Appendix 13.1

Air Quality Assessment Report

FICHTNER

MERCIA WASTE MANAGEMENT
ENVIRECOVER FACILITY
AIR QUALITY ASSESSMENT

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1 INTRODUCTION

1.1 Background

Mercia Waste Management are currently proposing to construct a single stream Energy from Waste (EfW) Plant at their site on the Hartlebury Trading Estate, south of Kidderminster. The plant is known as the Mercia EnviRecover facility. As part of the planning application for the plant, it is necessary to assess the impact of the atmospheric emissions of the plant on the air quality in the surrounding area.

The only significant source of atmospheric emissions from the plant will be the main chimney, containing one flue. These emissions will be regulated by the Environment Agency under the terms of an Environmental Permit and will comply with the requirements of the Waste Incineration Directive.

Traffic associated with the plant will also release pollutants into the atmosphere.

1.2 Methodology

The assessment contains the following sections:

- A statement of the current air quality standards, objectives and guidelines which apply to the pollutants which will be released from the plant.
- An assessment of the current air quality in the vicinity of the site, using results from national networks and monitoring stations operated by the local council.
- A description of the methodology used in the air dispersion modelling, including assumptions and data used.
- A description of the results of the air dispersion modelling, including dispersion diagrams.
- An assessment of plume visibility.
- An assessment of the health impacts of the atmospheric emissions.
- Discussion of other influences on the emissions.
- Conclusions.

2 AIR QUALITY STANDARDS, OBJECTIVES AND GUIDELINES

In the UK, air quality standards and objectives for major pollutants are described in The Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 (known as the National Air Quality Strategy or NAQS).[1] This document builds on the previous NAQS, published in 2000, and a 2003 Addendum to the NAQS.

The NAQS defines "standards" and "objectives", as defined in paragraph 17 of the NAQS:

"For the purposes of the strategy

- *standards are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive subgroups or on ecosystems*
- *objectives are policy targets often expressed as a maximum ambient concentration not to be exceeded, either without exception or with a permitted number of exceedences, within a specified timescale."*

The status of the objectives is clarified in paragraph 22 of the NAQS, which also emphasises the importance of European Directives.

The air quality objectives in the Air Quality Strategy are a statement of policy intentions or policy targets. As such, there is no legal requirement to meet these objectives except in as far as these mirror any equivalent legally binding limit values in EU legislation. Where UK standards or objectives are the sole consideration, there is no legal obligation upon regulators, to set Emission Limit Values (ELVs) any more stringent than the emission levels associated with the use of Best Available Techniques (BAT) in issuing permits under the PPC Regulations. This aspect is dealt with fully in the PPC Practical Guides.

The EU has recently adopted a new Air Quality Directive 2008/50/EC[2], which unifies most of the previous directives on air quality with the exception of the Fourth Daughter Directive and also introduces a new regulatory framework for PM2.5s.

The Environment Agency includes Environmental Assessment Levels (EALs) for other pollutants in Appendix B to Part 2 of Technical Guidance Note EPR-H1[3]. The long term and short term EALs from this document have been used when the NAQS does not contain relevant objectives.

Both AQOs and EALs are set at levels well below those at which significant adverse health effects have been observed in the general population and in particularly sensitive groups.

Standards and objectives for the protection of sensitive ecosystems are discussed in section 4.5.

[1] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, CM 7169 NIA 61/06-07, July 2007, DEFRA – para 17 of Volume 1.

[2] Directive 2008/50/EC on ambient air quality and cleaner air for Europe.

[3] Horizontal Guidance Note EPR- H1 *Environmental Risk Assessment*, Environment Agency, March 2008

2.1 Nitrogen dioxide

All combustion processes produce nitric oxide (NO) and nitrogen dioxide (NO_2), known by the general term of NO_x. In general, the majority of the NO_x released is in the form of NO, which then reacts with ozone in the atmosphere to form NO_2. Of the two compounds, nitrogen dioxide is associated with adverse effects on human health, principally relating to respiratory illness. The World Health Organisation (WHO) has stated that "many chemical species of nitrogen oxides (NO_x) exist, but the air pollutant species of most interest from the point of view of human health is nitrogen dioxide (NO_2)."[4]

The major sources of NO_x in the UK are road transport and power stations. According to the most recent annual report from the National Atmospheric Emissions Inventory (NAEI), road transport accounted for 37% of UK emissions, with power stations accounting for a further 27%.[5] High levels of NO_x in urban areas are almost always associated with high traffic densities.

The NAQS includes two objectives to be achieved by 31st December 2005. Both of these objectives are included in the Air Quality Directive, with an achievement date of 1st January 2010.

- *A limit for the one-hour mean of 200 µg/m^3, not to be exceeded more than 18 times a year (equivalent to the 99.79th percentile[6].)*
- *A limit for the annual mean of 40 µg/m^3.*

In addition, the NAQS includes an objective for the protection of sensitive vegetation and ecosystems of 30 µg/m^3 for the annual mean concentration of nitrogen oxides.

2.2 Sulphur Dioxide

Sulphur dioxide is predominantly released by the combustion of fuels containing sulphur. Around 68% of UK emissions in 2004 were associated with power stations[7], with much of the remainder associated with other combustion processes. Emissions of SO_2 have reduced by 87% since 1970[8], due to the reduction in coal combustion, the installation of flue gas desulphurisation plants on a number of large coal-fired power stations and the reduction in sulphur content of liquid fuels.

The NAQS contains three objectives for the control of SO_2:

- *A limit for the 15 minute mean of 266 µg/m^3, not to be exceeded more than 35 times a year (the 99.9th percentile), to be achieved by 31st December 2005.*
- *A limit for the one hour mean of 350 µg/m^3, not to be exceeded more than 24 times a year (the 99.73rd percentile) to be achieved by 31st December 2004.*
- *A limit for the daily mean of 125 µg/m^3, not to be exceeded more than 3 times a year (the 99.2nd percentile), to be achieved by 31st December 2004.*

The hourly and daily objectives are included in the Air Quality Directive.

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[4] Air Quality Guidelines – Second Edition, 2000, World Health Organisation

[5] *UK Emissions of Air Pollutants 1970-2004,* December 2006, National Environmental Technology Centre – page 76

[6] A percentile is the point below which a specified percentage of the observations fall, so the 95th percentile, for example, is higher than 95 percent of the observations.

[7] *UK Emissions of Air Pollutants 1970-2004,* December 2006, National Environmental Technology Centre, page 83

[8] Ibid, page 82

In addition, the NAQS includes two objectives for the protection of vegetation and ecosystems. These are a concentration of 20 µg/m^3 as an annual mean and as a winter average.

2.3 Particulate Matter

Concerns over the health impact of solid matter suspended in the atmosphere tend to focus on particles with a diameter of less than 10 µm, known as PM_{10}s. These particles have the ability to enter and remain in the lungs. Various epidemiological studies have shown increases in mortality associated with high levels of PM_{10}s, although the underlying mechanism for this effect is not yet understood. Significant sources of PM_{10}s are road transport (22%), quarrying (16%) and stationary combustion (34%).

The NAQS includes two objectives for PM_{10}s to be achieved by the end of 2004, both of which are included in the Air Quality Directive.

- *A limit for the annual mean of 40 µg/m^3, to be achieved by 2004.*
- *A daily limit of 50 µg/m^3, not to be exceeded more than 35 times a year (the 90.4th percentile) to be achieved by 2004.*

The previous NAQS included some provisional objectives for 2010. These have been replaced by an exposure reduction objective for $PM_{2.5}$s in urban areas and a target value for $PM_{2.5}$s of 25 µg/m^3 as an annual mean. This target value is included in the Air Quality Directive.

2.4 Carbon Monoxide

Carbon Monoxide is produced by the incomplete combustion of fuels containing carbon. By far the most significant source is road transport, which produces 67% of the UK's emissions.[9] Carbon monoxide can interfere with the processes that transport oxygen around the body, which can prove fatal at very high levels.

Concentrations in the UK are well below levels at which health effects can occur. The NAQS includes the following objective for the control of carbon monoxide, which is also included in the Air Quality Directive:

- *A limit for the 8-hour running mean of 10 mg/m^3, to be achieved by 1 January 2005.*

2.5 Hydrogen Chloride

There are no objectives for hydrogen chloride, but the Environment Agency regulates the emissions of HCl. Technical Guidance Note EPR-H1 defines the short-term EAL as 800 µg/m^3 and the long-term EAL as 20 µg/m^3. EPAQS[10] have recently recommended a short term EAL of 750 µg/m^3.

The derivation of these EALs is described in Appendix B of Technical Guidance Note EPR-H1. In the case of hydrogen chloride, the short term EAL is one-tenth of the short term exposure limit defined by the Health and Safety Executive (HSE) and the long term EAL is one-hundredth of the long term occupational exposure limit.

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[9] *UK Emissions of Air Pollutants 1970-2004,* December 2006, National Environmental Technology Centre – page 60

[10] "Guidelines for halogens and hydrogen halides in ambient air for protecting human health against acute irritancy effects", February 2006

2.6 Hydrogen Fluoride

There are no objectives for hydrogen fluoride, but the Environment Agency regulates the emissions of HF. Technical Guidance Note EPR-H1 defines the short-term EAL as 250 µg/m^3 but there is no long-term EAL. As for hydrogen chloride, the short term EAL for hydrogen fluoride is one-tenth of the short term exposure limit defined by the HSE. EPAQS have recommended a short term EAL of 160 µg/m^3.

2.7 Ammonia

There are no standards or objectives for ammonia, but the Environment Agency regulates the emissions of ammonia. Technical Guidance Note EPR-H1 defines the short-term EAL as 2500 µg/m^3 and the long-term EAL as 180 µg/m^3.

2.8 Metals

Lead is the only metal included in the NAQS objectives. Lead can have many health effects, including effects on the synthesis of haemoglobin, the nervous system and the kidneys. Emissions of lead in the UK have declined by 98% since 1970, due principally to the virtual elimination of leaded petrol. [11]

The NAQS includes objectives to limit the annual mean to 0.5 µg/m^3 by the end of 2004 and to 0.25 µg/m^3 by the end of 2008. Only the first objective is included in the Air Quality Directive.

The fourth Daughter Directive on air quality (Commission Decision 2004/107/EC) includes target values for arsenic, cadmium and nickel. However, the preamble to the Directive makes it clear that the use of these target values is relatively limited. Paragraph (5) states:

> *"The target values would not require any measures entailing disproportionate costs. Regarding industrial installations, they would not involve measures beyond the application of best available techniques (BAT) as required by Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (5) and in particular would not lead to the closure of installations. However, they would require Member States to take all cost-effective abatement measures in the relevant sectors."*

And paragraph (6) states:

> *"In particular, the target values of this Directive are not to be considered as environmental quality standards as defined in Article 2(7) of Directive 96/61/EC and which, according to Article 10 of that Directive, require stricter conditions than those achievable by the use of BAT."*

Although these target values have been included in the assessment, it is important to note that the application of the target values would not have an effect on the design or operation of the EfW facility. The EfW Facility will be designed in accordance with BAT and will include cost effective methods for the abatement of arsenic, cadmium and nickel, including the injection of activated carbon and a fabric filter.

Emissions limits have been set in Environmental Permits for a number of heavy metals which do not have air quality standards associated with them. The EALs for these metals, and lead, are summarised in Table 2.1.

[11] *UK Emissions of Air Pollutants 1970-2004,* December 2006, National Environmental Technology Centre – page 137

Table 2.1 Environmental Assessment Levels (EALs) for Metals			
Metal	Daughter Directive Target Level (µg/m^3)	Environmental Assessment Levels	
		Long-term (µg/m^3)	Short-term (µg/m^3)
Arsenic	0.006	0.2	15
Antimony	-	5	150
Cadmium	0.005	0.005	1.5
Chromium (II & III)	-	5	150
Chromium (VI)	-	0.1	3
Cobalt	-	0.2	6
Copper	-	10	200
Lead	-	0.25	-
Manganese	-	1	1500
Mercury	-	0.25	7.5
Nickel	0.020	1	30
Thallium	-	1	30
Vanadium	-	5	1

These are all taken from Technical Guidance Note EPR-H1. However, lower EALs have recently been recommended by EPAQS for arsenic (0.003 µg/m^3), nickel (0.020 µg/m^3) and chromium (VI) (0.0002 µg/m^3) and these have also been considered in the assessment. [12]

2.9 Volatile Organic Compounds (VOCs)

A variety of VOCs could be released from the SERC, of which benzene and 1,3-butadiene are included in the National Air Quality Strategy and monitored at various sites around the UK. The NAQS includes the following objectives for the running annual mean:

- *Benzene 5 µg/m^3, to be achieved by 2010.*
- *1,3-butadiene 2.25 µg/m^3, to be achieved by 2003.*

2.10 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are members of a large group of organic compounds widely distributed in the atmosphere. The best known PAH is benzo[a]pyrene (B[a]P).The NAQS included an objective to limit the annual mean of B[a]P to 0.25 ng/m^3 by the end of 2010. This goes beyond the requirements of European Directives, since the fourth Daughter Directive on air quality (Commission Decision 2004/107/EC) includes a target value for benzo(a)pyrene of 1 ng/m^3 as an annual mean.

[12] "Guidelines for metals and metalloids in ambient air for the protection of human health", EPAQS, 2009

2.11 Dioxins and Furans

Dioxins and furans are a group of organic compounds with similar structures, which are formed as a result of combustion in the presence of chlorine. Principal sources include steel production, power generation, coal combustion and uncontrolled combustion, such as bonfires. Waste incineration used to be a major source of dioxins, but the Municipal Waste Incineration Directive and UK legislation imposed strict limits on dioxin emissions in 1995, with the result that current emissions from incineration of municipal solid waste in the UK in 1999 were less than 1% of the emissions from waste incinerators in 1995. The new Waste Incineration Directive imposes even lower limits, reducing the limit to one tenth of the previously permitted level.

One dioxin, 2,3,7,8-TCDD, is a definite carcinogen and a number of other dioxins and furans are considered to be possible carcinogens. A tolerable daily intake (TDI) for Dioxins has been recommended by the Committee on the Toxicity of Chemicals in Food, Consumer Products and the Environment[13] of 2 pg I-TEQ per kg bodyweight per day.

Dioxins are not normally compared with set EALs, but the probable ingestion rates of dioxins by different groups of people is considered as part of the health risk assessment.

2.12 Summary

Table 2.2 overleaf summarises the air quality objectives and guidelines used in the air quality assessment. The sources for each of the values can be found in the preceding sections.

[13] http://www.food.gov.uk/science/ouradvisors/toxicity/

Table 2.2 Air Quality Standards (AQS) and Environmental Assessment Levels (EALs)			
Pollutant	**Limit Value ($\mu g/m^3$)**	**Averaging Period**	**Frequency of exceedence**
Nitrogen Dioxide	200	1 hour	18 times per year (99.79th %ile)
	40	Annual	-
Sulphur Dioxide	266	15 minutes	35 times per year (99.9th %ile)
	350	1 hour	24 times per year (99.73rd %ile)
	125	24 hours	3 times per year (99.18th %ile)
Particulate matter (PM_{10})	50	24 hours	35 times per year (90.4th %ile)
	40	Annual	-
Particulate matter ($PM_{2.5s}$)	25	Annual	-
Carbon Monoxide	10,000	8 hours, running	-
Hydrogen chloride	750	1 hour	-
	20	Annual	-
Hydrogen fluoride	160	1 hour	-
Ammonia	2500	1 hour	-
	180	Annual	-
Lead	0.25	Annual	-
Benzene	5	Annual	-
1,3-butadiene	2.25	Annual, running	-
PAHs	0.00025	Annual	-

3 BACKGROUND AIR QUALITY

The site is located on the Hartlebury Trading Estate in Worcestershire approximately 4 miles south of Kidderminster, close to the A449. The plant is located on Oak Drive, directly opposite the junction with Elm Drive, on a plot of brownfield land.

3.1 Automatic Monitoring Stations

There is limited air quality monitoring carried out in the vicinity of the Mercia EnviRecover facility. The closest relevant continuous monitoring stations considered were as follows:

- Sandwell West Bromwich, an urban background monitoring station, located 26.0 km north of the Mercia EnviRecover facility.
- Birmingham centre, an urban centre monitoring station, located 26.5 km north of the Mercia EnviRecover facility.

Table 3.1 Automatic Monitoring Results, Mercia EnviRecover facility 2006-08

Pollutant	Quantity (in µg/m3)	Sandwell West Bromwich			Birmingham Centre			AQS
		2006	2007	2008	2006	2007	2008	
Nitrogen dioxide	Annual Mean	24.5	29.2	27.2	34.5	34.0	33.1	40
	99.79th %ile of hourly means	111.0	113.0	128.0	113.0	105.6	136.0	200
Particulate matter	Annual mean	-	-	-	26.5	18.6	15.7	40
	90.4th %ile of daily means	-	-	-	46.0	38.0	33.0	50
Carbon monoxide	Peak 8 hourly running mean	1625	1288	-	2175	1400	-	10,000
	Annual mean	265	224	-	349	326	-	
Sulphur Dioxide	Annual mean	3.5	2.1	2.6	3.7	3.0	-	
	99.73rd %ile of hourly means	29.0	19.0	32.0	32.0	21.0	-	350
	99.18th %ile of daily means	15.2	9.6	14.9	17.3	9.8	-	125
Ozone	Annual mean	42.0	42.0	48.1	38.4	43.0	-	

Walsall Alumwell, an urban background monitoring station is located 31.4 km north east of the Mercia EnviRecover facility. This monitoring site can only supply limited data up to 2007 and is therefore not considered further.

3.2 National Nitrogen Dioxide Survey Results

There are 6 sites within about 15 km of the site that monitored nitrogen dioxide (NO_2) concentrations as part of DEFRA's national NO_2 diffusion tube survey between 1st January 2006 and 31st December 2008. The monitoring sites considered fall into two categories:

- Roadside (R), 1-5 m from a busy road (2 sites)
- Urban Background (B), more than 50 metres from any road (4 sites)

The data from the diffusion tube sites has been analysed to give the results shown below.

Table 3.2 Diffusion Tube Survey Results, (µg/m3)

Type of Site	Average Concentration of All Tubes			Highest Annual Average			Highest Monthly Average		
	2006	2007	2008	2006	2007	2008	2006	2007	2008
Roadside	46.3	42.0	44.9	58.6	42.0	60.6	73.0	62.0	95.0
Urban Background	21.6	25.8	20.3	23.1	27.7	22.6	50.0	49.0	33.0

The annual average air quality objective of 40 µg/m^3 was exceeded at both of the roadside sites (Bromsgrove 1N and Worcester 1N).

The urban background sites are more likely to be representative of the area around the Mercia EnviRecover facility than the roadside sites. The highest annual average at an urban background site was 27.7µg/m^3 in Bromsgrove 3N, which is below the air quality objectives. Diffusion tube data has not been ratified for 2009 so has not been included.

3.3 National Modelling Data

In order to assist councils with their responsibilities under Local Air Quality Management (LAQM), NETCEN have modelled the background concentration of pollutants throughout the UK on a 1 km by 1 km grid. This model is based on known pollution sources and background measurements and should therefore include the effect of the local brickworks on the background concentration. The predicted concentrations closest to the site stack location (at 385974, 269904) were as follows:

- Nitrogen dioxide 15.37 µg/m^3 for 2010
- Nitrogen dioxide 14.58 µg/m^3 for 2013
- PM_{10} 22.15 µg/m^3 for 2010
- PM_{10} 22.07 µg/m^3 for 2013
- $PM_{2.5}$ 14.23 µg/m^3 for 2010
- $PM_{2.5}$ 14.1 µg/m^3 for 2013
- Benzene 0.214 µg/m^3 for 2010

- Sulphur dioxide 2.92 µg/m^3 for 2001
- Carbon monoxide 0.258 mg/m^3 for 2001
- 1,3-butadiene 0.107 µg/m^3 for 2003

All of these predicted concentrations are below the relevant air quality objectives.

3.4 Wychavon District Council Air Quality Data

The site is located within Wychavon district. Wychavon District Council does not operate any continuous monitoring sites, but there are more than 50 passive diffusion tube sites monitoring nitrogen dioxide. No other pollutants are monitored.

3.4.1 Nitrogen dioxide

Nitrogen dioxide was measured at some 51 diffusion tube sites during 2008. The average bias background adjusted concentration during 2008 was 33.9 µg/m^3 from all the diffusion tube sites across Wychavon district. The majority of these sites are roadside locations in the Evesham and West Droitwich and are therefore not representative. There were two locations in Pershore that measured urban background concentrations in 2008 of 22.48 µg/m^3 and 17.22 µg/m^3. These are more representative, but are still expected to be slightly high in comparison with the background concentrations in the of the area surrounding the facility.

3.5 Other Pollutants

3.5.1 Volatile Organic Compounds

The UK monitoring network includes a number of sites which measure the concentration of benzene and 1,3-butadiene. None of the national sites are particularly close to the facility. The results for 2006-2008 for those sites which are relatively close are shown below.

Table 3.3 VOC Monitoring Results

Site	Benzene			1,3-butadiene		
	2006	2007	2008	2006	2007	2008
Birmingham Roadside	2.08	1.7275	1.30	0.07	0.13	-
Birmingham Tyburn	-	-	0.72	-	-	-
Bristol Old Market	-	-	-	0.21	0.15	-
Bath Roadside	-	-	0.65	-	-	-
Maximum	**2.08**	**1.73**	**1.30**	**0.21**	**0.15**	**-**
Air Quality Objective	5			2.25		
All figures in µg/m^3						

It can be seen that none of the air quality objectives are exceeded at any of the monitoring sites. The highest benzene reading was measured in 2006 at Birmingham Roadside, and was 41.6% of the air quality objective. The highest reading of 1,3-butadiene was measured in 2006 at Bristol Old Market, and was 9% of the air quality objective.

3.5.2 Metals

There are no monitoring sites for heavy metals close to the site. The monitoring results for 2006-2008 for those sites which are relatively close are shown below.

Table 3.4 Heavy Metal Monitoring Results, Walsall

Metal	EAL (concs in ng/m^3)	Walsall Centre (Site 46) (concs in ng/m^3)			Walsall Willenhall (concs in ng/m^3)		
		2006	2007	2008	2006	2007	2008
Arsenic	200	1.19	1.18	0.98	1.20	1.46	1.15
Cadmium	5	0.88	0.72	0.48	3.64	2.19	2.24
Chromium	5000	5.01	4.71	1.46	4.90	4.24	3.38
Copper	10,000	25.93	17.2	15.7	50.60	42.7	60.4
Manganese	1000	10.81	9.25	9.0	11.01	11.77	9.5
Mercury	250	0.32	0.41	0.03	0.32	0.45	0.06
Nickel	1000	3.50	2.13	1.47	7.56	2.77	1.66
Vanadium	5000	2.48	1.58	1.35	1.97	1.94	1.32
Lead	250	30.9	22.7	19.3	92.3	51.4	88.1

It can be seen that none of the EALs are close to being breached at any of the monitoring sites. The concentrations are generally less than 1% of the EAL, with the exception of cadmium and lead for which the worst concentrations are 73% and 37% of the EAL respectively. It should be noted that the closest monitoring sites are at metal refining works and therefore the background concentrations are relatively high.

Additionally, the nickel concentrations are close to or exceed the new EPAQS guideline of 3 ng/m^3 and the chromium concentrations exceed the new EPAQS guideline for chromium (VI) or 0.2 ng/m^3 by a factor of around 10 to 25. Even if chromium (VI) is only 10-20% of all chromium in the atmosphere, as suggested in the EPAQS report referenced earlier, it is clear that chromium(VI) concentrations currently exceed the new guideline value.

3.5.3 Dioxins and Furans

In addition to the short term on site monitoring, dioxins and furans are monitored on a quarterly basis at a number of sites in the UK. The latest data available is for 2007 and this is shown below with data for 2002-2006.

Table 3.5 - Dioxin Monitoring Results, National

Site	2007		2002-2006	
	Average Concentration (fg TEQ/m3)	Maximum Quarterly Concentration (fg TEQ/m3)	Average Concentration (fg TEQ/m3)	Maximum Quarterly Concentration (fg TEQ/m3)
Hazelrigg	6.68	17.78	12.5	58.72
High Muffles	1.35	5.23	4.4	11.8
London	7.25	11.59	16.2	27.7
Manchester	18.33	32.78	54.6	134.3
Middlesbrough	18.49	24.77	30.1	58
Stoke Ferry	5.90	13.27	1.3	16.07
All Sites	**9.67**	**32.78**	**23.3**	**134.3**

The variation in concentration between sites is due to the fact that some sites are in rural areas while the other sites are in cities. There are no air quality standards for dioxins.

3.5.4 Polycyclic Aromatic Hydrocarbons (PAHs)

The concentration of PAHs is measured at a number of sites across the UK, although none of the sites are particularly close to the facility. For the purposes of this assessment, the most important PAH is benzo(a)pyrene, as this is the PAH for which an air quality objective is set. The highest annual average concentrations of benzo(a)pyrene at rural sites in England 2003-2007 were as follows:

- Hazelrigg 0.11 ng/m^3
- High Muffles 0.051 ng/m^3
- Stoke Ferry 0.14 ng/m^3

These are all below the air quality objective of 0.25 ng/m^3.

3.5.5 Hydrogen Fluoride and Hydrogen Chloride

Background concentrations of hydrogen fluoride are not measured locally or nationally, since these are not generally of concern in terms of local air quality. However, the EPAQS report "Guidelines for halogens and hydrogen halides in ambient air for protecting human health against acute irritancy effects" contains some estimates of background levels, reporting that measured concentrations have been in the range of 0.034 µg/m^3 to 2.35 µg/m^3.

Hydrogen chloride is measured at 30 rural sites as part of DEFRA's nitric acid survey. In 2006, the annual average concentration varied from 0.14 µg/m^3 to 0.56 µg/m^3.

3.6 Summary

The following values for the annual average background concentrations have been used to evaluate the impact of the plant.

Table 3.6 Summary of Background Concentrations

Pollutant	Background	Long term EAL/AQO	Justification
	($\mu g/m^3$)	($\mu g/m^3$)	
Nitrogen Dioxide:	27.7	40	The nearest continuous monitoring site is Sandwell West Bromwich which is 26 km away. Several non-continuous monitoring sites for NO_2 are located closer to the facility so this continuous data has not been used. The background concentration is taken as the highest annual average recorded by urban background national monitoring site in 2007 (Bromsgrove 3N - 15km away). The nearest local authority data from Pershore (20 km away) was recorded as 22.48 $\mu g/m^3$. National modelled data which takes into account the rural setting and the local industrial sites such as the brickworks and landfill gives a background concentration of 15.37 $\mu g/m^3$ for 2010. The background concentration used is therefore expected to be conservative.
Sulphur Dioxide	3.5	-	Highest annual average recorded by Sandwell West Bromwich, an urban background monitoring station, located 26 km north of the facility (2006). Birmingham Centre monitoring station is an urban centre type and is therefore not representative of the local area surrounding the facility. National modelled data which takes into account the rural setting and the local industrial sites such as the brickworks and landfill gave a background concentration of 2.92 $\mu g/m^3$ in 2001. The background concentration used is therefore expected to be conservative.
Carbon monoxide	265	-	Highest annual average recorded by Sandwell West Bromwich, an urban background monitoring station, located 26 km north of the facility (2006). Birmingham Centre monitoring station is an urban centre type and is therefore not representative of the local area surrounding the facility.
Hydrogen chloride	0.56	20	Highest recorded figure at rural sites in the UK
Benzene	2.08	5	The highest annual reading measured in 2006 at Birmingham Roadside monitoring station
1,3-butadiene	0.21	2.25	The highest annual reading of 1,3-butadiene was measured in 2006 at Bristol Old Market monitoring station
PM_{10}	22.15	40	Highest result from the NETCEN predicted concentration for 2010 within 1 km of the site
$PM_{2.5}$	14.23	25	Highest result from the NETCEN predicted concentration for 2010 within 1 km of the site

Table 3.6 Summary of Background Concentrations			
Pollutant	**Background**	**Long term EAL/AQO**	**Justification**
	(ng/m^3)	**(ng/m^3)**	
Benzo[a]pyrene	0.14	0.25	Highest recorded rural concentation
Arsenic	1.46	200	Highest recorded figure measured at Walsall Willenhall Monitoring Station (2007). Note: this monitoring station is close to a metals processing site.
Antimony	-	5000	Not measured
Cadmium	3.64	5	Highest recorded figure measured at Walsall Willenhall Monitoring Station (2006). Note: this monitoring station is close to a metals processing site.
Chromium	5.01	5000	Highest recorded figure measured at Walsall Centre Monitoring Station (2006).
Copper	50.60	10,000	Highest recorded figure measured at Walsall Willenhall Monitoring Station (2007). Note: this monitoring station is close to a metals processing site.
Manganese	11.77	1000	Highest recorded figure measured at Walsall Willenhall Monitoring Station (2007). Note: this monitoring station is close to a metals processing site.
Mercury	0.45	250	Highest recorded figure measured at Walsall Willenhall Monitoring Station (2007). Note: this monitoring station is close to a metals processing site.
Lead	92.3	250	Highest recorded figure measured at Walsall Willenhall Monitoring Station (2006). Note: this monitoring station is close to a metals processing site.
Nickel	7.56	1000	Highest recorded figure measured at Walsall Willenhall Monitoring Station (2006). Note: this monitoring station is close to a metals processing site.
Thallium	-	1000	Not measured
Vanadium	2.48	5000	Highest recorded figure measured at Walsall Centre Monitoring Station (2006).
Dioxins	23.3 fg/m^3	-	Highest average UK concentration measured between 2002 and 2007.

4 DISPERSION MODELLING

4.1 Model Inputs

4.1.1 Selection of Model

The detailed flue gas dispersion modelling was carried out using the computer model ADMS 4.1, developed and supplied by Cambridge Environmental Research Consultants (CERC). This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the Monin-Obukhov length and the boundary layer depth. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. Modules within the model take account of the effect of complex terrain and nearby buildings.

ADMS 4.1 has been used on many occasions for the modelling of emissions for planning and PPC (Pollution Prevention and Control) purposes and air quality assessments using ADMS have generally been accepted by the Environment Agency.

The modelling of traffic emissions will be carried out as outlined in Section 3 of Volume 11 of the Design Manual for Roads and Bridges (DMRB) produced by the Highways Agency. A software tool is available to implement this method.

4.1.2 Chemistry

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

ADMS 4.1 includes a chemistry module, which models the progress of this reaction in the atmosphere. This module requires the background concentrations of NO_2, NO and ozone to be provided. Since there is no continuous monitoring data close to the facility, chemistry has not been used in the general assessment. The concentrations from the dispersion model assume that all of the NOx released from the plant is oxidised to NO_2 immediately. In reality, at the distances from the stack at which the peaks occur, the atmospheric oxidation process will not be completed, so that the actual concentrations of NO_2 will be lower than those predicted by the model. A conversion factor has therefore been applied to the outputs from the ADMS modelling as recommended by the Environment Agency. The long term NO_2 results are multiplied by 0.7 to calculate the expected ratio of NO_2 to NO and the short term results are multiplied by 0.35.

4.1.3 Source and Emissions Data

The principal inputs to the model with respect to the releases from the main EfW stack are shown in Table 4.1.

Table 4.1 EfW Source and Emissions Data			
Item	**Unit**	**Stack**	
Stack Height (from ground level)	m	75	
Effective Internal Stack Diameter	m	2.1	
Stack Position (Eastings, Northings)	m, m	385974, 269904	
Stack Flue Gas Exit Velocity	m/s	15.37	
Flue Gas Conditions			
Temperature	°C	150	
Oxygen	% v/v, dry	8.0	
Moisture Content	% v/v	18.02	
Volume at reference conditions (dry)	Nm^3/s	36.5	
	Nm^3/h	131,371	
Volume at discharge conditions (wet)	Am^3/s	53.05	
	Am^3/h	190,992	
Emissions		**Conc. (mg/m3)**	**Rate (g/s)**
Oxides of nitrogen (as NO_2)		200	7.298
Sulphur dioxide		50	1.825
Carbon monoxide		50	1.825
Particulates (PM_{10})		10	0.365
Particulates ($PM_{2.5s}$)		3.33	0.122
Hydrogen Chloride		10	0.365
Hydrogen Fluoride		1	0.036
Ammonia		10	0.365
VOCs		10	0.365
Mercury		0.05	1.825 mg/s
Cadmium and Thallium		0.05	1.825 mg/s
Other Metals		0.5	18.25 mg/s
PaHs (as B[a]P)		0.002	73.0 µg/s
Dioxins and Furans		$0.1ng/m^3$	3.65 ng/s

Notes:

Emission concentrations are for dry flue gas, 11% oxygen, and are taken from the Waste Incineration Directive, except for ammonia and PaHs which are not included in WID. Emission rates are corrected to the actual flue gas conditions.

"Other Metals" are Antimony, Arsenic, Chromium, Cobalt, Copper, Lead, Manganese, Nickel, Vanadium.

The PAH concentration is a typical measured concentration of benzo(a)pyrene at a UK energy from waste plant. Total PAHs are typically up to 0.02 mg/m^3.

There have been limited measurements of $PM_{2.5s}$ emissions from waste incineration plants. From information available on the Environment Agency's public registers for the plants at Bolton, Stoke and Lewisham indicating that the $PM_{2.5}$ faction makes up around 33% of the PM_{10} fraction

4.1.4 Meteorological Data

The impact of weather data was taken into account by using data from the Meteorological Office for the years 2004-2008 from the Pershore weather station. This is located near Worcester around 20 km to the south-east of the site, so will give representative wind speed and direction data.

Wind roses for each year can be found in Figure 1 in Appendix A, showing that the winds are predominantly from the south-west. Five years of data were used to ensure that fluctuations in weather conditions would be accounted for.

4.1.5 Terrain

The land surrounding the site is not particularly flat and so the effects of the local terrain on dispersion have been taken into account by using Ordnance Survey Digital Terrain Data.

The area around the Mercia EnviRecover site is generally agricultural land but with small isolated areas of woodland. One of these small areas of woodland is located adjacent to the site to the east. A surface roughness length of 0.3 metres, representative of agricultural areas, has been used in the model. The sensitivity of the results to the surface roughness has been considered in section 4.4.2.

4.1.6 Buildings

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

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

It is generally accepted that building effects are only significant for buildings which are taller than one third of the stack height. The only building in the vicinity of the stack which is significant is the main combustion plant and flue gas treatment building. The building has been split into three simple sections for modelling purposes. The details of the buildings are shown in Table 4.2 below. The locations of the stack and buildings are shown in Figure 2 in Appendix A.

Table 4.2 Building Details

Item	Unit	EfW Boiler Building	EfW Bunker Building	Flue Gas Treatment Building
Building Height	m	35	35	27
Building Length	m	55	30.5	25
Building Width	m	26.6	55.3	22.6
Position of centre (Eastings, Northings)	m, m	385993, 269861	385999, 269819	385991, 269901
Angle of building to north (clockwise)	°	177	177	177

Since the buildings are contained within an 8 metre excavation, the heights of the buildings have been reduced by 8 metres for the purposes of the dispersion model, so that the buildings and stack are both modelled relative to the prevailing ground level.

4.1.7 Sensitive Receptors

The general approach to the assessment of the impact of air quality on human health is to evaluate the highest predicted contribution of the emissions to ground level concentrations of pollutants at any point in the vicinity, irrespective of the occupancy of the location of that highest predicted contribution. In addition, the predicted contribution at a number of sensitive receptors has also been evaluated. These sensitive receptors are shown on Figure 2 and listed below.

Table 4.3: Sensitive Receptors

Receptor Name	Location
Oldhouse Farm	Around 1.1 km west of the stack
Manor House Farm	Around 1.25 km west of the stack
Central Waresley (Police Station)	Around 1.7 km west of the stack
Moors Farm	Around 1.1 km north-west of the stack
New Elizabethan School (Quarry Bank)	Around 2 km north-west of the stack
Hartlebury Post Office	Around 1.6 km north-west of the stack
Nearest dwelling on Walton Road	Around 0.84 km north of the stack
Nearest dwelling on Walton Lane	Around 0.8 km north-west of the stack
Whitlenge Farm	Around 1.7 km north of the stack
Pyehill Farm	Around 1.16 km north of the stack
Ryelands Farm	Around 1.2 km north-east of the stack
New House Farm	Around 0.65 km north-east of the stack
Callimore Farm	Around 1.9 km north-east of the stack
Elmley Lovett	Around 1.2 km east of the stack
Cutnall Green School	Around 2.4 km south-east of the stack
Bassage Farm	Around 0.8 km south of the stack
Bassage Cottages	Around 1 km south of the stack
Mountpleasant Farm	Around 1.4 km south of the stack
Valley Farm	Around 1.4 km south of the stack
Norchard Farm	Around 1.7 km south-west of the stack
Nearest dwelling in Bellington	Around 0.35 km south east of the stack
The Rectory	Around 0.45 km south east of the stack

The impact on sensitive environmental receptors is considered in section 4.5.

4.2 Results

The full results of the dispersion modelling of the emissions from the plant stack can be found in Table 4.4 below.

According to the Environment Agency's Technical Guidance Note H1, the contribution to air quality is considered to be insignificant if the short-term contribution is less than 10% of the air quality objective and the long-term contribution is less than 1% of the air quality objective. Those contributions which are not considered to be insignificant are highlighted in the table.

Table 4.4: Stack Emission Dispersion Modelling Results								
Pollutant	**Quantity**	**Contribution to Ground Level Concentration at point of greatest impact (µg/m^3)**						**Max as % of AQO/EAL**
		2004	**2005**	**2006**	**2007**	**2008**	**Max**	
Nitrogen dioxide	Annual mean	0.61	0.56	0.61	0.60	0.626	**0.626**	1.56%
	99.79th %ile of hourly means	6.12	5.91	5.98	5.58	6.02	**6.12**	3.1%
Sulphur dioxide	99.9th %ile of 15 min. means	4.81	4.72	4.73	5.03	5.05	**5.05**	1.9%
	99.73rd %ile of hourly means	4.28	4.17	4.24	3.95	4.25	**4.28**	1.22%
	99.18th %ile of daily means	1.89	2.28	1.71	1.49	1.72	**2.28**	1.82%
Particulate matter (PM_{10})	Annual mean	0.04	0.04	0.04	0.04	0.05	**0.05**	0.11%
	90.4th %ile of daily means	0.15	0.15	0.14	0.15	0.15	**0.15**	0.31%
Particulate matter ($PM_{2.5s}$)	Annual mean	0.015	0.013	0.015	0.014	0.015	**0.015**	0.06%
Carbon monoxide	8 hour running mean	5.7	5.56	5.69	5.34	5.54	**5.7**	0.06%
Hydrogen chloride	Annual mean	0.044	0.040	0.044	0.043	0.045	**0.045**	0.22%
	Hourly mean	1.20	1.32	1.27	1.36	1.29	**1.36**	0.18%
Hydrogen fluoride	Hourly mean	0.12	0.13	0.13	0.14	0.13	**0.14**	0.085%
Ammonia	Annual mean	0.044	0.040	0.044	0.043	0.045	**0.045**	0.025%
	Hourly mean	1.20	1.32	1.27	1.36	1.29	**1.36**	0.054%
VOCs	Annual mean	0.044	0.040	0.044	0.043	0.045	**0.045**	2.0%
Mercury (ng/m^3)	Annual mean	0.22	0.20	0.22	0.22	0.22	**0.22**	0.1%
	Hourly mean	6.0	6.6	6.4	6.8	6.5	**6.8**	0.1%
Cd & Tl (ng/m^3)	Annual mean	0.22	0.20	0.22	0.22	0.22	**0.22**	4.5%
	Hourly mean	6.0	6.6	6.4	6.8	6.5	**6.8**	0.45%
Other metals (ng/m^3)	Annual mean	2.2	2.0	2.2	2.2	2.2	**2.2**	1.1%
	Hourly mean	59.9	66.0	63.6	68.0	64.7	**68.0**	0.45%
Dioxins (fg/m3)	Annual mean	0.44	0.40	0.44	0.43	0.45	**0.45**	
PAHs (pg/m^3)	Annual mean	8.70	7.99	8.70	8.61	8.94	**8.94**	3.6%

These results are discussed in section 4.3.

4.3 Discussion of Results

The following discussion focuses on the contributions to ground level concentrations at the point of greatest impact. The highest predicted contribution of stack emissions to ground level concentrations of nitrogen dioxide and sulphur dioxide at the sensitive receptors is shown in the following table and compares these results with the highest predicted contribution at the point of maximum impact. (The results for other pollutants are similar, but are not shown for clarity). The point of maximum impact does not coincide with any of the sensitive receptors.

Table 4.5 EfW Stack Emission Dispersion Modelling Results, Sensitive Receptors

Location	Contribution to Ground Level Concentration at Specified Points (µg/m^3)				
	Nitrogen dioxide		Sulphur dioxide		
	Annual mean	99.79th %ile of hourly means	99.9th %ile of 15 min. means	99.73rd %ile of hourly means	99.18th %ile of daily means
Oldhouse Farm	0.123	2.799	2.386	1.846	0.718
Manor House Farm	0.078	2.570	2.224	1.808	0.518
Central Waresley (Police Station)	0.059	1.901	1.756	1.288	0.374
Moors Farm	0.075	3.034	2.612	2.126	0.521
New Elizabethan School (Quarry Bank)	0.043	1.534	1.551	1.081	0.336
Hartlebury Post Office	0.054	2.137	1.839	1.453	0.405
Nearest dwelling on Walton Road	0.164	4.554	3.792	3.168	1.055
Nearest dwelling on Walton Lane	0.214	4.328	3.458	3.059	1.277
Whitlenge Farm	0.096	1.917	1.739	1.345	0.470
Pyehill Farm	0.157	2.990	2.564	2.116	0.734
Ryelands Farm	0.555	2.756	2.323	1.953	1.076
New House Farm	0.298	4.482	3.689	3.146	0.719
Callimore Farm	0.139	1.738	1.556	1.211	0.490
Elmley Lovett	0.175	2.695	2.217	1.882	0.692
Cutnall Green School	0.051	1.404	1.279	0.991	0.253
Bassage Farm	0.109	3.724	3.052	2.526	0.619
Bassage Cottages	0.095	3.143	2.708	2.175	0.529
Mountpleasant Farm	0.090	2.371	2.121	1.669	0.465
Valley Farm	0.061	2.059	1.828	1.417	0.642
Norchard Farm	0.083	1.836	1.681	1.295	0.622
Nearest dwelling in Bellington	0.086	3.681	3.821	2.449	0.383
The Rectory	0.181	5.449	4.254	3.759	1.722

4.3.1 Nitrogen Dioxide

The highest contribution of the plant to the annual average ground level concentration is predicted to be 0.626 µg/m^3, based on 2008 weather data. This ground level concentration includes a multiplication factor of 0.7 to account for the expected conversion rate from NO to NO_2 as described in section 4.1.2. The peak occurs about 800 metres north-east of the stack and is 1.56% of the air quality objective. If the peak contribution is added to the background concentration of 27.7 µg/m^3, the total predicted ground level concentration is 28.33 µg/m^3, which is less than the air quality objective of 40 µg/m^3. This distribution is shown in Figure 3.

The highest contribution of the plant to the 99.79th percentile of hourly average ground level concentrations is predicted to be 6.12 µg/m^3, based on 2004 weather data. This ground level concentration includes a multiplication factor of 0.35 to account for the expected conversion rate from NO to NO_2 as described in section 4.1.2. The peak occurs about 480 metres north-west of the stack and is 3.1% of the air quality objective. This distribution is shown in Figure 4.

It would not be correct to add the peak short-term contribution from the plant to the highest recorded background concentration, since the two peaks would not be coincident in time or space. Instead, the Environment Agency recommends in Technical Guidance Note EPR-H1 that the short-term process contribution should be added to twice the long-term ambient concentration. If the short-term peak is added to two times the highest annual average concentration, the total predicted ground level concentration is 61.5 µg/m^3, which is less than a third of the AQO of 200 µg/m^3.

Overall, the contribution of the stack emissions to the short term nitrogen dioxide levels in the atmosphere can be considered insignificant. The contribution of the plant to the long term nitrogen dioxide levels in the atmosphere cannot be considered insignificant but no breaches of air quality standards or objectives are anticipated. At sensitive receptors, the highest contribution to long term nitrogen dioxide concentrations is only 1.4% of the air quality objective.

4.3.2 Sulphur Dioxide

The highest contribution to the 99.9th percentile of 15-minute means of ground level concentration of sulphur dioxide is predicted to be 5.05 µg/m^3, based on 2008 weather data. This peak occurs about 480 metres away from the stack in a north-westerly direction and is 1.9% of the air quality objective. If this short-term peak is added to twice the annual average background concentration of 3.5 µg/m^3, the total predicted peak is 12.05 µg/m^3, which is less than the air quality objective of 266 µg/m^3. This distribution is illustrated in Figure 5.

The highest contribution to the 99.73rd percentile hourly average ground level concentration of sulphur dioxide from the plant is predicted to be 4.28 µg/m^3, based on 2004 weather data. This peak occurs about 480 metres away from the stack in a north westerly direction and is 1.22% of the air quality objective. If this short-term peak is added to twice the annual average background concentration, the total predicted peak is 11.28 µg/m^3, which is less than the air quality objective of 350 µg/m^3.

The highest contribution to the 99.18th percentile daily average ground level concentration of sulphur dioxide is predicted to be 2.28 µg/m^3, based on 2005 weather data. This peak occurs about 550 metres away from the stack in a south-easterly direction and is 1.82% of the air quality objective. If this short-term peak is added to twice the annual average background concentration, the total predicted peak is 9.28 µg/m^3, which is less than the air quality objective of 125 µg/m^3.

Overall, the contribution of the plant to sulphur dioxide levels in the atmosphere can be considered insignificant.

4.3.3 Particulate Matter

PM10s

The highest contribution of the stack emissions to the annual average ground level concentration of particulate matter is predicted to be 0.05 µg/m^3, which is 0.11% of the AQO. The highest contribution to the 90.4th percentile of the daily average ground level concentration is predicted to be 0.15 µg/m^3, which is 0.31% of the EAL. Therefore, the stack emissions will not make a significant contribution to particulate levels in the atmosphere. Since the contribution is so low, no diagram for the dispersion is included.

$PM_{2.5s}$

$PM2_{.5s}$ are a fraction of PM_{10s}, so the concentration of $PM_{2.5s}$ is lower than the concentration of PM_{10s}.

There have been limited measurements of $PM_{2.5}$s emissions from waste incineration plants. Three sets of measurements are available from the Environment Agency's public registers from the plants at Bolton, Stoke and Lewisham. These indicate that the PM2.5 faction makes up around 33% of the PM_{10} fraction. We have modelled emissions at 33% of the PM_{10} rate. The highest contribution of stack emissions to the annual average concentration of $PM_{2.5}$s is predicted to be around 0.015 µg/m^3. This is 0.06% of the new target value of 25 µg/m^3, so it can be seen that the plant is not predicted to make a significant contribution to $PM_{2.5}$ levels in the atmosphere.

Even if all of the particulate matter was assumed to be smaller than 2.5 microns, the contribution of stack emissions to ground level concentrations would be less than 0.2% of the air quality objective.

4.3.4 Carbon Monoxide

The highest contribution of stack emissions to the eight-hourly running mean ground level concentration is predicted to be 5.7 µg/m^3, which is 0.06% of the EAL. Therefore, the plant will not make a significant contribution to carbon monoxide levels in the atmosphere. Since the contribution is so low, no diagram for the dispersion is included.

4.3.5 Hydrogen Chloride

The highest contribution to the annual average ground level concentration of hydrogen chloride is predicted to be 0.045 µg/m^3, which is 0.22% of the AQO. The highest contribution to the hourly average ground level concentration is predicted to be 1.36 µg/m^3, which is 0.18% of the EAL. Therefore, the stack emissions will not make a significant contribution to hydrogen chloride levels in the atmosphere. Since the contribution is so low, no diagram for the dispersion is included.

4.3.6 Hydrogen Fluoride

The highest contribution to the hourly ground level concentration of hydrogen fluoride is predicted to be 0.136 µg/m^3, which is 0.085% of the EAL. Therefore, the plant will not make a significant contribution to hydrogen fluoride levels in the atmosphere. Since the contribution is so low, no diagram for the dispersion is included.

4.3.7 Ammonia

The highest contribution to the annual average ground level concentration of ammonia is predicted to be 0.045 µg/m^3, which is 0.025% of the AQO. The highest contribution to the hourly average ground level concentration is predicted to be 1.36 µg/m^3, which is 0.054% of the EAL. Therefore, the stack emissions will not make a significant contribution to ammonia levels in the atmosphere. Since the contribution is so low, no diagram for the dispersion is included.

4.3.8 Volatile Organic Compounds (VOCs)

The highest contribution of the plant to the annual average ground level concentration of VOCs is predicted to be 0.045 µg/m^3. If this is assumed to be all benzene, this concentration would be 0.89% of the air quality objective. Alternatively, if this is assumed to be entirely 1,3-butadiene, this would be 2.0% of the air quality objective. In reality, only a small fraction of the VOCs released from the plant will be benzene and 1,3-butadiene. Therefore, the plant will not make a significant contribution to VOC levels in the atmosphere.

4.3.9 Heavy Metals

Under the Incineration Directive, the plant will operate to three emission limits for heavy metals, covering three groups of metals:

(1) Mercury and compounds ..... 0.05 mg/m^3

(2) Cadmium, Thallium and compounds .....0.05 mg/m^3

(3) Antimony, Arsenic, Chromium, Cobalt, Copper, Lead, Manganese, Nickel, Vanadium and compounds..... 0.5 mg/m^3

For the second and third groups, monitoring data from waste combustion plants in the UK recorded in the Environment Agency public registers confirms that the emissions of each metal are a fraction of the total emission limit. Specifically, 19 individual test results over the period September 2005 to April 2007 were reviewed and the results are shown below.

Table 4.6 Measured Heavy Metal Concentrations

Element		Average Concentration (mg/m^3)	Percentage Contribution to Total Heavy Metals	Percentage of Emission Limit
Antimony	Sb	0.009	6.7%	1.80%
Arsenic	As	0.012	8.8%	2.40%
Cobalt	Co	0.001	1.0%	0.20%
Chromium	Cr	0.016	12.5%	3.20%
Copper	Cu	0.008	6.1%	1.60%
Lead	Pb	0.029	21.8%	5.80%
Manganese	Mn	0.014	10.5%	2.80%
Nickel	Ni	0.042	31.9%	8.40%
Vanadium	V	0.001	0.7%	0.20%
Total		0.132	100.0%	26.4%

It can be seen that, although Nickel, Lead and Chromium all contribute more than 11.1% of the total metals emissions, none of these contribute more than 11.1% of the emission limit.

Therefore, emissions of each of the nine metals in the third group have been taken as one-ninth of the combined limit. This makes the implicit assumption that the performance of the abatement system at the Mercia EnviRecover facility (injection of activated carbon and a bag filter) will be as effective as the same abatement system employed at all other EfW plants in the UK. We consider that this is a reasonable assumption.

The emissions of cadmium and thallium have been taken as half of the combined limit.

Using these assumptions, the highest predicted contribution to ground level concentrations for each metal are shown in the table below and compared with the EAL for each metal. The results show the contribution to the ground level concentration of each metal at the point of maximum impact from the 5 years of weather data.

Table 4.7 Detailed Metals Results						
Metal	**Long Term (Annual)**			**Short Term (Hourly)**		
	Concentration (ng/m^3)	**EAL (ng/m^3)**	**% of EAL**	**Concentration (ng/m^3)**	**EAL (ng/m^3)**	**% of EAL**
Arsenic	0.248	200	0.12	7.55	15,000	0.05
Antimony	0.248	5,000	0.005	7.55	150,000	0.005
Cadmium	0.112	5	2.24	3.40	1,500	0.23
Chromium	0.248	5,000	0.005	7.55	150,000	0.005
Chromium (VI)	0.0298	100	0.03	0.91	3000	0.03
Cobalt	0.248	200	0.12	7.55	6,000	0.13
Copper	0.248	10,000	0.002	7.55	200,000	0.004
Lead	0.248	250	0.01	7.55	-	-
Manganese	0.248	1,000	0.025	7.55	1,500,000	0.001
Mercury	0.224	250	0.09	6.80	7,500	0.09
Nickel	0.248	1,000	0.025	7.55	30,000	0.025
Thallium	0.112	1,000	0.01	3.40	30,000	0.01
Vanadium	0.248	5,000	0.005	7.55	1,000	0.76

It can be seen that only long-term contributions of cadmium exceed 1% of the EAL and that none of the short term contributions exceed 10% of the EAL. Therefore, only cadmium does not make an insignificant contribution to atmospheric concentrations. Since the recorded background concentration of cadmium was 3.64 ng/m³ from Walsall Willenhall monitoring station, it can be seen that no breaches of the EAL for cadmium, 5 ng/m^3, are predicted.

The Fourth Daughter Directive on air quality includes target emission limits of 6 ng/m^3 for arsenic and 20 ng/m^3 for nickel. The predicted contribution from the plant to the annual average ground level concentration of arsenic or nickel is 0.248 ng/m^3, which is 4.13% of the target value for arsenic and 1.24% of the target value for nickel. While these are not insignificant contributions, the background concentrations of nickel (7.56 ng/m^3) and arsenic (1.46 ng/m^3) are low enough that the target values will not be exceeded.

Chromium can be released in two oxidised forms: Chromium (III) and Chromium (VI). Since humans are more sensitive to Chromium (VI), it should be considered separately. The speciation of chromium emissions is considered in the 18th annual report from the UK National Atmospheric Emissions Inventory[14]. Table 6.4b from this report is reproduced below. Emissions of chromium from waste are too small for the speciation figure to be meaningful, but the speciation of emissions from stationary combustion processes ("Public Power", "Other Industrial Combustion" and "Combustion in Dom/Inst/Com") shows that, out of 24.2 tonnes of Chromium released, 2.9 tonnes, or 12%, is estimated to be Chromium(VI).

[14] *"UK Emissions of Air Pollutants 1970 to 2004",* NAEI, December 2006

Table 6.4b Speciated Emissions of Chromium (tonnes)

	Cr^{6+}	Cr^{3+}	Total (2004)
BY aggregated UN/ECE CATEGORY[1]			
Public Power	0.8	4.7	5.5
Other Industrial Combustion	1.8	14.4	16.2
Combustion in Dom/Inst/Com	0.3	2.3	2.5
Production Processes	3.9	10.8	14.7
Road Transport	0.2	0.8	1.0
Off-road Vehicles and Other Machinery	0.0	0.2	0.2
Waste	0.0	0.3	0.4
TOTAL	7.0	33.0	40.0

[1] See Annex 1 for definition of UN/ECE Categories

Therefore, it can be assumed that no more than 12% of chromium released from the facility would be Chromium (VI). Therefore, if it is assumed that the facility released chromium at one-ninth of the emission limit for other metals, the highest annual average ground level concentration of Chromium (VI) would be 0.0298 ng/m^3 and the peak hourly ground level concentration would be 0.91 ng/m^3. These concentrations are 0.03% of the long term EAL and 0.03% of the short term EAL respectively.

As mentioned earlier, EPAQS have published new guidelines for nickel, arsenic and chromium (VI). The predicted contributions are 1.24% of the guideline for nickel, 8.27% for arsenic and 14.9% for chromium (VI).

4.3.10 Polycyclic Aromatic Hydrocarbons

The highest annual average ground level concentration of benzo(a)pyrene from the plant is predicted to be 8.94 pg/m^3, using weather data from 2008. This is around 3.58% of the provisional AQO for benzo[a]pyrene. If this is added to the background concentration of 0.14 ng/m^3 (or 140 pg/m^3), the total predicted ground level concentration is 148.9 pg/m^3, which is well below the provisional air quality objective of 250 pg/m^3.

4.3.11 Dioxins and Furans

The highest annual average ground level concentration of dioxins from the plant is predicted to be 0.45 fg/m^3, using weather data from 2008. This is around 1.9 % of the average background concentration.

As the key health risk due to dioxins is due to ingestion via the food chain, peaks in dioxin emissions are not considered to be a problem. It is the accumulated annual emission which must be assessed.

Inhalation of dioxins from the air is a relatively minor exposure route for humans. In order to assess the true impact of the facility on human health, it is necessary to consider all possible exposure pathways. This is done in section 8 below.

4.4 Sensitivities

4.4.1 Stack Height

The sensitivity of the results to changing the height of the main stack was considered by re-running the model with stack heights between 60 metres and 100 metres. The results show the contribution to the ground level concentration of the emissions of nitrogen dioxide at the point of maximum impact for 2006 weather data.

Table 4.8: Impact of Changing Stack Height on Nitrogen Dioxide Concentrations, Stack Emissions Only

Boiler Stack Height (m)	Annual Averages		99.79th percentile of hourly averages	
	PC	PEC	PC	PEC
60	1.28	28.98	13.89	69.29
70	0.77	28.47	7.39	62.79
75	**0.61**	**28.31**	**5.93**	**61.33**
80	0.52	28.22	4.81	60.21
85	0.43	28.13	4.29	59.69
90	0.41	28.11	4.12	59.52
100	0.40	28.10	4.03	59.43

PC = "Process Contribution", which is the peak contribution of the emissions from the plant to the ground level concentration.

PEC = "Predicted Environmental Concentration", which is obtained by adding the background concentration of 27.7 µg/m^3 to the annual average contribution or 55.4 µg/m^3 to the 99.79th percentile contribution.

All figures are shown in µg/m^3

It can be seen that increasing the stack height from 75 metres to 100 metres has a small impact on the annual average Predicted Environmental Concentration. The reduction in peak contribution is 0.21 µg/m^3, which is a reduction of 0.74% of the total concentration or 0.53% of the air quality objective of 40 µg/m^3.

An increase in stack height has a more noticeable effect on the peak contribution of the plant to the 99.79th percentile of hourly means. An increase from 75 metres to 100 metres leads to a reduction in the PEC of 1.9 µg/m^3, which is a reduction of 3.1% of the total concentration or 0.95% of the air quality objective of 200 µg/m^3.

The stack height of 75 metres has been chosen as it represents the point where increasing the height does not lead to significant reductions in ground level concentration.

4.4.2 Roughness

The sensitivity of the results to the surface roughness length has been assessed by rerunning the model using 2008 weather data and a roughness length of 0.2, 0.3 and 0.5 metres. The results for nitrogen dioxide were as follows:

- The contribution to the annual average ground level concentration increased with increasing roughness length. The results were 0.537, 0.626 and 0.767 µg/m^3 respectively for the three roughness lengths.
- The contribution to the 99.79th percentile of the hourly ground level concentration decreased with increasing roughness length. The results were 6.043, 6.022 and 6.057 µg/m^3 respectively for the three roughness lengths.

The variation in roughness causes a negligible difference to the short term ground level concentrations and a slight difference to the long term concentration.

The selected roughness length of 0.3 metres is representative of agricultural land and is therefore considered to be representative of the area around the site.

4.4.3 Complex Terrain Sensitivity

To model the impact of terrain in the surrounding area on the air dispersion, the complex terrain option was used within ADMS. A sensitivity assessment was undertaken to examine the impact of the land restoration levels of the restored landfill site, situated to the north of the site. As a result of the changes to land levels following the restoration, the long term nitrogen dioxide ground level concentration at the point of maximum impact was decreased by 0.02 µg/m^3, which is around 3% of the current modelled contribution, or 0.05% of the AQO.

4.5 Sensitive Environmental Receptors

4.5.1 Location of Sensitive Environmental Receptors

The Mercia EnviRecover site is not located in close proximity to any sites classified as a Special Area of Conversation (SAC) or a Special Protection Area (SPA) under the European Habitats and Birds Directives. The closest SAC is the Lyppard Grange Ponds site which is located 14.4km to the south of the facility in Worcester. The facility is also not located near any sites protected under the Ramsar convention on wetlands. However, there are some Sites of Special Scientific Interest (SSSI) within 5 km of the site. Details of these sites are listed below.

Table 4.9 Sensitive Environmental Receptors

Site	Eastings	Northings	Distance from site (km)	Designation
SAC, SPA Ramsar (within 15 km)				
LYPPARD GRANGE PONDS	387967	255684	14.4	SAC containing: 8% - inland water body. 22% - heath, scrub, maquis and garrigue, phygrana. 70% - improved grassland. Ponds are particularly important for great crested newts.
SAC, SPA Ramsar (within 10 km)				
NONE				
SSSI's (within 5 km)				
HARTLEBURY COMMON & HILLDITCH COPPICE	383233	270864	2.9	Important area of dry dwarf shrub heathland. Supports heather, gorses, vetch. A valley mire has developed over thick peat and is dominated by mosses. All three British newts found at this site.
WILDEN MARSH & MEADOWS	382731	273191	4.62	Wilden Marsh is the richest and most diverse wetland habitat in Worcestershire and includes examples of fen, damp meadow, marshy grassland and carr.
RIVER STOUR FLOOD PLAIN	382446	272937	4.65	Important for paleohydrological studies of the River Severn.

Table 4.9 Sensitive Environmental Receptors				
Site	**Eastings**	**Northings**	**Distance from site (km)**	**Designation**
Local Nature Reserves, Ancient Woodland, Woodland Trust sites (within 3 km)				
HARTLEBURY COMMON & HILLDITCH COPPICE	383233	270864	2.9	Local Nature Reserve (As above)
THE FOREST	386326	269089	0.89	Ancient and semi-natural woodland
UPPER SHOOTERS WOOD + LITTLE SHOOTERS WOOD	386694	268415	1.65	Ancient, semi-natural and replanted woodland
MIDDLE COVERT	386100	269900	0.13	Broad leaf woodland

4.5.2 Assessment Criteria

The Air Quality Limit Values Regulations 2003 contain the following limit values for the protection of ecosystems

(1) For nitrogen oxides (as NO_2): 30 µg/m^3 as an annual mean.

(2) For sulphur dioxide: 20 µg/m^3 as an annual mean, and as a winter average.

4.5.3 Impact of Plant

The highest predicted contributions to ground level concentrations at the protected habitats listed above are shown in Table 4.10 below.

Table 4.10 Impact at Sensitive Environmental Receptors		
Site	**Nitrogen oxides, annual average µg/m^3**	**Sulphur dioxide, annual average µg/m^3**
LYPPARD GRANGE PONDS	0.025	0.006
HARTLEBURY COMMON & HILLDITCH COPPICE	0.044	0.011
WILDEN MARSH & MEADOWS	0.034	0.009
RIVER STOUR FLOOD PLAIN	0.034	0.008
THE FOREST	0.726	0.181
UPPER SHOOTERS WOOD + LITTLE SHOOTERS WOOD	0.391	0.098
MIDDLE COVERT	0.025	0.006

The impact at the Middle Covert is taken as the highest predicted concentration at two separate points within the wood (386100,269900 and 386100,270000) since it is located in close proximity to the stack.

4.5.3.1 Oxides of Nitrogen

The highest average predicted annual contribution to the ground level concentration of nitrogen oxides at a SSSI is 0.044 µg/m³ at Hartlebury Common. This is 0.15% of the air quality objective for the protection of ecosystems. The contribution at the Lyppard Grange Ponds SAC is extremely small at 0.08% of the air quality objective and is therefore considered insignificant.

The highest average concentration at the non-statutary habitats is 0.726 µg/m³ at The Forest. This is 2.4% of the air quality objective for the protection of ecosystems.

Therefore, the EfW plant will have not have a significant impact on the concentration of nitrogen oxides at any of the SSSIs, but will have a slight impact at The Forest and Upper and Little Shooters Wood.

The impact of nitrogen deposition at The Forest and Upper and Little Shooters wood is therefore considered further in section 4.5.4 along with the SSSIs that are sensitive to nitrogen deposition.

4.5.3.2 Sulphur Dioxide

The highest average predicted annual contribution to the ground level concentration of sulphur dioxide at a SSSI is 0.011 µg/m³ at Hartlebury Common. This is 0.055% of the air quality objective for the protection of ecosystems. The contribution at the Lyppard Grange Ponds SAC is extremely small at 0.03% of the air quality objective and is therefore considered insignificant.

The highest average concentration at the other habitats is 0.181 µg/m³ at the The Forest. This is 0.91% of the air quality objective for the protection of ecosystems.

Therefore, the EfW plant will have not have a significant impact on the concentration of sulphur dioxide at any location, including the designated sites.

4.5.4 Deposition

In addition to the air quality standards considered above, the APIS Database[15] contains the following critical loads for nitrogen deposition:

- 10-20 kg N/hectare/year for broad leaf woodland (found in Middle Covert, the Forest and Upper and Little Shooters Wood)
- 10-20 kg N/hectare/year for lowland heathland (found on Hartlebury Common and Lyppard Grange Ponds)
- 10-30 kg N/hectare/year for grazing marsh (found at Wilden Marsh)

There is no critical load provided for acid deposition for any of the specific habitats. However, critical loads are provided by the Simple Site Based Assessment tool, which take account of the soil types present but not the habitats. The impact of acid deposition has therefore been assessed against these critical loads.

The Apis database has also been used to provide current deposition levels.

[15] UK Air Pollution Information System at www.apis.ac.uk

4.5.4.1 Deposition Modelling Methodology

The impact of deposition has been assessed using the deposition modules within ADMS and the approach recommended by the Environment Agency.

ADMS includes two deposition modules.

(1) Dry Deposition occurs when material is lost from the plume at the surface of the ground. This is the primary method of deposition for particulate matter. The Environment Agency recommends that the following deposition velocities be used:

a) NO_2 1.5 mm/s for grassland,3 mm/s for woodland

b) SO_2 12 mm/s for grassland, 24 mm/s for woodland

c) NH_3 20 mm/s for grassland, 30 mm/s for woodland

d) HCl 2.5 mm/s for grassland, 6 mm/s for woodland

(2) Wet Deposition occurs when pollutants are washed out of the plume by rain. The Environment Agency recommends that wet deposition be ignored for deposition within about 15 km of the emission point, as in this case, with the exception of hydrogen chloride.

ADMS predicts deposition results in units of $\mu g/m^2/s$. These have been converted into suitable units for comparison with the benchmarks as follows:

- It is converted to kg/hectare/year by multiplying by 3600 x 24 x 365 (seconds/year), then by 10000 (m^2/hectare) and then dividing by 1,000,000,000 (µg/kg).
- For nitrogen deposition, the deposition rate of NO_2 is multiplied by 14/46, the deposition rate of NO is multiplied by 14/30 and the deposition rate of NH_3 is multiplied by 14/17 to give total deposition in kg of N/he/year.

The Environment Agency has recently issued guidance on the assessment of ammonia deposition. This states that wet deposition of NH_3 is negligible and that dry deposition of ammonia should not be used within ADMS. The ground level concentrations of ammonia should be used to calculate the dry deposition flux by multiplying by the dry deposition velocities above:

This provides a value in units of $\mu g/m^2/s$ which must then be converted as above. This approach is expected to be conservative.

4.5.4.2 Impact of Plant

The highest predicted levels of nitrogen deposition at the protected habitats listed above are shown in Table 4.11 below.

Table 4.11 Nitrogen Deposition at Sensitive Environmental Receptors

Site	Critical Load, kg N/he/yr	Current Deposition Rate, kg N/he/yr	Nitrogen Deposition, kg N/he/yr	Percentage of Critical Load
LYPPARD GRANGE PONDS	10-20	22	0.001	0.05
HARTLEBURY COMMON & HILLDITCH COPPICE	10-20	25.8	0.017	0.09
WILDEN MARSH & MEADOWS	10-30	25.8	0.014	0.05
THE FOREST	10-20	20	0.387	1.93
UPPER SHOOTERS WOOD + LITTLE SHOOTERS WOOD	10-20	38.9	0.208	1.04
MIDDLE COVERT	10-20	38.9	0.073	0.37

The predicted levels of nitrogen deposition at the SAC (Lyppard Grange Ponds) and the SSSI sites of Hartlebury Common and Wilden Marsh and Meadows are well below 1% of the critical load and are therefore insignificant.

The impact of nitrogen deposition at The Forest, Upper Shooters Wood and Little Shooters Wood cannot be considered insignificant. However, the main contribution to the nitrogen deposition rate is from ammonia deposition which is modelled using a conservative modelling method. Furthermore this is based on emissions of ammonia at a concentration of 10 mg/m^3 for 8760 hours per year. In actual operation the facility is likely to emit at a rate of around 5-6 mg/m^3 for around 8000 hours per year, reducing the level of nitrogen deposition.

The highest predicted levels of acid deposition at the protected habitats listed above are shown in Table 4.12 below.

Table 4.12 Acid Deposition at Sensitive Environmental Receptors				
Site	**Critical Load, keq/he/yr**	**Current Deposition Rate, keq/he/yr**	**Acid Deposition, keq/he/yr**	**Percentage of Critical Load**
LYPPARD GRANGE PONDS	4	1.94	0.0009	0.02
HARTLEBURY COMMON & HILLDITCH COPPICE	0.35	2.27	0.0021	0.59
WILDEN MARSH & MEADOWS	0.75	2.27	0.0015	0.20
THE FOREST	10.55	3.03	0.070	0.66
UPPER SHOOTERS WOOD + LITTLE SHOOTERS WOOD	10.55	3.03	0.037	0.35
MIDDLE COVERT	10.55	3.03	0.0149	0.14

It can be seen that the contribution to acid deposition at each of the receptors is less than 1% of the respective critical loads, and so the impact is insignificant.

5 TRAFFIC MODELLING RESULTS

5.1 Model Methodology

The assessment was carried out using the screening method outlined in Section 3 of Volume 11 of the Design Manual for Roads and Bridges (DMRB), produced by the Highways Agency. A software tool is available to implement this method.

5.2 Model Inputs

The traffic assessment has identified the effect that the development will have on the traffic volumes for 2014 traffic and 2024 traffic. 2014 has been selected because this is the expected operational start year for the facility. 2024 has been selected to provide an estimate of the facility's contribution to future traffic emissions.

The inputs for the dispersion modelling of the traffic movements are taken from the detailed transport assessment carried out by traffic consultants Axis. The following assumptions were made:

(1) Emission factors were taken as typical vehicles in 2014 and 2024 respectively;

(2) The receptors were taken to be 15 metres from the centre of the road with the exception of Oldhouse Farm which is 100 m from the road;

(3) Six traffic loads have been considered as follows and illustrated on Figure 6.

   a) The A449 north bound from the A449/Crown Lane roundabout;

   b) The A449 southbound from the A449/Crown Lane roundabout;

   c) Crown Lane eastbound from the A449/Crown Lane roundabout;

   d) Crown Lane to the west of the Crown Lane/Trading Estate junction;

   e) Crown Lane to the east of the Crown Lane/Trading Estate junction; and

   f) The road north leading into the Trading Estate from the Crown Lane/Trading Estate Junction.

(4) The average vehicle speed on all the roads was taken as 30km/h;

(5) The baseline traffic includes current traffic to and from the facility; and

(6) Only 12 hour data has been made available (7 am to 7 pm) but the DMRB method uses an hourly basis over an entire day. The 2008 TSGB report information has been used to factor up the 12 hour records to a 24 hour basis.

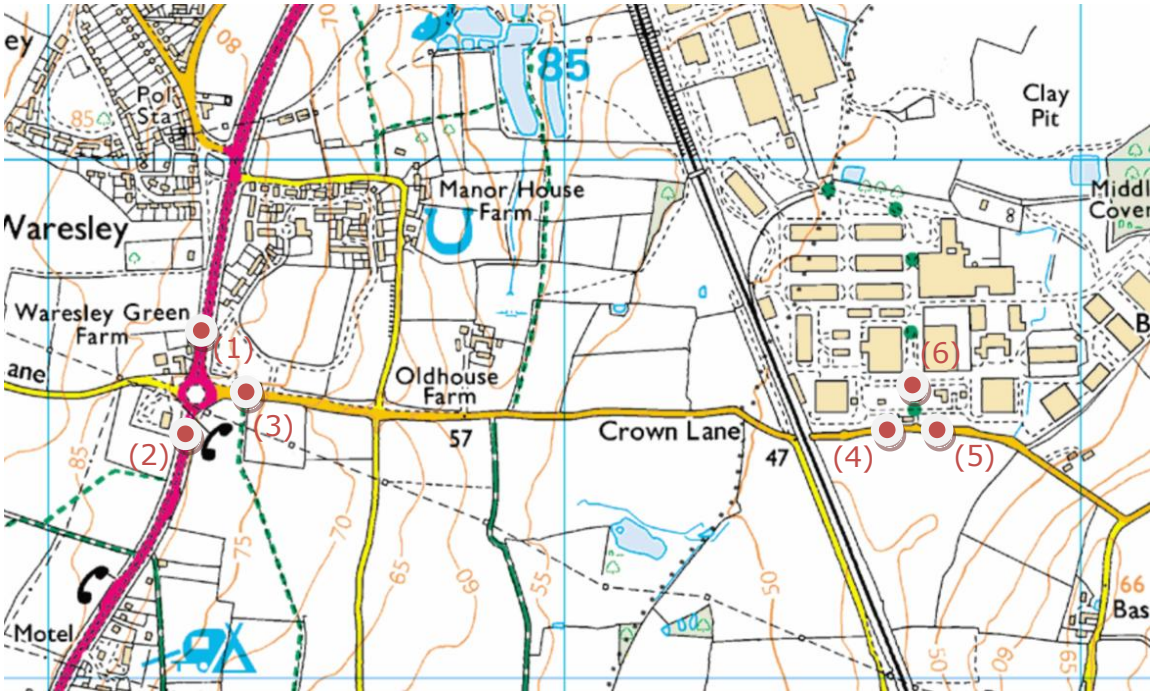

Figure 6 – Map of the local road network

The total two way flows along each of the roads and the composition of the traffic can be seen in the tables below:

Table 5.1 2014 Base Traffic Volume Data

Road Name	Daily Traffic Volume (24 hours)	% LDV	% HDV
The A449 north bound from the A449/Crown Lane roundabout	22,580	93.75	6.25
The A449 southbound from the A449/Crown Lane roundabout	21,330	93.13	6.87
Crown Lane eastbound from the A449/Crown Lane roundabout	5,959	88.35	11.65
Crown Lane to the west of the Crown Lane/Trading Estate junction	4,455	84.98	15.02
Crown Lane to the east of the Crown Lane/Trading Estate junction;	714	98.04	1.96
The road north leading into the Trading Estate from the Crown Lane/Trading Estate Junction	4,406	84.95	1.96

Table 5.2 2024 Base Traffic Volume Data			
Road Name	**Daily Traffic Volume (24 hours)**	**% LDV**	**% HDV**
The A449 north bound from the A449/Crown Lane roundabout	23,895	93.58	6.42
The A449 southbound from the A449/Crown Lane roundabout	22,801	93.02	6.98
Crown Lane eastbound from the A449/Crown Lane roundabout	5,470	86.23	13.77
Crown Lane to the west of the Crown Lane/Trading Estate junction	4,839	84.98	15.02
Crown Lane to the east of the Crown Lane/Trading Estate junction;	775	98.07	1.94
The road north leading into the Trading Estate from the Crown Lane/Trading Estate Junction	4,786	84.96	15.04

Table 5.3 2014 Background Traffic Volumes Plus Development Traffic			
Road Name	**Daily Traffic Volume (24 hours)**	**% LDV**	**% HDV**
The A449 north bound from the A449/Crown Lane roundabout	22,748	93.54	6.46
The A449 southbound from the A449/Crown Lane roundabout	21,612	92.21	7.79
Crown Lane eastbound from the A449/Crown Lane roundabout	6,409	84.87	13.14
Crown Lane to the west of the Crown Lane/Trading Estate junction	4,906	80.71	19.28
Crown Lane to the east of the Crown Lane/Trading Estate junction;	714	98.04	1.96
The road north leading into the Trading Estate from the Crown Lane/Trading Estate Junction	4,857	80.65	19.35

Table 5.4 2024 Background Traffic Volumes Plus Development Traffic			
Road Name	**Daily Traffic Volume (24 hours)**	**% LDV**	**% HDV**
The A449 north bound from the A449/Crown Lane roundabout	24,642	93.56	6.44
The A449 southbound from the A449/Crown Lane roundabout	23,431	92.24	7.76
Crown Lane eastbound from the A449/Crown Lane roundabout	6,847	84.91	15.09
Crown Lane to the west of the Crown Lane/Trading Estate junction	24,642	93.56	6.44
Crown Lane to the east of the Crown Lane/Trading Estate junction;	23,431	92.24	7.76
The road north leading into the Trading Estate from the Crown Lane/Trading Estate Junction	6,847	84.91	15.09

5.3 Modelling Results

The results of the dispersion modelling of the traffic emissions can be found below. All figures represent the annual average ground level concentrations for the relevant pollutant.

Table 5.5 Results of Assessment of Traffic Emissions

Pollutant	15 m from road side					
	Nitrogen dioxide (µg/m^3)			Particulate matter (µg/m^3)		
Air Quality Objective (Long Term)	40			40		
Background Concentration	27.7			22.2		
Location	**Baseline**	**Baseline and Development**	**Increase**	**Baseline**	**Baseline and Development**	**Increase**
A449 Roundabout Area						
2014 Roundabout North	5.44	5.53	0.09	1.75	1.77	0.02
2014 Roundabout South	5.57	5.93	0.36	1.76	1.84	0.08
2014 Roundabout East	3.08	3.81	0.73	0.74	0.90	0.16
2024 Roundabout North	4.96	5.02	0.06	1.61	1.63	0.02
2024 Roundabout South	5.06	5.34	0.28	1.62	1.68	0.06
2024 Roundabout East	2.72	3.45	0.73	0.62	0.80	0.18
Old House Farm Area						
2014 Oldhouse Farm	0.47	0.60	0.13	0.08	0.10	0.02
2024 Oldhouse Farm	0.43	0.54	0.11	0.07	0.08	0.01
Junction to Industrial Estate Area						
2014 Junction West	2.82	3.57	0.75	0.62	0.78	0.16
2014 Junction East	0.24	0.24	0.00	0.06	0.06	0.00
Baseline 2014 Junction North	2.79	3.55	0.76	0.62	0.78	0.16
Baseline 2024 Junction West	2.58	3.21	0.63	0.57	0.69	0.12
Baseline 2024 Junction East	0.23	0.23	0.00	0.06	0.06	0.00
Baseline 2024 Junction North	2.56	3.19	0.63	0.56	0.68	0.12

It can be seen that the increase in ground level concentrations is very small for most receptors. It is less than 1% of the air quality objective for PM10s and less than 2% for nitrogen dioxide. Where the contribution to nitrogen dioxide concentrations is greater than 1%, this occurs at locations close to Crown Lane where there are no areas of human habitation. At the closest residence to Crown Lane –Oldfield Farm – the predicted contribution is less than 0.5% of the air quality objective.

Impact of Sulphur Dioxide

The impact of sulphur dioxide emissions released from traffic associated with the development has not been assessed because the contribution of sulphur dioxide to background air quality levels will be extremely small as vehicles associated with the development (for waste deliveries, material deliveries etc.) will be fuelled by ultra-low sulphur diesel (ULSD). Ultra low sulphur diesel contains a maximum of 10 ppm of sulphur.

6 PLUME VISIBILITY

A plume visibility assessment was carried out, with water content in the flue gases of 18.02 % by volume, or 0.131 kg water per kg dry gas. The results were as follows:

Table 6.1 Plume Visibility Results

Weather Data	Percentage of time plume is visible, [%]	Longest Visible Plume Length (m)	Average Visible Plume Length(m)	Percentage of time there is a visible plume over 75 metres [%]	Percentage of time there is a visible plume outside site boundary
2004	27.30%	215.8	38.8	2.36%	4.70%
2005	29.90%	192.4	43.0	3.22%	5.10%
2006	27.80%	186.3	39.9	2.31%	6.45%
2007	25.90%	172.4	38.9	1.91%	5.66%
2008	30.10%	197.4	42.5	3.32%	6.88%
All Data	**28.20%**	**193**	**40.6**	**2.62%**	**5.76%**

It can be seen that the plume is visible for around 28% of the time. The chance of the plume being visible is different depending upon the time of day. There is a slightly higher chance in the morning (6 am to 10 am) and a slightly lower chance in the afternoon (2 pm to 6 pm). Over the year, the plume is rarely visible in the summer (June to September) and most visible in January and February.

From analysis of the results, it can be seen that:

- the length of the visible plume only exceeds 75 metres, which is the height of the stack, for around 2.62 % of the time;
- The plume is predicted to be visible outside the site boundary for less than 5.8% of the time, with the site boundary being between 30m and 175m away from the stack; and
- The plume does not extend to any residential areas when visible.

For these reasons, the visibility of the plume is considered to be acceptable.

7 OTHER INFLUENCES

7.1 Brickworks Kiln

Hartlebury Brickworks is located on land adjacent to the proposed site, to the north-west. This is a potential source of atmospheric emissions, which could combine with the emissions from the EfW plant. The potential interactions have been examined using dispersion modelling, based on information from the brickworks PPC operational monitoring results.

The inputs to the dispersion model for the Brickworks are shown below.

Table 7.1 Brickworks Source and Emissions Data

Item	Unit	Stack	
Stack Height (from ground level)	m	27	
Effective Internal Stack Diameter	m	1.6	
Stack Position (Eastings, Northings)	m, m	385465, 270307	
Stack Flue Gas Exit Velocity	m/s	21.81	
Flue Gas Conditions			
Temperature	°C	381	
Volume at reference conditions (dry)	Nm^3/s	18.3	
	Nm^3/h	65,893	
Volume at discharge conditions (wet)	Am^3/s	43.85	
	Am^3/h	157,854	
Emissions		**Conc. (mg/m3)**	**Rate (g/s)**
Oxides of nitrogen (as NO_2)		49	0.897
Sulphur dioxide		14	0.256
Particulates (PM_{10})		3.2	0.059
Hydrogen Chloride		3	0.055

7.1.1 Impact of Brickworks Alone

The results of the dispersion modelling of the Brickworks alone, without the EfW plant, are shown below. The results are only shown for nitrogen dioxide, because this has the most significant impact.

Table 7.2 Brickworks Dispersion Modelling Results								
Pollutant	Quantity	Contribution to Ground Level Concentration at point of greatest impact (µg/m^3)						Max as % of AQO/EAL
		2004	2005	2006	2007	2008	Max	
Nitrogen dioxide	Annual Mean	2.39	2.88	3.12	2.72	3.20	3.20	7.99%
	99.79th %ile of hourly means	14.05	13.06	12.99	13.40	13.94	14.05	7.03%

The predicted contribution of the brickworks to the long term nitrogen dioxide levels in the atmosphere is significant, but the short term contribution can be considered insignificant. However, since the conservative background concentration of nitrogen dioxide is 27.7 µg/m^3 and 55.4 µg/m^3 for the long term and short term respectively, no breaches of air quality objectives are predicted.

7.1.2 Impact of Brickworks and EfW Plant

The results of the dispersion modelling of the brickworks and the EfW in combination require careful analysis. This is because the highest contributions from the two plants do not occur at the same place or under the same weather conditions.

The table below shows the following quantities:

- The highest contribution to ground level concentrations from the EfW facility independently.
- The highest contribution to ground level concentrations from the brickworks independently.
- The highest contribution to ground level concentrations from the two plants in combination.
- The difference between the peak combined contribution and the contribution from the brickworks. This shows the impact of the EfW on peak concentrations.
- The highest difference between the combined contribution and the brickworks contribution at any point. This shows the highest impact of the EfW.

Table 7.3 Combined Brickworks and EfW Plant Dispersion Modelling Results						
Pollutant	Quantity	Peak Contribution (µg/m^3)			Difference between peak conc. at the points of maximum impact. (µg/m^3)	Highest increase in Conc. at any point. (µg/m^3)
		EfW	Brickwork	EfW facility and the Brickwork		
Nitrogen dioxide	Annual Mean	0.63	3.20	3.34	0.14	0.63
	99.79th%ile of hourly means	6.11	14.05	14.05	0.00	5.37

It can be seen that the contribution from the emissions from the brickworks is significantly higher than that from the EfW facility and dominates the combined contribution for nitrogen dioxide. This is because the emissions from the brickworks are from a much shorter stack than the EfW facility stack so the dispersion is less effective.

However, even if the combined contribution is added to the background concentration, no breaches of air quality objectives are predicted. The predicted long term concentration is 31.0 µg/m^3, which is below the AQO of 40 µg/m^3, and the predicted short term concentration is 69.4 µg/m^3, which is well below the AQO of 200 µg/m^3.

It should be noted that some of the emissions from the brickworks should have been taken into account in the National modelled data (NETCEN). This NETCEN data gives a background concentration of 15.37 µg/m^3 for 2010, significantly below the background concentration used in this assessment of 27.7 µg/m^3 for NO_2. Hence, this assessment is likely to overstate the actual concentration in the area.

8 HUMAN HEALTH RISK ASSESSMENT

8.1 Introduction

There is no evidence that a well managed modern waste management facility leads to adverse health impacts on the local population. The recent DEFRA report "Review of Environmental and Health Effects of Waste Management"[16] reviewed a large number of papers and studies on health impacts of waste management facilities. A section of the summary of this report on "Health effects linked to municipal solid waste" is reproduced below.

"The health effects of some waste management facilities have been investigated in detail, in response to public concerns.

- *The review did not find a link between the current generation of municipal solid waste incinerators and health effects. Adverse health effects have been observed in populations living around older, more polluting incinerators and industrial areas. However, the current generation of waste incinerators result in much lower levels of exposure to pollutants. We considered cancers, respiratory diseases and birth defects, but found no evidence for a link between the incidence of disease and the current generation of incinerators.*
- *A detailed UK study was carried out to investigate whether there is any indication that living close to landfill sites results in an increase in the occurrence of cancer. This study did not detect an increase in the occurrence of cancer.*
- *Studies have been carried out to investigate the existence of a link between composting facilities and the occurrence of cancers and asthma. No link has been identified.*

Thus the studies suggest that if the operation of these facilities does have any effect on the health outcomes which have been investigated, any effect is very small – smaller than many other influences on these health outcomes.

The Health Protection Agency has issued a more recent statement on "The Impact on Health of Emissions to Air from Municipal Waste Incinerators" (September 2009)[17]. The summary of this statement is reproduced below:

[16] Review of Environmental and Health Effects of Waste Management: Municipal Solid Wastes and Other Similar Wastes, March 2004, DEFRA

[17] The Impact on Health of Emissions to Air from Municipal Waste Incinerators, September 2009, HPA.

The Health Protection Agency has reviewed research undertaken to examine the suggested links between emissions from municipal waste incinerators and effects on health. While it is not possible to rule out adverse health effects from modern, well regulated municipal waste incinerators with complete certainty, any potential damage to the health of those living close-by is likely to be very small, if detectable. This view is based on detailed assessments of the effects of air pollutants on health and on the fact that modern and well managed municipal waste incinerators make only a very small contribution to local concentrations of air pollutants. The Committee on Carcinogenicity of Chemicals in Food, Consumer Products and the Environment has reviewed recent data and has concluded that there is no need to change its previous advice, namely that any potential risk of cancer due to residency near to municipal waste incinerators is exceedingly low and probably not measurable by the most modern techniques. Since any possible health effects are likely to be very small, if detectable, studies of public health around modern, well managed municipal waste incinerators are not recommended.

Despite the advice from health specialists such as the Health Protection Agency that the damage to health is likely to be very small, and probably not detectable, the specific effects on human health of the proposed EfW plant have been considered. For most substances released from the plant, the most significant effects on human health will arise by inhalation. The air quality objectives discussed above have been set by the various authorities at a level which is considered to present minimum or zero risk to human health. It is widely accepted that, if the concentrations in the atmosphere are less than the air quality objectives, then the pollutant is unlikely to have an adverse effect on human health.

For some pollutants which accumulate in the environment, inhalation is only one of the potential exposure routes. Therefore, other exposure routes are considered in this document.

8.2 Assessment Methodology

A detailed health risk assessment has been carried out using the Industrial Risk Assessment Program-Human Health (IRAP-h View – Version 4.0). The programme, created by Lakes Environmental is based on the United States Environment Protection Agency (USEPA) Human Health Risk Assessment Protocol. This Protocol is a development of the approach defined by HMIP in 1996, taking account of further research since that date.

8.3 Modelled Emissions

For the purpose of assessing potential health impact from the emission from the EfW facility the following relevant emissions have been considered to be relevant to the long-term exposure (chronic).

(1) Group 1 metals - Mercury and compounds

(2) Group 2 metals - Cadmium, Thallium and compounds

(3) Group 3 metals - Antimony, Arsenic, Cadmium Chromium, Lead, Nickel; and

(4) Dioxins and furans.

The following table gives the emissions rates of each chemical of potential concern (COPC) modelled.

Table 8.1: COPC Emissions modelled			
COPC	**Emission rate (g/s)**	**COPC**	**Emission rate (g/s)**
Antimony	0.002027	TetraCDD,2,3,7,8-	0.000000000113
Arsenic	0.002027	HexaCDD,1,2,3,7,8,9-	0.000000000748
Benzo(a)pyrene	0.000073	OctaCDD,1,2,3,4,6,7,8,9-	0.000000014750
Cadmium	0.0009125	HeptaCDD,1,2,3,4,6,7,8-	0.000000006218
Chromium	0.002027	OctaCDF,1,2,3,4,6,7,8,9-	0.000000013013
Chromium, hexavalent	0.0009125	HexaCDD,1,2,3,4,7,8-	0.000000001047
Hydrogen Chloride	0.365	PentaCDD,1,2,3,7,8-	0.000000000894
Lead	0.002027	TetraCDF,2,3,7,8-	0.000000001011
Mercuric chloride	8.76E-04	HeptaCDF,1,2,3,4,7,8,9-	0.000000001566
Mercury	3.65E-06	PentaCDF,2,3,4,7,8-	0.000000001952
Nickel	0.002027	PentaCDF,1,2,3,7,8-	0.000000001011
Thallium (I)	0.0009125	HexaCDF,1,2,3,6,7,8-	0.000000002945
		HexaCDD,1,2,3,6,7,8-	0.000000000941
		HexaCDF,2,3,4,6,7,8-	0.000000003178
		HeptaCDF,1,2,3,4,6,7,8-	0.000000016038
		HexaCDF,1,2,3,4,7,8-	0.000000007952
		HexaCDF,1,2,3,7,8,9-	0.000000000153

8.3.1 Pathway Assessment

This health impact assessment considered the possible effects on human health of key receptors, which are likely to be exposed to the greatest impact from the facility.

The emissions from the proposed EfW facility are expected to be significant only in the locality of the plant and the sensitive receptors identified as part of the air quality assessment (as identified in Section 4.1.7) have been considered in this assessment.

The assessment utilises the IRAP-h health impact assessment program to consider the possible pathways of exposure and the accumulation in the environment and food chain.

Exposure to gaseous contaminants will occur by direct inhalation or vapour phase transfer to plants.

Exposure to particulate phase contaminants will primarily occur via indirect pathways following the deposition of particles to soil. The pathways include:

- Ingestion of soil and dust;
- Uptake of contaminants from soil into the food-chain (through home-grown produce and crops); and
- Direct deposition of particles onto above ground crops.

8.3.1.1 Concentration in Soil

The concentration of each chemical in the soil is calculated from the deposition results of the air quality modelling for vapour phase and particle phase deposition. The critical variables in calculating the accumulation of pollutants in the soil are as follows:

- The lifetime of the facility is taken as 30 years.
- The soil mixing depth is taken as 2 cm and 15 cm for produce.
- The split between the solid and vapour phase for the chemicals considered depends on the specific physical properties of each chemical.

In order to assess the amount of chemical which is lost from the soil each year through volatilisation, leaching and surface run-off, a soil loss constant is calculated. The rates for leaching and surface runoff are taken as constant, while the rate for volatilisation is calculated from the physical properties of each chemical.

8.3.1.2 Concentration in Plants

The concentrations in plants are determined by considering direct deposition and air-to-plant transfer for above ground produce, and root uptake for above ground and below ground produce. The calculation takes account of the different types of plant; for example, uptake of chemicals through the roots will differ for below ground and above ground vegetables, and deposition onto plants will be more significant for above ground vegetables.

8.3.1.3 Concentration in Animals

The concentrations in animals, based on consumption of plants, are calculated from the concentrations in plants, assumed consumption rates and bio-concentration factors. These vary for different animals and different chemicals, since the transfer of chemicals between the plants consumed and animal tissue varies.

It is also assumed that 100% of the plant materials eaten by animals is grown on soil contaminated by emission sources. This is likely to be a highly pessimistic assumption for UK farming practice.

8.3.1.4 Concentration in Humans

- **Intake via Inhalation**

  This is calculated from inhalation rates of typical adults and children and atmospheric concentrations. The calculation also takes account of time spent outside, since most people spend most of their time indoors.

- **Intake via Soil Ingestion**

  This calculation allows for the ingestion of soil and takes account of different exposure frequencies. It allows for ingestion of soil attached to unwashed vegetables, unintended ingestion when farming or gardening and, for children, ingestion of soil when playing.

- **Ingestion of Food**

  The calculation of exposure due to ingestion of food draws on the calculations of concentrations in animals and plants and takes account of different ingestion rates for the various food groups by different age groups. The data for this is UK-specific from the previous Ministry for Agriculture, Fisheries and Food.

  Most people only eat a fraction of locally-produced food and so exposure factors are applied to allow for this.

- **Breast Milk Ingestion**

  For infants, the primary route of exposure is through breast milk. The calculation draws on the exposure calculation for adults and then allows for the transfer of chemicals in breast milk to an infant who is exclusively breast-fed.

8.4 Assessment Pathways

The pathways through which inhalation and ingestion occur and the receptors that have been considered to be impacted are:

(1) Direct inhalation .....All receptors;

(2) Ingestion of soil .....All receptors;

(3) Ingestion of home-grown produce .....All receptors;

(4) Ingestion Eggs from home-grown chickens .....Only farms/schools

(5) Ingestion of home-grown chickens .....Only farms/schools

(6) Ingestion of home-grown beef .....Only farms/schools

(7) Ingestion of home-grown pork .....Only farms/schools

(8) Ingestion of home-grown milk .....Only farms/schools

8.5 Impact at receptors

The potential impact at a number of local receptors was considered. These are listed in Table 8.2 which contains the receptor designation considered most appropriate.

Table 8.2: Sensitive Receptors	
Receptor Name	**Receptor Designation**
Oldhouse Farm	Farmer Receptor
Manor House Farm	Farmer Receptor
Central Waresley (Police Station)	Residential Receptor
Moors Farm	Farmer Receptor
New Elizabethan School (Quarry Bank)	Farmer Receptor (to take account of additional home grown produce that might be consumed)
Hartlebury Post Office	Residential Receptor
Nearest dwelling on Walton Road	Residential Receptor
Nearest dwelling on Walton Lane	Residential Receptor
Whitlenge Farm	Farmer Receptor
Pyehill Farm	Farmer Receptor
Ryelands Farm	Farmer Receptor
New House Farm	Farmer Receptor
Callimore Farm	Farmer Receptor
Elmley Lovett	Residential Receptor
Cutnall Green School	Farmer Receptor (to take account of additional home grown produce that might be consumed)
Bassage Farm	Farmer Receptor
Bassage Cottages	Residential Receptor
Mountpleasant Farm	Farmer Receptor
Valley Farm	Farmer Receptor
Norchard Farm	Farmer Receptor
Nearest dwelling in Bellington	Residential Receptor
The Rectory	Residential Receptor

8.6 Estimation of COPC Concentration in Media

The IRAP-h model uses a database of physical and chemical parameters to calculate the COPC concentrations through each of the different pathways identified. The base physical and chemical parameters have been used in this assessment.

In order to calculate the COPC concentrations a number of site specific pieces of information are required, including:

(1) Weather data. MORECS data was obtained from the met office for the period 2007-09 for the MORECS square 136. The average evaporation, rainfall and precipitation can be used to calculate the general IRAP-h input parameters:

- Actual evaporation from the crop and soil into the air ... 552.5 cm/year
- Annual average precipitation ..... 770.7 cm/year
- Annual average irrigation ..... 0.0 cm/year
- Annual average runoff ..... 218.2 cm/year

(2) Average Wind Speed, 3.53 m/s calculated from the average of the 5 years of weather data that was obtained from the met office.

8.7 Hazard/Risk Characterisation and Assessment

IRAP calculates the combined impact through each of the different pathways and combining the exposure quantities and the toxicity to determine a lifetime total cancer risk or a non-cancer hazard quotient.

The total cancer risk is the probability that a human will develop cancer in their lifetime from exposure from the stack emissions. An acceptable risk level of 1E-05 (1×10^{-5}) has been used for each COPC emitted by the facility. A risk of 1E-05 can be interpreted as meaning that an individual has an increased chance of up to one in a 100,000 of developing cancer during their lifetime.

The hazard quotient is the calculation of the risk associated with developing non-cancer health effects as a result of exposure to emissions from the stack. This is not a probability but a comparison against a standard exposure level. The standard exposure level is estimated to pose no unacceptable risk in terms of adverse health effects. Therefore a hazard index of 1 is considered to be acceptable in the UK.

Table 8.3: Sum of all Cancer Risks and Hazard Quotients at each receptor

	Adult (Resident or Farmer)		Child (Resident or Farmer)	
Receptor Name	**Cancer Risk**	**Hazard Quotient**	**Cancer Risk**	**Hazard Quotient**
Oldhouse Farm	9.64E-07	4.35E-03	2.26E-06	4.68E-03
Manor House Farm	6.51E-07	2.96E-03	1.52E-06	3.17E-03
Central Waresley (Police Station)	9.41E-08	2.20E-03	2.33E-07	2.28E-03
Moors Farm	6.50E-07	2.78E-03	1.53E-06	3.00E-03
New Elizabethan School (Quarry Bank)	4.12E-07	1.82E-03	9.68E-07	1.95E-03
Hartlebury Post Office	7.59E-08	1.79E-03	1.89E-07	1.86E-03
Nearest dwelling on Walton Road	2.45E-07	5.74E-03	6.19E-07	5.98E-03
Nearest dwelling on Walton Lane	4.39E-07	1.03E-02	1.12E-06	1.07E-02
Whitlenge Farm	1.91E-06	7.89E-03	4.51E-06	8.59E-03
Pyehill Farm	2.81E-06	1.18E-02	6.65E-06	1.28E-02
Ryelands Farm	4.51E-06	1.89E-02	**1.06E-05**	**2.06E-02**
New House Farm	2.65E-06	1.13E-02	6.25E-06	1.22E-02
Callimore Farm	1.65E-06	7.02E-03	3.90E-06	7.63E-03
Elmley Lovett	1.89E-06	6.83E-03	4.53E-06	7.50E-03
Cutnall Green School	1.03E-06	4.30E-03	2.42E-06	4.65E-03
Bassage Farm	1.81E-06	7.09E-03	4.28E-06	7.70E-03
Bassage Cottages	2.20E-07	5.36E-03	5.53E-07	5.58E-03
Mountpleasant Farm	1.32E-06	4.88E-03	3.15E-06	5.32E-03
Valley Farm	7.45E-07	3.14E-03	1.76E-06	3.38E-03
Norchard Farm	7.55E-07	3.19E-03	1.78E-06	3.44E-03
Nearest dwelling in Bellington	3.15E-07	6.57E-03	6.79E-07	6.84E-03
The Rectory	4.69E-07	9.80E-03	1.01E-07	1.02E-02

From the results in Table 8.3 the calculated total risks from the combination of all contaminants through all pathways is greater than the lowest acceptable level for an individual compound of 1E-05 at only 1 receptor, Ryelands farm. This is based on the assumption that this receptor is a farm and that the farm produces beef, pork, poultry, eggs, milk and produce, all of which are consumed by the farmer.

The identified cancer risk for Ryelands Farm was predicted to be 4.51E-06 for an adult receptor and 1.06E-05 for a child receptor. The hazard quotient was predicted to be 1.89E-03 and 2.06E-02 for an adult and child receptor respectively. The risk from the individual COPC has therefore been assessed for Ryelands Farm in the following two figures.

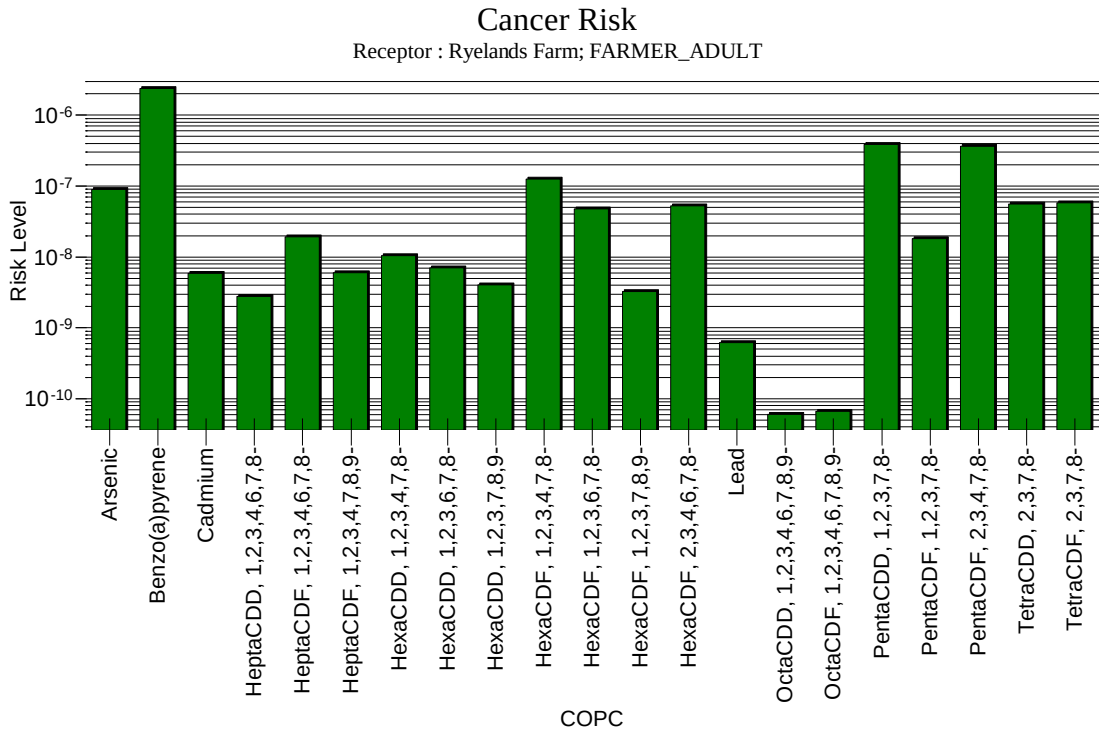

Figure 7 - Cancer Risk at Ryelands Farm for an Adult Farmer

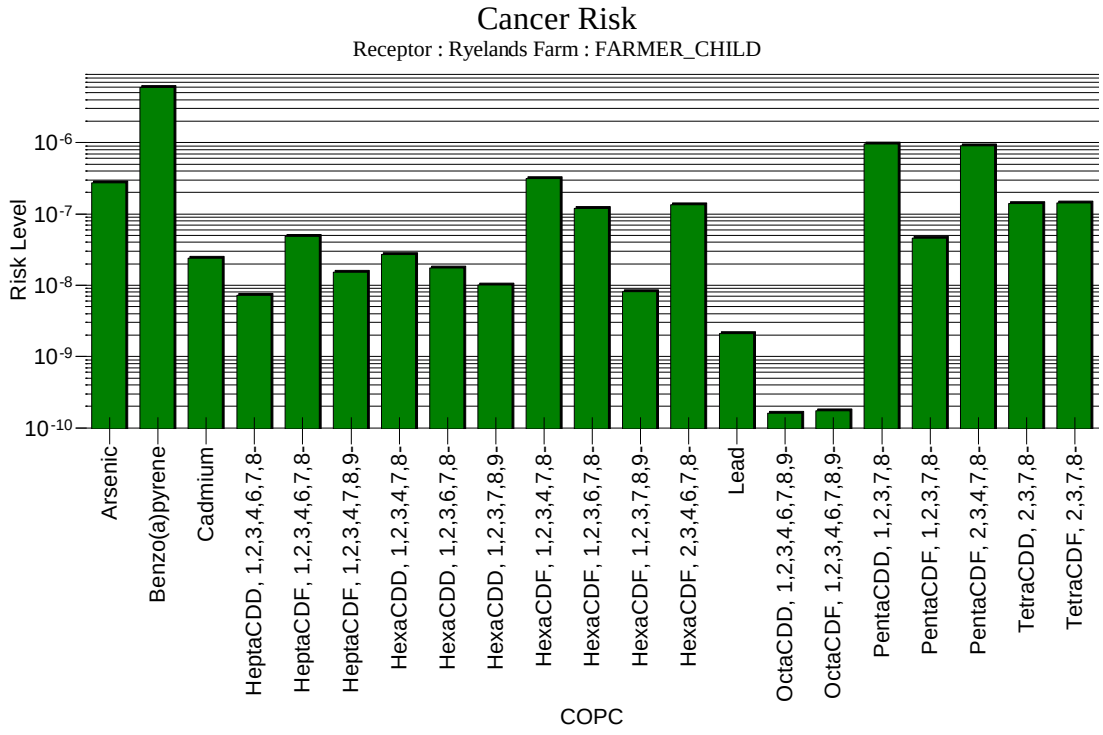

Figure 8- Cancer Risk at Ryelands Farm for a Child Farmer

The highest contribution to the cancer risk at Ryelands farm is from Benzo(a)pyrene, and this risk is less than 1E-05.

It is important to note that the modelled exposure represents a highly unlikely situation, with a number of conservative assumptions, and that in the general area the risk will be less. Even at the maximum impacted receptor all the hazard and cancer risks are well below their target levels and therefore it is unlikely that exposure to emissions from the facility will lead to an adverse impact on health.

8.8 Dioxins and Furans

For Dioxins and furans, a Tolerable Daily Intake of 2 pg ITEQ/kg bodyweight/day, or 2000 fg ITEQ/kg bodyweight/day is set in the UK. The predicted daily intake of dioxins and furans was predicted in the IRAP assessment as being 11.8 fg ITEQ/kg/day for the adult receptor at Ryelands Farm, which is 0.6% of the Tolerable Daily Intake.

8.9 COMEAP Methodology

The Department of Health Committee on the Medical Effects of Air Pollutants (COMEAP) developed a methodology applicable to the results of time series epidemiological studies which allows calculation of the public health impact of exposure to the classical air pollutants in terms of the numbers of "deaths brought forward" and the "number of hospital admissions for respiratory disease brought forward or additional". This was published in 1998[18]. Only acute effects of exposure are quantified.

This methodology was developed to be applied to urban areas of Great Britain. While it is possible to use this methodology to estimate the effects of air pollutants emitted by industrial processes on smaller areas, COMEAP have expressed reservations about this approach[19]. While COMEAP accepts that the methodology may provide broad estimates of the impact on health, there are a number of unquantified uncertainties. In the context of the EnviRecover Facility, one important caveat is that most studies into the health effects of air pollution are undertaken in urban areas, and so these studies, and any estimates based on these studies, may not be representative of the rural area around Hartlebury. COMEAP also specifically noted that

> *"If estimates of effect are made for very small areas it is likely that only small numbers of, for example, deaths or hospital admissions will be generated. It would be unwise to put too much weight on small differences between already small numbers: for example, 2 extra deaths as compared with 1 extra death"*

While acknowledging these reservations, the COMEAP methodology has been used to estimate the health impact of emissions of sulphur dioxide, nitrogen dioxide and particulate matter.

In 2009, COMEAP published a further report on the effects on mortality of long term exposure to air pollution[20]. In this report, COMEAP concluded that there is evidence to allow the quantification of impacts from PM2.5, but not from any other pollutants. The conclusions from this later report have also been considered below, and replace the equivalent figure for PM10 from the 1998 report.

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[18] COMEAP (Committee on the Medical Effects of Air Pollutants) (1998) The quantification of the effects of air pollution on health in the United Kingdom. Department of Health, London: The Stationary Office

[19] COMEAP (2000) Statement on the applicability of time-series coefficients to areas affected by emissions of air pollutants from industrial sources.

[20] COMEAP (2009) Long Term Exposure to Air Pollution: Effect on Mortality.

(1) Population Assessed

The plant would be located in Wychavon District Council. The atmospheric emissions would have their greatest effect in the parishes of Elmey Lovett, Hartlebury and Rushock (in Wyre Forest District Council), with virtually no impact in other adjacent parishes. The affected population has been taken as the population of these three parishes from the 2001 Census[21], being:

- Hartlebury: 2,549
- Elmey Lovett: 347
- Rushock: 138

(2) Exposure Response Coefficients

The exposure response coefficients developed by COMEAP are summarised below.

- *Particulate matter (PM_{10})*
  - Respiratory hospital emissions increased by 0.8% per 10 µg/m^3
  - Cardiovascular hospital emissions increased by 0.8% per 10 µg/m^3
- *Particulate matter ($PM_{2.5}$)*
  - Deaths brought forward increased by 6% per 10 µg/m^3
- *Sulphur dioxide*
  - Deaths brought forward increased by 0.6% per 10 µg/m^3
  - Respiratory hospital emissions increased by 0.5% per 10 µg/m^3
- *Nitrogen dioxide*

  No coefficient was determined, but a coefficient of 0.5% per 10 µg/m^3 was used to estimate the effect on respiratory hospital admissions in a sensitivity analysis.

(3) Emission Concentrations

The dispersion diagrams in Appendix A and the detailed results for sensitive receptors in Table 4.5 show that the highest contribution from the plant to ground level concentrations of pollutants only occurs in very small areas which are not major areas of human habitation. For example, Figure 3 shows the distribution of the contribution of the plant to the annual average ground level concentration of nitrogen dioxide. It can be seen that, while the peak contribution is 0.63 µg/m^3, the concentration in Hartlebury village is well below 0.2 µg/m^3; the concentration at Hartlebury Post Office, for example, is only 0.054 µg/m^3

Therefore, in order to assess the impact of the plant over the three parishes, the concentration has been taken to be lower than the peak concentration.

- For Hartlebury, the concentration has been taken as a sixth of the peak concentration.
- For Elmey Lovett, the concentration has been taken as half of the peak concentration, considering that this parish includes some downwind areas near to the point of maximum impact and some upwind areas.
- For Rushock, the concentration has been taken as a quarter of the peak concentration, reflecting the predicted impact at Callimore Farm:

[21] Taken from 2001 Census Worcestershire County Population Report, obtained from www.worcestershire.gov.uk.

(4) Base Health Data

- The death rate for the area covered by the Government Office of the West Midlands in 2008 was 9.7 per 1000 population.[22] (Hence, the total number of deaths expected per year in the three parishes would be about 29 or 30.)
- Total emergency respiratory hospital emissions for England for 2008/9 were 584,412 for a population of 51,446,000, giving a rate of 11.36 per 1000 population. [23]
- Total emergency cardiovascular hospital emissions for England for 2008/9 were 317,101, giving a rate of 6.16 per 1000 population.[24]

(5) Estimated Health Impacts

The population figures, exposure coefficients and emission concentrations have been combined to give the following estimated health impacts over the three parishes.

- Respiratory hospital admissions increased by 0.0034 per annum
- Deaths brought forward increased by 0.0027 per annum (0.0018 due to $PM_{2.5}$, 0.0009 due to sulphur dioxide)

It can be seen that these increases will not be noticeable. The total number of deaths brought forward over 30 years would be 0.081, which can be compared with the expected number of deaths over 25 years of 882.

[22] National Statistics Online, Vital Statistics: Population and Health Reference Tables (http://www.statistics.gov.uk/STATBASE/Product.asp?vlnk=15354)

[23] Health Episode Statistics Online (www.hesonline.nhs.uk) – Codes ICD10 J00-J99

[24] Health Episode Statistics Online (www.hesonline.nhs.uk) – Codes ICD10 I20-I52

9 DETAILED AGRICULTURAL RISK ASSESSMENT

In addition to the health impact assessment carried out (in Section 8) on the most sensitive receptors, this section identifies the increase in COPC concentrations within the surrounding farming area as a result of the operation of the EfW facility. The area around the facility is mainly agricultural with significant proportions of the land being used for arable crops, production of above ground vegetables or grazing of sheep. Therefore, estimates have been made of the following:

(1) Increased concentration of COPCs in produce;

(2) Increased concentration of COPCs in sheep; and

(3) Increased concentration of COPCs in the soil.

The increased concentration of COPC has been assessed against relevant statutory limits.

For produce and meat including lamb, the maximum levels for certain contaminants in foodstuffs are reported in the Commission Regulations (EC) No 1881/2006 as amended by the Commission Regulations (EC) No 629/2008 and the Commission Regulations (EC) No 124/2009. These are enforced by The Contaminants in Food (England) Regulations 2009 No 1223.

For soil, Soil Guideline Values (SGVs) have been taken from the most recently published Environment Agency Guidance (2009).

9.1 Identification Farming Activities

A land uses and agricultural survey was undertaken for the land surrounding the Mercia EnviRevover facility. The farm land in the surrounding area is a mixture between arable, grass for the grazing of sheep and above ground vegetables.

The following figure identifies the crop types in the surrounding fields, overlaid with the predicted ground level concentrations of nitrogen dioxide.

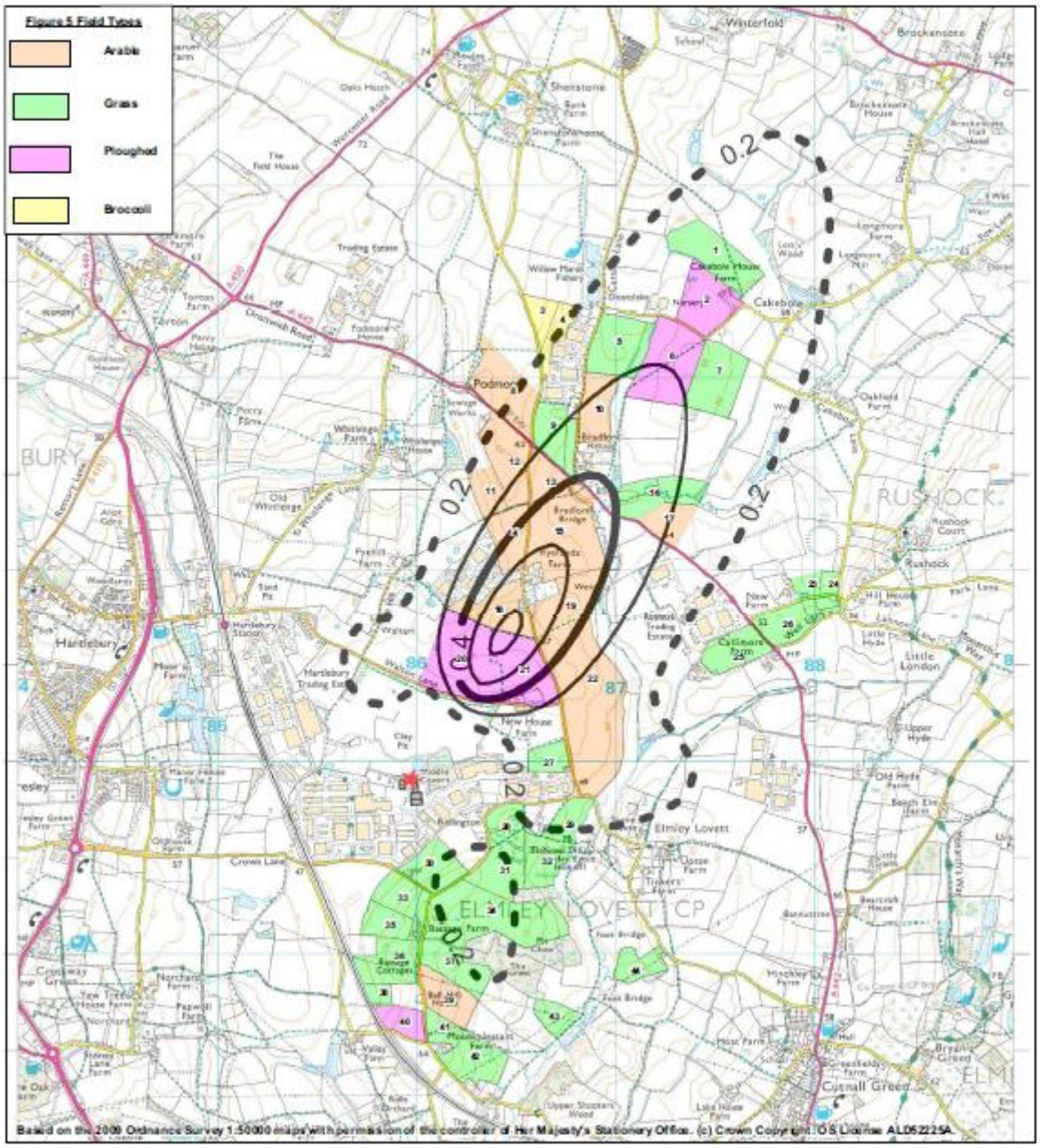


Figure 9 – Crop types in the surrounding farm land.

To enable a detailed assessment of the impact to the farmland in the area 5 separate groups of fields where identified. These can be seen on the following figure.

Area 1 - fields directly to the north of the facility, currently ploughed.

Area 2 - fields directly to the north and east of the facility, mainly arable crops.

Area 3 - fields directly to the east of the facility, mainly grass for the grazing of sheep

Area 4 - fields directly to the south of the facility, mainly grass for the grazing of sheep

Area 5 - fields directly to the far north of the facility, mixture of grass for the grazing of sheep, arable and above ground vegetables.

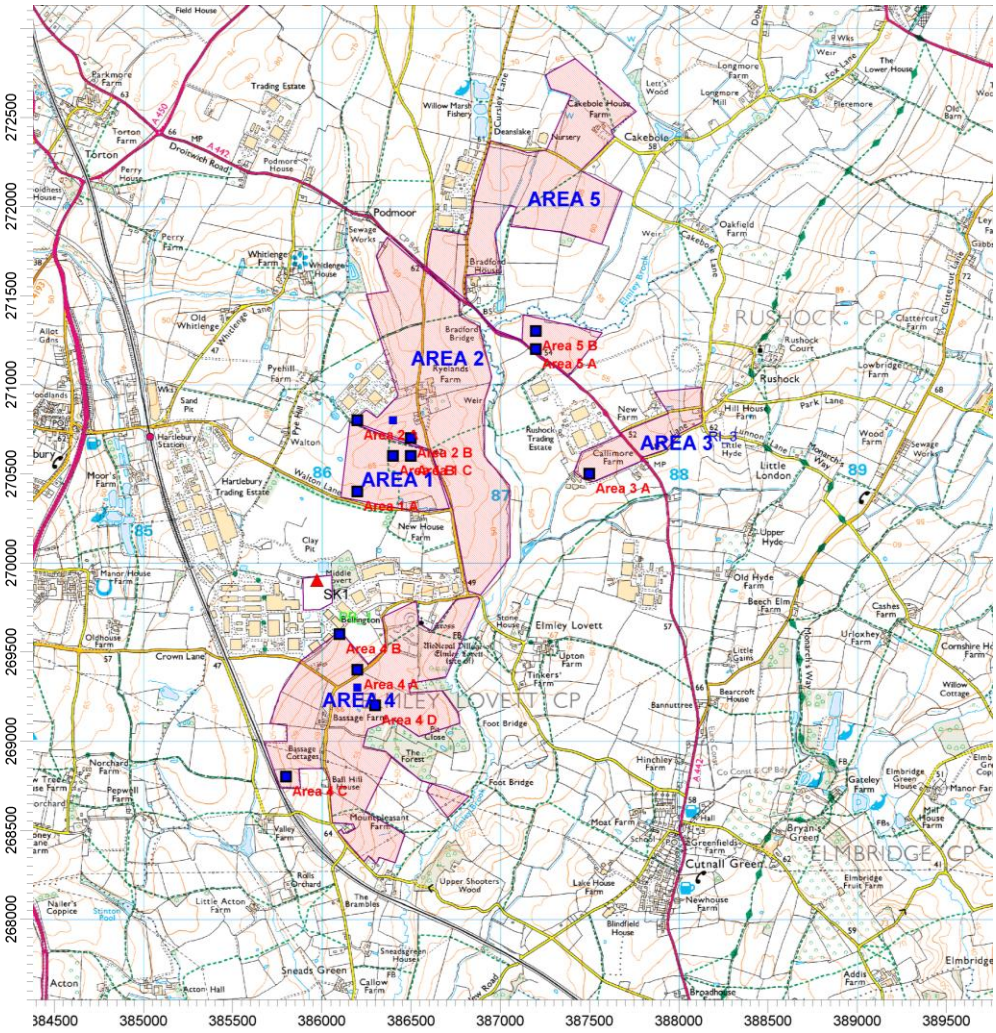


Figure 10 – Modelled Agricultural Receptors

9.2 Concentrations of COPC's within Produce

The increased levels of COPCs within produce farmed in the surrounding fields as a result of the emission from the facility have been considered. The impact at the point of maximum impact within each of the 5 farming areas has been considered and compared with the regulatory limits. The limits are given below and have been taken from the Commission Regulations setting maximum levels for certain contaminants in foodstuffs. For each COPC the most stringent level has been chosen.

Cadmium ..... 0.05 mg/kg wet weight[25]

Lead ..... 0.1 mg/kg wet weight[26]

[25] Commission Regulation (EC) No 629/2008 Annex Section 3: Metals 3.2.15. Vegetables and fruit, excluding leaf vegetables, fresh herbs, fungi, stem vegetables, root vegetables and potatoes

[26] Commission Regulation (EC) No 1881/2006 Annex Section 3: Metals 3.1.10. Vegetables, excluding brassica vegetables, leaf vegetables, fresh herbs and fungi

The following table lists the maximum concentration in produce at each area

Table 9.1: Concentration of COPCs in Produce					
COPC Name	**Total Concentration in Produce (mg/kg)**				
	Area 1	**Area 2**	**Area 3**	**Area 4**	**Area 5**
Cadmium	6.95E-05	6.78E-05	1.98E-05	5.48E-05	3.35E-05
Most stringent Limit	*5.00E-02*	*5.00E-02*	*5.00E-02*	*5.00E-02*	*5.00E-02*
Percentage of Limit	**0.14%**	**0.14%**	**0.04%**	**0.11%**	**0.07%**
Lead	1.55E-04	1.51E-04	4.41E-05	1.22E-04	7.46E-05
Most stringent Limit	*1.00E-01*	*1.00E-01*	*1.00E-01*	*1.00E-01*	*1.00E-01*
Percentage of Limit	**0.16%**	**0.15%**	**0.04%**	**0.12%**	**0.07%**

In each area the concentration of COPCs are predicted to be less than 0.2% of the relevant limits for produce.

9.3 Concentrations of COPC's within Lamb

The increased levels of COPC's within lamb as a result of the emission from the facility has been considered. The impact at the point of maximum impact within each of the 5 farming areas has been considered and compared with the regulatory limits. The limits are given below and have been taken from the Commission Regulations setting maximum levels for certain contaminants in foodstuffs. For each COPC the most stringent level has been chosen.

Cadmium[27] ..... 0.05 mg/kg wet weight

Lead[28] ..... 0.1 mg/kg wet weight

Dioxins and PCB's[29] ..... 3.0 pg WHO-TEQ /g fat

The base data on which the IRAP-h models is based does not include the accumulation of COPC within lamb. It is notable that the previously available UK guidance HMIP "Risk assessment of dioxin release from municipal waste incineration processes" includes the pathways relating to the consumption of lamb.

Therefore the existing parameters in IRAP have been modified to take into account the different pathways for lamb, taking account of the different dietary intake along with modified biotransfer factors. The dietary information for lamb has been used and the HMIP methodology for the scaling of the biotransfer factor based on the relative fat content of beef and lamb applied to the biotransfer functions used in IRAP for each COPC. The following table sets out the predicted concentration of the above identified COPCs within lamb.

[27] Commission Regulation (EC) No 1881/2006 Annex Section 3: Metals 3.1.. Meat (excluding offal) of bovine animals, sheep, pig and poultry

[28] Commission Regulation (EC) No 629/2008 Annex Section 3: Metals 3.2.1. Meat (excluding offal) of bovine animals, sheep, pig and poultry

[29] Commission Regulation (EC) No 1881/2006 Section 5: Dioxins and PCBs 5.1. Meat and meat products (excluding edible offal) of bovine animals and sheep.

Table 9.2: Concentration of COPC within Lamb					
COPC Name	**Total Concentration in Lamb (mg/kg)**				
	Area 1	**Area 2**	**Area 3**	**Area 4**	**Area 5**
Cadmium	7.97E-08	7.78E-08	2.27E-08	6.29E-08	3.85E-08
Most stringent Limit	*5.00E-02*	*5.00E-02*	*5.00E-02*	*5.00E-02*	*5.00E-02*
Percentage of Limit	**0.0002%**	**0.0002%**	**0.0000%**	**0.0001%**	**0.0001%**
Lead	4.44E-07	4.34E-07	1.27E-07	3.51E-07	2.15E-07
Most stringent Limit	*1.00E-01*	*1.00E-01*	*1.00E-01*	*1.00E-01*	*1.00E-01*
Percentage of Limit	**0.0004%**	**0.0004%**	**0.0001%**	**0.0004%**	**0.0002%**
DIOXINS AND PCB's Total (pg WHO-TEQ/g)	7.40E-04	7.30E-04	2.22E-04	6.03E-04	3.84E-04
DIOXINS AND PCB's Limit (pg WHO-TEQ/g)	*3.00*	*3.00*	*3.00*	*3.00*	*3.00*
Percentage of Limit	**0.025%**	**0.024%**	**0.007%**	**0.020%**	**0.013%**

In each area the concentration of COPCs are less than 0.1% of the relevant limits for lamb.

9.4 Concentrations of COPC's within Soil

The increased levels of COPC's in the soil as a result of the emission from the facility has been considered. The impact at the point of maximum impact within each of the 5 farming areas has been considered and compared with the regulatory soil guideline values (SGV's). The guidelines are developed from the Tolerable Daily Intake (TDI) for each COPC and likely exposure pathways. The values given below are for residential/allotments land rather than farming and would therefore represent a worst case.

The SGVs are themselves only guideline values of the level that are tolerable or pose a minimal risk to human health from long term exposure. Soil concentrations above this level may pose a possibility of harm to human health but the SGVs do not represent the threshold at which there is a significant possibility of significant harm or represent an unacceptable intake in the context of Part 2A of the Environmental Protection Act 1990.

The following table indicates the SGVs from the most recently published Environment Agency Guidance (2009). The table below also includes average soil concentrations in rural settings from the UK Soil and Herbage Survey which was undertaken in 2007.

Table 9.3: Background levels of COPC and SGV's		
COPC	**Rural Soil Level (mg/kg)[30]**	**Soil Guideline Value (mg/kg)[31]**
Arsenic	10.9	32
Cadmium	0.39	1.8
Chromium	34.4	130
Lead	52.5	450
Mercury (Total)	0.13	Elemental Mercury 1 Inorganic Mercury 80 Mthyl Mercury 8
Nickel	21.1	130
Dioxins	0.229 (ug/kg) TEQ	8 (ug/kg) TEQ

The following table lists the maximum concentration in the soil at each of the areas identified.

[30] UK Soil and Herbage Pollutant Survey. Report No. 7: Environmental concentrations of heavy metals in UK soil and herbage,2007,Environment Agency.

[31] Soil Guideline Values for each COPC, Science Report SC050021, Environmental Agency 2009. (SCHO0309BPQG-E-P), (SCHO0409BPVY-E-P), (SCHO0409BPWB-E-P),

Table 9.4: Concentration of COPC in soil					
COPC Name	**Total Concentration in Lamb (mg/kg)**				
	Area 1	**Area 2**	**Area 3**	**Area 4**	**Area 5**
Arsenic	3.93E-09	1.82E-04	1.12E-09	3.11E-09	1.90E-09
SGV Level	32	32	32	32	32
Percentage of SGV	**0.000%**	**0.001%**	**0.000%**	**0.000%**	**0.000%**
Cadmium	1.13E-07	4.93E-05	3.24E-08	8.95E-08	5.47E-08
SGV Level	1.8	1.8	1.8	1.8	1.8
Percentage of SGV	**0.000%**	**0.003%**	**0.000%**	**0.000%**	**0.000%**
Chromium	1.11E-04	2.24E-05	3.17E-05	8.78E-05	5.37E-05
SGV Level	130	130	130	130	130
Percentage of SGV	**0.000%**	**0.000%**	**0.000%**	**0.000%**	**0.000%**
Lead	3.75E-06	7.42E-09	1.07E-06	2.96E-06	1.81E-06
SGV Level	450	450	450	450	450
Percentage of SGV	**0.000%**	**0.000%**	**0.000%**	**0.000%**	**0.000%**
Mercury Chloride	8.38E-04	5.16E-09	2.39E-04	6.64E-04	4.11E-04
SGV Level	1	1	1	1	1
Percentage of SGV	**0.084%**	**0.000%**	**0.024%**	**0.066%**	**0.041%**
Methyl Mercury	1.51E-05	4.72E-09	4.30E-06	1.20E-05	7.39E-06
SGV Level	8	8	8	8	8
Percentage of SGV	**0.000%**	**0.000%**	**0.000%**	**0.000%**	**0.000%**
Nickel	2.71E-07	3.84E-09	7.72E-08	2.14E-07	1.31E-07
SGV Level	130	130	130	130	130
Percentage of SGV	**0.000%**	**0.000%**	**0.000%**	**0.000%**	**0.000%**
Dioxins and Furans (ug WHO TEQ/kg)	1.12E-05	6.66E-05	3.20E-06	8.84E-06	5.41E-06
SGV Level (ug WHO TEQ/kg)	8	8	8	8	8
Percentage of Limit	**0.0001%**	**0.0008%**	**0.0000%**	**0.0001%**	**0.0001%**

In each area the concentration of COPCs are less than 0.01% of the relevant soil guideline values for each COPC.

10 CONCLUSIONS

(1) The methodology used in this assessment of the impact on air quality of the Mercia EnviRecover facility uses a number of conservative assumptions. These include the following:

a) It is assumed that the plant will continually operate at the maximum emission limits allowed under the Waste Incineration Directive. In practice, this will not be the case and actual emissions will be less than the limits.

b) The maximum ground level concentrations are considered in each case. These concentrations occur in small areas; in general, the concentration will be much lower.

(2) Even with the conservative assumptions listed above, no breaches of air quality objectives or guidelines are predicted and the impact on local people is predicted to be negligible.

(3) The impact of atmospheric emissions on nearby sensitive environmental receptors has been evaluated and has been found to be insignificant for all SSSIs, SACs and SPAs, being less than 0.6% of the relevant air quality objectives and Critical Loads. The atmospheric emissions do not lead to a breach of the air quality objectives or Critical Loads at any sensitive environmental receptor.

(4) A full human health risk assessment was carried out for dioxins, heavy metals and benzo(a)pyrene, including all exposure pathways. This concluded that:

a) the increased cancer risk is below the acceptable level at the most affected property, and well below the acceptable level in the nearest village, Hartlebury;

b) the increased hazard for chronic health effects is well below the accepted level; and

c) For dioxins and furans, the contribution from the plant would be less than 0.6% of the Tolerable Daily Intake for a local farmer at the most affected property.

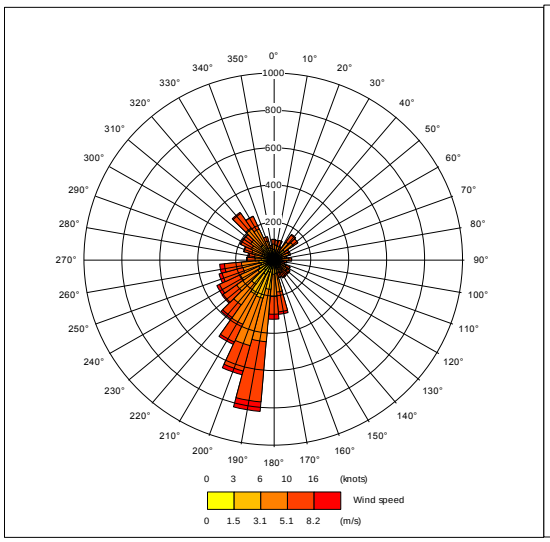
(5) A similar assessment was carried out for the impact on agricultural land and produce, and the impact was found to be below 0.2% of all relevant standards.

It can therefore be concluded that the impact of the Mercia EnviRecover facility on the general population and the local community will be negligible.

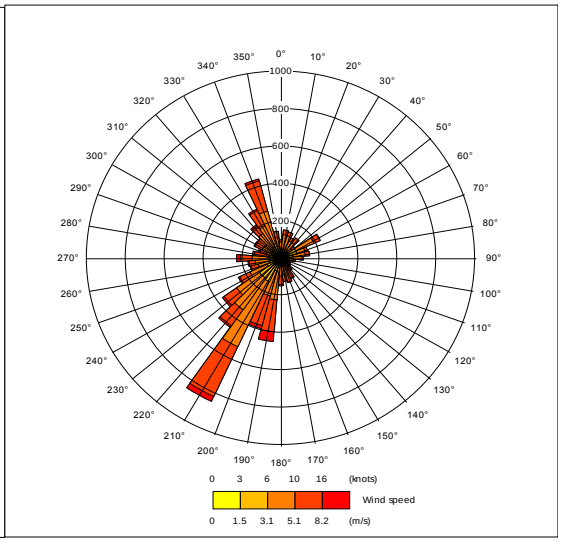
Appendix A Figures

Figure 1: Wind Roses- Pershore Weather Station

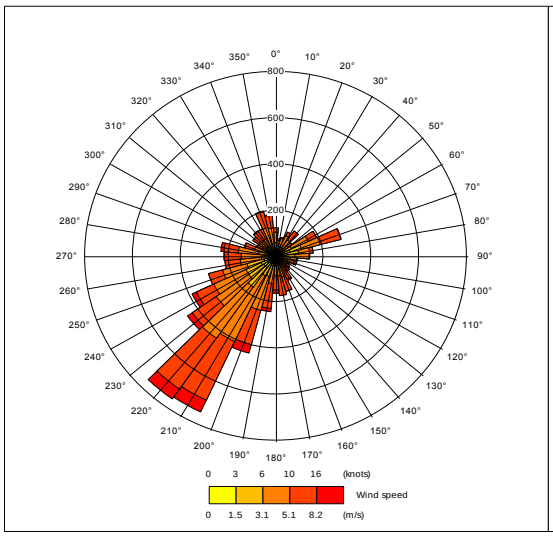
Pershore 2004



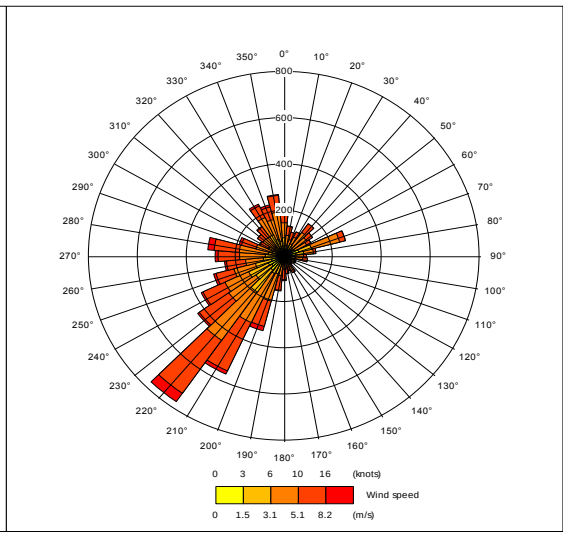
Pershore 2005



Pershore 2006



Pershore 2007



Pershore 2008

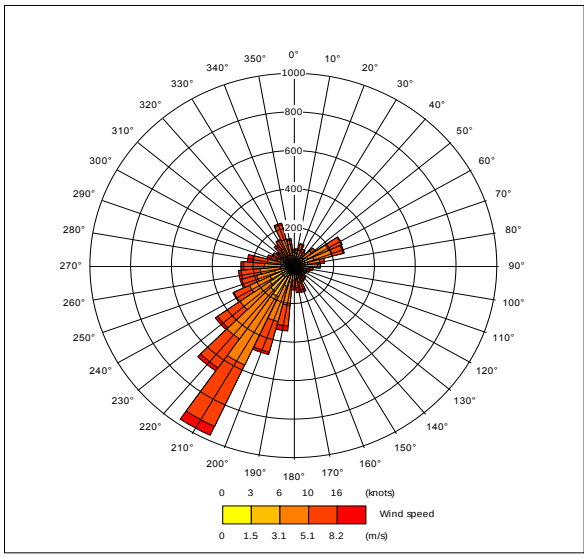


Figure 2: Location of site, buildings and sensitivity receptors

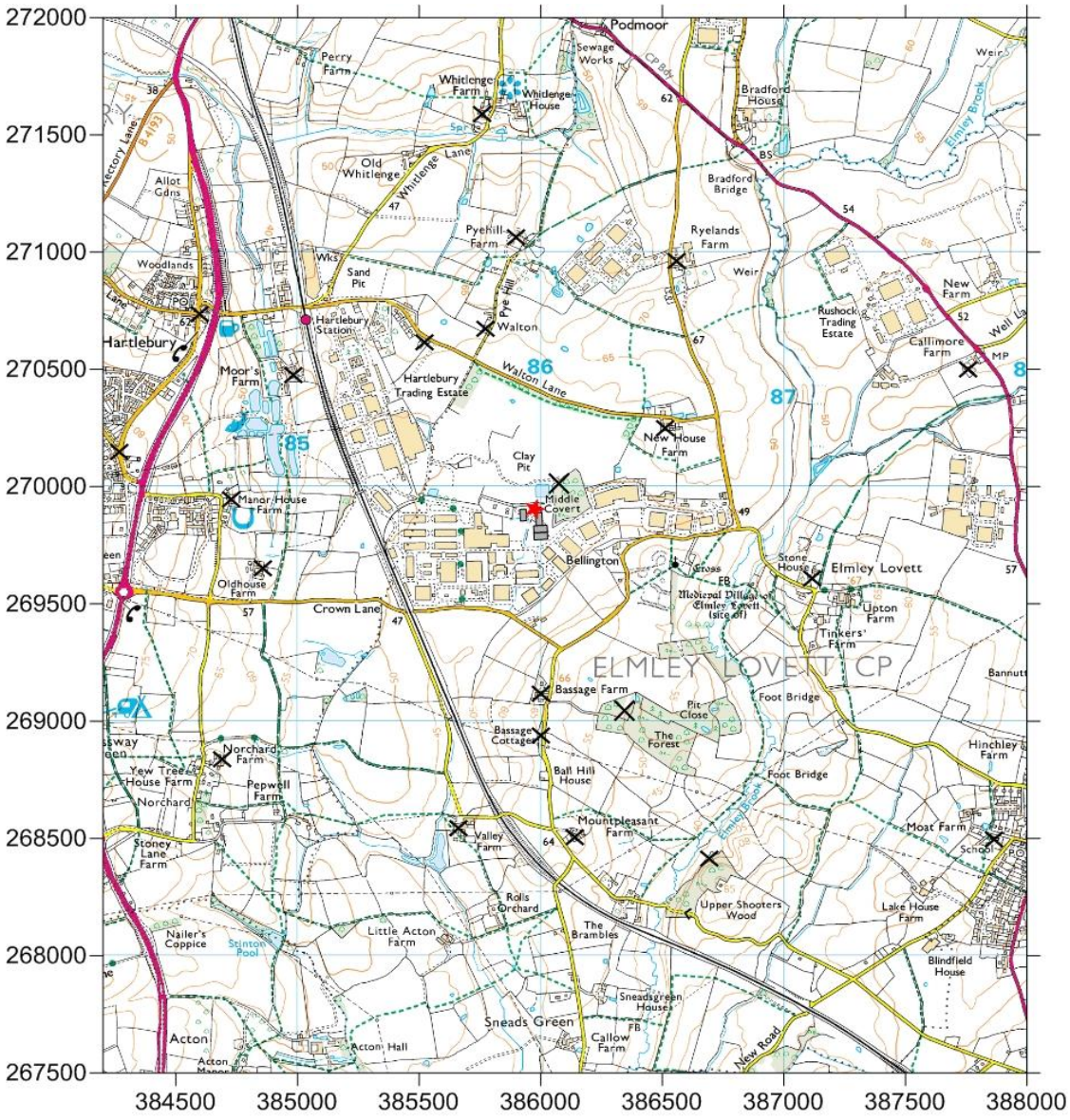


Figure 3: Annual Average Ground Level Concentration of NO_2, Stack Emissions

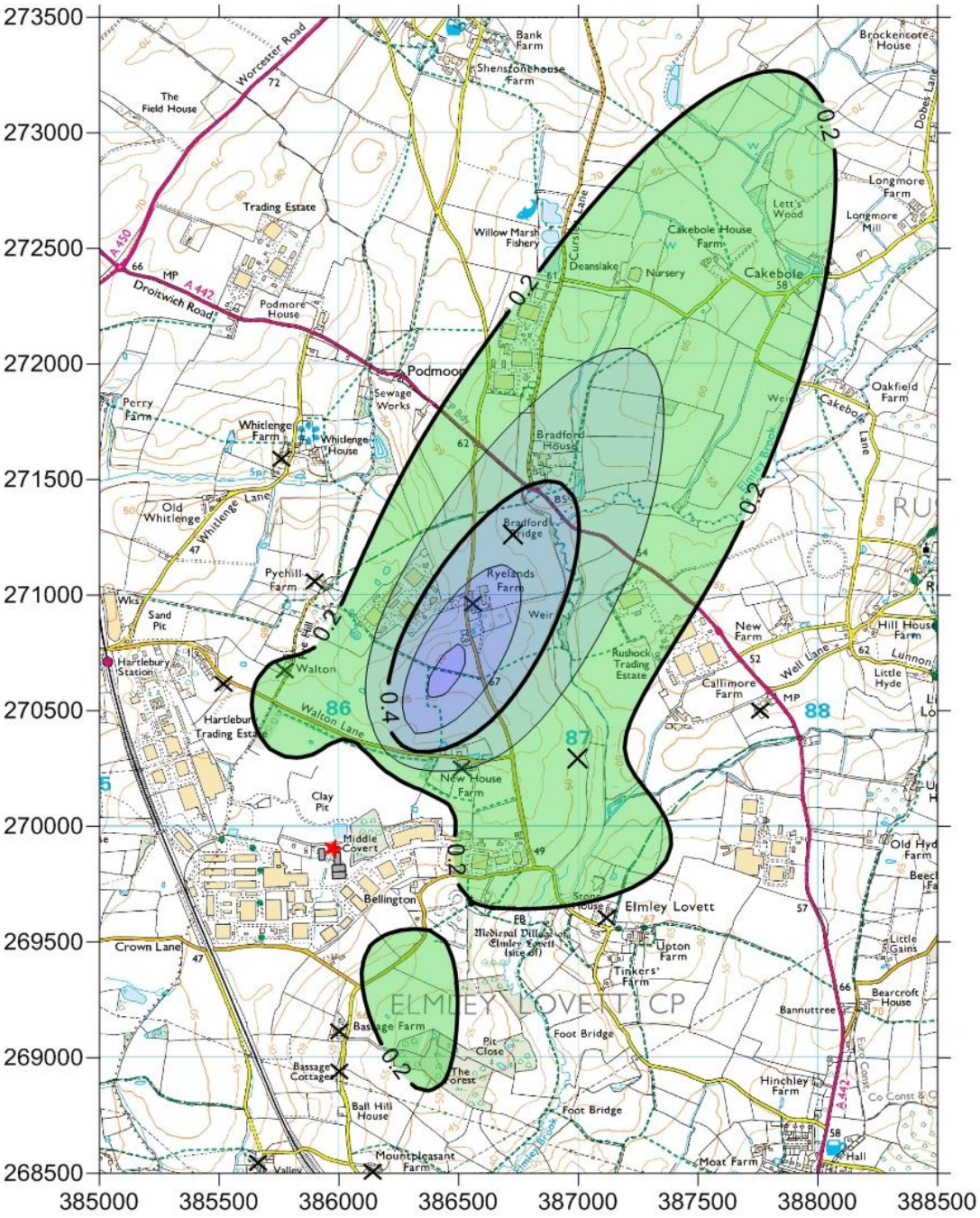


Figure 4: Short term Ground Level Concentration of NO_2 (99.79th %ile of hourly means), Stack Emissions

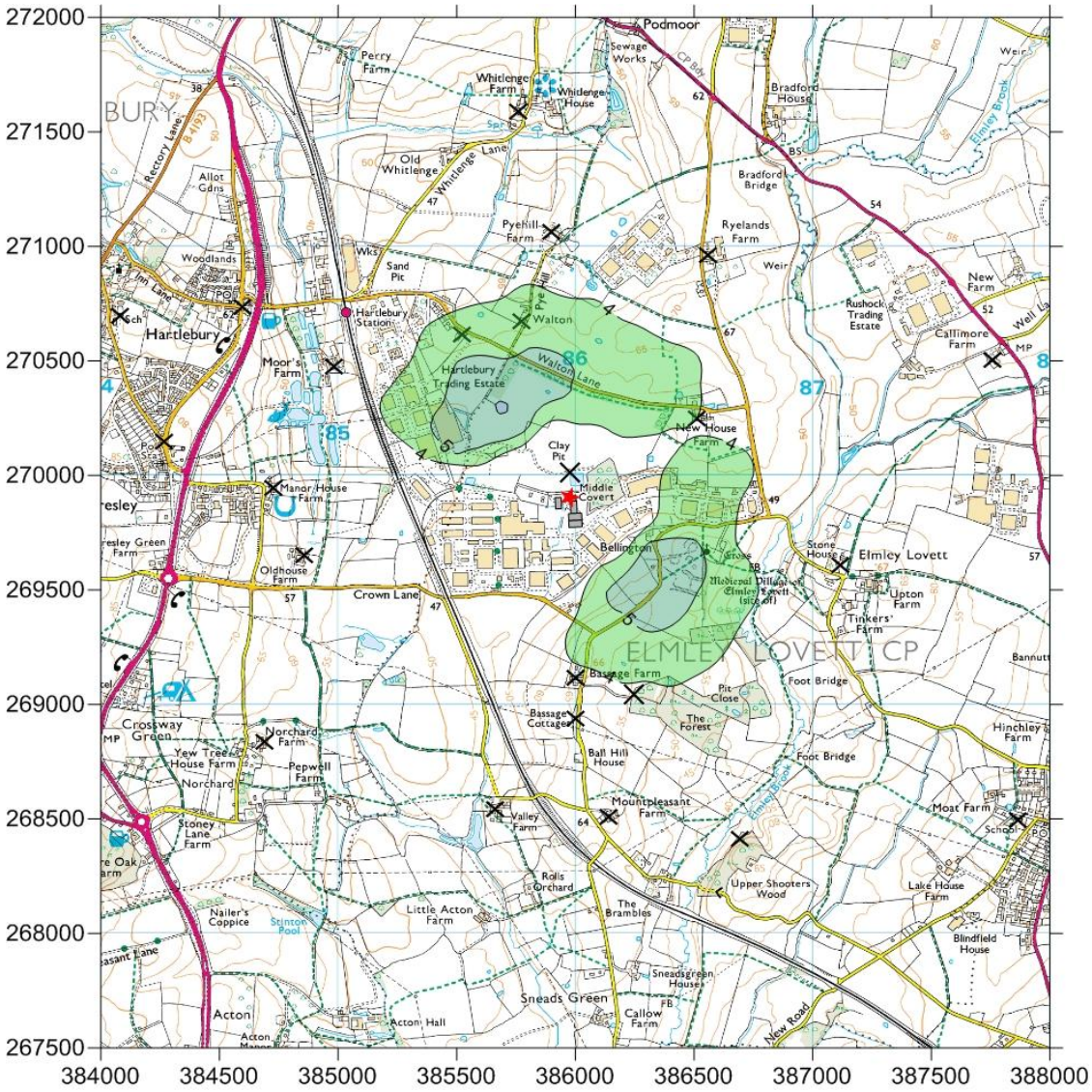
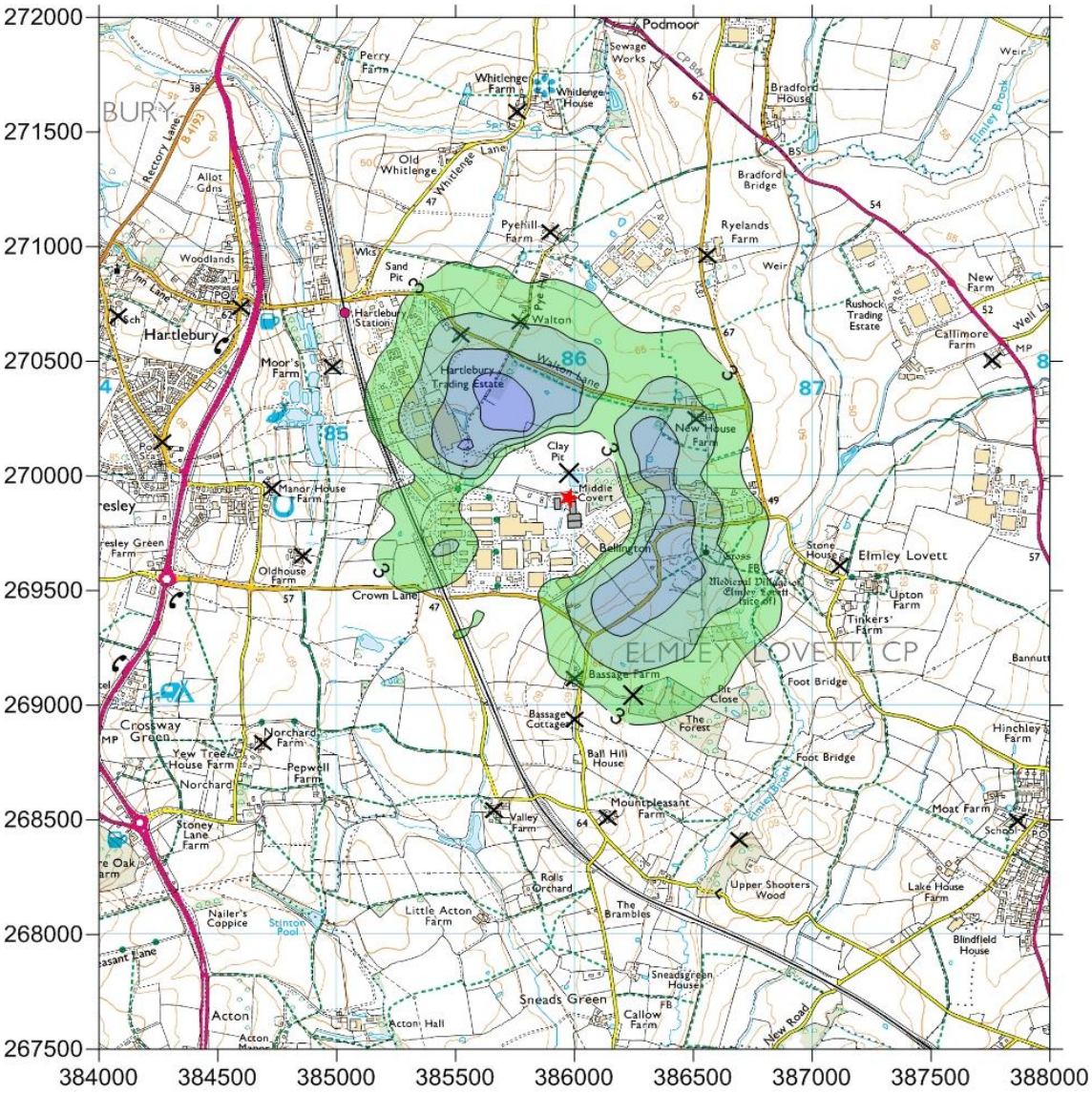


Figure 5: Short term Ground Level Concentration of SO_2 (99.99th %ile of 15 min means)



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