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SECTION 6 – HUMAN BEINGS

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6 HUMAN BEINGS

6.1 INTRODUCTION

In accordance with the EPA ‘Advice Notes on Current Practice (in the preparation of an 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

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 Indaver Ireland 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 ‘Central Statistics Office, ‘Census of Population 2002, Small Area Population Statistics’. The DED of Duleek includes 15 townsland areas including:

- Carranstown*
- Abbeyland
- Caulstown*
- Commons*
- Cruicerath*
- Downestown
- Drumman
- Gillinstown
- Longford*
- Lougher
- Newtown*
- Prioryland
- Reask
- Roughgrange
- Stalleen*

The proposed development is located in the townsland 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.

Ongoing housing development is also occurring at various locations within the study area most notably in the village of Donore and Duleek town. A complete housing survey has been conducted in the vicinity (3Km radius) of the proposed development and is illustrated in Figure 6.1.

Cognisence of the facilities in the villages of Duleek and Donore are also referenced as the proposed 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. The closest residential dwellings to the site are;

- One dwelling 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 include two farm houses about 400 metres to the west of the site across the railway line.

CSO information for 1996 and 2002 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, 1996 and 2002

	1996	2002	Increase/ Decrease
Persons in private households (Duleek DED)	2434	2922	+488
Number of households (Duleek DED)	685	941	+256

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 1996 and 2002. This decrease in household occupancy is reflected throughout the country although the decrease in the study area is greater than the national average. Household size, however, is still larger in the study area and County Meath than the national average.

Table 6.2 Households Sizes on National, County and DED Level, 1996 and 2002

	1996 (Units/people per household)	2002 (Units/people per household)	% Increase/Decrease
State	3.14	2.94	- 0.2 %
County Meath	3.41	3.2	- 0.21%
Duleek DED	3.55	3.1	- 0.45%

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 Proposed development area 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 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 proposed 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 proposed 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 proposed development. 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 and an area of 490 square meters has been allocated for commercial space including crèche and car parking facilities. There are 35 commercial units in the centre of Duleek village. These include five convenience stores, one comparison outlet and service businesses. The service units include hairdressers, betting offices, pubs, restaurants, post office and credit union. Nine additional retail units are being developed within the village centre to the east of the Main Street.

A new commercial park is the in process of being built to the east outskirts of Duleek village. This park has the capacity of up to 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 provide an ability to review recent trends in population within the Study Area over a six year period i.e. from 1996 to 2002 as illustrated in Table 6.4. During this period the population in the study area increased by 20.8%. This is consistent with growth at county level at 22.1% and well above the national growth rates of 8 %. The 2002 census figures revealed that the population of Duleek expanded by 25.5% to 2173 between 1996 and 2002. In contrast the population of Carranstown townsland has decreased in recent years from 116 (1996) to 107 in the 2002 census.

Table 6.4 1996 and 2002 Population of the Study Area

	1996	2002	% Increase
State	3,626,087	3,917,203	8.0
County Meath	109,732	134,005	22.1
Duleek DED	2434	2941	20.8

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 dramatic increase in overall population with notable increases across all age groups. A slight decrease in the overall population % was noted amongst the 0-24 range. This was also evident in the 45-65 and 65+ age brackets. The most significant increase is noticed among the 25-44 age groups which have increased from 25.8% to 32.33%.

Table 6.5 Demographic Profile within the Study Area

	1996		2002	
	Actual	**%**	**Actual**	**%**
0 - 14	584	23.99	651	22.13
15 - 24	501	20.58	512	17.40
25 - 44	628	25.80	951	32.33
45 - 64	512	21.03	603	20.50
65+	209	8.58	224	7.61
Total	2434	100.0	2941	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 3.58%, which is a decrease on the 1996 statistics of 10.27%.

Upon evaluation of the principal employment profiles as illustrated in Table 6.7, it is evident that employment rates in agriculture are decreasing while employment rates in building and construction and commerce are increasing.

Table 6.6 Employment Figures

	Persons aged 15+		At Work		Unemployed		Labourforce		Participation Rate		Unemployment Rate of Workforce	
	1996	**2002**	**1996**	**2002**	**1996**	**2002**	**1996**	**2002**	**1996**	**2002**	**1996**	**2002**
DED	1850	2290	844	1277	190	82	859	1413	45.62%	55.76%	10.27%	3.58%

Table 6.7 Distribution of Employment Sectors within the Study Area

	DED	
	1996	**2002**
Agriculture	11.84	5.71
Manufacturing/ Industry	28.31	21.45
Building/ Construction	12.79	18.48
Commerce	16.58	20.83
Transport	5.8	6.73
Public Admin	2.7	4.15
Prof. Services	12.32	9.47
Other	8.4	13.16
Totals	100	100

6.2 HEALTH AND SAFETY

6.2.1 Human Health Introduction

Dr. Martin Hogan AFOM, FFOMI, is a Medical Doctor specializing in Occupational Medicine. He is a full time consultant occupational & environmental physician and Director of Employment Health Advisers Ltd (EHA). EHA were asked to assess the potential effect on human health of the proposed Municipal Waste Incinerator at Carranstown Co Meath. The outcome of this study is discussed below.

In assessing this EHA relied on their own knowledge and experience, evidence available in the 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. EHA also relied on the information contained elsewhere in the EIS for the proposed site performed for Indaver by White Young Green. In making the assessment EHA have 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 Background

The introduction of waste incinerators has resulted in numerous studies of the effects of this process on human health. This has been carried out in either the occupational or community setting. Most of the published studies have looked at incinerators whose emissions of dioxins, particulates and heavy metal were far greater than would be emitted by a modern incinerator such as that proposed for Carranstown. Basic scientific principles indicate that the more controlled the emissions are, the less potential for any health effects. Therefore the studies that are available in many ways show a “worst case” scenario for modern incinerators but are nevertheless valuable in making an assessment of the possible human health effects.

The health outcomes that have been examined in the various published studies include respiratory symptoms and illness, reproductive effects and the development of cancer. In addition to studies of the possible consequences of non-specific exposure to emissions from waste incinerators, research has also been conducted to determine the presence or effects of exposure to certain substances known to be present in incinerator emissions.

6.2.3 HRB Report

In Ireland in 2003 the publication by the Health Research Board on *Health and Environmental Effects of Landfilling and Incineration of Waste* was issued. (An Executive Summary of the HRB's report is included in Appendix 6.1.) This was commissioned to review existing data on Waste management methods. It presented the available data and did not propose the "best" solution. Regarding the human health effects of incineration it stated:-

"*There is some evidence that incinerator emissions may be associated with respiratory morbidity. Acute and chronic respiratory symptoms are associated with incinerator emissions.*

A number of well-designed studies have reported associations between developing certain cancers and living close to incinerator sites. Specific cancers identified include primary liver cancer, laryngeal cancer, soft-tissue sarcoma and lung cancer. It is hard to separate the influences of other sources of pollutants, and other causes of cancer and, as a result, the evidence for a link between cancer and proximity to an incinerator is not conclusive.

Further research, using reliable estimates of exposure, over long periods of time, is required to determine whether living near landfill sites or incinerators increases the risk of developing cancer.
Studies of specific environmental agents and specific cancers may prove more definitive in the future."

The current status of this statement and its implications for facilities such as Carranstown will be explored in more detail in this assessment.

In its 2003 report the HRB stated:

"*Ireland presently has insufficient resources to carry out adequate risk assessment for proposed waste management facilities"*

The statement is quoted by objectors to all types of facilities.

Whilst it is true that the relevant Irish research facilities were underdeveloped this statement was in my opinion a plea to develop them rather than a statement that we should not proceed with necessary waste management.

It is obvious that we are not totally self reliant in this matter. Comprehensive risk assessments of waste management systems have been made in other countries where they do have the resources. In Europe the UK and Germany are good examples. We can extrapolate many of these findings and information to an Irish setting.

To put another way whilst we still may not have the facility to make a risk assessment from scratch on any waste management facility we do not have to because others have done much of the work and we have only to include local factors to make a reliable assessment and we do have the resources to do that.

In addition there has been considerable progress in developing these resources even since 2003.

In 2001 the Department of Health and Children published a Health Strategy for Ireland titled “Quality and Fairness: A Health System for You”.

This strategy document contained a number of goals and objectives among them;

National Goal No. 1: Better health for everyone, Objective 1: The health of the population is at the centre of public policy;

This objective stated that….”*Health impact assessment will be introduced as part of the public policy development process”*

In Ireland the Institute of Public Health has been given responsibility for building up Ireland’s capacity to conduct Health Impact Assessment (HIA) skills.

The institute has been very active in this regard. In June 2003 the Institute of Public Health published a document” Health Impact Assessment (HIA) a practical Guide”. In effect most of the elements of a HIA are contained in an EIS particularly if that EIS contains a comprehensive human health section. There is currently no legal requirement to perform a stand alone HIA for a facility such as an incinerator. As a result no statutory body or other appropriate body is responsible for the assessment of a Health Impact Statement.

The Strategy also states that: “An independent Health Information and Quality Authority (HIQA) will be established. HIQA was established in January 2005.

The key areas of responsibility for HIQA are:-

- Developing health information systems
- Promoting and implementing structured programmes of quality assurance
- Overseeing accreditation
- Developing health technology assessment and
- Reviewing and reporting on selected services

It will ensure the availability of a central database to provide information on the occurrences of major diseases such as cancer, cardiovascular disease etc. It has subsumed, for example, the National Cancer Registry (NCR).

Another recent increase in resources has been the establishment of INIsPHO. The Ireland and Northern Ireland's Population Health Observatory (INIsPHO) is housed in the Institute of Public Health in Ireland.

The Observatory supports those working to improve health and reduce health inequalities by producing and disseminating health intelligence, and strengthening the research and information infrastructure on the island of Ireland. It works closely with others involved in the production of health intelligence and its translation into evidence-based policy and practice. INIsPHO is part of a network of health observatories that includes the Association of Public Health Observatories (APHO).

INIsPHO makes a unique contribution by:

- maximising awareness,
- access and use of existing information;
- bringing together information - of different types and on different topics - in innovative ways to give a more comprehensive understanding of public health issues;
- working collaboratively with others to produce, disseminate and use health intelligence;
- supporting local and regional needs within an appropriate national and international context;
- helping to translate intelligence into evidence-based policy and practice;
- advocating and supporting the co-ordinated development of health research and information; and
- placing inequalities at the heart of their work.

In 2003 the HRB also stated:-

> "*Irish health information systems cannot support routine monitoring of the health of people living near waste sites"*

This statement must be taken in context. Obviously the establishment of HIQA and the Observatory has gone some distance to filling this perceived gap in service but the first question should not be whether we have the capacity to support routine monitoring of the health of people living near waste sites but rather "Do we need to monitor the health of theses people and if so how?"

In effect it is far more valuable to monitor "exposure". This is far more sensitive to potential changes in the environment and gives results before human effects allowing for prevention.

We know of no reliable or valuable form of routine monitoring of health and would not suggest it needs to be done around Carranstown for example. I would however strongly support exposure monitoring in the form of emissions, air, soils and food sampling.

This point is further emphasised by the following quote from the 2004 UK Government report:

"-the published epidemiological studies of the health of communities living in the vicinity of incinerators have failed to establish any convincing links between incinerator emissions and adverse effects on public health; specifically no impact was demonstrated on the incidence of cancer, respiratory health symptoms or reproductive outcomes. Consequently, the epidemiology specific to incinerators gives no basis for developing quantitative health impact functions and no attempt is made to use it in this way.

A more fruitful approach is to examine the specific substances known to be discharged from an incinerator to model resultant environmental concentrations and to use exposure-response coefficients relating to those specific substances to estimate the magnitude of adverse health outcomes. "

The HRB in its report identifies the need for further baseline studies and monitoring programmes to be put in place. There is however on going monitoring on a National level. A summary of air, soil and food measurements of dioxins and furnas in Ireland is presented below.

Air Measurements of PCDD/F in Ireland

Monitoring of PCDD/F in ambient air has been carried out frequently over the last five years. Monitoring has been carried out in both urban and rural locations over varying periods (typically between three to eight weeks). Table 6.8 shows the range of concentrations measured in ambient air in Ireland over this period.

Table 6.8 I-TEQ values derived from measurements of airborne PCDD/F in various locations in Ireland.

Location	Site Type	Duration	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, Co. Cork (2001)(3)	Industrial	8 weeks	Lower Limit – 4.0(6) Upper Limit – 16.4(7)
Carranstown, Co. Meath (2001)(4)	Rural	3 weeks	Lower Limit – 28(6) Upper Limit – 46(7)
Confidential, Co. Meath (2001)	Rural	4 weeks	Lower Limit – 13(6) Upper Limit – 16(7)
Pfizer Loughbeg, Co. Cork (2003)(5)	Industrial	4 weeks	Lower Limit – 16(6) Upper Limit – 17(7)
Poolbeg Baseline Monitoring (2003)	Urban	8 weeks	Lower Limit – 93.1(6) Upper Limit – 93.8(7)

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

(5) Taken from Chapter 9 of Pfizer Loughbeg Liquid Waste Incinerator Facility EIS, (2003)

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

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

Soil Measurements of PCDD/F In Ireland

Monitoring of PCDD/F in soil has been carried out on many occasions over the last 15 years. Monitoring has been carried out in both urban and rural locations. Table 6.9 shows the range of concentrations measured in soil in Ireland over this period.

Table 6.9 I-TEQ values derived from measurements of soil PCDD/F in various locations in Ireland.

Location	Site Type	I-TEQ (NATO CCMS) (ng/kg)
Carranstown (2006)(8)	Rural	<0.5 – 3.5
Ringaskiddy, Co. Cork (2001)(9)	Industrial	<0.5 – 3.4
Courtlough, Co. Dublin (2001)(10)	Rural	<0.5 – 1.2
Confidential, Co. Meath (2002) (11)	Rural	<0.5 – 1.2
Poolbeg Baseline Monitoring (2003) [12]	Urban	0.54 - 10
Haulbowline Naval Base (2000) (13)	Industrial	1.6 – 28
Cork Harbour (2000) (14)	Urban/Rural/Industrial	0.6 – 1
Cork Harbour(1990) (15)	Industrial	21.6 – 23.7
Cork Harbour (1994) (16)	Industrial	2.95
Farms around Askeaton, Limerick (2001)	Rural	0.6 – 1.5

(8) Taken from AWN Survey)

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

(10) Taken from Soil Chapter of Waste Management Facility, Eco/ The Waste Company, Herhoff Process EIS, Courtlough, Co Dublin, Baseline Dioxin Survey (2001)

(11) Survey for proposed Incinerator site at Nobber, Co Meath b AWN Consulting Ltd, 2002

(12) Survey for proposed incinerator site at Poolbeg, Dublin, 2003

(13) EPA Survey 2000

(14) EPA Survey 2000

(15) EOLAS Soil Monitoring, submitted as Appendix II Attachment No. 12 Sandoz Ringaskiddy Ltd Baseline Studies 1991/1992.

(16) Cork Dioxin Surveys, Cork County Council, Environmental Section, Annual Report, 1994.

(17) Investigation of animal health problems, at Askeaton, Co. Limerick, 2001

Food Measurements of PCDD/F in Ireland

Monitoring of PCDD/F in food has been carried out on many occasions over the last 10 years. Table 6.10 shows the range of concentrations measured in food in Ireland over this period.

Table 6.10 I-TEQ values derived from measurements of food PCDD/F in various locations in Ireland.

Location	Site Type	I-TEQ (NATO CCMS) (ng/kg) unless otherwise stated
Milk Surveys (1995)[18]	Rural	0.005 – 0.018
Milk Surveys (2000) [19]	Rural	0.0028 – 0.0124
Milk Surveys (2004) [20]	Rural	0.0053 – 0.038
Dioxins in Fish Samples (2003) (21)	Rural	0.32
90 Cheese Samples (1998/1999) (22)	Rural	0.1 – 1.2 pg/g fat
15 Meat Samples (2001) [23]	Rural	< 5 pg/g fat

(18) Dioxins in the Irish Environment, 1995, EPA, 1996

(19) Dioxins in the Irish Environment, 2000, EPA, 2001

(20) Dioxins in the Irish Environment, 2004, EPA, 2005

(21) FSAI Discussion Paper, Waste Incineration and Possible Contamination of the Food Supply, 2003

(22) Teagasc, Food Residue Database, November, 2001

(23) Teagasc, Food Residue Database, November, 2001

6.2.4 Irish Government Position

The Department of the Environment, Heritage and Local Government in its website Race against Waste states:

"Properly managed and monitored Municipal Waste Incinerators do not impact on the environment, health or food quality.

This is because incineration of waste is strictly controlled and the gases emitted are cleaned and scrubbed to ensure that any emissions are extremely low. However, incinerators do emit a broad spectrum of chemicals to the environment – albeit in extremely small quantities. Many opponents of incineration argue that because incinerators emit these chemicals they should not be built. However, the reality is that chemicals like dioxins already exist in our environment and come from very familiar sources like smoking, traffic, illegal burning of waste – even home heating systems. What determines whether they do us harm is the amount or DOSE we are exposed to; for example, common chemicals like salt can be toxic to the human body if taken in large enough quantities.

Even if we incinerated 1 million tonnes of municipal waste in Ireland, this would contribute less than 2% of the dioxins emitted to air (EPA, 2001). Most dioxins will continue to come from uncontrolled burning of waste in back gardens, bonfires and accidental fires."

6.2.5 World Health Organisation (W.H.O)

The World Health Organisation is the United Nations specialised agency for health. It was established on 7 April 1948. WHO's objective, as set out in its Constitution, is the attainment by all peoples of the highest possible level of health. Health is defined in WHO's Constitution as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

WHO is governed by 192 Member States through the World Health Assembly. The Health Assembly is composed of representatives from WHO's Member States. The main tasks of the World Health Assembly are to approve the WHO programme and the budget for the following biennium and to decide major policy questions.

In a statement on incineration it said:

"The incineration of waste is an hygienic method of reducing its volume and weight which also reduces its potential to pollute. Not all wastes are suitable for combustion. Residues from incineration processes must still be landfilled, as must the non-combustible portion of the waste stream, so incineration alone cannot provide a disposal solution.

Generating electricity or producing hot water or steam as a by-product of the incineration process has the dual advantages of displacing energy generated from finite fossil fuels and improving the economics of waste incineration, which is the most capital-intensive waste disposal option."

The World Health Organisation's Pamphlet on Waste Incineration is contained in Appendix 6.2

6.2.6 European Council Directive 2000/76/EC on the Incineration of Waste

The Waste Incineration Directive (WID) introduced stringent operating conditions and sets minimum technical requirements for waste incineration and co-incineration[1]. It consolidates new and existing incineration controls into a single piece of European legislation.

The requirements of the Directive were developed to reflect the ability of incineration plants to more cost effectively achieve high standards of emission control in comparison to the 1980s. Previous waste incineration directives only applied to municipal and hazardous waste. WID updated the requirements of the 1989 municipal waste incineration (MWI) directives (89/429/EEC and 89/369/EEC) and, merged them into the 1994 Hazardous Waste Incineration Directive (94/67/EC), and consolidate new and existing incineration controls into a single piece of European legislation.

It covers virtually all waste incineration, and co-incineration plants, going beyond the plant previously covered by incineration directives. Additionally, it also replaced Article 8(1) and the Annex to the Waste Oil Directive (75/439/EEC) thus extending the scope of incineration controls to cover the burning of waste oils. WID sets stringent requirements that apply to all new incinerator installations from 28 December 2002 and to all existing installations from 28 December 2005. It specifies air emission limits which must not be exceeded. It also sets requirements concerning normal and abnormal operating conditions, water discharges from cleaning exhaust gases, ash recycling, plant control and monitoring, and public access to information. WID also requires all incinerators and co-incinerators to have continuous monitors for certain pollutants.

This best practice document was developed in consultation with WHO and IARC (International Agency Research in Cancer) which is in itself a constituent part of the WHO and the best scientific advice. It means that the proposed incinerator which has to be in compliance from day one will have to meet the most stringent of emission criteria.

6.2.7 Dioxins

Much of the attention in recent debates about the human health effects of incinerators has concentrated on dioxins and furans. This is despite the fact that most dioxins we are exposed to are in our diet. The major sources are dairy products, as well as some other food. One however rarely sees this fact highlighted in the press except perhaps after occasional “scares” such as the relatively recent case in Belgian where large quantities of food produce became contaminated with dioxins as a result of PCB oil being recycled back into the food chain rather than being disposed of appropriately by incineration.

Because the food we eat is increasingly not from the immediate vicinity in which we live but rather from the broader national and international sources the effect of any source may be dispersed far and wide but equally we may be more vulnerable to high levels coming from all parts of the world rather than our own “back-yard”.

'Dioxins' and 'furans' are generic terms for a group of more than 200 individual chemical compounds, all of which are of different toxicity. They cause chloracne and are carcinogenic particularly in some animal studies.

Dioxins and furans will form spontaneously from chlorine atoms, carbon that has not been fully oxidised, and various catalysts in cooling smoke; hence, the process is the same for waste incineration plants, turf fires and tiled stoves alike. Each of the 200 dioxin and furan compounds is of a different degree of toxicity; for that reason, their so-called toxicity units (TUs) are determined and summarized into units of grams per toxicity unit (g TU).

Indeed the public concern on dioxins was so significant that the Food Safety Authority of Ireland (FSAI) published a report in 2003 (Appendix 6.3) on the potential effect of food if waste incineration of municipal waste was introduced into Ireland. They stated:

> "In *relation to the introduction of waste incineration in Ireland, as part of a national waste management strategy, the FSAI considers that such incineration facilities, if properly managed, will not contribute to dioxin levels in the food supply to any significant extent and will not affect food quality or safety*".

The dioxin emissions from modern incinerators are up to 1000 times less than 20 years ago. This can be seen from the situation in Germany, one of the countries in Europe that has studied this area most closely and one where environmental concerns are taken very seriously. Whereas in 1990 one third of all dioxin emissions in Germany came from waste incineration plants, for the year 2000 the figure was less than 1%. It is estimated that in Germany today for example chimneys and tiled stoves in private households alone discharge approximately twenty times more dioxin into the environment than all the waste incineration plants together. This is also evident from the fact that in winter airborne dioxin loads are up to five times higher than in summer when heating systems are out of operation.

The same story is true with regard to particulate matter, or dust, emitted from incinerators in Germany. This matter will be dealt with more comprehensively later. Between 1990 and 2001 the particulate matter emitted by incinerators in Germany dropped from 25,000 tonnes of dust per year to 3,000 tonnes. Even still this is of no consequence when one realizes that each year Germany emits 171,000,000,000 tonnes of fine dust.

The results of dioxin sampling performed by AWN and detailed separately in this document show that Duleek had a slightly lower concentration than those measured at Cobh and Balbriggan but a higher concentration than the site outside Nobber which is located in a rural environment. Duleek village shows a similar congener profile (or, types of dioxins and furans) to Nobber, and Cobh.

Background soil dioxin and furan (PCDD/F) concentrations for the sites sampled in the Duleek area were typical of a mixed urban/rural area. Background soil dioxin-like PCBs were undetectable for all sites sampled in the area. The dioxin and furan values measured in the AWN Consulting Ltd. survey are well below any of the recorded levels or limits defined in the above literature and are low by international standards.

Air modelling carried out as part of the environmental impact assessment (refer to section 7 Air Quality) predicts that the contribution from the site in this context is minor with levels even under maximum operation remaining significantly below levels which would be expected in urban areas even at the worst-case boundary receptor to the south of the site. Levels at the nearest residential receptor will be minor, with the annual contribution from the proposed facility accounting for less than 0.6% of the existing background concentration under maximum operating conditions. In addition the theoretical

MARI (Most at Risk Individual), someone who has the maximal exposure from the site shows exposure to dioxins significantly below “safe” levels.

Because of the absence of impact on the local levels, and bearing in mind most human dioxin exposure is dietary anyway and the food we eat and the milk we drink usually comes from far and wide it is a straightforward conclusion that the proposed facility will have no significant effect on dioxin intake either locally or nationally

The W.H.O issued a fact sheet on dioxins No. 255.

Regarding effects on human health it commented:

“Short-term exposure of human to high levels of dioxins may result in skin lesions, such as chloracne and patchy darkening of the skin, and altered liver function. Long-term exposure is linked to impairment of the immune system, the developing nervous system, the endocrine system and reproductive functions. Chronic exposure of animals to dioxins has resulted in several types of cancer. TCDD was evaluated by International Agency for Research on Cancer (IARC) in 1997. Based on human epidemiology data, dioxin was categorised by IARC as a "known human carcinogen". However, TCDD does not affect genetic material and there is a level of exposure below which cancer risk would be negligible.”

Regarding the WHO’s policy on the safe destruction of dioxin contaminated material, the Organisation is of the view that incineration is currently the safest method of disposal of such material. The Fact Sheet states that:

“Incineration is the best available answer although other methods are being investigated. The process requires high temperatures, over 850° C. For destruction of large amounts of contaminated material, even higher temperatures -1000°C or more - are required”.

6.2.8 Respiratory symptoms and illness

Respiratory symptoms are one of the most sensitive markers for adverse health effects associated with air pollution (Hall 1995). Shy et al. (1995) examined three separate populations living near a biomedical incinerator, a municipal incinerator and a hazardous waste incinerator. The investigators measured air quality, respiratory symptoms and respiratory function in these populations. Results were compared with three matched-comparison communities. Environmental air quality measurements included those of particulates, and gases. No differences in concentrations of particulates were detected among the three pairs of communities. For the municipal incinerator, it was reported that emissions accounted for 2% of the fine particulate mass detected at the monitoring station. It should be noted that this study predated stricter environmental controls on the emissions of particulates to which the proposed Carranstown site would operate.

Symptoms of respiratory illness, such as chronic cough, wheeze and sinus trouble, were significantly greater in those living near the hazardous waste incinerator than in their control community. However, this difference did not remain when all three incinerators were combined and compared with their comparison populations. Even the limited finding about the hazardous incinerator is of limited relevance for the Carranstown development as it is a non hazardous incinerator.

Studies of self reported symptoms must always be treated with caution as they can be more revealing about peoples concerns rather than actual health effects. One of theses studies examined respiratory symptoms in over 4000 residents living in four communities near waste incinerators were compared to those in similar but separate nearby populations (Mohan et al. 2000). A higher prevalence of self-reported respiratory symptoms was reported in one community near a hazardous waste incinerator than in its control population. However, the investigators also reported that this community was located the greatest distance from its comparison population, and that respondents in this community showed more concerns about air quality. In addition, the socio-demographics of these areas were not directly comparable. This may have lead to the introduction of a number of biases and confounding factors.

An other paper examined whether chronic pulmonary effects were related to emissions from the three waste incinerators (Hu et al., 2001). A total of 1,018 subjects underwent a spirometric test once a year between 1992 to 1994. The study attempted to assess exposure using three surrogate measures; living in an incinerator community, distance from the incinerator and an incinerator exposure index, which was a function of the distance and direction of the subjects residence to the incinerator, the number of days the subject spent downwind and the average time spent outdoors. Overall, the test results showed no consistent statistically significant association between pulmonary function and exposure. Some changes were noted in lung function in certain areas but the study could not link these directly to incineration.

Gray et al. (1994) examined asthma severity and morbidity among children living in two areas of Sydney, Australia containing high temperature sewage sludge burning incinerators. Again this must be interpreted with care in assessing a municipal waste incinerator but it is included here for sake of completeness.

A total of 713 children aged between eight to twelve years were studied in the two regions close to the incinerators, together with a further 626 children in a control region which did not contain a sludge burning incinerator. Respiratory illness was measured by questionnaire, airway hyper-responsiveness and atopy. The study found no statistically significant differences in the prevalence of current asthma (as defined by airway hyper-responsiveness and recent wheeze), atopy, symptom frequency between the control and two study regions.

Furthermore, air monitoring data did not demonstrate any major differences in air quality in the study and control areas. The study concluded that releases from high temperature sewage sludge incinerators appeared to have no adverse effect on the prevalence or severity of childhood asthma.

A small study on open air wire reclamation incineration carried out in the open in Taiwan reported a higher incidence of pulmonary effects in children exposed to pollution from the incinerator when compared with a non-exposed control population (Hsuie et al., 1991). Again even greater caution applies when extrapolating this to Carranstowns as this was a highly specialised type of open air incinerator which has essentially nothing in common with a modern municipal waste incinerator. Whilst air monitoring confirmed that air pollution was worse in the exposed area, it was unclear whether other industrial sources were present and the study could not confirm whether this pollution was in fact directly related to emissions from the incineration. The study also did not find any significant difference in the prevalence of cough and wheeze, which tended to contradict the findings of the pulmonary measurements. The findings of this study leave open the possibility that emissions from wire reclamation incineration may have caused pulmonary problems in local children. However, the air pollutant concentrations were not reported, and as the incineration was carried out in the open without abatement, its relevance to modern municipal waste incinerators is extremely limited.

6.2.9 Particulate Matter

Much of the attention on respiratory issues has occurred because of concerns regarding particulate matter or dust. This is despite much lower emissions from modern incinerators than was achievable heretofore.

Background particulate measurements taken as part of the environmental impact assessment suggest low levels of PM_{10} and $PM_{2.5}$ in the area. These represent Particulate Matter less than 10 microns and 2.5 microns respectively.

A number of locals have disputed this pointing to high dust levels visible on cars from time to time. These have been attributed by some to a nearby cement factory. This fact does not however contradict the low PM levels. Dusts settling on cars are by their nature the heavier larger particles. These larger particles are visible but of much less health effect. Particles greater than about 30 microns are not even inhaled and those between 15 and 30 microns are filtered out in the nose before they reach the lung. It is for this reason that the PM_{10} and $PM_{2.5}$ are of much more health impact. Air modelling suggests and the proposed incinerator will have minimal impact on these measurements and not enough to put the levels above air quality standards

6.2.10 Reproductive Effects

Lloyd et al. (1988) reported an increase in the frequency of twinning in human and cattle populations in an area in central Scotland at increased risk from incinerator emissions. The findings of this study were reported to be consistent with the hypothesis that PCHs (polychlorinated hydrocarbons) or other agents with oestrogenic and fertility-related properties were introduced into the local environment. This study, however, was an analysis of the geographical distribution of twinning and did not analyse environmental emissions. There was no attempt for example to localise the effect or to establish a dose response effect, that is a higher incidence in the area of greatest exposure. This would be expected if the effect was causal. In addition, the authors acknowledged that the genetic component of twinning was not examined. Although maternal age was taken into account, other social factors that may have influenced human twinning rates were not examined. Four years later, in an analysis of the same area in Falkirk, in central Scotland, a similar study reported a significant excess of female births in an area at risk from emissions from two incinerators (Williams et al. 1992). Again this should be interpreted with caution. In any event the relevance of these findings is limited as the studies pre dated higher control standards on potentially oestrogenic emissions.

A later study, carried out in Sweden, examined whether spatial clustering of twin births was associated with 14 incinerators constructed during the study period (Rydhstroem 1998). Between 1973 and 1990, 1,224 municipalities, with 17,067 twin deliveries, were examined. No clustering of twin deliveries was evident in time or in geographic areas, including the areas in which incinerators were built. This much larger study over a significant period of time therefore failed to demonstrate the twinning effect.

A study of open chemical combustion in Zeeburg, Amsterdam, during the years 1961 to 1969 was reported by Tusscher et al. (2000). This study was carried out to investigate the incidence of orofacial clefts in the region and to determine any association with the local combustion facility. The authors concluded that these results inferred an association between the incinerator and the increased local incidence of orofacial clefts. Although this increase was probably a true finding, the possibility of other influencing factors, such as alternative sources of exposure, could not be ruled out.

This study is of open chemical combustion and not municipal incineration and so is of no relevance to the proposed facility but again is described as it is often quoted by persons opposing incineration per se.

6.2.11 Cancer

In an analysis of childhood cancers, Knox (2000) examined migration patterns around 70 municipal waste incinerators, 460 landfill sites and 307 hospital incinerators. Birth and death addresses of affected children who moved house were mapped and examined. Although there were no significant association related to landfill sites, there was a highly significant excess of migration away from birthplaces close to incinerator sites. The author comments that these findings may be the result of age-related circulation around available housing stock, with, for example, young mothers living with their inner-city parents and moving out to less industrial areas over time. This is primarily a study of social patterns as opposed to health effects and probably reflects that incinerators have traditionally been located in heavily industrialised areas.

In the UK the Small Area Health Statistics Unit (SAHSU) analysed the incidence of cancers of the larynx and lung near the incinerator of waste solvents and oils at Charnock Richard in Lancashire (which operated between 1972 and 1980) and nine other similar incinerators in Great Britain, after reports of a cluster of cases of cancer of the larynx near the Charnock Richard site (Elliott et al. 1992). Standardised cancer ratios were assessed within 3 km and between 3 and 10 km of each site and then aggregated over all sites. Zones of exposure were also drawn concentrically around each site to test for trend in cancer rates with distance. For Charnock Richard, none of the cancer rates within 3 km or between 3 and 10 km differed significantly from those of the general population. No increase in cases of cancer of the larynx was detected near the Charnock Richard former waste site. This is reassuring. Again while not a study of municipal incinerators, on first toxicological principles one would expect if any effect was present it would be higher around an older chemical incinerator than a modern non hazardous facility.

In a study of over 14 million people, Elliot et al. (1996) examined cancer incidence in Great Britain, using cancer registry data and proximity to one of 72 municipal solid waste incinerators. Although a statistically significant decline in risk was reported for all cancers combined, and individually for stomach, lung, colorectal and primary liver cancers, this was thought to be largely due to residual confounding by socio-economic factors. Liver cancer was the most strongly significant (37% excess risk within 1 km of municipal waste incinerators) but, on review of cancer registration data, this cancer category was reported to be frequently misclassified or misdiagnosed (mainly secondary liver tumours). In a recent study to investigate the validity of these liver cancer diagnoses, Elliot et al. (2000) attempted to determine the size of any true excess in the vicinity of municipal waste incinerators. In a sample of cases subjected to histological and medical record reviews, over half were reported to be true primary liver cancer. This resulted in a re-estimation of the calculated excess risk previously reported (from 0.95 excess cases 10^{-5}/year to between 0.53 and 0.78 excess cases 10^{-5}/year).

The strong association between deprivation and primary liver cancer was thought to remain an influence on this result.

Urbanisation as another potential confounder was also unlikely, as other local densely populated areas did not show the same excesses of these cancers. Other pollutants from the incinerator could also have contributed to the overall exposure of this population.

Nevertheless the overall finding from this very large study was of no increase in cancers in those living close to incinerators. In fact a decreased risk was the finding.

Biggeri et al. (1996) reported a case-control study of lung cancer around four sources of environmental pollution (shipyard, iron foundry, incinerator, and city centre) in Trieste, Italy. The risk of lung cancer was strongly associated with residence near the city centre and near the incinerator. In each of these two locations, as distance increased from the source, risk was reduced. The observed effects in relation to the city centre may have been influenced by the close proximity of two of the other sites, namely the shipyard and, to a lesser degree, the iron foundry. The presence of so many confounders make this study on it’s own of limited value.

Gustavsson (1989) investigated mortality among 176 male workers employed at a municipal waste incinerator in Sweden. The incinerator handled municipal waste, although earlier in its 60 years of operation it had dealt with both municipal and industrial waste. Excess deaths were reported for lung cancer and for ischaemic heart disease. The excess deaths from ischaemic heart disease were significant for those workers with 30 or more years of employment, but not for lung cancer deaths. This might have been because there were too few lung cancer deaths in the study sample. Although no particular chemical exposures were implicated, exposure to combustion products and polycyclic aromatic compounds were reported to be common. Potential confounders such as smoking were examined and were felt not to have contributed to the excess deaths reported. As this is an occupational study over a long period with historical multiple exposures it is not appropriate to extrapolate the findings to environmental risks surrounding a modern municipal incinerator.

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A small area study of mortality among residents of Malagrotta, a suburb of Rome, Italy found no association between proximity to industrial sites and mortality from a range of cancers including laryngeal cancer for the period 1987 to 1993 (Michelozzi et al., 1998). This area contained a number of industrial point sources, including a waste incinerator that closed in 1985 because of a failure to comply with pollution control standards. Despite no evidence linking mortality from laryngeal cancer or any other cancer with specific sources in the area, there was a decline in mortality from laryngeal cancer with distance from the industrial sites. However, the actual dispersion of pollution from these sites was not evaluated and no direct link with the incinerator can be made.

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Several studies by Knox have examined a possible association between childhood cancers and industrial emissions including those from incinerators (Knox and Gilman, 1996; 1998; Knox 2000). These studies employ spatial analysis of postcodes of those diagnosed with childhood cancer but limitations with the methodologies used mean that the results of these studies are far from certain. No direct measure of exposure is included in the analysis, with exposure estimates being entirely reliant on using distance from the source as a proxy for exposure.

The standardisation technique employed in the earlier studies (Knox and Gilman, 1995; 1998) does not attempt to account for the potential effect of deprivation, which would be a major potential confounding factor. Both of the early studies have been heavily criticised on the basis of lack of proper control for population density and the extreme implausibility of some of the findings, which tentatively linked childhood cancer with a wide range of combustion sources including major highways, but only at considerable distances from the road, at which no elevation in pollutant concentrations from on-road emissions would have occurred.

The most recent study by Knox (2000) differs in that it is based upon an analysis of the birth and death addresses of children diagnosed with cancer. This showed a greater incidence of cancer in children born close to incinerators and moving away than in those who moved closer to an incinerator. As its basis, the study assumes that migration of children who subsequently develop cancer should be essentially random. A comparison was made with non-combustion industrial markers including cathedrals, mail order firms and biscuit makers; activities that are not necessarily located in the same sort of areas as incinerators. It is not clear whether hospital incinerators are included in the analysis, since their results are not presented separately. The effect observed by Knox was due to just ten of the incineration plants studied, all but one of which had been open since before 1955 and therefore may have produced substantial historical contamination. All were sited close to other potential sources of environmental hazards. It cannot therefore be taken as representing more modern combustion plants. The work is also liable to criticism on the grounds that there is no information provided on the net migration of total population inwards or outwards from the vicinity of such plants and therefore, again, no control for temporal changes in population densities.

The overall conclusion drawn by authors of the study was that the inferred increased probability of childhood cancer stems from residence near to large-scale combustion processes as a whole, of which incinerators are one component. This is weak evidence indeed.

Viel et al. (2000) examined the spatial distribution of soft-tissue sarcomas and non- Hodgkin's lymphomas around a French municipal waste incinerator near Besançon, south-west France, with "high" dioxin emissions from 1980 to 1995. The study found localised case clusters of soft-tissue sarcoma and non-Hodgkin's lymphoma in the vicinity of a municipal solid waste incinerator, which were more pronounced at the end of the study period. Again, caution is advised before attributing these clusters to emissions from the incinerator, since as the study did not take into consideration socio-economic status as a contributing factor and there were other uncertainties, due to low spatial resolution of clusters. Furthermore these findings are not consistent with the much more detailed epidemiological study by Elliott and colleagues in the UK, which did not find any association between soft-tissue sarcoma and non-Hodgkin's lymphomas and distance from municipal solid waste incinerators (Elliott et al., 1996). Also because the study was undertaken specifically because of high historical dioxin levels it is of lesser relevance in assessing a modern plant.

A subsequent paper (Floret et al., 2003) reports a study of greater sophistication into the non-Hodgkin lymphoma cluster (Viel et al., 2000) using a case control study design. A dispersion modelling study of dioxins was conducted and used to assign population to three exposure zones. The study found a significant excess of disease only in the high exposure zone although this finding is surprising given that the predicted dioxin concentrations were far below the usual urban and rural background for dioxins. No measured exposure data were available. The authors reported that no other relevant industrial plant operated within the area and hence, if the effect is causal it would most likely relate to emissions from the incinerator, although given the level of predicted concentrations, it seems unlikely that dioxins were responsible. However, whilst in many ways this study was one of the best designed available, the authors were unable to firmly exclude the possibility that residual confounding affected the reported odds ratios. Levels of dioxin emissions from the incinerator when measured in 1997 were found to be 163 times the normal maximum emission limit for dioxins from incineration.

Indeed the UK government report published in 2004 and referred to in the introduction concluded:

"We looked in detail at studies of incineration facilities, and found no consistent or convincing evidence of a link between cancer and incineration. There is little evidence that emissions from incinerators make respiratory problems worse. In most cases the incinerator contributes only a small proportion to local levels of pollutants."

6.2.12 Non-Carcinogenic Toxicants

Other heavy metals, such as lead and mercury, are also retained in the filtering devices of waste incineration plants. They are not regarded as carcinogens. Whether or not they are poisonous for human beings will depend on whether they reach their thresholds of effectiveness. In effect for these to have a human health effect they must leave the incinerator in the form of emissions and enter the human body either by inhalation or ingestion and theoretically but rarely in practice through the skin.

For these substances, too, there has been an impressive decline in emissions from modern incinerators compared with historical measures. It is also important to realize that these substances are not formed in the incineration process. They must enter as components of the waste. One would not expect large levels in pretreated municipal wastes. This in addition to improved controls explains the marked reduction experience in their emissions.

For example whereas in 1990, emissions in Germany amounted to as much as 57,900 kilograms (kg) of lead and 347 kg of mercury from the incineration of household waste, the respective levels declined to 130.5 kg (equivalent to 0.2% of initial emissions) and 4.5 kg (1.3% of initial emissions) in the year 2001. Thus, lead and mercury emissions from the incineration of household waste are also no longer significant for human exposure to emissions of toxic substances.

Air modeling carried out for the proposed facility suggests there will be no significant increase in heavy metals in the vicinity of the proposed site and all measurements will continue to be below safety standards.

6.2.13 Mispelstratt Report

We were asked to comment on this report as it is often quoted by those who have concerns about incineration.

It would not normally be studied by the scientific community as it has not been published in a pier reviewed scientific journal, the accepted location for publication of any reports/ papers of scientific interest. This is seen as an important filter as it is necessary to demonstrate robust scientific logic to get the article published.

The "report" focuses on one area around a relatively old incinerator. It states that the incinerator was not fitted with filters and ashes were stored and transported in open containers. This makes any conclusions even if scientifically based unreliable in making an assessment for the proposed waste-to-energy facility.

The English in the report is obviously a translation written by a non native English speaker. Whilst at times this is no more than an inconvenience there are critical parts of the report where one has to make assumptions on what the authors meant to say. For example in the very brief “exposure” section it comments on “perpetuous exposition”

The report appears to emanate from one family’s concerns. The history of this family is detailed and is indeed tragic but in no way unique and would not in itself lead to any direct connection to incineration or any other source.

The report takes the format of a community questionnaire. This method is associated with multiple difficulties at any rate such as bias that those who have concerns are more likely to return questionnaires.

The questionnaire itself does not appear to have been validated. It is normal to include validation questions, that is questions that are believed to be unrelated to what is being studied to act as a control on those who say “yes” to every question.

The questionnaire is then compared to population statistics. This is comparing apples with oranges. To be of any value at all questionnaires in an “exposed” group must be compared with questionnaires of “unexposed” or by not using questionnaires at all and comparing population statistics in one area with statistics in another.

There was significant non participation including a high number of “refusal”. No attempt has been made to allow for these. It is accepted that those who believe they have been affected are far more likely to complete and return questionnaires than those who believe there has been no effect.

There has been no attempt to statistically analyse the information to quantify the significance of any effect. This is the most basic part of any scientific paper and without it conclusions are of no scientific value.

The number sampled is small. The number of samples is 88 questionnaires totalling 281 individuals. If the author’s own family is one of the 88, for example, and one suspects it is this alone could skew data.

In summary the paper is of extremely low scientific value. It has not been published in a pier reviewed journal and in our opinion will not be accepted by any journal of standing in it’s current form. No conclusions can be drawn from it.

6.2.14 Conclusion

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 the observed excess of all cancers, stomach, lung and colorectal cancers was due to socio-economic confounding and was not associated with emissions from incinerators. 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.

Any of studies which are often cited to demonstrate effect are either not scientifically reliable because of design or confounders or deal with open and/or hazardous combustion which is of no real relevance to the proposed facility. Reports of reproductive effects such as increased twinning have not been reproducible and are again limited value anyway because of the marked drop in emission levels.

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 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 also against the relatively low dioxin levels in the area by international standards and indeed in the country in general. Viewed in this way, the projected increase in dioxin levels due to the facility is negligible. 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"*

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. This is consistent with the data from risk assessments, emissions and ambient air monitoring in the vicinity of incinerators which indicate that modern, well-managed waste incinerators will only make a very small contribution to background levels of air pollution. In many cases, air monitoring data demonstrates that emissions from the incinerators do not significantly impact on air quality standards.

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

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

6.3.1 Introduction

AWN Consulting Limited at the request of Indaver Ireland, conducted an assessment of the potential dioxin (Polychlorinated Dibenzo Dioxin and Polychlorinated Dibenzo Furan) exposure through inhalation in the vicinity of the proposed expanded Carranstown waste-to-energy facility. The findings of this report are detailed below.

6.3.2 Modelling Philosophy

It was proposed to model the impact of the emissions on human health and the environment following the methodology defined by the US EPA for hazardous waste facilities 1.

The modelling philosophy was as follows:

- Develop a (Conceptual Site Model) CSM to assess the potential dietary intake of dioxin and furans for the theoretical Maximum at Risk Individual (MARI);
- Select most appropriate background soil and ambient air dioxin and furan concentration
- Model dioxin and furan intake using background concentrations in soil and air;
- Obtain data on deposition rates for dioxin and furans from proposed waste-to-energy facility;
- Model impact of deposition rates on soil concentrations of dioxin and furans over 30 year operating life of facility;
- Model increase in ambient air concentrations;
- Model impact of waste-to-energy facility related dioxin and furan deposition rates and increased ambient air concentrations on dietary intake of dioxin and furans for the MARI.

6.3.3 Conceptual Site Model and Maximum at Risk Individual

6.3.3.1 Conceptual Site Model

The Conceptual Site Model (CSM) was developed, using the methodology presented in the relevant US EPA Modelling Guidance [1].

The methodology chosen follows the UK recommended methodology “Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes, HMIP/CPR2/41/1/181, London 1996” in that it considers all likely pathways for dioxin and furan intake in a human and examines the impact of dioxin and furan deposition rate on soil dioxin and furan concentrations and subsequently food dioxin and furan concentrations.

The UK methodology uses the concept of the Hypothetically Maximum Exposed Individual (HMEI), in which the individual is assumed to live in the area of predicted maximum impact from the waste-to-energy facility and whose entire food intake is also assumed to be from this area (worst case scenario).

The US EPA Methodology uses the concept of the MARI (Maximum at Risk Individual), which is identical to the HMEI. The US EPA Methodology was chosen as it includes a mathematical model which allows calculation of average dioxin and furan concentrations over the lifetime of the facility, taking into account the natural processes which affect dioxin and furan concentrations in the soil over time, such as leaching, volatilisation and degradation.

Background concentrations of the 17 PCDD/F of interest are principally transferred to a human receptor by the following pathways (It should be noted that there are 75 polychlorinated dibenzo-p-dioxins and 135 polychlorinated dibenzo furans and only 17 of these have been shown to be toxic to laboratory animals, hence these 17 are considered appropriate for further assessment) including:

- Inhalation indoor air
- Inhalation outdoor air
- Ingestion of soil
- Dermal contact with soil
- Inhalation of soil dust
- Ingestion of drinking water
- Dermal contact with shower water
- Inhalation of water vapour in the shower
- Ingestion of meat
- Ingestion of milk

- Ingestion of vegetables
- Ingestion of surface water
- Ingestion of suspended matter in water
- Dermal contact with surface water

The CSM assumes all of the dioxin and furans emitted deposited on the ground and is available for uptake, apart from the fractions which are removed through volatilisation, surface water run off, erosion and degradation. These elements are calculated for each of the 17 dioxin and furan congeners.

The CSM then assumes the remainder of the dioxin and furans deposited is available for uptake through the pathways listed above.

The group of 17 dioxin and furan congeners vary widely in molecular weight and chemical characteristics and behave quite differently with respect to the fraction which absorbs to soil, dissolves in water, is present in the vapour phase or accumulates in meat or milk. It is therefore not valid to model the dioxin and furan concentrations as I-TEQ values and each congener must be modelled separately.

6.3.3.2 Maximum At Risk Individual (MARI)

In order to conduct a conservative assessment of the potential impact of dioxin and furan emissions on a theoretical individual, the following assumptions were made for the MARI (these assumptions are based on the MARI as used by the US EPA for hazardous waste facility assessment) [1].

- The MARI lives at the point where the dioxin and furan deposition rate predicted to be generated by the facility when operating at maximum capacity impacts on the ground.
- The MARI is a subsistence farmer, who spends 16 hours per day, 7 days per week, 50 weeks per year outside in the field where the deposition occurs;
- The MARI spends 6 years as a child and 60 years as an adult living on the site; Ingestion of suspended matter in water
- The MARI only eats vegetables grown on this soil, milk from a cow grazing on the site and meat from cattle raised on the site;

6.3.4 Soil and Ambient Air Background Concentrations

6.3.4.1 Soil concentrations

Indaver Ireland commissioned AWN Consulting Ltd to conduct a soil dioxin sampling exercise as part of the EIS for the proposed waste-to-energy facility. The results of this survey and the location of the monitoring points are summarised in Tables 6.11 - 6.13.

Table 6.11 Location of Soil Sampling Points

Location No.	Sampling Point Location	***Position (Grid Ref.)***	Sample Date
A	**Duleek Village** Green area at edge of the village	05273 68830	15th Nov. '05
B	**The Commons, North of Duleek** Open area next to residential estate	04679 69275	17th Nov. '05
C	**Donore Village** Open area next to residential estate	04516 72249	16th Nov. '05
D	**On a public road near Platin** Grass verge along road	06969 72061	16th Nov. '05
E	**At proposed site location** On the agricultural land	06349 70729	15th Nov. '05
F	**Gafney, on road leading southbound** Grass verge along road	07696 70236	16th Nov. '05

Table 6.12 Analysis results

Sample ID	***Amount ng/kg I-TEQ*** *Note 1*
A	0.7
B	1.2
C	1.4
D	3.5
E	1.5
F	<0.5

Note 1. NATO/CCMS I TEQ

The highest dioxin and furan value recorded for agricultural land (NATO CCMS TEQ OF 1.5 ng/kg) was for the sample taken on the site of the proposed waste-to-energy facility.

The 3.5 ng/kg value recorded for Sample Site D was somewhat higher than that recorded for sample site E, but this sample was taken from the road side verge near Platin, and displayed a dioxin and furan profile indicative of traffic related emissions.

The profile recorded was similar to that recorded for samples from Ringsend, Irishtown and Clontarf in Dublin,(in a separte study – see Soil Sampling Report FC/05/2903SR01). Although the concentration recorded for Sample Site E was at the lower end of the range for those recorded at the sites in Dublin (3.2 - 5.7 ng/kg) the similar profile indicates traffic related emissions were the likely source of the dioxin and furan concentrations measured at both the Dublin City and Duleek samples.

Given that this could represent dioxin and furan agricultural land concentrations in the area it was therefore decided that the soil concentration for the background on the site inhabited by the MARI would have a dioxin soil concentration of 1.5 ng/kg NATO CCMS I-TEQ (worst case scenario).

6.3.4.2 Ambient Air Concentrations

Indaver Ireland also commissioned an ambient air survey at the site. The highest background air concentration measured was 0.053 pg/m^3 WHO TEQ. It was therefore decided that the ambient air dioxin concentration for the background on the site inhabited by the MARI would 0.053 pg/m^3 WHO TEQ (worst case scenario).

6.3.5 Baseline Modelling Of Intake Of PCDD/F

6.3.5.1 Model Selection and Set up

The RISC Human Model Version 3.2 (May 2005) package was chosen to model intake of dioxin and furans. The model was developed by the Dutch National Institute of Public Health and Environmental Protection (RIVM), on behalf of the Dutch Ministry for Spatial Planning, Housing and the Environment and has been used to model the Dutch Soil standards for protection of human health [2].

The model consists of series of equations which allow each of the pathways listed in Section 6.3.3.1 to be modelled mathematically. The principal model variables used to calculate total exposure are presented as Appendix 6.9. The equations used to calculate each variable are presented in Appendix 6.10. The values selected for the model variables and the justification for selecting these values is presented as Appendix 6.11.

The model data base contains many of the necessary chemical parameters such as the octanol-water coefficient, Henry's coefficient and the water solubility, which are necessary to model the behaviour of substances in soil and water environments. Where these parameters were not available from the model database, The Handbook of Physical Chemistry [3] and Appendices A – J of the US EPA Human Health and Ecological Risk Assessment Report [1] were used.

The ambient air quality data available for the proposed site was presented as an I-TEQ value as part of the EIS for the proposed development and individual congener concentrations in ambient air were not available, it was decided to model the intake of dioxin and furans from ambient air as a separate exercise and add it to the RISC Human predicted value for exposure from other media.

6.3.5.2 Model Results

The Model Output Report, for each of the 17 PCDD/F congeners for each intake pathway is presented as Appendix 6.12. The modelled NATO CCMS and WHO TEF intake value for the MARI, in pg/kg body weight/day, is presented in Table 6.13.

The model predicted a baseline dioxin and furan intake of 5.8708 pg/kg body weight/week (0.8387 pg/kg body weight/day), using the WHO TEF values.

As the dioxin and furan concentration for ambient air was available only as a TEQ value, it was decided to model this impact separately, using a dose model, based on inhaled air and fraction of dioxin and furans retained, as shown in Table 6.14 and assuming the highly conservative scenario that the MARI is exposed continuously to this dioxin and furan concentration in ambient air.

The background dose due to inhalation is then added to this dose, to give a total predicted background dose, the inhalation dose is calculated as per Table 6.14.

Table 6.13 Modelled baseline PCDD/F intake for MARI– using both

PCDD Congeners	mg/kg/d	pg/kg/d	TEF	TEF	pg/kd/d	pg/kg/d
			NATO CCMS	WHO	NATO CCMS	WHO
2,3,7,8-TCDD	0.00E+00	0.00E+00	1	1	0.00E+00	0.00E+00
1,2,3,7,8-PeCDD	0.00E+00	0.00E+00	0.5	1	0.00E+00	0.00E+00
1,2,3,4,7,8-HxCDD	0.00E+00	0.00E+00	0.1	0.1	0.00E+00	0.00E+00
1,2,3,6,7,8-HxCDD	0.00E+00	0.00E+00	0.1	0.1	0.00E+00	0.00E+00
1,2,3,7,8,9-HxCDD	0.00E+00	0.00E+00	0.1	0.1	0.00E+00	0.00E+00
1,2,3,4,6,7,8-HpCDD	8.18E-09	8.18E+00	0.01	0.01	8.18E-02	8.18E-02
OCDD	2.67E-08	2.67E+01	0.001	0.0001	2.67E-02	2.67E-03
PCDF Congeners						
2,3,7,8-TCDF	1.20E-10	1.20E-01	0.1	0.1	1.20E-02	1.20E-02
1,2,3,7,8-PeCDF	4.01E-10	4.01E-01	0.05	0.05	2.01E-02	2.01E-02
2,3,4,7,8-PeCDF	4.68E-10	4.68E-01	0.5	0.5	2.34E-01	2.34E-01
1,2,3,4,7,8-HxCDF	1.89E-09	1.89E+00	0.1	0.1	1.89E-01	1.89E-01
1,2,3,6,7,8-HxCDF	9.89E-10	9.89E-01	0.1	0.1	9.89E-02	9.89E-02
1,2,3,7,8,9-HxCDF	0.00E+00	0.00E+00	0.1	0.1	0.00E+00	0.00E+00
2,3,4,6,7,8-HxCDF	1.52E-09	1.52E+00	0.1	0.1	1.52E-01	1.52E-01
1,2,3,4,6,7,8-HpCDF	4.74E-09	4.74E+00	0.01	0.01	4.74E-02	4.74E-02
1,2,3,4,7,8,9-HpCDF	0.00E+00	0.00E+00	0.01	0.01	0.00E+00	0.00E+00
OCDF	8.79E-09	8.79E+00	0.001	0.0001	8.79E-03	8.79E-04
					0.870640	0.838699

WHO TEF and NATO CCMS TEF

Table 6.14 Modelled Intake due to Inhalation

Measured background PCDD/F air concentration	**0.053**	**pg/m3**
Normal breathing rate	20	m3/day
Mass Fraction retained in the lungs	75	%
Mass of PCDD/F absorbed through inhalation over a day	0.795	pg/day
Mass PCDD/F per kg body weight/day(60 kg body weight)	**0.01325**	**pg/kg/day**

Note 1: Konz, J.J, Lisi, K., Friebele, E and Nixon, D. Exposure Factors Handbook, EPA/600/8-89/043, Washington DC EPA 1989.

Note 2; Compilation of EU Dioxin Exposure and Health Data - Task 4 Human Exposure European Commission DG Environment, October 1999

The total predicted background dose, combining both inhaled and ingested dioxin and furans is therefore 0.85195 pg/kg body weight/day (WHO TEQ) (5.964 pg/kg bw/wk).

This is considerably less than the EU TWI value of 14 pg WHO-TEQ/kg body weight/wk (from Opinion of the Scientific Committee on the Risk Assessment of Dioxins and Dioxin-like PCBs in Food 22/11/2000 (SCF/CS/CNTMDIOXIN/ 8 Final)). 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.

6.3.5.3 Maximum Deposition Rate Of PCDD/F From Waste-to-Energy Emissions And Calculations Of Predicted Soil And Air Concentrations

Air emissions from the proposed waste-to-energy facility were modelled by AWN Consulting, using the USEPA AERMOD Model, with the proposed facility operating at maximum capacity. Details of the modelling study are provided in the Air Quality Chapter of the EIS. The annual predicted deposition rate under maximum operating conditions for each of the 17 PCDD/F congeners is shown in Table 6.15.

Table 6.15 Predicted annual average PCDD/F flux at Waste-to-Energy facility (based on maximum emission rate)

	Total flux g/m^2/yr
2,3,7,8-TCDD	0.00320
1,2,3,7,8-PeCDD	0.01565
1,2,3,6,7,8-HxCDD	0.00554
1,2,3,4,7,8-HcCDD	0.01117
1,2,3,7,8,9-HxCDD	0.01345
1,2,3,4,6,7,8-HpCDD	0.00985
OCDD	0.00151
2,3,7,8-TCDF	0.01113
1,2,3,7,8-PeCDF	0.00137
2,3,4,7,8-PeCDF	0.03714
1,2,3,4,7,8-HxCDF	0.02275
1,2,3,6,7,8 HxCDF	0.00754
2,3,4,6,7,8-HpCDF	0.00152
1,2,3,7,8,9-HxCDF	0.02531
1,2,3,4,6,7,8-HpCDF	0.00418
1,2,3,4,7,8,9-HpCDF	0.00128
OCDF	0.00056

The deposition flux data from Table 6.15 was used to predict the average soil concentration over the exposure duration period, by applying the model used by the US EPA for Assessment of Hazardous Waste Facilities [1].

The model enables increases in soil concentrations due to aerial deposition of dioxin and furans to be calculated, over a set time period and includes for natural processes such as volatilisation and sediment removal by surface water run-off, which reduce dioxin and furan concentrations in soil.

The model equation to predict the increase in soil concentration of dioxin and furans, resulting from aerial deposition is:

$$Sc_1 = \frac{Ds}{ks\ \ (Tc - T_1)} \left[\left(Tc + \frac{\exp(-ks\ \ Tc)}{ks}\right) - \left(T_1 + \frac{\exp(-ks\ \ T_1)}{ks}\right)\right] for\ 0 < T_1 < Tc$$

Equation terms are defined in Appendix 6.12.

Ks, the soil loss constant due to all processes, is calculated using the following equation;

$$ks = ksl + kse + ksr + ksg + ksv$$

Equation terms and the equations used to calculate each of the “Ks” terms, are defined in Appendix 6.13.

Ds, the dioxin and furan deposition term, expressed in terms of mg/kg/yr, is calculated as per Appendix 6.14.

A radius of 50m was used to calculate the Ds values used in the modelling study. This assumes that the deposition occurs over a 100m diameter area, inside which the MARI spends all their time.

Tc, the time period over which the emissions occur, has been set at 30 years, as it has been assumed that the facility will have a 30 year operational lifetime and T_1 = Tc – ED (where ED is the exposure duration).

The calculation of predicted soil concentration over the exposure period is presented as Appendix 6.15.

Ambient air dioxin and furan concentrations were also modelled using the AERMOD model and were used to calculate the dioxin and furan intake from inhalation.

6.3.5.4 Modelling of Impact Of Waste-to-Energy Emissions On PCDD/ F Intake

The predicted ambient air concentrations and predicted soil concentrations were used to model the impact of waste-to-energy emissions on dioxin and furan intake for the MARI. The modelling methodology was as for the baseline intake modelling. The Model output, for each of the 17 PCDD/F congeners for each intake pathway is presented as Attachment J. The modelled dioxin and furan intake (for all ingestion sources) for the impact of waste-to-energy emissions on dioxin and furan intake for the MARI, in pg/kg body weight/day, is presented in Table 6.16.

Table 6.16 Modelled waste-to-energy baseline PCDD/F intake for MARI

PCDD Congeners	mg/kg/d	pg/kg/d	TEF	TEF	pg/kd/d	pg/kg/d
			NATO CCMS	WHO	NATO CCMS	WHO
2,3,7,8-TCDD	5.13E-13	5.13E-04	1	1	5.13E-04	5.13E-04
1,2,3,7,8-PeCDD	2.88E-11	2.88E-02	0.5	1	1.44E-02	2.88E-02
1,2,3,4,7,8-HxCDD	1.30E-11	1.30E-02	0.1	0.1	1.30E-03	1.30E-03
1,2,3,6,7,8-HxCDD	4.91E-14	4.91E-05	0.1	0.1	4.91E-06	4.91E-06
1,2,3,7,8,9-HxCDD	1.49E-11	1.49E-02	0.1	0.1	1.49E-03	1.49E-03
1,2,3,4,6,7,8-HpCDD	8.18E-09	8.18E+00	0.01	0.01	8.18E-02	8.18E-02
OCDD	2.67E-08	2.67E+01	0.001	0.0001	2.67E-02	2.67E-03
PCDF Congeners						
2,3,7,8-TCDF	1.27E-10	1.27E-01	0.1	0.1	1.27E-02	1.27E-02
1,2,3,7,8-PeCDF	4.01E-10	4.01E-01	0.05	0.05	2.01E-02	2.01E-02
2,3,4,7,8-PeCDF	4.70E-10	4.70E-01	0.5	0.5	2.35E-01	2.35E-01
1,2,3,4,7,8-HxCDF	1.90E-09	1.90E+00	0.1	0.1	1.90E-01	1.90E-01
1,2,3,6,7,8-HxCDF	9.89E-10	9.89E-01	0.1	0.1	9.89E-02	9.89E-02
1,2,3,7,8,9-HxCDF	1.06E-12	1.06E-03	0.1	0.1	1.06E-04	1.06E-04
2,3,4,6,7,8-HxCDF	1.54E-09	1.54E+00	0.1	0.1	1.54E-01	1.54E-01
1,2,3,4,6,7,8-HpCDF	4.74E-09	4.74E+00	0.01	0.01	4.74E-02	4.74E-02
1,2,3,4,7,8,9-HpCDF	1.46E-12	1.46E-03	0.01	0.01	1.46E-05	1.46E-05
OCDF	8.79E-09	8.79E+00	0.001	0.0001	8.79E-03	8.79E-04
Increased Dose					0.893169	0.875628

It can be seen that the predicted dioxin and furan intake increase (WHO TEQ) was (0.838699 – 0.875628 =) 0.0369 pg/kg bw/d, for all exposure routes excluding inhalation.

The highest measured baseline value for ambient air was 0.053 pg/ m^3 (WHO TEQ) hence the highest predicted ambient air concentration, combining baseline and predicted concentrations, is (0.053+0.0008) = 0.05380 pg/m^3. The predicted inhalation dose (from combined background and modelled increased ambient air concentration) is shown in Table 6.17 (as WHO TEQ).

Table 6.17 Predicted increased PCDD/F (WHO TEQ) dose from inhalation

Predicted PCDD/F air concentration	0.05380	pg/m3
Normal breathing rate	20	m3/day
Mass Fraction retained in the lungs	75	%
Mass of PCDD/F absorbed through inhalation over a day	0.807	pg/day
Mass PCDD/F per kg body weight/day(60 kg body weight)	**0.01345**	**pg/kg/day**

The predicted increased dose, from inhalation and ingestion, for both WHO TEQ and NATO CCMS I-TEQ, is summarised in Table 6.18

Table 6.18 Predicted increased in PCDD/F intake

Dose	NATO TEF	WHO TEF
Baseline Dose Intake (pg/kg bw/d)	0.87064	0.83869
Baseline Dose from Ambient Air (pg/kg bw/d)	0.0115	0.01325
Baseline Dose Ambient Air Plus Intake (pg/kg bw/d)	0.88214	0.8519
Dose(baseline+inrcease) Intake (pg/kg bw/d)	0.893169	0.875628
Ambient air (baseline+increase) dose (pg/kg bw/d)	0.0117	0.01345
Predicted Dose air plus intake (pg/kg bw/d)	0.9048	0.8890

The predicted dioxin and furan dose (for all exposure routes) was therefore estimated to increase by only (0.8890 – 0.8519) = 0.0371 pg/body weight/day (as WHO-TEQ), to the theoretical MARI, that is in an increase from 0.8519 pg/kg bodyweight/day to 0.8890 pg/body weight/day (6.2223 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.

6.3.5.5 Modelling Of Accident Scenario

It was also decided to model an accident scenario whereby it was assumed the facility operated for 5 weeks at 5 times the Waste Incineration Directive limit for dioxin and furans of 0.1 ng/Nm^3 I-TEQ, for each year of the operational life of the facility.

A summary of the model output is presented in Table 6.19. It can be seen that although the predicted dose increases (an increase over basline dose (expressed as WHO TEQ) of 8.4%), it is still well below the relevant EU criteria.

Table 6.19 **Predicted increased in PCDD/F intake for accident scenario**

Dose	NATO TEF	WHO TEF
Baseline Dose Intake (pg/kg bw/d)	0.87064	0.838699
Baseline Dose from Ambient Air (pg/kg bw/d)	0.0115	0.01325
Baseline Dose Ambient Air Plus Intake (pg/kg bw/d)	0.88214	0.851949
Dose(baseline+inrcease) Intake (pg/kg bw/d)	0.917068	0.909877
Ambient air (baseline+increase) dose (pg/kg bw/d)	0.01254	0.0143
Predicted Dose air plus intake (pg/kg bw/d)	**0.9296**	**0.9241**

6.3.5.6 Modelling Of Dioxin Inhalation in Vicinity Of Proposed Waste-To-Energy Facility and Comparison With Dioxin Intake From Milk

The potential inhaled dioxins and furans dose for a theoretical maximum at risk individual (MARI) living at the point where ambient ground level dioxin concentrations are predicted to be highest when the proposed waste-to-energy facility is operational, was determined (See Appendix 6.18 for full report).

The dioxin intake by inhalation was then expressed in terms of unit volumes of milk produced in the Meath area. The emissions from the proposed waste-to-energy facility are predicted to increase the inhaled daily dioxin dose to the MARI by the equivalent of an additional 0.29 glasses per month of milk produced within the local area, assuming a glass volume of 300 ml.

6.3.7 Conclusion

It was concluded that the predicted impact of the emissions from the waste-to-energy facility, in terms of dioxin and furan dose to a theoretical MARI, are not significant, with the dioxin and furan dose to the MARI predicted to increase from 0.8519 pg/kg body weight/day to 0.8889 pg/body weight/day.

Based on a worst case scenario, the predicted dioxin and furan intake for the MARI was predicted to be well the EU 14 pg/kg bw/wk value, a limit set for the protection of human health and the environment.

Emissions under abnormal operating conditions (potential accident scenario) were modelled and it was found that the predicted dioxin and furan intake for a worst case accident scenario occurring annually was also well below relevant EU limit values.

It can 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 and that with respect to dioxin and furan intake, the facility will have no impact on human health or the environment.

6.4 ODOUR

6.4.1 Introduction

An odour emission survey was performed on a similar operating plant located in Kallo, Belgium by OdourNet (Philips, G., 2005), in order to allow for process specific data to be used within the dispersion model. All odour sampling and measurement was performed in accordance with the PrEN13725:2003.

Using this process specific odour emission data for the three proposed odour control technique, an odour dispersion modelling assessment was performed using the EPA recommended dispersion model ISC ST3 and the latest US and UK Environment Agency recommended dispersion model Aermod Prime. All source characteristics were inputted into the dispersion models including, topography, stack heights, volumetric airflow and building dimensions. Building wake and terrain effects were assessed. Two Cartesian grids were used to take account of a total assessment area of 25 Km^2 for grid one and 361 Km^2 for grid two thereby providing 10,562 individual receptors.

Following dispersion modelling, the predicted ground level concentrations (GLC's) of odour will be from 13% to 90% lower than the EPA odour limit value of less than 3.0 Ou_E m^{-3} at the 98th percentile for all odour control techniques.

It is recommended that a strict odour management plan be established for the proposed site to ensure that no odour impact will occur beyond the boundary of the facility. No putrescible waste will be allowed upon the waste reception hall floor. All cladding joints will be overlapped and sealed in order to ensure a high integrity building skin in order to ensure no odour/air leakage. A total volumetric flow rate of 50,000 m^3 Nhr^{-1} will be maintained upon the waste bunkers during scheduled shutdown.

6.4.2 Materials and Methods

This section describes the materials and methods used during the study.

6.4.2.1 Olfactometry measurements

Olfactometry determines the odour concentration of an air sample by using an olfactometer. The odour concentration is defined as the number of dilutions at which 50% of a trained panel of observers is still able to distinguish the diluted air from pure, odour-free air. Olfactometry measurements consist of two steps:

- sampling in situ of the odorous air emitted at the source and
- performance of olfactometric analyses of the samples in the laboratory.

A sample is taken on location in a specially designed sampling bag. After sampling, the bags were transported by express mail to the accredited odour lab in Amsterdam (Netherlands), where the air was analysed within 30 hours according to PrEN13725:2003. The odour concentration of the samples were determined (performance of the olfactometric analysis) by presenting a panel of selected and screened human subjects with the sample, varying the concentrations by diluting with neutral gas, in order to determine the dilution factor at the 50% detection threshold. Odour concentrations are expressed in European odour units per cubic meter (Ou_E m^{-3}). In order to reduce the variability, bound to the measuring method, triplicate samples were taken and triplicate analyses were executed (Philips, G., 2003).

6.4.2.2 Determination physical characteristics air

In addition to the olfactometry measurements, the physical characteristic of the air stream was determined (i.e. temperature, relative humidity, flow, pressure). These were determined using a calibrated instrument and probes attached to a Testo 400 handheld.

6.4.2.3 Odour emission rate

The measurement of the strength of a sample of odourous air is, however, only part of the problem of quantifying odour. Just as pollution from a stack is best quantified by a mass emission rate, the rate of production of an odour is best quantified by the odour emission rate. For a point emission source such as this schedules stack emission, this is equal to the odour threshold concentration (Ou_E m^{-3}) of the discharge air (determined by olfactometry) multiplied by its exhaust airflow rate (m^3 s^{-1}). It is equal to the volume of air contaminated every second to the threshold odour limit (Ou_E s^{-1}).

6.4.2.4 Dispersion modelling

Any material discharged into the atmosphere is carried along by the wind and diluted by the turbulence, which is always present in the atmosphere. This dispersion process has the effect of producing a plume of polluted air that is roughly cone shaped with the apex towards the source and can be mathematically described by the Gaussian equation (Carney and Dodd, 1989). Atmospheric dispersion modelling has been applied to the assessment and control of odours for many years, originally using Gaussian form ISC (Industrial Source Complex) (Keddie et al., 1980) and more recently utilising advanced boundary-layer physics models such as ADMS (Atmospheric Dispersion Modelling Software) and AERMOD. Once the odour emission rate from the source is known, Ou_E s^{-1}, the impact on the vicinity can be estimated.

These models can be applied to facilities in three different ways:

1. To assess the dispersion of odours and to correlate with complaints;
2. To estimate which source is causing greatest impact;
3. In a “reverse” mode, to estimate the maximum odour emissions which can be permitted from a site in order to prevent odour complaints occurring (Zannetti, 1990; McIntyre et al., 2000; Sheridan, 2002).

In this latter mode, models can be employed to predetermine the amount of abatement required to prevent odour complaints, therefore reducing capital investment in abatement technologies (Sheridan et al., 2001).

6.4.2.5 Meteorological Data

Three years worth of hourly sequential meteorology data representative of the area was used for the operation of ISC ST 3 and AERMOD Prime. This allowed for the determination of the worst-case scenario for the overall impact of odour emissions from the facility on the surrounding vicinity. Dublin airport 2001 to 2003 inclusive was used for the study period.

6.4.2.6 Terrain Data

All major topographically features were accounted for within the dispersion modelling assessment. Building wakes affects were also accounted for within the dispersion modelling assessment. Figure 6.3 illustrates the Cartesian grid network used within the dispersion model and relative location of the facility and boundary.

6.4.2.7 Dispersion models used

For this study BREEZE Industrial Source Complex Short Term 3 and AERMOD Prime was used.

ISC ST3

ISC ST3 is recommended in USA EPA's guideline on Air Quality Modelling (ISC, 2002), for applications to refinery-like sources and other industrial sources in simple terrain. It is also be recommended by the Irish EPA for odour impact assessments as it is the only currently validated dispersion model for odours. It is a straight-line trajectory, Gaussian-based model. It assumes a Gaussian distribution of the concentration in the crosswind vertical and horizontal directions, which is based on the 1960's description of boundary layer physics (Sheridan 2002). It is used with meteorological input data from the nearest source. The most important parameters needed in the meteorological data are wind speed and direction, ceiling heights, cloud cover, and Pasquill-Gifford stability class for each hour. ISC ST3 is run with a sequence of hourly meteorological conditions to predict concentrations at receptors for averaging times of one hour up to a year. It is necessary to use many years of hourly data to develop a better understanding of the statistics associated with calculated short-term hourly peaks or of longer time averages. ISC ST3 gives robust predictions. The programme can function with a low meteorological input.

Input data from olfactometry, and source characteristics will be used to construct the basis of the modelling scenarios.

AERMOD Prime

AERMOD Prime (EPA Version 04300) was used during this section of the study. This model is a third generation model utilising advanced boundary-layer physics. The most important parameters needed in the meteorological data are wind speed, wind direction, Monin Obukhov length, mechanical mixing height, friction velocity, etc. for each hour. AERMOD is run with a sequence of hourly meteorological conditions to predict concentrations at receptors for averaging times of one hour up to a year. It is necessary to use many years of hourly data to develop a better understanding of the statistics of calculated short-term hourly peaks or of longer time averages. Utilities associated with the dispersion model allow computation of ground level concentrations of pollutants over defined statistical averaging periods, consideration of building wake/downwash effects and the effects of elevated terrain in the vicinity of the assessed facility.

6.4.2.8 Proposed Odour Control Techniques

Three odour control techniques are assessed for the control of ground level odour concentrations during scheduled shutdown (i.e. for a period of 14 to 30 days). These include:

1. Negative ventilation of bunker storage with primary air during scheduled shutdown and exhaust through the existing 65-metre stack,
2. Negative ventilation of bunker storage during schedule shutdown and treatment in a fixed bed biofiltration system,
3. Negative ventilation of bunker storage during schedule shutdown and treatment in a annular bed carbon filtration system,

The source characteristics provided in Table 6.22, were then inputted into ISC ST3 and AERMOD Prime dispersion models in order to assess the maximum ground level odour concentration in the vicinity of the waste to energy facility.

Odour control through dispersion from Existing 65 metre Stack

During normal operation, primary air required for combustion is drawn in from the waste bunker storage area, which in turn draws in air from the waste reception hall. The primary air is used within the combustion process where odour compounds are oxidised to their odourless form. During unscheduled shut down, primary air will bypass the combustion chamber and be exhausted through the existing 65-metre stack. No operational issues are apparent if this technology is implemented. Due to the significant height of the stack, odour emissions are dispersed whereby the predicted ground level concentrations of odours will fall below the odour impact criteria.

Odour control through treatment in Biofiltration system

Biofiltration is an air pollution control technology used for the abatement of odours and volatile organic carbons (Sheridan et al, 2000). It has been used in many industries for the end of pipe treatment of emissions including, waste water treatment plants (Wani et al, 1997), rendering plants (Lou et al, 1997), intensive agricultural facilities (Classen et al, 1999, Sheridan et al, 2002a), tobacco, waste transfer, composting and polymer production plants (Hardy et al, 1995). The operational principle of a biofilter is that the contaminated air from a building/process is passed through a chamber, which contains a moist filter based media (organic and/or inorganic). The surface of the media is surrounded by a biofilm, where the microbes reside. As the contaminated air passes over the biofilm, it transverses the aqueous film, where the microbial consortium breaks downs the contaminants to water, carbon dioxide and inorganic salts. Biofilters are usually associated with high airflow rates and low concentration.

The design of biofilters for waste processing needs to be carefully optimised if the technology is to fulfil its potential. Initial studies have indicated that the packing medium and electrical running costs of a biofilter represent a high proportion of the overall cost (Sheridan et al, 2002c). For efficient operation, a filter material should provide optimum environmental conditions for the microbes (i.e. oxygen, temperature, humidity, nutrients and pH). The medium should possess uniform particle size, providing low pressure drop, minimal gas channelling, high reactive surface area and especially good mechanical strength that leads to negligible bed compaction in operation to minimise maintenance and media replacement. The addition of inert lightweight solids such as polystyrene beads and volcanic rock to the packing matrix to reduce compaction could lengthen the life span of organic packing materials. The addition of granular activated carbon and zeoliths will enhance biofilter start-up time during cyclic process operation.

During unscheduled shut down, primary air will bypass the combustion chamber and be exhausted through the biofiltration system. All process air will be extracted from the waste bunker storage area at a flow rate of 50,000 m3 N hr-1 and piped to the biofilter from where it will discharge to atmosphere through a 28-meter stack with an efflux of 15 m s-1. Maximum superficial air velocities of 100 m h-1 should be maintained upon the biofilter in order to achieve maximum removal efficiency. A bed depth of 1.2 meters and bed moisture content of 60% should be maintained within the media. Dust in the inlet odourous air stream will need to be addressed if this technology is implemented. Additionally, a continuous feed of 10,000 m3 hr-1 should be fed to the biofilter in order to keep the living bed active before unscheduled shutdown. In the case of this document a conservative odour threshold concentrations of 1000 OuE m-3 in the outlet treated exhaust will be assumed for modelling scenarios based on experience.

Odour control through treatment in Carbon filtration system

A carbon filtration system is defined as an adsorption system whereby substances accumulate at a surface of interface. In the case of waste transfer station odourous air, adsorption/removal of odourous compounds from the foul air is the objective. One way to accomplish this objective is to collect the odourous air and pass it through an adsorptive medium to which the odourous constituents will adhere. Although several different types of media are used for the adsorption of odourous compounds, the most widely used medium is granular activated carbon (GAC).

Activated carbon is a microsporous carbonaceous material that is produced from various raw materials, such as peat, wood, lignite, anthracite, fruit pits or shells. The thermal process is a two-stage process. In the first stage, the raw material is heated in the absence of air to avoid combustion, thereby driving out volatile materials. The material is then activated in the second stage by passing a high temperature gas, usually steam or carbon dioxide, through the medium. The high temperature gas creates a complex pore structure whose surface area may exceed 1500 m 2/g. It is by far the most important adsorptive media due to its wide range of pore sizes.

The transfer of odourous compounds from the gas phase to the adsorptive medium surface is the result of the motion of the molecule in the gas phase ad the physical attraction between the adsorbent and the gas-phase molecule. The molecules of gas mover rapidly between collisions. For example a molecule of nitrogen in air at 00C moves at approximately 1450 km/hr. This is more than sufficient to bring about contact between the adsorbent surface and the odourous molecule. Once in contact is made, a physical attraction causes a bonding to the available surface area. The attractive force, a result of forces imbalances at the adsorbent surface is known as van der Waals force. Together the adsorption affinity of the internal surface (V/d Waals adhesion forces) and the pore size distribution (cohesion forces), constitute an activated carbon's purification capability. The mass transfer from the air stream to the carbon occurs in the mass transfer zone (MTZ) of the carbon bed. The zone moves steadily downstream in the bed as more of the upstream capacity is exhausted. The movement of the MTZ can be seen in Figure 6.5. The upstream portion of the bed becomes exhausted when the adsorbent concentration is in approximate equilibrium with the vapour phase concentration. Breakthrough finally occurs when the MTZ reaches the end of the bed. If the bed depth is shallower than the required MTZ breakthrough is instantaneous. Thus, it is essential to choose a bed depth that provides sufficient bed life without requiring excessive power for passing air through the bed.

During unscheduled shut down, primary air will bypass the combustion chamber and be exhausted through the carbon filtration system. All process air will be extracted from the waste bunker storage area at a flow rate of 50,000 m3 N hr-1 and piped to the carbon filter from where it will discharge to atmosphere through a 28-meter stack with an efflux of 15 m s-1. Maximum superficial air velocities of 0.30 m s-1 should be maintained upon the carbon filter bed in order to achieve maximum removal efficiency. A bed depth of greater than 0.50 meter should be used. Carbon filtration has significant advantages over biofiltration in terms of startup, as it does not require a continuous feed in order to attain maximum odour removal. Dust and moisture in the inlet odourous air stream will need to be addressed if this technology is implemented. In the case of this document a conservative odour threshold concentrations of 500 OuE m-3 in the outlet treated exhaust will be assumed for modelling scenarios based on experience.

6.4.2.9 Odour impact criteria

An odour impact criterion of less than or equal to 3.0 OuE m-3 at the 98th percentile will be used for the odour impact assessment criterion. This has been recommended by the Irish EPA for the assessment of odours from tanneries, mushroom composting facilities and intensive pig production enterprises. Any odours been exhausted from the outlet stack of the three proposed odour control techniques would be considered more hedonically pleasant in comparison to tannery, mushroom compost or intensive pig production enterprises. In this case, in order to be very conservative, Indaver NV is using the stricter odour impact criteria established for more hedonically offensive odours.

6.4.3 Results

6.4.3.1 Odour sample location

The odour air samples were taken from the primary air stream of furnace line 1 of the similar Waste to energy process carried out in Kallo, Belgium. Normally, the flow here is about 50,000 Nm³ hr^{-1}.

6.4.3.1 Physical parameters of air stream

Table 6.20 summarizes the different physical parameters measured in the air stream of the similar plant operating in Kallo in Belgium. The odour emission rate is calculated as the product of the outgoing odour concentration and the standard off-gas flow. The standard off-gas flow is being calculated from the off-gas flow measured during sampling and recalculated to a temperature of 20℃, standard pressure and wet off-gas.

Table 6.20. Characteristics of waste air stream of similar process in Belgium.

Sample Identity	Velocity (m s^{-1})	Mean velocity (m s^{-1})	Temperature (Kelvin)	Relative humidity (%)	Standard flow (Nm^3 hr^{-1})
Sample 1	8.10	7.40	294.55	48	40,058
Sample 2	7.30				
Sample 3	6.90				

6.4.3.2 Results of the olfactometry measurements

Odour concentrations were measured in OdourNet's accredited olfactometry lab in Amsterdam. Table 6.21 shows the results of the odour concentrations, measured by dynamic olfactometry according to PrEN13725:2003.

Table 6.21. Odour threshold concentrations of similar processes in Belgium.

Sample Identity	Odour threshold conc. (Ou_E m^{-3})	Geomean conc. (Ou_E m^{-3})	Total bunker flow (Nm^3 s^{-1})	Odour emission rate (Ou_E s^{-1})
Sample 1	3034	2448	38.88	95,178
Sample 2	2176			
Sample 3	2222			

6.4.3.3 Odour results related to amount of waste

During measurement, there was a waste surface of about 1200 m². This means that 1200 m² of waste emits 95,178 Ou_E s^{-1} or an equivalent odour unit flux of 79.31 Ou_E m^{-2} s^{-1}. The bunker in Ireland will have a waste surface of approximately 800 m². During the annual period of shutdown, the bunker will be ventilated with a volumetric airflow rate of approximately 50,000 Nm³/hr. Taking into account the unit odour emission flux per square meter waste exposed, the actual total odour emission of the bunker in Ireland will be approximately 68,154 Ou_E s^{-1}. This equates to an odour concentration of approximately 4571 Ou_E m^{-3} from the bunker. The assumption of working with a fixed emission concentration per square meter of waste results in a higher odour concentration while using a lower volumetric flow rate. The calculated odour mass flow can, as a consequence, be considered as a worst-case situation (Philips, G., 2005).

6.4.3.4. Input data to odour dispersion model

Table 6.22 illustrates the overall exhaust stream characteristics used within the dispersion modelling assessment. This data is inputted into the dispersion model whereby maximum downwind ground level concentrations (GLC's) of odour are predicted for a worst-case meteorological file. Dublin Airport 2001 to 2003 inclusive was used to calculate the dispersion estimates. Dublin 2002 provided worst-case dispersion estimate. All buildings were incorporated into the dispersion model in order to account for any building wake affects. As base mapping was not available, all maximum ground level concentration of odours are presented in tabular format (see Table 6.23).

Table 6.22. Odour emission input data to odour dispersion model three odour abatement scenarios.

Input parameter	Dispersion parameters for Stack odour control	Dispersion parameters for Biofiltration odour control	Dispersion parameters for Carbon odour control
Odour emission flux (Ou_E m^{-2} s^{-1})	79.31	79.31	79.31
Waste surface area (m^2)	800	800	800
Volumetric airflow rate (Am^3 s^{-1})	14.91	14.91	14.91
Odour threshold conc. (Ou_E m^{-3})	4571	4571	4571
Odour removal efficiency (%)	78% (less than 1000 Ou_E m^{-3} in outlet air stream)	89% (less than 500 Ou_E m^{-3} in outlet air stream)	0% (odour emission exhaust through 65 metre stack)
Odour emission rate (Ou_E s^{-1})	14,910	7,455	68,154
Stack height (meters)	65	28	28
Stack tip diameter (m^2)	2.20	1.10	1.10
Temperature (K)	293.15	298.15	293.15
Efflux velocity (m s^{-1})	3.92	15	15

Table 6.23 illustrates comparison of the predicted ground level concentrations and the established limit ground level concentration at the 98th percentile of hourly averages. Additionally, the 99th maximum percentile concentration is presented as worst-case scenario. As can be observed, the predicted ground level concentrations are within the established limit value for all three proposed techniques.

Table 6.23 Predicted ground level concentrations from proposed technologies using ISCST3 and AERMOD Prime.

98th percentile	Stack Maximum predicted ground level conc. (Ou$_E$ m^{-3})	Biofilter Maximum predicted ground level conc. (Ou$_E$ m^{-3})	Carbon Maximum predicted ground level conc. (Ou$_E$ m^{-3})	Limit value-3.0 Ou$_E$ m^{-3} at the 98th percentile
ISC ST3	2.60	1.20	0.60	3.0 Ou$_E$ m^{-3} at the 98th percentile
AERMOD Prime	0.30	1.0	0.60	3.0 Ou$_E$ m^{-3} at the 98th percentile

6.4.4 Discussion of Results

Table 6.23 illustrates the maximum predicted ground level concentrations of odours from the three proposed technologies. Using both ISC ST3 and AERMOD Prime dispersion models, all proposed techniques achieve the proposed odour impact criterion limit value.

The predicted odour concentration of the proposed techniques Stack dispersion, Biofiltration and Carbon filtration using ISC ST3 dispersion model is higher than AERMOD Prime. This is due to the Building Prime algorithmic treatment of the stack source. The AERMOD Prime model provides more accurate treatment of building wake effects through the more advance building prime algorithm. Knowing this fact, dispersion through the proposed existing 65-metre stack provided better dispersion and lower ground level concentrations of odours than either Biofiltration or Carbon filtration (see Figures 6.3 and 6.4). Since the proposed stack will be existing, and since there will be no dependency on a particular technology, it is proposed that the risk of odour impact is less using the stack dispersion technique in comparison to biofiltration/carbon filtration.

6.4.5 Conclusions

The following conclusions were drawn:

1) An average odour threshold concentration of 2448 Ou$_E$ m^{-3} was measured on a similar Waste to energy plant in Kallo, Belgium. This was used to calculate an odour threshold concentration of 4571 Ou$_E$ m^{-3} for the proposed Waste to energy plant to be located in Callanstown, Duleek, Co. Meath. The assumption of working with a fixed emission concentration per square meter of waste results in a higher odour threshold concentration while using a lower volumetric flow

rate. The calculated odour mass flow can, as a consequence, be considered as a worst-case situation (Philips, G., 2005).

2) Since the waste surface area in the new proposed plant will be 800 m^2, and the total volumetric airflow extraction rate from the bunker area will be 50,000 $Nm^3\ hr^{-1}$, the predicted odour emission rate will be 68,154 $Ou_E\ s^{-1}$ at 293.15 K assuming no dilution in odour threshold concentration.

3) Three odour control techniques were assessed in order to control odour emissions during scheduled shut down (from 14 to 30 days). These included:
   - Negative ventilation of bunker storage with primary air during scheduled shutdown and exhaust through the existing 65-metre stack,
   - Negative ventilation of bunker storage during schedule shutdown and treatment in a fixed bed biofiltration system,
   - Negative ventilation of bunker storage during schedule shutdown and treatment in an annular bed carbon filtration system.

   The three odour control techniques were assessed in terms of maximum predicted ground level concentration of odour.

4) Following dispersion modelling assessment using the two recommended EPA dispersion-modelling packages ISC ST3 and Aermod Prime, all predicted ground level concentrations will be less than 3.0 $Ou_E\ m^{-3}$ at the 98th percentile limit value for a worst-case meteorological year. It is therefore concluded that no predicted odour impacts will be generated from the three proposed odour control techniques.

5) Following analysis of the data, dispersion through the proposed existing 65-metre stack provides better dispersion and lower ground level concentrations of odours than either Biofiltration or Carbon filtration. Since the proposed stack will be existing, and since there will be no dependency on a particular technology, it is proposed that the risk of odour impact is less using the stack dispersion technique in comparison to biofiltration/carbon filtration. Only primary air during scheduled shut down will be exhausted through the stack through by passing the furnace.

6.4.6 Recommendations

The following recommendations are presented:

1. Develop and maintain a strict odour management plan for the proposed waste to energy facility operation.
2. Maintain a 50,000 $Nm^3\ hr^{-1}$ extraction volume on the waste holding bunkers during normal operation and scheduled maintenance.
3. Prevent the handling and sorting of putrescible waste within the waste reception hall floor. All putrescible waste will be directly tipped into the bunker area.
4. Place a lime layer over the stored waste within the bunker to prevent any significant emissions from the surface of the waste during scheduled shutdown. Alkaline-based lime will adsorb acidic-based odour precursors commonly found in waste.
5. Exhaust all extraction air from the bunker area through the proposed 65-metre stack.

6. Ensure all cladding joints are overlapped and sealed on the waste reception hall to ensure high quality building integrity and no odour/air leakage. This is good building construction practice.
7. Ensure that controllable fresh air intake dampers are installed on the waste reception hall in order to prevent a reduction in negative air pressure when waste reception hall doors are opened.

6.5 SOCIAL CONSIDERATIONS

6.5.1 Introduction

This proposed development is for the construction of a 70 MW waste-to-energy facility which will have an operating capacity of between 150,000 and 200,000 tonnes per annum, as outlined in previous sections. As discussed in Section 2, Ireland is 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 proposed 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 2004 was 1.2 M tonnes which greatly exceeds the national target. Due to the substantial increase in the amount of BMW generated within Ireland over the past number of years, there is an urgent requirement to establish necessary treatment facilities in order to achieve the National targets as set out by the landfill directive and the Draft National Strategy for Biodegradable Waste.

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

Some of the attractions within Duleek and the surrounding areas are listed above under 'Heritage and Amenity'. There is one tourist accommodation facility (B+B) within a 3Km radius of the proposed development which is Whiterock Farmhouse, Newtown, Donore, Co. Meath. Despite its close proximity to the Boyne Valley, there are no hotels, caravan sites or self-catering accommodation in the study area.

Incinerator in Vienna

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.

Incinerator in Portugal

Incinerator in Maderia

Incinerator in Majorca

6.7 LAND USE

6.7.1 Introduction

The proposed facility will be located on an area of 10.13 hectares (25 acres in the townsland 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.)

6.7.2 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.

6.8 ECONOMIC ACTIVITY

6.8.1 Introduction

The total labourforce within the study area in 2002 was 1,413. The largest employment sector is in the manufacturing and industry sector accounting for 21.45% of the employment rate i.e. 274 people. This is followed closely by both the commerce and construction sectors comprising 20.8% and 18.45% of the workforce respectively. The agricultural sector has decreased by 6.13% in the six year period from 1996 to 2002, while the building and construction sector has increased by nearly 6% in the same time frame.

6.8.2 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 236 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

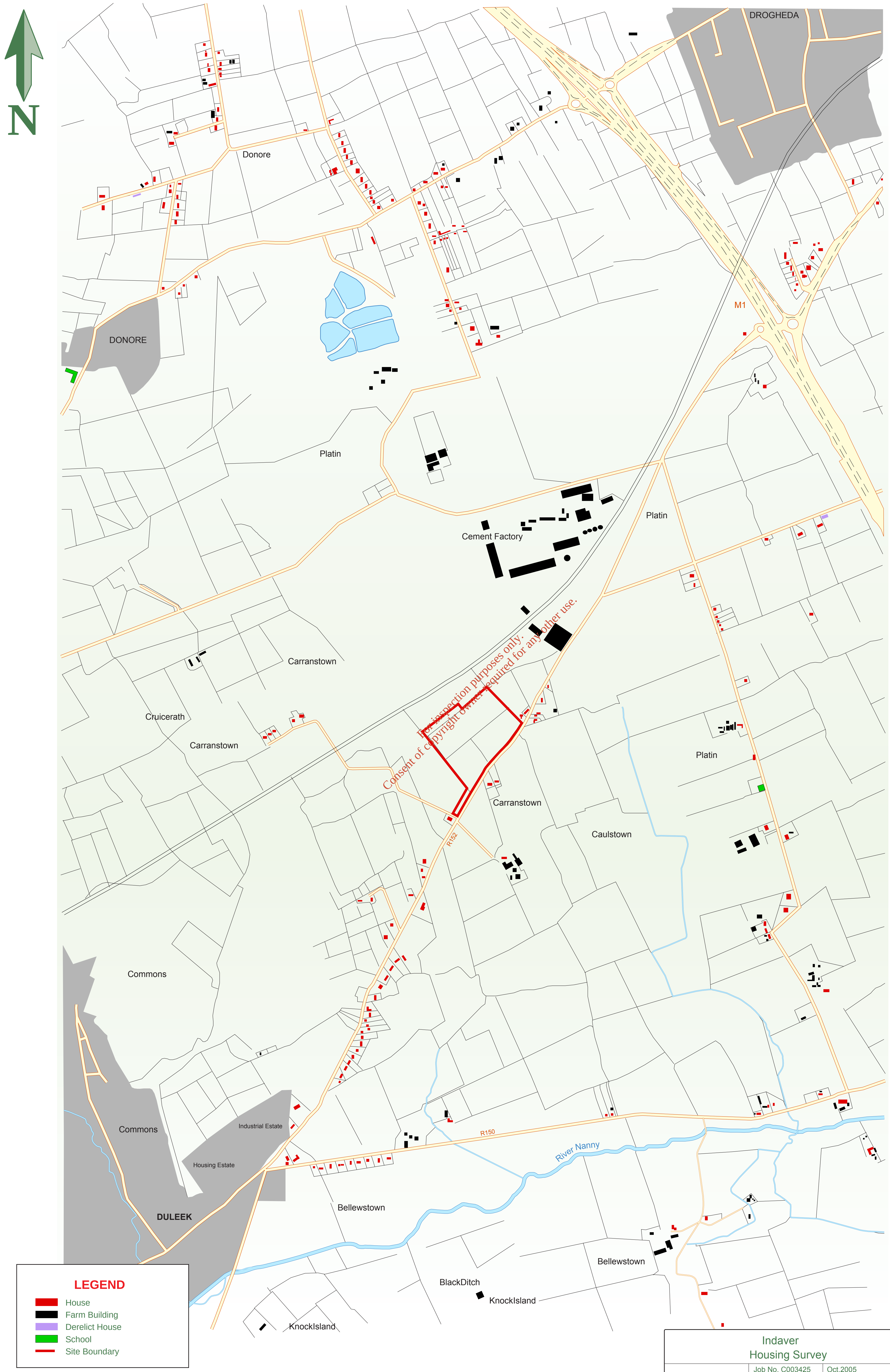
If Indaver Ireland was to be successful in its planning application, it is expected that a condition of this permission would be an annual financial contribution to Meath County Council for the provision of environmental improvement and recreational/community facility projects in the vicinity of the proposed facility. It is likely the amount of the contribution will be based on a payment per tonne of waste thermally treated and agreed between Indaver Ireland and Meath County Council. From experience to date, the local community of Carranstown and its environs could expect an annual contribution in the region of €250,000 into this environmental fund. The identification of environmental/recreational/community facility projects shall be decided by Meath County Council and the Community Liaison Committee (See Section 1).

6.8.3 Mitigation Measure

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.

6.9 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 from the construction and operation phases of the proposed development.



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

Indaver
Housing Survey

Figure No.6.1
Job No. C003425 | Oct.2005
Finalised By -

White Young Green

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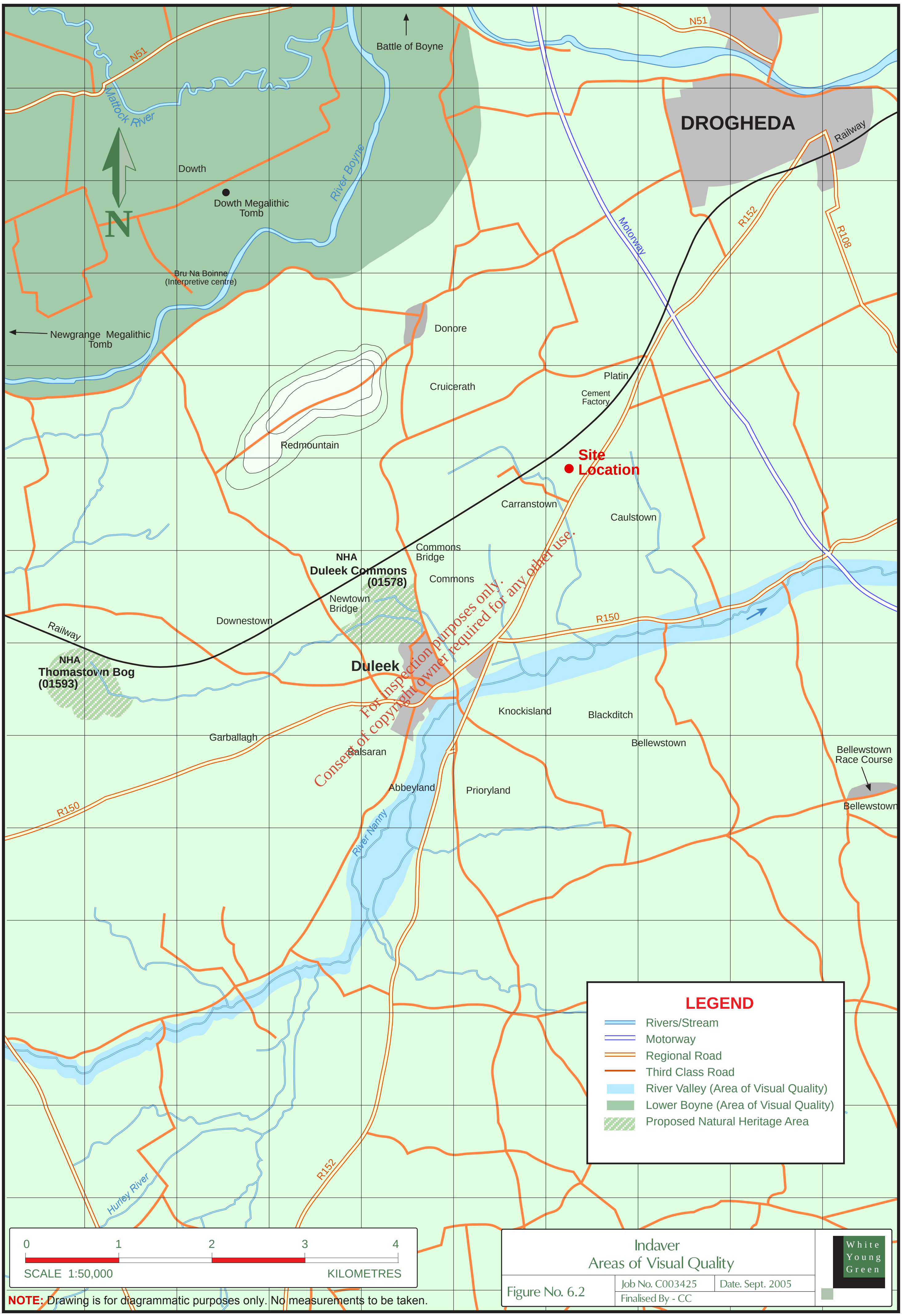

NOTE: Drawing is for diagrammatic purposes only. No measurements to be taken.

Indaver
Areas of Visual Quality

Figure No. 6.2

Job No. C003425 | Date. Sept. 2005

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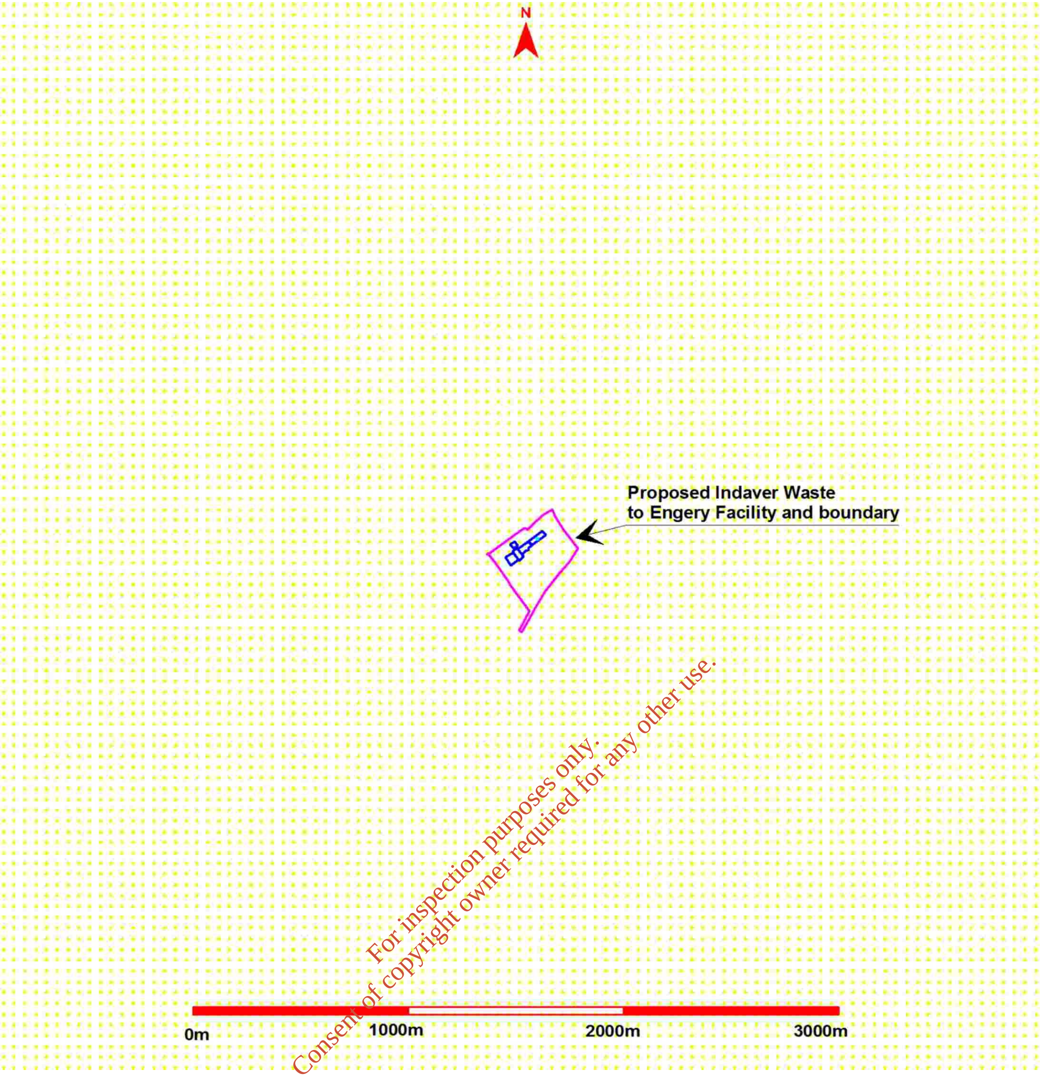

Figure 6.3. Indaver NV facility location and boundary.

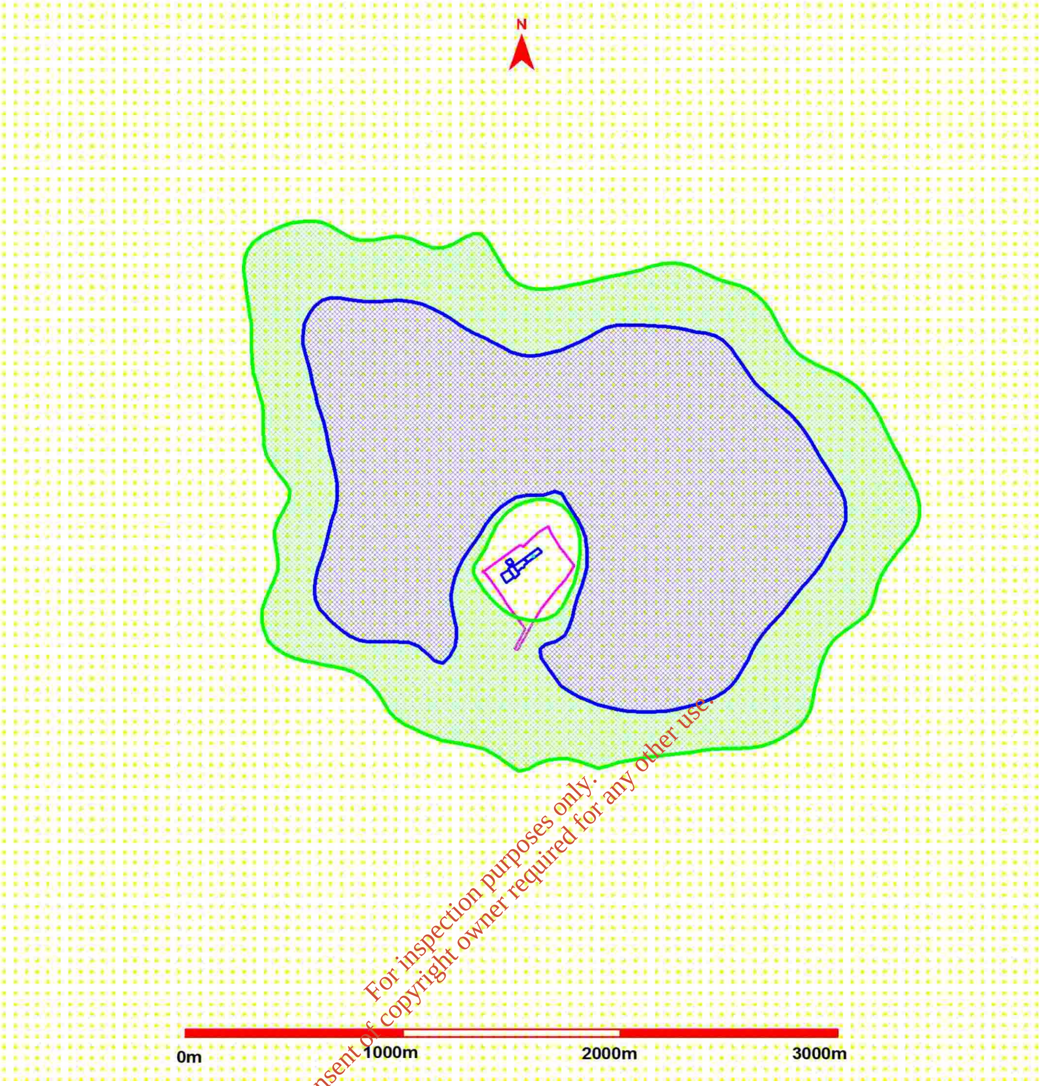

Figure 6.4. Predicted odour concentrations of 0.10 OuE m-3 for the 98th (—) and 99th (—) percentile using Aermod Prime dispersion model.

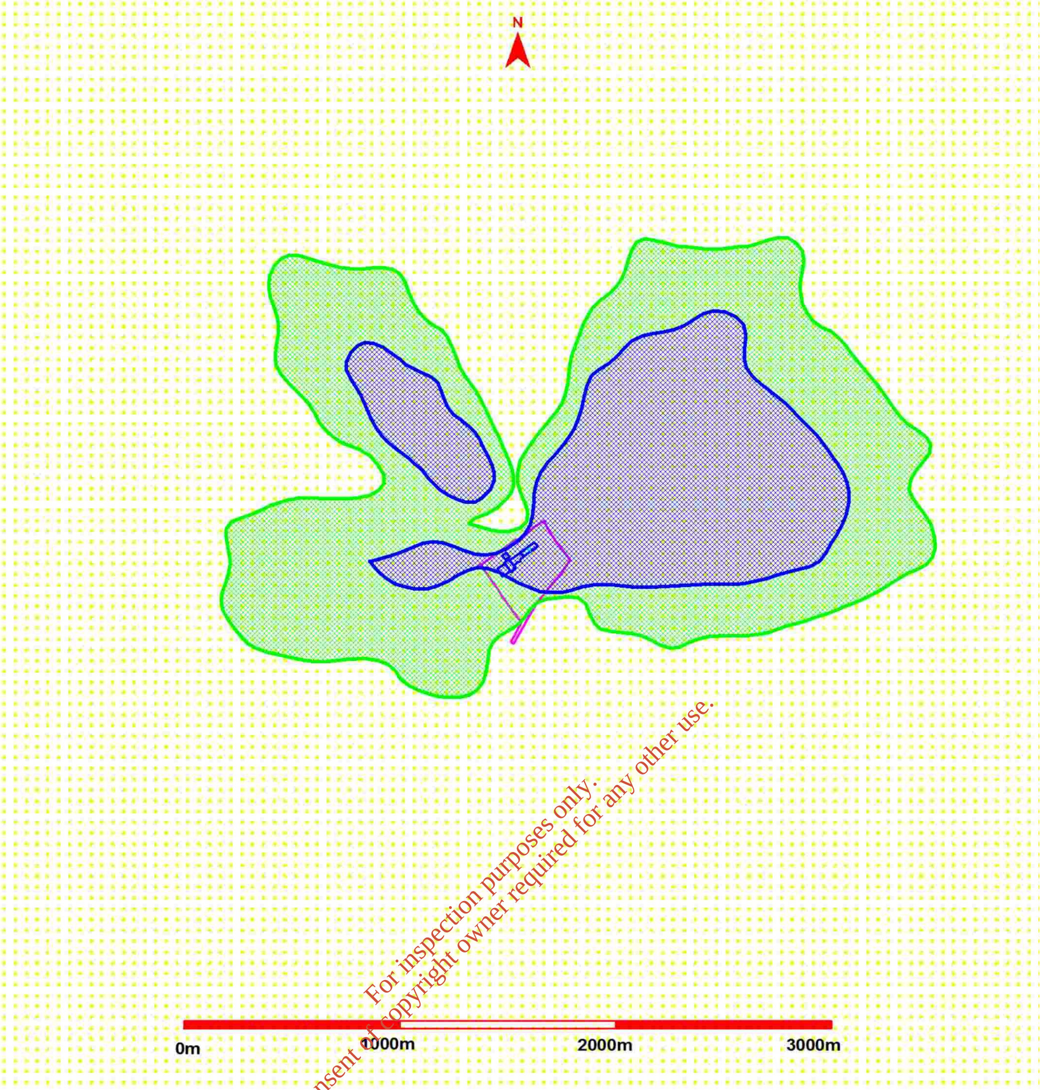

Figure 6.5. Predicted odour concentrations of 0.20 Ou$_E$ m^{-3} for the 98th (▬) and 99th (▬) percentile using ISC ST dispersion model.