Ambient Air Monitoring

At

Blackpool, Cork City

19th January 2000 – 31st May 2000

Contents

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Summary

An assessment of air quality was carried out in the Cork city suburb of Blackpool between 19th January 2000 and 31st May 2000. No limit values were exceeded during the measurement period.

Levels of benzene and lead were below their respective lower assessment thresholds. Concentrations of nitrogen dioxide and sulphur dioxide were above their lower assessment thresholds while levels of PM_{10} were above the upper assessment threshold for this pollutant.

	Below Lower Assessment Threshold	**Below Upper Assessment Threshold**	**Above Upper Assessment Threshold**	**Above Limit**
PM_{10}				
NO_2				
SO_2				
Benzene				
Pb				

For the purpose of this assessment, Ireland has been divided into four zones ; Dublin (Zone A), Cork (Zone B), specified population centres > 15,000 inhabitants (Zone C) and non-urban areas (Zone D). The implications of this assessment are that within Zone B of the country

- Levels of PM_{10} will need to be monitored continuously
- Levels of NO_2 and SO_2 can be assessed using a combination of measurement and modelling.
- Levels of benzene and Lead can be assessed used modelling or objective estimation techniques.

The directive stipulates that modelling or objective estimation techniques may be used to assess air quality if levels of the pollutant in question in that zone are below the lower assessment threshold. A combination of measurement and modelling can be used if levels are between the two assessment thresholds while continuous monitoring is required if levels exceed the upper assessment threshold.

Introduction

The European Union introduced a new approach to the monitoring, assessment and management of air quality in 1996 when it introduced a framework directive on air quality (96/62/EC, 2nd September 1996). The basic principle of the framework directive is that each country should be divided into zones and that the monitoring, assessment, management and reporting of air quality will be undertaken in relation to these zones. For the purposes of the directive, Ireland has been divided into four zones; Dublin (Zone A), Cork Urban Area (Zone B), specified population centres > 15,000 inhabitants (Zone C) and non-urban areas (Zone D).

Limit values are set for each individual pollutant which need to be met by a specific attainment date. Upper and lower assessment thresholds are also set for each pollutant, assessment thresholds are levels below the limit value, used solely in the determination of the level of monitoring needed for that pollutant in a particular zone. The extent of monitoring in any zone is determined by population size and air quality status. Measurement is mandatory in agglomerations (population >250,000) and where concentrations are above the lower assessment threshold. The greatest monitoring effort applies if concentrations are above the upper assessment threshold. Less intensive monitoring is required when concentrations are between the two assessment thresholds.

Limit values, assessment thresholds, measurement techniques and other specifics for each pollutant are defined in a series of daughter directives. The first daughter directive was adopted in April 1999 (1999/30/EC) and covered SO_2, NO_X, particulate matter and lead. The second daughter directive was adopted in November 2000 (2000/69/EC) and covers CO and Benzene. The directives were transposed into Irish law as the Air Quality Standard Regulations 2002 (S.I No. 271 of 2002).
To comply with the directive the Environmental Protection Agency uses mobile laboratories to carry out assessments in areas with no history of air pollution measurements. These trailers contained the following instruments:

- Monitoring instruments which continuously measure and record concentrations of the pollutants sulphur dioxide, nitrogen oxides and carbon monoxide.
- Instrument which continuously measures and records the levels of particulate matter.
- Gas chromatograph which measures levels of benzene and toluene.
- Sampler for particulate matter (the official method specified for this parameter by the EU commission involves collection of the particulate matter on a filter on site followed by laboratory determination of the filter's increase in weight).
- Sampler for lead and other metals in air (collection on filter for determination in the laboratory).
- Mini meteorological station for measuring and recording temperature, relative humidity, wind speed and direction.

The sample inlets are at a height of ~3m.
For further information please contact

John Finnan, Barbara O' Leary or Ciaran O' Donnell.

Time Period

The mobile laboratory was in place from 19th January 2000 to 31st May 2000.

Siting

The mobile laboratory was situated in the yard of a fire station owned by Cork Corporation (Figure 1). The fire station is located in the Cork City suburb of Blackpool. The back entrance of the station opens onto Great William O'Brien Street. The laboratory was sited immediately adjacent to the back entrance where it was approximately 10 metres distant from the kerbside. The area is a mixed commercial/ residental district with a high volume of traffic, the main road to the city of Limerick being approximately 100m from where the mobile laboratory was sited.

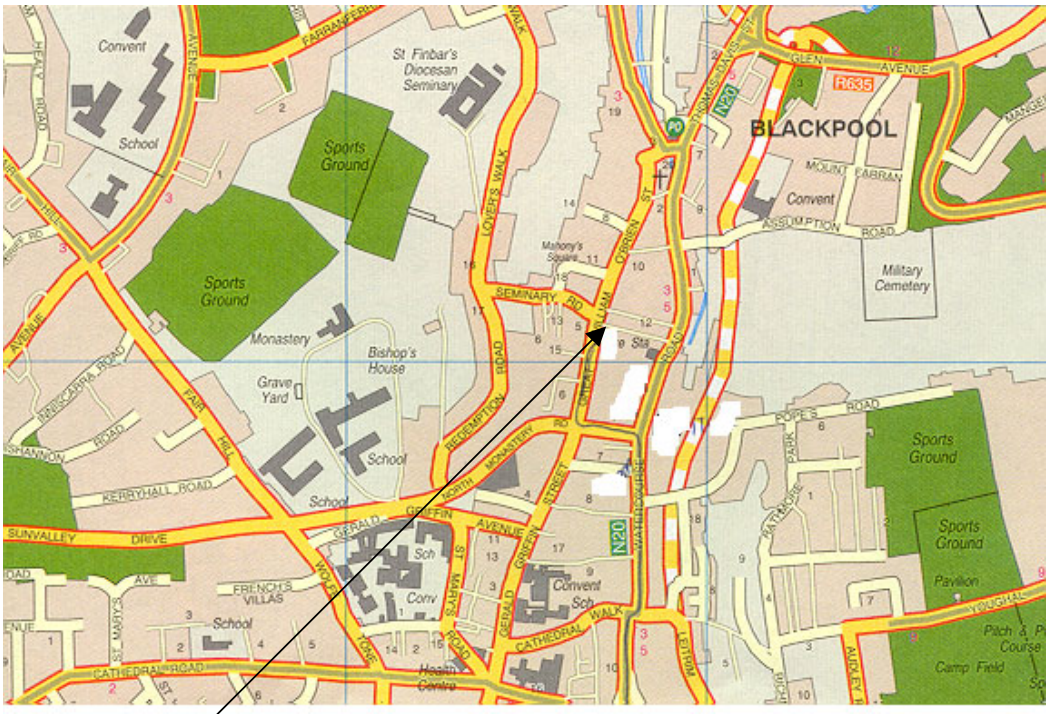


Fig. 1 Map of site location

Location of mobile laboratory

Monitoring Methods

Carbon Monoxide

Carbon monoxide was monitored using a Gas Filter Correlation CO Analyser (Model 300, Advanced Pollution Instrumentation, 6565 Nancy Ridge Drive, San Diego, California). This is a continuous analyser based on the absorption of infrared radiation by CO molecules at wavelengths near 4.7μm. This is the reference method for CO as specified in Council Directive 2000/69/EC (Annex viii).

Sulphur Dioxide

Sulphur dioxide was monitored using an Advanced Pollution Instrumentation SO_2 Fluorescent Analyser - Model 100A. This is a continuous analyser which measures the fluorescence of SO_2 due to absorption of ultraviolet radiation. This is the reference method for SO2 as specified in Council Directive 1999/30/EC (Annex xi).

Nitrogen Dioxide and Oxides of Nitrogen

NO_x species were monitored using an Advanced Pollution Instrumentation Chemiluminescent $NO/NO_2/NO_x$ Analyser - Model 200A. This is a continuous analyser which utilises the chemiluminescent reaction of nitric oxide in the sample and ozone to measure the NO concentrations. Any NO_2 present is then reduced to NO by a molybdenum converter giving a second value for total NO_x concentration. The amount of NO_2 present is found by subtraction. This is the reference method for oxides of nitrogen as specified in Council Directive 1999/30/EC (Annex xi).

Particulate Matter

A gravimetric method was used to monitor PM_{10} particles (as defined in European Standard, prEN12341, July 1998, Central Secretariat, rue de Stassart, 36, B-1050 Brussels). The air was sampled by an Ambient Dust Automatic Monitor (Model SM200CD with β source removed, OPSIS, S-24402, Furulund, Sweden) which changed the filters daily at midnight. An inertial impactor sampling head restricted the sampled particles to those with a diameter less than 10μm. The particles were collected on preweighed glassfibre filters (Whatman GF/A, 47mm). The filters were equilibrated at constant temperature and humidity (T = 293±1°K, R.H. = 50±3%) for at least 48 hours in a WTB Binder APT.Line KBF115 Climatic Chamber prior to weighing. This is the reference method for PM_{10} as specified in Council Directive 1999/30/EC (Annex xi).

Particulate matter was also measured using an OSIRIS Environmental Dust Monitor (Turnkey Instruments, 1&2 Dalby Court, Gadbrook Business Centre, Northwitch, Cheshire CW9 7TN). This instrument uses a light scattering technique to determine the concentration of airborne particles and dust; it is not an approved method. Results are given for total suspended particulates, PM_{10}, $PM_{2.5}$ and PM_1.

Benzene

Benzene was measured using a gas chromatograph (BTX Analyser GC855 supplied by Syntech Spectras, G. Meirstraat 11, 9728 TB Groningen, Nederland). This gas chromatograph samples automatically every 15 minutes and is equipped with a photoionisation detector.

Lead and Other Metals

Ambient air was pumped through a Metricel membrane filter (Gelman, 37mm, 0.8µm) situated in a calming chamber. The filters were changed every 1-2 weeks. They were digested in conc. HNO_3 and analysed for lead and other metals using ICP-MS (Inductively Coupled Plasma-Mass Spectrometry).

All results for CO, SO_2, NO_X and the continuous particulate monitor were integrated to give 1-hour average values as required for comparison with the Directive limit values.

Results

Carbon Monoxide

No. of hours	3188	
Missing values	2587	
(including routine maintenance)	(0)	
No. of measured values	601	
Percentage covered	18.8%	
Maximum hourly value	21.8	$mg.m^{-3}$
98 percentile for hourly values	2.9	$mg.m^{-3}$
Mean hourly value	0.9	$mg.m^{-3}$
Maximum 8-hour mean	10.9	$mg.m^{-3}$
98 percentile for 8-hour mean	3.8	$mg.m^{-3}$

Proposed Directive Limits

	Averaging Period	Limit Value	Date by which limit value is to be met
Limit Value for the protection of human health	8-hour running average	10 mg m^{-3}	1 January 2005
Upper assessment threshold	8-hour running average	7 mg m^{-3}	
Lower assessment threshold	8-hour running average	5 mg m^{-3}	

A limited data set is available from 19th January until 13th Febuary due to a technical problem with the carbon monoxide monitor. During this period there was an exceedence of the 10 $mg.m^{-3}$ limit during the period 29th –30th January (Figure 2).This was an isolated result and may have been attributable to a local effect at the sampling location. Otherwise, all data is below the lower assessment threshold for the protection of human health.

Fig. 2 Carbon Monoxide 8-hour Running Average
Trailer 1 in Blackpool, Cork 19/1/00-31/5/00

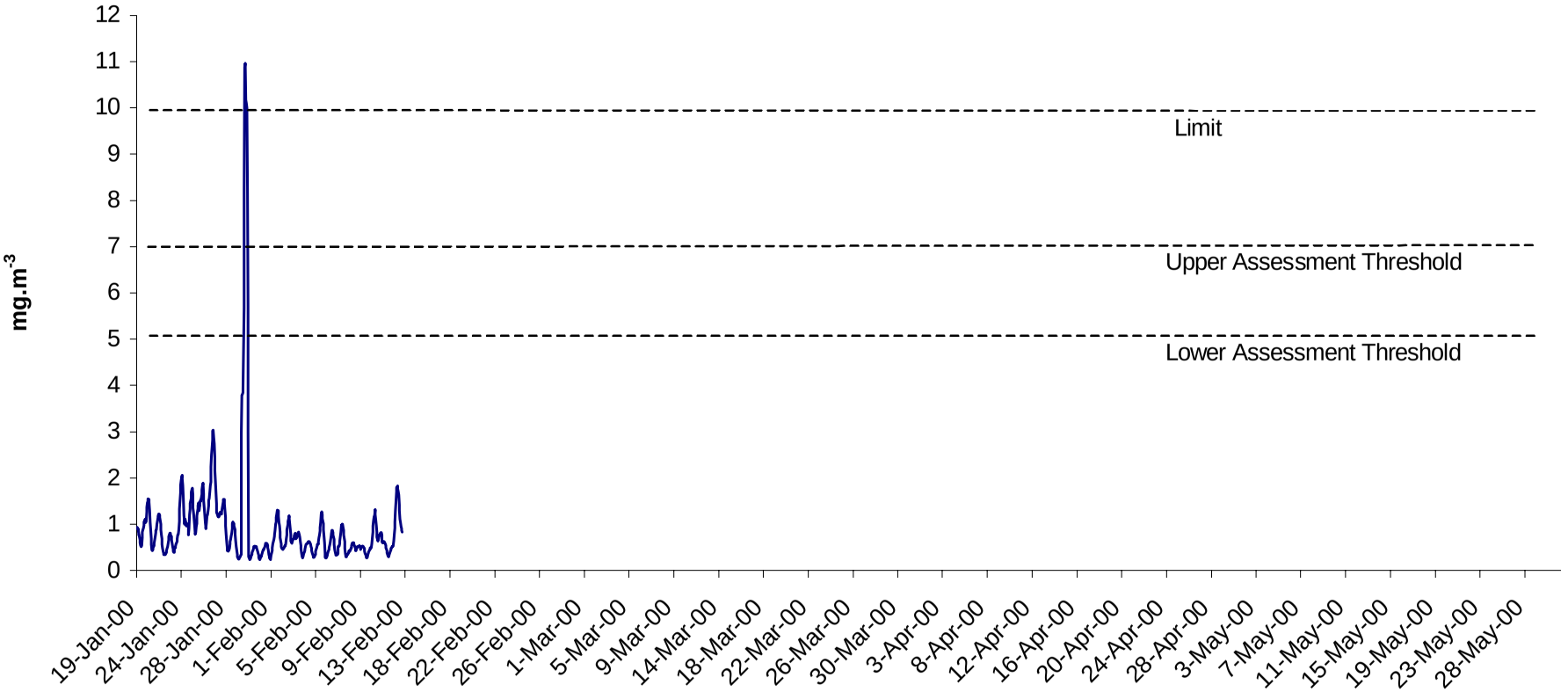
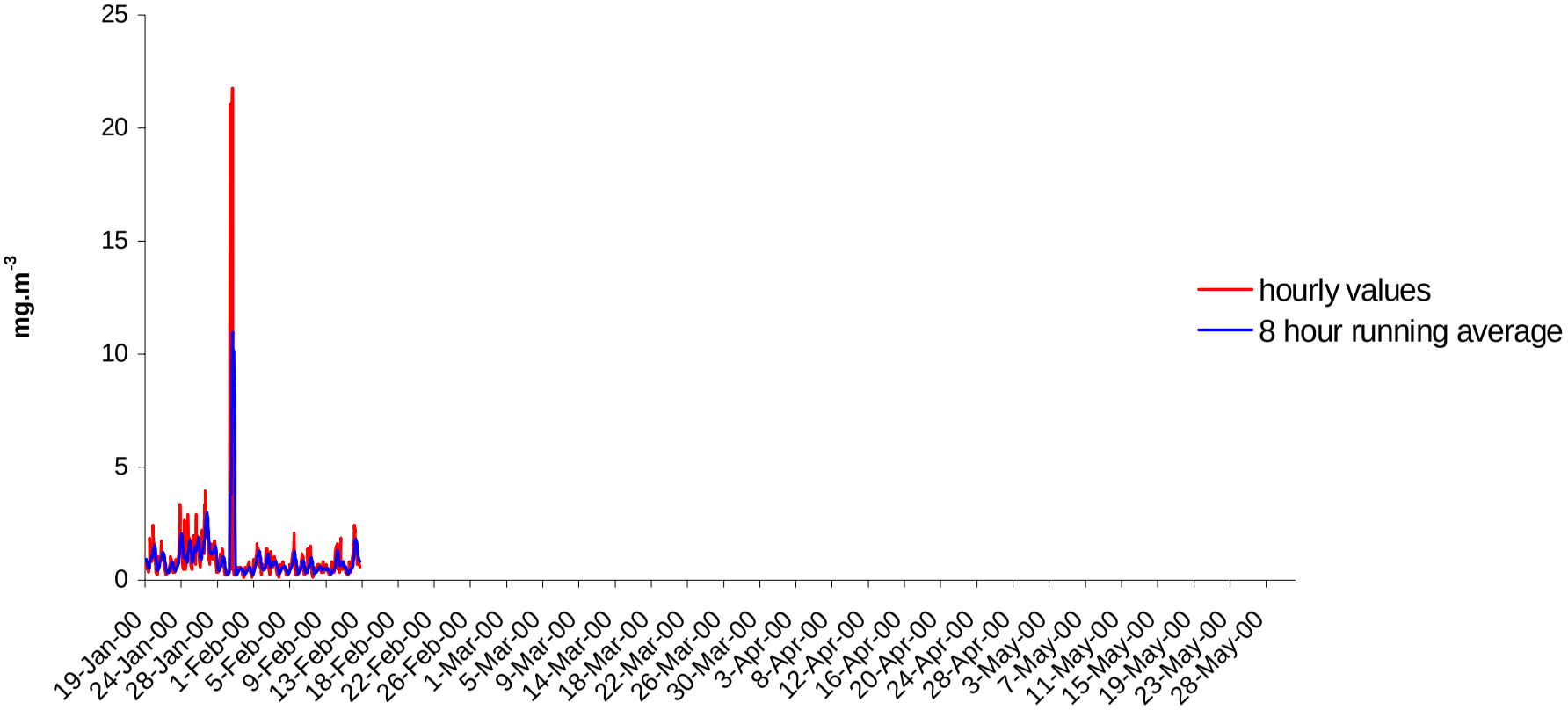


Fig. 3 Carbon Monoxide
Trailer 1 in Blackpool, Cork 19/1/00-31/5/00



Sulphur Dioxide

No. of hours	3188	
Missing values	1236	
(including routine maintenance)	(0)	
No. of measured values	1952	
Percentage covered	61.2%	
Maximum hourly value	161.3	$\mu g.m^{-3}$
98 percentile for hourly values	96.1	$\mu g.m^{-3}$
Mean hourly value	25.3	$\mu g.m^{-3}$
Maximum 24-hour value	58.3	$\mu g.m^{-3}$
98 percentile for 24-hour values	47.3	$\mu g.m^{-3}$

Directive Limits (1999/30/EC)

	Averaging Period	Limit Value	Date by which limit value is to be met
Hourly limit value for the protection of human health	1 hour	350 $\mu g\ m^{-3}$ not to be exceeded more than 24 times a calendar year	1 January 2005
Daily limit value for the protection of human health	24 hours	125 $\mu g\ m^{-3}$ not to be exceeded more than 3 times a calendar year	1 January 2005
Limit value for the protection of ecosystems	Calendar year and winter (1 October to 31 March)	20 $\mu g\ m^{-3}$	19 July 2001
Alert threshold		500 $\mu g\ m^{-3}$ over three consecutive hours	

Directive Limits (1999/30/EC) continued

	Averaging Period	Limit Value	Date by which limit value is to be met
Upper assessment threshold for the protection of human health	24 hours	75 $\mu g\ m^{-3}$ not to be exceeded more than 3 times a calendar year	
Lower assessment threshold for the protection of human health	24 hours	50 $\mu g\ m^{-3}$ not to be exceeded more than 3 times a calendar year	
Upper assessment threshold for the protection of ecosystems	Calendar year and winter (1 October to 31 March)	12 $\mu g\ m^{-3}$	
Lower assessment threshold for the protection of ecosystems	Calendar year and winter (1 October to 31 March)	8 $\mu g\ m^{-3}$	

Data is available from 19th January to 29th March and from 18th May to 31st May. A technical problem with the SO_2 monitor meant that no data was collected between 29th March and 18th May. During the period of operation there were no exceedences of the 350 $\mu g.m^{-3}$ hourly limit for the protection of human health (Figure 5). There were two exceedences of the 50 $\mu g.m^{-3}$ lower assessment threshold (Figure 4). The two exceedences occurred on 26th and 27th January. The directive stipulates that the lower assessment threshold should not be exceeded more than three times in the calendar year.

The mean hourly value of 25.1$\mu g.m^{-3}$ exceeds the limit value for the protection of ecosystems. However, this limit may not be relevant to monitoring in an urban environment. Additionally, the sampling period did not coincide with the prescribed dates and should consequently be taken as indicative.

Fig. 4 Sulphur Dioxide 24 Hour Averages
Trailer 1 in Blackpool, Cork 19/1/00- 31/5/00

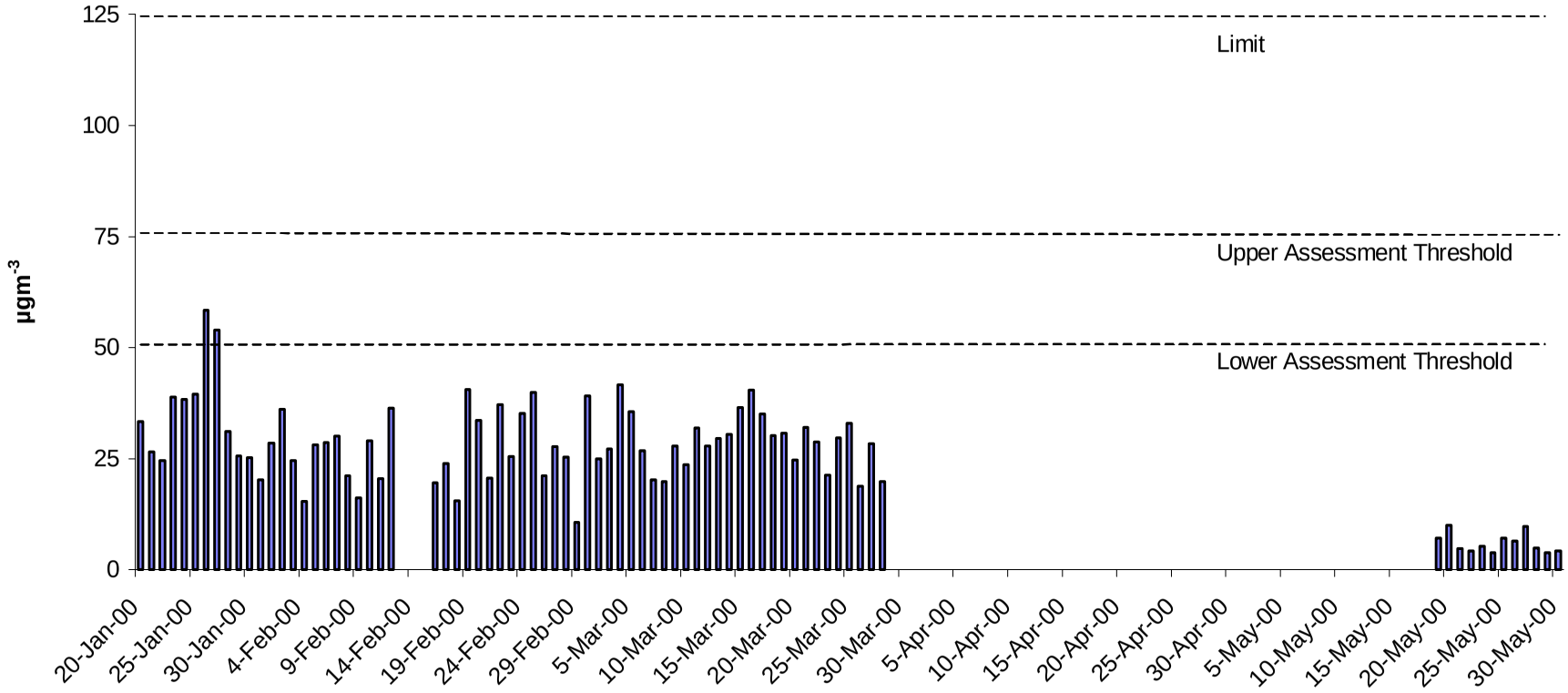
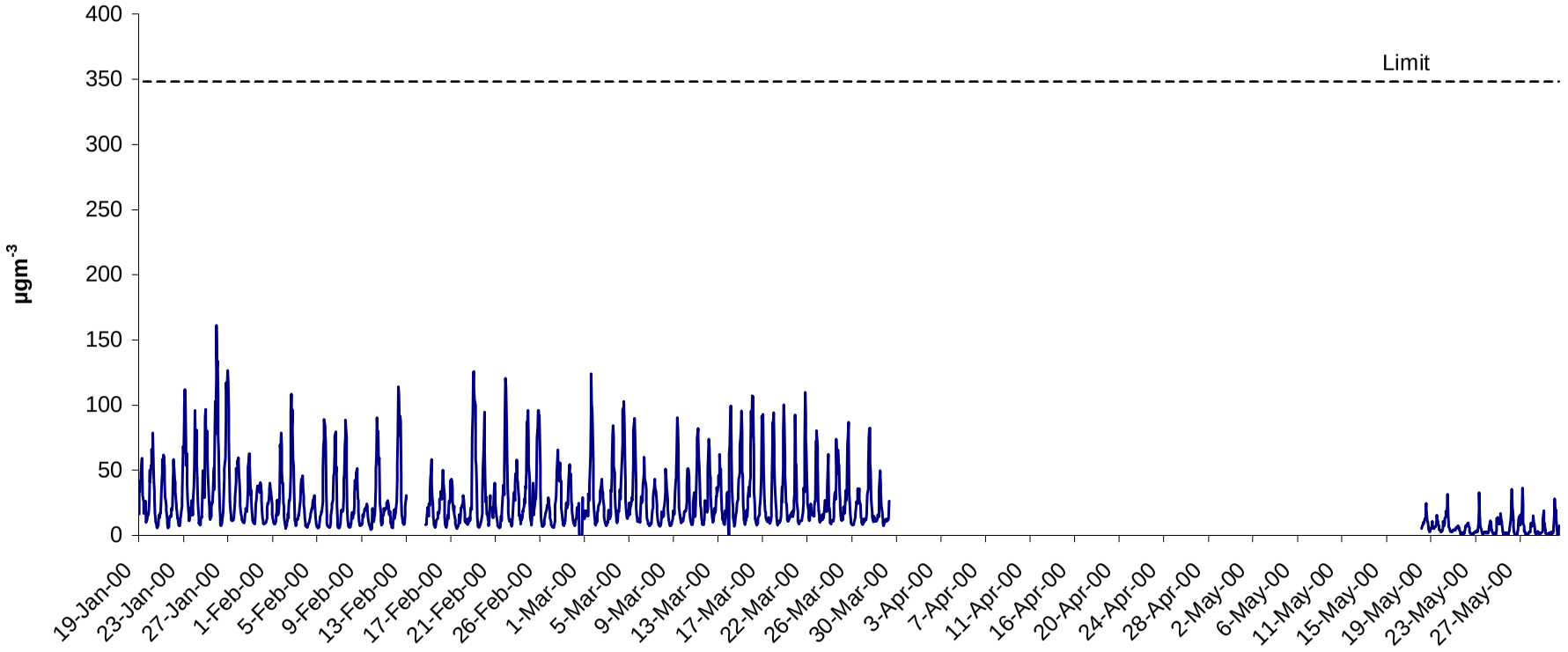


Fig. 5 Sulphur Dioxide Hourly Averages
Trailer 1 in Blackpool, Cork 19/100-31/5/00



Nitrogen Dioxide and Oxides of Nitrogen

No. of hours	3188	
Missing values	1934	
(including routine maintenance)	(0)	
No. of measured values	1254	
Percentage covered	39.3%	
Maximum hourly value (NO_2)	107.1	$\mu g.m^{-3}$
98 percentile for hourly values (NO_2)	72.9	$\mu g.m^{-3}$
Mean hourly value (NO_2)	26.8	$\mu g.m^{-3}$
Mean hourly value (NO_x)	55.4	$\mu g.m^{-3}$ NO_2

Directive Limits (1999/30/EC)

	Averaging Period	Limit Value	Date by which limit value is to be met
Hourly limit value for the protection of human health	1 hour	200 μg m^{-3} NO_2 not to be exceeded more than 18 times a calendar year	1 January 2010
Annual limit value for the protection of human health	Calendar year	40 μg m^{-3} NO_2	1 January 2010
Annual limit value for the protection of vegetation	Calendar year	30 μg m^{-3} NO_x	19 July 2001
Alert threshold		400 μg m^{-3} NO_2 over three consecutive hours	

Directive Limits (1999/30/EC) continued

	Averaging Period	Limit Value	Date by which limit value is to be met
Upper assessment threshold for the protection of human health	1 hour	140 μg m^{-3} NO_2 not to be exceeded more than 18 times a calendar year	
Upper assessment threshold for the protection of human health	Calendar year	32 μg m^{-3} NO_2	
Lower assessment threshold for the protection of human health	1 hour	100 μg m^{-3} NO_2 not to be exceeded more than 18 times a calendar year	
Lower assessment threshold for the protection of human health	Calendar year	26 μg m^{-3} NO_2	
Upper assessment threshold for the protection of vegetation	Calendar year	24 μg m^{-3} NO_x	
Lower assessment threshold for the protection of vegetation	Calendar year	19.5 μg m^{-3} NO_x	

Data is available from 19th January to 29th Febuary and from 18th May to 31st May. No data was collected between 29th Febuary and 18th May because of a technical problem with the NO_X monitor. All hourly mean NO_2 values are below the lower assessment threshold (100 $\mu g.m^{-3}$) except for one exceedence on 23rd Febuary (Figure 6). The directive stipulates that the lower assesment threshold should not be exceeded more than 18 times in a calendar year.

The mean hourly NO_2 value (26.9 $\mu g.m^{-3}$) during the period of measurement is below the annual limit for the protection of human health (40 $\mu g.m^{-3}$) but just above the annual lower assessment threshold for the protection of human health (26 $\mu g.m^{-3}$).

The mean hourly value of NO_X (55.1 µg.m-3 NO_2) during the measurement period exceeds the annual limit value for the protection of vegetation (30 $\mu g.m^{-3}$ NO_X). However, the applicability of this limit to urban air pollution monitoring is questionable.

Fig. 6 NO_2 Hourly Values
Trailer 1 in Blackpool, Cork 19/1/00-31/5/00

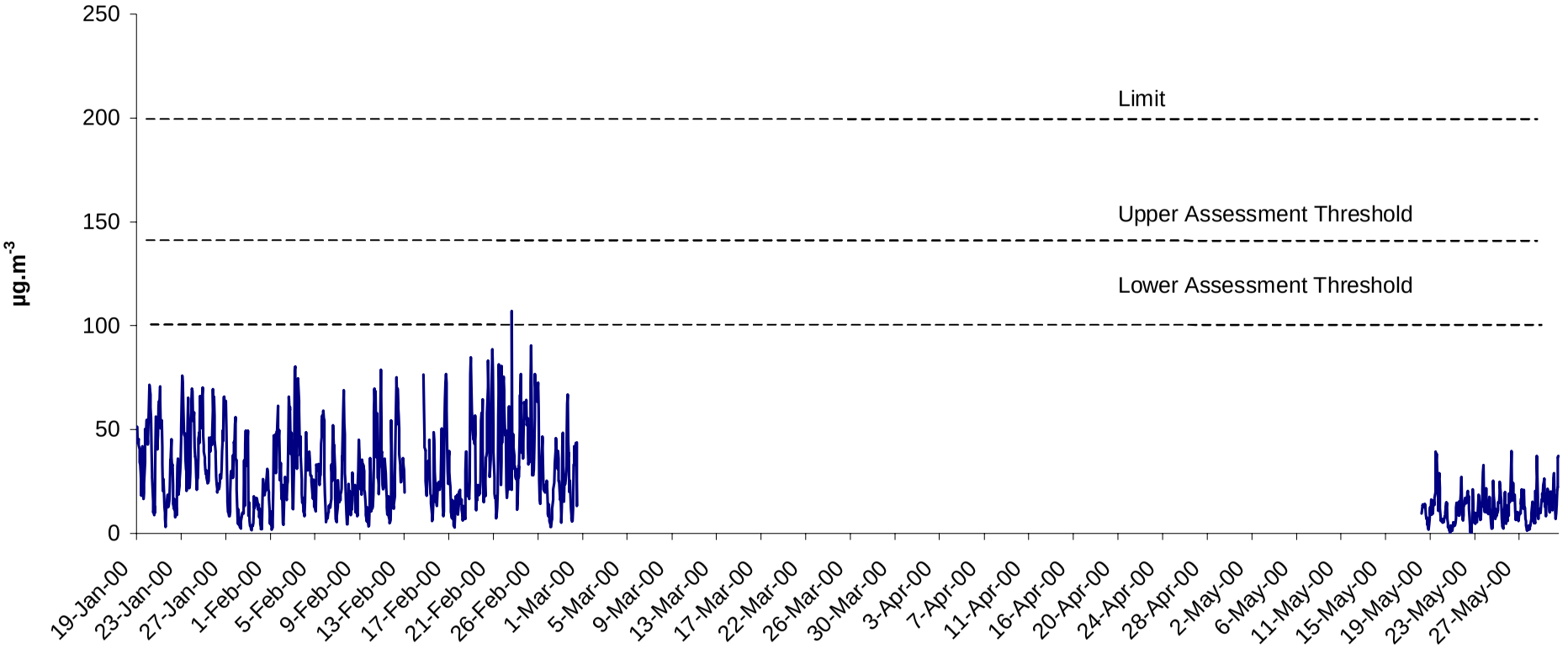
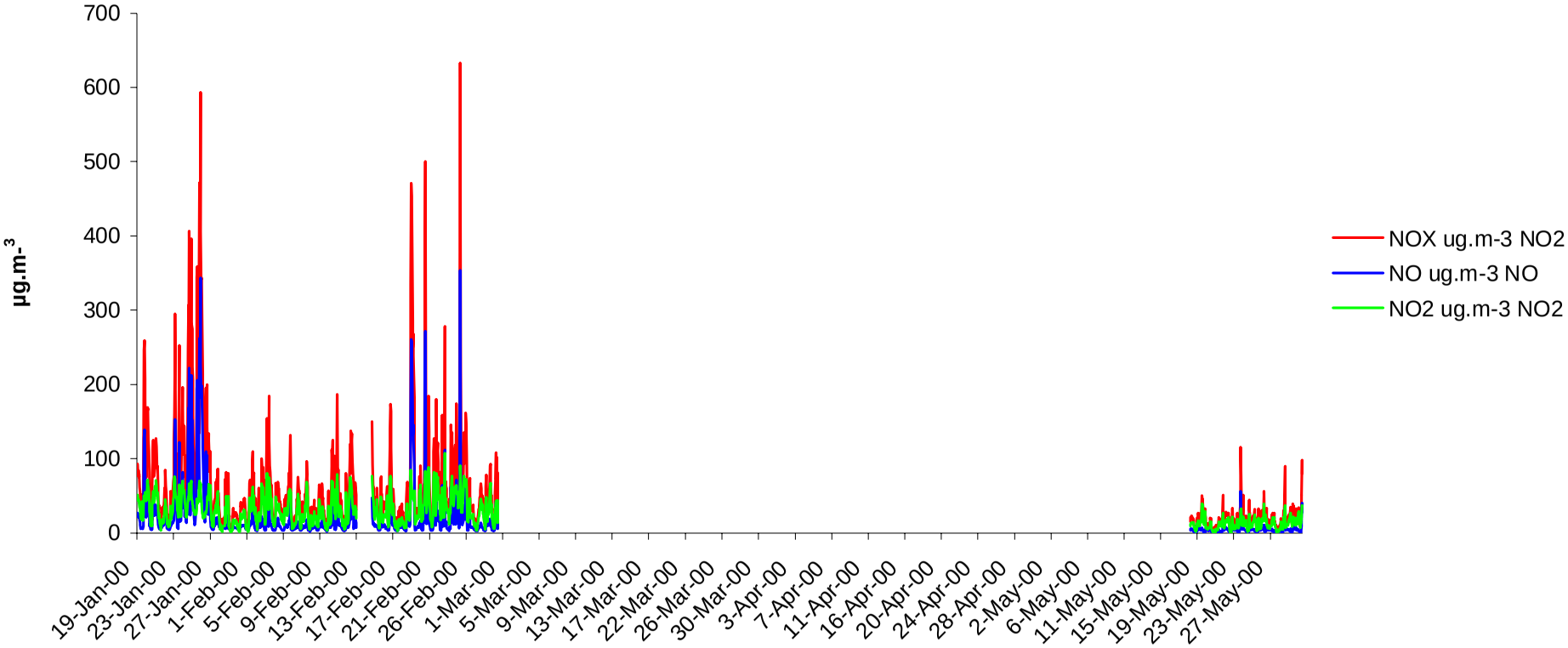


Fig. 7 NO_X Hourly Values
Trailer 1 in Blackpool, Cork 19/1/00-31/5/00



Particulate Matter

PM_{10} : gravimetric method

No. of days	133	
Missing values	16	
(including routine maintenance)	(0)	
No. of measured values	117	
Percentage covered	87.9%	
Maximum daily value	239.4	$\mu g.m^{-3}$
98 percentile for daily values	111.5	$\mu g.m^{-3}$
Mean daily value	49.1	$\mu g.m^{-3}$

Directive Limits (1999/30/EC)

STAGE I

	Averaging Period	Limit Value	Date by which limit value is to be met
24-hour limit value for the protection of human health	24 hour	50 $\mu g\ m^{-3}$ PM_{10} not to be exceeded more than 35 times a calendar year	1 January 2005
Annual limit value for the protection of human health	Calendar year	40 $\mu g\ m^{-3}$ PM_{10}	1 January 2005
Upper assessment threshold for the protection of human health	24 hour	30 $\mu g\ m^{-3}$ PM_{10} not to be exceeded more than 7 times a calendar year	*based on the indicative limit values for 1 January 2010*
Upper assessment threshold for the protection of human health	Calendar year	14 $\mu g\ m^{-3}$ PM_{10}	*based on the indicative limit values for 1 January 2010*

Directive Limits (1999/30/EC) Stage I continued

	Averaging Period	Limit Value	Date by which limit value is to be met
Lower assessment threshold for the protection of human health	24 hour	20 µg m^{-3} PM_{10} not to be exceeded more than 7 times a calendar year	*based on the indicative limit values for 1 January 2010*
Lower assessment threshold for the protection of human health	Calendar year	10 µg m^{-3} PM_{10}	*based on the indicative limit values for 1 January 2010*

STAGE II

	Averaging Period	Limit Value	Date by which limit value is to be met
24-hour limit value for the protection of human health	24 hour	50 µg m^{-3} PM_{10} not to be exceeded more than 7 times a calendar year	1 January 2010
Annual limit value for the protection of human health	Calendar year	20 µg m^{-3} PM_{10}	1 January 2010

The 24-hour limit for the protection of human health was breached 46 times (39.2% of values) during the measurement period (Figure 8), the directive only permits the limit value to be exceeded 35 times in a calendar year. The upper assessment limit was exceeded on 88 occasions (75.2% of values) while the lower assessment limit was exceeded on 113 occasions (96.6% of values).

The mean of the daily values during the measurement period (49.1 $\mu g.m^{-3}$) exceeds the annual limit value for the protection of human health (40 $\mu g.m^{-3}$). The value also exceeds the limit value plus the margin of tolerance permitted until January 2001 (48 $\mu g.m^{-3}$).

Particulate Matter : $PM_{2.5}$

Article 5 of Council Directive 1999/30/EC of 22 April 1999 states that

"Member States shall ensure that measuring stations to supply data on concentration of $PM_{2.5}$ are installed."

In the mobile laboratory,the concentration of $PM_{2.5}$ was measured with an OSIRIS Environmental Dust Monitor. This also measured total suspended particles (TSP), PM_{10} and PM_1. All measurements were hourly values.

The concentration of PM_{10} measured by the OSIRIS and that measured using the gravimetric method were compared to give a daily correction factor. The correction factor was used to estimate the concentration of $PM_{2.5}$ using the formula:

$$\text{24-hour average concentration of } PM_{2.5} = \text{OSIRIS 24-hour average concentration of } PM_{2.5} \times \frac{\text{gravimetric 24-hour average } PM_{10}}{\text{OSIRIS 24-hour average } PM_{10}}$$

Results:

No. of days	133
Missing values	68
(including routine maintenance)	(0)
No. of measured values*	65
Percentage covered	51.1%
Maximum daily value	62.2
98 percentile for daily values	26.2
Mean daily value	11.7
Median daily value	10.2

* no. of days with measurements from both the OSIRIS monitor and the gravimetric method

Fig. 8 PM_{10} Daily Values
Trailer 1 in Blackpool, Cork 19/1/00-31/5/00

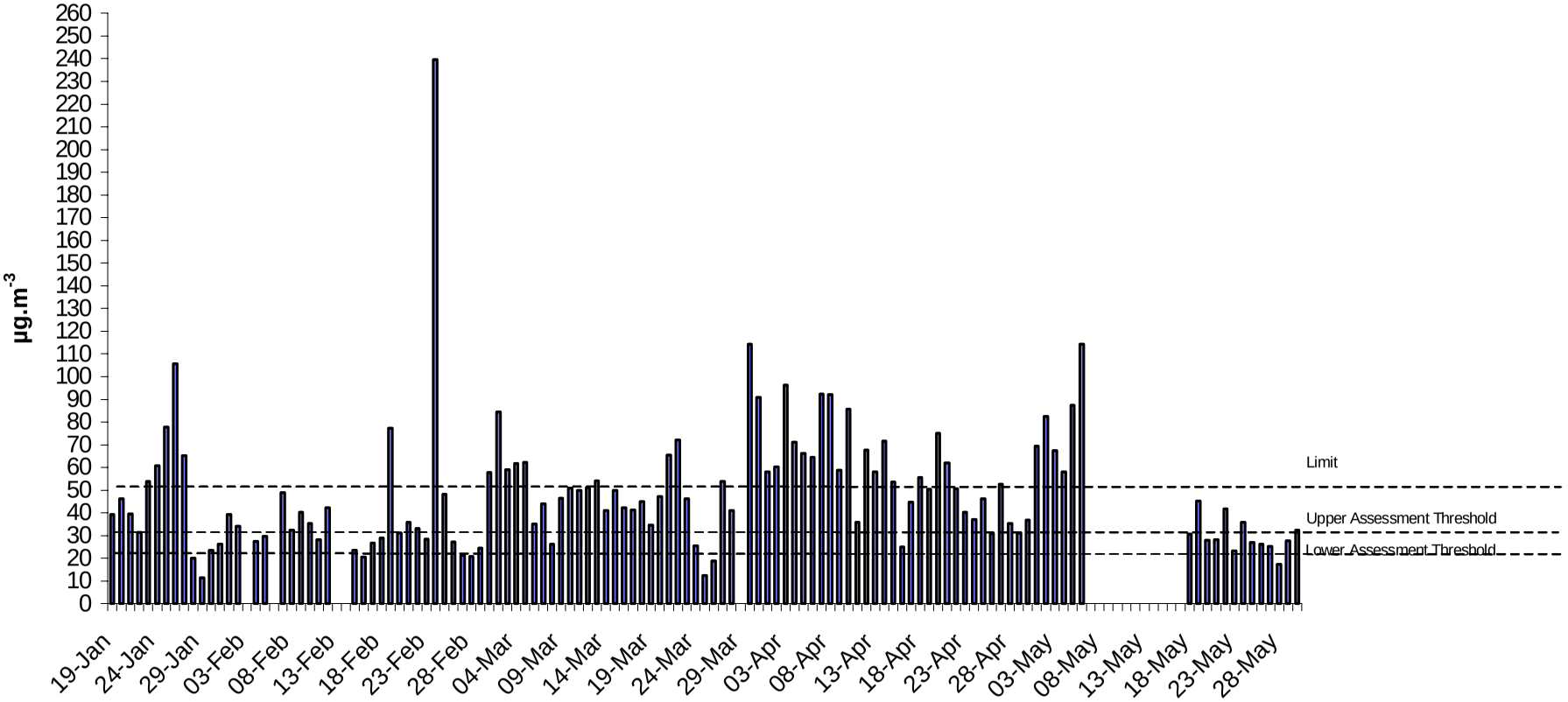
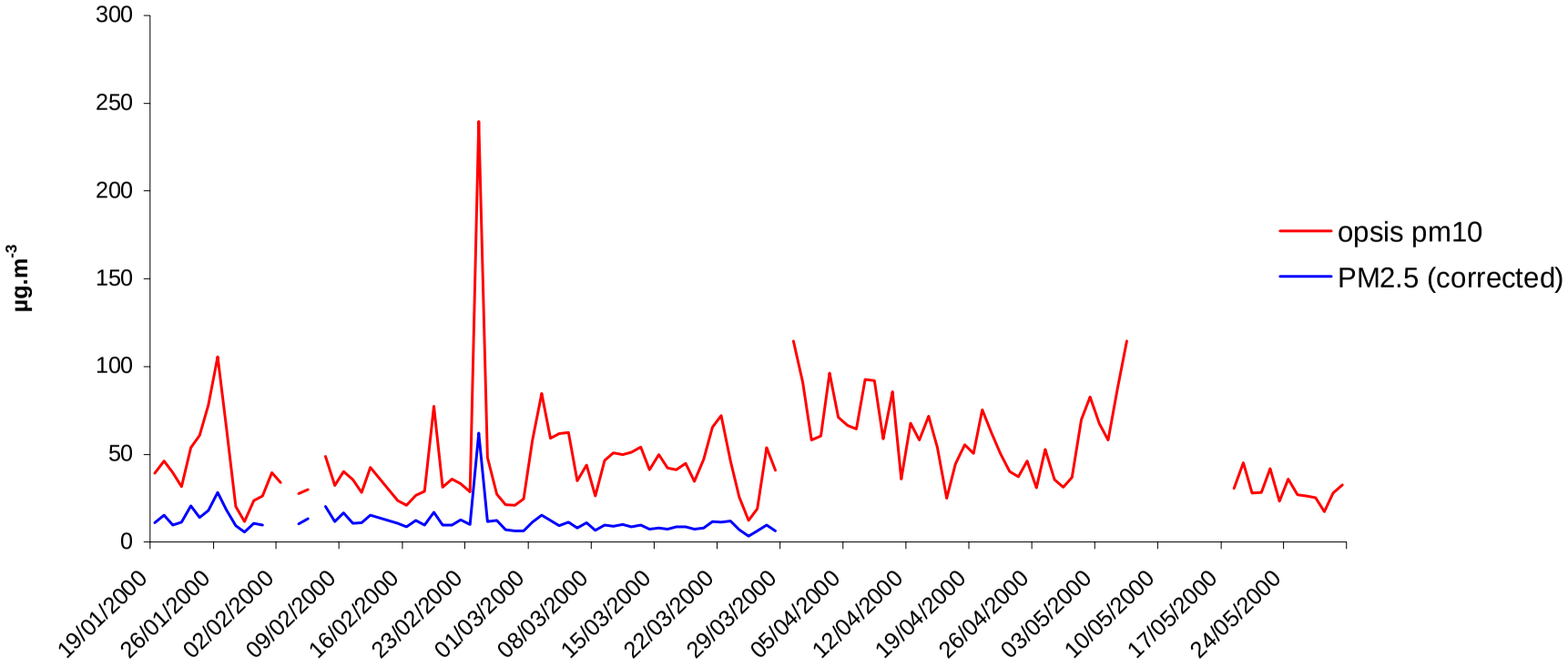


Fig. 9 PM_{10} AND $PM_{2.5}$ Daily Values
Trailer 1 in Blackpool, Cork 19/1/00-31/5/00



Benzene

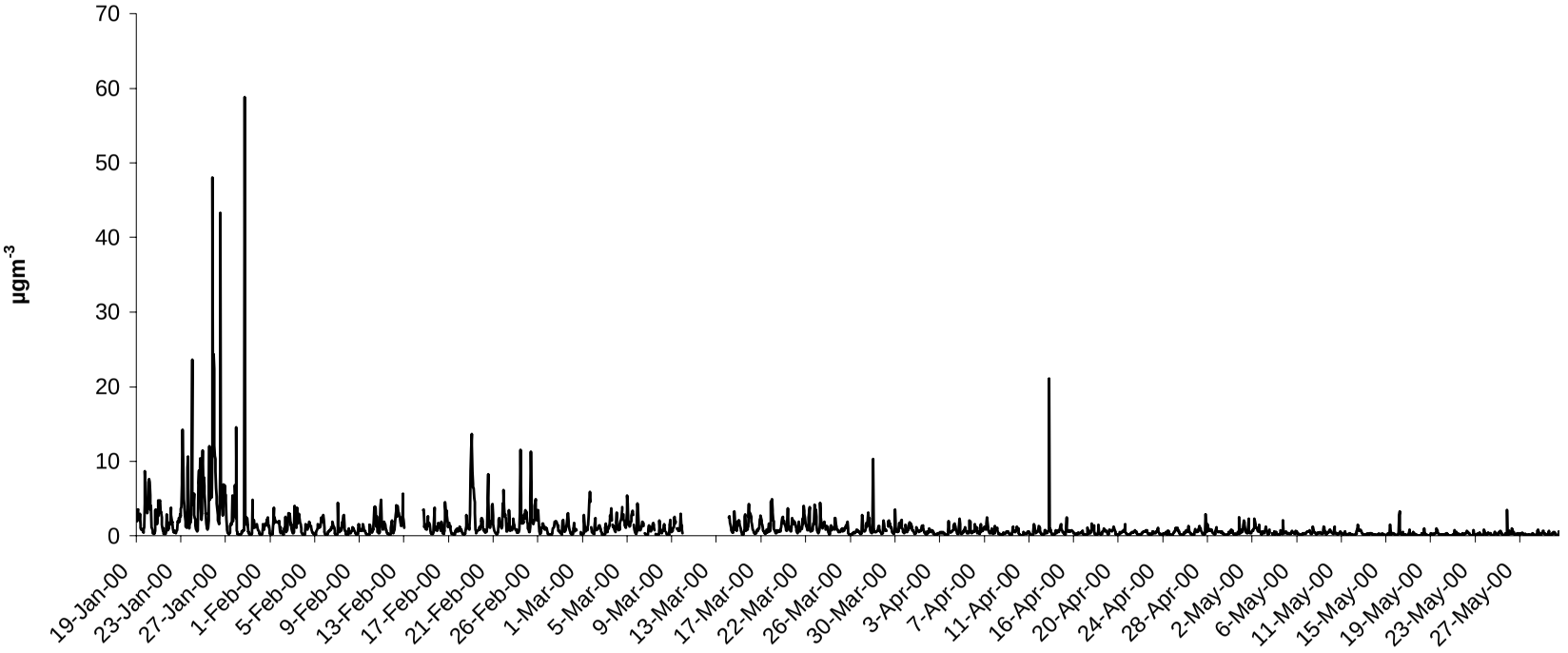
No. of hours	3188	
Missing values	176	
(including routine maintenance)	29	
No. of measured values	3012	
Percentage covered	94.5%	
Maximum hourly value	58.9	$\mu g.m^{-3}$
98 percentile for hourly values	5.7	$\mu g.m^{-3}$
Mean hourly value	1.1	$\mu g.m^{-3}$

Proposed Directive Limits

	Averaging Period	Limit Value	Date by which limit value is to be met
Limit value for the protection of human health	Calendar year	5 $\mu g\ m^{-3}$	1 January 2010
Upper assessment threshold for the protection of human health	Calendar year	3.5 $\mu g\ m^{-3}$	
Lower assessment threshold for the protection of human health	Calendar year	2 $\mu g\ m^{-3}$	

The mean hourly value (1.1 $\mu g.m^{-3}$) for the period measured is below the lower assessment threshold for the protection of human health (Figure 10).

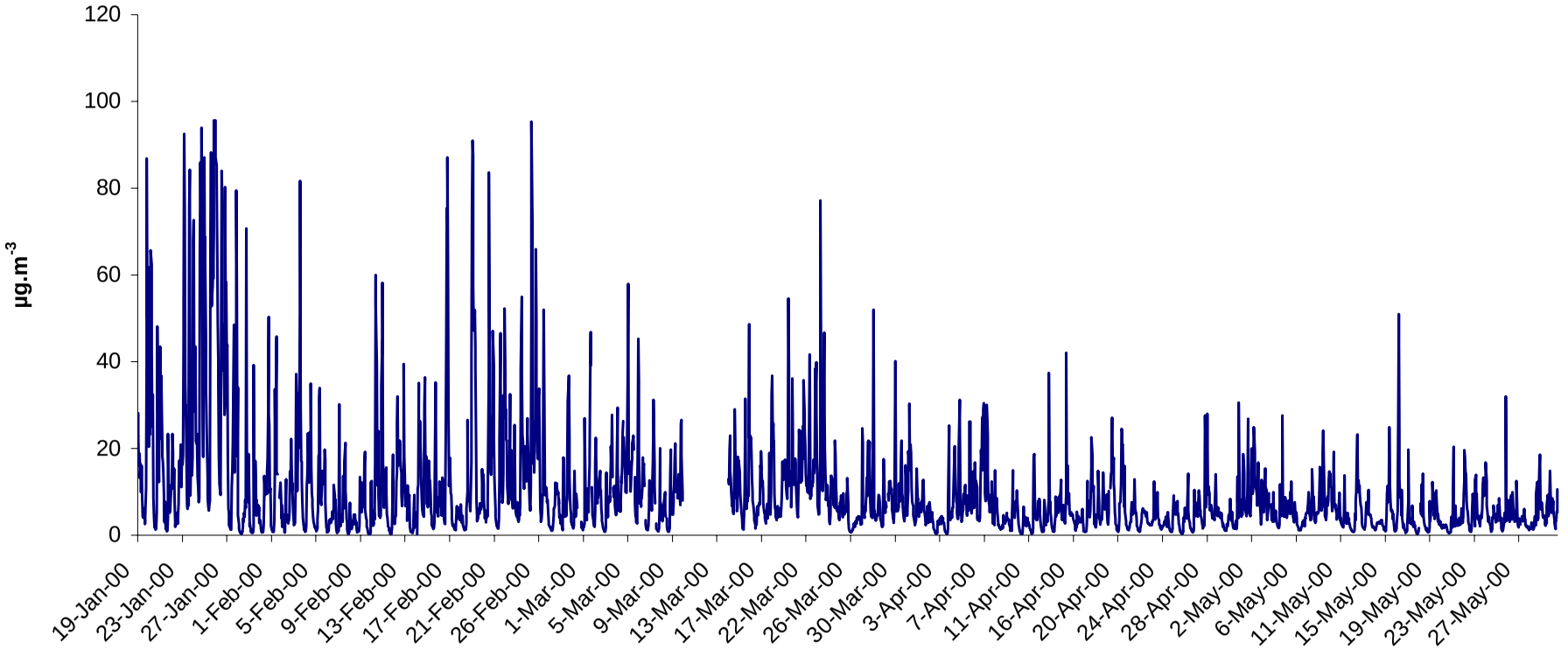
Fig. 10 Benzene Hourly Values
Trailer 1 in Blackpool, Cork 19/1/00-31/5/00



Toluene

No. of hours	3188	
Missing values (including routine maintenance)	137	
No. of measured values	3051	
Percentage covered	95.7	
Maximum hourly value	95.7	$\mu g.m^{-3}$
98 percentile for hourly values	54.5	$\mu g.m^{-3}$
Mean hourly value	10.1	$\mu g.m^{-3}$

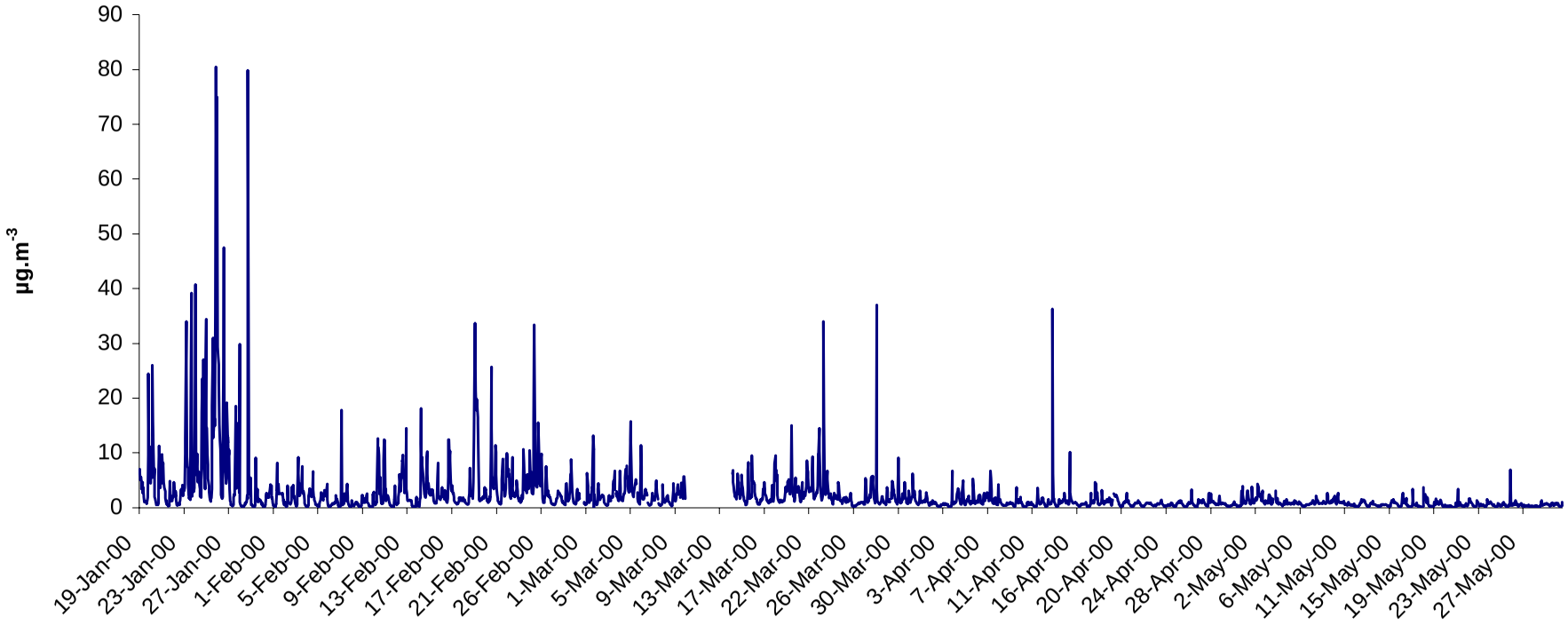
Fig. 11 Toluene Hourly Values
Trailer 1 in Blackpool, Cork 19/1/00-31/5/00



o-Xylene

No. of hours	3188	
Missing values (including routine maintenance)	139	
No. of measured values	3049	
Percentage covered	95.6	
Maximum hourly value	80.4	$\mu g.m^{-3}$
98 percentile for hourly values	14.6	$\mu g.m^{-3}$
Mean hourly value	2.3	$\mu g.m^{-3}$

Fig. 12 o-Xylene hourly values
Trailer 1 in Blackpool, Cork 19/1/00-31/5/00



Lead

No. of days	134	
Missing days	1	
(including routine maintenance)	(0)	
No. of measured days	133	
Percentage covered	99.3	
Concentration of Pb	0.013	$\mu g.m^{-3}$

Directive Limits (1999/30/EC)

	Averaging Period	Limit Value	Date by which limit value is to be met
Annual limit value for the protection of human health	Calendar year	0.5 $\mu g\ m^{-3}$	1 January 2005
Upper assessment threshold	Calendar year	0.35 $\mu g\ m^{-3}$	
Lower assessment threshold	Calendar year	0.25 $\mu g\ m^{-3}$	

The concentration of lead during the measurement period is well below the lower assessment threshold.

Other Metals:

Annex I of council directive 96/62/EC (Air Framework Directive) lists four metals other than lead to be taken into consideration in the assessment and management of ambient air quality. These are cadmium, arsenic, nickel and mercury. Limit values and measurement methods for these metals as well as certain polycyclic aromatic hydrocarbons will be set out in the fourth daughter directive.

An indicative method was used during this assessment to measure prevailing concentrations of cadmium, nickel and arsenic in air. This method is detailed above and essentially involves pumping air through a filter for several weeks before digesting the filter and analysing the digest for lead and other metals using ICP-MS. The problem with this method is that the detection limit is influenced by any traces of metal in the filter paper as well as by the volume of air passed through the filter.
The results, although indicative, do provide some indication of the concentrations of these metals in air.

During this assessment

The maximum concentration of cadmium in air was found to be 0.15 $ng.m^{-3}$

The maximum concentration of arsenic in air was found to be 0.7 $ng.m^{-3}$

The maximum concentration of nickel in air was found to be 3.9 $ng.m^{-3}$