



**Ambient Air Monitoring**

**At**

**Newbridge, Co. Kildare**

**1<sup>st</sup> October 2009 – 24<sup>th</sup> May 2010**

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## Summary

An assessment of air quality was carried out in Newbridge, Co. Kildare from 1<sup>st</sup> October 2009 to 24<sup>th</sup> May 2010. No limit values were exceeded during the measurement period.

Concentrations of carbon monoxide, nitrogen dioxide and sulphur dioxide were below their respective lower assessment thresholds. Concentrations of benzene and particulate matter exceeded the lower assessment threshold for the protection of human health.

	<b>Below Lower Assessment Threshold</b>	<b>Below Upper Assessment Threshold</b>	<b>Above Upper Assessment Threshold</b>	<b>Above Limit</b>
<b>PM<sub>10</sub></b>				
<b>NO<sub>2</sub></b>				
<b>CO</b>				
<b>SO<sub>2</sub></b>				
<b>Benzene</b>				

Newbridge, Co. Kildare 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 SO<sub>2</sub>, CO, NO<sub>2</sub>, PM10 and benzene 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 21<sup>st</sup> May 2008. The directive replaced the pre-existing Air Quality framework directive (96/62/EC, 2<sup>nd</sup> 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 may be 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 SO<sub>2</sub>, NO<sub>x</sub>, 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). The fourth Daughter Directive was transposed into Irish law as the arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in Ambient Air Regulations 2009 ( S.I. No 58 of 2009).

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 PM<sub>10</sub>.
- The sample inlets are at a height of ~3m.

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***Time Period***

The mobile laboratory was in place from 1<sup>st</sup> October 2009 to 24<sup>th</sup> May 2010.

***Siting***

The assessment was positioned at the Kildare County Council Roads Yard, Newbridge, Co. Kildare (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 $\mu$ m.

### *Sulphur Dioxide*

Sulphur dioxide was monitored using an Advanced Pollution Instrumentation SO<sub>2</sub> Fluorescent Analyser - Model 100A. This is a continuous analyser, which measures the fluorescence of SO<sub>2</sub> molecules after excitation by ultraviolet radiation.

### *Nitrogen Dioxide and Oxides of Nitrogen*

NO<sub>x</sub> species were monitored using an Advanced Pollution Instrumentation Chemiluminescent NO/NO<sub>2</sub>/NO<sub>x</sub> 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 NO<sub>2</sub> present is then reduced to NO by a molybdenum converter giving a second value for total NO<sub>x</sub> concentration. The amount of NO<sub>2</sub> present is found by subtraction.

### *Particulate Matter*

Concentrations of PM<sub>10</sub> 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 $\mu$ m. A filter dynamic measurement system, (FDMS), was coupled with the TEOM. The FDMS operates by drying the main line air flow. As a result, the main line air flow relative humidity is lowered allowing the mass transducer to operate at a lower temperature, in this case 30 $^{\circ}$  C. This reduced operating temperature removes the need to adjust the observed concentrations by 1.303, attributable to weight loss of volatile components.

### *Benzene*

Benzene concentrations were measured using a Syntech Spretas Analyser GC955. This is an automated pumped sampling system with in situ gas chromatography. Air samples are preconcentrated on a Tenax<sup>®</sup> column. After a period of time, the preconcentrated column is rapidly heated, allowing desorption to take place and transfer to a capillary column for separation of the components. Detection is achieved through use of a Photo Ionisation Detector (PID).

All results for CO, SO<sub>2</sub>, NO<sub>x</sub> and the continuous particulate monitor were integrated to give 1-hour average values as required for comparison with the Directive limit values. Benzene concentrations were integrated for comparison to the annual limit value in line with Directive requirements.

## Results

The following sections detail the results observed at the Newbridge 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	5484
Missing values (including routine maintenance)	169 12
No. of measured values	5315
Percentage covered	96.9%
Maximum hourly value	2.2 mg m <sup>-3</sup>
98 percentile for hourly values	1.2 mg m <sup>-3</sup>
Mean hourly value	0.4 mg m <sup>-3</sup>
Maximum 8-hour mean	1.87 mg m <sup>-3</sup>
98 percentile for 8-hour mean	1.09 mg m <sup>-3</sup>

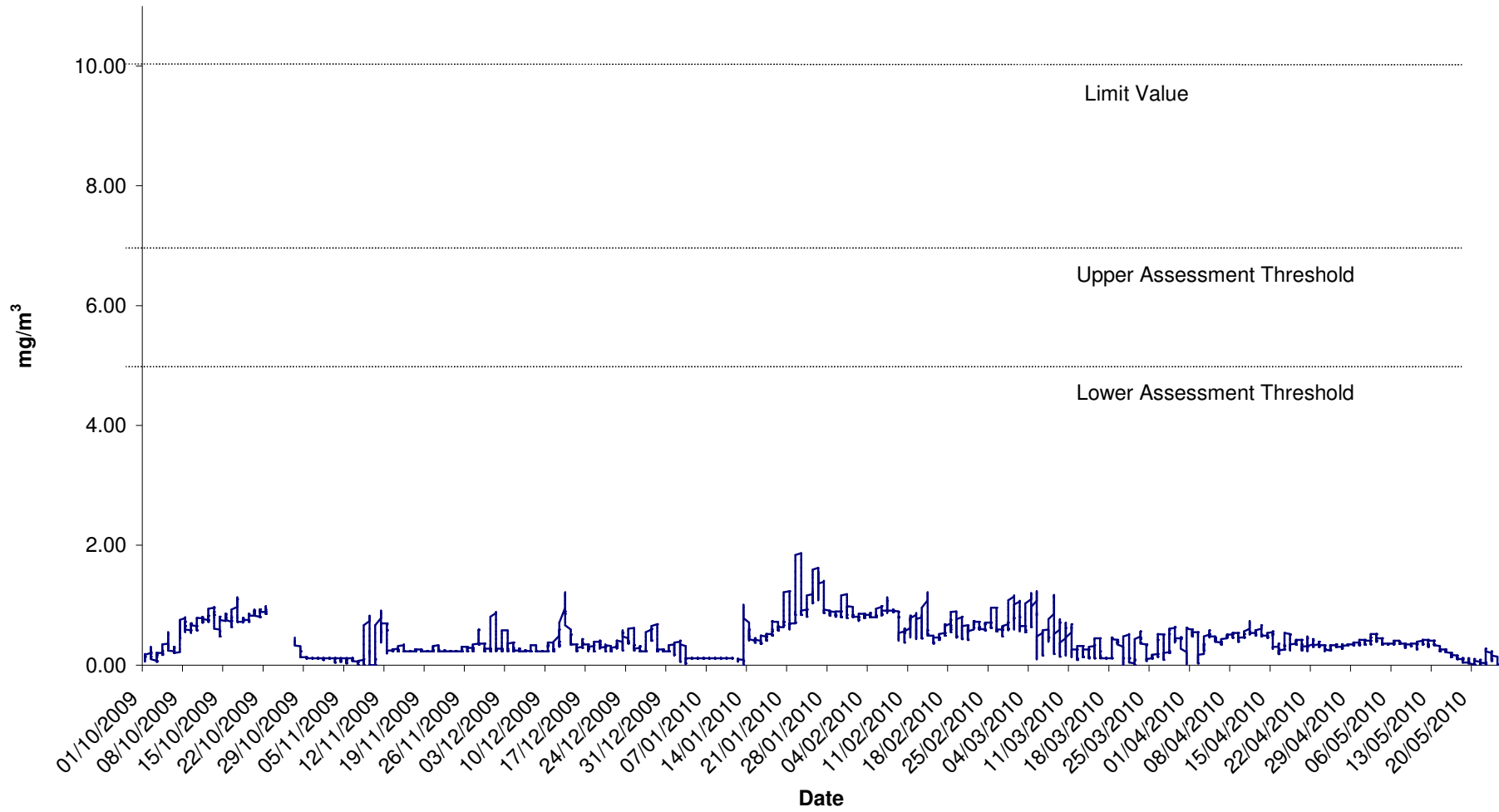
### Directive 2008/50/EC – Carbon Monoxide - Limit values and Assessment Thresholds

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

Figure 2 displays 8 hour average carbon monoxide (CO) concentrations at the site. No exceedances of the Limit Value or Thresholds occurred. Figure 3 displays both hourly and 8-Hour average CO concentrations.



Figure 2 : Carbon Monoxide 8 Hour Running Average Concentrations 01/10/09 - 24/05/10



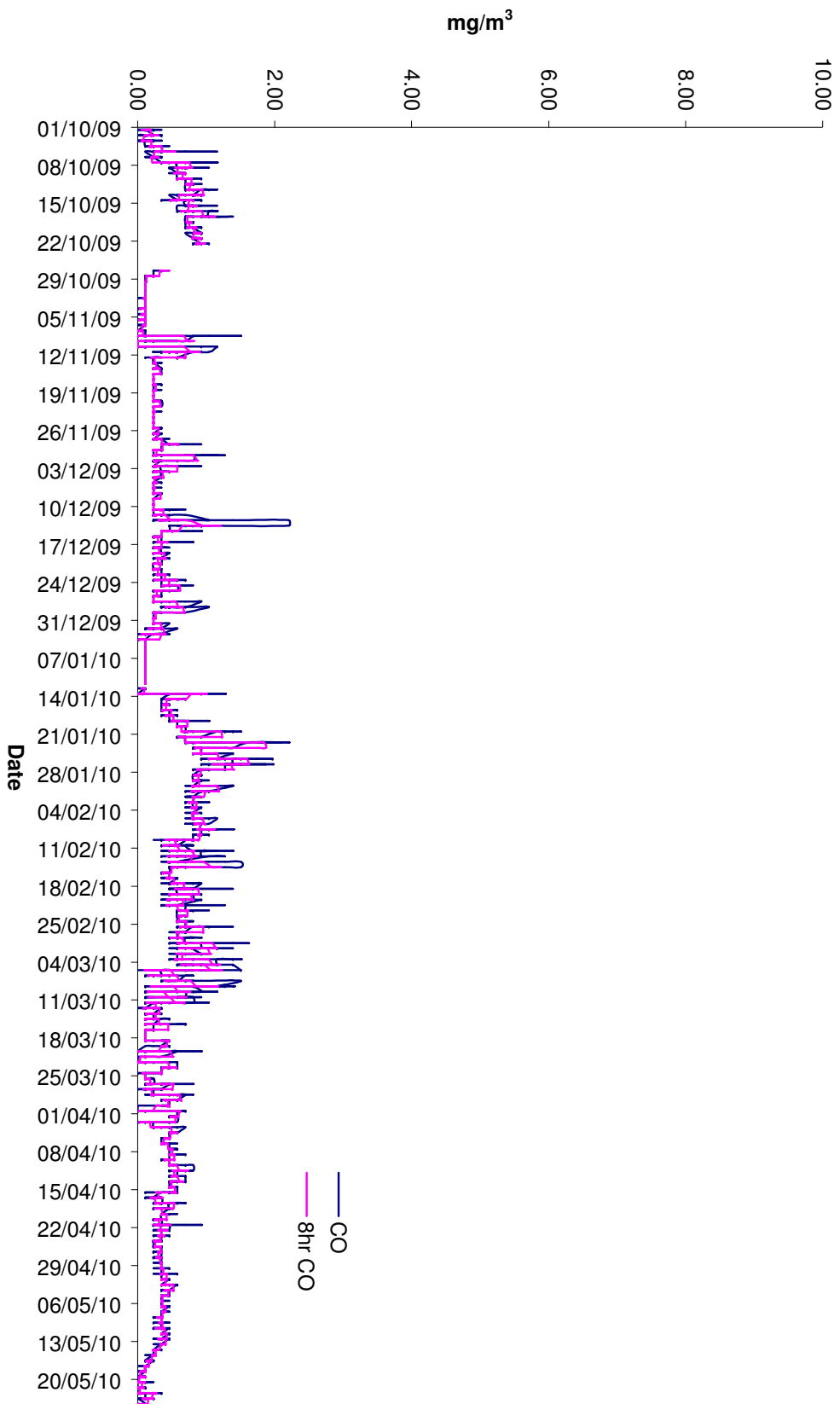


Figure 3: Carbon Monoxide 1 Hour and 8 Hour Running Average, Newbridge, 01/10/09 - 24/05/10

## Sulphur Dioxide – SO<sub>2</sub>

No. of hours	5635
Missing values (including routine maintenance)	442 15
No. of measured values	5193
Percentage covered	92.2%
Maximum hourly value	31.9 $\mu\text{g m}^{-3}$
98 percentile for hourly values	8.8 $\mu\text{g m}^{-3}$
Mean hourly value	2.9 $\mu\text{g m}^{-3}$
Maximum 24-hour value	7.7 $\mu\text{g m}^{-3}$
98 percentile for 24-hour values	7.0 $\mu\text{g m}^{-3}$

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

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

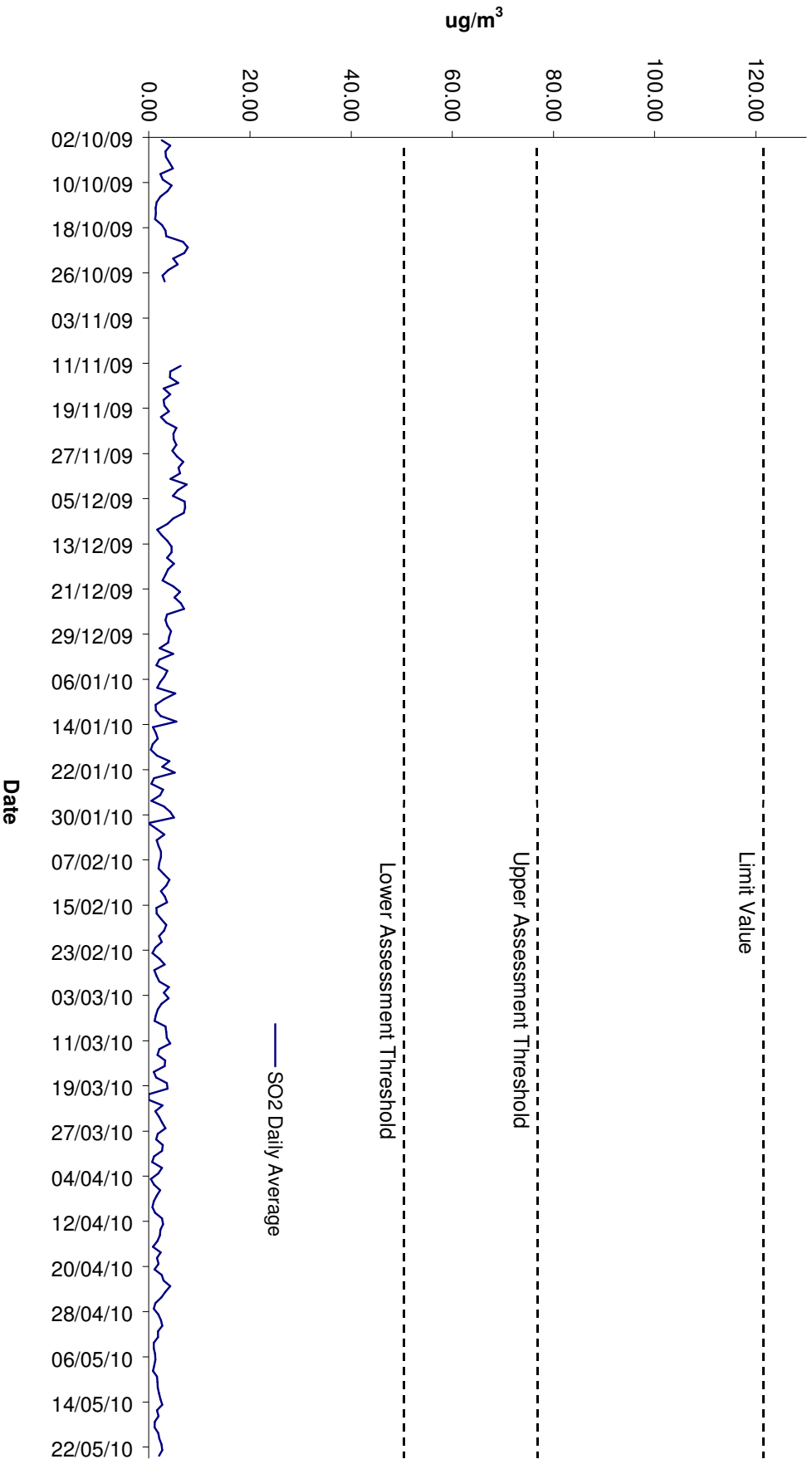
**Directive 2008/50/EC – Sulphur Dioxide - Limit values and Assessment  
Thresholds Continued**

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

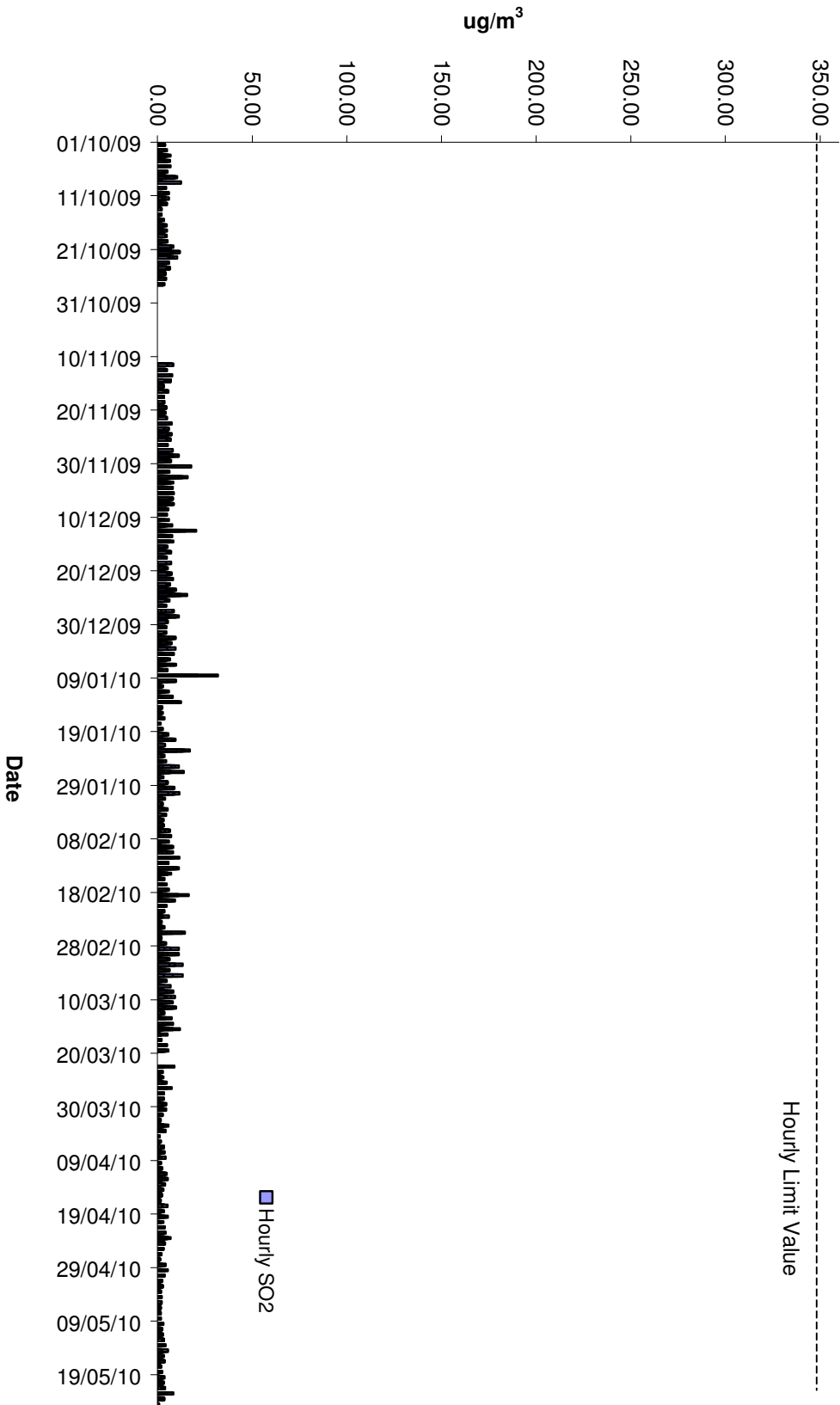
Figure 4 displays the average 24 hour SO<sub>2</sub> concentrations. There were no exceedances of the 24 hour limit value of 125  $\mu\text{g m}^{-3}$  or either assessment threshold. The directive stipulates that the lower assessment threshold should not be exceeded more than three times in a calendar year.

Figure 5 displays hourly SO<sub>2</sub> 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, Newbridge, 01/10/09 - 24/05/10



**Figure 5: Sulphur Dioxide 1 - Hour Average Concentrations, Newbridge, 01/10/09 - 24/05/10**



## Nitrogen Dioxide and Oxides of Nitrogen – NO<sub>2</sub> , NO<sub>x</sub>

No. of hours	5200
Missing values (including routine maintenance)	23 18
No. of measured values	5177
Percentage covered	99.6%
Maximum hourly value (NO <sub>2</sub> )	104.3 µg m <sup>-3</sup>
99.7 percentile for hourly values (NO <sub>2</sub> )	78.3 µg m <sup>-3</sup>
Mean hourly value (NO <sub>2</sub> )	15.4 µg m <sup>-3</sup>
Mean hourly value (NO <sub>x</sub> )	24.8 µg m <sup>-3</sup> NO <sub>2</sub>

### 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
<b>Hourly limit value for the protection of human health</b>	1 hour	200 µg m <sup>-3</sup> NO <sub>2</sub> not to be exceeded more than 18 times a calendar year	1 January 2010
<b>Annual limit value for the protection of human health</b>	Calendar year	40 µg m <sup>-3</sup> NO <sub>2</sub>	1 January 2010
<b>Annual limit value for the protection of vegetation</b>	Calendar year	30 µg m <sup>-3</sup> NO <sub>x</sub>	19 July 2001
<b>Alert threshold</b>		400 µg m <sup>-3</sup> NO <sub>2</sub> over three consecutive hours	

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

	<b>Averaging Period</b>	<b>Limit Value</b>	<b>Date by which limit value is to be met</b>
<b>Upper assessment threshold for the protection of human health</b>	1 hour	140 $\mu\text{g m}^{-3}$ NO <sub>2</sub> not to be exceeded more than 18 times a calendar year	-
<b>Upper assessment threshold for the protection of human health</b>	Calendar year	32 $\mu\text{g m}^{-3}$ NO <sub>2</sub>	-
<b>Lower assessment threshold for the protection of human health</b>	1 hour	100 $\mu\text{g m}^{-3}$ NO <sub>2</sub> not to be exceeded more than 18 times a calendar year	-
<b>Lower assessment threshold for the protection of human health</b>	Calendar year	26 $\mu\text{g m}^{-3}$ NO <sub>2</sub>	-
<b>Upper assessment threshold for the protection of vegetation</b>	Calendar year	24 $\mu\text{g m}^{-3}$ NO <sub>x</sub>	-
<b>Lower assessment threshold for the protection of vegetation</b>	Calendar year	19.5 $\mu\text{g m}^{-3}$ NO <sub>x</sub>	-

Figure 6 displays the hourly NO<sub>2</sub> 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

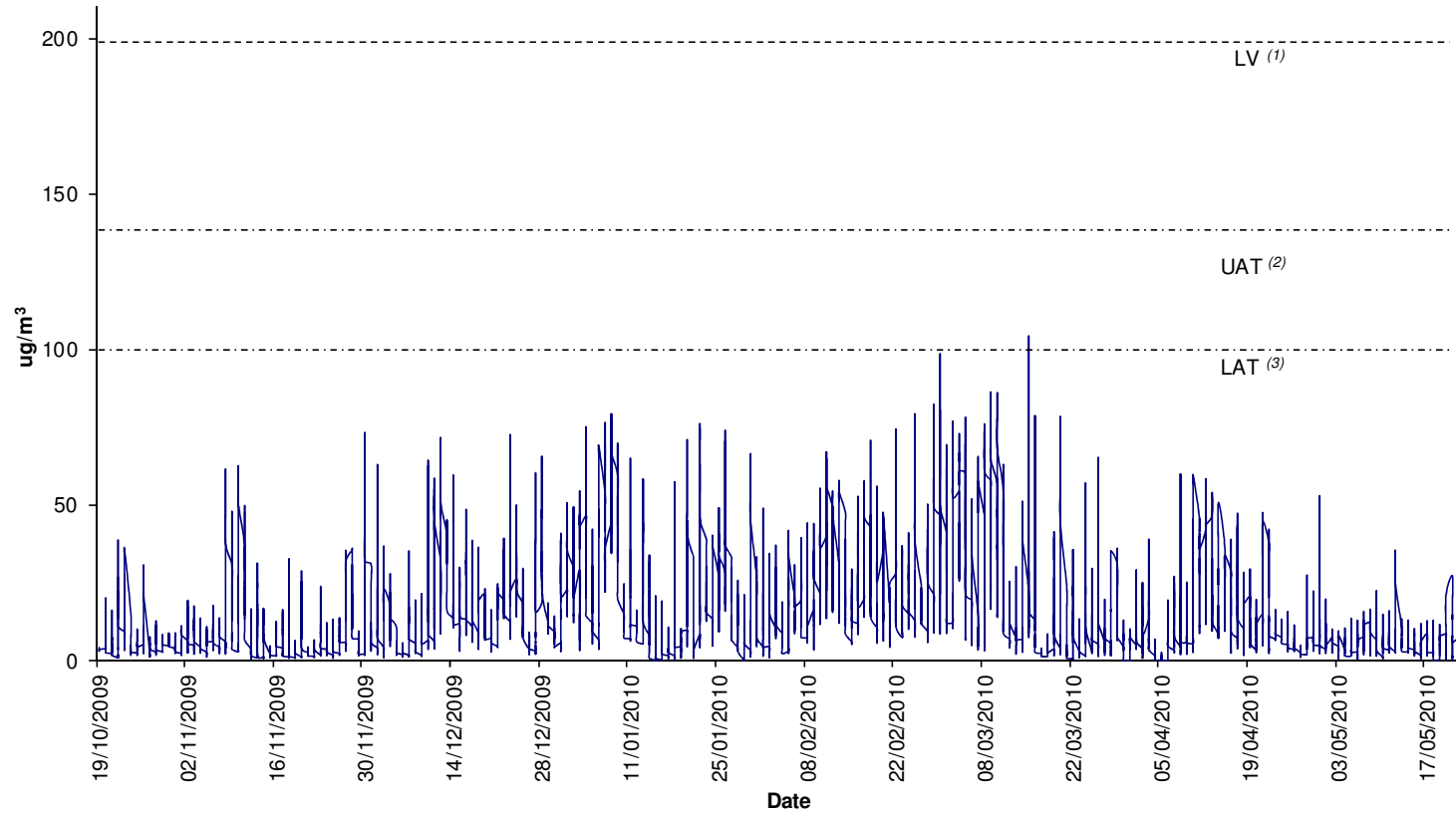


assessment threshold, upper assessment threshold and limit value are allowed per year. The mean hourly  $\text{NO}_2$  concentration was  $15.4 \mu\text{g}\cdot\text{m}^{-3}$ . This was below the lower assessment threshold value of  $26 \mu\text{g}\cdot\text{m}^{-3}$  for the protection of human health. The mean annual  $\text{NO}_x$  concentration was  $24.8 \mu\text{g}\cdot\text{m}^{-3}$ . This exceeds the lower assessment threshold concentration concerning protection of vegetation and natural ecosystem, however this assessment criterion is not applicable to the Newbridge site (Zone C). The criteria for the assessment of  $\text{NO}_x$  with regard to the protection of vegetation are as follows (2005/EC/50, Annex II B.2):

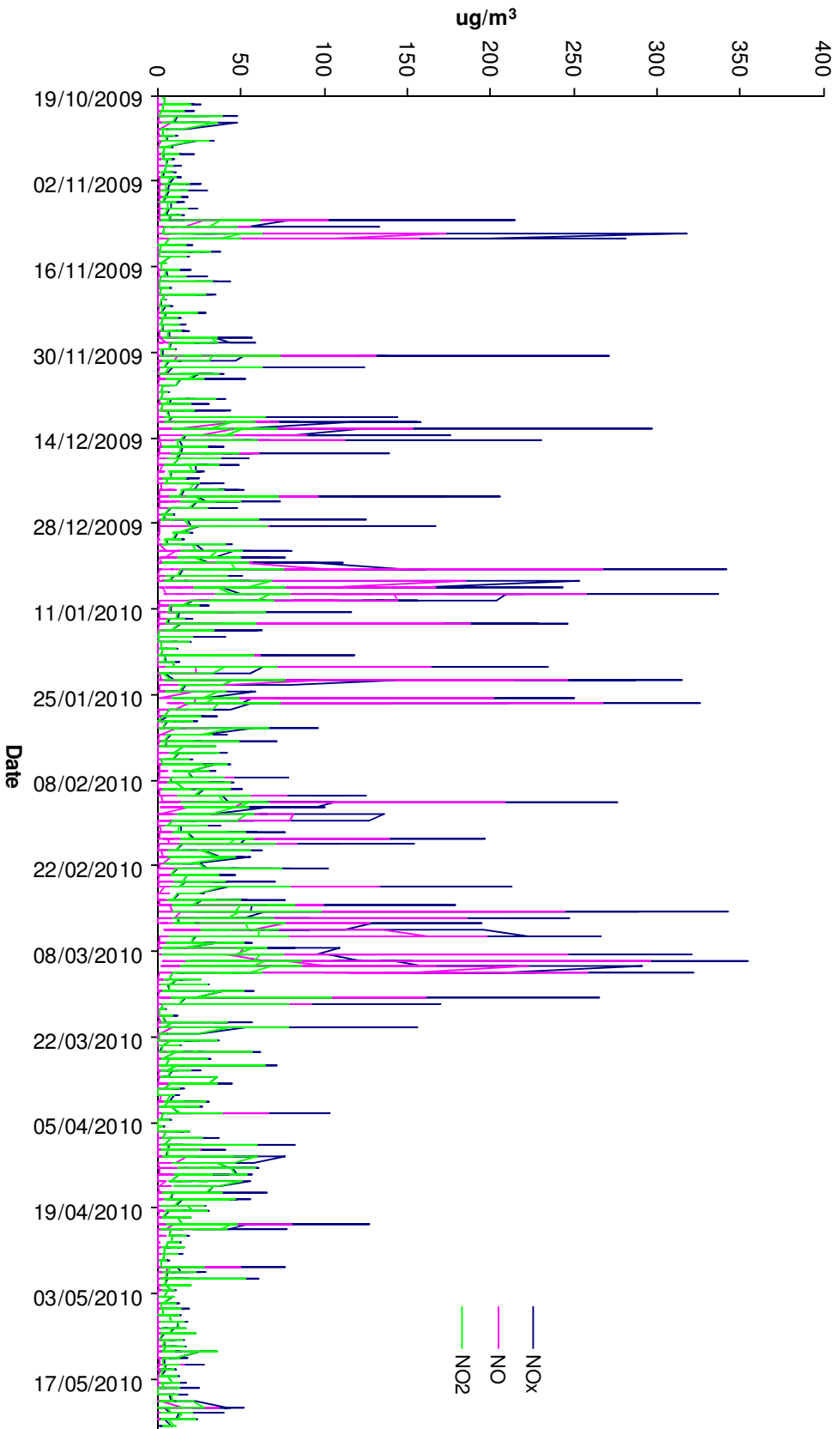
- Sampling points targeted at the protection of vegetation and natural ecosystems shall be sited more than 20 km away from agglomerations or more than 5 km away from other built-up areas, industrial installations or motorways or major roads with traffic counts of more than 50 000 vehicles per day, which means that a sampling point must be sited in such a way that the air sampled is representative of air quality in a surrounding area of at least 1 000  $\text{km}^2$ .

Figure 7 displays hourly  $\text{NO}$ ,  $\text{NO}_2$  and  $\text{NO}_x$  concentrations in  $\mu\text{g}\cdot\text{m}^{-3}$ .  $\text{NO}_2$  and  $\text{NO}_x$  are measured as ppb (parts per billion) by volume. To convert to  $\mu\text{g m}^{-3}$ , a factor (1.25 for  $\text{NO}$ , 1.91 for  $\text{NO}_2$ ) is used. No formula is specified for  $\text{NO}_x$ , the directive requires it to be expressed as  $\text{NO}_2$  (i.e.  $\text{ppb}\cdot 1.91$ ). This applies even when most of the  $\text{NO}_x$  is present as  $\text{NO}$ .

Figure 6: Nitrogen Dioxide Hourly Concentrations, Newbridge, 01/10/09 - 24/05/10



- (1) Limit Value 200ug/m<sup>3</sup> 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, Newbridge, 01/10/09 - 24/05/10**

## Particulate Matter – PM<sub>10</sub>

### PM<sub>10</sub> : TEOM method

No. of days	236
Missing values (including routine maintenance)	39 6
No. of measured values	197
Percentage covered	83.5%
Maximum daily value	74.3 $\mu\text{g m}^{-3}$
Mean daily value	17.3 $\mu\text{g m}^{-3}$

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

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

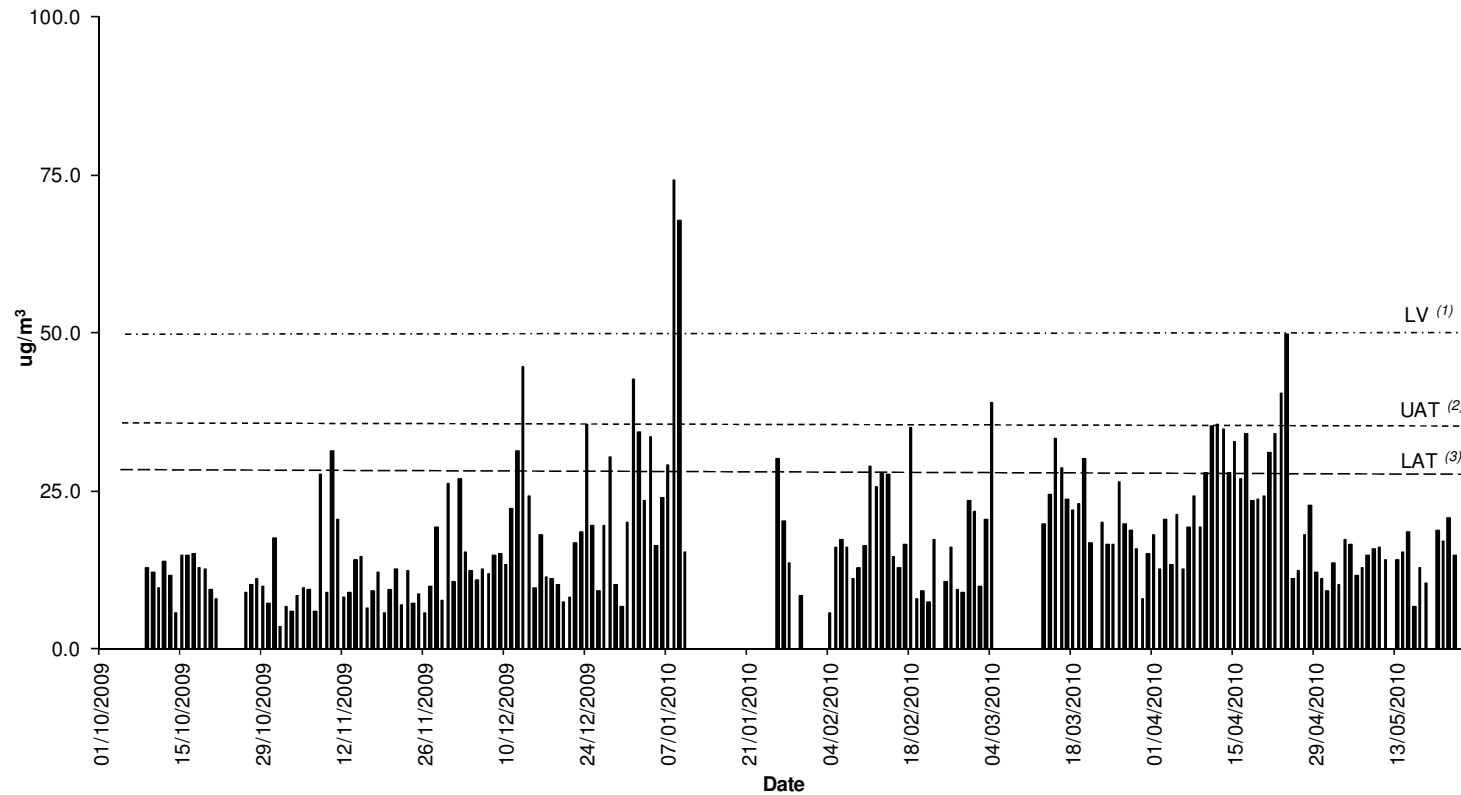
**Directive 2008/50/EC – Particulate Matter - Limit Values and Assessment Thresholds, Continued**

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

Figure 8 displays 24 hour average concentration of PM<sub>10</sub> at the site. The 24 hour limit value for the protection of human health (50  $\mu\text{g.m}^{-3}$ ) was exceeded 2 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 10 days, the lower assessment threshold (25  $\mu\text{g.m}^{-3}$ ) was exceeded on 37 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 (17.3  $\mu\text{g.m}^{-3}$ ) is below the annual limit value for the protection of human health (40  $\mu\text{g.m}^{-3}$ ).

Figure 8: Daily PM10 Concentrations, Newbridge, 01/10/09 - 24/05/10



- (1) Limit Value 50ug/m<sup>3</sup> 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

## Benzene

No. of days	212
Missing values (including routine maintenance)	83 2
No. of measured days	129
Percentage covered	60.8%
Maximum daily value	21.6 $\mu\text{g m}^{-3}$
Mean daily value	2.2 $\mu\text{g m}^{-3}$

### Directive 2008/50/EC - Benzene - Limit Values and Assessment Thresholds

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

The mean daily value for the measurement period (2.2  $\mu\text{g.m}^{-3}$ ) is below the annual average limit value of 5  $\mu\text{g m}^{-3}$  and the upper assessment threshold value of 3.5  $\mu\text{g m}^{-3}$ .

Figure 9 Daily Benzene Concentrations, Newbridge, 01/10/09 - 24/05/10

