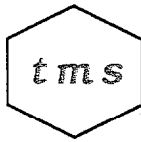


ATTACHMENT 4

AMBIENT AIR QUALITY SURVEY

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Confidential Report

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TMS Environment Ref: 2510, 2671

Order No.	Commencement Date: 12/06/2000	Completion Date: 19/10/2000
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Report title: Ambient air quality survey, Carranstown, Co Meath

Report by:

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1.0 Scope

This report presents the results of a survey of ambient air quality at the site of a proposed industrial development at Carranstown, Co Meath. The scope of the survey included 24-hour average measurements of smoke, sulphur dioxide, nitrogen oxides, hydrogen fluoride, hydrogen chloride and heavy metals over a period of 28-days between 12th June and 13th July 2000. A suite of nineteen metals was included in the analysis (job reference 2510). A further study of 1-hour average nitrogen oxide measurements was completed over a period of 28 days during the period 4th September to 7th October 2000 (job reference 2671). This report is a composite report on the measurement results from both surveys.

2.0 Site location and description

The location of the proposed development is identified in Figure 1 attached as Appendix I to this report.

The site is in a rural location, situated 6 km to the south west of Drogheda and 2 km north east of Duleek. The site is adjacent to the Navan-to-Drogheda railway line on one side and a regional road, the R152, to the other side.

The existing site and surrounds are predominantly rural with a cluster of rural residences approximately 200 m north east of the monitoring location. A cement factory owned by Irish Cement Limited is located approximately 1 km to the north east of the site.

3.0 Survey methodology

3.1 Sampling protocol

Two surveys were conducted by TMS Environment Ltd personnel. Samples for the range of contaminants in the survey were collected within the site of the proposed development area for a total of twenty-eight 24-hour periods over the period 12th June to 13th July 2000. One-hour average nitrogen oxide levels were monitored for 28 days over the period 4th September to 7th October.

An automated 8-day sampler was employed for sample collection for the 24-hour samples. The 1-hour average nitrogen oxide samples were collected in a series of 3 automated 8-day samplers, programmed to collect samples at one-hour intervals.

Measurements were taken at the monitoring location identified in Appendix I, Figure 1. The monitoring site was located in accordance with the relevant standards and was approximately 100 m distant from the regional road and 200 m distant from the nearest rural residences.

Concentrations were expressed at the standard air temperature of 20 °C to allow comparison with the relevant ambient air standards and in particular those of the European Union.

All the sampling and analytical methodologies employed conformed with the relevant Standard Methods.

3.2 Smoke, sulphur dioxide and nitrogen oxides

Samples were collected over 24-hour and 1-hour sampling periods conforming to the relevant standard methods. Sulphur dioxide was collected by absorption in hydrogen peroxide and nitrogen oxides were collected in Griess-Saltzman reagent (for nitric oxide and nitrogen dioxide) and the results expressed as nitrogen dioxide.

Sulphur dioxide analysis was performed according to BS1747: Part 7: 1983 Barium-Thorin spectrophotometric method, and nitrogen oxides were determined according to ASTM D1607: 1976 and the Griess-Saltzman method.

Particulate matter was collected by filtration and smoke was measured using a Reflectometer.

3.3 Hydrogen fluoride and hydrogen chloride

Hydrogen fluoride, and hydrogen chloride measurements were performed according to US EPA Method 26.

Samples were collected over 24-hour sampling periods by absorption in a solution of sulphuric acid and analysis for the halide ions using the ion selective electrodes method.

3.4 Metals

Metal sampling was performed using a filtration technique according to the US Intersociety Committee Methods of Air sampling and analysis. Samples were collected onto MCE filters over 24-hour sampling periods.

The samples were returned to the laboratory for digestion and ICP analysis according to the relevant Standard Methods. Samples were analysed for nineteen metals.

4.0 Measurement results

Full result tables for sulphur dioxide, nitrogen oxides, metals, smoke, HF and HCl are presented in Appendices II and III. Table 1 provides a summary of the results for smoke, sulphur dioxide, nitrogen oxides, HF and HCl. Table 2 provides a summary of the results for metals.

Table 1 Summary of ambient air quality monitoring results for smoke and inorganic substances at Carranstown

Pollutant Concentration $\mu\text{g}/\text{m}^3$, 24-hour averages, June and July 2000			
	Minimum	Average	Maximum
<i>Smoke</i>	0.5	4.3	11
<i>Sulphur Dioxide</i>	< 1	1	7
<i>Nitrogen Oxides, as NO_2</i>	0.3	1.3	2.6
<i>Hydrogen Flouride, as HF</i>	< 0.0001	0.0001	< 0.0001
<i>Hydrogen Chloride, as HCl</i>	< 0.0001	0.0002	0.0018
Pollutant Concentration $\mu\text{g}/\text{m}^3$, 1-hour average, September to October 2000			
	Minimum	Average	Maximum
<i>Nitrogen Oxides, as NO_2</i>	< 2.1	8.1	36.4

Note 1. The < values are less than the limit of detection.

Note 2. The average values were calculated by including values at the limit of detection where appropriate.

Table 2 Summary of 24-hour average ambient air quality monitoring results for metals at Carranstown June and July 2000

Metal	Minimum measured concentration $\mu\text{g}/\text{m}^3$	Maximum measured concentration $\mu\text{g}/\text{m}^3$
<i>Zinc</i>	< 0.005	0.08
<i>Copper</i>	< 0.003	0.03
<i>Nickel</i>	< 0.003	0.069
<i>Chromium</i>	< 0.003	0.12
<i>Lead</i>	< 0.003	0.13
<i>Selenium</i>	< 0.005	0.38
<i>Arsenic</i>	< 0.02	< 0.02
<i>Antimony</i>	< 0.0003	0.012
<i>Molybdenum</i>	< 0.001	0.007
<i>Titanium</i>	< 0.002	0.01
<i>Tin</i>	< 0.011	4.7
<i>Barium</i>	< 0.0002	< 0.0002
<i>Boron</i>	< 0.004	0.22
<i>Cobalt</i>	< 0.001	< 0.001
<i>Thallium</i>	< 0.021	< 0.021
<i>Silver</i>	< 0.01	< 0.01
<i>Mercury</i>	< 0.005	< 0.005
<i>Cadmium</i>	< 0.002	< 0.002
<i>Vanadium</i>	< 0.001	< 0.001

Note 1. A mean concentration has not been calculated for metals because many of the results were below the limit of detection of the method of analysis.

Note 2. The < values are less than the limit of detection.

5.0 Evaluation of results

5.1 Air Quality Standards

Air quality standards and guidelines are available from a number of sources. The guidelines and standards referenced in this report include those from the European Union, Ireland, WHO and Germany (TA Luft).

Where ambient air quality criteria do not exist, as is the case for some of the metals surveyed, it is usual to use $1/40^{\text{th}}$ of the occupational exposure limit (OEL) for an eight-hour reference period¹. Occupational exposure limits are published in Ireland by the National Authority for Occupational Safety and Health and worldwide by other occupational safety agencies².

Air quality standards are developed at different levels for different purposes. European legislation on air quality has been framed in terms of two categories, limit values and guide values. Limit values are concentrations that cannot be exceeded and are based on WHO guidelines for the protection of human health. Guide values are set as a long-term precautionary measure for the protection of human health and the environment.

In this report these guidelines provide the context for categorising air quality measured at the development site as good (well below guidelines levels), poor (approaching guideline levels) or unacceptable (exceeding guideline levels).

Ambient air quality guidelines and standards relevant to the pollutants measured in this survey are summarised in Tables 3, 4, 5, 7 and 8 below. It should be noted that Table 6 presents the EC Daughter Directive Limit Values for PM₁₀, which are included for completeness only. No PM₁₀ monitoring was undertaken in this survey and no specific conclusions can be drawn in regard to ambient concentrations of PM₁₀. The relevant OELs and the values for $1/40^{\text{th}}$ of the OEL are presented in Table 10.

A discussion of the results in relation to the guidelines and standards and expected typical concentrations for similar environments is presented for all pollutants surveyed.

¹ Her Majesty's Inspectorate of Pollution, Environmental Protection Act 1990, Technical Guidance Note (Dispersion), D1, Guidelines on discharge stack heights for polluting emissions, June 1993.

² Code of Practice for the Safety, Health and Welfare at Work (Chemical Agents) Regulations, 1994.

Table 3 Current air quality standards and guidelines for sulphur dioxide, smoke and nitrogen oxides

Air Quality Standard		Parameter and averaging period
Source	$\mu\text{g}/\text{m}^3$	
NO₂		
EU Directive Limit value	200	98 th -percentile of hourly means
Guide Value	135 50	98 th -percentile of hourly means 50 th -percentile of hourly means
WHO Guideline	40 – 50 200	Annual mean Maximum of one-hour means
SO₂		
EU Directive Limit value	350 if smoke = or < 150 250 if smoke > 150	98 th -percentile of daily means; no more than three consecutive days
	180 if smoke = or < 60 130 if smoke > 60	Winter median of daily mean values
Guide Value	120 if smoke = or < 40 80 if smoke > 40	Annual median of daily mean values
WHO Guideline	40 – 60	Annual mean
	50 350 500	Annual mean Maximum one-hour mean Maximum 10-minute mean
Smoke		
EU Directive Limit value	80	Annual median of daily mean values
	130	Winter median of daily mean values
	250	98 th -percentile of daily means
	250	No more than three consecutive days

Table 4 EC Daughter Directive Limit Values for nitrogen dioxide and nitric oxide, (EC/99/30)

Purpose	Averaging period	Limit value	Date by which limit value is to be met
<i>Protection of human health</i>	1 hour	200 µgm ⁻³ NO ₂ not to be exceeded more than 18 times per calendar year	1 January 2010
<i>Protection of human health</i>	Calendar year	40 µgm ⁻³ NO ₂	1 January 2010
<i>Protection of vegetation</i>	Calendar year	30 µgm ⁻³ NO + NO ₂	-

Table 5 EC Daughter Directive Limit Values for sulphur dioxide, (EC/99/30)

Purpose	Averaging period	Limit value	Date by which limit value is to be met
<i>Protection of human health</i>	1 hour	350 µgm ⁻³ not to be exceeded more than 24 times per calendar year ⁽¹⁾	1 January 2005
<i>Protection of human health</i>	24 hours	25 µgm ⁻³ not to be exceeded more than 3 times per calendar year	1 January 2005
<i>Protection of ecosystems</i>	Calendar year (1 October to 31 March)	20 µgm ⁻³	Two years from entry into force of the Directive

⁽¹⁾ Designed to protect against exceedances of the WHO 1996 10-minute guideline to protect health

Table 6 EC Daughter Directive Limit Values for PM₁₀, (EC/99/30)

Purpose	Averaging period	Limit value	Date by which limit value is to be met
<i>Protection of human health</i>	24- hour	50 µgm ⁻³ not to be exceeded more than 35 times per calendar year	1 January 2005
<i>Protection of human health</i>	Calendar year (1 October to 31 March)	40 µgm ⁻³	1 January 2005
<i>Protection of human health</i>	24- hour	50 µgm ⁻³ not to be exceeded more than 7 times per calendar year	1 January 2010
<i>Protection of human health</i>	Calendar year (1 October to 31 March)	20 µgm ⁻³	1 January 2010

Table 7 Air quality standards and guidelines for hydrogen chloride and hydrogen fluoride

Air Quality Standard		Parameter and averaging period
Source	$\mu\text{g}/\text{m}^3$	
<i>TA Luft, 1986</i>	100	HCl Arithmetic mean ⁽²⁾
	200	95 th -percentile
	300 ⁽¹⁾	95 th -percentile
<i>TA Luft, 1986</i>	1.0	HF Arithmetic mean ⁽²⁾
	3.0	95 th -percentile

⁽¹⁾ As long as HCl cannot be clearly separated from Chlorides the 95th -percentile shall be 300 $\mu\text{g}/\text{m}^3$.

⁽²⁾ Interpreted as an hourly average.

Table 8 Ambient air quality standards and guidelines for metals

Air Quality Standard		Parameter and averaging period
Source	$\mu\text{g}/\text{m}^3$	
<i>EU Daughter Directive (EC/99/30)</i> <i>Limit value 1999</i> <i>WHO 1999</i>		Lead
	0.5	Annual average
	0.5	Annual average
<i>WHO 1999</i>	0.005	Cadmium Annual average
<i>WHO 1999</i>	1	Mercury Annual average
<i>WHO 1987</i>	1	Vanadium 24 hour average

Note: WHO Guidelines quoted are as published in "Guidelines for Air Quality," WHO, Geneva, 2000.

5.2 Nitrogen oxides

The measurement results for nitrogen oxides as a 24-hour average are presented in Table A1 of Appendix II. The daily mean concentration was $1.3 \mu\text{g}/\text{m}^3$ as a 24-hour average. A survey of nitrogen oxides was previously conducted by TMS Environment Ltd in the vicinity of this site, which gave a daily mean concentration of $4.5 \mu\text{g}/\text{m}^3$ as a 24-hour average. The results of this survey are similar to those obtained during a previous survey conducted by TMS Environment Ltd at Platin.

Hourly-average measurements were completed at Carranstown for NO_2 for 28 - days during September and October 2000. The average hourly concentration over this period was $8.1 \mu\text{g}/\text{m}^3$ and the range of results was < 2.1 to $36 \mu\text{g}/\text{m}^3$. The variation that occurred during the month is likely to have been due to variations in wind direction and strength relative to sources of NO_2 and variations in temperature.

Nitrogen oxide monitoring in Ireland is relatively limited. The only full time measurement sites are in Dublin. Some monitoring near point sources has been done in non-urban areas. No data relevant to the Carranstown site is available. Annual mean concentrations of nitrogen oxides in rural atmospheres are however, expected to be in the range $0 - 30 \mu\text{g}/\text{m}^3$, and $20 - 90 \mu\text{g}/\text{m}^3$ in urban locations. Winter averages are generally higher than summer averages (World Health Organisation: Guidelines for Air Quality May 2000.)

The results of this survey are within the expected concentration range for a rural environment. The air quality with respect to nitrogen oxide concentrations is described as very good and the results are consistent with expectations for this type of environment.

Limit and Guide values have been set by the European Community. The EU Limit Value as referenced in Table 3 is $200 \mu\text{g}/\text{m}^3$ for NO_2 , expressed as the 98th percentile of hourly averages over a period of one year. The associated EU Guide Value is $135 \mu\text{g}/\text{m}^3$. The EU Limit and Guide Values are not even approached in the area where the survey was completed.

The EU Daughter directive as referenced in Table 4 has specified a new Limit Value of $200 \mu\text{g}/\text{m}^3$ for the 1-hour average concentration of NO_2 , not to be exceeded more than 18 times in a calendar year (99.8th percentile). This is to be met before January 2010. The results of the one-hour average monitoring conducted in September and October 2000, presented in Tables A9 – A24 of Appendix III. The results demonstrate that the existing ambient air quality also meets the requirements of the proposed new EU legislation.

5.3 Sulphur dioxide

The measurement results for sulphur dioxide are presented in Table A2 of Appendix II. The daily mean concentration was $1 \mu\text{g}/\text{m}^3$ as a 24-hour average.

There are 20 networks that monitor sulphur dioxide in Ireland. One station monitoring SO_2 is located in Drogheda. The annual median concentration for

1998³ was 13 µg/m³ and the 98th percentile was 26 µg/m³. Annual mean concentrations of sulphur dioxide in rural areas are expected to be in the range 3 - 6 µg/m³ and 25 - 100 µg/m³ in urban locations (World Health Organisation: Guidelines for Air Quality May 2000).

The values recorded in this survey are consistent with expectations as the site is located in a predominantly rural area.

Limit and Guide values have been set by the European Community. The EU Limit Value for SO₂ as referenced in Table 3 is 80 µg/m³ where smoke is greater than 40 µg/m³. This is expressed as the annual average of daily mean concentrations over a period of one year. The associated Guide Value is 40 µg/m³. The existing ambient air quality at the site meets the regulatory requirements.

The EU Daughter directive as referenced in Table 5 has specified a new Limit Value of 125 µg/m³ for the 24-hour average concentration of SO₂, not to be exceeded more than 3 times in a calendar year. This is to be met before January 2010. A Limit Value of 20 µg/m³ as an annual average is also being introduced for the protection of ecosystems. The existing ambient air quality also meets the requirements of the proposed new legislation, although it is noted that no comparison is possible with the EU Daughter Directive 1 hour limit value because no 1 hour data was collected for SO₂ and the 24-hour results are not directly comparable.

5.4 Hydrogen fluoride and hydrogen chloride

The measurement results for hydrogen fluoride and hydrogen chloride are presented in Table A3 and A4 of Appendix II. Results for hydrogen fluoride and hydrogen chloride were very low. Most results for HCl were below the limit of detection of the method and all the results for HF were below the limit of detection. All of the results were many orders of magnitude lower than the respective TA Luft guideline values.

No background data for HF and HCl was available from other studies.

5.5 Smoke

The measurement results for smoke are presented in Table A5 of Appendix II. The daily mean concentration was 4.3 µg/m³ as a 24-hour average. A previous two week survey of smoke was conducted by TMS Environment Ltd at Platin, report reference 1811 Rev. 3.0. The study gave a daily mean concentration of 8 µg/m³ as a 24-hour average for smoke, similar to the results from this study.

There are 20 networks that monitor smoke in Ireland. Data relevant to the Carranstown site is available for Drogheda. The winter average concentrations of smoke (24-hour averaging period) for Drogheda are reported in the EPA State of the Environment in Ireland Report, dated 1996 and the Air Quality Monitoring Report for 1998, which were reviewed for the purposes of this study.

For the period 1984 to 1994, the winter mean smoke concentration recorded at

³ Environmental Protection Agency, Air Quality Monitoring Annual Report, 1998.

Drogheda was in the range 29 - 69 $\mu\text{g}/\text{m}^3$ and the corresponding 98th percentile range was 118 - 163 $\mu\text{g}/\text{m}^3$. The annual median concentration for 1998 was 10 $\mu\text{g}/\text{m}^3$ and the 98th percentile was 34 $\mu\text{g}/\text{m}^3$.

The monitoring results obtained during this study are much lower than that recorded at Drogheda and can be said to be representative of a rural background site.

The Air Quality Standards for smoke specify that the annual median of daily mean values should not exceed 80 $\mu\text{g}/\text{m}^3$. It is clear from the data presented in Table A5 that the levels recorded during the four weeks over which the monitoring was carried out were very substantially lower than the Limit Value. The Standards further specify that a limit of 250 $\mu\text{g}/\text{m}^3$ should not be exceeded for more than 3 consecutive days, and again this Limit Value is not approached or exceeded during the period for which monitoring data is available.

5.6 Metals

The measurement results for metals are presented in Tables A6 to A8 of Appendix II. The maximum measured concentrations for the metals included in the survey are summarised in Tables 9 and 10 below. Where there are no ambient air quality guidelines for the concentration of metals in air, 1/40th of the occupational exposure limit (OEL) for an eight-hour reference period has been used for comparison with measured concentrations.

Table 9 Maximum 24 - hour metal concentration measured compared with air quality guidelines

Air Quality Guidelines WHO $\mu\text{g}/\text{m}^3$		Maximum measured 24 - hour concentration $\mu\text{g}/\text{m}^3$	Annual average concentration range $\mu\text{g}/\text{m}^3$
Lead			
Annual mean of daily values	0.5	0.13	0.01 - 2
Cadmium			
Annual average	0.005	< 0.002	0.0001 - 0.02
Mercury			
Annual average	1	< 0.005	0.002 - 0.01
Vanadium			
24 hour average	1	< 0.001	0.05 - 0.2

Note 1. WHO Guidelines quoted are as published in "Guidelines for Air Quality," WHO, Geneva, 2000.

Note 2. The < values are less than the limit of detection.

Table 10 Maximum 24-hour metal concentration measured compared with OEL guidelines

Metal	OEL mg/m³	OEL 1/40th µg/m³	Maximum measured 24 - hour concentration µg/m³
<i>Zinc – total inhalable dust</i>	10	250	0.08
<i>Copper – dusts and mists</i>	1	25	0.03
<i>Nickel</i>	0.1	2.5	0.069
<i>Chromium</i>	0.5	12.5	0.12
<i>Lead</i>	0.15	3.75	0.13
<i>Selenium</i>	0.1	2.5	0.38
<i>Arsenic</i>	0.1	2.5	< 0.02
<i>Antimony</i>	0.5	12.5	0.012
<i>Molybdenum (soluble compounds)</i>	5	125	0.007
<i>Titanium (dioxide) total inhalable dust</i>	10	250	0.01
<i>Tin – inorganic</i>	2	50	4.7
<i>Barium</i>	0.5	12.5	< 0.0002
<i>Boron (oxide)</i>	10	250	0.22
<i>Cobalt</i>	0.1	2.5	< 0.001
<i>Thallium</i>	0.1	2.5	<0.021
<i>Silver</i>	0.1	2.5	<0.01
<i>Mercury (Inorganic)</i>	0.025	0.625	< 0.005
<i>Cadmium</i>	0.025	0.625	< 0.002

Note 1. The < values are less than the limit of detection.

Lead monitoring is undertaken in Dublin at 8 locations. Monitoring as reported in the the EPA State of the Environment in Ireland Report, dated 1996 has shown that major reductions in lead emissions have occurred since the mid-1980s with the reduction in the lead content of petrol. The maximum annual mean concentration of airborne lead at eight sites in Dublin over 1988 to 1993 was approximately $1.75 \mu\text{g}/\text{m}^3$. The annual mean concentration for most sites was less than $0.5 \mu\text{g}/\text{m}^3$.

Data relevant for rural locations was not available for Lead. Concentrations in rural areas are expected to be much lower and will be substantially less than relevant guideline levels as demonstrated by this study.

Data from the World Health Organisation: Guidelines for Air Quality May 2000 for annual average concentrations of metals in ambient air where available are provided in Table 9. No background data for other metals was available.

All of the maximum measured 24-hour values for the metals measured are within the limit of $1/40^{\text{th}}$ of the occupational exposure limit (OEL) and comply with the available air quality standards.

6.0 Conclusion

Ambient air quality at Carranstown has been monitored over a period of 28 days for 24-hour averages of sulphur dioxide, smoke, nitrogen oxides, metals, hydrogen fluoride and hydrogen chloride and 1-hour averages of nitrogen oxides. Air quality with respect to ambient concentrations of pollutants surveyed is extremely good. The air quality complies with all relevant guidelines and is characteristic of an unpolluted rural location.

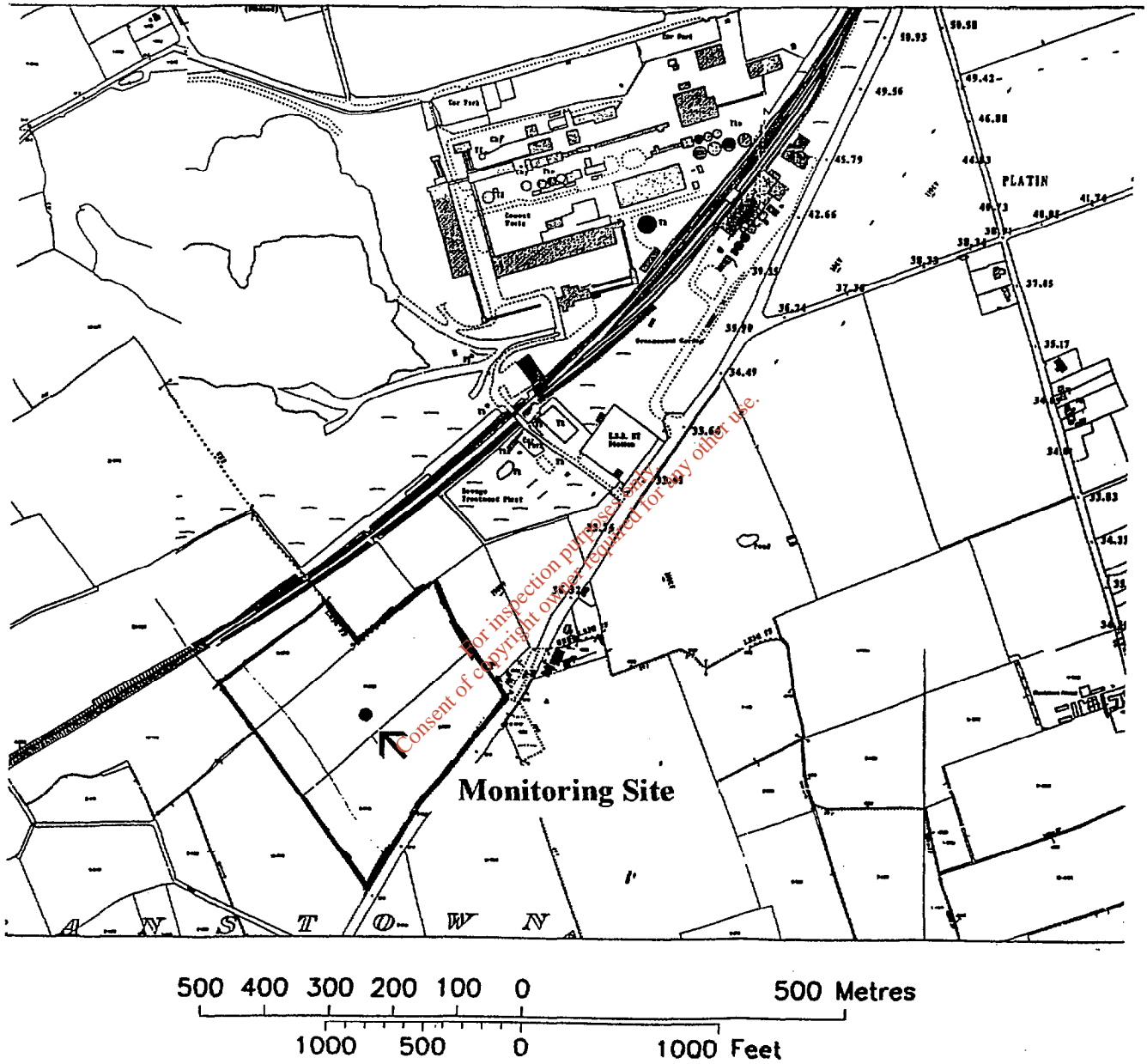
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APPENDIX I

MONITORING LOCATION FOR CARRANSTOWN AMBIENT AIR QUALITY SURVEY

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Figure 1 Monitoring Site Location for Ambient Air Survey at Carranstown



APPENDIX II

**RESULT TABLES FOR SULPHUR DIOXIDE, NITROGEN OXIDES, METALS, HF,
HCl AND SMOKE**

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Table A1 Ambient 24 - hour NO_x as NO₂ at Carranstown, 15 June to 13 July 2000

Date	Start day	Finish day	Sample ID	NO ₂ µg/m ³
15/06/00	Thu	Fri	2510-22	1.9
16/06/00	Fri	Sat	2510-23	1.7
17/06/00	Sat	Sun	2510-24	1.6
18/06/00	Sun	Mon	2510-25	1.6
19/06/00	Mon	Tue	2510-51	1.4
20/06/00	Tue	Wed	2510-52	1.2
21/06/00	Wed	Thu	2510-53	0.9
22/06/00	Thu	Fri	2510-54	0.8
23/06/00	Fri	Sat	2510-55	0.8
24/06/00	Sat	Sun	2510-56	0.7
25/06/00	Sun	Mon	2510-57	0.8
26/06/00	Mon	Tue	2510-86	1.9
27/06/00	Tue	Wed	2510-87	1.9
28/06/00	Wed	Thu	2510-88	1.9
29/06/00	Thu	Fri	2510-89	1.8
30/06/00	Fri	Sat	2510-90	1.6
01/07/00	Sat	Sun	2510-91	1.3
02/07/00	Sun	Mon	2510-92	1.2
03/07/00	Mon	Tue	2510-100	2.4
04/07/00	Tue	Wed	2510-101	2.6
05/07/00	Wed	Thu	2510-102	1.4
06/07/00	Thu	Fri	2510-103	1.3
07/07/00	Fri	Sat	2510-104	0.6
08/07/00	Sat	Sun	2510-105	0.5
09/07/00	Sun	Mon	2510-106	0.5
10/07/00	Mon	Tue	2510-135	0.7
11/07/00	Tue	Wed	2510-136	0.7
12/07/00	Wed	Thu	2510-137	0.6
13/07/00	Thu	Fri	2510-138	0.3

Table A2 Ambient 24 - hour SO₂ at Carranstown, 12 June to 9 July 2000

Date	Start day	Finish day	Sample ID	SO ₂ µg/m ³
12/06/00	Mon	Tue	2510-8	< 1
13/06/00	Tue	Wed	2510-9	7
14/06/00	Wed	Thu	2510-10	< 1
15/06/00	Thu	Fri	2510-11	1
16/06/00	Fri	Sat	2510-12	< 1
17/06/00	Sat	Sun	2510-13	< 1
18/06/00	Sun	Mon	2510-14	< 1
19/06/00	Mon	Tue	2510-37	< 1
20/06/00	Tue	Wed	2510-38	< 1
21/06/00	Wed	Thu	2510-39	< 1
22/06/00	Thu	Fri	2510-40	< 1
23/06/00	Fri	Sat	2510-41	< 1
24/06/00	Sat	Sun	2510-42	< 1
25/06/00	Sun	Mon	2510-43	< 1
26/06/00	Mon	Tue	2510-72	< 1
27/06/00	Tue	Wed	2510-73	< 1
28/06/00	Wed	Thu	2510-74	< 1
29/06/00	Thu	Fri	2510-75	< 1
30/06/00	Fri	Sat	2510-76	< 1
01/07/00	Sat	Sun	2510-77	< 1
02/07/00	Sun	Mon	2510-78	< 1
03/07/00	Mon	Tue	2510-121	< 1
04/07/00	Tue	Wed	2510-122	< 1
05/07/00	Wed	Thu	2510-123	< 1
06/07/00	Thu	Fri	2510-124	< 1
07/07/00	Fri	Sat	2510-125	< 1
08/07/00	Sat	Sun	2510-126	< 1
09/07/00	Sun	Mon	2510-127	< 1

Table A3 Ambient 24 - hour HCl at Carranstown, 12 June to 9 July 2000

Date	Start day	Finish day	Sample ID	HCl $\mu\text{g}/\text{m}^3$
12/06/00	Mon	Tue	2510-1	0.0005
13/06/00	Tue	Wed	2510-2	0.0003
14/06/00	Wed	Thu	2510-3	0.0018
15/06/00	Thu	Fri	2510-4	0.0010
16/06/00	Fri	Sat	2510-5	0.0003
17/06/00	Sat	Sun	2510-6	0.0002
18/06/00	Sun	Mon	2510-7	< 0.0001
19/06/00	Mon	Tue	2510-30	< 0.0001
20/06/00	Tue	Wed	2510-31	< 0.0001
21/06/00	Wed	Thu	2510-32	< 0.0001
22/06/00	Thu	Fri	2510-33	< 0.0001
23/06/00	Fri	Sat	2510-34	< 0.0001
24/06/00	Sat	Sun	2510-35	< 0.0001
25/06/00	Sun	Mon	2510-36	< 0.0001
26/06/00	Mon	Tue	2510-65	< 0.0001
27/06/00	Tue	Wed	2510-66	< 0.0001
28/06/00	Wed	Thu	2510-67	< 0.0001
29/06/00	Thu	Fri	2510-68	< 0.0001
30/06/00	Fri	Sat	2510-69	< 0.0001
01/07/00	Sat	Sun	2510-70	< 0.0001
02/07/00	Sun	Mon	2510-71	< 0.0001
03/07/00	Mon	Tue	2510-114	< 0.0001
04/07/00	Tue	Wed	2510-115	< 0.0001
05/07/00	Wed	Thu	2510-116	< 0.0001
06/07/00	Thu	Fri	2510-117	< 0.0001
07/07/00	Fri	Sat	2510-118	< 0.0001
08/07/00	Sat	Sun	2510-119	< 0.0001
09/07/00	Sun	Mon	2510-120	< 0.0001

Table A4 Ambient 24 - hour HF at Carranstown, 12 June to 9 July 2000

Date	Start day	Finish day	Sample ID	HF $\mu\text{g}/\text{m}^3$
12/06/00	Mon	Tue	2510-1	< 0.0001
13/06/00	Tue	Wed	2510-2	< 0.0001
14/06/00	Wed	Thu	2510-3	< 0.0001
15/06/00	Thu	Fri	2510-4	< 0.0001
16/06/00	Fri	Sat	2510-5	< 0.0001
17/06/00	Sat	Sun	2510-6	< 0.0001
18/06/00	Sun	Mon	2510-7	< 0.0001
19/06/00	Mon	Tue	2510-30	< 0.0001
20/06/00	Tue	Wed	2510-31	< 0.0001
21/06/00	Wed	Thu	2510-32	< 0.0001
22/06/00	Thu	Fri	2510-33	< 0.0001
23/06/00	Fri	Sat	2510-34	< 0.0001
24/06/00	Sat	Sun	2510-35	< 0.0001
25/06/00	Sun	Mon	2510-36	< 0.0001
26/06/00	Mon	Tue	2510-65	< 0.0001
27/06/00	Tue	Wed	2510-66	< 0.0001
28/06/00	Wed	Thu	2510-67	< 0.0001
29/06/00	Thu	Fri	2510-68	< 0.0001
30/06/00	Fri	Sat	2510-69	< 0.0001
01/07/00	Sat	Sun	2510-70	< 0.0001
02/07/00	Sun	Mon	2510-71	< 0.0001
03/07/00	Mon	Tue	2510-114	< 0.0001
04/07/00	Tue	Wed	2510-115	< 0.0001
05/07/00	Wed	Thu	2510-116	< 0.0001
06/07/00	Thu	Fri	2510-117	< 0.0001
07/07/00	Fri	Sat	2510-118	< 0.0001
08/07/00	Sat	Sun	2510-119	< 0.0001
09/07/00	Sun	Mon	2510-120	< 0.0001

Table A5 Ambient 24 - hour Smoke at Carranstown, 12 June to 9 July 2000

Date	Start day	Finish day	Sample ID	Black Smoke $\mu\text{g}/\text{m}^3$
12/06/00	Mon	Tue	2510-15	2
13/06/00	Tue	Wed	2510-16	3
14/06/00	Wed	Thu	2510-17	6
15/06/00	Thu	Fri	2510-18	4
16/06/00	Fri	Sat	2510-19	5
17/06/00	Sat	Sun	2510-20	5
18/06/00	Sun	Mon	2510-21	6
19/06/00	Mon	Tue	2510-44	4
20/06/00	Tue	Wed	2510-45	3
21/06/00	Wed	Thu	2510-46	2
22/06/00	Thu	Fri	2510-47	2
23/06/00	Fri	Sat	2510-48	4
24/06/00	Sat	Sun	2510-49	3
25/06/00	Sun	Mon	2510-50	3.5
26/06/00	Mon	Tue	2510-79	7
27/06/00	Tue	Wed	2510-80	4
28/06/00	Wed	Thu	2510-81	1
29/06/00	Thu	Fri	2510-82	11
30/06/00	Fri	Sat	2510-83	9
01/07/00	Sat	Sun	2510-84	5
02/07/00	Sun	Mon	2510-85	6
03/07/00	Mon	Tue	2510-128	4
04/07/00	Tue	Wed	2510-129	9
05/07/00	Wed	Thu	2510-130	6
06/07/00	Thu	Fri	2510-131	2
07/07/00	Fri	Sat	2510-132	2.5
08/07/00	Sat	Sun	2510-133	0.5
09/07/00	Sun	Mon	2510-134	1

Table A6 Ambient 24 - hour Metals at Carranstown, 15 June to 13 July 2000

Sample number	Sample Date	Sample Concentration $\mu\text{g}/\text{m}^3$					
		Ag	As	B	Ba	Cd	Co
2510-26	15/06/00	< 0.010	< 0.021	0.082	< 0.0002	< 0.002	< 0.001
2510-27	16/06/00	< 0.010	< 0.021	< 0.004	< 0.0002	< 0.002	< 0.001
2510-28	17/06/00	< 0.010	< 0.021	0.100	< 0.0002	< 0.002	< 0.001
2510-29	18/06/00	< 0.010	< 0.021	< 0.004	< 0.0002	< 0.002	< 0.001
2510-58	19/06/00	< 0.010	< 0.021	0.098	< 0.0002	< 0.002	< 0.001
2510-59	20/06/00	< 0.010	< 0.021	0.082	< 0.0002	< 0.002	< 0.001
2510-60	21/06/00	< 0.010	< 0.021	0.035	< 0.0002	< 0.002	< 0.001
2510-61	22/06/00	< 0.010	< 0.021	< 0.004	< 0.0002	< 0.002	< 0.001
2510-62	23/06/00	< 0.010	< 0.021	0.056	< 0.0002	< 0.002	< 0.001
2510-63	24/06/00	< 0.010	< 0.021	0.115	< 0.0002	< 0.002	< 0.001
2510-64	25/06/00	< 0.010	< 0.021	0.011	< 0.0002	< 0.002	< 0.001
2510-93	26/06/00	< 0.010	< 0.021	< 0.004	< 0.0002	< 0.002	< 0.001
2510-94	27/06/00	< 0.010	< 0.021	< 0.004	< 0.0002	< 0.002	< 0.001
2510-95	28/06/00	< 0.010	< 0.021	< 0.004	< 0.0002	< 0.002	< 0.001
2510-96	29/06/00	< 0.010	< 0.021	< 0.004	< 0.0002	< 0.002	< 0.001
2510-97	30/06/00	< 0.010	< 0.021	< 0.004	< 0.0002	< 0.002	< 0.001
2510-98	01/07/00	< 0.010	< 0.021	< 0.004	< 0.0002	< 0.002	< 0.001
2510-99	02/07/00	< 0.010	< 0.021	< 0.004	< 0.0002	< 0.002	< 0.001
2510-107	03/07/00	< 0.010	< 0.021	0.051	< 0.0002	< 0.002	< 0.001
2510-108	04/07/00	< 0.010	< 0.021	0.051	< 0.0002	< 0.002	< 0.001
2510-109	05/07/00	< 0.010	< 0.021	0.216	< 0.0002	< 0.002	< 0.001
2510-110	06/07/00	< 0.010	< 0.021	0.152	< 0.0002	< 0.002	< 0.001
2510-111	07/07/00	< 0.010	< 0.021	0.154	< 0.0002	< 0.002	< 0.001
2510-112	08/07/00	< 0.010	< 0.021	0.031	< 0.0002	< 0.002	< 0.001
2510-113	09/07/00	< 0.010	< 0.021	0.069	< 0.0002	< 0.002	< 0.001
2510-139	10/07/00	< 0.010	< 0.021	0.056	< 0.0002	< 0.002	< 0.001
2510-140	11/07/00	< 0.010	< 0.021	0.037	< 0.0002	< 0.002	< 0.001
2510-141	12/07/00	< 0.010	< 0.021	0.130	< 0.0002	< 0.002	< 0.001
2510-142	13/07/00	0.010	< 0.021	0.024	< 0.0002	< 0.002	< 0.001

Table A7 Ambient 24 - hour Metals at Carranstown, 15 June to 13 July 2000

Sample number	Sample Date	Sample Concentration $\mu\text{g}/\text{m}^3$					
		Cr	Cu	Hg	Mo	Ni	Pb
2510-26	15/06/00	0.079	< 0.003	< 0.005	< 0.001	0.009	0.006
2510-27	16/06/00	0.015	< 0.003	< 0.005	< 0.001	0.006	0.007
2510-28	17/06/00	0.063	< 0.003	< 0.005	< 0.001	< 0.003	< 0.003
2510-29	18/06/00	0.012	< 0.003	< 0.005	< 0.001	< 0.003	< 0.003
2510-58	19/06/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	0.008
2510-59	20/06/00	0.034	< 0.003	< 0.005	< 0.001	< 0.003	< 0.003
2510-60	21/06/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	< 0.003
2510-61	22/06/00	0.044	< 0.003	< 0.005	< 0.001	< 0.003	< 0.003
2510-62	23/06/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	< 0.003
2510-63	24/06/00	0.077	< 0.003	< 0.005	< 0.001	< 0.003	0.025
2510-64	25/06/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	< 0.003
2510-93	26/06/00	0.124	< 0.003	< 0.005	< 0.001	0.020	0.010
2510-94	27/06/00	< 0.003	0.004	< 0.005	< 0.001	< 0.003	0.017
2510-95	28/06/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	0.008
2510-96	29/06/00	< 0.003	0.014	< 0.005	< 0.001	< 0.003	< 0.003
2510-97	30/06/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	0.019
2510-98	01/07/00	0.019	0.005	< 0.005	< 0.001	0.009	0.004
2510-99	02/07/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	0.036
2510-107	03/07/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	0.002
2510-108	04/07/00	< 0.003	< 0.003	< 0.005	0.001	< 0.003	0.034
2510-109	05/07/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	0.024
2510-110	06/07/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	0.130
2510-111	07/07/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	0.045
2510-112	08/07/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	0.032
2510-113	09/07/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	< 0.003
2510-139	10/07/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	< 0.003
2510-140	11/07/00	< 0.003	< 0.003	< 0.005	< 0.001	< 0.003	< 0.003
2510-141	12/07/00	< 0.003	< 0.003	< 0.005	0.007	< 0.003	0.068
2510-142	13/07/00	< 0.003	0.029	< 0.005	< 0.001	0.069	0.075

Table A8 Ambient 24 - hour Metal at Carranstown, 15 June to 13 July 2000

Sample number	Sample Date	Sample Concentration $\mu\text{g}/\text{m}^3$						
		Sb	Se	Sn	Ti	Tl	V	Zn
2510-26	15/06/00	< 0.0003	< 0.005	0.297	< 0.002	< 0.021	< 0.001	< 0.005
2510-27	16/06/00	< 0.0003	< 0.005	4.664	< 0.002	< 0.021	< 0.001	< 0.005
2510-28	17/06/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-29	18/06/00	< 0.0003	< 0.005	0.038	< 0.002	< 0.021	< 0.001	< 0.005
2510-58	19/06/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-59	20/06/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-60	21/06/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-61	22/06/00	< 0.0003	< 0.005	3.638	< 0.002	< 0.021	< 0.001	< 0.005
2510-62	23/06/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-63	24/06/00	0.0115	< 0.005	< 0.011	0.014	< 0.021	< 0.001	< 0.005
2510-64	25/06/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-93	26/06/00	< 0.0003	0.260	< 0.011	< 0.002	< 0.021	< 0.001	0.027
2510-94	27/06/00	< 0.0003	0.364	< 0.011	< 0.002	< 0.021	< 0.001	0.077
2510-95	28/06/00	< 0.0003	0.166	0.050	0.003	< 0.021	< 0.001	0.012
2510-96	29/06/00	< 0.0003	0.376	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-97	30/06/00	< 0.0003	0.296	0.245	0.005	< 0.021	< 0.001	< 0.005
2510-98	01/07/00	< 0.0003	0.366	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-99	02/07/00	< 0.0003	0.122	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-107	03/07/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-108	04/07/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-109	05/07/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-110	06/07/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-111	07/07/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-112	08/07/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-113	09/07/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-139	10/07/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-140	11/07/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-141	12/07/00	< 0.0003	< 0.005	< 0.011	< 0.002	< 0.021	< 0.001	< 0.005
2510-142	13/07/00	< 0.0003	< 0.005	1.896	< 0.002	< 0.021	< 0.001	< 0.005

APPENDIX III

**RESULT TABLES FOR ONE-HOUR AVERAGE DETERMINATIONS OF
NITROGEN OXIDES**

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Table A9 Ambient 1-hour NO₂ at Carranstown, 4 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
04/09/00	15:00	16:00	2671-1	9.8
	16:00	17:00	2671-2	5.9
	17:00	18:00	2671-3	6.9
	18:00	19:00	2671-4	9.4
	19:00	20:00	2671-5	7.9
	20:00	21:00	2671-6	6.9
	21:00	22:00	2671-7	4.6
	22:00	23:00	2671-8	6.3
	23:00	00:00	2671-9	8.9

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Table A10 Ambient 1-hour NO₂ at Carranstown, 5 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
05/09/00	00:00	01:00	2671-10	3.3
	01:00	02:00	2671-11	3.9
	02:00	03:00	2671-12	9.9
	03:00	04:00	2671-13	7.4
	04:00	05:00	2671-14	14.8
	05:00	06:00	2671-15	17.3
	06:00	07:00	2671-16	17.9
	07:00	08:00	2671-17	13.7
	08:00	09:00	2671-18	15.8
	09:00	10:00	2671-19	15.5
	10:00	11:00	2671-20	20.1
	11:00	12:00	2671-21	12.2
	12:00	13:00	2671-22	13.5
	13:00	14:00	2671-23	19.7
	14:00	15:00	2671-24	18.9
	15:00	16:00	2671-25	12.4
	16:00	17:00	2671-26	14.7
	17:00	18:00	2671-27	16.0
	18:00	19:00	2671-28	13.0
	19:00	20:00	2671-29	19.5
	20:00	21:00	2671-30	13.3
	21:00	22:00	2671-31	16.4
	22:00	23:00	2671-32	24.8
23:00	00:00	2671-33	18.6	

Table A11 Ambient 1-hour NO₂ at Carranstown, 6 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
06/09/00	00:00	01:00	2671-34	22.6
	01:00	02:00	2671-35	14.9
	02:00	03:00	2671-36	17.3
	03:00	04:00	2671-37	18.5
	04:00	05:00	2671-38	15.2
	05:00	06:00	2671-39	13.4
	06:00	07:00	2671-40	14.0
	07:00	08:00	2671-41	18.5
	08:00	09:00	2671-42	17.3
	09:00	10:00	2671-43	16.9
	10:00	11:00	2671-44	20.4
	11:00	12:00	2671-45	12.1
	12:00	13:00	2671-46	13.0
	13:00	14:00	2671-47	16.4
	14:00	15:00	2671-48	13.8
	15:00	16:00	2671-49	16.9
	16:00	17:00	2671-50	14.4
	17:00	20:00	2671-51	19.6
	20:00	21:00	2671-52	16.4
	21:00	22:00	2671-53	12.7
	22:00	23:00	2671-54	22.5
	23:00	00:00	2671-55	15.8

Table A12 Ambient 1-hour NO₂ at Carranstown, 7 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
07/09/00	00:00	01:00	2671-56	11.5
	01:00	02:00	2671-57	15.5
	02:00	03:00	2671-58	15.5
	03:00	04:00	2671-59	16.9
	04:00	05:00	2671-60	17.9
	05:00	06:00	2671-61	14.9
	06:00	07:00	2671-62	14.3
	07:00	08:00	2671-63	14.3
	08:00	09:00	2671-64	14.6
	09:00	10:00	2671-65	20.5
	10:00	11:00	2671-66	22.0
	11:00	12:00	2671-67	18.4
	12:00	13:00	2671-68	16.6
	13:00	14:00	2671-69	14.4
	14:00	15:00	2671-70	17.3
	15:00	16:00	2671-71	14.7
	16:00	17:00	2671-72	31.0
	17:00	18:00	2671-73	26.8
	18:00	19:00	2671-74	25.2
	19:00	20:00	2671-75	21.7
	20:00	21:00	2671-76	23.6
	21:00	22:00	2671-77	22.1
	22:00	23:00	2671-78	27.2
	23:00	00:00	2671-79	12.0

Table A13 Ambient 1-hour NO₂ at Carranstown, 8 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
08/09/00	00:00	01:00	2671-80	15.5
	01:00	02:00	2671-81	10.1
	02:00	03:00	2671-82	14.3
	03:00	04:00	2671-83	11.4
	04:00	05:00	2671-84	20.9
	05:00	06:00	2671-85	12.2
	06:00	07:00	2671-86	18.8
	07:00	08:00	2671-87	19.0
	08:00	09:00	2671-88	16.7
	09:00	10:00	2671-89	16.4
	10:00	11:00	2671-90	13.1
	11:00	12:00	2671-91	16.7
	12:00	13:00	2671-92	18.4
	14:00	15:00	2671-93	13.8
	17:00	18:00	2671-94	19.6
	18:00	19:00	2671-95	19.2
	18:00	19:00	2671-96	22.1
	19:00	20:00	2671-97	26.4
	20:00	21:00	2671-98	21.9
	21:00	22:00	2671-99	21.5
	23:00	00:00	2671-101	14.5

Table A14 Ambient 1-hour NO₂ at Carranstown, 9 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
09/09/00	00:00	01:00	2671-102	22.5
	01:00	02:00	2671-103	20.1
	02:00	03:00	2671-104	19.6
	03:00	04:00	2671-105	19.5
	04:00	05:00	2671-106	23.6
	05:00	06:00	2671-107	17.4
	06:00	07:00	2671-108	20.7
	07:00	08:00	2671-109	25.6
	08:00	09:00	2671-110	19.4
	09:00	10:00	2671-111	18.2
	10:00	11:00	2671-112	18.9
	11:00	12:00	2671-113	16.1
	12:00	13:00	2671-114	16.7
	13:20	14:00	2671-115	18.3
	14:00	15:00	2671-116	18.0
	15:00	16:00	2671-117	20.9
	16:00	17:00	2671-118	20.2
	17:00	18:00	2671-119	21.7
	18:00	19:00	2671-120	17.1
	19:00	20:00	2671-121	21.1
	20:00	21:00	2671-122	27.3
	21:00	22:00	2671-123	15.8
	22:00	23:00	2671-124	18.3
	23:00	00:00	2671-125	19.9

Table A15 Ambient 1-hour NO₂ at Carranstown, 10 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
10/09/00	00:00	01:00	2671-126	23.6
	01:00	02:00	2671-127	20.5
	02:00	03:00	2671-128	22.9
	03:00	04:00	2671-129	19.9
	04:00	05:00	2671-130	25.4
	05:00	06:00	2671-131	16.7
	06:00	07:00	2671-132	17.5
	07:00	08:00	2671-133	15.5
	08:00	09:00	2671-134	14.7
	09:00	10:00	2671-135	16.4
	10:00	11:00	2671-136	17.5
	12:00	13:00	2671-138	16.4
	13:00	14:00	2671-139	18.3
	14:00	15:00	2671-140	21.3
	15:00	16:00	2671-141	13.4
	16:00	17:00	2671-142	15.5
	17:00	18:00	2671-143	19.7
	18:00	19:00	2671-144	19.0
	19:00	20:00	2671-145	21.4
	20:00	21:00	2671-146	18.1
	21:00	22:00	2671-147	21.3
	22:00	23:00	2671-148	28.7
	23:00	00:00	2671-149	28.1

Table A16 Ambient 1-hour NO₂ at Carranstown, 11 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
11/09/00	00:00	01:00	2671-150	26.6
	01:00	02:00	2671-151	18.2
	02:00	03:00	2671-152	15.2
	03:00	04:00	2671-153	16.7
	04:00	05:00	2671-154	20.1
	05:00	06:00	2671-155	27.6
	06:00	07:00	2671-156	31.7
	07:00	08:00	2671-157	26.5
	10:00	11:00	2671-158	36.4
	11:00	12:00	2671-159	25.3
	12:00	13:00	2671-160	23.5
	13:00	14:00	2671-161	15.5
	14:00	15:00	2671-162	23.6
	15:00	16:00	2671-163	22.9
	16:00	17:00	2671-164	17.8
	17:00	18:00	2671-165	18.4
	18:00	19:00	2671-166	22.0
	19:00	20:00	2671-167	25.3
	20:00	21:00	2671-168	20.3
	21:00	22:00	2671-169	19.6
	22:00	23:00	2671-170	13.5
	23:00	00:00	2671-171	15.5

Table A17 Ambient 1-hour NO₂ at Carranstown, 12 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
12/09/00	00:00	01:00	2671-172	18.1
	01:00	02:00	2671-173	12.3
	02:00	03:00	2671-174	14.9
	03:00	04:00	2671-175	18.1
	04:00	05:00	2671-176	13.0
	05:00	06:00	2671-177	15.8
	06:00	07:00	2671-178	13.4
	07:00	08:00	2671-179	22.5
	08:00	09:00	2671-180	13.7
	09:00	10:00	2671-181	15.8
	10:00	11:00	2671-182	9.8
	11:00	12:00	2671-183	13.7
	12:00	13:00	2671-184	11.2
	13:00	14:00	2671-185	5.2
	14:00	15:00	2671-186	13.8
	15:00	16:00	2671-187	13.0
	16:00	17:00	2671-188	23.3
	17:00	18:00	2671-189	6.2
	18:00	19:00	2671-190	15.5
	19:00	20:00	2671-191	< 2.3
	20:00	21:00	2671-192	7.4
	21:00	22:00	2671-193	5.7
	22:00	23:00	2671-194	7.0
	23:00	00:00	2671-195	7.6

Table A18 Ambient 1-hour NO₂ at Carranstown, 13 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
13/09/00	00:00	01:00	2671-196	7.4
	01:00	02:00	2671-197	7.4
	02:00	03:00	2671-198	6.2
	03:00	04:00	2671-199	7.9
	04:00	05:00	2671-200	8.5
	05:00	06:00	2671-201	7.2
	06:00	07:00	2671-202	6.3
	07:00	08:00	2671-203	7.6
	08:00	09:00	2671-204	7.0
	09:00	10:00	2671-205	8.5
	10:00	11:00	2671-206	8.8
	11:00	12:00	2671-207	6.2
	12:00	13:00	2671-208	6.3
	13:00	14:00	2671-209	< 2.4
	14:00	15:00	2671-210	6.6
	15:00	16:00	2671-211	< 2.3
	16:00	17:00	2671-212	14.1
	17:00	18:00	2671-213	10.5
	18:00	19:00	2671-214	6.1
	19:00	20:00	2671-215	4.0
	20:00	21:00	2671-216	5.1
	21:00	22:00	2671-217	6.1
	22:00	23:00	2671-218	4.1
23:00	00:00	2671-219	22.3	

Table A19 Ambient 1-hour NO₂ at Carranstown, 14 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
14/09/00	00:00	01:00	2671-220	5.0
	01:00	02:00	2671-221	5.5
	02:00	03:00	2671-222	6.2
	03:00	04:00	2671-223	4.5
	04:00	05:00	2671-224	< 2.5
	05:00	06:00	2671-225	6.2
	06:00	07:00	2671-226	5.9
	07:00	08:00	2671-227	8.6
	08:00	09:00	2671-228	< 2.9
	09:00	10:00	2671-229	< 2.8
	10:00	11:00	2671-230	4.9
	11:00	12:00	2671-231	< 2.8
	12:00	13:00	2671-232	3.7
	13:00	14:00	2671-233	< 3.0
	14:00	15:00	2671-234	3.9
	15:00	16:00	2671-235	8.3
	16:00	17:00	2671-236	8.8
	17:00	18:00	2671-237	6.2
	18:00	19:00	2671-238	8.5
	19:00	20:00	2671-239	8.3
	20:00	21:00	2671-240	9.2
	21:00	22:00	2671-241	7.7
	22:00	23:00	2671-242	7.0
	23:00	00:00	2671-243	10.8

Table A20 Ambient 1-hour NO₂ at Carranstown, 15 September

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
15/09/00	00:00	01:00	2671-244	12.5
	01:00	02:00	2671-245	4.5
	02:00	03:00	2671-246	7.0
	03:00	04:00	2671-247	6.0
	04:00	05:00	2671-248	< 2.9
	05:00	06:00	2671-249	7.8
	06:00	07:00	2671-250	10.8
	07:00	08:00	2671-251	11.5
	08:00	09:00	2671-252	9.9
	09:00	10:00	2671-253	12.0

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Table A21 Ambient 1-hour NO₂ at Carranstown, 18 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
18/09/00	11:00	12:00	2671-254	3.9
	12:00	13:00	2671-255	5.1
	13:00	14:00	2671-256	4.5
	14:00	15:00	2671-257	5.2
	15:00	16:00	2671-258	2.2
	16:00	17:00	2671-259	3.3
	17:00	18:00	2671-260	2.9
	18:00	19:00	2671-261	4.6
	19:00	20:00	2671-262	3.4
	20:00	21:00	2671-263	4.0
	21:00	22:00	2671-264	3.4
	22:00	23:00	2671-265	3.9
	23:00	00:00	2671-266	5.0

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Table A22 Ambient 1-hour NO₂ at Carranstown, 19 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
19/09/00	00:00	01:00	2671-267	4.5
	01:00	02:00	2671-268	3.1
	02:00	03:00	2671-269	3.1
	03:00	04:00	2671-270	2.6
	04:00	05:00	2671-271	< 2.5
	05:00	06:00	2671-272	3.7
	06:00	07:00	2671-273	4.7
	07:00	08:00	2671-274	7.3
	08:00	09:00	2671-275	2.9
	09:00	10:00	2671-276	5.6
	10:00	11:00	2671-277	5.0
	11:00	12:00	2671-278	2.9
	12:00	13:00	2671-279	9.9
	13:00	14:00	2671-280	8.8
	14:00	15:00	2671-281	8.7
	15:00	16:00	2671-282	8.5
	16:00	17:00	2671-283	10.9
	17:00	18:00	2671-284	17.3
	18:00	19:00	2671-285	5.2
	19:00	20:00	2671-286	8.5
	20:00	21:00	2671-287	11.7
	21:00	22:00	2671-288	15.2
	22:00	23:00	2671-289	12.4
	23:00	00:00	2671-290	9.5

Table A23 Ambient 1-hour NO₂ at Carranstown, 20 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
20/09/00	00:00	01:00	2671-291	5.3
	01:00	02:00	2671-292	3.8
	02:00	03:00	2671-293	4.6
	03:00	04:00	2671-294	4.5
	04:00	05:00	2671-295	15.4
	05:00	06:00	2671-296	6.6
	06:00	07:00	2671-297	7.2
	07:00	08:00	2671-298	6.3
	08:00	09:00	2671-299	5.1
	09:00	10:00	2671-300	7.9
	10:00	11:00	2671-301	8.1
	11:00	12:00	2671-302	5.9
	12:00	13:00	2671-303	10.4
	13:00	14:00	2671-304	7.6
	14:00	15:00	2671-305	9.9
	15:00	16:00	2671-306	11.3
	16:00	17:00	2671-307	12.2
	17:00	18:00	2671-308	10.7
	18:00	19:00	2671-309	12.4
	19:00	20:00	2671-310	17.3
	20:00	21:00	2671-311	9.2
	21:00	22:00	2671-312	11.2
	22:00	23:00	2671-313	9.7
	23:00	00:00	2671-314	9.3

Table A24 Ambient 1-hour NO₂ at Carranstown, 21 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
21/09/00	00:00	01:00	2671-315	9.9
	01:00	02:00	2671-316	7.1
	02:00	03:00	2671-317	8.2
	03:00	04:00	2671-318	7.8
	04:00	05:00	2671-319	8.3
	05:00	06:00	2671-320	8.3
	06:00	07:00	2671-321	7.0
	07:00	08:00	2671-322	8.3
	08:00	09:00	2671-323	8.3
	09:00	10:00	2671-324	7.0
	10:00	11:00	2671-325	5.6
	11:00	12:00	2671-326	7.3
	12:00	13:00	2671-327	5.4
	13:00	14:00	2671-328	4.8
	14:00	15:00	2671-329	6.3
	15:00	16:00	2671-330	5.2
	16:00	17:00	2671-331	9.0
	17:00	18:00	2671-332	5.5
	18:00	19:00	2671-333	6.3
	19:00	20:00	2671-334	7.8
	20:00	21:00	2671-335	7.1
	21:00	22:00	2671-336	6.8
	22:00	23:00	2671-337	5.1
	23:00	00:00	2671-338	3.6

Table A25 Ambient 1-hour NO₂ at Carranstown, 22 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
22/09/00	00:00	01:00	2671-339	3.8
	01:00	02:00	2671-340	3.7
	02:00	03:00	2671-341	< 2.3
	03:00	04:00	2671-342	6.5
	04:00	05:00	2671-343	< 2.6
	05:00	06:00	2671-344	5.0
	06:00	07:00	2671-345	5.8
	09:00	10:00	2671-348	3.4
	10:00	11:00	2671-349	6.5
	11:00	12:00	2671-350	4.1
	12:00	13:00	2671-351	< 2.3
	13:00	14:00	2671-352	< 2.5
	15:00	16:00	2671-354	4.6
	16:00	17:00	2671-355	2.8
	17:00	18:00	2671-356	4.7
	18:00	19:00	2671-357	3.5
	19:00	20:00	2671-358	3.6
	20:00	21:00	2671-359	2.8
	21:00	22:00	2671-360	2.5
	22:00	23:00	2671-361	3.0
	23:00	00:00	2671-362	< 2.6

Table A26 Ambient 1-hour NO₂ at Carranstown, 23 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
23/09/00	00:00	01:00	2671-363	3.7
	01:00	02:00	2671-364	2.5
	02:00	03:00	2671-365	3.7
	03:00	04:00	2671-366	3.7
	04:00	05:00	2671-367	2.8
	05:00	06:00	2671-368	5.6
	06:00	07:00	2671-369	5.6
	07:00	08:00	2671-370	6.1
	08:00	09:00	2671-371	5.8
	09:00	10:00	2671-372	5.8
	15:00	16:00	2671-373	5.6
	16:00	17:00	2671-374	6.3
	17:00	18:00	2671-375	3.5
	18:00	19:00	2671-376	3.5
	19:00	20:00	2671-377	2.8
	20:00	21:00	2671-378	2.8
	21:00	22:00	2671-379	6.5
	22:00	23:00	2671-380	2.5
	23:00	00:00	2671-381	4.3

Table A27 Ambient 1-hour NO₂ at Carranstown, 26 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
26/09/00	00:00	01:00	2671-382	2.4
	01:00	02:00	2671-383	2.5
	02:00	03:00	2671-384	< 2.4
	03:00	04:00	2671-385	< 2.4
	04:00	05:00	2671-386	< 2.5
	05:00	06:00	2671-387	6.6
	06:00	07:00	2671-388	5.5
	07:00	08:00	2671-389	5.8
	08:00	09:00	2671-390	4.6
	09:00	10:00	2671-391	3.4
	10:00	11:00	2671-392	4.6
	11:00	12:00	2671-393	3.5
	12:00	13:00	2671-394	< 2.4
	13:00	14:00	2671-395	< 2.8
	14:00	15:00	2671-396	< 2.7
	15:00	16:00	2671-397	< 2.8
	16:00	17:00	2671-398	< 2.8
	17:00	18:00	2671-399	< 2.8
	18:00	19:00	2671-400	< 2.8
	19:00	20:00	2671-401	< 2.8
	20:00	21:00	2671-402	3.7
	21:00	22:00	2671-403	< 2.5
	22:00	23:00	2671-404	3.2
23:00	00:00	2671-405	< 2.6	

Table A28 Ambient 1-hour NO₂ at Carranstown, 27 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
27/09/00	00:00	01:00	2671-406	< 2.6
	01:00	02:00	2671-407	< 2.5
	02:00	03:00	2671-408	< 2.5
	03:00	04:00	2671-409	< 2.3
	04:00	05:00	2671-410	< 2.3
	05:00	06:00	2671-411	< 2.3
	06:00	07:00	2671-412	< 2.3
	07:00	08:00	2671-413	< 2.3
	08:00	09:00	2671-414	< 2.3
	09:00	10:00	2671-415	2.9
	10:00	11:00	2671-416	4.2
	11:00	12:00	2671-417	< 2.8
	12:00	13:00	2671-418	< 2.8
	13:00	14:00	2671-419	4.9
	14:00	15:00	2671-420	9.0
	15:00	16:00	2671-421	8.5
	16:00	17:00	2671-422	7.5
	17:00	18:00	2671-423	5.5
	18:00	19:00	2671-424	< 2.4
	19:00	20:00	2671-425	3.2
	20:00	21:00	2671-426	7.5
	21:00	22:00	2671-427	7.3
	22:00	23:00	2671-428	7.7
	23:00	00:00	2671-429	< 2.5

Table A29 Ambient 1-hour NO₂ at Carranstown, 28 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
28/09/00	00:00	01:00	2671-430	5.8
	01:00	02:00	2671-431	3.3
	02:00	03:00	2671-432	5.3
	03:00	04:00	2671-433	7.3
	04:00	05:00	2671-434	5.6
	05:00	06:00	2671-435	4.5
	06:00	07:00	2671-436	4.4
	07:00	08:00	2671-437	4.3
	08:00	09:00	2671-438	7.7
	09:00	10:00	2671-439	7.6
	10:00	11:00	2671-440	3.4
	11:00	12:00	2671-441	2.8
	12:00	13:00	2671-442	< 2.8
	13:00	14:00	2671-443	5.1
	14:00	15:00	2671-444	< 2.2
	15:00	16:00	2671-445	< 2.2
	16:00	17:00	2671-446	< 2.3
	17:00	18:00	2671-447	< 2.3
	18:00	19:00	2671-448	< 2.2
	19:00	20:00	2671-449	< 2.2
	20:00	21:00	2671-450	< 2.2
	21:00	22:00	2671-451	< 2.2
	22:00	23:00	2671-452	< 2.4
	23:00	00:00	2671-453	< 2.3

Table A30 Ambient 1-hour NO₂ at Carranstown, 29 September

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
29/09/00	00:00	01:00	2671-454	< 2.3
	01:00	02:00	2671-455	< 2.3
	02:00	03:00	2671-456	< 2.3
	03:00	04:00	2671-457	< 2.3
	04:00	05:00	2671-458	< 2.8
	05:00	06:00	2671-459	< 2.8
	06:00	07:00	2671-460	< 2.9
	07:00	08:00	2671-461	< 2.8
	08:00	09:00	2671-462	< 2.8
	09:00	10:00	2671-463	< 2.9
	10:00	11:00	2671-464	< 2.8
	11:00	12:00	2671-465	< 2.4
	12:00	13:00	2671-466	< 2.5
	13:00	14:00	2671-467	< 2.6
	14:00	15:00	2671-468	< 2.5
	15:00	16:00	2671-469	< 2.5
	16:00	17:00	2671-470	< 2.5
	17:00	18:00	2671-471	< 2.2
	18:00	19:00	2671-472	< 2.3
	19:00	20:00	2671-473	< 2.3
	20:00	21:00	2671-474	< 2.3
	21:00	22:00	2671-475	< 2.3
	22:00	23:00	2671-476	< 2.3
	23:00	00:00	2671-477	< 2.3

Table A31 Ambient 1-hour NO₂ at Carranstown, 30 September 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
30/09/00	00:00	01:00	2671-478	< 2.8
	01:00	02:00	2671-479	< 2.8
	02:00	03:00	2671-480	< 2.8
	03:00	04:00	2671-481	< 2.8
	04:00	05:00	2671-482	< 2.9
	05:00	06:00	2671-483	< 2.9
	06:00	07:00	2671-484	< 2.8
	07:00	08:00	2671-485	< 2.6
	08:00	09:00	2671-486	< 2.5
	09:00	10:00	2671-487	< 2.5
	10:00	11:00	2671-488	< 2.5
	11:00	12:00	2671-489	< 2.6
	12:00	13:00	2671-490	< 2.6
	13:00	14:00	2671-491	< 2.4
	15:00	16:00	2671-491*	< 2.2
	16:00	17:00	2671-492	< 2.2
	17:00	18:00	2671-493	< 2.2
	18:00	19:00	2671-494	< 2.3
	19:00	20:00	2671-495	< 2.2
	20:00	21:00	2671-496	< 2.2
	21:00	22:00	2671-497	< 2.2
	22:00	23:00	2671-498	< 2.8
	23:00	00:00	2671-499	< 2.7

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Table A32 Ambient 1-hour NO₂ at Carranstown, 1 October

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
1/10/00	00:00	01:00	2671-500	< 2.8
	01:00	02:00	2671-501	< 2.7
	02:00	03:00	2671-502	< 2.8
	03:00	04:00	2671-503	< 2.8
	04:00	05:00	2671-504	< 2.7
1/10/00	05:00	06:00	2671-505	< 2.5
	06:00	07:00	2671-506	< 2.4
	07:00	08:00	2671-507	< 2.4
	08:00	09:00	2671-508	< 2.4
	09:00	10:00	2671-509	< 2.5
	10:00	11:00	2671-510	< 2.5
	11:00	12:00	2671-511	< 2.5
	13:00	14:00	2671-513	< 2.2
	14:00	15:00	2671-514	< 2.3
	15:00	16:00	2671-515	< 2.1
	16:00	17:00	2671-516	< 2.1
	17:00	18:00	2671-517	< 2.4
	18:00	19:00	2671-518	< 2.1
	19:00	20:00	2671-519	< 2.0
	20:00	21:00	2671-520	< 2.8
	21:00	22:00	2671-521	< 2.8
	22:00	23:00	2671-522	< 2.9
	23:00	00:00	2671-523	< 2.8

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Table A33 Ambient 1-hour NO₂ at Carranstown, 2 October 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
02/10/00	00:00	01:00	2671-524	< 2.8
	01:00	02:00	2671-525	< 2.8
	02:00	03:00	2671-526	< 2.8
	03:00	04:00	2671-527	< 2.4
	04:00	05:00	2671-528	< 2.4
	05:00	06:00	2671-529	< 2.2
	06:00	07:00	2671-530	< 2.4
	07:00	08:00	2671-531	< 2.4
	08:00	09:00	2671-532	< 2.4
	09:00	10:00	2671-533	< 2.4
	11:00	12:00	2671-534	< 2.2
	12:00	13:00	2671-535	< 2.2
	13:00	14:00	2671-536	< 2.1
	14:00	15:00	2671-537	< 2.2
	15:00	16:00	2671-538	< 2.3
	16:00	17:00	2671-539	< 2.3
	17:00	18:00	2671-540	< 2.3
	18:00	19:00	2671-541	< 2.3
	19:00	20:00	2671-542	< 2.3
	20:00	21:00	2671-543	< 2.3
	21:00	22:00	2671-544	< 2.3
	22:00	23:00	2671-545	< 2.3
	23:00	00:00	2671-546	< 2.9

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Table A34 Ambient 1-hour NO₂ at Carranstown, 3 October 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
03/10/00	00:00	01:00	2671-547	< 2.8
	01:00	02:00	2671-548	< 2.9
	02:00	03:00	2671-549	< 2.8
	03:00	04:00	2671-550	< 2.8
	04:00	05:00	2671-551	< 2.9
	05:00	06:00	2671-552	< 2.9
	06:00	07:00	2671-553	< 2.4
	07:00	08:00	2671-554	< 2.4
	08:00	09:00	2671-555	< 2.3
	09:00	10:00	2671-556	< 2.3
	10:00	11:00	2671-557	< 2.4
	11:00	12:00	2671-558	< 2.4
	12:00	13:00	2671-559	< 2.4
	13:00	14:00	2671-560	< 2.3
	14:00	15:00	2671-561	< 2.1
	15:00	16:00	2671-562	< 2.2
	16:00	17:00	2671-563	< 2.2
	17:00	18:00	2671-564	< 2.3
	18:00	19:00	2671-565	< 2.2
	19:00	20:00	2671-566	< 2.2
	20:00	21:00	2671-567	< 2.3
	21:00	22:00	2671-568	< 3.1
	22:00	23:00	2671-569	< 2.7
	23:00	00:00	2671-570	< 2.8

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Table A35 Ambient 1-hour NO₂ at Carranstown, 4 October 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
04/10/00	00:00	01:00	2671-571	< 2.7
	01:00	02:00	2671-572	< 2.7
	02:00	03:00	2671-573	< 2.8
	03:00	04:00	2671-574	< 2.7
	04:00	05:00	2671-575	< 2.4
	05:00	06:00	2671-576	< 2.5
	06:00	07:00	2671-577	< 2.4
	07:00	08:00	2671-578	< 2.4
	08:00	09:00	2671-579	< 2.5
	09:00	10:00	2671-580	< 2.4
	10:00	11:00	2671-581	< 2.5
	11:00	12:00	2671-582	< 2.5
	12:00	13:00	2671-583	< 2.7
	13:00	14:00	2671-584	< 2.2
	14:00	15:00	2671-585	< 2.7
	15:00	16:00	2671-586	< 2.2
	16:00	17:00	2671-587	< 2.2
	17:00	18:00	2671-588	< 2.3
	18:00	19:00	2671-589	< 2.2
	19:00	20:00	2671-590	< 2.7
	20:00	21:00	2671-591	< 2.7
	21:00	22:00	2671-592	< 2.7
	22:00	23:00	2671-593	< 2.7
	23:00	00:00	2671-594	< 2.7

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Table A36 Ambient 1-hour NO₂ at Carranstown, 5 October 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
05/10/00	00:00	01:00	2671-595	< 2.7
	01:00	02:00	2671-596	< 2.6
	02:00	03:00	2671-597	< 2.3
	03:00	04:00	2671-598	< 2.3
	04:00	05:00	2671-599	< 2.3
	05:00	06:00	2671-600	< 2.2
	06:00	07:00	2671-601	< 2.3
	07:00	08:00	2671-602	< 2.3
	08:00	09:00	2671-603	< 2.2
	10:00	11:00	2671-604	< 2.2
	11:00	12:00	2671-605	< 2.3
	12:00	13:00	2671-606	< 2.2
	13:00	14:00	2671-607	< 2.2
	14:00	15:00	2671-608	< 2.2
	15:00	16:00	2671-609	< 2.5
	16:00	17:00	2671-610	< 2.6
	17:00	18:00	2671-611	< 2.6
	18:00	19:00	2671-612	< 2.6
	19:00	20:00	2671-613	< 2.7
	20:00	21:00	2671-614	< 2.6
	21:00	22:00	2671-615	< 2.6
	22:00	23:00	2671-616	< 2.2
	23:00	00:00	2671-617	< 2.2

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Table A37 Ambient 1-hour NO₂ at Carranstown, 6 October 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
06/10/00	00:00	01:00	2671-618	< 2.2
	01:00	02:00	2671-619	< 2.2
	02:00	03:00	2671-620	< 2.2
	03:00	04:00	2671-621	< 2.3
	04:00	05:00	2671-622	< 2.3
	05:00	06:00	2671-623	< 2.3
	06:00	07:00	2671-624	< 2.3
	07:00	08:00	2671-625	< 2.2
	08:00	09:00	2671-626	< 2.2
	09:00	10:00	2671-627	< 2.2
	10:00	11:00	2671-628	< 2.2
	11:00	12:00	2671-629	< 2.2
	12:00	13:00	2671-630	< 2.5
	13:00	14:00	2671-631	< 2.5
	14:00	15:00	2671-632	< 2.6
	15:00	16:00	2671-633	< 2.6
	16:00	17:00	2671-634	< 2.6
	17:00	18:00	2671-635	< 2.6
	18:00	19:00	2671-636	< 2.8
	19:00	20:00	2671-637	< 2.2
	20:00	21:00	2671-638	< 2.1
	21:00	22:00	2671-639	< 2.3
	22:00	23:00	2671-640	< 2.2
	23:00	00:00	2671-641	< 2.2

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Table A38 Ambient 1-hour NO₂ at Carranstown, 7 October 2000

Date	Start time	Finish time	Sample ID	NO ₂ µg/m ³
7/10/00	00:00	01:00	2671-642	< 2.1
	01:00	02:00	2671-643	< 2.2
	02:00	03:00	2671-644	< 2.2
	03:00	04:00	2671-645	< 2.2
	04:00	05:00	2671-646	< 2.2
	05:00	06:00	2671-647	< 2.3
	06:00	07:00	2671-648	< 2.2
	07:00	08:00	2671-649	< 2.2
	08:00	09:00	2671-650	< 2.3

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ATTACHMENT 5

AIR DISPERSION MODELLING REPORT

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Document Lead Sheet

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INDAVER IRELAND

WASTE MANAGEMENT FACILITY, CARRANSTOWN

AIR DISPERSION MODELLING REPORT

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ISSUE	DATE	ORIG	AUTH CHK	REVIEW	APPRVD PM	APPRVD CLIENT	DESCRIPTION
A	8/1/2001	JP	JS		JP		For Planning

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1. EXECUTIVE SUMMARY

Project Management Ltd. (PM) conducted an air dispersion modelling analysis on the emissions from the proposed Waste to Energy plant located in Carranstown, Co. Meath. The modelling was carried out first to determine the appropriate stack height and then to assess in detail the potential impacts arising from emissions from the stack height selected. The cumulative impacts of emissions from the waste to energy plant and two other developments in the vicinity, the existing Platin cement factory and the proposed Marathon power plant were also assessed.

The modelling analysis was carried out to determine the impact of emissions of a number of air substances from the waste to energy plant, namely oxides of nitrogen (NO_x), sulphur dioxide (SO₂), particulates, hydrocarbons, hydrogen chloride (HCl), hydrogen fluoride (HF), Poly-chlorinated dibenzo dioxins (PCDD), Poly-chlorinated dibenzo furans (PCDF) and heavy metals. The plant will also emit minor quantities of carbon monoxide (CO). However due to the relatively low levels of CO emissions and the relatively high air quality standards for CO these emissions are insignificant.

The air dispersion modelling analysis was carried out using the Industrial Source Complex Short Term 3 (ISCST 3) computer model. The model input data included the stack discharge parameters, emission concentrations, receptor locations, five years of Dublin airport meteorological data (1993-1997), building downwash and land use.

Hourly average, daily average and annual average concentrations were calculated. Relevant percentiles of hourly and daily averages were also calculated. Contour plots of the maximum ground level concentrations occurring on and off site were plotted.

A 40m stack height was chosen as being adequate to disperse the atmospheric emissions without causing any undue visual impact. All the maximum predicted ground level concentrations of emissions were found to be below Irish and EU air quality standard limit values and WHO guideline values. The cumulative emissions from the waste to energy plant and the two other developments in the vicinity did not cause the maximum predicted ground level concentrations of emissions to reach air quality standard limit values and guidelines.

2. INTRODUCTION

This report was compiled by Project Management Ltd on behalf of Indaver Ireland to assess the potential impacts on air quality arising from emissions from the proposed waste to energy plant. The modelling analysis was carried out to select the appropriate stack height in the first instance, and then to assess in detail the impact of the emissions from the stack selected.

The proposed site for the waste to energy plant is in Carranstown, Co. Meath. The area immediately surrounding the site is primarily agricultural land with some dispersed housing. The Platin Cement factory is located to the north-east of the development site.

Atmospheric emissions from the proposed waste to energy plant will include the following:

- Oxides of nitrogen (NO_x)
- Sulphur Dioxide (SO₂)
- Particulates (Dust)
- Hydrocarbons (expressed as Total Organic Carbon (TOC))
- Hydrogen Chloride (HCl)
- Hydrogen Fluoride (HF)
- Poly-chloro dibenzo dioxins (PCDD) and Poly-chloro dibenzo furans (PCDF)
- Heavy metals: Cadmium (Cd), Thallium (Tl), Mercury (Hg), Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), Vanadium (V).

The oxide of nitrogen of primary concern in terms of air quality is NO₂. However, as NO converts to NO₂ in the atmosphere all NO_x emissions are modelled and are compared to NO₂ air quality limits. This is in fact a conservative assessment as all NO_x will not have converted into NO₂ in the time it takes to reach the ground. For example, it is estimated that approximately 50% of NO_x will be NO₂ by the time emissions from a typical combustion plant reach the ground.

Carbon Monoxide emissions are not modelled as the concentration in the plume is low (50 mg/m³) and the ambient air quality limit value is high relative to that for other substances such as NO₂. For example in a proposal for emission limit values for carbon monoxide (COM (1998)591) the EU proposes a limit of 10 mg/m³ on ground level CO concentrations. Due to dispersal of the plume the ground level concentrations resulting from the waste to energy plant will be a tiny fraction of this proposed limit.

The cumulative impact of NO_x and SO₂ emissions from the waste to energy plant and two other developments in the vicinity, namely the Platin Cement factory and the proposed Marathon power plant was assessed by carrying out air dispersion modelling for the three combined developments.

The dispersion modelling results are compared with the following air quality standards (AQSs) and guidelines:

- The Air Pollution Act, 1987 (Air Quality Standards) Regulations (SI No. 244 of 1987) which implements EU Directive 80/779/EEC on limit and guideline values for sulphur dioxide and suspended particulates, EU Directive 85/203/EEC on limit and guideline values for nitrogen dioxide, EU Directive 82/884/EEC on a limit value for lead in the air.
- EU Directive 99/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air. The limit values specified in this directive are more stringent than the existing limit values and will start to come into effect from July 2001 and onwards.
- World Health Organisation (WHO) 1999 Air Quality Guidelines for Europe
- The National Authority for Occupational Safety and Health Code of Practice (1999) for the Safety, Health and Welfare at Work (Chemical Agents) Regulations, 1994 (S.I. No. 445 of 1994). Environmental Air Quality Standard (AQS) limit values were not available for a number of emissions, so occupational exposure limits (OELs) were used as a basis for setting limit values. Therefore one fortieth of the OEL was taken as the AQS limit value in accordance with Her Majesty's Inspectorate of Pollution (HMIP) Technical Guidance Note D1: Guidelines on Discharge Stack Heights for Polluting Emissions.

Air Quality Standard (AQS) limit values are often expressed as percentiles which allow the specified Ground Level Concentration (GLC) to be exceeded a set number of times in the monitoring period, e.g. 99.8th percentile of a years hourly average values (this means that the AQS can only be exceeded for 0.2% of the time or 18 hours per year).

3. DISPERSION MODELLING

3.1 Dispersion Model

Dispersion modelling has been carried out using the Industrial Source Complex (ISC 3) computer model.

ISC 3 is a Gaussian dispersion model, which represents the plume as having a normal distribution in both the horizontal and vertical directions. The short term model (ISCST 3) predicts average concentrations over 1 hour, 24 hour and annual periods and percentiles thereof. The model allows for the effects of general plume rise, stack tip downwash and building downwash.

3.2 Meteorological Data

The meteorological data required by the dispersion model is wind speed, wind direction, Pasquill-Gifford stability category, boundary layer height and ambient temperature. The stability category and boundary layer height are used to characterise the turbulence within, and the height of the lower levels of the atmosphere.

Extremely unstable conditions can cause plume looping and elevated concentrations close to the stack. Under stable conditions elevated concentrations can occur due to the emissions being trapped below the boundary layer. Neutral conditions, characterised by cloudy skies and strong winds, are most favourable for dispersion due to the mechanical mixing of the lower atmosphere. The wind direction determines the direction in which the plume is blown, and for a particular stability, higher wind speeds will result in reduced plume rise so causing the plume to reach ground level closer to the stack with elevated emission concentrations. The boundary layer height determines the total vertical distance over which the plume may spread.

Five years (1993-1997) of Meteorological data for Dublin Airport was obtained from Trinity Consultants (the producers of the model). The data obtained consists of hourly values of wind speed, wind direction, air temperature, stability category and mixing height. Wind direction is converted to a flow vector (the direction toward which the emission moves) by adjusting the direction by 180 degrees.

3.3 Building Downwash

Air streams blowing across buildings can become disrupted, with turbulent eddies occurring downwind in the building wake. If an emission point is sufficiently close to a building, then the plume may become entrained in the turbulent eddies of the building wake. This entrainment can cause plume downwash resulting in elevated emission concentrations close to the emission point.

The ISC model interprets the influence zone of each building for a given wind direction to be the area included by the rectangle described by the location 5 building lengths (L) downwind, 2L upwind and 0.5L in the crosswind direction from the building. This has been updated by the Building Profile Input Program (BPIP) which was used in this modelling analysis. BPIP uses the arc of the original 5L limit line as the downwind structure influence zone (SIZ) boundary.

The BPIP programme determines a building height and a projected width for the dominant structure for each 10° of azimuth about each source for use as input to the ISCST 3 program.

The main buildings on the proposed site were included in the modelling analysis which were the Furnace building (30m), Flue Gas Treatment building (25m), Waste Acceptance Hall (25m), Warehouse (9m) and Administration building (7.5m).

Elevated terrain may increase the ground level concentrations by reducing the vertical dimension within which the plume can disperse. In this case since the change in terrain within the vicinity of the site is not significant enough to influence plume dispersion, terrain has been considered flat for the model.

This is in accordance with the USEPA guidelines where it is recommended that terrain be considered simple (or flat) if the ground level does not exceed the height of the stack within the vicinity of the stack. In order to ensure that the slope of the ground on the site does not influence dispersion of the emissions, a check run was carried out where the stack and buildings are 10m below the surrounding levels. This yielded identical results as for flat terrain, and confirms that the slope of the site does not affect dispersion of emissions.

3.4 Land Use

To calculate ground level concentrations, either rural or urban dispersion parameters must be specified for the model. In the rural mode, the model uses the Pasquill-Gifford dispersion coefficients and rural mixing heights. In the urban mode, the model uses Briggs urban dispersion coefficients and urban heights. USEPA guidelines were used to determine whether the area is urban or rural.

According to these guidelines if the land use categories within a circle of 3 km radius comprise less than 50% of the following categories: heavy or medium industrial, commercial or multi family residential, the area should be classified as rural. It was found that this is the case at the proposed site and rural dispersion parameters were chosen.

3.5 Stack Discharge Parameters and Emission Data

There will be one main stack on site through which atmospheric emissions will be discharged. It is assumed that the emission from the stack will be continuous.

The waste to energy plant can operate over a range of loads, and with a corresponding range of discharge parameters. Preliminary model runs indicated that the maximum GLCs occurred for maximum loading (ie. 120% of nominal capacity). These discharge parameters were used in the analysis and therefore the worst case parameters, i.e. those that would lead to the highest ground level concentrations, are used in the modelling analysis.

The stack parameters, emission concentrations and mass emission rates used in the modelling assessment are shown in Tables 3.1 and 3.2.

Table 3.1 Stack Discharge Parameters (at 120% of Nominal Load)

Discharge Parameters	
Stack Location (NG Co-ordinates)	306200E, 270910N
Stack Internal Diameter (m)	2.0
Exit Temperature (K)	373
Flow Rate (Nm ³ /s dry gas, 11% O ₂)	41.94
Flow Rate at discharge conditions (m ³ /s at 100 °C, 8% O ₂ , 21% H ₂ O)	64.5
Exit Velocity (m/s)	20.5

Table 3.2 Emission Data

Emission	Emission Concentration Limit at 273 K (mg/Nm ³)	Emission Rate (g/s)
NO _x (as NO ₂)	200	8.389
SO ₂	50	2.097
TOC	10	0.419
Total Dust	10	0.419
HCl	10	0.419
HF	1	0.042
Dioxins (PCDD) & Furans (PCDF)	0.01 (ng/m ³)	0.42 (ng/s)
Cd & Tl	0.05	0.002
Hg	0.05	0.002
Sum of 9 Heavy Metals: Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V	0.5	0.021

The emission concentrations in the flue gas will not exceed the limits specified in the amended proposal for a European Parliament and Council Directive on the Incineration of Waste (98/0289). Indeed the dioxin emission concentrations, at 0.01 ng/m³, will be only 10% of the EU Limit (0.1 ng/m³) and the hourly NO_x concentration will not exceed 200 mg/m³, compared to the EU ½ hourly limit of 400 mg/m³.

For the purposes of the air dispersion modelling certain emissions are grouped together (eg. cadmium and thallium or the sum of 9 heavy metals) as the emissions are grouped together in this manner in the proposed Directive.

One of the input parameters to the dispersion model is the emission rate (g/s) of the substance. As there are several different substances with different emission rates, for the purposes of running the model a Unity Value (ie. 1 g/s) was input into the model. The results were then multiplied by the appropriate emission rate to determine the maximum predicted ground level concentration for each individual emission.

4. STACK HEIGHT DETERMINATION

4.1 Screening Analysis

The stack height screening analysis was carried out using a 3.5 km (east) x 2.5 km (north) grid as it was found in an initial analysis that the maximum ground level concentrations occurred within 1km of the stack.

The grid used consisted of 3640 receptor points spaced at 50m intervals. Five years (1993-1997) of meteorological data for Dublin airport was used in the screening analysis. The stack height was assessed at 5m intervals from 35m to 45m.

The highest concentration of any emitted pollutant from the stack will be NO_x (modelled as NO₂) and therefore the stack height determination was carried out with respect to NO_x emissions. The maximum 99.8th percentile hourly average ground level NO₂ concentrations were calculated for the range of stack heights.

4.2 Assessment of Results and Stack Height Selection

The results are shown in Figure 4.1. The new 99.8th percentile (not to be exceeded for more than 18 hours per annum) limit value as per EU Directive 99/30/EC is also indicated on Figure 4.1 for reference.

As can be seen in Figure 4.1 the maximum ground level concentration of NO₂ decreases steadily as the stack height increases.

At forty metres the maximum ground level concentration is less than half that for a 35m stack. It is also well below the new limit value.

Although the concentrations arising from a 45m stack are lower again, as choosing the stack height is based on the conflicting objectives of providing adequate pollutant dispersion without creating any undue visual impact, it was decided that a 40m stack would best meet both of these objectives. The detailed assessment was therefore carried out on a 40m stack.

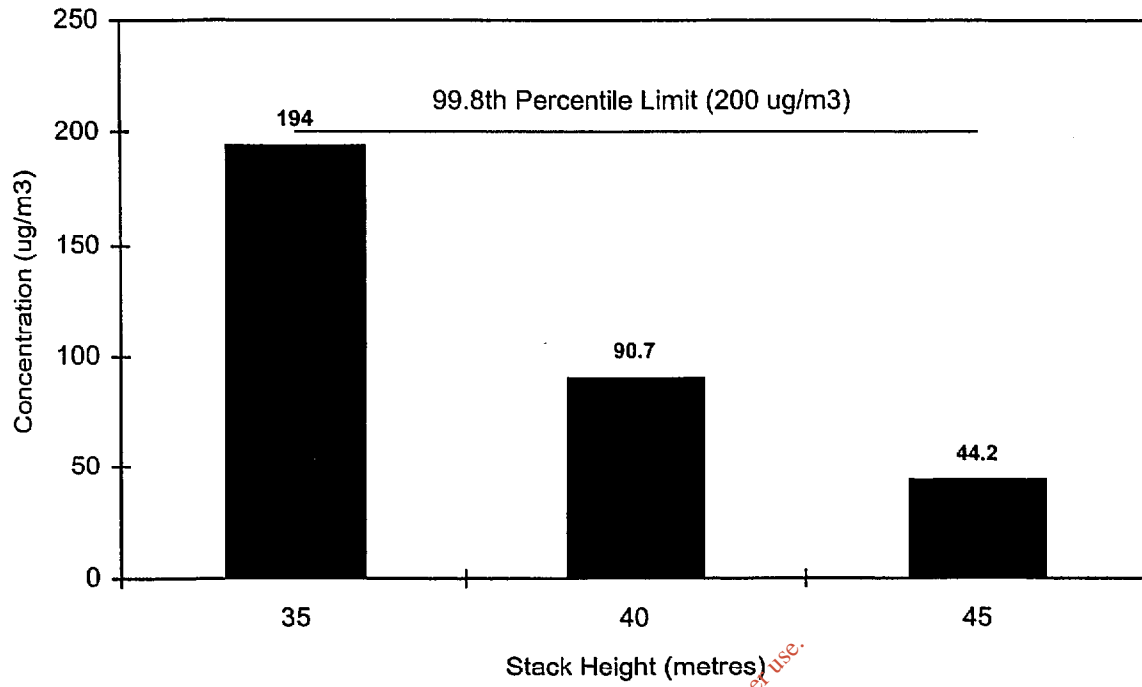


Figure 4.1: Maximum 99.8th Percentile Hourly Average Ground Level Concentrations of NO₂

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5. ASSESSMENT OF IMPACTS FROM A 40M STACK

5.1 Dispersion Modelling

The stack discharge parameters used in the detailed assessment are as listed in Tables 4.1 and 4.2. The grid used in the analysis was a 3.5km (east) by 2.5km (north) grid. The grid has the stack located approximately in the centre and consists of over 3,640 receptor points within the grid, maximising the resolution and accuracy of the modelling.

Hourly sequential meteorological data has been used in ISCST 3 to generate predictions of the full range of maximum hourly, daily and yearly averages and percentiles thereof for comparison with all relevant Air Quality Standards (AQSS) and guidelines.

The buildings, terrain and land use are as detailed in Section 3.

The maximum predicted Ground Level Concentrations (GLCs) of emissions and the relevant air quality standards are presented in Table 5.1. Contour plots of the dispersion modelling results are included in Attachment 1. For individual emissions some of the contour plots require the predicted GLC to be multiplied by the appropriate emission factor as a Unity Value (1 g/s) was used in the dispersion model (refer to Section 3.5).

5.2 Assessment of Results

The maximum predicted ground level concentrations of emissions occur approximately 230m north-east of the stack as shown on the Contour Plots in Attachment 1. The prevailing wind is from a south-westerly direction however occasionally when the wind is blowing from the opposite direction the maximum ground level concentrations can also occur 380m south-west of the stack.

The waste to energy plant will emit higher concentrations of NO_x in the flue gas than any other emission. The oxide of nitrogen of primary concern in terms of air quality is NO₂. However, as NO converts to NO₂ in the atmosphere all NO_x emissions were modelled and are compared to NO₂ air quality limits. This is in fact a conservative assessment as all NO_x will not have converted into NO₂ in the time it takes to reach the ground. The maximum predicted ground level concentrations (GLCs) of NO₂ are well below both existing and the new more stringent Irish and EU AQS limit values. The maximum 99.8th percentile hourly GLC is 45% of the relevant limit value and the maximum annual average value is 13-17% of the relevant limit value.

The maximum predicted GLCs of SO₂ are significantly below Irish and EU AQS limit values (2-9% of limit values) and also well below WHO guidelines (11% of limit value). The maximum predicted GLCs of dust (particulates) are only 1-2% of the relevant Irish and EU limit values.

Environmental AQS limit values are not available for Hydrocarbons (Total Organic Carbon). Therefore an Occupational Exposure Limit (OEL) for toluene was used as a basis for setting an AQS limit value. The predicted maximum hourly average GLC of total organic carbon is 0.05% of the limit value. Similarly there are no AQS limit values available for hydrogen chloride (HCl) and hydrogen fluoride (HF), so OEL's were used to set limit values. The predicted maximum hourly average GLCs of HCl and HF are only 2% and 1% of their respective limit values.

There are no Irish, European or World Health Organisation AQS limit values for dioxins or furans. The WHO expresses a limit value in terms of Tolerable Daily Intake which cannot be directly related to ambient air concentration of dioxins. However the predicted maximum hourly and annual average GLC's of dioxins are $7 \times 10^{-15} \text{ g/m}^3$ (0.007 pg/m^3) and $2.5 \times 10^{-16} \text{ g/m}^3$ (0.00025 pg/m^3) respectively. At these extremely low ambient air concentrations the dioxins/furans will be below the detection threshold for dioxins. (For a more detailed discussion on dioxins see Section 4.4 of the main EIS).

There are no AQS limit values for Thallium (Tl) so the OEL was used to set a limit value. The maximum predicted annual and hourly average GLCs are for the sum of cadmium and thallium. If one assumes that the GLC consisted entirely of either Cd or Tl, the GLCs would be well below the corresponding limit values for the individual metals.

The maximum annual average GLC of mercury is $1 \times 10^{-3} \mu\text{g/m}^3$ which is only 0.001% of the limit value.

For the sum of nine heavy metals, OELs were used to set limit values for all of the heavy metals with the exception of lead (Pb). As a conservative assessment the maximum GLC for each heavy metal was predicted based on the assumption that that metal alone is emitted at the concentration limit for the sum of the nine heavy metals. Even based on this assumption, which is unlikely to happen, the predicted GLCs are significantly lower than the AQS limit values.

In summary, atmospheric emissions from the 40m stack of the waste to energy plant do not caused the maximum predicted GLCs of emissions to reach Irish and EU AQS limit values or WHO guidelines.

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Table 5.1 Predicted Maximum Ground Level Concentrations of Emissions compared to Air Quality Standards

Emission	Type of Prediction	Maximum Concentration ($\mu\text{g}/\text{m}^3$)	SI No. 244 of 1987 ($\mu\text{g}/\text{m}^3$)	% of Limit	Directive 99/30/EC ($\mu\text{g}/\text{m}^3$)	% of Limit	WHO 1999 ($\mu\text{g}/\text{m}^3$)	% of Limit	SI No. 445 of 1994 ($\mu\text{g}/\text{m}^3$)	% of Limit
NO ₂	98th Percentile of a Years Hourly Average	73.65	200	37	----	----	----	----	----	----
NO ₂	99.8th percentile of a Years Hourly Average	90.65	----	----	200	45	----	----	----	----
NO ₂	Annual Average	5.13	----	----	30-40 ⁽¹⁾	13 - 17	----	----	----	----
SO ₂	99.7th percentile of a Years Hourly Average	22.47	----	----	350	6	----	----	----	----
SO ₂	Daily Average	14.10	----	----	----	----	125	11	----	----
SO ₂	98th Percentile of a Years Daily Average	8.47	250-350 ⁽²⁾	2-3	----	----	----	----	----	----
SO ₂	99.2th percentile of a Years Daily Average	10.77	----	----	125	9	----	----	----	----
SO ₂	Annual Average	1.28	----	----	20 ⁽³⁾	6	50	3	----	----
Dust	98th Percentile of a Years Daily Average	1.69	250	1	----	----	----	----	----	----
Dust	90th Percentile of a Years Daily Average	0.98	----	----	50 ⁽⁴⁾	2	----	----	----	----
Dust	Annual Average	0.26	----	----	20 ⁽⁴⁾	1	----	----	----	----

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Table 5.1....continued

Emission	Type of Prediction	Maximum Concentration ($\mu\text{g}/\text{m}^3$)	SI No. 244 of 1987 ($\mu\text{g}/\text{m}^3$)	% of Limit	Directive 99/30/EC ($\mu\text{g}/\text{m}^3$)	% of Limit	WHO 1999 ($\mu\text{g}/\text{m}^3$)	% of Limit	SI No. 445 of 1994 ($\mu\text{g}/\text{m}^3$)	% of Limit
TOC	Hourly Average	7.12	----	----	----	----	1,000 ⁽⁶⁾	1	----	----
HCl	Hourly Average	7.12	----	----	----	----	----	----	350 ⁽⁶⁾	2
HF	Hourly Average	0.71	----	----	----	----	----	----	63 ⁽⁶⁾	1
PCDD / PCDF ⁽⁷⁾	Hourly Average	7×10^{-9}	----	----	----	----	----	----	----	----
	Annual Average	2.5×10^{-10}	----	----	----	----	----	----	----	----
Cd & Tl ⁽⁸⁾	Annual Average (Cd)	1×10^{-3}	----	----	----	----	5×10^{-3}	20	----	----
	Hourly Average (Tl)	0.03	----	----	----	----	----	----	2.5	1
Hg	Annual Average	1×10^{-3}	----	----	----	----	1	0.001	----	----
Sum of 9 Heavy Metals ⁽⁹⁾	Annual Average (Pb)	0.01	2	0.5	0.5	2	0.5	2	----	----
	Hourly Average (Sb)	0.37	----	----	----	----	----	----	12.5	3
	Hourly Average (As)	0.37	----	----	----	----	----	----	2.5	15
	Hourly Average (Cr)	0.37	----	----	----	----	----	----	1.25	30
	Hourly Average (Co)	0.37	----	----	----	----	----	----	2.5	15
	Hourly Average (Cu)	0.37	----	----	----	----	----	----	5	7
	Hourly Average (Mn)	0.37	----	----	----	----	----	----	25	2
	Hourly Average (Ni)	0.37	----	----	----	----	----	----	2.5	15
	Hourly Average (V)	0.37	----	----	----	----	----	----	1	37

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Notes:

- (1) Limit value of 30 $\mu\text{g}/\text{m}^3$ is for the protection of vegetation and limit value of 40 $\mu\text{g}/\text{m}^3$ is for the protection of human health.
- (2) Limit value of 250 $\mu\text{g}/\text{m}^3$ applies when corresponding percentile of suspended particulates $>150 \mu\text{g}/\text{m}^3$ and limit value of 350 $\mu\text{g}/\text{m}^3$ applies when corresponding percentile of suspended particulates $\leq 150 \mu\text{g}/\text{m}^3$.
- (3) Limit value is for the protection of ecosystems.
- (4) Directive 99/30/EC sets limit values for PM_{10} (particulate matter $\leq 10 \mu\text{m}$ in diameter) rather than all particulate matter. After the limit values have been implemented in Member States they will be reviewed and more stringent limit values may be applied as part of Stage 2 of the Directive.
- (5) Limit value is for Toluene which can be used as a standard for measuring Total Organic Carbon (TOC). The limit value is a 1987 WHO guideline and is based on an averaging time of 30 minutes.
- (6) Limit value is derived by dividing the Occupational Exposure Limit (OEL) by a factor of 40
- (7) There are no air quality standard limit values for dioxins and furans. The 1999 WHO guidelines expressed a limit for dioxin like compounds in terms of Tolerable Daily Intake in TEQ/ kg bwd (Toxic Equivalent uptakes per kilogram of body weight per day). The Tolerable Daily Intake for dioxin like compounds is 1-4 TEQ/ kg bwd.
- (8) The maximum predicted annual and hourly average GLCs are for the sum of Cd & Tl. The WHO annual average limit value is for Cd. The hourly average limit value is for Tl and was derived by dividing the Occupational Exposure Limit (OEL) by a factor of 40.
- (9) The maximum predicted annual and hourly average GLCs are for the sum of the nine heavy metals. The limit values for all of the heavy metals with the exception of Pb are derived by dividing the Occupational Exposure Limits (OELs) by a factor of 40.

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6. POTENTIAL FOR CUMULATIVE IMPACTS ON AIR QUALITY

6.1 Point Sources of Atmospheric Emissions

Two other developments in the vicinity of the proposed waste to energy plant, the existing Platin Cement factory and the proposed Marathon Combined Cycle Gas Turbine power plant, can be considered significant point sources of atmospheric emissions. Platin Cement factory is located approximately 750m north east of the proposed development site and the Marathon power plant will be located on a site across the R152 road to the south-east of the proposed development site.

Atmospheric emissions from all three developments could potentially give rise to a cumulative impact on ground level concentrations of NO₂ and SO₂. Therefore air dispersion modelling was carried out to assess the cumulative impact of the waste to energy plant and the two other developments on ground level concentrations of these emissions.

Details on atmospheric emissions for Platin cement factory were obtained from the Platin Cement IPC licence application and details on atmospheric emissions for the Marathon power plant were obtained from the Marathon Environmental Impact Statement (EIS). The stack parameters and emission data for these two sources are summarised in Tables 6.1 and 6.2 below. The emission data was input into the model together with the emissions data for the waste to energy plant. Emission data for operation on distillate oil for the Marathon power plant was used in the model as higher levels of emissions occur than when operating on natural gas.

Table 6.1: Stack Parameters and Emissions Data for Platin Cement factory

Parameter	Kiln1	Kiln2
Stack Location	306523E, 271756N	306493E, 271083N
Stack Height (m)	106.7	103.3
Stack Diameter (m)	2.3	3.7
Temperature (K)	513	397
Exit Velocity (m/s)	12.06	11.233
Volume Flow (Nm ³ /hr)	96,000	299,000
Actual Volume Flow (m ³ /hr)	180,396	434,180
Emission Concentration (mg/Nm³)		
SO ₂	4,000	4,000
NO _x	1,800	1,800
Emission Rate (g/s)		
SO ₂	107.6	335.13
NO _x	48	149.5

Table 6.2: Stack Parameters and Emission Data for proposed Marathon power plant

Discharge Parameters	
Stack Location (NG Co-ordinates)	306780E, 270785N
Stack Height (m)	49.9
Stack Internal Diameter (m)	7.0
Exit Temperature (K)	369
Flow Rate (Nm ³ /s dry gas, 15% O ₂)	503
Flow Rate (m ³ /s at discharge conditions)	681
Exit Velocity (m/s)	17.695
Emission Concentration (mg/Nm ³)	
Operation on Distillate Oil	
SO ₂	140
NO _x	120
Emission Rates (g/s)	
Operation on Distillate Oil	
SO ₂	70
NO _x	60.53

6.2 Assessment of Results

The results of the cumulative impact modelling together with the relevant air quality standards are presented in Table 6.3.

The results indicate that the cumulative impact of emissions from the proposed waste to energy plant, Platin cement works and the proposed Marathon power plant do not cause the predicted maximum GLCs of NO₂ and SO₂ to reach Air Quality Standard limit values or guidelines.

Due to the height of the stacks and discharge temperature from Platin cement factory the maximum predicted GLCs of NO₂ and SO₂ from the cement factory occur approximately 5-6 km north-east of the factory and therefore do not coincide with the maximum GLCs of emissions from the proposed waste to energy plant or the Marathon power plant.

The maximum predicted GLCs from the waste to energy plant usually occur approximately 230m north-east of the stack. The maximum predicted GLCs from the Marathon power plant occur approximately 270m north-east of the Marathon stack and do not coincide with the maximum GLC's from the waste to energy plant as illustrated in Figures 13 & 14 in Attachment 1.

The maximum 99.8th percentile hourly average GLC of NO₂ is 72% of the relevant Irish and EU limit value. The maximum 99.7th percentile hourly average GLC of SO₂ is 71% of the relevant Irish and EU limit value.

It should be noted that the contribution from the Marathon power plant is based on the plant running on distillate oil (rather than natural gas) which results in much higher emissions of NO₂ and SO₂. According to the Marathon EIS, distillate oil will be used as a backup fuel and therefore will be used infrequently if at all, so that during normal operation on natural gas much lower levels of NO₂ and SO₂ will be emitted and consequently any cumulative impact will be greatly reduced.

Furthermore, the cumulative modelling is based on the worst case discharge conditions occurring at the three plants at the same time and also at the same time as the worst case meteorological conditions. The maximum predicted GLCs are therefore based on a worst case scenario which is unlikely to arise and the modelling is therefore very conservative.

In summary, the cumulative atmospheric emissions from the waste to energy plant, Platin cement factory and Marathon power plant will not cause ground level concentrations of NO₂ and SO₂ to reach Air Quality Standard limit values or guidelines.

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Table 6.3: Predicted Maximum Ground Level Concentrations of NO₂ and SO₂ resulting from Cumulative Emissions

Emission	Type of Prediction	Maximum Concentration (µg/m ³)	SI No. 244 of 1987 (µg/m ³)	% of Limit	Directive 99/30/EC (µg/m ³)	% of Limit	WHO 1999 (µg/m ³)	% of Limit
NO ₂	98th Percentile of a Years Hourly Average	74.2	200	37	----	----	----	----
NO ₂	99.8th percentile of a Years Hourly Average	143.65	----	----	200	72	----	----
NO ₂	Annual Average	5.89	----	----	30-40 ⁽¹⁾	15 - 20	----	----
SO ₂	99.7th percentile of a Years Hourly Average	247.9	----	----	350	71	----	----
SO ₂	Daily Average	101.7	----	----	----	----	125	81
SO ₂	98th Percentile of a Years Daily Average	48.76	250-350 ⁽²⁾	14-20	----	----	----	----
SO ₂	99.2th percentile of a Years Daily Average	76.29	----	----	125	61	----	----
SO ₂	Annual Average	4.55	----	----	20 ⁽³⁾	23	50	9

(1) Limit value of 30 µg/m³ is for the protection of vegetation and limit value of 40 µg/m³ is for the protection of human health.

(2) Limit value of 250 µg/m³ applies when corresponding percentile of suspended particulates >150 µg/m³ and limit value of 350 µg/m³ applies when corresponding percentile of suspended particulates ≤ 150 µg/m³.

(3) Limit value is for the protection of ecosystems.

7. CONCLUSIONS

The stack height screening exercise has demonstrated that a 40m high stack will adequately disperse atmospheric emissions of emissions from the waste to energy plant without causing undue visual impact. Air dispersion modelling has shown that atmospheric emissions of emissions from the waste energy plant will not result in the maximum ground level concentrations of these emissions reaching Irish and EU air quality standard limit values or WHO guidelines.

The cumulative atmospheric emissions from the waste to energy plant, Platin cement works and the proposed Marathon power plant will not cause ground level concentrations of NO₂ and SO₂ to reach the relevant air quality standard limit values and guidelines.

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ATTACHMENT 1

Contour Plots of Predicted Maximum Ground Level Concentrations

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LIST OF CONTOUR PLOTS

<u>Figure</u>	<u>Title</u>
1	98 th Percentile (Hourly Average) NO ₂ Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
2	99.8 th Percentile (Hourly Average) NO ₂ Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
3	Annual Average NO ₂ Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
4	99.7 th Percentile (Hourly Average) SO ₂ Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
5	98 th Percentile (Daily Average) SO ₂ Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
6	99.2 th Percentile (Daily Average) SO ₂ Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
7	Annual Average SO ₂ Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
8	98 th Percentile (Daily Average) Particulate Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
9	90 th Percentile (Daily Average) Particulate Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
10	Annual Average Particulate Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
11	Hourly Average Unity Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
12	Annual Average Unity Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
13	99.8 th Percentile (Hourly Average) Cumulative NO ₂ Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
14	99.2 th Percentile (Daily Average) Cumulative SO ₂ Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)
15	Annual Average Cumulative NO ₂ Ground Level Concentrations ($\mu\text{g}/\text{m}^3$)