



Ambient Air Monitoring

At

Letterkenny, Co. Donegal

16th May 2008 – 14th July 2009

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Summary

An assessment of air quality was carried out in Letterkenny, Co. Donegal from 16th May 2008 to 14th July 2009. No limit values were exceeded during the measurement period.

Concentrations of carbon monoxide, nitrogen dioxide, sulphur dioxide and lead were below their respective lower assessment thresholds. Concentrations of oxides of nitrogen exceeded the lower assessment threshold value concerning the protection of vegetation however this only applies in rural areas and thus does not apply at the Letterkenny site. Concentrations of PM₁₀ exceeded the lower assessment threshold value concerning the protection of human health.

	Below Lower Assessment Threshold	Below Upper Assessment Threshold	Above Upper Assessment Threshold	Above Limit
PM₁₀				
NO₂				
NO_x				
CO				
SO₂				
Pb				
As				
Ni				
Cd				

Letterkenny, Co. Donegal is located in Zone C. The implications of this assessment are that within Zone C (specified urban centres with population in excess of 15,000)

- Levels of PM₁₀ can be assessed using a combination of measurement and modelling
- Levels of SO₂, CO, NO₂, benzene and lead can be assessed using modelling or objective estimation techniques

Directive 2008/50/EC, commonly referred to as the Cleaner Air for Europe, (CAFÉ), Directive states that modelling or objective estimation techniques may be used to assess ambient air quality if levels of the pollutant in question in that zone are below the lower assessment threshold. A combination of measurement and modelling is required if levels exceed the lower assessment threshold while continuous monitoring is required if levels exceed the upper assessment threshold.

Indicative measurements of legislative heavy metals do not exceed the ambient air quality limit values described in the fourth daughter directive (2004/107/EC).

Introduction

An updated and integrated approach to monitoring, assessment and management of air quality within the European Union was introduced through the Clean Air for Europe directive, (CAFE, 2008/50/EC) on the 21st May 2008. The directive replaced the pre-existing Air Quality framework directive (96/62/EC, 2nd September 1996) and three of the four preceding Air Quality framework daughter directives. It came into effect as of June 2010.

The basic principle of the CAFE 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 and maybe subsequently supported or replaced with ambient air modelling.

Limit values, assessment thresholds, measurement techniques and other specifics for each pollutant which were previously described in the series of Daughter Directives, are now detailed in CAFE, with the exception of the most recent Fourth Daughter Directive . The first Daughter Directive was adopted in April 1999 (1999/30/EC) and covered SO₂, NO_x, particulate matter and lead. The second Daughter Directive was adopted in November 2000 (2000/69/EC) and covers CO and Benzene. The third Daughter Directive relates to ozone (2002/3/EC) while the fourth Daughter Directive relates to heavy metals and polycyclic aromatic hydrocarbons (2004/107/EC). The first three Directives were transposed into Irish law as the Air Quality Standard Regulations 2002 (S.I. No 271 of 2002) and the Ozone in Ambient Air Regulations 2004 (S.I. No 53 of 2004).

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, carbon monoxide and PM₁₀.
- Sampler for lead and other metals in air (collection on filter for determination in the laboratory).

The sample inlets are at a height of ~3m.

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Time Period

The mobile laboratory was in place from the from 16th May 2008 to 14th July 2009.

Siting

The assessment was positioned at the County Museum, High Street, Letterkenny (Figure 1).



Figure 1. Map of site location (courtesy of OSI)

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 whose measurement technique is based on the absorption of infrared radiation by CO molecules at wavelengths near 4.7 μ m.

Sulphur Dioxide

Sulphur dioxide was monitored using an Advanced Pollution Instrumentation SO₂ Fluorescent Analyser - Model 100A. This is a continuous analyser, which measures the fluorescence of SO₂ molecules after excitation by ultraviolet radiation.

Nitrogen Dioxide and Oxides of Nitrogen

NO_x species were monitored using an Advanced Pollution Instrumentation Chemiluminescent NO/NO₂/NO_x Analyser - Model 200A. This is a continuous analyser which utilises the chemiluminescent reaction between nitric oxide in the sample and ozone to measure NO concentrations. Any NO₂ present is then reduced to NO by a molybdenum converter giving a second value for total NO_x concentration. The amount of NO₂ present is found by subtraction.

Particulate Matter

Concentrations of PM₁₀ were measured using an instrument which employed tapered element oscillating microbalance technology (TEOM, Rupprecht & Patashnick Co. Inc., 25 Corporate Circle, Albany, New York). This is a continuous method in which the air from the sampling head is passed through a filter placed on a tapered element. A mass transducer relates changes in the frequency of the tapered element to changes in particulate matter on the filter, the difference between the filter's current weight and its initial weight gives the total mass of collected particulate matter. An inertial impactor sampling head restricted the sampled particles to those with a diameter less than 10 μ m. A filter dynamic measurement system, (FDMS), was coupled with the TEOM to compensate for the loss of volatile components which thus remove the need for a correction factor.

Lead, Arsenic, Nickel and Cadmium

Ambient air was pumped through a Metrical membrane filter (Gelman, 37mm, 0.8 μ m) situated in a calming chamber. The filters were changed every 3-4 weeks. They were digested in conc. HNO₃ and analysed for lead, arsenic, nickel and cadmium using ICP-MS (Inductively Coupled Plasma-Mass Spectrometry).

All results for CO, SO₂, 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

The following sections details the results observed at the Letterkenny site during the assessment period. Summary statistics and graphical representations of the data are provided. Relevant threshold and limit values per parameter are stated.

Carbon Monoxide - CO

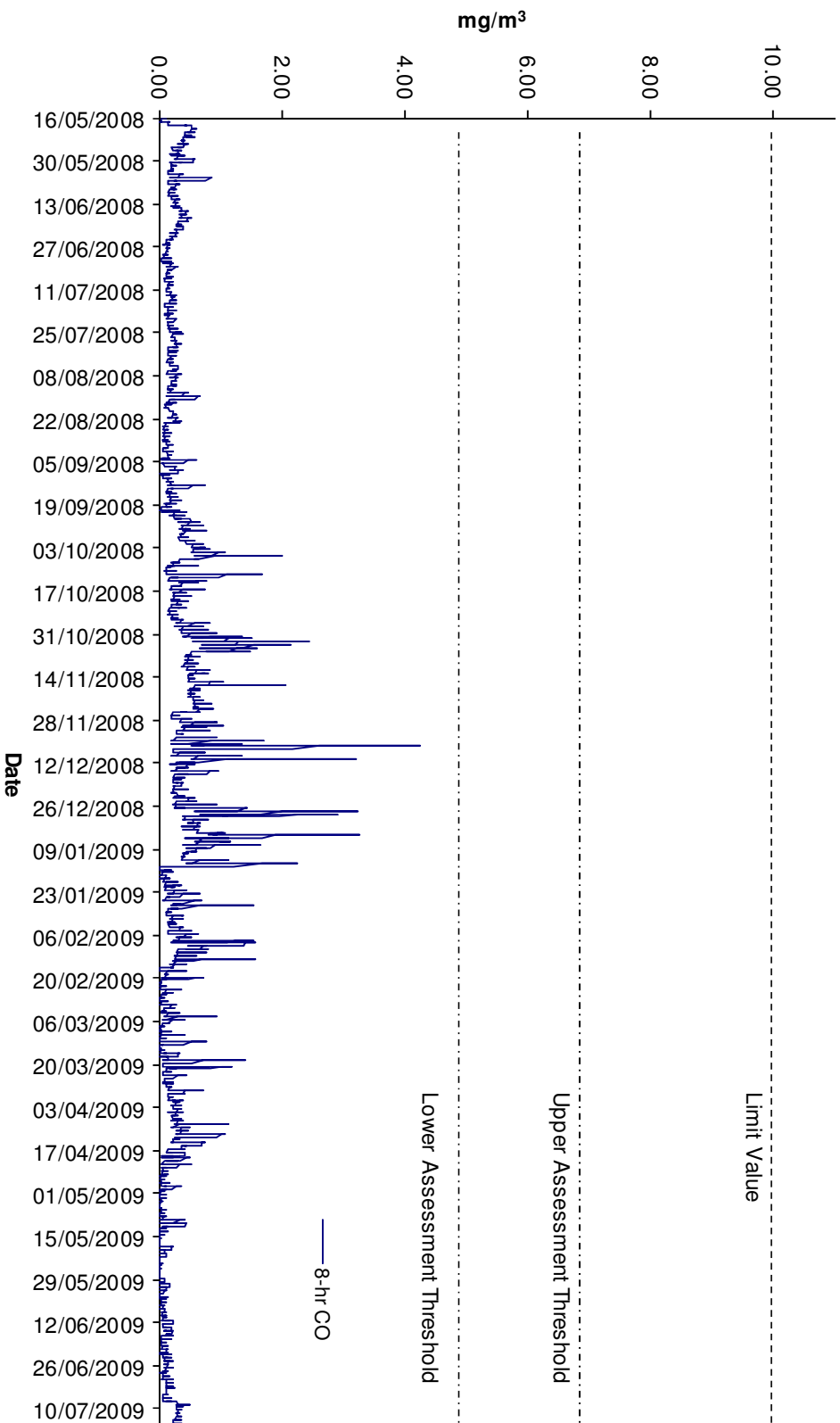
No. of hours	10179
Missing values (including routine maintenance)	76 19
No. of measured values	10103
Percentage covered	99.2%
Maximum hourly value	5.7 mg.m ⁻³
98 percentile for hourly values	1.3 mg.m ⁻³
Mean hourly value	0.3 mg.m ⁻³
Maximum 8-hour mean	4.23 mg.m ⁻³
98 percentile for 8-hour mean	1.25 mg.m ⁻³

Directive 2008/50/EC – Carbon Monoxide - Limit values and Assessment Thresholds

	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	

Figure Two displays eight hour average carbon monoxide (CO) concentrations at the site. No exceedances of the Limit Value or Thresholds occurred. Figure 3 displays both hourly and eight hour average CO concentrations.

Figure 2: Carbon Monoxide 8- Hour Running Average Concentrations, Letterkenny, 16/05/08 - 14/07/09



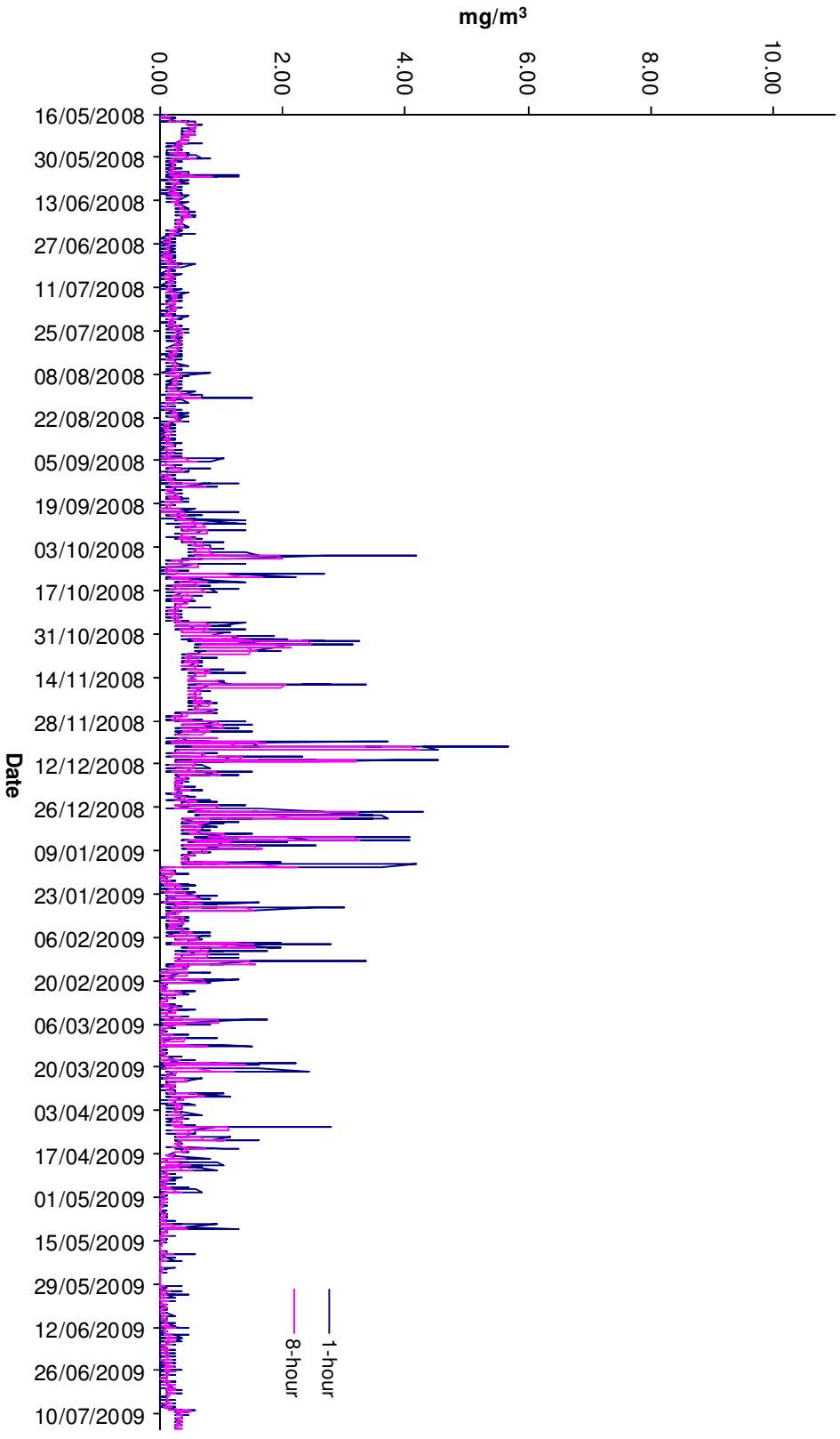


Figure 3: Carbon Monoxide 1-Hour & 8-Hour Average Concentrations, Letterkenny, 16/05/08 - 14/07/09

Sulphur Dioxide – SO₂

No. of hours	10179
Missing values (including routine maintenance)	297 78
No. of measured values	9882
Percentage covered	97.1%
Maximum hourly value	131.9 $\mu\text{g.m}^{-3}$
98 percentile for hourly values	25.5 $\mu\text{g.m}^{-3}$
Mean hourly value	6.3 $\mu\text{g.m}^{-3}$
Maximum 24-hour value	33.9 $\mu\text{g.m}^{-3}$
98 percentile for 24-hour values	17.9 $\mu\text{g.m}^{-3}$

Directive 2008/50/EC – Sulphur Dioxide - Limit values and Assessment Thresholds

	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 $\mu\text{g m}^{-3}$ 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 $\mu\text{g m}^{-3}$ not to be exceeded more than 3 times a calendar year	1 January 2005
Limit value for the protection of vegetation	Calendar year and winter (1 October to 31 March)	20 $\mu\text{g m}^{-3}$	-
Alert threshold	-	500 $\mu\text{g m}^{-3}$ over three consecutive hours	-

**Directive 2008/50/EC – Sulphur Dioxide - Limit values and Assessment
Thresholds 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 $\mu\text{g m}^{-3}$ not to be exceeded more than 3 times a calendar year	-
Lower assessment threshold for the protection of human health	24 hours	50 $\mu\text{g m}^{-3}$ not to be exceeded more than 3 times a calendar year	-
Upper assessment threshold for the protection of vegetation	Calendar year and winter (1 October to 31 March)	12 $\mu\text{g m}^{-3}$	-
Lower assessment threshold for the protection of ecosystems	Calendar year and winter (1 October to 31 March)	8 $\mu\text{g m}^{-3}$	-

Figure 4 displays the average 24 hour SO₂ concentrations. There were no exceedances of the 24 hour limit value of 125 $\mu\text{g.m}^{-3}$ or either assessment threshold. The directive stipulates that the lower assessment threshold should not be exceeded more than three times in a calendar year.

Figure 5 displays hourly SO₂ concentrations over the monitoring period. No exceedances of the hourly limit value of 350 $\mu\text{g m}^{-3}$ were measured.

Figure 4: Sulphur Dioxide 24-Hour Average Concentration, Letterkenny, 17/05/08 - 13/07/09

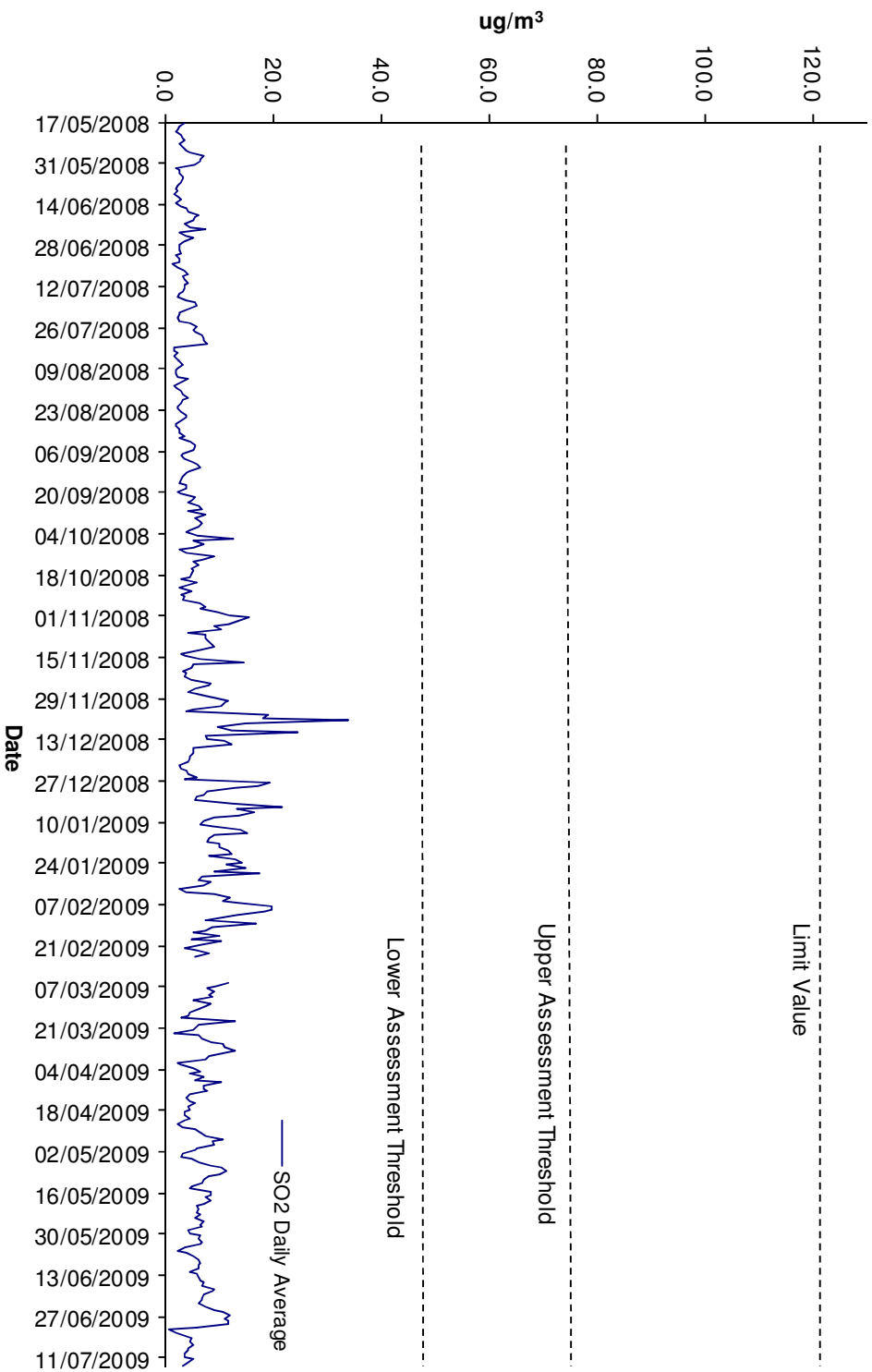
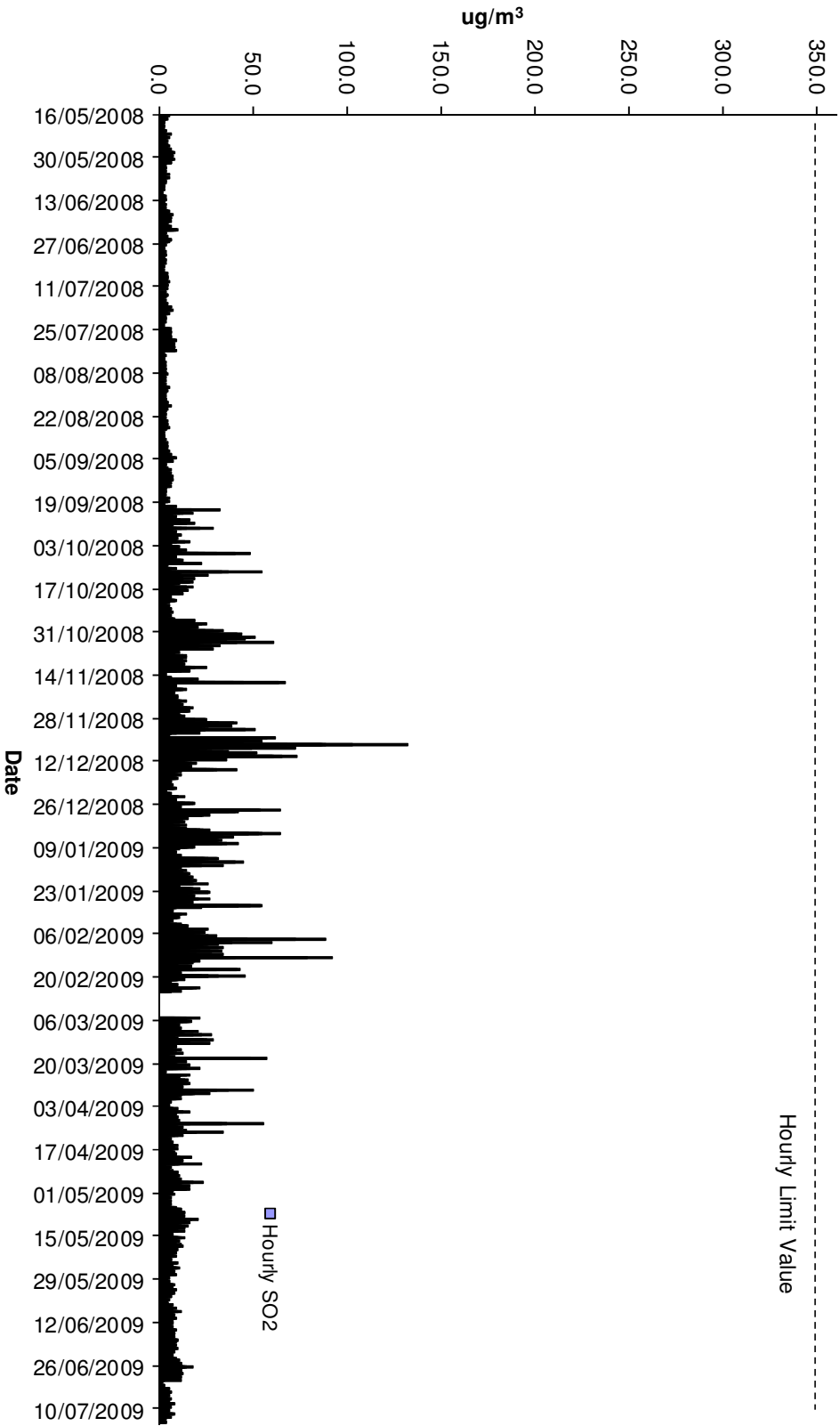


Figure 5: Sulphur Dioxide 1 - Hour Average Concentrations, Letterkenny, 16/05/08 - 14/07/09



Nitrogen Dioxide and Oxides of Nitrogen – NO₂ , NO_x

No. of hours	10179
Missing values (including routine maintenance)	315 74
No. of measured values	9864
Percentage covered	96.9%
Maximum hourly value (NO ₂)	111.9 µg.m ⁻³
99.7 percentile for hourly values (NO ₂)	76.6 µg.m ⁻³
Mean hourly value (NO ₂)	13.1 µg.m ⁻³
Mean hourly value (NO _x)	22.1 µg.m ⁻³ NO ₂

Directive 2008/50/EC – Nitrogen Dioxide and Oxides of Nitrogen - Limit Values and Assessment Thresholds

	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 2008/50/EC – Nitrogen Dioxide and Oxides of Nitrogen - Limit Values
and Assessment Thresholds continued**

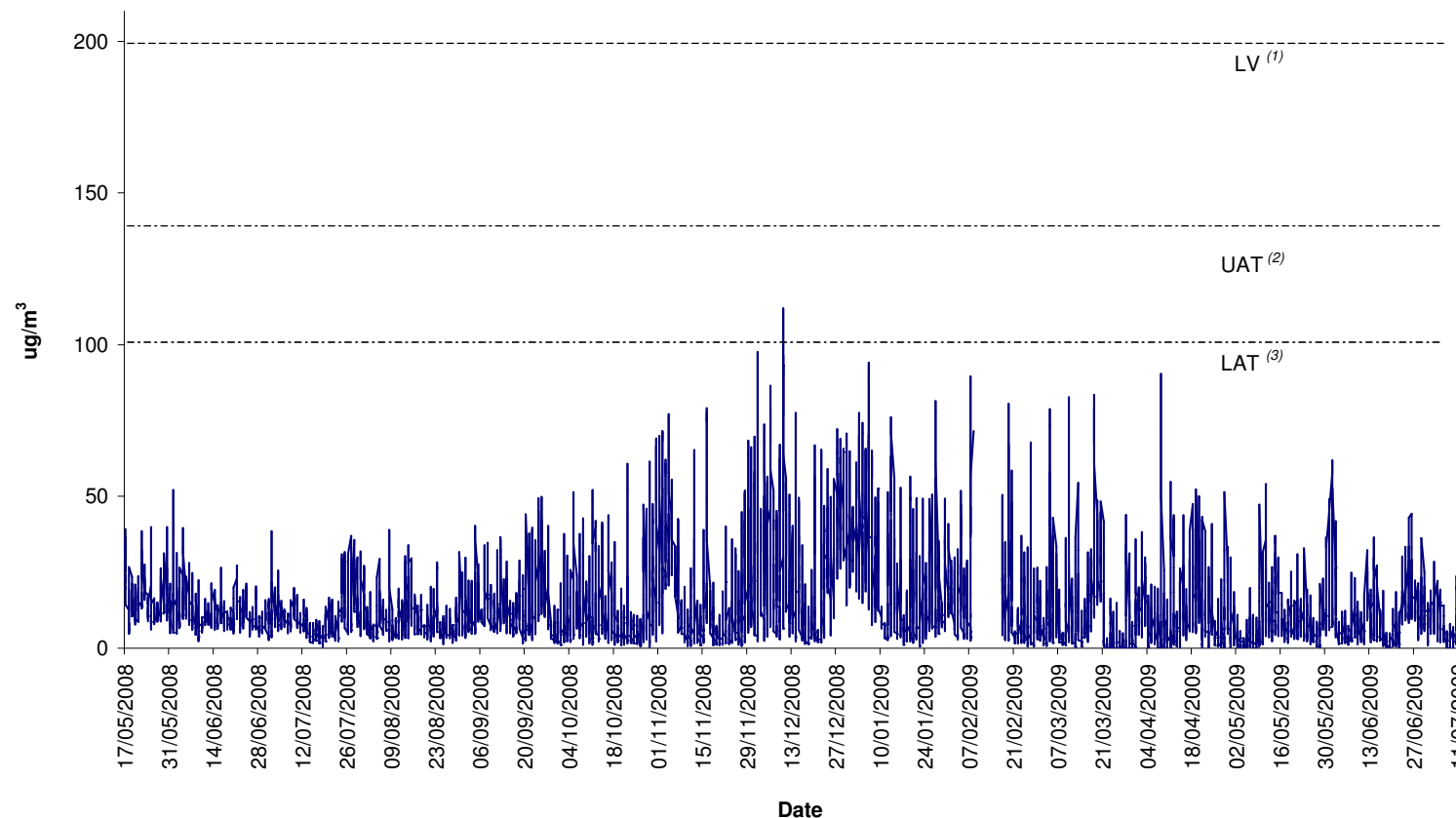
	Averaging Period	Limit Value	Date by which limit value is to be met
Upper assessment threshold for the protection of human health	1 hour	140 $\mu\text{g m}^{-3}$ NO ₂ not to be exceeded more than 18 times a calendar year	-
Upper assessment threshold for the protection of human health	Calendar year	32 $\mu\text{g m}^{-3}$ NO ₂	-
Lower assessment threshold for the protection of human health	1 hour	100 $\mu\text{g m}^{-3}$ 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 $\mu\text{g m}^{-3}$ NO ₂	-
Upper assessment threshold for the protection of vegetation	Calendar year	24 $\mu\text{g m}^{-3}$ NO _x	-
Lower assessment threshold for the protection of vegetation	Calendar year	19.5 $\mu\text{g m}^{-3}$ NO _x	-

Figure 6 displays the hourly NO₂ concentrations at the site for the entire monitoring period. There was one exceedance of the lower threshold value concerning the protection of human health. No more than 18 exceedances each of the lower

assessment threshold, upper assessment threshold and limit value are allowed per year. The mean hourly NO_2 concentration was $13.1 \mu\text{g.m}^{-3}$. This was below the lower assessment threshold value of $26 \mu\text{g.m}^{-3}$ for the protection of human health. The mean annual NO_x concentration was $22.1 \mu\text{g.m}^{-3}$. This exceeds the lower assessment threshold concentration concerning protection of vegetation and natural ecosystems. However, this threshold applies only in rural areas and thus is not applicable to the Letterkenny site.

Figure 7 displays hourly NO , NO_2 and NO_x concentrations in $\mu\text{g.m}^{-3}$. NO_2 and NO_x are measured as ppb (parts per billion) by volume. To convert to $\mu\text{g m}^{-3}$, a factor (1.25 for NO , 1.91 for NO_2) is used. No formula is specified for NO_x , the directive requires it to be expressed as NO_2 (i.e. $\text{ppb} \times 1.91$). This applies even when most of the NO_x is present as NO .

Figure 6: Nitrogen Dioxide Hourly Concentrations, Letterkenny, 17/05/08 - 14/08/09



- (1) Limit Value 200ug/m³ EU Directive 2008/50/EC - > 18 exceedances per year denotes limit value breach
- (2) Upper Assessment Threshold EU Directive 2008/50/EC - > 18 exceedances per year denotes threshold breach
- (3) Lower Assessment Threshold EU Directive 2008/50/EC - > 18 exceedances per year denotes threshold breach

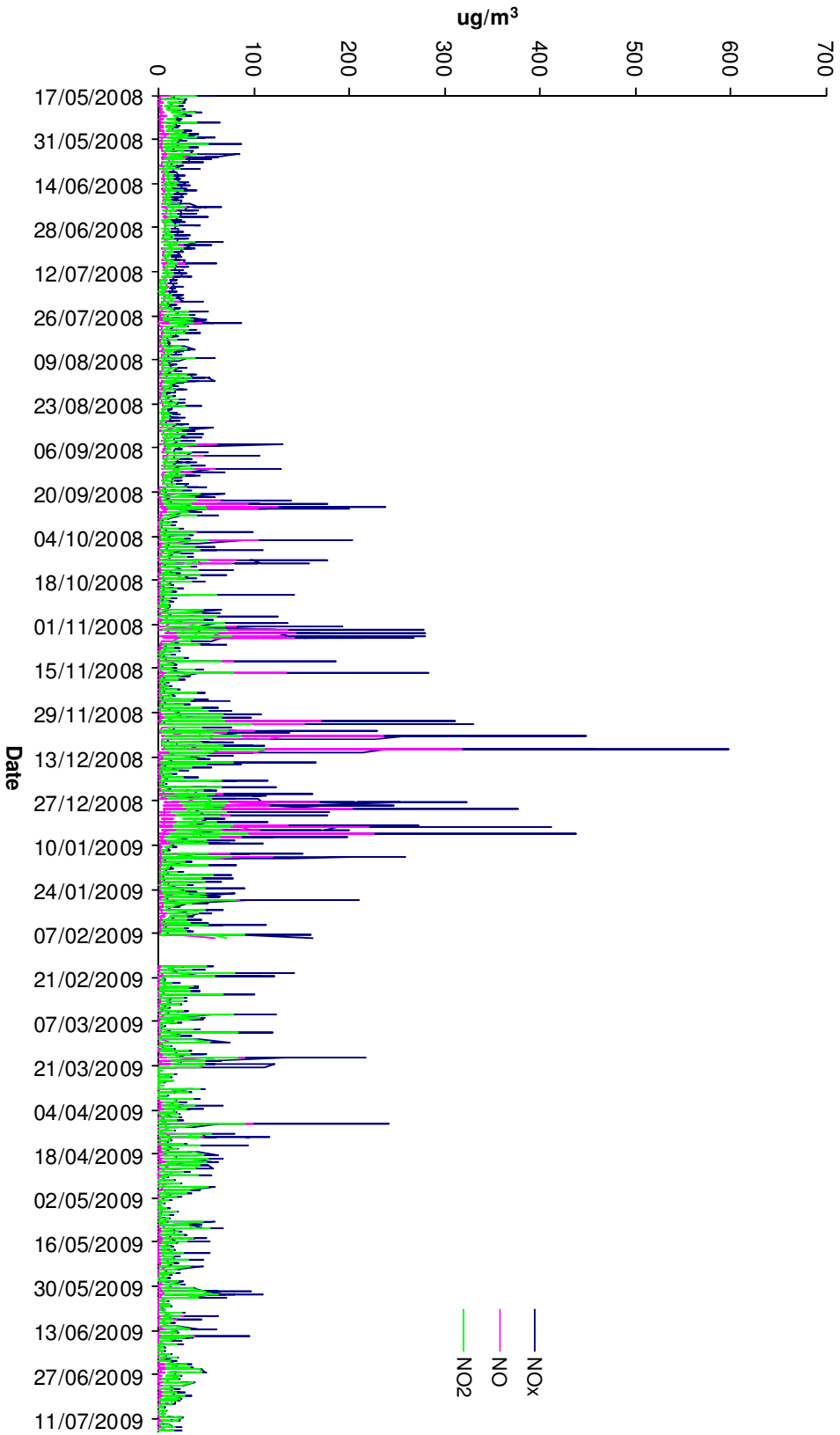


Figure 7: NOx Hourly Concentrations, Letterkenny, 17/05/08 - 14/08/09

Particulate Matter – PM₁₀

PM₁₀ : TEOM method

No. of days	353
Missing values (including routine maintenance)	41 6
No. of measured values	312
Percentage covered	88.4%
Maximum daily value	160.2 $\mu\text{g.m}^{-3}$
Mean daily value	18.0 $\mu\text{g.m}^{-3}$

Directive 2008/50/EC – Particulate Matter - Limit Values and Assessment Thresholds

	Averaging Period	Limit Value
24-hour limit value for the protection of human health	24 hour	50 $\mu\text{g m}^{-3}$ PM ₁₀ not to be exceeded more than 35 times a calendar year
Annual limit value for the protection of human health	Calendar year	40 $\mu\text{g m}^{-3}$ PM ₁₀
Upper assessment threshold for the protection of human health	24 hour	35 $\mu\text{g m}^{-3}$ PM ₁₀ not to be exceeded more than 35 times a calendar year
Upper assessment threshold for the protection of human health	Calendar year	28 $\mu\text{g m}^{-3}$ PM ₁₀

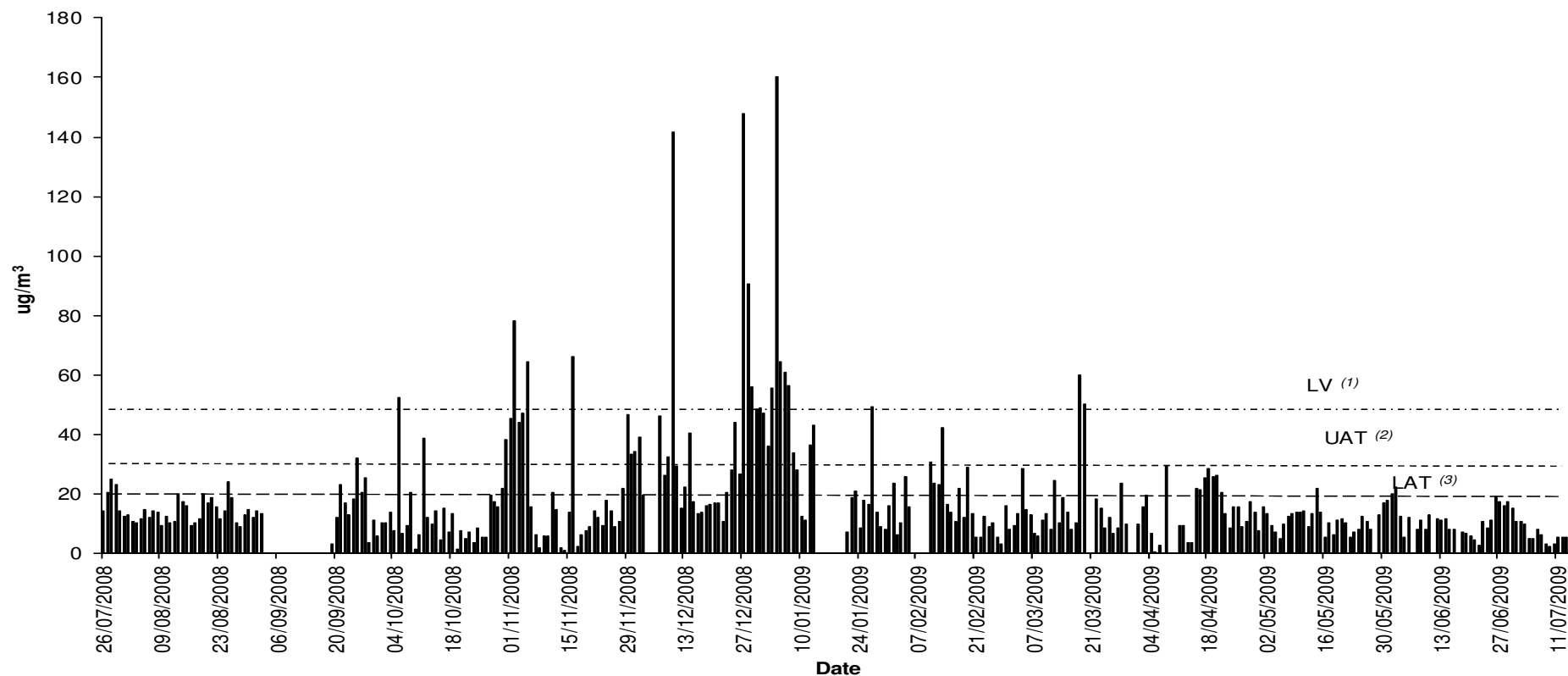
**Directive 2008/50/EC – Particulate Matter - Limit Values and Assessment
Thresholds, Continued**

	Averaging Period	Limit Value
Lower assessment threshold for the protection of human health	24 hour	25 $\mu\text{g m}^{-3}$ PM ₁₀ not to be exceeded more than 35 times a calendar year
Lower assessment threshold for the protection of human health	Calendar year	20 $\mu\text{g m}^{-3}$ PM ₁₀

Figure 8 displays 24 hour average concentration of PM₁₀ at the site. The 24 hour limit value for the protection of human health (50 $\mu\text{g.m}^{-3}$) was exceeded 15 times during the measurement period. The directive stipulates that the limit value should not be exceeded more than 35 times in a calendar year. The upper assessment threshold (35 $\mu\text{g.m}^{-3}$) was exceeded on 33 days, the lower assessment threshold (25 $\mu\text{g.m}^{-3}$) was exceeded on 53 days. The directive stipulates that each of the assessment thresholds should not be exceeded more than 35 times in a calendar year.

The mean of the daily values during the measurement period (18.0 $\mu\text{g.m}^{-3}$) is below the annual limit value for the protection of human health (40 $\mu\text{g.m}^{-3}$).

Figure 8: Daily PM10 Concentrations, Letterkenny 26/07/08 - 13/08/09



- (1) Limit Value 50ug/m³ EU Directive 2008/50/EC , > 35 exceedances of daily limit value in a year denotes an exceedance
- (2) Upper Assessment Threshold EU Directive 2008/50/EC, > 35 exceedances denotes threshold breach
- (3) Lower Assessment Threshold EU Directive 2008/50/EC, > 35 exceedances denotes threshold breach

Lead - Pb

No. of days	455
Missing days (including routine maintenance)	92
No. of measured days	363
Percentage covered	79.8%
Concentration of Pb	0.003 $\mu\text{g}\cdot\text{m}^{-3}$

Directive 2008/50/EC – Lead - Limit Values and Assessment Thresholds

	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 $\mu\text{g m}^{-3}$	1 January 2005
Upper assessment threshold	Calendar year	0.35 $\mu\text{g m}^{-3}$	
Lower assessment threshold	Calendar year	0.25 $\mu\text{g m}^{-3}$	

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

Arsenic(As), Cadmium(Cd) and Nickel(Ni):

No. of days	455
Missing days (including routine maintenance)	92
No. of measured days	363
Percentage covered	79.8%
Concentration of As	0.2 ng.m ⁻³
Concentration of Cd	0.05 ng.m ⁻³
Concentration of Ni	3.6 ng.m ⁻³

Directive 2004/107/EC – Arsenic, cadmium and nickel - Limit Values and Assessment Thresholds

	Averaging Period	Target Value	Upper Assessment Threshold , Lower Assessment Threshold
Arsenic	Calendar year	6 ng m ⁻³	3.6 ng m ⁻³ , 2.4 ng m ⁻³
Cadmium	Calendar year	5 ng m ⁻³	3.0 ng m ⁻³ , 2.0 ng m ⁻³
Nickel	Calendar year	20 µg m ⁻³	14.0 ng m ⁻³ , 10.0 ng m ⁻³

Four metals in addition to lead must be considered when carrying out an air quality assessment These are cadmium, arsenic, nickel and mercury . Limit values and measurement methods for these metals as well as certain polycyclic aromatic hydrocarbons are set out in the fourth Daughter Directive (2004/107/EC).

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. With this method, 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.

The average concentration of arsenic measured in air during the assessment period was 0.2 ng.m⁻³ . The target value is 6 ng m⁻³

The average concentration of cadmium measured in air during the assessment period was 0.05 ng.m^{-3} . The target value is 5 ng m^{-3}

The average concentration of nickel measured in air during the assessment period was 3.6 ng.m^{-3} . The target value is 20 ng m^{-3}

The target values of 6 ng m^{-3} for arsenic, 5 ng m^{-3} for cadmium and 20 ng m^{-3} for nickel have cross Europe attainment target dates of 31st of December 2012