4. PLANNING AND POLICY CONTEXT

4.1 INTRODUCTION

This section intends to outline how the proposed amendments in this application do not impact on the planning and policy context of the waste-to-energy facility at Carranstown, Co. Meath. In addition, recent policy developments have confirmed the need for waste-to-energy facilities as part of an integrated waste management system and as an alternative to landfill.

4.2 ASSESSMENT OF PLANNING AND POLICY CONTEXT

Based on the amendments to the existing permission outlined in Section 1.1 of this document, it can be seen there are no material changes to the existing permission and that the type of waste, maximum annual throughput and traffic volumes associated with the plant are unchanged. As outlined in Section 2.5 the principle has been established in the existing permission that the site is suitable for a development of this nature and scale. It has also been accepted by both Meath County Council and An Bord Pleanala (ABP) through the granting of final planning permission in October 2007, that the facility fits with both European and National Policy, including the Waste Plan for the North East Region, and that there is a need for the scheme in the context of these policies. There is nothing within this application which interferes with the rationale for the decisions of both Meath Co Co and ABP from a Planning and Policy context.

However, in order to demonstrate that the facility is still relevant, based on any changes in a policy context since the granting of final permission in 2007, the following sets out the key policies which are relevant and identifies the changes and potential impacts on the facility.

The key European, National and Regional policies relevant to Waste management are summarised below. Any modifications or additions to these policies that have been made since the 2006 application was lodged or planning permission PL17.219721 was granted in October 2007 have been highlighted in column 2 in the following tables.

EU Directives and Planning/Policy Guidance

Policy / Directive	**New/Updated?**	**Description**	**Impact on Facility**
The Sixth Environmental Action Programme *'Environment 2010: Our Future, Our Choice'* and Thematic Strategy on the Prevention and Recycling of Waste	NO	Sets out the basic objectives of EU waste policy which are to minimize the negative effects of the generation and management of waste on human health and the environment, and become a recycling society that seeks to avoid waste or to use waste as a resource.	No changes
Waste Framework Directive 75/442/EEC (revised by Directive 91/156/EEC & 91/689/EEC)	UPDATED	Directive 2008/98/EC on waste, which strengthens the waste hierarchy, facilitates life cycle thinking and sets mandatory recycling targets.	Under this updated Directive, the facility is likely to be classified as a recovery activity.
EU Directive 1999/31/EC – Landfill of Waste	NO	This Directive on the diversion of biodegradeable municipal solid waste from landfill was in place when the 2006 application was lodged.	No changes.
EU Directive 2000/76/EC – Incineration of Waste	NO	This Directive on the control of Waste Incineration was in place when the 2006 application was lodged.	No changes.
EU Directive 2001/77/EC – Renewable Energy	UPDATED	Directive 2009/28/EC on the promotion of the use of energy from renewable sources, which sets mandatory renewable energy targets and requires national action plans to be developed.	The facility will contribute to renewable energy targets as part of Ireland's bioenergy action plan.
Kyoto Protocol To The United Nations Framework Convention On Climate Change (1997)	NO	EU Climate and Energy Package, which includes the Decision on the effort of Member States to reduce their emissions, fixing mandatory GHG reduction targets for the period 2013-2020.	No changes.
Strategic Infrastructure Act 2006	NEW	This Act allows for projects of Strategic National Importance to apply directly to An Bord Pleanala. Incinerators of 100,000 tonnes per annum and over are considered to qualify. Meath Co Co asked Indaver to make a submission to ABP in respect of this application.	Indaver made a submission to ABP on 23/06/2009 and ABP replied on 16/07/2009 that the application for the proposed amendments did not come under the scope of the Act (please refer to Appendix 4.1)
ECJ Decision C-215-06	NEW	European Court of Justice ruled that the EIA Directives require assessment of impacts on the environment before development is carried out and concluded that permission for retention of unauthorised development was inconsistent with this requirement	This development is entirely consistent with this ruling. The waste-to-energy facility has been the subject of detailed environmental impact assessment before planning permission was granted. Nothing has been or will be done in breach of this existing permission and planning law. By this application, Indaver requests permission for marginal changes. Importantly, this request has been made before those changes are carried out. If this application for permission is refused, then the project can only be completed in accordance with the existing permission and planning law.

National Policy Guidance

Policy / Directive	New/Updated?	Description	Impact on facility
Sustainable Development – A Strategy for Ireland (1997)	NO	Sets out strategic objectives to promote waste reduction, reuse and recycling, and higher environmental standards in waste disposal. It also promotes the application of the precautionary principle, the polluter pays principle and the adoption of an integrated approach involving environmental considerations throughout other policy initiatives.	No changes.
National Development Plan 2000 – 2006	UPDATED	National Development Plan (2007-2013), which places greater emphasis on the role of waste-to-energy as a preferred option for dealing with residual waste.	The facility will align with the NDP by providing the preferred treatment technology for residual waste.
National Climate Change Strategy Ireland (2000)	UPDATED	National Climate Change Strategy (2007-2012), which specifies that waste-to-energy plants help minimize the climate impacts of waste and contribute to the security of energy supply. It also prioritises energy recovery ahead of landfill.	The facility will align with the Strategy by providing a preferred waste treatment technology, will help to mitigate greenhouse gas emissions from waste.
Waste Management: Changing our Ways (1998)	NO	Introduced the waste hierarchy, and set national targets for landfill diversion and recycling. Suggests waste-to-energy could be a beneficial option that could contribute to renewable energy targets..	No changes.
Waste Management: Preventing and Recycling Waste Delivering Change (2001)	NO	This document is primarily focused on waste prevention and recycling, but also reinforces the position of thermal treatment as preferable to landfill and seeks the introduction of the levy as a means to increase diversion	No changes.
Waste Management: Taking Stock & Moving Forward (2004)	NO	Assesses progress made on waste plans and confirms that waste-to-energy has a role to play as one element of an integrated waste management system.	No changes.
National Strategy for Biodegradable Waste Draft Report (2004)	UPDATED	National Strategy for Biodegradable Waste (2006), which seeks to maximise the recovery of useful materials and energy from residual waste, and suggests thermal treatment with energy recovery as the preferred option. It recognises that waste-to-energy is a *"key element of Irish waste management policy."*	The facility will provide the preferred treatment technology for residual waste and will contribute to biodegradable waste diversion goals.
Policy Guidance Circular WIR: 04/05	NO	Ministerial Order under Section 60 of the Waste Management Act 1996 on action against illegal waste activity and the movement of waste -	No changes.
Bioenergy Action Plan for Ireland (2007)	NEW	New policy that reinforces the importance of energy recovery over the landfill of residues, and introduces financial support for the renewable portion of energy from waste-to-energy plants, to *"assist in the development of waste-to-energy projects"*.	The facility will provide the preferred treatment technology for residual waste and will qualify for financial supports for any renewable energy generated.
Municipal Solid Waste – Pre-treatment & Residuals Management: An EPA Technical Guidance Document (2009)	NEW	New guidance that sets out pre-treatment requirements for landfill and waste-to-energy plants.	The facility will help landfills to meet the pre-treatment requirements. It will accept residual waste that has been pre-treated in line with the guidance. This will also be a condition of Indaver's waste licence from the EPA.
Policy Guidance Circular 09/07 on the Direction of Waste	NEW	This Ministerial Order under Section 60 of the Waste Management Act 1996 sought to prevent Local Authorities from entering into long term contracts with waste-to-energy plants and to prevent the direction of waste to a waste-to-energy plant or landfill.	The facility is a merchant plant and hence has to rely on the open market for its waste. Indaver will therefore not be relying on long term contracts with local authorities for waste for the economic success of the project.

Regional & Local Policy Guidance

Policy / Directive	New/Updated?	Description	Impact on facility
Waste Management Plan for North East Region (1999)	UPDATED	North East Region Waste Management Plan 2005-2010, which confirms the need for a thermal treatment plant with a capacity of 150,000 – 200,000 tonnes per annum.	The facility's capacity aligns with the needs of the Region's Plan, demonstrating the need for the scheme as discussed in Section 2.
Proposed Replacement North East Region Waste Management Plan 2005-2010	FINALISED		
Meath County Development Plan (2001)	UPDATED	County Meath Development Plan (2007-2013) which includes the policy goals of implementing the hierarchy and the Regional Waste Management Plan, taking into account the proximity principle, the inter regional movement of waste and the need for quality, cost effective waste infrastructure and services that align with the polluter pays principle. There are no changes to zoning of the site.	The facility will ensure waste is treated higher in the hierarchy than landfill, and will primarily serve the North East region in line with the proximity principle. It will be a quality, cost effective infrastructure development that aligns with the polluter pays principle.

As shown, any new policy directions have strengthened the position of waste-to-energy as a residual waste management option. In particular, the revised Waste Framework Directive has confirmed the position of waste-to-energy as a recovery option higher in the hierarchy than landfill disposal. Recent policy developments in Ireland including the Bioenergy Action Plan and the Pre-Treatment Guidance Note also support the development of waste-to-energy.

It is acknowledged that Irish waste policy is currently under review. The review is intended to address how best to implement waste prevention and minimisation and the emergence of new technologies in waste management. In parallel with this review, a number of policy instruments have also been proposed including a waste facilities levy a cap on waste-to-energy capacity and policies around the direction of waste.

If a waste facilities levy were pursued, it seems likely that all residual waste treatment options would be included with the highest levy being applied to landfill. Such a levy, if applied to waste-to-energy, would be passed onto the consumer in line with the polluter pays principle and would not otherwise impact on the need for, or policy context of, the facility. Likewise, a cap would not impact on the need for, or the policy context of, the facility. This is because the Meath project will be one of the first facilities to be developed in Ireland and would fall within the 30% capacity cap on MSW. The proposed policy direction on a capacity cap for waste-to-energy also sought to prevent Local Authorities from attaching conditions in waste collection permits that would direct that waste be taken to a landfill or incinerator. As noted above in relation to Circular WIR 09/07, the Meath facility will be a merchant plant and will be designed to accept residual waste that has already been subject to pre-treatment. This direction would therefore not impact on the facility. Finally, preliminary recommendations from the international policy review study do not suggest any significant departure from existing policy other than, possibly, more ambitious reduction and recycling targets as well as the two policy instruments already described.

For these reasons, the proposed policy changes would not impact on the need for or the policy context of the Meath waste-to-energy plant.

Appendix 4.1

An Bord Pleanala Letter July 2009

Our Ref: 17.PC0083

Your Ref:

An Bord Pleanála

Conor Jones
Indaver Ireland,
4 Haddington Terrace,
Dún Laoghaire,
Co. Dublin.

16th July 2009

Re: Proposed amendments to existing planning permission for a waste to energy facility at Carranstown, Duleek, Co. Meath

Dear Sir,

Please be advised that following consideration of the issues raised at the above consultation and having regard to the scale and nature of the proposed development, An Bord Pleanála has concluded that the proposed development does not come within the scope of section 37A(2)(a), (b) or (c) of the Planning and Development Act, 2000, as amended. Accordingly any application for planning consent for the proposed development should be made to the local planning authority for the area in accordance with the provisions of section 34 of the Planning and Development Act, 2000, as amended.

Yours faithfully,

Kieran Somers

Kieran Somers
Executive Officer

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Baile Átha Cliath 1.

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64 Marlborough Street,
Dublin 1.

5 DESCRIPTION OF THE PROPOSED AMENDMENTS

5.1 CHARACTERISTICS OF THE APPLICATION

Indaver Ireland intends to apply for amendments to the existing permission (ref. SA/60050 & PL 17.219721) for a 70 MW waste-to-energy plant for the acceptance of Non Hazardous Waste on lands in the townland of Carranstown, approximately 2.5 km north east of Duleek in Co. Meath (Figure 5.1). Planning permission was received from Meath Co Co in August 2006 and An Bord Pleanala gave a final decision on the subsequent appeal in October 2007.

The proposed amendments are to facilitate the final detailed design of the main process building but do not materially alter the main tenets of the existing permission. Details of the proposed amendments are outlined in Section 5.1.2 below.

5.1.1 Description of Site Layout

The 10ha site is located at Carranstown, Duleek, Co. Meath off the R152 regional road. The site is bounded to the north, west and east by agricultural land and to the south by the R152 road.

The site is located approximately 2.5 km north east of Duleek and approximately 3km south west of Drogheda. There are approximately 55 houses within 1km of the site boundary (Figure 5.1).

Existing developments within the vicinity of the site include a cement factory and quarry located to the north of the property. A commercial freight railway is located approximately 60 metres north of the site boundary. This line is used for the transport of freight for Tara Mines, Navan and the Platin cement factory.

A 110kV power line traverses the site however; there will be no requirement for line diversion as a result of the proposed amendments.

A natural gas pipeline runs directly under the development site. There is also a low pressure gas main running along the R152. There will be no requirement for diversion of the gas main as a result of the proposed amendments either.

The area of the site for development is approximately 2 hectares (5 acres), with the remaining areas of the site to be utilised for landscaping and particular emphasis on the boundary screen planting to minimise the visual impact of the facility.

5.1.2 Description of Design, Size and Scale

As described previously, the proposed amendments to the application now being submitted are for the same development, on the same site, but on a slightly reduced building footprint. No changes are proposed to the annual tonnage throughput which remains at a maximum of 200,000 tonnes per annum. The proposed amendments will reduce the overall length of the building by 45 metres and decrease the overall visual impact.

Other improvements proposed are the incorporation of the turbine building and the education centre/workshop into the main process building, further reducing the space required on site for the development. For increased safety of visitors to the plant, it is also proposed that the location of the security building is changed to avoid visitors crossing the path of waste trucks entering and leaving the facility. It is also proposed to build a bottom ash storage and handling building instead of an underground ash bunker to facilitate further metal extraction from the ash in the future.

The permitted general site layout and the proposed layout are illustrated on Figures 5.2 & 5.3 below and a comparison between both can also be seen on PMG-MEATH-ARC-DWG-000-1703 attached to the planning package.

The proposed amendments can be summarised as follows;

- Amendments to main process building dimensions, including reduction in building length of 45m
- Incorporation of warehouse, workshop and education centre into main process building
- Incorporation of Turbine building into main process building
- Re-location & re-design of Air Cooled Condenser building,
- Re-location & re-design of gatehouse, associated weighbridges & car parking area
- Addition of a bottom ash storage and handling building and removal of bottom ash bunker
- Addition of aqueous ammonia storage tank
- Re-design and relocation of ESB substation and associated transformer compound
- Re-location & re-design of pump house and process water storage tank
- Re-location of light fuel storage area
- Changes to internal road network to incorporate the above amendments.

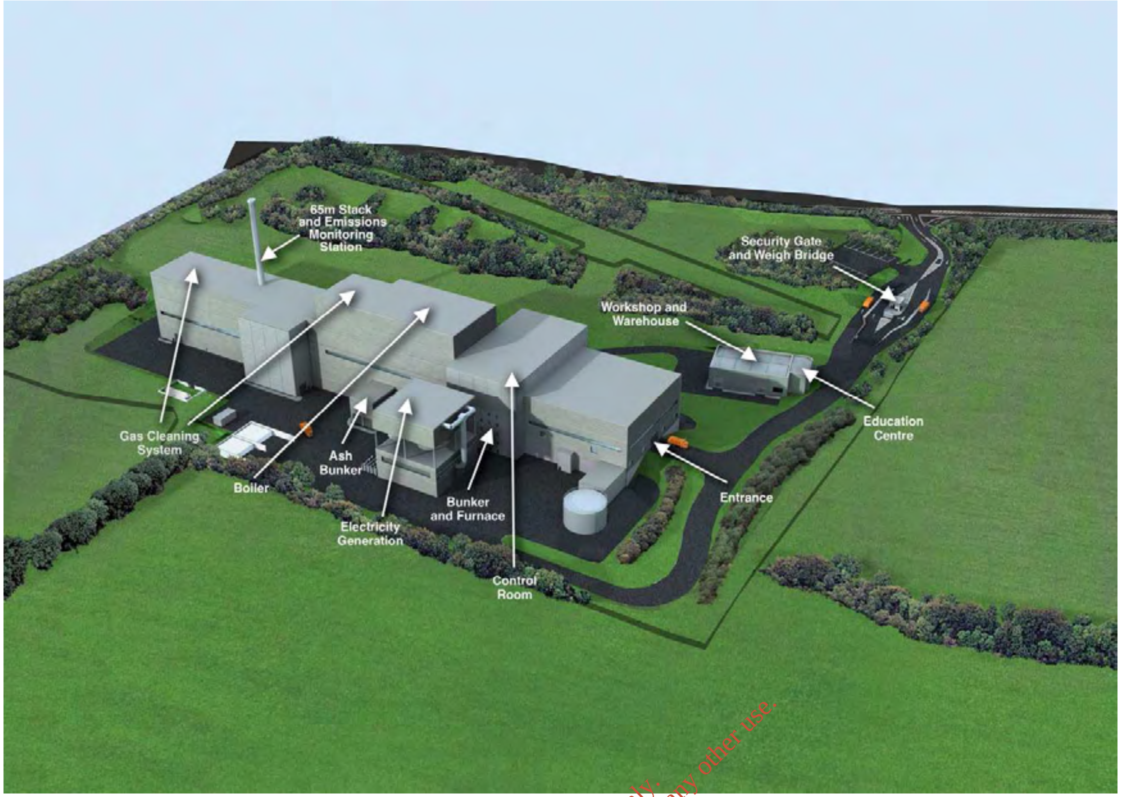


Figure 5.2 Existing Permitted Site Layout

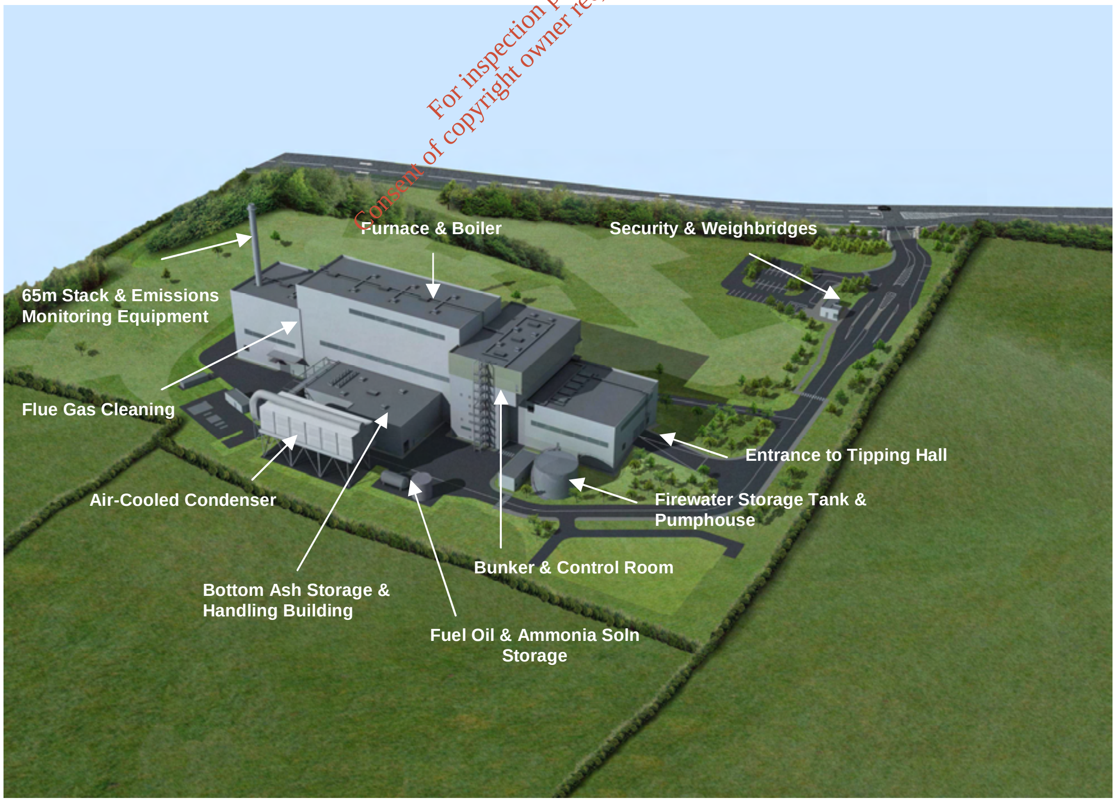


Figure 5.3 Proposed Site Layout

The above changes have been described in Section 1.1 of this document. Where relevant in this section, a description of these changes is also provided. The location and design of individual buildings as amended by this application are presented in the engineering drawings attached to the planning package.

5.1.3 Description of Existing Development

In September 2008, Indaver began construction at the site with an enabling works contract. The purpose of this contract was to prepare the site for the main construction activities and included the following;

- Site clearance and topsoil strip including formation of berms for landscaping
- Establish perimeter fencing
- Construct new site entrance including widening of R152
- Bring temporary power and drinking water to the site
- Provide car parking spaces for construction workers
- Provision of a contractors compound area (or “construction village”)
- Construct public footpath and lighting along R152

At the time of compilation of this EIS, a second contract had started for the excavation and construction of the bunker and building foundations. It should be noted that all such development is being carried out in compliance with the existing permission. Aerial photographs of the development of the site from February 2009 can be seen in Figures 5.4 & 5.5 below.

Figure 5.4 Existing Site Entrance with car park and security hut

Figure 5.5 Overview of site development

5.2 NEED FOR THE SCHEME

Under the EPA Advice Notes on Current Practice in the Preparation of Environmental Impact Statements the description of the existence of the projects defines all aspects of the proposed lifecycle of the facility under the following headings:

- Construction;
- Commissioning;
- Operation;
- Decommissioning; and
- Description of Other Developments.

5.2.1 Description of Construction

Description of construction is dealt with under Section 18.

5.2.2 Description of Commissioning

The proposed amendments will have no impact on the commissioning activities. The commissioning of the waste-to-energy facility will begin approximately 12 weeks prior to start up operations. The commissioning activity will involve a number of work groups certifying the various components of the facility. For the final eight weeks of commissioning approximately Indaver Ireland's operating team will join the commissioning crew and from this point continual shift works will begin (i.e. 24hrs/day; 7days/week).

5.2.3 Operation of the Project

The following sections detail the operation of the project in so far as they differ from the original application in 2006.

5.3 DESCRIPTION OF PRINCIPLE PROCESS OR ACTIVITIES

The proposed amendments do not propose to change the conventional grate incineration technology identified in the 2006 EIS. This technology is proven and reliable and has been widely used in many countries worldwide.

The plant capacity also remains unchanged at a maximum of 200,000 tonnes per annum and will consist of a 70MW furnace and a state-of-the-art flue gas cleaning system. The flue gas cleaning system has been altered slightly to reflect recent developments in technology and a greater focus on energy efficiency and recovery.

The changes to the flue gas cleaning system can be summarised as follows;

- Replacement of the wet flue gas cleaning with a dry lime injection stage prior to the baghouse filter
- Re-circulation of a portion of flue gas cleaning residues to decrease raw materials (lime) usage
- Second stage dioxin removal is now by expanded clay injection system prior to the spray reactor rather than in the wet scrubber.

This configuration will ensure that the emission limits set in the Waste Incineration Directive will be easily met. The advantages and dis-advantages of the above changes have been discussed in Sections 3.1.4 and 3.1.5. All of these techniques are considered to be BAT and these changes have increased the energy efficiency of the process due to;

- No plume re-heating required as the wet stage has been removed
- More energy recovery in the boiler as scrubbing liquid no longer needs to be evaporated in the spray reactor.

The proposed amendments do not alter the fact that the facility will have no process effluent. All process water used for flue gas cleaning will be evaporated, leaving only solid residues and thereby eliminating any process effluent from the facility.

A schematic representation of the waste incineration process and amended flue gas cleaning system is shown in Figure 5.6. A review of the existing waste licence (Ref: W0167-01) has been applied for to the Environmental Protection Agency, which has identified this configuration of the flue gas cleaning process. This is discussed in Section 5.14.1 below.

5.4 SCOPE OF THE PROJECT

The scope of the project remains unchanged from the previous application in 2006. The annual maximum capacity and operating ranges of the moving grate furnace are un-affected by the proposed amendments in this application. The maximum capacity of the plant is 200,000 tonnes of waste per annum.

The facility can operate at 60 - 100% of its capacity at a range of calorific values. The maximum operating capacity of 200,000 tonnes per annum is based on an average calorific value of the waste of 9.35 MJ/kg. This maximum capacity is in line with current NE Waste Management Plan. If the calorific value of the waste is lower than 9.35 MJ/kg then the capacity will still be limited to 200,000 tonnes per annum. If the calorific value of the waste is higher than 9.35MJ/kh then the annual throughput will be lower than 200,000 tonnes per annum.

5.5 GENERAL OPERATION

The proposed amendments will also not affect the hours of waste acceptance between 0800 and 1830 Monday to Friday and between 0800 and 1400 on Saturdays. Waste will only be accepted during these hours but the waste-to-energy plant will operate 24 hours a day for, on average, 7,500 hours/annum. The capacity of the waste bunker will allow the acceptance of waste during shut downs up to 1 week. Scheduled shutdowns will be unchanged by the proposed amendments and will happen once per year and last between 1 week and 3 weeks.

The types of waste to be burned at the plant are also unchanged by the proposed amendments and non hazardous household, commercial, industrial and other suitable waste will be accepted. In doing so it will produce energy in the form of electricity, of which, that produced from the biodegradable waste fraction of the waste will be renewable energy, thereby contributing to a reduction in the consumption of fossil fuels. The types and quantities of waste produced also remain unchanged by the proposed amendments. Bottom ash will be produced, much of which may be suitable for use as fill for road construction or for daily cover of landfill sites. A small quantity of hazardous waste will be produced, primarily as a result of the flue gas cleaning process (see Section 5.12.1 below). This will be disposed of to hazardous waste landfill, either in Ireland if one is available or abroad.

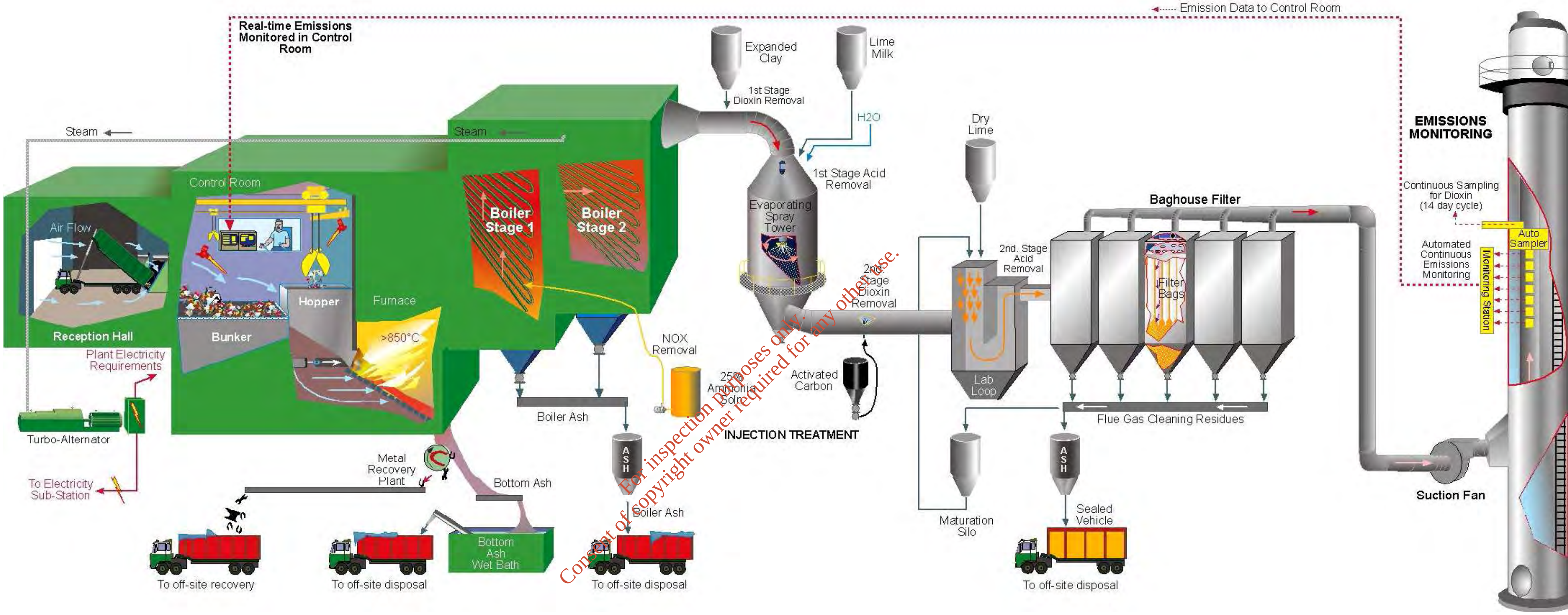


Figure 5.6 Process Overview

5.6 PROCESSES

The main processes and items of plant remain unchanged and are as follows. The change to the flue gas cleaning is reflected in the list below:

- Waste Reception
- Moving Grate Incinerator
- NO_x Reduction - Ammonia Solution Injection
- Waste Heat Boiler
- Turbine
- Expanded clay injection
- Evaporating Spray Reactor
- Activated carbon, dry lime and residue injection into LAB loop reaction duct
- Baghouse Filter
- Recirculation of flue gas cleaning residues
- Ash Handling
- Emissions Monitoring Station

A simplified schematic of the overall incineration process flow is shown in Figure 5.7 below.

5.6.1 Waste Reception

The waste reception process remains unchanged from the previous application and the same controls and procedures will be applied. Waste will be accepted from 0800 to 1830 Monday to Friday and between 0800 and 1400 on Saturdays. All trucks delivering waste will be covered and weighed upon arrival and departure from the facility. The bunker and tipping hall area will be maintained under negative pressure to prevent any odours escaping from this area.

This application proposes to change the dimensions of the reception hall and waste bunker based on a review of the delivery requirements and required storage capacity. These changes are as follows;

- Reduction in roof height of tipping hall
- Increase in height of waste bunker

It is proposed that the tipping hall roof be lowered by approximately 5 metres based on a review of required internal clearance heights and the detailed design of the roof construction. An increase is required in the bunker roof height of 4 metres to give the required clearance above the bunker cranes for maintenance and installation. The total bunker capacity remains at 16,000 m^3, which is sufficient to allow the plant to accept waste during periods of shut down, such as one-week scheduled shutdown for maintenance, and to continue operating over prolonged periods (e.g. long weekends) without deliveries. This waste storage area will be chemically and mechanically resistant to the waste. It will be impermeable and have a secondary containment system with an inspection chamber to check for leakage.

The control room, where the operators control the process and the crane operators are located, remains overlooking the waste bunker. The discharge, mixing and feeding of waste into the hopper will be controlled manually. The bunker will be continuously monitored by the operator of the grab crane, who will ensure that the correct mix and volume of waste will be fed into the hopper.

The design of the bunker and waste acceptance and handling criteria proposed is considered BAT.

5.6.2 Moving Grate Incinerator

There are no changes to the proposed technology and a moving grate furnace will be provided for the facility. The moving grate mechanism will transport the waste slowly from the feed point at the top of the furnace to the ash discharge at the bottom of the furnace. The rate at which the waste will travel through the furnace will be controlled to optimise the combustion. The residence time for waste in the furnace will be approximately one hour. The rate of waste feed will be controlled to maintain constant steam production at the desired temperature and pressure. The furnace will operate at a temperature between 850℃ and 1000℃. The bottom ash produced i s discharged from the bottom of the furnace and cooled in a water bath prior to transport by conveyors to the bottom ash storage & handling building.

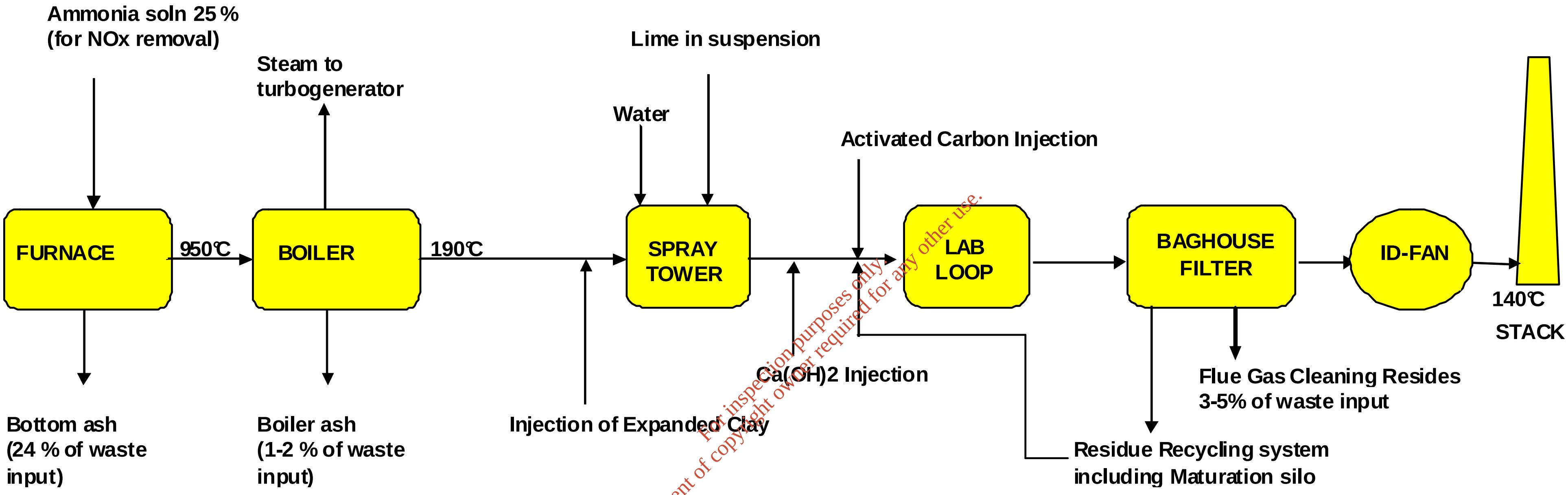
It is proposed that the height in this section of the main process building be increased by 1m to allow for the construction of a 1m high parapet wall to provide safe access to the roof during maintenance.
The technology chosen and the operational conditions proposed are considered BAT for the incineration of waste.

5.6.3 De-NO$_x$ - Ammonia Solution Injection

There are no changes to the proposed de-NO$_x$ technology and Ammonia has been chosen as the preferred re-agent. De-NOx technology must be used to reduce the oxides of nitrogen to below the limit of 200 mg/Nm^3. A solution of <25% ammonia in water will be used in the process where it will be injected into the flue gases in the area above the furnace. It is proposed to locate the ammonia tank in the same area as the fuel-oil storage tank, adjacent to the air cooler condenser building and near the western boundary of the site. The tank will be double skinned, approximately 70m^3 in size and will have a diameter of 3.5m and will be approximately 7m in height. It is proposed to construct a pipebridge at approximately 6 metres above ground level connecting the main process building with the ammonia and fuel storage areas.

The technology proposed is considered BAT for the removal of NO_x from the flue gases.

Figure 5.7 Process Schematic of Incineration Process



5.6.4 Waste Heat Boiler

There are no changes to the proposed technology and energy will be transformed into useful motive power and electricity using a conventional steam cycle. The steam boiler will operate to 40 bar and 400℃, the maximum steam parameters technically possible for electricity generation from waste incineration, as anything greater than this will result in excessive corrosion of the boiler and reduced efficiency.

The boiler outlet temperature for the proposed development will be reduced from a minimum of 230℃ to 190°. This is because evaporation of excess water from the flue gas cleaning process will no longer be required. This will increase the overall energy efficiency of the plant.

It is proposed that the building height in this section of the main process building be increased by 1m to allow for the construction of a 1m high parapet wall to provide safe access to the roof area during maintenance.

The technology chosen and the operational conditions proposed are considered BAT for the recovery of energy from waste.

5.6.5 Steam Turbine/Generator

There are no changes to the proposed technology and a turbine & generator set will be utilised to convert steam into electricity for internal use and for export.

Based on the order placed for the turbine and generator, the electrical output will be approximately 18 MW which is 2 MW higher than identified in the 2006 EIS. The extra 2MW will provide enough power for approximately 3,000 homes annually and brings the total to 22,000 homes based on the net electrical output. The electrical demand within the plant remains at 3 MW, leaving the net electrical output at approximately 15 MW. This increase was made possible by the choice of the final supplier who provided a very efficient turbine/generator set.

It is proposed to locate the steam turbine inside the main process building, removing the need to provide space elsewhere on site and also reducing the height of the air cooled condensers (which were located on top of the turbine building in the 2006 application). It is also proposed to construct a pipebridge at 12m above ground level to connect the turbine exhaust to the air cooled condensers.

The technology chosen and the operational conditions proposed are considered BAT for the generation of electricity from waste.

5.6.6 Emergency Generator

An emergency generator is still required and the size of the generator will be 1.25 MVA. Such a unit will consume approximately 200 l/hr of light fuel oil (diesel). This will support critical items of plant and equipment in the event of power failure and assist in a controlled plant shutdown if required.

5.6.7 Expanded Clay Injection (1st Stage Dioxin Removal System)

Process Description

Dioxins and furans are complex chlorinated hydrocarbon molecules, which are formed as a consequence of any combustion process. The plant is designed to minimise the formation of dioxins, by maintaining the flue gases at a high temperature (over 850^{o}C) for over 2 seconds in the furnace and by rapidly cooling the gases from 450^{o}C to 250^{o}C. These measures reduce the dioxin concentration in the flue gases to a low level. The flue gas cleaning process provides for a two-stage dioxin removal process to reduce dioxin concentrations in the flue gas to levels well below the limit set in the Waste Incineration Directive (typical emissions from such a facility would be 0.01ng TEQ/m^3 (0.000,000,001 g TEQ/m^3)). Adding expanded clay is the first step of this two-stage process.

A fixed amount of expanded clay will be injected into the flue gas as it is entering the evaporating spray reactor. The clay consists of small, porous particles, which due to their porosity have a very large surface area. The large surface area will adsorb heavy metals and trace levels of organics present in the flue gas, such as dioxins, furans, PAH's and hydrocarbons. These clay particles and other particulates, such as dust, will then be removed by filtration as the flue gases pass through the baghouse filter.

Process Control

The expanded clay will be injected at a fixed rate controlled by a volumetric dosing screw. This fixed rate will be based on operating experience of the company's incineration plants in Belgium. The rate of dosing will allow for the maximum reduction in emissions.

The weight of the expanded clay feed bin will be monitored continuously to ensure that dosing is continual. Should the weight of the feed bin remain steady, which would indicate that the feed to the process has stopped, an alarm will be activated in the process control room. This will alert the plant operators to investigate the problem immediately and make the necessary repairs. Because there is full redundancy and backup in the 2nd stage dioxin removal system, which can meet the limit set in the waste incineration directive, the plant does not need to be shut down while the repairs are being made.

Emissions

Expanded clay will be stored in a silo fitted with a HEPA filter. Therefore the only emission will be filtered air and such emissions will only occur when the silo is being filled.

Inputs and Outputs

The inputs and outputs from this stage of the process will be the expanded clay & flue gases.

The technology chosen is considered BAT for the removal of dioxin from the flue gases.

5.6.8 Evaporating Spray Reactor (1st Stage Acid Removal System)

There are no changes to the proposed technology and an evaporating spray reactor with the injection of lime milk and water will be utilised to remove acid gases from the flue gas. The evaporating spray reactor will serve the triple function of;

- cooling the flue gases, prior to the activated carbon injection and baghouse filter
- neutralising acids with lime
- evaporating all process waters from the plant.

A rotary atomiser will be used to inject the lime milk and water into the reactor and to guarantee uniform contact with the flue gases. The atomiser will be replaced and cleaned on a weekly basis to avoid blockages.

The entry temperature to the evaporating spray reactor from the boiler will be 190℃ which is 40℃ lower than that proposed in 2006. This reflects the improved energy efficiency of the plant. It is proposed to increase the building height in this area to facilitate ease of maintenance of the rotary atomiser on the top of the spray reactor. This has been described in Section 1.1 of this document and can be seen on Drawing PMG-MEATH-ARC-000-1711 between gridlines 22 and 24 in section A-A with the previously approved layout indicated in a dotted line on the proposed.

The technology chosen is considered BAT for the removal of acids from the flue gases.

5.6.9 Dry Lime Injection and LAB Loop Reaction Duct (2nd Stage Acid Removal System)

Process Description

Dry lime injection ($Ca(OH)_2$) has been chosen as the preferred method of 2nd stage acid gas removal from the flue gases in preference to the wet system proposed in the 2006 application. The dry lime will be injected into a reaction duct (LAB loop) between the evaporating spray tower and the baghouse filter. The advantages of this system over a wet scrubbing stage have been discussed in Section 3.1.4, but the end result is that SO_2, HF and HCl will be removed from the flue gases in a polishing step.

Because the semi-wet stage (evaporating spray reactor) is the main acid gas removal step and the limits set out in the Waste Incineration Directive (2000/76/EC) can be easily met using this technology, this second stage is a backup system and polishing step for the removal of acid gases. The reacted lime is then captured with particulates and expanded clay and activated carbon in the baghouse filter as described in Section 5.6.10 below.

The technology chosen is considered BAT for the second stage removal of acids and trace quantities of dust, dioxins and heavy metals.

Process Controls

The rate of injection of dry lime will be controlled based on the measurement of HCl & SO_2 in the stack and also based on a measurement of these pollutants in the raw flue gases leaving the boiler. In the event of a spike in acid gas concentration, the dry lime injection system has the capacity to remove the excess HCl and SO_2 from the flue gases and the rate of injection is increased to ensure that the EU limits are protected at all times in the stack.

Emissions

There will be no emissions from the injection of dry lime into the flue gases.

Inputs and Outputs

The main inputs will flue gases and dry lime ($Ca(OH)_2$). Activated carbon will also be injected at this stage. A portion of the flue gas cleaning residues from the collection hoppers of the baghouse filter will also be sent back to the reaction duct to reduce the usage of dry lime in the process.

The outputs will be the flue gases, reacted/unreacted lime, expanded clay, activated carbon and particulates.

5.6.10 Activated Carbon Injection & Baghouse Filter (2nd Stage Dioxin Removal and Dust Removal System)

There are no changes to the proposed technology and a baghouse filter with the injection of activated carbon will be utilised to remove dioxin and heavy metals from the flue gas. A fixed amount of activated carbon or lignite coke will be injected into the flue gas as it is leaving the evaporating spray reactor. Activated carbon consists of small, porous carbon particles, which due to their porosity have a very large surface area. The large surface area will adsorb heavy metals and trace levels of organics present in the flue gas, such as dioxins, furans, PAHs and hydrocarbons. These carbon granules and other particulates, such as dust, will then be removed by filtration as the flue gases pass through the baghouse filter.

The baghouse filter contains multiple filter bags in 6 separate compartments. The separate compartments allow for maintenance and changing of filter bags whilst the filter is on-line. The dust laden flue gases are sucked from the outside (foul side) to the inside (clean side) of the filter bags leaving a dust cake on the outside of the bags. The pressure drop over the bags increases as more dust gets accumulated. A reverse pulse of clean compressed air will be blown inside the bag as soon as a preset pressure drop set-point is reached. The airwave will inflate the bag and make the carbon and particulates at the outside crack and fall into collection hoppers below.

This residue is called flue gas cleaning residues and is transported in enclosed conveyors to an enclosed silo within the main process building.
The technology chosen is considered BAT for the removal of dust, dioxin and heavy metals from the flue gases.

5.6.11 Ash Handling

There are no changes proposed to the types and amount of ash produced. There will be three ash streams from the waste-to-energy plant:

- Bottom Ash
- Boiler Ash
- Flue Gas Cleaning Residues

The approximate quantities of ash and residues expected to be produced from the waste-to-energy process are detailed in the following table.

Table 5.1 Estimated Residue Quantity and Type

Ash Type	Tonnes/annum (Approximate)	Hazardous/Non-Hazardous
Bottom Ash (incl. 15 % moist)	50,000	Non-Hazardous
Boiler Ash	3,000	Non-Hazardous
Flue Gas Cleaning Residue	10,000	Hazardous
Total	**63,000**	

It is proposed to store the ash in a dedicated enclosed building in preference to an underground ash bunker.

Bottom ash from the wet de-slagger will be transferred to the bottom ash storage and handling building by conveyors. A metal separator (over-band rotating magnet), located on the last conveyor before discharge to floor of the bottom ash storage building, will remove ferrous metal and transfer it to a separate location in the building. Space is provided within the bottom ash storage and handling building to accommodate more ash handling equipment if further recovery of materials or processing of the ash is required in the future.

The proposed bottom ash storage and handling building has a floor area approximately 1100 m^2 and will have the capacity to store the equivalent of 10 days of bottom ash production. It is proposed to locate this building adjacent to the main process building on its western side. The building will be enclosed and drainage from this area will be contained and re-used in the wet-deslagger. Ash will be transferred from the building to collection trucks using a front loader. The transfer will take place in an enclosed loading bay. All trucks leaving the facility will be securely covered to prevent any ash escaping from the facility. The bottom ash is expected to be non-hazardous and will be disposed of at a licensed non-hazardous waste landfill site.

The boiler ash is collected in hoppers at the bottom of the boiler and is produced from the cleaning of the boiler tubes by mechanical rapping or by steam blowing. The boiler ash will be transported by enclosed conveyors to the boiler ash silo (100 m^3 capacity) located within the main process building. The silo will be equipped with HEPA filters to prevent any dust emissions. The boiler ash will be loaded into an enclosed container prior to shipment off-site for disposal. It is anticipated that the boiler ash will be non-hazardous, but until this can be proven, it will be treated as hazardous and exported for disposal.

Flue gas cleaning residues will be removed from the baghouse filter by an enclosed conveyor system and transferred to a silo located within the enclosed building. Silos will be fitted with HEPA filters to prevent dust emissions. These residues will be transferred to a specialised collection truck which will have an enclosed container box. This material is not classified as hazardous under transport regulations but is classified as hazardous for disposal. Hence this material will be exported for disposal. There is no prerequisite to solidify this residue prior to transport off-site. Two flue gas cleaning residue silos will be sized at 210 m^3 and each will have the capacity to store the equivalent of 7 days of residue.

5.6.12 Control System

The control system and safety philosophy for the plant with safety interlock levels has not changed. The facility's automated computer system is located in the control room. The control room is located above the bunker. From here crane operators visually inspect the waste and, using a grab and automated transfer system, control waste entering the furnace from the bunker.

The process is controlled from here and the system monitors all the parameters and measurements required in order to have a good overview of plant performance. It executes plant control loops, reports low-level and high-level alarms and will control different levels of safety interlocking. Emissions data from the emissions monitoring station located on the stack are also monitored here.

The system proposed is considered BAT for the control of the incineration process.

5.6.13 Emissions Monitoring

EU Directive 2000/76/EC requires continuous monitoring of specific parameters and regular sampling of dioxins present in the flue gases prior to discharge from the stack to ensure compliance with emission limit values.

It is not proposed to alter any of the equipment for monitoring as part of this application.

The following parameters will be continuously measured in the stack: total dust, TOC, HCl, HF, SO_2, NO_x, NH_3, H_2O, CO, CO_2 temperature and O_2. These continuous measurements can be reviewed in 'real time' in the control room. A continuous sampling system for dioxin will also be installed.

There will also be regular monitoring for the heavy metals Cadmium, Thallium, Mercury, Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel, Vanadium and Tin.

The system proposed is considered BAT for the control of the incineration process.

5.7 DESCRIPTION OF PROCESS INPUT AND OUTPUT REQUIREMENTS

The major input to the process is waste for incineration and the major outputs are flue gases, ash, flue gas cleaning residue and electricity. Based on the amendments proposed, there will be a reduction in the water usage for the plant when compared to that identified in 2006 and a change to the types of raw materials used in the flue gas cleaning process. The inputs and outputs are summarised in Table 5.2 below.

Table 5.2 Process Inputs and Outputs

Inputs	Outputs
Waste	Ash
Water	Electricity
Raw Materials	Stack emissions
Light fuel oil	

Water Supply and Use

The water requirement for the process has been reduced from 11.6 m^3 per hour to 8.5 m^3 per hour. The major water requirement will be for flue gas cleaning. Process water (for the steam cycle), domestic potable water and water for cleaning account for the rest of the demand. The expected water requirements are listed in Table 5.3 below:

Table 5.3 Water requirement

Use	Quality	Quantity (m^3/hr)
Flue gas cleaning	Well water	3.3
Process (steam cycle)	Well water	1.0
Drinking Water	Potable water	1.0
Cleaning & Domestic supplies	Well water	3.0
Fire fighting	Well water	0.2
Total		**8.5**

The raw water requirement will be supplied by groundwater abstraction and a small supply of potable water from the local water main. Approximately 1m^3/hr will be supplied from Meath County Council's water main on the R152 for potable supplies.

Raw Materials Use

Several raw materials are utilised for both the flue gas cleaning process and also the preparation of the water for use in the boiler (de-mineralisation). The hydrated lime, quicklime, hydrochloric acid and sodium hydroxide will be sourced from Irish suppliers. The ammonia solution, activated carbon and expanded clay will be imported. The usage of each raw material is summarised in Table 5.4 below.

Table 5.4 Raw Materials Usage

Use	Raw Material	Quantity (kg/hr)
Flue gas cleaning	Hydrated Lime	13.4
Flue gas cleaning	Quicklime	307.2
Flue gas cleaning	Activated Carbon	13.4
Flue gas cleaning	Expanded Clay	26.7
Flue gas cleaning	Ammonia Solution	130
De-mineralisation	Ammonia Solution	3.8
De-mineralisation	Hydrochloric Acid	3.8
De-mineralisation	Sodium Hydroxide	3.5

Light Fuel Oil Consumption

The plant will use light fuel oil at start up to bring the furnaces to the required operating temperature of 850°C. Light fuel oil may also be occasionally required as a supplementary fuel to maintain the temperature if waste of an exceptionally low calorific value is received. This low light fuel oil demand will be supplied from an on-site light fuel oil double-skinned storage tank of 40m^3 capacity which is now proposed to be located near the western site boundary to the south of the air cooled condensers. It is proposed to construct a pipebridge at 6m above ground level to connect this tank to the main process building.

Ash

Three types of ash will be produced by the facility totalling approximately 31% of the waste input calculated by mass. This topic is discussed in detail in Section 5.6.11 above.

Electricity

The waste-to-energy plant will convert the thermal energy produced by the combustion of the waste into electricity, some of which will be used by the plant itself with the remainder (approximately 15 MW) being exported to the national grid which is enough to power 22,000 homes annually. Overall the plant will supply over 98 GWh of renewable electricity per annum, which will contribute to reducing Ireland's Greenhouse Gas emissions.

Heat Balance

The heat produced from the combustion of the waste will be used to generate steam, which will be used to drive a steam turbine and electricity generator.

For a 69.3 MW thermal output the following heat balance is expected;

Heat loss by radiation from hot equipment (furnace, boiler, steam cycle) is approximately 1.5 MW (2%). This heat, while not recovered, heats the building. It is emitted to atmosphere through the natural draft of the building ventilation system.

57.6 MW of the heat generated is converted to steam. This steam is converted to 17.6 MW of electricity and 40 MW of hot air from the aerocondenser. Steam enters the turbine at a pressure of 40 bar and a temperature of 400°C.

Steam leaves the turbine at a pressure of 0.15 bar, a temperature of 50°C and only 10% condensed. The remaining 90% of the steam is condensed in the aerocondenser using an indirect cooling system. Therefore the steam is condensed in a closed loop and ambient air is heated.

The remaining 10.2 MW of heat is released from the boiler to the flue gas cleaning system and is emitted via the stack. The heat balance is summarised in Figure 5.8 below.

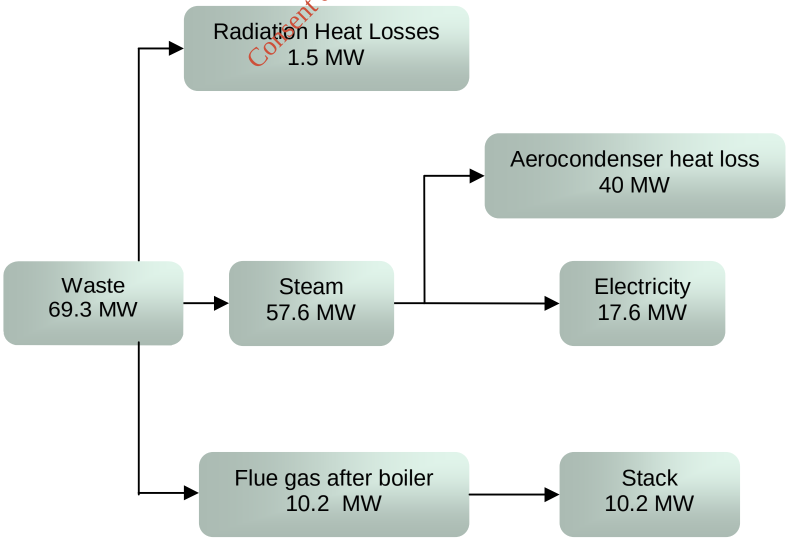


Figure 5.8 **Heat Balance**

Energy Efficiency

The choice of the flue gas cleaning system and careful selection of a higher efficiency turbine/generator has meant that the overall energy efficiency of the plant has improved. The electrical generation efficiency of this design is 25.4% compared with the previously envisaged figure of 23.8%.

Stack Emissions

The emissions from the stack will comply in full with the requirements of the Waste Incineration Directive 2000/76 EC. The assessment of the impact of those emissions is discussed fully in Section 7 of this EIS.

5.8 OCCUPANTS/STAFFING

The staffing levels have not been altered by the proposed amendments to the existing planning permission. It is expected that a maximum of 50 people will be employed at the plant. 20 of these will be shift workers who will work in teams of 4 and will run and control the plant on a 24 hour basis. Employed personnel will be split between the following functions:

- Management and Administration
- Operations
- Maintenance
- Quality Control and Assessment
- Shift operators for the waste-to-energy plant

Key staff will be recruited prior to commissioning and will be trained by experienced personnel at a similar waste-to-energy plant in Belgium. As part of the contractual agreement, the incinerator manufacturer will be required train the operators and to remain on-site until the facility has been fully commissioned. Training will also be carried out in co-operation with the equipment designers and suppliers. By doing this, the operators will become familiar with the equipment and learn first hand from the equipment's design engineers.

As described in Section 1.1 of this document, it is proposed to re-design the accommodation block within the main process building to allow for the re-located education centre and to facilitate 20 visitors comfortably within the control room area.

5.9 DESCRIPTION OF NATURAL RESOURCES USED

The requirements for natural resources are discussed under Section 17 Material Assets.

5.10 DESCRIPTION OF EFFECTS, RESIDUES AND EMISSIONS

Detailed descriptions of the effects, residues and emissions associated with the facility are presented in Sections 6-18 under the following headings:

- Human Beings
- Air
- Noise
- Geology and Soils
- Groundwater and Hydrogeology
- Surface Water
- *Ecology
- Traffic
- Landscape & Visual
- Climate
- Cultural Heritage
- Material Assets
- Construction

*Flora and Fauna included under Ecology

5.11 EMISSIONS FROM RESIDUES

As described in Section 5.6.11 above, the proposed bottom ash storage and handling building and bottom ash loading area will be enclosed eliminating the potential for windblown ash. In addition, the bottom ash is deposited in the ash storage area as a wet product and hence the potential for fugitive emissions are minimised. All trucks carrying bottom ash from the plant will be covered to remove any potential for windblown ash during transport off-site.

The boiler ash and flue gas cleaning residue handling systems will be fully enclosed, with enclosed conveyors transporting the ash to silos. The silos will be equipped with High Efficiency Particulate Abatement (HEPA) filters to prevent fugitive emissions of ash. The ash will be transported off site in closed containers.

5.12 RELATED DEVELOPMENTS AND INDIRECT IMPACTS

5.12.1 Ash Disposal

As described in Section 5.6.11, the waste-to-energy plant will produce three distinct residues which will require disposal:

- Bottom Ash (50,000 tonnes per annum)
- Boiler Ash (3,000 tonnes per annum)
- Flue Gas Cleaning Residues (10,000 tonnes per annum).

The methods for re-use or disposal of these residues has not changed since the previous application.

The bottom ash is expected to be classified as non-hazardous and sent for reuse or to a non-hazardous landfill site. If a market for recycled bottom ash comes available in the future, then an ash recycling plant may be built in Ireland. If such an option were available in Ireland then the bottom ash would be sent there. In the absence of such a facility, the bottom ash will be sent to a licensed non-hazardous waste landfill.

However, in the absence of the waste-to-energy plant envisaged in the NE Waste Management Plan, the requirement for new landfill capacity would be much greater. This is because the volume of ash produced by a waste-to-energy plant is only 10% of the volume of the incoming waste.

Due to the relatively inert nature of the ash it will have lesser adverse impacts than untreated waste disposed directly to landfill.

The boiler ash is also expected to be non-hazardous and will be sent to a non-hazardous landfill site. This will have a slightly elevated concentration of heavy metals and dioxins than the bottom ash and is, therefore, not suitable for re-use as construction material.

The flue gas cleaning residues will contain high concentrations of salts and slightly elevated concentrations of heavy metals and dioxins. This residue will therefore be classified as hazardous waste and will have to be disposed of to a hazardous waste landfill. The flue gas cleaning residues will be mixed with cement and water and solidified prior to landfill. Solidification will take place either on site or at the disposal site, depending on whether the site is located in Ireland or abroad. These measures will ensure that there will be no adverse impact due to the disposal of the flue gas cleaning residues.

5.13 DESCRIPTION OF SECONDARY PROCESS/ACTIVITIES

Off Site Traffic Movements

As discussed in Section 13 of this EIS, the proposed amendments do not change the traffic figures associated with the permitted development. The number of staff employed, maximum tonnage throughput and quantities of ash requiring disposal remain the same. Although there has been a change to some of the raw materials used in the flue gas cleaning process (mainly the use of hydrated lime instead of sodium hydroxide) the traffic generated remains the same.

On Site Waste/Personnel Movements

Although it is proposed to change the on-site road layout, there is no change to the philosophy of how vehicular traffic and personnel traffic will be managed on site. All waste material transported to the facility will be directed to the waste reception and processing building for unloading into the waste bunker. Staff will be provided with parking facilities which will be located to the east of the gatehouse and weighbridges. No unauthorised personnel will be permitted access beyond the gatehouse unless permitted to do so or accompanied by a facility employee.

With the proposed changes in this application to the gatehouse and weighbridge area, visitors reporting to security on site will not have to cross the exit lanes for HGV movements off the site. Visitor safety was the driving force for making the change and in addition, a larger waiting area for groups visiting the site is also proposed. The revised location of the building can be seen in Drawing PMG-MEATH-ARC-000-1703 and the security building in Drawing PMG-MEATH-ARC-0700-1701 included as part of this application.

Surface and Foul Water Management

Surface and foul water management is discussed in Section 11 of this document.

Monitoring

Environmental monitoring is discussed in the individual Sections 6-18. The facility will have regular monitoring in accordance with the governing waste licence and such monitoring will be documented in the Standard Operating Procedures (SOPs) as part of Indaver's management system.

Security

Site security will be provided by a combination of suitable infrastructure and security personnel.

The proposed amendments to the gatehouse where security will be located facilitate safe access and egress of visitors to the site and also ensures that no an-authorised persons can enter. There is currently a security fence consisting of pallisade fencing (2.4m high) placed along the frontage to the R152. The remaining perimeter boundaries of the facility consist of a 2.4m chain link fence. There will be CCTV cameras located at suitable points around the site. Some of these will be mounted on camera towers. The exact number and location of the cameras will be reviewed on an ongoing basis.

A record will be kept of all visitors to the site. Visitors will be monitored and supervised at all times.

Wheel Wash

A wheel wash is currently used on site for construction activities but when operational, the facility will have hard-surfaced roads and a permanent wheel wash will not be required.

5.14 REGULATORY CONTROL

5.14.1 Waste Licence

In order to operate the waste management facility, Indaver require a licence from the EPA. Indaver currently have a waste licence (ref. W0167-01), and have submitted a licence review application to the EPA to increase the annual tonnage accepted in line with the existing planning permission and the current NE Regional Waste Management Plan.

In parallel with the preparation of this application, Indaver are responding to an Article 12 & 13 Compliance request as part of the review process. This EIS has been designed to address issues raised by the EPA and also to satisfy the requirements of the Planning Authority for the proposed amendments. Hence, the level of detail required for the proposed amendments has been augmented to meet the requirements of both.

The review application was submitted in March 2009 and Indaver expect to have a final licence in advance of facility commissioning in 2011.

5.15 DESCRIPTION OF DECOMMISSIONING

There is no site life defined for the facility therefore detailed financial, administrative and technical provisions are not presented under a decommissioning plan for the site. On decommissioning of the facility it will be a condition of the waste licence for the facility to provide the EPA with a detailed decommissioning plan for their approval prior to any works proceeding. In the event of decommissioning measures will be undertaken by Indaver to ensure that there will be no environmental impacts from the closed facility. Such measures are outlined as follows:

- All wastes at the facility at time of closure will be disposed/recycled by an authorised waste contractor;
- All oils, fuels etc on site at the time of closure will be collected and disposed/recycled by an authorised waste contractor;
- It is expected that the bulk of the site infrastructure will be sold on to a prospective buyer as an asset. The will include the site buildings, offices, weighbridges, fencing, gates, lighting and drainage/sewage infrastructure. Other plant may also be acquired by the potential buyer. However, if not this will be sold to other potential buyers separately or dismantled and disposed of at a licensed facility;
- All site floor and process building walls will be power swept and washed to clear all debris and dust;

- All tanks will be de-sludged and interceptors cleaned. The waste from the cleaning operations will be disposed to relevant licensed facilities; and

- A monitoring programme of all potential emissions including surface water and dust will be conducted after the decommissioning process in order to ensure that emissions from the facility have ceased. The monitoring programme will consist of two monitoring rounds carried out within two months of decommissioning of the facility.

It is a current condition of planning that the site must be returned to greenfield condition after the plant is fully de-commissioned and financial provision will be made in agreement with Meath Co Co and the EPA to guarantee this. Hence, once de-commissioned there will be no requirement for long-term aftercare management at the site.

In accordance with waste licence requirements the company must prepare a decommissioning programme in agreement with the EPA when the facility becomes operational.

5.16 DESCRIPTION OF OTHER DEVELOPMENTS

The following subsections detail offsite and secondary developments which occur directly or indirectly from facility operations.

5.16.1 Transportation

The upgrade of the R152 road is detailed in Section 13.

5.16.2 Energy

Electricity Generation & Substation

In the 2006 application it was envisaged that a 20kV overhead line connection would be installed and this was based on the best information available at that time. However, Indaver subsequently made an application to ESB networks for a connection offer and Indaver were advised that 38kV infrastructure would be utilised.

The waste-to-energy plant will export electricity to the local electrical distribution system via a 38 kV line to Rathmullan Substation about 2.5km north of the site. The line will be installed as an underground cable and hence will not have any visual impact. Planning permission is not required for an underground cable of this size and the final route for the cable will be determined by the ESB.

Based on the changes since the 2006 application, a new location and orientation of the import-export compound and associated substation building has been proposed. Location and detail of this area is indicated on Drawing PMG-MEATH-ARC-030-1703 which forms part of this application. Due to the layout of the facility and its location to the northerly end of the site, there will be no requirement to divert the existing 110 kV lines traversing the site.

5.16.3 Other

Water

The mains water supply piped along the R152 road supplies many of the residential dwellings in the area. The development will use a small quantity of mains water as a potable supply for the facility. On site water well(s) will be used as process water within the facility as detailed in Section 5.7. The water usage will be less than that indicated in the 2006 application.

Sanitary Service

Domestic sewage from toilets, changing and kitchen areas will discharge via the foul drainage system into an on site effluent treatment system which will then pass through a percolation area to ground as detailed in Section 9. It is proposed that there will be two such percolation areas, one for the main process building facilities and one for the gatehouse.

Telecom

A telecom network including phone lines has been ducted from the site entrance parallel to the roadway to the contractors compound (construction village) on site. The telecommunications network will be extended prior to operation to the main process building and to all areas of the site where telemetry or remote monitoring is required. All cables will be underground and ducted.

5.17 HEALTH AND SAFETY

5.17.1 Design & Construction Health and Safety

The facility and proposed amendments have been designed in accordance with the Safety Health and Welfare at Work Act, 2005, Health, Safety and Welfare at Work (General Application) Regulations, S.I. No. 299 of 2007 and associated Regulations.

The plant was designed by skilled personnel according to internationally recognised standards, design codes, legislation, good practice and experience.

The design was reviewed to check for safety hazards in steady and non-steady state conditions and for ease of operability. Backup systems for pumps, control systems, power supply and instruments etc. are provided for critical situations.

The following principals are also incorporated into the design of the proposed facility.

- Fire detection and fire fighting systems will be installed;
- The design complies with Irish Building Regulations Part B Fire Safety and with Indaver's insurance company's requirements;
- The installation is validated as part of commissioning procedures;
- The installation is well maintained and cleaned;
- Indaver applies strict rules on safety such as a working permit system, training of operators and staff, and provision and use of personal protection equipment where appropriate; and
- Wherever possible Indaver strives to minimise human interaction in safety critical operations in order to eliminate the potential for 'human factors' to initiate or exacerbate major accidents at the site.

It is the policy of Indaver Ireland to attach the greatest importance to the health and safety of all persons employed on the project and indirectly affected by the works. All construction projects are carried out, so far as is reasonably practicable, in such a way that the risks to the health and safety of all persons engaged in, or affected by, its construction and maintenance are eliminated or reduced to an acceptable level under current health and safety legislation, namely the Safety, Health & Welfare at Work Act 2005, Health, Safety and Welfare at Work (General Application) Regulations, S.I. No. 299 of 2007 and good practice.

Relevant notifications to the HSA and planning authorities have been submitted within the statutory periods prior to construction. Project supervisors for the construction and design phases have been appointed in accordance with the Health, Safety and Welfare at Work (Construction) Regulations, S.I. No. 504 of 2006, and a Preliminary Health and Safety Plan has been formulated during the design stages to address health and safety issues from the design stages, through to the completion of the construction and maintenance phases. This Health and Safety Plan has been developed further in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2006 for the construction stage of the project.

All those involved with the construction phase have a statutory duty to comply with its requirements and to provide Indaver with any relevant information needed to keep the plan up to date.

Indaver employ consultants to act as Health as Safety Co-Ordinators on larger projects. Indaver also employ a full time, fully qualified Health and Safety Officer who is responsible for ensuring that relevant legislation is adhered to and that best practice in Health and Safety is employed and enforced during construction.

5.17.2 General Operational Safety

No changes are proposed to the systems and general approach to operational safety. Hazard and operability studies were carried out at the detailed design stage of the project. These studies are a systematic method of identifying hazards and assessing mitigation measures.

Indaver operates a combined Quality, Environmental, Safety & Health (QESH) Management System. The facility will operate to ISO 9001:2000, ISO 14001 and OHSAS 18001, the internationally recognised quality, environmental and health and safety standards/assessment series.

The QESH policies are the top-level documents of each element of the system. They define Indaver's overall aims and objectives with respect to the provision of a quality service to customers, the provision of a quality workplace to employees and the control over the environmental and health & safety impacts of its activities respectively.

Indaver maintains a Register of Environmental Aspects, which identifies the aspects of Indaver's activities that can interact with the environment and determines where controls are required. Indaver also carries out Health & Safety Risk Assessments in order to identify the health & safety hazards associated with Indaver's activities and to determine where controls are required. Both the Register of Environmental Aspects and the Health and Safety Risk Assessments will be updated to incorporate the activities at the facility.

Prior to start up a comprehensive set of operational procedures covering all aspects of the different activities will be drawn up. The purpose of these procedures is to ensure that Indaver:

- Maintains control over the environmental, quality and safety aspects of its activities;
- Meets the aims laid down in the Environmental, Quality and Health & Safety Policies; and
- Remains compliant with all relevant operating licences, permits and legislative requirements.

In compliance with the Safety, Health and Welfare at Work Act, 2005, Indaver Ireland will draw up a safety statement covering the operation of the plant and appoint safety representatives from the plant workforce. The Employees of Indaver represent the Company's greatest asset.

By providing opportunities, facilities and financial resources, the Company aims to ensure that all members of staff are in possession of the knowledge, skills and experience necessary to perform their jobs to a satisfactory standard.

The incineration process will be controlled manually and automatically by employees and a computerised control system in the control room. Through recruitment, training, performance management, employee development and succession planning, Indaver provides employees with sufficient training, experience & knowledge for their roles and ensures that they are competent to perform them.

In the unlikely event of a failure of the plant, and a simultaneous failure of the supply from the electrical distribution system, the plant's un-interruptible power supply (UPS) will supply electricity to the critical systems, such as the gas cleaning and computer systems. The UPS will be designed to maintain a power supply to the control systems for 15 to 30 minutes.

The emergency generator will come on line at the same time as the UPS and will supply electricity to motors, pumps and fans until the plant is safely shut down.

5.17.3 Fire Safety

It is not proposed to change the approach to fire safety and systems as outlined in the 2006 application. The fire safety objectives adopted in the design of the Meath waste-to-energy facility are:

- to achieve compliance with the Building Regulations with particular reference to Part B (Fire), so that a Fire Safety Certificate will be obtained prior to the commencement of construction; and
- to follow as far as practicable the recommendations in the Code of Practice for Fire Safety in Buildings – BS5588 which is referred to in Technical Guidance Document B (Fire) to the Building Regulations.

Indaver have received the first fire safety certificate for the bunker complex construction on the site.

Fire Systems

The entire plant will be designed and provided with adequate fire protection and detection systems consistent with the requirements of the Building Regulations and in consultation with Indaver's insurers. The fire protection system will be based on tried and tested systems which are provided in Indaver's existing waste-to-energy plants. The systems for detection and fire fighting will include:

- smoke/heat detectors;
- fire alarm system;
- on site storage of water for fire fighting purposes; and manual call points.

5.17.4 Potential Operating Hazards

There is no change to the operating hazards identified or the safety measures proposed in the application of 2006.

5.17.4.1 Waste Bunker

The greatest potential for fire arises in the waste bunker, where localised heating can occur due to decomposition of organic material or as a result of hot ash in the waste leading to isolated fires. Decomposition of waste can raise the temperature to 75℃, which dries the waste and causes it to smolder. Incoming ashes from domestic fires wrapped in other waste can retain their heat. When waste in the bunker is moved these ashes could be exposed to air and could start to smolder.

Proposed Operational Safety Measures

As the waste bunker is permanently monitored by the crane operator, such a fire can be detected at an early stage by the operator of the mechanical grab. Should the crane operator fail to detect a fire, automatic fire detection systems will activate an alarm in the control room. However, a localised fire can usually be more quickly detected by the human eye than by the fire detection systems installed.

In the event of such a fire, the part of waste on fire is lifted into the hoppers from whence it goes into the furnace. This waste is then covered by placing another layer of waste into the hopper.

Should the fire become uncontrollable by this method, the fire can be put out using one of a number of water cannons. The crane operators will be trained in fire fighting techniques. All firewater will be contained within the bunker, eliminating the need for a firewater retention pond from this event.

A number of design considerations will prevent flame back flow from the furnaces through the hopper into the bunker. Firstly, the furnace is kept under negative pressure. Secondly, the waste-feeding hopper is always filled to a minimum level generating a waste plug between furnace and bunker. This level is measured and safeguarded by an interlocking system. The feeding hopper and feeding ram also provide a seal between the high temperature furnace and the bunker. Finally, a valve in, or on, the hopper closes automatically in case of fire or other safety initialising signals.

5.17.4.2 Moving Grate Furnace

Proposed Operational Safety Measures

The waste-to-energy plant will be provided with detailed control and safety systems. Interlocks will shut down the installation automatically as soon as a fire risk is detected. In an emergency shut down, all air and waste supply will be stopped to extinguish the fire. In this event all gases will continue to be discharged through the stack via the flue gas cleaning plant. In the event of failure of the main control computer or of the supply of utilities such as air or electricity the plant will be automatically shut down in a safe manner.

5.17.4.3 Steam Production

Proposed Operational Safety Measures

The design of the steam circuit will be carried out to the best industry standards to minimise hazards. In the event of a power failure the emergency generator will keep one boiler feedwater pump in operation to keep the water level in the boiler above a minimum. This will prevent overheating of the boiler.

5.17.4.4 Flue Gas Cleaning System

The main hazard is an elevated flue gas temperature at the outlet of the evaporating spray reactor. This has potential to cause damage to the baghouse filter and ignite the activated carbon.

Proposed Operational Safety Measures

The risk for fire from the use of activated carbon is minimised by the following considerations:

- A dedicated hazard assessment on the storage and dosing system will be performed;
- To prevent an elevated flue gas temperature it will be monitored and the temperature of the activated carbon will be maintained below 180℃;
- Activated carbon will be injected with lime to maintain the carbon content of the mixture below 40 % to reduce the risk for self-oxidation of carbon, hence the formation of hot spots; and
- In the event of a temperature threshold being exceeded, the plant will automatically shut down.

5.17.5 Emergency Response Planning

A Site Emergency Plan will be prepared prior to operational start-up, which will set out the response measures to be taken by personnel in the event of an emergency. These measures will be designed to ensure maximum protection for the site employees, site visitors and people in other premises near the site, to limit property damage and to minimise the impact on site operations and on the environment. The Site Emergency Plan will have four basic components:

Prevention

Prevention involves identifying potential hazards and then taking measures to remove the hazard, or reduce the potential for the hazard and its adverse effects.

Preparedness

Emergency planning, training programmes, emergency drill and exercise programmes are integral components of an effective preparedness programme. The site will have a dedicated ‘emergency response team’, which will be given specific training. Evacuation routes will be defined and all personnel will be aware of them.

Response

The site will be manned on a continuous basis except during shut-down periods when there will be a maintenance and security presence. Response activities address the immediate and short-term effects of an emergency.

Recovery

Recovery activities and programmes involve restoration of site services and systems to normal status.

Contact has been made by the future plant manager with the emergency services to start this process and to ensure that the procedures drafted in advance of operation satisfy all relevant stakeholders.

5.18 SITE STATUS IN RELATION TO THE EU CONTROL OF MAJOR ACCIDENTS HAZARDS INVOLVING DANGEROUS SUBSTANCES DIRECTIVE

5.18.1 Background to the 'Seveso' Directive

The European Union Council Directive 96/82/EC on the Control of Major Accident Hazards Involving Dangerous Substances ('Seveso 2' Directive) came into force in February 1997 and has been implemented in Ireland under SI 476 of 2000.

The new directive required the repeal of the original 'Seveso' Directive (82/501/EC) which was adopted following a series of accidents involving dangerous substances, such as the accident which occurred at Seveso, Italy in 1976.

The Directive defines a major accident as:

'an occurrence such as a major emission, fire, or explosion resulting from uncontrolled developments in the course of the operation of any establishment covered by this directive, and leading to serious danger to human health and/or the environment, immediate or delayed, inside or outside the establishment, and involving one or more dangerous substances.'

Hazard is defined as:

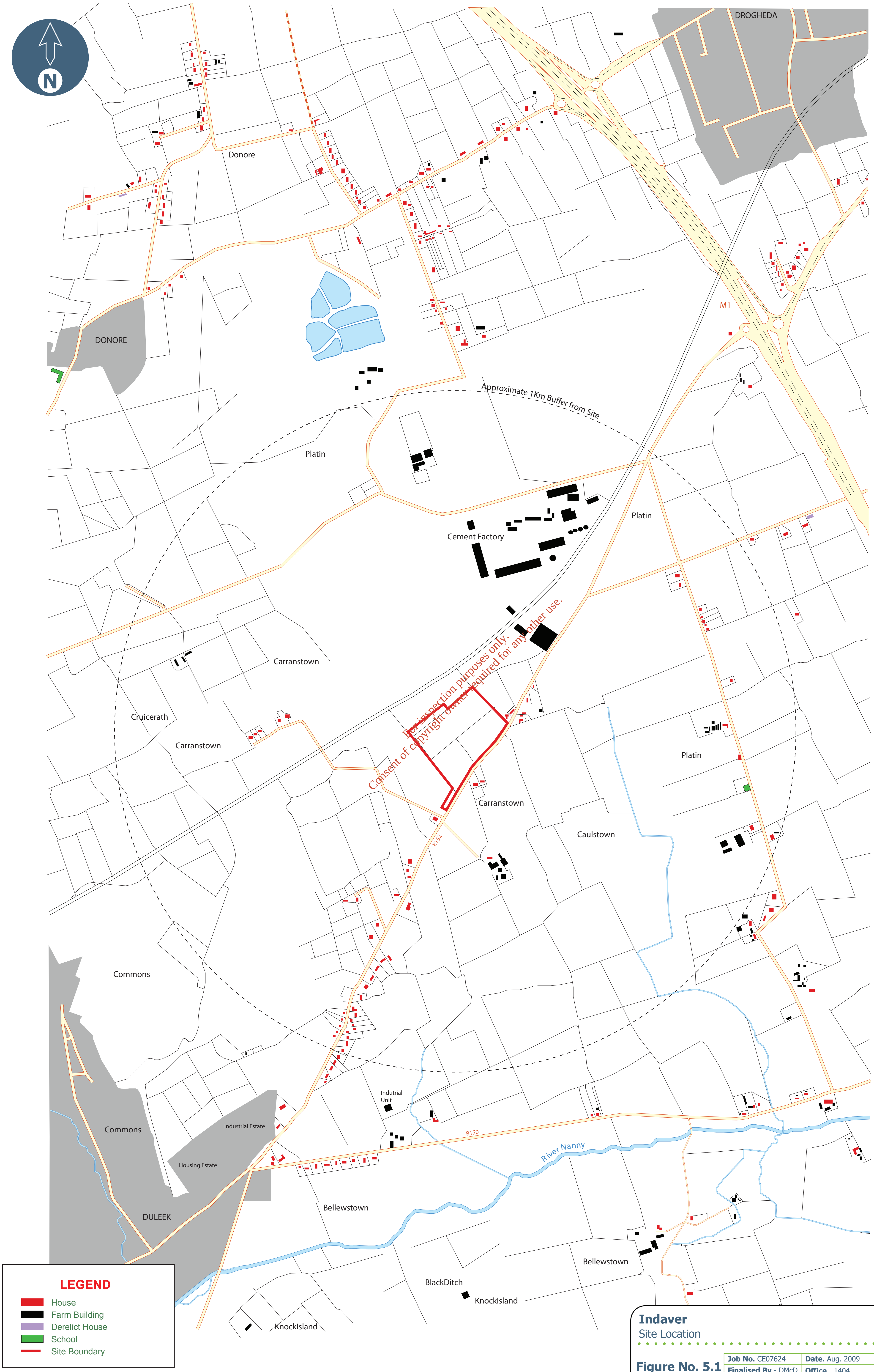
'the intrinsic property of a dangerous substance or physical situation, with a potential for creating damage to human health and/or the environment.'

This second Seveso directive revises the previous directive on the basis of experience acquired during its implementation with the aim of preventing major accidents, limiting their consequences and ensuring a high level of protection throughout the European Union in a consistent and effective manner. The directive covers all establishments having quantities of dangerous substance equal to or in excess of the thresholds.

5.18.2 Seveso Status of the Meath Waste Management Facility

In 2005, Indaver Ireland commissioned Byrne Ó Cléirigh Consulting Engineers, who specialise in safety and risk management, to undertake a study to determine if the waste management facility would come under the European Communities (Control of Major Accident Hazards Involving Dangerous Substances) regulations, S.I. 476 of 2000, due to the quantity and nature of the materials that will be stored on the site. The conclusions of the study indicated that the facility was not one to which the Seveso Regulations apply.

In 2006, the Regulations were updated (S.I. No. 74 of 2006) and as part of the waste licence review application to the EPA in March 2009, Indaver commissioned Byrne Ó Cléirigh to revise the study in light of the new regulations (see Appendix 5.1 for the complete study). The new study confirmed that the facility was not within the scope of the Regulations. It should be noted that although Ammonia solution (<25% Ammonium Hydroxide solution) has been chosen as the preferred re-agent for De-NOx, this material is not classified as toxic or dangerous to the environment and hence does not appear in the assessment included in Appendix 5.1.



NOTE: Drawing is for diagrammatic purposes only. No measurements to be taken.

Indaver
Site Location

Figure No. 5.1

Job No. CE07624	**Date.** Aug. 2009
Finalised By - DMcD	**Office** - 1404
Drawn By: J Farrar - CS2,Illustrator	

WYG Ireland

Appendix 5.1

Byrne O'Cleirigh Report

BYRNE Ó CLÉIRIGH
ENGINEERS CONSULTANTS

Indaver Ireland,
Haddington Terrace,
Dún Laoghaire

9th July 2008

Ref: 08P0614
FBS: 321.07.01 24

Re: Classification of Carranstown under Seveso Regulations (SI 74 of 2006)

Dear Sirs,

We have been requested by Indaver Ireland to provide a technical opinion as to whether, at a maximum throughput of 200,000 tonnes per year of municipal waste, the proposed Municipal Solid Waste Incineration Plant at Carranstown, Co. Meath would be classified as a 'Seveso' site under the relevant "Seveso" Directive and Regulations in force in Ireland as at June 2008.

A new development can only qualify as a "Seveso" site if it exceeds (or will exceed when operational) an inventory threshold for dangerous substances as set out in SI 74 of 2006. If the inventory of an establishment exceeds one or more of the thresholds in SI 74 then some or all of the regulations in the "*European Communities (Control of Major Accident Hazards Involving Dangerous Substances) Regulations*", (SI 74 of 2006) would apply to the site.

These Regulations, signed in February 2006, implement the EU Seveso II Directive 96/82/EC in Ireland as Amended by Directive 2003/105/EC. The latest rules regarding inventory thresholds for Seveso sites are contained in SI 74 of 2006 and have been applied in this assessment by Byrne Ó Cléirigh Limited.

At the time of preparing this letter (June 2008), the plant at Carranstown has not been built. The provisions in SI 74 relating to new establishments would thus be applicable to the Carranstown project if it were found to be a Seveso site on the basis of its projected inventory of substances covered by the Directive. The purpose of this letter is to establish whether the proposed development at Carranstown would be a Seveso site once operational, based on current legislation.

In the First Schedule to the Regulations there are two parts which set out the threshold levels for dangerous substances above which sites are deemed to be covered by the Regulations. Part 1 of the First Schedule has thresholds (generally expressed in tonnes) for "named" substances. These substances are either listed as an individual chemical or in some cases as groups of "named" substances. The latter type includes the furans and dioxins family of chemicals and another "named" grouping lists certain specific carcinogens.

Part 2 of the First Schedule sets out threshold levels for a list of 13 *'categories of substances and preparations which are not specifically named in Part 1"*.

In order to determine if a site qualifies under Seveso, the inventory of all Seveso substances expected to be present on the site must be examined. Having applied the addition rules there are several possible outcomes.

- **The site is not a Seveso site** (a) if no individual named substance in Part 1 of the First Schedule exceeds its lower tier inventory threshold AND (b) if no combined inventory within the categories of dangerous substances covered by Part 2 is exceed AND (c) having applied three addition rules in the First Schedule that no value of q/Q for either toxicity, flammability or eco toxicity exceeds 1.0. (The addition rules are set out in Note 4 to Part 2 of the First Schedule).

- **The site can be a Lower Tier Seveso site** under several circumstances (a) if any one of the named substances exceeds its Lower Tier Threshold in Part 1 of the First Schedule or (b) if the aggregated inventory of any category of dangerous substances exceeds the lower threshold for that category as set out in Column 2 of the Tables in Part 2 of the First Schedule. A site can also be a Lower Tier site if having applied three addition rules in the First Schedule the value of q/Q for either toxicity, flammability or eco toxicity exceeds 1.0.

  In addition, in order to be considered as a lower tier site (and not an Upper Tier site) then no individual named substance or aggregated category inventory may be present at an inventory level which is above the threshold for upper tier sites. These are set out in Columns 3 in both Parts 1 and 2 of the First Schedule.

- **The site is an Upper Tier Seveso site** if (a) any named substance exceeds the Quantitative Threshold in Column 3 of Part 1 of the First Schedule or (b) if any of the aggregated inventories exceed the Upper Tier threshold values for a category of substances in Part 2 of the First Schedule as set out in Column 3 of Part 2.

In order to provide an opinion on whether the proposed operation at Carranstown would be a classified as a Seveso site we undertook the following actions.

- We reviewed the inventory threshold data from the First Schedule of the Regulations of SI 74 of 2006.

- We had previously requested Indaver Ireland to provide data indicating which of the 'named substances' and which of the generic categories of dangerous substances they expected to be present on their site.

- In June 2008 we sought information from Indaver in respect of their current best estimates of the substances likely to be present on the Carranstown site and we received data on the revised inventories which would apply to a maximum throughput of 200,000 tonnes per annum of municipal waste.

- There is a natural gas pipeline traversing the Carranstown site. Section 4.2.c. (v) of S.I. 74 of 2006 (and in the previous SI 476 of 2000 Regulations) states that the regulations do not apply to the transport of dangerous substances in pipelines and pumping stations. Notwithstanding that, we held clarification discussions with the HSA in 2001. Following that discussion we assessed the inventory of natural gas immediately under the Indaver site for the length of 200 mm diameter gas pipeline which traversed the site. We have included this quantity of natural gas in the inventory used to establish if the site was one to which S.I. 74 would apply. The inventory of natural gas in the pipeline under the site is based on the pipeline diameter (200 mm), maximum gas pressure (70 bar) and the estimated length of pipeline within the site boundary (300m).

- For dioxins, petroleum products and HCL solutions we estimated the inventories based on Indaver data on the maximum storage quantities and concentration data supplied by Indaver. The result of the inventory assessments are shown in the tables below.

Of the named substances in Part 1 of the First Schedule in SI 74 of 2006, Indaver predicts that only the four listed in Table 1 below will be present at the proposed facility in any predictable quantities.

Table 1: Review of Inventory of 'Named Substances' (Part 1 of the First Schedule)

Named Substance[1]	**Max Quantity on Site (tonnes)**	**Lower Tier Threshold (tonnes)**	**Upper Tier Threshold (tonnes)**	**Factor by which Carranstown inventory is below Lower Tier Threshold**
Liquefied extremely flammable gases (including LPG) and natural gas Natural Gas –present in a gas pipeline crossing the site.	0.62	50	200	81
Polychlorodibenzofurans and Polychlorodibenzodioxins (including TCDD) calculated in TCDD equivalent – Present in incoming domestic / municipal waste and also in 3 types of waste ash (See Annex 1 for calculation of maximum dioxin inventory)	0.00000070	-	0.001	1429
Petroleum Products Automotive Petrol – present in fuel tanks of employees cars – based on 40 cars with 30 l/tank & petrol density of 0.7 kg/l (0.84 tonnes) plus Diesel Oil (Defined in Directive as including diesel fuels, home heating oils, and gas oil blending streams). The oil fuel tank will be 40m3, but 50 tonnes are included in inventory assessment to be conservative. 5 tonnes other oils for machinery	55.84	2500	25000	45
Hydrogen Chloride[2] (liquefied gas)	0.02	25	250	1250

Notes to Table 1:

1. It can be assumed that the above are the only named substances that Indaver expects on their site in a predictable quantity. However, small quantities of other named substances could enter the site via household waste streams e.g. minor LPG residues in aerosols, household cleaning agents in empty containers etc

2. The HCl material present on the site will be in the form of aqueous Hydrogen Chloride in a 30% solution by weight. The maximum quantity of solution stored is 1 tonne and the material will be stored indoors. It should be noted that the aqueous HCl is not classified as a Seveso substance in its own right. However, we have included in the inventory a quantity of 20 kg of Hydrogen Chloride gas. HCl when present as a liquefied gas can evaporate if released and it is classed as a dangerous "named" substance in Part 1 of the

First Schedule). We estimate that a 20 kg quantity of HCl gas could be evolved over a 1 hour period in the event of a spill of the 30 % solution hence we include this quantity in the inventory

As can be seen from the above table, the quantities of each of the individual 'named substances' or families of named substances that are expected to be present on the Indaver site at Carranstown at any one time are all very much below their respective minimum thresholds at which the site would qualify for regulation under SI 74 (either as a Lower or Upper Tier site).

In the case of the aggregate quantity of dioxins in the incoming waste and in the ash/residue streams, we have updated the projected dioxin inventory on the site using the latest dioxin concentration data from Indaver's Beveren plant and on dioxin levels measured on that site in municipal waste, bottom ash (slag), boiler ash (fly ash) and gas cleaning residues. The concentration data were provided by Indaver based on analysis at their municipal waste incineration facilities in Beveren near Antwerp.

Based on the maximum projected tonnes of materials stored on the site we have calculated that the maximum site inventory of dioxins at any time will be ~ 0.685 grams. This is a factor of 1,459 (one thousand, four hundred and fifty nine) times lower than the 1 kg threshold quantity which would qualify a site as a Seveso site based solely on the threshold for dioxins in Part 1 of the First Schedule. (See also Tables 3, 4 and 5 for the effects of aggregation of named substances and categories of several substances.)

The named substance with the highest percentage of the Lower Tier Threshold limit is under the category of named substances entitled "Petroleum Products". The inventory of this category of named substances is 55.8 tonnes[1] most of which is accounted for by 50 tonnes of gas oil used as a standby fuel. The factor by which this quantity is below the Lower Tier Threshold for petroleum products in the Regulations is 45.

In addition to checking the status by reference to the thresholds for the "Named" Seveso substances in Part 1 of the First Schedule, it is also necessary to compute inventory levels for substances under three other categories using the three addition rules in the Regulations. These categories are

- substances categorised as toxic or very toxic
- flammable substances
- substances which are Dangerous for the Environment

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[1] We have conservatively assumed that the light fuel oil proposed by Indaver is gas oil and that it falls under the new category of "Petroleum Products in the First Schedule of SI 74 of 2006.

Table 2: Review of Categories of Substances not specifically named in Part 1 of First Schedule in SI 74

Category of Substance	Max Quantity on Site (tonnes)	Lower Tier Threshold (tonnes)	Upper Tier Threshold (tonnes)	Expected Inventory as % of Lower Tier Threshold	Factor by which Carranstown inventory is below Lower Tier Threshold
Dangerous for the environment in combination with the risk phrase R53 (may cause long term adverse effects in the aquatic environment): Indaver will store 5 tonnes of diesel fuel for machinery. It will also store 50 tonnes of light fuel oil to fuel the auxiliary burners. If this oil is in the diesel range then the Risk Phrase R51/53 would apply. As a named substance the appropriate threshold is that of "Petroleum Products" for which the lower tier threshold is 2500 tonnes	55.84	2500[2]	25,000	2.03	45

In relation to other materials with the potential to be classified as "Dangerous for the environment" we have conducted a separate assessment of whether any of the ash residues produced would fall under this category due to their respective heavy metal contents. (See table in Appendix 2).

Application of Addition Rules by combining Named Substances in Part 1 of the First Schedule with Categories of Substances in Part 2

The addition rules involve the calculation of a value, commonly referred to as the q/Q value, for each Seveso substance, where:

q = quantity of the substance present on the site;

Q = threshold quantity for either Lower or Upper Tier site.

In accordance with Note 4 of Part 2 of the First Schedule SI 74 the q/Q values should be aggregated separately under three different categories:

- toxicity,
- flammability and
- eco toxicity.

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[2] Revised threshold for named "Petroleum Products" per SI 74 of 2006

This is done by computing (a) q/Q for all toxic substances (b) for all flammable substances and (c) q/Q for substances dangerous to the aquatic environment present at the site. The results of these calculations are set out in Tables 3 and 4 and 5 below.

Table 3: Application of Addition Rule for Toxic Substances - Carranstown

Substance	*Q* *(tonnes)*	$Q_{Lower\ Tier}$ *(tonnes)*	*q/Q* *Lower Tier Basis*
Dioxins	0.00000070	0.001	0.00070
HCl gas	0.02	25	0.0008
Petroleum Products	55.84	2500	0.0223
Sum *q/Q* for toxics			**0.0238**
Safety Factor below Seveso Lower Tier Threshold (Q/q)			**42**

Table 4: Application of Addition Rule for Flammable Substances - Carranstown

Substance	***Q*** **(tonnes)**	$Q_{Lower\ Tier}$ **(tonnes)**	***q/Q***
Natural Gas – in pipeline on site (Named Substance)	0.62	50	0.0124
Automotive Petrol – in employees cars (Named Substance Petroleum Products)	0.84	2500	0.000168
Sum *q/Q* for Flammables			**0.0126**
Safety Factor below Seveso Lower Tier Threshold (Q/q)			**79**

Note: The petrol in employee cars is flammable and is included in the q/Q computation for flammability for completeness of the inventory of flammable substances in Table 4 above.

The gas-oil which Indaver will use as standby fuel is not classed as flammable but is classified as a Class 3 Petroleum liquid and so does <u>not</u> have the risk phrases which would render as a flammable material as defined under the Seveso Regulations. The gas oil/diesel is however included below under the analysis of materials which are dangerous for the environment. (See table 5)

Table 5: Application of Addition Rule for Substances Dangerous to Environment - Carranstown

Substance	*Q* *(tonnes)*	*Q_{Lower Tier}* *(tonnes)*	*q/Q* *Lower Tier*
Petroleum Products (Named Substance – Gas Oil and automotive petrol)	55.84	2500	0.022
Sum *q/Q* for Dangerous to Environment			0.022
Safety Factor Below the Seveso Lower Tier Threshold			**45**

Classification of Ash/Residues

We examined correspondence between the HSA and Indaver on the subject of the metal content of the ash and residue materials which will be generated by the incineration process. We have checked to see whether these residues are ones which are covered under Part 2 of the First Schedule under the category "Dangerous for the environment (either with risk phrases R50/53 or R51/53)".

Based on the concentration values provided to us for the heavy metal content of residues at Indaver's plant at Beveren near Antwerp, we consider that these materials would have the risk phrase R52-R53 (harmful to the aquatic environment) and as such are not Seveso Substances. The details of that calculation are included in Annex 2.

Outcome of q/Q Analysis

As can be seen from the Tables above the aggregate values for *q/Q* under the three separate headings (a) toxic substances, (b) flammable substance, and (c) substances which are dangerous to the environment (based on the Lower Tier thresholds) are all significantly less than 1.0.

The factors by which the site is below the relevant threshold range from 42 to 79 for the three types of aggregation. In summary the projected site inventories in the three different categories are all over forty times lower than the inventory levels at which the site would become a Seveso site.

This result together with the fact that none of the named substances exceeds or even approaches its lower tier threshold means the proposed facility would not be classified as a Seveso Site under SI 74 of 2006 based on the inventories of dangerous substances associated with a plant of capacity of 200,000 tonnes per year.

Based on the information provided to us by Indaver Ireland, which has been updated to June 2008 it is our view that the proposed incineration facility at Carranstown, Co. Meath is **not** one to which the Regulation in S.I. 74 of 2006 (the Seveso Regulations) apply and the site is not a Seveso site.

Indaver may use this letter, when it is quoted in full, for the purpose of informing discussions with the HSA or the EPA.

Yours sincerely

Thomas Cleary BE, C Eng, Eur Ing, FIChemE, FIEI
Senior Partner
Byrne Ó Cléirigh

Annex 1

Estimation of Maximum Dioxin Inventory on Site

An estimate of the maximum dioxin inventory on the Carranstown site was conducted as set out below.

The dioxins on the site are associated with different waste streams including incoming municipal solid waste and by-product ash streams. In order to calculate the maximum combined inventory, the bunker sizes and maximum quantity of the different waste and residue streams to be stored were provided by Indaver and updated in June 2008. The dioxin concentrations in the individual waste streams were provided by Indaver based on their operating experience with Indaver's municipal waste incineration plant at Beveren near Antwerp, Belgium.

Table A1: Derivation of Maximum Dioxin Inventory on Carranstown site

Material Containing Dioxin	**Max Bunker Capacity (m3)**	**Maximum Quantity[1] of waste expected to be on the site at any time (tonnes)**	**Dioxin[2] Concentrations (ng TEQ/kg)**	**Maximum Dioxin Inventory (g TEQ)**
Incoming Municipal Waste	16,000	6,400	50	0.320
Bottom Ash (Slags)	1600	1,600	22	0.035
Boiler Ash (Fly Ash)	200	120	42	0.005
Residues from Gas Cleaning	420	252	1290	0.325
Total		-	-	**0.685**

Notes:

1. *Based on proposed plant design philosophy, bunker sizes, inventories as of June 2008*
2. *Based on sampling at Indaver's Beveren facility in Belgium*

The total expected inventory of 0.685 grams is a factor of 1,459 (one thousand, four hundred and fifty nine) times lower than the quantity which would qualify the site as a Seveso site based on dioxins alone which is 1.0 kgs according to Part 1 of the First Schedule of SI 74 of 2006.

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Annex 2

Check on Risk Phrases for Incineration Residues Based on Heavy Metal Content

An check was made of the metal contents of the bottom ash (slag), boiler ash (fly ash) and the gas cleaning residues to establish what the appropriate risk phrases would be for the individual residues and whether the heavy metals content would render them as "Dangerous for the Environment" with risk phrase R50 or R51/53.

There are thresholds in the Seveso Regulations for materials with these risk phrases.

SI 74 cited threshold values for two categories of materials:

- R50: Very toxic to aquatic organisms" (including R50/53) – with a threshold for Lower Tier Site of 100 tonnes
- R51/53: "Toxic to aquatic organisms; may cause long term adverse effects in the aquatic environment" – the threshold for a Lower Tier Sites is 200 tonnes.

Table A2: Derivation of Risk Phrases for Ash Residues Based on Heavy Metal Content

Material Containing Dioxin	**Heavy Metals Concentration total (% by weight)**	**Risk Phrase based on concentrations of N,R50-R53 Heavy Metals In materials**
Bottom Ash (Slags)	1.68%	R52-53
Boiler Ash (Fly Ash)	1.21%	R52-53
Residues from Gas Cleaning	1.61%	R52-53
Total		

The designation assigned in column 3 in the above table is based on the rules of the EC Dangerous Preparations Directive 1999/45/EC which provides the basis for classification of mixtures or preparations containing dangerous substances.

Based on the concentration of individual heavy metals in the residues in Indaver's MSW incineration plant at Beveren (see detailed table overleaf), the total heavy metal concentrations in the ash/slag and gas cleaning residues from the incineration process are all lower than 2.5% w/w. This is below concentration at which the residue would be classified either as R50-53 or as R51-53. Based on the Indaver analysis the ash, slags and gas cleaning residues would each be classified as R52-R53 and so are not included in the inventories as they are not deemed as Seveso substances under Part 2 of the First Schedule.

The individual metal concentrations are set out in the following table:

Table A2-1: Heavy Metal Concentrations in Ash and Residues at Beveren

		Heavy Metal Concentration (mg/kg)		
Heavy Metal	Classification	Residues from Gas Cleaning	Boiler Ash (Fly Ash)	Bottom Ash (Slags)
Cd	N - R50/53	170	23	-
Ti	N – R50/53	-	-	-
Hg	N - R50/53	80	-	9
As	N – R50/53	-	20	-
Co	N - R50/53	-	330	560
Cr	N – R50/53	351	1250	484
Cu	N - R50/53	1280	894	3500
Ni	N - R50/53[1]	52	130	300
Pb	N - R50/53	4750	2160	2220
Sb	N – R50/53	910	480	140
Sn	N - R50/53[1]	700	400	350
Zn	N – R50/53	7820	6380	9270
Total Heavy Metal Concentration (mg/kg)		16,113	12,067	16,833

Note 1: "Information Approved for the Classification and Labelling of Substances and Preparations Dangerous for Supply" (CHIP List) by Health and Safety Commission (HSC) UK indicates that some Nickel compounds and some Tin compounds are R50/53 while others are not. For the purposes of this calculation we have conservatively assumed that all Ni and Sn compounds present in the ash residues have this classification.

Table A2-2: Preparation classification based on aquatic toxicity effects.

Classification of the substance	**Classification of the preparation**		
	N, R50-53	N, R51-53	R52-53
N, R50-53	$C_n \geq 25\%$	$2.5\% \leq C_n < 25\%$	$0.25\% \leq C_n < 2.5\%$
N, R51-53		$C_n \geq 25\%$	$2.5\% \leq C_n < 25\%$
			$C_n \geq 25\%$

By comparing the Indaver concentrations in Table A2-1 with the ranges in Table A2-2 it can be seen that heavy metal concentrations in ash/residues fall in the range $0.25\% \leq C_n < 2.5\%$. On this basis it would appear that the appropriate designations is R52-53 which is not a Seveso category under the section Dangerous for the Environment in Part 2 of the First Schedule in SI 74.

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6 HUMAN BEINGS

6.1 INTRODUCTION

This chapter evaluates the impacts, if any, which the development will have on Human Beings. This chapter has been revised to reflect the impact on human beings as a result of the proposed amendments to the existing permission.

In accordance with the Environmental Protection Agency (EPA) ‘Advice Notes on Current Practice (in the preparation of Environmental Impact Statements’), 2003, this chapter has considered the ‘existence, activities and well being of people’ with respect to ‘topics which are manifested in the environment such as new land-uses, more buildings or greater emissions’. Issues examined in this section include:

- Health and Safety
- Social Consideration
- Land Use
- Economic Activity

These issues are discussed below in further detail. Consideration of other issues as recommended by the EPA ‘such as employment, commercial competition, zoning and social and economic activity are also dealt with in this section.

6.1.2 Human Beings Baseline Study

6.1.2.1 Introduction

This portion of the human beings assessment is conducted by reviewing the current socio economic status in the areas close to the proposed development. In the case of this facility, this is the District Electoral Division (DED) of Duleek in Co. Meath.

Identification of principal potential receptors and analysis of recent trends in population, employment economic performance and land use including local amenities was reviewed and the impact of the development was assessed against this background. Reference is made to the most recent census data available from the Central Statistics Office (CSO), ‘Census of Population 2006, Small Area Population Statistics’. The DED of Duleek includes 15 townland areas including:

- Carranstown*
- Abbeyland
- Caulstown*
- Commons*
- Cruicerath*
- Downestown
- Drumman
- Gillinstown
- Longford*
- Lougher

- Newtown*
- Prioryland
- Reask
- Roughgrange
- Stalleen*

The proposed development is located in the townland of Carranstown. Townlands accompanied with an asterix (*) are those within 3km of the proposed development.

6.1.2.2 Principal Potential Receptors

An assessment of principal potential receptors within the environs of the facility including homes, hotels, holiday accommodation, schools and rehabilitation workshops and commercial premises was conducted and is detailed below.

Housing development in the Duleek area between 2002 and 2006 intensified considerably, since the completion of the previous application, most notably in the village of Donore and Duleek town. A complete housing survey was conducted in the vicinity (3Km radius) of the proposed development and is illustrated in Figure 6.1.

Cognisance of the facilities in the villages of Duleek and Donore are also referenced as the development site is located approximately 2.7 km north east of Duleek and 2.6 km south east of Donore in Co. Meath.

Homes

Residential development in Carranstown is predominantly ribbon development along the main roads. These vary from one off housing to garages and two-storey farmhouses with associated sheds. A number of small commercial/industrial units including a petrol station and forecourt shop have been constructed approximately half way between the site and Duleek village. The closest residential dwellings to the site are;

- Two dwellings adjacent to the eastern boundary of the site,
- Two dwellings located across the R152 to the south of the site,
- A group of five residential dwellings and a garage located across the R152 road from the eastern corner of the site,
- One unoccupied house and a newly built house adjacent to the southern boundary
- A further group of dwellings including two farm houses about 400 metres to the west of the site across the railway line.

CSO information for 2002 and 2006 was used in assessing the number of households and the number of people in private households within the study area. The household size i.e. the number of people residing permanently at a household was evaluated on a national, county and DED level. The findings are illustrated in Table 6.1 and 6.2 respectively.

Table 6.1 Numbers of Households in the Study Area, 2002 and 2006

	2002	2006	Increase/ Decrease
Persons in private households (Duleek DED)	2922	3236	+314
Number of households (Duleek DED)	941	1107	+166

The findings illustrate that within the study area the number of households has increased and that the number of people residing permanently at a household has decreased between 2002 and 2006 as it also did between 1996 and 2002. This follows the general national trend.

Table 6.2 Households Sizes on National, County and DED Level, 2002 and 2006

	2002 (Units/people per household)	2006 (Units/people per household)	% Increase/Decrease
State	2.94	2.81	- 0.13%
County Meath	3.2	3.00	- 0.2%
Duleek DED	3.1	2.92	- 0.05%

Health, Social and Community Facilities

Health, social and community facilities located in the study area are limited but include:

- Local Football Club, Opposite Carranstown Lodge
- Duleek Pitch 'n' Putt Club

Schools

Details are provided below on the four primary schools located in the study area, including their address.

Table 6.3 Educational Facilities in the Area

School Type	Name	Address	Approximate Distance from Site (km)
Primary	Scoil Colm Cille	Mt Hanover, Duleek Co. Meath	1
Primary	Donore Primary	Donore, Duleek, Co. Meath	2
Primary	Duleek Girls NS	Duleek, Co. Meath	2.5
Primary	Duleek Boys NS	Duleek Co., Meath	2.5

Heritage and Amenity

The Area is classified under the County Development Plan as 'Rural and Agricultural'. The closest 'Areas of Visual Quality' to the development site are the 'Lower Boyne Valley' located about 2km to the north and the 'River Valleys' located about 2km to the South (See figure 6.2). The Area immediately surrounding the site is not a significant tourist attraction.

The Boyne Valley holds significant archaeological value that attracts tourists. In addition it has the tourism potential for fishing holidays in the River Boyne. Duleek village does have heritage connections to the events of the Battle of the Boyne. The village boasts a number of religious crosses, churches and Abbeys as well as the oldest Lime tree in Ireland. Heritage protected structures and amenities in the area include:

- Bellewstown Race Course
- Bru Na Boinne visitor centre incorporating Newgrange, Knowth and Dowth Megalithic tombs
- The Boyne River Valley
- The Battle of the Boyne historic area
- Duleek village churches and crosses- the Priory, St. Cianan's Church, Dowdall Cross

Some of the heritage sites listed above form part of the Meath Heritage trail, which ends at Newgrange (6Km from the proposed site Fig 6.2).

Proposed Natural Heritage Areas (pNHA) in the locality includes (see Chapter 13 for more information on these):

- pNHA. Duleek Commons (No. 01578)
- pNHA Thomastown Bog (No. 01593)
- cSAC Boyne River Islands (No. 01862)
- pNHA Dowth Wetland (No. 01861)

The above proposed natural heritage areas (pNHAs) are located between 2km and 5km from the proposed facility. Therefore there was no requirement to assess the potential impact of the facility on these sites. The locations of the above pNHAs including site synopses are further discussed in Section 12 – Ecology.

Commercial and Industrial premises

The development is situated to the southwest of the existing Irish Cement Ltd. cement manufacturing plant and associated quarry works at Platin, Duleek, Co. Meath. Annual output here is about 1.4 million tonnes of Cement annually.

As mentioned previously there is a garage and tyre shop located across the R152 to the eastern boundary of the development site. In addition there are industrial units in the townsland of Gaffney approximately 1.5km to the southwest of the site. As much of the study area is farmland the majority of the non-residential buildings in the area are farm sheds and related agri-business. These small businesses are scattered around the study area.

Areas in Duleek have been targeted for mixed residential and commercial development. There are many commercial units in the centre of Duleek village including convenience stores, comparison outlet and service businesses. The service units include hairdressers, betting offices, pubs, restaurants, post office and credit union. Additional retail units are being developed within the village centre to the east of the Main Street.

A commercial park has been established to the east of Duleek village. This park has the capacity of approximately 30 Industrial units.

6.1.2.3 Recent Trends in Population

The closest population centres to the development site are Duleek village to the south west and Drogheda town to the north east. Carranstown is located within Duleek DED. CSO data provides an ability to review recent trends in population within the Study Area over a four year period i.e. from 2002 to 2006 as illustrated in Table 6.4. During this period the population in the study area increased by c.10 %. This is in excess of the growth experienced at state level at 8.2% though below the county growth rates of 21.5 %. The 2006 census figures revealed that the population of Duleek expanded to 3,236 between 2002 and 2006.

Table 6.4 **2002 and 2006 Population of the Study Area**

	2002	2006	% Increase
State	3,917,203	4,239,848	8.2
County Meath	134,005	162,831	21.5
Duleek DED	2941	3,236	10.0

The demographic profile i.e. the age structure, of the population in the study area is illustrated in Table 6.5. The table shows a notable increase in overall population with notable increases particularly in the 25-44 age group. An increase of 36% was noted in this age group.

Table 6.5 **Demographic Profile within the Study Area**

	2002		2006	
	Actual	**%**	**Actual**	**%**
0 - 14	651	22.13	765	23.64
15 - 24	512	17.40	464	14.33
25 - 44	951	32.33	1297	40.1
45 - 64	603	20.50	539	16.65
65+	224	7.61	171	5.28
Total	2941	100.0	3236	100.0

6.1.2.4 Recent Trends in Employment

Recent trends in employment were evaluated using CSO information and information generated from the Small Area population Statistics. The information was complied on the basis that:

- The labour force is defined as the sum of people aged 15+ who are at work or who are unemployed
- The participation rate is the proportion of persons in the workforce aged 15 and over expressed as a percentage of all persons in that age group
- The unemployment rate is the proportion of all people unemployed expressed as a percentage of all persons in the labour force

The findings illustrate that the unemployment rate within the study area is 3.69%, which is a slight increase on the 2002 statistics of 3.58%.

Upon evaluation of the principal employment profiles as illustrated in Table 6.7, it is evident that employment rates in agriculture, manufacturing and building/construction are decreasing while employment rates in commerce, clerical and professional services are increasing. Clearly as this data relates to an employment profile based on 2006 census data, the employment profile is likely to have changed significantly in the area between 2006 and 2009, particularly in light of the changed economic circumstances.

Table 6.6 Employment Figures

	Persons aged 15+		At Work		Unemployed		Labourforce		Participation Rate		Unemployment Rate of Workforce	
	2002	**2006**	**2002**	**2006**	**2002**	**2006**	**2002**	**2006**	**2002**	**2006**	**2002**	**2006**
DED	2290	3358	1277	2149	82	124	1359	2273	59.3%	67.6%	3.58%	3.69%

Table 6.7 Distribution of Employment Sectors within the Study Area

	DED	
	2002 %	**2006 %**
Agriculture (including fishing,forestry)	5.71	3.07
Manufacturing/ Industry	21.45	14.65
Building/ Construction	18.48	13.77
Commerce (including service)	20.83	22.25
Transport	6.73	8.8
Clerical/ Public Admin	4.15	18.24
Prof Workers	9.47	10.42
Other	13.16	8.8
Totals	100	100

6.2 HEALTH AND SAFETY

6.2.1 Human Health

As part of the 2006 EIS, Dr. Martin Hogan AFOM, FFOMI, a Medical Doctor specialising in Occupational Medicine was asked to assess the potential effect on human health of the Municipal Waste Incinerator at Carranstown Co Meath. It is considered that the proposed amendments, which do not result in a change to the primary process or the nature or characteristics of the emissions will not result in an impact on human health. This is demonstrated in the findings of the revision of the air quality study and the dioxin uptake modelling as per Section 7 Air Quality and Section 6.3 on Dioxin Uptake below. It is therefore not considered necessary to reassess the potential impacts of the facility on human health.. A summary of the study conducted in 2005 is discussed below.

Dr Hogan is a full time consultant occupational & environmental physician and Director of Employment Health Advisers Ltd (EHA). In assessing this project EHA relied on their own knowledge and experience, evidence available in the literature on this topic. EHA also relied on the information contained elsewhere in the EIS for the development site prepared for Indaver by various specialists. In making the assessment EHA made the assumption that the incinerator will be built and operated as per terms described in the EIS and as licenced by the EPA.

6.2.2 Assessment Methodology

An independent health assessment was conducted to assess the potential effect on human health of the waste-to-energy facility. The assessment included a review of evidence available in literature and in particular the publication by the Health Research Board on *Health and Environmental Effects of Landfilling and Incineration of Waste* and the recent publication *A review of the environmental and Health effects of Waste Management* published in May 2004 by the UK Department of the Environment, Food and Rural affairs. The primary topics examined in the various published studies include respiratory symptoms and illness, reproductive effects and the development of cancer.

6.2.3 Discussion

Cancer

Despite reports of cancer clusters, no consistent or convincing evidence of a link between cancer and incineration has been published. In the UK, the large epidemiological studies by Elliott and colleagues of the Small Area Health Statistics Unit (SAHSU) examined an aggregate population of 14 million people living with 7.5 km of 72 municipal solid waste incinerators. This included essentially all incineration plants irrespective of age up to 1987. Despite the consequent inclusion of incinerators with emissions of potential carcinogens much higher than would occur from modern incinerators, both studies were unable to convincingly demonstrate an excess of cancers once socio-economic confounding was taken into account (Elliott et al., 1992; 1996; 2000).

As a result of these, the UK Department of Health's Committee on Carcinogenicity published a statement in March 2000 evaluating the evidence linking cancer with proximity to municipal solid waste incinerators in the UK (Committee on Carcinogenicity, 2000). The Committee specifically examined the results of these studies and concluded that, "any potential risk of cancer due to residency (for periods in excess of ten years) near to municipal solid waste incinerators was exceedingly low and probably not measurable by the most modern techniques". The Committee agreed that, at the present time, there was no need for any further epidemiological investigations of cancer incidence near municipal solid waste incinerators.

Dioxins

It has been hypothesised that exposure to dioxins and furans (either directly via inhalation or indirectly via the food-chain) is responsible for some cancers in communities around incinerators. However, epidemiological studies on the older generation of incinerators that emitted significantly greater amounts of dioxins than newer facilities have failed to identify an effect. Given that the emissions of dioxins and furans from modern incinerators are of orders of magnitude lower than from older incinerators, it can be said with some confidence that any impacts of dioxin and furan on cancer rates in local people are small or non-existent and unlikely to be quantified through epidemiology. This is confirmed by no less a body than the W.H.O. which stated regarding dioxins that;-" *there is a level of exposure below which cancer risk would be negligible"*

Respiratory Issues

Available studies have typically examined respiratory health around the older generation of incinerators. Most are based upon self-reported symptoms and therefore may be subject to bias. Overall, there is little evidence to suggest that waste incinerators are associated with increased prevalence of respiratory symptoms in the surrounding population.

Any of studies which are often cited to demonstrate effect are either not scientifically reliable because of: the design of the study; confounders; they deal with open and/or hazardous combustion; or they deal with facilities with limited or no gas cleaning not operating to the current EU emission limits. Therefore such studies are of no real relevance to the proposed facility. Reports of reproductive effects such as increased twinning have not been reproducible and are again of limited value anyway because of the marked drop in emission levels.

The fact that the proposed incinerator will have to be operated in accordance with the strict terms of the EU incineration directive means emissions will be lower than from practically all studied incinerators reducing even further any possible risk.

6.2.4 Conclusions

All information on the proposed municipal waste incinerator suggest that there will be no deleterious effect on human health either in the immediate vicinity or further away, in the short term or in the longer term.

6.3 DIOXINS

Soil sampling and ambient air monitoring data, was used to establish a baseline for PCDD/F (hereafter referred to as ‘dioxins and furans’) intake for a theoretical Maximum At Risk Individual (MARI) in the Carranstown area as part of the 2006 EIS for the proposed Carranstown Waste to Energy Facility. The MARI was assumed to live at the point of maximum dioxin and furan deposition from the proposed development and to be a subsistence farmer, who obtained all their meat, milk and vegetables from a 100m diameter site, upon which the maximum deposition flux impacted.

The baseline dioxin and furan intake for the MARI was modelled following US EPA Methodology and using the Dutch Government approved Model RISC Human 3.2 (May 2005). The baseline dioxin and furan intake was predicted to be 0.8519 pg/kg bodyweight/day (5.96 pg/kg bw/wk), significantly below the EU TWI of 14 pg WHO-TEQ /kg body weight, which is considerably more stringent than the WHO intake criteria of 1 – 4 pg/kg body weight/day.

The annual average dioxin and furan emissions under maximum operating conditions (worst case emissions) from the proposed waste-to-energy facility were then used to model soil PCDD/F concentrations over the operating life of the facility. This was a very conservative assumption as it assumed the plant operated 24 hours per day, 365 days per year at the maximum emission concentration and flue gas flow rate.

The modelled soil and air values were then added to the existing background values for dioxin and furans and input to the RISC HUMAN Model.

The model predicted that the emissions from the waste-to-energy facility, were predicted to increase the PCDD/F dose to a theoretical MARI by only 0.0371 pg/body weight/day (as WHO-TEQ), from 0.8519 pg/kg bodyweight/day to 0.8890 pg/body weight/day (6.22 pg/kg bw/wk).

The predicted dioxin and furan intake for the MARI was therefore determined to be low and to be well below the EC TWI of 14 pg WHO-TEQ /kg body weight. The TWI was set by the EU in order to protect human health and was based on applying a safety factor to the LOAEL (Lowest Observed Abnormal Effect Levels) for dioxin and furans.

It should be noted that the MARI assessment is extremely conservative, as it assumes the MARI is a subsistence farmer living at the point of maximum dioxin and furan deposition and it also assumes the WTE operates at maximum licensed flow rates and dioxin and furan concentration.

A potential accident scenario was modelled and it was found that the predicted dioxin and furan intake for the accident scenario occurring annually was also well below relevant EU limit values.

It was therefore be concluded that the proposed waste-to-energy facility will have no significant impact on dioxin and furan intake for even the theoretical MARI.

The predicted PCDD/F deposition flux for the 2006 application in summarised in Table 6.8 below and the predicted PCDD/F flux for the 2009 application is shown in Table 6.9.

Table 6.8 Predicted Dioxin Deposition Flux 2006 Planning Application

Pollutant / Scenario	**Averaging Period**	**Process Contribution (pg/m^2/day)**	**Predicted Total Particulate Deposition Flux (pg/m^2/day)**
PCCD/PCDFs / Maximum	Annual Average	0.47	0.47
PCCD/PCDFs / Abnormal A	Annual Average	0.60	0.60
PCCD/PCDFs / Abnormal B	5 Weeks	0.48	0.48
PCCD/PCDFs / Abnormal B	Annual Average	0.80	0.80

Table 6.9 Predicted Dioxin Deposition Flux 2009 Planning Application

Pollutant / Scenario	**Averaging Period**	**Predicted Total Particulate Deposition Flux (pg/m^2/day)**
PCCD/PCDFs / Average	Annual Average	0.30
PCCD/PCDFs / Maximum	Annual Average	0.32
PCCD/PCDFs / Abnormal A	Annual Average	0.34
PCCD/PCDFs / Abnormal B	5 Weeks	1.60
PCCD/PCDFs / Abnormal B	Annual Average	0.44

It can be seen that in the case of the 2009 modelling scenarios, predicted dioxin flux for the average and maximum scenarios is significantly below the predicted 2006 values, and therefore it follows that predicted dioxin intake will also be significantly less than the modelled 2006 intake.

Short term dioxin flux in the “Abnormal B” scenario is somewhat elevated compared to the 2006 scenario. The 2006 “5 weeks” scenario was predicted to lead to an increase of 8.4% in PCDD/F intake over the baseline intake scenario. The 2009 “5 weeks” scenario is predicted to lead to a short term increase in dioxin deposition which is some 3.3 times the 2006 predicted value. This would translate to a 25% increase in PCDD/F intake compared with the baseline intake value, which is only 7.4 pg/kg bw/week, just over 50% of the limit value of 14 pg/kg bw/wk.

Based on the above it was concluded that there was no requirement to conduct detailed PCDD/F intake modelling in support of the 2009 planning application.

6.4 ODOUR

As part of the EIS completed in 2006, Odour Monitoring Ireland Ltd completed an odour impact assessment of the Waste to Energy Facility at Carranstown Co Meath. It is considered having rerun the “AERMOD Prime” odour model using five years of hourly sequential meteorological data and allowed for the proposed amendments including the updated building dimensions, there will be no increase in predicted ground level concentrations of odour. All predicted ground level concentrations will be below the EPA and UK Environment Agency odour impact criterion for high risk odours. Therefore there will be no odour impact in the vicinity of the facility as a result of the building height changes and dimensions, as established in the previously submitted EIS. It is therefore not necessary to revisit the odour assessment presented in the 2006 EIS. A summary of the study conducted in 2005 is presented below.

In 2005 an odour emission survey was performed on a similar operating plant at Kallo, Belgium in order to allow process specific data be used within the dispersion model.

Three scenarios were assessed:

1. Maintenance of negative air pressure during shutdown and exhaust through the existing 65-metre stack,
2. Maintenance of negative air pressure during shutdown and treatment in a fixed bed biofiltration system,
3. Maintenance of negative air pressure during shutdown and treatment in an annular bed carbon filtration system,

Odour dispersion modelling was performed using the recommended Environmental Protection Agency (EPA) dispersion model ISC ST3 and the more advanced US and UK EPA recommended Aermod Prime. A worst-case meteorological year (Dublin Airport 2002) was used to ascertain the worst-case ground level concentrations (GLC’s) of odour in the vicinity of the proposed site.

Following dispersion modelling of odours for all three scenarios, it was concluded that there will be no significant ground level impact of odours from the exhaust stack, with all predicted concentrations lower than the EPA recommended odour concentration of 3.0 Ou_E m^{-3} at the 98th percentile of hourly averages.

It is proposed to maintain negative air pressure and exhaust air through the stack. During periods of shutdown odour emissions from the proposed facility will be insignificant and therefore will not impact on the local community or the environment.

6.5 SOCIAL CONSIDERATIONS

6.5.1 Introduction

Planning permission has been granted for the construction of a 70 MW waste-to-energy facility on the site, which will have an operating capacity of a maximum of 200,000 tonnes per annum, as outlined in previous sections. As discussed in Sections 2 & 4, Ireland remains in urgent need of alternatives to landfill due to pressures from the EU and Irish legislation. While waste-to-energy is not the definitive solution to the waste issue in this country, its necessity is paramount to the success of sustainable waste management in Ireland.

While being an end of cycle process for waste, the re-use of the waste as energy is in line with the principles of the waste hierarchy and sustainable development as detailed in Section 2 the Background to the Project. Furthermore the permitted development will have a significant role in the following:

- The facility will service the North East region, which generated 954,746 (including agricultural) tonnes of waste in 2003. An estimated 454,198 tonnes of household, commercial and industrial waste was generated within the North East Region in 2003. The development is in line with the North East Regional Waste Plan, which calls for a Thermal Treatment plant for 150,000 – 200,000 tonnes of residual waste.

- It will contribute to Ireland's renewable energy targets as required under EU Directive 2001/77/EC. Renewable energy will be generated from the biodegradable fraction, which is, on average over 50% of the waste treated. The proposed facility can provide enough electricity for 19,000 homes annually. It will also contribute to the production of electricity to reduce both the reliance on energy imports and exposure to international markets.

- Ireland has committed, under the Kyoto Protocol, to maintaining its green-house gas emissions to some 13% above its 1990 levels in the period 2008- 2012. The reduction from the fossil fuel energy sector will make a significant contribution to achieving Ireland's Kyoto obligations.

- Reduce landfill emissions of methane due to diversion of the waste stream from landfill to incineration.

- The Landfill Directive 1999/31/EC set national targets for the diversion of biodegradable waste from landfill (based on the 1995 waste figures). The quantity of biodegradable waste going to landfill in 2007 was 1.47 M tonnes. There remains an ever more urgent requirement to establish necessary treatment facilities in order to achieve the National targets as set out by the landfill directive and the National Strategy for Biodegradable Waste (2006).

6.5.2 Impacts and Mitigation Measures

Impacts upon society as a result of this development have been considered in detail in this EIS. Detailed descriptions of the effects, residues and emissions associated with the facility are presented in Sections 6-17 under the following headings:

Section 6: Human Beings
Section 7: Air
Section 8: Noise
Section 9: Geology and Soils
Section 10: Groundwater and Hydrogeology
Section 11: Surface Water
Section 12: Ecology
Section 13: Traffic
Section 14: Landscape- Visual Impact
Section 15: Climate
Section 16: Cultural Heritage
Section 17: Material Assets

6.6 TOURISM , LAND USE & ECONOMIC ACTIVITY

As outlined above the proposed amendments will not impact on the local population from a health perspective i.e. medical, dioxins or odour. The following sections describe the potential indirect impact of the proposed facility on human beings via tourism, landuse and employment. Impacts on a number of other related economic assets are described in Chapter 17 Material Assets. The proposed amendments for largely the same development within the same site will have no impact on tourism, land use or economic activity in the site or its environs. A summary of the findings of the assessments completed in 2006 is presented below.

Incinerator in Vienna

Incinerator in Portugal

6.6.1 Tourism

In general the site and environs are predominantly agricultural and therefore tourism is not a major industry in the area. The primary attractions in Duleek and the surrounding areas are listed above under ‘Heritage and Amenity’. There is some tourist accommodation in the form of B+Bs within a 3km radius of the proposed development though there are no hotels, caravan sites or self-catering accommodation in the study area. These facilities are available at the nearby towns of Drogheda, Ardee and Navan.

6.6.1.1 Impacts and Mitigation Measures

Many of the 450-500 European municipal waste-to-energy facilities are located in the vicinity of major tourist attractions. Incinerators are currently operating in European cities such as Paris, Monaco, Vienna and Lisbon and on islands such as Madeira and Majorca, all popular holiday destinations and where tourism makes a significant contribution to the national economy. From research to date there is no evidence to suggest that a waste-to-energy plant has a significant impact on tourism in the vicinity. No mitigation is proposed in relation to potential impact for tourism.

Incinerator in Maderia

Incinerator in Majorca

6.6.2 Land Use

The facility is located on an area of approximately 10 hectares (25 acres in the townland of Carranstown, County Meath (Figure 6.1). This environmental impact assessment evaluates the site in its entirety. As outlined in Section 17 there will be no severance of land as a result of the proposed development. There will also be no loss of rights of ways, amenities or rezoning of land required. The operation of the development is not predicted to have any significant impact on the land-use of the surrounding areas and is not predicted to have any significant impact on the housing in the surrounding areas. (See section 17– Material Assets for further information.)

6.6.2.1 Impacts and Mitigation Measures

Cognisance of the impact that this development will have on the environment as a whole has been evaluated in Section 6-17.

6.7 ECONOMIC ACTIVITY

6.7.1 Introduction

On the basis of the most recent Census data, the total labourforce within the study area in 2006 was 2,273. The largest employment sector is in the commerce sector accounting for 22.25% of the employment rate. This is followed closely by the clerical/public admin sectors comprising 18.24% of the workforce respectively.

6.7.2 Impacts

Direct Impacts

As outlined in Section 18, it is expected that during peak activities, approximately 300 people will be working directly on the construction site. The staff will comprise of managerial, technical, skilled and unskilled workers. The number of employees working in the building and construction sector in the DED in 2002 is 296 people. It is anticipated that this proposed development will increase the numbers of employees in this sector.

Money generated during the construction phase alone will have an associated benefit to the study area and its surroundings with respect to expenditure on local goods, services and accommodation.

It is estimated that approximately 50 personnel will be employed in a full time capacity at the proposed facility during its operation. It is considered that the revenue generated from the additional employment of 50 persons within the study area will result in additional money being spent in the locality. This will have effects on local service demand, accommodation etc over a long term basis resulting in continued expenditure within the locality.

Indirect Impacts

Additional employment associated with the support services sector will also be generated in the locality which will include areas such as goods deliveries, cleaning and catering contracts. Such long term indirect employment will result in continued expenditure within the locality and as such will have a positive impact on the local economy.

Community Gain

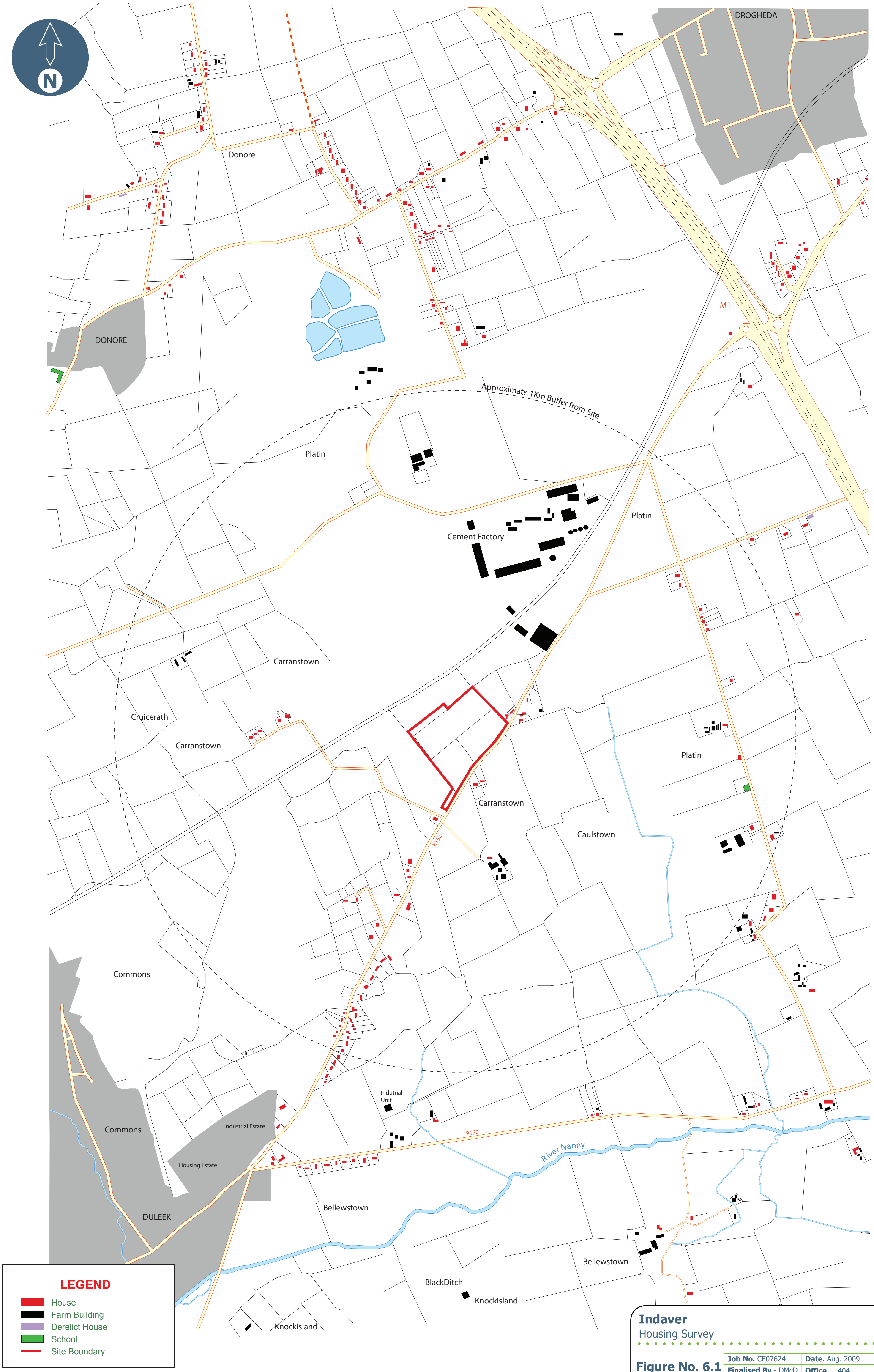
As a condition of the planning permission granted to Indaver Ireland an annual financial contribution is made to Meath County Council for the provision of environmental improvement and recreational/community facility projects in the vicinity of the proposed facility. The identification of environmental/recreational/community facility projects shall be decided by Meath County Council and the Community Liaison Committee.

6.7.3 Mitigation Measures

During the operational phase of the proposed development an increase in employment within the DED will occur and introduce related expenditure into the economy as detailed above. Furthermore, the construction works for the proposed development is scheduled to take place over approximately two years, as outlined in Section 18. It is estimated that a maximum of 300 people will be employed during this period at the peak of construction activities. Therefore no mitigation measures are suggested as the proposed development will have a positive impact on the economic activity of the study area.

6.8 RESIDUAL IMPACTS

Strict adherence to the mitigation measures recommended in Sections 6 to 18 will ensure that there will be no negative environmental impacts or effects on Human beings as a result of the proposed amendments to the development.



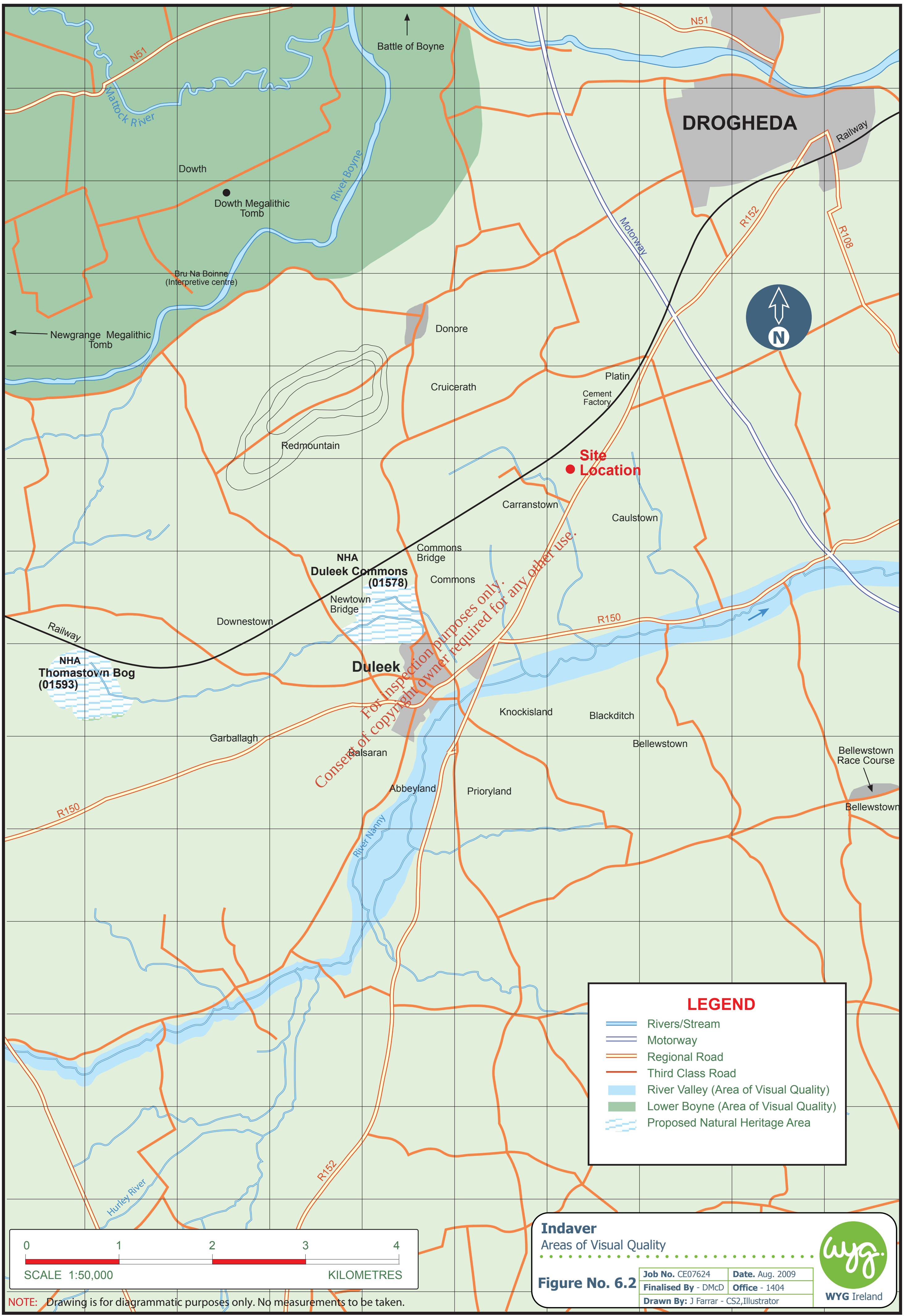
NOTE: Drawing is for diagrammatic purposes only. No measurements to be taken.

Indaver
Housing Survey

Figure No. 6.1

Job No. CE07624	**Date.** Aug. 2009
Finalised By - DMcD	**Office** - 1404
Drawn By: J Farrar - CS2,Illustrator	

WYG Ireland



NOTE: Drawing is for diagrammatic purposes only. No measurements to be taken.

Indaver
Areas of Visual Quality

Figure No. 6.2

Job No. CE07624	**Date.** Aug. 2009
Finalised By - DMcD	**Office** - 1404
Drawn By: J Farrar - CS2,Illustrator	

WYG Ireland

7.0 AIR QUALITY

7.1 INTRODUCTION

Planning permission has been granted (File Reference Number SA/600050 & PL.219721) for the development of a 70 MW waste-to-energy facility with a maximum annual capacity of 200,000 tonnes at Carranstown, Duleek, Co. Meath. The current air modelling study has been undertaken to assess the impacts of the proposed amendments to the existing planning permission solely relating to some minor changes to the relative position of the stack and associated buildings. The height of the stack remains unchanged from the previous application.

An additional scenario has also been added to modelling scenarios. This additional scenario was undertaken to assess the impact of maximum emission limit values at nominal flue gas flow rates. This scenario is in addition to the modelling exercise carried out at 110% of the flue gas flow rate at maximum emission limit values.

7.1.1 Overview of Assessment

Indaver has commissioned an extensive and detailed examination of air emissions from the waste management facility in Carranstown, Duleek Co. Meath as a result of the proposed amendments to the existing planning permission. As described in detail elsewhere, the waste management facility will be based on conventional grate incineration technology. The waste is tipped into a bunker prior to being fed into the furnace. In the furnace the waste is incinerated, producing heat, ash and combustion gases.

The combustion of waste produces a number of emissions, the discharges of which is regulated by the EU Directive on Waste Incineration (2000/76/EC). The emissions to atmosphere which have been regulated are:

- Nitrogen Dioxide (NO_2)
- Sulphur Dioxide (SO_2)
- Total Dust (as PM_{10} and $PM_{2.5}$)
- Carbon Monoxide (CO)
- Total Organic Carbon (TOC)
- Hydrogen Fluoride (HF) and Hydrogen Chloride (HCl)
- Dioxins/Furans (PCDD/PCDFs)
- Cadmium (Cd) & Thallium (Tl)
- Mercury (Hg)
- and the sum of Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Maganese (Mn), Nickel (Ni) and Vanadium (V).

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

The scope of the study consists of the following components:

- Review of maximum emission levels and other relevant information needed for the modelling study;
- Identification of the significant substances which are released from the site;
- Review of background ambient air quality in the vicinity of the plant;
- Air dispersion modelling of significant substances released from the site;
- Air dispersion and deposition modelling of dioxin and heavy metals released from the site;
- Identification of predicted ground level concentrations of released substances at the site boundary and at sensitive receptors in the immediate environment;
- A full cumulative assessment of significant releases from the site taking into account the releases from all other significant industry in the area based on the Prevention of Significant Deterioration (PSD) approach;
- Evaluation of the significance of these predicted concentrations, including consideration of whether these ground level concentrations are likely to exceed the most stringent ambient air quality standards and guidelines;
- Impact in the unlikely event of “abnormal” operating conditions.

7.1.2 Revisions to February 2006 Dispersion Modelling Assessment

This air dispersion modelling assessment represents an update to that performed for the Indaver revised planning application and EIS submitted to Meath County Council in February 2006. The following revisions to the dispersion model are included in this assessment:

- Changes to the building layout at the site;
- Revision to volume flow, stack internal diameter and emission temperature;
- Updated AERMOD (07026) was used, which includes bug fixes and enhancements from AERMOD (04300) used for the February 2006 planning application and EIS;
- More recent Dublin meteorological data (for the period 2001-2005) were used;
- Recent USEPA guidance on the use of the meteorological pre-processor AERMET has been used for this assessment. This includes determination of input parameters for AERMET based on the land use at Dublin Airport (rather than the subject site as was previously the case);
- Revised gas/particle deposition parameters based on new USEPA guidance are included;
- Maximum 1-hour emission rates for NO_x, SO_2, HCl & HF have been revised upwards. These emission rates are now based on the half-hourly emission limit values set by Council Directive 2000/76/EC;
- Revised UK guidance on the addition of background concentrations to 1-hour NO_2 concentrations, 1-hour & 24-hour SO_2 concentrations and 24-hour PM_{10} concentrations was also used;
- For the cumulative assessment, revised emission data from Platin Cement was used based on their 2008 IPPC Licence.

7.2 STUDY METHODOLOGY

7.2.1 Introduction

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

Throughout this study a worst-case approach was taken. This will most likely lead to an over-estimation of the levels that will arise in practice. The worst-case assumptions are outlined below:

- Emissions from all emission points in the cumulative assessment were assumed to be operating at their maximum emission level, 24 hours/day over the course of a full year. This represents a very conservative approach as typical emission from the proposed facility will be well within the emission limit values set out in the Waste Incineration Directive.

- For the maximum scenario, emission points were assumed to be operating at their maximum volume flow, 24 hours/day over the course of a full year.

- For maximum and average operating scenario, it has been assumed that the emission point is operating for 24-hrs/day over the course of the full year and at the maximum levels allowed by the Waste Incineration Directive.

- Abnormal operating emissions (above the emission limits of the Waste Incineration Directive) were pessimistically assumed to occur every Monday of the year with the exception of metals (2 days every month) and dioxins/PAHs (5 weeks/annum) and at maximum volume flow.

- Maximum predicted ambient concentrations for all pollutants measured within a 9 km radius of the site were reported in this study even though, in most cases, no residential receptors were near the location of this maximum ambient concentration. Concentrations at the nearest residential receptors are generally significantly lower than the maximum ambient concentrations reported.

- Worst-case background concentrations were used to assess the baseline levels of substances released from the site

- The worst-case meteorological conditions for Dublin Airport over the five year period 2001-2005 have been used for each individual pollutant and averaging period. The worst-case year with regard to annual average concentrations was 2004, with annual average concentrations 18% higher than the five-year average. With regard to the 1-hour averaging period and limit values (i.e. maximum 1-hour, 99.8th%ile, 99th%ile & 98th%ile), the worst-case year (2005) ranges from 10-11% higher than the five-year average. For the 8-hour period and 24-hour averaging period and limit values (i.e. 90.4th%ile, 99.2nd%ile), the worst-case year is 8% and12% higher respectively than the five year average.

7.2.2 Meteorological Considerations

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

The selection of the appropriate meteorological data has followed the guidance issued by the USEPA(1). A primary requirement is that the data used should have a data capture of greater than 90% for all parameters. Two meteorological stations were identified near the site – Casement Aerodrome and Dublin Airport. Data collection of greater than 90% for all parameters is required for air dispersion modelling. Both Casement Aerodrome and Dublin Airport fulfil this requirement.

The additional requirements of the selection process depend on the representativeness of the data. The representativeness can be defined as “the extent to which a set of measurements taken in a space-time domain reflects the actual conditions in the same or different space-time domain taken on a scale appropriate for a specific application”(2). The meteorological data should be representative of conditions affecting the transport and dispersion of pollutants in the area of interest as determined by the location of the sources and receptors being modelled.

The representativeness of the data is dependent on(1):

1) the proximity of the meteorological monitoring site to the area under consideration,

2) the complexity of the terrain,

3) the exposure of the meteorological monitoring site (surface characteristics around the meteorological site should be similar to the surface characteristics within the modelling domain),

4) the period of time during which data is collected.

In the region of the site, Dublin Airport is the nearest suitable meteorological station to the site and due to its proximity the weather pattern experienced would be expected to be similar. On account of the modest terrain features to the north of the site, some channelling of wind may be expected to occur along the direction of the Boyne Valley. However, this would not be expected to be significant at stack height due to the modest nature and shallow gradient of this terrain feature.

The windrose from Dublin Airport for the years 2001-2005 is shown in Figure 7.1. The windrose indicates the prevailing wind speed and direction over the five-year period. The prevailing wind direction is generally from the W-SW direction with wind speeds averaging around 4-6 m/s.

7.2.3 Modelling Methodology

Emissions from the proposed site have been modelled using the AERMOD dispersion model (Version 07026) in conjunction with the AERMET pre-processor (Version 06341) which has been developed by the U.S. Environmental Protection Agency (USEPA)(3). The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources. The model has been designated the regulatory model by the USEPA for modelling emissions from industrial sources in both flat and complex terrain(1). An overview of the model is outlined in Appendix 7.1.

7.2.4 Assessment Methodology

Council Directive 2000/76/EC

The assessment methodology used in the current study was developed following the recommendations outlined in Council Directive 2000/76/EC on the Incineration of Waste.

The Directive has outlined air emission limit values, which are to be complied with as set out in Table 7.1. The Directive has also outlined stringent operating conditions in order to ensure sufficient combustion of waste thus ensuring that dioxin formation is minimised. Specifically, the combustion gases must be maintained at a temperature of 850°C for at least two seconds under normal operating conditions for non-hazardous waste whilst for hazardous waste containing more than 1% halogenated organic substances, the temperature should be raised to 1100°C for at least two seconds. These measures will ensure that dioxins/furans, polychlorinated biphenyls (PCBs) and PAHs are minimised through complete combustion of waste.

Specific emission measurement requirements have been outlined in the directive for each pollutant:

1) continuous measurements of the following substances; NO_x, CO, total dust, TOC, HCl, and SO_2.
2) bi-annual measurements of heavy metals, dioxins and furans.

Indaver Ireland is committed, as a minimum, to meeting all the requirements of Council Directive 2000/76/EC. Indeed, due to the advanced post-combustion flue gas cleaning technology employed, expected average emission values will be significantly lower than the values used in this study. The maximum and abnormal emission concentrations and mass emission rates have been detailed in Table 7.2.

Very low levels of dioxin will be emitted under typical operating conditions from the incineration process. Typical emissions will be well below the stringent limit value set out in Council Directive 2000/76/EC. This rigorous limit value will be achieved through a targeted removal system over several stages of the flue gas cleaning system. Prior to abatement, the formation of dioxins will be minimised by the maintenance of high combustion temperatures (over 850°C at all times) for a period of two seconds followed by rapid cooling of gases from 400°C to 200°C which is the critical temperature range for dioxins formation in combustion systems. Post-combustion, dioxins will be removed via a two-stage removal process. The first stage involves the injection of clay into the flue gas duct, directly after the boiler. The large surface area of the clay helps to adsorb dioxins, furans, hydrocarbons and heavy metals. The clay, containing these particulates, is removed from the gases in the baghouse filter. In the second stage, activated carbon is injected into the flue gas duct between the evaporating spray reactor and the baghouse filter. The activated carbon containing these particulates is be removed from the gases in the baghouse filter. The combined efficiency of these dioxin removal steps will ensure that emission concentrations will be well below the emissions limits of the EU Council Directive 2000/76/EC. In order to confirm this efficiency target, a continuous dioxin sampler will be employed to determine average fortnightly concentrations, thus allowing an accurate comparison with the emission limit values.

USEPA Guidelines On Air Quality Models

In the absence of detailed local guidance, the selection of appropriate modelling methodology has followed the guidance from the USEPA which has issued detailed and comprehensive guidance on the selection and use of air quality models(1,3-5).

Based on guidance from the USEPA, the most appropriate regulatory model for the current application is AERMOD (Version 07026). The model is applicable in both flat and complex terrain, urban or rural locations and for all averaging periods(1,3).

The USEPA has outlined guidance in order to establish the operating conditions that cause the maximum ground level concentration. The guidance indicates that a range of operating conditions should be assessed in the initial screening analysis. Table 7.3 outlines the recommended range of operating conditions to be assessed and which was adopted in the current assessment.

Cumulative Assessment

As the region around Carranstown is partly industrialised and thus has several other potentially significant sources of pollutants, a detailed cumulative assessment has been carried out using the methodology outlined by the USEPA. Table 7.3 outlines the recommended range of operating conditions to be assessed in the cumulative assessment.

The impact of nearby sources should be examined where interactions between the plume of the point source under consideration and those of nearby sources can occur. These include:

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

Background concentrations for the area, based on natural, minor and distant major sources need also to be taken into account in the modelling procedure. A major baseline monitoring programme (see Section 7.3 below) was undertaken over several months which, in conjunction with other available baseline data, was used to determine conservative background concentrations in the region (see Table 7.12).

The methodology adopted in the cumulative assessment was based on the USEPA recommended Prevention of Significant Deterioration (PSD) Increment approach(6). The PSD increment is the maximum increase in concentration that is allowed to occur above a baseline concentration for each pollutant. However, no exceedence of the ambient air quality limit values (or NAAQS in the USA) is allowed even if not all of the PSD increment is consumed.

The PSD has three classifications of land use as outlined below:

Class I Areas:	Class I areas include national parks, national wilderness areas and other areas of special national or regional value.
Class II Areas:	Attainment areas that are neither industrialised nor meet the specific requirements for classification as Class I areas.
Class III Areas:	Industrialised attainment areas.

Although Platin Cement is located close to the proposed facility, the current location would not be considered an industrialised attainment area. It has therefore been considered as a Class II area and thus the PSD applicable to Class II areas has been applied in the current case. Due to the variations in pollutant averaging times and standards between the USA and the EU, only relative PSD Increments can be derived. The relative PSD Increment, as a percentage of the respective NAAQS, is shown in Table 7.4 with the corresponding concentration as it would be applied to the EU ambient air quality standards. In the current context, the PSD increment has been applied only to zones were significant overlap occurs between plumes from each of the sources.

In the context of the cumulative assessment, all significant sources should be taken into account. The USEPA has defined “significance” in the current context as an impact leading to a 1µg/m^3 annual increase in the annual average concentration of the applicable criteria pollutant (PM_{10}, NO_2, and SO_2)(6). However, no significant ambient impact levels have been established for non-criteria pollutants (defined as all pollutants except PM_{10}, NO_2, SO_2, CO and lead). The USEPA does not require a full cumulative assessment for a particular pollutant when emissions of that pollutant from a proposed source would not increase ambient levels by more than the significant ambient impact level (annual average of 1µg/m^3). An assessment of releases from the proposed facility has indicated that releases of SO_2, CO, PM_{10} and TOC are not significant and thus no cumulative assessment need be carried out for these substances (see Table A7.4 in Appendix 7.2). However, due to the presence of Platin Cement, a cumulative impact assessment was conducted for SO_2, PM_{10} and $PM_{2.5}$ thus representing a worst-case approach.

The project impact area for the cumulative assessment is the geographical area for which the required air quality analysis for PSD increments are carried out. The USEPA has defined the "impact area" as a circular area with a radius extending from the source to the most distant point where dispersion modelling predicts a significant ambient impact will occur irrespective of pockets of insignificant impact occurring within it. Within this impact area, all nearby sources should be modelled, where "nearby" is defined as any point source expected to cause a significant concentration gradient in the vicinity of the proposed new source.

In order to determine compliance, the predicted ground level concentration (based on the full impact analysis and existing air quality data) at each model receptor is compared to the applicable ambient air quality limit value or PSD increment. If the predicted pollutant concentration increase over the baseline concentration is below the applicable increment, and the predicted total ground level concentrations are below the ambient air quality standards, then the applicant has successfully demonstrated compliance.

When an air quality standard or PSD increment is predicted to be exceeded at one or more receptor in the impact area, it should be determined whether the net emissions increase from the proposed source will result in a significant ambient impact at the point of each violation, and at the time the violation is predicted to occur. The source will not be considered to cause or contribute to the violation if its own impact is not significant at any violating receptor at the time of each violation(6).

Table 7.1 Council Directive 2000/76/EC, Annex V Air Emission Limit Values

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

(1) Until 1/1/2007 the emission limit value for NO_x does not apply to plants only incinerating hazardous waste

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

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

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

Table 7.2 Air Emission Values From Proposed Waste-to-Energy Facility, Carranstown, Co. Meath

Daily Average Values Unless Stated Otherwise	EU Maximum Emission Concentration	Maximum Operating Values	Abnormal Emission Concentration	Abnormal Operating Values
		Emission Rate (g/s)		Emission Rate (g/s)
Total Dust	10 mg/m^3	0.41	30 mg/m^3	1.2
Total Dust (Maximum Half-hour Average)	30 mg/m^3	1.2	30 mg/m^3	1.2
Total organic carbon (TOC)	10 mg/m^3	0.41	30 mg/m^3	1.2
Total organic carbon (TOC) (Maximum Half-hour Average)	20 mg/m^3	0.82	30 mg/m^3	1.2
Hydrogen Chloride (HCl)	10 mg/m^3	0.41	60 mg/m^3	2.5
Hydrogen Chloride (HCl) (Maximum Half-hour Average)	60 mg/m^3	2.5	60 mg/m^3	2.5
Hydrogen Fluoride (HF)	1 mg/m^3	0.041	4 mg/m^3	0.16
Hydrogen Fluoride (HF) (Maximum Half-hour Average)	4 mg/m^3	0.16	4 mg/m^3	0.16
Sulphur Dioxide (SO_2)	50 mg/m^3	2.0	200 mg/m^3	8.2
Sulphur Dioxide (SO_2) (Maximum Half-hour Average)	200 mg/m^3	8.2	200 mg/m^3	8.2
Nitrogen Oxides (as NO_2)	200 mg/m^3	8.2	400 mg/m^3	16.3
Nitrogen Oxides (as NO_2) (Maximum Half-hour Average)	400 mg/m^3	16.3	400 mg/m^3	16.3
Cadmium and its compounds, expressed as Cd	Total 0.05 mg/m^3	0.0020	Total 1 mg/m^3	0.041
Thallium and its compounds, expressed as Tl				
Mercury and its compounds, expressed as Hg	0.05 mg/m^3	0.0020	1 mg/m^3	0.041
Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel, Vanadium and their compounds, expressed as the relevant metal	Total 0.5 mg/m^3	0.020	Total 30 mg/m^3	1.2
Dioxins and furans	0.1 ng/m^3	4.1 x 10^{-9}	0.5 ng/m^3	2.0 x 10^{-8}
Carbon Monoxide	50 mg/m^3	2.0	200 mg/m^3	8.2
Carbon Monoxide (Maximum Half-hour Average)	100 mg/m^3	4.1	200 mg/m^3	8.2

Table 7.3 Model Input Data For Point Sources For PSD Compliance

Average Time	**Emission Limit (mg/m^3)**	**X Operating Level (mg/hr)**	**X Operating Factor (hr/year)**
Proposed Major New Source			
Annual	Maximum allowable emission limit	Design capacity	Continuous operation
Short term (≤ 24 hrs)	Maximum allowable emission limit	Design capacity	Continuous operation
Nearby Major Source			
Annual	Maximum allowable emission limit	Design capacity	Actual Operating Factor averaged over 2 years
Short term (≤ 24 hrs)	Maximum allowable emission limit	Design capacity	Continuous operation

Table 7.4 PSD Increments Relative To NAAQS (US) and As Applied To EU Directives

Pollutant	Averaging Period	Class II PSD Increment µg/m^3	% of NAAQS (& % of EU Directives)	PSD Increment as applied to EU Standards (µg/m^3) / Averaging Periods
PM_{10}	Annual	34	25%	Annual - 10 / 24-Hour – 12.5
$PM_{2.5}$ (1)	Annual	10	25%	Annual - 6.25
SO_2	24-Hour	182	25%	24-Hour – 31.3 / 1-Hour – 87.5
NO_2	Annual	50	25%	Annual - 10 / 1-Hour - 50

(1) PSD Increment not designated - based on the PSD increment for PM_{10}.

7.3 BASELINE MONITORING REPORT

7.3.1 Introduction

A detailed baseline air monitoring programme has been carried out to assess baseline levels of the significant substances which may be released from the proposed waste–to-energy facility in Carranstown, Duleek, County Meath. The substances monitored were NO_2, $PM_{2.5}$, benzene, SO_2 and heavy metals. The air monitoring programme was used to determine long-term average concentrations for pollutants of concern and to provide information on the general air quality in the Carranstown region.

An extensive baseline survey was carried out in the region of the site between June and December 2005. This survey compliments and updates the baseline monitoring which was undertaken in 2000/01 for the parameters outlined in the incineration directive. The rationale for the updated 2005 survey was based on those pollutants that have local sources such as traffic and may have changed in the intervening period. The main pollutants associated with traffic are no2, pm10 and benzene. Platin cement would also be considered a significant local source although the emissions from this facility are best captured by air dispersion modelling as part of a detailed cumulative air dispersion modelling assessment. Since 2005, there has been the potential for some changes in traffic levels in the area. In addition, recent years have also seen a significant improvement in the national fleet in terms of air emissions as older more polluting vehicles are replaced with cleaner vehicles. Thus, although traffic levels may have increased somewhat over the period 2005 - 2009, overall vehicle emissions are unlikely to have increased to any significant degree. Hence the 2005 study is considered to be valid for the purposes of this assessment.

7.3.2 Methodology

$PM_{2.5}$

The $PM_{2.5}$ monitoring programme, using a $PM_{2.5}$ continuous monitor, focused on assessing 24-hour average concentrations at the on-site monitoring station over a three-week period at location N1 (see Figure 7.2). $PM_{2.5}$ sampling was carried out by means of an R&P Partisol®-Plus Sequential Air Sampler (Model 2025). The sampler is a manual air sampling platform which has been designed to meet US EPA Reference Designation (RFPR-0694-09). Approximately 24 m^3 of air was sampled daily through an impactor, which was contained within the $PM_{2.5}$ sampling head. The impactor removed particles with a diameter >2.5 µg and the remaining particles were collected on pre-weighed 47mm diameter filters. The Partisol® sampler was programmed to automatically replace each sampled filter by a new pre-weighed filter at midnight. This ensured that each filter represented a sampling period of exactly 24 hours. Gravimetric determination was carried out at a NAMAS accredited laboratory (Casella Seal Ltd, Manchester, UK). The results, which are shown in Figure 7.3 and Table 7.5, allowed an indicative comparison with both the 24-hour and annual limit values. Weather conditions during the survey periods were also obtained (see Table 7.6) and may be used to help apportion the source of any raised levels of pollutants during the sampling period.

NO_2

Monitoring of nitrogen dioxide in Carranstown was carried out using passive diffusion tubes. The spatial variation in NO_2 levels away from sources is particularly important, as a complex relationship exists between NO, NO_2 and O_3 leading to a non-linear variation of NO_2 concentrations with distance. In order to assess the spatial variation in NO_2 levels in the Carranstown region, NO_2 was monitored using passive diffusion tubes over three four-week periods at ten locations in the area (see Figure 7.2). Passive sampling of NO_2 involves the molecular diffusion of NO_2 molecules through a polycarbonate tube and their subsequent adsorption onto a stainless steel disc coated with triethanolamine. Following sampling, the tubes were analysed using UV spectrophotometry, at a NAMAS accredited laboratory (Casella Seal Ltd, Manchester, UK, which is part of the Department of the Environment, Transport & the Regions (DETR's) UK Monitoring Network). The diffusion tube locations were strategically positioned to allow an assessment of both worst-case and typical exposure of the residential population. The passive diffusion tube results, which are given in Table 7.7, allow an indicative comparison with the annual average limit value.

Benzene

In order to assess the spatial variation in benzene levels in the Carranstown region, benzene was monitored using passive diffusion tubes over a three-month period at five locations in the area (see Figure 7.2). Passive sampling of benzene involves the molecular diffusion of benzene molecules through a stainless steel tube and their subsequent adsorption onto a stainless steel gauze coated with Chromasorb 106. Following sampling, the tubes were analysed using Gas Chromatography, at a NAMAS accredited laboratory (Casella Seal Ltd). The diffusion tube locations were strategically positioned to allow an assessment of both worst-case and typical exposure of the residential population (see Table 7.8).

SO_2

In order to assess the spatial variation in sulphur dioxide levels in the area, SO_2 was monitored using passive diffusion tubes over a three-month period at five locations (see Figure 7.2 and Table 7.9). Passive sampling of SO_2 involves the molecular diffusion of SO_2 molecules through a tube fabricated of PTFE and their subsequent adsorption onto a stainless steel gauze coated with sodium carbonate. Following sampling, the adsorbed sulphate was removed from the tubes with deionised water and was then analysed using ion chromatography. This analysis was carried out at a NAMAS accredited laboratory (Casella Seal Ltd). The diffusion tube locations were strategically positioned to allow an assessment of both worst-case and typical exposure of the residential population.

Metals

Metal sampling was carried out by means of an R&P Partisol®-Plus Sequential Air Sampler (Model 2025). The sampler is a manual air sampling platform which has been designed to meet US EPA Reference Designation (RFPR-0694-09). Approximately 24 m^3 of air was sampled daily through an impactor, which was contained within a $PM_{2.5}$ sampling head. The impactor removed particles with a diameter >2.5 µg and the remaining particles were collected on pre-weighed 47mm diameter filters. The Partisol® sampler was programmed to automatically replace each sampled filter by a new pre-weighed filter at midnight. This ensured that each filter represented a sampling period of exactly 24 hours.

The filters were acid digested in batches of seven with concentrated nitric acid and hydrogen peroxide in a sealed vessel at 120℃ for 2 hours. An internal standard containing isotopes of bismuth, yttrium, germanium and indium was added prior to the digestion step. The digest was then analysed by Inductively Coupled Plasma - Mass Spectrometry (ICP/MS) by Casella Seal Ltd.

7.3.3 Ambient Air Quality Compliance Criteria

PM_{10} & $PM_{2.5}$

EU Directive 2008/50/EC has set 24-hour and annual limit values for PM_{10} for the protection of human health. A 24-hour limit of 50 µg/m^3 must not be exceeded more than 35 times per year. EU Directive 2008/50/EC has set an annual limit value of 40 µg/m^3. EU Directive 2008/50/EC also sets an annual limit value for $PM_{2.5}$ of 25 µg/m^3.

NO_2

EU Directive 2008/50/EC has set 1-hour and annual limit values for NO_2 for the protection of human health. An hourly limit of 200 µg/m^3 must not be exceeded more than 18 times per year. The annual limit value is 40 µg/m^3. A margin of tolerance for both limit values of 20% currently applies. This will reduce linearly to 0% by 2010.

Benzene

EU Directive 2008/50/EC has set an annual limit value for the protection of human health of 5 µg/m^3 for benzene. A margin of tolerance of 80% currently applies. This will reduce linearly to reach 0% by 2010.

SO_2

EU Directive 2008/50/EC has set hourly, daily and annual limit values for the protection of human health for SO_2. The hourly limit value is 350 µg/m^3 which must not be exceeded more than 24 times per annum. The daily and annual limit values are 125 µg/m^3 (not be exceeded more than 3 times per annum) and 20 µg/m^3 respectively.

Metals

Ambient air quality guidelines and limits for the protection of human health for various metals have been set by the European Union, the WHO and in the TA Luft Guidelines. In the absence of statutory standards, ambient air quality guidelines can also be derived from occupational exposure limits (OEL). The ambient air quality standards and guidelines for a number of metals are detailed in Tables 7.54 - 7.55.

7.3.4 Results

$PM_{2.5}$

Daily concentrations of $PM_{2.5}$ measured using the sequential $PM_{2.5}$ sampler are shown in Figure 7.3 and Table 7.5. The 24-hour $PM_{2.5}$ concentrations measured over the three-week period is significantly below the annual average limit value of 25 µg/m^3 (for the protection of human health) which is applicable from 2015 onwards. The average over this period is 15 µg/m^3.

Average wind speed data measured by Met Eireann at Dublin Airport, which would be representative of conditions at Carranstown, are listed in Table 7.6 and are compared to the $PM_{2.5}$ monitoring results in Figure 7.3. Although, wind direction will have an influence on the on-site $PM_{2.5}$ concentrations, the data in Figure 7.3 indicates that $PM_{2.5}$ measured at Carranstown were inversely related to wind speed to a statistically significant degree. This would indicate that there is greater dispersion of $PM_{2.5}$ at higher wind speeds and that wind-blown sources are not significant.

PM_{10} data is also available from a PM_{10} TEOM monitor operated by the EPA at Kiltrough(8) which is situated several kilometres east of the site. The PM_{10} concentration during the same monitoring period as the on-site $PM_{2.5}$ survey averaged 20 µg/m^3 whilst the annual average concentration for PM_{10} in 2005 was 17 µg/m^3. This indicates that during the measurement period PM concentrations were raised relative to the annual limit value (of the order of 15%) indicating that a long-term average may be of the order of 13 µg/m^3.

NO_2

The passive diffusion tube survey targeted the exposure of the nearest residential receptors to the proposed scheme. The monitoring locations have been designed to optimise both the spatial coverage in the region and to determine the worst-case air quality at the nearest sensitive receptors. Average concentration of nitrogen dioxide at Locations M1-M10 (refer to Figure 7.2), are significantly below the EU annual limit value for the protection of human health of 40 µg/m^3, which is enforceable in 2010 (See Table 7.7). The highest NO_2 level, which was measured at the M1/R152 roundabout is still less than 63% of this annual limit value.

Benzene

Average concentrations of benzene measured at five locations are shown in Table 7.8. The results show that levels are significantly below the EU annual limit value for the protection of human health, which is enforceable in 2010. The highest benzene level of 0.8 µg/m^3, measured at Location M8, peaks at 20% of the limit value which is set at 5 µg/m^3.

SO_2

Average concentrations of SO_2 measured at the five locations in the Carranstown area are shown in Table 7.9. The results show that levels are significantly below the annual average EU limit value for the protection of ecosystems. The highest SO_2 level of 4 µg/m^3, measured at Location M2, is only 20% of the annual limit value which is set for the protection of ecosystems.

Metals

Average concentrations of a number of metals measured over a three-week period at the on-site monitoring station in Carranstown are shown in Table 7.10. The results show that the average concentrations of all metals measured were significantly below their respective annual limit values for the protection of human health.

Table 7.5 Measured $PM_{2.5}$ Ambient Concentrations Measured at On-site Monitoring Station.

Date	$PM_{2.5}$ (µg/m^3)	Date	$PM_{2.5}$ (µg/m^3)
09-Nov-05	5	05-Dec-05	4
10-Nov-05	3	06-Dec-05	20
11-Nov-05	6	07-Dec-05	9
12-Nov-05	9	08-Dec-05	9
13-Nov-05	9	09-Dec-05	7
14-Nov-05	4	10-Dec-05	14
15-Nov-05	6	11-Dec-05	21
16-Nov-05	15	12-Dec-05	27
17-Nov-05	37	13-Dec-05	39
18-Nov-05	17	14-Dec-05	16
19-Nov-05	22	15-Dec-05	14
20-Nov-05	42	16-Dec-05	15
Average		**15**	
Annual Average Limit Value		25 µg/m$^{3(1)}$	

(1) 2008/50/EC.

Table 7.6 Meteorological Data during the $PM_{2.5}$ Ambient Survey

Date	Wind Speed (m/s)	Rainfall (mm)	Date	Wind Speed (m/s)	Rainfall (mm)
09-Nov-05	7.0	1	05-Dec-05	8.0	0.1
10-Nov-05	7.1	4.4	06-Dec-05	3.6	0
11-Nov-05	11.2	0.9	07-Dec-05	5.9	14.5
12-Nov-05	6.6	0	08-Dec-05	4.0	1.4
13-Nov-05	4.3	0	09-Dec-05	3.0	0.5
14-Nov-05	8.5	0	10-Dec-05	6.0	0
15-Nov-05	5.5	0.1	11-Dec-05	4.9	0
16-Nov-05	4.3	0	12-Dec-05	3.0	0
17-Nov-05	2.2	0	13-Dec-05	4.8	0
18-Nov-05	5.4	0	14-Dec-05	4.6	0
19-Nov-05	1.2	0	15-Dec-05	7.7	0
20-Nov-05	1.4	0	16-Dec-05	7.6	0.2

Source: Met Eireann.

Table 7.7 **Average NO_2 concentrations at each location during the period 16/06/05 – 28/09/05, as measured by passive diffusion tubes.**

Location No.	Location Description	Period 1 16/06/05-19/07/05 (µg/m^3)	Period 2 19/07/05-22/08/05 (µg/m^3)	Period 3 22/08/05-28/09/05 (µg/m^3)	Average (µg/m^3)
M1	NW of Site	5	6	10	**7**
M2	South of Platin	18	22	22	**21**
M3	Platin North Boundary	10	8	16	**11**
M4	Cruicerath	10	10	11	**10**
M5	Clonlusk	6	7	14	**9**
M6	Commons	6	7	9	**7**
M7	Duleek	13	16	23	**17**
M8	R152 South of Site	10	10	16	**12**
M9	R152 Opposite Site	14	23	24	**20**
M10	M1/R152 Roundabout	18	23	34	**25**
EU Limit Value (µg/Nm^3)					40(1)

(1) EU Ambient Air Standard (2008/50/EC) (as an annual average).

Table 7.8 **Average Benzene concentrations at each location during the period 16/06/05 – 28/09/05, as measured by passive diffusion tubes.**

Location No.	Location Description	Period 1 16/06/05-19/07/05 (µg/m^3)	Period 2 19/07/05-22/08/05 (µg/m^3)	Period 3 22/08/05-28/09/05 (µg/m^3)	Average (µg/m^3)
M1	NW of Site	0.2	0.3	0.2	**0.2**
M2	South of Platin	0.2	0.7	0.8	**0.6**
M3	Platin North Boundary	0.2	0.4	0.2	**0.3**
M4	Cruicerath	0.6	0.2	0.4	**0.4**
M8	R152 South of Site	0.7	0.8	0.5	**0.7**
EU Limit Value (µg/Nm^3)					5(1)

(1) EU Ambient Air Standard (2000/690/EC) (as an annual average).

Table 7.9 **Average Sulphur Dioxide concentrations at each location during the period 16/06/05 – 28/09/05, as measured by passive diffusion tubes.**

Location No.	Location Description	Period 1 16/06/05-19/07/05 (µg/m^3)	Period 2 19/07/05-22/08/05 (µg/m^3)	Period 3 22/08/05-28/09/05 (µg/m^3)	Average (µg/m^3)
M1	NW of Site	0.8	3.0	2.8	**2.2**
M2	South of Platin	0.9	3.7	3.5	**2.7**
M3	Platin North Boundary	1.9	2.7	2.1	**2.2**
M4	Cruicerath	0.8	2.2	2.5	**1.8**
M8	R152 South of Site	1.1	3.1	4.3	**2.8**
EU Limit Value (µg/Nm^3)					20(1)

(1) EU Ambient Air Standard (2008/50/EC) (as an annual average for the protection of ecosystems).

Table 7.10 Levels of metals measured at the on-site monitoring station during the period 09/11/05 – 16/12/05.

Species	Period 1 09/11/05-15/11/05 (ng/m^3)	Period 2 16/11/05-22/11/05 (ng/m^3)	Period 3 10/12/05-16/12/05 (ng/m^3)	Average (ng/m^3)$^{(1)}$	Limit Values (ng/m^3)$^{(2)}$
Arsenic	0.24	0.77	0.29	**0.43**	6
Cadmium	0.04	0.17	0.10	**0.10**	5
Cobalt	0.01	0.07	0.03	**0.04**	1000
Chromium	6.0	6.1	6.1	**6.1**	500
Copper	0.82	11.7	1.9	**4.8**	2000
Mercury	<0.06	0.06	0.06	**0.06**	100
Manganese	0.58	3.6	1.9	**2.0**	150
Nickel	3.2	0.95	0.91	**1.7**	20
Lead	2.4	17.0	4.3	**7.9**	500
Antimony	0.25	2.0	0.35	**0.87**	1000
Thallium	0.01	0.11	0.02	**0.05**	1000
Vanadium	0.27	1.4	0.89	**0.85**	1000

(1) Values at detection limit have been taken to equal to the detection limit

(2) Annual average limit values (see Tables 7.54 - 7.55).

7.4 MODELLING RESULTS

7.4.1 Introduction

Emissions from the proposed site has been modelled using the AERMOD dispersion model which is the USEPA's regulatory model used to assess pollutant concentrations associated with industrial sources(1). Emissions have been assessed, firstly under the maximum emissions limits of the EU Directive 2000/76/EC and secondly under abnormal operating conditions.

7.4.2 Process Emissions

Indaver Ireland has one main process emission point (stack). The operating details of this major emission point has been taken from information supplied by Indaver Ireland and are outlined in Table 7.11. Full details of emission concentrations and mass emissions are given in Appendix 7.5.

Table 7.11 Process Emission Design Details

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Volume Flow (Nm^3/hr)(1)	Exit Velocity (m/sec actual)(2)
Stack	65	2.2	3.80	413	147,000 – Maximum	16.40
Stack	65	2.2	3.80	413	134,000 – Average	14.95

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

(2) 413K, 6.6% Oxygen, 21.4% H_2O

Emissions from the site have been assessed for maximum, average and abnormal operating conditions. The AERMOD model was run using a unitised emission rate of 1 g/s. The unitised concentration and deposition output has then been adjusted for each substance based on the specific emission rate of each.

7.4.3 Background Concentrations

The ambient concentrations detailed in the following sections include both the emissions from the site and the ambient background concentration for that substance. Background concentrations have been derived from a worst-case analysis of the cumulative sources in the region in the absence of the development. Firstly, a detailed baseline air quality assessment (see Section 7.3) was carried out to assess baseline levels of those pollutants, which are likely to be significant releases from the site. Secondly, modelling of traffic emissions (see Appendix 7.3) was carried out both with and without the facility to assess the impact of increased traffic emissions in the region. Thirdly, a detailed cumulative assessment of all significant releases from nearby sites was carried out based on an analysis of their IPPC Licences (see Appendix 7.2). The estimated annual background concentrations are shown in Table 7.12. In arriving at the combined annual background concentration, cognisance has been taken of the accuracy of the approach and the degree of double counting inherent in the assessment. In relation to NO_2, the baseline monitoring programme will have taken into account both the existing traffic levels and existing industrial sources. However, some increases in traffic levels will occur due to the development which has been incorporated into the final combined background levels. Again, in recognition of the various inaccuracies in this approach, the values have been rounded accordingly. A similar approach has been adopted for the other pollutants. In relation to baseline dioxins/furans, a range of concentrations has been given in recognition of the influence that non-detects have on the reported values.

In order to obtain the predicted environmental concentration (PEC), background data was added to the process emissions. In relation to the annual averages, the ambient background concentration was added directly to the process concentration. However, in relation to the short-term peak concentrations, concentrations due to emissions from elevated sources cannot be combined in the same way. Guidance from the UK DEFRA (9) advises that for NO_2, SO_2 and PM_{10} an estimate of the maximum combined pollutant concentration can be obtained as shown below:

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

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

b) The maximum of either:

- 99.8th%ile process contribution NO_X + 2 x (annual mean background NO_2); or
- 99.8th%ile hourly background NO_2 + 2 x (annual mean process contribution NO_X).

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

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

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

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

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

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

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

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

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

The above formulae were used along with EPA monitoring data(8) to derive the appropriate background concentrations which were subsequently used in the assessment of the impact of the facility in the surrounding environment.

Table 7.12 Estimated annual background concentrations In Carranstown Region (µg/m^3).

	NO_2	SO_2	PM_{10}	$PM_{2.5}$	CO	TOC(1)	HCl	HF	Dioxins(3)	PAHs	Cd	Hg	Sb	As	Ni
Baseline Monitoring Programme(1)	18	3	18	13	-	0.6	0.01	0.005	0.046 pg/m^3 0.028 pg/m^3	0.001	0.001	0.001	0.001	0.001	0.002
Traffic Impact Assessment(4)	1	-	0.3	0.3	100	0.01	-	-	-	-	-	-	-	-	-
Cumulative Assessment	1	1	0.7	0.7	-(2)	-(2)	-(2)	-(2)	-(2)	-(2)	-(2)	-(2)	-(2)	-(2)	-(2)
Annual Background Concentration	**20**	**4**	**20**	**14**	**200**	**0.7**	**0.01**	**0.005**	**0.046pg/m^3** **0.028 pg/m^3**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.002**

(1) TOC assumed to be composed of benzene solely as a worst-case

(2) No cumulative assessment carried out as emissions from the site (or nearby sites) are less than significance criteria (defined as greater than 2% of ambient limit value)

(3) Baseline results for dioxins given as firstly (i) Non-detects = limit of detection, (ii) Non-detects = 50% of limit of detection.

(4) See Appendix 7.4 for full details of the traffic impact assessment.

7.5 NITROGEN DIOXIDE EMISSIONS AND RESULTS

7.5.1 Source Information

Source information including emission release heights, volume flows, locations and stack diameters has been summarised in Appendix 7.5.

7.5.2 Modelling of Nitrogen Dioxide

Nitrogen oxides (NO_X), containing both nitrogen oxide (NO) and nitrogen dioxide (NO_2) are emitted from the combustion process on-site, although it is the latter which is considered the more harmful to human health. These combustion processes lead to emissions which are mainly in the form of nitrogen oxide (NO) (typically 95%) with small amounts of the more harmful nitrogen dioxide.

NO_2 has been modelled following the approach outlined by the USEPA(1) for assessing the impact of NO_X from point sources. The approach involves assessing the air quality impact through a three tiered screening technique. The initial analysis, termed the Tier 1 approach, assumes a worst-case scenario that there is total conversion of NO_X to NO_2. The guidance indicates that if this worst-case assumption leads to an exceedance of the appropriate limit value, the user should proceed to the next Tier.

Tier 2 is appropriate for estimating the annual average NO_2 concentration. The Tier 2 approach indicates that the annual average concentration should either be derived from an empirically derived NO_2/NO_X ratio or alternatively to use the default value of 0.75. This default value has been used in the current assessment.

In order to determine the maximum one-hour value, the Tier 3 approach is recommended by the USEPA. The Tier 3 approach involves the application of a detailed screening method on a case-by-case basis. The suggested methodologies include the ozone-limiting method or a site-specific NO_2/NO_X ratio. In the current assessment, no site-specific ratio has been developed because the monitoring data obtained by Indaver measured much lower concentrations than that predicted to occur very occasionally during operations at the boundary of the site. However, empirical evidence suggests that a conservative estimate of this ratio would be 0.50 based on data from the EPA (9). Thus, a ratio of 0.50 for NO_2/NO_X has been used in the current assessment for the 99.8th%ile of one-hour maximum concentrations.

Ambient Ground Level Concentrations (GLCs) of Nitrogen Dioxide have been predicted for the following scenarios in Table 7.13.

Table 7.13 Emission Scenario for Nitrogen Dioxide

Pollutant	Scenario	Concentration	Emission Rate (g/s)
NO_2	Average 1-Hour Operation	400 mg/m^3	14.9
	Average 24-Hour Operation	200 mg/m^3	7.4
	Maximum 1-Hour Operation	400 mg/m^3	16.3
	Maximum 24-Hour Operation	200 mg/m^3	8.17
	Abnormal Operation(1)	400 mg/m^3	16.3

(1) Abnormal operation scenario based on an emission level of 400 mg/m^3 for two hours every Monday for a full year.

Abnormal Operation

Elevated levels of NO_X may occur due to the malfunctioning of the de-NOx system. Such conditions will be detected immediately from an elevation in the NO_2 emission value which will be continuously observed on the computerised control system in the control room. An automatic alarm will be activated well in advance of exceedance of the emission limit value to allow adequate time for intervention. Therefore for the purpose of the air modelling study the following abnormal operation conditions were used: 2hrs of operation at an emission value of 400 mg/Nm^3.

7.5.3 Comparison with Standards and Guidelines

The relevant air quality standard for Nitrogen Dioxide has been detailed in Table 7.14. In this report the ambient air concentrations have been referenced to Council Directive 2008/50/EC and S.I. 271 of 2002. The directive also details margins of tolerance, which are trigger levels for certain types of action in the period leading to the attainment date. The margin of tolerance is currently 20% for both the hourly and annual limit value for NO_2. The margin of tolerance is reducing every 12 months by equal annual percentages to reach 0% by the attainment date of 2010. However, reflecting a worst-case approach, results have been compared with the applicable limit value which will be enforceable in 2010.

Table 7.14 EU Ambient Air Standards - Council Directive 2008/50/EC

Pollutant	Regulation	Limit Type	Current Margin of Tolerance	Value
Nitrogen Dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	20% in 2006 reducing linearly to 0% by 2010	200 $\mu g/m^3$ NO_2
		Annual limit for protection of human health	20% in 2006 reducing linearly to 0% by 2010	40 $\mu g/m^3$ NO_2
		Annual limit for protection of vegetation	None	30 $\mu g/m^3$ NO + NO_2

7.5.4 Modelling Results

Modelling was carried out for the three scenarios described in Section 7.5.2. Table 7.15 details the predicted Tier 2 (applied to the annual average) & Tier 3 (applied to the maximum one-hour) NO_2 GLC for each scenario at the worst-case locations whereas Table 7.16 details the spatial variation in nitrogen dioxide concentrations at specific locations in the surrounding region.

Table 7.15 Dispersion Model Results – Nitrogen Dioxide

Pollutant / Scenario	Annual Mean Background ($\mu g/m^3$) (1)	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard(2) ($\mu g/Nm^3$)	Indaver emissions as a % of ambient limit value
NO_2 / Average Operation	20	Annual Mean(3)	1.2	21.2	40	3%
		99.8th%ile of 1-hr means(4)	29.1	104.5(5)	200	15%
NO_2 / Maximum Operation	20	Annual Mean(3)	1.1	21.1	40	3%
		99.8th%ile of 1-hr means(4)	27.8	104.2(5)	200	14%
NO_2 / Abnormal Operation	20	Annual Mean(3)	1.2	21.2	40	3%
		99.8th%ile of 1-hr means(4)	29.1	104.5(5)	200	15%

(1) Includes contribution from traffic and background sources (based on results from diffusion tubes) and incorporating the cumulative assessment results.
(2) Directive 2008/50/EC
(3) Conversion factor following guidance from USEPA (Tier 2 analysis, annual average) based on the default ratio of 0.75 (worst-case).
(4) Conversion factor, following guidance from USEPA (Tier 3 analysis), based on empirically derived site-specific maximum 1-hour value for NO_2 / NO_X of 0.50
(5) Background added using UK DEFRA guidance - see Section 7.4.3.

Table 7.16 Dispersion Model Results – Nitrogen Dioxide Maximum Operation, Specific Receptors

Pollutant / Location	Annual Mean Background (µg/m^3) (1)	Averaging Period	Process Contribution (µg/m^3)	Predicted Emission Concentration (µg/Nm^3)	Standard(2) (µg/Nm^3)	Indaver emissions as a % of ambient limit value
NO_2 Maximum / Worst-case Residential Receptor	20	Annual Mean(3)	0.55	20.6	40	1.4%
		99.8th%ile of 1-hr means(4)	10.6	102.3(5)	200	5.3%
NO_2 Maximum / Donore School	20	Annual Mean(3)	0.08	20.1	40	0.2%
		99.8th%ile of 1-hr means(4)	3.9	101.3(5)	200	2.0%
NO_2 Maximum / Duleek	20	Annual Mean(3)	0.04	20.0	40	0.1%
		99.8th%ile of 1-hr means(4)	3.9	101.3(5)	200	2.0%
NO_2 Maximum / Drogheda	20	Annual Mean(3)	0.04	20.0	40	0.1%
		99.8th%ile of 1-hr means(4)	4.1	101.3(5)	200	2.1%
NO_2 Maximum / Newgrange Cemetery	20	Annual Mean(3)	0.02	20.0	40	0.05%
		99.8th%ile of 1-hr means(4)	1.7	101.2(5)	200	0.85%

(1) Includes contribution from traffic and background sources (based on results diffusion tubes) and incorporating the cumulative assessment results.

(2) Directive 2008/50/EC

(3) Conversion factor following guidance from USEPA (Tier 2 analysis, annual average) based on site-specific ratio of 0.75 (worst-case).

(4) Conversion factor, following guidance from USEPA (Tier 3 analysis), based on empirically derived site-specific maximum 1-hour value for NO_2 / NO_X of 0.50

(5) Background added using UK DEFRA guidance - see Section 7.4.3.

7.5.5 Concentration Contours

The geographical variation in NO_2 ground level concentrations beyond the site boundary are illustrated as concentration contours in Figures 7.4 to 7.5. The contents of each figure are described below.

Figure 7.4 Maximum Operations: Predicted Tier 3 NO_2 99.8th Percentile Concentration

Figure 7.5 Maximum Operations: Predicted Tier 2 NO_2 Annual Average Concentration

7.5.6 Result Findings

In relation to the maximum one-hour limit value, NO_2 Tier 3 modelling results indicate that the ambient ground level concentrations are below these ambient standards for the protection of human health under average, maximum and abnormal operation of the site. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient NO_2 concentrations (including background concentrations) which are 52% of the maximum ambient 1-hour limit value (measured as a 99.8th%ile) at the worst-case receptor (2.5km north-west of the site-boundary). The annual average concentration (including background concentration) is also significantly below the limit value for the protection of human health accounting for 53% of the annual limit value at the worst-case receptor which is located 500m east of the site. The impact under abnormal operation is essentially unchanged compared to normal operation due to the infrequent nature of the occurrence (approximately 1% of the time in any one week).

The modelling results indicate that the maximum 1-hour and annual average concentrations occur at or near the site's north-west to eastern boundaries. Concentrations fall off rapidly away from this maximum and for the maximum 1-hour concentration (as a 99.8th%ile) will be only 5% of the limit value (not including background concentrations) at the nearest sensitive receptor to the site (see Table 7.16). The annual average concentration decreases away from the site with concentrations from emissions at the proposed facility accounting for only 1.4% of the limit value (not including background concentrations) at worst case sensitive receptors near the site. Thus, the results indicate that the potential impact from the proposed facility on human health and the environment is minor and limited to the immediate environs of the site (i.e. close to the site boundary).

In the surrounding main population centres, Drogheda and Duleek, levels are significantly lower than background sources with the concentration from emissions at the proposed facility accounting for less than 0.1% of the annual limit value for the protection of human health.

7.6 SULPHUR DIOXIDE AND TOTAL DUST (AS PM_{10} AND $PM_{2.5}$) EMISSIONS AND RESULTS

7.6.1 Source Information

Source information including emission release heights, volume flows, locations and stack diameters has been summarised in Appendix 7.5.

Ambient Ground Level Concentrations (GLC's) of Sulphur Dioxide (SO_2) and Total Dust (as PM_{10} and $PM_{2.5}$) have been predicted for the following scenarios in Table 7.17.

Table 7.17 Emission Scenario for Sulphur Dioxide and Total Dust (as PM_{10} and $PM_{2.5}$)

Pollutant	Scenario	Concentration	Emission Rate (g/s)
SO_2	Average 1-Hour Operation	200 mg/m^3	7.44
	Average 24-Hour Operation	50 mg/m^3	1.86
	Maximum 1-Hour Operation	200 mg/m^3	8.17
	Maximum 24-Hour Operation	50 mg/m^3	2.0
	Abnormal Operation$^{(1)}$	200 mg/m^3	8.2
Total Dust	Average 24-Hour Operation	10 mg/m^3	0.37
	Maximum 24-Hour Operation	10 mg/m^3	0.41
	Abnormal Operation$^{(2)}$	30 mg/m^3	1.2

(1) Abnormal operation scenario based on an emission level of 200 mg/m^3 for six hours every Monday for a full year.

(2) Abnormal operation scenario based on an emission level of 30 mg/m^3 for eight hours every Monday for a full year.

Abnormal Operation

Elevated levels of SO_2 may occur due to the malfunctioning of the evaporating spray reactor. Such conditions will be detected immediately from an elevation in the SO_2 emission value which will be continuously observed on the computerised control system in the control room. An automatic alarm will be activated well in advance of exceedance of the emission limit value to allow adequate time for intervention. Therefore for the purpose of the air modelling study the following abnormal operation conditions were used: 6hrs of operation at an emission value of 200 mg/Nm^3.

Elevated levels of dust may occur due to malfunctioning of one or more bags of the baghouse filter. Dust is continuously monitored therefore this abnormal condition will be detected immediately from an elevation in the dust emission values which will be continuously observed on the computerised control system in the control room. An automatic alarm will be activated well in advance of exceedance of the emission limit value to allow adequate time for intervention. The baghouse filter consists of a number of compartments, including a spare compartment. Each compartment can be checked individually to detect the malfunctioning bag. This bag will be by-passed and retrofitted. If dust emissions exceed the daily average emission of 10 mg/Nm^3 an alarm will be activated resulting in automatic shut down of the facility. Therefore for the purpose of the air modelling study the following abnormal operation conditions were used: 8hrs of operation at an emission value of 30 mg/Nm^3.

7.6.2 Comparison with Standards And Guidelines

The relevant air quality standards for Sulphur Dioxide, PM_{10} and $PM_{2.5}$ have been detailed in Table 7.18. In this report the ambient air concentrations for SO_2 and PM_{10} have been referenced to Council Directive 2008/50/EC and S.I. 271 of 2002.

Table 7.18 EU Ambient Air Quality Current & Proposed Standards

Pollutant	Regulation	Limit Type	Current Margin of Tolerance	Value
Sulphur Dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	None	350 µg/m^3
		Daily limit for protection of human health - not to be exceeded more than 3 times/year	None	125 µg/m^3
		Annual & Winter limit for the protection of ecosystems	None	20 µg/m^3
PM_{10}	2008/50/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	None	50 µg/m^3
		Annual limit for protection of human health	None	40 µg/m^3
$PM_{2.5}$	2008/50/EC	Annual limit for protection of human health	None	25 µg/m^3

7.6.3 Modelling Results

Modelling was carried out for the three scenarios described in Section 7.6.1.

Tables 7.19 – 7.21 details the predicted SO_2, PM_{10} and $PM_{2.5}$ GLC for each scenario.

Table 7.19 Dispersion Model Results – Sulphur Dioxide

Pollutant / Scenario	Annual Background (µg/m^3)	Averaging Period	Process Contribution (µg/m^3)	Predicted Emission Concentration (µg/Nm^3)	Standard[(1)] (µg/Nm^3)
SO_2 / Average Operation	4	99.7th%ile of 1-hr means 99.2th%ile of 24-hr means	27.9 2.9	32.4(2) 9.5(2)	350 125
SO_2 / Maximum Operation	4	99.7th%ile of 1-hr means 99.2th%ile of 24-hr means	26.4 2.8	34.4(2) 10.9(2)	350 125
SO_2 / Abnormal Operation	4	99.7th%ile of 1-hr means 99.2th%ile of 24-hr means	27.9 3.7	34.4(2) 10.2(2)	350 125

(1) Directive 2008/50/EC

(2) Background added using UK DEFRA guidance - see Section 7.4.3.

Table 7.20 Dispersion Model Results – Total Dust (referenced to PM_{10})

Pollutant / Scenario	Annual Mean Background (µg/m^3)	Averaging Period	Process Contribution (µg/m^3)	Predicted Emission Concentration (µg/Nm^3)	Standard(1) (µg/Nm^3)
PM_{10} / Average	20	90.4th%ile of 24-hr means	0.25	37.3(2)	50
		Annual mean	0.08	20.1	40
PM_{10} / Maximum	20	90.4th%ile of 24-hr means	0.25	37.3(2)	50
		Annual mean	0.08	20.1	40
PM_{10} / Abnormal Operation	20	90.4th%ile of 24-hr means	0.27	39.7(2)	50
		Annual mean	0.09	20.1	40

(1) Directive 2008/50/EC

(2) Background added using UK DEFRA guidance - see Section 7.4.3.

Table 7.21 Dispersion Model Results – Total Dust (referenced to $PM_{2.5}$)

Pollutant / Scenario	Annual Mean Background (µg/m^3)	Averaging Period	Process Contribution (µg/m^3)	Predicted Emission Concentration (µg/Nm^3)	Limit Value(1) (µg/Nm^3)
$PM_{2.5}$ / Average	14	Annual mean	0.08	14.1	25
$PM_{2.5}$ / Maximum	14	Annual mean	0.08	14.1	25
$PM_{2.5}$ / Abnormal Operation	14	Annual mean	0.09	14.1	25

(1) 2008/50/EC

7.6.4 Concentration Contours

The geographical variation in SO_2, PM_{10} and $PM_{2.5}$ ground level concentrations beyond the site boundary are illustrated as concentration contours in Figures 7.6 to 7.10. The contents of each figure are described below.

Figure 7.6 Maximum Operations: Predicted SO_2 99.7th Percentile of Hourly Concentrations

Figure 7.7 Maximum Operations: Predicted SO_2 99.2th Percentile of 24-Hourly Concentrations

Figure 7.8 Maximum Operations: Predicted PM_{10} 90.4th Percentile of 24-Hourly Concentrations

Figure 7.9 Maximum Operations: Predicted PM_{10} Annual Concentrations

Figure 7.10 Maximum Operations: Predicted $PM_{2.5}$ Annual Concentrations

7.6.5 Result Findings

SO_2

SO_2 modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for the protection of human health for sulphur dioxide under average, maximum and abnormal operation of the site. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient SO_2 concentrations (including background concentrations) which are 9% of the maximum ambient 1-hour limit value (measured as a 99.7th%ile) and 8% of the maximum ambient 24-hour limit value (measured as a 99.2th%ile) at the worst-case receptor.

PM_{10}

PM_{10} modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for the protection of human health for PM_{10} under average, maximum and abnormal operation of the site. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient PM_{10} concentrations (including background concentrations) which are 75% of the maximum ambient 24-hour limit value (measured as a 90.4th%ile) and 50% of the annual average limit value at the worst-case receptor. The contribution from the proposed facility equates to 0.5% and 0.2% of the 24-hour and annual limit values respectively under maximum operating conditions.

$PM_{2.5}$

$PM_{2.5}$ modelling results indicate that the ambient ground level concentrations are below the proposed air quality standard for the protection of human health for $PM_{2.5}$ under average, maximum and abnormal operation of the site. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient $PM_{2.5}$ concentrations (including background concentrations) which are 56% of the proposed annual average limit value at the worst-case receptor, with the contribution from the proposed facility equating to 0.3% of the limit value.

7.7 TOTAL ORGANIC CARBON (TOC), HYDROGEN CHLORIDE AND HYDROGEN FLUORIDE EMISSIONS AND RESULTS

7.7.1 Source Information

Source information including emission release heights, volume flows, locations and stack diameters has been summarised in Appendix 7.5.

Ambient Ground Level Concentrations (GLC's) of Total Organic Carbon (TOC), Hydrogen Chloride (HCl) and Hydrogen Fluoride (HF) have been predicted for the following scenarios in Table 7.22.

Table 7.22 Emission Scenario for TOC, HCl and HF

Pollutant	Scenario	Concentration	Emission Rate (g/s)
TOC	Average 1-Hour Operation	30 mg/m^3	1.12
	Average 24-Hour Operation	10 mg/m^3	0.37
	Maximum 1-Hour Operation	30 mg/m^3	1.23
	Maximum 24-Hour Operation	10 mg/m^3	0.41
	Abnormal Operation(1)	30 mg/m^3	1.23
HCl	Average 1-Hour Operation	60 mg/m^3	2.23
	Average 24-Hour Operation	10 mg/m^3	0.37
	Maximum 1-Hour Operation	60 mg/m^3	2.45
	Maximum 24-Hour Operation	10 mg/m^3	0.41
	Abnormal Operation(2)	60 mg/m^3	2.45
HF	Average 1-Hour Operation	4mg/m^3	0.149
	Average 24-Hour Operation	1 mg/m^3	0.037
	Maximum 1-Hour Operation	4mg/m^3	0.163
	Maximum 24-Hour Operation	1 mg/m^3	0.041
	Abnormal Operation(3)	4 mg/m^3	0.163

(1) Abnormal operation scenario based on an emission level of 30 mg/m^3 for eight hours every Monday for a full year.

(2) Abnormal operation scenario based on an emission level of 60 mg/m^3 for four hours every Monday for a full year.

(3) Abnormal operation scenario based on an emission level of 4 mg/m^3 for six hours every Monday for a full year.

Abnormal Operation

Elevated levels of HCl and HF may occur due to the malfunctioning of the evaporating spray reactor. Such conditions will be detected immediately from an elevation in the HCl emission value which will be continuously observed on the computerised control system in the control room. An automatic alarm will be activated well in advance of exceedance of the emission limit value to allow adequate time for intervention.

Taking HCl as an example, as there are two stages of HCl removal in the flue gas cleaning system, namely the evaporating spray reactor and by the injection of dry lime into the duct between the evaporating spray reactor and the baghouse filter, excess levels of HCl observed on the computerised control system in the control room will immediately indicate a malfunctioning of one of these systems. Each system provides an element of redundancy for the other in the event of a malfunction of one of these systems.

Similar conditions apply for elevated levels of HF. Therefore for the purpose of the air modelling study the following abnormal operation conditions were used:

HCl: 4hrs of operation at an emission value of 60 mg/Nm^3,
HF: 6hrs of operation at an emission value of 4 mg/Nm^3.

Elevated levels of TOC may occur due to abnormal operating conditions in the furnace. This abnormal condition will be detected immediately from an elevation in the TOC emission value which will be continuously observed on the computerised control system in the control room. An automatic alarm will be activated well in advance of exceedance of the emission limit value to allow adequate time for intervention. Therefore for the purpose of the air modelling study the following abnormal operation conditions were used: 8hrs of operation at an emission value of 30 mg/Nm^3.

7.7.2 Comparison with Standards and Guidelines

The organic emissions from the site will consist of a range of aliphatic and aromatic compounds at low concentration. The toxicity of these compounds will vary by several orders of magnitude. Ambient benzene levels have been regulated by the EU (Council Directive 2008/50/EC) due to the higher toxicity of this compound compared to other common hydrocarbons. In this assessment, it has been assumed that all emissions from the site are composed of benzene. This is a very pessimistic assumption and thus will significantly overestimate the impact of TOC emissions from the site.

TA Luft standards have been proposed for HCl and HF. The TA-Luft standard is based on a 30-minute averaging period. As the meteorological data used in the modelling is collated on an averaging period of one hour, the dispersion model can only predict concentrations for averaging periods of one hour or above. Predicted hourly-average concentrations have subsequently been compared against the standard. Typically the peak 30-minute average will be 10 to 20% higher than the corresponding 1-hour period average.

Table 7.23 Air Standards for TOC, HCl and HF

Pollutant	Regulation	Limit Type	Value
TOC (assumed t be benzene)	EU Council Directive 2008/50/EC	Annual Average	5 μg/m^3
HCl	TA Luft	Hourly limit for protection of human health – expressed as a 98th%ile	100 μg/m^3
HF	TA Luft	Hourly limit for protection of human health – expressed as a 98th%ile	3 μg/m^3
HF	WHO	Gaseous fluoride (as HF) as an annual average.	0.3 μg/m^3
HF	Dutch	Mean fluoride (as HF) concentration during the growing season (April to September)	0.4 μg/m^3
HF	Dutch	Ambient gaseous fluoride (as HF) as a 24-hour average concentration.	2.8 μg/m^3

7.7.3 Modelling Results

Modelling was carried out for the three scenarios described in Section 7.7.1 for each pollutant. Tables 7.24 – 7.26 details the predicted TOC, HCl and HF GLC for each scenario.

Table 7.24 Dispersion Model Results – TOC (assumed to be benzene)

Pollutant / Scenario	Annual Mean Background (μg/m^3)	Averaging Period	Process Contribution (μg/m^3)	Predicted Emission Concentration (μg/Nm^3)	Standard(1) (μg/Nm^3)
TOC / Average	0.7	Annual Average	0.08	0.78	5
TOC / Maximum	0.7	Annual Average	0.08	0.78	5
TOC / Abnormal Operation	0.7	Annual Average	0.09	0.79	5

(1) Council Directive 2008/50/EC

Table 7.25 Dispersion Model Results – HCl

Pollutant / Scenario	Annual Mean Background (μg/m^3)	Averaging Period	Process Contribution (μg/m^3)	Predicted Emission Concentration (μg/Nm^3)	Standard(1) (μg/Nm^3)
HCl / Average	0.01	98th%ile of 1-hr means	5.56	5.58	100
HCl / Maximum	0.01	98th%ile of 1-hr means	5.17	5.19	100
HCl / Abnormal Operation	0.01	98th%ile of 1-hr means	5.79	5.81	100

(1) TA Luft Emission Standard

Table 7.26 Dispersion Model Results – HF

Pollutant / Scenario	Annual Mean Background ($\mu g/m^3$)	Averaging Period	Process Contribution ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard ($\mu g/Nm^3$)
HF / Average	0.005	98th%ile of 1-hr means	0.37	0.38	3.0(1)
		Maximum 24-hr	0.08	0.09	2.8(2)
		Annual Average	0.008	0.013	0.3(3)
HF / Maximum	0.005	98th%ile of 1-hr means	0.34	0.35	3.0(1)
		Maximum 24-hr	0.08	0.09	2.8(2)
		Annual Average	0.008	0.013	0.3(3)
HF / Abnormal Operation	0.005	98th%ile of 1-hr means	0.37	0.38	3.0(1)
		Maximum 24-hr	0.09	0.10	2.8(2)
		Annual Average	0.009	0.014	0.3(3)

(1) TA Luft Emission Standard

(2) Netherlands Emission Regulations Staff Office

(3) World Health Organisation

7.7.4 Concentration Contours

The geographical variation in TOC (as benzene), HCl and HF ground level concentrations beyond the site boundary is illustrated as concentration contours in Figures 7.11 – 7.14. The content of the figures is described below.

Figure 7.11 Maximum Operations: Predicted TOC (as benzene) Annual Average Concentration

Figure 7.12 Maximum Operations: Predicted 98%ile of Maximum 1-Hour HCl Concentrations

Figure 7.13 Maximum Operations: Predicted 98%ile of Maximum 1-Hour HF Concentrations

Figure 7.14 Maximum Operations: Predicted HF Annual Average Concentration

7.7.5 Result Findings

TOC

TOC modelling results indicate that the ambient ground level concentrations are below the relevant air quality standard for the protection of human health for benzene under average, maximum and abnormal operation of the site. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to a maximum ambient TOC concentration (including background concentration) which is 16% of the benzene annual limit value.

HCl

HCl modelling results indicate that the ambient ground level concentrations are below the relevant air quality guideline for the protection of human health for HCl under average, maximum and abnormal operation of the site. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient HCl concentrations (including background concentrations) which are 6% of the maximum ambient 1-hour limit value (measured as a 98th%ile).

HF

HF modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards and guidelines for HF for the protection of human health and vegetation under average, maximum and abnormal operation of the site. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient HF concentrations (including background concentrations) which are 13% of the maximum ambient 1-hour limit value (measured as a 98th%ile) and 4% of the annual limit value.

7.8 DIOXIN-LIKE COMPOUNDS

7.8.1 Description of Dioxin-Like Compounds

The term “Dioxin-like Compounds” generally refers to three classes of compounds; polychlorinated dibenzo-p-dioxins (PCDDs or CDDs), polychlorinated dibenzofurans (PCDFs or CDFs), and polychlorinated biphenyls (PCBs). PCDDs include 75 individual compounds, or congeners, PCDFs include 135 congeners and PCBs include 209 congeners (see Table 7.27). Both PCDDs and PCDFs are usually formed as unintentional by-products through a variety of chemical reactions and combustion processes. These compounds are lipophilic that bind to sediment and organic matter in the environment and tend to be absorbed in animal and human fatty tissue. They are also generally extremely resistant towards chemical and biological degradation processes, and, consequently, persist in the environment and accumulate in the food chain (10).

The toxic effects of dioxins are initiated at the cellular level, by the binding of the dioxin to a specific protein in the cytoplasm of the body cells, the aryl hydrocarbon receptor (AhR). The binding of TCDD to the Ah receptor constitutes a first and necessary step to initiate the toxic and biochemical effects of this compound. Dioxins effects in humans include increased prevalence of diabetes, immunotoxic effects and effects on neurodevelopment and neurobehavior in children. Studies have shown TCDD to be carcinogenic but a lack of direct DNA-damaging effects indicates that TCDD is not an initiator but a promoter of carcinogenesis (11).

130 of the 209 PCB congeners have historically been manufactured for a variety of uses including dielectric fluids in transformers and capacitors and as lubricants and adhesives. However, the marketing, use and disposal of PCBs has been severely restricted in the EU through Directives 85/467/EC and 96/59/EC (10).

The toxicity of dioxins varies widely with 2, 3, 7, 8-TCDD being the most potent dioxin congener and with only particular configurations of these compounds thought to have dioxin-like toxicity (See Table 7.28). For PCDDs (Dioxins), only 7 of the 75 congeners have dioxin-like toxicity; these are the ones with chlorine substitutions in, at least, the 2, 3, 7 and 8 positions. For PCDFs (Furans), only 10 of the 135 congeners have dioxin-like toxicity; these are again the ones with chlorine substitutions in, at least, the 2, 3, 7 and 8 positions. In relation to PCBs, only 13 of the 209 congeners are likely to have dioxin-like toxicity; these are the PCBs with four or more chlorines with just one or no substitutions in the ortho position (coplanar)(10,12).

As dioxin-like compounds have varying degrees of toxicity, a toxicity equivalency procedure has been developed to describe the cumulative toxicity of these mixtures. The procedure involved assigning individual Toxicity Equivalency Factors (TEFs) to the 2, 3, 7, 8- substituted PCDD and PCDF congeners and to selected coplanar and mono-ortho PCBs. The TEFs are referenced to 2, 3, 7, 8-TCDD, which is assigned a TEF of 1.0. Calculation of the toxic equivalency (TEQ) of a mixture involves multiplying the concentration of individual congeners by their respective TEF. The sum of the TEQ concentrations for the individual congeners is the TEQ concentration for the mixture.

Since 1989, three different TEF schemes have been developed $^{(12)}$:

I-TEQ$_{DF}$ – Developed by NATO/CCMS in 1988, the I-TEQ$_{DF}$ (DF = dioxin, furan, I = International) procedure assigns TEFs only for the 7 dioxins (PCDDs) and 10 furans (PCDFs). This scheme does not include dioxin-like PCBs. This scheme has been adopted in Council Directive 2000/76/EC and has been applied in the current assessment.

TEQ$_{DFP}$-WHO$_{94}$ – In 1994, the WHO added 13-dioxin-like PCBs to the TEF scheme for dioxins and furans. However, no changes were made to the TEFs for dioxins and furans I-TEQ$_{DF}$ (DFP = dioxin, furan, PCBs).

TEQ$_{DFP}$-WHO$_{98}$ – In 1998, the WHO re-evaluated the TEF scheme for dioxins, furans and dioxin-like PCBs. Changes were made to the TEFs for dioxins, furans and dioxin-like PCBs. Table 7.28 outlines the TEF for the most recent scheme for comparison with the scheme recommended in Council Directive 200/76/EC (I-TEQ$_{DF}$).

7.8.2 Modelling Strategy

The emissions of dioxin-like compounds from the waste-to-energy plant have been evaluated in this chapter. Firstly, the stack emissions have been characterised in terms of mass of each Dioxin/Furan congener released, and the partitioning of these releases into a vapour and particle phase. Thereafter, air dispersion modelling has been used to translate these releases to ambient air vapour and particle phase concentrations, and wet vapour and wet and dry particulate deposition fluxes, in the vicinity of the release.

As recommended by the USEPA, individual dioxin congeners have been modelled from source to receptor. Only at the interface to human exposure, e.g., ingestion, inhalation, dermal absorption, etc., are the individual congeners recombined and converted into the toxic equivalence of 2, 3, 7, 8-TCDD to be factored into a quantitative risk assessment.

Emission Rate

The dioxin emission factor is defined as the total mass (in vapour and particulate form) of dioxin-like compound emitted per mass of feed material combusted. For the current proposal, a test burn is not possible as the waste-to-energy plant has not been commissioned yet. However, Indaver has several flue gas cleaning systems similar to that proposed in the current facility, in operation in Belgium. An analysis of these flue gas cleaning systems has suggested that the likely emission rate will out perform the most stringent limit value set by the EU in the recent Council Directive on Incineration (2000/76/EC).

Congener-specific emission data are needed for the analyses of the ambient air impacts and deposition flux of dioxin-like compounds using air dispersion and deposition models. As each specific congener has different physico-chemical properties, the proportion of each congener will affect the final result. Thus, the congener profile expected from the current facility must be derived. The congener profile will be dependent on various factors including the type of waste being burnt, the temperature of combustion, the type of combustion chamber being operated and the air pollution control devices (APCDs) installed. In the present case, no site-specific stack testing for specific congeners is possible as the facility is not yet built. Shown in Table 7.29 are typical relative PCDD/PCDF (Dioxins/Furans) congener emission factors for a municipal waste incinerator similar to that proposed in the current facility (Mass-Burn Waterwall Facility, APCS consisting of Dry Scrubber, Carbon Injection and Fabric Filter, (MB-WW, DS/CI/FF)), taken from the Database of Sources of Environmental Releases of Dioxin-Like Compounds in the United States (USEPA, 1998 (CD-ROM)) (13). It would be expected that the relative congener profiles for this type of waste-to-energy plant would be somewhat similar to the current case. Figures 7.15 – 7.16 show the ratio of congeners and the TEQ equivalent releases from this type of facility corrected to the maximum emission limit outlined in Council Directive 2000/76/EC.

Abnormal Operation

There is a two stage dioxin removal system, namely injection of expanded clay prior to the evaporating spray reactor and activated carbon prior to baghouse filter. During the malfunctioning of one stage the alternative stage can provide a back up system.

If the first stage malfunctions, operation of the second stage alone will result in a typical dioxin emission value of well below 0.1ngTEQ/Nm^3. Should the second stage fail, the first stage will result in a typical dioxin emission value of below 0.1ngTEQ/Nm^3 also. In order to assume a worst case scenario, it is assumed that a value of 0.5ngTEQ/Nm^3 could be experienced due to a failure involving both systems, which is 5 times the EU limit.

There is little likelihood of the either dioxin removal system malfunctioning for any significant length of time as this would occur due to a failing of the clay or activated carbon injection. This injection system and the weight of the clay / carbon in the dosing bin and in the storage silos are monitored continuously. Each dosing bin (volumetric dosing device) continuously transfers carbon or clay from the silo and injects it into flue gases. The bin must be filled 10 times per day and this is monitored. If the number of fills is less than a preset daily value this activates an automatic alarm. No change in the weight of carbon in the silo after one or two days would also clearly indicate a malfunctioning of the system. Therefore the worst case scenario would be where the first stage malfunctions but is detected within two days from monitoring the dosing bin.

While dioxin emissions are continuously sampled, emission values would be historic. It would typically take two weeks to analyse a dioxin filter which operates on a two-week cycle. Therefore for the purpose of the air modelling study the following two abnormal operation conditions were used: firstly, dioxin emission values of 0.5 ngTEQ/Nm^3 for two days per month and secondly, a dioxin emission values of 0.5

ngTEQ/Nm^3 for five weeks per year (based on a two week sampling period and three week analysis period).

Vapour / Particulate Partitioning

In order to accurately model emissions of PCDD/PCDFs (Dioxins/Furans), PAHs and mercury, the partitioning of stack emissions into the vapour and particle (V/P) state is required.

In relation to PCDD/PCDFs (Dioxins/Furans), V/P partitioning based on stack tests data is highly uncertain (4). Research has indicated that higher temperatures favour the vaporous states for the lower chlorinated congeners and the particulate state for the higher chlorinated congeners(4). However, measured data has indicated significant variability in the V/P partitioning. For these reasons, the USEPA has indicated that V/P distributions obtained from stack sampling should not be used.

Data can also be obtained from ambient air sampling using a glass fibre particulate filter and polyurethane foam (PUF) absorbent trap. As the sampler is not subjected to artificial heating or cooling, the method can be used to imply the vapour phase and particle bound partitioning of PCDD/Fs (Dioxins/Furans) in ambient air. However, the results will be only approximate as mass transfer between the particulate matter on the filter and the vapour trap cannot be ruled out (4).

The recommended USEPA approach to obtaining the vapour/particulate partitioning at the current time is theoretical and based on the Junge-Pankow model for estimating the particle/gas distribution of PCDD/PCDFs (Dioxins/Furans) (4). This model is the one most commonly used for estimating the adsorption of semi-volatile compounds to aerosols:

$$\Phi = c\Theta / (\rho^o_L + c\Theta)$$

where:
Φ = fraction of compound adsorbed to aerosol particles
c = constant (assumed 17.2 Pa-cm)
Θ = particle surface area per unit volume of air, cm^2 aerosol/cm^3 air
ρ^o_L = saturation liquid phase vapour pressure, Pa

The particulate fraction can also be expressed by:

$$\Phi = C_p(TSP) / (C_g + C_p(TSP))$$

where:
Φ = fraction of compound adsorbed to aerosol particles
C_p = concentration of semi-volatile compounds associated with aerosols, ng/µg particles
C_g = gas-phase concentration, ng/m^3
TSP = total suspended particle concentration, µg/m^3

In the above calculations, it is assumed that all compounds emitted from the combustion sources are freely exchangeable between vapour and particle fractions. This may be a simplification as some of the particulate fraction may be trapped and be unavailable for exchange.

As the ρ^o_L is referenced to 25ºC and an ambient temperature of 10ºC has been assumed which is appropriate for average annual temperatures in Ireland, the ρ^o_L has been converted to the ambient temperature as indicated in Table 7.30. Other relevant data used in the calculations and the derived particle fraction at 10ºC is also shown in Table 7.30.

The advantages of the theoretical approach is that it is based on current adsorption theory, considers the molecular weight and degree of halogenation of the congeners and uses the availability of surface area for adsorption of atmospheric particles corresponding to specific airsheds (background plus local sources used in the current case).

7.8.3 Modelling of Vapours and Particles Concentrations

PCDD/PCDFs (Dioxins/Furans) have a range of vapour pressures and thus exist in both vapour and particle-bound states to various degrees. In order to adequately model dispersion and deposition of PCDD/PCDFs (Dioxins/Furans), modelling of both vapour and particle-bound states is thus necessary. For the vapour phase modelling, no dry deposition was assumed, as recommended by the USEPA (4,5). Using the congener profile from Table 7.29 and the vapour – particle partitioning from Table 7.30, the vapour concentrations of the respective dioxin congeners was determined as outlined in Table 7.32 for a default MWI (MS-WW DS/CI/FF) profile and diagrammatically in Figure 7.17. Results are shown under maximum operating conditions.

When modelling semi-volatile organics (such as Dioxins/Furans and PAHs) and mercury (Hg) the surface area weighting rather than mass weighting is used for deposition. The surface weighting reflects the mode of formation where volatiles condense on the surface of particulates in the post-combustion chamber (see Column 6 of Table 7.31). Thus, the apportionment of emissions by particle size becomes a function of the surface area of the particle which is available for chemical adsorption.

For the particle-phase concentration, the congener profile from Table 7.29 and the vapour – particle partitioning from Table 7.30 were used to give the particulate concentrations of the respective dioxin congeners as determined in Table 7.33 and diagrammatically in Figure 7.17. Results are shown under maximum operating conditions.

7.8.4 Deposition Modelling of Particulates

Deposition refers to a range of mechanisms which can remove emissions from the atmosphere. These include Brownian motion of aerosol particles and scavenging of particles and vapours by precipitation.

Dry Deposition

Dry deposition of particles refers to the transfer of airborne particles to the surface by means of the forces of gravity and turbulent diffusion followed by diffusion through the laminar sub-layer (thickness of 10^{-1} to 10^{-2} cm) to the surface (collectively know as the deposition flux)(4). The meteorological factors which most influence deposition include the friction velocity and aerodynamic surface roughness. The AERMOD model uses an algorithm which relates the deposition flux to functions of particle size, density, surface roughness and friction velocity.

In order to model dry deposition using AERMOD, the particle-size distribution from the stack must be derived. In the absence of a site-specific particle-size distribution, a generalised distribution recommended by the USEPA has been outlined in Table 7.31. This distribution is suitable as a default for some combustion facilities equipped with either electrostatic precipitators (ESPs) or fabric filters (such as the current case), because the distribution is relatively typical of particle size arrays that have been measured at the outlet to advanced equipment designs(5). As described above, the particles are apportioned based on the fraction of available surface area (see Column 6 of Table 7.31).

Dry gaseous deposition, although considered in the AERMOD model, has not been calibrated for the estimation of the deposition flux of dioxin-like compounds into vegetation and thus the USEPA has recommended that this algorithm should not be used for site-specific applications(4,5).

Wet Particulate Deposition

Wet particulate deposition physically washes out the chemically contaminated particulates from the atmosphere. Wet deposition flux depends on the fraction of the time precipitation occurs and the fraction of material removed by precipitation per unit of time by particle size. The AERMOD model uses the particle-phase washout coefficient, precipitation rate and the concentration of particulate in air.

Modelling Approach

For the deposition modelling of Dioxins/Furans, both wet and dry particulate deposition fluxes were calculated. The modelling also incorporated wet and dry depletion into the calculations to ensure that the conservation of mass was maintained, as recommended by the USEPA.

For the particle and gas-phase deposition, the congener profile from Table 7.29 and the vapour – particle partitioning from Table 7.30 were used to give the emission rate of the respective dioxin congeners as determined in Table 7.34. The deposition flux for each congener was calculated by multiplying the emission rate of each congener by the unitised deposition flux as shown in Table 7.34 and diagrammatically in Figure 7.18. Results are shown under maximum operating conditions.

7.8.5 Comparison with Standards And Guidelines

Currently, no internationally recognised ambient air quality concentration or deposition standards exist for PCDD/PCDFs (Dioxins/Furans). Both the USEPA and WHO recommended approach to assessing the risk to human health from Dioxins/Furans entails a detailed risk assessment analysis involving the determination of the impact of Dioxins/Furans in terms of the TDI (Tolerable Daily Intake) approach(14,15). A TDI has been defined by the WHO as "an estimate of the intake of a substance over a lifetime that is considered to be without appreciable health risk" (15). Occasional short term excursions above the TDI would have no health consequences provided the long-term average is not exceeded. The WHO currently proposes a maximum TDI of between 1-4 pgTEQ/kg of body weight per day. A TDI of 4 pgTEQ/kg of body weight per day should be considered a maximal tolerable intake on a provisional basis and that the ultimate goal is to reduce human intake levels of below 1 pgTEQ/kg of body weight per day. This reflects the concept that guidance values for the protection of human health should consider total exposure to the substance including air, water, soil, food and other media sources.

Table 7.27 The number of dioxin-like and total congeners within dioxin, furan, and coplanar PCB Homologue groups (1).

Homologue Group	**n: Number of Dioxin-Like Congeners**	**N: Number of Congeners**	**1/N**
I. Dioxins			
Tetra-CDD	1	22	0.022
Penta-CDD	1	14	0.071
Hexa-CDD	3	10	0.100
Hepta-CDD	1	2	0.500
Octa-CDD	1	1	1.000
II. Furans			
Tetra-CDF	1	38	0.026
Penta-CDF	2	28	0.036
Hexa-CDF	4	16	0.063
Hepta-CDF	2	4	0.250
Octa-CDF	1	1	1.000
III. Mono-ortho coplanar PCBs			
Tetrachloro-PCBs	1	42	0.024
Pentachloro-PCBs	5	46	0.022
Hexachloro-PCBs	4	42	0.024
Heptachloro-PCBs	3	24	0.042

(1) USEPA (2000) Estimating Exposure to Dioxin-Like Compounds Volume II, Chapter 3

Table 7.28 The TEF scheme for TEQ_{DFP}-WHO_{98} and I-TEQ_{DF} (1).

Dioxin Congeners	**TEF**	**Furan Congeners**	**TEF**
2,3,7,8-TCDD	1.0	2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDD	1.0 (0.5)(2)	1,2,3,7,8-PeCDF	0.05
1,2,3,4,7,8-HxCDD	0.1	2,3,4,7,8-PeCDF	0.5
1,2,3,6,7,8-HxCDD	0.1	1,2,3,4,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDD	0.1	1,2,3,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDD	0.01	1,2,3,7,8,9-HxCDF	0.1
OCDD	0.0001 (0.001)(2)	2,3,4,6,7,8-HxCDF	0.1
PCB Chemical Structure	**TEF**	1,2,3,4,6,7,8-HpCDF	0.01
3,3’,4,4’-TeCB	0.0001	1,2,3,4,7,8,9-HpCDF	0.01
3,4,4’,5-TCB	0.0001	OCDF	0.0001 (0.001)(2)
2,3,3’,4,4’-PeCB	0.0001		
2,3,4,4’,5-PeCB	0.0005		
2,3’,4,4’,5-PeCB	0.0001		
2’,3,4,4’,5-PeCB	0.0001		
3,3’,4,4’,5-PeCB	0.1		
2,3,3’,4,4’,5-HxCB	0.0005		
2,3,3’,4,4’,5’-HxCB	0.0005		
2,3’,4,4’,5,5’-HxCB	0.00001		
3,3’,4,4’,5,5’-HxCB	0.01		
2,3,3’,4,4’,5,5’-HpCB	0.0001		

(1) USEPA (2000) Estimating Exposure to Dioxin-Like Compounds Volume II, Chapter 1

(2) Values in parentheses are those given in Annex 1, Council Directive 2000/76/EC and equate to I-TEQ_{DF}.

Table 7.29 PCDD/PCDF Relative Emission Factors for Municipal Waste Incinerator (MB-WW DS/CI/FF) (1)

	Emission Factor (relative to sum of toxic congeners)	**Emission Concentration (ng/m^3 from stack)**	**Emission Factor (ng/sec from stack)**
Congener Group	Nondetects set to zero	Nondetects set to zero	Nondetects set to zero
2,3,7,8-TCDD	0.0006	0.0014	5.66E-02
1,2,3,7,8-PeCDD	0.0070	0.0077	3.15E-01
1,2,3,4,7,8-HxCDD	0.0121	0.0027	1.09E-01
1,2,3,6,7,8-HxCDD	0.0148	0.0033	1.33E-01
1,2,3,7,8,9-HxCDD	0.0276	0.0061	2.49E-01
1,2,3,4,6,7,8-HpCDD	0.1276	0.0028	1.15E-01
OCDD	0.2159	0.0005	1.95E-02
2,3,7,8-TCDF	0.0044	0.0010	3.96E-02
1,2,3,7,8-PeCDF	0.0114	0.0012	5.12E-02
2,3,4,7,8-PeCDF	0.0246	0.0270	1.11E+00
1,2,3,4,7,8-HxCDF	0.0870	0.0191	7.85E-01
1,2,3,6,7,8-HxCDF	0.0370	0.0081	3.34E-01
1,2,3,7,8,9-HxCDF	0.0000	0.0000	0.00E+00
2,3,4,6,7,8-HxCDF	0.0620	0.0136	5.59E-01
1,2,3,4,6,7,8-HpCDF	0.2130	0.0047	1.92E-01
1,2,3,4,7,8,9-HpCDF	0.0246	0.0005	2.22E-02
OCDF	0.1304	0.0003	1.18E-02
Total PCDD/PCDF	**1.0**	**0.1 ng/m^3**	**4.1 ng/sec**

(1) Database of Sources of Environmental Releases of Dioxin-Like Compounds in the United States (1998, USEPA (CD-ROM)).

Table 7.30 PCDD/PCDF Particle Fraction, Φ, at 10ºC In Airshed (Background plus Local Sources) (1)

Congener Group	**E-Hρ^o_L (25ºC)**	**E-Hρ^o_L (10ºC)$^{(2)}$**	**Particle Fraction**
2,3,7,8-TCDD	1.14×10^{-4}	1.87×10^{-5}	0.763
1,2,3,7,8-PeCDD	1.74×10^{-5}	2.47×10^{-6}	0.961
1,2,3,4,7,8-HxCDD	3.96×10^{-6}	4.98×10^{-7}	0.992
1,2,3,6,7,8-HxCDD	3.96×10^{-6}	4.98×10^{-7}	0.992
1,2,3,7,8,9-HxCDD	3.96×10^{-6}	4.98×10^{-7}	0.992
1,2,3,4,6,7,8-HpCDD	1.02×10^{-6}	1.18×10^{-7}	0.998
OCDD	2.77×10^{-7}	2.91×10^{-8}	0.9995
2,3,7,8-TCDF	1.23×10^{-4}	2.01×10^{-5}	0.75
1,2,3,7,8-PeCDF	3.64×10^{-5}	5.46×10^{-6}	0.917
2,3,4,7,8-PeCDF	2.17×10^{-5}	3.11×10^{-6}	0.951
1,2,3,4,7,8-HxCDF	8.09×10^{-6}	1.09×10^{-6}	0.982
1,2,3,6,7,8-HxCDF	8.09×10^{-6}	1.09×10^{-6}	0.982
1,2,3,7,8,9-HxCDF	4.99×10^{-6}	6.49×10^{-7}	0.989

2,3,4,6,7,8-HxCDF	4.99×10^{-6}	6.49×10^{-7}	0.989
1,2,3,4,6,7,8-HpCDF	2.24×10^{-6}	2.77×10^{-7}	0.995
1,2,3,4,7,8,9-HpCDF	1.31×10^{-6}	1.56×10^{-7}	0.9974
OCDF	2.60×10^{-7}	2.71×10^{-8}	0.9995

(1) USEPA (2000) Estimating Exposure to Dioxin-Like Compounds Volume II, Chapter 3

(2) Background plus local sources default values: $\Theta = 3.5 \times 10^{-6}$ cm^2 aerosol/cm^3 air, TSP =42 µg/m^3.

Table 7.31 Generalized Particle Size Distribution & Proportion of Available Surface Area (1)

Mean Particle Diameter (µm)	**Particle Radius (µm)**	**Surface Area/Volume (µm^{-1})**	**Fraction of Total Mass (2)**	**Proportion Available Surface Area**	**Fraction of Total Surface Area(3)**
>15.0	7.50	0.400	0.128	0.0512	0.0149
12.5	6.25	0.480	0.105	0.0504	0.0146
8.1	4.05	0.741	0.104	0.0771	0.0224
5.5	2.75	1.091	0.073	0.0796	0.0231
3.6	1.80	1.667	0.103	0.1717	0.0499
2.0	1.00	3.000	0.105	0.3150	0.0915
1.1	0.55	5.455	0.082	0.4473	0.1290
0.7	0.40	7.500	0.076	0.5700	0.1656
<0.7	0.40	7.500	0.224	1.6800	0.4880

(1) USEPA (1998) Chapter 3: Air Dispersion and Deposition Modelling, Human Health Risk Assessment Protocol, Region 6 Centre for Combustion Science and Engineering

(2) Used in the deposition modelling of metals (except Hg)

(3) Used in the deposition modelling of PCDD/PCDFs, PAHs and Hg.

7.8.6 Modelling Results

Tables 7.32 – 7.36 details the predicted PCCD/PCDFs (Dioxins/Furans) GLC and deposition flux for the maximum scenario.

Table 7.32 PCDD/PCDF Annual Vapour Concentrations (Based on a Default MWI Profile (MB-WW DS/CI/FF)) Under Maximum Operating Conditions

Congener Group	Vapour Fraction	Vapour Emission Rate (ng/sec)	Annual Vapour Concentration (fg/m^3)
2,3,7,8-TCDD	0.237	1.34E-02	2.49E-03
1,2,3,7,8-PeCDD	0.039	1.23E-02	2.28E-03
1,2,3,4,7,8-HxCDD	0.008	8.72E-04	1.62E-04
1,2,3,6,7,8-HxCDD	0.008	1.07E-03	1.98E-04
1,2,3,7,8,9-HxCDD	0.008	1.99E-03	3.71E-04
1,2,3,4,6,7,8-HpCDD	0.002	2.30E-04	4.28E-05
OCDD	0.0005	9.73E-06	1.81E-06
2,3,7,8-TCDF	0.25	9.89E-03	1.84E-03
1,2,3,7,8-PeCDF	0.083	4.25E-03	7.91E-04
2,3,4,7,8-PeCDF	0.049	5.43E-02	1.01E-02
1,2,3,4,7,8-HxCDF	0.018	1.41E-02	2.63E-03
1,2,3,6,7,8-HxCDF	0.018	6.01E-03	1.12E-03
1,2,3,7,8,9-HxCDF	0.011	0.00E+00	0.00E+00
2,3,4,6,7,8-HxCDF	0.011	6.15E-03	1.14E-03
1,2,3,4,6,7,8-HpCDF	0.005	9.60E-04	1.79E-04
1,2,3,4,7,8,9-HpCDF	0.0026	5.76E-05	1.07E-05
OCDF	0.0005	5.88E-06	1.09E-06
Sum			**0.023 fg/m^3**

Table 7.33 PCDD/PCDF Annual Particulate Concentrations (Based on a Default MWI Profile (MB-WW DS/CI/FF)) Under Maximum Operating Conditions

Congener Group	Particulate Fraction	Particulate Emission Rate (ng/sec)	Annual Particulate Concentration (fg/m^3)
2,3,7,8-TCDD	0.763	4.32E-02	8.33E-03
1,2,3,7,8-PeCDD	0.961	3.03E-01	5.84E-02
1,2,3,4,7,8-HxCDD	0.992	1.08E-01	2.09E-02
1,2,3,6,7,8-HxCDD	0.992	1.32E-01	2.55E-02
1,2,3,7,8,9-HxCDD	0.992	2.47E-01	4.77E-02
1,2,3,4,6,7,8-HpCDD	0.998	1.15E-01	2.22E-02
OCDD	0.9995	1.95E-02	3.75E-03
2,3,7,8-TCDF	0.75	2.97E-02	5.73E-03
1,2,3,7,8-PeCDF	0.917	4.70E-02	9.06E-03
2,3,4,7,8-PeCDF	0.951	1.05E+00	2.03E-01
1,2,3,4,7,8-HxCDF	0.982	7.71E-01	1.49E-01
1,2,3,6,7,8-HxCDF	0.982	3.28E-01	6.33E-02
1,2,3,7,8,9-HxCDF	0.989	0.00E+00	0.00E+00
2,3,4,6,7,8-HxCDF	0.989	5.53E-01	1.07E-01
1,2,3,4,6,7,8-HpCDF	0.995	1.91E-01	3.69E-02
1,2,3,4,7,8,9-HpCDF	0.9974	2.21E-02	4.27E-03
OCDF	0.9995	1.17E-02	2.27E-03
Sum			**0.767 fg/m^3**

Table 7.34 PCDD/PCDF Annual Deposition Fluxes (Based on a Default MWI Profile (MB-WW DS/CI/FF)) Under Maximum Operating Conditions

Congener Group	Emission Rate (ng/sec)	Dry Deposition Flux (ng/m^2)	Wet Deposition Flux (ng/m^2)	Combined Deposition Flux (ng/m^2)
2,3,7,8-TCDD	5.66E-02	1.44E-03	1.15E-03	1.47E-03
1,2,3,7,8-PeCDD	3.15E-01	8.58E-03	7.99E-03	8.82E-03
1,2,3,4,7,8-HxCDD	1.09E-01	3.00E-03	2.86E-03	3.09E-03
1,2,3,6,7,8-HxCDD	1.33E-01	3.67E-03	3.49E-03	3.77E-03
1,2,3,7,8,9-HxCDD	2.49E-01	6.86E-03	6.53E-03	7.06E-03
1,2,3,4,6,7,8-HpCDD	1.15E-01	3.17E-03	3.03E-03	3.27E-03
OCDD	1.95E-02	5.37E-04	5.14E-04	5.53E-04
2,3,7,8-TCDF	3.96E-02	1.00E-03	7.87E-04	1.02E-03
1,2,3,7,8-PeCDF	5.12E-02	1.37E-03	1.24E-03	1.41E-03
2,3,4,7,8-PeCDF	1.11E+00	3.01E-02	2.78E-02	3.09E-02
1,2,3,4,7,8-HxCDF	7.85E-01	2.15E-02	2.04E-02	2.22E-02
1,2,3,6,7,8-HxCDF	3.34E-01	9.17E-03	8.66E-03	9.43E-03
1,2,3,7,8,9-HxCDF	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,4,6,7,8-HxCDF	5.59E-01	1.54E-02	1.46E-02	1.58E-02
1,2,3,4,6,7,8-HpCDF	1.92E-01	5.29E-03	5.05E-03	5.45E-03
1,2,3,4,7,8,9-HpCDF	2.22E-02	6.11E-04	5.84E-04	6.29E-04
OCDF	1.18E-02	3.24E-04	3.10E-04	3.34E-04
Sum		**0.112 ng/m^2**	**0.105 ng/m^2**	**0.115 ng/m^2**
Equivalent Daily Deposition Flux		**0.307 pg/m^2/day**	**0.288 pg/m^2/day**	**0.316 pg/m^2/day**

Table 7.35 Dispersion Model Summary of Combined Vapour and Particulate Concentrations – PCCD/PCDFs.

Pollutant / Scenario	Annual Mean Background (1) (pg/m^3)	Averaging Period	Process Contribution (pg/m^3)	Predicted Emission Concentration (pg/Nm^3)
PCCD/PCDFs / Average Operation	0.028 0.046	Annual Average	0.00082	0.0288 0.0468
PCCD/PCDFs / Maximum Operation	0.028 0.046	Annual Average	0.00079	0.0288 0.0468
PCCD/PCDFs / Abnormal Operation A(2)	0.028 0.046	Annual Average	0.00086	0.0289 0.0469
PCCD/PCDFs / Abnormal Operation B(3)	0.028 0.046	Five weeks	0.0041	0.032 0.050
PCCD/PCDFs / Abnormal Operation B(3)	0.028 0.046	Annual Average	0.0011	0.029 0.047

(1) Baseline results for dioxins given as sum of cumulative impacts (in the absence of the proposed facility) and baseline monitoring data firstly as (i) Non-detects = zero, (ii) Non-detects = limit of detection.

(2) Abnormal operation A scenario based on an emission level of 0.5 ng/m^3 for 2 days per month.

(3) Abnormal operation B scenario based on an emission level of 0.5 ng/m^3 for five weeks in a full year.

Table 7.36 Deposition Model Summary of Combined Particulate Deposition Flux – PCCD/PCDFs.

Pollutant / Scenario	Averaging Period	Predicted Total Particulate Deposition Flux (pg/m^2/day)
PCCD/PCDFs / Average	Annual Average	0.30
PCCD/PCDFs / Maximum	Annual Average	0.32
PCCD/PCDFs / Abnormal A	Annual Average	0.34
PCCD/PCDFs / Abnormal B	5 Weeks	1.60
PCCD/PCDFs / Abnormal B	Annual Average	0.44

Table 7.37 I-TEQ values derived from measurements of airborne dioxins in various locations

Location	**Site Type**	**I-TEQ(1) (fg/m^3)**
Kilcock , Co. Meath (1998)(2)	Rural	Range 2.8 – 7
Ireland(2)	Baseline	Mean – 26
	Potential Impact Areas	Mean – 49
Ringaskiddy (2001)(3)	Industrial	Lower Limit – 4.0(7) Upper Limit – 16.4(8)
Germany (1992)(4)	Rural	< 70
	Urban	71 – 350
	Close to Major Source	351 – 1600
UK(5)	London (1993)	Mean – 50
	Manchester (1993)	Mean – 100
	Cardiff (1993)	Mean – 100
	Stevenage (1993)	Mean – 70
Sweden(5)	Urban/Suburban	13 – 24
	Remote/Coastal	3 – 4
Manchester (2000 - 2003)(6)	Urban	Range – 61 - 92
Middlesbrough (2000 - 2003)(6)	Urban	Range –- 31 - 52
Hazelrigg (2000 - 2003)(6)	Semi-rural	Range – 8 - 11
Stoke Ferry (2000 - 2003)(6)	Rural	Range – 18 - 21
High Muffles (2000 - 2003)(6)	Rural	Range – 6 - 8

(1) I-TEQ$_{DF}$ values based on NATO/CCMS (1988) and as used in Annex 1, Council Directive 2000/76/EC.

(2) Taken from Chapter 8 of Thermal Waste Treatment Plant, Kilcock EIS, Air Environment (1998)

(3) Taken from Chapter 9 of Waste Management Facility, Indaver Ireland Ringaskiddy EIS, Baseline Dioxin Survey (2001)

(4) Raffe, C (1996) Sources and environmental concentrations of dioxins and related compounds, *Pure & Appl. Chem* **Vol. 68**, No. 9, pp 1781-1789

(5) Duarte-Davidson et al (1994) Polychlorinated Dibenzo-*p*-Dioxins (PCDDs) and Furans (PCDFs) in Urban Air and Deposition, *Environ. Sci. & Pollut. Res.*, **1 (4)**, 262-270

(6) Taken from TOMPS Network website, www.defra.gov.uk/environment/statistics/airqual/aqpops.htm#aqtb29.

(7) Lower Limit TEQ calculated assuming non-detects are equal to zero.

(8) Upper limit assuming non-detects are equal to limit of detection.

Table 7.38 Mean I-TEQ Deposition Fluxes of Dioxins In Various Locations

Location	**Site Type**	**Mean I-TEQ[(1)]** **($pg/m^2/$ day)**
Germany (1992)[(2)]	Rural	5 -22
	Urban	10 – 100
	Close to Major Source	123 - 1293
UK[(3)]	Stevenage	3.2
	London	5.3
	Cardiff	12
	Manchester	28

(1) I-TEQ_{DF} values based on NATO/CCMS (1988) and as used in Annex 1, Council Directive 2000/76/EC.

(2) Raffe, C (1996) Sources and environmental concentrations of dioxins and related compounds, *Pure & Appl. Chem* Vol. 68, No. 9, pp 1781-1789

(3) Duarte-Davidson et al (1994) Polychlorinated Dibenzo-*p*-Dioxins (PCDDs) and Furans (PCDFs) in Urban Air and Deposition, *Environ. Sci. & Pollut. Res.*, 1 (4), 262-270

7.8.7 Concentration Contours

The geographical variation in PCCD/PCDFs (Dioxins/Furans) ground level concentrations and deposition fluxes beyond the site boundary are illustrated as concentration contours in Figures 7.19 - 7.21. The content of the figure is described below.

Figure 7.19 Maximum Operations: Predicted PCCD/PCDFs (Dioxins/Furans) Annual Average Vapour Concentration

Figure 7.20 Maximum Operations: Predicted PCCD/PCDFs (Dioxins/Furans) Annual Average Particulate Concentration

Figure 7.21 Maximum Operations: Predicted PCCD/PCDFs (Dioxins/Furans) Annual Average Total Particulate Deposition

7.8.8 Result Findings

Background levels of PCDD/PCDFs (Dioxins/Furans) occur everywhere and existing levels in the surrounding area have been extensively monitored as part of this study. Monitoring results indicate that the existing levels are significantly lower than urban areas and typical of rural areas in the UK and Continental Europe. The contribution from the site in this context is minor with levels under average, maximum and abnormal operations remaining significantly below levels which would be expected in urban areas even at the worst-case receptor to the east of the site (see Table 7.37). Levels at the nearest residential receptor will be minor, with the annual contribution from the proposed facility accounting for less than 1.3% of the existing background concentration under maximum operating conditions and accounting for less than 2% of the existing background concentration under abnormal operating conditions.

Shown in Table 7.36 is the maximum dioxin deposition rate. Modelled total dioxin particulate deposition flux indicate that annual deposition levels under both maximum and abnormal operations would be expected to be significantly less than that experienced in either urban or rural locations (< 5 pg/m^2/day) (see Table 7.38).

7.9 POLYCYCLIC AROMATIC HYDROCARBONS (PAHS)

Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous chemicals found in urban airsheds throughout the world(16). They are formed from the incomplete combustion of organic matter and are released into ambient air as constituents of highly complex mixtures of polycyclic organic matter (POM). They are also found in crude oil, coal tar, creosote and asphalt. In towns and cities, road traffic emissions are the dominant source of PAHs. In a recent study in Birmingham 88% of the concentration of benzo[*a*]pyrene (B[*a*]P) in air was due to road traffic emissions(17).

PAHs can occur in the form of gases (e.g. 2-ringed naphthalene), solids adsorbed to surfaces of fine particles (e.g. 5-ringed benzo[*a*]pyrene) and in both gas- and particle-phases (e.g. 3-ringed phenanthrene). The air concentrations of gas-phase 2- and 3-ring PAHs are generally significantly higher than those of the 5- and 6- ring particle phase species. Moreover, the percentage found in the gas phase decreases with the size of the PAH. It has also been found that at higher masses of suspended particulate matter (TSP) in the air parcel the percentage of PAHs in the particle phase increases significantly(16).

The International Agency for Research on Cancer (IARC) has classified 48 PAHs according to their likely human carcinogenicity in 1987. The three potent animal carcinogens benzo[*a*]pyrene, benz[*a*]anthracene and dibenz[*ah*]anthracene are classified as "probably carcinogenic to humans". "Possible human carcinogens" consisted of four compounds – benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, indeno[123-*cd*]pyrene and chrysene. The USEPA has also classified seven chemicals as probable human carcinogens (USEPA Class B2). In 1993, the USEPA formally adopted provisional guidance for estimating cancer risks associated with PAHs(18). The procedure makes use of the relative potencies of several PAHs with respect to benz[*a*]pyrene which is though to be one of the most potent PAH's(15,16,18-19).

Various approaches have been adopted to quantify exposure to the complex mixtures of PAHs including total PAH levels or the level of a marker substance such as benzo[*a*]pyrene. Recent studies have found that the relation of B[*a*]P to the levels of 18 other individual PAHs was relatively stable(20). Together these 19 PAH compounds constitute 90-95% of the PAHs measured in the air in this study(20). The UK DETR Expert Panel on PAHs(19) has reviewed extensively the data available in terms of animal toxicology in deriving an ambient air quality standard for PAHs. The approach used by the Panel was to compare the sum of potential carcinogenic contribution of 7 individual PAHs (possible & probable carcinogens, see above) in ambient air with that of B[*a*]P. Contributions to total carcinogenicity from other PAH compounds are expected to be small relative to those considered above. Results from the comparison indicated that the estimated contribution of B[*a*]P to the total carcinogenicity of the seven chosen PAH compounds was similar in the three locations studied (ranging from 37.5%-49.3%)(19). The overall conclusion from this approach was that using B[*a*]P as a marker of PAH exposure in the environment was suitable so long as major changes in the ambient mixture of PAH compounds do not occur in the future and that an air quality standard for PAH mixtures could be expressed in terms of the ambient concentration of B[*a*]P.

The EU has confirmed the validity of this approach in Council Directive 2004/107/EC which designates B[*a*]P as a marker for PAHs in general. The Directive has set a target value for the protection of human health for B[*a*]P of 1 ng/m^3 to be achieved prior to 2013.

Background PAHs are routinely monitored at seven sites in the UK as part of the Toxic Organic Micropollutants Network (TOMPS)$^{(21)}$. Shown in Table 7.39 are representative concentrations of PAHs at selected sites in the UK. Annual average rural and semi-rural background concentrations of B[*a*]P in this network ranged from 0.02 - 0.09 ng/m^3 over the period 2001 - 2004. In general, urban PAH concentrations are higher than rural background PAH concentrations due to the concentration of emission sources in urban areas.

Table 7.39 Annual average B[a]P at selected sites in UK In 2001 - 2004

Year	**B[a]P Annual Mean Concentration (ng/m^3) in 2001 - 2004**			
	Belfast	**Hazelrigg**	**High Muffles**	**Stoke Ferry**
	Urban	Semi-rural	Rural	Rural
2001	0.37	0.083	0.05	0.09
2002	0.13	0.048	0.043	0.083
2003	0.08	0.043	0.045	0.08
2004	0.15	0.02	0.026	0.043

7.9.1 Modelling Strategy

Data from the monitoring of PAHs in Indaver facilities in Belgium indicates that benzo[a]pyrene, which is the parameter identified in the proposed EU ambient standard(22), has never been detected above the detection limit of 0.1 – 0.3 µg/m^3. For the purposes of this assessment, emissions from the facility have been assumed to be at the upper range of the detection limit (0.3 µg/m^3). Literature data has indicated that B[*a*]P exists almost solely in the particulate phase(16) and the EU reference method for the monitoring of B[*a*]P is based on particulate sampling only(22). Therefore, the current analysis assumes that B[a]P exists in the particulate phase only.

The emission of B[*a*]P from the waste-to-energy plant has thus been evaluated in terms of mass of release into the particle-bound phase. Thereafter, air dispersion and deposition modelling has been employed to translate these releases to ambient air particle phase concentration and wet and dry particulate deposition amounts, in the vicinity of the release. The maximum scenario has been modelled as outlined in Table 7.40. Abnormal operation was also investigated based on the same assumptions as for dioxins (an increase in the maximum operational emission limit by a factor of 5 for 5 weeks every year).

When modelling PAHs the surface area weighting rather than mass weighting is used for deposition. The surface weighting reflects the mode of formation where volatiles condense on the surface of particulates in the flue gas cleaning system (see Column 6 of Table 7.31). Thus, the apportionment of emissions by particle size becomes a function of the surface area of the particles which is available for chemical adsorption.

The particulate concentration of B[a]P was determined as shown in Table 7.42. Results are shown under average, maximum and abnormal operating conditions.

7.9.2 Deposition Modelling of Particulates

In order to model dry deposition of PAHs, using AERMOD, the generalised particle-size distribution recommended by the USEPA has again been used as outlined in Table 7.31(5). For the deposition modelling of B[a]P both wet and dry particulate deposition were calculated. The modelling also incorporated wet and dry depletion into the calculations to ensure that the conservation of mass was maintained, as recommended by the USEPA(5). Results are shown in Table 7.43 for the maximum and abnormal operating conditions.

Table 7.40 Emission Scenario for B[*a*]P

Pollutant	Scenario	Emission Concentration	Emission Rate (μg/s)
B[*a*]P	Average Operation	0.3 μg/m^3	11.2
B[*a*]P	Maximum Operation	0.3 μg/m^3	12.3
B[*a*]P	Abnormal Operation(1)	1.5 μg/m^3	61.5

(1) Abnormal operation scenario based on an emission level of 1.5 μg/m^3 for five weeks per annum.

7.9.3 Comparison With Standards And Guidelines

Predicted GLCs have been compared with the applicable EU ambient air quality target value for B[*a*]P as set out in Table 7.41.

Table 7.41 B[a]P Ambient Air Quality Standards & Guidelines

Pollutant	Regulation	Limit Type	Target Value
B[a]P	Council Directive 2004/107/EC	Annual Average	1.0 ng/m^3

7.9.4 Modelling Results

Tables 7.42 – 7.44 details the predicted B[*a*]P GLC for the particulate concentration and deposition scenarios.

Table 7.42 B[a]P Particulate Concentrations Under Average, Maximum And Abnormal Operating Conditions

Compound	Particulate Fraction	Particulate Emission Rate (µg/sec)	Annual Averaged Particulate Concentration (pg/m^3)
B[a]P	1.0	Average - 11.2	2.3
B[a]P	1.0	Maximum - 12.3	2.4
B[a]P	1.0	Abnormal - 61.5(1)	3.3

(1) Abnormal operation scenario based on an emission level of 1.5 µg/m^3 for five weeks per annum.

Table 7.43 B[*a*]P Deposition Fluxes – Maximum Operating and Abnormal Conditions

Compound	Fraction	Emission Rate (µg/sec)	Annual Deposition Flux (µg/m^2)
B[a]P - Average Operation	Dry particulate	11.2	0.323
	Wet particulate		0.299
	Total particulate		0.332
Sum of Total Particulate Deposition			**0.33 µg/m^2**
			0.91 ng/m^2/day
B[a]P - Maximum Operation	Dry particulate	12.3	0.338
	Wet particulate		0.323
	Total particulate		0.348
Sum of Total Particulate Deposition			**0.35 µg/m^2**
			0.95 ng/m^2/day
B[a]P - Abnormal Operation	Dry particulate	61.5(1)	0.466
	Wet particulate		0.446
	Total particulate		0.480
Sum of Total Particulate Deposition			**0.48 µg/m^2**
			1.32 ng/m^2/day

(1) Abnormal operation scenario based on an emission level of 1.5 µg/m^3 for five weeks per annum.

Table 7.44 Dispersion Model Summary Of Particulate B[a]P Concentrations Under Average, Maximum And Abnormal Operating Conditions.

Pollutant / Scenario	Annual Mean Background (pg/m^3)$^{(1)}$	Averaging Period	Process Contribution (pg/m^3)	Predicted Emission Concentration (pg/Nm^3)	Standard (pg/Nm^3)
B[a]P / Average	90	Annual mean	2.3	92.3	1000
B[a]P / Maximum	90	Annual mean	2.4	92.4	1000
B[a]P / Abnormal	90	Annual mean	3.3	93.3	1000

(1) Based on data from semi-rural locations in the UK (see Table 7.39)

7.9.5 Concentration Contours

The geographical variation in particulate B[*a*]P ground level concentrations beyond the site boundary is illustrated as concentration contours in Figure 7.22. The geographical variation in B[*a*]P total particle-bound deposition beyond the site boundary is illustrated as concentration contours in Figure 7.23:

Figure 7.22 Maximum Operations: Predicted B[a]P Annual Average Particulate Concentration

Figure 7.23 Maximum Operations: Predicted B[*a*]P Annual Average Total Particle-Bound Deposition Flux

7.9.6 Result Findings

B[*a*]P modelling results indicate that the ambient ground level concentrations are significantly below the EU target value for the protection of human health under average, maximum and abnormal operation of the site. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient B[a]P particle-bound concentration (excluding background concentrations) which are only 0.2% of the annual average limit value at the worst-case receptor.

7.10 MERCURY

7.10.1 Mercury's Environmental Transport & Fate

Mercury exists in three oxidation states; metallic or elemental (Hg^0); mercurous (Hg_2^{2+}); and mercuric (Hg^{2+}). Elemental Hg is a liquid at room temperature with low volatility. Other forms of mercury are solids with low vapour pressures. It is naturally occurring and cycles between the atmosphere, land and water through a series of complex transformations. Elemental mercury is the most common form of mercury found in the atmosphere whereas in all other environmental media, mercury is found in the form of inorganic mercuric salts and organo-mercury compounds(23).

USEPA methodology relating to waste-to-energy plants assumes that stack emissions containing mercury include both vapour and particle-bound phases. Additionally, the USEPA assumes that mercury exits the stack in only the elemental and divalent species. Of the total mercury in the stack, 80% is estimated to be in the vapour phase and 20% is particle-bound. In addition, the USEPA assumes that speciation of the total mercury is 80% divalent (20% in the particle-bound and 60% in the vapour phase) and 20% elemental (all 20% in the vapour phase)(23). Although the USEPA allows a loss to the global cycle for each form of mercury (99% of the elemental vapour form, 32% of the divalent vapour form, and 64% of the particle-bound form are assumed lost to the global cycle and do not deposit within the localized study area), this has not been incorporated into the current assessment in keeping with the worst-case approach adopted in this assessment.

7.10.2 Modelling Strategy

The emissions of mercury from the waste-to-energy plant have been evaluated in terms of mass of release into both vapour and particle-bound phases. Thereafter, air dispersion and deposition modelling has been employed to translate these releases to ambient air vapour and particle phase concentrations, and wet vapour & wet and dry particulate deposition amounts, in the vicinity of the release. Average, maximum and abnormal scenarios have been modelled as outlined in Table 7.45.

Vapour / Particulate Partitioning

In order to adequately model dispersion and deposition of mercury, modelling of both vapour and particle-bound states is thus necessary. For the vapour phase modelling, no dry deposition was assumed, as recommended by the USEPA(5,23). Using the vapour – particle partitioning described in Section 7.8.2, the vapour concentrations of mercury was determined as outlined in Table 7.47. Results are shown under maximum operating conditions.

When modelling mercury (Hg) the surface area weighting rather than mass weighting is used for deposition. The surface weighting reflects the mode of formation where volatiles condense on the surface of particulates in the flue gas cleaning system (see Column 6 of Table 7.31). Thus, the apportionment of emissions by particle size becomes a function of the surface area of the particle which is available for chemical adsorption.

For the particle-phase concentration, the vapour – particle partitioning described in Section 7.8.2 was used to give the particulate concentrations of mercury as determined in Table 7.48. Results are shown under average, maximum and abnormal operating conditions.

7.10.3 Deposition Modelling of Particulates

In order to model dry deposition, using AERMOD, the generalised particle-size distribution recommended by the USEPA has again been used for Hg as outlined in Table 7.31(3). Dry gaseous deposition, although considered in the AERMOD model, has not been adequately calibrated for the estimation of the deposition flux into vegetation and thus the USEPA has recommended that this algorithm should not be used for site-specific applications(4).

For the deposition modelling of mercury both wet and dry particulate deposition were calculated. The modelling also incorporated wet and dry depletion into the calculations to ensure that the conservation of mass was maintained, as recommended by the USEPA(5). Results are shown in Tables 7.49 and 7.50 for average, maximum and abnormal operating conditions.

Table 7.45 Emission Scenario for Mercury

Pollutant	Scenario	Emission Concentration	Emission Rate (g/s)
Hg	Average Operation	0.05 mg/m^3	0.0019
	Maximum Operation	0.05 mg/m^3	0.0020
	Abnormal Operation(1)	1 mg/m^3	0.041

(1) Abnormal operation scenario based on an emission level of 1 mg/m^3 for two days every month for a full year.

Abnormal Operation

Hg is absorbed by activated carbon / clay and thus elevated levels are detected in the same way as dioxins as outlined in Section 7.7.2.

For the purpose of the air modelling study the following abnormal operation conditions were used: Hg: 1 mg/Nm^3 for two days.

7.10.4 Comparison With Standards And Guidelines

Predicted GLCs have been compared with the applicable WHO ambient air quality guideline for the protection of human health for mercury as set out in Table 7.46.

Table 7.46 Hg Ambient Air Quality Standards & Guidelines

Pollutant	Regulation	Limit Type	Value
Inorganic Mercury (as Hg)	WHO	Annual Average	1.0 µg/m^3

7.10.5 Modelling Results

Tables 7.47 – 7.51 details the predicted mercury GLC for each vapour and particulate concentration and deposition scenario.

Table 7.47 Mercury Vapour Concentrations Under Average, Maximum and Abnormal Operating Conditions

Oxidation State	Vapour Fraction	Vapour Emission Rate (g/sec)	Vapour Concentration (ng/m^3)
Elemental Hg	0.20	Average - 0.00038	0.076
Divalent Hg^{2+}	0.60	Average - 0.00114	0.229
Sum			**0.31 ng/m^3**
Elemental Hg	0.20	Maximum - 0.00041	0.076
Divalent Hg^{2+}	0.60	Maximum - 0.00122	0.228
Sum			**0.30 ng/m^3**
Elemental Hg	0.20	Abnormal Operation - 0.062	0.171
Divalent Hg^{2+}	0.60	Abnormal Operation - 0.186	0.51
Sum			**0.68 ng/m^3**

(1) Abnormal operation scenario based on an emission level of 1 mg/m^3 for two days every month for a full year.

Table 7.48 Mercury Particulate Concentrations Under Average, Maximum & Abnormal Operating Conditions

Oxidation State	Particulate Fraction	Particulate Emission Rate (g/sec)	Particulate Concentration (ng/m^3)
Divalent Hg^{2+}	0.20	Average - 0.00041	0.079
Divalent Hg^{2+}	0.20	Maximum - 0.00041	0.079
Divalent Hg^{2+}	0.20	Abnormal - 0.0082	0.178

Table 7.49 Mercury Deposition Fluxes – Average & Maximum Operating Conditions

Oxidation State	Fraction	Emission Rate (g/sec)	Annual Deposition Flux (µg/m^2)
Sum of Elemental Hg and Divalent Hg^{2+}	Dry	0.0019	138
	Wet		56
	Total		142
Sum of Total Deposition (Average)			**142 µg/m^2**
			390 ng/m^2/day
Sum of Elemental Hg and Divalent Hg^{2+}	Dry	0.0020	141
	Wet		59
	Total		145
Sum of Total Deposition (Maximum)			**145 µg/m^2**
			398 ng/m^2/day

Table 7.50 Mercury Deposition Fluxes – Abnormal Operating Conditions

Oxidation State	Fraction	Emission Rate (g/sec)	Annual Deposition Flux (µg/m^2)
Sum of Elemental Hg and Divalent Hg^{2+}	Dry	0.0408	317
	Wet		133
	Total		326
Sum of Total Deposition (Abnormal)			**326 µg/m^2**
			894 ng/m^2/day

Table 7.51 Dispersion Model Summary Of Combined Vapour And Particulate Hg Concentrations Under Average, Maximum And Abnormal Operating Conditions

Pollutant / Scenario	Annual Mean Background (ng/m^3)	Averaging Period	Process Contribution (ng/m^3)	Predicted Emission Concentration (ng/Nm^3)	Standard (ng/Nm^3)
Hg / Average	1.0	Annual mean	0.38	1.4	100
Hg / Maximum	1.0	Annual mean	0.38	1.4	100
Hg / Abnormal	1.0	Annual mean	0.86	1.9	100

7.10.6 Concentration Contours

The geographical variation in mercury ground level concentrations beyond the site boundary is illustrated as concentration contours in Figure 7.24. The geographical variation in mercury total particle-bound deposition beyond the site boundary is illustrated as concentration contours in Figure 7.25:

Figure 7.24 Maximum Operations: Predicted Mercury Annual Average Concentration

Figure 7.25 Maximum Operations: Predicted Mercury Annual Average Total Particle-Bound Deposition

7.10.7 Result Findings

Hg modelling results indicate that the ambient ground level concentrations are significantly below the WHO guideline for the protection of human health under average, maximum and abnormal operation of the site. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient mercury combined concentration (both vapour and particle-bound) (excluding background concentrations) which are only 0.4% of the annual average limit value at the boundary of the site.

7.11 HEAVY METAL EMISSIONS AND RESULTS (EXCL. MERCURY)

7.11.1 Modelling Approach

The emissions of heavy metals (except Hg) from the waste-to-energy plant have been evaluated in terms of mass of release into the particulate phase only as recommended by the USEPA(4,5). Thereafter, air dispersion and deposition modelling has been employed to translate these releases to ambient particle phase concentrations, and wet and dry particulate deposition amounts, in the vicinity of the release.

When modelling heavy metals (except Hg) the mass weighting rather than surface weighting is used for deposition as it is assumed that the metals are all in the particulate state (see Column 4 of Table 7.31). Results are shown under average, maximum and abnormal operating conditions.

For the deposition modelling of heavy metals (except Hg) both wet and dry particulate deposition were calculated. The modelling also incorporated wet and dry depletion into the calculations to ensure that the conservation of mass was maintained, as recommended by the USEPA(5).

Ambient ground level concentrations and deposition values (GLCs) of the Sum of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V) have been investigated using the concentration limits outlined in Council Directive 2000/76/EC (see Table 7.52) and also under abnormal operations at the site.

Data is available from a similar Indaver site in Beveren, Belgium (see Table 7.53) indicating the actual emission levels of these metals based on typical and maximum recorded levels over the period 2000 - 2004. This data has been used to identify the likely ratio of metals when emitting under average, maximum and abnormal operation conditions. It should be noted that modelled levels are significantly higher than that detected at this facility over this five year period.

Table 7.52 Emission Scenario for Heavy Metals Taken From Council Directive 2000/76/EC

Pollutant	Scenario	Concentration	Emission Rate (g/s)
Sum of Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V	Average Operation	0.50 mg/m^3	0.019
	Maximum Operation	0.50 mg/m^3	0.020
	Abnormal Operation(1)	30 mg/m^3	1.18

(1) Abnormal operation scenario based on an emission level of 30 mg/m^3 for two days every month for a full year.

Abnormal Operation

Heavy metals are absorbed by activated carbon / clay and thus elevated levels are detected in the same way as dioxins as outlined in Section 7.7.2.

For the purpose of the air modelling study the following abnormal operation conditions were used: Cd: 1 mg/Nm^3 for two days, Tl: 1 mg/Nm^3 for two days and Heavy metals: 30 mg/Nm^3 for two days.

Table 7.53 Actual Measured Emission Data From An Indaver Site In Belgium Over The Period 2000 - 2004 (mg/Nm^3)

	Average(1)	Maximum(1)	Maximum Operation(2)	Abnormal Operation(2)
	2000 - 2004	**2000 - 2004**	**0.50 mg/m^3**	**30 mg/m^3**
As	0.012	0.020	0.054	3.23
Cd	0.001	0.008		
Co	0.008	0.040	0.037	2.23
Cr	0.014	0.059	0.062	3.71
Cu	0.011	0.070	0.049	2.95
Mn	0.018	0.200	0.081	4.84
Ni	0.005	0.036	0.023	1.38
Pb	0.013	0.042	0.058	3.50
Sb	0.012	0.020	0.053	3.18
Sn	0.011	0.057	0.049	2.96
Tl	0.011	0.020		
V	0.008	0.020	0.035	2.07
Sum Cd+Tl	0.008	0.030		
Hg	0.002	0.024		
Sum Sb/As/Pb/Cr/Co/Cu/Mn/Ni/V/Sn	0.060	0.37	0.50	30.0

(1) Non-detects reported at the detection limit.

(2) Based on the ratio under average operation.

7.11.2 Comparison with Standards And Guidelines

Predicted GLCs have been compared with the applicable ambient air quality guidelines and standards for the protection of human health as set out in Tables 7.54 and 7.55.

In the absence of statutory standards, ambient air quality guidelines can also be derived from occupational exposure limits (OEL). The OEL for each compound (where available) divided by an appropriate safety factor may be used. This factor accounts for increased exposure time and susceptibility of the general population in comparison to on-site personnel. The OEL can be expressed on the basis of two averaging periods; an eight-hour average and a fifteen-minute average (the short term exposure limit or STEL). The OEL (8-hour reference) divided by a factor of 100 may be applied to generate an ambient air quality guideline or Environmental Assessment Level (EAL) for comparison with predicted annual averages and the STEL divided by 40 may be applied for comparison with the one-hour concentrations.

A comparison of Table 7.53 with Table 7.55 indicates that Arsenic is the metal which is emitted at the most significant level relative to its annual average limit value and thus has been reported below. All other metals will have a lower impact on the ambient environment. Antimony has also been investigated as it is emitted at the most significant level relative to the short-term limit values.

Table 7.54 Cd and Tl Ambient Air Quality Standards & Guidelines

Pollutant	Regulation	Limit Type	Value
Cd	TA Luft	Annual Average	0.04 µg/m^3
Cd	WHO	Annual Average	0.005 µg/m^3
Cd	EU	Annual Average	0.005 µg/m$^{3(1)}$
Tl	EAL	Annual Average	1.0 µg/m^3

(1) Council Directive 2004/107/EC(22)

Table 7.55 Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V Ambient Air Quality Standards & Guidelines

Pollutant	Regulation	Limit Type	Value
Sb (organic compounds)	EAL	Maximum One-Hour	5 µg/m^3
Sb (organic compounds)	EAL	Annual Average	1.0 µg/m^3
As	WHO	Annual Average	0.005 µg/m^3
As	EU	Annual Average	0.006 µg/m$^{3(1)}$
Pb	EU	Annual Average	0.5 µg/m^3
Cr (except VI)	EAL	Annual Average	5.0 µg/m^3
Cr (VI)	EAL	Annual Average	0.5 µg/m^3
Co	EAL	Annual Average	1.0 µg/m^3
Cu (fumes)	EAL	Annual Average	2.0 µg/m^3
Cu (dust & mists)	EAL	Annual Average	10 µg/m^3
Mn	WHO	Annual Average	0.15 µg/m^3
Mn (fume)	EAL	Maximum One-Hour	75 µg/m^3
Ni	EU	Annual Average	0.02 µg/m$^{3(1)}$
V (fume & respirable dust)	EAL	Annual Average	0.4 µg/m^3
V	WHO	24-Hour Average	1.0 µg/m^3

(1) Council Directive 2004/107/EC(22)

7.11.3 Modelling Results

Air dispersion and deposition modelling was carried out for the three scenarios described in Section 7.11.1. Table 7.56 outlines the average, maximum and abnormal emission levels for Cd and Tl and Tables 7.57 – 7.59 details the predicted Cd & Tl GLC and deposition value for each scenario and averaging period.

Table 7.56 Avearge, Maximum And Abnormal Operations for Cd & Tl

Heavy Metal	Limit Type	Value
Cd & Tl	Average & Maximum Operations	0.05 mg/m^3
	Abnormal Operation(1)	1 mg/m^3

(1) Abnormal operation scenario based on an emission level of 1 mg/m^3 for two days every month for a full year.

Table 7.57 Cd & Tl Particulate Concentrations Under Average, Maximum And Abnormal Operation

Heavy Metal	Emission Rate (g/sec)	Concentration (ng/m^3)
Cd & Tl	Average Operation - 0.0019	0.39
	Maximum Operation - 0.0020	0.39
	Abnormal Operation - 0.041	0.95

Table 7.58 Cadmium Deposition Fluxes – Average, Maximum and Abnormal Operation

Heavy Metal	Fraction	Emission Rate (g/sec)	Annual Deposition Flux (mg/m^2)
Cd & Tl / Average Operation	Dry particulate	0.0019	0.268
	Wet particulate		0.325
Sum of Total Deposition			**0.325 mg/m^2**
			0.89 µg/m^2/day
Cd & Tl / Maximum Operation	Dry particulate	0.0020	0.273
	Wet particulate		0.343
Sum of Total Deposition			**0.343 mg/m^2**
			0.94 µg/m^2/day
Cd & Tl / Abnormal Operation	Dry particulate	0.041	0.648
	Wet particulate		0.785
Sum of Total Deposition			**0.785 mg/m^2**
			2.15 µg/m^2/day

Table 7.59 Cadmium & Thallium Particulate Concentration Summary

Pollutant / Scenario	Annual Mean Background (ng/m^3)	Averaging Period	Process Contribution (ng/m^3)	Predicted Emission Concentration (ng/Nm^3)	Standard (ng/Nm^3)(1)
Cd / Average	1.0	Annual mean	0.39	1.4	5.0
Cd / Maximum	1.0	Annual mean	0.39	1.4	5.0
Cd / Abnormal	1.0	Annual mean	0.95	2.0	5.0

(1) Council Directive 2004/107/EC(22)

Tables 7.60 – 7.62 details the predicted GLC and deposition values for each scenario for arsenic and antimony.

Table 7.60 Arsenic and Antimony Particulate Concentration Under Average, Maximum & Abnormal Operating Conditions

Heavy Metal	Emission Rate (g/sec)	Maximum 1-hour Concentration (μg/m^3)	Annual Concentration (ng/m^3)
Arsenic	Average - 0.0020		0.41
Antimony	Average - 0.0020	16.5	
Arsenic	Maximum - 0.0022		0.42
Antimony	Maximum - 0.0022	17.6	
Arsenic	Abnormal - 0.13		2.06
Antimony	Abnormal - 0.13	85.6	

Table 7.61 Arsenic Deposition Fluxes – Average Maximum & Abnormal Operating Conditions

Heavy Metal	Fraction	Emission Rate (g/sec)	Annual Deposition Flux (mg/m^2)
Arsenic / Average	Dry particulate	0.0020	0.282
	Wet particulate		0.342
Sum of Total Deposition			**0.34 mg/m^2**
Arsenic / Maximum	Dry particulate	0.0022	0.295
	Wet particulate		0.370
Sum of Total Deposition			**0.37 mg/m^2**
Arsenic / Abnormal	Dry particulate	0.13	1.44
	Wet particulate		1.80
Sum of Total Deposition			**1.8 mg/m^2**

Table 7.62 Dispersion Model Results – Arsenic and Antimony

Heavy Metal / Scenario	Annual Mean Background (ng/m^3)	Averaging Period	Process Contribution (ng/m^3)	Predicted Emission Concentration (ng/Nm^3)	Standard (ng/Nm^3)
Arsenic / Average	1.0$^{(1)}$	Annual mean	0.41	1.4	**6.0$^{(3)}$**
Antimony / Average	1.0$^{(2)}$	Maximum One-Hour	16.5	17.5	**5000$^{(4)}$**
Arsenic / Maximum	1.0$^{(1)}$	Annual mean	0.42	1.4	**6.0$^{(3)}$**
Antimony / Maximum	1.0$^{(2)}$	Maximum One-Hour	17.6	18.6	**5000$^{(4)}$**
Arsenic / Abnormal	1.0$^{(1)}$	Annual mean	2.1	3.1	**6.0$^{(3)}$**
Antimony / Abnormal	1.0$^{(2)}$	Maximum One-Hour	85.6	86.6	**5000$^{(4)}$**

(1) Background concentration for arsenic based on on-site monitoring

(2) Background concentration for antimony based on on-site monitoring

(3) Ambient standard for arsenic which is the most stringent applicable limit value for this averaging period

(4) Ambient standard for antimony which is the most stringent applicable limit value for this averaging period.

7.11.4 Concentration Contours

The geographical variations in heavy metal ground level concentrations and deposition flux beyond the site boundary are illustrated as a concentration and deposition contours in Figures 7.26 to 7.29. The content of the figure is described below.

Figure 7.26 Maximum Operation: Predicted Cd Annual Average Concentration

Figure 7.27 Maximum Operation: Predicted Cd Annual Deposition Flux

Figure 7.28 Maximum Operation: Predicted As Annual Average Concentration

Figure 7.29 Maximum Operation: Predicted As Annual Deposition Flux

7.11.5 Result Findings

Cd and Tl

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for cadmium under average, maximum and abnormal operations of the site. Emissions at maximum operations equate to an ambient Cd and Tl concentration (excluding background concentration) which is 8% of the annual target value for Cd close to the site boundary (the comparison is made with the Cd limit value as this is more stringent than that for Tl).

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

Modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for the protection of human health for arsenic and antimony (the metals with the most stringent limit values) under average, maximum and abnormal emissions from the site. Thus, no adverse impact on public health or the environment is envisaged to occur under these conditions at or beyond the site boundary. Emissions at maximum operations equate to ambient As concentrations (excluding background concentrations) which are only 7% of the annual limit value at the worst-case receptor whilst emissions at maximum operations equate to ambient Sb concentrations (excluding background concentrations) which are only 0.3% of the maximum 1-hour limit value at the worst-case receptor. Emissions under abnormal operations equate to ambient As concentrations (excluding background concentrations) which are only 35% of the annual limit value at the worst-case receptor whilst emissions at maximum operations equate to ambient Sb concentrations (excluding background concentrations) which are only 1.7% of the maximum 1-hour limit value at the worst-case receptor.

7.12 COMPARISON WITH FEBRUARY 2006 DISPERSION MODELLING ASSESSMENT

This air dispersion modelling assessment represents an update to that performed for the Indaver revised planning application and EIS submitted to Meath County Council in February 2006. A number of revisions to the dispersion model are included in this assessment (see Section 7.1) and thus the predicted pollutant concentrations in this study vary from those reported in February 2006.

A comparison of the modelling results from this assessment with those from February 2006 is provided in Table 7.63. The results show that predicted pollutant concentrations are slightly increased as a result of the revisions to the air dispersion model. However, the increased concentrations are low relative to the limit values for each pollutant, ranging from unchanged (annual mean PM_{10}, $PM_{2.5}$) to 9% (1-hour HF) of the limit value. The highest predicted increases are for the 1-hour NO_2, SO_2 and HF concentrations and reflect the more conservative maximum 1-hour emission concentrations used in this assessment.

Table 7.63 Comparison With February 2009 Dispersion Model Results

Pollutant Modelled	Averaging Period	%Change in Predicted Conc. (Relative to Limit Value)
NO_2	1-Hour (99.8%ile)	+4.4%
	Annual	+0.1%
SO_2	1-Hour (99.7%ile)	+5.4%
	24-Hour (99.2%ile)	+0.7%
PM_{10}	24-Hour (90.4%ile)	+0.1%
	Annual	+0.0%
$PM_{2.5}$	Annual	+0.0%
TOC	Annual	+0.2%
HCl	1-Hour (98%ile)	+0.1%
HF	1-Hour (98%ile)	+8.7%
	24-Hour	+0.6%
	Annual	+0.3%
PCDD/PCDF	Annual (Vapour + Particle)	+0.1%(1)
PAH	Annual	+0.01%
Hg	Annual (Vapour + Particle)	+0.01%
Cd & Tl	Annual	+0.4%
Sum of Metals (as As)	Annual	+0.3%
Sum of Metals (as Sb)	Maximum 1-Hour	-0.05%

(1) Increase relative to background concentration.

7.13 SUMMARY OF AIR QUALITY IMPACTS

Based on the emission guidelines outlined in Council Directive 2000/76/EC, detailed air dispersion modelling has shown that the most stringent ambient air quality standards for the protection of human health are not exceeded either as a result of operating under average, maximum or abnormal operating conditions.

The modelling results indicate that the maximum ambient GLC occurs at or near the site's north-western to eastern boundaries. Concentrations fall off rapidly away from this maximum and levels (excluding background) at the nearest residential receptors will be less than 5% of the short-term limit values under maximum operations of the site. The annual average concentration has an even more dramatic decrease in maximum concentration away from the site with concentrations from emissions at the proposed facility accounting for less than 1.4% of the limit value (not including background concentrations) at worst case sensitive receptors near the site under maximum operations of the site. Thus, the results indicate that the impact from the proposed facility is minor and limited to the immediate environs of the site.

In the surrounding main population centres, Duleek and Drogheda, levels are significantly lower than background sources with the concentrations from emissions at the proposed facility accounting for less than 0.1% of the annual limit values for the protection of human health for all pollutants under maximum operations of the site.

7.14 STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS

The Stockholm Convention on Persistent Organic Pollutants (the Convention) was signed by 151 nations on May 23 2001 (or within one year from this date)(24). The Convention entered into force on the 17th May 2004 on the 90th day after the fiftieth country (France) ratified the Convention.

Persistent organic pollutants (POPs) are a small group of organic chemicals exhibiting the combined properties of persistence, bioaccumulation, toxicity, and long-range environmental transport(25). The 12 POPs referred to in the Convention are as outlined in Table 7.64:

Table 7.64 Priority Persistent organic pollutants

12 Priority POPS of Global Concern	Source	Convention Category
Aldrin	Fertilizer (Insecticide)	Annex A
Dieldrin	Fertilizer	Annex A
Endrin	Fertilizer	Annex A
DDT	Fertilizer, Disease vector control use (malaria)	Annex B
Chlordane	Fertilizer	Annex A
Heptachlor	Termiticide	Annex A
Mirex	Termiticide	Annex A
Toxaphene	Fertilizer	Annex A
Hexachlorobenzene (HCB)	Solvent in pesticide	Annex A
Polychlorinated Biphenyls (PCBs)	Unintentional release from thermal processes	Annex C
Polychlorinated dibenzo-p-dioxins (Dioxins)	Unintentional release from thermal processes	Annex C
Polychlorinated dibenzofurans (Furans)	Unintentional release from thermal processes	Annex C

The objective for POPs which fall under Annex A (see Table 7.64) is to have the production and use of these compounds eliminated whilst Annex B should only be used for disease vector control use (malaria control). In relation to Annex C, which includes dioxins and furans, a series of measures have been agreed to reduce or eliminate the release of these compounds.

Each signatory has agreed to a number of items which have relevance to the release of dioxins and furans including Article 5 - Measures to reduce or eliminate releases from unintentional production:

- Promote the application of available, feasible and practical measures that can achieve a realistic and meaningful level of release reduction or source elimination;
- Promote the development and, where it deems appropriate, require the use of substitute or modified materials, products and processes to prevent the formation and release of the chemicals listed in Annex C;

- Promote and require the use of best available techniques for new sources with a particular initial focus on source categories identified in Part II of Annex C;
- Parties are to promote the use of best environmental practices;
- Release limit values or performance standards can be used to fulfil the commitment for best available techniques.

Waste Incineration of municipal waste is defined as a Part II source category under the Convention. In Annex C general guidance is given in relation to what constitutes best available techniques (BAT) and best environmental practices including:

- The use of low-waste technology;
- The use of less hazardous substances;
- The promotion of the recovery and recycling of waste and of substances generated and used in a process;
- Replacement of feed materials which are persistent organic pollutants or where there is a direct link between the materials and release of persistent organic pollutants from the source;
- Good housekeeping and preventive maintenance programmes;
- Improvements in waste management with the aim of the cessation of open and other uncontrolled burning of wastes, including the burning of landfill sites.

Measures which can be considered in determining best available techniques include:

- Use of improved methods for flue-gas cleaning such as thermal or catalytic oxidation, dust precipitation, or adsorption;
- Treatment of residuals, wastewater, wastes and sewage sludge by, for example, thermal treatment or rendering them inert or chemical processes that detoxify them;
- Process changes that lead to the reduction or elimination of releases, such as moving to closed systems;
- Modifications of process designs to improve combustion and prevent formation of the chemicals listed in this Annex, through the control of parameters such as incineration temperature or residence time.

In relation to Carranstown Waste Management Facility, best available technology (BAT) has been employed in line with the Convention, Council Directive 2000/76/EC and the IPPC BREF Notes on waste incineration. Council Directive 2000/76/EC has outlined stringent operating conditions in order to ensure sufficient combustion of waste thus ensuring that dioxin formation is minimised. The Directive has outlined air emission limit values for dioxins which have been set at 0.1 ng/Nm^3. Indaver Ireland is committed, as a minimum, to meeting all the requirements of Council Directive 2000/76/EC. Indeed, due to the advanced post-combustion flue gas-cleaning technology employed, expected average emission values will be significantly below than these values. The proposed facility will thus significantly outperform the very stringent limit values imposed by Council Directive 2000/76/EC and thus in doing so will fulfil the requirements of BAT (Article 5).

The use of an advanced flue-gas cleaning systems and the controlling of incineration temperatures is also in accordance with Annex C Part IV Definitions B. Best Available Techniques which includes the use of improved methods for flue-gas cleaning such as thermal or catalytic oxidation, dust precipitation, or adsorption; the treatment of wastes by, for example, thermal treatment; and modifications of process designs to improve combustion and prevent formation of the chemicals listed in this Annex, through the control of parameters such as incineration temperature or residence time.

The Report of the first meeting of the Expert Group on Best Available Techniques and Best Environmental Practices (2005)(26) focuses on the issue of the destruction and irreversible transformation of the persistent organic pollutant content in wastes. The Expert Group noted that only two processes have been recommended as BAT. The two processes are hazardous waste incineration and cement kiln co-incineration. A further eight possible processes are currently being assessed by a working group.

The Report of the Second Session of the Expert Group on Best Available Techniques and Best Environmental Practices (2003)(27) focuses on draft guidelines on BAT and BEP for municipal waste incineration. The session recommends that techniques which have been demonstrated to be highly effective in preventing the formation and release of the unintentionally produced POPs are recommended. Techniques in the “Relatively Low to Moderate“ category were defined as 0.1-10 ng TEQ/kg waste. Carranstown, under maximum operation of the facility, will emit 0.1 g TEQ/annum of dioxins/furans which is equivalent to 0.5 ng TEQ/kg waste based on 200,000 tonnes / annum and thus is at the lower end of the recommended range.

Thus, the proposed waste-to-energy facility fulfils the definition of BAT under the Convention, both in terms of Article 5 of the Convention and in terms of Annex C Part IV. A comparison of Carranstown Waste Management facility’s operations with the obligations under the Stockholm Convention on Persistent Organic Pollutants indicates that the facility will achieve and promote the objectives of the Convention in terms of recovery, recycling, waste separation, release reduction, process modification and BAT.

7.15 REFERENCES

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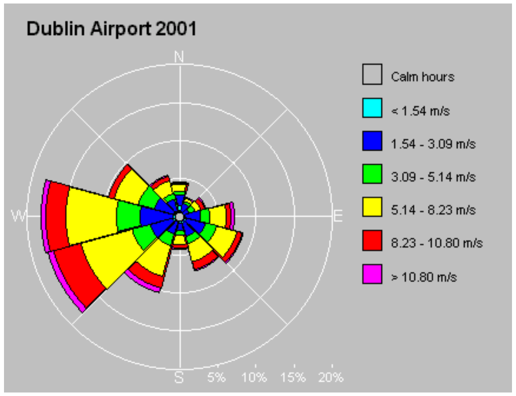

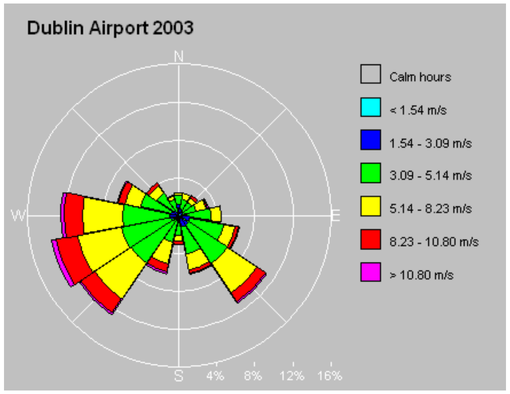

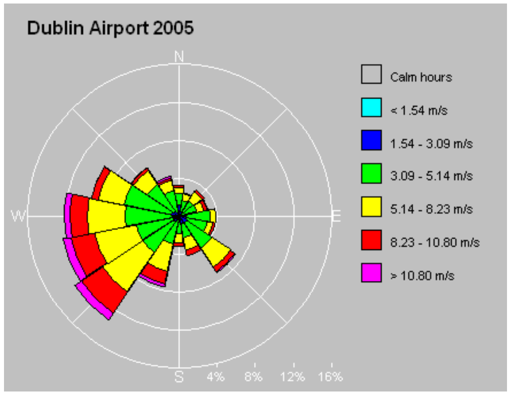

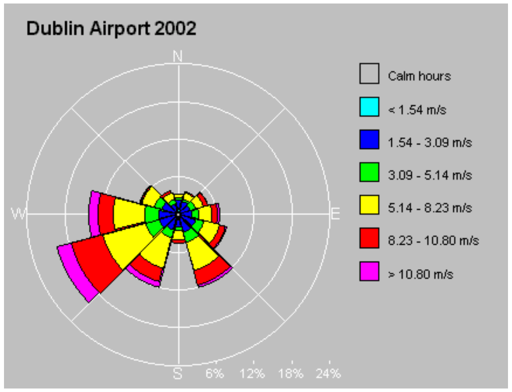

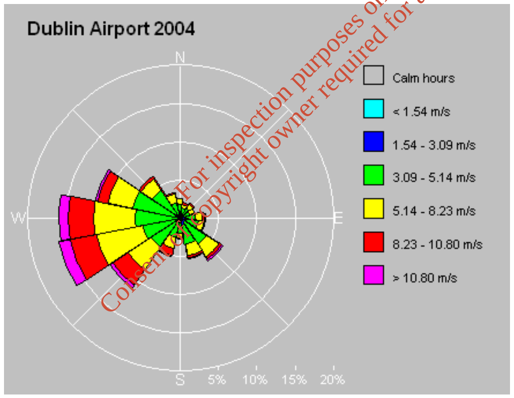

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Figure 7.1

Dublin Airport Windrose 2001 - 2005

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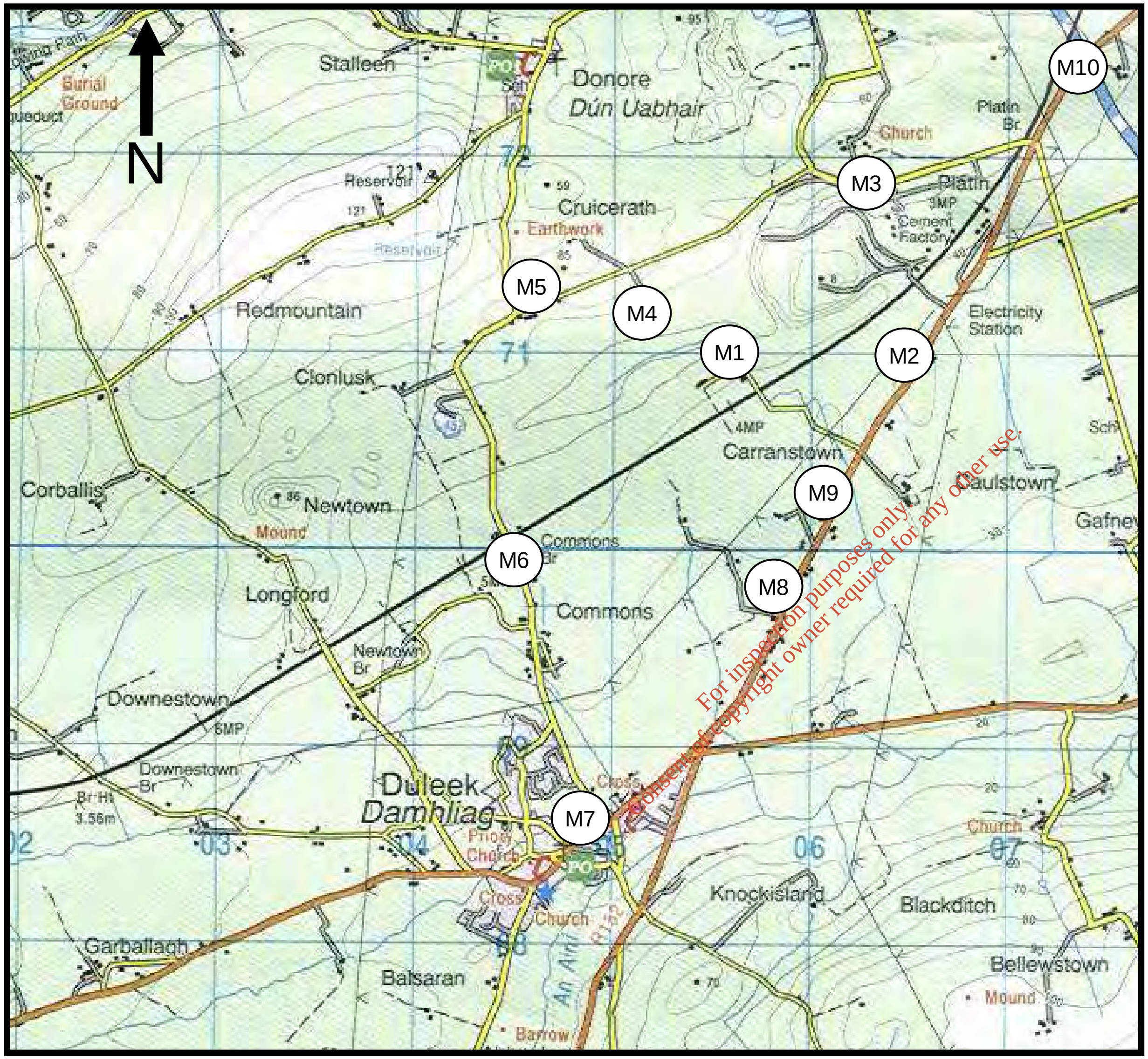

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Figure 7.2

Air Monitoring Locations

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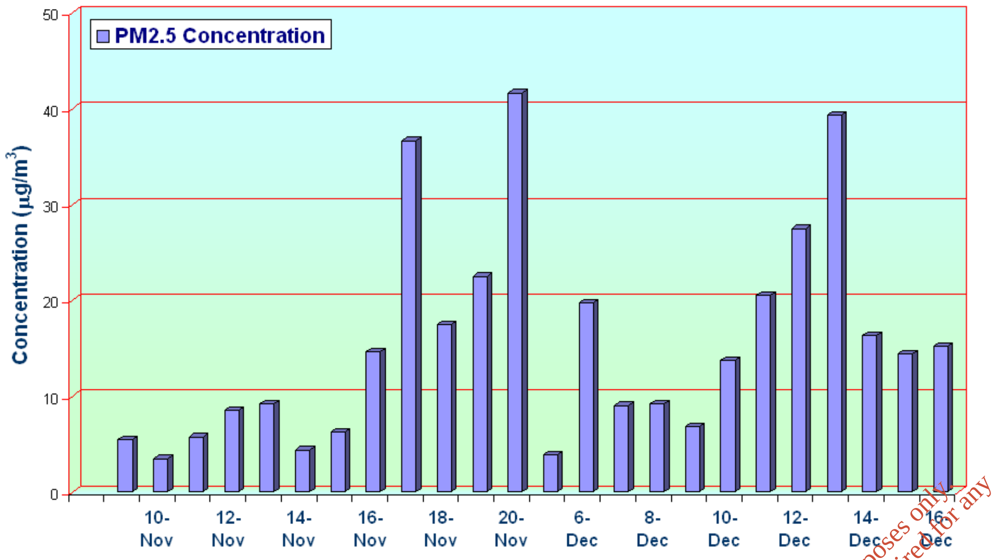
AMBIENT PM2.5 Concentrations ($\mu g/m^3$)



Correlation Between Wind Speed & $PM_{2.5}$ Concentration

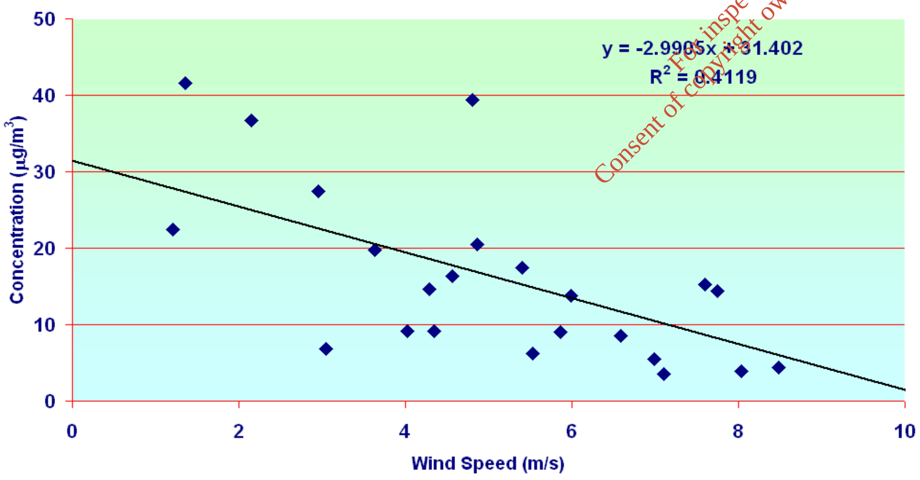


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Figure 7.3

$PM_{2.5}$ Monitoring Results & Correlation with Wind Speed

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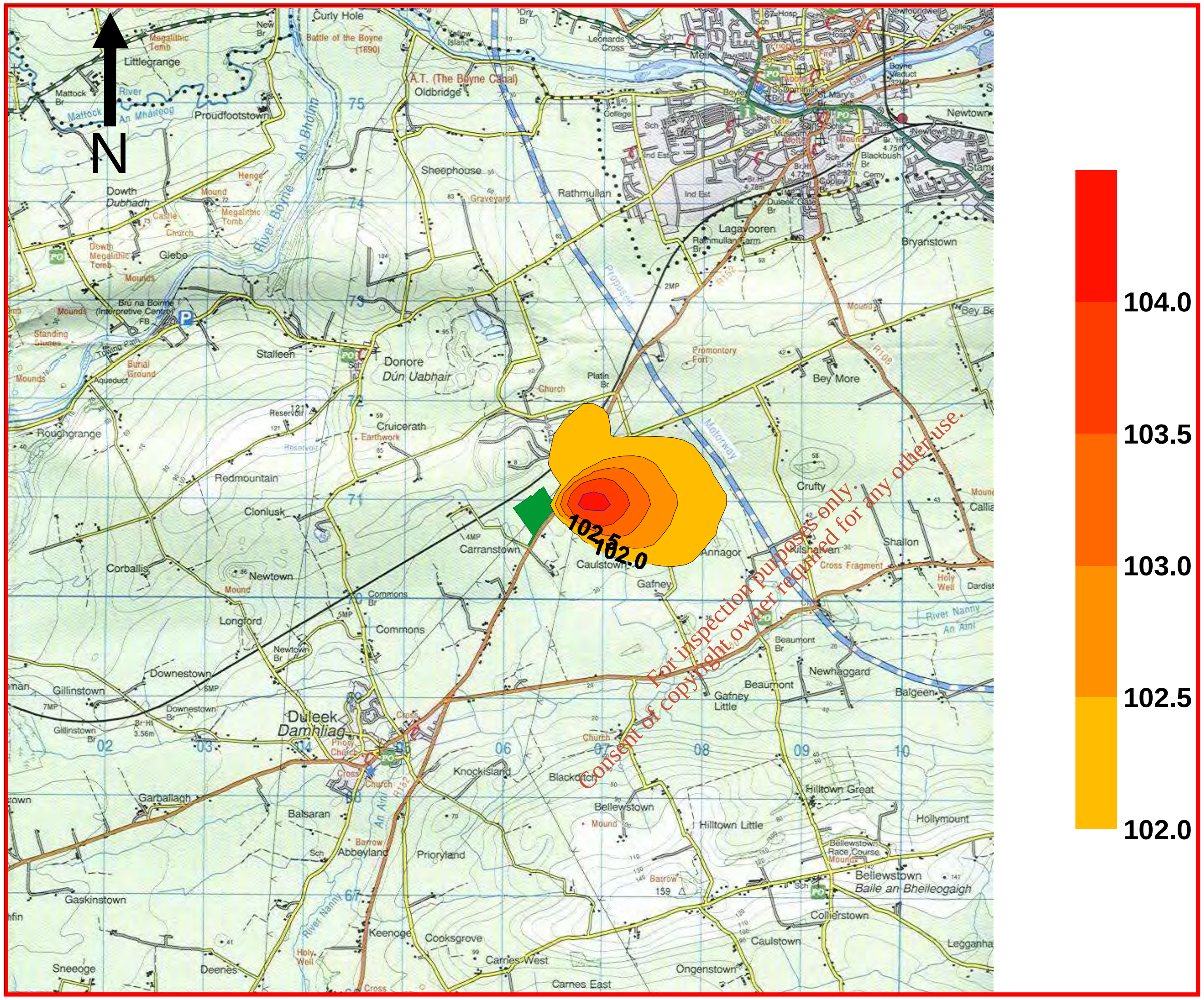

99.8%ile of Maximum 1-Hour NO_2 Concentration
Blue Contour = 104 µg/m^3

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Figure 7.4

Predicted 99.8%ile of NO_2 1-Hour Concentrations (µg/m^3)

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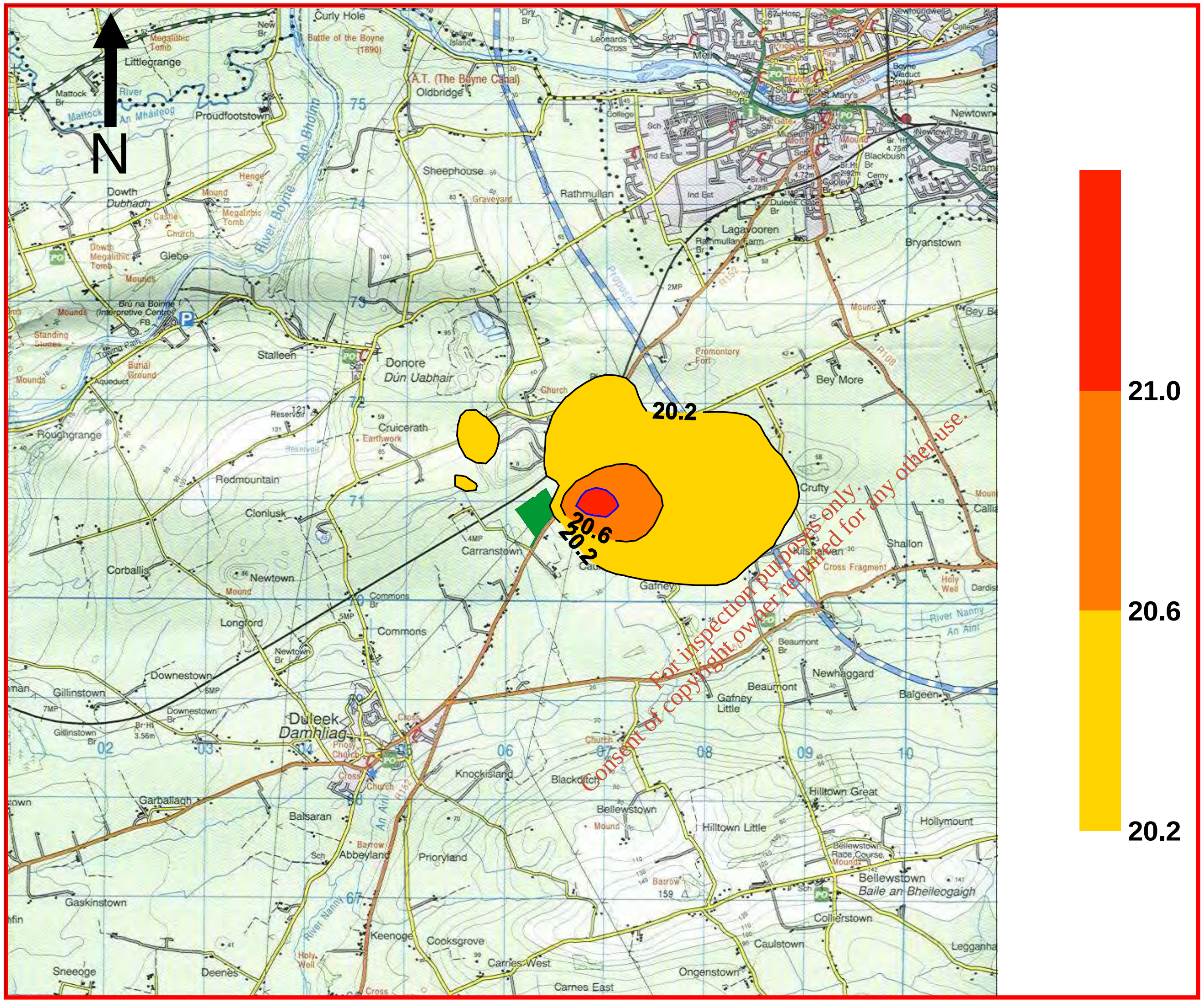

Annual Average
NO_2 Concentration
Blue Contour = 21 µg/m^3

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Figure 7.5

Predicted Annual Average NO_2 Concentrations (µg/m^3)

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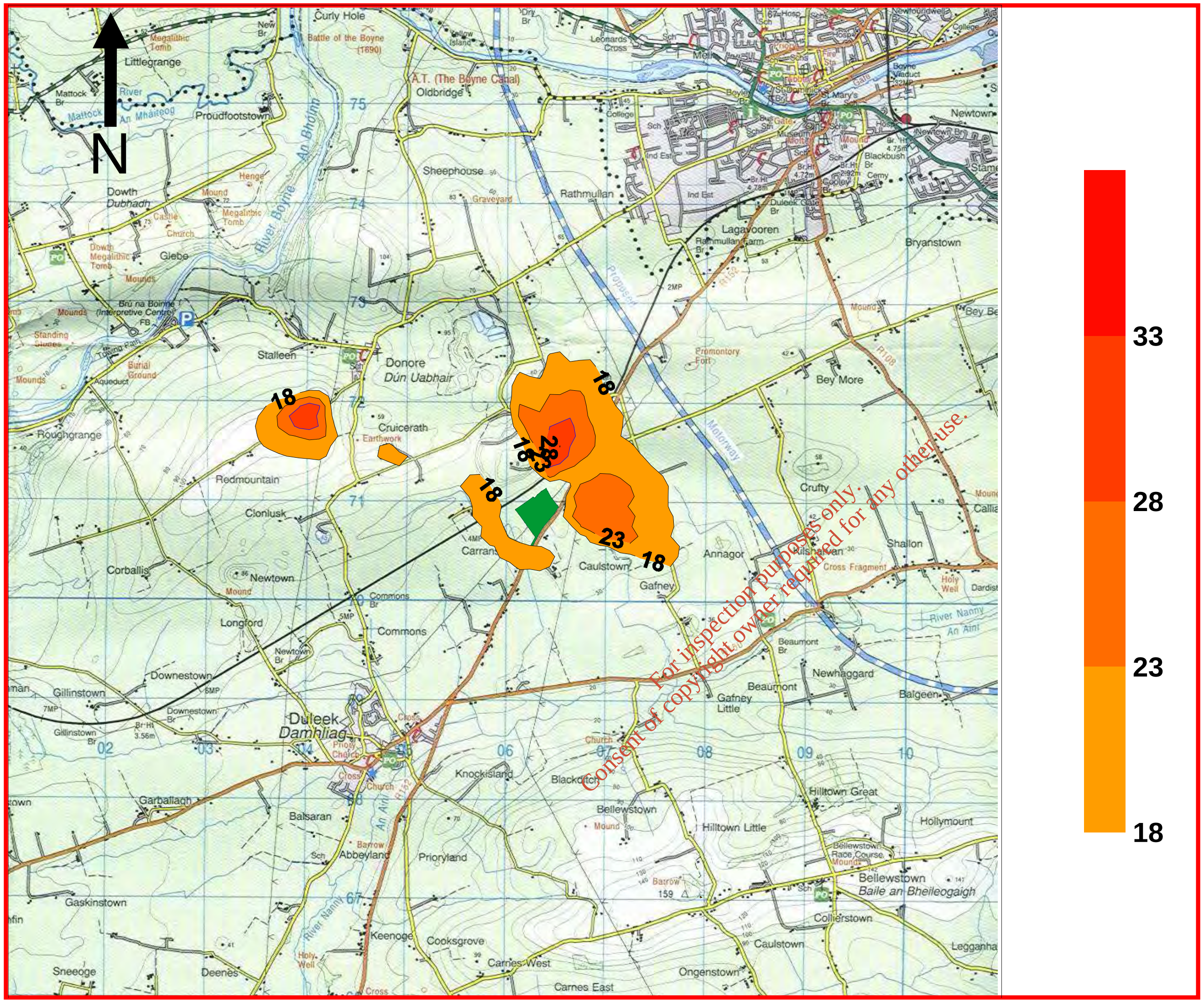

99.7%ile of Max 1-Hour SO_2 Concentration
Blue Contour = 28 µg/m^3

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Figure 7.6

Predicted 99.7%ile of Maximum 1-Hour SO_2 Concentrations (µg/m^3)

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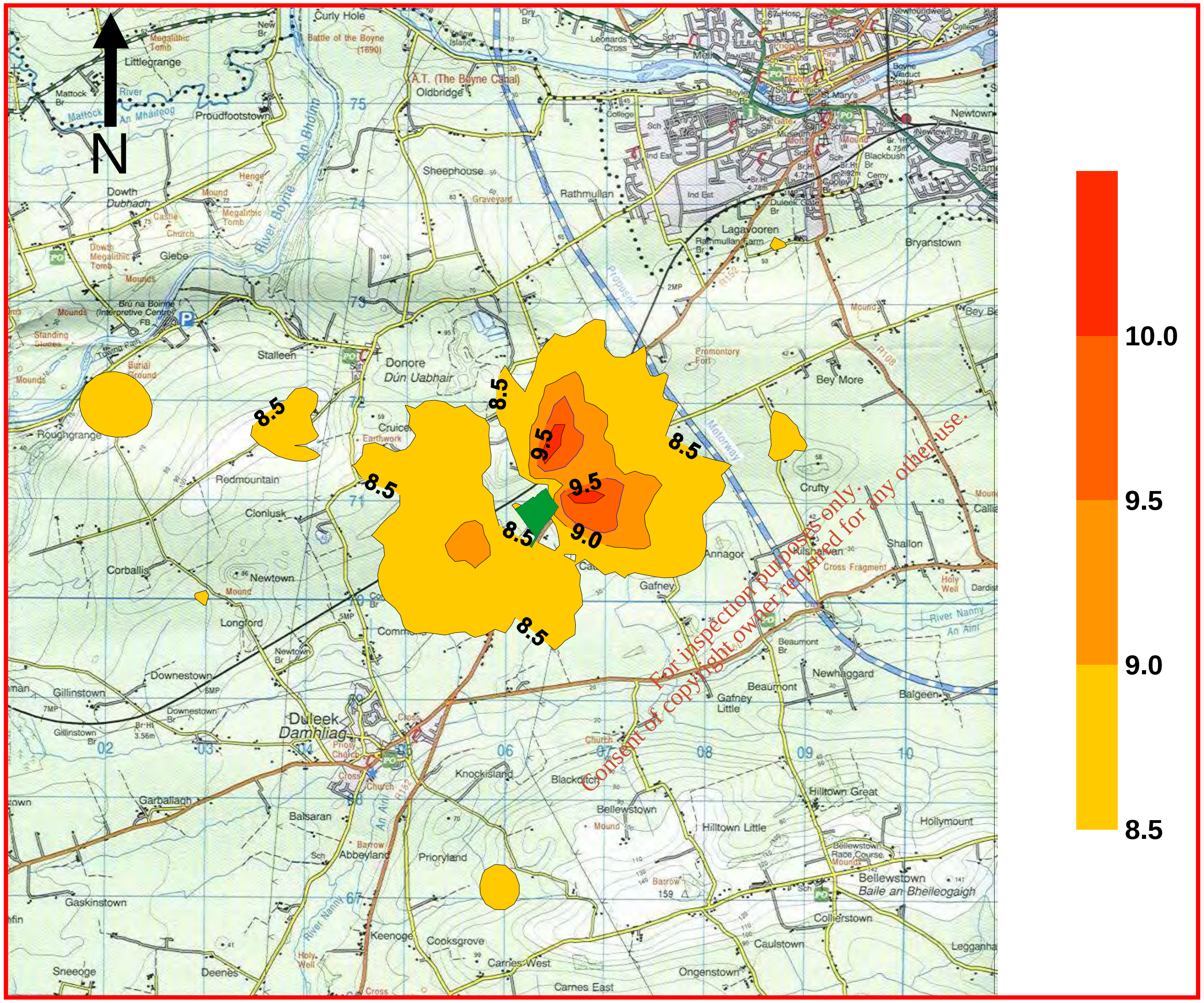

99.2%ile of Maximum 24-Hour SO_2 Concentration
Blue Contour = 9.5 µg/m^3

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Figure 7.7

Predicted 99.2%ile of Maximum 24-Hour SO_2 Concentrations (µg/m^3)

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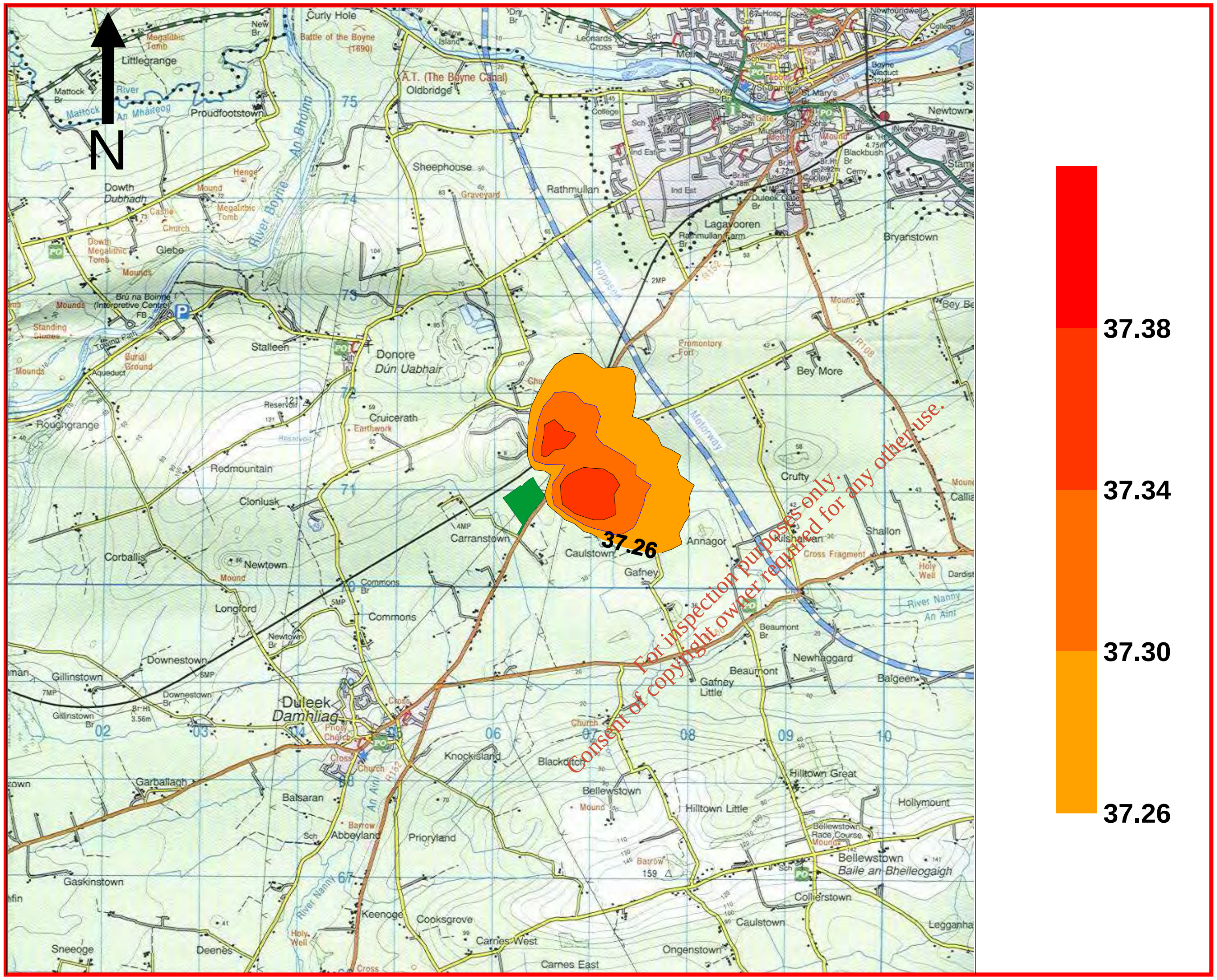

90.4%ile of Maximum 24-Hour PM_{10} Concentrations Blue Contour = 39.3 $\mu g/m^3$

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Figure 7.8

Predicted 90.4%ile of Maximum 24-Hour PM_{10} Concentrations ($\mu g/m^3$)

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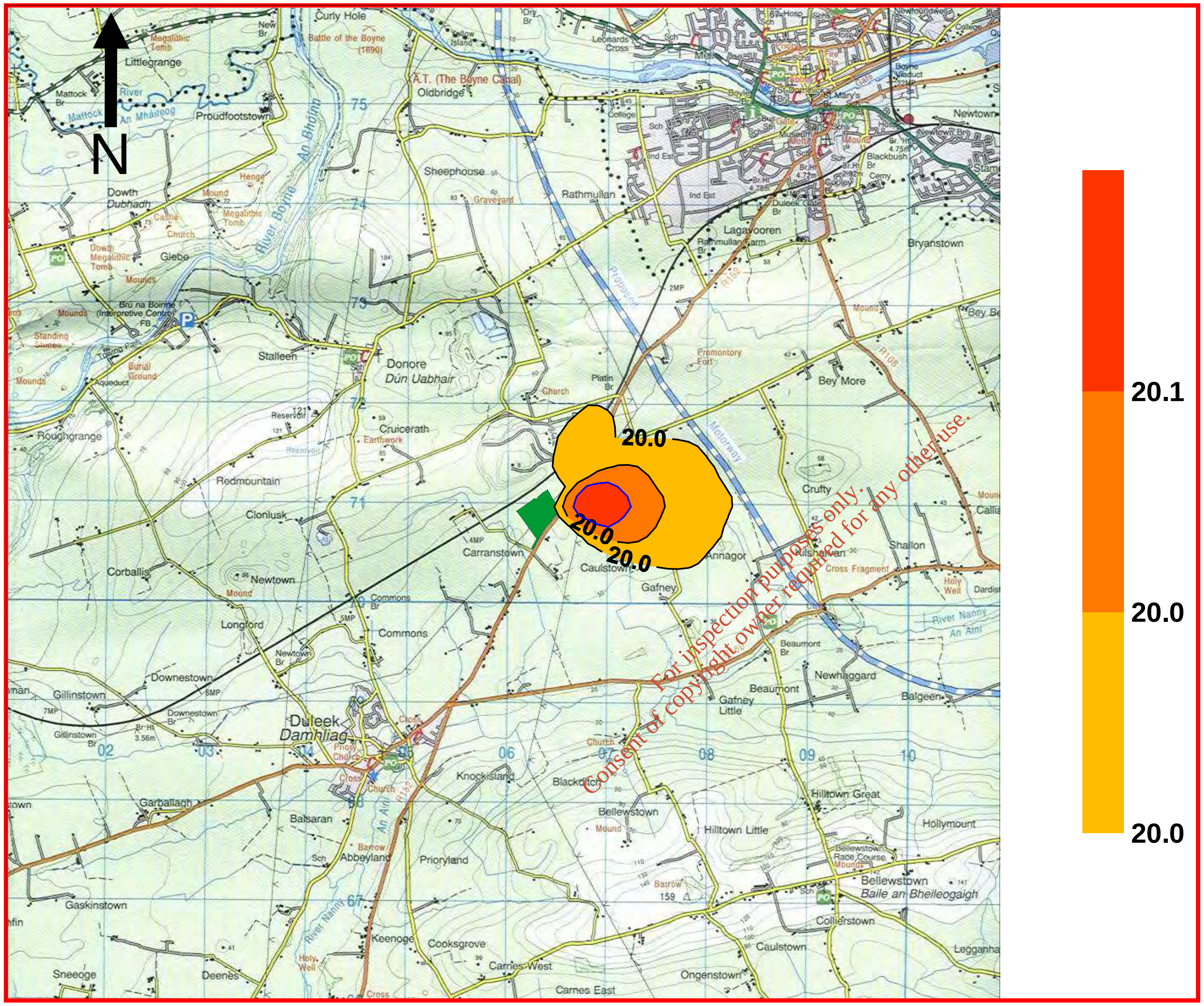

Annual Average
PM_{10} Concentrations
Blue Contour = 20.06 $\mu g/m^3$

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Figure 7.9

Predicted Annual Average PM_{10} Concentrations ($\mu g/m^3$)

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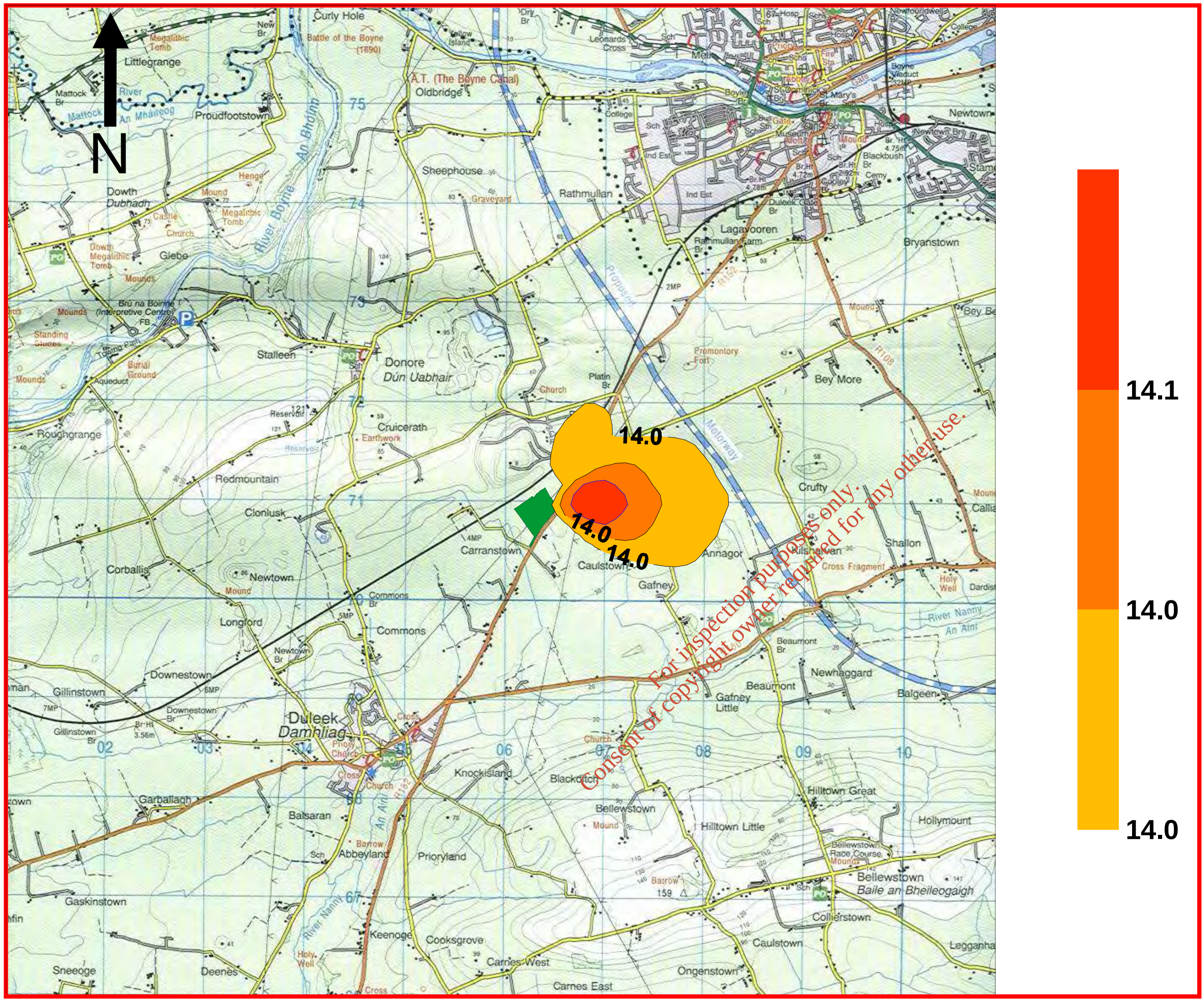

Annual Average
$PM_{2.5}$ Concentrations
Blue Contour = 14.06 $\mu g/m^3$

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Figure 7.10

Predicted Annual Average $PM_{2.5}$ Concentrations ($\mu g/m^3$)

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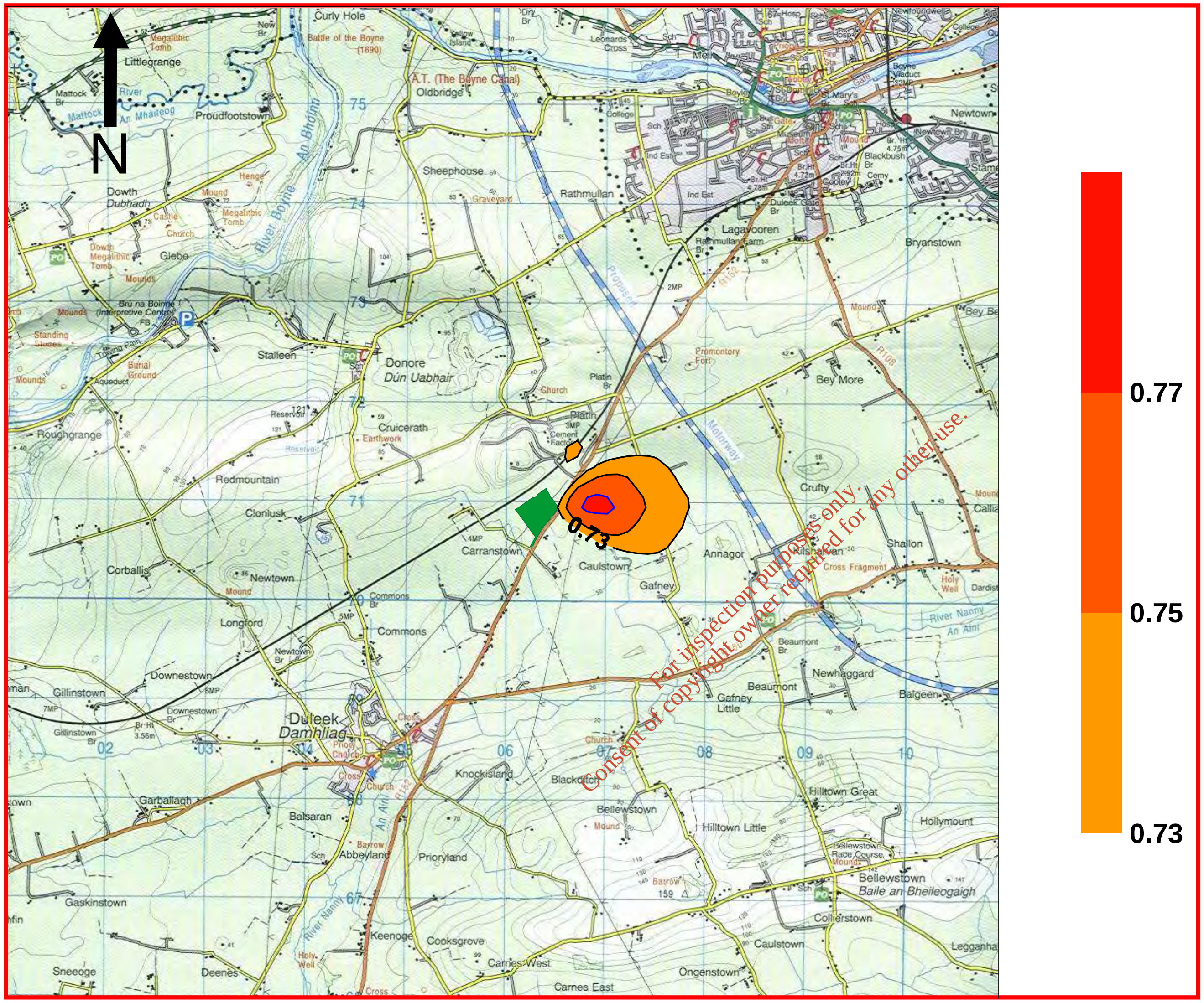

Annual Average
TOC Concentrations
Blue Contour = 0.73 µg/m^3

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Figure 7.11

Predicted Annual Average TOC (as Benzene) Concentrations (µg/m^3)

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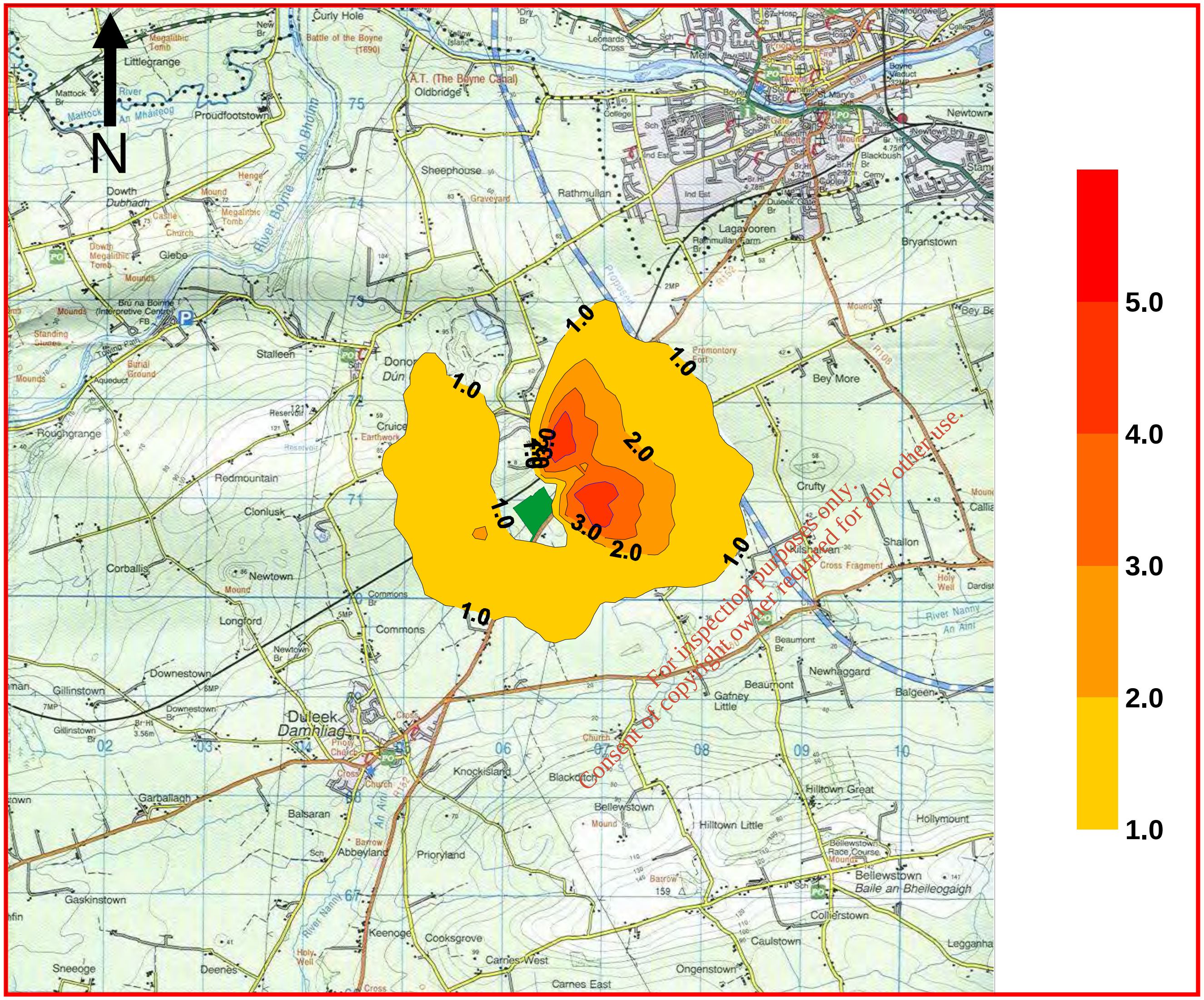

98%ile of Maximum 1-Hour
HCl Concentrations
Blue Contour = 4 µg/m^3

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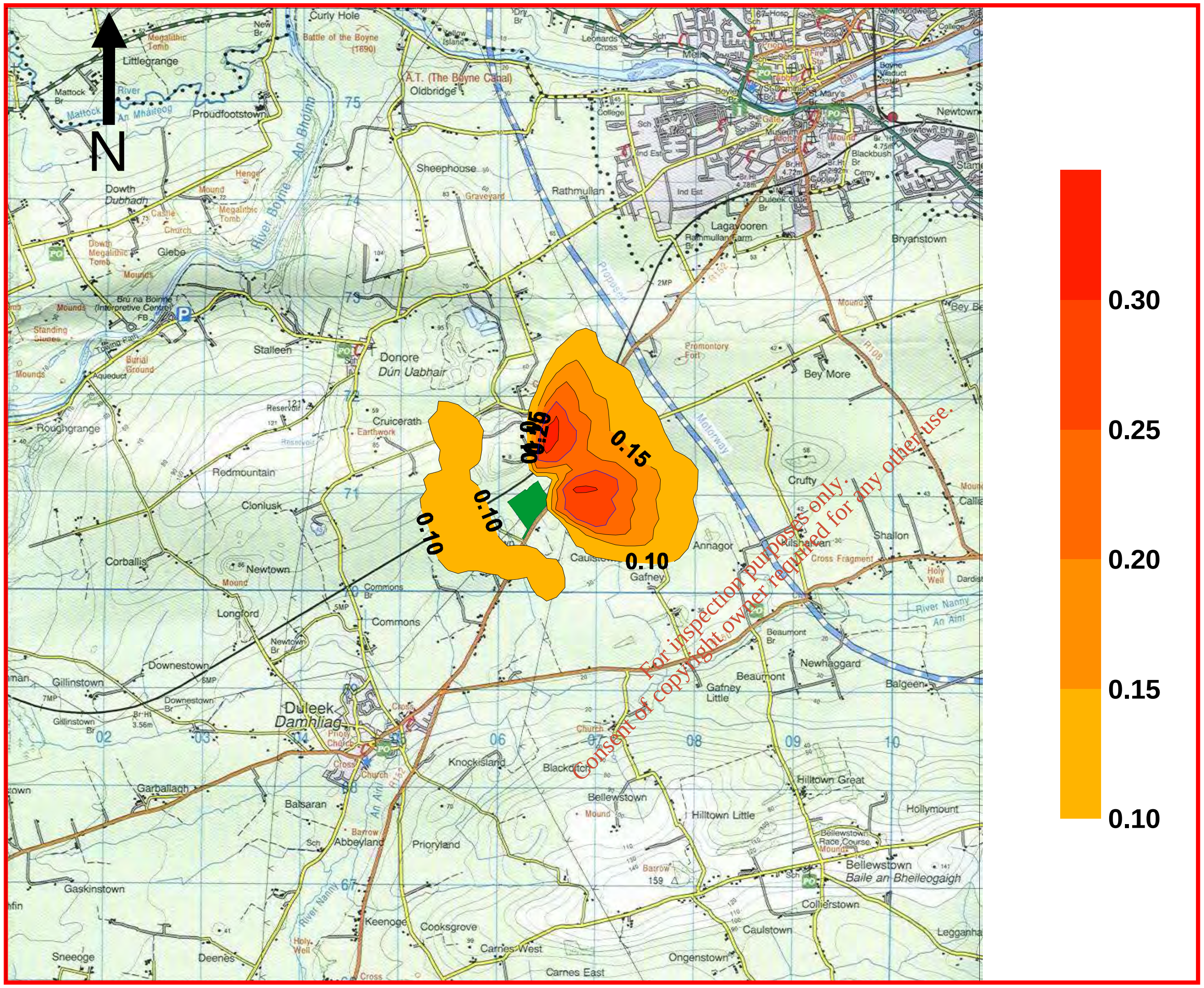
Figure 7.12

Predicted 98%ile of Maximum 1-Hour HCl Concentrations (µg/m^3)

awnconsulting



98%ile of Maximum 1-Hour
HF Concentrations
Blue Contour = 0.25 µg/m^3

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Scale 1:70,000 approx

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Figure 7.13

Predicted 98%ile of Maximum 1-Hour HF Concentrations (µg/m^3)

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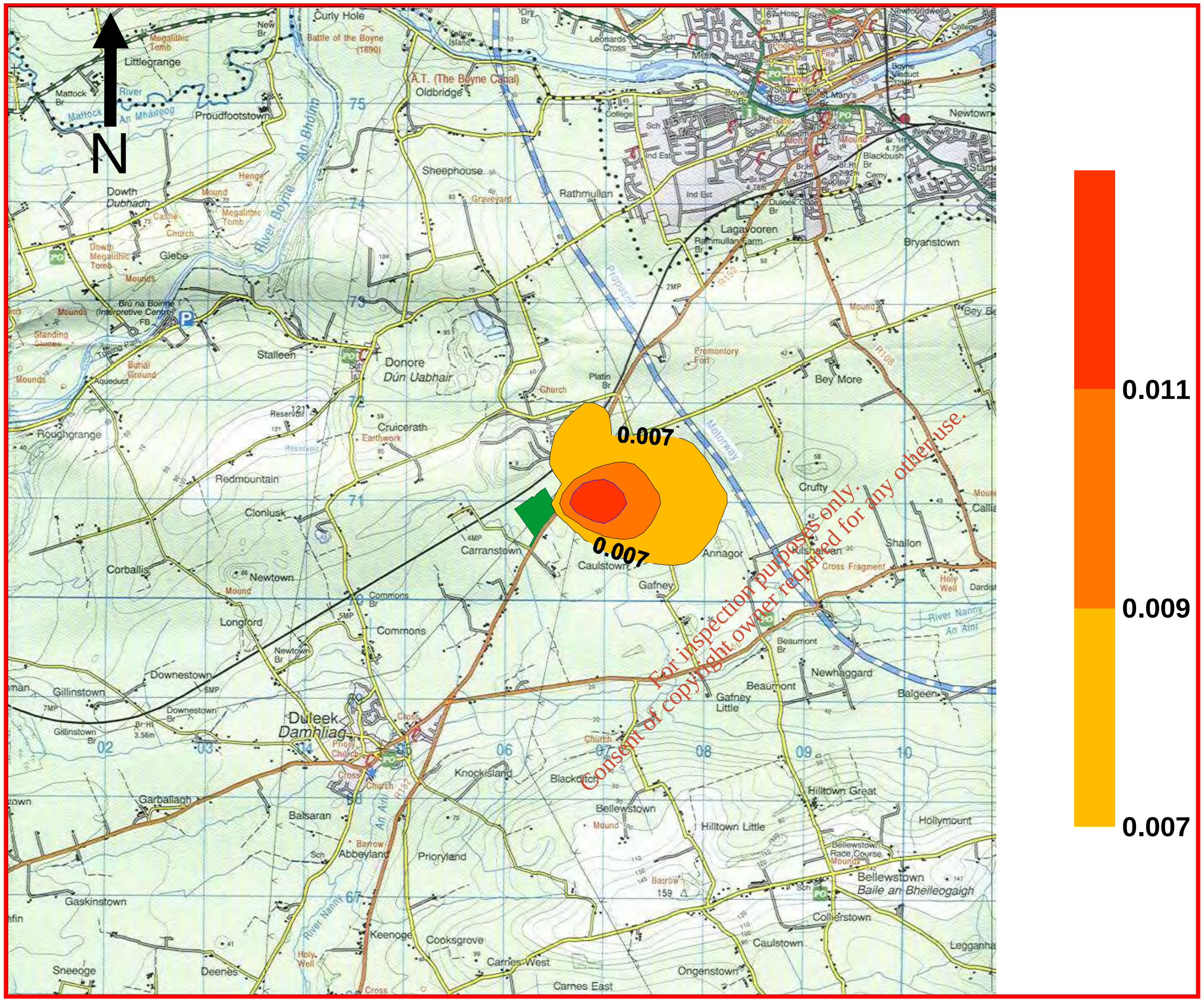

Annual Average
HF Concentration
Blue Contour = 0.011 µg/m^3

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Figure 7.14

Predicted Annual Average HF Concentrations (µg/m^3)

awnconsulting

The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17
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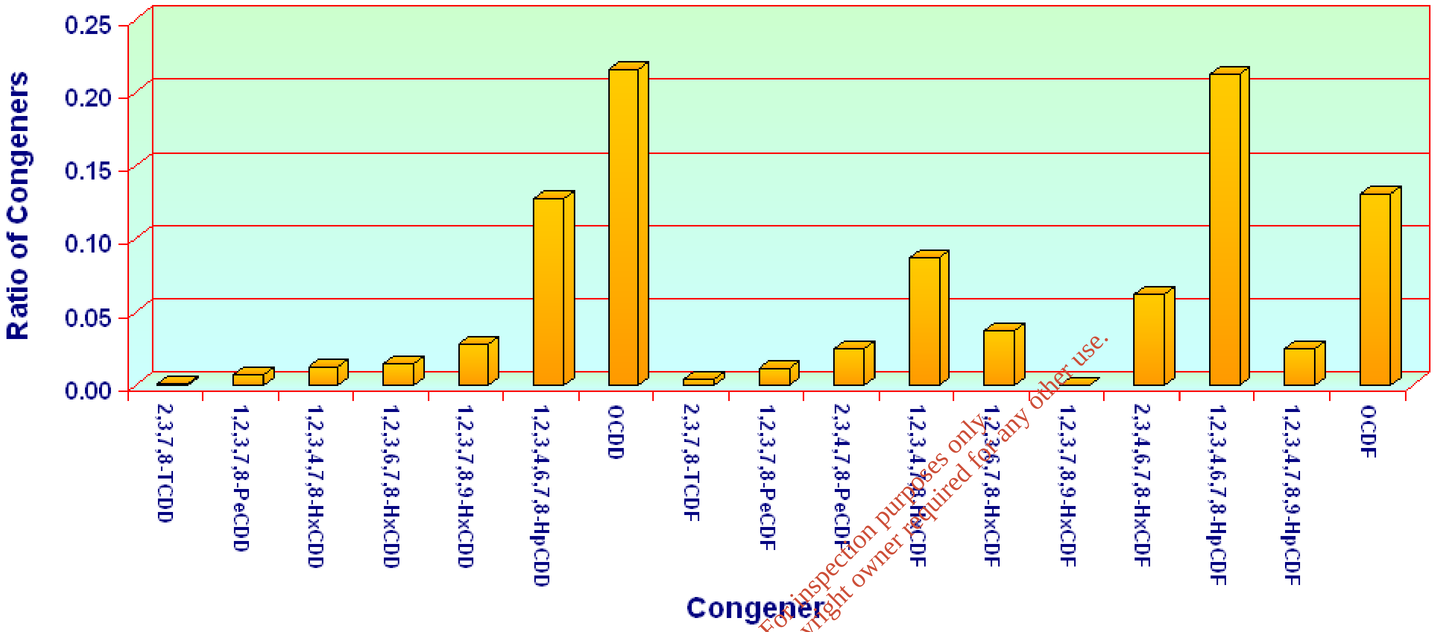
Figure 7.15 - Default MWI (MS-WW DS/CI/FF) Congener Profile



Project

Carranstown Waste Management Facility

Reference

09/4777AR02

Figure 7.15

Default MWI (MS-WW DS/CI/FF) Dioxin Congener Profile

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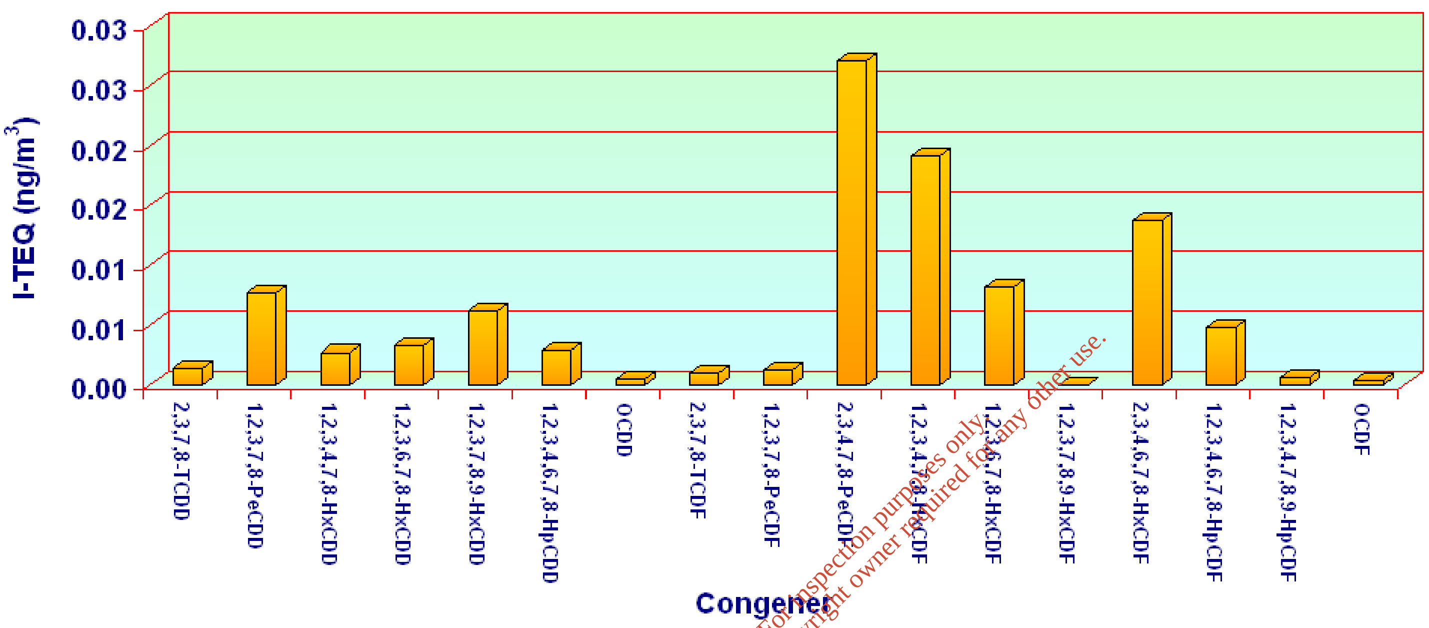
Figure 7.16 - Default MWI TEQ Equivalent Release Corrected To 0.1 ng/m^3



Project

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Reference

09/4777AR02

Figure 7.16

Default MWI TEQ Equivalent Release Corrected to 0.1ng/m^3

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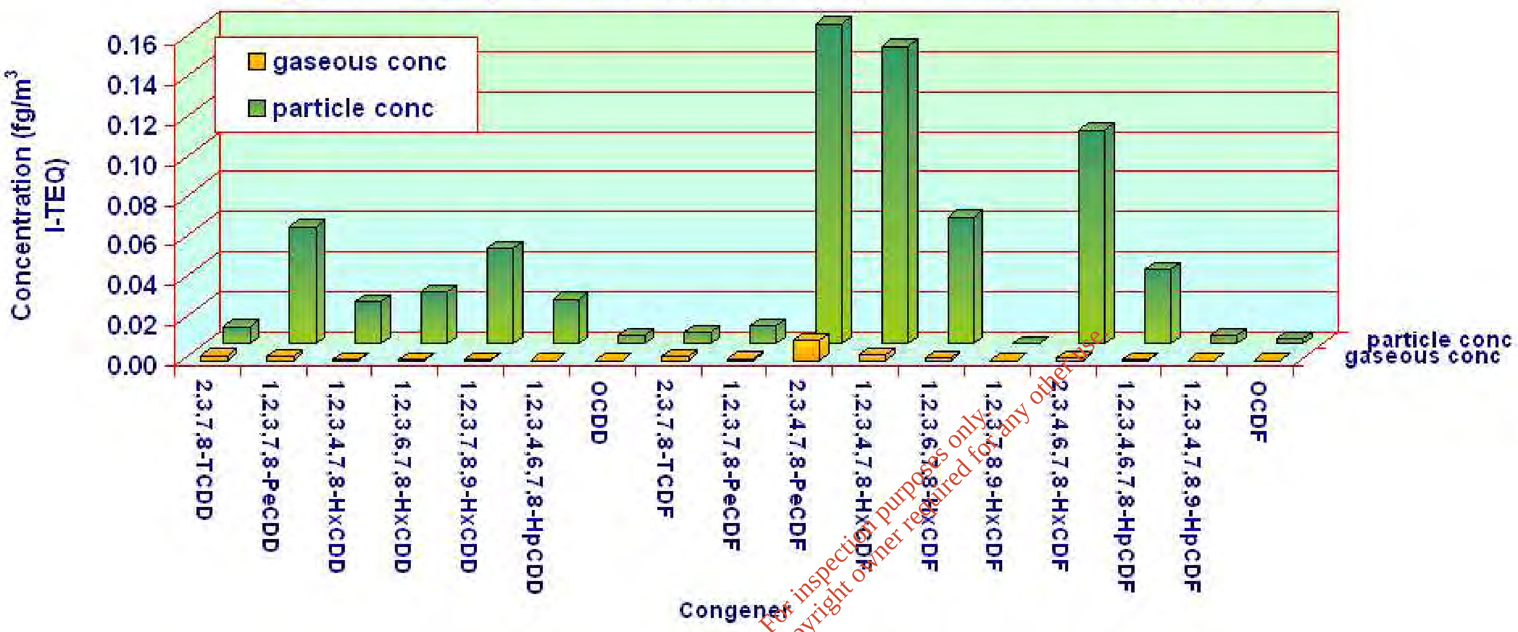
Figure 7.17 - Vapour and Particulate Congener Concentration (fg/m^3)



Project

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Reference

09/4777AR02

Figure 7.17

Vapour & Particulate Congener Concentration (fg/m^3) Under Maximum Operations

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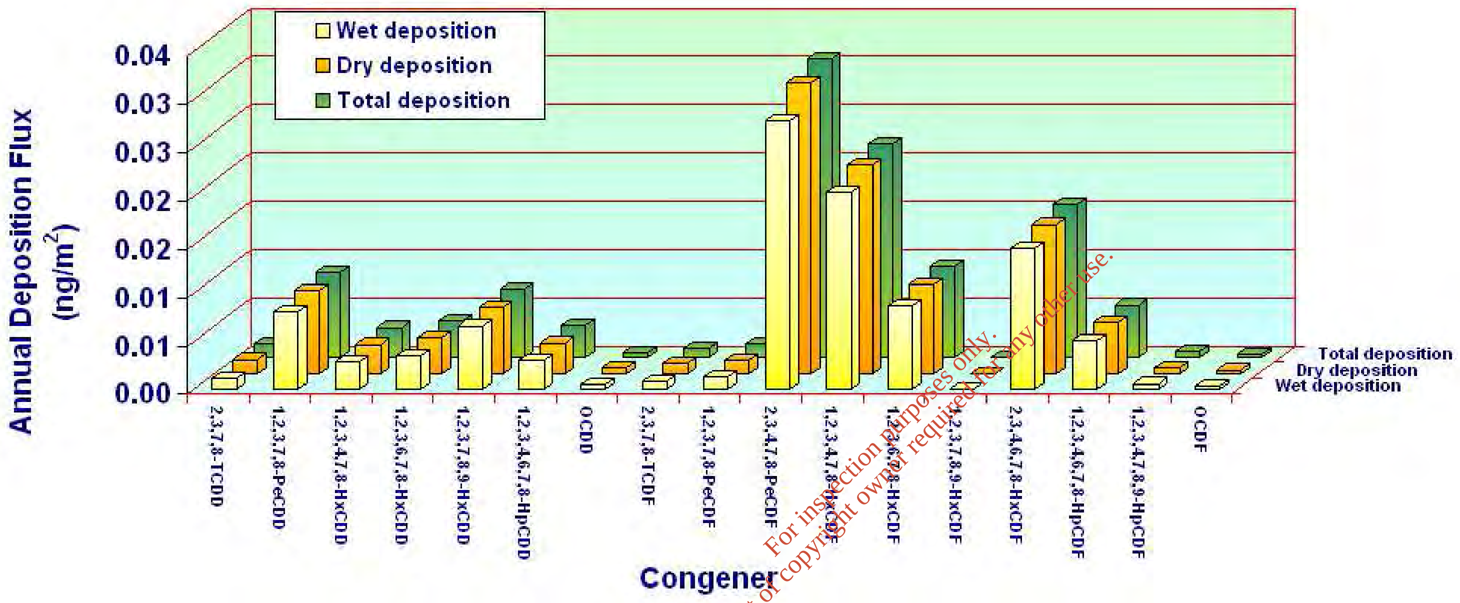

Figure 7.18 - Particulate & Gaseous Congener Deposition (ng/m^2) Under Maximum Operations

Project

Carranstown Waste Management Facility

Reference

09/4777AR02

Figure 7.18

Particulate Congener Deposition (ng/m^2) Under Maximum Operations

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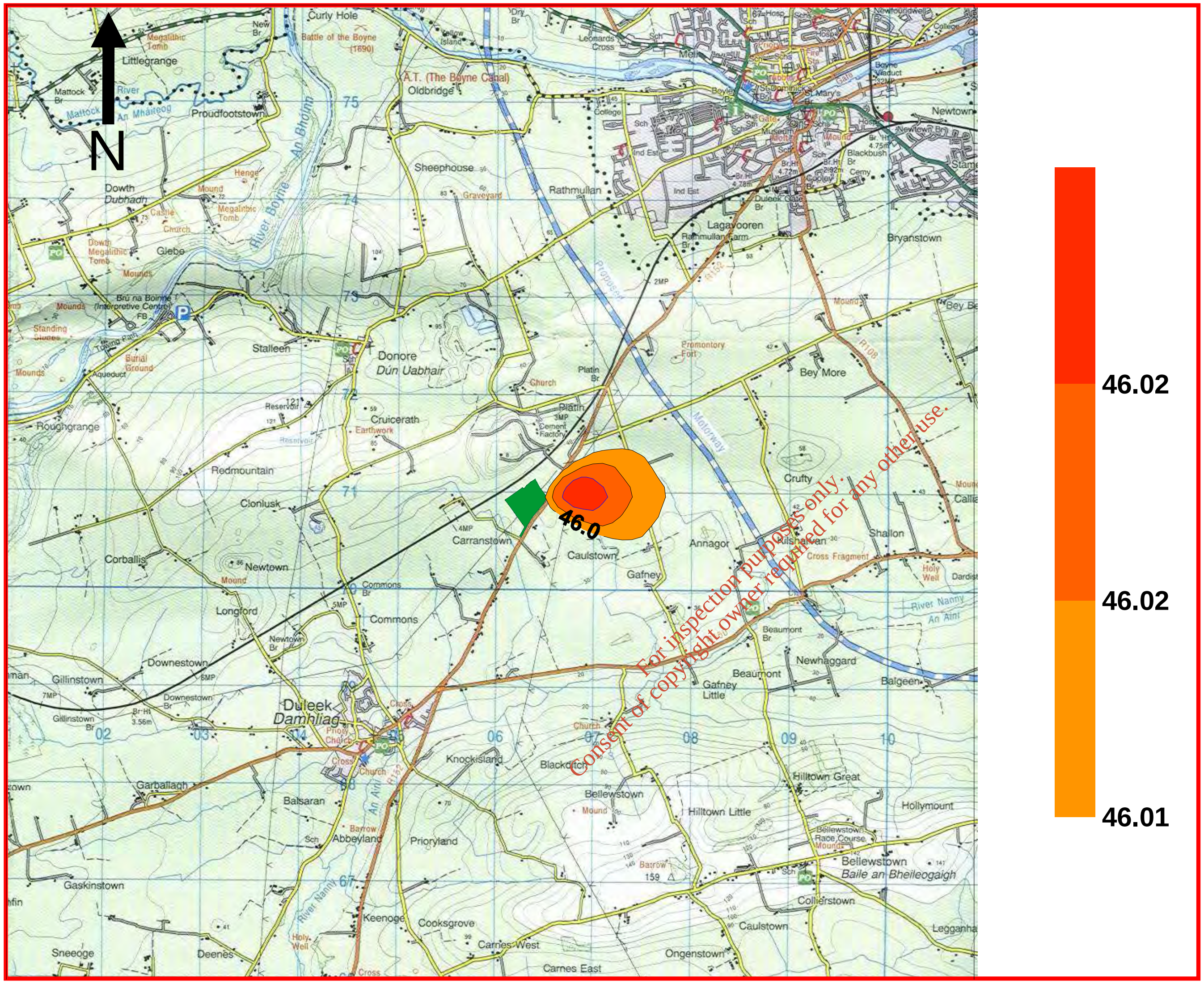

Annual Average Dioxin
Vapour Concentration
Blue Contour = 46.02 fg/m^3

Reproduced from
Ordnance Survey
Ireland
Permit No: EN 7509

Scale 1:70,000 approx

Project

Carranstown Waste Management Facility

Reference

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Figure 7.19

Predicted Annual Average Dioxin Vapour Concentrations (fg/m³)

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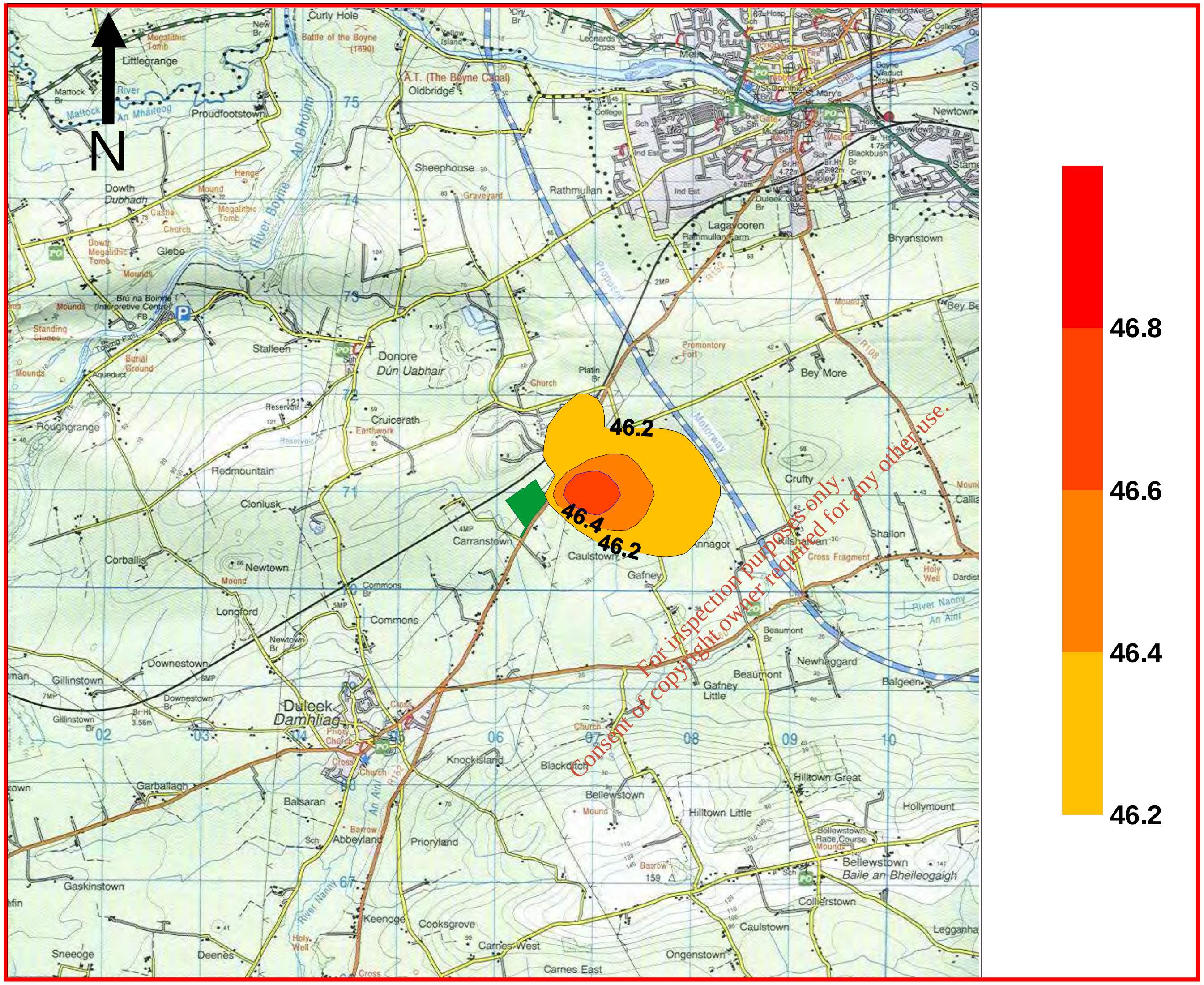

Annual Average Dioxin
Particulate Concentration
Blue Contour = 46.6 fg/m^3

Reproduced from
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Ireland
Permit No: EN 7509

Scale 1:70,000 approx

Project

Carranstown Waste
Management Facility

Reference

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Figure 7.20

Predicted Annual Average Dioxin Particulate Concentrations (fg/m^3)

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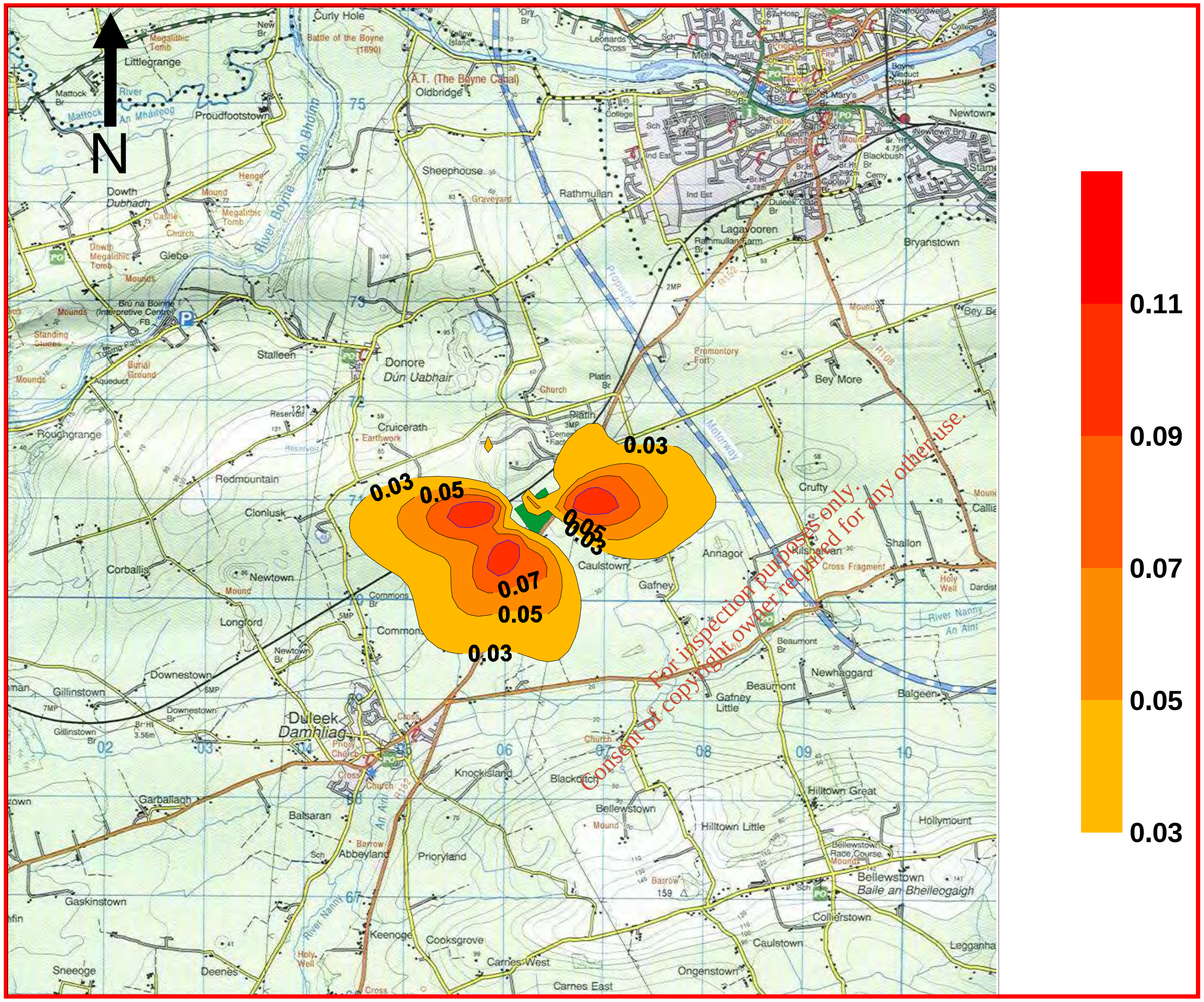

Annual Average Dioxin
Particulate Deposition Flux
Blue Contour = 0.09 ng/m^2/year

Reproduced from
Ordnance Survey
Ireland
Permit No: EN 7509

Scale 1:70,000 approx

Project

Carranstown Waste
Management Facility

Reference

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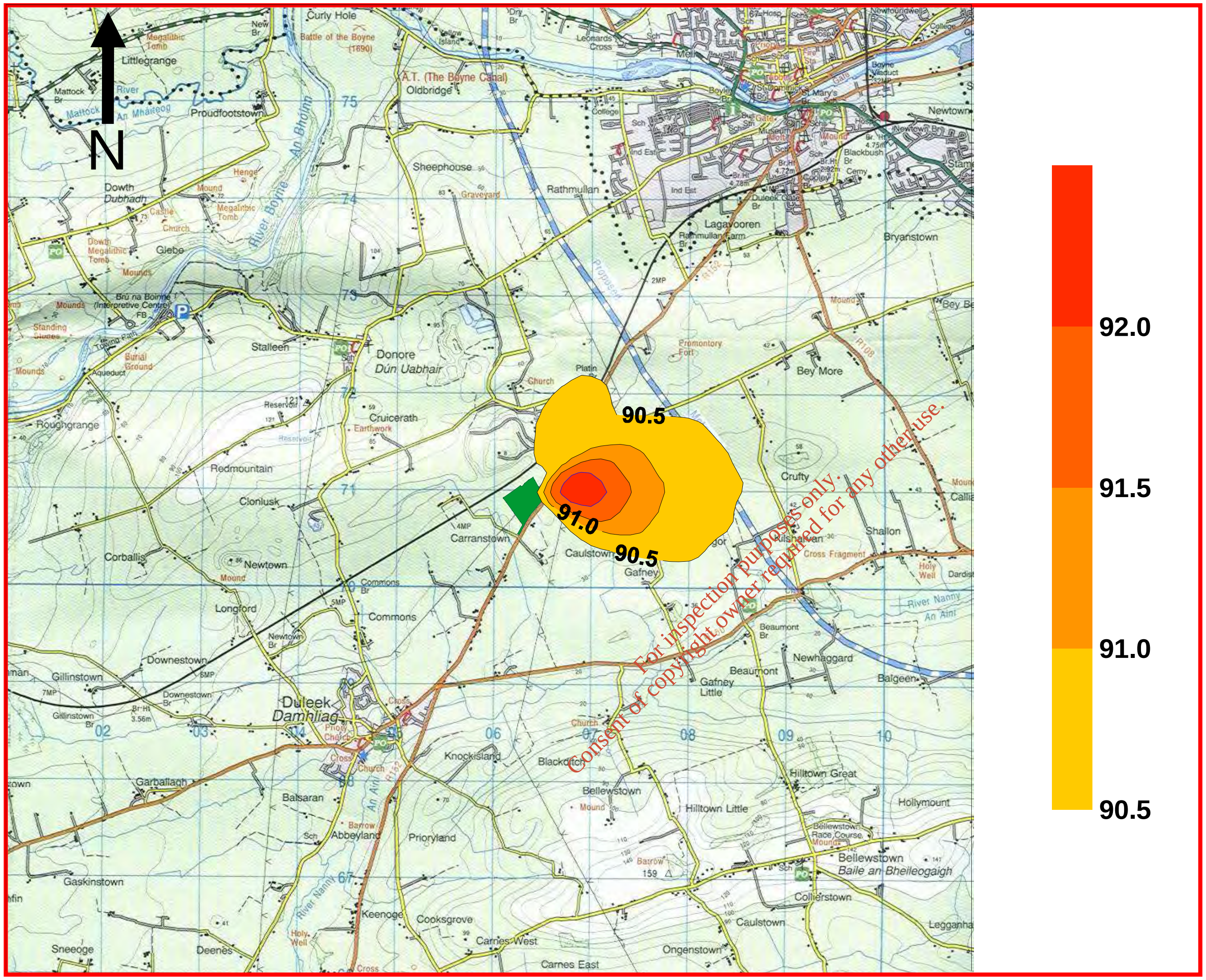
Figure 7.21

Predicted Annual
Average Dioxin
Particulate Deposition
Flux (ng/m^2/year)

awnconsulting



Annual Average B[a]P
Particulate Concentration
Blue Contour = 92 pg/m^3

Reproduced from
Ordnance Survey
Ireland
Permit No: EN 7509

Scale 1:70,000 approx

Project

Carranstown Waste Management Facility

Reference

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Figure 7.22

Predicted Annual Average B[a]P Particulate Concentration (pg/m^3)

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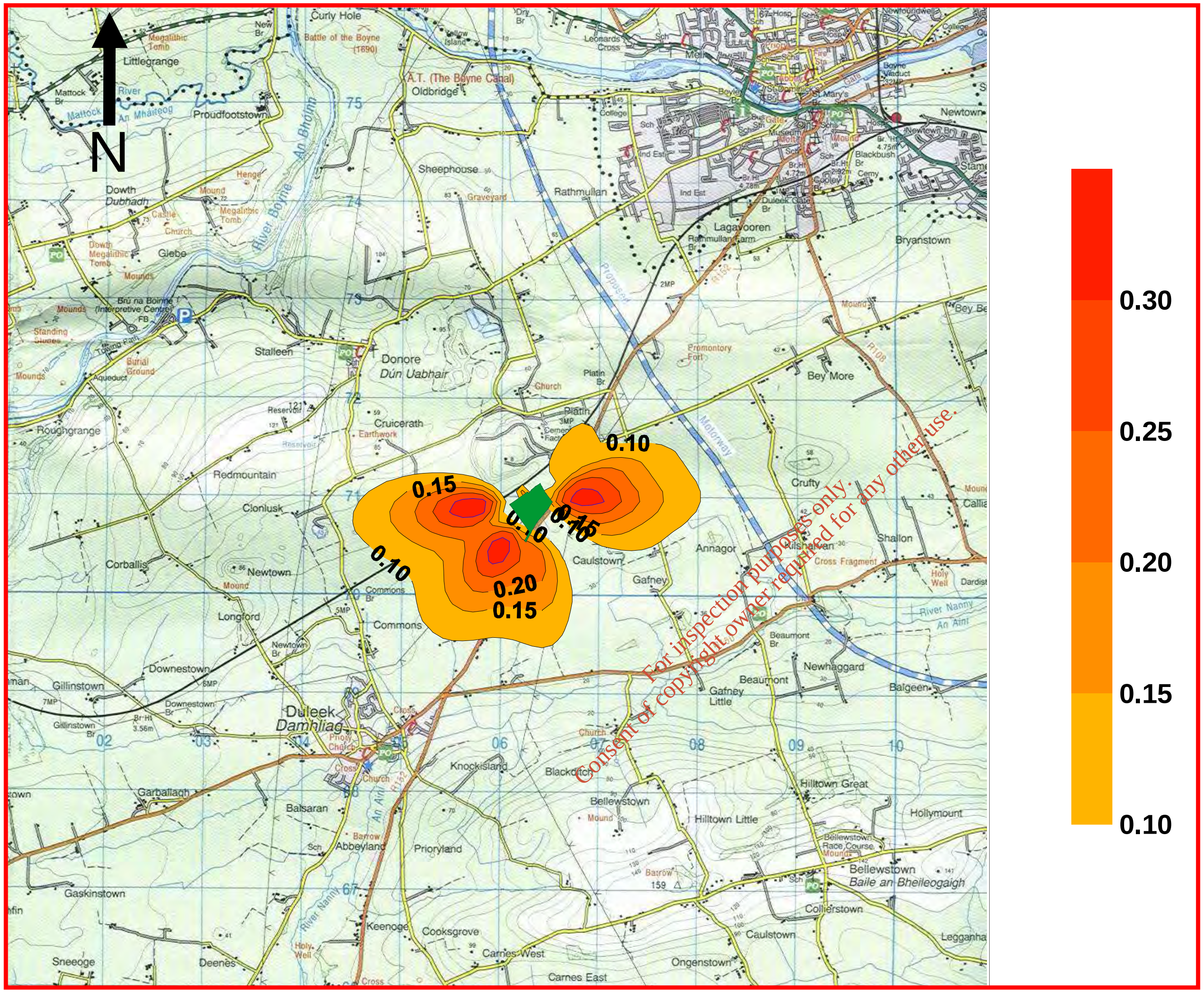

Annual Average B[a]P Particulate Deposition Flux
Blue Contour = 0.3 µg/m^2/year

Reproduced from Ordnance Survey Ireland
Permit No: EN 7509

Scale 1:70,000 approx

Project

Carranstown Waste Management Facility

Reference

09/4777AR02

Figure 7.23

Predicted Annual Average B[a]P Particulate Deposition Flux (µg/m^2/year)

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The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17
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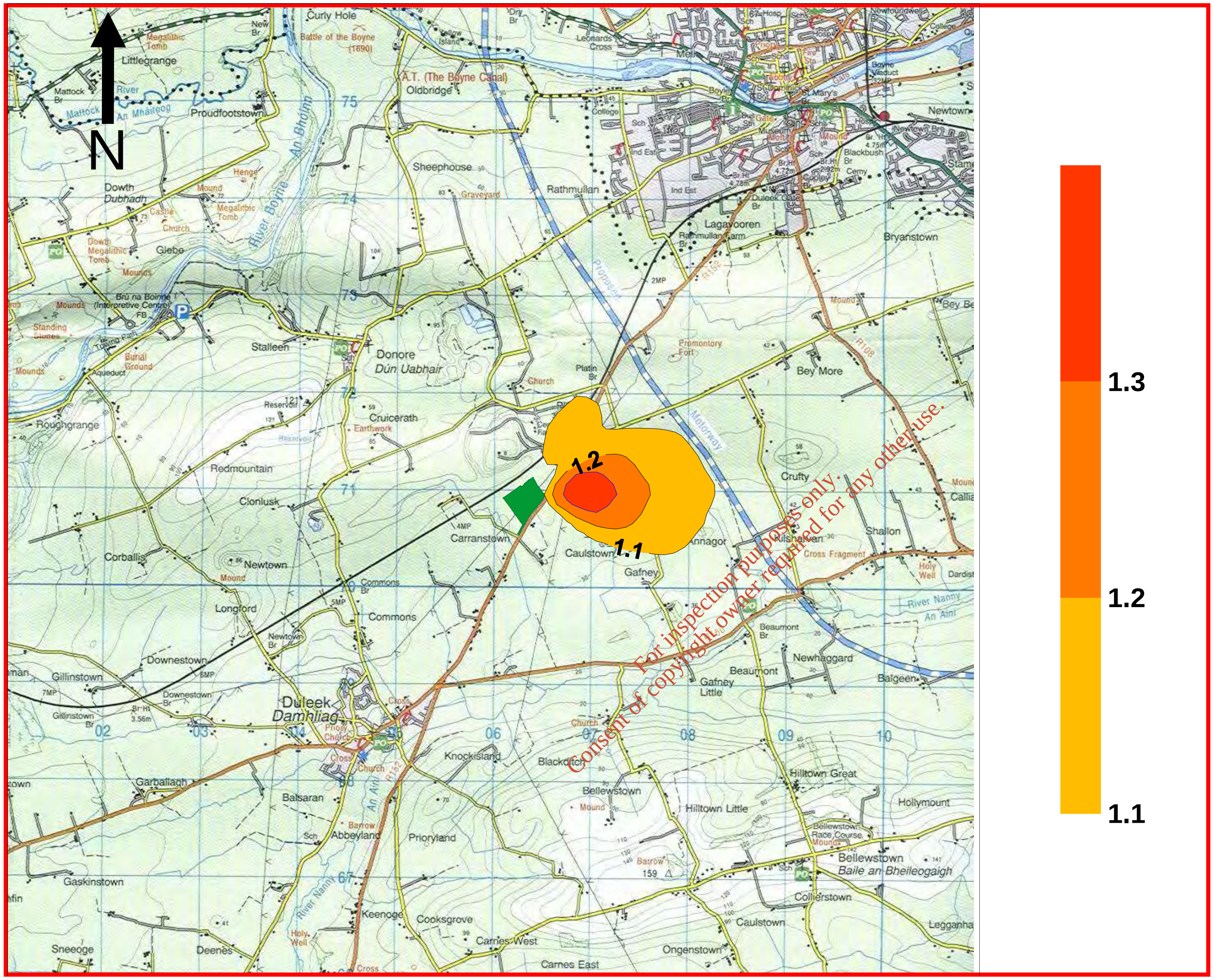

Annual Average Mercury Concentration
Blue Contour = 1.3 ng/m^3

Reproduced from
Ordnance Survey
Ireland
Permit No: EN 7509

Scale 1:70,000 approx

Project

Carranstown Waste Management Facility

Reference

09/4777AR02

Figure 7.24

Predicted Annual Annual Average Mercury Concentration (ng/m^3)

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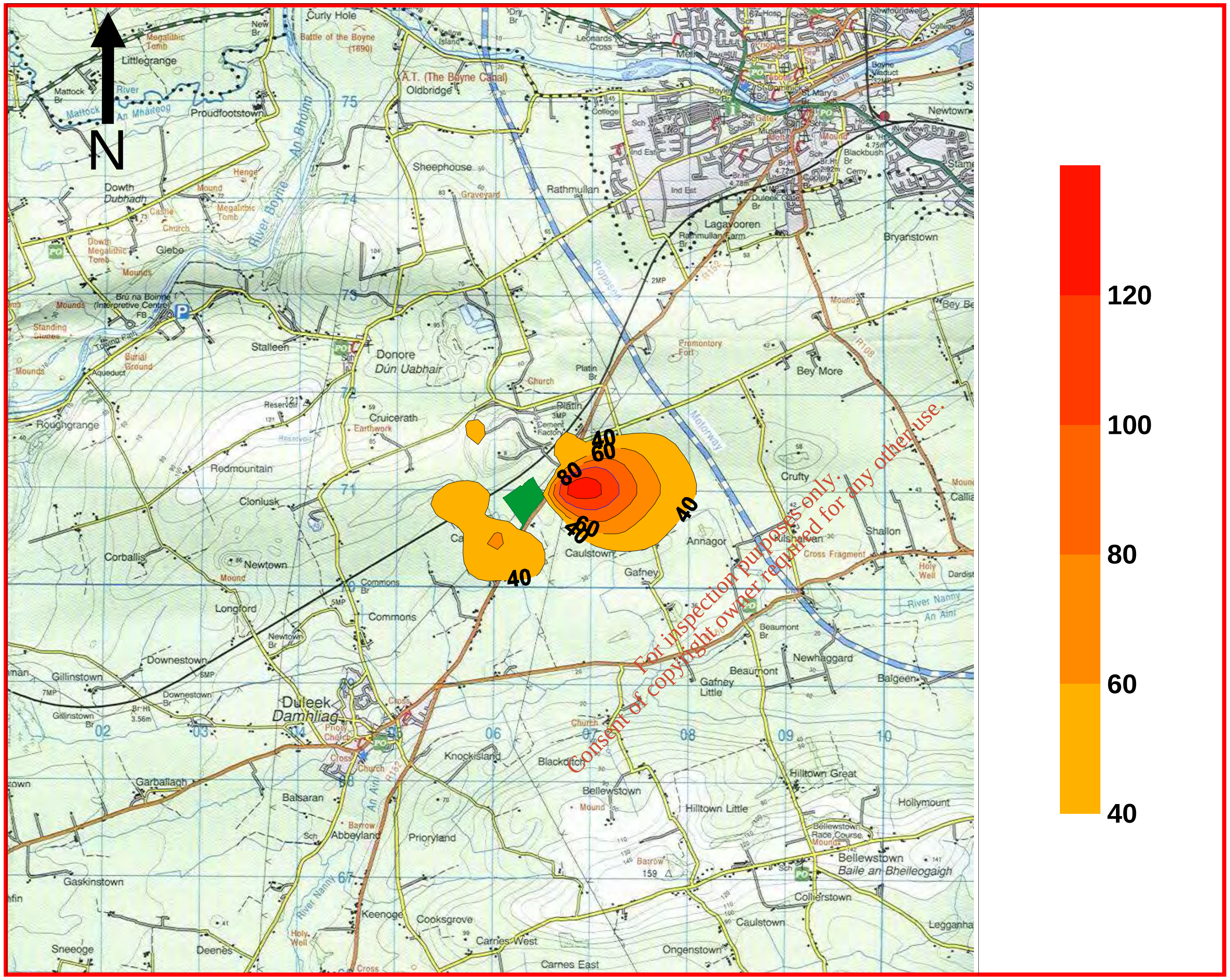

Annual Average Divalent Mercury Total Gaseous Deposition
Blue Contour = 100 µg/m²/year

Reproduced from Ordnance Survey Ireland
Permit No: EN 7509

Scale 1:70,000 approx

Project

Carranstown Waste Management Facility

Reference

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Figure 7.25

Predicted Annual Total Gaseous Divalent Mercury Deposition (µg/m²/year)

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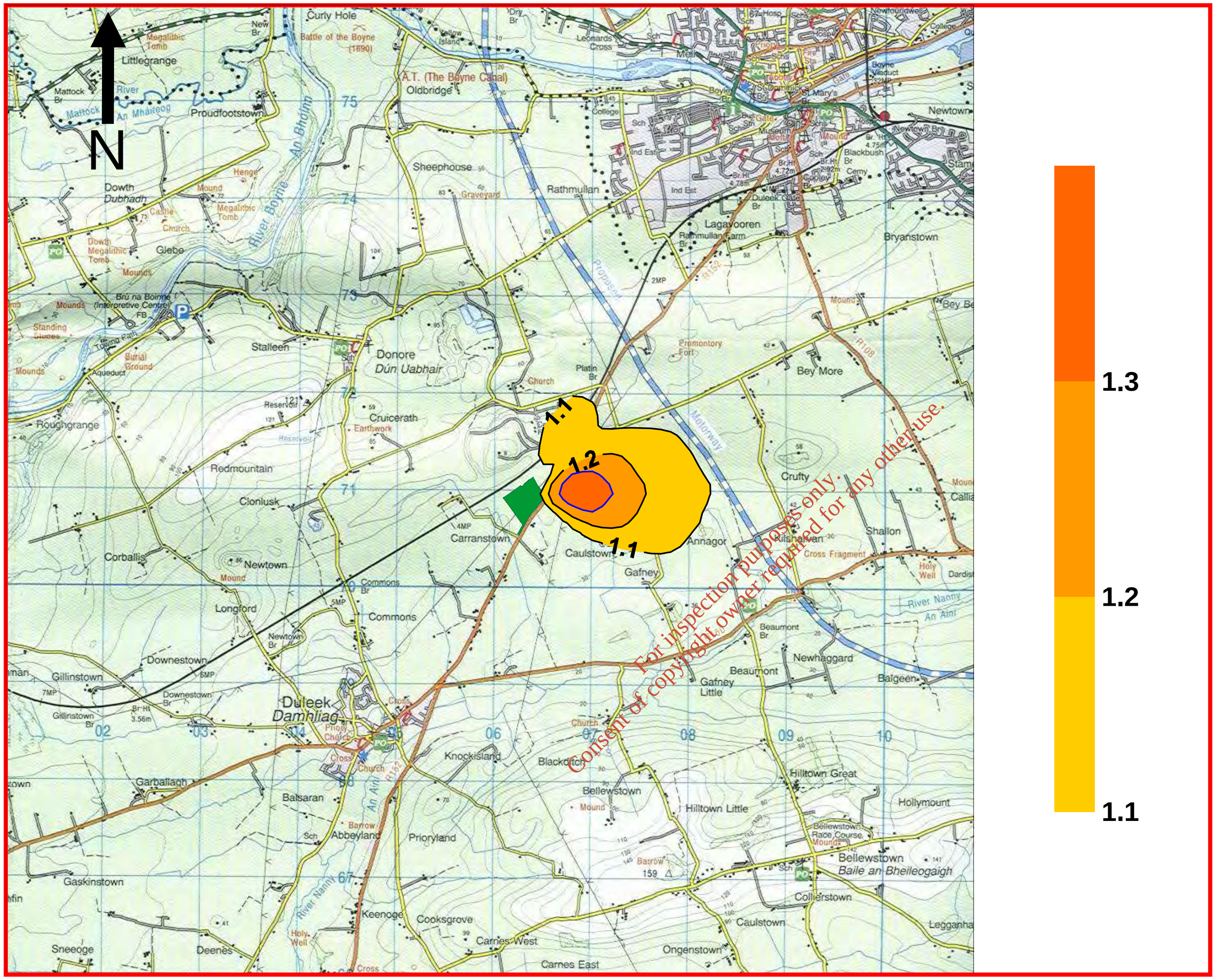

Annual Average
Cadmium Concentration
Blue Contour = 1.3 ng/m^3

Reproduced from
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Ireland
Permit No: EN 7509

Scale 1:70,000 approx

Project

Carranstown Waste Management Facility

Reference

09/4777AR02

Figure 7.26

Predicted Annual Average Cadmium (ng/m^3)

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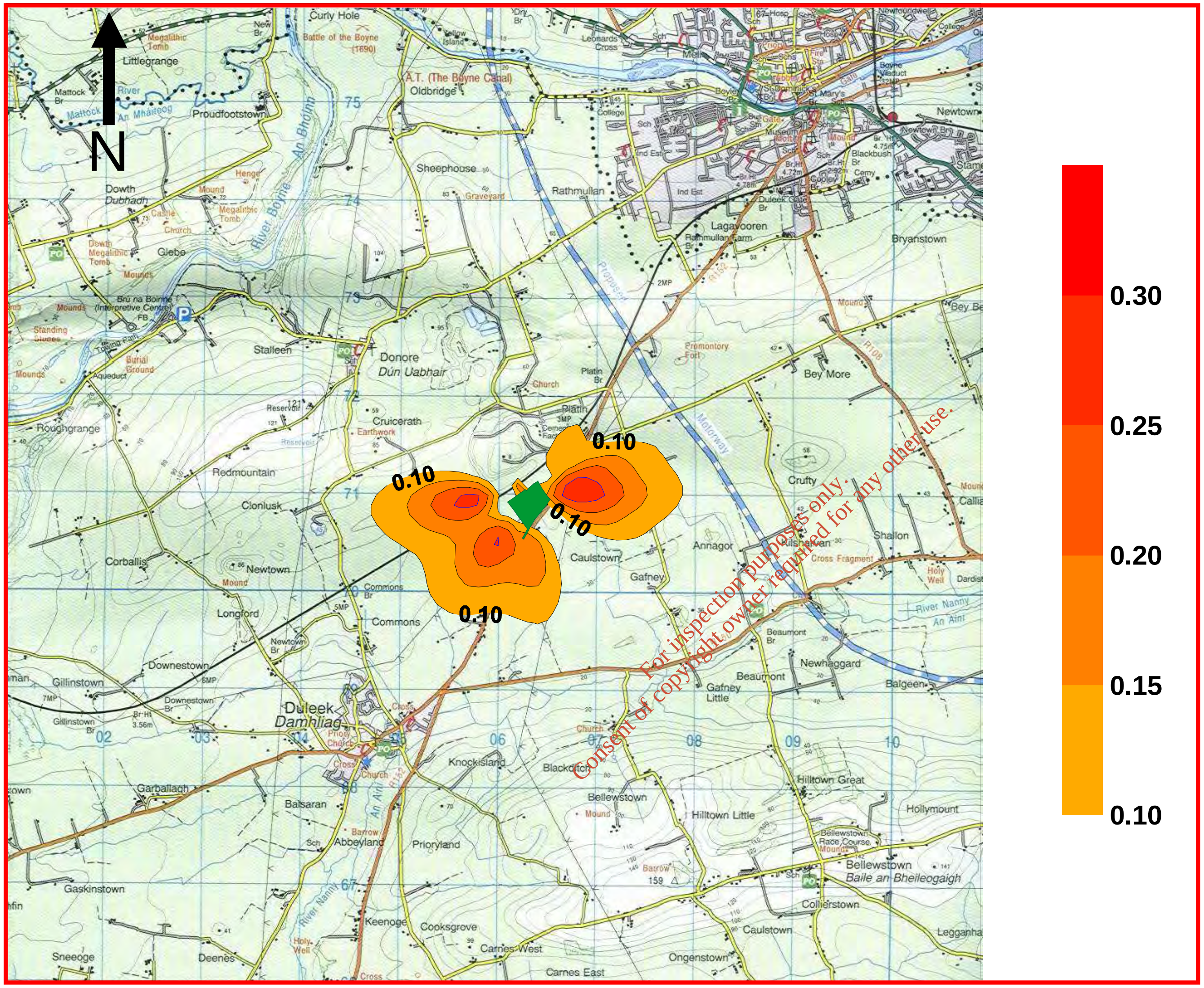

Annual Average Cadmium
Deposition Flux
Blue Contour = 0.25
mg/m^2/year

Reproduced from
Ordnance Survey
Ireland
Permit No: EN 7509

Scale 1:70,000 approx

Project

Carranstown Waste
Management Facility

Reference

09/4777AR02

Figure 7.27

Predicted Annual
Average Cadmium
Deposition Flux
(mg/m^2/year)

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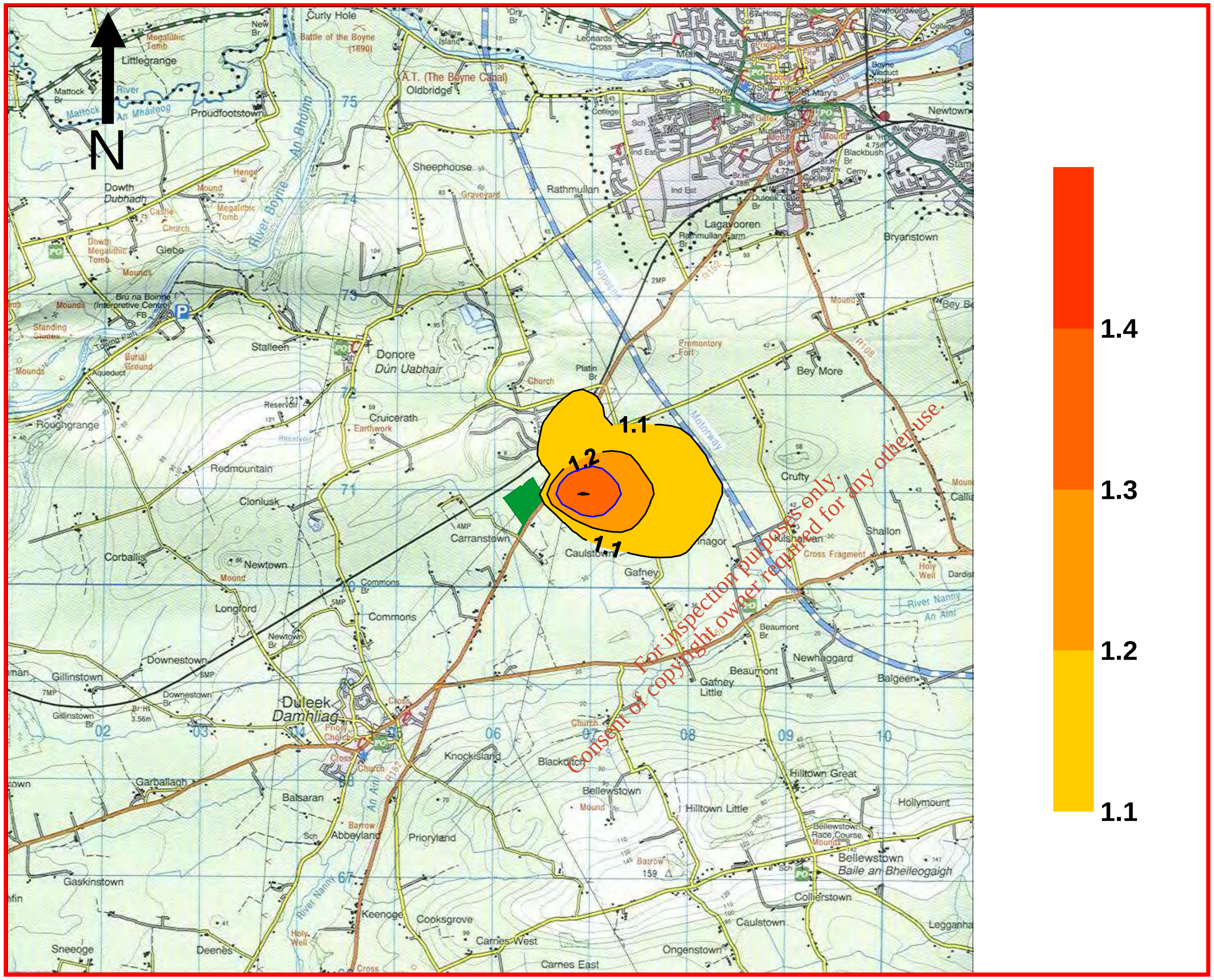
The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17
T: +353 1 847 4220 F: +353 1 847 4257



Annual Average Arsenic Concentration
Blue Contour = 1.3 ng/m^3

Reproduced from Ordnance Survey Ireland
Permit No: EN 7509

Scale 1:70,000 approx

Project

Carranstown Waste Management Facility

Reference

09/4777AR02

Figure 7.28

Predicted Annual Average Arsenic Concentration (ng/m^3)

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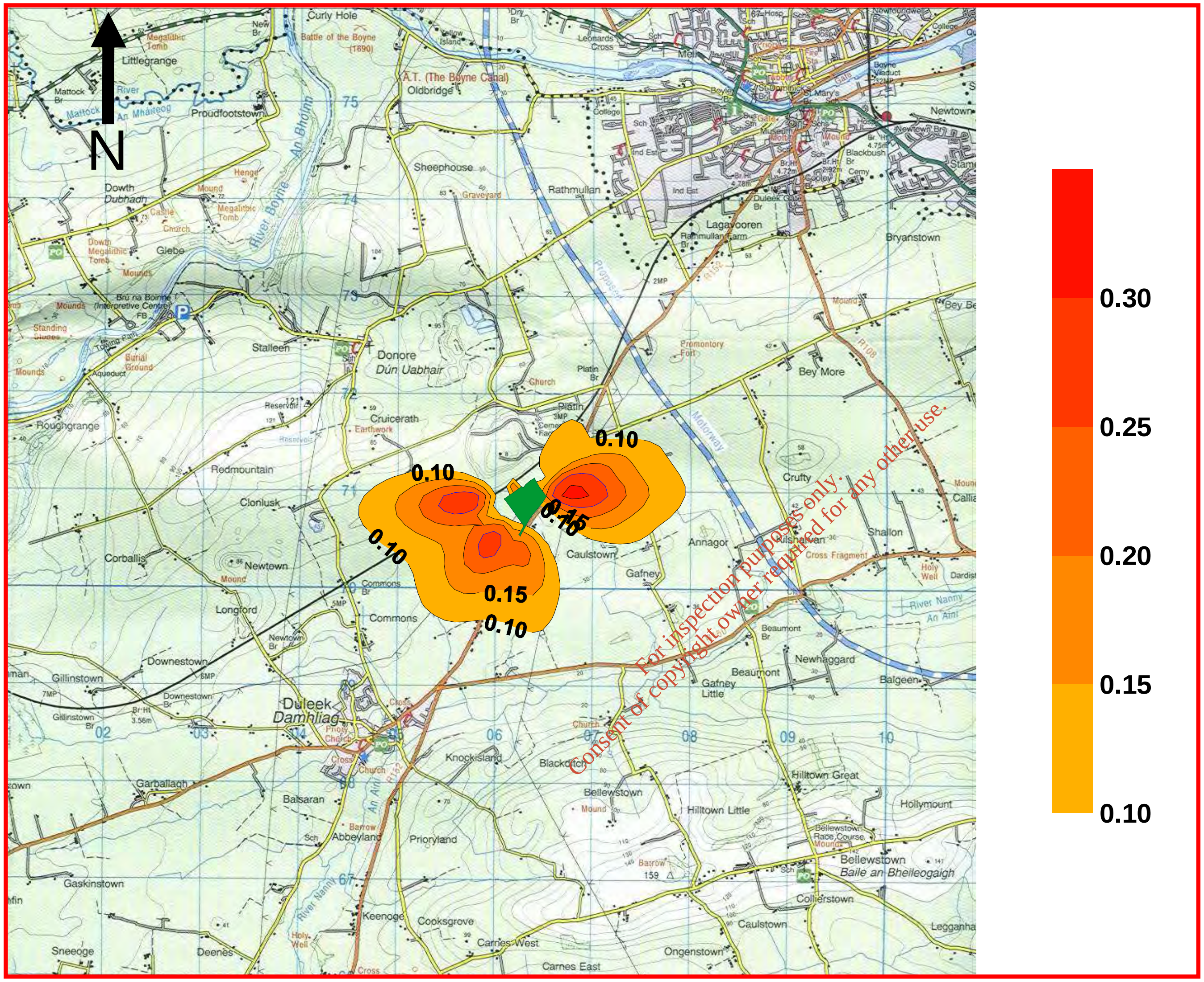

Annual Average Arsenic Deposition Flux
Blue Contour = 0.25 mg/m²/year

Reproduced from Ordnance Survey Ireland
Permit No: EN 7509

Scale 1:70,000 approx

Project

Carranstown Waste Management Facility

Reference

09/4777AR02

Figure 7.29

Predicted Annual Average Arsenic Deposition Flux (mg/m²/year)

awnconsulting

Appendix 7.1-7.5

Air Quality Appendices

APPENDIX 7.1

Description of the AERMOD Model

The AERMOD dispersion model has been recently developed in part by the U.S. Environmental Protection Agency (USEPA)(A1). The model is a steady-state Gaussian model used to assess pollutant concentrations associated with industrial sources. The model is an enhancement on the Industrial Source Complex-Short Term 3 (ISCST3) model which has been widely used for emissions from industrial sources. The 2005 Federal Register Part II (Guidelines on Air Quality Models) has recently approved the replacement of ISCST3 by AERMOD as the preferred model for a refined analysis from industrial sources, in all terrains(A2).

Improvements over the ISCST3 model include the treatment of the vertical distribution of concentration within the plume. ISCST3 assumes a Gaussian distribution in both the horizontal and vertical direction under all weather conditions. AERMOD with PRIME, however, treats the vertical distribution as non-Gaussian under convective (unstable) conditions while maintaining a Gaussian distribution in both the horizontal and vertical direction during stable conditions. This treatment reflects the fact that the plume is skewed upwards under convective conditions due to the greater intensity of turbulence above the plume than below. The result is a more accurate portrayal of actual conditions using the AERMOD model. AERMOD also enhances the turbulence of night-time urban boundary layers thus simulating the influence of the urban heat island.

In contrast to ISCST3, AERMOD is widely applicable in all types of terrain. Differentiation of the simple versus complex terrain is unnecessary with AERMOD. In complex terrain, AERMOD employs the dividing-streamline concept in a simplified simulation of the effects of plume-terrain interactions. In the dividing-streamline concept, flow below this height remains horizontal, and flow above this height tends to rise up and over terrain. Extensive validation studies have found that AERMOD (precursor to AERMOD with PRIME) performs better than ISCST3 for many applications and as well or better than CTDMPLUS for several complex terrain data sets(A3).

Due to the proximity to surrounding buildings, the PRIME (Plume Rise Model Enhancements) building downwash algorithm has been incorporated into the model to determine the influence (wake effects) of these buildings on dispersion in each direction considered. The PRIME algorithm takes into account the position of the stack relative to the building in calculating building downwash. In the absence of the building, the plume from the stack will rise due to momentum and/or buoyancy forces. Wind streamlines act on the plume leads to the bending over of the plume as it disperses. However, due to the presence of the building, wind streamlines are disrupted leading to a lowering of the plume centreline.

When there are multiple buildings, the building tier leading to the largest cavity height is used to determine building downwash. The cavity height calculation is an empirical formula based on building height, the length scale (which is a factor of building height & width) and the cavity length (which is based on building width, length and height). As the direction of the wind will lead to the identification of differing dominant tiers, calculations are carried out in intervals of 10 degrees.

In PRIME, the nature of the wind streamline disruption as it passes over the dominant building tier is a function of the exact dimensions of the building and the angle at which the wind approaches the building. Once the streamline encounters the zone of influence of the building, two forces act on the plume. Firstly, the disruption caused by the building leads to increased turbulence and enhances horizontal and vertical dispersion. Secondly, the streamline descends in the lee of the building due to the reduced pressure and drags the plume (or part of) nearer to the ground, leading to higher ground level concentrations. The model calculates the descent of the plume as a function of the building shape and, using a numerical plume rise model, calculates the change in the plume centreline location with distance downwind.

The immediate zone in the lee of the building is termed the cavity or near wake and is characterised by high intensity turbulence and an area of uniform low pressure. Plume mass captured by the cavity region is re-emitted to the far wake as a ground-level volume source. The volume source is located at the base of the lee wall of the building, but is only evaluated near the end of the near wake and beyond. In this region, the disruption caused by the building downwash gradually fades with distance to ambient values downwind of the building.

AERMOD has made substantial improvements in the area of plume growth rates in comparison to ISCST3(A1). ISCST3 approximates turbulence using six Pasquill-Gifford-Turner Stability Classes and bases the resulting dispersion curves upon surface release experiments. This treatment, however, cannot explicitly account for turbulence in the formulation. AERMOD is based on the more realistic modern planetary boundary layer (PBL) theory which allows turbulence to vary with height. This use of turbulence-based plume growth with height leads to a substantial advancement over the ISCST3 treatment.

Improvements have also been made in relation to mixing height(A1). The treatment of mixing height by ISCST3 is based on a single morning upper air sounding each day. AERMOD, however, calculates mixing height on an hourly basis based on the morning upper air sounding and the surface energy balance, accounting for the solar radiation, cloud cover, reflectivity of the ground and the latent heat due to evaporation from the ground cover. This more advanced formulation provides a more realistic sequence of the diurnal mixing height changes.

AERMOD also contains improved algorithms for dealing with low wind speed (near calm) conditions. As a result, AERMOD can produce model estimates for conditions when the wind speed may be less than 1 m/s, but still greater than the instrument threshold.

The AERMOD model incorporated the following features:

- Three receptor grids were created at which concentrations would be modelled. Receptors were mapped with sufficient resolution to ensure all localised “hot-spots” were identified without adding unduly to processing time. The receptor grids were based on Cartesian grids with the site at the centre. An outer grid extended to 9 km from the site with concentrations calculated at 1000m intervals. A middle grid extended to 5 km from the site with concentrations calculated at 50m intervals. An inner grid extended to 1 km from the site with concentrations calculated at 20m intervals. Boundary receptor locations were also placed along the boundary of the site, at 100m intervals, giving a total of 20,550 calculation points for each model case.

- All on-site and nearby off-site buildings and significant process structures were mapped into the computer to create a three dimensional visualisation of the site and its emission points. Buildings and process structures can influence the passage of airflow over the emission stacks and draw plumes down towards the ground (termed building downwash). The stacks themselves can influence airflow in the same way as buildings by causing low pressure regions behind them (termed stack tip downwash). Both building and stack tip downwash were incorporated into the modelling.

- Hourly-sequenced meteorological information has been used in the model. The worst-case year of meteorological data for each pollutant and averaging period over a five year period (Dublin Airport, 2001-2005) was selected for use in the model.

- Detailed terrain has been mapped into the model. The site is located on relatively flat terrain with gentle changes in terrain in the immediate environs of the site. The surrounding area is characterised by moderate terrain features north and south of the site, at which the terrain rises to 120-160m at a distance of approximately 2-5km. All terrain features have been mapped in detail into the model out to a diameter of 9km with the site at the centre using the terrain pre-processor AERMAP and using digital terrain data provided by Ordnance Survey Ireland.

AERMET PRO

AERMOD incorporates a meteorological pre-processor AERMET PRO(A4). AERMET PRO allows AERMOD to account for changes in the plume behaviour with height. AERMET PRO calculates hourly boundary layer parameters for use by AERMOD, including friction velocity, Monin-Obukhov length, convective velocity scale, convective (CBL) and stable boundary layer (SBL) height and surface heat flux. AERMOD uses this information to calculate concentrations in a manner that accounts for changes in dispersion rate with height, allows for a non-Gaussian plume in convective conditions, and accounts for a dispersion rate that is a continuous function of meteorology.

The AERMET PRO meteorological pre-processor requires the input of surface characteristics, including surface roughness (z_0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. A morning sounding from a representative upper air station, latitude, longitude, time zone, and wind speed threshold are also required.

Two files are produced by AERMET PRO for input to the AERMOD dispersion model. The surface file contains observed and calculated surface variables, one record per hour. The profile file contains the observations made at each level of a meteorological tower, if available, or the one-level observations taken from other representative data, one record level per hour.

From the surface characteristics (i.e. surface roughness, albedo and amount of moisture available (Bowen Ratio)) AERMET PRO calculates several boundary layer parameters that are important in the evolution of the boundary layer, which, in turn, influences the dispersion of pollutants. These parameters include the surface friction velocity, which is a measure of the vertical transport of horizontal momentum; the sensible heat flux, which is the vertical transport of heat to/from the surface; the Monin-Obukhov length which is a stability parameter relating the surface friction velocity to the sensible heat flux; the daytime mixed layer height; the nocturnal surface layer height and the convective velocity scale which combines the daytime mixed layer height and the sensible heat flux. These parameters all depend on the underlying surface.

The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, water, cultivated land etc) and vary with seasons and wind direction. The assessment of appropriate land-use type was carried out to a distance of 10km from the location of the meteorological station in line with USEPA recommendations(A5) for albedo and Bowen ratio with a 1km geometric determination undertaken for the surface roughness. In relation to wind direction, a minimum sector arc of 30 degrees is recommended. In the current model, the surface characteristics of Dublin Airport were assessed and two sectors identified with distinctly varying land use characteristics.

Surface roughness

Surface roughness length is the height above the ground at which the wind speed goes to zero. Surface roughness length is defined by the individual elements on the landscape such as trees and buildings. In order to determine surface roughness length, the USEPA recommends that a representative length be defined for each sector, based on geometric mean of the inverse distance area-weighted land use within the sector, by using the eight land use categories outlined by the USEPA. The area-weighted surface roughness length derived from the land use classification within a radius of 1km from the site is shown in Table A7.1.

Table A7.1 Surface Roughness based on an inverse distance area-weighted average of the land use within a 1km radius of Dublin Airport.

Sector	**Area Weighted Land Use Classification**	**Spring**	**Summer**	**Autumn**	**Winter**[Note 1]
340-100	0% Water, 100% Urban, 0% Grassland	1.000	1.000	1.000	1.000
100-340	0% Water, 0% Urban, 100% Grassland	0.050	0.100	0.010	0.010

Note 1: Winter defined as periods when surfaces covered permanently by snow whereas autumn is defined as periods when freezing conditions are common, deciduous trees are leafless and no snow is present (Iqbal (1983))(A6). Thus for the current location autumn more accurately defines "winter" conditions at the proposed facility.

Albedo

Noon-time Albedo is the fraction of the incoming solar radiation that is reflected from the ground when the sun is directly overhead. Albedo is used in calculating the hourly net heat balance at the surface for calculating hourly values of Monin-Obuklov length. The area-weighted arithmetic mean albedo derived from the land use classification over a 10km x 10km area centred on Dublin Airport is shown in Table A7.2.

Table A7.2 Albedo based on an area-weighted arithmetic mean of the land use over a 10km x 10km area centred on Dublin Airport.

Area Weighted Land Use Classification	**Spring**	**Summer**	**Autumn**	**Winter**[Note 1]
2% Water, 49% Urban, 31% Grassland, 19% Cultivated Land	0.152	0.173	0.185	0.185

Note 1: For the current location autumn more accurately defines "winter" conditions at the proposed facility.

Bowen Ratio

The Bowen ratio is a measure of the amount of moisture at the surface of the earth. The presence of moisture affects the heat balance resulting from evaporative cooling which, in turn, affects the Monin-Obukhov length which is used in the formulation of the boundary layer. The area-weighted geometric mean Bowen ratio derived from the land use classification over a 10km x 10km area centred on Dublin Airport is shown in Table A7.3.

Table A7.3 Bowen Ratio based on an area-weighted geometric mean of the land use over a 10km x 10km area centred on Dublin Airport.

Area Weighted Land Use Classification	**Spring**	**Summer**	**Autumn**	**Winter**[Note 1]
2% Water, 49% Urban, 31% Grassland, 19% Cultivated Land	0.628	1.23	1.36	1.36

Note 1: For the current location autumn more accurately defines "winter" conditions at the proposed facility.

APPENDIX 7.2

Cumulative Impact Assessment

As the region around Carranstown is partly industrialised and thus has several other potentially significant sources of air emissions, a detailed cumulative assessment has been carried out using the methodology outlined by the USEPA. Table 7.3 (see main report) outlined the recommended range of operating conditions to be assessed in the cumulative assessment. Full details are given below of the cumulative assessment carried out for the current study.

The impact of nearby sources should be examined where interactions between the plume of the point source under consideration and those of nearby sources can occur. These include:

a. the area of maximum impact of the point source,
b. the area of maximum impact of nearby sources,
c. the area where all sources combine to cause maximum impact$^{(A2,A7)}$.

The approach taken in the cumulative assessment followed the USEPA recommended Prevention of Significant Deterioration (PSD) Increment approach$^{(A7)}$ as outlined in Section 7.2.

As previously discussed in Section 7.2, the current location would be considered a Class II area and thus the PSD applicable to Class II areas has been applied in the current case. Due to the variations in pollutant averaging times and standards between the USA and the EU, only relative PSD can be derived. The relative PSD, as a percentage of the respective National Ambient Air Quality Standards (NAAQS), is shown in Table 7.4 with the corresponding concentration as it would be applied to the EU ambient air quality standards. In the current context, the PSD increment has been applied to zones where significant overlap occurs between plumes from each of the sources. The PSD increment has not been applied per se, as existing facilities were not designed to this standard.

In the context of the cumulative assessment, all significant sources should be taken into account. The USEPA has defined "significance" in the current context as an impact leading to a 1 µg/m^3 annual increase in the annual average concentration of the applicable criteria pollutant. However, no significance ambient impact levels have been established for non-criteria pollutants (defined as all pollutants except PM_{10}, NO_2, SO_2, CO and lead). The USEPA does not require a full cumulative assessment for a particular pollutant when emissions of that pollutant from a proposed source would not increase ambient levels by more than the significant ambient impact level (annual average of 1 µg/m^3). A similar approach has been applied in the current assessment. A significance criterion of 2% of the ambient air quality standard or guideline has been applied for all non-criteria pollutants. Table A7.4 outlines the significant releases from Indaver Ireland. These releases consist of NO_2, HF, Dioxins, Cd & Tl, and the sum of Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V. As emissions of SO_2, HCl, Total Dust (and PM_{10}), CO, TOC and Hg are not significant, no cumulative assessment need be carried out for these pollutants. However, due to the presence of the proposed Marathon Power facility and the existing Platin Cement facility, a cumulative impact assessment was conducted for SO_2, PM_{10} and $PM_{2.5}$ thus representing a worst-case approach.

The project's impact area is the geographical area for which the required air quality analysis for PSD increments are carried out. The USEPA has defined the "impact area" as a circular area with a radius extending from the source to the most distant point where dispersion modelling predicts a significant ambient impact will occur irrespective of pockets of insignificant impact occurring within it. Within this impact area, all nearby sources should be modelled, where "nearby" is defined as any point source expected to cause a significant concentration gradient in the vicinity of the proposed new source.

In order to determine compliance, the predicted ground level concentration (based on the full impact analysis and existing air quality data) at each model receptor is compared to the applicable ambient air quality limit value or PSD increment. If the predicted pollutant concentration increase over the baseline concentration is below the applicable increment, and the predicted total ground level concentrations are below the ambient air quality standards, then the applicant has successfully demonstrated compliance.

When an air quality standard or PSD increment is predicted to be exceeded at one or more receptor in the impact area, it should be determined whether the net emissions increase from the proposed source will result in a significant ambient impact at the point of each violation, and at the time the violation is predicted to occur. The source will not be considered to cause or contribute to the violation if its own impact is not significant at any violating receptor at the time of each violation.

In relation to nearby sources, several significant sources of releases were identified as outlined in Table A7.5. For each significant nearby source, an assessment was made of which pollutants from each source were significant. Due to the absence of any other significant sources of HF, Cd & Tl and the sum of Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V in the nearby environment, no cumulative assessment need be carried out for these substances. The significant pollutants from each site have been outlined in Table A7.5.

Table A7.4 Assessment of Significant Releases from Indaver Ireland

Pollutant	Significance Criteria ($\mu g/m^3$ annual average)	Indaver Ireland GLC ($\mu g/m^3$ annual average)	Significance
NO_2	1	1.5	√
SO_2	1	0.48	√(2)
PM_{10}	1	0.10	√(2)
$PM_{2.5}$	1(1)	0.10	√(2)
TOC (Benzene)	0.1	0.10	-
HCl	2 (98th%ile of 1-hr)	6.7 (98th%ile of 1-hr)	√
HF	0.006	0.01	√
Dioxins	-	1.0E-9	√
Cd & Tl	0.0001	0.0005	√
Hg	0.002	0.0005	**-**
Sum of metals (Arsenic)	0.0001	0.0005	√

(1) Assumed to equivalent to PM_{10}

(2) Not strictly necessary based on the PSD significance criteria approach but conducted in any case as a worst-case.

Table A7.5 Assessment of Significant Releases From Nearby Sources

Pollutant	Plant 1	Plant 2
NO_2	√	√
SO_2	√	√
PM_{10}	**-**	√
$PM_{2.5}$	**-**	√
HCl	-	-
HF	-	-
Dioxins	-	**-**
Cd & Tl	-	-
Sum of metals	-	-

Plant 1 - Marathon Power

Plant 2 - Platin Cement

The cumulative impact assessment has been carried out to assess the impact of emissions from Indaver Ireland on the surrounding environment. As such, several conservative approximations have been made in regards to the operating details and physical characteristics of the surrounding sources. Furthermore, the guidance for assessing cumulative impacts includes assessing everywhere off-site, including within the site boundary of all nearby sources(A7). Thus, the results outlined in this chapter, in regards to emissions from nearby sources, may apply to areas on-site within each source (and thus will not fall under the domain of ambient legislation) and will also most likely overestimate the impact of these sources in the surrounding environment.

Table A7.6 Assessment of Cumulative Impact of Nitrogen Dioxide Emissions ($\mu g/m^3$)

Pollutant	Plant 1	Plant 2	All Sources Except Indaver	Significance Criteria	All Sources (excl. background)	All Sources (incl. background)	Limit Value(4)
Impact of each source at Indaver Maximum – 99.8th%ile(1)	5.4 (304050, 271950)	18.8 (304050, 271950)	19.5 (304050, 271950)	50(5)	24.0 (304050, 271950)	105.8(3) (304050, 271950)	200
Impact of each source at Indaver Maximum – Annual Average(2)	0.21 (306980, 271060)	0.69 (306980, 271060)	0.90 (306980, 271060)	10(5)	1.7 (306980, 271060)	21.7 (306980, 271060)	40
Indaver Impact At Maximum of Each Source – 99.8th%ile(1)	11.0 (306200, 270540)	8.7 (305740, 271760)	-	50(5)	6.7 (306050, 272750)	101.8(3) (306050, 272750)	200
Indaver Impact At Maximum of Each Source – Annual Average(2)	0.41 (307450, 271350)	0.18 (307650, 272550)	-	10(5)	0.22 (307800, 271800)	20.6 (307800, 271800)	40

(1) Conversion factor, following guidance from USEPA (Tier 3 analysis), based on empirically derived site-specific maximum 1-hour value for NO$_2$ / NO$_X$ of 0.50

(2) Conversion factor following guidance from USEPA (Tier 2 analysis, annual average) based on a default ratio of 0.75 (worst-case).

(3) Background added using UKDEFRA guidance - see Chapter 7, Section 7.4.3.

(4) Directive 2008/50/EC

(5) PSD Class II Increment for Nitrogen Dioxide applicable in the current application (except for the All Sources scenario).

Note: Grid co-ordinates are National Grid co-ordinates and refer to the location of local maximum

Note: Refer to Appendix 7.4 for input information on nearby sources

Table A7.7 Assessment of Cumulative Impact of Sulphur Dioxide Emissions ($\mu g/m^3$)

Pollutant	Plant 1	Plant 2	All Sources Except Indaver	Significance Criteria	All Sources (excl. background)	All Sources (incl. background)	Limit Value
Impact of each source at Indaver Maximum – 99.7th%ile of 1-Hr(1)	15.2 (306520, 271420)	14.2 (306520, 271420)	18.2 (306520, 271420)	88(2)	27.2 (306520, 271420)	35.2(3) (306520, 271420)	350
Indaver Impact At Maximum of Each Source – 99.7th%ile of 1-Hr(1)	10.7 (306180, 270500)	9.0 (305720, 271780)	-	88(2)	4.9 (305850, 272650)	8.9(3) (305850, 272650)	350
Impact of each source at Indaver Maximum – 99.2th%ile of 24-Hr(1)	2.7 (306560, 271500)	1.6 (306560, 271500)	3.0 (306560, 271500)	31.3(2)	10.6 (306560, 271500)	18.6(3) (306560, 271500)	125
Indaver Impact At Maximum of Each Source – 99.2th%ile of 24-Hr(1)	3.9 (306120, 270320)	2.5 (305550, 271300)	-	31.3(2)	2.0 (306860, 270140)	10.0(3) (306860, 270140)	125

(1) Directive 1999/EU/30 – Maximum one-hour concentration not to be exceeded more than 24 times per year (99.7th%ile)

(2) PSD Increment for Sulphur Dioxide applicable in the current application (except for the All Sources scenario).

(3) Background added using UKDEFRA guidance - see Chapter 7, Section 7.4.3.

(4) Limit value not applicable in current location - modelling used as basis for baseline level of SO_2 in Table 7.12.

Note: Grid co-ordinates are National Grid co-ordinates and refer to the location of local maximum

Note: Refer to Appendix 7.4 for input information on nearby sources

Table A7.8 Assessment of Cumulative Impact of PM_{10} Emissions ($\mu g/m^3$)

Pollutant	**Plant 2**	**All Sources Except Indaver**	**Significance Criteria**	**All Sources (excl. background)**	**All Sources (incl. background)**	**Limit Value**(1)
Impact of each source at Indaver Maximum – 90%ile of 24-hr values	3.1 (306980, 270980)	3.1 (306980, 270980)	12.5(2)	3.2 (306980, 270980)	38.5(3) (306980, 270980)	50
Impact of each source at Indaver Maximum – Annual Average	0.98 (306980, 271060)	0.98 (306980, 271060)	10(2)	1.03 (306980, 271060)	21.0 (306980, 271060)	40
Indaver Impact At Maximum of All Sources – 90%ile of 24-hr values	0.13 (306780, 271860)	-	12.5(2)	0.13 (306780, 271860)	37.4(3) (306780, 271860)	50
Indaver Impact At Maximum of All Sources – Annual Average	0.032 (306780, 271860)	-	10(2)	0.033 (306780, 271860)	20.0 (306780, 271860)	40

(1) Directive 2008/50/EC

(2) PSD Class II Increment for PM_{10} applicable in the current application (except for the All Sources scenario).

(3) Background added using UKDEFRA guidance - see Chapter 7, Section 7.4.3.

Note: Grid co-ordinates are National Grid co-ordinates and refer to the location of local maximum

Note: Refer to Appendix 7.4 for input information on nearby sources

Table A7.9 Assessment of Cumulative Impact of $PM_{2.5}$ Emissions ($\mu g/m^3$)

Pollutant	Plant 2	All Sources Except Indaver	Significance Criteria	All Sources (excl. background)	All Sources (incl. background)	Limit Value(1)
Impact of each source at Indaver Maximum – Annual Average	0.98 (306980, 271060)	0.98 (306980, 271060)	6.25(2)	1.03 (306980, 271060)	21.0 (306980, 271060)	25
Indaver Impact At Maximum of All Sources – Annual Average	0.032 (306780, 271860)	-	6.25(2)	0.033 (306780, 271860)	20.0 (306780, 271860)	25

(1) Directive 2008/50/EC

(2) PSD Class II Increment for $PM_{2.5}$ applied in the current application (except for the All Sources scenario).

Note: Grid co-ordinates are National Grid co-ordinates and refer to the location of local maximum

Note: Refer to Appendix 7.4 for input information on nearby sources.

NO_2

The cumulative impact of nitrogen dioxide has been assessed in Table A7.6. Each individual source has been modelled both separately and as part of the cumulative assessment.

The impact of nearby sources has been examined where interactions between the plume of the point source under consideration and those of nearby sources may occur. These locations were:

1) the area of maximum impact of the point source,
2) the area of maximum impact of nearby sources,
3) the area where all sources combine to cause maximum impact(A7).

In the area of the hourly maximum impact of Indaver Ireland (Grid Co-ordinate 304050, 271950), the impact from each source was minor. In relation to the 99.8th%ile of maximum one-hour concentrations, the cumulative impact (excluding background) at this point was 10% of the limit value in the absence of Indaver Ireland. However, in the presence of Indaver Ireland, the assessment indicated that the cumulative impact (excluding background) was 12% of the limit value at this point.

The annual average cumulative assessment was likewise minor at the area of the maximum impact of Indaver Ireland (Grid Co-ordinate 306980, 271060). The overall impact leads to an increase of 2.2% in the annual average levels leading to a cumulative level of 4% of the limit value (not including background concentration).

In the area of the maximum impact of each nearby source, the impact from Indaver Ireland was very small. In relation to the 99.8th%ile of maximum one-hour concentrations, the impact of Indaver Ireland at the point of maximum impact of each nearby source was always less than 6% of the limit value. Moreover, the maximum one-hour impact of Indaver Ireland at each nearby source was separated in time and thus did not lead to any significant increase in levels above the impact of each individual source separately.

The annual average cumulative assessment was likewise minor at the area of the maximum impact of each individual source. The overall impact leads to an increase of 1% in the annual average level of the worst-case nearby source. Indeed, in the region where all sources combine to cause the maximum impact, an examination of the impact of Indaver Ireland reveals an insignificant impact of the order of 0.5% of the limit value.

SO_2

The cumulative impact of sulphur dioxide has been assessed in Table A7.7. Each individual source has been modelled both separately and as part of the cumulative assessment.

In the area of the hourly maximum impact of Indaver Ireland (Grid Co-ordinate 306520, 271420), the impact from the other main sources was minor. In relation to the 99.7th%ile of maximum one-hour concentrations, the cumulative impact at this point was 5% of the limit value in the absence of Indaver Ireland. In the presence of Indaver Ireland, the assessment indicated that the cumulative impact was 8% of the limit value at this point (excluding background concentration). This is equivalent to the predicted concentration resulting from Indaver alone which indicates that the contribution of the main nearby source was separated in time and thus did not lead to any significant increase in levels above the impact of Indaver Ireland alone.

In the area of the daily maximum impact of Indaver Ireland (Grid Co-ordinate 306560, 271500), the impact from the other main sources was minor. In relation to the 99.2th%ile of maximum daily concentrations, the cumulative impact at this point was 2% of the limit value in the absence of Indaver Ireland. In the presence of Indaver Ireland, the assessment indicated that the cumulative impact was 8% of the limit value at this point (excluding background concentration).

In the area of the maximum impact of each nearby source, the impact from Indaver Ireland was very small. In relation to the 99.7th%ile of maximum one-hour concentrations, the impact of Indaver Ireland at the point of maximum impact of each nearby source was always less than 3% of the limit value. Moreover, the maximum one-hour impact of Indaver Ireland at the main nearby source was separated in time and thus did not lead to any significant increase in levels above the impact of each individual source separately.

In relation to the 99.2th%ile of maximum daily concentrations, the impact of Indaver Ireland at the point of maximum impact of each nearby source was always less than 3% of the limit value.

PM$_{10}$

The cumulative impact of PM$_{10}$ has been assessed in Table A7.8. Each individual source has been modelled both separately and as part of the cumulative assessment.

In the area of the daily maximum impact of Indaver Ireland (Grid Co-ordinate 306980, 270980), the impact from the other main source was minor. In relation to the 90th%ile of maximum 24-hour concentrations, the cumulative impact at this point was 6.1% of the limit value in the absence of Indaver Ireland. In the presence of Indaver Ireland, the assessment indicated that the cumulative impact was 6.5% of the limit value at this point.

The annual average cumulative assessment was likewise minor at the area of the maximum impact of Indaver Ireland (Grid Co-ordinate 306980, 271060). The overall impact leads to an increase of 2.5% in the annual average levels leading to a cumulative level of 2.6% of the limit value.

In the area of the maximum impact of the main nearby source (Grid Co-ordinate 306780, 271860), the impact from Indaver Ireland was very small. In relation to the 90th%ile of maximum 24-hour concentrations, the impact of Indaver Ireland at the point of maximum impact of the main nearby source was only 0.3% of the limit value.

The annual average cumulative assessment was likewise minor at the area of the maximum impact of the main nearby source (Grid Co-ordinate 306780, 271860). The overall impact leads to an increase of 0.1% in the annual average level of the worst-case nearby source.

$PM_{2.5}$

The cumulative impact of $PM_{2.5}$ has been assessed in Table A7.9. Each individual source has been modelled both separately and as part of the cumulative assessment.

In the area of the maximum impact of Indaver Ireland (Grid Co-ordinate 306980, 271060), the impact from the other main source was minor. In relation to the annual average, the cumulative impact at this point was 3.9% of the limit value in the absence of Indaver Ireland. However, in the presence of Indaver Ireland, the assessment indicated that the cumulative impact was only 4.1% of the limit value at this point.

In the area of the maximum impact of the main nearby source (Grid Co-ordinate 306780, 271860), the impact from Indaver Ireland was very small. In relation to the annual average, the impact of Indaver Ireland at the point of maximum impact of the main nearby source was 0.1% of the limit value.

APPENDIX 7.3

AIR QUALITY IMPACT FROM BACK-UP GENERATOR

The back-up generator is expected to run only when both the national grid and the Carranstown incinerator are down. A monthly "test run" of the back-up generator will be carried out for one hour per month. Therefore, the back-up generator is expected to run at most for 12 hours per year. Emissions of NO_X, SO_2 and HCl from the back-up generator are detailed in Table A7.11. Annual emissions from the back-up generator are negligible compared to those from the incinerator. In particular, annual emissions of NO_X from the back-up generator are only 0.007% of the incinerator NO_X emissions.

As a worst-case, modelling has been conducted based on the operation of the back-up generator one hour per week for the full year (52 hours per year compared to the more likely 12 hours per year). Ambient results are outlined in Table A7.12 and indicate that all impacts are less than 1% of the ambient limit values.

Table A7.11 Air Emission Values From Back-Up Generator

Daily Average Values	**Back-up Generator**	
	Emission Rate (g/s)	**Emission Rate (tonnes/annum)(1)**
Nitrogen Oxides (as NO_2)	0.366	0.016
Sulphur Dioxide	0.44	0.002
HCl	0.004	0.0002

(1) Tonnes per annum for back-up generator calculated based on operating conditions of 12 hours/annum.

Table A7.12 Dispersion Model Results – Back-Up Generator

Pollutant / Scenario	Annual Mean Background (μμg/m^3)(1)	Averaging Period	Process Contribution (μg/m^3)	Predicted Emission Concentration (μg/Nm^3)	Standard (μg/Nm^3)	Indaver emissions as a % of ambient limit value
NO$_2$ / Back-Up Generator	20	Annual Mean(3)	0.03	20.03	40(2)	0.1%
		99.8th%ile of 1-hr means(4)	1.5	101.2(5)	200(2)	0.8%
SO$_2$ / Back-Up Generator	4	99.7th%ile of 1-hr means	1.8	6.3(5)	350(2)	0.5%
		99.2th%ile of 24-hr means	2.6	9.1(5)	125(2)	0.3%
HCl/ Back-Up Generator	0.01	98th%ile of 1-hr means	1.0(6)	1.01	100(7)	1%

(1) Includes contribution from traffic and background sources (based on results from diffusion tubes) and incorporating the cumulative assessment results.

(2) Directive 2008/50/EC

(3) Conversion factor following guidance from USEPA (Tier 2 analysis, annual average) based on the default ratio of 0.75 (worst-case).

(4) Conversion factor, following guidance from USEPA (Tier 3 analysis), based on empirically derived site-specific maximum 1-hour value for NO$_2$ / NO$_X$ of 0.5

(5) Background added using UKDEFRA guidance - see Chapter 7, Section 7.4.3.

(6) Maximum value reported as 98th%ile is zero.

(7) TA Luft (2002).

APPENDIX 7.4

AIR QUALITY IMPACT FROM TRAFFIC SOURCES

The impact of the operational traffic accessing the site has been assessed using the UK DMRB Screening Model. The worst-case operational impact in the region of the site has been assessed and is outlined in Table A7.13. Peak contributions to ambient air quality concentration tend not to overlap between traffic sources and industrial releases both temporally and spatially as these peak contributions from each source often occur under different weather conditions. However, for the purposes of this assessment, the maximum ambient levels due to traffic sources and process emissions have been combined to derive the worst-case cumulative impact from the site. The results indicate that the cumulative impact from operational traffic and process emissions at the worst-case roadside location leads to an increase in ambient levels (compared to baseline traffic and process levels) of up to 3% of the ambient limit values.

TABLE A7.13 Summary Of Predicted Traffic Derived Pollutant Levels At Worst-Case Receptors Located Near The Proposed Facility.

Scenarios	**Traffic Speed**	**Carbon Monoxide (mg/m^3)**		**Benzene (µg/m^3)**		**Nitrogen Dioxide (µg/m^3)**			**Particulates (PM$_{10}$) (µg/m^3)**	
	(km/hr)	**Annual Mean**	**Maximum 8-hour**	**Annual mean benzene**	**Rolling annual mean benzene**	**Annual average NO$_x$**	**Annual average NO$_2$**	**Maximum 1-Hour NO$_2$**	**Annual average**	**No of Days > 50 µg/m^3**
2012 No change	80	0.04	0.4	0.04	0.05	25.7	7.9	39.5	2.1	0
2012 With Development	80	0.04	0.4	0.04	0.05	29.7	8.8	44.0	2.4	0
2012 Difference	80	<0.01	<0.1	<0.01	<0.01	4.0	0.9	4.5	0.3	0
Standards			$10^{(1)}$		$5^{(1)}$	-	$40^{(2)}$	$200^{(2,3)}$	40^{2}	$35^{(2,4)}$

(1) EU Council Directive 2000/69/EC (S.I. 271 of 2002)

(2) EU Council Directive 2008/50/EC (S.I. 271 of 2002)

(3) 1-hr limit of 200 µg/m^3 not to be exceeded > 18 times/year (99.8th %ile)

(4) 24-Hr limit of 50 µg/m^3 not to be exceeded > 35 times/year (90.1th %ile)

APPENDIX 7.5

Summary of Source Emission Data

Plant 1 Marathon Power

Plant 2 Platin Cement

Table A7.14: Source Emission Data for Emissions of Indaver Ireland

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temperature (K)	Max Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)	Concentration (mg/Nm^3)	Mass Emission (g/s)
Stack - Maximum Operation	65	2.2	3.80	413	147000	15.0	NO_2 – 200 SO_2 – 50 PM_{10} – 10 CO – 100 TOC – 10 HCl – 10 HF – 1.0 Dioxins – 0.1 ng/m^3 Cd & Tl – 0.05 Hg – 0.05 Sum of Metals – 0.5	NO_2 – 7.44 SO_2 – 1.86 PM_{10} – 0.37 CO – 3.72 TOC – 0.37 HCl – 0.37 HF – 0.037 Dioxins – 3.7E-9 Cd & Tl – 0.0019 Hg – 0.0019 Sum of Metals – 0.019

Stack - Maximum Operation	65	2.2	3.80	413	147000	16.4	NO_2 – 200 SO_2 – 50 PM_{10} – 10 CO – 100 TOC – 10 HCl – 10 HF – 1.0 Dioxins – 0.1 ng/m^3 Cd & Tl – 0.05 Hg – 0.05 Sum of Metals – 0.5	NO_2 – 8.17 SO_2 – 2.04 PM_{10} – 0.41 CO – 4.1 TOC – 0.41 HCl – 0.41 HF – 0.041 Dioxins – 4.1E-9 Cd & Tl – 0.0020 Hg – 0.0020 Sum of Metals – 0.020
Stack - Abnormal Operation	65	2.2	3.80	413	147000	16.4	NO_2 – 400 SO_2 – 200 PM_{10} – 30.0 CO – 200 TOC – 30.0 HCl – 60.0 HF – 4.0 Dioxins – 0.5 ng/m^3 Cd & Tl – 1.0 Hg – 1.0 Sum of Metals – 30.0	NO_2 – 16.3 SO_2 – 8.2 PM_{10} – 1.2 CO – 8.2 TOC – 1.2 HCl – 2.45 HF – 0.16 Dioxins – 2.0E-8 Cd & Tl – 0.041 Hg – 0.041 Sum of Metals – 1.23
Back-Up Generator	3	0.25	0.049	423	3656	20.7	NO_2 – 360 SO_2 – 44 HCl – 4	NO_2 – 0.366 SO_2 – 0.045 HCl – 0.0041

Table A7.15: Source Emission Data For Emissions of Plant 1(1)

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temperature (K)	Max Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)	Concentration (mg/Nm^3)	Mass Emission (g/s)
Stack	49.9	7.0	38.5	369	1810800	17.7	NO_2 – 120 SO_2 - 140	60.4 70.4

(1) Taken from IPC Licence Application for the site.

Table A7.16: Source Emission Data For Emissions of Plant 2(1)

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temperature (K)	Max Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)	Concentration (mg/Nm^3)	Mass Emission (g/s)
Kiln 2	103	3.7	10.8	394	400000	16.6	NO_x – 800 SO_2 - 750 PM_{10} – 50 $PM_{2.5}$ – 50	NO_x – 88.9 SO_2 - 83.3 PM_{10} – 5.6 $PM_{2.5}$ – 5.6
Kiln 3	123	3.8	11.0	381	410000	19.4	NO_x – 800 SO_2 - 400 PM_{10} – 30 $PM_{2.5}$ – 30	NO_x – 91.1 SO_2 - 45.6 PM_{10} – 3.4 $PM_{2.5}$ – 3.4
K2 Grate Cooler	30.4	3.6	9.9	523	210000	11.3	PM_{10} – 50 $PM_{2.5}$ – 50	PM_{10} – 6.1 $PM_{2.5}$ – 6.1
K3 Grate Cooler	35.0	3.0	7.1	590	219000	18.6	PM_{10} – 30 $PM_{2.5}$ – 30	PM_{10} – 1.8 $PM_{2.5}$ – 1.8
Coal Mill 2	48.1	1.0	0.79	354	31000	18.9	PM_{10} – 50 $PM_{2.5}$ – 50	PM_{10} – 0.43 $PM_{2.5}$ – 0.43
CM1 EF	28.6	0.71	0.40	374	18500	18.1	PM_{10} – 75 $PM_{2.5}$ – 75	PM_{10} – 0.39 $PM_{2.5}$ – 0.39
CM2 BF	34.8	1.9	2.9	358	120000	15.4	PM_{10} – 50 $PM_{2.5}$ – 50	PM_{10} – 1.7 $PM_{2.5}$ – 1.7
CM3 BF	26.4	2.0	3.1	381	135000	19.4	PM_{10} – 50 $PM_{2.5}$ – 50	PM_{10} – 1.9 $PM_{2.5}$ – 1.9
CM4 BF	39.0	2.0	3.1	378	110000	13.5	PM_{10} – 30 $PM_{2.5}$ – 30	PM_{10} – 0.92 $PM_{2.5}$ – 0.92

(1) Taken from EIS for the site (2005) IPPC Licence Application Update (2007), and also IPC Licence No.268.

(2) Concentrations and mass emissions based on EIS which refers to PM_{10}. As a worst case, all particulates are assumed to be in the form of $PM_{2.5}$ for the present assessment.

References

(A1) USEPA (2005) AERMOD - Description of Model Formulation

(A2) USEPA (2005) Guidelines on Air Quality Models, Appendix W to Part 51, 40 CFR Ch.1

(A3) USEPA (1999) Comparison of Regulatory Design Concentrations: AERMOD vs. ISCST3 vs. CTDM PLUS

(A4) USEPA (1998) User’s Guide to the AERMOD Meteorological Preprocessor (AERMET)

(A5) USEPA (2008) AERMOD Implementation Guide

(A6) Auer Jr, (1978) Correlation of Land Use and Cover with Meteorological Anomalies, *Journal of Applied Meteorology* 17(5):636-643

(A7) USEPA (1989) Prevention of Significant Deterioration