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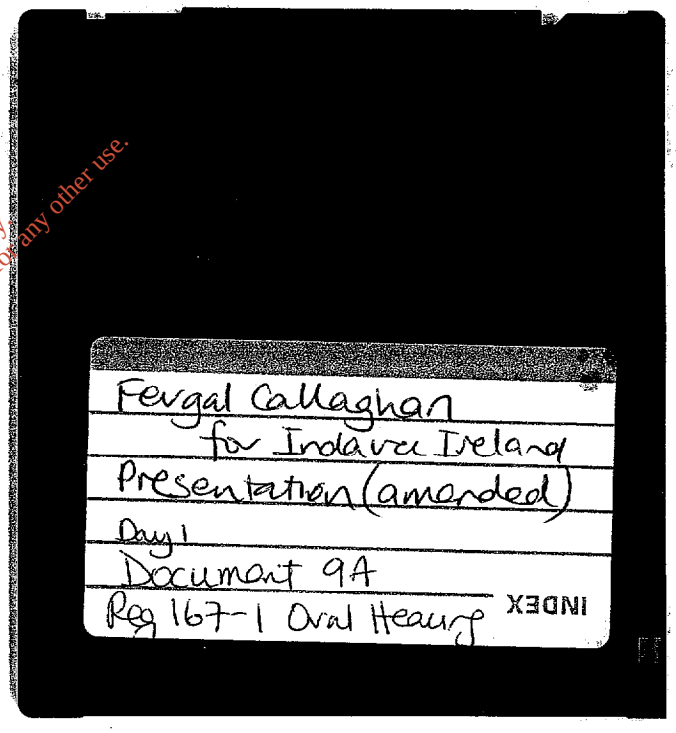

# ORAL HEARING INTO THE

# CARRANSTOWN WASTE MANAGEMENT FACILITY

## PROOF OF EVIDENCE

## SOIL PCDD/F CONCENTRATIONS AND PCDD/F INTAKE

(including amendment on page 8 where the number 0.0025 was corrected to 0.00025)



DR FERGAL CALLAGHAN

AWN CONSULTING LTD

## CONTENTS

## 1.0 QUALIFICATIONS AND EXPERIENCE

Fergal J. Callaghan will say:

1.1 I hold a 2.1 honours degree of Bachelor of Science in Chemistry (1991) from the University of Limerick, where I majored in Environmental Chemistry and a Ph.D. in Chemical Engineering from the University of Birmingham (1998), where I specialised in the chemistry and degradation of waste materials. I am an associate member of the Institute of Chemical Engineers (AMIChemE), a graduate member of the Chartered Institute of Water and Environmental Management, a member of the IChemE Environmental Protection Subject Group (EPSG), a member of the IChemE Loss Prevention and Safety Group and a Member of the Institute of Environmental Management and Assessment (IEMA) and am currently on the Irish Committee of this Organisation. It is a requirement of membership of these organisations that I am active in the field of professional chemistry and environmental assessment and satisfy their requirements with regard to level of qualifications and experience.

1.2 I have been active in the field of chemistry and environmental assessment for 17 years, the last 8 as an Environmental Consultant. I have considerable experience with respect to the analysis and behaviour of chemicals in the environment, and have monitored and modelled the behaviour of many man made chemicals on green field and brown field sites. I have conducted soil PCDD/F sampling studies in both urban and rural environments, in Ireland and the UK, for private developers and Local Authorities, and have modelled PCDD/F exposure for PCDD/F uptake and movement in the environment, in the UK and Ireland. I worked for many years in the UK where I designed and implemented soil contaminant monitoring programmes for the UK (Environment Agency) EA and private companies, and constructed mathematical models of contaminated sites to determine impacts on soil, water and human beings, through multiple exposure pathways. I have represented major brown field developers and Government Agencies developing brown field sites, in the UK and put together models and contaminant assessment strategies for PCDD/F, PAH, heavy metals and other contaminants, which have been accepted by the UK EA, as part of planning and licensing submissions. I have prepared soil quality assessments and modelled contaminant behaviour on development sites in Ireland and successfully presented these assessments to An Bord Pleanala and the EPA.

1.3 I am currently Director with responsibility for Soil Quality with AWN Consulting.

## 2.0 INTRODUCTION

2.1 AWN Consulting Limited was commissioned to model the possible impact of PCDD/F emissions from the Carranstown Waste Management Facility.

2.2 The existing soil PCDD/F concentrations had previously been quantified by means of a soil sampling survey.

2.3 Consideration was given, through reference to published guidance and standards, to suitable means for assessing the potential impact associated with the proposed Carranstown Waste Management Facility.

2.4 Using background (measured) soil and ambient air PCDD/F and also modelled PCDD/F ambient air concentration and deposition data, the theoretical worst case impact of the Facility was modelled, in terms of PCDD/F dose to a theoretical Maximum At Risk Individual (MARI) following US EPA methodology and modelling techniques.

## 3.0 SUMMARY OF RESULTS

### Introduction

The PCDD/F intake study comprised the following components:

- the existing soil and air PCDD/F concentrations in the vicinity of the proposed site at Carranstown were measured previously and these studies were examined
- the air emissions from the proposed Carranstown waste management facility were characterised and quantified (by Dr Edward Porter of AWN Consulting Ltd)
- the dispersion of these emissions was modelled by computer (by Dr Edward Porter of AWN Consulting Ltd)
- the resulting ground level concentrations and wet and dry deposition rates were used to model the theoretical PCDD/F exposure of the MARI.

### Existing Soil PCDD/F at the Carranstown Site

Soil sampling was conducted at 4 locations at the WTE site, in August of 2000, with the aim of determining background PCDD/F. The results of the sampling are shown in Table 2.1 below.



| Sample | Site Location | PCDD/F (ng/kg) [1] |
|---|---|---|
| D1 | WTE Site | 1 |
| D2 | WTE Site | 0.9 |
| D3 | WTE Site | 0.6 |
| D4 | WTE Site | 0.6 |

**Table 2.1** Soil PCDD/F results (as NATO CCMS TEQ)

- Background soil PCDD/F concentrations were found to be low when compared with data from other countries. For comparison, a comprehensive UK study in 1985 found a range of 2,3,7,8 TCDD concentrations from 0.5 – 11

2,3,7,8 TCDD. A study in 1994 in the Rhine Delta in the Netherlands found PCDD/F concentrations in the range of 23 – 93 ng/kg NATO CCMS 2,3,7,8 TCDD TEQ.

- PCDD/F concentrations are similar to those measured elsewhere in rural Ireland and significantly lower than those concentrations measured in urban areas in Ireland (see Table 2.2 below).

| Location | Site Type | I-TEQ (NATO CCMS) (ng/kg) |
|---|---|---|
| Ringaskiddy, Co. Cork (2001)[1] | Industrial | <0.5 – 3.4 |
| Courtlough, Co. Dublin (2001)[2] | Rural | <0.5 – 1.2 |
| Confidential, Co. Meath (2002) [3] | Rural | <0.5 – 1.2 |
| Poolbeg Baseline Monitoring (2003) [4] | Urban | 0.54 - 10 |
| Cork Harbour (2000) [5] | Urban/Rural/Industrial | 0.6 – 1 |
| Cork Harbour(1990) [6] | Industrial | 21.6 – 23.7 |
| Cork Harbour (1994) [7] | Industrial | 2.95 |
| Farms around Askeaton, Limerick (2001) [8] | Rural | 0.6 – 1.5 |



**Table 2.2** PCDD/F concentrations in soil in Ireland.

(1) Taken from Soil Chapter of Waste Management Facility, Indaver Ireland Ringaskiddy EIS, Baseline Dioxin Survey (2001)
(2) Taken from Soil Chapter of Waste Management Facility, Eco/ The Waste Company, Herhoff Process EIS, Courtlough, Co. Dublin, Baseline Dioxin Survey (2001)
(3) Survey for proposed Incinerator site at Nobber, Co Meath, AWN Consulting Ltd, 2002
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(6) EOLAS Soil Monitoring, submitted as Appendix II Attachment No. 12 Sandoz Ringaskiddy Ltd Baseline Studies 1991/1992.
(7) Cork Dioxin Surveys, Cork County Council, Environmental Section, Annual Report, 1994.
(8) Investigation of animal health problems, at Askeaton, Co. Limerick, 2001

## Emissions from the Carranstown Waste Management Facility

The PCDD/F emissions from the facility were characterised by Dr Edward Porter of AWN Consulting Ltd.

## Computer Modelling of the Dispersion of the Stack Emissions

The PCDD/F emissions from the facility were characterised by Dr Edward Porter of AWN Consulting Ltd.

## Theoretical PCDD/F Exposure

Soil sampling and ambient air monitoring data was used to establish a baseline for PCDD/F intake for a theoretical Maximum At Risk Individual at Carranstown.

The MARI was assumed to live at the point of maximum PCDD/F deposition from the proposed development and to be a subsistence farmer, who obtained all of their food (vegetables, milk and meat) from a 100m diameter site, upon which the maximum PCDD/F deposition flux impacted.



The baseline PCDD/F intake for the MARI was modelled following US EPA Methodology (Human Health And Ecological Risk Assessment Support To The Development Of Technical Standards For Emissions From Combustion Units Burning Hazardous Waste, EPA Contract No. 68 - W6 – 0053, US EPA, Washington, July 1999.) and using the Dutch Government Approved Model RISC Human 3.1.

The baseline PCDD/F intake for the MARI was predicted to be 0.575 WHO TEQ 2,3,7,8 TCDD pg /kg body wt/day which is well within the WHO 1 – 4 pg/kg body weight/day and EU PCDD/F 2 pg/kg body wt/day averaged over a week (14 pg/kg body wt/wk) intake criteria.

The annual average PCDD/F emissions under maximum operating conditions (worst case emissions) from the proposed WTE facility were then used to model average soil concentrations of PCDD/F over the operating life of the facility.

The modelled soil and air values were then added to the existing background values for PCDD/F and input to the RISC HUMAN Model.

The model predicted that the PCDD/F intake for the MARI, with the WTE operating at the maximum emission rate to be 0.5777 WHO TEQ 2,3,7,8 TCDD pg/kg body weight per day (a 0.5% increase in theoretical PCDD/F intake) which was still well within the recommended WHO and EU Guideline values for PCDD/F intake.

It was therefore concluded that the proposed WTE facility will have no significant impact on PCDD/F intake for even the theoretical MARI.

It is important to note that the majority of dioxin intake to which the inhabitants of the area around Carranstwon are exposed to currently is from food, and this will still be the case when this facility is operational.

The EU SCF in their report of 2000 have noted that some 90% of dioxin intake for citizens of European countries, is from food, with 80% of food related intake being from fish, meat and milk products.

The following modelling exercise puts the idea of dioxin exposure in context.

If we take an inhabitant of the area around Carranstown, the principal dioxin exposure routes for this individual will be inhalation of air and consumption of food, most if not all of which will be sourced from outside the Carranstown area.

The highest background concentration of PCDD/F measured at the site was 46 TEQ fg/ $m^3$ of air. The normal breathing rate for a healthy adult is on average 20 $m^3$/day of air (Konz, J.J, Lisi, K., Friebele, E and Nixon, D. Exposure Factors Handbook, EPA/600/8-89/043, Washington DC EPA 1989).



The EU DG Environment estimates that 75% of inhaled PCDD/F is absorbed (Compilation of EU Dioxin Exposure and Health Data - Task 4 Human Exposure European Commission DG Environment, October 1999). Therefore, a typical adult in the Carranstown area will receive a PCDD/F dose from inhalation of 0.69pg/day. Assuming a 60 kg adult, this equates to a PCDD/F dose from inhalation of 0.0115 TEQ pg/kg bw/d.

To put this in context, milk samples from rural Meath showed PCDD/F concentrations of 10.1 pg/kg I-TEQ. A 300 ml glass of milk from rural Meath therefore provides a PCDD/F dose of 3.12 pg of PCDD/F, so 1/5$^{th}$ of a glass of milk from rural Meath provides the same daily PCDD/F dose as one day's inhalation of PCDD/F in the Carranstown area.

The annual average predicted ground level concentration of PCDD/F, from the proposed WTE facility is 1 fg/$m^3$. The additional PCDD/F dose from inhalation is therefore predicted to be 0.015 pg or 0.00025 pg expressed as TEQ pg/kg bw/d or the equivalent of drinking an additional 1/200$^{th}$ of a glass of milk from rural Meath each day.

This PCDD/F dose should also be put in the context of the PCDD/F dose experienced by the population from other food stuffs. Taking meat and milk related PCDD/F dose, which is derived as follows, using Irish Department of Agriculture data for food consumption, PCDD/F data from the Teagasc Food Research Centre and the EPA PCDD/F Milk Studies.

| ADULT | | PCDD/F | PCDD/F | PCDD/F | Adult | PCDD/F |
|---|---|---|---|---|---|---|
| | kg/day | ng/kg | ng/day | pg/day | Body Wt | pg/kg/day |
| Meat | 0.258 | 0.062 | 0.015996 | 15.996 | 60 | 0.2666 |
| Milk | 0.425 | 0.01 | 0.00425 | 4.25 | 60 | 0.070833 |
| | | | | | | |
| Sum | | | | | | **0.337** |

The predicted dose is 0.337 pg/kg bw/day. This is over 1000 times the PCDD/F dose through inhalation predicted for the WTE facility. This puts in context the insignificant PCDD/F exposure from the WTE facility.

**Summary of Assessment**

The background soil PCDD/F in the Carranstown area was found to be low when compared with data from other countries. The predicted impact of the facility was found to be insignificant for even the theoretical MARI.

We would like to address a specific objection at this point, which was raised by Dundalk Town Council. We feel that all of the other objections and comments have been addressed by the preceeding text.



The comment specifically refers to the potential risk to the unborn and proposes to calculate a toxic dose to a theoretical "unborn" of 4 pg, assuming a theoretical body weight of 1 kg. It is important to point out the flaws and misunderstandings inherent in this submission. Firstly, the predicted increased dose to even a MARI receptor adult is calculated to be 0.0027 pg/kg body weight/day, as discussed in the previous sections of this report.

Secondly the WHO chose the 1 – 4 pg/kg bw/day limit to include for protection of full grown healthy adults, children and the un born, who of course do not directly inhale the atmosphere but will be exposed to PCDD/F through the PCDD/F concentration within the mothers body.

The 1 – 4 pg/kg bw/day range was chosen based on the NOAEL (no observable affect) and LOAEL (lowest observable effect) values from numerous studies and then a safety factor of 10 was included as a precaution. Hence the argument contained in this objection has no substance.

It is also important to note the insignificant contribution of incineration plant to PCDD/F concentrations in the environment, when compared with other sources of PCDD/F.

The EPA National Dioxin Inventory 2002 noted that, even assuming incinerator projects currently in planning are in operation, the projected contribution of incinerators to airborne PCDD/F emissions is at most 0.75 TEQ/annum or 1.8% of

airborne PCDD/F emissions in 2010. The bulk of PCDD/F emissions (84%) will continue to come from accidental fires at buildings and uncontrolled burning of wastes.

The following Figures from the Inventory are particularly relevant in this regard, for both the situation in Year 2000 and in 2010.

Figure I: Best Estimate Emissions to air – 2000 (range also shown)

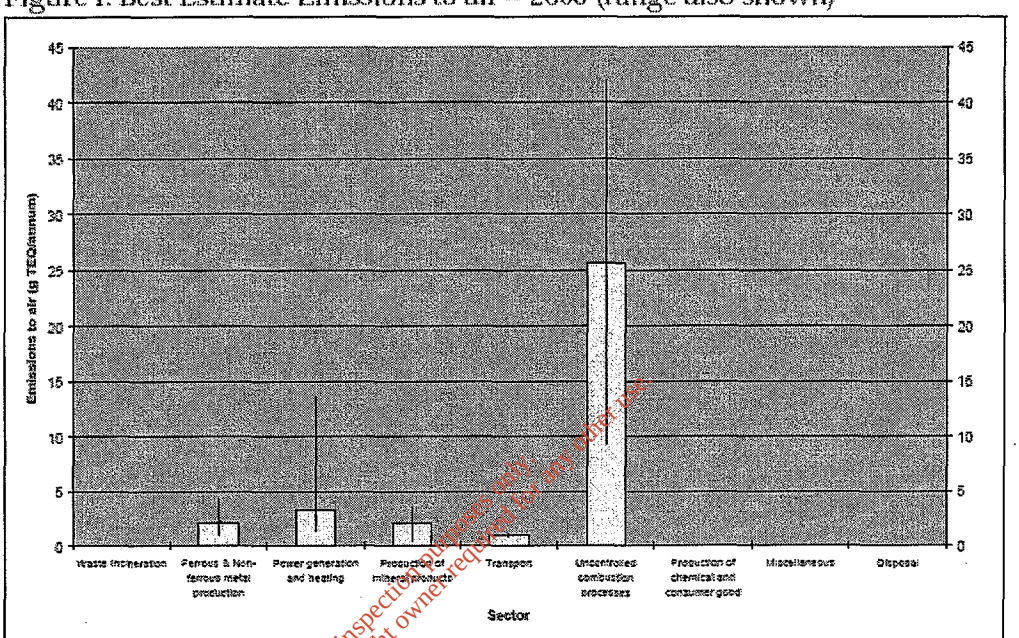
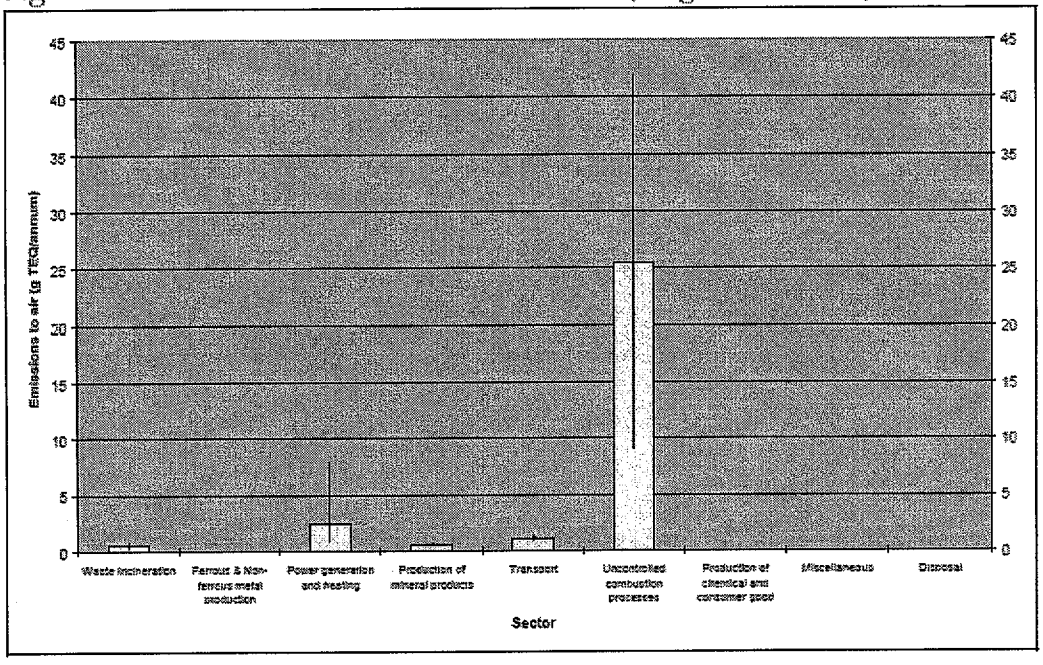


Figure III: Best estimate emissions to air – 2010 (range also shown)



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2.4 Using background (measured) soil and ambient air PCDD/F and also modelled PCDD/F ambient air concentration and deposition data, the theoretical worst case impact of the Facility was modelled, in terms of PCDD/F dose to a theoretical Maximum At Risk Individual (MARI Adult or $MARI_A$) and a $MARI_C$ (Child) following US EPA methodology and modelling techniques.

## 3.0 SUMMARY OF RESULTS

### Introduction

The risk assessment study comprised the following components:

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- the dispersion of these emissions was modelled by computer (by Dr Edward Porter of AWN Consulting Ltd)
- the resulting ground level concentrations and wet and dry deposition rates were used to model the theoretical PCDD/F exposure of the MARI $_A$ and MARI $_C$.

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| Cork Harbour (1994) [7] | Industrial | 2.95 |
| Farms around Askeaton, Limerick (2001) [8] | Rural | 0.6 – 1.5 |



**Table 2.2** PCDD/F concentrations in soil in Ireland.

(1) Taken from Soil Chapter of Waste Management Facility, Indaver Ireland Ringaskiddy EIS, Baseline Dioxin Survey (2001)
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## Emissions from the Carranstown Waste Management Facility

The PCDD/F emissions from the facility were characterised by Dr Edward Porter of AWN Consulting Ltd.

## Computer Modelling of the Dispersion of the Stack Emissions

The PCDD/F emissions from the facility were characterized by Dr Edward Porter of AWN Consulting Ltd.

### Theoretical PCDD/F Exposure

Soil sampling and ambient air monitoring data was used to establish a baseline for PCDD/F intake for a theoretical Maximum At Risk Individual Adult and a MARI Child ($MARI_A$ and $MARI_C$ respectively) at Carranstown.

The MARI's were assumed to live at the point of maximum PCDD/F deposition from the proposed development and to be subsistence farmers, who obtained all of their food (vegetables, milk and meat) from a 100m diameter site, upon which the maximum PCDD/F deposition flux impacted.

The baseline PCDD/F intake for the MARI was modelled following US EPA Methodology (Human Health And Ecological Risk Assessment Support To The Development Of Technical Standards For Emissions From Combustion Units Burning Hazardous Waste, EPA Contract No. 68 - W6 – 0053, US EPA, Washington, July 1999.) and using the Dutch Government Approved Model RISC Human 3.1.



The baseline PCDD/F intake for the $MARI_A$ was predicted to be 0.575 WHO TEQ 2,3,7,8 TCDD pg /kg body wt/day and for the $MARI_C$ was predicted to be 1.39 WHO TEQ 2,3,7,8 TCDD pg /kg body wt/day, both of which are within the WHO 1 – 4 pg/kg body weight/day and EU PCDD/F 2 pg/kg body wt/day averaged over a week (14 pg/kg body wt/wk) intake criteria.

The annual average PCDD/F emissions under maximum operating conditions (worst case emissions) from the proposed WTE facility were then used to model average soil concentrations of PCDD/F over the operating life of the facility.

The modelled soil and air values were then added to the existing background values for PCDD/F and input to the RISC HUMAN Model.

The model predicted that the PCDD/F intake for the $MARI_A$, with the WTE operating at the maximum emission rate to be 0.5777 WHO TEQ 2,3,7,8 TCDD pg/kg body weight per day (a 0.5% increase in theoretical PCDD/F intake), and, for the $MARI_C$ 1.46 WHO TEQ 2,3,7,8 TCDD pg/kg body weight per day (a 4.8% increase in the theoretical PCDD/F intake) which was still within recommended WHO and EU Guideline values for PCDD/F intake.

It was therefore concluded that the proposed WTE facility will have no significant impact on PCDD/F intake for even the theoretical MARI.

It is important to note that the majority of dioxin intake to which the inhabitants of the area around Carranstwon are exposed to currently is from food, and this will still be the case when this facility is operational.

The EU SCF in their report of 2000 have noted that some 90% of dioxin intake for citizens of European countries, is from food, with 80% of food related intake being from fish, meat and milk products.

The following modelling exercise puts the idea of dioxin exposure in context.

If we take an inhabitant of the area around Carranstwon, the principal dioxin exposure routes for this individual will be inhalation of air and consumption of food, most if not all of which will be sourced from outside the Carranstown area.

The highest background concentration of PCDD/F measured at the site was 46 TEQ fg/ $m^3$ of air. The normal breathing rate for a healthy adult is on average 20 $m^3$/day of air (Konz, J.J, Lisi, K., Friebele, E and Nixon, D. Exposure Factors Handbook, EPA/600/8-89/043, Washington DC EPA 1989).

The EU DG Environment estimates that 75% of inhaled PCDD/F is absorbed (Compilation of EU Dioxin Exposure and Health Data - Task 4 Human Exposure European Commission DG Environment, October 1999). Therefore, a typical adult in the Carranstown area will receive a PCDD/F dose from inhalation of 0.69pg/day. Assuming a 60 kg adult, this equates to a PCDD/F dose from inhalation of 0.0115 TEQ pg/kg bw/d and assuming a 30 kg child, this assumes a PCDD/F dose from inhalation of 0.023 pg/kg bw/d.



To put this in context, milk samples from rural Meath showed PCDD/F concentrations of 10.1 pg/kg I-TEQ. A glass of milk from rural Meath therefore provides a PCDD/F dose of 3.12 pg of PCDD/F, so 1/5$^{th}$ of a glass of milk from rural Meath provides the same daily PCDD/F dose as one days inhalation of PCDD/F in the Carranstown area.

The annual average predicted ground level concentration of PCDD/F, from the proposed WTE facility is 1 fg/$m^3$. The additional PCDD/F dose from inhalation is therefore predicted to be 0.0025 and 0.005 for an adult and child respectively expressed as TEQ pg/kg bw/d or the equivalent of drinking an additional 1/200$^{th}$ of a glass of milk from rural Meath each day.

This PCDD/F dose should also be put in the context of the PCDD/F dose experienced by the population from other food stuffs. Taking meat and milk related PCDD/F dose, which is derived as follows, using Irish Department of Agriculture data for food consumption, PCDD/F data from the Teagasc Food Research Centre and the EPA PCDD/F Milk Studies.

| ADULT | | PCDD/F | PCDD/F | PCDD/F | Adult | PCDD/F |
|---|---|---|---|---|---|---|
| | kg/day | ng/kg | ng/day | pg/day | Body Wt | pg/kg/day |
| Meat | 0.258 | 0.062 | 0.015996 | 15.996 | 60 | 0.2666 |
| Milk | 0.425 | 0.01 | 0.00425 | 4.25 | 60 | 0.070833 |
| | | | | | | |
| Sum | | | | | | **0.337433** |

| CHILD | | PCDD/F | PCDD/F | PCDD/F | Child | PCDD/F |
|---|---|---|---|---|---|---|
| | kg/day | ng/kg | ng/day | pg/day | Body Wt | pg/kg/day |
| Meat | 0.258 | 0.062 | 0.015996 | 15.996 | 30 | 0.5332 |
| Milk | 0.425 | 0.01 | 0.00425 | 4.25 | 30 | 0.141667 |
| | | | | | | |
| Sum | | | | | | **0.674867** |

The predicted dose is 0.337 and 0.674 pg/kg bw/day for an adult and child respectively. This is over 100 times the PCDD/F dose through inhalation predicted for the WTE facility. This puts in context the insignificant PCDD/F exposure from the WTE facility.



**Summary of Assessment**

The background soil PCDD/F in the Carranstown area was found to be low when compared with data from other countries. The predicted impact of the facility was found to be insignificant for even the theoretical MARI (for both adult and child).

We would like to address a specific objection at this point, which was raised by Dundalk Town Council. We feel that all of the other objections and comments have been addressed by the preceeding text.

The comment specifically refers to the potential risk to the unborn and proposes to calculate a toxic dose to a theoretical "unborn" of 4 pg, assuming a theoretical body weight of 1 kg. It is important to point out the flaws and misunderstandings inherent in this submission. Firstly, the predicted increased dose to even a MARI receptor adult is calculated to be 0.0027 pg/kg body weight/day, as discussed in the previous sections of this report.

Secondly the WHO chose the 1 – 4 pg/kg bw/day limit to include for protection of full grown healthy adults, children and the un born, who of course do not directly inhale the atmosphere but will be exposed to PCDD/F through the PCDD/F concentration within the mothers body.

The 1 – 4 pg/kg bw/day range was chosen based on the NOAEL (no observable affect) and LOAEL (lowest observable effect) values from numerous studies and then a safety factor of 10 was included as a precaution. Hence the argument contained in this objection has no substance.

It is also important to note the insignificant contribution of incineration plant to PCDD/F concentrations in the environment, when compared with other sources of PCDD/F.

The EPA National Dioxin Inventory 2002 noted that, even assuming incinerator projects currently in planning are in operation, the projected contribution of incinerators to airborne PCDD/F emissions is at most 0.75 TEQ/annum or 1.8% of airborne PCDD/F emissions in 2010. The bulk of PCDD/F emissions (84%) will continue to come from accidental fires at buildings and uncontrolled burning of wastes.

The following Figures from the Inventory are particularly relevant in this regard, for both the situation in Year 2000 and in 2010.

Figure I: Best Estimate Emissions to air – 2000 (range also shown)

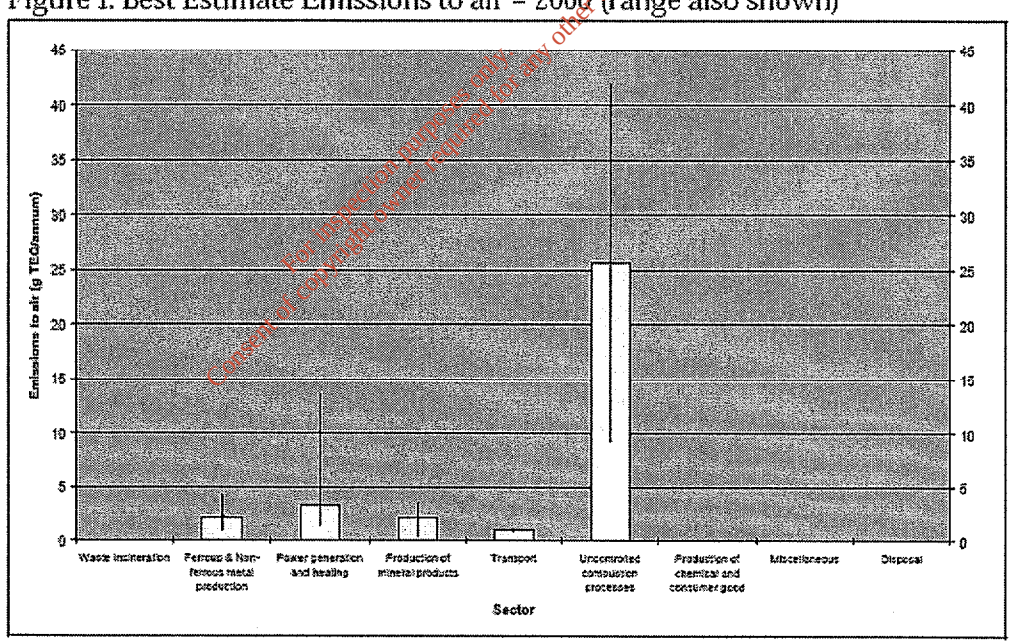

Figure III: Best estimate emissions to air – 2010 (range also shown)