Energy from Waste and Recycling Facility
TRIDENT PARK, CARDIFF

AIR QUALITY – TECHNICAL APPENDIX 19-1
ATMOSPHERIC DISPERSION MODELLING

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1.0 INTRODUCTION

This Technical Appendix presents an air quality assessment undertaken in support of an Environmental Impact Assessment (EIA) for a proposed EFW and recycling facility at Trident Park, Cardiff Bay, Cardiff..

Viridor Limited (Viridor) is proposing to develop an Energy from Waste (EfW) facility that would treat 350,000 tonnes of residual non-hazardous waste per annum which will be equipped with two process lines (Lines 1 & 2). Trident Park is located to the south-east of Cardiff City Centre at Glass Avenue. The site and its surroundings formed part of the East Moors Steelworks that closed in 1978. Following its reclamation the Nippon Electric Glass (UK) Limited developed a cathode ray tube components factory on the land, which ceased production in 2005.

This report presents the detailed atmospheric dispersion modelling undertaken in relation to emissions from stacks serving the Energy from Waste (EfW) process and forms a technical appendix to the air quality Chapter of the Environmental Statement (ES).

1.1 Scope

This assessment quantifies and assesses the potential direct air quality impacts associated with releases from the Energy from Waste (EfW) process of the proposed EFW facility using Environment Agency approved techniques against published standards for the protection of human health and sensitive ecological receptors.

Additionally, data used for the Health Impact Assessment (HIA) as presented in Appendix 12 of the ES in relation to emissions to air from the stack have been generated as part of the air quality assessment.

1.2 Structure of Report

The remainder of this report is structured as follows:

- Section 2 provides a summary of the legislation and guidelines relevant to the proposed activities at the site;
- Section 3 details the methodology applied in undertaking the assessment;
- Section 4 provides a description of the surrounding environment, including the identification of potentially sensitive receptors and a description of local climate and air quality conditions;
- Section 5 details how the emission rates discharge characteristics from the installation have been calculated and a detailed description of the dispersion modelling inputs;
- Section 6 reports the predicted impacts of the proposed operations on air quality; and
- Section 7 assesses the sensitivity of the dispersion model and the effect on predicted impacts.

2.0 POLICY, LEGISLATION AND RELEVANT GUIDANCE

2.1 Ambient Air Quality

2.1.1 (National) Air Quality Strategy

The 'Air Quality Strategy for England, Scotland, Wales and Northern Ireland' (UKAQS) was first published in 2000 and updated with an addendum in February 2003. Following extensive consultation and developments in the applicable Regulations, the Strategy has been updated and a new Air Quality Strategy[1] was released by in July 2007.

The UKAQS sets out a comprehensive strategic framework within which air quality policy will be taken forward in the short to medium term, and the roles that Government, industry, the Environment Agency, local government, business, individuals and transport have in protecting and improving air quality.

2.1.2 Air Quality Standards and Objectives

The UKAQS contains air quality objectives based on the protection of both human health and vegetation (ecosystems) and have been set taking into account the air quality standards defined in the Air Quality Standard Regulations 2007 (Statutory Instrument 2007 No. 64, 15th February 2007).

These standards in turn are defined by 'limit values' contained in the first, second, third and fourth Air Quality Daughter Directives. A summary of the current air quality standards for the pollutants detailed in the UKAQS 2007 for the purpose of Local Air Quality Management is provided in Table 2-1 below.

Table 2-1
UKAQS Air Quality Standards

Pollutant	Concentration	Measured as
Human Health Standards		
Benzene (C_6H_6)	16.25 μg/m^3	Running annual mean
	5 μg/m^3	Annual mean
1,3-butadiene (C_4H_6)	2.25 μg/m^3	Running annual mean
Carbon monoxide (CO)	10 mg/m^3	Maximum daily running 8 hour mean
Lead (Pb)	0.5 μg/m^3	Annual mean
	0.25 μg/m^3	Annual mean
Nitrogen dioxide (NO_2)	200 μg/m^3	1 hour mean (18 exceedences per year 99.79%ile of hourly averages)
	40 μg/m^3	Annual mean
Sulphur dioxide (SO_2)	266 μg/m^3	15 minute mean (35 exceedences per year; 99.90%ile of 15-min averages)
	350 μg/m^3	1 hour mean (24 exceedences per year; 99.73%ile of hourly averages)
	125 μg/m^3	24 hour mean (3 exceedences per year;

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

		99.18%ile of 24-hr averages)
Particulate matter (PM_{10}) (gravimetric)	40 µg/m^3	Annual mean
	50 µg/m^3	24 hour mean (35 exceedences per year ; 90.41%ile of 24-hr averages)
Particulate matter ($PM_{2.5}$) (gravimetric)	25 µg/m^3	Annual mean
Polycyclic aromatic hydrocarbons (PAHs)	0.25 ng/m^3	Annual mean
Ozone (O_3)	100 µg/m^3	Maximum daily running 8 hour mean
Vegetation and Ecosystem Standards		
Nitrogen oxides (NO_x)	30 µg/m^3	Annual mean
Sulphur dioxide (SO_2)	20 µg/m^3	Annual mean
	20 µg/m^3	Winter mean (1 October to 31 March)
Ozone	18 mg/m^3	5yr average of summer 1hr values AOT40

The UKAQS actually includes more exacting objectives for some pollutants than those required by EC legislation. This air quality assessment refers only to UK Air Quality Standards, as compliance with these standards will also ensure that the less demanding European Air Quality limit values would also be met.

In addition to these UKAQS objectives, the following additional 'target values' are defined within the Air Quality Standard Regulations 2007, and 4th EU Daughter Directive:

Table 2-2
Additional Air Quality 'Target Values'

Pollutant	Concentration	Measured as	Target date
Arsenic (As)	6 ng/m^3	Annual average in PM_{10} fraction	31.12.2012
Cadmium (Cd)	5 ng/m^3		
Nickel (Ni)	20 ng/m^3		

These 'target values' are different from the 'limit values' set for other pollutants in that they are not intended to be considered as 'Environmental Quality Standards' (EQSs)[2] and have therefore not been directly applied in this assessment.

Fine Particulate Matter ($PM_{2.5}$)

The effect of particulate matter on human health has been the subject of considerable development in regulation over recent years. The key development is the acknowledgement that the finer fraction (typically considered to be <2.5µm aerodynamic diameter) of particulate matter can be more directly attributed to human health effects than the coarser fraction (typically between 2.5µm and 10µm aerodynamic diameter). Considerable research has been undertaken (and is ongoing) and the findings have been used to inform the

[2] Explanatory Memorandum to the Air Quality Standards Regulations 2007. DEFRA 15th January 2007.

changes to regulation worldwide as summarised below. Whilst it is acknowledged that the composition of fine particulate matter (size and compounds) can influence its effect on health; all of the standards discussed below are based only on gravimetric $PM_{2.5}$.

In the UK, the 2008 Air Quality Strategy introduced targets and exposure reduction values for use in the UK. These have been applied in this assessment. The 2008 AQS sets an annual average target value of 25µg/m^3 by 2020 (for UK except Scotland) and an urban background exposure reduction of 15% between 2010 and 2020. These targets were informed by the findings of a review of research undertaken by the Committee on the Medical Effects of Air Pollutants[3] (COMEAP) which based its recommendations on a 10µg/m^3 increase in fine particles being associated with a 6% increase in risk of mortality.

In Europe, this issue has been recognised in the 'Directive on ambient air quality and cleaner air for Europe (2008/50/EC)'[4] which is due to be transposed by member states by 2010. The EU Directive defines both limits values and exposure reductions targets based on the impact of $PM_{2.5}$ on human health. These are detailed in Annex XIV of the Directive and details a Stage 1 limit value (Article 16) of 25µg/m^3 by 2010 and a provisional Stage 2 limit value of 20µg/m^3 by 2015 (to be reviewed in 2013). The National exposure reduction targets for urban background $PM_{2.5}$ concentrations between 2010 and 2020 are set based on existing levels with reductions between 20% where baseline levels are >25µg/m^3 and 0% where levels are less than 8µg/m^3. The 2008 AQS may be revised once this Directive is transposed in the UK.

Future developments within Europe involve the revision of the National Emission Ceilings Directive 2001/81/EC (NECD) which is still under preparation and should introduce an emission ceiling for the primary emissions of $PM_{2.5}$. To inform this proposed revision of the NECD, an emission inventory of $PM_{2.5}$ has been prepared[5] for the EU which shows the small contribution of 'waste treatment' (including energy from waste) estimated at 0.2% of the total from the EU25, compared to 20% from agriculture, of which the largest contributor is wind erosion of soils.

A significant proportion of research and regulation of $PM_{2.5}$ has been undertaken in the USA where National Ambient Air Quality Standards (NAAQS) limits for $PM_{2.5}$ have be in place prior to 2000. An evaluation of the health and welfare effects of fine particulate matter[6] was completed in 2006 in accordance with the Clean Air Act. Following this review the 1997 NAAQS for fine particulate matter were revised[7] with the 24-hr average standard decreased from 65 µg/m^3 to 35µg/m^3 and the annual standard remaining at 15µg/m^3.

The World Health Organisation (WHO) have also updated their Air Quality Guidelines[8] for particulate matter with Interim Targets (IT) and Air Quality Guidelines (AQG) set for both 24-hr average and annual average $PM_{2.5}$ concentrations. The Interim Targets are intended to be used as an incremental step in progressive reduction of exposure. The WHO guidelines for

[3] Long-Term Exposure to Air Pollution: Effect on Mortality. A report by the committee on the Medical Effects of Air Pollutants (COMEAP). Draft report for comments, 2007. Available from: http://www.advisorybodies.doh.gov.uk/comeap/index.htm

[4] Available from EU website: http://ec.europa.eu/environment/air/legis.htm (accessed 07/10/08)

[5] Estimation of emissions of fine particulate matter ($PM_{2.5}$) in Europe. Final report March 2007. TNO Report Ref: 2007-A-R0322/B, from http://ec.europa.eu/environment/air/pollutants/rev_nec_dir.htm

[6] USEPA website: http://www.epa.gov/ttn/naaqs/standards/pm/s_pm_cr.html (accessed 07/10/08).

[7] USEPA website: http://www.epa.gov/oar/particlepollution/standards.html (accessed 07/10/08).

[8] WHO Air Quality Guidelines – Global Update 2005. Particulate matter, ozone, nitrogen dioxide and sulfur dioxide.

annual average exposure to $PM_{2.5}$ include an IT-1 of 35µg/m^3, IT-2 of 25µg/m^3, IT-3 of 15µg/m^3 and an AQG of 10 µg/m^3. The WHO guidelines for 24-hr average exposure to $PM_{2.5}$ include an IT-1 of 75 µg/m^3, IT-2 of 50 µg/m^3, IT-3 of 37.5 µg/m^3 and an AQG of 25 µg/m^3.

In summary, whilst it is clear that different numerical limits or standards are being applied worldwide in relation to $PM_{2.5}$, the limits currently applied in the UK (as detailed in the 2008 AQS) are of a similar magnitude based on the findings of detailed research.

2.1.3 Local Authority Air Quality Review and Assessment

Part IV of the Environment Act 1995 requires local authorities to review and assess existing and predict future air quality in their areas as part of a rolling 'review and assessment' process. In areas where exceedence of one or more of the air quality objectives are predicted the local authority must designate an Air Quality Management Area (AQMA). Once designated; the local authority must then draw up an Air Quality Action Plan (AQAP) setting out the measures it intends to take in pursuit of achieving the air quality objectives in the AQMA.

The core guidance documents for use by persons involved in Local Air Quality Management (LAQM), or considering the impacts of a development with the potential to impact on air quality as covered by LAQM, are LAQM TG (09)[9] and LAQM PG (09)[10].

2.2 Environmental Permitting Regulations

The Environmental Permitting (England and Wales) Regulations 2007 (SI 2007 No, 3538) came into force on 6th April 2008 and transpose the Waste Incineration Directive, 2000/76/EC (WID) in UK legislation. The Directive applies to incineration and co-incineration plants which burn waste as defined in the Waste Framework Directive. Such wastes include municipal waste, clinical waste, hazardous waste, general waste and waste derived fuels. The Directive applies to the proposed operation.

The WID defines items such as:

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

2.2.1 Emission Limit Values to Air

The WID sets out emission limit values for emissions to air as detailed in the Table 2-3; these emission limits would be set as Environmental Permit conditions by the Environment Agency as part of the permitting process.

Table 2-3
WID Emission Limit Values

Pollutant	Emission Limits (mg/Nm^3) (a)		
	Daily average values	Half hourly averages	
		100th Percentile	97th Percentile

[9] DEFRA, Local Air Quality Management Technical Guidance LAQM.TG(09), (February 2009).
[10] DEFRA, Local Air Quality Management Policy Guidance, LAQM.PG(09) (February 2009).

	Emission Limits (mg/Nm^3) (a)		
Continuous Monitoring			
Particles	10	30	10
TOC	10	20	10
HCl	10	60	10
HF	1	4	2
SO_2	50	200	50
NOx	200	400	200
CO (b)	50	150	100
Spot sample measurements			
Group 1 metals (c)		0.05	
Group 2 metals (d)		0.05	
Group 3 metals (e)		0.5	
Dioxins and furans (f)		0.0000001	

Notes:

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

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

(c) Cadmium (Cd) and thallium (Tl)

(d) Mercury (Hg)

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

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

Typical Emissions

The WID details the maximum permitted emission limits and in order to ensure that compliance with these limits can be guaranteed (by the manufacturer), EfW plants are designed to achieve lower emission rates. Actual measured emissions from operational EfW's plants utilising similar technologies processing Municipal Solid Waste (MSW) in the UK are therefore typically significantly lower as summarised in Table 2-4:

Table 2-4
Typical EfW Emission Concentrations

Pollutant		Emission Concentrations (mg/Nm^3)		UK average as % of WID
		UK average(a)	WID Limit	
Particles		1.9	10	18.7%
TOC		0.6	10	6.1%
HCl		4.9	10	48.9%
HF		0.21	1	5.3%
SO_2		13.6	50	27.2%
NOx		150.7	200	75.3%
CO		11.1	50	22.2%
Dioxins (ng/m^3)		0.031	0.1	30.9%
Group 1 Metals (b)	Cadmium	0.0017	0.05	3.4%
	Thallium	0.0005		1.0%
Group 2 Metals	Mercury	0.0171	0.05	34.2
Group 3 Metals	Antimony	0.009	0.5	1.80%
	Arsenic	0.012		2.40%
	Cobalt	0.001		0.20%

Emission Concentrations (mg/Nm^3)		
Chromium	0.016	3.20%
Copper	0.008	1.60%
Lead	0.029	5.80%
Manganese	0.014	2.80%
Nickel	0.042	8.40%
Vanadium	0.001	0.20%

(a) Based on a review of available Environment Agency public records data from operational EfW plants in the UK.
(b) Only data from 1 plant available.

2.2.2 Monitoring Requirements

In addition to the monitoring of process parameters such as temperature within the combustion chamber and the oxygen concentration, temperature, moisture and pressure of flue gases; the WID prescribes that continuous monitoring of emissions to air for NOx, TOC, SO_2 and HCl and HF are to be undertaken. Although the requirement for continuous monitoring of HF may be omitted if treatment stages are applied which ensure that the emission limit for HCl is not exceeded because the abatement of HCl to below the WID emission limits would also ensure the abatement of HF to below the WID limits.

Furthermore at least two measurements per year of metals, dioxins and furans, dioxin like PCBs and PAHs is required by the WID. Whilst dioxins and furans are specifically regulated under the WID, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) are not specifically regulated under the WID but are effectively controlled through the process conditions and limitation of TOC emissions.

2.3 Regulation of Industrial Processes

Industrial process emissions to air, such as those from the proposed EFW are controlled under the Environmental Permitting (England and Wales) Regulations 2007 by the Environment Agency. Guidance Notes produced by DEFRA provide a framework for regulation of installations and additional Technical Guidance Notes produced by the Environment Agency are used to provide the basis for permit conditions in relation to releases to air and mitigation measures.

The proposed EFW would be classed as a Part A(i) process under these regulations, amongst other conditions of operation would be emission limits for various pollutants produced by the process, which must be demonstrated through various monitoring requirements as prescribed by the WID. The relevant Sector Guidance Note is EPR5.01[11].

Of particular relevance to the assessment of air quality impacts is the guidance document EPR H1 Environmental Risk Assessment[12]. The purpose of this guidance note is to provide supplementary information, relevant to all sectors, to assist applicants in responding to the requirements described in the EPR Sector and General Guidance Notes. The H1 assessment can be used to support an Environmental Impact Assessment of the overall impact of the emissions resulting from the installation to confirm that the emissions are acceptable (i.e. do not cause significant pollution). The H1 guidance provides the assessor

[11] How to comply with your environmental permit - Additional guidance for The Incineration of Waste, EPR 5.01. Environment Agency, March 2009.

[12] EPR H1: Environmental Risk Assessment Part 2: Assessment of point source releases and cost-benefit analysis, version 080328. Environment Agency March 2008.

with Environmental Assessment Levels (EAL's) for each pollutant against which impact may be assessed.

2.3.1 Environmental Assessment Levels (EAL)

The EALs used in this assessment have been reproduced from EPR Guidance H1, which are based upon the air quality standards and occupational exposure limits (OEL) and maximum exposure levels (MEL) presented in HSE EH40 (2005). A summary of the appropriate EALs for pollutants emitted by the proposed facility are included in Table 2-5. EALs have been applied in this assessment where no air quality standard exists, or where the EAL is lower than the corresponding air quality standard.

Table 2-5
Relevant EALs (µg/m^3)

Pollutant		**Long Term EAL (Annual average)**	**Short Term (Hourly average) EAL**
Nitrogen dioxide	(NO_2)	40	200
Carbon monoxide	(CO)	-	10,000
Sulphur dioxide	(SO_2)	50	267
Particulates	(PM_{10})	40	50
Hydrogen chloride	(HCl)	20	800 (EPAQS 750)[(a)]
Hydrogen fluoride	(HF)	-	250 (EAPQS 160)[(a)]
Benzene (surrogate for TOC)		16.25	208
Arsenic[(c)]	(As)	0.003	15
Antimony	(Sb)	5	150
Cadmium	(Cd)	0.005	1.5
Chromium (II & III)	(Cr)	5	150
Chromium (VI) [(c)]	(Cr)	0.0002	3
Cobalt	(Co)	0.2	6
Copper	(Cu)	2	60
Lead	(Pb)	0.5	-
Manganese	(Mn)	1	1500
Mercury	(Hg)	0.25	7.5
Nickel [(c)]	(Ni)	0.02	30
Thallium	(Tl)	1	30
Vanadium	(V)	5	20[(b)]
Ammonia	(NH_3)	180	2500

Note:

(a) The Expert Panel on Air Quality Standards (EPAQS) has recommended lower short term limits for HCl and HF, and whilst these have not be carried forward into the H1 guidance, these have been applied in this assessment.

(b) There is some uncertainty relating to the validity of the short-term EAL for Vanadium from H1 of 1µg/m^3. For all compounds, except Vanadium, the short-term EAL is higher than the long-term EAL (5µg/m^3); typically by a factor of 10 or more. It is therefore considered that a more appropriate short-term assessment level would be the World Health Organisation13 lowest observed adverse effect level (LOAEL) at 20µg/m^3.

(c) The Expert Panel on Air Quality Standards (EPAQS) has recommended new limits for Arsenic, Nickel, and Chromium[14], and whilst these have not yet been carried forward into the H1 guidance, these have been considered in this assessment and have been by the Environment Agency in the consultation for an updated H1.

[13] Chapter 6.12:Vanadium. Air Quality Guidelines for Europe, Second Edition, 2000. WHO Regional Publication, European series, No. 91.

[14] DEFRA, Expert Panel on Air Quality Standards Guidelines for metals and metalloids in ambient air for the protection of human health (May 2009).

EALs for the protection of Ecosystems and Vegetation

The following EALs for the protection of ecosystems and vegetation are also defined in H1 as critical levels for ammonia.

Table 2-6
Additional EALs for Ecosystems

Pollutant	Averaging period	Concentration (μg/m^3)
Ammonia	Hourly	3300
	Daily	270
	Monthly	23
	Annual mean	3

The impact of ammonia on sensitive ecosystems is a matter of ongoing research and debate; however the 2007 workshop on atmospheric ammonia, convened by the Executive body for the convention on long-range transboundary air pollution[15] recommended that the annual critical level for vegetation for ammonia be reduced from 8μg/m^3 to 3μg/m^3.for all 'higher plants' (i.e. heathland, grassland and forests) and 1μg/m^{3}for lichen and bryophytes.

2.4 Impacts on Sensitive Ecosystems

2.4.1 The Conservation (Natural Habitats &c) Regulations

The Conservation (Natural Habitats &c) Regulations 1994 ('Habitats Regulations') transpose Council Directive 79/409/EEC on the conservation of wild birds ('Birds Directive') and Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora ('Habitats Directive') into national law (in conjunction with the Wildlife and Countryside Act, see below).

Regulation 48(1) states:

> *"A competent authority, before deciding to undertake, or give consent, permission or other authorisation for a plan or project which (a) is likely to have a significant effect on a European site in Great Britain (either alone or in a combination of projects), and (b) is not directly connected with or necessary to the management of the site, shall make an appropriate assessment of the site in view of the site's conservation objectives".*

Assessment under the Habitats Regulations

In order to clarify the procedure for assessing the impact of industrial facilities regulated by the Environment Agency on sites designated under the Habitat Regulations; the Environment Agency has prepared Operational Instructions. These operational instructions form Appendix 7[16] of the Agency's guidance (the EU Habitats and Birds Directive Handbook) on how the Agency implements the Habitats Regulations when they consider new consents and review old consents. They define a 4-stage assessment procedure as detailed below:

- Stage1 – identification of relevant application by distance from designated site;

[15] Report on the Workshop on Atmospheric Ammonia, (http://www.ammonia-ws.ceh.ac.uk). Executive body for the convention on long-range transboundary air pollution, April 2007.

[16] Appendix 7, Assessment of new PIR permissions under the Habitat Regulations, Operational Instruction. Environment agency, Version 2, 06/06/07.

- Stage 2 – identification of permissions that are likely to be significant;
- Stage 3 – the 'appropriate assessment'; and
- Stage 4 – determination of the permission.

The 'stage 1' assessment indicates that any EP application within 10km of a designated site and 15km for centrally dispatched coal or oil-fired power station is considered relevant. For this assessment a study area of 10km has been adopted.

As part of the 'stage 2' assessment, the significance of the long-term process contribution (PC) is assessed against the following criteria:

- If the PC is less than 1% of the relevant long-term benchmark (EAL, critical level or critical load), the emission is 'not likely to have a significant effect alone or in combination irrespective of the background levels'

Where this criterion is exceeded; consideration of the predicted environmental concentration (PEC) is required and the following criteria applied:

- If the PEC is less than 70% of the relevant long-term benchmark, the emission is 'not likely to have a significant effect'.

If on the basis of this Stage 2 assessment it cannot be concluded that the emission is not likely to have a significant effect, a Stage 3 'appropriate assessment' is required.

Where it is identified that a Stage 3 'appropriate assessment' is required in relation to emissions to air, the results of detailed atmospheric dispersion modelling are used to predict impacts of various pollutants at the sensitive locations. The procedure for undertaking such an 'appropriate assessment' has been defined by the Agency in conjunction with Natural England in the AQTAG06[17] guidance document.

The AQTAG06 procedure defines the dispersion modelling approach in terms of receptor location and arrays, use of topographical and terrain data, the calculation of deposition fluxes, how these should be considered alongside the background conditions and relevant critical levels and loads.

2.4.2 Wildlife & Countryside Act

The Wildlife and Countryside Act 1981 (as amended) is the principal mechanism for the legislative protection of wildlife in Great Britain. This legislation is the means by which the Convention on the Conservation of European Wildlife and Natural Habitats (the 'Bern Convention') and the European Union Directives on the Conservation of Wild Birds (79/409/EEC) and Natural Habitats and Wild Fauna and Flora (92/43/FFC) are implemented in Great Britain.

Planning authorities are required to consult Countryside Council for Wales (CCW) before granting planning permission for the development of land in a Site of Special Scientific Interest (SSSI), or within the consultation area around a SSSI, as defined by CCW.

The planning authority is also required to consult CCW if the development is considered likely to affect a SSSI, even if the application site falls outside the SSSI and surrounding consultation area.

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[17] AQTAG06 – Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air. Environment Agency, working Draft version 9, 12/05/06.

3.0 ASSESSMENT METHODOLOGY

3.1 Dispersion Modelling

Detailed atmospheric dispersion modelling has been undertaken with due consideration to relevant guidance[18,19] and the modelling approach is based upon the following stages:

- identification of sensitive receptors;
- review of emissions from other existing and proposed local industrial sources;
- review of process design proposals and emission sources;
- compilation of the existing air quality baseline with due regard to Review and Assessments of local air quality;
- calculation of process contribution to ground level concentrations and deposition for key pollutants emitted from the process;
- evaluation of effects on ecological receptors;
- consideration of cumulative effects; and
- sensitivity analyses of model input data.

A number of commercially available dispersion models are able to predict ground level concentrations arising from emissions to atmosphere from elevated point sources such as the Trident Park facility. No dispersion model is wholly accurate and all models will produce variations in results under certain conditions. For this assessment the AERMOD GIS PRIME model[20] has been applied.

The AERMOD dispersion modelling program is widely used and accepted by the Environment Agency in the UK for undertaking such assessments and its predictions have been validated against real-time monitoring data by the USEPA[21]. It is therefore considered a suitable model for this assessment. The issue of model sensitivity and different dispersion modelling systems (specifically ADMS) has been considered in Section 7.0 of this report.

3.1.1 Combined Effects with Existing Air Pollution Sources

There are a number of sources of emissions to air in the area surrounding the application site, predominately these are associated with traffic, domestic and small industrial sources within the Cardiff City centre. Larger industries that have the potential for combined effects on air quality with atmospheric emissions from the proposed Trident Park EfW facility are detailed in Section 4.2.1 and mainly include the nearby Steelworks (Celsa) and docks.

Emissions from the Clesa steelworks are released over 1km from the proposed development and therefore it is considered that combined effects on air quality have been addressed through the selection of baseline ambient air quality data that includes impacts associated with existing traffic related and industrial facilities.

[18] Air Dispersion modelling report requirements (for detailed air dispersion modelling). AQMAU, Environment Agency (not dated).
[19] Guidelines for the Preparation of Dispersion Modelling Assessment for Compliance with Regulatory Requirements – an update to the 1995 Royal Meteorological Society guidance. UK Atmospheric Dispersion Modelling Committee (ADMLC), Version 1.4, 2004.
[20] Software used: BREEZE AERMOD GIS Pro, v6.2.
[21] AERMOD: Latest Features and Evaluation Results. USEPA Report: EPA-4519/R-03-003 June 2003, (http://www.epa.gov/scram001/dispersion_prefrec.htm#aermod)

3.1.2 Assessment of Impacts on Human Receptors

The predicted ground level concentration of the modelled pollutants have been compared as a Process Contribution (PC) and Predicted Environmental Concentration (PEC; PC plus existing background pollutant concentration) and presented as a percentage of the relevant air quality standard or EAL.

3.2 Deposition Modelling – Metals and dioxins

In order to inform the assessment of potential impacts on human health (as detailed in Appendix 12 of the ES), the air dispersion model has been interrogated to provide deposition rates of metals and dioxins. In the absence of suitable UK guidance, this has been undertaken based on guidance[22] issued by the United States Environmental Protection Agency (USEPA) as discussed in the following sections. Modelling has been conducted on a receptor grid (10km square, 250m spacing) with additional discrete receptors at identified sensitive receptor locations (hospitals, schools and allotments) as detailed in Section 4.7.1.

3.2.1 Approach

The emissions to atmosphere from the stacks serving the waste treatment process occur as either vapour or particulate matter and the modelling methodology depends on the phase in which the pollutant is emitted from the facility.

Guidance indicates that in general it can be assumed that:

- Most metals and organic pollutants with very low volatility (i.e. fraction of the pollutant in the vapour phase is less than 0.05) occur only in the particle phase;
- Highly volatile organic pollutants occur only in the vapour phase (i.e. the fraction of the pollutant in the vapour phase is 1.0);and
- The remains pollutants are condensed onto the surface of particulate matter (particle-bound).

The fraction of the identified pollutants in the vapour phase, and the assigned phase for the dispersion modelling, are presented in the following table:

Table 3-1
Assigned Phases for Metals and Dioxins

	Pollutant	Fraction in Vapour Phase (Fv) [(a)]	Assigned phase
Group 1 Metal	Cadmium	0.009	Particle
	Thallium	0.009	Particle
Group 2	Mercury	1	Particle-bound & vapour[(b)]
Group 3 Metals	Antimony	1[(c)]	Particle-bound
	Arsenic	0.006	Particle
	Lead	0.007	Particle
	Chromium	0.009	Particle
	Cobalt	No data available	Particle

[22] USEPA, Office of Solid Waste and Emergency Response, Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, FINAL September 2005. Chapter 3: Air Dispersion and Deposition Modelling.

	Copper	No data available	Particle
	Manganese	No data available	Particle
	Nickel	0.008	Particle
	Vanadium	No data available	Particle
Dioxins and Furans	2,3,7,8–TCCD	0.664	Vapour
	1,2,3,7,8–PeCDD	0.117	Particle-bound
	1,2,3,4,7,8-HxCDD	0.024	Particle
	1,2,3,6,7,8–HxCDD	0.029	Particle
	1,2,3,7,8,9–HxCCD	0.016	Particle
	1,2,3,4,6,7,8–HpCCD	0.003	Particle
	OCCD	0.002	Particle
	2,3,7,8-TCDF	0.77	Vapour
	1,2,3,7,8-PeCDF	0.268	Particle-bound
	2,3,4,7,8-PeCDF	0.221	Particle-bound
	1,2,3,4,7,8-HxCDF	0.049	Particle
	1,2,3,6,7,8-HxCDF	0.052	Particle
	1,2,3,7,8,9-HxCDF	0.09	Particle
	2,3,4,6,7,8-HxCDF	0.058	Particle
	1,2,3,4,6,7,8-HpCDF	0.01	Particle
	1,2,3,4,7,8,9-HpCDF	0.057	Particle
	OCDF	0.002	Particle

(a) Data from Appendix 3 of the USEPA, OSW, Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, FINAL September 2005.

(b) The classification of emission of Mercury is discussed further in the following section on metal deposition.

(c) Despite a published vapour fraction of 1, Antinomy has a melting point of over 600ºC and therefore has been assigned to the particle-bound category.

Particulate Deposition

Particle deposition is determined mainly by the particle size (aerodynamic) and density, with the terminal velocity of a particle determining how far and soon it will deposit. Wet deposition is a further factor with larger particles being scavenged more easily by precipitation. AERMOD incorporates 2 methods for modelling deposition of particles:

- Method 1 is used when a significant fraction (> 10%) of the total particulate mass has a diameter greater than 10 microns and the particle size distribution is reasonably well known.
- Method 2 is used when the particle size distribution is not well known and when a small fraction (less than 10% of the mass) consists of particles with a diameter of 10 microns or larger.

For this assessment, as data relating to particle size and density is limited, the Method 2 approach has been applied using published data[23] relating to particle size distribution for individual pollutants.

[23] Deposition Parameterizations for the Industrial Source Complex (ISC3) Model. Environmental Research Division, Argonne National Laboratory on behalf of US Department of Energy, June 2002.

Vapour Deposition

Vapour phase compounds are deposited via both wet and dry processes, dependent on factors relating to their solubility etc. and not by particle size, mass or surface area. Published data[24] relating to solubility etc has been applied to individual pollutants.

3.2.2 Deposition of Metals

As shown in Table 3-1, for the purposes of this assessment all metals have been assumed to be particle (or particle-bound) with the exception of Mercury.

In relation to Mercury, stack emissions will comprise both vapour and particle-bound forms of Mercury, speciated as both elemental and divalent Mercury. USEPA guidance[25] indicates that for the purposes of assessments such as these it is to be assumed that 80% of emission of Mercury will be present as vapour, and 20% as particle-bound. In terms of speciation, the vapour is considered to be three-quarters divalent and one-quarter elemental mercury and the particle-bound Mercury to be entirely divalent.

3.2.3 Deposition of Dioxins (and furans)

As shown in Table 3-1, for the purposes of this assessment all Dioxins (and furans) have been assumed to be particle (or particle-bound) with the exception of 2,3,7,8-TCCD and 2,3,7,8-TCDF which have been assumed to be vapour phase (gaseous).

Furthermore, as each specific congener has different physico-chemical properties, congener-specific emission data are needed for the assessment of deposition of dioxins. The congener profile will be dependent on various factors including the type of waste being burnt, the temperature of combustion, the type of combustion chamber being operated and the air pollution control devices (APCDs) installed. For the purposes of this assessment published data[26] relating to the measured congener profile from the combustion of MSW has been applied as summarised in Table 3-2.

Table 3-2
Assigned Congener Partitioning

Compound	I-TEQ Factor	HMIP Measured Concentration (ng/Nm^3)	Applied Emission Concentration (ng/Nm^3)	% Congener Contribution	Congener Emission Rate (I-TEQ ng/Nm^3)
2,3,7,8 –TCCD	1	0.031	0.0031	0.15%	0.0031
1,2,3,7,8–PeCDD	0.5	0.245	0.0245	1.22%	0.0123
1,2,3,4,7,8–Hx CDD	0.1	0.287	0.0287	1.42%	0.0029
1,2,3,6,7,8–HxCDD	0.1	0.258	0.0258	1.28%	0.0026
1,2,3,7,8,9–HxCCD	0.1	0.205	0.0205	1.02%	0.0021
1,2,3,4,6,7,8–HpCCD	0.01	1.704	0.1704	8.46%	0.0017
OCCD	0.001	4.042	0.4042	20.06%	0.0004

[24] Deposition Parameterizations for the Industrial Source Complex (ISC3) Model. Environmental Research Division, Argonne National Laboratory on behalf of US Department of Energy, June 2002.

[25] USEPA, Office of Solid Waste and Emergency Response, Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, FINAL September 2005. Chapter 2: Facility Characterization.

[26] Table 7.2a: Summary of Emission Characteristics of the Representative Incinerator. Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes. HMIP 1996.

2,3,7,8-TCDF	0.1	0.277	0.0277	1.37%	0.0028
1,2,3,7,8-PeCDF	0.05	0.277	0.0277	1.37%	0.0014
2,3,4,7,8-PeCDF	0.5	0.535	0.0535	2.66%	0.0268
1,2,3,4,7,8-HxCDF	0.1	2.179	0.2179	10.81%	0.0218
1,2,3,6,7,8-HxCDF	0.1	0.807	0.0807	4.00%	0.0081
1,2,3,7,8,9-HxCDF	0.1	0.042	0.0042	0.21%	0.0004
2,3,4,6,7,8-HxCDF	0.1	0.871	0.0871	4.32%	0.0087
1,2,3,4,6,7,8-HpCDF	0.01	4.395	0.4395	21.81%	0.0044
1,2,3,4,7,8,9-HpCDF	0.01	0.429	0.0429	2.13%	0.0004
OCDF	0.001	3.566	0.3566	17.70%	0.0004
TOTAL	**-**	20.15	2.015	100.00%	**0.1**

3.3 Assessment of Impacts on Vegetation and Ecosystems

3.3.1 Critical Levels

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

For all European sites, SSSIs and other ecological sites in the study area (10km from the site), which includes the Severn Estuary sites, process contributions (and predicted environmental concentrations where required) of NO_x , NH_3, and SO_2 have been calculated for comparison against critical level thresholds.

3.3.2 Critical Loads

Critical loads are a quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge.

Critical loads are set for the deposition of various substances to sensitive ecosystems. Predicted contributions to acid deposition and nitrogen deposition have been calculated and compared with the relevant critical load range for the habitat types associated with each designated site as derived from the UK Air Pollution Information System (APIS) website (www.apis.ac.uk/).

Deposition rates were calculated using dispersion modelling results processed by following empirical methods recommended by the Environment Agency in AQTAG06 and summarised in the following sections

3.3.3 Calculation of Contribution to Critical Loads

Deposition rates were calculated using empirical methods recommended by the Environment Agency (AQTAG06), as described below.

Calculate dry deposition flux using the following equation:

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

The applied deposition velocities for various chemical species are as shown in Table 3-3.

Table 3-3
Applied Deposition Velocities

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

The units are then converted from µg/m^2/s to units of kg/ha/year by multiplying the dry deposition flux by standard conversion factors as summarised in Table 3-4.

Table 3-4
Applied Deposition Conversion Factors

Chemical Species	Conversion factor [µg/m^2/s to kg/ha/year]	
NO_2	of N:	96
SO_2	of S:	157.7
NH_3	of N:	259.7
HCl	Of Cl:	306.7

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

Critical Loads - Eutrophication

The contribution to critical loads for Nitrogen deposition are recorded as KgN/ha/yr.

Critical Loads - Acidification

The predicted deposition rates are converted to units of equivalents (keq/ha/year), which is a measure of how acidifying the chemical species can be, by dividing the dry deposition flux (kg/ha/year) by standard conversion factors as presented in Table 3-5.

Table 3-5
Applied Acidification Conversion Factors

Chemical Species	Conversion factor [kg/ha/year to keq/ha/year]
of N:	divide by 14
of S:	divide by 16
of Cl:	Divide by 35.5

The predicted dry N, S and Cl deposition (keq/ha/year) are summed to determine total acid deposition.

4.0 BASELINE ENVIRONMENT

4.1 Site Location

The proposed site for the facility is located within the Trident Park complex, at NGR ST 205 755. The Trident Park site is approximately 2km south west of Cardiff city centre. The nearest residential areas are Splott and Adamstown and the Cardiff Bay developments, approximately 1Km NE and west respectively as shown on Drawing 19/2.

There are also a number of sensitive habitats and protected sites within 10km of the application site. These include the Severn Estuary SPA which at its closest is some 500m to the east of the proposed site as shown on Drawing 19/3.

4.2 Existing Local Sources

4.2.1 Pollution Control

A summary of major point sources, as detailed in the NAEI, within a 5km radius of the centre of the site coordinates 320500,175500, is presented in Table 4-1.

Table 4-1
Major Industrial Sources within 2km of the Proposed Development

Source	Operator	Location (NGR)	Distance from Site	Pollutants Emitted
Iron and Steel – combustion plant, Cardiff	Celsa Manufacturing (UK) Ltd	319500, 175400	1.01km	CO_2
Iron and Steel – combustion plant, Tremorfa	Celsa Manufacturing (UK) Ltd	320770, 176240	0.79km	CO_2
Iron and Steel – combustion plant, Tremorfa	Celsa Manufacturing (UK) Ltd	321350, 176500	1.31 km	CO_2
Ladle arc furnaces, Tremorfa	Celsa Manufacturing (UK) Ltd	321350, 176500	1.31 km	CO_2
Electric arc furnaces, Tremorfa	Celsa Manufacturing (UK) Ltd	321350, 176500	1.31km	CO_2, CO, NO_x, N_2O, SO_2, Se, PM_{10}, $PM_{2.5}$, Dioxins, Cd, Hg, As, Cr, Cu, Mn, Pb, VOC, Zn, BaP, CH_4, Ni, V

4.3 Local Air Quality Management

Following the first round of review and assessment of air quality in Cardiff, three Air Quality Management Areas (AQMAs) were declared in December 2000. These are the Newport Road AQMA, the Philog AQMA, and the Cardiff West AQMA. A fourth AQMA was declared in respect of St Mary Street/High Street in September 2002. These AQMAs were declared on the bases of monitoring and modelling data that demonstrated that NO_2 concentrations within the areas were expected to exceed the annual objective.

However, the latest review and assessment document[27] concluded that monitoring data indicates that the Newport Road and Philog AQMAs may now be unnecessary and that the Cardiff West AQMA may have been over-declared (in terms of its extents) and could be replaced with an AQMA covering the Ely Bridge area.

4.3.1 South Wales Air Quality Action Plan

In 2008 the Welsh Assembly Government (WAG) consulted on an air quality action plan for the South Wales zone[28]. It is proposed that this Short term air quality action plan be adopted as a model for action should it be determined that there is a risk of exceedence of one or more of the air quality standards. Currently the only identified area of concern relates to PM_{10} levels in Port Talbot, Neath which has been the subject of more detailed assessments.

4.4 Background Levels and Predictions

This section describes the existing baseline air quality in the region of the Trident Park Site.

4.4.1 Cardiff City Council Monitoring

Automatic Monitoring Data

Until May 2008, CCC operated an automatic monitor located at the Council's Briardene Road Safety Centre on North Road, which is classified as a "Roadside" site. This site monitors for nitrogen oxides (NO_x) sulphur dioxide (SO_2), carbon monoxide (CO) and particulate matter (PM_{10}).

Table 4-2
Automatic Monitoring Data: Briardene Road (Annual average µg/m³).

Pollutant	2006	2007	2008[(a)]
CO	351	347	474
PM_{10}	27.8	27.0	28.4
NO_2	27.2	27.2	32.2
SO_2	10.8	13.4	3.9

(a) 2008 data complete up to 06/05/2008 and is provisional only. Station closed in May 2008.

Non-automatic monitoring data

In addition to these real-time monitors, CCC monitors levels of Nitrogen Dioxide via a diffusion tube survey at 59 locations throughout the County. The tubes are located both inside and outside of the AQMAs; however it is those located within the Newport Road AQMA (yet to be undeclared) which are of particular interest due to their proximity to the site. The results from the tubes located within the Newport Road AQMA are shown in Table 4-3 below.

[27] The County Council of the City and County of Cardiff. Draft Detailed Assessment and Air Quality Management Area Review, October 2006

[28] Consultation by the Welsh Assembly Government on a short term air quality action plan for zones in Wales and a short term air quality action plan for the South Wales zone incorporating a local plan of action in respect of PM10 levels in Neath Port Talbot. Welsh Assembly Government, August 2008.

Table 4-3
Newport Road AQMA Nitrogen Dioxide Diffusion Tube Survey Results (µg/m^3)

Site Number	Site Name	Classification	2002	2003	2004	2005
8	Newport Road	Kerbside	39	39	41	39
69	Dominion's Way	Kerbside	49	-	-	-
70	Oakfield Street	Kerbside	39	47	40	39
71	Marlborough Road	Kerbside	24	32	30	31
97	Newport Road (premises)	Façade	37	36	36	34
105	196 Broadway	Façade	-	36	30	34
107	Lynx Hotel	Façade	-	37	37	36

As can be seen from this monitoring data, in 2005 none of the sites, kerbside or façade, measured concentrations above the annual average air quality objective, leading to the proposed removal of the AQMA status.

4.4.2 Automatic Urban and Rural Monitoring Network

The Automatic Urban and Rural Monitoring Networks (AURN) run on behalf of Defra provide automatic monitoring data from a network of stations in urban and rural locations across the UK. There is one AURN monitoring location in the vicinity of the proposed development; Cardiff Centre.

Cardiff Centre (OS Grid: 318417, 176505), is classified as an urban centre site approximately 2.3km from the Trident Park site. Measured concentrations of CO, NO_2, SO_2, PM_{10} and benzene are available for this site. The most recent annual mean levels are presented in Table 4-4 below.

Table 4-4
Automatic Monitoring Network data from Cardiff Centre Station (µg/m^3).

Pollutant	2007	2008	2009[(a)]
Benzene	0.64	0.28	Not monitored
CO	260	282	Not monitored
PM_{10}	22.4	20.0	18.4
$PM_{2.5}$		13.2[(b)]	12.5
NO_2	31.4	29.0	31.1
SO_2	2.8	2.4	2.2

(a) 2009 data ratified unitl 31st September, provisional from 1st October
(b) $PM_{2.5}$ monitoring commenced on 14th August 2008

4.4.3 National Air Quality Archive

Background pollutant concentrations have been obtained from the National Air Quality Archive UK Background Air Pollution Maps. These 1km grid resolution maps are derived from 2004 estimated background annual mean pollutant concentrations which are then projected to future years.

The estimated annual mean background concentrations for the grid square containing the Trident Park Site (GR 320500, 175500) are as shown in Table 4-5 for pollutants relevant to this assessment.

Table 4-5
Relevant Estimated Annual Mean Background Concentrations

Pollutant	Predicted 2010 (µg/m^3)	Predicted 2012 (µg/m^3)
PM_{10}	17.0	18.9
$PM_{2.5}$	13.1	12.8
NO_2	25.87	20.8
SO_2	4.01	4.01
Benzene	0.39	0.38
CO	156	145

4.4.4 Dioxins and Furans

Dioxins are currently monitored at six sites by DEFRA within the UK as part of the Toxic Organic Micropollutants Network; Table 4-6 presents available data from these sites for 2007 & 2008. None of these sites are in close proximity to Cardiff, and monitoring has not been undertaken in Cardiff since 1994.

It should be noted that the raw monitoring data for each dioxin or furan species have been multiplied by the associated World Health Organisation toxic equivalence factor to give a total dioxin and furan concentration in compliance with the I-TEQ reporting convention.

Table 4-6
Monitoring Data for Dioxins and Furans

Site	Site Classification	2007	2008
Hazelrigg	Semi-Rural	6.68	3.67
High Muffles	Rural	1.35	1.73
London	Urban	7.25	10.94
Manchester	Urban	18.33	18.99
Middlesbrough	Urban	18.49	23.98 (Q1 & Q2 only)
Auchenforth	Rural	n/m	6.44 (Q4 2008 only)
Stoke Ferry	Rural	5.90	Site relocated

a) The Dioxin TEQ values are best case estimates. In samples in which a congener is not detected during analysis, the value used in calculating concentrations is zero rather than the detection limit. Concentrations of 17 dioxins are measured at each site.

4.4.5 Metals

Monitoring of metals is currently carried out by Defra at 27 sites around the UK (17 as part the UK Heavy Metals Monitoring Network and 10 as part of the Rural Heavy Metals and Mercury Network).

The closest monitoring location to the Trident Park EFW site is located in Cardiff (Llandaff) as part of the UK Heavy Metals Monitoring network as shown in Table 4-7.

Table 4-7
Metals Monitoring Data at Cardiff (annual average ng/m^3)

Metal	2006	2007	2008
Cadmium	0.35	0.29	0.21

Mercury (particle and	2.95	2.19	1.92
Arsenic	1.09	1.02	0.66
Lead	18.71	13.84	13.4
Chromium	5.76	3.89	2.46
Copper	28.21	24.43	27.7
Manganese	13.96	9.53	9.2
Nickel	3.76	1.81	1.37
Vanadium	2.68	2.03	1.22

Monitoring is not routinely undertaken for thallium, antimony, Chromium VI or cobalt in the UK and therefore no background data are available.

4.4.6 Hydrogen Halides

Hydrogen Chloride

Hydrogen chloride is monitored as part of the (UK Acid Gases and Aerosols Monitoring Network (part of the acid deposition monitoring network). The closest monitoring station to the proposed EFW is located at Rosemaud (near Hereford), located approximately 75km to the northeast. Table 4-8 presents data from this site for the past 3-years.

Table 4-8
Annual Mean Concentrations of HCl at Rosemaud

Site Name	Hydrogen Chloride Annual Mean Concentration (µg/m^3)			
	2006	2007	2008	Mean 2006 to 2008
Rosemaud	0.31	0.30	0.22	0.28

Hydrogen Fluoride

In 2005 The Expert Panel on Air Quality Standards (EPAQS) published a draft report entitled 'Guidelines for halogen and hydrogen halides in ambient air for protecting human health against acute irritancy effects'. The report noted that only a small number of measurements of ambient concentrations of hydrogen fluoride have been made in the UK. All of these have been made in the vicinity of three industrial plants. Many samples were below the limit of detection. However, measurable values were in the range $5x10^{-5}$ to $3.5x10^{-3}$ mg/m^3 as approximate monthly averages.

4.5 Baseline Monitoring

During August 2007 SLR commenced a diffusion tube survey to quantify the current air quality in the area surrounding the proposed development. This was the first opportunity to deploy the diffusion tubes in line with the NO_2 Diffusion Tube Network schedule set by NETCEN[29]. Each tube was exposed for a period of either 4 or 5 weeks. The year is divided into 12 pollution 'months', each consisting of 4 or 5 whole weeks. Table 4-9 shows the relevant monitoring schedule dates for the SLR diffusion tube survey.

[29] UK National Air Quality Archive, NETCEN, www.airquality.co.uk.

Table 4-9
Monitoring Calendar for Year 2007/2008

NETCEN Period	Start Date	End Date	Duration (weeks)
9 (07)	29/08/2007	03/10/2007	5
10 (07)	03/10/2007	31/10/2007	4
11 (07)	31/10/2007	28/11/2007	4
12 (07)	28/11/2007	02/01/2008	5
1 (08)	02/01/2008	27/02/2008	4
2 (08)	27/02/2008	02/019/2008	5
3 (08)	02/019/2008	30/019/2008	4
4 (08)	30/019/2008	28/05/2008	4
5 (08)	28/05/2008	02/07/2008	4
6 (08)	02/07/2008	30/07/2008	5
7 (08)	30/07/2008	03/09/2008	5
8 (08)	03/09/2008	01/10/2008	5

The tubes were positioned to assess the air quality in two scenarios; roadside and background. At the roadside sites, diffusion tubes were placed between 1 and 5 metres from the road, and at background sites, diffusion tubes were placed at a distance of 50 metres or greater from any busy road. The pollutants which were monitored are hydrogen chloride (HCl), hydrogen fluoride (HF), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and VOCs as agreed with CCC.

Diffusion tubes were situated in the residential areas of Adamsdown, Splott and Tremofa to the east of Cardiff City centre and the Cardiff Bay area as shown in Drawing 19/4. Monitoring was also at SSSI location on the Gwent Levels and along the main transport routes likely to be impacted by traffic associated with the proposed development.

To allow for bias adjustment of the NO_2 diffusion tubes, tubes were co-located with a real-time monitor at Cardiff Centre, which is part of the AURN. The locations of the diffusion tubes are presented in Table 4-10 below and Drawing 19/4.

Table 4-10
Location of Diffusion Tubes for Baseline Assessment

Location					Distance from Site[b] (m)	Direction from Site	Pollutants Monitored
No.	Description	Type[a]	NGR Coordinates				
			X	Y			
1	Havannah Street	UB	318910	174275	1681	233º	NO_2, SO_2, HF, HCl, VOC
2	Pier Head Road	UB	319802	174665	769	216º	NO_2, SO_2, HF, HCl, VOC
3	Mervinian Street	UB	319083	175730	1247	291º	NO_2, SO_2, HF, HCl, VOC
4	System Street	UB	319535	176785	1657	334º	NO_2, SO_2, HF, HCl, VOC
5	Moorland Road	UB	320553	176257	1013	17º	NO_2, SO_2, HF, HCl, VOC
6	Handley	UB	321492	177165	2249	34º	NO_2, SO_2,

Location							
	Street[c]						HF, HCl, VOC
7	Rover Way	R	321862	176777	2193	47°	NO_2
8	Rover Way	R	320887	175560	692	67°	NO_2
9	Ocean Way	R	320555	175583	423	46°	NO_2
10	Ocean way	R	320390	175593	334	25°	NO_2
11	Titan Road	UB	319922	175875	671	331°	NO_2, SO_2, HF, HCl, VOC
12	Begnon Close	R	319605	175887	879	313°	NO_2
13	Newton Road	B	323365	178775	4674	42°	NO_2, SO_2, HF, HCl, VOC
14	Cardiff Centre	M	318400	176500	2211	303°	NO_2

(a) Monitoring Location type: M= Monitor, UB = Urban Background, B = Background, R = Roadside.
(b) Distance and direction from site relative to stack location of 320250,175290.
(c) No results obtained for this location as all tubes were missing despite moving monitoring location.

4.5.1 Baseline Monitoring Results

Urban Background Monitoring

The results of the 3-month diffusion tube monitoring at the background locations for NO_2, SO_2, HCl and HF are presented in Table 4-11 below:

Table 4-11
Urban Background Diffusion Tube Monitoring Results (3-month average µg/m^3)

Location	NO_2 (Bias Adjusted)	SO_2	HCl	HF
1	26.7	2.1	2.0	0.9
2	27.1	2.4	2.2	1.0
3	28.1	2.4	2.2	1.2
4	27.0	1.2	1.0	0.7
5	25.3	2.6	1.8	1.3
6	No data –tubes missing			
11	34.2	2.0	2.2	1.0
13	24.8	1.1	2.3	0.9

The results of the 3-month diffusion tube monitoring at the background locations for VOC's are presented in Table 4-12 below:

Table 4-12
Urban Background VOC Diffusion Tube Monitoring Results (3-month average µg/m^3)

Compound	Location							
	1	2	3	4	5	6	11	13
Benzene	0.13	0.11	0.09	0.15	0.25	No results - tubes missing.	0.20	0.12
Toluene	0.68	0.27	0.22	7.71	0.59		0.49	0.19
Ethylbenzene	0.06	0.05	0.06	0.13	0.06		0.05	0.03
p-Xylene	0.22	0.20	0.20	0.21	0.21		0.20	0.10
o-Xylene	0.07	0.07	0.06	0.15	0.07		0.07	0.26
Trichloromethane	<L.O.D	<L.O.D	<L.O.D	<L.O.D	<L.O.D		<L.O.D	<L.O.D
Vinyl Chloride	<L.O.D	<L.O.D	<L.O.D	<L.O.D	<L.O.D		<L.O.D	<L.O.D
Total VOCs	3.53	2.29	2.02	18.11	1.03		2.91	3.58

<L.O.D. – Less than limit of detection

Roadside Monitoring

The results of the 12-month diffusion tube monitoring at the roadside locations for NO_2, and NOx are presented in Table 4-13 below:

Table 4-13
Roadside Diffusion Tube Monitoring Results (12-month average µg/m^3)

ID	Month												Average NO_2 [(a)]
	1	2	3	4	5	6	7	8	9	10	11	12	
7	34.8	60.8	64.5	43.8	51.5	62.9	30.8	56.7	68.0	45.6	39.4	39.3	43.4
8	49.8	59.0	70.2	54.3	60.0	68.2	43.2	56.4	54.2	50.7	49.7	46.3	48.0
9	34.6	-	54.4	49.1	42.4	57.3	31.9	43.3	46.3	35.7	31.2	29.7	36.1
10	32.4	39.9	57.1	48.7	40.5	54.1	39.4	39.9	50.6	35.0	31.4	23.2	35.7
11	-	45.1	45.2	46.3	51.6	46.9	26.0	31.7	31.9	21.6	0.0	23.4	32.1
12	35.1	53.5	65.1	52.3	-	57.8	48.7	51.0	34.2	42.2	42.2	34.3	40.8
14	26.3	37.9	48.7	44.1	40.9	45.0	28.1	28.9	30.4	26.1	25.5	25.5	29.5

(a) The corrected NO_2 concentration has been calculated in accordance with LAQM TG(09). A period to annual mean factor of 0.93 was first applied; this was obtained from data for the real-time monitor for the survey duration (29.54µg/m^3) and 12-month period (29.48µg/m^3). A bias correction factor of 0.87 was then applied to the results based on the annual average results from the real-time monitor (29.5µg/m^3) and the co-located tubes (33.95µg/m^3).

4.6 Summary of Applied Background Concentrations

From the monitoring and predicted background concentrations detailed in the previous section, the background concentrations in Table 4-14 have been applied in this air quality assessment.

Table 4-14
Applied Background Concentrations

Pollutant	Background Concentration (µg/m^3)		Data Source
	Short Term	Long Term	
PM_{10}	40.0	20.0	Cardiff Centre AURN (2008)
$PM_{2.5}$	N/A	12.9	Cardiff Centre AURN (average 2007 & 2008)
NO_2	58.0	29.0	Cardiff Centre AURN (2008)
CO	2820	282	Cardiff Centre AURN (2008)
SO_2	4.8	2.4	Cardiff Centre AURN (2008)
HCl	4.6	2.3	SLR diffusion tube monitoring – max recorded
HF	2.6	N/A	
TOC (as Benzene)	1.28	0.64	Cardiff Centre AURN (2007)
Cadmium	0.41	0.21	Heavy Metal Monitoring Network – Cardiff 2008 (ng/m^3)
Mercury	3.84	1.92	
Arsenic	1.32	0.66	
Chromium	4.92	2.46	
Copper	55.4	27.7	
Lead	N/A	13.4	
Manganese	18.4	9.2	
Nickel	2.74	1.37	

Vanadium	2.44	1.22	
Ammonia	1.6	0.8	APIS database for site location

The conversion factor between short term (24-hr average) and long term (annual) PM_{10}, of 1.94, has been derived from the data from the continuous monitoring at Cardiff Centre from 2007. The conversion factor between short term and long term CO of 10 is based on typical observed ratios. For all other pollutants the hourly background has been calculated from the annual average using a factor of 2 as recommended in EPR H1.

4.7 Sensitive Receptors

The term 'sensitive receptors' includes any persons, locations or systems that may be susceptible to changes as a consequence of the proposed development.

4.7.1 Human Receptors

According to the LAQM TG(09), air quality standards should only apply to all locations where members of the public may be reasonably likely to be exposed to air pollution for the duration of the relevant objective. Thus short term standards such as the 1 hour standard for NO_2 should apply to footpaths at site boundaries and other areas which may be frequented by the public even for a short period of time. Longer term standards such as the 24 hour for PM_{10}, or annual means, should apply at houses other locations which the public can be expected to occupy on a continuous basis. These standards do not apply to exposure at the workplace.

The proposed development is in proximity to numerous residential areas (potentially long term sensitive receptors) located around the site. For the purposes of this assessment, a 100m resolution receptor grid has been applied to the city centre, with discrete receptors located at schools and hospitals within 5km. Identified discrete receptors are listed in Table 4-15 and shown in Drawing 19/2. An additional 6 discrete receptors have been located within the Newport Road AQMA to allow the significance of impacts to be clarified.

Whilst there are more than fifty-four sensitive receptors in the vicinity of the site, these discrete receptors are considered to be representative of sensitive locations around the site. Given that dispersion modelling has been completed using a 100m receptor grid, impact concentration for assessing impacts may effectively be determined at any location surrounding the site.

Table 4-15
Identified Sensitive Human Receptor Locations

Ref.	Receptor	Location (NGR)		Proximity to Trident Park EFW stack	
		X	Y	Distance (m)	Direction (°)
HR1	Willows High School	321116.0	176730.4	1681	031
HR2	Baden Powell County Primary School	320788.9	176837.1	1638	019
HR3	Splott Health centre	320656.7	176526.3	1301	018
HR4	Splott Rec South	320679.9	176623.7	1401	018
HR5	Splott Rec North	320621.9	176883.5	1636	013
HR6	Moorland Primary School #1	320473.4	176294.3	1029	013
HR7	College building	320314.5	176625.4	1337	003
HR8	Library	320017.6	176725.2	1454	351
HR9	Allottments	320358.6	178692.3	3404	002

		Location (NGR)		Proximity to Trident Park EFW stack	
HR10	Howardian Centre	320289.0	178569.3	3280	001
HR11	University of Wales Institute	320282.1	178279.4	2990	001
HR12	St Peters Rec	320182.3	177641.5	2352	358
HR13	Moorland park	320337.7	176219.5	934	005
HR14	National Assembly	319419.1	174558.6	1107	229
HR15	County Hall	319298.5	175168.7	959	263
HR16	St Cuthbert's RC Primary School	319034.1	175467.9	1229	278
HR17	Adamstown County Primary School	319569.9	176725.2	1588	335
HR18	College	319110.6	176669.5	1789	320
HR19	Cardiff Royal Infirmary #1	319247.5	176769.3	1787	326
HR20	Cardiff Royal Infirmary #2	319335.6	176845.8	1805	330
HR21	Cardiff Royal Infirmary #3	319423.8	176887.6	1799	333
HR22	St Peter's RC Primary School	319444.7	177098.7	1980	336
HR23	School building	318853.1	176834.2	2082	318
HR24	School building	318929.7	176973.4	2139	322
HR25	College building	318829.9	177249.4	2420	324
HR26	College building	319096.7	176978.0	2044	326
HR27	College building	318978.4	176776.2	1956	319
HR28	Moorland Primary School #2	320497.8	176365.6	1104	013
HR29	St Anne's Church in Wales Infant	319298.5	177437.3	2349	336
HR30	Marlborough Junior School	319539.8	177961.6	2764	345
HR31	College building	319196.5	178657.5	3528	343
HR32	Roath Park Recreation ground	319066.6	178355.9	3286	339
HR33	Roath Park Primary School	318887.9	178272.4	3279	335
HR34	School building	317999.5	178239.9	3710	323
HR35	School building	318997.0	177789.9	2796	333
HR36	University of Wales Cardiff	318136.4	177272.6	2898	313
HR37	Cathays Park	317994.9	177063.9	2869	308
HR38	Virgin Church in Wales Primary School	318614.2	175651.2	1675	282
HR39	Mountstuart Primary School	318855.5	174486.7	1609	240
HR40	Royal Hamadryad Hospital	318514.5	174354.5	1972	242
HR41	St Pauls Primary School	317739.7	174644.4	2592	256
HR42	St Patricks RC Primary School	317526.3	175242.9	2724	269
HR43	Ninian Park Primary School	317134.3	175152.5	3119	267
HR44	St Davids Hospital	317236.3	176576.7	3277	293
HR45	Castle Mews – College	317925.3	176929.3	2845	305
HR46	Nursery – plants	317621.4	177212.3	3256	306
HR47	Uni library	318006.5	177474.4	3131	314
HR48	Ysgol Mynydd Bychan School #1	317391.8	178413.9	4234	318
HR49	Ysgol Mynydd Bychan School #2	317582.0	178713.1	4340	322
HR50	Severn County Junior School	316802.6	176606.9	3690	291
HR51	St Marys Catholic Primary School	316860.6	176713.6	3676	293
HR52	Kitchener County Primary School	316756.2	176207.9	3612	285
HR53	Llandough Primary School	316888.4	173041.6	4044	236
HR54	Llandough Hospital N.H.S Trust	316621.6	172948.8	4318	237
HR55	Newport Rd AQMA 1	319589.9	177143.0	1967	340

		Location (NGR)		Proximity to Trident Park EFW stack	
HR56	Newport Rd AQMA 2	319712.1	177325.0	2105	345
HR57	Newport Rd AQMA 3	319815.4	177507.1	2259	349
HR58	Newport Rd AQMA 4	319956.7	177610.3	2339	353
HR59	Newport Rd AQMA 5	320114.3	177553.3	2267	357
HR60	Newport Rd AQMA 6	320375.2	177588.6	2302	003

Receptor Heights

Conventionally dispersion models are utilised to predict ground level impacts of pollutant for comparison with suitable assessment levels. However, given the nature of the surrounding city area in Cardiff it is evident that there are a number of elevated residential receptors. In order to account for this, additional receptor grids have been utilised at increment of 10m elevation across residential areas as shown in Drawing 19/5. This is based on satellite mapping data of building roof heights and is considered to account for existing developments and possible further developments of a similar size.

This was achieved by extracting the building footprints from the OS Master Map data and height data from a LIDAR database of Cardiff for both the DTM (Bold Earth Model, giving the interpolated ground level) and the DSM (First Point of contact, giving the tops of the buildings); by subtracting the DTM from the DSM a Building Height is obtained.

4.7.2 Ecological Receptors

Horizontal Guidance Note: EPR H1 states that receptors such as Sites of Special Scientific Interest (SSSI) or European sites (e.g. Special Area of Conservation) within 10km of an EPR processes should be considered when determining the impacts. A radius of 10km has been applied in this assessment. Table 4-16 lists the sites of ecological value within the zone of influence of the study area.

Table 4-16
Designated Sites within Zone of Influence of the Study Area

Geographical Frame of Reference	Site	Designation
International	Severn Estuary	SPA/Ramsar/SAC
	Peterstone Wentloog	SPA/Ramsar/SSSI
	Penarth Coast	
	Flatholme	
	Cardiff Beech Wood	SAC
	Garth Woods	
National	Ty Du Moor	SSSI
	Ely Valley	
	Glamorgan Canal / Long Wood	
	Castellcoch woodlands	
	Coed y Bedw	

	Fforest ganol a chwm nofydd	
	Lisvane reservoir & embankments	
	Cwm cydfin leckwith	
	Barry Woodlands	
	Cog Moors	
	Comeston Park	
	Lavernock Point	
	Sully Island	
	Hayes Pt 1	

It should be noted that impacts at geological SSSI's (such as Penylan Quarry, Rumney Quarry and Ryymney River Section SSSI's) have not been assessed due to the low sensitivity of these features to atmospheric pollution.

In accordance with AQTAG06, discrete receptors have been used to represent these sensitive sites. Table 4-17 lists the identified sites and features of ecological value within the study area and the location are shown in Drawings 19/3.

Table 4-17
Designated Sites within the Study Area

Ref.	Receptor	Receptor Location NGR		Dominant Habitat [(a)]
		X	Y	
ER1	Ty Du Moor	310751.1	179290.9	Alkaline fens and reedbeds
ER2	Ely Valley	311330.9	176516.3	Water
ER3	Glamorgan Canal/Long Wood	314033.1	180843.9	Beech Woodland
ER4	Castellcoch woodlands	312977	182686.8	Beech Woodland
ER5	Coed y Bedw	311185.9	182748.9	Beech Woodland
ER6	Garth Woods 1	311869.2	182614.3	Beech Woodland
ER7	Garth Woods 2	312597.6	182172.6	Beech Woodland
ER8	Cardiff Beech Woods 1	314250.3	183316.8	Beech Woodland
ER9	Cardiff Beech Woods 2	314398.7	183634.6	Beech Woodland
ER10	Cwm Nofydd & Fforest ganol	314557.6	183511.7	Ash/Beech Woodland
ER11	Fforest ganol a chwm nofydd 1	315013.2	183549.9	Ash/Beech Woodland
ER12	Fforest ganol a chwm nofydd 2	315119.1	182956.6	Ash/Beech Woodland
ER13	Lisvane reservoir	318933.6	182158.6	Water
ER14	Cwm cydfin leckwith	316427.3	173945	Oak/Ash Woodland
ER15	Penarth coast 1	319220.5	171876.5	Calcareous Grassland
ER16	Penarth coast 2	319009.1	171197	Calcareous Grassland
ER17	Penarth coast 3	318782.6	170366.6	Calcareous Grassland
ER18	Penarth coast 4	318707.1	169596.6	Calcareous Grassland
ER19	Penarth coast 5	318707.1	168856.7	Calcareous Grassland
ER20	Penarth coast 6	318797.7	168177.3	Calcareous Grassland

ER21	Flatholm	322074.1	164931.1	Calcareous Grassland
ER22	Barry Woodlands 1	312913.1	171437.4	Ash Woodland
ER23	Barry Woodlands 2	313122.8	171139.4	Ash Woodland
ER24	Barry Woodlands 3	312913.1	170797.2	Ash Woodland
ER25	Barry Woodlands 4	312692.4	170510.3	Ash Woodland
ER26	Cog Moors	315804.7	169439.7	Grazing Marsh
ER27	Comeston Park 1	317394	169803.9	Alkaline fens and reedbeds
ER28	Comeston Park 2	316952.5	169472.8	Alkaline fens and reedbeds
ER29	Comeston Park 3	317371.9	169252.1	Alkaline fens and reedbeds
ER30	Lavernock Point 1	318552.9	167971.8	Alkaline fens and reedbeds
ER31	Lavernock Point 2	317824.4	167618.7	Alkaline fens and reedbeds
ER32	Sully Island	316720.8	166967.5	Shingle, rocks and cliff
ER33	Hayes Pt 1	314347.9	167508.3	Shingle, rocks and cliff
ER34	Hayes Pt 2	313840.2	167144.1	Shingle, rocks and cliff
ER35	Hayes Pt 3	313089.7	166967.5	Shingle, rocks and cliff
ER36	Gwent Levels	Receptor grid applied		Grazing marsh
ER37	Severn SAC	Receptor grid applied		Salt Marsh
ER38	Severn SPA	Receptor grid applied		Littoral sediments and water

(a) The applied habitat types are based on the designations and the APIS habitat categories.

In accordance with AQTAG06, either discrete or array receptors have been used to represent these sensitive sites depending on their distance to the application site. Specifically, an array (50m interval grid) of receptors has been applied to the Severn Estuary SPA/SAC and the Gwent Levels SSSI in addition to the discrete receptors detailed above.

Existing Levels

To assess the impact from the installation at the identified ecological receptors, discrete receptors were located within each SSSI as recommended in AQTAG06[30]. The location of the discrete receptors was then used alongside the citation of the SSSI to obtain the existing critical level of NOx and SO_2 , critical loads (and current loads) of nitrogen and acid deposition from the UK Air Pollution Information System (www.apis.ac.uk) as summarised in Table 4-18 below:

[30] AQTAG06 – Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air. Environment Agency, working Draft version 9, 12/05/06.

Table 4-18
Existing Levels of Deposition (N and Acid) and NOx and SO_2 at Ecological Receptors

Ref	Habitat Type	Acid Deposition (keq/ha/yr)		Nitrogen Deposition (kgN/ha/year)		Nitrogen Oxide $\mu g/m^3$ (as NO_2)	Sulphur Dioxide ($\mu g/m^3$)
		Critical Load	Current Level	Critical Load	Current Level	Current Level	Current Level
ER1	Alkaline fens and reedbeds	0.75	1.65	rich fens 15-35	17.2	24.5	4.4
ER2	Water	n/a	n/a	n/a	n/a	n/a	n/a
ER3	Beech Woodland	1.67	2.82	10-15	34.3	33.7	2.4
ER4	Beech Woodland	11.12	2.82	10-15	34.3	32.4	2.4
ER5	Beech Woodland	11.14	2.82	10-15	34.3	23.7	2.4
ER6	Beech Woodland	11.14	2.82	10-15	34.3	23.7	2.4
ER7	Beech Woodland	11.12	2.82	10-15	34.3	32.4	2.4
ER8	Beech Woodland	11.13	2.82	10-15	34.3	23.4	2.4
ER9	Beech Woodland	11.13	2.82	10-15	34.3	23.4	2.4
ER10	Ash/Beech Woodland	11.13	2.82	10-15	34.3	23.4	2.4
ER11	Ash/Beech Woodland	1.14	2.96	10-15	33.7	25.9	5
ER12	Ash/Beech Woodland	2.7	2.96	10-15	33.7	30.6	5
ER13	Water	n/a	n/a	n/a	n/a	n/a	n/a
ER14	Oak/Ash Woodland	10.83	2.37	10-15	26.2	23.1	5.2
ER15	Calcareous Grassland	4	1.44	15-35	14	18.4	5.2
ER16	Calcareous Grassland	4	1.44	15-35	14	18.4	5.2
ER17	Calcareous Grassland	1.5	1.44	15-35	14	17	5.2
ER18	Calcareous Grassland	1.5	1.44	15-35	14	17	5.2
ER19	Calcareous Grassland	1.5	1.07	15-35	11.8	13.3	1.9
ER20	Calcareous Grassland	1.5	1.07	15-35	11.8	13.3	1.9
ER21	Calcareous Grassland	1.5	N/A	15-35	N/A	N/A	N/A
ER22	Ash Woodland	10.82	2.43	10-15	30.4	15.3	1.5
ER23	Ash Woodland	10.81	2.43	10-15	30.4	15.9	1.5
ER24	Ash Woodland	2.46	2.43	10-15	30.4	16.7	1.5

		Acid Deposition (keq/ha/yr)		Nitrogen Deposition (kgN/ha/year)		Nitrogen Oxide µg/m^3 (as NO_2)	Sulphur Dioxide (µg/m^3)
ER25	Ash Woodland	2.46	2.43	10-15	30.4	16.7	1.5
ER26	Grazing Marsh	1.5	1.07	20-30	11.8	23.6	1.9
ER27	Alkaline fens and reedbeds	1.5	1.07	Rich fens 15-35	11.8	15	1.9
ER28	Alkaline fens and reedbeds	4	1.07	Rich fens 15-35	11.8	16.3	1.9
ER29	Alkaline fens and reedbeds	1.5	1.07	Rich fens 15-35	11.8	1.9	1.9
ER30	Alkaline fens and reedbeds	1.5	1.07	Rich fens 15-35	11.8	13.3	1.9
ER31	Alkaline fens and reedbeds	1.5	1.07	rich fens 15-35	11.8	13.3	1.9
ER32	Shingle, rocks and cliff	4	1.07	10-15	11.8	13	1.9
ER33	Shingle, rocks and cliff	1.5	1.39	10-15	12.9	29.8	5.8
ER34	Shingle, rocks and cliff	1.5	1.39	10-15	12.9	20.5	5.8
ER35	Shingle, rocks and cliff	1.5	1.39	10-15	12.9	20.5	5.8
ER36	Grazing marsh	4	1.03 – 1.46	20-30	14.6-16.9	Up to 23.2	Up to4.3
ER37	Salt Marsh	4	1.03 – 1.46	20-30	11.6-16.9	Up to 30.6	Up to 4.3
ER38	Water	N/A	N/A	N/A	N/A	19.9	2.1

Note:

'N/A' means that the parameter is not applicable to the habitat type. Where a range is given, the lower has been applied for critical loads and the higher for current levels/loads. Where habitat designations are not detailed on the APIS resource, the most suitable APIS designation has been applied. Current levels of Acid and nitrogen deposition are based on 2003-2005 3-yr average. Current levels of Nitrogen Oxides and Sulphur dioxide are based on 1999-2001 levels.

4.8 Meteorological Conditions

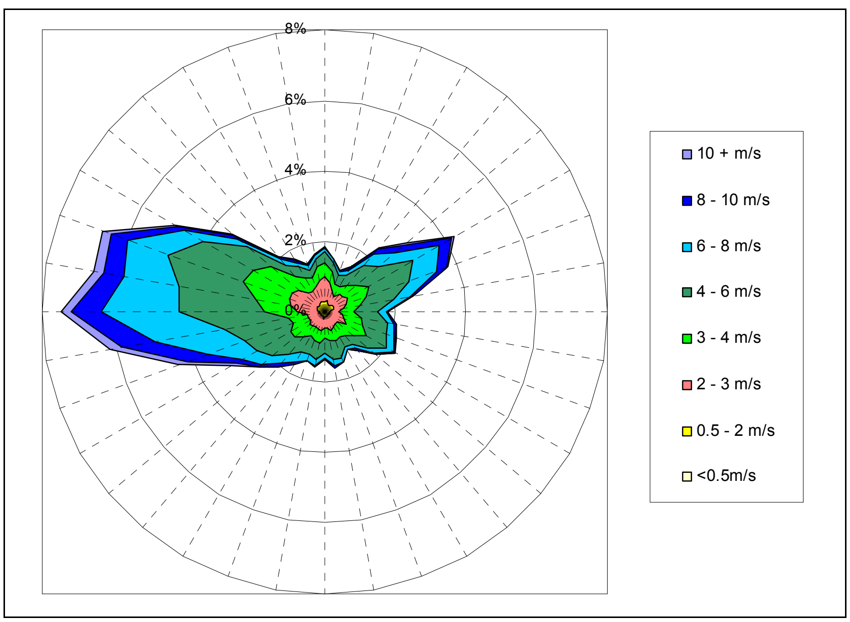
The most important meteorological parameters governing the atmospheric dispersion of pollutants are as follows:

- wind direction determines the broad transport of the emission and the sector of the compass into which the emission is dispersed;
- wind speed will affect ground level concentrations of emissions by increasing the initial dilution of pollutants in the emission; and
- Atmospheric stability: is a measure of the turbulence, particularly of the vertical motions present. Advanced dispersion models use Monin-Obukhov lengths - a more advanced method of determining stability[31] than Pasquilll.

Following consultation with the meteorological data provider, it was concluded that Cardiff International Airport, located at Rhoose approximately 15km to the southwest of the application site, with missing cloud cover data taken from Cardiff City Weather Station, would provide the most complete and representative data set for purposes of this assessment. A full data set for Cardiff City Weather Station is available but was not used due to significant bias exhibited in the wind direction due to surrounding buildings. Meteorological data used in this assessment was for the period 1st January 2003 to 31st December 2007 (inclusive).

A windrose for the Cardiff International Airport (Rhoose) meteorological data for the period 2003 to 2007 (inclusive), providing the frequency of wind speed and direction, is presented in Figure 4-1.

Figure 4-1
Windrose for Cardiff International Airport Observing Station (2003 – 2007)



31 Defined as: '*the height over the ground, where mechanically produced (by vertical shear) turbulence is in balance with the dissipative effect of negative buoyancy, thus where Richardson number equals to 1*.'

As is apparent from this windrose, the predominant wind direction is from the western quarter for all the years of data. Similarly, wind directions from the north occur relatively infrequently for all the years of data.

4.9 Topography

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

The topography of the surrounding area is relatively flat, especially to the south, northeast and southwest along the Severn Estuary at less than 10m AOD. Towards the north elevations increase to an elevation of 25m AOD at approximately 2km northwest of the site and continue to rise towards the north. These topographical features are considered unlikely to have a significant effect on the dispersion of emissions from the stack; however they have been included within the dispersion model.

5.0 QUANTIFICATION OF EMISSIONS TO ATMOSPHERE

5.1 Sources of Emission

The combustion of waste gives rise to emissions of a number of pollutants which are abated to low concentrations which are regulated under the WID. Emissions from the proposed Energy from Waste (EfW) process of the Trident Park EFW would be ducted through 2 separate, adjacent flues.

5.2 Concentration of Emissions

The pollutants emitted from the proposed EfW process of the Trident Park EFW and their emission limit values, as stated in the Waste Incineration Directive (WID), are shown in Table 2-3.

In order to predict a realistic 'worst case' scenario, the proposed Trident Park EFW has been assumed to be in operation continuously throughout the year, and to have pollutant emission rates at the daily average emission limits permitted by the WID. This ensures that the maximum possible impacts on air quality are predicted with the facility in operation within its authorisation limits.

In reality operational hours would typically be between 8000 and 8200 per year and emissions significantly below the WID emission limits as summarised in Table 2-4 and is discussed further in Section 7.1 of the sensitivity assessment.

5.2.1 Pollutant Specific Issues

Particulate Matter – Particle Size

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

Emissions of particulate matter from the proposed Trident Park EFW would range in particle size, with only a proportion being PM_{10} or smaller. There is limited monitoring data available as to the particle size distribution from any industrial facility; however published literature[32] does provide an indication that approximately 50% of particulate matter, from the combustion of MSW using similar technologies, is likely to comprise PM_{10} and approximately 30% as $PM_{2.5}$.

The proposed flue gas treatment would utilise a fabric filter (amongst other stages) which published data indicates has high collection efficiencies for a range of particle sizes. For example USEPA guidance for generation of particle size distributions[33] indicates a 99% collection efficiency for particle sixes <2.5 µm and 99.5% for particle sizes between 2.5 µm and 10 µm.

[32] AP42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Appendix B.1. (http://www.epa.gov/ttn/chief/ap42/index.html)

[33] AP42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, Appendix B.2. (http://www.epa.gov/ttn/chief/ap42/index.html)

For the purposes of this assessment, in order to provide a worst-case assessment of the potential impacts associated with $PM_{2.5}$, 100% of particulate matter has been assumed to be $PM_{2.5}$.

Total Organic Carbon

There are no relevant air quality assessment levels or background for Total Organic Carbon. Whilst it is unlikely that any benzene would be released from the process due to the high temperature of combustion a cautious approach has been adopted by assuming all the organic carbon would be in the form of benzene in line with guidance in EPR H1.

Metals

As shown in Table 2-3, the WID emission limits for metals are based on total emission rates for 3 different groups of compounds. The data presented in Table 2-4 indicates that the typical emission rate of each metal within Group 1 is less than 10% of the WID emission limit Therefore the emission rate for Group 1 Metals has been divided by 2 (i.e. each metal at 50% of the WID emission limit for the group). Similarly, the data presented in Table 2-4 indicates that the typical emission rate of each metal within Group 3 is less than 10% of the WID emission limit Therefore the emission rate for Group 3 Metals has been divided by 9 (i.e. each metal at 11.1% of the WID emission limit for the group). This is discussed further in Section 7.1.4 of the sensitivity assessment.

Chromium

In relation to chromium, it is important to note that different EALs apply depending on the oxidation state of chromium. The short-term EAL of 0.1µg/m^3 and long-term EAL of 3µg/m^3 relates specifically to chromium (VI) (i.e. hexavalent chromium), with the short-term EAL of 5µg/m^3 and long-term EAL of 150µg/m^3 applying to all other oxidation states of chromium. Data indicates that the actual fraction of chromium in the oxidation state VI is approximately 10% for combustion process burning solid fuels[34] and this factor has been applied to the predicted impacts.

Ammonia

The plant would be provided with deNOx system to convert oxides of nitrogen to nitrogen and water. As a result of this abatement of NO_2, there is the potential for residual ammonia to be released in small quantities from the stack. The manufacturers have indicated this would be limited to an annual average of 6mg/m^3.

5.3 Process Conditions

The following process conditions were used to determine the pollutant emission rates and during the dispersion modelling process:

Table 5-1
Emission Characteristics from Stack

Parameter / Source	Line 1	Line 2
Stack Diameter (m)	1.78	1.78
Stack Height (m)	90.0	90.0

[34] UK Particulate and Heavy Metal Emissions from Industrial Processes, Appendix B1. DEFRA 2002.

Volume Flow [(a)] (m^3/s) (273K, 11%, dry)	31.6	31.6
Emission Temperature [(a)] (ºC)	140	
Oxygen Content [(a)] (% O_2)	9.57 (in dry gas)	
Moisture content [(a)] (% H_2O)	16.42	
Actual Flow Rate (Am^3/s)	50.0	
Emission velocity (m/s)	20.1	
(a) Design flow rate provided by manufacturers.		

5.4 Applied Emission Rates

The applied emission rates are presented in Table 5-2 and have been calculated from the process conditions detailed in Table 5-1 above and the daily average WID emission limits as detailed in Table 2-3.

Table 5-2
Emission Rates from Trident Park EFW (per line)

Pollutant	Emission Rate (g/s)
PM_{10}	0.316
NOx	6.321
CO	1.580
SO_2	1.580
HCl	0.316
HF	0.032
TOC	0.316
Group 1 Metals (each metal)	0.001
Group 2 Metal	0.002
Group 3 Metals (each metal)	0.002
Dioxins	3.2E-09
Ammonia	0.190

5.5 Dispersion model Set-up

The Agency's H1 guidance provides a screening methodology for determining those pollutants that require detailed modelling. For the purposes of the EIA the H1 screening assessment has not been undertaken as all pollutants have been subjected to detailed dispersion modelling.

5.5.1 Modelling Scenarios

For the purposes of the dispersion modelling of emissions (i.e. process contribution) from the Trident Park EFW stacks; one scenario has been defined.

5.5.2 Stack Height Determination

To ensure the optimum dispersion of emission from the stack, a stack height determination was undertaken. This indicated that a stack height of 90m achieved sufficient dispersion and minimisation of building wake effects. Further increases in stack height do not achieve significant increases in dispersion and are therefore not considered to be justified.

5.5.3 Meteorological Data

Meteorological data used in this assessment comprised a 5-year sequential hourly average dataset from Cardiff International Airport, over the period 1st January 2003 to 31st December 2007 (inclusive). Five year met data was used to comply with current EA modelling guidance. This accounts for inter-year variability in meteorological conditions, with the average of the 5-year data set being used.

The meteorological data for Cardiff International Airport was obtained in .met format from the data supplier and converted to .the required surface and profile formats for use in AERMOD using AERMET Pro (v6.2). Details specific to the exact site location were used for the conversion, such as latitude, longitude and surface characteristics in accordance with the latest guidance[35]. Given the varying nature of the surface features in around the proposed development site, the surface characteristics were divided into two sectors and applied as shown in Table 5-3

Table 5-3
Met Data Preparation – Applied Surface Characteristics

Zone (Start)	Zone (end)	Landscape Character	Albedo	Bowen	Roughness
Trident Park, Cardiff					
67	196	Urban – industrial	0.195	0.98	0.5
196	67	Urban			1.0
Cardiff International Airport					
N/A	N/A	Cultivated land	0.20	0.80	0.5

From the dataset used, a total of 493 'calm hours', representing 1.1% of the total, were recorded over the 5-year period with 0 missing hours.

5.5.4 Urban/Rural Classification

For the purposes of this assessment the ‘urban’ classification has been used with a population of 320,000[36]. The ‘urban’ option utilises different calculations to estimate the night time boundary layer based on the urban heat island effects associated with larger cities. This results in a lowering of boundary layer from a ‘rural’ setting and therefore the potential for increased ground level impacts. The use of the urban option is therefore considered a conservative assumption given the proximity of Cardiff to the sea which will help to dissipate urban heat island effects.

5.5.5 Terrain Data

The model was run with OS 1:50,000 scale digital height contour data at 10m vertical intervals. Data was processed by the AERMAP function within AERMOD to calculate terrain heights, and interpolate data to calculate terrain heights for sources, buildings etc. The ground level elevations for buildings within the application site have been manually corrected to reflect site survey data.

[35] AERMOD Implementation guide. AERMOD implementation workgroup, USEPA. Last revised January 8, 2008.

[36] Cardiff census 2001 – population 317,500

5.5.6 Assessment Area

The potential air quality impact of the proposed plant was assessed over an area of 20km x 20km (SW corner NGR 310250, 165300) at a resolution of 250m. A more detailed 6km x 7km grid (SW corner NGR 316200, 173000) with a resolution of 100m was also located over Cardiff city. This was in order to give more precise pollutant concentration predictions in the immediate vicinity of the site. The resolution of the finer grid (100m) is approximately the same as the proposed Trident Park stack height (90m).

Discrete receptor points were identified at the locations indicated in Table 4-15 and Table 4-16.

5.5.7 Building Downwash

The integrated Building Profile Input Programme (BPIP) module within AERMOD was used to assess the potential impact of building downwash upon predicted dispersion characteristics. Building downwash occurs when turbulence, induced by nearby structures, causes pollutants emitted from an elevated source to be displaced and dispersed rapidly towards the ground, resulting in elevated ground level concentrations. Building downwash should always be considered for buildings that have a maximum height equivalent to at least 40% of the emission height, and which within a distance defined as five times the lesser of the height or maximum projected width of the building.

5.5.8 Nitric Oxide to NO_2 Conversion

Oxides of nitrogen (NO_x) emitted to atmosphere as a result of combustion will consist largely of nitric oxide (NO), a relatively innocuous substance. Once released into the atmosphere, NO is oxidised to NO_2. The proportion of NO converted to NO_2 depends on a number of factors including wind speed, distance from the source, solar radiation and the availability of oxidants, such as ozone (O_3).

The Environment Agency's guidance on conversion ratio for NOx and NO_2 (issued by AQMAU) and a screening worst case scenario has been applied in that 50% of NOx is presented as NO_2 in relation to short term impacts and 100% of NOx is present as NO_2 in relation to long term impacts.

5.5.9 Sulphur Dioxide – 15 minute averaging period

As dispersion models utilise hourly average meteorological data, calculation of 15-minute averages, such as required for SO_2, requires the application of conversion factors. For the purposes of detailed modelling of SO_2, a conversion factor of 1.34 is applied to hourly average data as detailed in Section 3.3 of EPR Guidance Note H1.

6.0 RESULTS – AIR QUALITY IMPACTS

6.1 Predicted Short-term Impacts

Predicted short-term impacts from the detailed modelling are presented as relevant isopleth plots of the modelled scenarios in Drawings 19/6 to 19/7. Isopleths have only been generated for pollutants where the predicted short-term process contributions are greater than 1% of the relevant air quality standard.

A summary of the peak predicted short-term process contributions (PC) from the proposed Trident Park EFW facility is presented in Table 6-1. These maximum predicted short-term impacts relate to the highest predicted level of impact at any location on the receptor grid and impacts at all other locations, and at all other times, will be lower.

Table 6-1
Predicted Short-term Process Contributions PC (µg/m^3)

Pollutant	Applied Standard	Av. Period	PC Max	PC Max as % of Standard
PM_{10}	50	24-hr -90.41 %ile	0.15	0.30%
NO_2	200	1-hr 99.79%ile	6.79	3.40%
CO	10000	8-hr average.	2.66	0.03%
SO_2 (24-hr)	125	24-hr, 99.18%ile	1.09	0.88%
SO_2 (1-hr)	267	1-hr, 99.73%ile	3.35	1.25%
SO_2 (15-min)	266	15-minute.	4.49	1.69%
HCl	750	1 hour max	1.12	0.15%
HF	160	1 hour max	0.11	0.05%
TOC	208	1 hour max	1.12	0.54%
Cadmium	1.5	1 hour max	0.003	0.19%
Thallium	30	1 hour max	0.003	0.01%
Mercury	7.5	1 hour max	0.006	0.07%
Antimony	150	1 hour max	0.006	<0.01%
Arsenic	15	1 hour max	0.006	0.04%
Chromium (III)	150	1 hour max	0.006	<0.01%
Chromium (IV)	3	1 hour max	0.001	<0.01%
Cobalt	6	1 hour max	0.006	0.10%
Copper	60	1 hour max	0.006	0.01%
Manganese	1500	1 hour max	0.006	<0.01%
Nickel	30	1 hour max	0.006	0.02%
Vanadium	20	1 hour max	0.006	0.03%
Ammonia	2500	1-hour max	2.96	0.12%

The predicted short-term PC is combined with the background concentration to identify the predicted environmental concentrations (PEC)., as presented in Table 6-2.

Table 6-2
Predicted Short-term Predicted Environmental Concentrations (PEC) (µg/m^3)

Pollutant	Applied Standard	Back-ground	PEC Max	Max PEC as % of Standard
PM10	50	40.00	40.15	80.3%

NO_2	200	58.00	64.79	32.4%
CO	10000	2820.00	2822.7	28.2%
SO_2 (24-hr)	125	4.80	5.89	4.72%
SO_2 (1-hr)	267	4.80	8.15	3.05%
SO_2 (15-min)	266	6.43	10.92	4.11%
HCl	750	4.60	5.72	0.76%
HF	160	2.60	2.71	1.70%
TOC	208	1.28	2.40	1.15%
Cadmium	1.5	4.20E-04	0.003	0.21%
Thallium	30		0.003	0.01%
Mercury	7.5	3.84E-03	0.009	0.13%
Antimony	150		0.006	0.00%
Arsenic	15	1.32E-03	0.008	0.05%
Chromium (III)	150	4.92E-03	0.011	0.01%
Chromium (VI)	3		0.001	0.02%
Cobalt	6		0.006	0.10%
Copper	60	5.54E-02	0.062	0.10%
Manganese	1500	1.84E-02	0.025	0.00%
Nickel	30	2.74E-03	0.009	0.03%
Vanadium	20	2.44E-03	0.009	0.04%
Ammonia	2500	1.60	4.56	0.18%

6.2 Predicted Long-term Impacts

Predicted long-term impacts from the detailed modelling are presented as relevant isopleth plots of the modelled scenarios in Drawings 7/8 to 7/11. Isopleths have only been generated for NO_2, TOC, Group 1 Metals (Cadmium and Thallium) and dioxins.

A summary of the peak predicted long-term process contributions (PC) from the Trident Park EFW presented in Table 6-3. These maximum predicted long-term impacts (annual average) relate to the highest predicted level of impact at any location on the receptor grid and impacts at all other locations will be lower.

Table 6-3
Predicted Long-term Process Contributions (µg/m^3)

Pollutant	Applied Standard (Annual Mean)	PC Max	PC Max as % of Standard
PM_{10}	40	0.05	0.13%
NO_2	40	1.09	2.73%
SO_2	50	0.26	0.52%
HCl	20	0.05	0.26%
TOC	5	0.05	1.02%
Cadmium	0.005	1.28E-04	2.56%
Thallium	1	1.28E-04	0.01%
Mercury	0.25	2.56E-04	0.10%
Antimony	5	2.84E-04	0.01%
Arsenic	0.003	2.84E-04	9.46%

Chromium (III)	5	2.56E-04	<0.01%
Chromium (VI)	0.0002	2.84E-05	14.20%
Cobalt	0.2	2.84E-04	0.14%
Copper	2	2.84E-04	0.01%
Lead	0.5	2.84E-04	0.06%
Manganese	1	2.84E-04	0.03%
Nickel	0.02	2.84E-04	1.42%
Vanadium	5	2.84E-04	0.01%
NH_3	180	0.13	0.07%
BaP	0.00025	6.92E-07	0.28%
$PM_{2.5}$	25	0.052	0.21%
Dioxins	N/A	5.11E-10	3.65%

The predicted peak long-term process contribution of $PM_{2.5}$ is less that 0.25% of the AQS target value of 25μg/m^3. As discussed in Section 2.1.2, the standards for assessing $PM_{2.5}$ are the subject of ongoing research and developing regulation. If the most stringent of these limits for $PM_{2.5}$ were applied (the WHO annual average AQG of 10μg/m^3); the peak long-term process contribution from the Trident Park EFW would only be 0.52% of this limit (assumes both lines are operating continuously at WID emission limits with 100% of particulate as $PM_{2.5}$). The WHO also sets guideline for 24-hr average $PM_{2.5}$ exposure, which are not part of UK regulation. If the most stringent of these were applied (the WHO 24-hr AQG of 25μg/m^3), the peak PC would only be 4.5% of this limit (assumes both lines operating at WID emission limits with 100% of particulate as $PM_{2.5}$).

The predicted peak long-term process contribution of Dioxins is 5.11e^{-10}μg/m^3.Further consideration is given to the potential effects associated with the predicted deposition of Dioxins (and metals) in the detailed Human Health Risk Assessment (presented in Appendix 13 of the ES).

The predicted long-term PCs from the Trident Park EFW are combined with the background concentration to identify the predicted environmental concentrations (PEC). and are presented in Table 6-4.

Table 6-4
Predicted Long-term Predicted Environmental Concentrations (μg/m^3)

Pollutant	Applied Standard	Back-ground	PEC Max	Max PEC as % of Standard
PM_{10}	40	20.0	20.05	50.1%
NO_2	40	29.0	30.09	75.2%
SO_2	50	2.4	2.66	5.3%
HCl	20	2.3	2.35	11.8%
TOC	5	0.64	0.69	13.8%
Cadmium	0.005	2.10E-04	3.38E-04	6.8%
Thallium	1		1.28E-04	<0.1%
Mercury	0.25	1.92E-03	0.002	0.9%
Antimony	5		0.000	<0.1%
Arsenic	0.2	6.60E-04	0.001	31.5%
Chromium (III)	5	2.46E-03	0.003	0.1%
Chromium (VI)	0.1		0.000	14.2%
Cobalt	0.2		0.000	0.1%
Copper	2	2.77E-02	0.028	1.4%

Lead	0.5	1.34E-02	0.014	2.7%
Manganese	1	9.20E-03	0.009	0.9%
Nickel	1	1.37E-03	0.002	8.3%
Vanadium	5	1.22E-03	0.002	<0.1%
NH_3	180	0.8	0.93	0.5%
PM2.5	25	12.9	12.95	51.8%

6.2.1 Impacts at Elevated Residential Receptors

As discussed previous in 4.7.1, it is acknowledged that numerous elevated residential receptors are located within the vicinity of the proposed development. This has been investigated through the use of elevated receptor grids derived from on satellite mapping data of the city centre.

The significance of elevated receptors has been investigated in the dispersion model through examining the short-term and long-term impacts of Nitrogen Dioxide at 10m intervals (above ground level) as shown in Drawing 19/5. The results (for 2004 meteorological data only) are summarised in Table 6-5 and indicate that impacts at these elevated (flag-pole) receptors are less than the predicted maximum discussed previously due to the lateral separation between the source and receptor.

Table 6-5
Predicted Impacts at Elevated Receptor Locations (µg/m^3)

Receptor Flagpole Height [above ground level]	Maximum Short-tem Impact [99.79%ile of 1-hour]	Maximum Long term Impact [Annual average]
Ground Level	12.70	1.22
10m	12.70	1.22
20m	12.70	1.22
30m	12.53	1.17
40m	11.97	1.17
50m	11.93	1.17
60m	11.93	1.17
70m	11.93	1.17
80m	11.93	1.17

6.2.2 Deposition to Land

The predicted deposition rate of metals an dioxins to land have been calculated and have been used as input to the Human Health Risk Assessment as presented in Appendix 13 of the ES..

6.3 Results –Sensitive Ecosystems

6.3.1 Critical Levels

Nitrogen Oxides

Table 6-6
Predicted Nitrogen Oxide Impacts on Sensitive Ecosystems (µg/m^3)

Ref	Critical Level	Process Contribution	PC as % of Critical Level

ER1	30	0.05	0.2%
ER2	30	0.05	0.2%
ER3	30	0.05	0.2%
ER4	30	0.03	0.1%
ER5	30	0.03	0.1%
ER6	30	0.03	0.1%
ER7	30	0.04	0.1%
ER8	30	0.03	0.1%
ER9	30	0.03	0.1%
ER10	30	0.03	0.1%
ER11	30	0.03	0.1%
ER12	30	0.03	0.1%
ER13	30	0.06	0.2%
ER14	30	0.20	0.7%
ER15	30	0.13	0.4%
ER16	30	0.12	0.4%
ER17	30	0.10	0.3%
ER18	30	0.09	0.3%
ER19	30	0.08	0.3%
ER20	30	0.08	0.3%
ER21	30	0.06	0.2%
ER22	30	0.09	0.3%
ER23	30	0.09	0.3%
ER24	30	0.09	0.3%
ER25	30	0.08	0.3%
ER26	30	0.08	0.3%
ER27	30	0.08	0.3%
ER28	30	0.07	0.2%
ER29	30	0.07	0.2%
ER30	30	0.07	0.2%
ER31	30	0.06	0.2%
ER32	30	0.05	0.2%
ER33	30	0.06	0.2%
ER34	30	0.06	0.2%
ER35	30	0.05	0.2%
ER36 (Gwent Levels Max)	30	0.15	0.5%
ER63 (RAMSAR site max)	30	0.78	2.6%
SPA Grid Max	30	1.02	3.4%

Predicted impacts (PC) from the Trident Park EfW are less than 1% of the applied critical level except for receptors located in the Severn Estuary RAMASR site where predicted impacts are up to 3.4% of the critical level. The area where predicted impacts exceed 1% of the critical level is limited to a small area.

In reality impacts would be significantly lower due to the abatement of NOx from the EFW stack; monitoring data indicate emissions are typically less than 160mg/m^3, or 80% of the WID emission limits as shown in Table 2-4. Furthermore this worst case assessment assumes that both the Trident Park EfW lines are operating continuously, with no allowance for plant shut down.

Therefore it is considered that the maximum impacts from the Trident Park EfW facility would be less than 75% of those predicted i.e. less than 0.75μg/m^3. These impacts should be considered alongside the declining trend of background concentration of nitrogen oxides in the UK as a whole. Predictions for the site location for the period 2008-2012 (i.e. assessment year to construction year), indicate that concentrations of nitrogen oxides are predicted to decrease by over 2.5μg/m^3. Therefore the impacts of the Trident Park EfW are considered to be insignificant and no further assessment is required.

Sulphur dioxide

Table 6-7
Predicted Sulphur Dioxide Impacts on Sensitive Ecosystems (μg/m^3)

Ref	Critical Level	Process Contribution	PC as % of Critical Level
ER1	20	0.01	0.1%
ER2	20	0.01	0.1%
ER3	20	0.01	0.1%
ER4	20	0.01	0.0%
ER5	20	0.01	0.0%
ER6	20	0.01	0.0%
ER7	20	0.01	0.0%
ER8	20	0.01	0.0%
ER9	20	0.01	0.0%
ER10	20	0.01	0.0%
ER11	20	0.01	0.0%
ER12	20	0.01	0.0%
ER13	20	0.01	0.1%
ER14	20	0.05	0.2%
ER15	20	0.03	0.2%
ER16	20	0.03	0.1%
ER17	20	0.02	0.1%
ER18	20	0.02	0.1%
ER19	20	0.02	0.1%
ER20	20	0.02	0.1%
ER21	20	0.01	0.1%
ER22	20	0.02	0.1%
ER23	20	0.02	0.1%
ER24	20	0.02	0.1%
ER25	20	0.02	0.1%
ER26	20	0.02	0.1%
ER27	20	0.02	0.1%
ER28	20	0.02	0.1%
ER29	20	0.02	0.1%
ER30	20	0.02	0.1%
ER31	20	0.02	0.1%
ER32	20	0.01	0.1%
ER33	20	0.01	0.1%
ER34	20	0.01	0.1%
ER35	20	0.01	0.1%

ER36 (Gwent Levels Max)	20	0.04	0.2%
ER63 (RAMSAR site max)	20	0.20	1.0%
SPA Grid Max	20	0.25	1.3%

Predicted impacts (PC) from the Trident Park EFW are less than 1% of the applied critical level at all location except for peak impacts on the Severn Estuary Ramsar, SAC and SPA

In reality impacts would be significantly lower due to the abatement of SO_2 from the EFW stack; monitoring data indicate emissions are typically less than 15mg/m^3, or 30% of the WID emission limits as shown in Table 2-4. Furthermore this worst case assessment assumes that both the Trident Park EFW lines are operating continuously, with no allowance for plant shut down.

Therefore it is considered that actual impacts would be less than 1% of the critical level, and no further assessment is required.

6.3.2 Ammonia

The peak annual impact of ammonia at a sensitive ecological receptor location is 0.024µg/m^3; less than 1% of the critical level of 3µg/m^3 for ammonia. Therefore it is considered that impacts would be insignificant, and no further assessment is required.

6.3.3 Acid Deposition

A summary of the predicted impacts are presented in the following table

Table 6-8
Predicted Acid Deposition on Sensitive Ecosystems (kg$_{eq}$/hr/yr)

Ref	Critical Load	Process Contribution	PC as % of Critical Load
ER1	0.75	0.002	0.3%
ER2	N/A	0.003	N/A
ER3	1.67	0.005	0.3%
ER4	11.12	0.003	0.0%
ER5	11.14	0.002	0.0%
ER6	11.14	0.003	0.0%
ER7	11.12	0.004	0.0%
ER8	11.13	0.003	0.0%
ER9	11.13	0.003	0.0%
ER10	11.13	0.003	0.0%
ER11	1.14	0.003	0.3%
ER12	2.7	0.003	0.1%
ER13	n/a	0.003	N/A
ER14	10.83	0.010	0.1%
ER15	4	0.007	0.2%
ER16	4	0.006	0.1%
ER17	1.5	0.005	0.3%
ER18	1.5	0.004	0.3%
ER19	1.5	0.004	0.3%
ER20	1.5	0.004	0.3%
ER21	1.5	0.003	0.2%

ER22	10.82	0.010	0.1%
ER23	10.81	0.010	0.1%
ER24	2.46	0.009	0.4%
ER25	2.46	0.008	0.3%
ER26	1.5	0.004	0.3%
ER27	1.5	0.004	0.3%
ER28	4	0.004	0.1%
ER29	1.5	0.004	0.2%
ER30	1.5	0.004	0.2%
ER31	1.5	0.003	0.2%
ER32	4	0.003	0.1%
ER33	1.5	0.003	0.2%
ER34	1.5	0.003	0.2%
ER35	1.5	0.003	0.2%
ER36 (Gwent Levels Max)	4	0.007	0.2%
ER63 (RAMSAR site max)	4	0.040	1.0%
SPA Grid Max	4	0.051	1.3%

Predicted impacts (PC) from the Trident Park EFW are less than 1% of the applied critical load except for peak impacts on the SPA grid where predicted impacts are up to 1.3% of the critical level.

These predictions are based on the WID emission limits for acid gases, with both lines operating continuously. Based on typical emission rates (as summarised in Table 2-4) the actual emission rates would be significantly lower due to the abatement of acid gases (NOx, SO_2 and HCl) prior to release from the EFW stack. Emission of NOx and SO_2 are likely to be 80% and 30% of the WID Limits respectively, and emissions of HCl are typically less than 6mg/m^3, or 60% of the WID emission limits. In addition, the lines would actually operate for less than 95% of the year (maximum of 8250 hours).

Therefore actual impacts based on these typical emission rates and operating hours would be significantly lower than predicted by the model, and would be less than 1% of the critical load, and no further assessment is required.

6.3.4 Eutrophication (Nitrogen Deposition)

A summary of the predicted impacts are presented in the following table with deposition rates for nitrogen as NOx and as NH_3 presented separately.

Table 6-9
Predicted Nitrogen Deposition on Sensitive Ecosystems (kg/hr/yr)

Ref	Critical Load (CL)	NOx-N deposition		NH_3 N deposition		Combined NOx and NH3-N Deposition	
		PC	PC as % of CL	PC	PC as % of CL	PC	PC as % of CL
ER1	10.00	0.007	0.07%	0.007	0.07%	0.014	0.1%
ER2	10.00	0.008	0.08%	0.008	0.08%	0.016	0.2%
ER3	10.00	0.014	0.14%	0.011	0.11%	0.025	0.2%
ER4	10.00	0.009	0.09%	0.007	0.07%	0.016	0.2%
ER5	10.00	0.005	0.05%	0.005	0.05%	0.010	0.1%
ER6	10.00	0.009	0.09%	0.007	0.07%	0.017	0.2%

ER7	10.00	0.010	0.10%	0.008	0.08%	0.019	0.2%
ER8	10.00	0.009	0.09%	0.007	0.07%	0.015	0.2%
ER9	10.00	0.008	0.08%	0.007	0.07%	0.015	0.1%
ER10	n/a	0.009	N/A	0.007	N/A	0.015	N/A
ER11	10.00	0.009	0.09%	0.007	0.07%	0.015	0.2%
ER12	15.00	0.009	0.06%	0.008	0.05%	0.017	0.1%
ER13	15.00	0.008	0.05%	0.009	0.06%	0.017	0.1%
ER14	15.00	0.029	0.19%	0.031	0.21%	0.060	0.4%
ER15	15.00	0.019	0.13%	0.021	0.14%	0.040	0.3%
ER16	15.00	0.017	0.11%	0.018	0.12%	0.035	0.2%
ER17	15.00	0.014	0.09%	0.015	0.10%	0.030	0.2%
ER18	N/A	0.013	N/A	0.014	N/A	0.026	N/A
ER19	10.00	0.012	0.12%	0.013	0.13%	0.024	0.2%
ER20	10.00	0.011	0.11%	0.012	0.12%	0.023	0.2%
ER21	10.00	0.008	0.08%	0.009	0.09%	0.017	0.2%
ER22	10.00	0.027	0.27%	0.022	0.22%	0.048	0.5%
ER23	10.00	0.026	0.26%	0.021	0.21%	0.047	0.5%
ER24	10.00	0.025	0.25%	0.020	0.20%	0.044	0.4%
ER25	10.00	0.023	0.23%	0.019	0.19%	0.042	0.4%
ER26	15.00	0.012	0.08%	0.013	0.09%	0.025	0.2%
ER27	15.00	0.011	0.07%	0.012	0.08%	0.023	0.2%
ER28	15.00	0.011	0.07%	0.012	0.08%	0.022	0.1%
ER29	10.00	0.010	0.10%	0.011	0.11%	0.022	0.2%
ER30	10.00	0.010	0.10%	0.011	0.11%	0.022	0.2%
ER31	10.00	0.009	0.09%	0.010	0.10%	0.019	0.2%
ER32	10.00	0.008	0.08%	0.008	0.08%	0.016	0.2%
ER33	20.00	0.008	0.04%	0.009	0.05%	0.018	0.1%
ER34	20.00	0.008	0.04%	0.009	0.04%	0.017	0.1%
ER35	20.00	0.008	0.04%	0.009	0.04%	0.016	0.1%
ER36	20.00	0.021	0.10%	0.023	0.11%	0.044	0.2%
ER63	30.00	0.113	0.38%	0.122	0.41%	0.235	0.8%
SPA Grid	30.00	0.146	0.49%	0.158	0.53%	0.304	1.0%

Predicted impacts (PC) from the Trident Park EFW are less than 1% of the applied critical load except for all receptors except for peak impacts on the SPA site grids where impacts of up to 1.01% of the critical load are predicted.

In reality these impacts will be lower as these predictions are based on the WID emission limits (for NOx) and 6mg/m^3 for NH_3 with both lines operating continuously (actual operating hours will be nearer 95% of the year). Actual emission rates of NO_x would be significantly lower due to abatement; data indicates that emissions are typically less than 160mg/m^3, or 80% of the WID emission limits.

It is also important to note that the critical load for Nitrogen deposition at the SPA is given as a range from 30-40 Kg/ha/yr. Therefore whilst predicted impacts will be marginally in excess of 1% of the minimum of the critical load range, they will be less than 1% of the maximum of this range.

Therefore actual impacts of nitrogen deposition (as NO_x and NH_3) are considered to be insignificant (i.e. less than 1% of the critical load) at all locations and no further assessment is required.

7.0 DISPERSION MODEL SENSITIVITY

The sensitivity of a dispersion model is defined in the ADMLC guidance[37] as the differential of model output by model input. This guidance identifies the following key input variables for the dispersion model:

- Emission characteristics (including rate, height and velocity);
- Meteorology, both annual and spatial variability;
- Atmospheric chemistry;
- Terrain;
- Building effects;
- Coastal effects; and
- Receptor spacing.

Given the location of the development (<2km from the coast), coastal effects are considered have been investigated using the Costal module of ADMS, this has also allowed assessment of a different dispersion model to be undertaken. Furthermore atmospheric chemistry is not considered significant given the pollutants emitted and the assumptions made relating to the $NO:NO_2$ ratio. The remainder of these potential sensitivities has been investigated as detailed in the following sections.

The possible variation in emission rates from the process has been discussed (in Section 7.1) separately to the sensitivity of the dispersion model itself in Section 7.2.

7.1 Variation in Emission Rates

The emission rates applied in this assessment are the applicable daily average WID emission limits; the variability of emissions from MSW EfW processes, typical operating hours, half-hourly WID emission limits and the variability of partition of metals is discussed in the following sections.

7.1.1 Typical MSW EfW Emissions

The emissions to air from EfW plants are designed to ensure compliance with the requirement of the WID and achieve significantly lower emissions as summarised in Table 2-4.

Therefore on this basis, it can be concluded that actual impacts are likely to lower than modelled for this assessment.

7.1.2 Annual Operating Hours

A typical EfW line requires a minimum of 3-weeks shutdown for maintenance per year, therefore operational hours would never be in excess of 8256 hours and EfW's in the UK typically achieve between 8000 and 8200 operational hours per annum.

Therefore on this basis, it can be concluded that actual long-term (annual) emissions, (and resultant impacts) are likely to between 5.7% and 8.6% lower than modelled for this assessment.

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

7.1.3 Half Hourly WID emission Limits

In addition to the daily average emission limits assessed in the main text of this report, the WID also stipulates half-hourly emission limit values (97th percentile) as presented in Table 2-3. In theory this means that emissions can be at these elevated values for 3% of the time as long as compliance with the daily average values is still achieved.

To ensure a robust assessment is carried out, the significance of the half-hourly emission limits have been investigated for NO_2, SO_2, TOC, HCl and HF. This has not been investigated for PM_{10} or CO as the short term air quality standard for PM_{10} and CO are based on a 24-hr and 8-hr periods, and would not be affected by the half-hourly WID limit.

The results are presented below, it should be remembered that these are peak impact which assume that the half-hourly limits are met for a whole hour and that this coincides with the worst possible weather conditions for dispersion. Even under this unlikely scenario, impacts are well below 10% of the applicable standard.

Table 7-1
Predicted Worst-case Short-term Impacts (PC) (µg/m^3)

Pollutant	Av. Period	Applied Standard	PC	Max PC as % of Standard
NO_2	1-hr 99.79%ile	200	13.58	6.79%
SO_2 (1-hr)	1-hr, 99.73%ile	267	13.40	5.02%
SO_2 (15-min)	15-min.	266	17.96	6.75%
HCl	1 hour max	750	6.71	0.90%
HF	1 hour max	160	0.23	0.14%
TOC	1 hour max	208	2.24	1.08%

7.1.4 Variation in Metal Partitioning

As discussed previously in Section 5.2.1, the metals in Groups 1 & 3 have been split on the basis of monitoring data, as is the standard practice in the UK. On the basis of monitoring data in the UK, a realistic 'worst-case' scenario with regard to metal emissions would be that:

- a single metal in Group 1, that with the lowest EAL, is emitted at approximately 90% the WID emission limit for it's group; and
- a single metal in Group 3, that with the lowest EAL, is emitted at approximately 50% the WID emission limit for it's group.

This scenario has been investigated in relation to Cadmium in Group 1 and for Chromium VI (assuming Cr VI represents 10% of total Cr emissions) in Group 3, which have the respective lowest short-term and long-term EALs. The results are summarised below, which indicate that even under this unlikely scenario, impacts are still well below the applicable standards.

Table 7-2
Predicted Worst-case Metal Impacts (PC) (µg/m^3)

Pollutant	Av. Period	Applied Standard	PC	Max PC as % of Standard
Short-term				
Cadmium	1 hour max	1.5	0.005	0.34%

Chromium VI	1 hour max	3	0.003	0.09%
Colbalt	1 hour max	6	0.028	0.47%
Long-term				
Cadmium	annual	0.005	2.30E-04	4.6%
Arsenic	Annual	0.003	1.28E-03	42.6%
Chromium VI	annual	0.0002	1.28E-04	63.9%

7.2 Assessment of Model Sensitivities

In order to investigate the sensitivity of the dispersion model to variation in the critical input parameters detailed previously, the following scenarios were investigated:

- Sensitivity 1 – Model type – ADMS4.1;
- Sensitivity 2 – Coastal effects (within ADMS4.1);
- Sensitivity 3 -Increased exit temperate (to 425K) and velocity (to 15.95m/s);
- Sensitivity 4 - Decreased exit temperature (to 400K) and velocity (to 15.01m/s);
- Sensitivity 5 – Meteorological data – surface roughness for 2004 data changed to cultivated land;
- Sensitivity 6 – Meteorological data - data from Lulsgate (Bristol Airport);
- Sensitivity 7 – Terrain – all elevations to 6m (flat);
- Sensitivity 8 – Buildings – all site buildings removed;
- Sensitivity 9 – Stack height - increased by 2m;
- Sensitivity 10 – Stack height – decreased by 2m;
- Sensitivity 11 – Receptor sensitivity - spacing decreased to 50m;
- Sensitivity 12 – Urban / rural – model set to 'rural' mode.

These model sensitivity assessments were assessed using meteorological data from 2004, results are summarised in Table 7-3. Scenario 0 represents the model presented in the main assessment.

Table 7-3
Results of Model Sensitivity Assessment

Scenario	Peak ST NO_2	Change from Sc0 ($\mu g/m^3$)	Change as % of Standard	Peak LT NO_2	Change from Sc0 ($\mu g/m^3$)	Change as % of Standard
0	6.99	0.0	0.0%	1.22	-	0.0%
1	12.77	+5.8	+2.9%	2.96	+1.4	+3.6%
2	10.81	+3.8	+1.9%	1.54	+0.3	+0.7%
3	6.72	-0.3	-0.1%	1.19	-0.0	-0.1%
4	7.32	+0.3	+0.2%	1.26	+0.0	+0.1%
5	7.65	+0.7	+0.3%	0.97	-0.2	-0.5%
6	6.89	-0.1	-0.1%	1.07	-0.1	-0.3%
7	7.00	0.0	0.0%	1.25	+0.0	+0.1%
8	6.99	0.0	0.0%	1.22	0.0	0.0%
9	6.77	-0.2	-0.1%	1.17	-0.0	-0.1%
10	7.23	+0.2	+0.1%	1.28	+0.0	+0.1%
11	7.22	+0.2	+0.1%	1.23	0.0	0.0%
12	6.99	0.0	0.0%	1.50	+0.2	+0.6%

In terms of the sensitivity of predicted short-term impacts to model inputs, the sensitivity is low with typically less than 1$\mu g/m^3$ variation in peak short term impacts with the exception of

Scenarios 1 & 2 i.e. those using a different modelling system (namely ADMS4.1). These differences, and the higher predictions from ADMS in predicted peak impacts between different modelling systems are typical as detailed in Environment Agency research[38]. Furthermore, as shown in Table 6-1 the predicted short-term impacts are well below the relevant assessment levels and therefore the findings of this assessment are not considered to be affected by this level of uncertainty.

The sensitivity of predicted long-term impacts to model inputs follows a similar pattern with typically less than 1μg/m^3 variation in peak annual average impacts, except for Scenario 1. As shown in Table 6-3 the predicted long-term impacts are well below the relevant EALs and therefore the findings of this assessment are not affected by this level of uncertainty.

[38] An Inter-comparison of the AERMOD, ADMS and ISC Dispersion Models for Regulatory Applications. Environment Agency R&D Technical Report P362, October 200.

UNITS AND ABBREVIATIONS USED

SI MASS UNIT MULTIPLES

Multiple (of grams)	Name	Symbol
1×10^{6}	Megagram (tonne	Mg
1×10^{3}	Kilogram	Kg
1 x 10	Gram	G
1×10^{-3}	Milligram	mg
1×10^{-6}	Microgram	µg
1×10^{-9}	Nanogram	ng

AQAP Air Quality Action Plan
AQMA Air Quality Management Area
CO carbon monoxide
DEFRA Department for Environment, Food and Rural Affairs
DR discrete receptor
EA Environment Agency
EAL Environmental Assessment Level
EPAQS Expert Panel on Air Quality Standards
HCl hydrogen chloride
HF hydrogen fluoride
LAQM Local Air Quality Management
µg.m-3 microgram per cubic metre of air
µm micrometre
MSW municipal solid waste
NAEI National Atmospheric Emissions Inventory
N Nitrogen
NO2 nitrogen dioxide
NO nitric oxide
NOX total oxides of nitrogen
OEL Occupational Exposure Limit
PAH polycyclic aromatic hydrocarbon
Pb lead
PM10 particulate matter with mean hydraulic diameter of 10 micrometres
S Sulphur
SO2 sulphur dioxide