



Ambient Air Monitoring

At

Shannon, Co. Clare

15th March 2011 – 18th July 2012

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Summary

An assessment of air quality was carried out in Shannon, Co. Clare from 15th March 2011 to 18th July 2012. No limit values were exceeded during the measurement period.

Concentrations of particulate matter, carbon monoxide, nitrogen dioxide, sulphur dioxide and benzene were below their respective lower assessment thresholds.

	Below Lower Assessment Threshold	Below Upper Assessment Threshold	Above Upper Assessment Threshold	Above Limit
PM₁₀				
NO₂				
CO				
SO₂				
C₆H₆				

Shannon, Co. Clare is located in Zone D. The implications of this assessment are that within Zone D (Rural Ireland),

- Levels of PM₁₀, SO₂, CO, NO₂ and C₆H₆ 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. 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 pertaining to PAH's and metals. The CAFÉ Directive was transposed into Irish legislation by the Air Quality Standards Regulation 2011 (S.I. No. 180 of 2011). 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, benzene and PM₁₀.
- 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 15th March 2011 to 18th July 2012.

Siting

The assessment was positioned at the Shannon Civic Offices, Town Hall, Shannon, Co. Clare (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 300A and 300E series), Teledyne Advanced Pollution Instrumentation, 9480 Carroll Park 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 a Teledyne Advanced Pollution Instrumentation SO₂ Fluorescent Analyser (Model 100E series). 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 a Teledyne Advanced Pollution Instrumentation Chemiluminescent NO/NO₂/NO_x Analyser (Model 200E series). 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, Thermo Fisher Scientific, 81 Wyman Street, MA 02454, USA). 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. 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° 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 Sprecra Analyser (Model GC855/GC955). This is an automated pumped sampling system with insitu gas chromatography. Air samples are preconcentrated on a Tenax® column. After a period of time, the preconc 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, SO₂ and NO_x were integrated to give 1-hour average values as required for comparison with the Directive limit values. Benzene and Particulate matter results were integrated to give 24-hour average values for comparison with Directive limit values.

Results

The following sections detail the results observed at the Shannon 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	11417
Missing values (including routine maintenance)	703 48
No. of measured values	10714
Percentage covered	93.8%
Maximum hourly value	2.5 mg m ⁻³
98 percentile for hourly values	0.5 mg m ⁻³
Mean hourly value	0.2 mg m ⁻³
Maximum 8-hour mean	1.29 mg m ⁻³
98 percentile for 8-hour mean	0.45 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 2 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 8 - Hour average CO concentrations.

Figure 2: Carbon monoxide 8 Hour Running Average, Shannon, 16/03/11 - 02/07/12

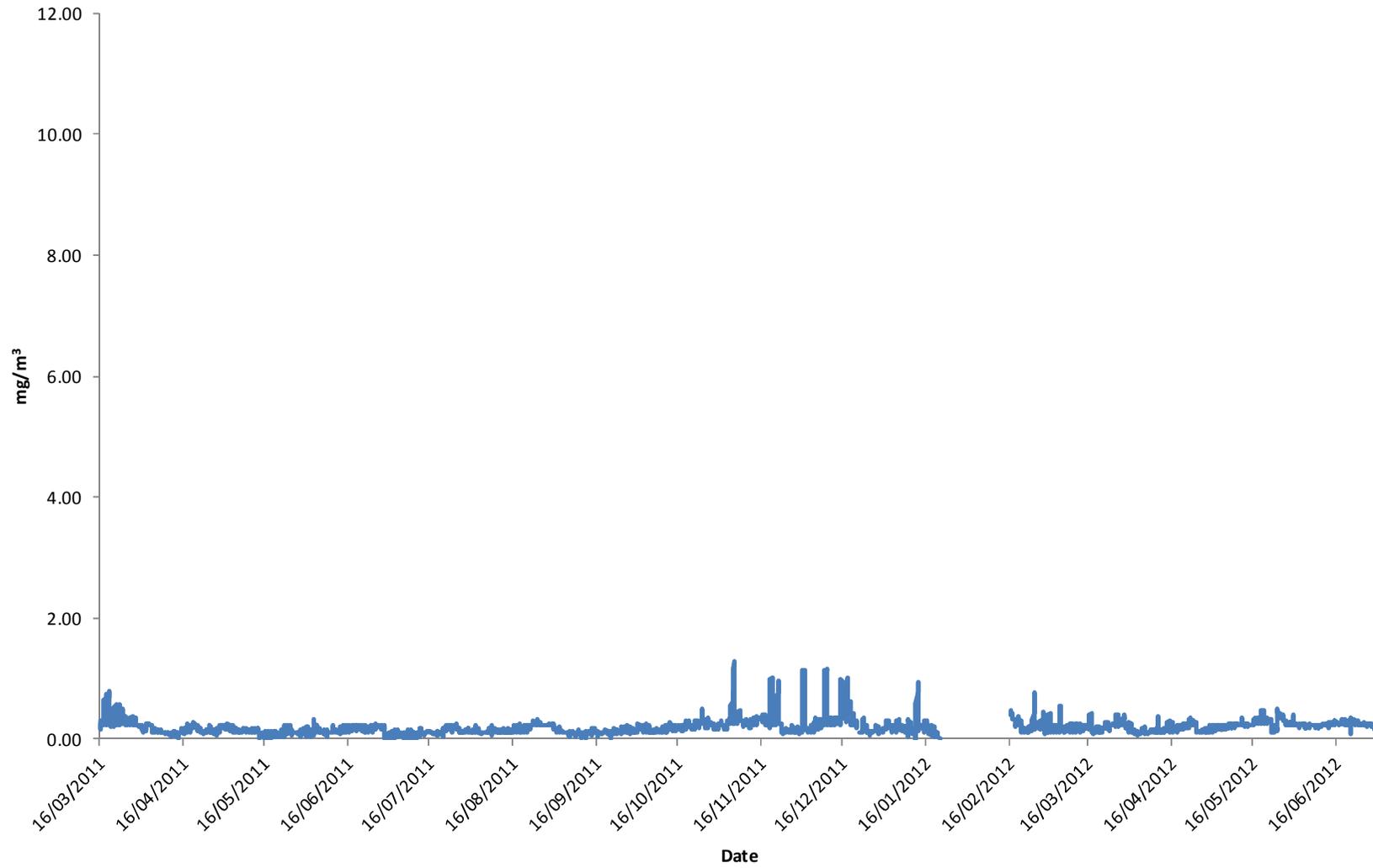
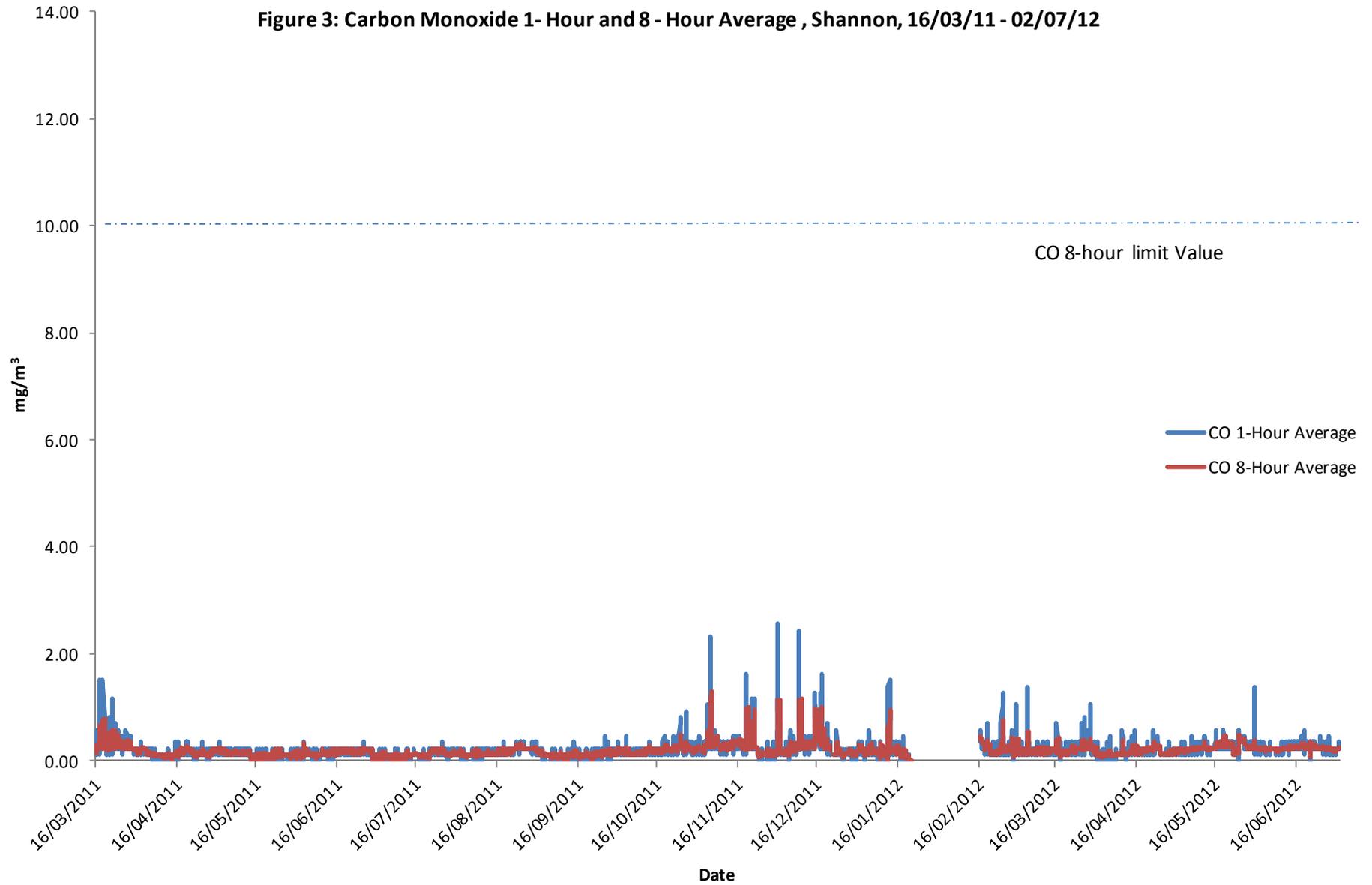


Figure 3: Carbon Monoxide 1- Hour and 8 - Hour Average , Shannon, 16/03/11 - 02/07/12



Sulphur Dioxide – SO₂

No. of hours	11407
Missing values (including routine maintenance)	819 65
No. of measured values	10588
Percentage covered	92.8%
Maximum hourly value	22.9 µg.m ⁻³
98 percentile for hourly values	6.1 µg.m ⁻³
Mean hourly value	1.7 µg.m ⁻³
Maximum 24-hour value	6.1 µg.m ⁻³
98 percentile for 24-hour values	4.1 µg.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 µg 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 µg 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 µg m ⁻³	-
Alert threshold	-	500 µg 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 Daily Average Concentrations, Shannon, 16/03/11 - 03/07/12

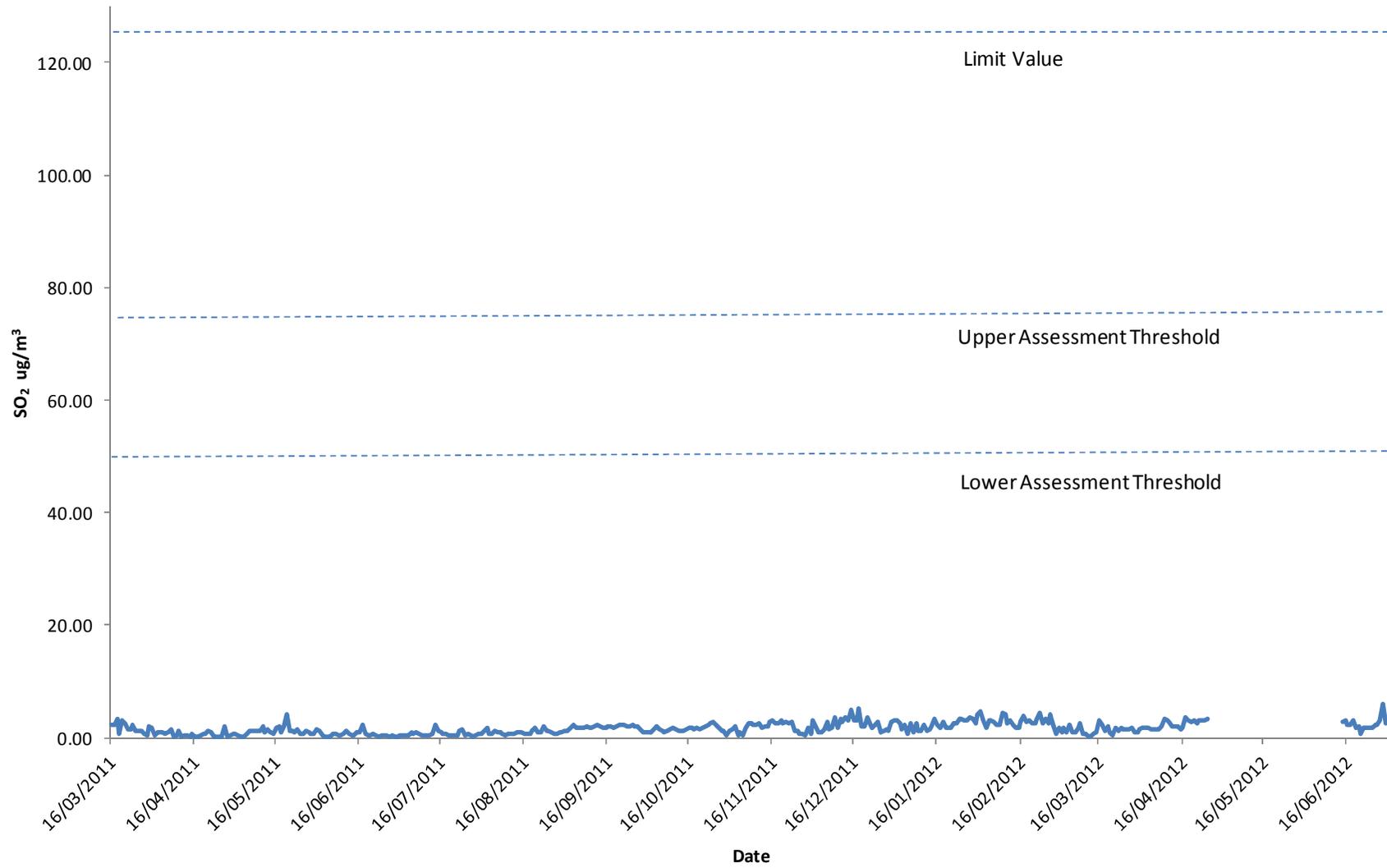
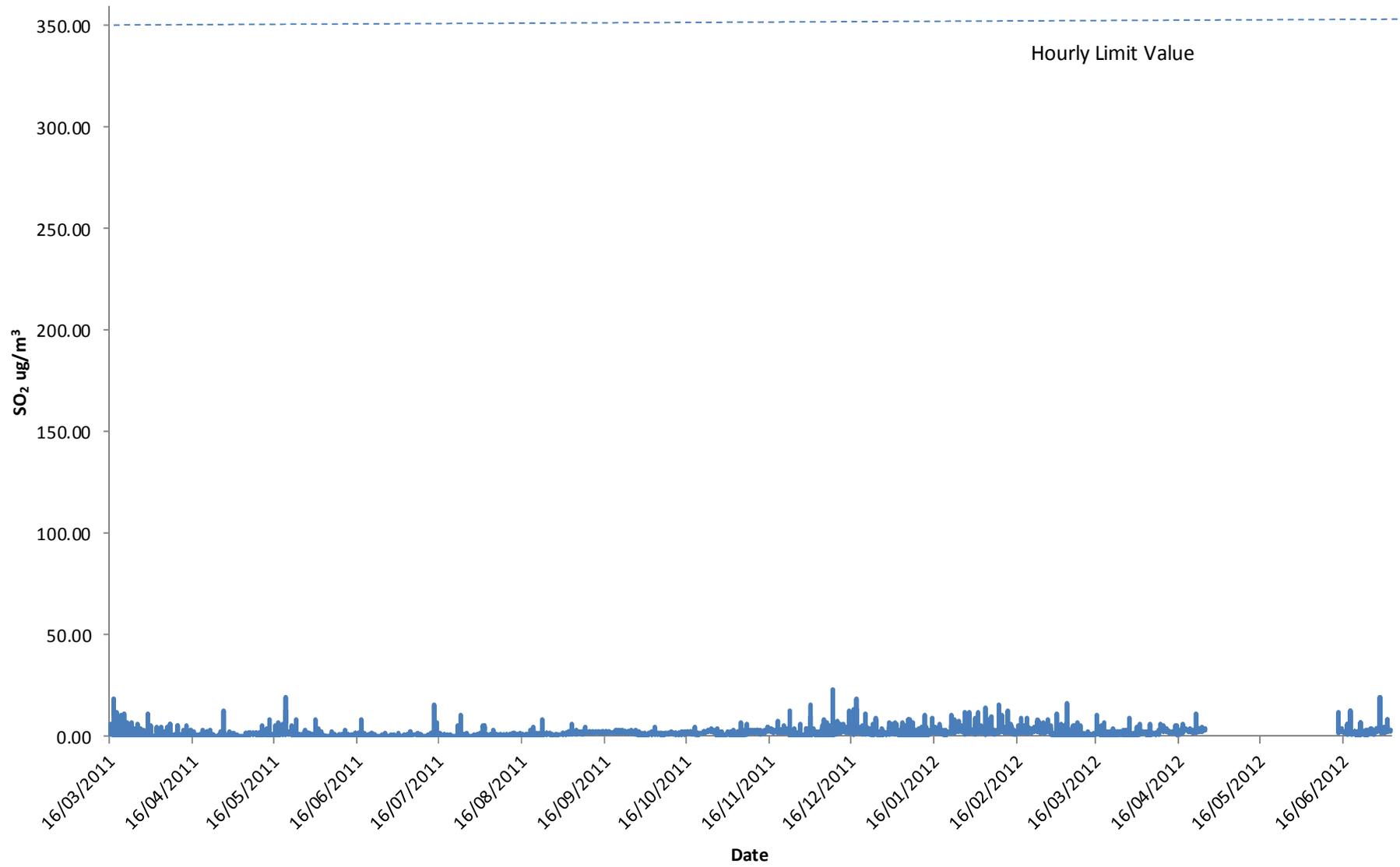


Figure 5: Sulphur Dioxide 1-Hour Average Concentrations, Shannon, 16/03/11 - 03/07/12



Nitrogen Dioxide and Oxides of Nitrogen – NO₂ , NO_x

No. of hours	11400
Missing values (including routine maintenance)	202 157
No. of measured values	11198
Percentage covered	98.2%
Maximum hourly value (NO ₂)	76.6 µg.m ⁻³
99.7 percentile for hourly values (NO ₂)	55.2 µg.m ⁻³
Mean hourly value (NO ₂)	7.6 µg.m ⁻³
Mean hourly value (NO _x)	10.1 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	-

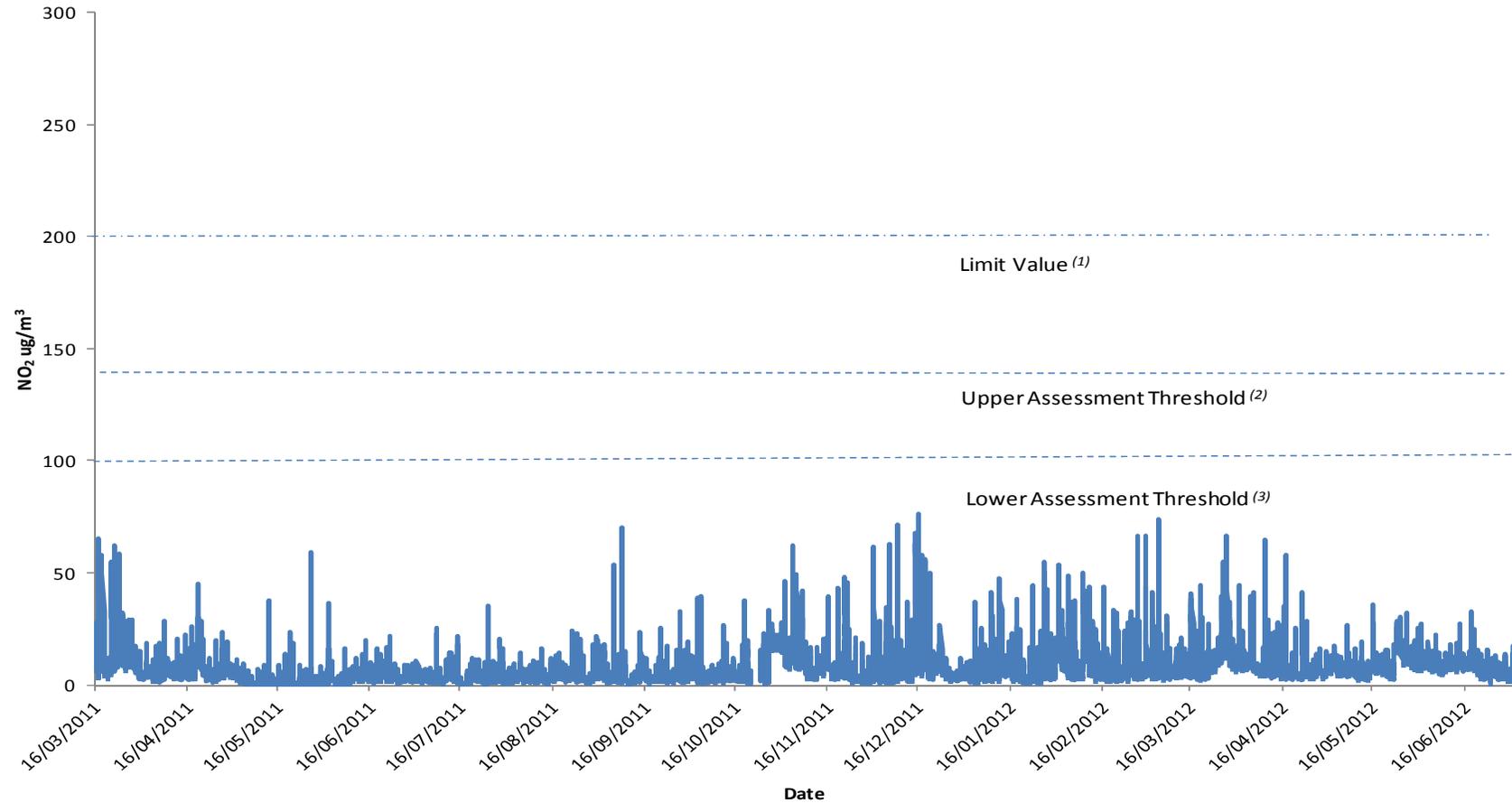
Figure 6 displays the hourly NO₂ concentrations at the site for the entire monitoring period. There were no exceedances of the lower threshold value concerning the protection of human health. No more than 18 exceedances each of the lower

assessment threshold, upper assessment threshold and limit value are allowed per year. The mean hourly NO_2 concentration was $7.6 \mu\text{g}\cdot\text{m}^{-3}$. 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 NO_x concentration was $10.1 \mu\text{g}\cdot\text{m}^{-3}$. This is below the lower assessment threshold concentration concerning protection of vegetation and natural ecosystem, however this assessment criterion is not applicable to the Shannon site (Zone D) as the monitoring location was within the boundaries of Shannon town. The criteria for the assessment of 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 km^2 .

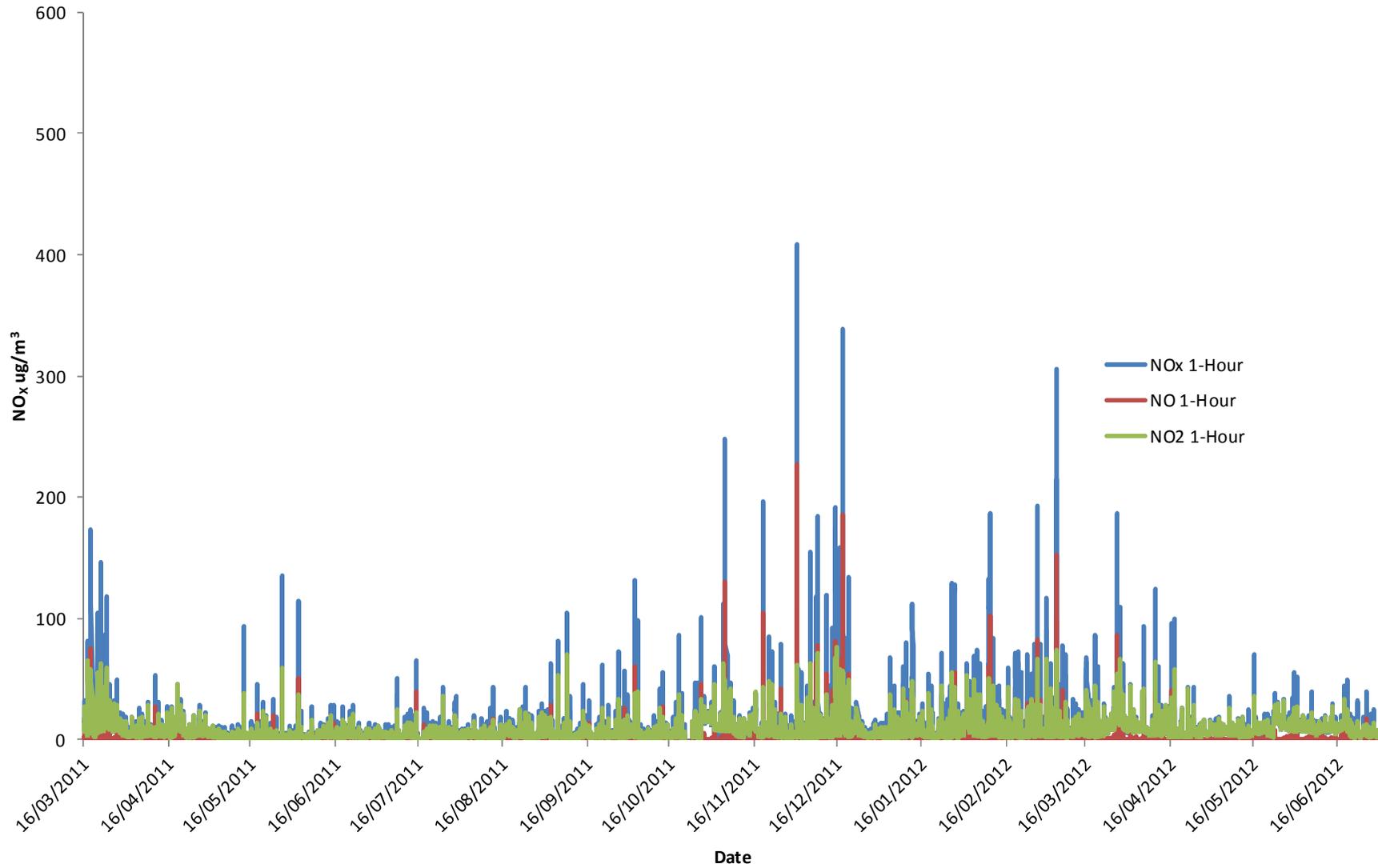
Figure 7 displays hourly NO , NO_2 and NO_x concentrations in $\mu\text{g}\cdot\text{m}^{-3}$. NO_2 and NO_x are measured as ppb (parts per billion) by volume. To convert to $\mu\text{g}\cdot\text{m}^{-3}$, a factor (1.25 for NO , 1.91 for NO_2) is used. No formula is specified for NO_x , the directive 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: Nitrogen Dioxide Hourly Average Concentrations, Shannon, 16/03/11 - 03/07/12



- (1) Limit Value $200\mu\text{g}/\text{m}^3$ 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: NO_x Hourly Average Concentrations, Shannon, 16/03/11 - 03/07/12



Particulate Matter – PM₁₀

PM₁₀ : TEOM method

No. of days	457	
Missing values (including routine maintenance)	36	
	6	
No. of measured values	421	
Percentage covered	92.1%	
Maximum daily value	57.2	µg.m ⁻³
Mean daily value	11.1	µg.m ⁻³
90.4 percentile for daily values	22.5	µg.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 µg 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 µg m ⁻³ PM ₁₀
Upper assessment threshold for the protection of human health	24 hour	35 µg 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 µg m ⁻³ PM ₁₀

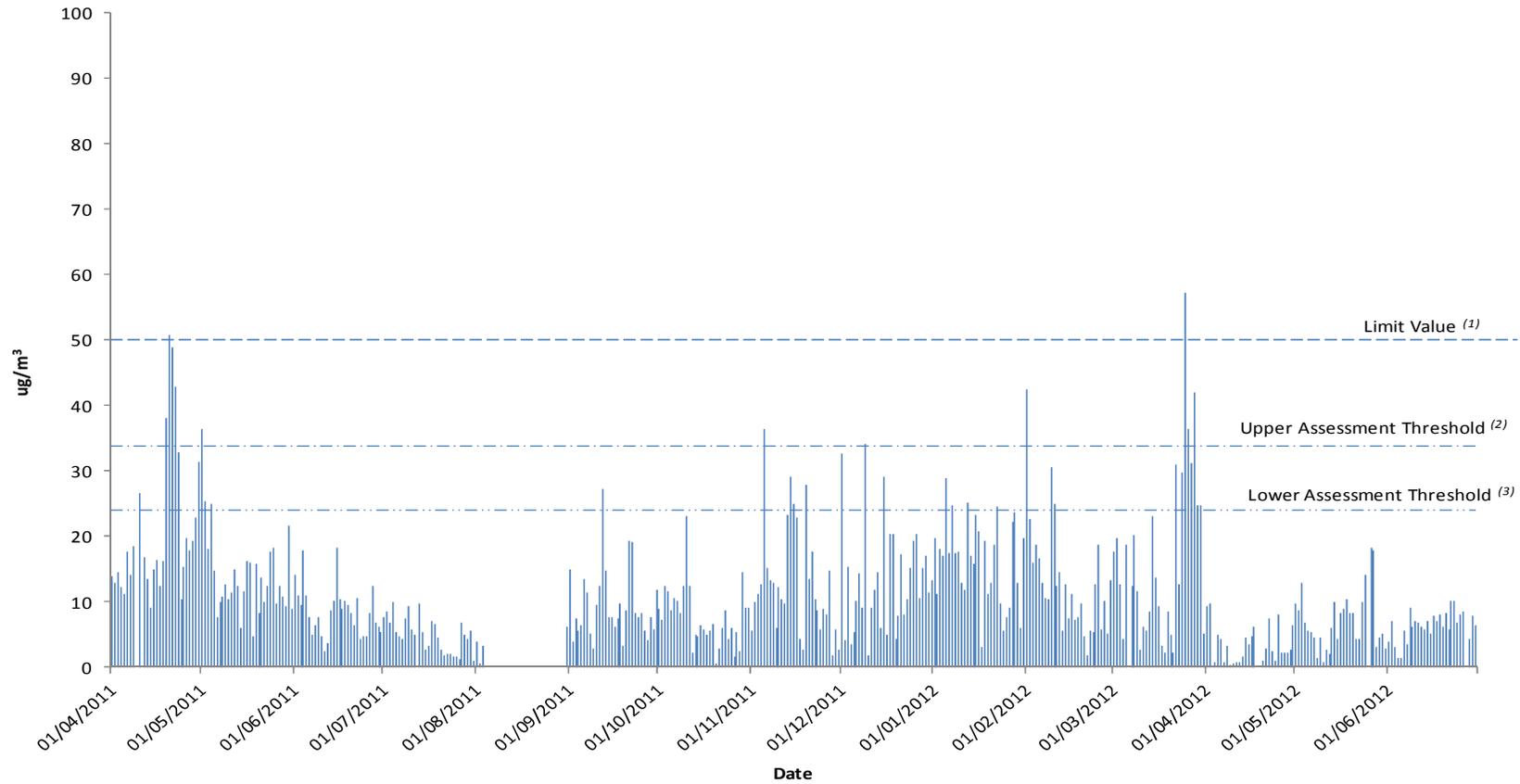
Directive 2008/50/EC – Particulate Matter - Limit Values and Assessment Thresholds, Continued

	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 daily average concentration of PM₁₀ at the site. The daily limit value for the protection of human health (50 $\mu\text{g.m}^{-3}$) was exceeded twice 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 $\mu\text{g.m}^{-3}$) with regard to the daily average PM₁₀ concentration was exceeded on 10 days while the lower assessment threshold (25 $\mu\text{g.m}^{-3}$) with regard to daily average PM₁₀ concentration was exceeded on 28 days. The Directive stipulates that each of the assessment thresholds should not be exceeded more than 35 times in a calendar year. The 90.4 percentile value (22.5 $\mu\text{g.m}^{-3}$) is below the lower assessment threshold value of 25 $\mu\text{g.m}^{-3}$.

The mean of the daily values during the measurement period (11.1 $\mu\text{g.m}^{-3}$) is below the lower assessment threshold with regard to annual average PM₁₀. The annual limit value for the protection of human health is 40 $\mu\text{g.m}^{-3}$.

Figure 8: Daily PM₁₀ Concentrations, Shannon, 01/04/11 - 30/06/12



- (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

Benzene

No. of days	397
Missing values (including routine maintenance)	76 9
No. of measured days	321
Percentage covered	80.8%
Maximum daily value	5.8 $\mu\text{g m}^{-3}$
Mean daily value	0.4 $\mu\text{g m}^{-3}$

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

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

Figure 9 displays the daily average benzene concentrations from 01/04/11 to 30/04/12. The mean daily value for the measurement period (0.4 $\mu\text{g.m}^{-3}$) is below the annual average limit value of 5 $\mu\text{g m}^{-3}$ and the lower assessment threshold value of 2.0 $\mu\text{g m}^{-3}$. No exceedances of the assessment thresholds or limit values occurred during the monitoring programme.

Figure 9: Daily Benzene Concentrations, Shannon, 01/04/11 - 30/04/12

