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EPA ORAL HEARING INTO THE

DUBLIN WASTE TO ENERGY FACILITY

BRIEF OF EVIDENCE

PCDD/F CONCENTRATION IN SOIL AND PCDD/F INTAKE

DR FERGAL CALLAGHAN

AWN CONSULTING

(10 April 2008)

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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 a Member of the UK Dioxin Network, a Member of the Royal Society of Chemistry (MRSC) 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 have been appointed to 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 11 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.

<u>Recent Soil PCDD/F Project Experience</u>

- Poolbeg Waste to Energy Plant, An Bord Pleanala, Oral Hearing, (2007)
- Carranstown Waste-to-Energy Plant An Bord Pleanala Oral Hearing (2007)
- Ringaskiddy Waste-to-Energy Plant Waste Licence & Oral Hearing (2005)

- Carranstown Waste-to-Energy Plant Waste Licence & Oral Hearing (2005)
- MBM Waste-to-Energy Plant EIS (2003)
- Liquid Waste Incinerator EIS, Cork (2003)
- Courtlough Waste-to-Energy Plant EIS (2002)

Other Soil Chemistry Assessment Project Experience

- Dublin Port Tunnel (2006)
- Metro North (2007)
- Dublin North Fringe Project (2006)
- Wyeth Expansion (2004)
- Dublin S2S (2004/2005)
- Alza Pharmaceuticals EIS (2001)
- Analog Devices IPC Licence Review (2001).
- Clifden Airstrip EIS & Oral Hearing (2000))
- Heuston Office & Technology Park EIS & Oral Hearing (2002)

EXECUTIVE SUMMARY OF EVIDENCE

I have provided a detailed description of my evidence in the following Sections (numbered Sections 2.0 – 5.0), however, I would like to present my brief and findings in a form which summarises the key points from the following 17 pages of evidence, and would ask, if the Inspector considers it appropriate, that the remaining 17 pages be taken as read.

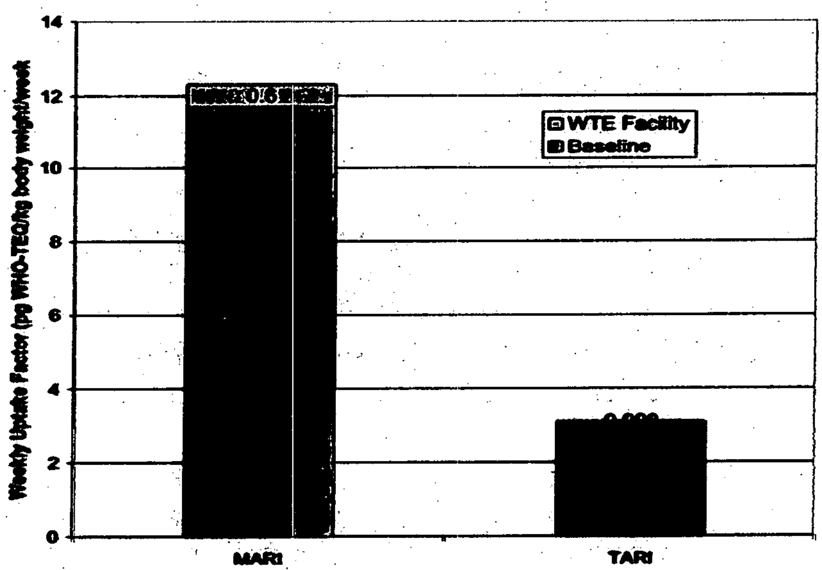
My brief for this project was to take the PCDD/F deposition data determined by my colleague Dr Porter and use this data to predict the potential increase in soil PCDD/F concentrations and subsequent exposure to PCDD/F associated with the proposed WTE facility, for two theoretical individuals, the Maximum At Risk Individual (MARI), who spends all their time at the point of maximum deposition and obtains all their vegetables from this point, and the Typical At Risk Individual (TARI), which is more representative of a typical receptor, in that all of their food is grown or raised outside the City of Dublin.

The results of the modelling work I undertook are shown in the Table E-1and Figure E-1..

Table E-1. PCDD/F Uptake Summary for Comparison with EC Tolerable Weekly Intake (TWI) Value

	Baseline PCDD/F Intake	PCDD/F Intake from WTE	Total PCDD/F Intake (WTE Plant and Baseline)	Contribution of WTE over Baseline as % Increase
	pg/kg/wk	pg/kg/wk	pg/kg/wk	%
MARI	11.7	0.6	12.3	5.1
TARI	3.0196	0.008	3.0276	0.27

Figure E.1. Comparison Baseline Condition and Total with WTE



The PCDD/F modelling study concluded that the predicted PCDD/F exposure for three scenarios were all less than the EC Tolerable Weekly Intake (TWI) of 14 pg/kg/wk. The three scenarios are Baseline, the WTE Facility itself and the sum of the two. .very low and is well within current limit values.

The predicted PCDD/F exposure for each scenario is based on a multiple pathway analysis that included conservative assumptions for both the receptor and the source . Table E-2 identifies the major pathways for MARI and TARI with Table E-3 identifying the conservative aspects of the source and how it was modelled.

Table E-2. Major Pathways and Parameters

Parameter	MARI	TARI
Pathway(s)	Inhalation	Same
	Ingestion of soil, dust, water, meat, milk, dairy products, vegetables	Same
	Dermal contact with soil, water	Same
Exposure	16 hours/Day; 7 days/week	Same
	50 Weeks/year	Same
	6 years as a child	Same
	60 years as an adult	Same
Location	Highest deposition rate	Same
Individual	Subsistence farmer that raises all vegetables (leafy and tuberous) at the point of maximum impact. Milk and Meat are from off-site.	All food is from off-site.

Table E-3. Modeling Assumptions

Parameter	MARI	TARI
Dispersion Modeling		
Flue Gas Rate	Maximum	Same
Stack Emission Value as ng-TEQ/m3 at 11 % O_2	Maximum allowable (0.1)	Same
Maximum Impact Area		
Location	Sean Moore Park is not a residential area and is a closed landfill.	Same
Soil Concentrations	Background assumed to be higher than urban garden areas	Same
RISC Human Model Version 3.2	Conservative default values used	Same

Together Table E-2 and E-3 describe a very conservative situation that is not likely to exist for a variety of reasons and as a result, the estimated update values for both MARI and TARI are considered to be high for the Baseline, the WTE facility only and the sum of the two. It is important to point out that the ingestion of vegetables is the primary pathway for the Baseline condition however this pathway is considered to be very unlikely in practice because the location for the MARI is Sean Moore Park, a reclaimed landfill that is not available for residential occupation or farming and the closest land area to the area of maximum deposition (the area of maximum deposition actually being over the sea to the south east of the WTE facility).

Estimated values for TARI are more reasonable however they are also considered to be very conservative for several reasons including the occupancy period, the fact that the maximum deposition occurs to the south east of the WTE site and not over Sean Moore Park the model default values and the fact that while the WTE contributes a small contribution relative to background, actual operations will be less than the maximum flue gas emission rate and maximum licensed emission rate for PCDD/F.

2.0 INTRODUCTION

2.1 AWN Consulting Limited was commissioned to conduct a detailed appraisal of the potential impact on PCDD/F intake associated with the Dublin Waste to Energy Facility. PCDD/F will be used as the term to describe dioxins and furans, the 17 dioxin and furan congeners which are considered to be of toxicological significance are commonly referred to as dioxins, although these 17 congeners comprise 7 dioxin congeners and 10 furan congeners. Dioxins and furans are chemically very similar compounds, with furans having one less oxygen atom than dioxins, in their chemical structure.

2.2 Soil PCDD/F quality data was assessed by means of a review of baseline data.

2.3 Available published guidance documents which are relevant to assessing the PCDD/F intake impacts from a WTE facility were consulted.

2.4 The impact of the proposed Dublin Waste To Energy Facility on PCDD/F intake was assessed. The assessment was carried out using Dutch, UK and USEPA modelling methodology, which has previously been accepted as a suitable approach for assessing the impacts of WTE plant, by the Irish EPA.

2.5 The impact of PCDD/F emissions was compared with relevant standards and guidance and PCDD/F intake from other sources.

3.0 ASSESSMENT APPROACH

3.1 The approach adopted for the PCDD/F intake assessment firstly involved a detailed consideration of the available published guidance documents and Directives which are relevant to assessing the PCDD/F intake impacts from an incineration facility. The key documents consulted in the assessment were:

- Council Directive 2000/76/EC (The Incineration Directive)
- 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 1999USEPA
- USEPA (1998) Human Health Risk Assessment Protocol, Chapter 3: Air Dispersion and Deposition Modelling
- RISC HUMAN (May 2005) Van Hall Institut, Leeuwarden/Groningen, for the Dutch National Institute of Public Health and Environmental Protection (RIVM), on behalf of the Dutch Ministry for Spatial Planning, Housing and the Environment, May 2005(Technical Guide)
- Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes, HMIP/CPR2/41/1/181, London 1996
- Opinion of the Scientific Committee on the Risk Assessment of Dioxins and Dioxin-like PCBs in Food 22/11/2000", adopted 30th May 2001 (SCF/CS/CNTMDIOXIN/ 20 Final)

3.2 The modelling approach, as per UK Dutch and USEPA guidance was as follows:

3.3 Develop a (Conceptual Site Model) CSM to assess the potential dietary intake of PCDD/F for the theoretical USEPA Maximum at Risk Individual (MARI) – known as the HMEI in the UK- and the Typical At Risk Individual (TARI);

3.4 The CSM was developed as follows using UK Dutch US EPA Guidance :

Background concentrations of PCDD/F are transferred to a human receptor by the following pathways;

- 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 (this pathway was eliminated as the area of land in question is not agricultural and PCDD/F exposure from known levels in Irish produce was used to model this component of PCDD/F intake)
- Ingestion of milk and dairy products (this pathway was eliminated as the area of land in question is not agricultural and PCDD/F exposure from known levels in Irish produce was used to model this component of PCDD/F intake)
- Ingestion of vegetables
- Ingestion of surface water
- Ingestion of suspended matter in water
- Dermal contact with surface water

3.5 The CSM assumes all PCDD/F is 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 PCDD/F congeners.

3.6 PCDD/F deposition data and concentration data (wet and dry phase, particulate and vapour phase) was determined by Dr Edward Porter of AWN Consulting Ltd, predicted ambient air PCDD/F concentrations were also determined.

3.7 The CSM assumes the remainder of the PCDD/F deposited is available for uptake through the pathways listed above. The group of 17 PCDD/F 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 or is present in the vapour phase. It is therefore not valid to model the PCDD/F concentrations as a total TEQ as 2,3,7,8 PCDD/F value or to only model the chemical characteristics of PCDD/F intake as 2,3,7,8 PCDD/F and each congener must therefore be modelled separately.

3.8 A conservative approach has been adopted in the current assessment. This will lead to estimated PCDD/F intake values which are likely to be over-estimates of the levels which will arise under normal operations, the approach is as follows:

- The MARI lives at the point where the highest deposition rate, for emissions from the proposed WTE facility occurs.
- The MARI is an individual, 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;

- The MARI only eats vegetables grown on this soil (milk and meat are obtained off site as the environment in question is an urban environment and cattle raising is not practised in this area)

- The TARI lives at the point where the highest deposition rate, for emissions from the proposed WTE facility occurs.

- The TARI is an individual, who spends 16 hours per day, 7 days per week, 50 weeks per year outside in the area where the deposition occurs;

- The TARI spends 6 years as a child and 60 years as an adult living on the site;

- The TARI does not eat any food produced in the area in which they live.

- The WTE facility operates at maximum permitted PCDD/F concentrations and maximum permitted flow rates, 24 hours per day, 365 days per year

- The chosen site for where the MARI is located is in Sean Moore Park, which is not a residential area, and is a former landfill site which has been capped with soil and urban fill material, and therefore background PCDD/F concentrations are likely to be more elevated than in urban garden areas

- The nearest area in which urban gardens are located is a considerable distance away from the site of maximum deposition and therefore, the deposition rate experienced by the MARI or the TARI will in reality be much less than the rate used in this modelling scenario, as deposition rate decrease significantly with distance from the emission point

4.0 BASELINE ASSESSMENT

4.1 Information existing (baseline) soil PCDD/F concentrations in the vicinity of the proposed WTE facility was obtained from a monitoring survey conducted in the region of the site of the proposed facility.

4.2 AWN Consulting Ltd previously carried out a programme of background soil sampling and monitoring (ref FC/03/2008SR01). Between 100 and 150 samples were taken at each sampling point and combined to form one sample, which was then analysed. The results of this survey and the location of the monitoring points are summarised in Tables 4.1 - 4.3.:

AWN Sampling Point	Sampling Point Location	Position	Sampling Date
A	Sean Moore Park	53° 20.169' N 006° 12.923' W	5th November 2003
B	Irishtown Nature Park	53° 20.161' N 006° 11.757' W	6th November 2003
C	Ringsend Park	53° 20.520' N 006° 13.258' W	3rd November 2003
D	Sandymount (grassed area along the sea front)	53° 19.584' N 006° 12.456' W	7th November 2003
E	Clontarf (grassed area along the sea front)	53° 21.476' N 006° 11.605' W	29th October 2003
F	Bull Island Nature Reserve	53° 21.962' N 006° 09.223' W	31st October 2003

Table 4.1 Location of AWN Sampling Points

Sampling Point	Sampling Point Location
A	SW of site, peak area from dispersion model
B	Adjacent and to the South of site, predicted peak area from dispersion model
C	West of site, closest residential community
D	SW of site, residential community (downwind of NE winds)
E	North of site, residential community
F	NE of site (downwind of SW winds)

Table 4.2 Rationale for choosing AWN sampling locations

Sample	Site Location	PCDD/F (ng/kg) [1]
A	Sean Moore Park	10
B	Irishtown Nature Park	5.7
C	Ringsend Park	3.2
D	Sandymount Promenade	23
E	Clontarf Promenade	3.9
F	Bull Island Nature Reserve	0.54

Table 4.3 Analysis results

1 NATO/CCMS I TEQ (Toxic Equivalent) (2,3,7,8 – tetrachloro dibenzo-p-dioxin)

4.3 The highest PCDD/F value recorded (NATO CCMS TEQ OF 23 ng/kg)was for the sample from the road side location at Sandymount, Sample D from the soil monitoring report. However, this is a road side location and is subject to localised PCDD/F emission sources such as traffic fumes and hence would not be a realistic background soil concentration for the MARI.

4.4 The next highest PCDD/F value, recorded for Sean Moore Park, which was also at the point of maximum ground level concentration as predicted using the US EPA approved AERMOD modelling software package (and as presented elsewhere in this EIS). This source is not close to significant traffic emissions and therefore is not likely to be significantly affected by the PCDD/F component of such emissions, unlike the Sandymount sample.

4.5 It was therefore decided that the soil concentration for the background on the site inhabited by the MARI and the TARI would consist of a soil PCDD/F contribution of 9.5 ng/kg WHO TEQ (for consistency, the soil concentration value has been converted to WHO TEQ, as the EU intake limit values are given in WHO TEQ). The ambient air concentrations used were those measured by AWN (and presented elsewhere in the EIS Document) in Winter 2004 which are considerably higher than those measured in Summer 2003 and hence it was felt that the use of these figures was suitably conservative

5.0 MODELLING ASSESSMENT

5.1 Baseline Modelling

5.1.1 The RISC Human Model Version 3.2 (May 2005) package was chosen to model intake of PCDD/F. 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. The model consists of series of equations which allow each of the pathways listed in Section 3.0 to be modelled mathematically.

5.1.2 Baseline modelling for the MARI and TARI was conducted using the baseline soil concentrations described in Section 4.0.

5.1.3 The model predicted a baseline PCDD/F intake for the MARI of 1.4 pg/kg body weight/day (9.8 pg/kg body weight/week) using the WHO TEF values and a baseline intake for the TARI of 0.0849 pg/kg body weight/day (0.594 pg/kg body weight/week) using the WHO TEF values . Both values are much less than the EC TWI (Tolerable Weekly Intake) of 14 pg WHO-TEQ/kg body weight/wk (from Update to "Opinion of the Scientific Committee on the Risk Assessment of Dioxins and Dioxin-like PCBs in Food 22/11/2000", adopted 30th May 2001 (SCF/CS/CNTMDIOXIN/ 20 Final)), the individual congeners are shown in Tables 5.1 and 5.2.

PCDD Congeners	pg/kg/d
	WHO TEQ
2,3,7,8-TCDD	1.66E-01
1,2,3,7,8-PeCDD	7.26E-01
1,2,3,4,7,8-HxCDD	3.28E-02
1,2,3,6,7,8-HxCDD	1.21E-01
1,2,3,7,8,9-HxCDD	7.01E-02
1,2,3,4,6,7,8-HpCDD	7.52E-02
OCDD	1.08E-02
PCDF Congeners	0.00E+00
2,3,7,8-TCDF	7.70E-03
1,2,3,7,8-PeCDF	4.89E-03
2,3,4,7,8-PeCDF	8.50E-02
1,2,3,4,7,8-HxCDF	3.60E-02
1,2,3,6,7,8-HxCDF	1.97E-02
1,2,3,7,8,9-HxCDF	9.90E-03
2,3,4,6,7,8-HxCDF	9.38E-03
1,2,3,4,6,7,8-HpCDF	1.64E-02
1,2,3,4,7,8,9-HpCDF	1.40E-02
OCDF	1.81E-03
WHO TEF	1.40668

Table 5.1 MARI Baseline PCDD/F congeners

PCDD Congeners	pg/kg/d
	WHO TEQ
2,3,7,8-TCDD	2.65E-03
1,2,3,7,8-PeCDD	5.28E-03
1,2,3,4,7,8-HxCDD	1.43E-03
1,2,3,6,7,8-HxCDD	1.47E-03
1,2,3,7,8,9-HxCDD	1.69E-03
1,2,3,4,6,7,8-HpCDD	3.48E-03
OCDD	2.90E-04
PCDF Congeners	
2,3,7,8-TCDF	3.10E-03
1,2,3,7,8-PeCDF	1.18E-03
2,3,4,7,8-PeCDF	4.53E-02
1,2,3,4,7,8-HxCDF	5.52E-03
1,2,3,6,7,8-HxCDF	3.89E-03
1,2,3,7,8,9-HxCDF	4.02E-03
2,3,4,6,7,8-HxCDF	2.09E-03
1,2,3,4,6,7,8-HpCDF	3.24E-03
1,2,3,4,7,8,9-HpCDF	3.01E-04
OCDF	3.45E-05
WHO TEF	0.08492

Table 5.2 Modelled baseline PCDD/F intake for TARI– using WHO TEF

Note: this exposure is, for both a child and an adult, from exposure to inhaled and ingested soil particles, and is only 4% of the EU t-TWI. This modelled value also assumes that the exposed individual spends 16 hours per day, 7 days per week outside in the exposed area, whereas the most likely exposure one could envisage might be 8 hours per day, 7 days per week so actual exposure is at most 2% of the t-TWI.

5.1.4 However, in order to determine PCDD/F total contribution for the MARI and TARI, it is necessary to include PCDD/F exposure from vegetables, meat and dairy products, based on dairy products sourced in the Dublin area and in the EU and meat sourced in Ireland and the EU and Food Safety Promotion Board food consumption data. The calculation procedure and calculated values are shown in Tables 5.3 and 5.4

MARI						
		PCDD/F	PCDD/F	PCDD/F	Adult	PCDD/F
	kg/day	ng/kg	ng/day	pg/day	Body Wt	pg/kg/day
Meat	0.157	0.067	0.010	10.458	60	0.17
Milk	0.238	0.022	0.005	5.232	60	0.09
Sum						0.26

Table 5.3 Calculated PCDD/F from off-site Meat and Milk Intake for MARI

TARI						
		PCDD/F	PCDD/F	PCDD/F	Adult	PCDD/F
	kg/day	ng/kg	ng/day	pg/day	Body Wt	pg/kg/day
Meat	0.157	0.067	0.010	10.458	60	0.17
Milk	0.238	0.022	0.005	5.236	60	0.09
Leafy Veg	0.118	0.012	0.001	1.416	60	0.02
Tuber Veg	0.225	0.017	0.004	3.825	60	0.06
Sum						0.35

Table 5.4 Calculated PCDD/F from off-site Meat, Milk and Vegetable Intake for TARI

5.1.5 The predicted MARI and TARI baselines, for the modelled site related PCDD/F dose from exposure to PCDD/F in the area and for the PCDD/F dose from food sources are shown in Table 5.5.

	A	B	C	D
	pg/kg/d	pg/kg/d	%	%
MARI	0.26	1.4066	16	84
TARI	0.35	0.0849	80	20

Table 5.5 Calculated total MARI and TARI Baselines and percentage of PCDD/F from outside area

Where:

A = Food sourced outside area pg/kg bw/day

B = PCDD/F intake from area pg/kg bw/day

C = % PCDD/F from outside area

D = % PCDD/F contribution from area

5.1.6 It is of interest to note that the strongly conservative modelling assumptions used to generate the MARI intake figures lead to a relatively high baseline dose for the MARI, when compared with the more realistic TARI, where the baseline dose from the area is shown to be quite low.

5.1.7 However, even the TARI is somewhat conservative, as it is assumed that the receptor in question spends all of their time (for 16 hours per day) in the environment where the soil value used in the modelling study was measured

5.2 Maximum Deposition Rate of PCDD/F from WTE Emissions and Calculation of Predicted Soil and Air Concentrations

5.2.1 Air emissions from the proposed WTE facility were modelled by AWN Consulting. Emissions were assessed assuming the unrealistically worst case scenario that the plant operated continuously under the maximum emission limits of EU Directive 2000/76/EC Modelling was carried out using AERMOD with meteorological data from Dublin Airport for the period 1993 - 2005 and using on-site data for the Years 2004 and Years 2005. The worst-case year (i.e. the year giving the highest ambient concentration) was the on-site data for 2004.

5.2.2 The deposition flux data determined by the air dispersion modelling exercise 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. The model enables increases in soil concentrations due to aerial deposition of PCDD/F 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 PCDD/F concentrations in soil.

5.3 Modelling of Impact of WTE Emissions on PCDD/F Intake

5.3.1 The modelled PCDD/F WHO TEQ intake value for the impact of WTE Emissions on PCDD/F intake for the MARI and the TARI (using the predicted soil and ambient air concentrations), in pg/kg body weight/day, are presented in Tables 5.6 and 5.7.

PCDD Congeners	mg/kg/d PCDD/F	WHO TEQ	mg/kg/d WHO TEQ	pg/kg/d WHO TEQ
2,3,7,8-TCDD	1.68E-10	1	1.68E-10	1.68E-01
1,2,3,7,8-PeCDD	8.15E-10	1	8.15E-10	8.15E-01
1,2,3,4,7,8-HxCDD	3.51E-10	0.1	3.51E-11	3.51E-02
1,2,3,6,7,8-HxCDD	1.27E-09	0.1	1.27E-10	1.27E-01
1,2,3,7,8,9-HxCDD	7.33E-10	0.1	7.33E-11	7.33E-02
1,2,3,4,6,7,8-HpCDD	7.54E-09	0.01	7.54E-11	7.54E-02
OCDD	1.08E-07	0.0001	1.08E-11	1.08E-02
PCDF Congeners				
2,3,7,8-TCDF	7.75E-11	0.1	7.75E-12	7.75E-03
1,2,3,7,8-PeCDF	9.80E-11	0.05	4.90E-12	4.90E-03
2,3,4,7,8-PeCDF	1.75E-10	0.5	8.75E-11	8.75E-02
1,2,3,4,7,8-HxCDF	3.67E-10	0.1	3.67E-11	3.67E-02
1,2,3,6,7,8-HxCDF	2.01E-10	0.1	2.01E-11	2.01E-02
1,2,3,7,8,9-HxCDF	1.01E-10	0.1	1.01E-11	1.01E-02
2,3,4,6,7,8-HxCDF	9.98E-11	0.1	9.98E-12	9.98E-03
1,2,3,4,6,7,8-HpCDF	1.64E-09	0.01	1.64E-11	1.64E-02
1,2,3,4,7,8,9-HpCDF	2.00E-11	0.01	2.00E-13	2.00E-04
OCDF	1.81E-08	0.0001	1.81E-12	1.81E-03
			1.50E-09	1.50004

Table 5.6 Modelled WTE + baseline PCDD/F intake for MARI

PCDD Congeners	mg/kg/d PCDD/F	WHO TEQ	mg/kg/d WHO TEQ	pg/kg/d WHO TEQ
2,3,7,8-TCDD	2.68E-12	1	2.68E-12	2.68E-03
1,2,3,7,8-PeCDD	5.71E-12	1	5.71E-12	5.71E-03
1,2,3,4,7,8-HxCDD	1.45E-11	0.1	1.45E-12	1.45E-03
1,2,3,6,7,8-HxCDD	1.53E-11	0.1	1.53E-12	1.53E-03
1,2,3,7,8,9-HxCDD	1.76E-11	0.1	1.76E-12	1.76E-03
1,2,3,4,6,7,8-HpCDD	3.48E-10	0.01	3.48E-12	3.48E-03
OCDD	2.92E-09	0.0001	2.92E-13	2.92E-04
PCDF Congeners				0.00E+00
2,3,7,8-TCDF	3.12E-11	0.1	3.12E-12	3.12E-03
1,2,3,7,8-PeCDF	2.38E-11	0.05	1.19E-12	1.19E-03
2,3,4,7,8-PeCDF	9.13E-11	0.5	4.57E-11	4.57E-02
1,2,3,4,7,8-HxCDF	5.60E-11	0.1	5.60E-12	5.60E-03
1,2,3,6,7,8-HxCDF	3.92E-11	0.1	3.92E-12	3.92E-03
1,2,3,7,8,9-HxCDF	4.06E-11	0.1	4.06E-12	4.06E-03
2,3,4,6,7,8-HxCDF	2.17E-11	0.1	2.17E-12	2.17E-03
1,2,3,4,6,7,8-HpCDF	3.24E-10	0.01	3.24E-12	3.24E-03
1,2,3,4,7,8,9-HpCDF	1.86E-11	0.01	1.86E-13	1.86E-04
OCDF	3.45E-10	0.0001	3.45E-14	3.45E-05
			8.61E-11	0.08607

Table 5.7 Modelled WTE + baseline PCDD/F intake for TARI

5.3.2 The increase in PCDD/F dose associated with the WTE facility, for both the MARI and TARI, is shown in Table 5.8. The baseline PCDD/F dose, from food sourced outside area of the WTE facility and within area, is shown in Table 5.9 to allow for comparison with the predicted PCDD/F dose when the WTE facility is operational, which is shown in Table 5.10.

5.3.3 It can be seen that the increase in PCDD/F dose, for both the MARI and TARI, is very low, and both MARI and TARI PCDD/F intake is still well below the recommended value of 14 pg/kg bw/week.

	Baseline	Inc. Dose	Predicted Dose	% Increase	Predicted Dose
	pg/kg/d	pg/kg/d	Pg/kg/d		pg/kg/wk
MARI	1.4066	0.0938	1.5004	6.67	10.5028
TARI	0.0849	0.00117	0.08607	1.38	0.60249

Table 5.8 Increase in PCDD/F dose associated with WTE facility, for site contribution only

	A	B	C	D	E	F
	pg/kg/d	pg/kg/d	%	%	pg/kg/d	pg/kg/wk
MARI	0.26	1.4066	16	84	1.67	11.7
TARI	0.35	0.0849	80	20	0.4314	3.0196

Table 5.9 Baseline PCDD/F dose from within and outside site

	A	B	C	D	E	F
	pg/kg/d	pg/kg/d	%	%	pg/kg/d	pg/kg/wk
MARI	0.26	1.5004	15	85	1.76	12.3
TARI	0.35	0.08607	80	20	0.4325	3.0278

Table 5.10 Predicted PCDD/F dose when WTE plant operational

Where:

A = Food sourced outside area pg/kg bw/day
B = PCDD/F intake from area pg/kg bw/day
C = % PCDD/F from food from outside area pg/kg bw/day
D = % PCDD/F contribution from area pg/kg bw/day
E= Combined Dose pg/kg bw/day
F= Combined Dose pg/kg bw/day

5.4 Modelling of Accident Scenario at WTE facility

5.4.1 It was also considered prudent to model the impact of a credible accident scenario, on PCDD/F intake, this was accomplished as follows. It was assumed that the facility operated at 10 ng/m^3 PCDD/F I-TEQ for 48 hours and the impact of this event was assessed, in terms of PCDD/F intake, in pg/kg bw/day. The results of this modelling assessment are shown in Tables 5.11 and 5.12.

PCDD Congeners	mg/kg/d PCDD/F	WHO TEQ	mg/kg/d WHO TEQ	pg/kg/d WHO TEQ
2,3,7,8-TCDD	1.68E-10	1	1.68E-10	1.68E-01
1,2,3,7,8-PeCDD	8.59E-10	1	8.59E-10	8.59E-01
1,2,3,4,7,8-HxCDD	3.60E-10	0.1	3.60E-11	3.60E-02
1,2,3,6,7,8-HxCDD	1.29E-09	0.1	1.29E-10	1.29E-01
1,2,3,7,8,9-HxCDD	7.48E-10	0.1	7.48E-11	7.48E-02
1,2,3,4,6,7,8-HpCDD	7.54E-09	0.01	7.54E-11	7.54E-02
OCDD	1.08E-07	0.0001	1.08E-11	1.08E-02
PCDF Congeners				0.00E+00
2,3,7,8-TCDF	7.76E-11	0.1	7.76E-12	7.76E-03
1,2,3,7,8-PeCDF	9.81E-11	0.05	4.91E-12	4.91E-03
2,3,4,7,8-PeCDF	1.77E-10	0.5	8.85E-11	8.85E-02
1,2,3,4,7,8-HxCDF	3.70E-10	0.1	3.70E-11	3.70E-02
1,2,3,6,7,8-HxCDF	2.02E-10	0.1	2.02E-11	2.02E-02
1,2,3,7,8,9-HxCDF	1.01E-10	0.1	1.01E-11	1.01E-02
2,3,4,6,7,8-HxCDF	1.02E-10	0.1	1.02E-11	1.02E-02
1,2,3,4,6,7,8-HpCDF	1.64E-09	0.01	1.64E-11	1.64E-02
1,2,3,4,7,8,9-HpCDF	2.00E-11	0.01	2.00E-13	2.00E-04
OCDF	1.81E-08	0.0001	1.81E-12	1.81E-03
			1.55E-09	1.55008

Table 5.11 Modelled WTE Accident + baseline PCDD/F intake for MARI

PCDD Congeners	mg/kg/d	WHO	mg/kg/d	pg/kg/d
	PCDD/F	TEQ	WHO TEQ	WHO TEQ
2,3,7,8-TCDD	2.72E-12	1	2.72E-12	2.72E-03
1,2,3,7,8-PeCDD	5.93E-12	1	5.93E-12	5.93E-03
1,2,3,4,7,8-HxCDD	1.46E-11	0.1	1.46E-12	1.46E-03
1,2,3,6,7,8-HxCDD	1.56E-11	0.1	1.56E-12	1.56E-03
1,2,3,7,8,9-HxCDD	1.78E-11	0.1	1.78E-12	1.78E-03
1,2,3,4,6,7,8-HpCDD	3.48E-10	0.01	3.48E-12	3.48E-03
OCDD	2.92E-09	0.0001	2.92E-13	2.92E-04
PCDF Congeners				0.00E+00
2,3,7,8-TCDF	3.13E-11	0.1	3.13E-12	3.13E-03
1,2,3,7,8-PeCDF	2.38E-11	0.05	1.19E-12	1.19E-03
2,3,4,7,8-PeCDF	9.20E-11	0.5	4.60E-11	4.60E-02
1,2,3,4,7,8-HxCDF	5.63E-11	0.1	5.63E-12	5.63E-03
1,2,3,6,7,8-HxCDF	3.93E-11	0.1	3.93E-12	3.93E-03
1,2,3,7,8,9-HxCDF	4.06E-11	0.1	4.06E-12	4.06E-03
2,3,4,6,7,8-HxCDF	2.21E-11	0.1	2.21E-12	2.21E-03
1,2,3,4,6,7,8-HpCDF	3.24E-10	0.01	3.24E-12	3.24E-03
1,2,3,4,7,8,9-HpCDF	1.87E-11	0.01	1.87E-13	1.87E-04
OCDF	3.45E-10	0.0001	3.45E-14	3.45E-05
			8.68E-11	0.08683

Table 5.12 Modelled WTE Accident + baseline PCDD/F intake for TARI

5.4.2 A comparison with the predicted PCDD/F intake under normal operating conditions and the % increase in PCDD/F dose resulting from an accident are shown in Table 5.13. It can be seen from Table 5.13 that the accident scenario described above is predicted to lead to an increase in PCDD/F dose for the MARI of 3.3% and of 0.88% for the TARI. Again, these dose levels are insignificant when compared with EU weekly intake guideline values.

	Normal Operation	Increase	Accident Scenario	% increase
	Predicted Dose	in Dose	Predicted Dose	
	pg/kg/d	pg/kg/d	pg/kg/d	
MARI	1.5004	0.04968	1.55008	3.31
TARI	0.08607	0.00076	0.08683	0.88

Table 5.13 Comparison with predicted PCDD/F intake and percentage increase

5.5 Summary of Impact on PCDD/F Intake

It was concluded that the predicted impact of the emissions from the proposed WTE facility, for both maximum operating conditions and an accident scenario, on the MARI and the TARI is not significant. The predicted PCDD/F intake for the MARI and the TARI was modelled to be well below the EC TWI of 14 pg/kg body weight/wk.

6.0 CONCLUSION

The PCDD/F modelling study concluded that, even using an extremely unlikely scenario, which assumes the WTE plant operates at maximum permitted emission flow rates and PCDD/F concentrations and that both MARI and TARI spend all their time at the point of highest PCDD/F deposition, the predicted PCDD/F exposure is very low and well within current limit values.