidly to below 30 – 60% of the pre-turbine plume concentration within 4 – 5 turbine diameters. Thus, given the plume concentrations expected at a distance of 400m from the facility, the impact of the DePuy turbine will not be significant and will not lead to an exceedance of the ambient air quality standards in the vicinity.

8.2.5 Ambient Air Quality Standards

The relevant ambient air quality standards are outlined in Table 8.2. Ambient air quality legislation designed to protect human health and the environment is generally based on assessing ambient air quality at locations where the exposure of the population is significant relevant to the averaging time of the pollutant. However, in the current assessment, ambient air quality legislation has been applied to all locations with a 10km radius of the facility regardless of whether any sensitive receptors (such as residential locations) are present for significant periods of time. This represents a worst-case approach and an examination of the corresponding concentrations at the nearest sensitive receptors relative to the actual quoted maximum concentration indicates that these receptors generally experience ambient concentrations significantly lower than that reported for the maximum value.

8.3 Receiving Environment

An extensive baseline survey was carried out in the region of the proposed Ringaskiddy Resource Recovery Centre facility over the period August 2014 to July 2015. This supplements the extensive baseline survey undertaken in November 2006 to February 2007 and from April 2008 to July 2008. These surveys focused on the significant pollutants likely to be emitted from the facility and which have been regulated in Council Directive 2010/75/EU. The substances monitored over these survey periods were NO_2, NO_X, PM_{10}, $PM_{2.5}$, benzene, SO_2, heavy metals, HCl, HF and PCDDs/PCDFs. The air monitoring program was used to determine long-term average concentrations for these pollutants in order to help quantify the existing ambient air quality in the region. NO_2, benzene and SO_2 were also monitored at a number of additional locations to give some spatial representation of the levels of these species.

The updated extensive baseline survey which was carried out in the region of the proposed Ringaskiddy Resource Recovery Centre facility over the period August 2014 to July 2015 focused on NO_2, PM_{10}, benzene, SO_2 and heavy metals over a year long period in order to capture any possible seasonal factors (as shown in Figure 8.1). The air monitoring programme was used to determine long-term average concentrations for these pollutants in order to help quantify the existing ambient air quality in the region. NO_2, benzene and SO_2 were also monitored at a number of additional locations to give greater spatial representation of the levels of these species.

Full details of the monitoring methodology, assessment and results are outlined in **Section 8.3** of **Appendix 8.1.**

PM_{10} concentrations measured during the 2014-15 monitoring campaign averaged 20 $\mu g/m^3$, which is below the annual limit value of 40 $\mu g/m^3$. Five exceedances of the 24-hour limit value were recorded over the six-month monitoring campaign. The standard allows for compliance with the ambient air quality standard to be maintained provided no more than 35 exceedances of the 24-hour limit value occur in any one year. Since only 5 exceedances were recorded over the monitoring survey, it is extremely unlikely that 35 exceedances would occur over 365 days at the current location.

The average $PM_{2.5}$ concentration measured over the period May / June 2008 was 7 $\mu g/m^3$ which is significantly below the annual average EU limit value of 25 $\mu g/m^3$ which is applicable in 2015.

Nitrogen dioxide (NO_2) concentrations measured over the 2008 monitoring period were below both the 1-hour and annual EU limit values. The annual average NO_2 concentration average 6 $\mu g/m^3$ over the three month period. The 99.8th%ile of 1-hour concentrations peaked at 38 $\mu g/m^3$ in 2008. Long term NO_2 concentrations at a further nine locations in the region of the facility were significantly lower than the annual average limit value. The average NO_2 concentration measured over the three month period at each location ranged from 4 - 14 $\mu g/m^3$ which is between 10 - 35% of the EU annual limit value of 40 $\mu g/m^3$. The results indicate a weak NO_2 spatial concentration gradient in the region. Updated diffusion monitoring results amounting to six months of data over the period August 2014 to May 2015 indicated an average concentration of between 6 – 19 $\mu g/m^3$ which is between 15 – 48% of the EU annual limit value.

Levels of sulphur dioxide (SO_2), benzene, hydrogen fluoride (HF) and hydrogen chloride (HCl) were all significantly below their respective limit values in 2008. Updated SO_2 diffusion monitoring results amounting to six months of data over the period August 2014 to May 2015 indicated an average concentration of between 5 – 13 $\mu g/m^3$ which is between 25 – 65% of the EU annual limit value for the protection of vegetation. Similarly, updated benzene diffusion monitoring results amounting to six months of data over the period August 2014 to July 2015 indicated an average concentration of between 1.2 – 1.3 $\mu g/m^3$ which is between 24 – 26% of the EU annual limit value.

Average concentrations of antimony (Sb), arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), mercury (Hg), manganese (Mn), nickel (Ni), lead (Pb), thallium (Tl) and vanadium (V) measured were significantly below their respective annual limit values both in 2008 and 2014-2015. Updated heavy metal monitoring results amounting to six months of data over the period August 2014 to July 2015 indicated an average concentration for each of the heavy metals which was between 0.004 – 37% of the EU annual limit value.

Background levels of PCDD / PCDFs cannot be compared to ambient air quality concentration or deposition standards. However, levels of PCDDs and PCDFs can be compared to existing levels measured sporadically in Ireland and continuously in the UK as part of the TOMPS network. The mean PCDD/PCDF concentration measured over the four one-week periods during April - May 2008 indicates that results are in line with measurements conducted elsewhere in Ireland, with an upper limit of 13.5 fg/m^3 compared to previous measurements ranging from 2.8 – 46 fg/m^3.

8.4 Characteristics of Proposed Development

8.4.1 Construction Phase

There is the potential for a number of emissions to the atmosphere during the construction phase of the proposed development. In particular, the construction activities may generate quantities of dust in the immediate region of the construction activities and along the route of the haulage trucks.

8.4.2 Operational Phase

Council Directive 2010/75/EU on Industrial Emissions Directive (IED) has established air emission limit values as set out in Table 8.3. The Directive has also outlined stringent operating conditions in order to ensure sufficient combustion of waste thus ensuring that dioxin formation is minimised. Specifically, combustion gases must be maintained at a temperature of 850°C for at least two seconds under normal operating conditions for non-hazardous waste whilst for hazardous waste containing more than 1% halogenated organic substances, the temperature should be raised to 1100°C for at least two seconds. These measures will ensure that dioxins/furans, polychlorinated biphenyls (PCBs) and PAHs are minimised through complete combustion of waste.

Emissions from the proposed facility have been modelled using the AERMOD dispersion model which is the USEPA's regulatory model used to assess pollutant concentrations associated with industrial sources[1]. Emissions have been assessed, firstly under maximum emissions limits of the EU Directive 2010/75/EU and secondly under abnormal operating conditions.

The Ringaskiddy Resource Recovery Centre facility has one main process emission point (flue). The operating details of this major emission point is outlined in Table 8.4. Full details of emission concentrations and mass emissions are given in Appendix 8.6.

In order to assess the potential impact from the proposed facility under maximum and abnormal operations, a conservative approach was adopted that is designed to over-predict ground level concentrations. This cautious approach will ensure that an over-estimation of impacts will occur and that the resultant emission standards adopted are protective of ambient air quality. The approach incorporated several conservative assumptions regarding operating conditions at the proposed facility. This approach incorporated the following features:

- Emissions from all emission points in the assessment were assumed to be operating at their maximum emission level, 24 hours/day over the course of a full year. This represents a very conservative approach as typical emissions from the proposed facility will be well within the emission limit values set out in the Industrial Emissions Directive.
- Maximum predicted ambient concentrations for all pollutants within a 10 km radius of the site were reported in this study even though, in many cases, no residential receptors were near the location of this maximum ambient concentration. Concentrations at the nearest residential receptors are generally significantly lower than the maximum ambient concentrations reported.
- Conservative background concentrations were used to assess the baseline levels of substances released from the site.
- Meteorological conditions leading to the highest ambient ground level concentrations, over the period 2010 - 2014 from Cork Airport and the on-site meteorological data from 2007, have been used in all assessments. For all averaging periods the year giving the highest ambient ground level concentration from 2007, 2010 - 2014 was used for comparison with the ambient air quality standards.

Table 8.1 Estimated annual background concentrations in the region of Ringaskiddy (μg/m³).

	NO_2	NO_X	SO_2	PM_{10}	$PM_{2.5}$	CO	TOC(2)	HCl	HF	Dioxins(1)	B(a)P	Cd	Hg	As	V	Ni
Baseline Monitoring Program - Year 2006 – 2008 & Year 2014 - 2015	10	13	9	20	12	-	1	1.2	0.05	0.0013 pg/m³	-	0.001	0.001	0.001	0.002	0.007
Annual Background Concentration - Year 2020	10	13	9	20	12	450	1	1.2	0.05	0.0013 pg/m³	0.71 ng/m³	0.001	0.001	0.001	0.002	0.007
Facility Traffic - Year 2020(3)	0.63	1.21	-	0.1	0.1	0.005	0.005	-	-	-	-	-	-	-	-	-
Cumulative Assessment	2	3	1	-(4)	-(4)	-(4)	-(4)	-(4)	-(4)	0.001 pg/m³	-(4)	-(4)	-(4)	-(4)	-(4)	-(4)
Annual Background & Facility Traffic Concentration (Year 2020)	**12**	**17**	**10**	**20**	**12**	**500**	**1.0**	**1.2**	**0.05**	**0.0014 pg/m³**	**0.71 ng/m³**	**0.001**	**0.001**	**0.001**	**0.002**	**0.007**

(1) Dioxins reported as non-detects as equal to the limit of detection.

(2) Assumed to consist solely of benzene as a worst-case.

(3) Derived using the DMRB screening model (see Appendix 8.3).

(4) No other significant source in the region.

Table 8.2 Ambient Air Quality Standards

Emission	Limit/Guideline	SI No. 180 of 2011 ($\mu g/m^3$)	UK EAL ($\mu g/m^3$)	WHO 2000 & 1999 ($\mu g/m^3$)	Council Directive 2004/107/ EC ($\mu g/m^3$)
NO_2	99.8th percentile of 1- Hourly Averages	200			
NO_2	Annual Average	40			
NO_x	Annual Average(1)	30			
SO_2	99.7th percentile of 1- Hourly Averages	350			
SO_2	99.2th percentile of 24- Hourly Averages	125			
SO_2	Annual Average(1)	20			
PM_{10}	90th percentile of 24- Hourly Averages	50			
PM_{10}	Annual Average	40			
$PM_{2.5}$	Annual Average	25			
TOC	Annual Average	5(2)			
HCl	Maximum 1- Hour Average		800		
HCl	Annual Average		20		
HF	Maximum 1- Hour Average		160		
HF	Annual Average		16		
PCDD/PCDF(3)	Annual Average				
Benzo[a]pyrene	Annual Average				0.001
Hg	Annual Average			1.0	
Cd & Tl	Annual Average (Cd)				0.005
Sum of 9 Heavy Metals	Annual Average (Pb)	0.50			
	Hourly Average (Sb)		150		
	Annual Average (As)				0.006
	Hourly Average (As)		15		
	Hourly Average (Cr) (Total)		3.0		
	Annual Average (Cr(VI))		0.0002		
	Hourly Average (Co)		6.0		
	Hourly Average (Cu)		60		
	Annual Average (Mn)			1.0	
	Annual Average (Ni)				0.020
	Hourly Average (Ni)		30		

(1) Critical level for the protection of vegetation.
(2) Limit value is for Benzene as a worst-case.
(3) There are no air quality standard limit values for dioxins and furans. The WHO currently proposes a maximum TDI of between 1-4 pgTEQ/kg of body weight per day. A TDI of 4 pgTEQ/kg of body weight per day should be considered a maximal tolerable intake on a provisional basis and that the ultimate goal is to reduce human intake levels of below 1 pgTEQ/kg of body weight per day.

Table 8.3 Council Directive 2010/75/EU, Annex V Air Emission Limit Values

Daily Average Values	**Concentration (Normalised (dry, 11%O_2, 273K, 1013kPa))**	
Total Dust	10 mg/m^3	
Gaseous & vaporous organic substances expressed as total organic carbon (TOC)	10 mg/m^3	
Hydrogen Chloride (HCl)	10 mg/m^3	
Hydrogen Fluoride (HF)	1 mg/m^3	
Sulphur Dioxide (SO_2)	50 mg/m^3	
Nitrogen Oxides (as NO_2)	200 mg/m^3	
Half-hourly Average Values	Concentration	
	(100%)	(97%)
Total Dust(1)	30 mg/m^3	10 mg/m^3
Gaseous & vaporous organic substances expressed as total organic carbon (TOC)	20 mg/m^3	10 mg/m^3
Hydrogen Chloride (HCl)	60 mg/m^3	10 mg/m^3
Hydrogen Fluoride (HF)	4 mg/m^3	2 mg/m^3
Sulphur Dioxide (SO_2)	200 mg/m^3	50 mg/m^3
Nitrogen Oxides (as NO_2)	400 mg/m^3	200 mg/m^3
Average Value Over 30 mins to 8 Hours	Concentration(2)	
Cadmium and its compounds, expressed as Cd	Total 0.05 mg/m^3	
Thallium and its compounds, expressed as Tl		
Mercury and its compounds, expressed as Hg	0.05 mg/m^3	
Antimony and its compounds, expressed as Sb	Total 0.5 mg/m^3	
Arsenic and its compounds, expressed as		
Lead and its compounds, expressed as Pb		
Chromium and its compounds, expressed as Cr		
Cobalt and its compounds, expressed as Co		
Copper and its compounds, expressed as Cu		
Manganese and its compounds, expressed as Mn		
Nickel and its compounds, expressed as Ni		
Vanadium and its compounds, expressed as V		
Average Values Over 6 – 8 Hours	Concentration	
Dioxins and furans	0.1 ng/m^3	
Average Value	Concentration(3)	
	Daily Average Value	30 Min Average Value
Carbon Monoxide	50 mg/m^3	100 mg/m^3

(1) Total dust emission may not exceed 150 mg/m^3 as a half-hourly average under any circumstances

(2) These values cover also the gaseous and vapour forms of the relevant heavy metals as well as their compounds

(3) Exemptions may be authorised for incineration plants using fluidised bed technology, provided that emission limit values do not exceed 100 mg/m^3 as an hourly average value.

Table 8.4 Process Emission Design Detail

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Volume Flow (Nm^3/hr)(1)	Exit Velocity (m/sec actual)(2)
Grate	70	2.30	4.15	418	142,000 – Maximum 106,900 – Nominal	14.0 10.5

(1) Normalised to 11% O_2, dry, 273K.

(2) Actual, 418K

8.5 Evaluation of Impacts

The results from the detailed air dispersion modelling of the facility are summarised below and in Figure 8.4. The modelling, undertaken using the USEPA regulatory model AERMOD, is discussed in detail in Appendix 8.2.

8.5.1 Do Nothing Impacts

For the Do Nothing scenario the existing air quality emission sources contained within the area of the proposed development will remain in place. Therefore, the existing baseline air quality environment is not expected to change in the Do Nothing scenario.

8.5.2 Do Something or Potential Development Impacts

8.5.2.1 NO_2 & NO_X

NO_2 modelling results, using AERMOD, indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for nitrogen dioxide under both maximum and abnormal operation of the facility. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations lead to ambient NO_2 concentrations (including background concentrations) which are 63% of the maximum ambient 1-hour limit value (measured as a 99.8th%ile) and 33% of the annual average limit value at the respective worst-case receptors.

The annual average NO_X concentration (including background concentration) will also be below the critical level for the protection of vegetation accounting for 61% of the annual limit value at the worst-case receptor in the region of the Lough Beg Proposed NHA and the Cork Harbour SPA.

8.5.2.2 SO_2, CO, PM_{10} & $PM_{2.5}$

AERMOD modelling results indicate that ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for sulphur dioxide, carbon monoxide and PM_{10} under maximum and abnormal operation of the facility. Results will also be below the air quality standard for $PM_{2.5}$ and the SO_2 critical level for the protection of vegetation under maximum and abnormal operation of the facility. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient concentrations (including background concentrations) ranging from 10% - 56% of the respective limit values at the worst-case receptors.

8.5.2.3 TOC, HCl & HF

AERMOD modelling results indicate that the ambient ground level concentrations will be below the relevant air quality guidelines for the protection of human health for TOC (assumed pessimistically to consist solely of benzene), HCl and HF under maximum and abnormal operation of the facility. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient concentrations (including background concentrations) for HCl and TOC of only 6% and 22% respectively of the ambient limit values.

HF modelling results indicate that emissions at maximum operations equate to ambient HF concentrations (including background concentrations) which will be 0.7% of the maximum ambient 1-hour limit value and 0.4% of the annual limit value.

8.5.2.4 PCDD / PCDFs (Dioxins/Furans)

Currently, no internationally recognised ambient air quality concentration or deposition standards exist for PCDD/PCDFs (Dioxins/Furans). Both the USEPA and WHO recommended approach to assessing the risk to human health from Dioxins/Furans entails a detailed risk assessment analysis involving the determination of the impact of Dioxins/Furans in terms of the TDI (Tolerable Daily Intake) approach. The WHO currently proposes a maximum TDI of between 1-4 pgTEQ/kg of body weight per day.

Background levels of Dioxins/Furans occur everywhere and existing levels in the surrounding area have been extensively monitored as part of this study. Monitoring results indicate that the existing levels are similar to rural areas in the UK and Ireland. The additional contribution from the proposed development to levels of Dioxins/Furans is minor, with levels at the maximum off-site receptor to the south of the facility, under maximum and abnormal operation, accounting for only a small fraction of existing levels. Levels at the nearest residential receptor will also be minor, with the annual contribution from the proposed facility accounting for less than 1% of the existing background concentration under maximum operating conditions.

8.5.2.5 PAHs

PAHs modelling results, based on AERMOD, indicate that the ambient ground level concentrations will be below the relevant air quality target value for the protection of human health under maximum and abnormal operation of the facility. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient benzo[a]pyrene concentrations (excluding background concentrations) which are 0.8% of the EU annual average target value at the worst-case receptor.

8.5.2.6 Hg

Hg modelling results, based on AERMOD, indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health under maximum and abnormal operation of the facility. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient mercury concentrations (including background concentrations) which are only 0.2% of the annual average limit value at the worst-case receptor.

8.5.2.7 Cd and Tl

AERMOD modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standard for the protection of human health for cadmium under maximum and abnormal operation from the facility. Emissions at maximum levels equate to ambient Cd and Tl concentrations (including background concentrations) which are 28% of the EU annual target value for Cd close to the facility boundary (the comparison is made with the Cd limit value as this is more stringent than that for Tl).

8.5.2.8 Sum of As, Sb, Pb, Cr, Co, Cu, Ni, Mn and V

AERMOD modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for arsenic (As), nickel (Ni) and vanadium (V) (the metals with the most stringent limit values) under maximum and abnormal operation emissions from the facility (based on the ratio of metals measured at a Waste to Energy facility in Carranstown, County Meath). Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Ambient concentrations have been compared to the annual target value for As and Ni and the maximum 1-hour limit value for V as these represent the most stringent limit values for the suite of metals. Emissions at maximum operations equate to ambient As and Ni concentrations (including background concentrations) which are 17% and 38% of the EU annual target value respectively at the worst-case receptor whilst emissions at maximum operations equate to ambient V concentrations (including background concentrations) which are only 0.1% of the maximum 1-hour limit value at the worst-case receptor. Emissions under abnormal operations equate to ambient As and Ni concentrations (including background concentrations) which are 18% and 44% of the annual limit value respectively at the worst-case receptor whilst emissions at maximum operations equate to ambient V concentrations (including background concentrations) which are 0.2% of the maximum 1-hour limit value at the worst-case receptor.

National Emissions Ceiling

A comparison of the proposed Facility's operations with the obligations under the National Emissions Ceiling Directive indicates the impact of the development is to increase SO_2 levels by 0.25% of the ceiling levels to be complied with in 2020, NO_X levels by 0.38% of the ceiling levels, VOC levels will be increased by 0.03% of the ceiling limits whilst $PM_{2.5}$ levels will be increased by 0.14% of the ceiling limits.

8.5.2.9 AERMOD Modelling Summary

AERMOD modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards or guidelines for the protection of human health for all parameters under both the maximum and abnormal operation scenarios. The modelling results indicate that the maximum long-term ground level concentration occurs to the south of the facility's boundary. Maximum operations are based on the emission concentrations outlined in EU

Directive 2010/75/EU. Abnormal operations are based on the emission concentrations outlined in Section 8.1.1.

An appropriate stack height has been selected to ensure that ambient air quality standards for the protection of human health will not be approached even under abnormal operating scenarios. Air dispersion modelling was undertaken in an iterative fashion in order to determine the stack height for the facility. The air dispersion modelling study found that a stack height of 70 metres was appropriate.

The spatial impact of the facility is limited with concentrations falling off rapidly away from the location of the maximum ambient ground level concentration. For example, the short-term concentrations due to process emissions at the nearest residential receptor will be less than 17% of the short-term ambient air quality limit values. The annual average concentration results in an even more dramatic decrease in maximum concentration away from the facility with concentrations from emissions at the proposed facility accounting for less than 2% of the limit value (not including background concentrations) at worst case sensitive receptors near the facility.

8.5.2.10 CALPUFF Modelling

The CALPUFF modelling system has been recommended by the USEPA as a Guideline Model for source-receptor distances of greater than 50km and for use on a case-by-case basis in complex flow situations within 50km(1). CALPUFF has some important advantages over steady-state Gaussian models such as AERMOD in areas of complex meteorology. Firstly, AERMOD, being a steady state straight line plume model cannot respond to the terrain-induced spatial variability in wind fields. Secondly, as AERMOD is based on a single-station wind observation, the wind fields do not vary spatially within the modelling domain. Thirdly, AERMOD cannot treat calm conditions and does not calculate concentrations during these hours. Because of these limitations, CALPUFF would be expected to more accurately reflect the meteorological and dispersion characteristics of the modelling domain and thus lead to more accurate ambient air concentrations. As shoreline fumigation was also raised as a possible concern in the previous application and AERMOD does not have the capability to model this phenomenon, CALPUFF (version 6.42) was selected as the most appropriate model which could assess all possible meteorological conditions within the one air dispersion model.

8.5.2.11 MM5 / CALMET Set-Up

Meteorological data is an important input into the air dispersion model. The local airflow pattern will be greatly influenced by the geographical location. Important features will be the location of hills and valleys or land-water-air interfaces and whether the existing and proposed facilities are located in simple or complex terrain.

Meteorological data for the assessment was based on various sources of information. Firstly, the Fifth Generation Penn State/NCAR (National Centre for Atmospheric Research) Mesoscale Model (known as MM5) was used for the years 2006 and 2007. The model output consists of hourly values of wind speed, wind direction, temperature and pressure on a grid size of 100 km x 100 km centred in Ringaskiddy. The data had 18 vertical levels with a base level of 15 m and a horizontal resolution of 12 km.

CALMET (version 6.5.0) meteorological pre-processor used the three-dimensional MM5 data along with all available surface observations within the 100km x 100km grid. As no upper air observations station were located within or near to the modelling domain, upper air data was obtained from MM5 and extrapolation of surface observations. One synoptic meteorological station operated by Met Eireann was identified near the site – Cork Airport. Data collection of greater than 90% for all parameters is required for air dispersion modelling. Cork Airport fulfils this requirement. A second surface station operated by Indaver as part of the current application was available for the year 2007 and thus was also used in the assessment. Buoy data for the stations M3 and M5 for 2006 and 2007 was obtained from the Marine Institute.

The CALMET modelling domain covered an area of 100 km x 100 km centred in Ringaskiddy. The CALMET wind field data had 11 vertical levels with a base level of 10 m and a horizontal resolution of 1 km. The eleven vertical levels are at 20, 40, 80, 160, 320, 650, 1000, 1500, 2200, 3000 and 4000 metres.

8.5.2.12 CALPUFF Set-Up

Emissions from the proposed site have been modelled using the CALPUFF dispersion model (Version 7.2.1) which has been developed by Earth Tech (now part of TRC Companies, Inc) and has been approved by the U.S. Environmental Protection Agency (USEPA)[(1)] for long-range transport and on a case-by-case basis for near-field (less than 50 km) applications involving complex meteorological conditions. The model is a non-steady-state Lagrangian puff model used to assess pollutant concentrations associated with a wide range of sources including industrial sources.

A receptor grid measuring 100 km by 100 km with the site at the centre was mapped out with terrain information at each receptor, derived from Shuttle Radar Topography Mission (SRTM) with 30 m resolution as input into the model. The model receptor grid entailed a total of 49,980 receptor points at which ambient ground levels concentrations were determined for each pollutant (inner grid at 25 m resolution, middle at 100 m resolution and outer grid at 500 m grid resolution as shown in Figure 8.5).

8.5.2.13 CALPUFF Modelling Results

The main study conclusions are presented below for each substance in turn with a graphical summary of results in comparison to the previously obtained AERMOD results presented in Figures 8.6 and 8.7. CALPUFF modelling was undertaken for both 2006 and 2007 with the worst-case result for either year reported for each averaging period.

8.5.2.14 NO_2 & NO_X

NO_2 modelling results, using CALPUFF, indicate that the ambient ground level concentrations will be below the relevant air quality standards with emissions at maximum operations leading to ambient NO_2 concentrations (including background concentrations) which are 69% of the maximum ambient 1-hour limit value (measured as a 99.8th%ile) and 32% of the annual average limit value at the respective worst-case receptors.

8.5.2.15 SO_2, CO, PM_{10} & $PM_{2.5}$

CALPUFF modelling results indicate that ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for sulphur dioxide, carbon monoxide and PM_{10} / $PM_{2.5}$ under maximum and abnormal operation of the facility. Emissions at maximum operations equate to ambient concentrations (including background concentrations) ranging from 10% - 50% of the respective limit values at the worst-case receptors.

8.5.2.16 TOC, HCl & HF

CALPUFF modelling results indicate that the ambient ground level concentrations will be below the relevant air quality guidelines for the protection of human health for TOC (assumed pessimistically to consist solely of benzene), HCl and HF under maximum and abnormal operation of the facility. Emissions at maximum operations equate to ambient concentrations (including background concentrations) for HCl and TOC of only 14% and 22% respectively of the ambient limit values.

HF modelling results indicate that emissions at maximum operations equate to ambient HF concentrations (including background concentrations) which will be 5% of the maximum ambient 1-hour limit value and 0.3% of the annual limit value.

8.5.2.17 PCDD / PCDFs (Dioxins/Furans)

Based on CALPUFF modelling results, the contribution from the facility is minor, with levels at the worst-case receptor to the south of the Facility, under maximum and abnormal operation, accounting for only a small fraction of existing levels. Levels at the nearest residential receptor will be minor, with the annual contribution from the proposed facility accounting for less than 1% of the existing background concentration under maximum operating conditions.

8.5.2.18 PAHs

PAHs modelling results, using CALPUFF, indicate that the ambient ground level concentrations will be below the relevant air quality target value for the protection of human health under maximum and abnormal operation of the Facility. Emissions at maximum operations equate to ambient benzo[*a*]pyrene concentrations (excluding background concentrations) which are only 0.5% of the EU annual average target value at the worst-case receptor.

8.5.2.19 Hg

CALPUFF modelling results indicate that the ambient ground level concentrations of Hg will be below the relevant air quality standards for the protection of human health under maximum and abnormal operation of the facility. Emissions at maximum operations equate to ambient mercury concentrations (including background concentrations) which are only 0.1% of the annual average limit value at the worst-case receptor.

8.5.2.20 Cd and Tl

CALPUFF modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standard for the protection of human health for cadmium under maximum and abnormal operation from the facility.

Emissions at maximum levels equate to ambient Cd and Tl concentrations (including background concentrations) which are 25% of the EU annual target value for Cd close to the facility boundary (the comparison is made with the Cd limit value as this is more stringent than that for Tl).

8.5.2.21 Sum of As, Sb, Pb, Cr, Co, Cu, Ni, Mn and V

CALPUFF modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for arsenic (As), nickel (Ni) and vanadium (V) (the metals with the most stringent limit values) under maximum and abnormal operation emissions from the facility (based on the ratio of metals measured at a Waste-to-Energy facility in Carranstown, County Meath). Ambient concentrations have been compared to the annual target value for As and Ni and the maximum 1-hour limit value for V as these represent the most stringent limit values for the suite of metals. Emissions at maximum operations equate to ambient As and Ni concentrations (including background concentrations) which are 17% and 37% of the EU annual target value respectively at the worst-case receptor whilst emissions at maximum operations equate to ambient V concentrations (including background concentrations) which are only 0.5% of the maximum 1-hour limit value at the worst-case receptor.

8.5.2.22 Modelling Conclusions

Based on the emission guidelines outlined in Council Directive 2010/75/EU, detailed air dispersion modelling has shown that the most stringent ambient air quality standards for the protection of human health are not exceeded either as a result of operating under maximum or abnormal operating conditions.

The modelling results, using both the USEPA regulatory model AERMOD and the more advanced CALPUFF model, indicate that the location of the maximum ambient ground level concentration occurs at or near the facility’s southern boundary. The spatial impact of the facility is limited with concentrations falling off rapidly away from the maximum peak. For example, the short-term limit values at the nearest residential receptor will be less than 17% of the short-term ambient air quality limit values. The annual average concentration has an even more dramatic decrease in maximum concentration away from the facility with concentrations from emissions at the proposed facility accounting for less than 2% of the limit value (not including background concentrations) at worst case sensitive receptors near the facility.

In the surrounding areas of Cobh, Carrigaline and Monkstown, levels are significantly lower than most background sources with the concentrations from emissions at the proposed facility accounting for less than 1% of the annual limit values for the protection of human health for all pollutants under maximum operations of the facility.

In terms of Ireland’s obligations under the Gothenburg Protocol and the POPs Convention, the impact of the facility will not be significant.

8.6 Mitigation Measures

In order to sufficiently ameliorate any potential negative impacts on the air environment, a schedule of measures has been formulated for both construction and operational phases associated with the proposed facility.

8.6.1 Construction Phase

The potential for dust to be emitted depends on the type of construction activity being carried out in conjunction with environmental factors including levels of rainfall, wind speeds and wind direction. The potential for impact from dust depends on the distance to potentially sensitive locations and whether the wind can carry the dust to these locations. The majority of dust produced will be deposited close to the generated source. A dust minimisation plan will be formulated for the construction phase of the project, as construction activities are likely to generate some dust emissions.

In order to ensure that no dust nuisance occurs, a series of measures will be implemented.

- Hard surface roads will be swept to remove mud and aggregate materials from their surface while any un-surfaced roads will be restricted to essential site traffic only apart from the contractor's car park which will be hardcore only.
- Furthermore, any road that has the potential to give rise to fugitive dust must be regularly watered, as appropriate, during dry and/or windy conditions.
- Vehicles using site roads will have their speed restricted, and this speed restriction must be enforced rigidly. On any un-surfaced site road, this will be 20 kph, and on hard surfaced roads as site management dictates.
- Vehicles delivering material with dust potential (soil, aggregates) will be enclosed or covered with tarpaulin at all times to restrict the escape of dust.
- Wheel washing facilities will be provided for vehicle exiting site in order to ensure that mud and other wastes are not tracked onto public roads.
- Public roads outside the site will be regularly inspected for cleanliness, and cleaned as necessary.
- Material handling systems and site stockpiling of materials will be designed and laid out to minimise exposure to wind. Water misting or sprays will be used as required if particularly dusty activities are necessary during dry or windy periods.
- During movement of materials both on and off-site, trucks will be stringently covered with tarpaulin at all times. Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions.

At all times, these procedures will be strictly monitored and assessed. In the event of significant dust deposition occurring outside the site boundary, movements of materials likely to raise dust would be curtailed and satisfactory procedures implemented to rectify the problem before the resumption of construction operations.

8.6.2 Operational Phase

A number of measures have been incorporated into the design of the resource recovery centre to ensure that emissions from the plant do not exceed regulatory emission limit values as outlined in Industrial Emissions Directive 2010/75/EU. In addition, the stack height has been designed in an iterative fashion in order to ensure that ambient ground level concentrations are minimised.

Air modelling predictions indicate that ambient air quality levels from the proposed facility will be within the ambient air quality standards at all locations beyond the site boundary, based on maximum and abnormal operating conditions. Thus no specific additional mitigation measures are required during the operational phase of the facility.

8.7 Residual Impacts

This section summarises the likely air quality impact associated with the proposed development, taking into account the mitigation measures.

8.7.1 Construction Phase

During the construction phase of the project there may be some impact on nearby properties due to dust emissions from the construction site and other activities. However, due to the formulation of an effective dust minimisation plan, it is considered that the residual impact will be slight.

8.7.2 Operational Phase

Based on the results of air dispersion modelling of process emissions, the air quality impact of the proposed facility will not be significant.

8.8 References

[1] USEPA (2005) *Guidelines on Air Quality Models, Appendix W to Part 51, 40 CFR Ch.1*

[2] USEPA (2004) *Minimum Meteorological Data Requirements For AERMOD – Study & Recommendations", 1998,* USEPA

[3] USEPA (2004) AERMOD Description of Model Formulation

[4] Auer Jr, (1978) *Correlation of Land Use and Cover with Meteorological Anomalies,* Journal of Applied Meteorology 17(5):636-643

[5] UK DEFRA (2009) *Part IV of the Environment Act 1995: Local Air Quality Management,* LAQM. TG(09)

[6] Fletcher & Brown (2010) *Interaction of an Eulerian Flue Gas Plume with Wind Turbines,* American Institute Of Aeronautics and Astronautics