



Ambient Air Monitoring

At

Knocklyon, Dublin 16

11th April 2008 – 15th January 2009

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Summary

An assessment of air quality was carried out in Knocklyon, Dublin 16 from 11th April 2008 to 15th January 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 PM₁₀ exceeded the upper assessment threshold for this pollutant.

| | Below Lower Assessment Threshold | Below Upper Assessment Threshold | Above Upper Assessment Threshold | Above Limit |
|------------------------|---|---|---|--------------------|
| PM₁₀ | | | | |
| NO₂ | | | | |
| CO | | | | |
| SO₂ | | | | |
| Pb | | | | |

Knocklyon, Dublin 16 is located in Zone A. The implications of this assessment are that within Zone A (Dublin agglomeration)

- Levels of SO₂, CO, NO₂, PM₁₀, lead, arsenic, nickel and cadmium 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.

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, and shall come into effect as of June 2010.

In accordance with the principles of CAFÉ, 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.

For further information please contact

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Time Period

The mobile laboratory was in place from 11th April 2008 to 15th January 2009.

Siting

The assessment was positioned in the premises of St Columcille's Community School (Figure 1).

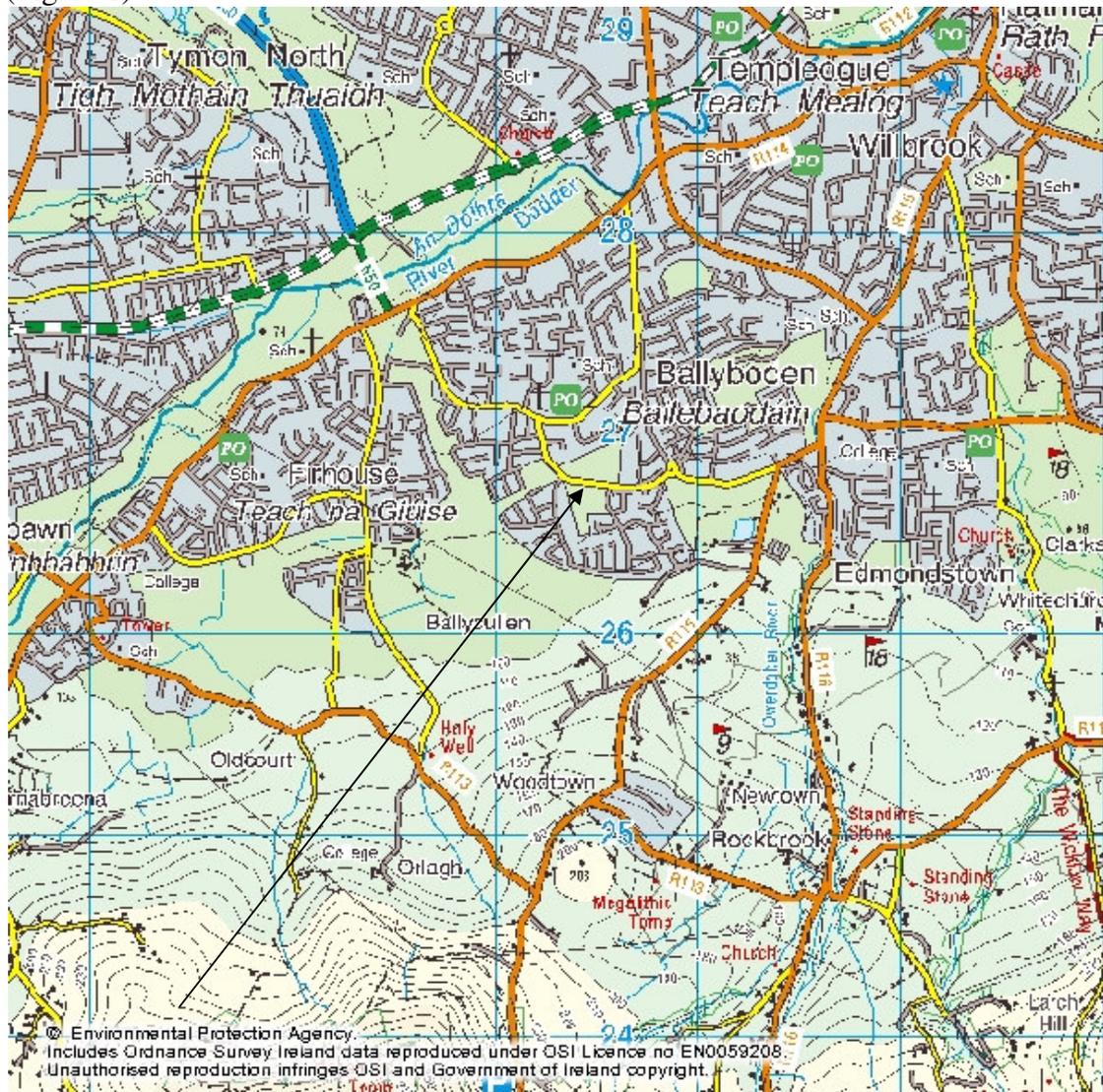


Figure 1. Map of site location (courtesy of OSI)

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. This allowed the unit to operate at a reduced temperature of 30 C, removing the need to adjust the observed concentrations by 1.303, attributable to weight loss of volatile components.

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 Knocklyon 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

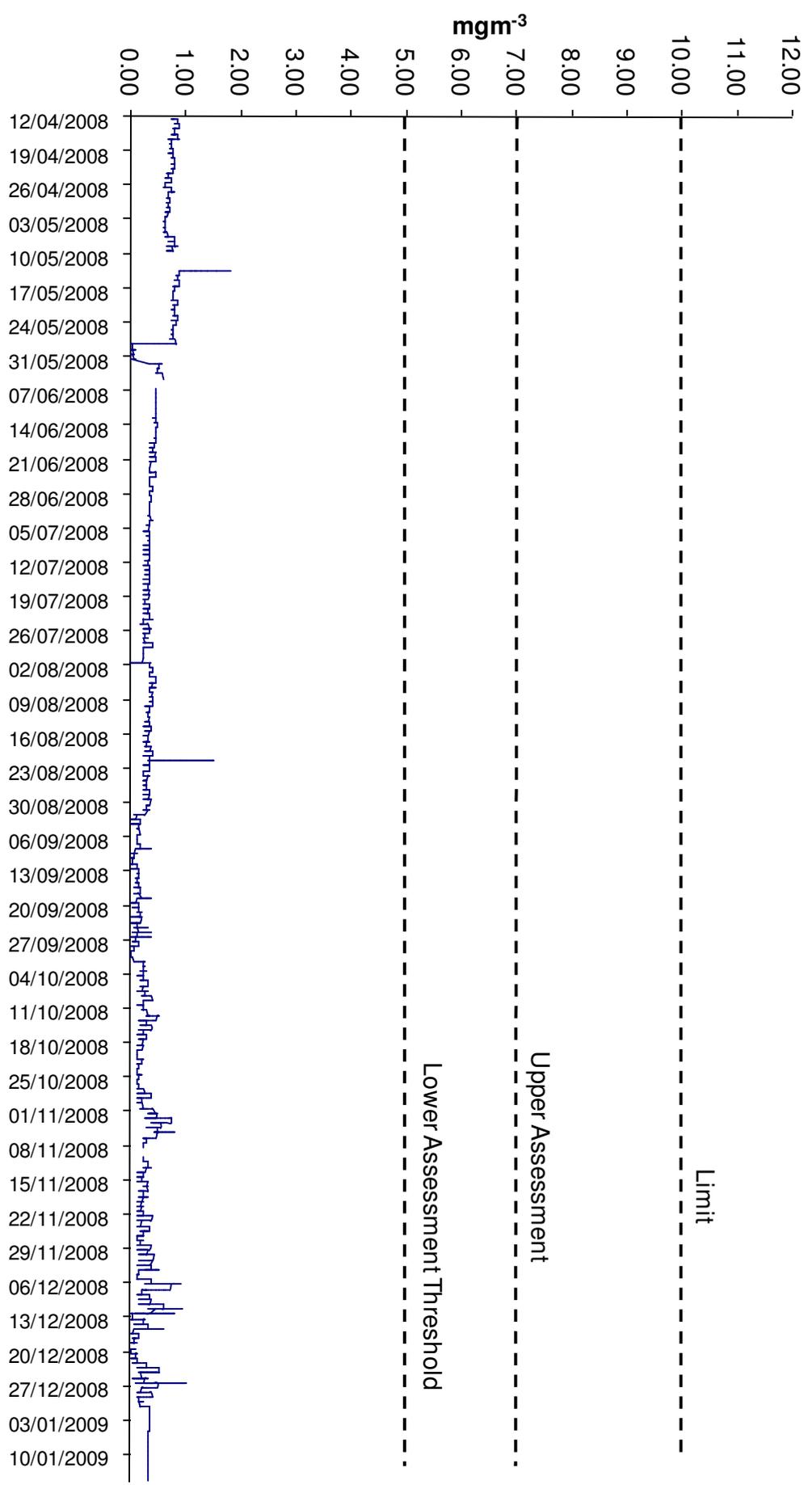
| | |
|---|-------------------------|
| No. of hours | 6683 |
| Missing values (including routine maintenance) | 361 19 |
| No. of measured values | 6322 |
| Percentage covered | 94.5% |
| Maximum hourly value | 13.3 mg.m ⁻³ |
| 98 percentile for hourly values | 0.9 mg.m ⁻³ |
| Mean hourly value | 0.34 mg.m ⁻³ |
| Maximum 8-hour mean | 1.84 mg.m ⁻³ |
| 98 percentile for 8-hour mean | 0.83 mg.m ⁻³ |

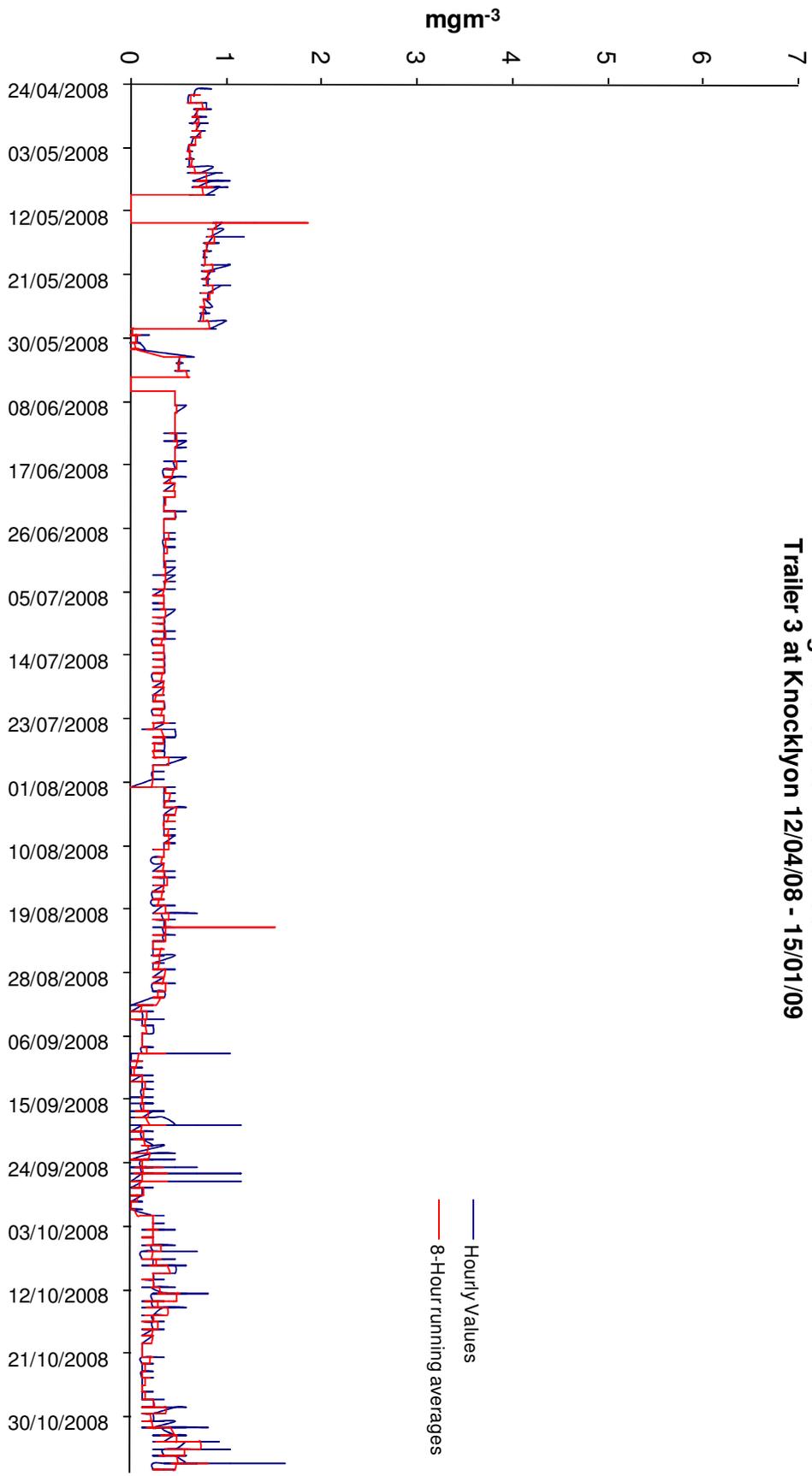
Directive 2008/50/EC – Carbon Monoxide - Limit values and Assessment Thresholds

| | 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
Trailer 3 at Knocklyon 12/04/2008 - 15/01/2009**





**Figure 3 Carbon Monoxide
Trailer 3 at Knocklyon 12/04/08 - 15/01/09**

Sulphur Dioxide – SO₂

| | |
|---|---------------------------|
| No. of hours | 6688 |
| Missing values (including routine maintenance) | 2334 2347 |
| No. of measured values | 4341 |
| Percentage covered | 64.9% |
| Maximum hourly value | 69.7 $\mu\text{g.m}^{-3}$ |
| 98 percentile for hourly values | 8.5 $\mu\text{g.m}^{-3}$ |
| Mean hourly value | 3.8 $\mu\text{g.m}^{-3}$ |
| Maximum 24-hour value | 13.5 $\mu\text{g.m}^{-3}$ |
| 98 percentile for 24-hour values | 10.2 $\mu\text{g.m}^{-3}$ |

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 | - |

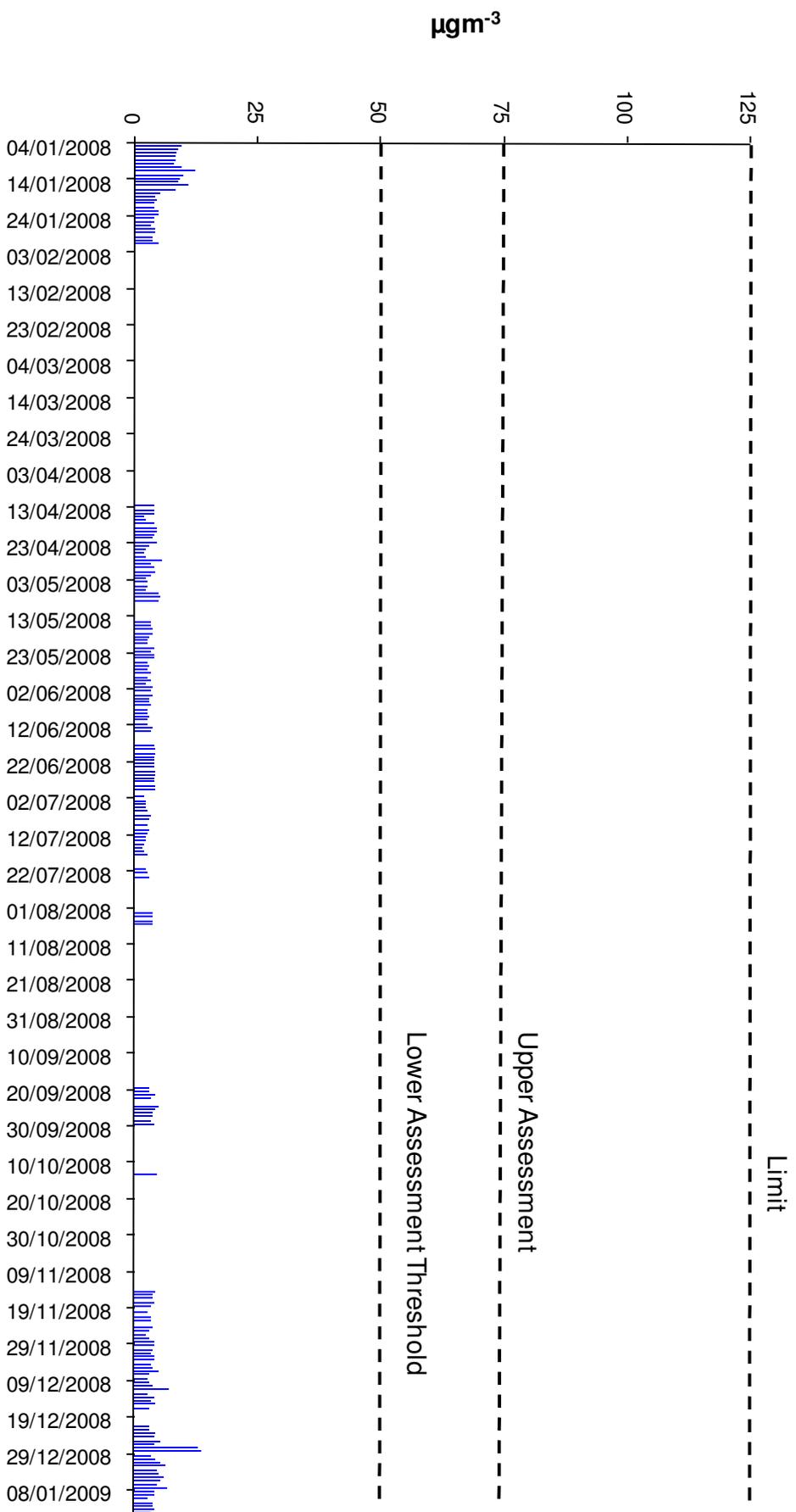
**Directive 2008/50/EC – Sulphur Dioxide - Limit values and Assessment
Thresholds Continued**

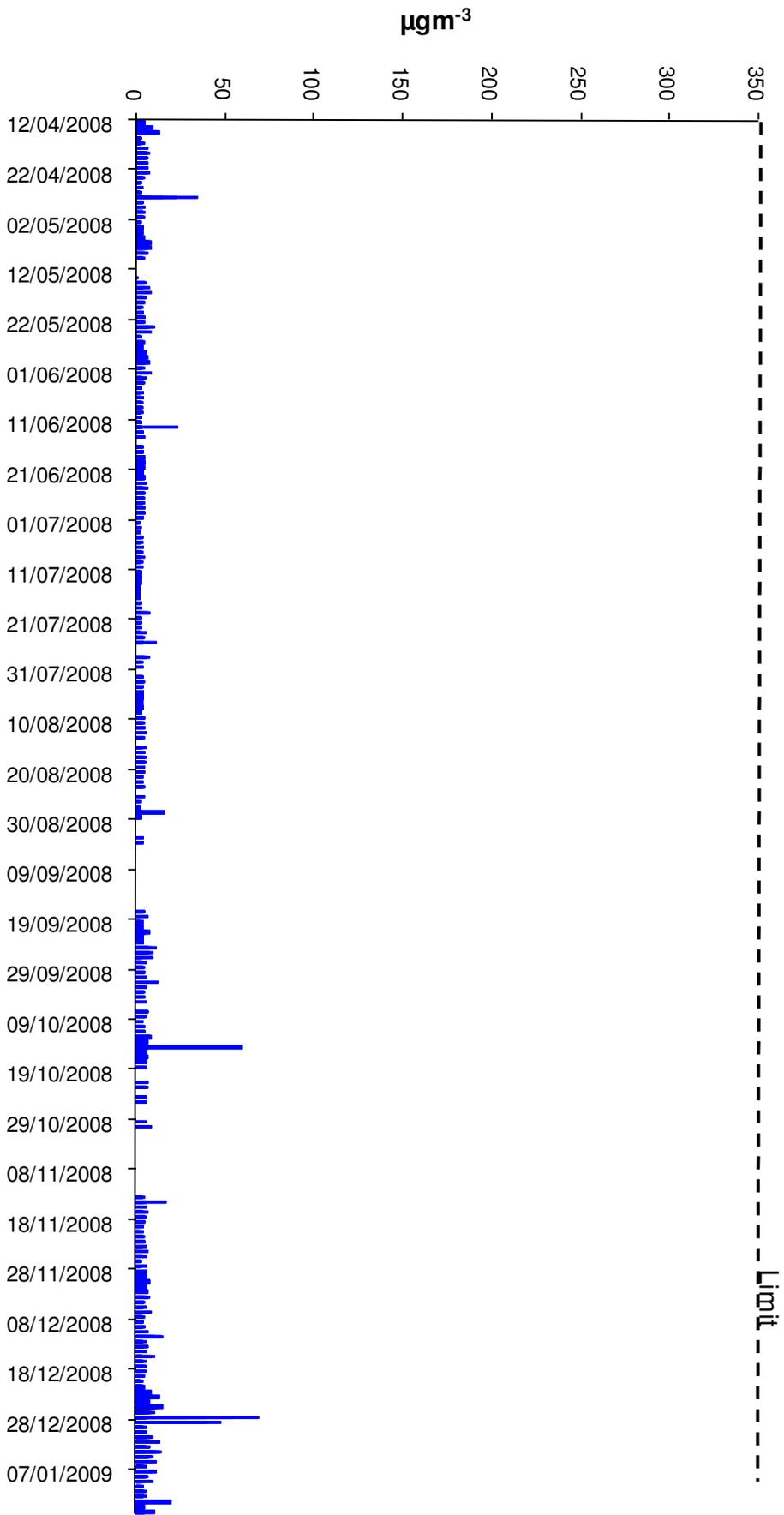
| | Averaging Period | Limit Value | Date by which limit value is to be met |
|--|--|--|---|
| Upper assessment threshold for the protection of human health | 24 hours | 75 $\mu\text{g m}^{-3}$ not to be exceeded more than 3 times a calendar year | - |
| Lower assessment threshold for the protection 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 125 μgm^{-3} were measured.

**Figure 4 Sulphur Dioxide 24-Hour Averages
Trailer 3 in Knocklyon 12/04/2008 - 15/01/2009**





**Figure 5 Sulphur Dioxide Hourly Averages
Trailer 3 in Knocklyon 12/04/2008 - 15/01/2009**

Nitrogen Dioxide and Oxides of Nitrogen – NO₂ , NO_x

| | |
|--|---|
| No. of hours | 6685 |
| Missing values (including routine maintenance) | 158 175 |
| No. of measured values | 6510 |
| Percentage covered | 97.4% |
| Maximum hourly value (NO ₂) | 123.9 µg.m ⁻³ |
| 99.7 percentile for hourly values (NO ₂) | 77.8 µg.m ⁻³ |
| Mean hourly value (NO ₂) | 15.9 µg.m ⁻³ |
| Mean hourly value (NO _x) | 23.4 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**

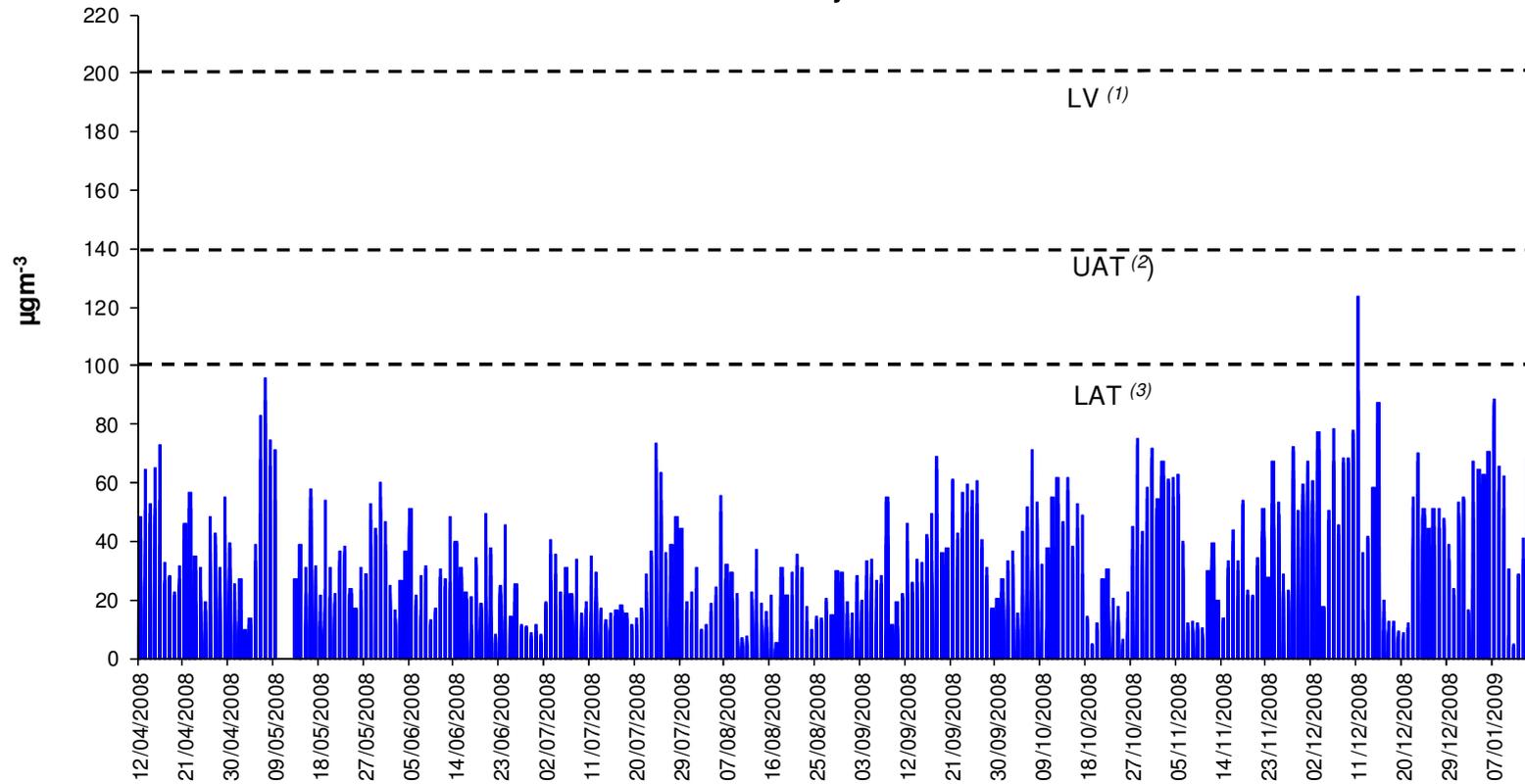
| | Averaging Period | Limit Value | Date by which limit value is to be met |
|--|-------------------------|---|---|
| Upper assessment threshold for the protection of human health | 1 hour | 140 $\mu\text{g m}^{-3}$ NO ₂ not to be exceeded more than 18 times a calendar year | - |
| Upper assessment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

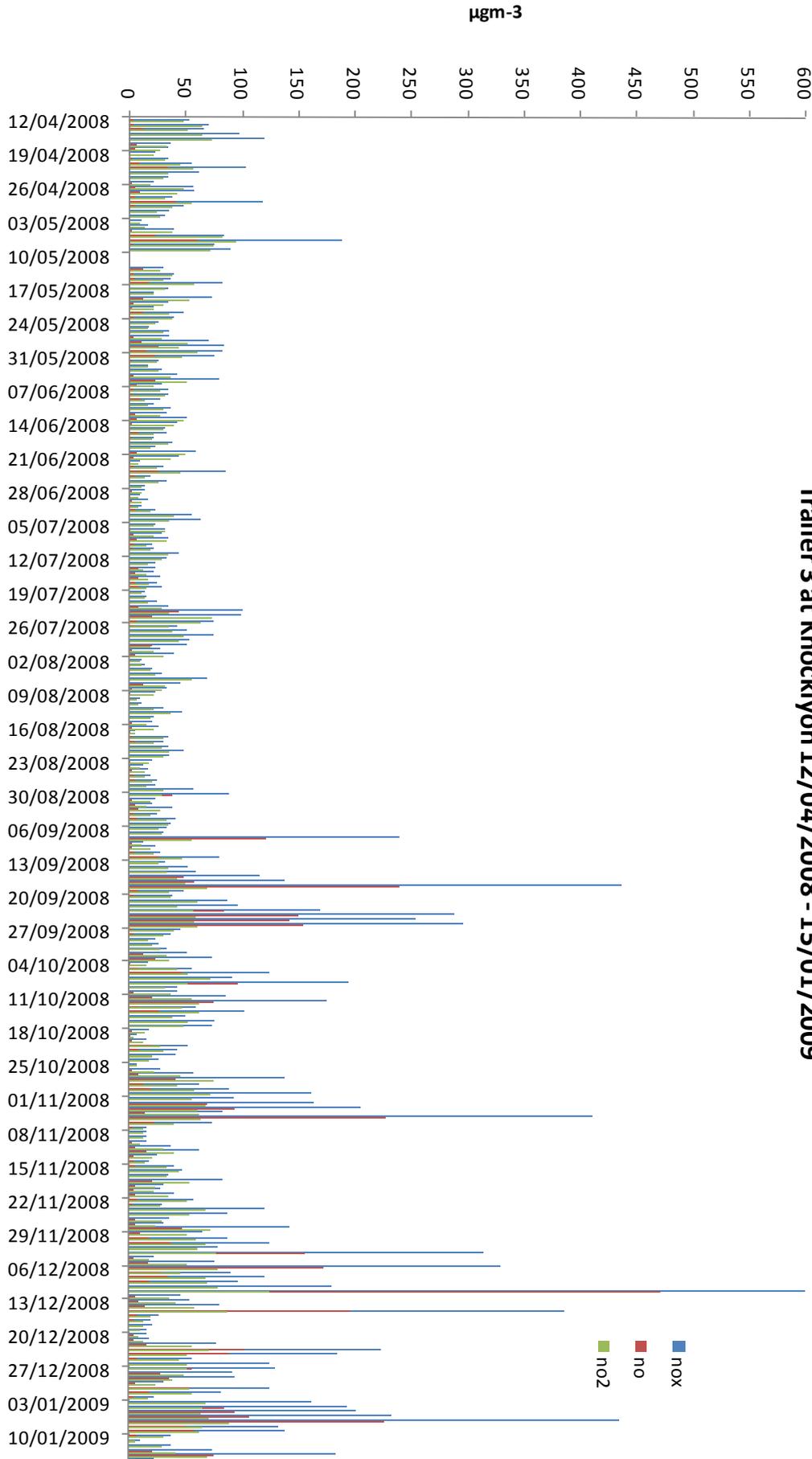
assessment threshold, upper assessment threshold and limit value are allowed per year. The mean hourly NO_2 concentration was $15.9 \mu\text{g}\cdot\text{m}^{-3}$. This was below the lower assessment threshold value of $26 \mu\text{g}\cdot\text{m}^{-3}$ for the protection of human health.

Figure 7 displays hourly NO , NO_2 and NO_x concentrations in $\mu\text{g}\cdot\text{m}^{-3}$. 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. $\text{ppb}\cdot 1.91$). This applies even when most of the NO_x is present as NO .

**Figure 6 NO₂ Hourly Values
Trailer 3 at Knocklyon 12/04/2008 - 15/01/2009**



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



**Figure 7 NOx Hourly Values
Trailer 3 at Knocklyon 12/04/2008 - 15/01/2009**

Particulate Matter – PM₁₀

PM₁₀ : gravimetric method

| | |
|---|---------------------------|
| No. of days | 279 |
| Missing values (including routine maintenance) | 71 |
| | 71 |
| No. of measured values | 208 |
| Percentage covered | 74.5% |
| Maximum daily value | 80.2 $\mu\text{g.m}^{-3}$ |
| Mean daily value | 17.2 $\mu\text{g.m}^{-3}$ |

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 |

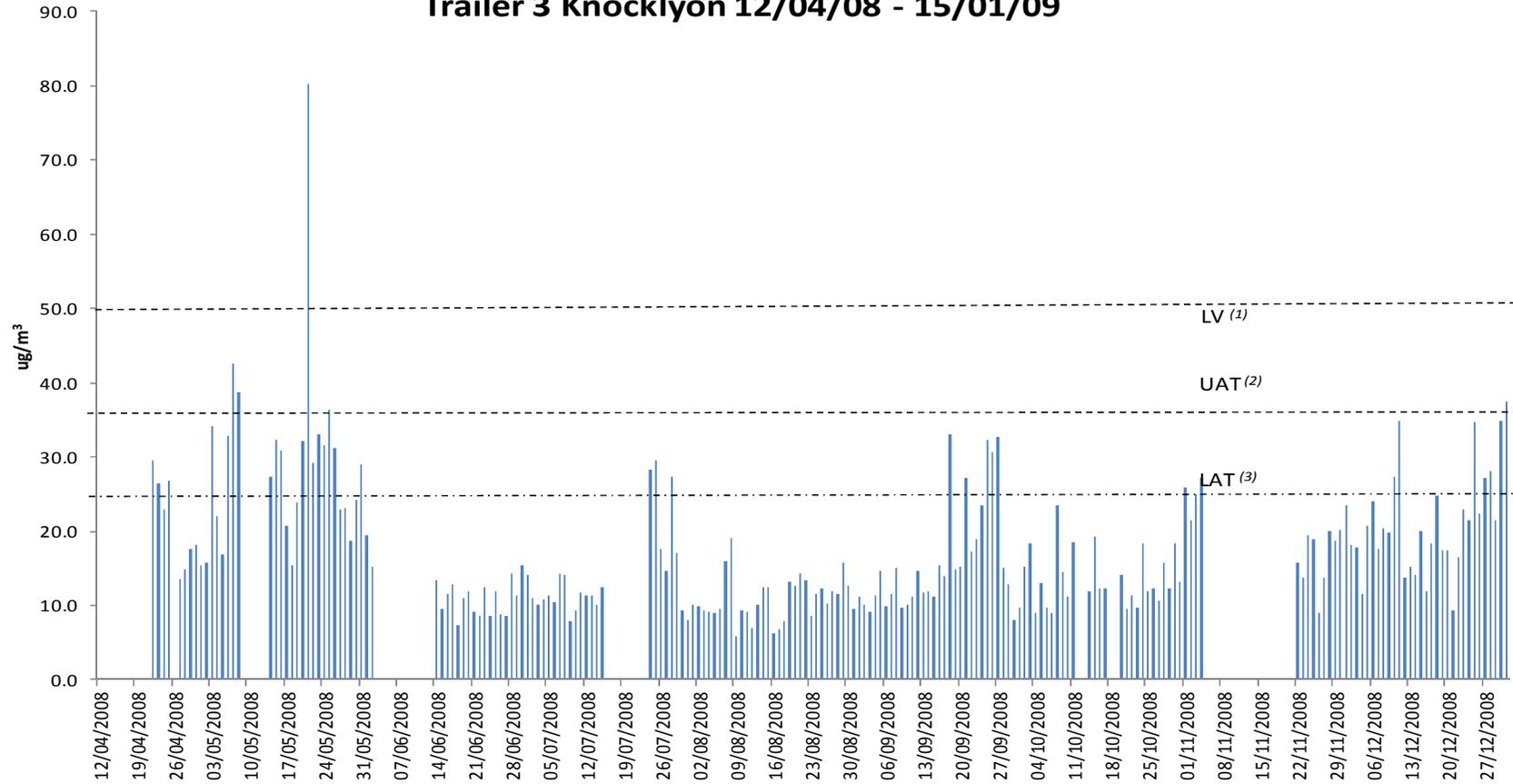
Directive 2008/50/EC – Particulate Matter - Limit Values and Assessment Thresholds, Continued

| | 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 once 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 5 days, the lower assessment threshold (25 $\mu\text{g.m}^{-3}$) was exceeded on 35 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 (17.2 $\mu\text{g.m}^{-3}$) is below the lower assessment threshold of 20 $\mu\text{g.m}^{-3}$. The annual limit value for PM₁₀ is 40 $\mu\text{g.m}^{-3}$.

**Figure 8 PM₁₀ Daily Values
Trailer 3 Knocklyon 12/04/08 - 15/01/09**



- (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 | 279 |
| Missing days (including routine maintenance) | 82 |
| No. of measured days | 197 |
| Percentage covered | 70.6% |
| Concentration of Pb | 0.001 $\mu\text{g}\cdot\text{m}^{-3}$ |

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 279
Missing days 82
(including routine maintenance) 82

No. of measured days 197
Percentage covered 70.6%

Concentration of As 1.1 ng.m⁻³
Concentration of Cd 0.5 ng.m⁻³
Concentration of Ni 2.0 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 1.1 ng.m⁻³ . The target value is 6 ng m⁻³

The average concentration of cadmium measured in air during the assessment period was 0.5 ng.m^{-3} . The target value is 5 ng m^{-3}

The average concentration of nickel measured in air during the assessment period was 2.0 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