

# FICHTNER

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## MANAGEMENT SUMMARY

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Fichtner Consulting Engineers Ltd ("Fichtner") has been engaged to undertake an Air Quality Assessment to support the planning and Environmental Permit applications for the proposed wood-fuelled boiler at the existing Intertissue paper manufacturing site off Brunell Way, Neath Port Talbot.

The assessment has been carried out in a number of stages.

### **(1) Review of Legislation**

In the UK, the levels of pollution in the atmosphere are controlled by a number of European Directives, which have been fully implemented, and by the National Air Quality Strategy. These have led to the setting of a number of Air Quality Objectives (AQOs) for the most significant pollutants, such as oxides of nitrogen and particulate matter. The AQOs are set at a level well below those at which significant adverse health effects have been observed in the general population and in particularly sensitive groups.

For other pollutants, the Environment Agency sets control levels, called Environmental Assessment Levels, based on work by the World Health Organisation and other national and international bodies.

The Environment Agency sets Critical Levels for the protection of ecosystems. In addition it is noted that deposition of nitrogen and acid gases can cause eutrophication and acidification of habitats. The Air Pollution Information System provides Critical Loads for different habitats which consider the existing pollution loading for the site.

### **(2) Review of Ambient Air Quality**

Monitoring information collected by the UK Government and by local authorities has been used to assess the current levels of pollutants in the atmosphere close to the facility.

Where local monitoring data is not available, conservative estimates based on national UK monitoring results have been used as a background concentration.

### **(3) Identification of Sensitive Receptors**

When assessing the impact of a development, the assessment considers the point of maximum impact as a worst-case. In addition, the impact has been assessed at a number of identified sensitive receptors including the local Air Quality Management Areas, the closest houses, local schools, all European statutory designated ecological sites within 10km, and all UK statutory and locally designated ecological sites within 2km of the facility.

### **(4) Dispersion Modelling of Emissions**

The ADMS 5.1 dispersion model is routinely used for air quality assessments to the satisfaction of local authorities and the Environment Agency and Natural Resources Wales. The model uses weather data from the local area to predict the spread and movement of the exhaust gases from the stack for each hour over a five year period. The model takes account of wind speed, wind direction, temperature, humidity and the amount of cloud cover, as all of these have an influence on the dispersion of emissions. The model also takes account of the effects of buildings and terrain on the movement of air.

Emissions from the facility have been assumed to comply with the limits outlined in the existing Environmental Permit which are based on those prescribed within Chapter VI of the Industrial Emissions Directive (IED) for waste incineration plants.

To set up the model, it has been assumed that the facility operates for the whole year and releases emissions at the emission limit all the time. In reality, this is very conservative as the facility will run below the emission limit and will be offline for about 10% of the year for maintenance.

The model was used to predict the ground level concentration of pollutants on a long term and short term basis across a grid of points. In addition concentrations were predicted at the identified sensitive receptors.

**(5) Approach and Assessment of Impact on Air Quality – Protection of Human Health**

The significance of the effect of the impact of emissions from the facility on human health has been assessed using a standard approach based on the Institute of Air Quality Management's (IAQM) 2015 guidance. Where this guidance does not provide a criteria for assessing the significance of an effect, it has been adapted using professional judgement incorporating the Environment Agency's guidance, as recommended.

In summary,

- a) Emissions from the facility will not cause a breach of any AQO or EAL;
- b) The change in impact compared to the existing baseline can be described as 'negligible' at all sensitive receptors for all pollutants; and therefore
- c) The emissions to atmosphere should not be considered a constraint to this application, based on professional judgement.

**(6) Approach and Assessment of Impact on Air Quality – Protection of Ecosystems**

The impact of air quality on ecosystems has been assessed using a standard approach.

- a) The Environment Agency has stated that, if the contribution within an entire protected site is less than 1% of the long-term and less than 10% of the short term benchmark, the emissions are not significant and it can be concluded no likely significant effect either alone and in-combination with other sources of pollutants, irrespective of background levels.
- b) If the process contribution at European and UK designated sites is greater than 1% of the relevant long-term, or 10% of the short term benchmark, but the total predicted concentration including background levels is less than 70% of the relevant benchmark, the Environment Agency has stated that the emissions are not likely to have a significant effect.
- c) If the process contribution at locally designated sites is less than the relevant benchmark, the Environment Agency has stated that the emissions are not likely to have a significant effect.

The impact of the deposition of nitrogen and acid gases on sensitive habitats has been assessed using a standard approach.

- a) It has been assumed that the facility operates at the emission limits for the entire year whereas actual operational emission concentrations will be lower.
- b) It has been assumed that all habitats are present at the point of greatest impact.
- c) The impact has been calculated based on the maximum predicted concentration over a 5-year period at each ecological site and applying conservative deposition assumptions from the Environment Agency.
- d) The results have been compared to habitat specific Critical Loads.

At all European designated sites within 10km of the facility, the impact of emissions is predicted to be less than 1% of the long term Critical Level and Loads and less than 10% of the short term Critical Levels. Therefore it can be concluded that emissions from the proposed scheme are not significant and there is no likely significant effect (alone and in-combination);

At all UK designated sites within 2km of the facility, the impact of emissions is predicted to be less than 1% of the long term Critical Level and Loads and less than 10% of the short term Critical Levels when operational availability is taken into account. Therefore it can be concluded that emissions from the proposed scheme are not significant and there is no likely significant effect (alone and in-combination); and

At all locally designated sites, emissions are not likely to have a significant impact. This conclusion has been drawn because the process contribution is less than 100% of the Critical Level or Load.

**(7) Assessment of Impact on Human Health**

For most pollutants, the main route for human exposure is through inhalation. However, some pollutants can accumulate in the environment so that the primary route for human exposure is through ingestion in food. For these pollutants, which include dioxins, furans and heavy metals, a detailed human health risk assessment has been carried out to consider all of the following routes for human exposure:

- a) Inhalation of gaseous emissions;
- b) Vapour phase transfer of gaseous emissions to plants and subsequent ingestion of food by animals and humans; and
- c) Deposition of dust to soil, followed by;
  - i) Ingestion of soil attached to unwashed vegetables, during gardening and, for children, during play; or
  - ii) Uptake of pollutants into plants and subsequent ingestion of food.

For ingestion of food, the model takes account of the proportion of home-grown vegetables which are consumed, with a higher level assumed for farmers.

The model predicts the total exposure to the various pollutants and compares this with standard intake criteria, in order to assess the predicted increase in health risks.

The assessment concludes that the Facility would not have a significant impact on human health and the change in impact from the consented development is extremely small.

**(8) Construction Phase Dust**

Analysis of the area has shown that the IAQM criteria for undertaking a detailed assessment have not been met and as such the impact of fugitive emissions of dust during construction can be screened out as 'negligible'. A detailed description of the proposed demolition and construction activities has been provided as part of the planning application.

In summary, a comprehensive assessment of the impact of the proposed facility has been carried out and has concluded that it will have a 'negligible' impact on the local environment.

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## 1 INTRODUCTION

### 1.1 Background

Fichtner Consulting Engineers Ltd ("Fichtner") has been engaged to undertake an Air Quality Assessment to support the planning and Environmental Permit application for the proposed wood-fuelled boiler at the existing Intertissue paper manufacturing site off Brunell Way, Neath Port Talbot.

When considering the impact on human health, the predicted atmospheric concentrations have been compared to the Air Quality Objectives (AQOs) and Environmental Assessment Levels (EALs) for the protection of human health. It is noted that for some pollutants such as metals and dioxins they have the potential to accumulate within the environment. A Human Health Risk Assessment has been undertaken to assess the pathway intake of these pollutants and impacts compared to the Tolerable Daily Intakes (TDIs).

When considering the impact on ecosystems the predicted atmospheric concentrations have been compared to the Critical Levels for the protection of ecosystems. It is noted that deposition of emissions over a prolonged period can have nitrification and acidification impacts. An assessment of the long term deposition of pollutants has been undertaken and the results compared to the habitat specific Critical Loads.

### 1.2 Structure of Report

This report has the following structure.

- National and international air quality legislation and guidance, and local planning policies which relate to air quality, are considered in section 2.
- The assessment methodology is outlined in section 3.
- The current levels of ambient air quality are described in section 4.
- Section 5 highlights residential properties and ecological receptors in the vicinity of the facility.
- Section 6 outlines the assessment methodology to be used when assessing the impact of emissions from the facility.
- The inputs used for the dispersion model are contained within section 7.
- The impact of emissions assuming the facility complies with the emission limit values is presented in section 8.
- Section 9 presents the assessment methodology and results of the assessment of the impact of emissions including their long term deposition at ecological sites.
- Section 10 provides a summary of the Human Health Risk Assessment which can be found in Appendix D.
- Section 11 provides an analysis of the potential impact of fugitive dust from construction activities.
- The conclusions of the assessment can be found in section 12.
- The Appendices include illustrative figures and detailed results tables.

## 2 LEGISLATION

### 2.1 European legislation

European air quality legislation is consolidated under Directive 2008/50/EC, which came into force on 11<sup>th</sup> June 2008. This Directive consolidates previous legislation which was designed to deal with specific pollutants in a consistent manner and provides new air quality objectives for fine particulates. The consolidated Directives include:

- Directive 99/30/EC – the First Air Quality "Daughter" Directive – which sets ambient air limit values for nitrogen dioxide and oxides of nitrogen, sulphur dioxide, lead and particulate matter;
- Directive 2000/69/EC – the Second Air Quality "Daughter" Directive – which sets ambient air limit values for benzene and carbon monoxide; and
- Directive 2002/3/EC – the Third Air Quality "Daughter" Directive – which seeks to establish long-term objectives, target values, an alert threshold and an information threshold for concentrations of ozone in ambient air.

The fourth daughter Directive – 2004/107/EC – was not included within the consolidation. It sets health-based limits on polycyclic aromatic hydrocarbons, cadmium, arsenic, nickel and mercury, for which there is a requirement to reduce exposure to as low as reasonably achievable.

### 2.2 UK legislation

Directives 2008/50/EC and 2004/107/EC are transposed under UK Law into the Air Quality Standards Regulations (2010).

The UK Air Quality Strategy (2007) is the method of implementation of the air quality limit values in England, Scotland, Wales and Northern Ireland.

The Air Quality Strategy defines "standards" and "objectives" in paragraph 17:

*"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, 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."*

### 3 AIR QUALITY STANDARDS, OBJECTIVES AND GUIDELINES

In the UK, air quality standards and objectives (AQOs) for major pollutants are described in The Air Quality Strategy (AQS).

The Environment Agency includes Environmental Assessment Levels (EALs) for other pollutants in Environmental Agency Horizontal Guidance Note H1 - Annex F. The long term and short term EALs from this document have been used when the Air Quality Strategy 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 and habitats are also contained within Environmental Agency Horizontal Guidance Note H1 - Annex F.

#### 3.1 Nitrogen dioxide

All combustion processes produce nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>), known by the general term of nitrogen oxides (NO<sub>x</sub>). In general, the majority of the NO<sub>x</sub> released is in the form of NO, which then reacts with ozone in the atmosphere to form nitrogen dioxide. 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 exist, but the air pollutant species of most interest from the point of view of human health is nitrogen dioxide".

The major sources of NO<sub>x</sub> 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%. High levels of NO<sub>x</sub> in urban areas are almost always associated with high traffic densities.

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

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

In addition, the AQS includes objectives for the protection of sensitive vegetation and ecosystems of 30 µg/m<sup>3</sup> for the annual mean, and 75 µg/m<sup>3</sup> for the daily mean concentration of nitrogen oxides.

#### 3.2 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, with much of the remainder associated with other combustion processes. Emissions of sulphur dioxide have reduced by 87% since 1970, due to a reduction in the number of coal fired combustion plants, 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 AQS contains three objectives for the control of sulphur dioxide:

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

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

In addition, the AQS includes two objectives for the protection of vegetation and ecosystems. These are a concentration of 20  $\mu\text{g}/\text{m}^3$  (reduced to 10  $\mu\text{g}/\text{m}^3$  where lichens or bryophytes are present) as an annual mean and as a winter average.

### 3.3 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  $\mu\text{m}$ , known as  $\text{PM}_{10\text{s}}$ . 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  $\text{PM}_{10\text{s}}$ , although the underlying mechanism for this effect is not yet understood. Significant sources of  $\text{PM}_{10\text{s}}$  are road transport (22%), quarrying (16%) and stationary combustion (34%).

The AQS includes two objectives for  $\text{PM}_{10\text{s}}$  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  $\mu\text{g}/\text{m}^3$ , to be achieved by 2004.
- A daily limit of 50  $\mu\text{g}/\text{m}^3$ , not to be exceeded more than 35 times a year (the 90.4th percentile) to be achieved by 2004.

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

### 3.4 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. 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 AQS 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  $\text{mg}/\text{m}^3$ , to be achieved by 1<sup>st</sup> January 2005.

### 3.5 Hydrogen chloride

There are no AQOs for hydrogen chloride contained within the AQS. However Environment Agency Horizontal Guidance Note H1 Annex F defines the short term EAL as 750  $\mu\text{g}/\text{m}^3$ . There is no long-term EAL.

### 3.6 Hydrogen fluoride

There are no AQOs for hydrogen fluoride contained within the AQS. However Environment Agency Horizontal Guidance Note H1 Annex F defines the short term EAL as 160  $\mu\text{g}/\text{m}^3$  and the long term EAL as 16  $\mu\text{g}/\text{m}^3$ .

Appendix B to Annex F of the Environment Agency Horizontal Guidance Note H1 also provides Critical Levels for the protection of vegetation and ecosystems of 5  $\mu\text{g}/\text{m}^3$  as a daily mean and 0.5  $\mu\text{g}/\text{m}^3$  as a weekly mean concentration of hydrogen fluoride.

### 3.7 Ammonia

There are no AQOs for ammonia contained within the AQS. However Environment Agency Horizontal Guidance Note H1 Annex F defines the short term EAL as 2,500  $\mu\text{g}/\text{m}^3$  and the long term EAL as 180  $\mu\text{g}/\text{m}^3$ .

In addition, Appendix B to Annex F of the Environment Agency Horizontal Guidance Note H1 also provides Critical Levels for the protection of vegetation and ecosystems. These are a concentration of 3  $\mu\text{g}/\text{m}^3$  as an annual mean, reduced to 1  $\mu\text{g}/\text{m}^3$  where lichens or bryophytes are present.

### 3.8 Metals

Lead is the only metal included in the AQS. 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.

The AQS includes objectives to limit the annual mean to 0.5  $\mu\text{g}/\text{m}^3$  by the end of 2004 and to 0.25  $\mu\text{g}/\text{m}^3$  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 facility. The 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 similar facilities 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 3.1.

Table 3.1: Environmental Assessment Levels (EALs) for Metals

Metal	Daughter Directive Target Level ( $\mu\text{g}/\text{m}^3$ )	EALs ( $\mu\text{g}/\text{m}^3$ )	
		Long Term	Short Term
Arsenic	0.006	0.003	-
Antimony	-	5	150
Cadmium	0.005	0.005	-
Chromium (II & III)	-	5	150
Chromium (VI)	-	0.0002	-
Cobalt	-	-	-
Copper	-	10	200
Lead	-	0.25	-
Manganese	-	0.15	1500
Mercury	-	0.25	7.5
Nickel	0.020	0.020	-
Thallium	-	-	-
Vanadium	-	5	1

The EALs in Appendix B to Annex F of the Environment Agency Horizontal Guidance Note H1 take into account the guidelines for metals and metalloids in ambient air for the protection of human health produced by EPAQS in 2009.

### 3.9 Volatile Organic Compounds (VOCs)

A variety of VOCs could be released from the stack, of which benzene and 1,3-butadiene are included in the AQS and monitored at various stations around the UK. The AQS includes the following objectives for the running annual mean:

- Benzene  $5 \mu\text{g}/\text{m}^3$ , to be achieved by 2010.
- 1,3-butadiene  $2.25 \mu\text{g}/\text{m}^3$ , to be achieved by 2003.

There are no short-term AQO/EALs for either benzene or 1,3-butadiene.

### 3.10 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. 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 Waste Incineration Directive, now included in the IED, 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, furans and dioxins like PCBs has been recommended by the Committee on the Toxicity of Chemicals in Food, Consumer Products and the Environment 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 Human Health Risk Assessment contained as Appendix D.

### 3.11 Polychlorinated biphenyl (PCBs)

PCBs have high thermal, chemical and electrical stability and were manufactured in large quantities in the UK between the 1950s and mid 1970s. Commercial PCB mixtures, which contained a range of dioxin-like and non-dioxin like congeners, were sold under a variety of trade names, the most common in the UK being the Aroclor mixtures. UK legislative restrictions on the use of PCBs were first introduced in the early 1970s.

Although now banned from production current atmospheric levels of PCBs are due to the ongoing primary anthropogenic emissions (e.g. accidental release of products or materials containing PCBs), volatilisation from environmental reservoirs which have previously received PCBs (e.g. sea and soil) or incidental formation of some congeners during the combustion process.

There are no AQOs for PCBs contained within the AQS. However Environment Agency Horizontal Guidance Note H1 Annex F defines the short term EAL as  $6 \mu\text{g}/\text{m}^3$  and the long term EAL as  $0.2 \mu\text{g}/\text{m}^3$ .

A number of PCBs are considered to possess dioxin like toxicity and are known as dioxin-like PCBs. The total intake from dioxins, furans and dioxins like PCBs is compared to the TDI for dioxins, furans and dioxin like PCBs as part of the Human Health Risk Assessment contained as Appendix D.

### 3.12 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 AQS included an objective to limit the annual mean of B[a]P to  $0.25 \text{ ng}/\text{m}^3$  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  $1 \text{ ng}/\text{m}^3$  as an annual mean.

### 3.13 Summary

Table 3.2 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.

<b>Pollutant</b>	<b>Limit Value (<math>\mu\text{g}/\text{m}^3</math>)</b>	<b>Averaging Period</b>	<b>Frequency of Exceedences</b>
Nitrogen dioxide	200	1 hour	18 times per year (99.79 <sup>th</sup> percentile)
	40	Annual	-
Sulphur dioxide	266	15 minutes	35 times per year (99.9 <sup>th</sup> percentile)
	350	1 hour	24 times per year (99.73 <sup>rd</sup> percentile)
	125	24 hours	3 times per year (99.18 <sup>th</sup> percentile)

**Table 3.2: Air Quality Standards (AQS) and Environmental Assessment Levels (EALs)**

Particulate matter (PM <sub>10</sub> )	50	24 hours	35 times per year (90.41 <sup>th</sup> percentile)
	40	Annual	-
Particulate matter (PM <sub>2.5</sub> )	25	Annual	-
Carbon monoxide	10,000	8 hours, running	-
Hydrogen chloride	750	1 hour	-
Hydrogen fluoride	160	1 hour	-
	16	Annual	-
Ammonia	2,500	1 hour	-
	180	Annual	-
Lead	0.25	Annual	-
Benzene	5.00	Annual	-
1,3-butadiene	2.25	Annual, running	-
PCBs	6	1-hour	-
	0.2	Annual	-
PAHs	0.00025	Annual	-

**Table 3.3 Critical Levels for the Protection of Vegetation and Ecosystems**

Pollutant	Concentration (µg/m <sup>3</sup> )	Measured as
Nitrogen oxides (as nitrogen dioxide)	75	Daily mean
	30	Annual mean
Sulphur dioxide	10	Annual mean for sensitive lichen communities and bryophytes and ecosystems where lichens and bryophytes are an important part of the ecosystems integrity
	20	Annual mean for all higher plants
Hydrogen fluoride	<5	Daily mean
	<0.5	Weekly mean
Ammonia	1	Annual mean for sensitive lichen communities and bryophytes and ecosystems where lichens and bryophytes are an important part of the ecosystems integrity
	3	Annual mean for all higher plants

## 4 BASELINE AIR QUALITY

The proposed development is located at the existing Intertissue paper manufacturing site off Brunel Way, Neath Port Talbot. Reference should be made to Figure 1 which shows the site location. In this section, we have reviewed the baseline air quality and defined appropriate background concentrations to be used within this assessment.

### 4.1 Air quality review and assessment

Under Section 82 of the Environment Act (1995) (Part IV) local authorities are required to undertake an ongoing exercises to review air quality within their area of jurisdiction. In 2000, Neath Port Talbot Council declared an AQMA in Taibach Margam due to concerns over the predicted failure to achieve the AQO for daily mean particulate matter (as PM<sub>10</sub>). In addition the neighbouring City and County of Swansea local authority has declared an AQMA due to elevated annual mean nitrogen dioxide concentrations. The impact of emissions from the facility on the local AQMAs will be quantified as part of this assessment.

### 4.2 National modelling – mapped background data

In order to assist local authorities with their responsibilities under Local Air Quality Management, the Department for the Environment Food and Rural Affairs (DEFRA) provides modelled background concentrations 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 is used by local authorities in lieu of suitable monitoring data. Mapped background concentrations were downloaded for the grid squares containing the facility and immediate surroundings. A summary is presented within Table 4.1.

In addition, mapped atmospheric concentrations of ammonia are available from DEFRA throughout the UK on a 5 km by 5 km grid. Mapped ammonia background concentrations were downloaded for grid square containing the facility, as presented within Table 4.1.

**Table 4.1: Mapped Background Data – at Facility**

Pollutant	Annual Mean Concentration (µg/m <sup>3</sup> )	Dataset
Nitrogen dioxide <sup>(1)</sup>	14.6	2011 mapped background dataset
Oxides of nitrogen <sup>(1)</sup>	19.5	2011 mapped background dataset
Sulphur dioxide <sup>(1)</sup>	2.76	2001 mapped background dataset
Particulate matter (as PM <sub>10</sub> ) <sup>(1)</sup>	15.3	2011 mapped background dataset
Particulate matter (as PM <sub>2.5</sub> ) <sup>(1)</sup>	10.7	2011 mapped background dataset
Carbon monoxide <sup>(1)</sup>	229	2001 mapped background dataset
Benzene <sup>(1)</sup>	0.4	2001 mapped background dataset
1,3-butadiene <sup>(1)</sup>	0.1	2001 mapped background dataset
Ammonia <sup>(2)</sup>	0.83	2012 mapped background dataset

*Notes:*  
 (1) 1km x 1km grid square centred upon 273500, 192500  
 (2) 5km x 5km grid square centred upon 275000, 195000

The mapped background data is calibrated against monitoring data. For instance, the 2011 mapped background concentrations are based on 2011 meteorological data and are calibrated against monitoring undertaken in 2011. As a conservative approach where mapped background data is used the concentration for the year against which the data was validated has been used for the purpose of this assessment. This eliminates any potential uncertainties over anticipated trends in future background concentrations.

Concentrations will vary over the modelling domain area. Therefore, the maximum mapped background concentration within the modelling domain has been calculated as presented in Table 4.2.

**Table 4.2: Mapped Background Data – Maximum within Modelling Domain**

<b>Pollutant</b>	<b>Annual Mean Concentration (<math>\mu\text{g}/\text{m}^3</math>)</b>	<b>Dataset</b>
Nitrogen dioxide	20.3	2011 mapped background dataset
Oxides of nitrogen	28.3	2011 mapped background dataset
Sulphur dioxide	6.9	2001 mapped background dataset
Particulate matter (as $\text{PM}_{10}$ )	15.9	2011 mapped background dataset
Particulate matter (as $\text{PM}_{2.5}$ )	10.7	2011 mapped background dataset
Carbon monoxide	240	2001 mapped background dataset
Benzene	0.5	2001 mapped background dataset
1,3-butadiene	0.1	2001 mapped background dataset
Ammonia	1.03	2012 mapped background dataset

### 4.3 AURN and LAQM monitoring data

The UK Automatic Urban and Rural Network (AURN) is a country-wide network of air quality monitoring stations operated on behalf of the DEFRA, which includes automatic monitoring of oxides of nitrogen, nitrogen dioxide, sulphur dioxide, ozone, carbon monoxide and particulates.

The closest site to the facility is Port Talbot Margam, approximately 6km to the south-east. This site is classified as an urban industrial site. Urban industrial sites are located such that the pollution level is influenced predominantly by emissions from nearby single industrial sources or industrial areas with many sources. This site is adjacent to the steel works and concentrations will only be representative of the area local to the analyser. It is not likely that pollution levels close to the facility will be similar. However, for completeness this site has been included in the assessment. A summary of the data from the Port Talbot Margam AURN site is presented in the following table.

Table 4.3: Port Talbot Margam

Averaging Period	Mapped Bg - 2011	2011	2012	2013	2014
<b>Nitrogen dioxide</b>					
Annual mean	16.5	18.4	18.0	16.9	17.3
99.79%ile of 1-hour mean	-	76	77	76	72
<b>Particulate matter (PM10)</b>					
Annual mean	15.6	29.2	23.1	22.6	24.3
90.41%ile of daily mean	-	49	39	41	40
<b>Particulate matter (PM2.5)</b>					
Annual mean	10.1	12.7	12.2	14.3	-(1)
<b>Carbon Monoxide</b>					
Annual mean	218	300	270	200	200
<b>Sulphur dioxide</b>					
Annual mean	-	4.8	3.7	4.4	4.8
99.18%ile of daily mean	-	32	26	30	31
99.73%ile of hourly mean	-	72	61	76	78
99.9%ile of 15-minute mean	-	109	85	110	121
Note:					
(1) Insufficient data capture for calculation of annual mean.					

As shown, the mapped background underestimates the monitored concentration for nitrogen dioxide and particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>).

In addition to the national AURN, local authorities undertake monitoring of a range of pollutants as part of the LAQM review process. A review of the monitoring undertaken by Neath Port Talbot Council and Swansea City Council as part of their LAQM commitments has shown that the following continuous analysers are operated within 6km of the facility:

- VG2 – roadside site – approximately 5.2 km to the north-east.
- TH1 – industrial site – approximately 5.6 km to the south-east;
- TR1 – roadside site – approximately 5.1 km to the south-east;
- LW1 – industrial site – approximately 4.7 km to the south-east; and
- DK1 – industrial site – approximately 4.8 km to the south-east.

Roadside sites are located such that the pollution level is influenced predominantly by emissions from nearby traffic and the site is generally representative of air quality in a street segment no less than 100m in length. The industrial sites are adjacent to the steel works and concentrations will only be representative of the area local to the analyser. It is not likely that pollution levels close to the facility will be similar to any of the monitoring sites. However, for completeness each of the above sites have been included in the assessment and the impact of the facility at each of the monitoring sites has been predicted.

**Table 4.4: Nitrogen Dioxide Monitoring within 6km of Facility**

Averaging Period	Mapped Bg - 2011	2011	2012	2013	2014
<b>Annual mean - particulate matter (PM10)</b>					
VG2 – Victoria Road		-	51	42	-

**Table 4.5: PM Monitoring within 6km of Facility**

Averaging Period	Mapped Bg - 2011	2011	2012	2013	2014
<b>Annual mean - particulate matter (PM10)</b>					
TH1 - Theodore Road		23	19	17	-
TR1 - Talbot Road		25	22	21	-
LW1 – Port Talbot Little Warren		-	19	19	-
DK1 – Port Talbot Docks		23	18	17	-

Neath Port Talbot Council also monitors nitrogen dioxide via 27 diffusion tubes at a number of locations across the borough. Of the diffusion tubes, 7 are located within 3km of the facility. Each of these sites is a roadside site and as such is highly influenced by local road traffic contributions and not considered representative of the wider area. Results of the monitoring at these sites are provided in the following table. For completeness these sites have been included in the assessment and the impact of the facility at each of the sites has been predicted.

**Table 4.6: Nitrogen Dioxide Diffusion Tubes – Neath Port Talbot Council**

Averaging Period	Mapped Bg - 2011	2011	2012	2013	2014
Mobys Neath Road	14.3	36	30.9	29.1	-
185 Neath Road	14.3	34	30.2	30.1	-
179 Neath Road	14.3	34	30.5	29.4	-
187 Neath Road	14.3	34	31.3	29.1	-
189 Neath Road	14.3	33	31.3	28.7	-
Stockhams Corner Flats	13.3	36	34.2	31.0	-
Old Fire Station Water Street	23.0	30	28.0	26.0	-

A review of the monitoring undertaken by the City and County of Swansea Council has shown that no diffusion tubes are operated within 5 km of the facility. Therefore, monitoring undertaken by the City and County of Swansea Council has not been considered as part of this assessment.

In lieu of any representative local background monitoring sites, the maximum DEFRA mapped background data within the modelling domain has been used for the background concentration for this analysis. The choice of background will be considered further if the impact of the facility cannot be described as 'negligible' irrespective of the background concentration.

#### 4.4 Hydrogen chloride

Hydrogen chloride is measured on behalf of DEFRA as part of the UK Eutrophying and Acidifying Atmospheric Pollutants (UKEAP) project. This consolidates the previous Acid Deposition Monitoring Network (ADMN), and National Ammonia Monitoring Network (NAMN). The closest monitoring station is located at Narbeth approximately 62km to the west of the Facility. A summary of the data from all sites in the UK is presented in Table 4.7.

**Table 4.7: Hydrogen Chloride Monitoring – UKEAP**

	Annual Mean Concentration ( $\mu\text{g}/\text{m}^3$ )			
	2011	2012	2013	2014
Min of all UK sites	0.10	0.14	0.15	0.10
Max of all UK sites	0.72	0.44	0.50	0.45
Average of all UK sites	0.29	0.27	0.31	0.25

*Notes:*  
Data for each site downloaded from the DEFRA website.

In lieu of any local monitoring, the maximum monitored at any site has been used for the purpose of this assessment ( $0.72 \mu\text{g}/\text{m}^3$  – 2011). The choice of background will be considered further if the impact of the facility cannot be described as 'negligible' irrespective of the background concentration.

#### 4.5 Hydrogen fluoride

Baseline 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 baseline levels, reporting that measured concentrations have been in the range of  $0.036 \mu\text{g}/\text{m}^3$  to  $2.35 \mu\text{g}/\text{m}^3$ .

In lieu of any local monitoring, the maximum measured baseline hydrogen fluoride concentration has been used for the purpose of this assessment as a conservative estimate. The choice of background will be considered further if the impact of the facility cannot be described as 'negligible' irrespective of the background concentration.

#### 4.6 Ammonia

Ammonia is also measured as part of the UKEAP project. The closest site is Narbeth. In lieu of any local monitoring the maximum mapped background over the modelling domain as presented in Table 4.2 has been used for the purpose of this assessment. The choice of background will be considered further if the impact of the facility cannot be described as 'negligible' irrespective of the background concentration.

#### 4.7 Volatile Organic Compounds

As part of the Automatic and Non-Automatic Hydrocarbon Network, benzene and 1,3-butadiene concentrations are measured at sites co-located with the AURN across the UK. The closest background monitoring site is located in Newport approximately 60km to the east of the facility. In lieu of any local monitoring the maximum mapped background over the modelling domain as presented in Table 4.2 has been used for the purpose of this assessment. The choice of background will be considered further if the impact of the facility cannot be described as 'negligible' irrespective of the background concentration.

#### 4.8 Metals

Metals are measured as part of the Rural Metals and UK Urban/Industrial Networks (previously the Lead, Multi-Element and Industrial Metals Networks). The closest monitoring site is the Port Talbot, Margam site co-located with the AURN. In addition there are a number of sites in the Swansea valley. A summary of the metals monitoring at all sites in South Wales is presented in Table 4.8.

**Table 4.8: Heavy Metals Monitoring – All Sites in South Wales**

Metal	Annual Mean EAL (ng/m <sup>3</sup> )	Annual Mean Conc. (ng/m <sup>3</sup> ) – Max All Sites			Max as % of EAL
		2012	2013	2014	
Antimony	5,000	1.60	0.26	-	0.03%
Arsenic	3	1.11	1.20	1.06	40.10%
Cadmium	5	0.51	0.93	0.93	18.69%
Chromium	5,000	7.63	13.31	10.05	0.27%
Cobalt	-	2.15	1.31	1.47	-
Copper	10,000	21.27	22.83	23.52	0.24%
Manganese	150	32.51	45.93	45.95	30.63%
Mercury	250	3.00	2.42		1.20%
Nickel	20	29.97	37.32	43.29	216.45%
Lead	250	11.36	15.32	16.89	6.75%
Thallium	-	-	-	-	-
Vanadium	5,000	1.71	2.56	3.16	0.06%

*Notes:*

*Mercury is based on the monitored mercury in particulate and vapour phase.*

As shown, the concentrations monitored over the last 3 years were significantly lower than the EALs, with the exception of nickel. The following table provides a breakdown of the nickel concentrations from each site as a percentage of the EAL.

Table 4.9: Nickel Monitoring – All Sites in South Wales

Site		Distance from facility (km)	Annual Mean Concentration (as % of EAL)		
Name	Type		2012	2013	2014
Cwmystwyth	Rural Background	81.5	4.1%	2.1%	2.6%
Cardiff Llandaff	Urban Traffic	44.5	4.8%	5.4%	-
Cardiff Rumney	Urban Background	50.9	3.1%	4.0%	-
Pontardawe Tawe Terrace	Urban Industrial	11.2	149.8%	186.6%	216.5%
Pontardawe Brecon Road	Suburban Industrial	11.9	32.9%	28.5%	39.5%
Port Talbot Margam	Urban Industrial	5.9	8.8%	8.5%	8.9%
Swansea Coedgwilym	Urban Background	9.5	42.4%	39.8%	62.2%
Swansea Morriston	Urban Traffic	7.6	27.8%	32.5%	47.2%

As shown for the majority of the sites the annual mean concentration is well below the EAL. However, for Pontardawe Tawe Terrace monitoring has shown an exceedance of the EAL in each year. The Pontardawe Tawe Terrace monitoring station was set up in order to investigate the potential for nickel emissions from Wall Colmonoy's Part B permitted site in Pontardawe, which uses approximately 500 tonnes of nickel each year to manufacture a variety of hard-wearing products.

The Port Talbot LAQM report concludes that, although results at Tawe Terrace currently exceed the EU Target, they are decreasing and this is now the only site where the EU Target is exceeded. The Brecon Road site is only 800m away from the Tawe Terrace site and was set up during 2011. The low concentrations at the Brecon Road sites shows that the exceedance is restricted to the area around the Tawe Terrace site, which is 11.2 km away from the development site.

Therefore, the concentration at Tawe Terrace is not representative of concentrations near to the development site and so the nickel monitoring from Pontardawe Tawe Terrace has been disregarded.

Hence, the maximum monitored metal concentration from a site in South Wales over the last 3 full calendar years has been used as the background concentration within this assessment, with the exception of nickel. For nickel the maximum from a site in South Wales over the last 3 full calendar years, excluding Pontardawe Tawe Terrace, has been used.

#### 4.9 Dioxins, furans and polychlorinated biphenyl (PCBs)

Dioxins, furans and PBCs are monitored on a quarterly basis at a number of urban and rural stations in the UK as part of the Toxic Organic Micro Pollutants (TOMPs) network. London is the closest monitoring site with data from the most recent year. A summary of dioxin and furan and PCB concentrations from all monitoring sites across the UK is presented in Table 4.10.

Table 4.10: Dioxin, Furan and PCBs Monitoring Results - National

Site	Annual Mean Dioxin and Furans Conc. (fg/TEQ/m <sup>3</sup> )			Annual Mean PCBs Conc. (pg/m <sup>3</sup> )		
	2008	2009	2010	2008	2009	2010
London	10.94	41.44	38.60	164.18	317.94	254.90
Manchester	18.99	14.21	14.21	133.42	168.38	185.28
Auchencorth*	6.44	0.56	5.01	12.12	44.66	37.40
Middlesbrough	23.98	-	-	138.43	-	-
High Muffles*	1.73	9.38	2.76	20.08	109.94	141.50
Hazelrigg*	3.67	13.49	8.03	14.52	89.18	110.00
Stoke Ferry	-	-	-	-	-	-
Weybourne*	-	22.82	2.49	-	44.66	21.30
UK Average	10.96	16.98	11.85	80.46	129.13	125.06

Notes:  
\* rural site

As shown, the concentrations vary significantly between sites and years. The maximum monitored concentration from across the UK has been used as the background concentration within this assessment (41.44 fg/TEQ/m<sup>3</sup> for dioxins and furans and 317.94 pg/m<sup>3</sup> for PCBs). The choice of background will be considered further if the impact of the facility cannot be described as 'negligible' irrespective of the background concentration.

#### 4.10 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic Aromatic Hydrocarbons (PAHs) are monitored as part of the PAH network. Both Port Talbot Margam and Swansea Cwm Level Car Park are included in the network. For the purpose of this assessment, benzo(a)pyrene is considered as this is the only PAH which an AQO has been set. A summary of benzo(a)pyrene concentrations from each of these sites is presented in Table 4.11.

Table 4.11: Benzo(a)pyrene Monitoring

	2010	2011	2012	2013	2014
<b>Port Talbot Margam</b>					
Annual Mean Concentration (ng/m <sup>3</sup> )	0.37	0.42	0.39	0.42	0.61
As % of AQO (0.25 ng/m <sup>3</sup> )	146%	166%	158%	169%	244%
As % of EC Target Value (1 ng/m <sup>3</sup> )	37%	42%	39%	42%	61%
As % of EC Upper Assessment Threshold (0.6 ng/m <sup>3</sup> )	61%	69%	66%	70%	102%
As % of EC Lower Assessment Threshold (0.4 ng/m <sup>3</sup> )	0.37	0.42	0.39	0.42	0.61
<b>Swansea Cwm Level Park</b>					
Annual Mean Concentration (ng/m <sup>3</sup> )	0.28	0.29	0.28	0.26	0.33
As % of AQO (0.25 ng/m <sup>3</sup> )	114%	117%	111%	105%	134%
As % of EC Target Value (1 ng/m <sup>3</sup> )	28%	29%	28%	26%	33%
As % of EC Upper Assessment Threshold (0.6 ng/m <sup>3</sup> )	47%	49%	46%	44%	56%
As % of EC Lower Assessment Threshold (0.4 ng/m <sup>3</sup> )	71%	73%	70%	65%	84%

As shown the concentrations of benzo(a)pyrene measured at both sites are below the EC Target Values but exceed the AQO. For the purpose of the initial analysis it has been assumed that the background concentration is the maximum monitored over the last 5 years from both sites (0.61 ng/m<sup>3</sup> – 2014 – Port Talbot Margam), noting that this is a conservative assumption due to the industrial nature of the area around this analyser. The choice of background will be considered further if the impact of the facility cannot be described as 'negligible' irrespective of the background concentration.

#### 4.11 Summary

Table 4.12 outlines the values for the annual average background concentrations that have been used to evaluate the impact of the facility. Further analysis of the background concentration has been undertaken where impacts cannot be described as 'negligible', irrespective of the background concentration. In addition the impact at all identified monitoring locations within the modelling domain will be quantified.

Table 4.12: Summary of Background Concentrations

Pollutant	Annual Mean Concentration	Units	Justification
Nitrogen dioxide	20.3	$\mu\text{g}/\text{m}^3$	2011 mapped background dataset maximum grid square within the modelling domain.
Oxides of nitrogen	28.3	$\mu\text{g}/\text{m}^3$	
Sulphur dioxide	6.9	$\mu\text{g}/\text{m}^3$	2001 mapped background dataset maximum grid square within the modelling domain.
Particulate matter (as PM <sub>10</sub> )	15.9	$\mu\text{g}/\text{m}^3$	2011 mapped background dataset maximum grid square within the modelling domain.
Particulate matter (as PM <sub>2.5</sub> )	10.7	$\mu\text{g}/\text{m}^3$	
Carbon monoxide	240	$\mu\text{g}/\text{m}^3$	2001 mapped background dataset maximum grid square within the modelling domain.
Hydrogen chloride	0.72	$\mu\text{g}/\text{m}^3$	Maximum from UK monitoring 2011-2014.
Hydrogen fluoride	2.35	$\mu\text{g}/\text{m}^3$	Maximum measured baseline hydrogen fluoride concentration as presented in the EPAQS report.
Ammonia	1.03	$\mu\text{g}/\text{m}^3$	Maximum mapped background concentration within the modelling domain – 2012 dataset.
Benzene	0.5	$\mu\text{g}/\text{m}^3$	Maximum mapped background concentration within the modelling domain – 2001 dataset.
1,3-butadiene	0.1	$\mu\text{g}/\text{m}^3$	
Mercury	3.00	$\text{ng}/\text{m}^3$	The maximum monitored metal concentration from a monitoring site in South Wales over the last 3 full calendar years, with the exception of nickel. For nickel the maximum from a site in South Wales over the last 3 full calendar years excluding Pontardawe Tawe Terrace has been used.
Cadmium	0.93	$\text{ng}/\text{m}^3$	
Arsenic	1.20	$\text{ng}/\text{m}^3$	
Antimony	1.60	$\text{ng}/\text{m}^3$	
Chromium	13.31	$\text{ng}/\text{m}^3$	
Cobalt	2.15	$\text{ng}/\text{m}^3$	
Copper	23.52	$\text{ng}/\text{m}^3$	
Manganese	45.95	$\text{ng}/\text{m}^3$	
Lead	16.89	$\text{ng}/\text{m}^3$	
Nickel	12.45	$\text{ng}/\text{m}^3$	
Vanadium	3.16	$\text{ng}/\text{m}^3$	
Dioxins and furans	41.44	$\text{fg}/\text{m}^3$	The maximum monitored concentration in the UK between 2008 and 2010.
Polychlorinated biphenyl (PCBs)	317.94	$\text{pg}/\text{m}^3$	
Benzo(a)pyrene (PaB)	0.61	$\text{ng}/\text{m}^3$	Maximum monitored concentration from the closest 2 sites over the last 5 years.

## 5 SENSITIVE RECEPTORS

## 5.1 Human sensitive receptors

The general approach to the assessment is to evaluate the highest predicted process contribution to ground level concentrations. In addition, the predicted process contribution at a number of sensitive receptors has been evaluated. These sensitive receptors are displayed in Figure 1 of Appendix A and listed in Table 5.1.

Table 5.1: Sensitive Receptors

ID	Receptor Name	Location		Distance from the Stack (m)
		X	Y	
R1	32 Ocean View	271498	193840	1.9
R2	Church St	273792	194137	1.5
R3	28 Swan Road	274238	193201	1.2
R4	Irving House Handel Avenue	273820	191461	1.5
R5	56 Fenbrook Close	274574	192048	1.7
R6	Baglan Primary School	274914	192712	1.8
R7	Sandfields Comprehensive School	274043	191404	1.7
R8	Ysgol Gynradd Gymraeg Rhosafan School	273940	190556	2.4
R9	St Thereses Catholic Primary School	274338	190421	2.7
R10	Blaenbaglan Primary School	275639	192908	2.6
R11	Llansawel Primary School	273772	194242	1.6
R12	Mercury School of Motoring	274190	194332	1.9
R13	Brynhyfryd Primary School	273828	194680	2.0
R14	Ynysmaerdy CP School	274295	194702	2.3
R15	Tyler Ynn Welsh Primary School	274055	195474	2.8
R16	CWRT Sart Comprehensive School	274396	195407	2.9
R17	Crym Iyn Primary School	271132	194032	2.3
R18	ABMU Health Board	274443	192129	1.5
R19	Fairfield Medical Centre	274743	191245	2.3
R20	Rushcliffe Independent Hospital	273397	190667	2.2
R21	Glanymor Primary School	274589	190449	2.8
R22	Allotment Gardens 1	274668	191610	2.0
R23	Allotment Gardens 2	274323	193335	1.4

In addition to the sensitive receptors highlighted above, the impact within the local AQMAs will be quantified.

## 5.2 Sensitive ecological receptors

A study was undertaken to identify the following sites of ecological importance in accordance with Environment Agency Horizontal Guidance H1:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), or Ramsar sites within 10 km of the facility (or 15 km coal- or oil- fired power station);
- Sites of Special Scientific Interest (SSSIs) within 2 km of the facility; and
- National Nature Reserves (NNR), Local Nature Reserves (LNRs), local wildlife sites and ancient woodlands within 2 km of the facility.

Some large emitters may be required to screen to 10 km or 15 km for SSSIs.

A screening distance of 10km has been used for all SACs, SPAs, Ramsar sites and 2km for all SSSIs. These sensitive ecological receptors are listed in Table 5.2 and displayed in Figure 2 of Appendix A. A review of the citation and APIS website for each site has been undertaken to determine if lichens are an important part of the ecosystem's integrity for the purposes of determining the relevant Critical Level for the habitat.

**Table 5.2: Sensitive Ecological Receptors**

Site	Location (m)		Distance from the Main Stack at Closest Point (m)	Lichens identified as present within APIS database
	x	y		
<b>European designated sites (within 10km)</b>				
Crymlyn Bog Ramsar, SAC and SSSI	271820	194171	1922	No
<b>UK designated sites (SSSIs) (within 2km)</b>				
Crymlyn Burrows SSSI	272626	193011	509	No
Earlswood Road Cutting and Ferryboat Inn Quarries SSSI	273039	193935	1190	No
Pant-y-Sais SSSI	271821	194171	1922	No
<b>Locally designated sites (within 2km)</b>				
Crymlyn Bog and Pant Y Sais NNR	271832	194195	1933	No
Pant-y-Sais LNR	271820	194168	1921	No
Red Jacket Fen WTR	272033	194305	1903	No
Ancient Woodlands 1	274672	192654	1620	No
Ancient Woodlands 2	274511	192944	1457	No
Ancient Woodlands 3	274234	193502	1381	No
Ancient Woodlands 4	274190	193796	1534	No
Ancient Woodlands 5	273540	194317	1656	No
Ancient Woodlands 6	273138	194309	1582	No

Earlswood Road Cutting and Ferryboat Inn Quarries SSSI has been designated due to geological interest and as such is not sensitive to air quality impacts.

## 6 ASSESSMENT METHODOLOGY

In 2015 the Institute of Air Quality Management (IAQM) published the guidance document Land-Use Planning & Development Control: Planning for Air Quality (referred to within this report as the IAQM 2015 guidance). This has been developed for professionals operating within the planning system. It provides them with a means of reaching sound decisions, having regard to the air quality implications of development proposals. This is not intended to replace the guidance that exists for industrial developments which require a permit but notes that the Environment Agency H1 guidance has not been developed for conducting an assessment to accompany a planning application.

The IAQM 2015 guidance states that this may be adapted using professional judgement, as such where appropriate Environment Agency guidance has been incorporated.

The IAQM 2015 guidance sets out the following two stage approach for assessing the impact of a development:

- (1) a qualitative or quantitative description of the impacts on local air quality arising from the development; and
- (2) a judgement on the overall significance of the effects of any impacts.

### 6.1 Description of the impact

The following matrix is provided in the IAQM guidance which should be used to describe the impact based on the change in concentration relative to the Air Quality Assessment Level (AQAL) – in this case the AQO or EAL- and the overall predicted concentration with the scheme – i.e. the future baseline plus the process contribution.

Long term average concentration at receptor in assessment year	% change in concentration relative to Air Quality Assessment Level (AQO/EAL)			
	1	2-5	6-10	>10
75% or less of AQO/EAL	Negligible	Negligible	Slight	Moderate
76-94% of AQO/EAL	Negligible	Slight	Moderate	Moderate
95-102% of AQO/EAL	Slight	Moderate	Moderate	Substantial
103-109% of AQO/EAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQO/EAL	Moderate	Substantial	Substantial	Substantial

It is intended that the change in concentration relative to the AQO/EAL (the process contribution) is rounded to the nearest whole number. Therefore any impact which is between 0.5% and 1.5% will be classified as a 1% change in concentration.

Table 6.1 is only designed to be used with annual mean concentrations. For short term concentrations (i.e. those averaged over a period of an hour or less) the following descriptors of change should be used to describe the impact:

- < 10% - negligible;
- 10 – 20% - slight;
- 20 – 50% - moderate; and
- > 50% - substantial.

The approach for assessing the impact of short term emissions has been carried out in line with the IAQM 2015 guidance and does not take into account the background concentrations as it is noted that background concentrations are less important in determining the severity of impact for short term concentrations.

The IAQM 2015 guidance does not provide any descriptors for averaging periods of between 1 hour and a year. Therefore for these periods we have drawn on the Environment Agency's Horizontal Guidance Note H1 criteria which states that:

*"process contributions can be considered insignificant if:*

- the long term process contribution is <1% of the long term environmental standard; and*
- the short term process contribution is <10% of the short term environmental standard."*

Where an impact cannot be screened out as 'insignificant' based on the outputs of the initial screening and modelling, the significance of the effect has been determined based on professional scientific judgement of the likelihood of emissions causing an exceedance of an AQO/EAL. This is a standard approach recognised by the Environment Agency which allows the risk and likelihood of exceedance to be investigated and assessed in detail, following the first stage assessment.

In addition the following screening criteria are outlined in the Environment Agency guidance document "Guidance to Applicants on Impact Assessment for Group 3 Metals Stack Releases – V.3 September 2012":

- Long-term Process Contribution (PC) <1% and Short-term Process Contribution (PC) <10%; or
- Long-term and Short-term Predicted Environmental Concentration (PEC) <100% (taking likely modelling uncertainties into account).

For screening purposes only, the Environment Agency methodology assumes that chromium (VI) comprises 20% of the total background chromium.

Where the impact is within these parameters, the Environment Agency concludes that there is no risk of exceeding the EAL. This criterion has been applied to determine the significance of the effect of emissions of metals from the facility.

## 6.2 Determining significance

The IAQM 2015 guidance explains that the framework for describing impacts, as outlined in Section 6.1, can be used to make a judgement on the significance of effect, but the impact descriptors are not a clear and unambiguous guide to reaching a conclusion on significance.

Any judgement on the overall significance of effect of development will need to take into account factors such as:

- The existing and future air quality in the absence of the development;
- The extent of current and future population exposure to the impact; and
- The influence and validity of any assumptions adopted when undertaking the prediction of impact.

## 7 DISPERSION MODELLING METHODOLOGY

### 7.1 Selection of model

Detailed dispersion modelling was undertaken using the model ADMS 5.1, 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 atmospheric stability and the boundary layer height. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. The model also includes modules to take account of the effect of buildings and complex terrain.

ADMS is routinely used for modelling of emissions for planning and Environmental Permitting purposes to the satisfaction of the Environment Agency, Natural Resources Wales and Local Authorities.

### 7.2 Model inputs

#### 7.2.1 Source and emissions data

The principal inputs to the model with respect to the emissions to air from the facility are presented in Table 7.1.

**Table 7.1: Source Data – Biomass Boiler**

Item	Unit	
<b>Stack Data</b>		
Height	m	30
Internal diameter	m	0.8
Location (E'ings,N'ings)	m, m	273079.6, 192802.1
<b>Flue Gas Conditions</b>		
Temperature	°C	180
Exit moisture content	% v/v	14.59
Exit oxygen content	% v/v dry	6.00
Reference oxygen content	% v/v dry	6.00
Volume at reference conditions (dry, ref O2)	Nm <sup>3</sup> /s	2.89
	Nm <sup>3</sup> /h	10,411
Volume at actual conditions	Am <sup>3</sup> /s	5.62
	Am <sup>3</sup> /h	20,223
Flue gas exit velocity	m/s	11.18
Moisture content	kg/kg	0.103

Emissions from the facility have been assumed to comply with the limits prescribed within Chapter VI Part 3 of the IED for a co-incineration plant.

**Table 7.2: Emissions Data – Biomass Boiler – Daily Emission Limit Values**

Pollutant	Conc. (mg/Nm <sup>3</sup> )	Release Rate (g/s)
Oxides of nitrogen (as NO <sub>2</sub> )	300	0.868
Sulphur dioxide	75	0.217
Carbon monoxide	75	0.217
Particulates	15	0.043
Hydrogen chloride	15	0.043
Volatile organic compounds (as TOC)	15	0.043
Hydrogen fluoride	1.5	0.004
Ammonia	15	0.043
Cadmium and thallium	0.05	0.145 mg/m <sup>3</sup>
Mercury	0.05	0.145 mg/m <sup>3</sup>
Other metals	0.5	1.446 mg/m <sup>3</sup>
Dioxins and furans	0.1 ng/Nm <sup>3</sup>	0.289 ng/s
Benzo(a)pyrene (PaHs)	0.158 µg/Nm <sup>3</sup>	0.445 µg/s
PCBs	7.5 µg/Nm <sup>3</sup>	21.690 µg/s

**NOTES:**

All emissions are expressed at reference conditions of dry gas, 6% oxygen, 273.15K.

As a worst-case it has been assumed that the entire PM emissions consist of either PM10 or PM2.5 for comparison with the relevant AQOs.

The highest recorded emission concentration of B[a]P from the Environment Agency's public register was 0.105 µg/m<sup>3</sup>, or 0.000105 mg/m<sup>3</sup> (dry, 11% oxygen, 273K). This has been assumed to be the emission concentration for the facility converted to 6% reference oxygen content.

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

The Waste Incineration BREF provides a range of values for PCB emissions to air from European municipal waste incineration plants. This states that the annual average total PCBs is less than 0.005 mg/Nm<sup>3</sup> (dry, 11% oxygen, 273K). In lieu of other available data, this has been assumed to be the emission concentration for the facility converted to 6% reference oxygen content.

## 7.2.2 Meteorological data and surface characteristics

The impact of meteorological data was taken into account by using weather data from Mumbles Head weather station for the years 2010 – 2014. Mumbles Head is approximately 7km to the south west of the facility. The period 2010 to 2014 was chosen as this was the most recent full set of data available at the time of starting to the air quality modelling. The Environment Agency recommends that 5 years of data are used to take into account inter-annual fluctuations in weather conditions. Wind roses for each year can be found in Figure 3.

The surface roughness length can be selected in ADMS for both the site and the meteorological site. A surface roughness length of 0.5m, representative of open suburbia, has been used in the model. This is considered to be the most suitable roughness length to take account of the combination of housing and open land.

The Monin-Obukov length for the site and meteorological site can be specified in ADMS. This provides a measure of the stability of the atmosphere and indicates the height above which convective turbulence (i.e. thermal) is more important than mechanical (i.e. friction). This allows for the effect of the urban heat island, to prevent the atmosphere from ever becoming very stable, to be simulated within the model. The Monin-Obukov length of the modelling domain was taken to be 30 m which is the value appropriate for mixed urban and industrial areas. The Monin-Obukov length of the meteorological site was taken to be 10 m which is the value appropriate for small towns.

### 7.2.3 Modelling domain

Modelling has been undertaken over a 3.15 km x 3.15 km grid with a spatial resolution of 31m. The maximum grid spacing in each is less than 1.5 times the stack height in accordance with the Environment Agency modelling rule of thumb. Reference should be made to Figure 4 of Appendix A for a graphical representation of the modelling domain site and terrain file used.

**Table 7.3: Modelling Domain**

<b>Grid</b>	<b>Domain</b>
Grid Spacing (m)	31
Grid Points	101
Grid Start X	271500
Grid Finish X	274650
Grid Start Y	191250
Grid Finish Y	194400

### 7.2.4 Terrain

It is recommended that, where gradients within 500 m of the modelling domain are greater than 1 in 10, the complex terrain module within ADMS (FLOWSTAR) should be used. A review of the local area has shown that modelling should include the effects of terrain. As such a terrain file with a grid resolution of 128 x 128 has been used.

### 7.2.5 Buildings

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

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

The Environment Agency<sup>1</sup> recommends that buildings should be included in the modelling if they are both:

- Within 5L of the stack (where L is the smaller of the building height and maximum projected width of the building); and
- Taller than 40% of the stack.

A review of the site layout has been undertaken and the details of the applicable buildings are presented in Table 7.4. Only those which are greater than 40% of the stack height have been included. A site plan showing which buildings have been contained in the model is presented in Figure 5 of Appendix A.

The building layout has been developed to ensure that the stack is located at a distance from the buildings to where the effects of the buildings on dispersion from the stack are minimised. The main building has been selected as B as this will have the greatest impact upon dispersion from the stack.

**Table 7.4: Building Details**

Buildings	Centre Point		Height (m)	Length (m)	Width (m)	Angle (°)
	X (m)	Y (m)				
B	273142.3	192872.8	23.56	130.45	33.2	69
A	273027.4	192793	9.57	85.7	139.7	69
B1	273070.6	192839	12.56	28.83	45.95	69
BA1	273115.5	192838.7	8.12	42.7	12.75	69
BA2	273177.3	192861.9	12.58	24	12.4	69
C	273244.6	192877.4	9.56	65.7	99.7	69
CA1	273219	192840	7.7	12.92	26.21	69
D	273343.5	192900	12	125.55	161.1	69
E	273393.7	192803	9.56	82.45	57.85	69
F	273491.4	192904.6	9.58	156.2	220.7	69
Bunker	273118.3	192807.1	7	15.6	22.44	69
Boiler House	273093.7	192797.7	18	28.8	22.74	69

### 7.3 Chemistry

The plant will release nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>) which are collectively referred to as NO<sub>x</sub>. In the atmosphere, a proportion of nitric oxide will be converted to nitrogen dioxide in a reaction with ozone which is influenced by solar radiation. Since the AQOs are expressed in terms of nitrogen dioxide, it is important to be able to assess the conversion rate of nitric oxide to nitrogen dioxide.

Ground level NO<sub>x</sub> concentrations have been predicted through dispersion modelling. Nitrogen dioxide concentrations reported in the results section assume 70% conversion from NO<sub>x</sub> to nitrogen dioxide for annual means and a 35% conversion for short term (hourly) concentrations, based upon the worst-case scenario in the Environment Agency methodology. Given the short travel time to the areas of maximum concentrations, this approach is considered conservative.

<sup>1</sup> AQTAG06 – Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air – January 2013.

#### 7.4 Background concentrations

Background concentrations for the assessment have been derived from monitoring as presented previously in Table 4.12.

For short term averaging periods the background concentration has been assumed to be twice the long term ambient concentration following the Environment Agency Horizontal Guidance Note H1 methodology.

## 8 RESULTS

### 8.1 Scenarios

As discussed the existing facility has a number of boilers which emit to atmosphere. It is not proposed to change any of the existing emissions points. As such this assessment has focussed on the change associated with the operation of the wood-fuelled boiler only.

### 8.2 Results

As discussed in Section 7.2.1, emissions from the facility will be subject to emission limits. This section details the impact of the facility assuming that the facility operates for the entire year at the emission limits which were outlined in Table 7.2.

Table 8.1 presents the results of the dispersion modelling of emissions from the facility at the point of maximum impact and compares these results with the AQO/EALs presented in Table 3.2.

Any change in concentration which is greater than 0.5% of the long term or 9.5% of the short term AQO/EAL is highlighted. For these pollutants the impact cannot be described as 'negligible' or 'insignificant' based on the process contribution alone and consideration of the background concentration is needed to describe the change in impact.

Table 8.1: Dispersion Modelling Results – Point of Maximum Impact – 100% Operation

Pollutant	Quantity	Units	AQO /EAL	Bg Conc.	Process Contribution (PC) at Point of Greatest Impact						Max as % of AQO /EAL	PEC (PC +Bg)	PEC as % of AQO /EAL
					2010	2011	2012	2013	2014	Max			
Nitrogen dioxide	Annual mean	µg/m <sup>3</sup>	40	20.3	2.39	2.64	2.21	2.24	2.55	2.64	6.60%	22.94	57.35%
	99.79th%ile of hourly means	µg/m <sup>3</sup>	200	40.6	9.07	9.83	9.14	9.17	9.19	9.83	4.91%	50.43	25.21%
Sulphur dioxide	99.18th%ile of daily means	µg/m <sup>3</sup>	125	13.8	4.12	4.22	4.18	4.16	3.92	4.22	3.38%	18.02	14.42%
	99.73rd%ile of hourly means	µg/m <sup>3</sup>	350	13.8	6.39	6.79	6.47	6.36	6.44	6.79	1.94%	20.59	5.88%
	99.9th%ile of 15 min. means	µg/m <sup>3</sup>	266	13.8	10.72	8.53	9.81	7.54	7.61	10.72	4.03%	24.52	9.22%
PM <sub>10S</sub>	Annual mean	µg/m <sup>3</sup>	40	15.9	0.17	0.19	0.16	0.16	0.18	0.19	0.47%	16.09	40.22%
	90.41th%ile of daily means	µg/m <sup>3</sup>	50	31.8	0.40	0.41	0.42	0.46	0.38	0.46	0.92%	32.26	64.52%
PM <sub>2.5S</sub>	Annual mean	µg/m <sup>3</sup>	25	10.7	0.17	0.19	0.16	0.16	0.18	0.19	0.75%	10.89	43.55%
Carbon monoxide	8 hour running mean	µg/m <sup>3</sup>	10,000	480.0	5.71	5.68	6.01	6.21	10.83	10.83	0.11%	490.83	4.91%
Hydrogen chloride	Hourly mean	µg/m <sup>3</sup>	750	1.4	2.41	3.46	2.53	2.84	2.94	3.46	0.46%	4.90	0.65%
Hydrogen fluoride	Annual mean	µg/m <sup>3</sup>	16	2.4	0.02	0.02	0.02	0.02	0.02	0.02	0.12%	2.37	14.80%
	Hourly mean	µg/m <sup>3</sup>	160	4.7	0.24	0.35	0.25	0.28	0.29	0.35	0.22%	5.05	3.15%
Ammonia	Annual mean	µg/m <sup>3</sup>	180	1.0	0.17	0.19	0.16	0.16	0.18	0.19	0.10%	1.22	0.68%
	Hourly mean	µg/m <sup>3</sup>	2,500	2.1	2.41	3.46	2.53	2.84	2.94	3.46	0.14%	5.52	0.22%
VOCs (as benzene)	Annual mean	µg/m <sup>3</sup>	5	0.5	0.17	0.19	0.16	0.16	0.18	0.19	3.74%	0.69	13.74%

Table 8.1: Dispersion Modelling Results – Point of Maximum Impact – 100% Operation

Pollutant	Quantity	Units	AQO /EAL	Bg Conc.	Process Contribution (PC) at Point of Greatest Impact						Max as % of AQO /EAL	PEC (PC +Bg)	PEC as % of AQO /EAL
					2010	2011	2012	2013	2014	Max			
VOCs (as 1,3-butadiene)	Annual mean	µg/m <sup>3</sup>	2.25	0.1	0.17	0.19	0.16	0.16	0.18	0.19	8.31%	0.29	12.75%
Mercury	Annual mean	ng/m <sup>3</sup>	250	3.0	0.84	0.93	0.78	0.79	0.90	0.93	0.37%	3.93	1.57%
	Hourly mean	ng/m <sup>3</sup>	7,500	6.0	12.03	17.28	12.64	14.18	14.68	17.28	0.23%	23.28	0.31%
Cadmium	Annual mean	ng/m <sup>3</sup>	5	0.93	0.84	0.93	0.78	0.79	0.90	0.93	18.69%	1.86	37.29%
	Hourly mean	ng/m <sup>3</sup>	-	1.86	12.03	17.28	12.64	14.18	14.68	17.28	-	19.14	-
Dioxins	Annual mean	fg/m <sup>3</sup>	-	41.44	1.69	1.87	1.56	1.59	1.80	1.87	-	43.31	-
PCBs	Annual mean	ng/m <sup>3</sup>	200	317.94	0.08	0.09	0.08	0.08	0.09	0.09	0.05%	318.03	159.02%
	Hourly mean	ng/m <sup>3</sup>	6,000	635.88	1.20	1.73	1.26	1.42	1.47	1.73	0.03%	637.61	10.63%
PAHs	Annual mean	pg/m <sup>3</sup>	250	0.61	1.77	1.96	1.64	1.67	1.89	1.96	0.79%	2.57	1.0%
Other metals	Annual mean	ng/m <sup>3</sup>	-	-	8.44	9.35	7.80	7.93	9.01	9.35	See metals assessment		
	Hourly mean	ng/m <sup>3</sup>	-	-	120.31	172.83	126.41	141.85	146.81	172.83			

The following sections describe the change in concentration for each pollutant and averaging period.

### 8.3 Nitrogen dioxide

The change in annual mean nitrogen dioxide concentrations from the existing baseline as a result of the proposals is predicted to be 6.60% of the AQO at the point of maximum impact. At this point the PEC is predicted to be 57.35% of the AQO. Using the IAQM guidance this change is described as 'negligible'.

We have analysed the plot files to determine the maximum change in concentration from the existing baseline as a result of emissions from the proposed scheme at residential areas in addition to the discrete receptor locations described in Table 5.1.

The maximum change in concentration from the existing baseline at a residential receptor is less than 0.5% of the AQO (Figure 6). Using the IAQM guidance this change in concentration in this area is described as 'negligible' irrespective of background levels.

The change in 99.79<sup>th</sup> percentile of hourly mean nitrogen dioxide concentrations from the existing baseline as a result of the proposals is predicted to be 4.91% of the AQO at the point of maximum impact. Using the IAQM guidance this change can be described as 'negligible'.

### 8.4 Sulphur dioxide

The change in 99.18<sup>th</sup> percentile of daily mean sulphur dioxide concentrations from the existing baseline as a result of the proposals is predicted to be 3.38% of the AQO at the point of maximum impact. The IAQM guidance does not provide criteria for describing the change in daily mean concentrations. Therefore the Environment Agency H1 screening criteria has been used instead. This states that if short term process contribution is less than 10% of the short term environmental standard the impact is "insignificant". The daily mean is a short term objective. The change in concentration from the existing baseline at the point of maximum impact can be described as 'insignificant'.

The change in 99.73<sup>th</sup> percentile of hourly mean sulphur dioxide concentrations from the existing baseline as a result of the proposals is predicted to be 1.94% of the AQO at the point of maximum impact. Using the IAQM guidance this change can be described as 'negligible'.

The change in 99.9<sup>th</sup> percentile of 15-minute mean sulphur dioxide concentrations from the existing baseline as a result of the proposals is predicted to be 4.03% of the AQO at the point of maximum impact. Using the IAQM guidance this change can be described as 'negligible'.

### 8.5 Particulate matter

For the purposes of this analysis, the predicted change in concentration of particulate matter from the existing baseline has been determined by assuming that the entire particulate matter emissions consists of either PM10 or PM2.5 in turn.

The change in annual mean particulate matter (as PM10) concentrations from the existing baseline as a result of the proposals is predicted to be 0.47% of the AQO at the point of maximum impact. At this point the PEC is predicted to be 40.22% of the AQO. Using the IAQM guidance this change is described as 'negligible' irrespective of background levels.

The change in 90.41<sup>th</sup> percentile of daily mean particulate matter (as PM10) concentrations from the existing baseline as a result of the proposals is predicted to be 0.92% of the AQO at the point of maximum impact. The IAQM guidance does not provide criteria for describing the change in daily mean concentrations. Therefore the Environment Agency H1 screening criteria has been used instead. This states that if short term process contribution is less than 10% of the short term environmental standard the impact is 'insignificant'. The daily mean is a short term objective. The change in concentration from the existing baseline at the point of maximum impact can be described as 'insignificant'.

The change in annual mean particulate matter (as PM2.5) concentrations the existing baseline as a result of the proposals from is predicted to be 0.75% of the AQO at the point of maximum impact. At this point the PEC is predicted to be 43.55% of the AQO. Using the IAQM guidance this change is described as 'negligible'. We have analysed the plot files to determine the maximum change at a sensitive receptor. This has shown that the change in annual mean particulate matter (as PM2.5) concentrations the existing baseline as a result of the proposals is only greater than 0.5% of the AQO for a few grid points within the site boundary. Therefore the change in concentration from the existing baseline at all sensitive receptors is less than 0.5% of the AQO. The change in concentration from the existing baseline at all sensitive receptors can be described as 'negligible' irrespective of background levels.

## 8.6 Carbon monoxide

The change in 8-hour running mean carbon monoxide concentrations from the existing baseline as a result of the proposals is predicted to be 0.11% of the AQO at the point of maximum impact. The IAQM guidance does not provide criteria for describing the change in daily mean concentrations. Therefore the Environment Agency H1 screening criteria has been used instead. This states that if short term process contribution is less than 10% of the short term environmental standard the impact is 'insignificant'. The 8-hour mean is a short term objective. The change in concentration from the existing baseline at the point of maximum impact can be described as 'insignificant'.

## 8.7 Hydrogen chloride

The change in 1-hour hydrogen chloride concentrations from the existing baseline as a result of the proposals is predicted to be 0.46% of the AQO at the point of maximum impact. Using the IAQM guidance this change from the existing baseline can be described as 'negligible'.

## 8.8 Hydrogen fluoride

The change in annual mean hydrogen fluoride concentrations from the existing baseline as a result of the proposals is predicted to be 0.12% of the AQO at the point of maximum impact. At this point the PEC is predicted to be 14.80% of the AQO. Using the IAQM guidance this change is described as 'negligible' irrespective of background levels.

The change in 1-hour hydrogen fluoride concentrations from the existing baseline as a result of the proposals is predicted to be 0.22% of the AQO at the point of maximum impact. Using the IAQM guidance this change from the existing baseline can be described as 'negligible'.

## 8.9 Ammonia

The change in annual mean ammonia concentrations from the existing baseline as a result of the proposals is predicted to be 0.10% of the AQO at the point of maximum impact. At this point the PEC is predicted to be 0.68% of the AQO. Using the IAQM guidance this change is described as 'negligible' irrespective of background levels.

The change in 1-hour ammonia concentrations from the existing baseline as a result of the proposals is predicted to be 0.14% of the AQO at the point of maximum impact. Using the IAQM guidance this change from the existing baseline can be described as 'negligible'.

## 8.10 VOCs

As a screening approach we have assumed that the facility continually operates at the emission limits for VOC. There are two VOCs for which a long term AQO have been prescribed – benzene and 1,3-butadiene. In assessing the impact of VOC emissions we have compared the total process contribution of VOCs to each of the AQOs. This is a highly conservative assumption as it does not take into account the speciation of VOCs in the emissions or the volatile nature of the compounds.

The change in annual mean VOC concentrations from the existing baseline as a result of the proposals is predicted to be 3.74% of the AQO for benzene at the point of maximum impact. At this point the PEC is predicted to be 13.74% of the AQO for benzene. Using the IAQM guidance this change is described as 'negligible'. We have analysed the plot files to determine the maximum impact from the existing baseline at a sensitive receptor. As shown in Figure 7 the change in concentration from the existing baseline at all sensitive receptors is less than 0.5% of the AQO for benzene. Therefore the change in concentration from the existing baseline at all sensitive receptors can be described as 'negligible', irrespective of background concentrations.

The change in annual mean VOC concentrations from the existing baseline as a result of the proposals is predicted to be 8.31% of the AQO for 1,3-butadiene at the point of maximum impact. At this point the PEC is predicted to be 12.75% of the AQO. Using the IAQM guidance this change is described as 'slight adverse'. We have analysed the plot files to determine the maximum impact at a sensitive receptor. As shown in Figure 8 the change in concentration at all sensitive receptors is less than 1.5% of the AQO. Therefore when rounded to the nearest whole number, as recommended by the IAQM, the change in concentration at all sensitive receptors can be described as 'negligible'.

## 8.11 Mercury

The change in annual mean mercury concentrations from the existing baseline as a result of the proposals is predicted to be 0.37% of the EAL at the point of maximum impact. At this point the PEC is predicted to be 1.57% of the EAL. Using the IAQM guidance this change is described as 'negligible' irrespective of background levels.

The change in 1-hour mercury concentrations from the existing baseline as a result of the proposals is predicted to be 0.23% of the AQO at the point of maximum impact. Using the IAQM guidance this change from the existing baseline can be described as 'negligible'.

## 8.12 Cadmium

There is a combined emission limit for cadmium and thallium and, as an initial screening assumption, it was assumed that the total cadmium and thallium emissions consist of only cadmium. However, this is a conservative assumption. The Wilton 10 facility processes the same feedstock as the proposed facility. Analysis of the Environment Agency's public register has indicated that combined concentrations of cadmium and thallium at the Wilton 10 Facility are a maximum of about 14% of the total cadmium and thallium ELV. Using this assumption the change in annual mean cadmium concentrations from the existing baseline as a result of the proposals is predicted to be 2.62% of the EAL. The PEC is predicted to be 21.2% of the EAL, and the change in concentration can be described as 'negligible'.

We have analysed the plot files to determine the maximum change in concentration from the existing baseline as a result of the proposals at a sensitive receptor. As shown in Figure 10, the change in concentration from the existing baseline at all sensitive receptors is less than 0.5% of the EAL. Therefore the change in concentration from the existing baseline at all sensitive receptors can be described as 'negligible', irrespective of background levels.

### 8.13 PCBs

The change in annual mean PCB concentrations from the existing baseline as a result of the proposals is predicted to be 0.05% of the AQO at the point of maximum impact. At this point the PEC is predicted to be 159.02% of the AQO. Using the IAQM guidance this change from the existing baseline is described as 'negligible' irrespective of background levels.

The change in 1-hour PCB concentrations from the existing baseline as a result of the proposals is predicted to be 0.03% of the AQO at the point of maximum impact. Using the IAQM guidance this change from the existing baseline can be described as 'negligible'.

### 8.14 PAHs

PAHs are members of a large group of organic compounds widely distributed in the atmosphere. The only PAH for which an AQO has been set is benzo[a]pyrene (B[a]P). Although this is not a regulated pollutant we have assessed the impact of PAH emissions by assuming the plant emits no more than the highest recorded emission concentration of B[a]P from the Environment Agency's public register.

The change in concentration from the existing baseline of annual means PAH concentration as a result of the proposals is predicted to be 0.79% of the AQO at the point of maximum impact. We have analysed the plot files to determine the maximum change at a sensitive receptor. This has shown that the change in annual mean PAH concentrations as a result of the proposals is only greater than 0.5% of the AQO for a few grid points within the site boundary. Therefore the change in concentration from the existing baseline at all sensitive receptors is less than 0.5% of the AQO. The change in concentration from the existing baseline at all sensitive receptors can be described as 'negligible' irrespective of background levels.

### 8.15 Summary of description of change

The following table presents a summary of the description of the change in concentration at the point of maximum impact and at sensitive receptors.

<b>Table 8.2: Summary of Description of Change</b>		
<b>Pollutant</b>	<b>Quantity</b>	<b>Description of Change at Maximum Impacted Sensitive Receptors</b>
Nitrogen dioxide	Annual mean	Negligible
	99.79th%ile of hourly means	Negligible
Sulphur dioxide	99.18th%ile of daily means	Insignificant
	99.73rd%ile of hourly means	Negligible
	99.9th%ile of 15 min. means	Negligible
PM <sub>10S</sub>	Annual mean	Negligible
	90.41th%ile of daily means	Insignificant

Table 8.2: Summary of Description of Change

Pollutant	Quantity	Description of Change at Maximum Impacted Sensitive Receptors
PM <sub>2.5S</sub>	Annual mean	Negligible
Carbon monoxide	8 hour running mean	Insignificant
Hydrogen chloride	Hourly mean	Negligible
Hydrogen fluoride	Annual mean	Negligible
	Hourly mean	Negligible
Ammonia	Annual mean	Negligible
	Hourly mean	Negligible
VOCs (as benzene)	Annual mean	Negligible
VOCs (as 1,3-butadiene)	Annual mean	Negligible
Mercury	Annual mean	Negligible
	Hourly mean	Negligible
Cadmium	Annual mean	Negligible
PCBs	Annual mean	Negligible
	Hourly mean	Negligible
PAHs	Annual mean	Negligible

### 8.16 Dioxins and furans (and dioxin-like PCBs)

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 Human Health Risk Assessment contained as Appendix D. This considers each of the scenarios identified in Section 8.1. Section 10 provides a summary of the Human Health Risk Assessment.

### 8.17 Metals – at point of maximum impact

To ensure that there is no significant adverse air quality impact of the metal emissions we have assessed the change in concentration from the existing baseline using the three stage screening methodology outlined in the Environment Agency guidance document "Guidance to Applicants on Impact Assessment for Group 3 Metals Stack Releases – V.3 September 2012".

#### 8.17.1 Stage 1

Using the Environment Agency methodology, the first stage is to predict the impact of each metal, assuming each metal is emitted at 100% of the emission level, and compare against the EALs outlined in Table 3.1.

Table 8.3 displays the results of the first stage screening methodology for long term impacts of metals. Any exceedences of the Environment Agency screening criteria are highlighted.

Table 8.3: Heavy Metal Screening Assessment - Step 1 – Long Term

Metal	EAL (ng/m <sup>3</sup> )	Background Conc. (ng/m <sup>3</sup> )	Process Contribution		PEC	
			Conc. (ng/m <sup>3</sup> )	As % of EAL	Conc. (ng/m <sup>3</sup> )	As % of EAL
Arsenic	3	1.20	6.23	207.68%	7.43	247.68%
Antimony	5,000	1.60	6.23	0.12%	7.83	0.16%
Chromium	5,000	13.31	6.23	0.12%	19.54	0.39%
Chromium (VI)	0.2	2.66	6.23	3115.27%	8.89	4446.27%
Cobalt	-	2.15	6.23	-	8.38	-
Copper	10,000	23.52	6.23	0.06%	29.75	0.30%
Lead	250	16.89	6.23	2.49%	23.12	9.25%
Manganese	150	45.95	6.23	4.15%	52.18	34.79%
Nickel	20	12.45	6.23	31.15%	18.68	93.40%
Vanadium	5,000	3.16	6.23	0.12%	9.39	0.19%

Using the first stage screening methodology, the PCs of arsenic, chromium (VI), lead, manganese and nickel are predicted to be greater than 1% of the EAL. However, only the PEC for arsenic, chromium (VI) and nickel is predicted to be greater than 100% of the EAL. The assessment methodology states that the PEC should take into account of modelling uncertainty. For lead and manganese the PEC is less than 40% which means that, even when taking into account of any modelling uncertainty, it is expected that the PEC will remain below the EAL. Therefore only arsenic, chromium (VI) and nickel have been progressed to the second stage of assessment.

The PC for all other metals is less than 1% and the PEC is less than 100% of the EAL and so these can be screened out from further assessment. It is considered that, even when taking likely modelling uncertainties into account, there is little potential for significant pollution and progression to the second stage of assessment is not necessary.

Table 8.4 presents the results of the first stage screening methodology for short term impacts of metals.

**Table 8.4: Heavy Metal Screening Assessment - Step 1 – Short Term**

Metal	EAL (ng/m <sup>3</sup> )	Background Conc. (ng/m <sup>3</sup> )	Process Contribution		PEC	
			Conc. (ng/m <sup>3</sup> )	As % of EAL	Conc. (ng/m <sup>3</sup> )	As % of EAL
Arsenic	-	2.40	115.22	-	117.62	-
Antimony	150,000	3.20	115.22	0.08%	118.42	0.08%
Chromium	150,000	26.62	115.22	0.08%	141.84	0.09%
Chromium (VI)	-	5.32	115.22	-	120.55	-
Cobalt	-	4.30	115.22	-	119.52	-
Copper	200,000	47.04	115.22	0.06%	162.26	0.08%
Lead	-	33.78	115.22	-	149.00	-
Manganese	1,500,000	91.90	115.22	0.01%	207.12	0.01%
Nickel	-	24.90	115.22	-	140.12	-
Vanadium	1,000	6.32	115.22	11.52%	121.54	12.15%

Using the stage 1 screening methodology, the PEC for all metals is less than 100% and so the short term impact of all metals can be screened out from further assessment. The PC for vanadium is greater than 10%, but the PEC is less than 15% of the EAL. Therefore, even when taking into account any modelling uncertainty, it is expected that the PEC will remain below the EAL. It is therefore not necessary to progress short term vanadium emissions to the second stage of assessment.

### 8.17.2 Stage 2

The second stage of the assessment is to consider a worst case scenario based on currently operating plant, assuming each metal comprises 11% of the total group (i.e. a process contribution of 6.23 ng/m<sup>3</sup> apportioned equally across the nine metals).

It is assumed for this worst case screening that the proportion of chromium (VI) to total chromium is 20% as suggested as a worst case by the Expert Panel on Air Quality Standards (EPAQS) paper on Metals and Metalloids.

The results of the second stage assessment are shown below. Any exceedences of the Environment Agency screening criteria are highlighted.

**Table 8.5: Heavy Metal Screening Assessment - Step 2 – Long Term**

Metal	EAL (ng/m <sup>3</sup> )	Background Conc. (ng/m <sup>3</sup> )	Process Contribution		PEC	
			Conc. (ng/m <sup>3</sup> )	As % of EAL	Conc. (ng/m <sup>3</sup> )	As % of EAL
Arsenic	3.00	1.20	0.69	23.08%	1.89	63.08%
Chromium (VI)	0.20	2.66	0.69	346.14%	3.35	1677.14%
Nickel	20	12.45	0.69	3.46%	13.14	65.71%

As shown, although the PC for arsenic and nickel is greater than 1% as a worst case scenario, the PEC is well below 100% of the EAL. As such it is considered that, even when taking likely modelling uncertainties into account, there is little potential for significant pollution and progression to the third stage of assessment for emissions of arsenic and nickel is not necessary.

The PC for arsenic is greater than 1% and the PEC is greater than 70% therefore, additional consideration has to be given to the assumptions used in assessing the impact of this pollutant.

Assuming the entire chromium emissions are in the hexavalent form (chromium VI), emissions cannot be screened out using the worst case scenario. Therefore, additional consideration has to be given to the assumptions used in assessing the impact of this pollutant.

### 8.17.3 Stage 3

The third stage of the assessment is to consider site specific assumptions.

#### Percentages lower than 11% of the IED ELV

The facility will incorporate a flue gas treatment system to remove heavy metals from the gas stream. This flue gas treatment system is similar to that in use at other UK waste biomass combustion facilities and, as such, we would expect the performance of the proposed flue gas treatment system to be as effective in removing heavy metals as the same system employed at a typical facility.

Wilton 10 biomass facility processes a similar feedstock to that proposed at the facility. Monitoring of metals within the APC residues is undertaken at Wilton 10 as a condition of the Environmental Permit. This data is provided as proportion composition of each monitored metal to the total metals within the APC residue. The total metals emission concentration has been multiplied by the proportion of each metal in the APC residue to estimate each individual metal release concentration as a proportion of the total metals ELV. This is reproduced in the following table. For comparative purposes, the table also includes the Environment Agency analysis of MWI from their guidance note dated September 2012. Where the measured concentration is greater than 11% of the Group 3 metals ELV, this is highlighted.

Table 8.6: Monitoring Data

Pollutant	Measured Concentration as % of IED Group 3 ELV – Environment Agency Guidance			Metals Data from Wilton 10 Biomass Facility Based on APC Residue Analysis – 2008 to 2010 as % of IED Group 3 ELV		
	Mean	Max	Min	Mean	Max	Min
Antimony	0.66%	2.30%	0.02%	-	-	-
Arsenic	0.14%	0.60%	0.06%	0.82%	1.60%	0.12%
Chromium	2.18%	10.42%	0.08%	1.87%	3.57%	0.64%
Cobalt	0.08%	0.78%	0.04%	0.25%	0.53%	0.08%
Copper	1.54%	3.26%	0.50%	2.88%	5.02%	0.43%
Lead	3.16%	7.36%	0.06%	10.65%	19.15%	1.40%
Manganese	3.44%	7.30%	0.30%	15.93%	28.34%	6.08%
Nickel	4.40%	27.24%	0.00%	3.63%	7.10%	0.83%
Tin	0.48%	0.48%	0.48%	-	-	-
Vanadium	0.06%	0.20%	0.04%	0.10%	0.18%	0.05%
<b>Total (calculated)</b>	<b>16.14%</b>	<b>59.94%</b>	<b>1.58%</b>	<b>16.61%</b>	<b>46.39%</b>	<b>4.24%</b>

## NOTES:

The measured nickel concentration from the MWIs is greater than 11% due to one single measurement outlier. The average is around 4% of the Group ELV.

Antimony and tin are not monitored in the APC residues at Wilton 10.

As shown, the arsenic, total chromium, and nickel emissions are well below 11% of the ELV. The total chromium emissions are a maximum of 3.57% of the limit; this includes some contribution from chromium (VI).

Only lead and manganese are greater than 11% of the group ELV. The impact of lead and manganese emissions could be screened out at the first stage, assuming that each metal is emitted at 100% of the ELV. Therefore applying the monitoring data presented in Table 8.6 would not change the assessment.

Speciation of chromium to chromium VI is not undertaken at Wilton 10 biomass facility. In lieu of any monitoring from the Wilton 10 facility we have reviewed the analysis of monitoring of metal emissions from 10 Municipal Waste Incinerators in England and Wales as presented in Appendix B of "Guidance to Applicants on Impact Assessment for Group 3 Metals Stack Releases – V.3 September 2012". This includes analysis of chromium VI in APC residues which is reproduced in the following table.

Table 8.7: Chromium VI Analysis from APC Residues

	Effective Cr(VI) Emission Concentration (mg/Nm <sup>3</sup> , 11% ref oxygen content)	% of IED Limit for Total Metals
Mean	3.5 x 10 <sup>-5</sup>	0.0070%
Minimum	2.3 x 10 <sup>-6</sup>	0.0005%
Maximum	1.3 x 10 <sup>-4</sup>	0.0260%

As shown, the maximum chromium (VI) emissions are very low at 0.026% of the total group 3 ELV. Although this data is from municipal waste incinerators it is not likely that chromium (VI) emissions would be any greater using the proposed feedstock.

The analysis of the monitoring of chromium (VI) by the Environment Agency has shown that the mean concentration as a proportion of the ELV is 2.2%. This is similar to the Wilton 10 biomass facility mean analysis. The combustion mechanism for chromium and chromium (VI) are similar; therefore, since the chromium concentrations are similar we would anticipate that the chromium (VI) contribution would also be similar.

The results of the third stage assessment are presented in the following table, taking into account the likely emissions based on the maximum monitored concentrations from Wilton 10 biomass facility and the maximum chromium (VI) speciation from the Environment Agency. Any exceedences of the Environment Agency screening criteria are highlighted.

Metal	EAL (ng/m <sup>3</sup> )	Background Conc. (ng/m <sup>3</sup> )	Process Contribution		PEC	
			Conc. (ng/m <sup>3</sup> )	As % of EAL	Conc. (ng/m <sup>3</sup> )	As % of EAL
Chromium (VI)	0.20	2.66	1.62E-03	0.81%	2.66	1331.81%

As shown, assuming the flue gas treatment system performance will be no worse than other facilities (the maximum of the Environment Agency analysis), the PC is less than 1% of the EAL at the point of maximum impact. Therefore, there is little potential for significant pollution as a result of emissions of chromium VI.

We have analysed the plot files to determine the maximum change at a sensitive receptor. This has shown that the change in annual mean chromium (VI) concentrations the existing baseline as a result of the proposals, assuming the plant performs similar to other facilities, is only greater than 0.5% of the AQO for a few grid points within the site boundary. Therefore the change in concentration from the existing baseline at all sensitive receptors is less than 0.5% of the AQO. The change in concentration from the existing baseline at all sensitive receptors can be described as 'negligible' irrespective of background levels.

#### 8.17.4 Summary of metals screening

To ensure that there is no significant adverse air quality impact of the metal emissions we have assessed the change in concentration from the existing baseline using the three stage screening methodology outlined in the Environment Agency guidance document "Guidance to Applicants on Impact Assessment for Group 3 Metals Stack Releases – V.3 September 2012".

This has shown that there is no risk of exceeding any EAL for these heavy metals as a result of the emissions from the facility.

#### 8.18 Impact at AQMAs

As identified there are a number of AQMAs near to the facility, the closest of which is in Port Talbot and is designated due to concern over daily mean particulate matter emissions. As explained above, the change in daily mean particulate matter concentrations at the point of maximum impact is well below 10% of the AQO and is considered 'negligible'. Therefore there is little risk of emissions from the facility significantly impacting upon the AQMA 3km away.

The AQMAs in Swansea have been designated due to concern over annual mean nitrogen dioxide concentrations. As shown in Figure 6, beyond 1km from the facility the impact is described as 'negligible' irrespective of background concentrations. Therefore there is little risk of emissions from the facility significantly impacting upon the AQMA located 4km away.

### 8.19 Impact at monitoring sites

As identified there are a number of local monitoring stations. The impact of process emissions has been predicted for all monitoring locations. This has shown at all monitoring locations the impact of the proposed boiler is 'negligible', irrespective of background concentrations.

### 8.20 Significance of effect

The preceding sections have described the risk of exceeding and AQO/EAL and the change in concentration associated with proposals. As outlined in Section 6.2 the impact descriptors are not an unambiguous guide to reaching a conclusion of the significance of effect. Professional judgement has been applied to determine the significance of the effect.

As noted the change in impact can be described as 'negligible' at all receptors. Therefore it is concluded that the significance of the effect is also negligible. Therefore, the emissions to atmosphere should not be considered a constraint to this planning application. This judgement has been made based on dispersion modelling using the following conservative assumptions:

- the facility operates concurrently at the emission limit for the entire year;
- the entire PM emissions are assumed to consist of PM10 or PM2.5;
- the entire VOC emissions are assumed to consist of benzene or 1,3-butadiene;
- the impact is based on the maximum using 5-years of weather data; and
- no allowance has been made for periods of maintenance when the plant will be offline.

## 9 IMPACT AT ECOLOGICAL RECEPTORS

This section provides an assessment of the impact of the operation of the facility at the identified ecological receptors. For the purpose of assessing the impact on ecological receptors it has been assumed that the facility operates at the emission limits for the entire year. The IAQM 2015 guidance specifically states that it is not designed for assessing the impact at ecological sites. Therefore the Environment Agency's guidance has been applied. This method is considered appropriate as the facility will be regulated by the Natural Resources Wales who adopt the Environment Agency guidance when determining Environmental Permit applications.

### 9.1 Screening

The Environment Agency has produced Operational Instruction documents which explain how to assess aerial emissions from new or expanding Integrated Pollution Prevention and Control (IPPC) regulated industry applications, issued under the Environmental Permitting Regulations. The process to follow to satisfy the requirements of the Conservation of Habitats and Species Regulations 2010, Countryside and Rights of Way (CROW) Act 2000, and the Environment Agency's wider duties under the Environment Act 1995 and the Natural Environment and Rural Communities Act 2006 (NERC06) are outlined.

Operational Instruction 67\_12 "Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation" provides the following risk based screening criteria for nature conservation sites.

**Table 9.1: Screening Criteria**

Threshold	European Sites	SSSIs	NNR, LNR, LWS, ancient woodland
Y (% threshold long-term)	1	1	100
Y (% threshold short-term)	10	10	100
Z (% threshold)	70	70	100

NOTES:  
Short term considers both daily and weekly

Where:

- Y is the long term process contribution calculated (PC) as a percentage of the relevant Critical Level or Load; and
- Z is the long term predicted environmental concentration (PEC) calculated as a percentage of the relevant Critical Level or Load.

Operational Instruction 66-12 states:

- If  $PC < Y\%$  Critical Level and Load then emissions from the application are not significant, and
- If  $PEC < Z\%$  Critical Level and Load it can be concluded 'no likely significant effect' (alone and in-combination).

AQTAG 17 – “Guidance on in combination assessments for aerial emissions from EPR permits” states that:

*“Where the maximum process contribution (PC) at the European site(s) is less than the Stage 2 de-minimis threshold of the relevant critical level or load, the PC is considered to be inconsequential and there is no potential for an alone or in-combination effects with other plans and projects.”*

Consultation with the Environment Agency has confirmed that the “Stage 2 de-minimis threshold” is the criteria outlined in Operational Instruction 67\_12 outlined above.

## 9.2 Atmospheric emissions - Critical Levels

In addition to the objectives for the protection of human health, the AQS includes Critical Levels for the protection of ecosystems as presented in Table 3.3.

Predicted process contributions have been compared to the Critical Levels for the protection of ecosystems. Where the emissions of a particular pollutant are greater than 1% of the long term or 10% of the short term Critical Level, further assessment has been undertaken.

For the purpose of the ecological assessment the APIS mapped background dataset has been used.

## 9.3 Deposition of emissions – Critical Loads

The Air Pollution Information System (APIS) provides Critical Loads for nature conservation sites at risk from acidification and nitrogen deposition (eutrophication).

An assessment has been made for each habitat feature identified in APIS for the specific site. The search by location tool has been used to identify the feature habitats then the search by location tool to find the habitat specific Critical Load for the specific grid (i.e. the point of maximum impact with the designated site). If the impact of process emissions upon nitrogen or acid deposition is greater than 1% of the Critical Load, further assessment has been undertaken.

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

### 9.3.1 Nitrogen deposition – eutrophication

A search has been undertaken on for each of the ecological receptors identified in Table 5.2. Appendix B summarises the Critical Loads for nitrogen deposition and background deposition rates as detailed in APIS for each habitat identified.

The impact of the facility has been assessed against these Critical Loads for nitrogen deposition.

### 9.3.2 Acidification

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

A search has been undertaken on for each of the ecological receptors identified in Table 5.2. Each site has a number of habitats, each with different Critical Loads. Appendix B summaries the Critical Loads for acidification and background deposition rates as detailed in APIS for each identified habitat.

The impact of the facility has been assessed against these Critical Load functions. Where a critical load function for acid deposition is not available, the total nitrogen, sulphur and hydrogen chloride deposition has been presented and compared with the background concentration.

### 9.3.3 Calculation methodology – nitrogen deposition

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

- (1) Determine the annual mean ground level concentrations of nitrogen dioxide and ammonia at each site.
- (2) Calculate the dry deposition flux ( $\mu\text{g}/\text{m}^2/\text{s}$ ) at each site by multiplying the annual mean ground level concentration by the relevant deposition velocity presented in Table 9.2.
- (3) Convert the dry deposition flux into units of  $\text{kgN}/\text{ha}/\text{yr}$  using the conversion factors presented in Table 9.2.
- (4) Compare this result to the nitrogen deposition Critical Load.

**Table 9.2: Deposition Factors**

Pollutant	Deposition Velocity (m/s)		Conversion Factor ( $\mu\text{g}/\text{m}^2/\text{s}$ to $\text{kg}/\text{ha}/\text{year}$ )
	Grassland	Woodland	
Nitrogen dioxide	0.0015	0.003	96.0
Sulphur dioxide	0.0120	0.024	157.7
Ammonia	0.0200	0.030	259.7
Hydrogen chloride	0.0250	0.060	306.7

#### 9.3.3.1 Acidification

Deposition of nitrogen, sulphur, hydrogen chloride and ammonia can cause acidification and should be taken into consideration when assessing the impact of the facility.

The steps to determine the acid deposition flux are as follows.

- (1) Determine the dry deposition rate in  $\text{kg}/\text{ha}/\text{yr}$  of nitrogen, sulphur, hydrogen chloride and ammonia using the methodology outlined in Section 9.3.3.
- (2) Apply the conversion factor for N outlined in Table 9.3 to the nitrogen and ammonia deposition rate in  $\text{kg}/\text{ha}/\text{year}$  to determine the total  $\text{keq N}/\text{ha}/\text{year}$ .
- (3) Apply the conversion factor for S to the sulphur deposition rate in  $\text{kg}/\text{ha}/\text{year}$  to determine the total  $\text{keq S}/\text{ha}/\text{year}$ .
- (4) Apply the conversion factor for HCl to the hydrogen chloride deposition rate in  $\text{kg}/\text{ha}/\text{year}$  to determine the dry  $\text{keq Cl}/\text{ha}/\text{year}$ .
- (5) Determine the wet deposition rate of HCl in  $\text{kg}/\text{ha}/\text{yr}$  by multiplying the model output by the factors presented in Table 9.3.
- (6) Apply the conversion factor for HCl to the hydrogen chloride deposition rate in  $\text{kg}/\text{ha}/\text{year}$  to determine the wet  $\text{keq Cl}/\text{ha}/\text{year}$ .
- (7) Add the contribution from S to HCl dry and wet and treat this sum as the total contribution from S.
- (8) Plot the results against the Critical Load functions.

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

Consultation with AQMAU confirmed that the maximum of the wet or dry deposition rate for HCl should be included in the calculation. For the purpose of this analysis it has been assumed that wet deposition of HCl is double dry deposition.

**Table 9.3: Conversion Factors** □

<b>Pollutant</b>	<b>Conversion Factor (kg/ha/year to keq/ha/year)</b>
Nitrogen	Divide by 14
Sulphur	Divide by 16
Hydrogen chloride	Divide by 35.5

The process contribution has been calculated using the APIS formula:

Where  $PEC\ N\ Deposition < CL_{minN}$ :

$$PC\ as\ \%\ of\ CL\ function = PC\ S\ deposition / CL_{maxS}$$

Where  $PEC\ N\ Deposition > CL_{minN}$ :

$$PC\ as\ \%\ of\ CL\ function = (PC\ S + N\ deposition) / CL_{maxN}$$

#### 9.4 Results – statutory designated sites

The impact of emissions at ecological receptors has been quantified and the results compared against the Critical Levels presented in Table 3.3. The highest predicted process contributions to ground level concentrations at the identified ecological receptors are presented in Table 9.4. Where impacts are greater than 1% of the long term standard or 10% of the short term standard these are highlighted.

As shown, the impact of emissions at all statutory designated sites is less than 1% of the Critical Levels, with the exception of Crymlyn Burrows. Therefore, it can be concluded that emissions from the proposed scheme are not significant and there is no likely significant effect (alone and in-combination). The plot files have been investigated to see determine the impact at Crymlyn Burrows. Figure 11 shows that at Crymlyn Burrows the annual mean NO<sub>x</sub> concentration is just above 1%. If availability is taken into account (Figure 12) the impact is less than 1% of the Critical Level and it can be concluded that emissions from the proposed scheme are not significant and there is no likely significant effect (alone and in-combination).

Table 9.4: Impact of Emissions at Statutory Designated Sensitive Ecological Receptors

Site	Oxides of Nitrogen				Sulphur Dioxide		Hydrogen Fluoride				Ammonia	
	Daily		Annual		Annual		Daily		Weekly		Annual	
	Conc. $\mu\text{g}/\text{m}^3$	As % of CL	Conc. $\mu\text{g}/\text{m}^3$	As % of CL	Conc. $\text{ng}/\text{m}^3$	As % of CL	Conc. $\text{ng}/\text{m}^3$	As % of CL	Conc. $\text{ng}/\text{m}^3$	As % of CL	Conc. $\text{ng}/\text{m}^3$	As % of CL
<b>European designated sites (within 10km)</b>												
Crymlyn Bog	0.77	1.02%	0.04	0.12%	9.35	0.05%	10.99	0.22%	1.03	0.21%	1.85	0.06%
<b>UK designated sites (within 10km)</b>												
Crymlyn Burrows	3.68	4.90%	0.31	1.05%	78.44	0.39%	42.94	0.86%	7.16	1.43%	15.54	0.52%
Pant-y-Sais	0.77	1.02%	0.04	0.12%	9.35	0.05%	10.99	0.22%	1.03	0.21%	1.85	0.06%
<b>Screening Criteria</b>	-	<b>10%</b>	-	<b>1%</b>	-	<b>1%</b>	-	<b>10%</b>	-	<b>10%</b>	-	<b>10%</b>

Table 9.5: Impact of Emissions at Non-Statutory Designated Sensitive Ecological Receptors												
Site	Oxides of Nitrogen				Sulphur Dioxide		Hydrogen Fluoride				Ammonia	
	Daily		Annual		Annual		Daily		Weekly		Annual	
	Conc. $\mu\text{g}/\text{m}^3$	As % of CL	Conc. $\mu\text{g}/\text{m}^3$	As % of CL	Conc. $\text{ng}/\text{m}^3$	As % of CL	Conc. $\text{ng}/\text{m}^3$	As % of CL	Conc. $\text{ng}/\text{m}^3$	As % of CL	Conc. $\text{ng}/\text{m}^3$	As % of CL
<b>Non statutory designated sites (within 2km)</b>												
Crymlyn Bog and Pant Y Sais NNR	0.74	0.99%	0.04	0.12%	9.22	0.05%	10.72	0.21%	1.01	0.20%	1.83	0.06%
Pant-y-Sais LNR	0.77	1.02%	0.04	0.12%	9.37	0.05%	11.02	0.22%	1.04	0.21%	1.86	0.06%
Red Jacket Fen WTR	0.65	0.87%	0.04	0.12%	9.04	0.05%	9.30	0.19%	0.79	0.16%	1.79	0.06%
Ancient Woodlands 1	0.96	1.28%	0.15	0.50%	37.69	0.19%	16.38	0.33%	3.31	0.66%	7.47	0.25%
Ancient Woodlands 2	1.20	1.60%	0.23	0.76%	56.67	0.28%	21.10	0.42%	3.89	0.78%	11.23	0.37%
Ancient Woodlands 3	1.38	1.84%	0.16	0.54%	40.50	0.20%	19.78	0.40%	2.89	0.58%	8.03	0.27%
Ancient Woodlands 4	0.74	0.98%	0.11	0.36%	26.90	0.13%	12.99	0.26%	1.91	0.38%	5.33	0.18%
Ancient Woodlands 5	0.48	0.64%	0.07	0.22%	16.58	0.08%	8.62	0.17%	1.01	0.20%	3.28	0.11%
Ancient Woodlands 6	0.75	1.00%	0.05	0.18%	13.74	0.07%	10.05	0.20%	1.13	0.23%	2.72	0.09%
<b>Screening Criteria</b>	-	<b>100%</b>	-	<b>100%</b>	-	<b>100%</b>	-	<b>100%</b>	-	<b>100%</b>	-	<b>100%</b>

## 9.5 Results – statutory designated sites – deposition

Appendix C contains detailed results tables including the calculations of the deposition of nitrogen, sulphur, hydrogen chloride and ammonia as a result of emissions from the facility.

The highest predicted levels of nitrogen and acid deposition at each habitat listed in APIS are presented in Appendix C. The process contribution for nitrogen and acid deposition is presented for completeness even if no Critical Load is specified within APIS. Where process contributions are greater than 1% of the Critical Load, these are highlighted.

As shown the impact of nitrogen and acid deposition at all statutory designated sites is less than 1% of the Critical Load, with the exception for nitrogen deposition at Crymlyn Burrows. Therefore, it can be concluded that emissions from the proposed scheme are not significant and there is no likely significant effect (alone and in-combination) on nitrogen deposition.

The plot files have been investigated to see determine the impact of nitrogen deposition at Crymlyn Burrows. Figure 13 shows that at Crymlyn Burrows the annual mean nitrogen deposition concentration is just above 1%. If availability is taken into account (Figure 14) the impact is less than 1% of the Critical Level and it can be concluded that emissions from the proposed scheme are not significant and there is no likely significant effect (alone and in-combination).

## 9.6 Results – non-statutory designated sites – emissions

As identified in Section 5.2, there are a number of non-statutory designated sites within 2km of the facility. The impact of emissions at these locally designated sites has been quantified and the results compared against the Critical Levels presented in Table 3.3. The highest predicted process contributions to ground level concentrations at the identified ecological receptors are presented in Table 9.5.

As shown the PC is not predicted to exceed the Critical Level at any of the locally-designated sites. Therefore, emissions from the proposed scheme at locally designated sites are not significant.

## 9.7 Results – non statutory designated sites – deposition

APIS does not include site specific Critical Loads for non-statutory designated sites. In lieu of this the search-by-location function of APIS has been used. The broad habitat type has been assumed.

The highest predicted levels of nitrogen and acid deposition are presented in Appendix C. Where process contributions are greater than 100%, or the PEC is greater than 100% of the Critical Load these are highlighted.

The maximum nitrogen deposition PC at a non-statutory designated site is predicted to be 1.33% and the maximum acid deposition is predicted to be 1.17% of the respective Lower Critical Loads. Therefore, the impact of emissions from the proposed scheme at locally designated sites is not significant.

## 9.8 Summary of impact at ecological receptors

For the purpose of the assessment it has been assumed that the facility operates at the emission limits for the entire year as a worst-case. Even with this highly conservative approach the impact of emissions at all statutory designated site is predicted to be less than 1% of the long term Critical Level and Loads and less than 10% of the short term Critical Levels, with the exception of nitrogen deposition at Crymlyn Burrows SSSI. At Crymlyn Burrows SSSI, if the operational availability is taken into account, the process contribution is less than 1% of the Critical Load. Therefore, it can be concluded that emissions from the proposed scheme are not significant and there is no likely significant effect (alone and in-combination).

A number of non-statutory designated sites have been identified within 2km of the facility. APIS does not include site specific Critical Loads for non-statutory designated sites. In lieu of this the search-by-location function of APIS has been used. The broad habitat type has been assumed. The assessment has concluded that emissions are not significant. This conclusion has been drawn because the PC is less than 100% of the Critical Level or Load.

## 10 HUMAN HEALTH RISK ASSESSMENT

For most pollutants, the main route for human exposure is through inhalation which has been considered in the preceding sections of this report. However, some pollutants can accumulate in the environment so that the primary route for human exposure is through ingestion in food. For these pollutants, which include dioxins, furans and heavy metals, a detailed Human Health Risk Assessment has been carried out to consider all of the following routes for human exposure:

- a) Inhalation of gaseous emissions;
- b) Vapour phase transfer of gaseous emissions to plants and subsequent ingestion of food by animals and humans; and
- c) Deposition of dust to soil, followed by;
  - i) Ingestion of soil attached to unwashed vegetables, during gardening and, for children, during play; or
  - ii) Uptake of pollutants into plants and subsequent ingestion of food.

The detailed Human Health Risk Assessment has been carried out using the Industrial Risk Assessment Program-Human Health (IRAP-h View – Version 4.0) for each scenario. This report is contained in Appendix D. The model predicts the total exposure to the various pollutants and compares this with standard intake criteria, in order to assess the predicted increase in health risks.

The assessment concludes that the proposed scheme would not have a significant impact on human health, and the change in impact from the consented scheme is extremely small.

## 11 CONSTRUCTION PHASE DUST

There is the potential for dust to be released into the atmosphere as a result of construction and demolition phase activities. These fugitive dust emissions have been assessed on a qualitative basis in accordance with the methodology outlined within the Institute of Air Quality Management (IAQM) guidance document 'Guidance on the assessment of dust from demolition and construction'. This guidance sets out the methodology for assessing the air quality impacts of construction and demolition and identifies good practice for mitigating and managing air quality impacts. It is noted that the quantity of dust emitted will be related to the area of land being worked and the nature, magnitude and duration of construction activities.

The first stage of the assessment of the impact of fugitive emissions of dust during construction is to determine whether the effect can be screened out as 'negligible', or whether a more detailed assessment is required. The IAQM recommend that the developer will normally be required to undertake a detailed assessment where there is:

A human receptor within:

- 350 m of the boundary of the site; or
- 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

An ecological receptor within:

- 50 m of the boundary of the site; or
- 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

A review of the site and anticipated construction area has shown that neither of the above criteria will be met and the impact of fugitive emissions of dust during construction can be screened out as 'negligible'. A detailed description of the proposed demolition and construction activities has been provided as part of the planning application.

## 12 CONCLUSIONS

This Air Quality Assessment has been undertaken to support the planning and permit application for proposed wood-fuelled boiler at the Baglan Intertissue paper manufacturing site.

This assessment has included a review of baseline pollution levels, dispersion modelling of emissions and determination of the significance of the impact of these emissions on local air quality.

- (1) The review of background monitoring data and DEFRA modelled data has been undertaken to determine the most suitable concentrations for use in the assessment. Where background monitoring is available this has been used in preference to modelled data.
- (2) The methodology used in the assessment of the impact on air quality of the proposals uses a number of conservative assumptions. These include the following:
  - a) The facility will be using BAT for the control of emissions and comply with the emission limits outlined in the Environmental Permit based on those outlined in the IED for a waste co-incineration plant;
  - b) It is assumed that the facility will continually operate at the proposed limits whereas, in practice, this will not be the case and actual emissions will be less than the limits;
  - c) It has been assumed that the facility operates continually at the daily emission limit values;
  - d) The maximum ground level concentrations are considered in each case. These concentrations occur in small areas; in general, the concentration will be much lower.
- (3) In relation to the impact on local air quality, we conclude that:
  - a) Emissions from the proposed scheme will not cause a breach of any AQO or EAL;
  - b) The change in impact for the proposed scheme compared to the existing baseline can be described as 'negligible' at all sensitive receptors for all pollutants; and
  - c) The emissions to atmosphere should not be considered a constraint to this planning application, based on professional judgement.
- (4) In relation to the impact on ecologically sensitive sites, it has been assumed that the facility operates at the emission limits for the entire year as a worst-case. Even with this highly conservative assumption we conclude that:
  - a) At all European designated sites within 10km of the facility, the impact of emissions is predicted to be less than 1% of the long term Critical Level and Loads and less than 10% of the short term Critical Levels. Therefore it can be concluded that emissions from the proposed scheme are not significant and there is no likely significant effect (alone and in-combination);
  - b) At all but one of the UK designated sites within 2km of the facility, the impact of emissions is predicted to be less than 1% of the long term Critical Level and Loads and less than 10% of the short term Critical Levels. At the other site, the long term impact is slightly more than 1% of the Critical Level, but is less than 1% when operational availability is taken into account. Therefore it can be concluded that emissions from the proposed scheme are not significant and there is no likely significant effect (alone and in-combination); and
  - c) At all locally designated sites emissions are not likely to have a significant impact.

- (5) A Human Health Risk Assessment has been undertaken to determine the impact of pollutants which have the potential to bio-accumulate in the environment. This has concluded that emissions from the proposed scheme would not have a significant effect on human health and the change in impact from the consented scheme is extremely small.
- (6) Analysis of the area has shown that the IAQM criteria for undertaking a detailed assessment have not been met and as such the impact of fugitive emissions of dust during construction can be screened out as 'negligible'. A detailed description of the proposed demolition and construction activities has been provided as part of the planning application.

In summary, a comprehensive assessment of the impact of the proposed facility will have a 'negligible' impact on the local environment.

Appendix A - Figures

Figure 1: Site Location and Sensitive Receptors

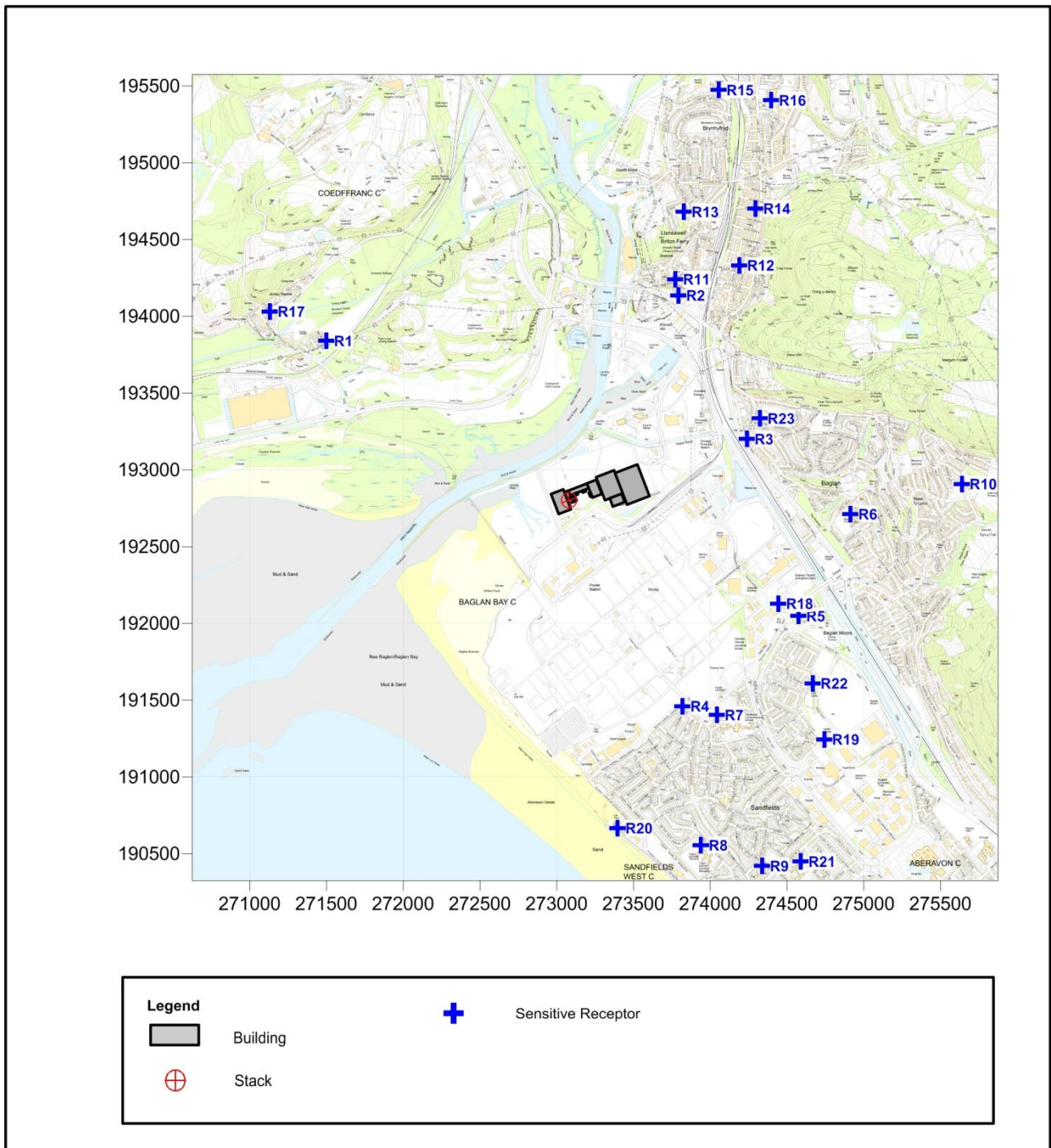


Figure 2: Sensitive Ecological Receptors

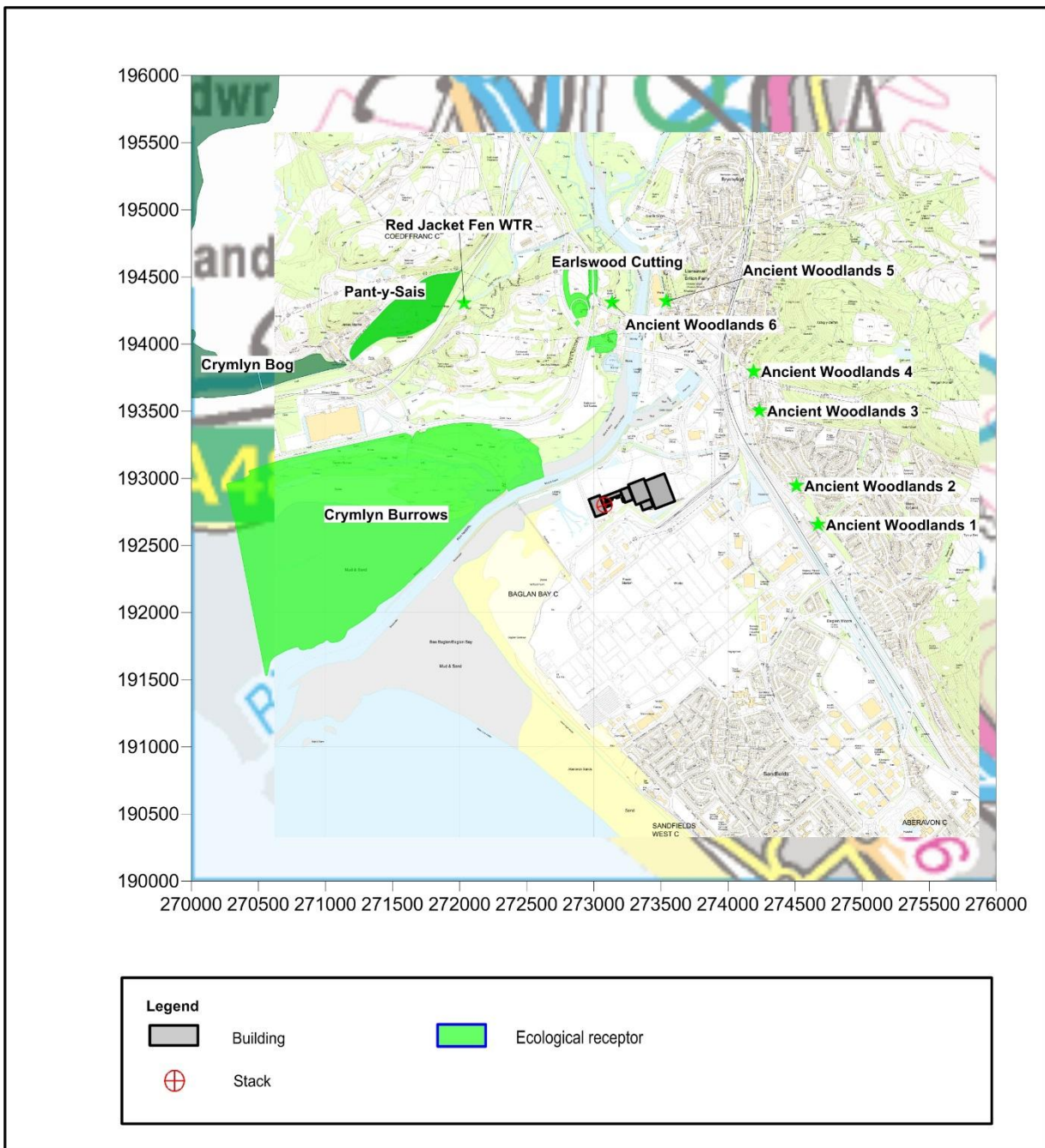
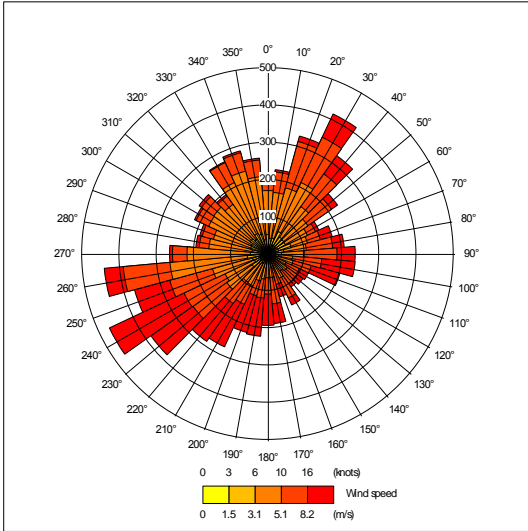
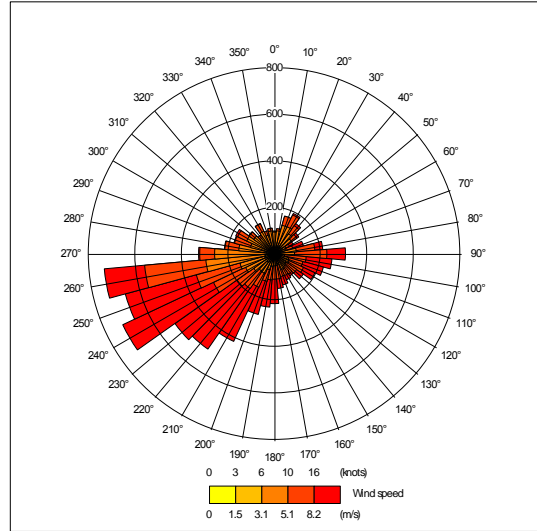


Figure 3: Wind Roses

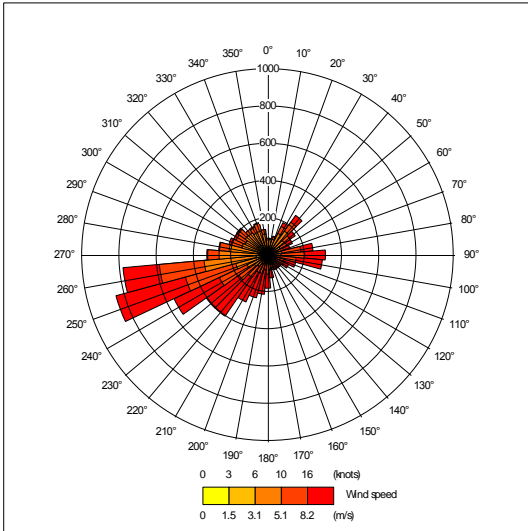
Mumbles Head 2010



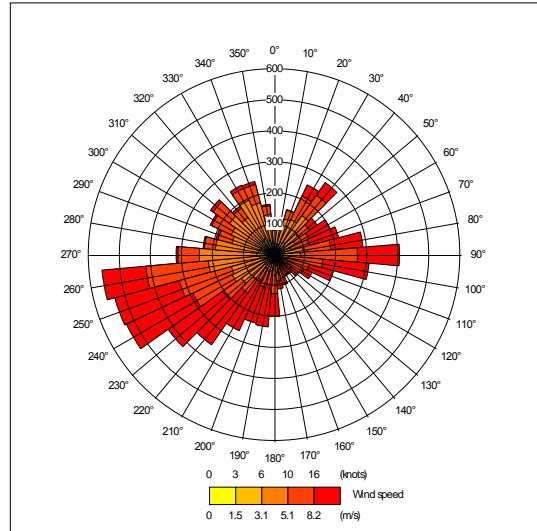
Mumbles Head 2011



Mumbles Head 2012



Mumbles Head 2013



Mumbles Head 2014

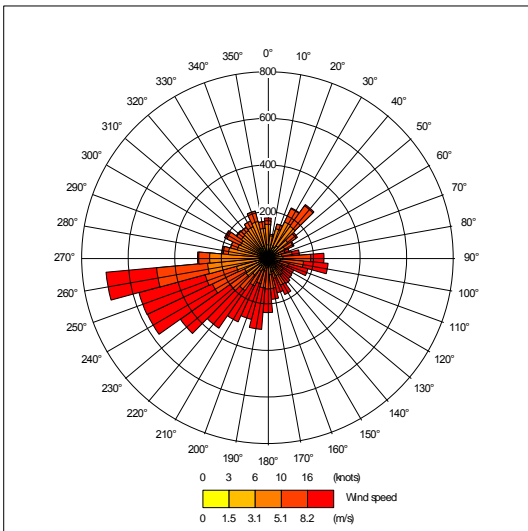


Figure 4: Modelling Domain

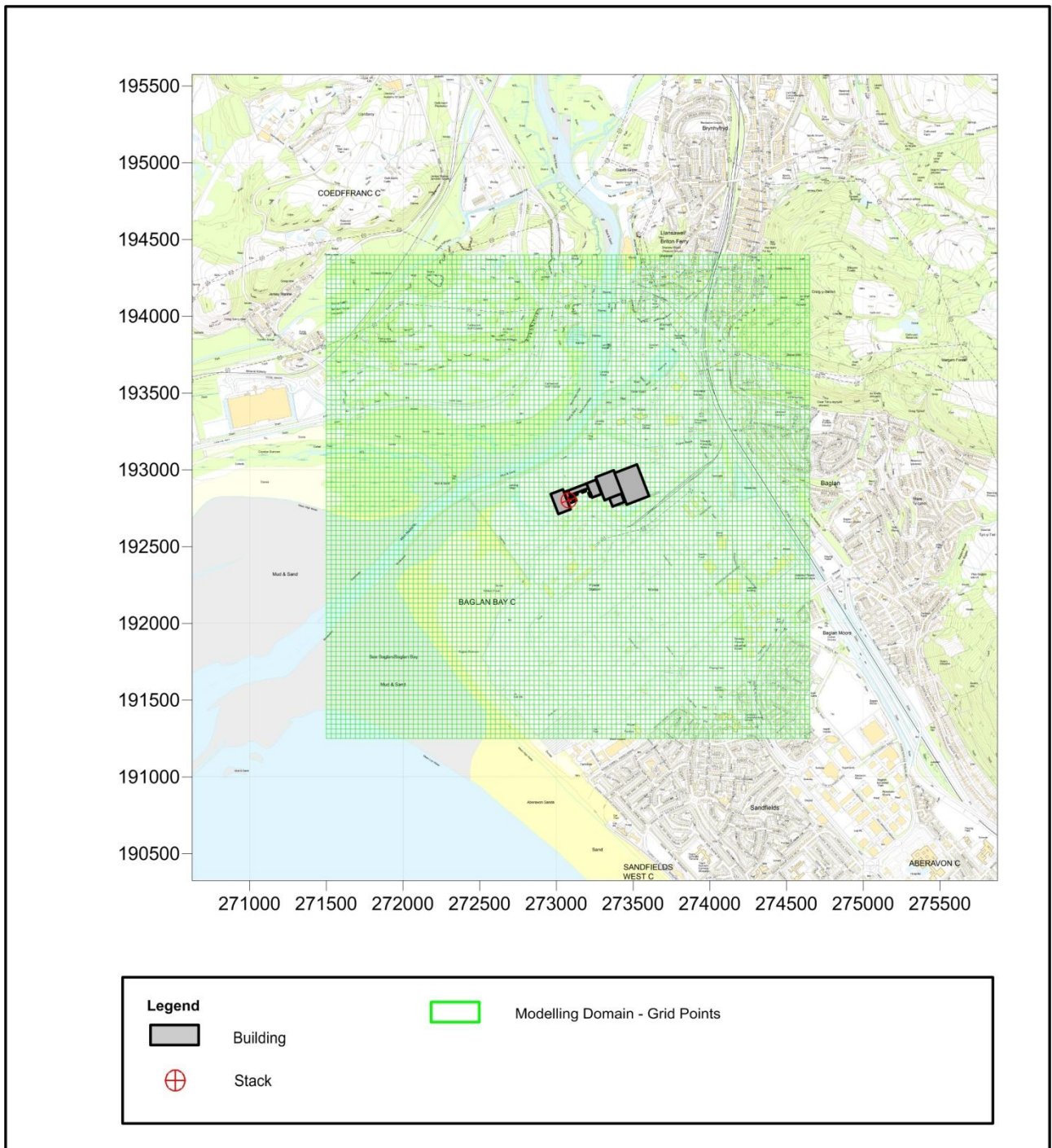
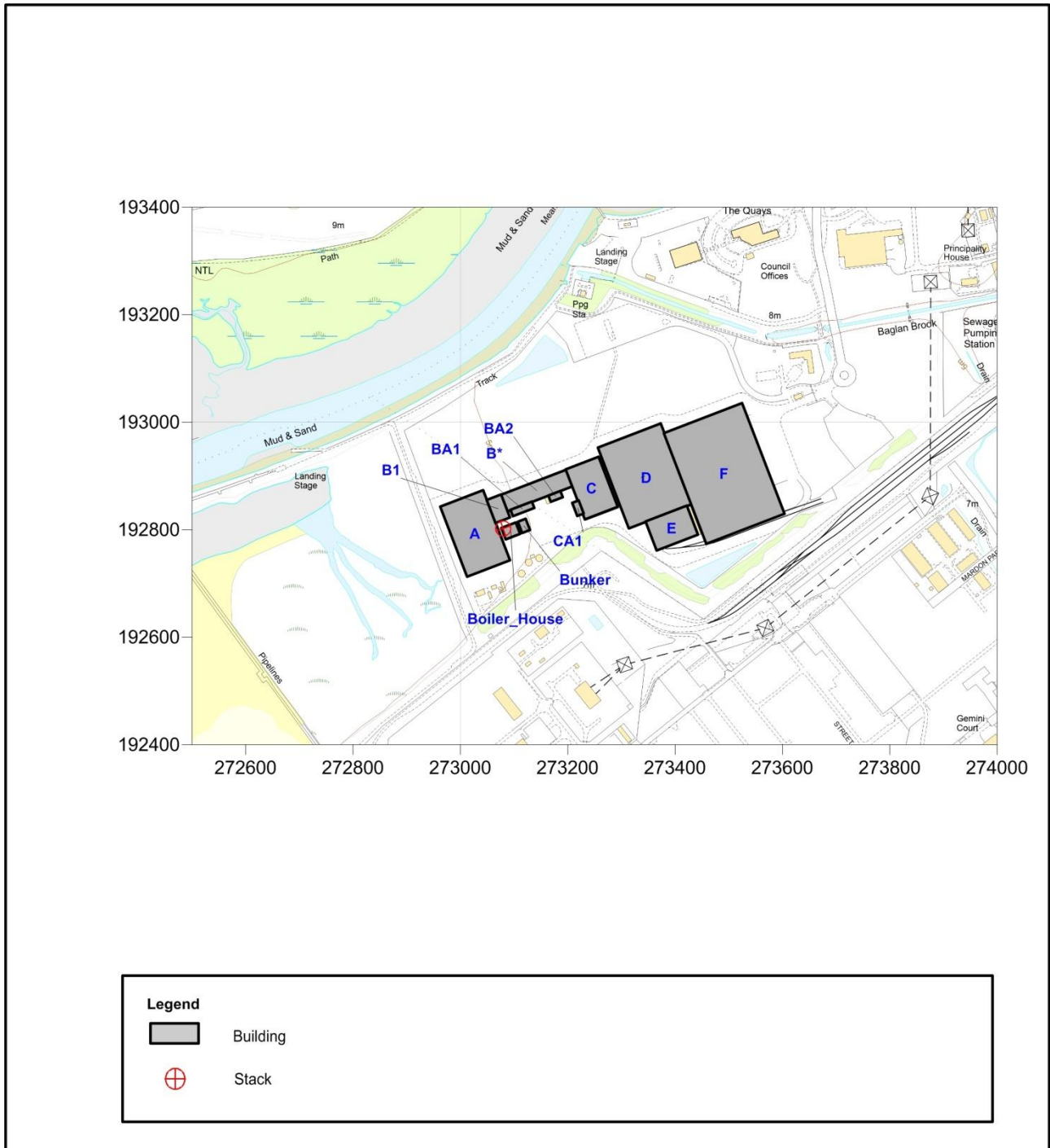
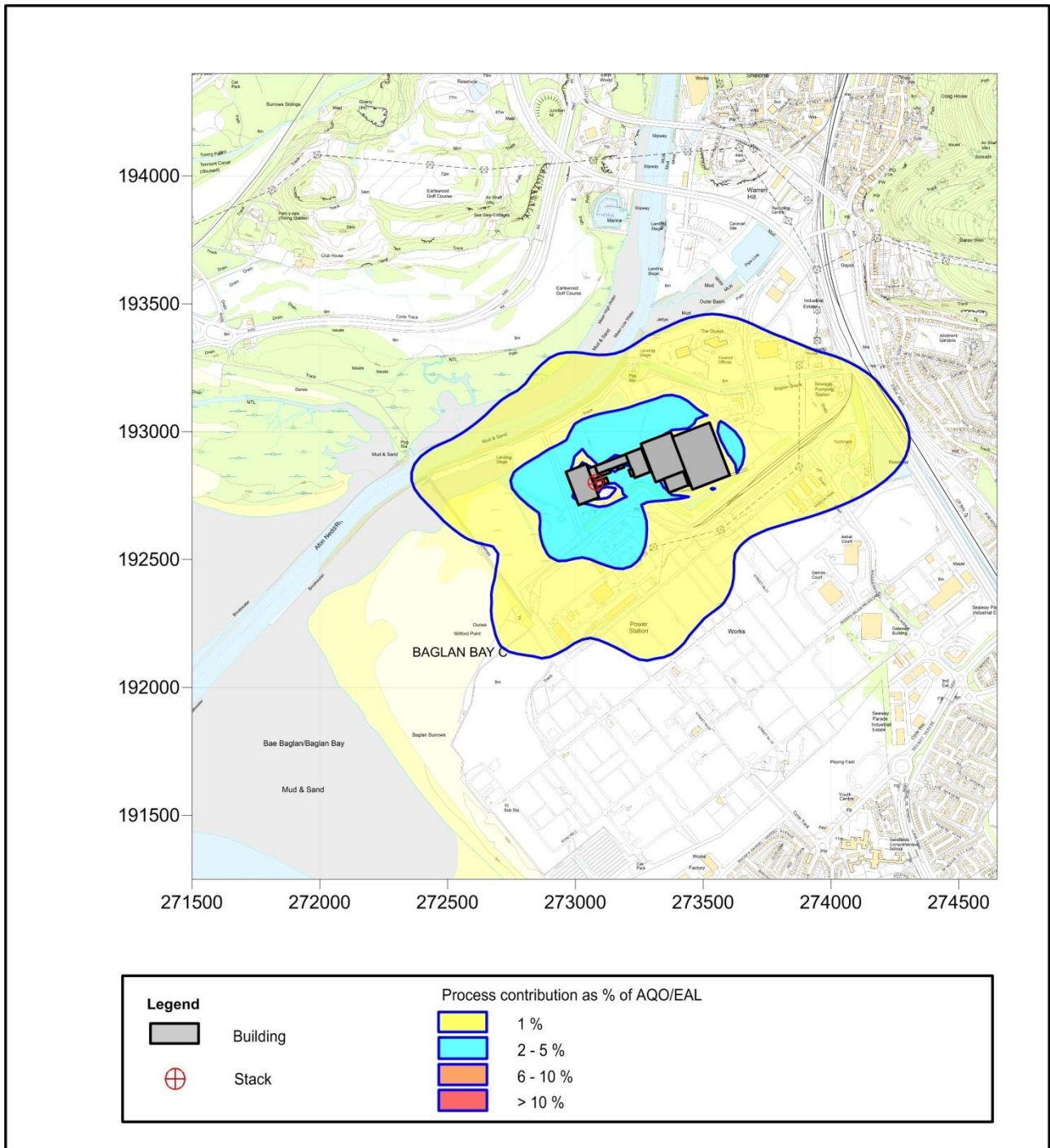


Figure 5: Building Layout

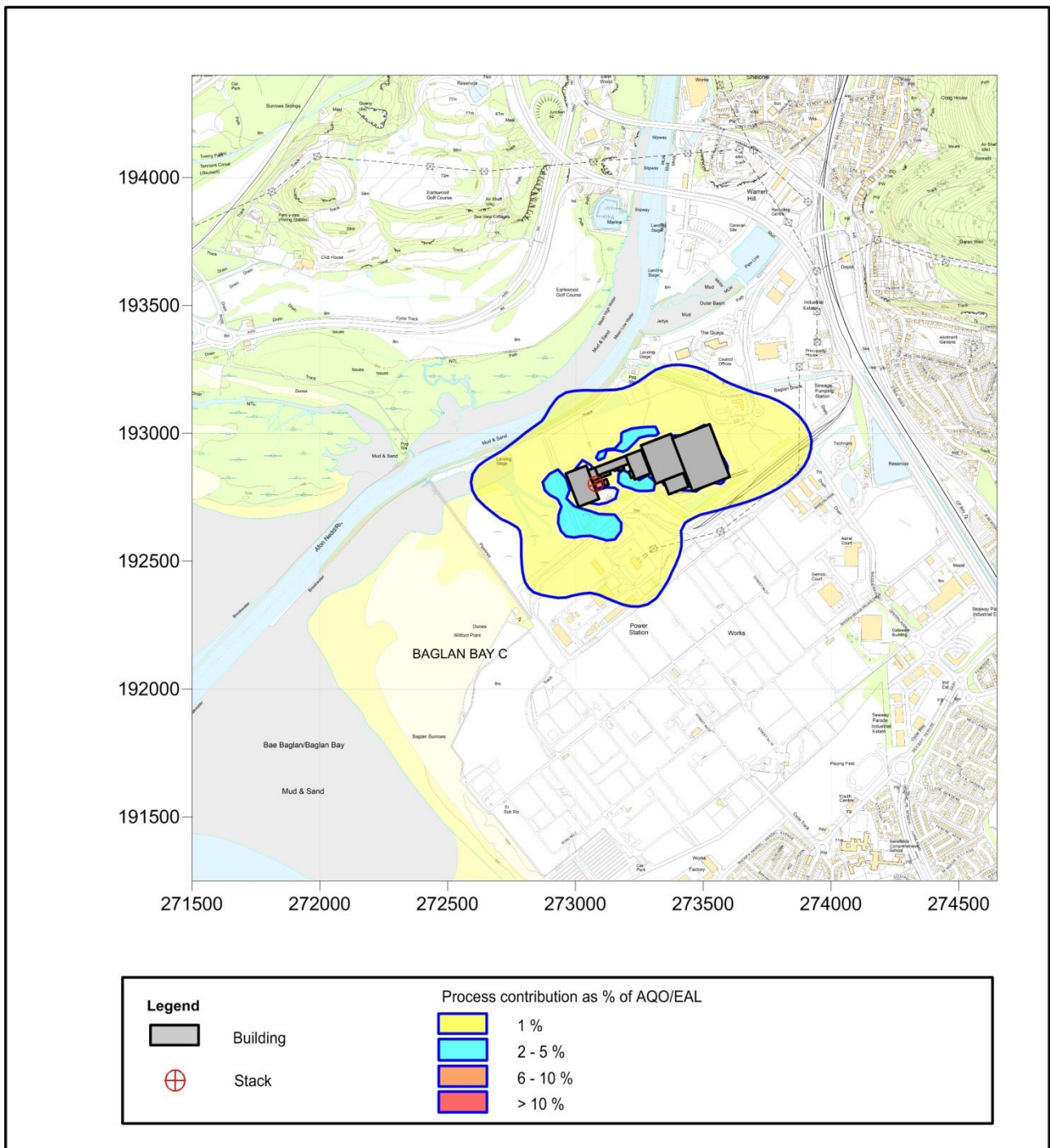


**Figure 6: Annual Mean Nitrogen Dioxide Process Contribution (as a % of AQO) – Max All Years – Change from Existing Baseline**



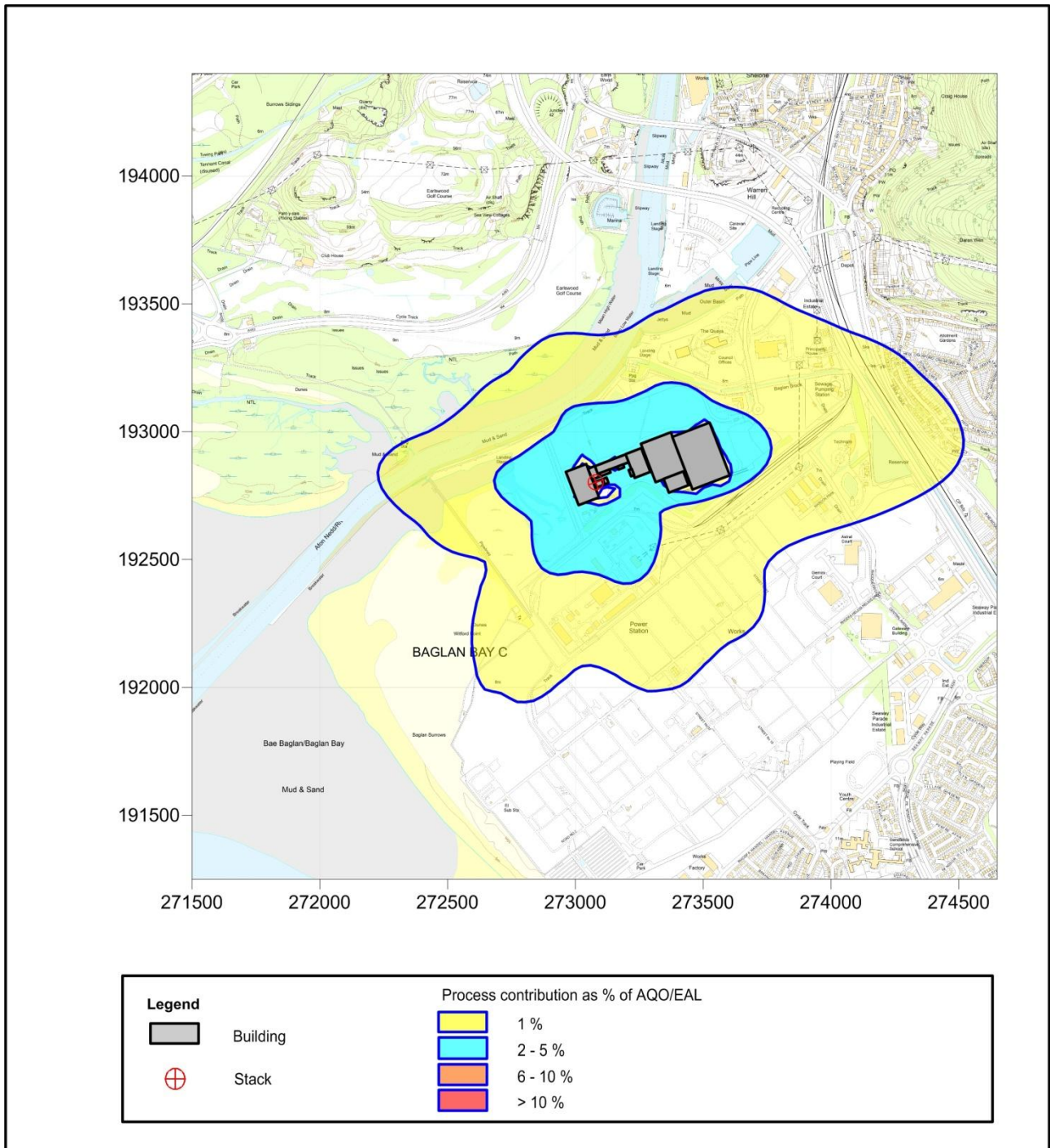
Process contribution assumes 100% operation of the Facility at capacity, and 70% conversion of NO<sub>x</sub> to NO<sub>2</sub>.

**Figure 7: Annual Mean VOC as Benzene Process Contribution (as a % of AQO) – Max All Years – Change from Existing Baseline**



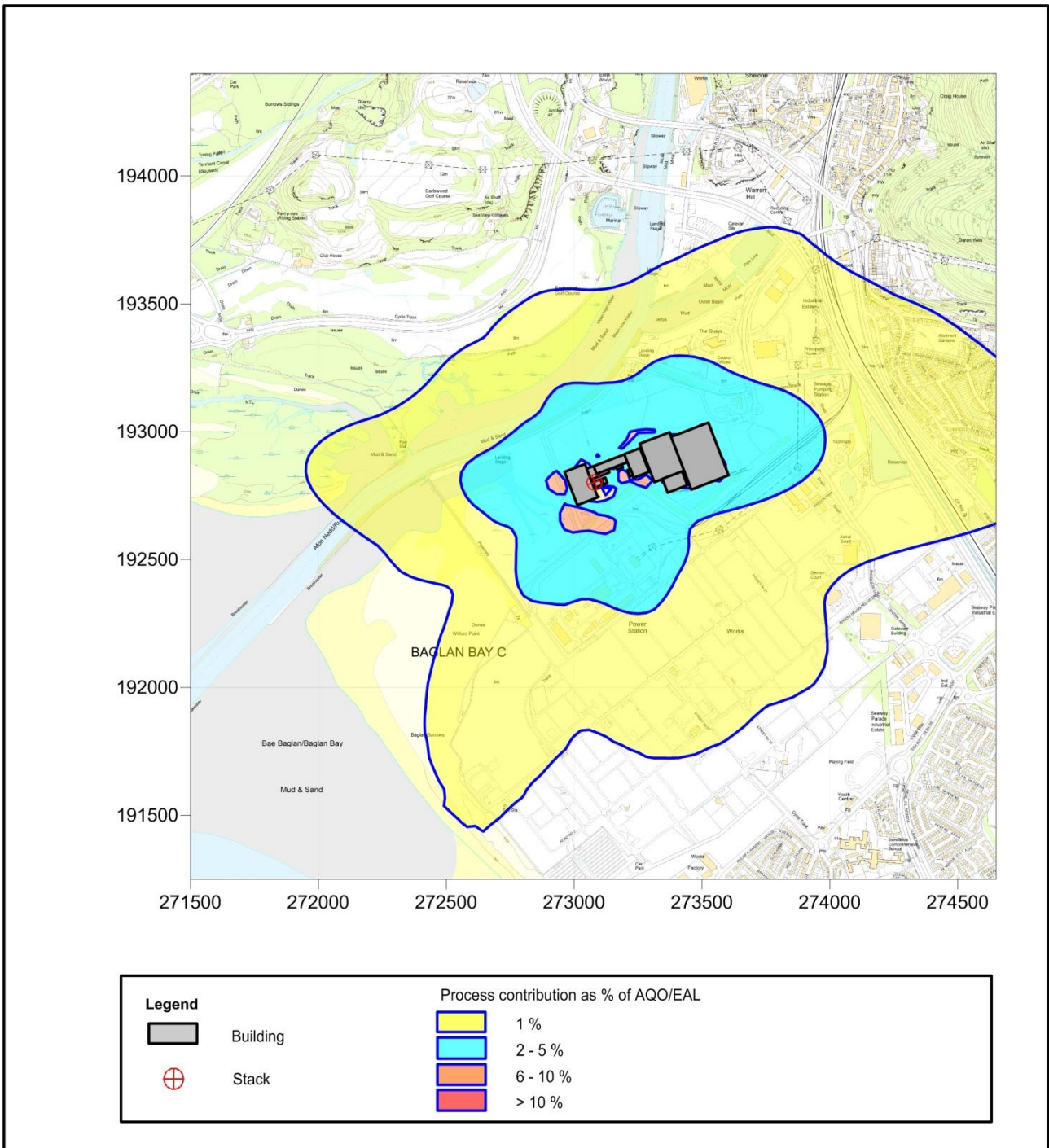
Process contribution assumes 100% of the VOC releases are as benzene and 100% operation of the Facility at capacity.

**Figure 8: Annual Mean VOC as 1,3-Butadiene Process Contribution (as a % of AQO) – Max All Years – Change from Existing Baseline**



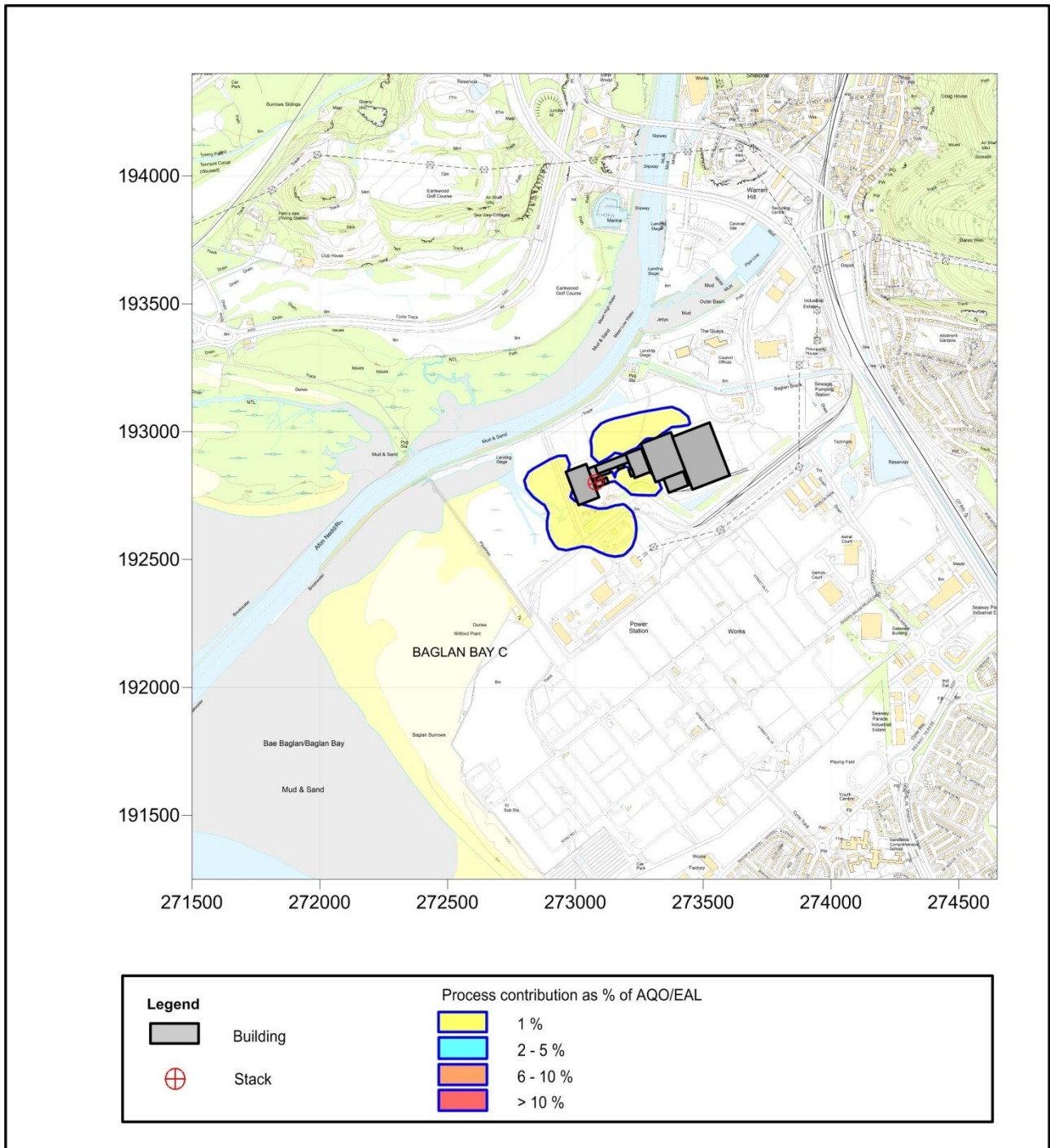
Process contribution assumes 100% of the VOC releases are as 1,3-butadiene and 100% operation of the Facility at capacity.

**Figure 9: Annual Mean Cadmium Process Contribution (as a % of AQO) – Max All Years – Change from Existing Baseline – 100% of Group ELV**



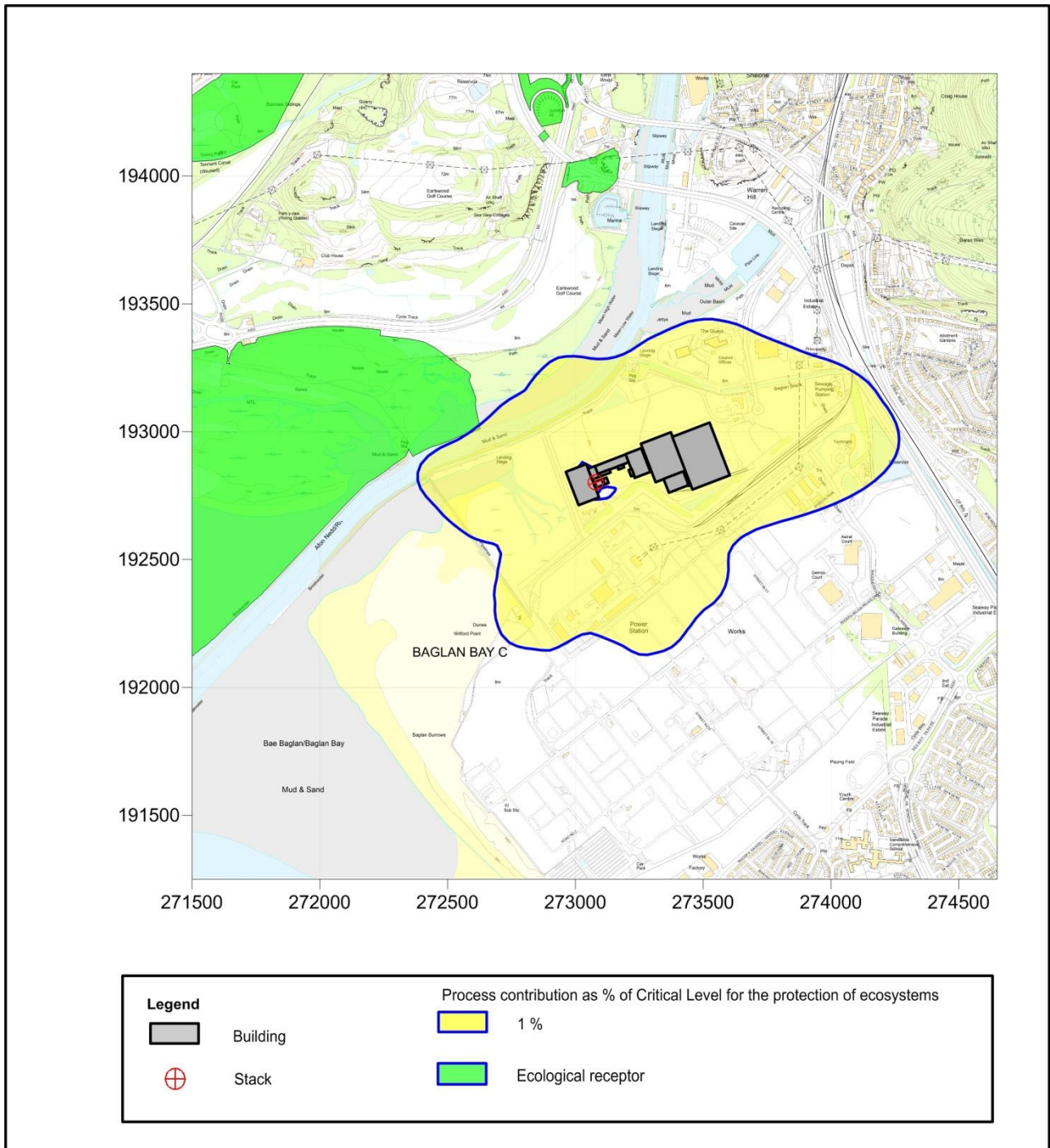
Process contribution assumes 100% of the cadmium and thallium releases are as cadmium and 100% operation of the Facility at capacity.

**Figure 10: Annual Mean Cadmium Process Contribution (as a % of AQO) – Max All Years – Change from Existing Baseline – 14% of Group ELV**



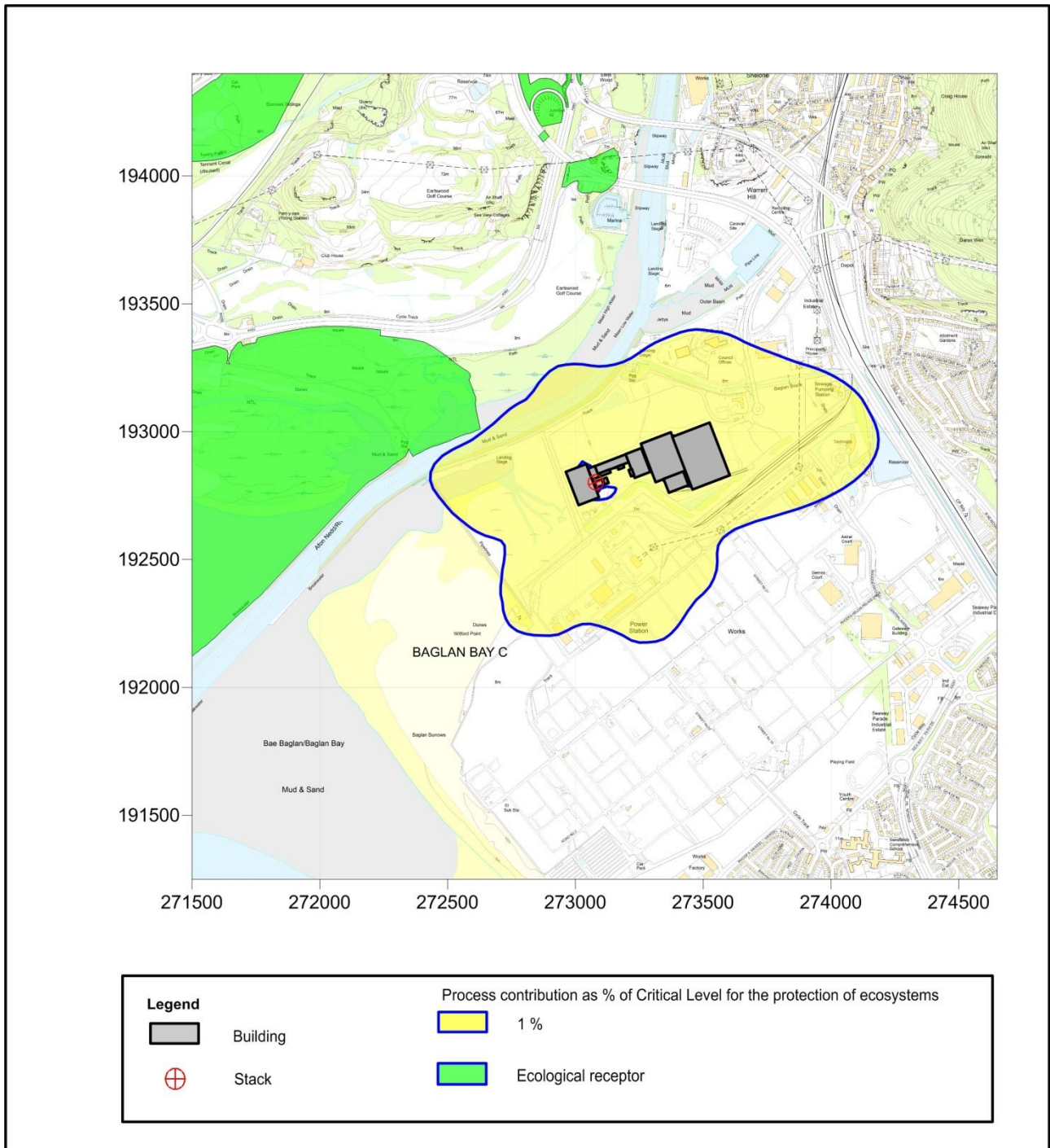
Process contribution assumes 14% of the cadmium and thallium releases are as cadmium and 100% operation of the Facility at capacity.

**Figure 11: Annual Mean Oxides of Nitrogen Process Contribution (as a % of CL) – Max All Years – Change from Existing Baseline – 100% Operation**



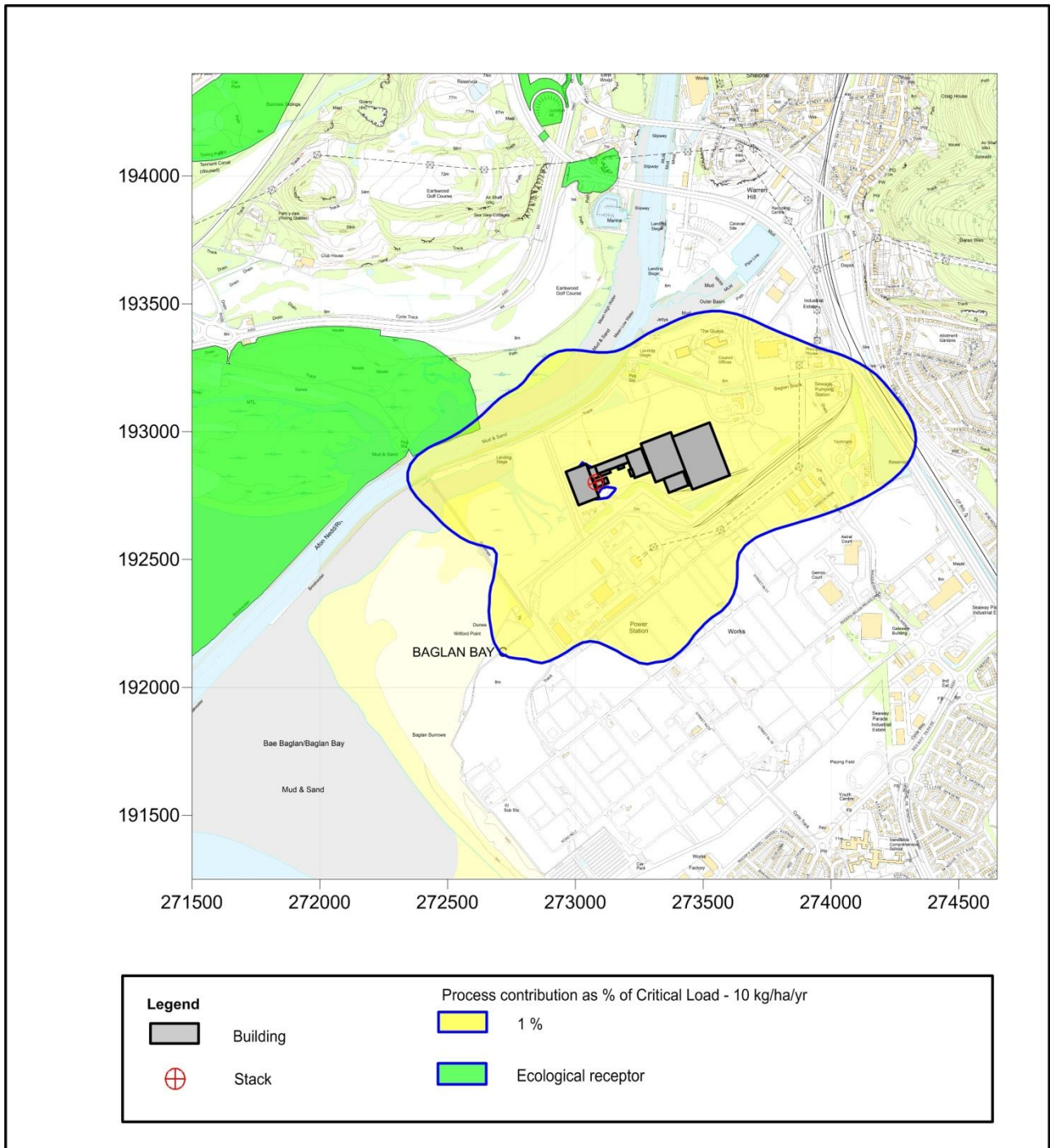
Process contribution assumes 100% operation of the Facility at capacity.

**Figure 12: Annual Mean Oxides of Nitrogen Process Contribution (as a % of CL) – Max All Years – Change from Existing Baseline – 90% Operation**



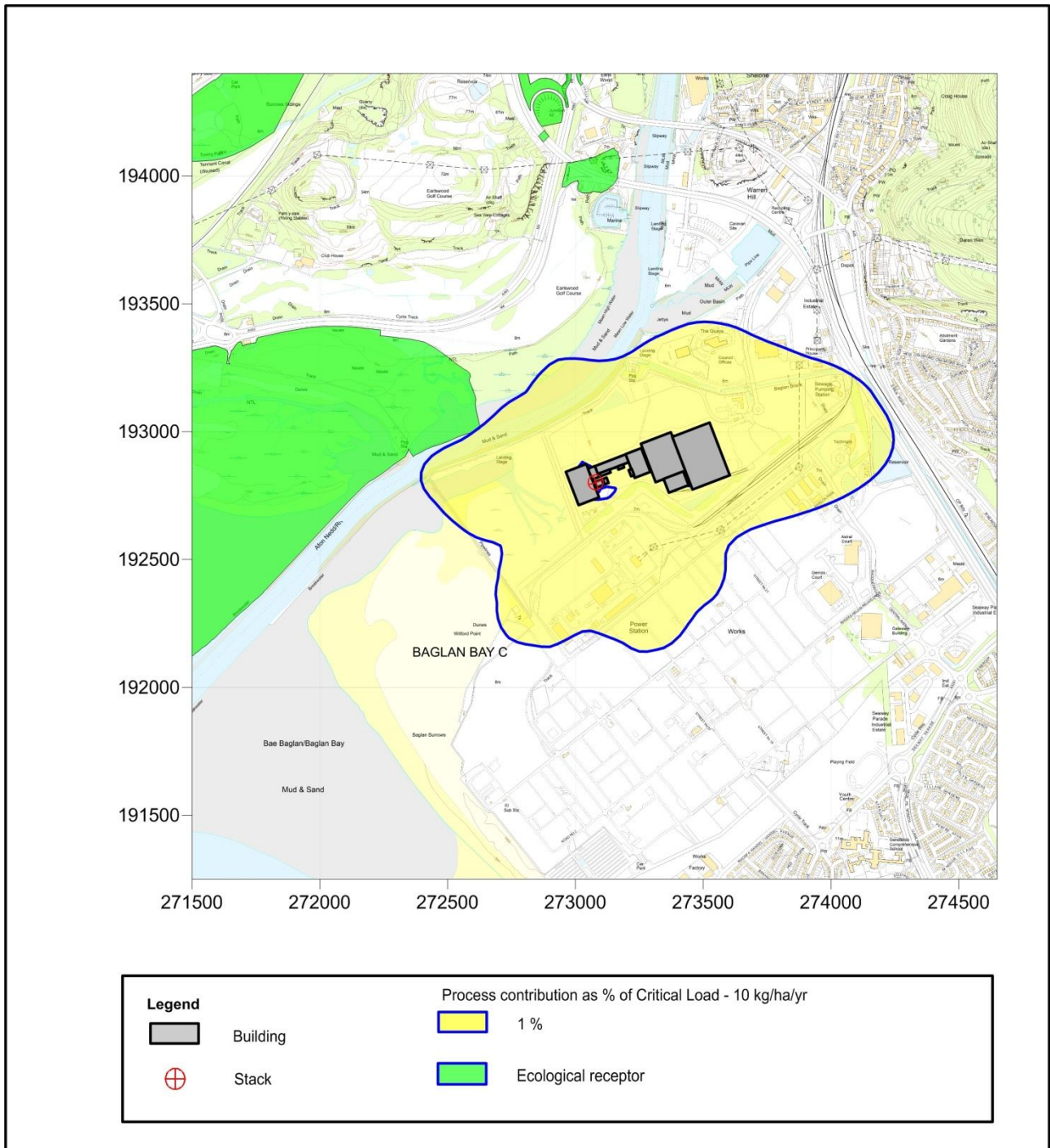
Process contribution assumes 90% operation of the Facility at capacity.

**Figure 13: Annual Mean Nitrogen Deposition Process Contribution (as a % of CL – 10kg/ha/yr) – Max All Years – Change from Existing Baseline**



Process contribution assumes 100% operation of the Facility at capacity.

**Figure 14: Annual Mean Nitrogen Deposition Process Contribution (as a % of CL – 10kg/ha/yr) – Max All Years – Change from Existing Baseline – 90% Operation**



Process contribution assumes 90% operation of the Facility at capacity.

Appendix B – APIS Critical Loads

Table D.1: N Deposition Critical Loads - APIS

Site	Habitat type	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Background (kgN/ha/yr)
<b>European statutory designated sites (within 10km)</b>					
Crymlyn Bog Ramsar, SAC	Transition mires and quaking bogs (H7140)	Valley mires, poor fens and transition mires	5	10	10.78
Crymlyn Bog Ramsar, SAC	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Rich fens	13	20	10.78
Crymlyn Bog Ramsar, SAC	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Designated feature/feature habitat not sensitive to eutrophication	-	-	18.62
Crymlyn Bog Ramsar, SAC	Poor fens	Valley mires, poor fens and transition mires	10	15	10.78
Crymlyn Bog Ramsar, SAC	Base-rich fens	Rich fens	15	30	10.78
<b>UK statutory designated sites (within 2km)</b>					
Pant-y-Sais SSSI	Poor fens	Valley mires, poor fens and transition mires	10	15	10.78
Pant-y-Sais SSSI	Base-rich fens	Rich fens	15	30	10.78
Pant-y-Sais SSSI	Transition mires and quaking bogs (H7140)	Valley mires, poor fens and transition mires	5	10	10.78
Pant-y-Sais SSSI	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Rich fens	13	20	10.78
Pant-y-Sais SSSI	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Designated feature/feature habitat not sensitive to eutrophication	-	-	18.62
Crymlyn Burrows SSSI	Dunes, Shingle & Machair	Shifting coastal dunes	10	20	10.78
Crymlyn Burrows SSSI	Dunes, Shingle & Machair	Coastal stable dune grasslands - calcareous type	10	15	10.78
Crymlyn Burrows SSSI	Coastal saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	20	30	10.78
<b>Non-statutory designated sites (within 2km)</b>					
Crymlyn Bog and Pant Y Sais NNR	Poor fens	Valley mires, poor fens and transition mires	10	15	10.78
Crymlyn Bog and Pant Y Sais NNR	Base-rich fens	Rich fens	15	30	10.78
Crymlyn Bog and Pant Y Sais NNR	Transition mires and quaking bogs (H7140)	Valley mires, poor fens and transition mires	5	10	10.78
Crymlyn Bog and Pant Y Sais NNR	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Rich fens	13	20	10.78
Crymlyn Bog and Pant Y Sais NNR	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Designated feature/feature habitat not sensitive to eutrophication	-	-	18.62
Pant-y-Sais LNR	Poor fens	Valley mires, poor fens and transition mires	10	15	10.78
Pant-y-Sais LNR	Base-rich fens	Rich fens	15	30	10.78
Pant-y-Sais LNR	Transition mires and quaking bogs (H7140)	Valley mires, poor fens and transition mires	5	10	10.78
Pant-y-Sais LNR	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Rich fens	13	20	10.78
Pant-y-Sais LNR	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Designated feature/feature habitat not sensitive to eutrophication	-	-	18.62
Red Jacket Fen WTR	Fen, Marsh and Swamp	Valley mires, poor fens and transition mires	10	15	10.78
Ancient Woodlands 1	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20	18.62

Table D.1: N Deposition Critical Loads - APIS

Site	Habitat type	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Background (kgN/ha/yr)
Ancient Woodlands 2	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20	18.62
Ancient Woodlands 3	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20	18.62
Ancient Woodlands 4	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20	18.62
Ancient Woodlands 5	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20	18.62
Ancient Woodlands 6	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20	18.62

Table D.2: Acid Deposition Critical Loads - APIS

Site	Broad habitat type	Acidity Class	Min Critical Load Function (keq/ha/yr)			Maximum Background (keq/ha/yr)	
			ClminN	CLmaxN	ClmaxS	N	S
<b>European statutory designated sites (within 10km)</b>							
Crymlyn Bog Ramsar, SAC	Transition mires and quaking bogs (H7140)	Bogs	0.321	0.661	0.342	0.77	0.15
Crymlyn Bog Ramsar, SAC	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Not sensitive to acidity	-	-	-	0.77	0.15
Crymlyn Bog Ramsar, SAC	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Not sensitive to acidity	-	-	-	1.33	0.17
Crymlyn Bog Ramsar, SAC	Poor fens	Acid grassland	0.223	0.536	0.17	0.77	0.15
Crymlyn Bog Ramsar, SAC	Base-rich fens	Not sensitive to acidity	-	-	-	0.77	0.15
<b>UK statutory designated sites (within 2km)</b>							
Pant-y-Sais SSSI	Poor fens	Acid grassland	0.223	0.536	0.17	0.77	0.15
Pant-y-Sais SSSI	Base-rich fens	Not sensitive to acidity	-	-	-	0.77	0.15
Pant-y-Sais SSSI	Transition mires and quaking bogs (H7140)	Bogs	0.321	0.661	0.342	0.77	0.15
Pant-y-Sais SSSI	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Not sensitive to acidity	-	-	-	0.77	0.15
Pant-y-Sais SSSI	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Not sensitive to acidity	-	-	-	1.33	0.17
Crymlyn Burrows SSSI	Dunes, Shingle & Machair	Dwarf shrub heath	1.25	5.31	4.06	0.77	0.15
Crymlyn Burrows SSSI	Dunes, Shingle & Machair	Dwarf shrub heath	1.25	5.31	4.06	0.77	0.15
Crymlyn Burrows SSSI	Coastal saltmarsh	-	-	-	-	0.77	0.15
<b>Non-statutory designated sites (within 2km)</b>							
Crymlyn Bog and Pant Y Sais NNR	Poor fens	Acid grassland	0.223	0.536	0.17	0.77	0.15
Crymlyn Bog and Pant Y Sais NNR	Base-rich fens	Not sensitive to acidity	-	-	-	0.77	0.15
Crymlyn Bog and Pant Y Sais NNR	Transition mires and quaking bogs (H7140)	Bogs	0.321	0.661	0.342	0.77	0.15

Table D.2: Acid Deposition Critical Loads - APIS

Site	Broad habitat type	Acidity Class	Min Critical Load Function (keq/ha/yr)			Maximum Background (keq/ha/yr)	
Crymlyn Bog and Pant Y Sais NNR	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Not sensitive to acidity	-	-	-	0.77	0.15
Crymlyn Bog and Pant Y Sais NNR	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Not sensitive to acidity	-	-	-	1.33	0.17
Pant-y-Sais LNR	Poor fens	Acid grassland	0.223	0.536	0.17	0.77	0.15
Pant-y-Sais LNR	Base-rich fens	Not sensitive to acidity		-	-	0.77	0.15
Pant-y-Sais LNR	Transition mires and quaking bogs (H7140)	Bogs	0.321	0.661	0.342	0.77	0.15
Pant-y-Sais LNR	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Not sensitive to acidity	-	-	-	0.77	0.15
Pant-y-Sais LNR	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Not sensitive to acidity	-	-	-	1.33	0.17
Red Jacket Fen WTR	Fen, Marsh and Swamp	Not sensitive to acidity	-	-	-	0.77	0.15
Ancient Woodlands 1	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	0.36	2.95	2.6	1.33	0.17
Ancient Woodlands 2	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	0.36	2.95	2.6	1.33	0.17
Ancient Woodlands 3	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	0.36	2.97	2.61	1.33	0.17
Ancient Woodlands 4	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	0.36	2.97	2.61	1.33	0.17
Ancient Woodlands 5	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	0.36	2.96	2.61	1.33	0.17
Ancient Woodlands 6	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	0.36	2.96	2.61	1.33	0.17

## Appendix C – Deposition Results Tables

<b>Table E.1: Annual Mean Process Contribution Used for Dry Deposition Analysis</b>				
<b>Site</b>	<b>Annual Mean Process Contribution (<math>\mu\text{g}/\text{m}^3</math>)</b>			
	<b>Nitrogen Dioxide</b>	<b>Sulphur Dioxide</b>	<b>Hydrogen Chloride</b>	<b>Ammonia</b>
<b>European statutory designated sites (within 10km)</b>				
Crymlyn Bog	26.18	9.35	1.85	1.85
<b>UK statutory designated sites (within 2km)</b>				
Pant-y-Sais SSSI	219.62	78.44	15.54	15.54
Crymlyn Burrows SSSI	26.19	9.35	1.85	1.85
<b>Non-statutory designated sites (within 2km)</b>				
Crymlyn Bog and Pant Y Sais NNR	25.81	9.22	1.83	1.83
Pant-y-Sais LNR	26.24	9.37	1.86	1.86
Red Jacket Fen WTR	25.32	9.04	1.79	1.79
Ancient Woodlands 1	105.54	37.69	7.47	7.47
Ancient Woodlands 2	158.69	56.67	11.23	11.23
Ancient Woodlands 3	113.40	40.50	8.03	8.03
Ancient Woodlands 4	75.32	26.90	5.33	5.33
Ancient Woodlands 5	46.41	16.58	3.28	3.28
Ancient Woodlands 6	38.48	13.74	2.72	2.72

Table E.3: Deposition Calculation – Grassland - Maximum

Site	Dry Deposition (kg/ha/yr)				Wet Deposition (kg/ha/yr)	Total N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
	Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia	Hydrogen Chloride		N	S
<b>European statutory designated sites (within 10km)</b>								
Crymlyn Bog	0.0038	0.0177	0.0142	0.0096	0.0284	0.0134	0.0010	0.0019
<b>UK statutory designated sites (within 2km)</b>								
Pant-y-Sais SSSI	0.0316	0.1484	0.1192	0.0807	0.2383	0.1124	0.0080	0.0160
Crymlyn Burrows SSSI	0.0038	0.0177	0.0142	0.0096	0.0284	0.0134	0.0010	0.0019
<b>Non-statutory designated sites (within 2km)</b>								
Crymlyn Bog and Pant Y Sais NNR	0.0037	0.0174	0.0140	0.0095	0.0280	0.0132	0.0009	0.0019
Pant-y-Sais LNR	0.0038	0.0177	0.0142	0.0096	0.0285	0.0134	0.0010	0.0019
Red Jacket Fen WTR	0.0036	0.0171	0.0137	0.0093	0.0275	0.0130	0.0009	0.0018
Ancient Woodlands 1	0.0152	0.0713	0.0573	0.0388	0.1145	0.0540	0.0039	0.0077
Ancient Woodlands 2	0.0229	0.1073	0.0861	0.0583	0.1722	0.0812	0.0058	0.0116
Ancient Woodlands 3	0.0163	0.0766	0.0615	0.0417	0.1231	0.0580	0.0041	0.0083
Ancient Woodlands 4	0.0108	0.0509	0.0409	0.0277	0.0817	0.0385	0.0028	0.0055
Ancient Woodlands 5	0.0067	0.0314	0.0252	0.0171	0.0504	0.0237	0.0017	0.0034
Ancient Woodlands 6	0.0055	0.0260	0.0209	0.0141	0.0418	0.0197	0.0014	0.0028

Table E.4: Deposition Calculation – Woodland - Maximum

Site	Dry Deposition (kg/ha/yr)				Wet Deposition (kg/ha/yr)	Total N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
	Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia	Hydrogen Chloride		N	S
<b>European statutory designated sites (within 10km)</b>								
Crymlyn Bog	0.0075	0.0354	0.0341	0.0144	0.0682	0.0220	0.0016	0.0041
<b>UK statutory designated sites (within 2km)</b>								
Pant-y-Sais SSSI	0.0633	0.2969	0.2860	0.1211	0.5720	0.1843	0.0132	0.0347
Crymlyn Burrows SSSI	0.0075	0.0354	0.0341	0.0144	0.0682	0.0220	0.0016	0.0041
<b>Non-statutory designated sites (within 2km)</b>								
Crymlyn Bog and Pant Y Sais NNR	0.0074	0.0349	0.0336	0.0142	0.0672	0.0217	0.0015	0.0041
Pant-y-Sais LNR	0.0076	0.0355	0.0342	0.0145	0.0684	0.0220	0.0016	0.0041
Red Jacket Fen WTR	0.0073	0.0342	0.0330	0.0140	0.0659	0.0213	0.0015	0.0040
Ancient Woodlands 1	0.0304	0.1427	0.1375	0.0582	0.2749	0.0886	0.0063	0.0167
Ancient Woodlands 2	0.0457	0.2145	0.2067	0.0875	0.4133	0.1332	0.0095	0.0250
Ancient Woodlands 3	0.0327	0.1533	0.1477	0.0625	0.2954	0.0952	0.0068	0.0179
Ancient Woodlands 4	0.0217	0.1018	0.0981	0.0415	0.1962	0.0632	0.0045	0.0119
Ancient Woodlands 5	0.0134	0.0627	0.0604	0.0256	0.1209	0.0390	0.0028	0.0073
Ancient Woodlands 6	0.0111	0.0520	0.0501	0.0212	0.1002	0.0323	0.0023	0.0061

Table E.5: Detailed Results – Nitrogen Deposition - Maximum

Site	Habitat	Deposition Velocity	Process Contribution			Predicted Environmental Concentration		
			PC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL	PEC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL
<b>European statutory designated sites (within 10km)</b>								
Crymlyn Bog Ramsar, SAC	Transition mires and quaking bogs (H7140)	Grassland	1.34E-02	0.27%	0.13%	10.793	215.87%	107.93%
Crymlyn Bog Ramsar, SAC	Calcareous fens with Cladium mariscus and species of the Caricion davalliana (H7210)	Grassland	1.34E-02	0.10%	0.07%	10.793	83.03%	53.97%
Crymlyn Bog Ramsar, SAC	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Woodland	2.20E-02	-	-	18.642	-	-
Crymlyn Bog Ramsar, SAC	Poor fens	Grassland	1.34E-02	0.13%	0.09%	10.793	107.93%	71.96%
Crymlyn Bog Ramsar, SAC	Base-rich fens	Grassland	1.34E-02	0.09%	0.04%	10.793	71.96%	35.98%
<b>UK statutory designated sites (within 2km)</b>								
Pant-y-Sais SSSI	Poor fens	Grassland	1.34E-02	0.13%	0.09%	10.793	107.93%	71.96%
Pant-y-Sais SSSI	Base-rich fens	Grassland	1.34E-02	0.09%	0.04%	10.793	71.96%	35.98%
Pant-y-Sais SSSI	Transition mires and quaking bogs (H7140)	Grassland	1.34E-02	0.27%	0.13%	10.793	215.87%	107.93%
Pant-y-Sais SSSI	Calcareous fens with Cladium mariscus and species of the Caricion davalliana (H7210)	Grassland	1.34E-02	0.10%	0.07%	10.793	83.03%	53.97%
Pant-y-Sais SSSI	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Woodland	2.20E-02	-	-	18.642	-	-
Crymlyn Burrows SSSI	Dunes, Shingle & Machair	Grassland	1.12E-01	1.12%	0.56%	10.892	108.92%	54.46%
Crymlyn Burrows SSSI	Dunes, Shingle & Machair	Grassland	1.12E-01	1.12%	0.75%	10.892	108.92%	72.62%
Crymlyn Burrows SSSI	Coastal saltmarsh	Grassland	1.12E-01	0.56%	0.37%	10.892	54.46%	36.31%
<b>Non-statutory designated sites (within 2km)</b>								
Crymlyn Bog and Pant Y Sais NNR	Poor fens	Grassland	1.32E-02	0.13%	0.09%	10.793	107.93%	71.95%
Crymlyn Bog and Pant Y Sais NNR	Base-rich fens	Grassland	1.32E-02	0.09%	0.04%	10.793	71.95%	35.98%
Crymlyn Bog and Pant Y Sais NNR	Transition mires and quaking bogs (H7140)	Grassland	1.32E-02	0.26%	0.13%	10.793	215.86%	107.93%
Crymlyn Bog and Pant Y Sais NNR	Calcareous fens with Cladium mariscus and species of the Caricion davalliana (H7210)	Grassland	1.32E-02	0.10%	0.07%	10.793	83.02%	53.97%
Crymlyn Bog and Pant Y Sais NNR	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Woodland	2.17E-02	-	-	18.642	-	-
Pant-y-Sais LNR	Poor fens	Grassland	1.34E-02	0.13%	0.09%	10.793	107.93%	71.96%
Pant-y-Sais LNR	Base-rich fens	Grassland	1.34E-02	0.09%	0.04%	10.793	71.96%	35.98%
Pant-y-Sais LNR	Transition mires and quaking bogs (H7140)	Grassland	1.34E-02	0.27%	0.13%	10.793	215.87%	107.93%
Pant-y-Sais LNR	Calcareous fens with Cladium mariscus and species of the Caricion davalliana (H7210)	Grassland	1.34E-02	0.10%	0.07%	10.793	83.03%	53.97%
Pant-y-Sais LNR	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Woodland	2.20E-02	-	-	18.642	-	-
Red Jacket Fen WTR	Fen, Marsh and Swamp	Grassland	1.30E-02	0.13%	0.09%	10.793	107.93%	71.95%
Ancient Woodlands 1	Broadleaved, Mixed and Yew Woodland	Woodland	8.86E-02	0.89%	0.44%	18.709	187.09%	93.54%

Table E.5: Detailed Results – Nitrogen Deposition - Maximum

Site	Habitat	Deposition Velocity	Process Contribution			Predicted Environmental Concentration		
			PC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL	PEC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL
Ancient Woodlands 2	Broadleaved, Mixed and Yew Woodland	Woodland	1.33E-01	1.33%	0.67%	18.753	187.53%	93.77%
Ancient Woodlands 3	Broadleaved, Mixed and Yew Woodland	Woodland	9.52E-02	0.95%	0.48%	18.715	187.15%	93.58%
Ancient Woodlands 4	Broadleaved, Mixed and Yew Woodland	Woodland	6.32E-02	0.63%	0.32%	18.683	186.83%	93.42%
Ancient Woodlands 5	Broadleaved, Mixed and Yew Woodland	Woodland	3.90E-02	0.39%	0.19%	18.659	186.59%	93.29%
Ancient Woodlands 6	Broadleaved, Mixed and Yew Woodland	Woodland	3.23E-02	0.32%	0.16%	18.652	186.52%	93.26%

Table E.6: Detailed Results – Acid Deposition

Site	Habitat	Deposition Velocity	Process Contribution			Predicted Environmental Concentration		
			N (keq/ha/yr)	S (keq/ha/yr)	% of Min CL Function	N (keq/ha/yr)	S (keq/ha/yr)	% of CL Function
<b>European statutory designated sites (within 10km)</b>								
Crymlyn Bog Ramsar, SAC	Transition mires and quaking bogs (H7140)	Grassland	9.57E-04	1.91E-03	0.43%	0.771	0.152	139.62%
Crymlyn Bog Ramsar, SAC	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Grassland	9.57E-04	1.91E-03	-	0.771	0.152	-
Crymlyn Bog Ramsar, SAC	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Woodland	1.57E-03	4.13E-03	-	1.332	0.174	-
Crymlyn Bog Ramsar, SAC	Poor fens	Grassland	9.57E-04	1.91E-03	0.53%	0.771	0.152	172.18%
Crymlyn Bog Ramsar, SAC	Base-rich fens	Grassland	9.57E-04	1.91E-03	-	0.771	0.152	-
<b>UK statutory designated sites (within 2km)</b>								
Pant-y-Sais SSSI	Poor fens	Grassland	9.57E-04	1.91E-03	0.53%	0.771	0.152	172.18%
Pant-y-Sais SSSI	Base-rich fens	Grassland	9.57E-04	1.91E-03	-	0.771	0.152	-
Pant-y-Sais SSSI	Transition mires and quaking bogs (H7140)	Grassland	9.57E-04	1.91E-03	0.43%	0.771	0.152	139.62%
Pant-y-Sais SSSI	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Grassland	9.57E-04	1.91E-03	-	0.771	0.152	-
Pant-y-Sais SSSI	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Woodland	1.57E-03	4.13E-03	-	1.332	0.174	-
Crymlyn Burrows SSSI	Dunes, Shingle & Machair	Grassland	8.03E-03	1.60E-02	0.39%	0.778	0.166	4.09%
Crymlyn Burrows SSSI	Dunes, Shingle & Machair	Grassland	8.03E-03	1.60E-02	0.39%	0.778	0.166	4.09%
Crymlyn Burrows SSSI	Coastal saltmarsh	Grassland	8.03E-03	1.60E-02	-	0.778	0.166	-
<b>Non-statutory designated sites (within 2km)</b>								
Crymlyn Bog and Pant Y Sais NNR	Poor fens	Grassland	9.43E-04	1.88E-03	0.53%	0.771	0.152	172.17%
Crymlyn Bog and Pant Y Sais NNR	Base-rich fens	Grassland	9.43E-04	1.88E-03	-	0.771	0.152	-
Crymlyn Bog and Pant Y Sais NNR	Transition mires and quaking bogs (H7140)	Grassland	9.43E-04	1.88E-03	0.43%	0.771	0.152	139.61%
Crymlyn Bog and Pant Y Sais NNR	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Grassland	9.43E-04	1.88E-03	-	0.771	0.152	-
Crymlyn Bog and Pant Y Sais NNR	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Woodland	1.55E-03	4.07E-03	-	1.332	0.174	-
Pant-y-Sais LNR	Poor fens	Grassland	9.59E-04	1.91E-03	0.54%	0.771	0.152	172.18%
Pant-y-Sais LNR	Base-rich fens	Grassland	9.59E-04	1.91E-03	-	0.771	0.152	-
Pant-y-Sais LNR	Transition mires and quaking bogs (H7140)	Grassland	9.59E-04	1.91E-03	0.43%	0.771	0.152	139.62%
Pant-y-Sais LNR	Calcareous fens with Cladium mariscus and species of the Caricion davallianae (H7210)	Grassland	9.59E-04	1.91E-03	-	0.771	0.152	-
Pant-y-Sais LNR	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	Woodland	1.57E-03	4.14E-03	-	1.332	0.174	-
Red Jacket Fen WTR	Fen, Marsh and Swamp	Grassland	9.25E-04	1.84E-03	-	0.771	0.152	-


Table E.6: Detailed Results – Acid Deposition

Site	Habitat	Deposition Velocity	Process Contribution			Predicted Environmental Concentration		
			N (keq/ha/yr)	S (keq/ha/yr)	% of Min CL Function	N (keq/ha/yr)	S (keq/ha/yr)	% of CL Function
Ancient Woodlands 1	Broadleaved, Mixed and Yew Woodland	Woodland	6.33E-03	1.67E-02	0.78%	1.336	0.187	51.63%
Ancient Woodlands 2	Broadleaved, Mixed and Yew Woodland	Woodland	9.51E-03	2.50E-02	1.17%	1.340	0.195	52.02%
Ancient Woodlands 3	Broadleaved, Mixed and Yew Woodland	Woodland	6.80E-03	1.79E-02	0.83%	1.337	0.188	51.34%
Ancient Woodlands 4	Broadleaved, Mixed and Yew Woodland	Woodland	4.52E-03	1.19E-02	0.55%	1.335	0.182	51.06%
Ancient Woodlands 5	Broadleaved, Mixed and Yew Woodland	Woodland	2.78E-03	7.33E-03	0.34%	1.333	0.177	51.02%
Ancient Woodlands 6	Broadleaved, Mixed and Yew Woodland	Woodland	2.31E-03	6.07E-03	0.28%	1.332	0.176	50.96%

Appendix D – Human Health Risk Assessment

# FICHTNER

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**SOFIDEL INTERTISSUE  
BAGLAN  
HUMAN HEALTH RISK  
ASSESSMENT**

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**SOFIDEL INTERTISSUE  
BAGLAN  
HUMAN HEALTH RISK ASSESSMENT**

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## 1 INTRODUCTION

Fichtner Consulting Engineers Ltd ("Fichtner") has been engaged to undertake a Human Health Risk Assessment (HHRA) to support the planning and Environmental Permit applications for the proposed wood-fuelled boiler at the existing Intertissue paper manufacturing site off Brunell Way, Neath Port Talbot. Due to the recycled nature of some of the fuel, the limits on emissions to air will be based on those outlined in Chapter IV and Annex VI of the Industrial Emissions Directive (IED) for waste incineration and co-incineration plants. This will include limits on emissions of heavy metals and dioxins and furans.

The advice from health specialists such as the Health Protection Agency that the damage to health from emissions from incineration and co-incineration plants is likely to be very small, and probably not detectable. Nevertheless, the specific effects on human health of the proposed plant have been considered, and are presented in this report.

For most substances released from the Facility, the most significant effects on human health will arise by inhalation. The air quality objectives (AQOs) outlined within the air quality assessment 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 AQOs, 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 assessment.

A number of agricultural and residential receptors have been identified and the impact of the Facility on those receptors considered. The point of maximum impact is located within the site boundary.

## 2 ISSUE IDENTIFICATION

### 2.1 Issue

The key issue is the release of substances from the proposed wood-fuelled boiler to atmosphere which have the potential to harm human health. No other sources will include emissions of either metals or dioxins. The Facility is to be located adjacent to the existing Intertissue paper manufacturing site, off Brunell Way, Neath Port Talbot. The closest residential properties are located in Baglan, approximately 1.2km to the east of the proposed Facility.

The Facility will be designed to meet the emission limits outlined in the IED (2010/75/EU). Limits have been set for pollutants known to be produced during the combustion of waste which have the potential to impact upon the local environment either on human health or ecological receptors. These pollutants include:

- nitrogen dioxide, sulphur dioxide, particulate matter, carbon monoxide, ammonia;
- acid gases - hydrogen chloride, and hydrogen fluoride;
- total organic carbon;
- metals - mercury, cadmium, thallium, antimony, arsenic, lead, cobalt, copper, manganese, nickel and vanadium;
- dioxin and furans;
- dioxin like PCBs; and
- polycyclic aromatic hydrocarbons (PAHs).

For most substances released from the Facility, the most significant effects on human health will arise by inhalation. An Air Quality Assessment has been undertaken to determine the impact of atmospheric concentrations of the pollutants listed above based on the levels transposed under UK Law in the UK Air Quality Strategy and those set by the Environment Agency. These levels have been set at a level which is considered to present minimum or zero risk to human health.

Some pollutants, including dioxins, furans, dioxin-like polychlorinated biphenyls (PCBs) and heavy metals, accumulate in the environment, which means that inhalation is only one of the potential exposure routes. Therefore, impacts cannot be evaluated in terms of their effects on human health by simply reference to ambient air quality standards. An assessment needs to be made of the overall human exposure to the substances by the local population and the risk that this exposure causes.

### 2.2 Chemicals of Potential Concern (COPC)

The substances which have been considered within this assessment are those which are authorised (as listed above). Although Emission Limit Values (ELVs) for PAHs are not currently set from installations, monitoring is required by legislation in the UK. Therefore, benzo(a)pyrene has been included in the assessment to represent PAH emissions. The following have been considered COPCs for the purpose of this assessment:

- PCDD/Fs (individual congeners) and dioxin like PCBs;
- Benzene
- Benzo(a)pyrene
- Mercury (Hg)
- Mercuric chloride
- Cadmium (Cd)
- Arsenic (As)
- Chromium (Cr), trivalent and hexavalent; and
- Nickel (Ni).

This risk assessment investigates the potential for long term health effect of these COPCs through other routes than just inhalation.

## 3 ASSESSMENT CRITERIA

IRAP calculates the total exposure through each of the different pathways so that a dose from inhalation and ingestion can be calculated for each receptor. By default, these doses are then used to calculate a cancer risk, using the USEPA's approach. However, the Environment Agency recommend that the results be assessed using the UK's approach, which is explained in the Environment Agency's document "Human Health Toxicological Assessment of Contaminants in Soil", ref SC050021. This approach involves two types of assessment:

- For those substances with a threshold level for toxicity, a Tolerable Daily Intake (TDI) is defined. This is "an estimate of the amount of a contaminant, expressed on a bodyweight basis, which can be ingested daily over a lifetime without appreciable health risk." A Mean Daily Intake (MDI) is also defined, which is the typical intake from background sources (including dietary intake) across the UK. In order to assess the impact of the Facility, the predicted intake of a substance due to emissions from the Facility is added to the MDI and compared with the TDI.
- For substances without a threshold level for toxicity, an Index Dose (ID) is defined. This is a level of exposure which is associated with a negligible risk to human health. The predicted intake of a substance due to emissions from the Facility is compared directly with the ID without taking account of background levels.

Substances can reach the body either through inhalation or through ingestion (oral exposure) and the body handles chemicals differently depending on the route of exposure. For this reason, different TDI and IDs are defined for inhalation and oral exposure.

The following table outlines the MDIs (the typical intake from existing background sources) for the pollutants released from the Facility. These figures are defined in the "Contaminants in soil: updated collation of toxicology data and intake values for humans" series of toxicological reports, available from the Environment Agency's website.

<b>Substance</b>	<b>Mean Daily Intake, 70 kg adult (µg/kg bw/day)</b>		<b>Mean Daily Intake, 20 kg child (µg/kg bw/day)</b>	
	<b>Intake Ingestion</b>	<b>Intake, Inhalation</b>	<b>Intake Ingestion</b>	<b>Intake, Inhalation</b>
Arsenic	0.07	0.0002	0.19	0.0005
Benzene	0.04	2.9	0.11	7.4
Benzene(a)pyrene	-	-	-	-
Cadmium	0.19	0.0003	0.5	0.0007
Chromium	1.81	0.0009	4.70	0.0022
Chromium (VI)	0.18	-	0.47	-
Methyl mercury	0.007	-	0.019	-
Mercuric chloride	0.014	-	0.037	-
Nickel	1.9	0.0009	4.8	0.002
Dioxins and dioxin like PCBs (pg WHO-TEQ/kg bw/day)	0.7		1.8	

Substance	Index dose, Ingestion	Index dose, Inhalation	TDI, Ingestion	TDI, Inhalation
Arsenic	0.3	0.002	-	-
Benzene	0.29	1.4	-	-
Benzene(a)pyrene	0.02	0.00007	-	-
Cadmium	-	-	0.36	0.0014
Chromium	-	-	3	-
Chromium (VI)	-	0.001	-	-
Methyl mercury	-	-	0.23	0.23
Mercuric chloride	-	-	2	0.06
Nickel	-	-	12	0.006
Dioxins and dioxin like PCBs ( $\mu\text{g WHO-TEQ kg-bw}^{-1} \text{ day}^{-1}$ )	-	-	2	

To allow comparison with the TDI for dioxins, intake values for each dioxin are multiplied by a factor known as the WHO-TEF. A full list of the WHO-TEF values for each dioxin is provided in Appendix A.

The following table presents the MDI for an adult and child as a proportion of the TDI.

Substance	Mean Daily Intake, 70 kg adult ( $\mu\text{g}/\text{kg bw}/\text{day}$ )		Mean Daily Intake, 20 kg child ( $\mu\text{g}/\text{kg bw}/\text{day}$ )	
	Intake Ingestion	Intake, Inhalation	Intake Ingestion	Intake, Inhalation
Cadmium	53.17%	20.41%	137.72%	52.86%
Chromium	60.48%	-	156.63%	-
Methyl mercury	3.11%	-	8.04%	-
Mercuric chloride	0.71%	-	1.85%	-
Nickel	15.48%	14.29%	40.08%	37.00%
Dioxins and dioxin like PCBs	35.00%		90.00%	

As shown, the cadmium and chromium intake from existing sources (the MDI) exceeds the TDI. The MDI for chromium is set for chromium III and taken from the DEFRA report "Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Chromium". This states that there are no published reports on the adverse effects in humans resulting from ingested chromium III. Almost all toxicological opinion is that chromium III compounds are of low oral toxicity, and indeed the UK Committee on Medical Aspects of Food Policy recommends chromium III in the diet. The World Health Organisation (WHO) have reviewed the daily intake of chromium from foods and found that existing levels do not represent a toxicity problem. The WHO conclude that "in the form of trivalent compounds, chromium is an essential nutrient and is relatively non-toxic for man and other mammalian species".

The DEFRA report explains that the TDI has been derived from the USEPA's Reference Dose of 3 µg/kg bw/day for chromium VI. This is the only explicitly derived safety limit for oral exposures of chromium. DEFRA recommends that the USEPA Reference Dose is applied to all the chromium content as a starting point. Therefore the TDI presented in Table 3.2 is actually the TDI for chromium VI, not total chromium. Assessing the total dietary intake of chromium against this TDI is highly conservative.

The key determinant of cadmium's toxicity potential is its chronic accumulation in the kidney. The Environment Agency, in its toxicology report "SC050021/TOx 3", explains that chronic exposure to levels in excess of the TDI might be associated with an increase in kidney disease in a proportion of those exposed, but (small) exceedances lasting for shorter periods are of less consequence. Therefore, assessing a lifetime exposure is appropriate. If we assess the exposure of a receptor over a lifetime (i.e. a period as a child and adult) the lifetime MDI is below the TDI.

## 4 CONCEPTUAL SITE MODEL

### 4.1 Conceptual site model

A detailed Human 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 for Hazardous Waste Combustion Facilities<sup>1</sup>. This Protocol is a development of the approach defined by Her Majesties Inspectorate on Pollution (HMIP) in the UK in 1996<sup>2</sup>, taking account of further research since that date. The exposure pathways included in the IRAP model are shown in Figure 1. Exposure to gaseous contaminants has the potential to occur by direct inhalation or vapour phase transfer to plants. In addition, exposure to particulate phase contaminants may occur via indirect pathways following the deposition of particles to soil. These 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.

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

- |  |                        |
|--|------------------------|
| • Direct inhalation                          | All receptors          |
| • Ingestion of soil                          | All receptors          |
| • Ingestion of home-grown produce            | All receptors          |
| • Ingestion of drinking water                | All receptors          |
| • Ingestion of eggs from home-grown chickens | Agricultural receptors |
| • Ingestion of home-grown chickens           | Agricultural receptors |
| • Ingestion of home-grown beef               | Agricultural receptors |
| • Ingestion of home-grown pork               | Agricultural receptors |
| • Ingestion of home-grown milk               | Agricultural receptors |
| • Ingestion of breast milk                   | Infants only           |

It is noted that some households may keep chickens and consume eggs and potentially the birds. The impact on these households is considered to be between the impact at an agricultural receptor and a standard resident receptor. The approach used considers an agricultural receptor at the point of maximum impact as a complete worst case.

As shown in Figure 1, the pathway from the ingestion of mother's milk in infants is considered within the assessment. This considers all dioxins and dioxin-like PCBs. The IRAP model calculates the amount of these COPCs entering the mother's milk and being passed on to the infants. The impacts are then compared against the TDI.

<sup>1</sup> USEPA (2005) Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

<sup>2</sup> HMIP (1996) Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes.

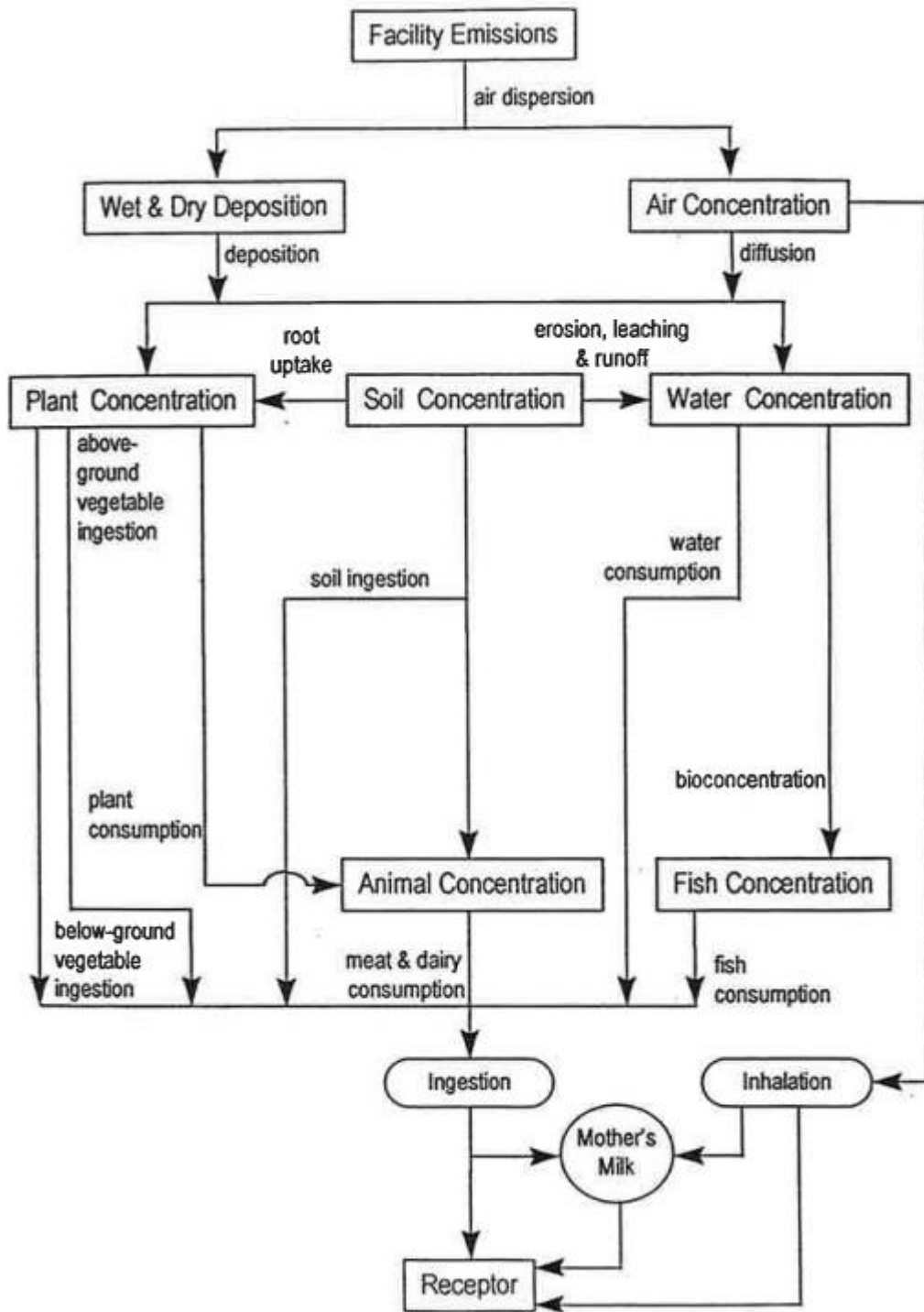


Figure 1: Conceptual Site Model – Exposure Pathways

## 4.2 Pathways excluded from assessment

The intake of dioxins via dermal absorption, groundwater and surface water exposure pathways is very limited and as such these pathways are excluded from the HHRA. The justification for excluding these pathways is highlighted in the following sections.

### 4.2.1 Dermal absorption

Both the HMIP and the USEPA note that the contribution from dermal exposure to soils impacted from waste combustion facilities is typically a very minor pathway and is typically very small relative to contributions resulting from exposures via the food chain. The USEPA<sup>3</sup> provide an example from the risk assessment conducted for the Waste Technologies, Inc. hazardous waste incinerator in East Liverpool, Ohio. This indicated that for an adult subsistence farmer in a subarea with high exposures, the risk resulting from soil ingestion and dermal contact was 50-fold less than the risk from any other pathway and 300-fold less than the total estimated risk.

The HMIP document<sup>4</sup> provides a screening calculation using conservative assumptions, which states for a 1 pg I-TEQ/m<sup>3</sup> the intake via dermal absorption is 30 times lower than the intake via inhalation, which is itself a minor contributor to the total risk.

As such the pathway from dermal absorption is deemed to be an insignificant risk and has been excluded from this assessment.

### 4.2.2 Groundwater

Exposure via groundwater can only occur if the groundwater is contaminated and consumed untreated by an individual.

The USEPA<sup>5</sup> have concluded that the build up of dioxins in the aquifer over realistic travel times relevant to human exposure was predicted to be so small as to be essentially zero.

As such the pathway from groundwater is deemed to be an insignificant risk and has been excluded from this assessment.

### 4.2.3 Surface water

It is noted that a possible pathway is via deposition of emissions directly onto surface water – i.e local drinking water supplies or rainwater storage tanks.

Surface water generally goes through several treatment steps and as such any contaminants would be removed from the water before consumption. It is noted that run off to rainwater tanks may not go through the same treatment. However, rain water tanks have a very small surface area and as such the potential for deposition and build up of COPCs is limited. As such the pathway from contaminated surface water is deemed to be an insignificant risk and has been excluded from this assessment.

### 4.2.4 Fish consumption

The consumption of locally caught fish has been excluded from the assessment. Whilst it is noted that fish makes up a proportion of the UK diet, it is not likely that this would be sourced wide-scale from close proximity to the Facility as the majority of UK dietary fish comes from marine habitats, not inland waterways.

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<sup>3</sup> USEPA (2005) Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

<sup>4</sup> HMIP (1996) Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes.

<sup>5</sup> USEPA (2005) Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

## 5 SENSITIVE RECEPTORS

This assessment considers the possible effects on human health at key receptors, where humans are likely to be exposed to the greatest impact from the Facility, and at the point of maximum impact of annual mean emissions.

For the purposes of this assessment, 'Residential' and 'Agricultural' receptors have been identified and can be defined as follows:

- Residential: A known place of residence that is occupied within the study area;
- Agricultural: A farm holding or area land of horticultural interest.

The emissions from the Facility are expected to be significant only in the locality of the plant. The specific receptors identified in the Air Quality Assessment have been considered in this Assessment. In addition a 'Point of maximum impact' receptor has been selected at the point of maximum impact within fields close to the Facility (and within the adjacent quarry) from annual mean process emissions, although it should be noted that this point is actually uninhabited.

These sensitive receptors are listed in Table 5.1, which also contains the receptor designation considered most appropriate for each receptor.

ID	Receptor Name	Location		Type of Receptor
		X	Y	
MAX	Point of maximum impact	560865	178050	Resident & Farmer
R1	32 Ocean View	271498	193840	Resident
R2	Church St	273792	194137	Resident
R3	28 Swan Road	274238	193201	Resident
R4	Irving House Handel Avenue	273820	191461	Resident
R5	56 Fenbrook Close	274574	192048	Resident
R7	Sandfields Comprehensive School	274043	191404	Resident
R11	Llansawel Primary School	273772	194242	Resident
R12	Mercury School of Motoring	274190	194332	Resident
R18	ABMU Health Board	274443	192129	Resident
R23	Allotment Gardens 2	274323	193335	Farmer

## 6 IRAP MODEL ASSUMPTIONS AND INPUTS

The following section details the user defined assumptions used within the IRAP model and provides justifications where appropriate.

### 6.1 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 in general and 15 cm for produce.

The split between the solid and vapour phase for the substance considered depends on the specific physical properties of each chemical.

In order to assess the amount of substance 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 substance.

### 6.2 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 substances through the roots will differ for below ground and above ground vegetables, and deposition onto plants will be more significant for above ground vegetables.

### 6.3 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 substances, 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.

### 6.4 Concentration in humans

#### 6.4.1 Intake via inhalation

This is calculated from inhalation rates of typical adults and children and atmospheric concentrations. The inhalation rates used for adults and children are:

- Adults - 20 m<sup>3</sup>/day; and
- Children - 7.2 m<sup>3</sup>/day.

These are as specified within the Environment Agency series of reports: "Contaminants in soil: updated collation of toxicology data and intake values for humans". The calculation also takes account of time spent outside, since most people spend most of their time indoors.

### 6.4.2 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.

### 6.4.3 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.

For most people, locally-produced food is only a fraction of their diet and so exposure factors are applied to allow for this.

### 6.4.4 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.

The only pathway considered for dioxins for a breast feeding infant is through breast milk. The modelled scenario consists of the accumulation of pollutants in the food chain up to an adult receptor, the accumulation of pollutants in breast milk and finally the consumption of breast milk by an infant.

The assumptions used were:

- |   |              |
|---|--------------|
| • Exposure duration of infant to breast milk          | 1 year       |
| • Proportion of ingested dioxin that is stored in fat | 0.9%         |
| • Proportion of mothers weight that is stored in fat  | 0.3%         |
| • Fraction of fat in breast milk                      | 0.04%        |
| • Fraction of ingested contaminant that is absorbed   | 0.9%         |
| • Half life of dioxins in adults                      | 2,555 days   |
| • Ingestion rate of breast milk                       | 0.688 kg/day |

## 6.5 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.

- Weather data was obtained for the period 2010-2014 from the Mumbles Head weather station, as used within the air quality dispersion modelling. This provides the annual average precipitation which can be used to calculate the general IRAP-h input parameters:

**Table 6.1: Ground Type Dependent Properties**

Input Variable	Assumption	Value (cm/year)
Annual average evapo-transpiration	70% of annual average precipitation	71.16
Annual average irrigation	0% of annual average precipitation	0.00
Annual average precipitation	100% of annual average precipitation	101.66
Annual average runoff	10% of annual average precipitation	10.17

- The average wind speed was taken as 6.64 m/s, calculated from the average of the 5 years of weather data for the period 2010-2014 from the Mumbles Head weather station.

A number of assumptions have been made with regard to the deposition of the different phases. These are summarised in the following table.

**Table 6.2: Deposition Assumptions**

Deposition Phase	Dry Deposition Velocities (m/s)	Ratio Dry deposition to Wet deposition	
		Dry Deposition	Wet Deposition
Vapour	0.005	1.0	2.0
Particle	0.010	1.0	2.0
Bound particle	0.010	1.0	2.0
Mercury vapour	0.029	1.0	0

The above deposition velocities have been agreed with the UK Environment Agency for all IRAP based assessments where modelling of specific deposition of pollutants is not undertaken. These are considered to be conservative.

These deposition assumptions have been applied to the annual mean concentrations predicted using the dispersion modelling which was undertaken as part of the Dispersion Modelling Assessment, to generate the inputs needed for the IRAP modelling. For details of the dispersion modelling methodology please refer to the Dispersion Modelling Assessment.

## 6.6 Modelled emissions

For the purpose of this assessment it is assumed that the Facility operates at the IED Emission Limit Values for its entire operational life. In actual fact the facility will be shut down for periods of maintenance and monitoring of similar facilities in the UK shows they do not operate at the Emission Limit Values.

The following tables gives the emissions rates of each COPC modelled and the associated Emission Limit Values which have been used to derive the emission rate.

Table 6.3: COPC Emissions Modelled

COPC	Emission Limit Value (mg/Nm <sup>3</sup> )	Emission rate (µg/s)
Benzene	15	43.350
PAHs (Benzo(a)pyrene)	0.0002	0.00087
Elemental mercury	0.0001	0.00029
Mercuric chloride	0.024	0.069
Cadmium	0.025	0.072
Arsenic	0.055	0.159
Chromium	0.055	0.159
Chromium, hexavalent	0.00013	0.000376
Nickel	0.055	0.159

Table 6.4: COPC Emissions Modelled

COPC	Emission Limit Value (ng I-TEQ/Nm <sup>3</sup> )	Emission rate (pg/s)	
TetraCDD,2,3,7,8	0.1	0.009	
HexaCDD,1,2,3,7,8,9		0.006	
OctaCDD,1,2,3,4,6,7,8,9		0.001	
HeptaCDD,1,2,3,4,6,7,8		0.005	
OctaCDF,1,2,3,4,6,7,8,9		0.001	
HexaCDD,1,2,3,4,7,8		0.008	
PentaCDD,1,2,3,7,8		0.035	
TetraCDF,2,3,7,8		0.008	
HeptaCDF,1,2,3,4,7,8,9		0.001	
PentaCDF,2,3,4,7,8		0.077	
PentaCDF,1,2,3,7,8		0.004	
HexaCDF,1,2,3,6,7,8		0.023	
HexaCDD,1,2,3,6,7,8		0.007	
HexaCDF,2,3,4,6,7,8		0.025	
HeptaCDF,1,2,3,4,6,7,8		0.013	
HexaCDF,1,2,3,4,7,8		0.063	
HexaCDF,1,2,3,7,8,9		0.001	
Dioxin like PCBs		0.0092	0.040

A number of points should be noted for each group of COPCs:

**(1) Benzene (Table 6.3).**

- a) It has been assumed that the entire TOC emissions consist of only benzene.
- b) It has been assumed that TOC emissions are emitted at the daily ELV.

**(2) PAHs (Table 6.3).**

- a) It has been assumed that the entire PAH emissions consist of only benzo(a)pyrene.
- b) Benzo(a)pyrene is not a regulated pollutant within the IED. The highest recorded emission concentration of Benzo(a)pyrene from the UK Environment Agency's public register was 0.105 ug/m<sup>3</sup>, or 0.000105 mg/m<sup>3</sup> (dry, 11% oxygen, 273K). As this is not a regulated pollutant and only monitored periodically we have applied a safety factor of 2. This has been corrected to 6% reference oxygen content before calculating the emission rate from the Air Quality Assessment.

**(3) Group 1 metals - mercury and compounds (Table 6.3).**

- a) It has been assumed that the ELV of total mercury is 0.05mg/Nm<sup>3</sup>
- b) The concentration of elemental mercury has been taken as 0.2% of the total mercury and compounds ELV
- c) The concentration of mercury chloride has been taken as 48% of the total mercury and compounds ELV.
- d) The losses to the global cycle have been taken as 51.8% of the total mercury and compounds ELV.

**(4) Group 2 metals - cadmium, thallium and compounds (Table 6.3).**

- a) The assessment is based on the IED ELV of 0.05 mg/Nm<sup>3</sup> for cadmium, thallium and compounds.
- b) It is assumed that the emissions of cadmium and thallium are each half of the combined ELV.

**(5) Group 3 metals – antimony, arsenic, chromium, lead and nickel (Table 6.3).**

- a) The assessment is based on the IED ELV of 0.5 mg/Nm<sup>3</sup> for "other metals".
- b) The emissions of each of the nine "other metals" in the third group have been taken as one-ninth of the combined limit. The Environment Agency "Guidance to Applicants on Impact Assessment for Group 3 Metals Stack Releases – V.3 September 2012" considers this to be a "worst case" scenario. The monitoring from Wilton 10 biomass facility, presented in the Air Quality Assessment, substantiates this.
- c) The emission rate of Chromium (VI) has been taken as equal to 0.026% (0.00013/0.5 mg/Nm<sup>3</sup>) of the total chromium emission from the facility. This value is from the Environment Agency "Guidance to Applicants on Impact Assessment for Group 3 Metals Stack Releases – V.3 September 2011" which is based on the speciation of chromium emissions at ten municipal waste incinerators operating under IED in the UK, as justified in the Air Quality Assessment.

**(6) Dioxins and furans (Table 6.4).**

These are a group of similar halogenated organic compounds, which are generally found as a complex mixture. The toxicity of each compound is different and is generally expressed as a Toxic Equivalent Factor (TEF), which relates the toxicity of each individual compound to the toxicity of 2,3,7,8-TCDD, the most toxic dioxin. A full list of the TEF values for each dioxin is provided in Appendix A. The total concentration is then expressed as a Toxic Equivalent (TEQ).

The split of the different dioxins and furans is based on split of congeners for a release of 0.1 ng I-TEQ/Nm<sup>3</sup> as presented in Table A.7.

To determine the Emission Rate, the split of the different dioxins for a 0.1 ng I-TEQ/Nm<sup>3</sup> has been multiplied by the TEF value for the specific compound and then multiplied by the normalised flow rate as shown in Table 6.6.

**(7) Dioxin like PCBs (Table 6.4).**

There are a total of 209 PCBs, which act in a similar manner to dioxins, are generally found in complex mixtures and also have TEFs.

The UK Environment Agency has advised that 44 measurements of dioxin like PCBs have been taken at 24 MWIs between 2008 and 2010. The following data summarises the measurements, all at 11% reference oxygen content:

- Maximum =  $9.2 \times 10^{-3}$  ng[TEQ]/m<sup>3</sup>
- Mean =  $2.6 \times 10^{-3}$  ng[TEQ]/m<sup>3</sup>
- Minimum =  $5.6 \times 10^{-5}$  ng[TEQ]/m<sup>3</sup>

For the purpose of this assessment, as a conservative assumption, the maximum monitored PCB concentration has been used which has been converted to an emission rate using the volumetric flow rate at reference conditions.

The IRAP software, and the HHRAP database which underpins it, does not include any data on individual PCBs, but it does include data for take-up and accumulation rates within the food chain for two groups of PCBs, known as Aroclor 1254 and Aroclor 1016. Each Aroclor is based on a fixed composition of PCBs. Since we are not aware of any data on the specification of PCBs within incinerator emissions, as a worst case assumption we have assumed that the PCBs are released in each of the two Aroclor compositions.

As noted it is assumed that the metals are emitted as 11% of the total emission limit for group 3 metals. This metals monitoring from Wilton 10 is provided in the following table. For comparative purposes, the table also includes the Environment Agency analysis of MWI from the guidance note dated September 2012. Where the measured concentration is greater than 11% of the Group 3 metals ELV, this is highlighted.

**Table 6.5: Monitoring Data**

Pollutant	Measured Concentration as % of IED Group 3 ELV – Environment Agency Guidance			Metals Data from Wilton 10 Biomass Facility Based on APC Residue Analysis – 2008 to 2010 as % of IED Group 3 ELV		
	Mean	Max	Min	Mean	Max	Min
Arsenic	0.14%	0.60%	0.06%	0.82%	1.60%	0.12%
Chromium	2.18%	10.42%	0.08%	1.87%	3.57%	0.64%
Nickel	4.40%	27.24%	0.00%	3.63%	7.10%	0.83%

NOTES:  
 The measured nickel concentration from the MWIs is greater than 11% due to one single measurement outlier. The average is around 4% of the Group ELV.  
 Antimony and tin are not monitored in the APC residues at Wilton 10.

As shown, the total chromium emissions are a maximum of 3.57%, or on average 1.87% of the limit at Wilton 10; this includes some contribution from chromium (VI). In addition assuming that any of the metals are emitted at 11% of the total group 3 limit is conservative.

Table 6.6: Basis for the Emission Rate of Dioxins and Furans

Dioxin / furan	Split of Congeners for a release of 0.1 ng I-TEQ/Nm <sup>3</sup>	I-TEFs for the congeners <sup>6</sup>	Total (I-TEQ) ng/Nm <sup>3</sup>	Emission rate (pg/s)
2,3,7,8-TCDD	0.0031	1	0.0031	0.318
1,2,3,7,8-PeCDD	0.0245	0.5	0.0123	1.258
1,2,3,4,7,8-HxCDD	0.0287	0.1	0.0029	0.295
1,2,3,6,7,8-HxCDD	0.0258	0.1	0.0026	0.265
1,2,3,7,8,9-HxCDD	0.0205	0.1	0.0021	0.211
1,2,3,4,6,7,8-HpCDD	0.1704	0.01	0.0017	0.175
1,2,3,4,6,7,8,9-OctaCDD	0.4042	0.001	0.0004	0.042
2,3,7,8-TCDF	0.0277	0.1	0.0028	0.285
1,2,3,7,8-PCDF	0.0277	0.05	0.0014	0.142
2,3,4,7,8-PCDF	0.0535	0.5	0.0268	2.748
1,2,3,4,7,8-HxCDD	0.2179	0.1	0.0218	2.238
1,2,3,6,7,8-HxCDF	0.0807	0.1	0.0081	0.829
1,2,3,7,8,9-HxCDF	0.0042	0.1	0.0004	0.043
2,3,4,6,7,8-HxCDF	0.0871	0.1	0.0087	0.895
1,2,3,4,6,7,8-HpCDF	0.4395	0.01	0.0044	0.451
1,2,3,4,7,8,9-HpCDF	0.0429	0.01	0.0004	0.044
1,2,3,4,6,7,8,9-OctaCDF	0.3566	0.001	0.0004	0.037
Total (I-TEQ)	2.0150	-	0.1000	-

<sup>6</sup> Kutz et al.(1990) The International Toxicity Equivalency Factor (I-TEF) method for estimating risks associated with exposures to complex mixtures of dioxins and related compounds.

## 7 RESULTS

## 7.1 At point of maximum impact

The following tables outline the impact of emissions from the Facility at the Point of maximum impact for an 'Agricultural' receptor located on an open field (within the adjacent quarry) to the north of the Facility. As explained in section 4, this receptor type includes direct inhalation, and ingestion from soil, drinking water, and home-grown eggs and meat, beef, pork, and milk. This assumes that the person lives at the point of maximum impact and consumes home-grown produce etc. This is considered to be a very worst-case scenario. Where appropriate a comparison has been made to the TDI or ID.

**Table 7.1: Impact Analysis – TDI – Point of Maximum Impact – “Agricultural”**

Substance	MDI (% of TDI)		Process Contribution (% of TDI)		Overall (% of TDI)	
	Inhalation	Ingestion	Inhalation	Ingestion	Inhalation	Ingestion
<b>Adult</b>						
Cadmium	20.41%	53.17%	6.36%	0.17%	26.77%	53.35%
Chromium	-	60.48%	-	0.43%	-	60.91%
Methyl mercury	-	3.11%	-	0.07%	-	3.18%
Mercuric chloride	-	0.71%	-	0.26%	-	0.97%
Nickel	14.29%	15.48%	3.26%	0.08%	17.55%	15.56%
Dioxins and dioxin like PCBs	35.00%		1.59%		36.59%	
<b>Child</b>						
Cadmium	52.86%	137.72%	8.01%	0.41%	60.87%	138.13%
Chromium	-	156.63%	-	0.70%	-	157.33%
Methyl mercury	-	8.04%	-	0.15%	-	8.19%
Mercuric chloride	-	1.85%	-	0.43%	-	2.28%
Nickel	37.00%	40.08%	4.11%	0.12%	41.11%	40.20%
Dioxins and dioxin like PCBs	90.00%		2.19%		92.19%	

The TDI is an estimate of the amount of a contaminant, expressed on a bodyweight basis, which can be ingested daily over a lifetime without appreciable health risk. As shown for this worst-case receptor the overall impact (including the contribution from existing dietary intakes) is less than the TDI for methyl mercury, mercuric chloride, nickel and dioxins. Therefore there would not be an appreciable health risk based on the emission of these pollutants.

For a child receptor the cadmium and chromium MDI (that sourced from existing dietary intake) exceeds the TDI. However, the process contribution is exceptionally small and the exceedance is a reflection of the fact the MDI is over 100% of the TDI. On this basis it is not considered that the Facility would increase the health risks from cadmium or chromium for children significantly.

As noted in Section 3, the key determinant of cadmium's toxicity potential is its chronic accumulation in the kidney. The Environment Agency explains that chronic exposure to levels in excess of either the TDI might be associated with an increase in kidney disease in a proportion of those exposed, but (small) exceedances lasting for shorter periods are of less consequence. If we assess the lifetime exposure (i.e. a period being a child and an adult) the overall impact is well below the TDI. Therefore there would not be an appreciable health risk based on the emission of cadmium over a lifetime of an individual.

As shown in **Error! Reference source not found.** the concentrations of total chromium in emissions from Wilton 10 which processes a similar feedstock are typically 1.87% of the emission limit, this consists of some in the hexavalent form. Even using the worst case assumption that emissions of chromium are 11% of the group 3 IED limit, the process contribution is only 0.70% of the TDI for a child at the point of maximum impact. As explained in Section 3, almost all toxicological opinion is that chromium III compounds are of low oral toxicity and the WHO state that "in the form of trivalent compounds, chromium is an essential nutrient and is relatively non-toxic for man and other mammalian species".

As explained in Section 3, although the TDI is predicted to be exceeded, this is due to existing dietary intake. The WHO have reviewed the daily intake of chromium from foods and found that existing levels do not represent a toxicity problem, and state that "in the form of trivalent compounds, chromium is an essential nutrient and is relatively non-toxic for man and other mammalian species". The TDI is based on the USEPA's Reference Dose for chromium IV. Assessing the total dietary intake of chromium against this TDI is highly conservative. As the process contribution is small, the existing levels of chromium do not represent a toxicity problem, and the TDI is highly conservative there would not be an appreciable health risk based on the emission of cadmium over a lifetime of an individual.

The total accumulation of dioxins in an infant, considering the breast milk pathway and based on the adult receptor at the point of maximum impact feeding an infant, is 0.408 pg WHO-TEQ / kg-bw / day which is 20.41% of the TDI.

**Table 7.2: Impact Analysis – ID – Point of Maximum Impact – "Agricultural" Receptor**

Substance	Inhalation (% of ID)	Ingestion (% of ID)
<b>Adult</b>		
Arsenic	9.79%	0.79%
Benzene	3.81%	0.44%
Benzo[a]pyrene	1.53%	3.20%
Chromium (VI)	19.58%	-
<b>Child</b>		
Arsenic	12.34%	1.38%
Benzene	4.81%	1.04%
Benzo[a]pyrene	1.92%	4.63%
Chromium (VI)	24.67%	-

The ID is the level of exposure which is associated with a negligible risk to human health. As shown for this worst-case receptor the process contribution is well below the ID. Therefore, emissions from the Facility are considered to have a negligible impact on human health.

## 7.2 Maximum impact at a receptor

The following tables outline the impact of emissions from the Facility at the most affected receptor (i.e the receptor with the greatest impact from ingestion and inhalation of emissions) (HH25 – Grange Farm). Where appropriate a comparison has been made to the TDI or ID.

**Table 7.3: Impact Analysis – TDI –Maximum Impacted Receptor**

Substance	MDI (% of TDI)		Process Contribution (% of TDI)		Overall (% of TDI)	
	Inhalation	Ingestion	Inhalation	Ingestion	Inhalation	Ingestion
<b>Adult</b>						
Cadmium	20.41%	53.17%	0.44%	0.01%	20.85%	53.18%
Chromium	-	60.48%	-	0.02%	-	60.50%
Methyl mercury	-	3.11%	-	0.004%	-	3.11%
Mercuric chloride	-	0.71%	-	0.014%	-	0.73%
Nickel	14.29%	15.48%	0.23%	0.007%	14.51%	15.48%
Dioxins and dioxin like PCBs	35.00%		0.084%		35.08%	
<b>Child</b>						
Cadmium	52.86%	137.72%	0.56%	0.02%	53.41%	137.74%
Chromium	-	156.63%	-	0.04%	-	156.67%
Methyl mercury	-	8.04%	-	0.01%	-	8.05%
Mercuric chloride	-	1.85%	-	0.02%	-	1.87%
Nickel	37.00%	40.08%	0.29%	0.018%	37.29%	40.10%
Dioxins and dioxin like PCBs	90.00%		0.116%		90.12%	

As shown, the overall impact (including the contribution from existing dietary intakes) for the most impacted receptor is less than the TDI for methyl mercury, mercuric chloride, nickel and dioxins. Therefore there would not be an appreciable health risk based on the emission of these pollutants.

For a child receptor, the cadmium and chromium MDI (that sourced from existing dietary intake) exceeds the TDI. However, the process contribution is exceptionally small and the exceedance is a reflection of the fact the MDI is over 100% of the TDI. On this basis it is not considered that the Facility would increase the health risks from cadmium or chromium for children significantly.

The total accumulation of dioxins in an infant, considering the breast milk pathway and based on the most impacted receptor R23 –feeding an infant, is 0.022 pg WHO-TEQ / kg bw / day which is 1.08% of the TDI.

Table 7.4: Impact Analysis – ID – Maximum Impacted Receptor

Substance	Inhalation (% of ID)	Ingestion (% of ID)
<b>Adult</b>		
Arsenic	0.68%	0.04%
Benzene	0.26%	0.033%
Benzo[a]pyrene	0.11%	0.170%
Chromium (VI)	1.36%	-
<b>Child</b>		
Arsenic	0.86%	0.07%
Benzene	0.33%	0.058%
Benzo[a]pyrene	0.13%	0.245%
Chromium (VI)	1.71%	-

As shown for this worst-case receptor the process contribution is well below the ID. Therefore, emissions from the Facility are considered to have a negligible impact on human health.

### 7.3 Uncertainty and sensitivity analysis

To account for uncertainty in the modelling the impact on human health was assessed for a receptor at the point of maximum impact.

To account for uncertainty in the dietary intake of a person, both residential and agricultural receptors have been assessed. The agricultural receptor is assumed to consume a greater proportion of home grown produce, which has the potential to be contaminated by the COPCs released, than for a residential receptor. In addition, the Agricultural receptor includes the pathway from consuming animals grazed on land contaminated by the emission source. This assumes that 100% of the plant materials eaten by the animals is grown on soil contaminated by emission sources.

The agricultural receptor at the point of maximum impact is considered the upper maximum of the impact of the Facility.

### 7.4 Upset process conditions

Article 46(6) of the IED (Directive 2010/75/EU) states that:

*"... the waste incineration plant ... shall under no circumstances continue to incinerate waste for a period of more than 4 hours uninterrupted where emission limit values are exceeded.*

*The cumulative duration or operation in such conditions over 1 year shall not exceed 60 hours."*

Article 47 continues with:

*"In the case of a breakdown, the operator shall reduce or close down operations as soon as practicable until normal operations can be restored."*

In addition Annex VI, Part 3, 2 of the IED states the emission limit values applicable in the circumstances described in Article 46(6) and Article 47:

*"The total dust concentration in the emissions into the air of a waste incineration plant shall under no circumstances exceed 150 mg/Nm<sup>3</sup> expressed as a half-hourly average. The air emission limit values for TOC and CO set out in points 1.2 and 1.5(b) shall not be exceeded."*

The conditions detailed in Article 46(6) are considered to be "Upset Operating Conditions". As identified these periods are short term events which can only occur for a maximum of 60 hours per year.

Start-up of the Facility from cold will be conducted with clean support fuel (low sulphur light fuel oil). During start-up waste will not be introduced onto the grate unless the temperature within the oxidation zone is above the 850°C as required by Article 50, paragraph 4(a) of the IED. During start-up, the flue gas treatment plant will be operational as will be the combustion control systems and emissions monitoring equipment.

The same is true during plant shutdown where waste will cease to be introduced to the grate. The waste remaining on the grate will be combusted, the temperature not being permitted to drop below 850°C through the combustion of clean support auxiliary fuel. During this period the flue gas treatment equipment is fully operational, as will be the control systems and monitoring equipment. After complete combustion of the waste, the auxiliary burners will be turned off and the plant will be allowed to cool.

Start-up and shutdown are infrequent events. The facility is designed to operate continuously, and ideally only shutdown for its annual maintenance programme.

In relation to the magnitude of dioxin emissions during plant start-up and shutdown, research has been undertaken by AEA Technology on behalf of the Environment Agency<sup>7</sup>. Whilst elevated emissions of dioxins (within one order of magnitude) were found during shutdown and start-up phases where the waste was not fully established in the combustion chamber, the report concluded that:

*"The mass of dioxin emitted during start-up and shutdown for a 4-5 day planned outage was similar to the emission which would have occurred during normal operation in the same period. The emission during the shutdown and restart is equivalent to less than 1 % of the estimated annual emission (if operating normally all year)."*

There is therefore no reason why such start-up and shutdown operations or upset operating conditions will affect the long term impact of the facility.

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<sup>7</sup> AEA Technology (2012) Review of research into health effects of Energy from Waste facilities.

## 8 CONCLUSIONS

Of all the pollutants considered with a Tolerable Daily Intake (TDI), cadmium is the pollutant that results in the highest level of existing exposure (MDI). The combined impact of cadmium from existing background sources and contributions from the proposed Facility at the point of maximum impact is 138.13% of the ingestion TDI for children. However, the process contribution from the Facility for cadmium is exceptionally small, being only 0.41% of the TDI at the point of maximum impact, and 0.02% or less at receptors. Similarly, the ingestion of chromium from existing background sources and contributions from the proposed Facility also exceeds the ingestion TDI for children. However, the process contribution from the proposed Facility for chromium is again exceptionally small, being only 0.70% of the TDI at the point of maximum impact, and 0.04% or less at receptors.

The TDI is set at a level "that can be ingested daily over a lifetime without appreciable health risk". The ingestion of cadmium and chromium by children as a result of background sources is already above the TDI. On the basis that the process contribution of these substances is exceptionally small it is not considered that the Facility would increase the health risks from this pollutant significantly. For all other pollutants, the combined impact from the Facility plus the existing MDI is below the TDI, so there would not be an appreciable health risk based on the emission of these pollutants.

Although the MDI exceeds the cadmium TDI for children, the Environment Agency explains that chronic exposure to levels in excess of either the TDI might be associated with an increase in kidney disease in a proportion of those exposed, but (small) exceedances lasting for shorter periods are of less consequence. Therefore, assessing a lifetime exposure is appropriate. If we assess the exposure over the lifetime (i.e. a period as a child and adult) the overall impact is well below the TDI, so there would not be an appreciable health risk based on the emission of cadmium.

Again the TDI for chromium for children is predicted to be exceeded due to existing dietary intake. Toxicological opinion is that chromium III is of low oral toxicity and is needed as part of a health diet. The UK Committee on Medical Aspects of Food Policy recommend a minimum safe and adequate intake, but do not restrict an upper limit. The WHO have analysed human intake for chromium through food and conclude that existing levels do not represent a toxicity problem. The TDI is based on the USEPA's Reference Dose for chromium IV. Assessing the total dietary intake of chromium against this TDI is highly conservative. Therefore it is concluded that as the process contribution is so small and the TDI is set at a highly conservative level there would not be an appreciable health risk based on the emission of chromium.

For pollutants which do not have a TDI, a comparison has been made against an Index Dose (ID). The ID is a threshold below which there are considered to be negligible risks to human health. The greatest contribution from the Facility is from chromium (VI), which is only 24.67% of the Index Dose for children at the point of maximum impact. Therefore, emissions from the Facility of chromium (VI) and all other pollutants are considered to have a negligible impact on human health.

In conclusion, the Facility will not result in appreciable health risks resulting from its operation.

Appendix A - Detailed Results Tables

Table A.1: Comparison with ID Limits for Adult Receptors

Receptor	Ingestion (% of ID)			Inhalation (% of ID)			
	Arsenic	Benzene	Benzo(a)pyrene	Arsenic	Benzene	Benzo(a)pyrene	Chromium (VI)
Point of maximum impact - Agricultural	0.790%	0.444%	3.203%	9.791%	3.815%	1.526%	19.582%
Point of maximum impact - Residential	0.293%	0.471%	0.032%	9.791%	3.815%	1.526%	19.582%
R1	0.003%	0.005%	0.000%	0.094%	0.037%	0.015%	0.189%
R2	0.007%	0.012%	0.001%	0.243%	0.095%	0.038%	0.485%
R3	0.020%	0.033%	0.002%	0.680%	0.265%	0.106%	1.359%
R4	0.008%	0.012%	0.001%	0.257%	0.100%	0.040%	0.513%
R5	0.006%	0.009%	0.001%	0.197%	0.077%	0.031%	0.393%
R7	0.007%	0.011%	0.001%	0.220%	0.086%	0.034%	0.440%
R11	0.007%	0.011%	0.001%	0.219%	0.085%	0.034%	0.438%
R12	0.006%	0.009%	0.001%	0.193%	0.075%	0.030%	0.386%
R18	0.007%	0.011%	0.001%	0.225%	0.088%	0.035%	0.450%
R23	0.042%	0.024%	0.170%	0.518%	0.202%	0.081%	1.037%

Table A.2: Comparison with ID Limits for Child Receptors

Receptor	Ingestion (% of ID)			Inhalation (% of ID)			
	Arsenic	Benzene	Benzo(a)pyrene	Arsenic	Benzene	Benzo(a)pyrene	Chromium (VI)
Point of maximum impact - Agricultural	1.382%	1.043%	4.630%	12.336%	4.807%	1.923%	24.673%
Point of maximum impact - Residential	0.705%	0.836%	0.086%	12.336%	4.807%	1.923%	24.673%
R1	0.007%	0.008%	0.001%	0.119%	0.046%	0.019%	0.238%
R2	0.017%	0.021%	0.002%	0.306%	0.119%	0.048%	0.612%
R3	0.049%	0.058%	0.006%	0.856%	0.334%	0.133%	1.713%
R4	0.018%	0.022%	0.002%	0.323%	0.126%	0.050%	0.647%
R5	0.014%	0.017%	0.002%	0.248%	0.097%	0.039%	0.495%
R7	0.016%	0.019%	0.002%	0.277%	0.108%	0.043%	0.555%
R11	0.016%	0.019%	0.002%	0.276%	0.108%	0.043%	0.552%
R12	0.014%	0.016%	0.002%	0.243%	0.095%	0.038%	0.486%
R18	0.016%	0.019%	0.002%	0.283%	0.110%	0.044%	0.567%
R23	0.073%	0.055%	0.245%	0.653%	0.254%	0.102%	1.306%

Table A.3: Comparison with TDI Limits for Adult Receptors

Receptor	Ingestion (% of ID)					Inhalation (% of ID)	
	Cadmium	Chromium	Methyl Mercury	Mercuric Chloride	Nickel	Cadmium	Nickel
<b>MDI of TDI (%)</b>	<b>53.17%</b>	<b>60.48%</b>	<b>3.11%</b>	<b>0.71%</b>	<b>15.48%</b>	<b>20.41%</b>	<b>14.29%</b>
Point of maximum impact - Agricultural	53.349%	60.908%	3.177%	0.972%	15.555%	26.766%	17.549%
Point of maximum impact - Residential	53.287%	60.511%	3.134%	0.749%	15.483%	26.766%	17.549%
R1	53.176%	60.477%	3.106%	0.715%	15.476%	20.469%	14.317%
R2	53.177%	60.477%	3.106%	0.715%	15.476%	20.566%	14.367%
R3	53.182%	60.479%	3.108%	0.717%	15.477%	20.850%	14.512%
R4	53.178%	60.477%	3.106%	0.715%	15.476%	20.575%	14.371%
R5	53.177%	60.477%	3.106%	0.715%	15.476%	20.536%	14.351%
R7	53.177%	60.477%	3.106%	0.715%	15.476%	20.551%	14.359%
R11	53.177%	60.477%	3.106%	0.715%	15.476%	20.550%	14.359%
R12	53.177%	60.477%	3.106%	0.715%	15.476%	20.533%	14.350%
R18	53.177%	60.477%	3.106%	0.715%	15.476%	20.554%	14.361%
R23	53.184%	60.499%	3.109%	0.728%	15.480%	20.745%	14.459%

Table A.4: Comparison with TDI Limits for Child Receptors

Receptor	Ingestion (% of ID)					Inhalation (% of ID)	
	Cadmium	Chromium	Methyl Mercury	Mercuric Chloride	Nickel	Cadmium	Nickel
<b>MDI of TDI (%)</b>	<b>137.72%</b>	<b>156.63%</b>	<b>8.04%</b>	<b>1.85%</b>	<b>40.08%</b>	<b>52.86%</b>	<b>37.00%</b>
Point of maximum impact - Agricultural	138.129%	157.331%	8.192%	2.278%	40.204%	60.868%	41.112%
Point of maximum impact - Residential	137.992%	156.730%	8.122%	1.997%	40.101%	60.868%	41.112%
R1	137.725%	156.634%	8.044%	1.851%	40.084%	52.934%	37.040%
R2	137.729%	156.636%	8.045%	1.854%	40.084%	53.056%	37.102%
R3	137.741%	156.640%	8.049%	1.860%	40.085%	53.413%	37.285%
R4	137.729%	156.636%	8.046%	1.854%	40.084%	53.067%	37.108%
R5	137.728%	156.635%	8.045%	1.853%	40.084%	53.018%	37.083%
R7	137.728%	156.636%	8.045%	1.853%	40.084%	53.037%	37.092%
R11	137.728%	156.635%	8.045%	1.853%	40.084%	53.036%	37.092%
R12	137.728%	156.635%	8.045%	1.853%	40.084%	53.015%	37.081%
R18	137.728%	156.636%	8.045%	1.853%	40.084%	53.041%	37.094%
R23	137.744%	156.670%	8.051%	1.873%	40.090%	53.281%	37.218%

Table A.5: Comparison with Total Dioxin TDI Limits for Adult Receptors

Receptor	Total Inhalation, (pg WHO-TEQ kg <sup>-1</sup> bw day <sup>-1</sup> )	Total Ingestion, (pg WHO-TEQ kg <sup>-1</sup> bw day <sup>-1</sup> )	Total uptake, (pg WHO-TEQ kg <sup>-1</sup> bw day <sup>-1</sup> )	Comparison (% of limit)
<b>MDI (% of TDI)</b>				<b>35.00%</b>
Point of maximum impact - Agricultural	1.13E-04	3.16E-02	3.17E-02	36.59%
Point of maximum impact - Residential	1.13E-04	6.28E-04	7.41E-04	35.04%
R1	1.09E-06	6.06E-06	7.14E-06	35.00%
R2	2.79E-06	1.56E-05	1.84E-05	35.00%
R3	7.82E-06	4.36E-05	5.14E-05	35.00%
R4	2.95E-06	1.65E-05	1.94E-05	35.00%
R5	2.26E-06	1.26E-05	1.49E-05	35.00%
R7	2.53E-06	1.41E-05	1.67E-05	35.00%
R11	2.52E-06	1.41E-05	1.66E-05	35.00%
R12	2.22E-06	1.24E-05	1.46E-05	35.00%
R18	2.59E-06	1.44E-05	1.70E-05	35.00%
R23	5.96E-06	1.67E-03	1.68E-03	35.08%

Table A.6: Comparison with Total Dioxin TDI Limits for Adult Receptors

Receptor	Total Inhalation, (pg WHO-TEQ kg <sup>-1</sup> bw day <sup>-1</sup> )	Total Ingestion, (pg WHO-TEQ kg <sup>-1</sup> bw day <sup>-1</sup> )	Total uptake, (pg WHO-TEQ kg <sup>-1</sup> bw day <sup>-1</sup> )	Comparison (% of limit)
<b>MDI (% of TDI)</b>				<b>90.00%</b>
Point of maximum impact - Agricultural	1.42E-04	4.36E-02	4.37E-02	92.19%
Point of maximum impact - Residential	1.42E-04	2.00E-03	2.14E-03	90.11%
R1	1.37E-06	1.93E-05	2.07E-05	90.00%
R2	3.52E-06	4.96E-05	5.31E-05	90.00%
R3	9.85E-06	1.39E-04	1.49E-04	90.01%
R4	3.72E-06	5.24E-05	5.62E-05	90.00%
R5	2.85E-06	4.02E-05	4.30E-05	90.00%
R7	3.19E-06	4.50E-05	4.81E-05	90.00%
R11	3.18E-06	4.48E-05	4.79E-05	90.00%
R12	2.80E-06	3.94E-05	4.22E-05	90.00%
R18	3.26E-06	4.59E-05	4.92E-05	90.00%
R23	7.51E-06	2.31E-03	2.32E-03	90.12%

Table A.7: Basis for the Emission Rate of Dioxins and Furans

Compound	WHO-TEF Multiplier <sup>8</sup>
HeptaCDD, 1,2,3,4,6,7,8-	0.0031
HeptaCDF, 1,2,3,4,6,7,8-	0.0245
HeptaCDF, 1,2,3,4,7,8,9-	0.0287
HexaCDD, 1,2,3,4,7,8-	0.0258
HexaCDD, 1,2,3,6,7,8-	0.0205
HexaCDD, 1,2,3,7,8,9-	0.1704
HexaCDF, 1,2,3,4,7,8-	0.4042
HexaCDF, 1,2,3,6,7,8-	0.0277
HexaCDF, 1,2,3,7,8,9-	0.0277
HexaCDF, 2,3,4,6,7,8-	0.0535
OctaCDD, 1,2,3,4,6,7,8,9-	0.2179
PentaCDD, 1,2,3,7,8-	0.0807
PentaCDF, 1,2,3,7,8-	0.0042
PentaCDF, 2,3,4,7,8-	0.0871
TetraCDD, 2,3,7,8-	0.4395
TetraCDF, 2,3,7,8-	0.0429

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<sup>8</sup> Van den Berg et al, 2006



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