



Preliminary Assessment for the Ambient Air Quality Directive (2008/50/EC) for the United Kingdom

Report to the Department for Environment, Food and Rural
Affairs, Welsh Assembly Government, the Scottish
Government and the Department of the Environment for
Northern Ireland

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ED 48208
AEAT/ENV/R/2961 Issue 1
April 2010

Title	Preliminary Assessment for the Ambient Air Quality Directive (2008/50/EC) for the United Kingdom
Customer	The Department for Environment, Food and Rural Affairs, Welsh Assembly Government, the Scottish Government and the Department of the Environment for Northern Ireland
Customer reference	CPEA 15
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File reference	w:\ddreview\prelim_CAFE_2010\Prelim_rpt_for_CAFE_(8).doc
Reference number	AEAT/ENV/R/2961 Issue 1

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Executive summary

This report provides a comprehensive summary of the work undertaken to ensure compliance with the air quality assessment requirements of EU Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe (the CAFE Directive). The preliminary assessment was carried out in 2006 for all nine pollutants (SO₂, NO₂, NO_x, PM₁₀, PM_{2.5}, lead, benzene, CO, and ozone) considered within the then proposed Directive. The CAFE Directive superseded the Framework Directive (96/62/EC) and the first three Daughter Directives (1999/30/EC, 2000/69/EC and 2002/3/EC). In common with the preliminary assessments carried out for the Daughter Directives, a preliminary assessment for the CAFE Directive was necessary to review the scope and coverage of existing monitoring and supplementary data and to assess what further monitoring was required. Recommendations were then made for compliant monitoring in all agglomerations and zones. The data available for the CAFE Directive preliminary assessment are more extensive than that available for the preliminary assessment carried out for the Daughter Directives. For most of the pollutants considered for CAFE Directive, there were five years of monitoring data available and four years of supplementary data available for the assessment.

The monitoring data are collected by the Automatic Urban and Rural Network, Automatic and Non-Automatic Hydrocarbon Networks. These are designated national monitoring networks, funded by Defra and the Devolved Administrations, and aim to provide compliant monitoring coverage. Supplementary data are available in the form of national concentration maps that provide estimates of background and roadside concentrations throughout the United Kingdom. These maps are also produced on behalf of Defra and the Devolved Administrations. The number of sampling sites required within a zone or agglomeration depends on the population and the status of observed concentrations relative to the assessment thresholds within the zone. The number of sampling sites may be reduced if supplementary data, such as modelling data, are available.

Since the preliminary assessment was carried out in 2006, the CAFE Directive has superseded the Framework and first, second and third Daughter Directives. The Directive is also to be transposed into UK legislation by June 2010.

The CAFE Directive updates the monitoring site requirements in a number of ways, including:

- More monitoring to be carried out at roadside sites (at least one urban background and one roadside site in each zone unless this increases the number of sites and sets a ratio between the total number of roadside sites and the total number of sites across the member state).
- The establishment of a network to measure concentrations of PM_{2.5} along with complex requirements in relation to the combined monitoring of both PM₁₀ and PM_{2.5}.

This report summarises the monitoring requirements and provides an update of the current status of the monitoring networks in relation to the CAFE Directive. In addition, it shows the extent to which the United Kingdom is compliant for monitoring each pollutant. Monitoring compliance for the following pollutants has been determined:

- Sulphur dioxide;
- Oxides of nitrogen;
- Lead;
- Benzene;
- Carbon monoxide;
- Ozone.

For nitrogen dioxide, all agglomerations are compliant with the monitoring requirements of the CAFE Directive. However, there are a number of zones (West Midlands, Central Scotland, East Midlands, South East and South West) for which full monitoring is yet to commence. Plans are in place to ensure that sampling commences at these sites as soon as possible.

For particulate matter, monitoring is compliant in the majority of agglomerations and zones. However, for those agglomerations and zones that are not yet fully compliant, plans are underway to ensure compliance. These agglomerations and zones include: Greater Manchester Urban Area and Glasgow Urban Area, South West zone, South East zone, West Midlands zone and East Midlands zone.

In addition, the CAFE Directive requires that speciation of the component constituents of $PM_{2.5}$, is carried out at two sampling sites within the United Kingdom. $PM_{2.5}$ speciation measurements currently occurs at two sites (Harwell and Auchencorth Moss), covering SO_4^{2-} , Na^+ , NH_4^+ , Ca^{2+} , NO_3^- , K^+ , Cl^- , Mg^{2+} . Options for measurements of elemental and organic carbon are under evaluation.

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1 Introduction

The Framework Directive (96/62/EC) and its associated Daughter Directives aimed to provide a consistent approach to ambient air quality assessment and management. As a first step, and before the air quality assessments could be performed, preliminary assessments (as specified in Article 5 of the Framework Directive) were required so that Member States would have in place the necessary monitoring before the Daughter Directive became transposed into national legislation. Preliminary assessment reports (Bush, 2000, Bush 2002, Bush and Kent, 2003, Bush 2007) have been produced for the United Kingdom for each Daughter Directive on behalf of Defra and the Devolved Administrations. These reports reviewed the existing monitoring in place and made recommendations for compliant monitoring in all agglomerations and zones.

In light of the then proposed Ambient Air Quality and Cleaner Air for Europe (CAFE) Directive a first draft of a preliminary assessment was carried out in 2006 for all nine pollutants (SO_2 , NO_2 , NO_x , PM_{10} , $\text{PM}_{2.5}$, lead, benzene, CO, and ozone) considered within the directive. The assessment used monitoring data from the Automatic, Urban and Rural Network (AURN), Auto and Non-Automatic Hydrocarbon Networks and modelled estimates of ambient concentrations from Defra's Pollution Climate Mapping (PCM) contract. The latter contract also contributes to the annual CAFE 'questionnaire' on air quality assessments of the Daughter Directive pollutants.

Measured and modelled data were compared with the upper and lower assessment thresholds within each zone or agglomeration. The number of sampling sites required within each zone or agglomeration depends upon the population and the status of the highest observed concentration relative to the assessment threshold within the zone. Under the guidelines set out in the CAFE Directive, the number of sampling sites can be reduced if supplementary data, such as the modelling data, are available.

The new Directive updates the monitoring site requirements in a number of key ways, notably by requiring:

- More monitoring to be carried out at roadside sites (at least one urban background and one roadside site in each zone unless this increases the number of sites and sets a ratio between the total number of roadside sites and the total number of sites across the Member State).
- The establishment of a network to measure concentration of $\text{PM}_{2.5}$ along with complex requirements in relation to the combined monitoring of both PM_{10} and $\text{PM}_{2.5}$.

This report provides comprehensive documentation of the preliminary assessment process for the CAFE Directive and aims to demonstrate that the monitoring networks in the United Kingdom are compliant with the Directive and to present how the United Kingdom's compliance approach has been configured, enhanced and optimised for compliance with the CAFE Directive.

This report is structured as follows:

- Chapter 2 describes the general approach to the assessment in terms of: describing the zones and agglomerations; assumptions with regards to most appropriate averaging period upon which to base the assessment for each pollutant; summary of monitoring and modelling data available and the sampling criteria for each pollutant based on assessment thresholds and supplementary data.
- Chapters 3 to 9 consider the monitoring requirements for each pollutant to ensure compliance with the CAFE Directive. Within each chapter the assessment thresholds are presented. There is then a short description of the supplementary, or modelling method for each pollutant and the main features of the concentration distribution are shown in pollutant maps. For those pollutants with limit values, an evaluation is made as to the extent to which the measurement data over the five year period may exceed the lower or upper assessment thresholds. The number of sites required based on the observed exceedance status by zone, and the background/roadside ratio, if applicable, are presented in tabular format. The use of modelling data (supplementary data) allows a much larger geographical area to be assessed within each zone or agglomeration and permits the number of required sampling sites to be reduced by up

to 50 %. The current configuration (April 2010) of the monitoring networks are presented at the end of each chapter.

Preliminary assessment results for pollutants covered by the Fourth Daughter Directive are not covered by this report, these pollutants being beyond the regulatory scope of the CAFE Directive. A preliminary assessment report for the Fourth Daughter Directive and its pollutants was presented by Bush (2007).

The limit values, target values or long term objectives for the respective pollutants can be found in the CAFE Directive:

<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF>

See also Annexes XI, XIII and XIV.

2 General Approach

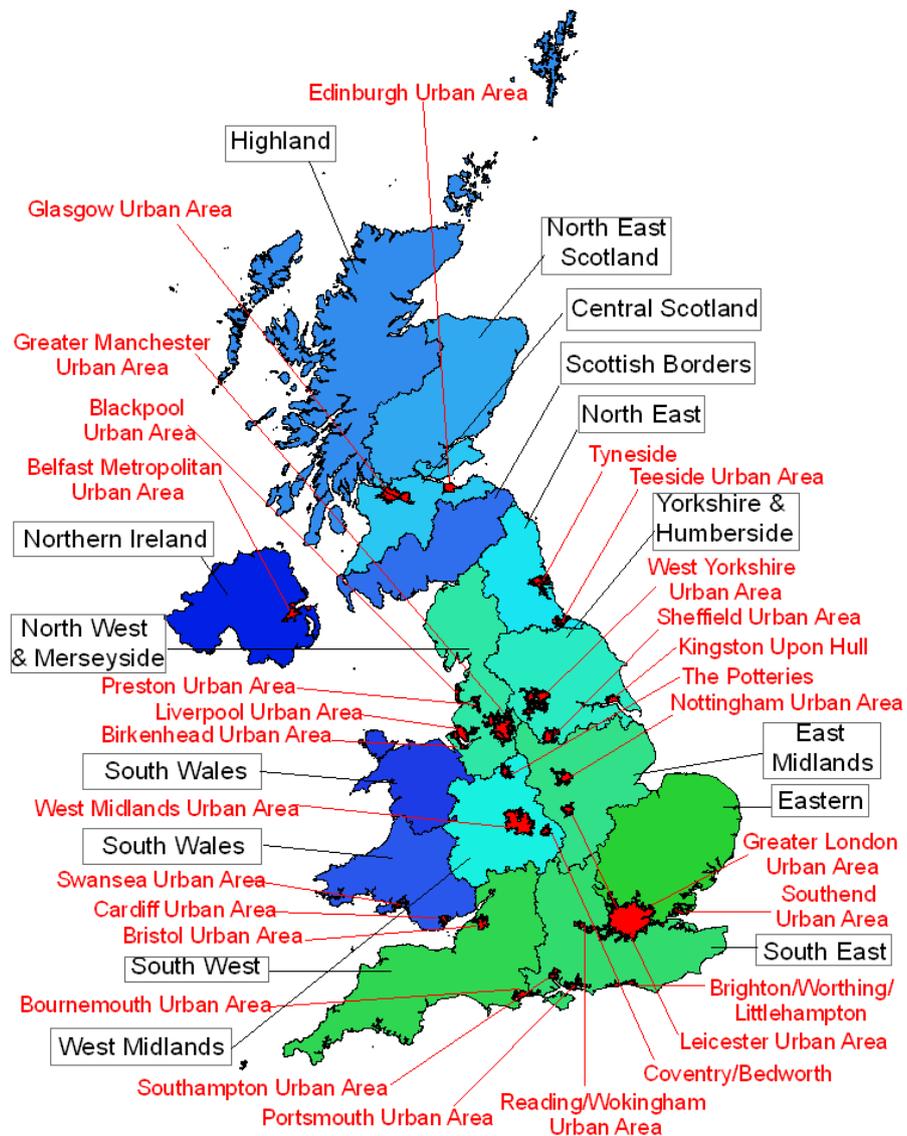
The United Kingdom's preliminary assessment for the CAFE Directive benefits from the extensive databases on measured and modelled data established under the Framework and Daughter Directives. Monitoring, using consistent methods, has taken place since 2000 and the modelled data is available for most pollutants since 2001.

The monitoring requirement has been assessed for the same zones and agglomerations (urban areas with a population of greater than 250,000) defined for the previous preliminary assessments. These are listed in Table 2-1 and illustrated in Figure 2.1.

Zone	Zone code	Ag or nonag*	Population	Area (km ²)
Greater London Urban Area	UK0001	ag	8278251	1629.9
West Midlands Urban Area	UK0002	ag	2284093	599.7
Greater Manchester Urban Area	UK0003	ag	2244931	556.5
West Yorkshire Urban Area	UK0004	ag	1499465	370.0
Tyneside	UK0005	ag	879996	210.7
Liverpool Urban Area	UK0006	ag	816216	186.1
Sheffield Urban Area	UK0007	ag	640720	162.2
Nottingham Urban Area	UK0008	ag	666358	158.4
Bristol Urban Area	UK0009	ag	551066	139.8
Brighton/Worthing/Littlehampton	UK0010	ag	461181	94.1
Leicester Urban Area	UK0011	ag	441213	101.6
Portsmouth Urban Area	UK0012	ag	442252	94.4
Teesside Urban Area	UK0013	ag	365323	114.3
The Potteries	UK0014	ag	362403	96.6
Bournemouth Urban Area	UK0015	ag	383713	108.1
Reading/Wokingham Urban Area	UK0016	ag	369804	93.2
Coventry/Bedworth	UK0017	ag	336452	75.5
Kingston upon Hull	UK0018	ag	301416	80.4
Southampton Urban Area	UK0019	ag	304400	72.8
Birkenhead Urban Area	UK0020	ag	319675	89.1
Southend Urban Area	UK0021	ag	269415	66.8
Blackpool Urban Area	UK0022	ag	261088	65.8
Preston Urban Area	UK0023	ag	264601	60.4
Glasgow Urban Area	UK0024	ag	1168270	368.7
Edinburgh Urban Area	UK0025	ag	452194	120.1
Cardiff Urban Area	UK0026	ag	327706	75.6
Swansea Urban Area	UK0027	ag	270506	79.7
Belfast Metropolitan Urban Area	UK0028	ag	580276	198.1
Eastern	UK0029	nonag	4850132	19133.7
South West	UK0030	nonag	3980991	23562.6
South East	UK0031	nonag	6016677	18672.6
East Midlands	UK0032	nonag	3084598	15495.9
North West & Merseyside	UK0033	nonag	2826622	13722.9
Yorkshire & Humberside	UK0034	nonag	2514947	14796.6
West Midlands	UK0035	nonag	2271650	12186.3
North East	UK0036	nonag	1269803	8291.4
Central Scotland	UK0037	nonag	1813314	9347.6
North East Scotland	UK0038	nonag	1001499	18631.4

Zone	Zone code	Ag or nonag*	Population	Area (km ²)
Highland	UK0039	nonag	380062	39134.5
Scottish Borders	UK0040	nonag	254690	11184.1
South Wales	UK0041	nonag	1578773	12228.4
North Wales	UK0042	nonag	720022	8382.6
Northern Ireland	UK0043	nonag	1104991	13974.1
Total			59211755	244813.3

Figure 2.1. UK zones and agglomerations



Agglomeration zones (red). Non-agglomeration zones (blue/green).

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The following assumptions and definitions have been used for the purposes of this assessment:

1. The UK is composed of 28 agglomerations zones and 15 non-agglomeration zones.
2. For pollutants except ozone (for which there is no limit values or assessment thresholds), the exceedance status each zone has been determined using valid measured and modelled data available over a five year period 2000-2004 and based on guidance provided by Annex II, Section B of the CAFE Directive.
3. The measurement data is generally available for the years 2000 to 2004. The supplementary assessment data is available for most pollutants for the years 2001 to 2004.
4. Formal exceedance was deemed to have occurred, for each zone or agglomeration, if there was exceedance of the assessment threshold on three or more years during the five year period, 2000-2004.
5. In determining an exceedance of the assessment threshold, precedence has been given to measurement data where this is available, unless higher concentrations are predicted elsewhere in a given zone by model outputs;
6. According to Article 7, Section 3 of the CAFE Directive, and the sampling criteria presented in Annex V, Table 1 of the CAFE Directive, the number of monitoring stations maybe reduced by up to 50 % where information other than fixed measurements is available.
7. For NO₂ and PM₁₀ the assessment is based on the annual average threshold.
8. For sulphur dioxide, the assessment is based on the 24-hour assessment threshold
9. For ozone, the minimum number of sampling sites is provided in Article 10 and Annex IX of the CAFE Directive.
10. The preliminary assessment method for PM_{2.5} differs from that that for other pollutants since there are limited pre-existing historical datasets to calculate assessment thresholds. In this case, the network size is based on the minimum number of sampling sites to assess compliance with the exposure reduction target (see Annex V, Section B of the CAFE Directive).
11. No monitoring is required in cases where the ambient concentration is less than the lower assessment threshold.

2.1 Ambient air quality concentration data inputs

2.1.1 Measurement data

Monitoring of pollutant concentrations to meet the requirements of the Framework and Daughter Directives began in 2001. Table 2-2 summarises the number of sampling sites for the years 2000 to 2004 within the national monitoring networks (AURN and hydrocarbon networks).

Table 2-2: Number of sampling sites in the AURN with a data capture greater than 75% for the years 2000 to 2004					
Year	NO ₂	SO ₂	PM ₁₀	Benzene	CO
2000	78	60	52	13	60
2001	88	71	61	4	63
2002	90	69	59	2	61
2003	86	70	60	35	65
2004	99	70	65	37	75

Note: Due to the small number of sampling sites PM_{2.5} monitoring data was not used in the preliminary assessment. The minimum number of sampling sites required for ozone is independent of measured concentration.

2.1.2 Modelled data

Annual air quality assessments as required for the First Daughter Directive were carried out in 2001, 2002, 2003 and 2004. For each of these years, modelled concentrations for SO₂, NO_x, NO₂ and PM₁₀ were used to supplement the measurement data. Concentrations of lead throughout the UK were shown in the preliminary assessment to be below the lower assessment threshold thereby negating the need for further modelling (although limited measurement and emission inventory data compilation still continue).

Annual air quality assessments for benzene and carbon monoxide, as required for the Second Daughter Directive, started in 2003. Monitoring and modelling data were available before this date so that estimates of pollution distributions can be provided for years before 2003. For carbon monoxide, model estimates can be provided for 2001 to 2004. For benzene, modelled estimates can be provided for 2001, 2003 and 2004.

Annual air quality assessments for ozone started in 2004, as required for the Third Daughter Directive.

Table 2-3 summarises the modelling data that were available as a result of the annual air assessments carried out for the Framework and Daughter Directives.

Table 2-3: A summary of modelling data available for the preliminary assessment of the CAFE Directive

Pollutant	Model year available	Used in annual air quality assessment	Modelling described respective report
SO ₂	2001	Yes	Stedman <i>et al.</i> , (2002)
	2002	Yes	Stedman <i>et al.</i> , (2003)
	2003	Yes	Stedman <i>et al.</i> , (2005)
	2004	Yes	Stedman <i>et al.</i> , (2006)
NO ₂	2001	Yes	Stedman <i>et al.</i> , (2002)
	2002	Yes	Stedman <i>et al.</i> , (2003)
	2003	Yes	Stedman <i>et al.</i> , (2005)
	2004	Yes	Stedman <i>et al.</i> , (2006)
NO _x ,	2001	Yes	Stedman <i>et al.</i> , (2002)
	2002	Yes	Stedman <i>et al.</i> , (2003)
	2003	Yes	Stedman <i>et al.</i> , (2005)
	2004	Yes	Stedman <i>et al.</i> , (2006)
PM ₁₀	2001	Yes	Stedman <i>et al.</i> , (2002)
	2002	Yes	Stedman <i>et al.</i> , (2003)
	2003	Yes	Stedman <i>et al.</i> , (2005)
	2004	Yes	Stedman <i>et al.</i> , (2006)
PM _{2.5}	No modelling data available in 2006		
Lead	2001	< LAT	Stedman <i>et al.</i> , (2002)
	2002	< LAT	Stedman <i>et al.</i> , (2003)
	2003	< LAT	Stedman <i>et al.</i> , (2005)
	2004	< LAT	Stedman <i>et al.</i> , (2006)
Benzene	2001	Yes	Used same modelling method as for 2003 and 2004 air quality assessment report
	2002	No	No modelled values
	2003	Yes	Stedman <i>et al.</i> , (2005)
	2004	Yes	Stedman <i>et al.</i> , (2006)
CO	2001	Yes	Used same modelling method as for 2003 and 2004 air quality assessment report
	2002	Yes	Used same modelling method as for 2003 and 2004 air quality assessment report
	2003	Yes	Stedman <i>et al.</i> , (2005)
	2004	Yes	Stedman <i>et al.</i> , (2006)
Ozone	2002-2004 (target value) 2004 (long term objective)	Yes	Bush <i>et al.</i> , (2006)

2.2 Sampling Criteria

By the time the first draft of the preliminary assessment for the CAFE Directive was carried out in 2006, the United Kingdom's national monitoring networks were compliant with the requirements of the pre-existing EU air quality directives. The CAFE Directive brought together the siting criteria and minimum sampling requirements for each pollutant. Article 7 discusses sampling points for:

- sulphur dioxide,
- nitrogen dioxide,
- oxides of nitrogen,
- PM₁₀,
- PM_{2.5},
- lead,
- benzene
- carbon monoxide.

Annex V of the CAFE Directive prescribes the number of required sites for each of these pollutants (see Table 2-4 below). The number of sites required is dependent upon observed concentrations, the population within each zone/agglomeration and whether supplementary data such as modelling data are available. As indicated previously, where supplementary data are available the number of monitoring stations can be reduced by up to 50 % provided the following conditions are met (see also Article 7, Paragraph 3 of the CAFE Directive):

- a) the supplementary methods provide sufficient information for the assessment of air quality with regard to limit values or alert thresholds, as well as adequate information for the public;
- b) the number of sampling points to be installed and the spatial resolution of other techniques are sufficient for the concentration of the relevant pollutant to be established in accordance with the data quality objectives specified in Section A of Annex I of the CAFE Directive and enable assessment results to meet the criteria specified in Section B of Annex I of the CAFE Directive.

Article 10 discusses sampling points for ozone, with Annex IX of the CAFE Directive providing guidance on the number of sites required, summarised in Table 2-5 below. As for the other pollutants the number of sampling sites can be reduced if the following conditions are met (see also Article 10, Paragraph 3 of the CAFE Directive):

- a) the supplementary methods provide sufficient information for the assessment of air quality with regard to target values, long-term objectives, information and alert thresholds;
- b) the number of sampling points to be installed and the spatial resolution of other techniques are sufficient for the concentration of ozone to be established in accordance with the data quality objectives specified in Section A of Annex I and enable assessment results to meet the criteria specified in Section B of Annex I;
- c) the number of sampling points in each zone or agglomeration amounts to at least one sampling point per two million inhabitants or one sampling point per 50 000 km², whichever produces the greater number of sampling points, but must not be less than one sampling point in each zone or agglomeration;
- d) nitrogen dioxide is measured at all remaining sampling points except at rural background stations as referred to in Section A of Annex VIII.

Table 2-4 presents the criteria for assessment of diffuse sources of each pollutant (as defined within Annex V of the CAFE Directive).

Table 2-4: Criteria for determining the minimum of sampling points for fixed measurement of SO₂, NO₂, PM, lead, benzene and carbon monoxide (from Annex V, Section A.1) (note number of sampling points will be reduced when Article 7 is applied see Table 2-6 below)

Population of zone or agglomeration (1000s)	If maximum concentrations exceed the upper assessment threshold ⁽¹⁾		If maximum concentrations are between the upper and lower assessment thresholds	
	Pollutants except PM	PM ⁽²⁾ (sum of PM ₁₀ and PM _{2.5})	Pollutants except PM	PM ⁽²⁾ (sum of PM ₁₀ and PM _{2.5})
0-249	1	2	1	1
250-499	2	3	1	2
500-749	2	3	1	2
750-999	3	4	1	2
1000-1499	4	6	2	3
1500-1999	5	7	2	3
2000-2749	6	8	3	4
2750-3749	7	10	3	4
3750-4749	8	11	3	6
4750-5999	9	13	4	6
≥ 6000	10	15	4	7

⁽¹⁾ For nitrogen dioxide, particulate matter, benzene and carbon monoxide: to include at least one urban background monitoring station and one traffic-orientated station provided this does not increase the number of sampling points. For these pollutants, the total number of urban-background stations and the total number of traffic oriented stations in a Member State required under Section A(1) shall not differ by more than a factor of 2. Sampling points with exceedances of the limit value for PM₁₀ within the last three years shall be maintained, unless a relocation is necessary owing to special circumstances, in particular spatial development.

⁽²⁾ Where PM_{2.5} and PM₁₀ are measured in accordance with Article 8 at the same monitoring station, these shall count as two separate sampling points. The total number of PM_{2.5} and PM₁₀ sampling points in a Member State required under Section A(1) shall not differ by more than a factor of 2, and the number of PM_{2.5} sampling points in the urban background of agglomerations and urban areas shall meet the requirements under Section B of Annex V.

Further guidance on how to assess the impact on ambient concentrations from emissions arising from point sources is given by Section A-2 of Annex V of the CAFE Directive, also below.

Section A, 2 Annex V

For the assessment of pollution in the vicinity of point sources, the number of sampling points for fixed measurement shall be calculated taking into account emission densities, the likely distribution patterns of ambient-air pollution and the potential exposure of the population.

In summary, the required number of sampling sites to assess ambient concentrations from emissions arising from point sources shall be based on knowledge of the existing pollution footprint from the emission source.

Table 2-5 present the criteria for ozone assessment for diffuse sources (as defined within Annex IX of the CAFE Directive).

Table 2-5: Minimum number of sampling points for fixed continuous measurements to assess compliance for ozone with target values, long-term objectives and information and alert thresholds where such measurements are the sole source of information (from Annex IX Section A)

(1000s)	Agglomerations (urban and suburban) ⁽¹⁾	Other zones (suburban and rural) ⁽¹⁾	Rural background
< 250		1	1 station 50000 km ² as an average density over all zones per country ⁽²⁾
< 500	1	2	
< 1000	2	2	
< 1500	3	3	
< 2000	3	4	
< 2750	4	5	
< 3750	5	6	
> 3750	One additional station per 2 million inhabitants	One additional station per 2 million inhabitants	

⁽¹⁾ At least 1 station in suburban areas, where the highest exposure of the population is likely to occur. In agglomerations at least 50 % of the stations shall be located in suburban areas.

⁽²⁾ 1 station per 25 000 km² for complex terrain is recommended.

Section B, Annex IX of the CAFE Directive further considers the minimum number of sampling points for ozone in zones and agglomerations attaining the long-term objectives and with supplementary assessment data. Section B is reproduced below:

Section B, Annex IX

The number of sampling points for ozone shall, in combination with other means of supplementary assessment such as air quality modelling and collocated nitrogen dioxide measurements, be sufficient to examine the trend of ozone pollution and check compliance with the long-term objectives. The number of stations located in agglomerations and other zones may be reduced to one-third of the number specified in Section A. Where information from fixed measurement stations is the sole source of information, at least one monitoring station shall be kept. If, in zones where there is supplementary assessment, the result of this is that a zone has no remaining station, coordination with the number of stations in neighbouring zones shall ensure adequate assessment of ozone concentrations against long-term objectives. The number of rural background stations shall be one per 100 000 km².

The impact of Section B, Annex IX for the United Kingdom can then be summarised as:

- The number of ozone monitoring can be reduced to one-third if other supplementary data are available.
- The number of rural ozone monitoring stations must not be less than 1 per 100,000 km².
-

2.3 Minimum number of fixed monitoring sites

Table 2-6 presents the minimum number of fixed monitoring sites based on population, exceedance status and availability or otherwise of supplementary assessment techniques.

Table 2-6: Minimum sampling frequency based on population for SO₂, NO₂, NO_x, PM₁₀, PM_{2.5}, lead, benzene and CO (based on criteria in Article 7 and Annex V)									
Agglomeration or zone	Population	No supplementary information				Supplementary information available			
		>UAT		LAT_UAT		>UAT		LAT_UAT	
		not-PM	PM	not-PM	PM	not-PM	PM	not-PM	PM
Greater London Urban Area	8278251	10	15	4	7	5	8	2	4
West Midlands Urban Area	2284093	6	8	3	4	3	4	2	2
Greater Manchester Urban Area	2244931	6	8	3	4	3	4	2	2
West Yorkshire Urban Area	1499465	4	6	2	3	2	3	1	2
Tyneside	879996	3	4	1	2	2	2	1	1
Liverpool Urban Area	816216	3	4	1	2	2	2	1	1
Sheffield Urban Area	640720	2	3	1	2	1	2	1	1
Nottingham Urban Area	666358	2	3	1	2	1	2	1	1
Bristol Urban Area	551066	2	3	1	2	1	2	1	1
Brighton/Worthing/Littlehampton	461181	2	3	1	2	1	2	1	1
Leicester Urban Area	441213	2	3	1	2	1	2	1	1
Portsmouth Urban Area	442252	2	3	1	2	1	2	1	1
Teesside Urban Area	365323	2	3	1	2	1	2	1	1
The Potteries	362403	2	3	1	2	1	2	1	1
Bournemouth Urban Area	383713	2	3	1	2	1	2	1	1
Reading/Wokingham Urban Area	369804	2	3	1	2	1	2	1	1
Coventry/Bedworth	336452	2	3	1	2	1	2	1	1
Kingston upon Hull	301416	2	3	1	2	1	2	1	1
Southampton Urban Area	304400	2	3	1	2	1	2	1	1
Birkenhead Urban Area	319675	2	3	1	2	1	2	1	1
Southend Urban Area	269415	2	3	1	2	1	2	1	1
Blackpool Urban Area	261088	2	3	1	2	1	2	1	1
Preston Urban Area	264601	2	3	1	2	1	2	1	1
Glasgow Urban Area	1168270	4	6	2	3	2	3	1	2
Edinburgh Urban Area	452194	2	3	1	2	1	2	1	1
Cardiff Urban Area	327706	2	3	1	2	1	2	1	1
Swansea Urban Area	270506	2	3	1	2	1	2	1	1
Belfast Urban Area	580276	2	3	1	2	1	2	1	1
Eastern	5124072	9	13	4	6	5	7	2	3
South West	3980991	8	11	3	6	4	6	2	3
South East	6392004	10	15	4	7	5	8	2	4
East Midlands	3084598	7	10	3	4	4	5	2	2
North West & Merseyside	2826622	7	10	3	4	4	5	2	2
Yorkshire & Humberside	2514947	6	8	3	4	3	4	2	2
West Midlands	2271650	6	8	3	4	3	4	2	2
North East	1269803	4	6	2	3	2	3	1	2
Central Scotland	1813314	5	7	2	3	3	4	1	2
North East Scotland	1001499	4	6	2	3	2	3	1	2
Highland	380062	2	3	1	2	1	2	1	1
Scottish Borders	254690	2	3	1	2	1	2	1	1
South Wales	1578773	5	7	2	3	3	4	1	2
North Wales	720022	2	3	1	2	1	2	1	1
Northern Ireland	1104991	4	6	2	3	2	3	1	2

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Table 2-7 presents the minimum sampling requirements for ozone, assuming a co-location of NO_x and Ozone analysers at least 50% of monitoring stations (see Article 10, Paragraph 4 of the CAFE Directive).

Table 2-7: Minimum sampling frequency based on population for ozone (Based on criteria in Article 10 and Annex IX)		
Zone/Agglomeration	Population 2001	Number of sites
Greater London Urban Area	8278251	4
West Midlands Urban Area	2284093	2
Greater Manchester Urban Area	2244931	2
West Yorkshire Urban Area	1499465	1
Tyneside	879996	1
Liverpool Urban Area	816216	1
Sheffield Urban Area	640720	1
Nottingham Urban Area	666358	1
Bristol Urban Area	551066	1
Brighton/Worthing/Littlehampton	461181	1
Leicester Urban Area	441213	1
Portsmouth Urban Area	442252	1
Teesside Urban Area	365323	1
The Potteries	362403	1
Bournemouth Urban Area	383713	1
Reading/Wokingham Urban Area	369804	1
Coventry/Bedworth	336452	1
Kingston upon Hull	301416	1
Southampton Urban Area	304400	1
Birkenhead Urban Area	319675	1
Southend Urban Area	269415	1
Blackpool Urban Area	261088	1
Preston Urban Area	264601	1
Glasgow Urban Area	1168270	1
Edinburgh Urban Area	452194	1
Cardiff Urban Area	327706	1
Swansea Urban Area	270506	1
Belfast Urban Area	580276	1
Eastern	5124072	3
South West	3980991	2
South East	6392004	2
East Midlands	3084598	2
North West & Merseyside	2826622	2
Yorkshire & Humberside	2514947	2
West Midlands	2271650	2
North East	1269803	1
Central Scotland	1813314	1
North East Scotland	1001499	1
Highland	380062	1
Scottish Borders	254690	1
South Wales	1578773	1
North Wales	720022	1
Northern Ireland	1104991	1
		56

3 Sulphur Dioxide

Sulphur dioxide monitoring using automatic instrumentation began in the 1970's. The number of sampling sites increased during the 1990's with a more formalised network established following the preliminary assessment required for the First Daughter Directive (Bush, 2000).

The assessment thresholds for sulphur dioxide which have been used to determine the exceedance status of each zone in the UK are presented in Table 3-1.

Assessment threshold	Health Protection	Vegetation Protection
Upper Assessment Threshold (UAT)	60 % of 24-hour limit value (75 $\mu\text{g m}^{-3}$ not to be exceeded more than 3 times in any calendar year)	60 % of winter critical level (12 $\mu\text{g m}^{-3}$)
Lower Assessment Threshold (LAT)	40 % of 24-hour limit value (50 $\mu\text{g m}^{-3}$ not to be exceeded more than 3 times in any calendar year)	40 % of winter critical level (8 $\mu\text{g m}^{-3}$)

Note, for protection of vegetation:

if the maximum concentrations exceeded the upper assessment threshold then one monitoring station is required every 20,000 km^2

if the maximum concentrations exceeded the lower assessment threshold then one monitoring station is required every 40,000 km^2 .

3.1 Supplementary assessment data

The supplementary data provided for the preliminary assessment provides sufficient information for assessment of air quality with regards to limit values. Using the data quality objectives (DQO) provided in Annex I, the modelled concentration estimates are shown to fall within the required DQO specification. The supplementary data consists of a modelling methodology (the PCM model) developed to provide a more comprehensive geographical representation of sulphur dioxide concentrations throughout the country (see Abbott and Vincent (1999) and Abbott and Vincent (2006)).

3.1.1 Model description

The annual assessment of air quality for the First Daughter Directive 1999/30/EC generated maps of annual mean, winter mean, 99.73 percentile of hourly mean and 99.18 percentile of daily mean SO_2 concentrations for each year from 2001 to 2004.

Emissions from point and area sources were modelled separately and the resultant concentrations outputs were combined within a geographical information system. Emissions from large sources, such as power stations, were based upon data obtained from the Environment Agency's Pollution Inventory. Emissions from smaller point sources (< 500 tonnes) were modelled using the "small point source model". For the large point emission sources, concentrations are predicted for 5 km x 5 km receptors within a number of receptor areas (or tiles), which together covered the UK. The size of the receptor areas was typically 100 km x 100 km, extending out to 150 km where appropriate. All sources within the receptor area and extending out 100 km from the square's border were assumed to influence concentrations within the receptor area. Emissions were modelled using sequential meteorological data for Waddington in Lincolnshire. This site was chosen as the most representative of meteorology in the vicinity of the largest point sources in the UK. This approach ensures that the combined impact of several sources on ambient high percentile concentrations is estimated correctly. The contribution

to ambient SO₂ concentrations from area sources was calculated using a dispersion kernel approach. Concentrations are predicted for 1 km x 1 km receptors.

The map of winter mean SO₂ concentrations was derived from the annual mean map using a factor derived from the average concentration measured at rural SO₂ monitoring sites during each respective winter period and each annual mean concentration. Further details on the modelling process can be found in the reports shown in column four of Table 2-3. An updated description of the modelling process can be found in the most recent annual assessment report (Grice *et al.*, 2009).

3.1.2 Geographical distribution of sulphur dioxide concentrations

Figure 3.1a and 3.1b shows maps of 99.18 percentile of daily mean and winter mean sulphur dioxide concentrations from 2004 and 2002/2003, respectively. Daily concentrations above the LAT (50 µg m⁻³) can be seen at Bedfordshire, around Stewartby Brick works, and around the oil refinery near Southampton.

The area to which the winter mean applies was calculated by removing non-vegetation areas from the background SO₂ map and calculating a zonal mean of 1 km² grid squares within a 30 km² grid overlay. Mean concentrations on a 30 km² grid have been used to approximate the representivity of concentrations over a 1000 km² area as specified in Directive 1999/30/EC for monitoring sites used to assess concentrations for the ecosystems and vegetation limit values.

Figure 3.1: Example maps of SO₂ concentrations from the period 2001 to 2004.

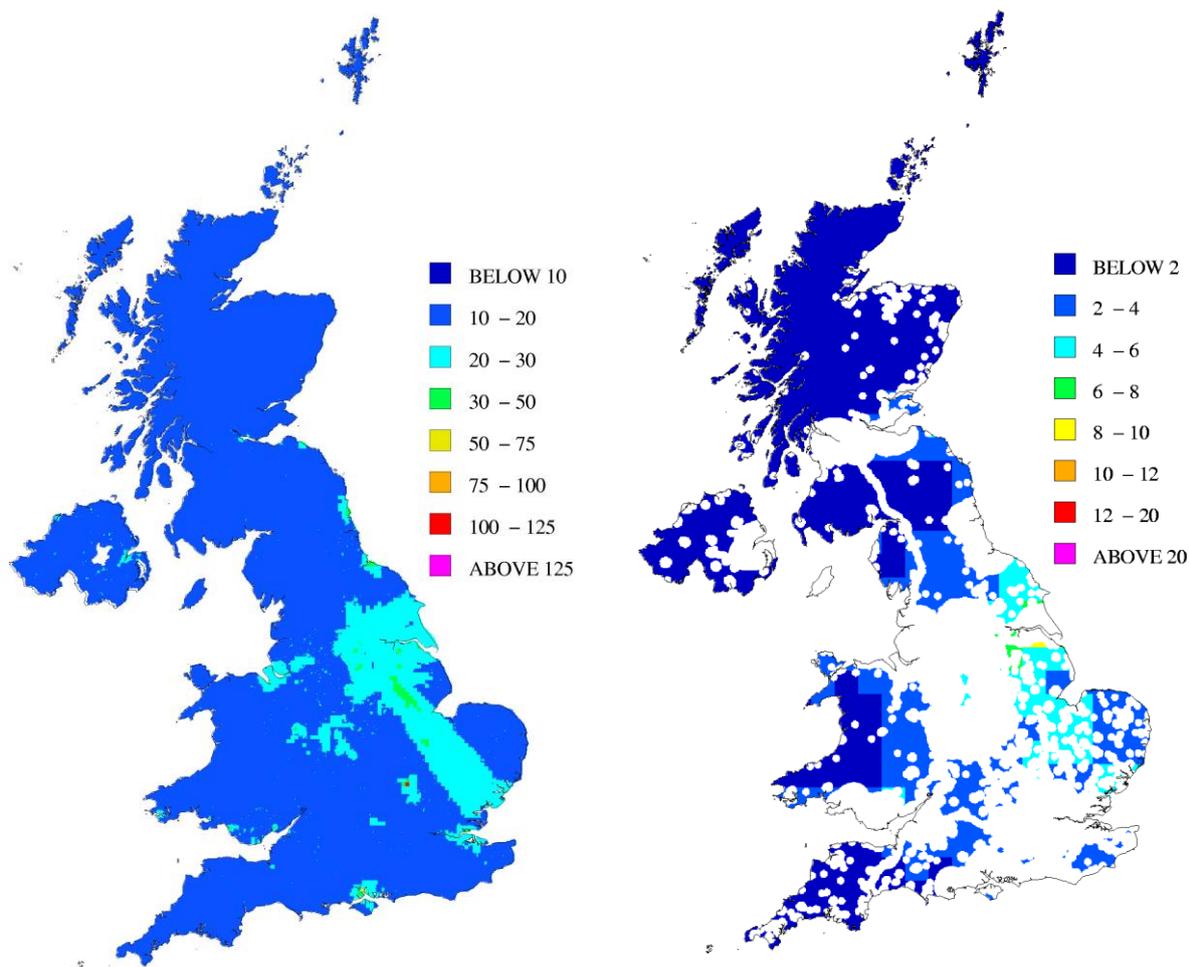


Figure 3.1a: 99.18 percentile of daily SO₂ concentrations ($\mu\text{g m}^{-3}$) in 2004

Figure 3.1b: Winter mean SO₂ concentrations ($\mu\text{g m}^{-3}$) in 2002/2003

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3.2 Number of monitoring sites required for protection of human health

The measurements and modelling of ambient sulphur dioxide concentrations commissioned for compliance with the Framework and Daughter Directives have provided a baseline of data on which to base this preliminary assessment.

The exceedance status of each zone has been determined in accordance with the protocol set out in section 2 and based on guidance provided by the Directive. Table 3-2 summarises the exceedance status of each zone and agglomeration. Precedence is given to measured data as this is viewed as having lower uncertainty than modelled datasets. Modelled exceedances have only been declared where these are predicted to be higher than those based on measured data. Only one zone agglomeration (Belfast Urban Area) was shown to exceed the upper assessment threshold (UAT) based on the measured concentration. Two zones showed exceedance of the lower assessment threshold (LAT).

Table 3-3 presents the minimum number of sampling sites required in each zone based on the exceedance status of each zone presented in Table 3-2 and availability of both measurement and supplementary data. Altogether, 15 sampling sites are required in the UK to meet the minimum monitoring obligations for the CAFE Directive. Also presented is the number of pre-existing background and roadside sites measuring sulphur dioxide prior to the reconfiguration/optimisation of the network for CAFE. These are presented alongside the final optimised CAFE network showing the

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breakdown of the network composition in terms of station type (e.g. traffic, background urban, background rural and industrial urban). The total number of sampling sites currently operating in the AURN exceeds the minimum CAFE requirement by a factor of three.

Table 3-4 presents the stations measuring sulphur dioxide in 2010. The table provides the following information regarding the sulphur dioxide sampling sites in each zone:

- Zone/Agglomeration
- Population (2001)
- Exceedance classification
- No of sites required per Annex V (monitoring data only)
- No of sites required when Article 7 is applied (monitoring data and supplementary information)
- Site Name
- Start date for SO₂ sampling
- UK Classification
- EU classification: type_of_station
- EU classification station_type_of_area
- Number of traffic or urban sites
- Number of background urban sites
- Number of background rural sites
- Number of industrial urban sites
- Total number of sites currently in operation
- Does number of sites within zone meet CAFE requirements? (Yes/No)

Table 3-3 and Table 3-4 show that the United Kingdom is compliant with the monitoring provision for sulphur dioxide when supplementary data are available (in accordance with Article 7, Paragraph 3 of the CAFE Directive). Indeed as indicated earlier in this section, the number of sites monitoring sulphur dioxide is larger than the minimum specified. This is because many of the sites form long-term running data sets that are useful for policy evaluation purposes.

There are 44 sites currently measuring sulphur dioxide. One site is due to be commissioned at Whittlesey near Peterborough. This site is required due to the proposed increase in brick production at the Whittlesey brickworks following the closure of the brickworks at Stewartby. The site is a direct replacement for the Stewartby monitoring station and is currently classified as an urban background location – the site classification may change.

There are four sites located in industrial zones (Port Talbot Margam, Middlesbrough, Salford Eccles and Scunthorpe Town). These were required since the sites are located near major sulphur dioxide emission sources that could lead to exceedances of a limit value.

Table 3-2: Summary of comparison of measured and modelled sulphur dioxide concentration with assessment thresholds for the period 2000 to 2004 (for protection of health)

Zone or agglomeration	Number of years monitoring data are available	Years threshold is exceeded		Threshold classification based on measurement only	Modelled exceedance if higher than measured threshold
		LAT	UAT		
Greater London Urban Area	5	1	0	<LAT	
West Midlands Urban Area	5	1	0	<LAT	
Greater Manchester Urban Area	5	3	0	LAT-UAT	
West Yorkshire Urban Area	5	2	0	<LAT	
Tyneside	5	0	0	<LAT	
Liverpool Urban Area	1	0	0	n/a	<LAT
Sheffield Urban Area	5	0	0	<LAT	
Nottingham Urban Area	5	1	0	<LAT	
Bristol Urban Area	5	0	0	<LAT	
Brighton/Worthing/Littlehampton	4	0	0	<LAT	
Leicester Urban Area	5	0	0	<LAT	
Portsmouth Urban Area	4	0	0	<LAT	
Teesside Urban Area	5	1	0	<LAT	LAT-UAT
The Potteries	5	0	0	<LAT	
Bournemouth Urban Area	4	0	0	<LAT	
Reading/Wokingham Urban Area	1	0	0	n/a	<LAT
Coventry/Bedworth	4	0	0	<LAT	
Kingston upon Hull	2	0	0	n/a	<LAT
Southampton Urban Area	4	0	0	<LAT	
Birkenhead Urban Area	4	0	0	<LAT	
Southend Urban Area	4	0	0	<LAT	
Blackpool Urban Area	2	1	0	n/a	<LAT
Preston Urban Area	4	0	0	<LAT	
Glasgow Urban Area	5	0	0	<LAT	
Edinburgh Urban Area	1	0	0	n/a	<LAT
Cardiff Urban Area	5	0	0	<LAT	
Swansea Urban Area	5	0	0	<LAT	
Belfast Urban Area	5	3	2	>UAT	
Eastern	5	0	0	<LAT	LAT-UAT
South West	5	0	0	<LAT	
South East	5	1	0	<LAT	LAT-UAT
East Midlands	5	0	0	<LAT	LAT-UAT
North West & Merseyside	3	0	0	<LAT	
Yorkshire & Humberside	5	4	0	LAT-UAT	
West Midlands	5	0	0	<LAT	
North East	4	0	0	<LAT	LAT-UAT
Central Scotland	3	2	0	<LAT	
North East Scotland	4	0	0	<LAT	
Highland	0	0	0	n/a	<LAT
Scottish Borders	0	0	0	n/a	<LAT
South Wales	4	0	0	<LAT	
North Wales	2	0	0	n/a	LAT-UAT
Northern Ireland	5	0	0	<LAT	LAT-UAT

Note: '0' indicates that there was no measured exceedance of the LAT.

'n/a' indicates that data were not available.

Table 3-3: A comparison of the minimum number of sampling sites for sulphur dioxide required by the CAFE Directive and number of sampling sites before and after the preliminary assessment

Zone code	Zone/Agglomeration	Minimum number of sites based on supplementary data	Number of sites before preliminary assessment		Number of sites after preliminary assessment from 2010					
			Background sites	Roadside sites	Traffic Urban	Backg round Urban	Backg round Rural	Indust rial Urban	Total Number of Sites in AURN	
1	Greater London Urban Area	0	10	3	2	4	0	0	6	
2	West Midlands Urban Area	0	4	0	0	2	0	0	2	
3	Greater Manchester Urban Area	2	6	1	0	1	0	1	2	
4	West Yorkshire Urban Area	0	2	0	0	1	0	0	1	
5	Tyneside	0	1	0	0	1	0	0	1	
6	Liverpool Urban Area	0	1	0	0	1	0	0	1	
7	Sheffield Urban Area	0	2	0	0	1	0	0	1	
8	Nottingham Urban Area	0	1	0	0	1	0	0	1	
9	Bristol Urban Area	0	1	0	0	1	0	0	1	
10	Brighton/Worthing/Littlehampton	0	1	1	0	0	0	0	0	
11	Leicester Urban Area	0	1	0	0	1	0	0	1	
12	Portsmouth Urban Area	0	1	0	0	0	0	0	0	
13	Teesside Urban Area	1	2	0	0	1	0	0	1	
14	The Potteries	0	1	0	0	0	0	0	0	
15	Bournemouth Urban Area	0	1	0	0	0	0	0	0	
16	Reading/Wokingham Urban Area	0	1	0	0	0	0	0	0	
17	Coventry/Bedworth	0	1	0	0	0	0	0	0	
18	Kingston upon Hull	0	1	0	0	1	0	0	1	
19	Southampton Urban Area	0	1	0	0	1	0	0	1	
20	Birkenhead Urban Area	0	1	0	0	0	0	0	0	
21	Southend Urban Area	0	1	0	0	0	0	0	0	
22	Blackpool Urban Area	0	1	0	0	0	0	0	0	
23	Preston Urban Area	0	1	0	0	0	0	0	0	
24	Glasgow Urban Area	0	1	0	0	1	0	0	1	
25	Edinburgh Urban Area	0	1	0	0	1	0	0	1	
26	Cardiff Urban Area	0	1	0	0	1	0	0	1	
27	Swansea Urban Area	0	2	0	0	0	0	1	1	
28	Belfast Urban Area	1	2	0	0	1	0	0	1	
29	Eastern	2	2	0	1	2	1	0	4	
30	South West	0	2	1	0	0	0	0	0	
31	South East	2	1	1	0	0	3	0	3	
32	East Midlands	2	1	0	0	1	1	0	2	
33	North West & Merseyside	0	1	0	0	0	0	0	0	
34	Yorkshire & Humberside	2	3	0	0	2	0	1	3	
35	West Midlands	0	1	0	0	2	0	0	2	
36	North East	1	1	0	0	1	0	0	1	
37	Central Scotland	0	1	0	0	0	0	1	1	
38	North East Scotland	0	1	0	0	0	0	0	0	
39	Highland	0	0	0	0	0	0	0	0	
40	Scottish Borders	0	0	0	0	0	0	0	0	
41	South Wales	0	1	0	0	0	1	0	1	
42	North Wales	1	1	1	1	0	0	0	1	
43	Northern Ireland	1	1	0	0	2	0	0	2	
	TOTALS	15	67	8	4	31	7	3	45	

Table 3-4: Detailed description of sulphur dioxide sampling sites in each zone and agglomeration in 2010

Zone/Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start_SO2	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic Urban background urban	Background rural	industrial urban	total	Sites in AURN to meet requirement		
Greater London Urban Area	8278251	1	0	0	London Bexley	01/05/1994	SUBURBAN	Background	suburban	2	4	0	0	6	Y	
					London Bloomsbury	23/01/1992	URBAN CENTRE	Background	urban							
					London Cromwell Road 2	20/05/1998	ROADSIDE	Traffic	urban							
					London Marylebone Road	17/07/1997	KERBSIDE	Traffic	urban							
					London N. Kensington	01/04/1996	URBAN BACKGROUND	Background	urban							
					London Westminster	17/07/2001	URBAN BACKGROUND	Background	urban							
West Midlands Urban Area	2284093	1	0	0	Birmingham Tyburn	16/08/2004	URBAN BACKGROUND	Background	urban	0	2	0	0	2	Y	
					Sandwell West Bromwich	04/11/1998	URBAN BACKGROUND	Background	urban							
Greater Manchester Urban Area	2244931	2	3	2	Manchester Piccadilly	18/12/1995	URBAN CENTRE	Background	urban	0	1	0	1	2	Y	
					Salford Eccles	20/03/1997	URBAN INDUSTRIAL	Industrial	urban							
West Yorkshire Urban Area	1499465	1	0	0	Leeds Centre	04/01/1993	URBAN CENTRE	Background	urban	0	1	0	0	1	Y	
Tyneside	879996	1	0	0	Newcastle Centre	08/03/1992	URBAN CENTRE	Background	urban	0	1	0	0	1	Y	
Liverpool Urban Area	816216	1	0	0	Liverpool Speke	21/05/2003	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y	
Sheffield Urban Area	640720	1	0	0	Sheffield Centre	22/12/1995	URBAN CENTRE	Background	urban	0	1	0	0	1	Y	
Nottingham Urban Area	666358	1	0	0	Nottingham Centre	02/09/1996	URBAN CENTRE	Background	urban	0	1	0	0	1	Y	
Birstol Urban Area	551066	1	0	0	Bristol St Paul's	15/06/2006	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y	
Brighton/ Worthing/ Littlehampton	461181	1	0	0						0	0	0	0	0		

Zone/Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start_SO2	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic background	Urban background urban	Background rural	industrial urban	total	Sites in AURN to meet requirement
Leicester Urban Area	441213	1	0	0	Leicester Centre	04/01/1994	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Portsmouth Urban Area	442252	1	0	0						0	0	0	0	0	Y
Teeside Urban Area	365323	2	1	1	Middlesbrough	21/04/1995	URBAN INDUSTRIAL	Industrial	urban	0	1	0	0	1	Y
The Potteries	362403	1	0	0						0	0	0	0	0	Y
Bournemouth Urban Area	383713	1	0	0						0	0	0	0	0	Y
Reading/ Wokingham Urban Area	369804	1	0	0						0	0	0	0	0	Y
Coventry/ Bedworth	336452	1	0	0						0	0	0	0	0	Y
Kingston Upon Hull	301416	1	0	0	Hull Freetown	06/11/2002	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Southampton Urban Area	304400	1	0	0	Southampton Centre	04/01/1994	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Birkenhead Urban Area	319675	1	0	0						0	0	0	0	0	Y
Southend Urban Area	269415	1	0	0						0	0	0	0	0	Y
Blackpool Urban Area	261088	1	0	0						0	0	0	0	0	Y
Preston Urban Area	264601	1	0	0						0	0	0	0	0	Y
Glasgow Urban Area	1168270	1	0	0	Glasgow Centre	26/07/1996	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Edinburgh Urban Area	452194	1	0	0	Edinburgh St Leonards	24/11/2003	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y

Zone/Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start_SO2	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic background	Urban background urban	Background rural	industrial urban	total	Sites in AURN to meet requirement
Cardiff Urban Area	327706	1	0	0	Cardiff Centre	12/05/1992	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Swansea Urban Area	270506	1	0	0	Port Talbot Margam	24/07/2007	URBAN INDUSTRIAL	Industrial	urban	0	0	0	1	1	Y
Belfast Urban Area	580276	3	2	1	Belfast Centre	08/03/1992	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Eastern	5124072	2	4	2	Stanford-le-Hope Roadside	22/01/2008	ROADSIDE	Traffic	urban	1	2	1	0	4	Y
					Thurrock	01/09/1996	URBAN BACKGROUND	Background	urban						
					Wicken Fen	12/11/1997	RURAL	Background	rural						
					Whittlesey	Not started	Awaits classification	Background	urban						
South West	3980991	1	0	0						0	0	0	0	0	Y
South East	6392004	2	4	2	Harwell	11/09/1995	RURAL	Background	rural	0	0	3	0	3	Y
					Lullington Heath	16/03/1988	RURAL	Background	rural						
					Rochester Stoke	26/01/1996	RURAL	Background	rural						
East Midlands	3084598	2	3	2	Ladybower	07/08/1988	RURAL	Background	rural	0	1	1	0	2	Y
					Northampton	12/02/2001	URBAN BACKGROUND	Background	urban						
North West & Merseyside	2826622	1	0	0						0	0	0	0	0	
Yorkshire & Humberside	2514947	2	3	2	Barnsley 12	21/03/1994	URBAN BACKGROUND	Background	urban	0	2	0	1	3	Y
					Barnsley Gawber	07/07/1997	URBAN BACKGROUND	Background	urban						
					Scunthorpe Town	06/06/2004	URBAN INDUSTRIAL	Industrial	urban						
West Midlands	2271650	1	0	0	Leamington Spa	26/07/1996	URBAN BACKGROUND	Background	urban	0	2	0	0	2	Y
					Leominster	06/02/2008	SUBURBAN	Background	suburban						
North East	1269803	2	2	1	Sunderland Silksworth	01/04/2008	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y

Zone/Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start_SO2	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic Urban background urban	Background rural	industrial urban	total	Sites in AURN to meet requirement	
Central Scotland	1813314	1	0	0	Grangemouth	01/01/2001	URBAN INDUSTRIAL	Industrial	urban	0	0	0	1	1	Y
North East Scotland	1001499	1	0	0						0	0	0	0	0	Y
Highlands	380062	1	0	0						0	0	0	0	0	Y
Scottish Borders	254690	1	0	0						0	0	0	0	0	Y
South Wales	1578773	1	0	0	Narberth	20/01/1997	REMOTE	Background	rural	0	0	1	0	1	Y
North Wales	720022	2	1	1	Wrexham	06/03/2002	ROADSIDE	Traffic	urban	1	0	0	0	1	Y
Northern Ireland	1104991	2	2	1	Derry Ballymena	29/04/1997 01/01/2010	URBAN BACKGROUND Awaits classification	Background Background	urban urban	0 0	2 2	0 0	0 0	2 2	Y Y
TOTAL				15						4	31	7	3	45	

*1, 2, 3 are used to indicate the respective assessment thresholds, where:

1 = <LAT
2 = LAT - UAT
3 => UAT

3.3 Number of monitoring sites required for protection of vegetation

The measurements and modelling of ambient sulphur dioxide concentrations for the protection of vegetation commissioned for compliance with the Framework and Daughter Directives have provided a baseline of data on which to base this preliminary assessment.

The exceedance status of each zone has been determined in accordance with the protocol set out in Section 2 and based on guidance provided by the Directive. For the protection of vegetation metric, exceedance statistics based on winter mean sulphur dioxide concentrations have been calculated using contiguous winter months commencing in the calendar years 2000 to 2004 (i.e. winter periods in 2000/2001, 2001/2002, 2002/2003 to 2003/2004).

Table 3-5 summarises which exceedance thresholds have been assigned to each zone. The generic definition provided Annex III B paragraph of areas protected by the vegetation and ecosystem limit values excludes locations which are within 20 km of agglomerations and 5 km of motorways, other urban areas or industrial plant. This definition is reflected in Table 3-5, where exceedances for stations and modelled data within such areas have been excluded from our assessment. .

For areas of zones protected by vegetation and ecosystem limit values, there are no measured or modelled concentrations above the lower or upper assessment thresholds; hence, there is no requirement for the United Kingdom to monitor to assess compliance with the critical level. However, for the purposes of providing data for public information, modelling and research, continuous monitoring continues at a small number of rural sites. In 2010, there are six sulphur dioxide monitoring sites in rural locations. These are located at:

- Narbeth (Wales);
- Harwell (England);
- Ladybower (England);
- Lullington Heath (England);
- Rochester (England);
- Wicken Fen (England).

Table 3.5: A comparison of measured and modelled concentration with assessment thresholds for winter mean sulphur dioxide for the period 2000/2001 to 2003/2004- for vegetation protection

Zone or agglomeration	Number of winter periods monitoring available	Number of years threshold was exceeded		Threshold classification based on measurement only	Modelled exceedance if higher than measured threshold
		LAT	UAT		
Greater London Urban Area	n/a			n/a	
West Midlands Urban Area	n/a			n/a	
Greater Manchester Urban Area	n/a			n/a	
West Yorkshire Urban Area	n/a			n/a	
Tyneside	n/a			n/a	
Liverpool Urban Area	n/a			n/a	
Sheffield Urban Area	n/a			n/a	
Nottingham Urban Area	n/a			n/a	
Bristol Urban Area	n/a			n/a	
Brighton/Worthing/Littlehampton	n/a			n/a	
Leicester Urban Area	n/a			n/a	
Portsmouth Urban Area	n/a			n/a	
Teesside Urban Area	n/a			n/a	
The Potteries	n/a			n/a	
Bournemouth Urban Area	n/a			n/a	
Reading/Wokingham Urban Area	n/a			n/a	
Coventry/Bedworth	n/a			n/a	
Kingston upon Hull	n/a			n/a	
Southampton Urban Area	n/a			n/a	
Birkenhead Urban Area	n/a			n/a	
Southend Urban Area	n/a			n/a	
Blackpool Urban Area	n/a			n/a	
Preston Urban Area	n/a			n/a	
Glasgow Urban Area	n/a			n/a	
Edinburgh Urban Area	n/a			n/a	
Cardiff Urban Area	n/a			n/a	
Swansea Urban Area	n/a			n/a	
Belfast Urban Area	n/a			n/a	
Eastern	4	0	0	<LAT	
South West	0	0	0	n/a	<LAT
South East	4	1	0	<LAT	
East Midlands	4	0	0	<LAT	
North West & Merseyside	0	0	0	n/a	<LAT
Yorkshire & Humberside	0	0	0	n/a	<LAT
West Midlands	0	0	0	n/a	<LAT
North East	0	0	0	n/a	<LAT
Central Scotland	0	0	0	n/a	<LAT
North East Scotland	0	0	0	n/a	<LAT
Highland	0	0	0	n/a	<LAT
Scottish Borders	0	0	0	n/a	<LAT
South Wales	1	0	0	n/a	<LAT
North Wales	0	0	0	n/a	<LAT
Northern Ireland	0	0	0	n/a	<LAT

4 Nitrogen Dioxide

Nitrogen dioxide monitoring using automatic instrumentation began in the late 1980's being required to assess potential compliance against the then emerging EC Directive limit values on air quality. The number of sampling sites increased during the 1990's with a more formalised network established following the preliminary assessment required for the First Daughter Directive (Bush, 2000).

The assessment thresholds for nitrogen dioxide which have been used to determine the exceedance status of each zone in the UK are presented in Table 4-1.

Table 4-1: Upper and Lower Assessment Thresholds for nitrogen dioxide and oxides of nitrogen (adapted from Annex II, Section A, Table 2 of CAFE Directive)

Assessment threshold	Hourly limit value for the protection of human health (NO ₂)	Annual limit value for the protection of human health (NO ₂)	Annual critical level for the protection of vegetation and natural ecosystems (NO _x)
Upper Assessment Threshold (UAT)	70 % of limit value (140 µg m ⁻³ not to be exceeded more than 18 times in any calendar year)	80 % of limit value (32 µg m ⁻³)	80 % of limit value (24 µg m ⁻³)
Lower Assessment Threshold (LAT)	50 % of limit value (100 µg m ⁻³ not to be exceeded more than 18 times in any calendar year)	65 % of limit value (26 µg m ⁻³)	65 % of limit value (19.5 µg m ⁻³)

Note, for protection of vegetation and natural ecosystems;
 if the maximum concentrations exceeded the upper assessment threshold then one monitoring station is required every 20,000 km²
 if the maximum concentrations exceeded the lower assessment threshold then one monitoring station is required every 40,000 km².

4.1 Supplementary assessment data

The supplementary data provided for the preliminary assessment provides sufficient information for assessment of air quality with regards to limit values. Using the data quality objectives (DQO) provided in Annex I of the CAFE Directive, the modelled concentrations estimates are shown to fall within the required DQO specification. The supplementary data consists of a modelling methodology developed to provide a more comprehensive geographical representation of nitrogen dioxide concentrations throughout the UK (see Stedman *et al.*, 2005)). Nitrogen dioxide concentrations have been predicted throughout the country for both background (at 1 km x 1 km grid square resolution) and roadside locations.

4.1.1 Model description

The modelling method for background locations relies on a dispersion model to predict how oxides of nitrogen emissions released from a wide variety of sources will disperse in the atmosphere. A calibration coefficient is applied to account for any under or over prediction in the estimate. Oxides of nitrogen concentrations at road side locations are derived from an empirical model. The model correlates the roadside increment of annual mean NO_x concentrations at roadside or kerbside AURN monitoring sites to the NO_x emission estimates, adjusted for traffic flow on the individual road links alongside which the monitoring sites are located. For both the background and roadside models, nitrogen dioxide concentrations are derived from the oxides of nitrogen concentration by applying the oxidant-partitioning model (Jenkin, 2004). Further details on the modelling process can be found in the reports shown in column four of Table 2-3. An updated description of the modelling process can be found in the most recent annual assessment report (Grice *et al.*, 2009).

4.1.2 Geographical distribution of nitrogen dioxide concentrations

Maps showing distribution of concentrations at background and roadside locations are shown in Figure 4.1. Highest concentrations are observed in the major conurbations.

Figure 4.1: Modelled background and roadside NO₂ concentrations ($\mu\text{g m}^{-3}$) in 2004

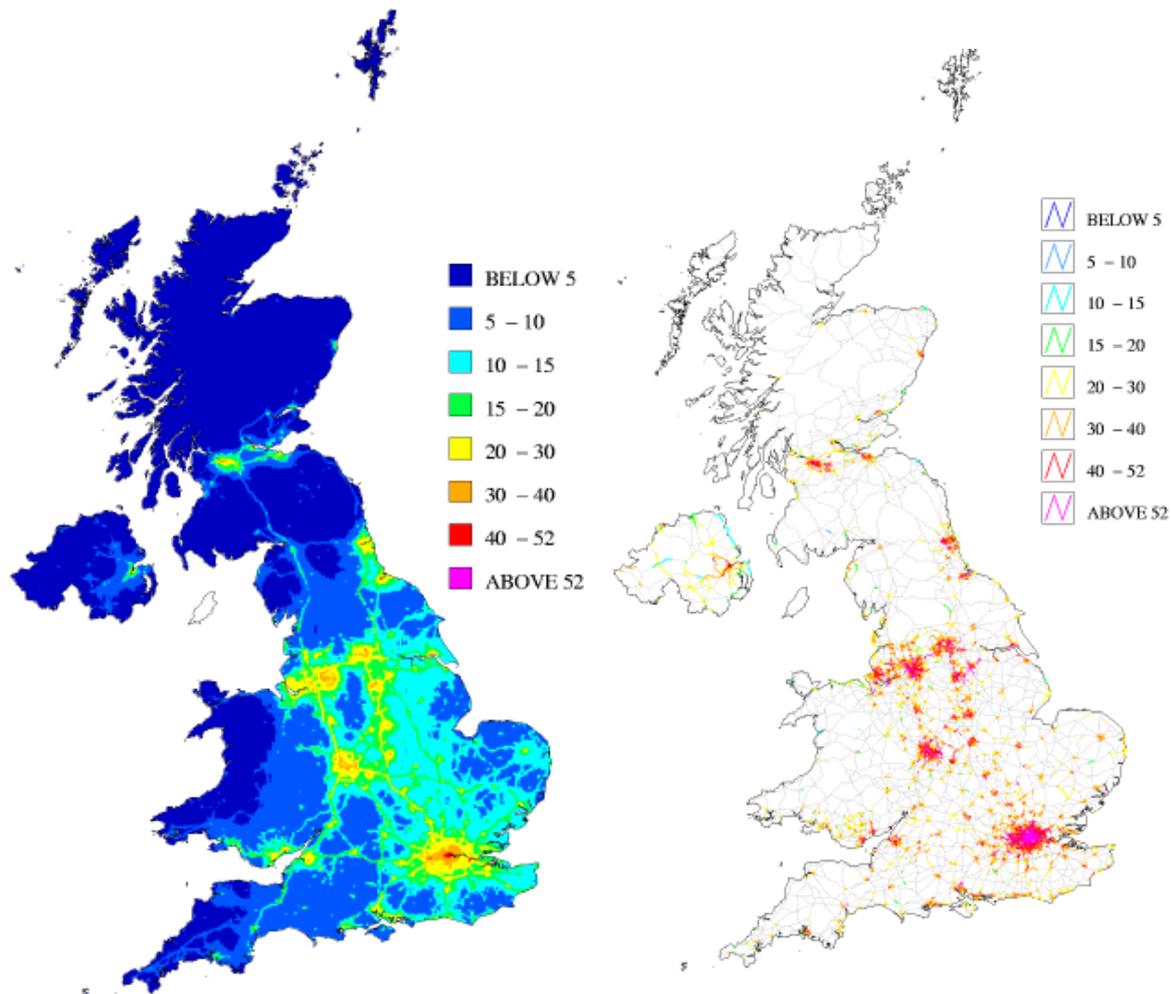


Figure 4.1a: Background

Figure 4.1b: Roadside

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4.2 Number of sites required for protection of human health

The measurements and modelling of ambient nitrogen dioxide concentrations commissioned for compliance with the Framework and Daughter Directives have provided a baseline of data on which to base this preliminary assessment.

The exceedance status of each zone has been determined in accordance with the protocol set out in section 2 and based on guidance provided by the Directive. Table 3-2 summarises the exceedance status of each zone and agglomeration. Precedence is given to measured data as this is viewed as having lower uncertainty than modelled datasets. Modelled exceedances have only been declared where these are predicted to be higher than those based on measured data. Less than half (18 out of 43) UK zones were shown to exceed the UAT based on the measured concentration. All other zones apart from the Highland zone exceeded the UAT based on supplementary assessment data.

Table 4-3 presents the minimum number of sampling sites required in each zone based on the supplementary modelled data being available. Altogether, 82 sampling sites are required in the UK to meet the monitoring obligations for the CAFE Directive. Also presented is the number of pre-existing background and roadside sites in place prior to the reconfiguration of the network for CAFE. These are presented alongside the final optimised CAFE network showing the breakdown of the network composition in terms of station type (e.g. traffic, background urban, background rural and industrial urban). The total number of sites in the CAFE optimised network exceeds the minimum requirements of the Directive.

Table 4-2: Summary of comparison of measured and modelled nitrogen dioxide concentration with assessment thresholds for the period 2000 to 2004 (for protection of health)

Zone or agglomeration	Years available			Threshold classification based on measurement only	Modelled exceedance if higher than measured exceedance
	Number of years monitoring data available	Years threshold is exceeded			
		LAT	UAT		
Greater London Urban Area	5	5	5	>UAT	
West Midlands Urban Area	5	5	5	>UAT	
Greater Manchester Urban Area	5	5	5	>UAT	
West Yorkshire Urban Area	5	5	4	>UAT	
Tyneside	5	5	0	LAT-UAT	>UAT
Liverpool Urban Area	1	0	0	n/a	>UAT
Sheffield Urban Area	5	5	5	>UAT	
Nottingham Urban Area	5	5	5	>UAT	
Bristol Urban Area	5	5	5	>UAT	
Brighton/Worthing/Littlehampton	5	5	5	>UAT	
Leicester Urban Area	5	5	5	>UAT	
Portsmouth Urban Area	4	1	0	<LAT	>UAT
Teesside Urban Area	5	5	1	LAT-UAT	>UAT
The Potteries	5	5	1	LAT-UAT	>UAT
Bournemouth Urban Area	3	0	0	<LAT	>UAT
Reading/Wokingham Urban Area	1	0	0	n/a	>UAT
Coventry/Bedworth	3	0	0	<LAT	>UAT
Kingston upon Hull	2	2	1	n/a	>UAT
Southampton Urban Area	5	5	5	>UAT	
Birkenhead Urban Area	4	1	0	<LAT	>UAT
Southend Urban Area	4	0	0	<LAT	>UAT
Blackpool Urban Area	4	0	0	<LAT	>UAT
Preston Urban Area	4	3	0	LAT-UAT	>UAT
Glasgow Urban Area	5	5	5	>UAT	
Edinburgh Urban Area	1	0	0	n/a	>UAT
Cardiff Urban Area	5	5	3	>UAT	
Swansea Urban Area	5	5	4	>UAT	
Belfast Urban Area	5	5	0	LAT-UAT	>UAT
Eastern	5	5	5	>UAT	
South West	5	5	5	>UAT	
South East	5	5	5	>UAT	
East Midlands	5	0	0	<LAT	>UAT
North West & Merseyside	4	3	1	LAT-UAT	>UAT
Yorkshire & Humberside	5	1	0	<LAT	>UAT
West Midlands	4	3	0	LAT-UAT	>UAT
North East	4	4	4	>UAT	
Central Scotland	3	0	0	<LAT	>UAT
North East Scotland	5	2	0	<LAT	>UAT
Highland	3	0	0	<LAT	
Scottish Borders	4	4	4	>UAT	
South Wales	3	0	0	<LAT	>UAT
North Wales	3	0	0	<LAT	>UAT
Northern Ireland	5	0	0	<LAT	>UAT

Table 4-3: A comparison of the minimum number of sampling sites for nitrogen dioxide required by the CAFE Directive and number of sampling sites before and after the preliminary assessment

Zone code	Zone/Agglomeration	Minimum number of sites based on supplementary data	Number of sites before preliminary assessment		Number of sites after preliminary assessment				
			Background sites	Roadside sites	Traffic - Urban	Background Urban	Background Rural	Industrial Urban	Total Number of Sites in AURN
1	Greater London Urban Area	5	14	9	6	8	0	1	15
2	West Midlands Urban Area	3	6	0	1	3	0	0	4
3	Greater Manchester Urban Area	3	6	1	1	2	0	1	4
4	West Yorkshire Urban Area	2	2	0	1	1	0	0	2
5	Tyneside	2	1	0	1	1	0	0	2
6	Liverpool Urban Area	2	1	0	1	1	0	0	2
7	Sheffield Urban Area	1	3	0	0	1	0	1	2
8	Nottingham Urban Area	1	1	0	0	1	0	0	1
9	Bristol Urban Area	1	1	1	1	1	0	0	2
10	Brighton/Worthing/Littlehampton	1	1	2	1	1	0	0	2
11	Leicester Urban Area	1	1	0	0	1	0	0	1
12	Portsmouth Urban Area	1	1	0	0	1	0	0	1
13	Teesside Urban Area	1	3	0	0	0	0	2	2
14	The Potteries	1	1	0	0	1	0	0	1
15	Bournemouth Urban Area	1	1	0	0	1	0	0	1
16	Reading/Wokingham Urban Area	1	1	0	0	1	0	0	1
17	Coventry/Bedworth	1	1	0	0	1	0	0	1
18	Kingston upon Hull	1	1	0	0	1	0	0	1
19	Southampton Urban Area	1	1	0	0	1	0	0	1
20	Birkenhead Urban Area	1	1	0	0	1	0	0	1
21	Southend Urban Area	1	1	0	0	1	0	0	1
22	Blackpool Urban Area	1	1	0	0	1	0	0	1
23	Preston Urban Area	1	1	0	0	1	0	0	1
24	Glasgow Urban Area	2	2	1	1	2	0	0	3
25	Edinburgh Urban Area	1	1	0	0	1	0	0	1
26	Cardiff Urban Area	1	1	0	0	1	0	0	1
27	Swansea Urban Area	1	2	0	1	0	0	1	2
28	Belfast Urban Area	1	1	0	0	1	0	0	1
29	Eastern	5	2	2	3	2	2	0	7
30	South West	4	1	2	2	2	2	0	6
31	South East	5	1	1	2	4	3	0	9
32	East Midlands	4	1	0	2	2	2	0	6
33	North West & Merseyside	4	2	0	2	3	0	0	5
34	Yorkshire & Humberside	3	1	0	1	1	1	1	4
35	West Midlands	3	2	0	1	2	0	0	3
36	North East	2	1	1	1	1	0	0	2
37	Central Scotland	3	1	0	1	1	1	1	4
38	North East Scotland	2	1	0	1	1	0	0	2
39	Highland	0	1	1	1	1	0	0	2
40	Scottish Borders	1	0	1	1	1	1	0	3
41	South Wales	3	1	0	1	2	1	0	4
42	North Wales	1	0	1	1	1	1	0	3
43	Northern Ireland	2	1	0	1	1	0	0	2
	TOTALS	82	74	23	36	62	14	8	120

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Table 4-4 presents the sampling sites within the AURN currently measuring nitrogen dioxide (April 2010). The rural sites listed are presented for information only since they are not involved with the Article 7 assessment. The table provides the following information regarding the nitrogen dioxide sampling sites in each zone:

- Zone/Agglomeration
- Population (2001)
- Exceedance classification
- No of sites required per Annex V (monitoring data only)
- No of sites required when Article 7 is applied (monitoring data and supplementary information)
- Site Name
- Start date for NO₂
- UK Classification
- EU classification: type_of_station
- EU classification station_type_of_area
- Number of traffic or urban sites
- Number of background urban sites
- Number of background rural sites
- Number of industrial urban sites
- Total number of sites currently in operation (includes all types of station)
- Does number of sites within zone meet CAFE requirements? (Yes/No)

As indicated in the footnote to Table 2-4, each zone shall have at least one urban background site and one traffic site measuring NO₂ where this does not increase the number of stations and, the overall, the network-wide ratio of urban background to traffic sites shall not differ by a factor of two. Table 4-4 shows that the UK will be compliant when planned monitoring stations sites begin sampling (see below).

The following monitoring stations are required for those zones where both roadside and background sampling sites are needed but currently have no roadside sites:

- Leamington Spa Roadside (West Midlands zone);
- Dunbarton Roadside (Central Scotland zone).

The following zones require additional monitoring:

- East Midlands zone (proposed site at Lincoln Roadside);
- South East zone (proposed sites at Chatham Roadside and Eastbourne Urban Background);
- South West zone. Sampling site has yet to be identified.

In two of the three zones sampling sites have been identified but sampling is yet to commence.

Article 10, Paragraph 4 of the CAFE Directive requires that NO₂ is measured at a minimum of 50 % of the ozone sampling points. There are 81 ozone sampling points (see Table 9-3) of which 72 are also measuring NO₂, therefore, the UK is compliant with the requirements of Article 10, Paragraph 4.

In addition, the total number of sampling points monitoring nitrogen dioxide is larger than the minimum specified. This is due to many of the sites forming long-term running data sets that are useful for policy evaluation purposes.

Table 4-4: Detailed description of nitrogen dioxide sampling sites in each zone and agglomeration in 2010

Zone/ Agglomeration	Population (2001)	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start date for NO ₂	UK Classification	EU classification: type_of_station	EU classification station_type_ of_area	Traffic Urban	Background urban	Background rural	industrial urban	Total	Sites in AURN to meet requirements	
Greater London Urban Area	8278251	3	10	5	London Harlington	01/01/2004	AIRPORT	Industrial	Urban	6	8	0	1	15	Y	
					Camden Kerbside	16/05/1996	KERBSIDE	Traffic	urban							
					London Marylebone Road	17/07/1997	KERBSIDE	Traffic	urban							
					Tower Hamlets Roadside	01/04/1996	ROADSIDE	Traffic	urban							
					Haringey Roadside	16/05/1996	ROADSIDE	Traffic	urban							
					Southwark Roadside	01/04/1997	ROADSIDE	Traffic	urban							
					London Cromwell Road 2	20/05/1998	ROADSIDE	Traffic	urban							
					London Eltham	01/04/1996	SUBURBAN	Background	suburban							
					London Bexley	01/05/1994	SUBURBAN	Background	suburban							
					London Hillingdon	02/08/1996	SUBURBAN	Background	suburban							
					London N. Kensington	01/04/1996	URBAN BACKGROUND	Background	urban							
					London Teddington	08/08/1996	URBAN BACKGROUND	Background	urban							
					London Westminster	17/07/2001	URBAN BACKGROUND	Background	urban							
					London Bloomsbury	23/01/1992	URBAN CENTRE	Background	urban							
					London Haringey	29/11/2007	URBAN CENTRE	Background	urban							
West Midlands Urban Area	2284093	3	6	3	Birmingham Tyburn Roadside	11/02/2009	ROADSIDE	Traffic	urban	1	3	0	0	4	Y	
					Walsall Willenhall	29/04/1997	SUBURBAN	Background	suburban							
					Sandwell West Bromwich	04/11/1998	URBAN BACKGROUND	Background	urban							
					Birmingham Tyburn	16/08/2004	URBAN BACKGROUND	Background	urban							
Greater Manchester Urban Area	2244931	3	6	3	Bury Roadside	20/01/1997	ROADSIDE	Traffic	urban	1	2	0	1	4	Y	
					Manchester South	06/12/1996	SUBURBAN	Background	suburban							
					Manchester Piccadilly	18/12/1995	URBAN CENTRE	Background	urban							
					Salford Eccles	20/03/1997	URBAN INDUSTRIAL	Industrial	urban							

Zone/ Agglomeration	Population (2001)	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start date for NO ₂	UK Classification	EU classification: type_of_station	EU classification station_type_ of_area	Traffic Urban	Background urban	Background rural	industrial urban	Total	Sites in AURN to meet requirements
West Yorkshire Urban Area	1499465	3	4	2	Leeds Headingley Kerbside	17/02/2008	KERBSIDE	Traffic	urban	1	1	0	0	2	Y
					Leeds Centre	04/01/1993	URBAN CENTRE	Background	urban						
Tyneside	879996	3	3	2	Newcastle Cradlewell Roadside	10/03/2008	ROADSIDE	Traffic	urban	1	1	0	0	2	Y
					Newcastle Centre	08/03/1992	URBAN CENTRE	Background	urban						
Liverpool Urban Area	816216	3	3	2	Liverpool Queen's Drive Roadside	01/01/2008	ROADSIDE	Traffic	urban	1	1	0	0	2	Y
					Liverpool Speke	21/05/2003	URBAN BACKGROUND	Background	urban						
Sheffield Urban Area	640720	3	2	1	Sheffield Centre	22/12/1995	URBAN CENTRE	Background	urban	0	1	0	1	2	Y
					Sheffield Tinsley	28/11/1990	URBAN INDUSTRIAL	Industrial	urban						
Nottingham Urban Area	666358	3	2	1	Nottingham Centre	02/09/1996	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Bristol Urban Area	551066	3	2	1	Bristol Old Market	01/07/1996	ROADSIDE	Traffic	urban	1	1	0	0	2	Y
					Bristol St Paul's	15/06/2006	URBAN BACKGROUND	Background	urban						
Brighton/ Worthing/ Littlehampton	461181	3	2	1	Brighton Roadside	10/02/1998	ROADSIDE	Traffic	urban	1	1	0	0	2	Y
					Brighton Preston Park	03/11/2004	URBAN BACKGROUND	Background	urban						
Leicester Urban Area	441213	3	2	1	Leicester Centre	04/01/1994	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Portsmouth Urban Area	442252	3	2	1	Portsmouth	01/01/2001	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y

Zone/ Agglomeration	Population (2001)	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start date for NO ₂	UK Classification	EU classification: type_of_station	EU classification station_type_ of_area	Traffic Urban	Background urban	Background rural	industrial urban	Total	Sites in AURN to meet requirements
Teeside Urban Area	365323	3	2	1	Billingham	01/01/1987	URBAN INDUSTRIAL	Industrial	urban	0	0	0	2	2	Y
					Middlesbrough	21/04/1995	URBAN INDUSTRIAL	Industrial	urban						
The Potteries	362403	3	2	1	Stoke-on-Trent Centre	11/03/1997	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Bournemouth Urban Area	383713	3	2	1	Bournemouth	05/03/2001	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y
Reading/ Wokingham Urban Area	369804	3	2	1	Reading New Town	17/10/2003	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y
Coventry/ Bedworth	336452	3	2	1	Coventry Memorial Park	26/02/2001	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y
Kingston Upon Hull	301416	3	2	1	Hull Freetown	06/11/2002	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Southampton Urban Area	304400	3	2	1	Southampton Centre	04/01/1994	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Birkenhead Urban Area	319675	3	2	1	Wirral Tranmere	14/05/2000	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y
Southend Urban Area	269415	3	2	1	Southend-on-Sea	24/07/2000	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y
Blackpool Urban Area	261088	3	2	1	Blackpool Marton	14/06/2005	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y
Preston Urban Area	264601	3	2	1	Preston	06/06/2000	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y
Glasgow Urban Area	1168270	3	4	2	Glasgow Kerbside	10/03/1997	KERBSIDE	Traffic	urban	1	2	0	0	3	Y

Zone/ Agglomeration	Population (2001)	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start date for NO ₂	UK Classification	EU classification: type_of_station	EU classification station_type_ of_area	Traffic Urban	Background urban	Background rural	industrial urban	Total	Sites in AURN to meet requirements
Edinburgh Urban Area	452194	3	2	1	Glasgow City Chambers	06/01/1987	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y
					Glasgow Centre	26/07/1996	URBAN CENTRE	Background	urban						
					Edinburgh St Leonards	24/11/2003	URBAN BACKGROUND	Background	urban						
Cardiff Urban Area	327706	3	2	1	Cardiff Centre	12/05/1992	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Swansea Urban Area	270506	3	2	1	Swansea Roadside	20/09/2006	ROADSIDE	Traffic	urban	1	0		1	2	Y
					Port Talbot Margam	24/07/2007	URBAN INDUSTRIAL	Industrial	urban						
Belfast Urban Area	580276	3	2	1	Belfast Centre	08/03/1992	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Eastern	5124072	3	9	5	Cambridge Roadside	26/06/1999	ROADSIDE	Traffic	urban	3	2	2	0	7	Y
					Stanford-le-Hope Roadside	22/01/2008	ROADSIDE	Traffic	urban						
					Sandy Roadside	28/07/2008	ROADSIDE	Traffic	urban						
					Wicken Fen	12/11/1997	RURAL	Background	rural						
					St Osyth	11/05/2002	RURAL	Background	rural						
					Norwich Lakenfield	25/09/2009	URBAN BACKGROUND	Background	urban						
					Thurrock	01/09/1996	URBAN BACKGROUND	Background	urban						
South West	3980991	3	8	4	Exeter Roadside	02/07/1996	ROADSIDE	Traffic	urban	2	2	2	0	6	Y
					Bath Roadside	18/11/1996	ROADSIDE	Traffic	urban						
					Yarner Wood	15/09/2003	RURAL	Background	rural						
					Charlton Mackrell	03/09/2008	RURAL	Background	rural						
					Plymouth Centre	29/09/1997	URBAN CENTRE	Background	urban						
					New Urban Background	Site yet to be identified	URBAN BACKGROUND	Background	urban						
South East	6392004	3	10	5	Oxford Centre Roadside	15/04/1996	ROADSIDE	Traffic	urban	2	4	3	0	9	Y

Zone/ Agglomeration	Population (2001)	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start date for NO ₂	UK Classification	EU classification: type_of_station	EU classification station_type_ of_area	Traffic Urban	Background urban	Background rural	industrial urban	Total	Sites in AURN to meet requirements	
					Chatham Roadside	Not started	ROADSIDE	traffic	urban							
					Harwell	11/09/1995	RURAL	Background	rural							
					Lullington Heath	29/09/1988	RURAL	Background	rural							
					Rochester Stoke	26/01/1996	RURAL	Background	rural							
					Horley ¹	21/11/2007	SUBURBAN	Background	suburban							
					Canterbury	01/02/2001	URBAN BACKGROUND	Background	urban							
					Oxford St Ebbes	01/01/2008	URBAN BACKGROUND	Background	urban							
					Eastbourne	Not started	URBAN BACKGROUND	Background	urban							
East Midlands	3084598	3	7	4	Chesterfield Roadside	11/03/2008	ROADSIDE	Traffic	urban	2	2	2	0	6	Y	
					Lincoln Roadside	Not started	ROADSIDE	Traffic	urban							
					Ladybower	27/10/1988	RURAL	Background	rural							
					Market Harborough	10/12/2003	RURAL	Background	rural							
					Northampton	23/05/2001	URBAN BACKGROUND	Background	urban							
					Chesterfield	13/03/2008	URBAN BACKGROUND	Background	urban							
North West & Merseyside	2826622	3	7	4	Carlisle Roadside	14/02/2008	ROADSIDE	Traffic	urban	2	3	0	0	5	Y	
					Blackburn Roadside	15/06/2009	ROADSIDE	Traffic	urban							
					Glazebury	26/01/2004	SUBURBAN	Background	suburban							
					Wigan Centre	08/10/2004	URBAN BACKGROUND	Background	urban							
					Warrington	21/10/2008	URBAN BACKGROUND	Background	urban							
Yorkshire & Humberside	2514947	3	6	3	York Fishergate	01/01/2008	ROADSIDE	Traffic	urban	1	1	1	1	4	Y	
					High Muffles	20/10/2003	RURAL	Background	rural							
					Barnsley Gawber	07/07/1997	URBAN BACKGROUND	Background	urban							
					Scunthorpe Town	10/01/2008	URBAN INDUSTRIAL	Industrial	urban							
West Midlands	2271650	3	6	3	Leamington Spa Roadside	Not started	ROADSIDE	Traffic	urban	1	2	0	0	3	Y	
					Leominster	18/07/2005	SUBURBAN	Background	suburban							
					Leamington Spa	26/07/1996	URBAN BACKGROUND	Background	urban							

Zone/ Agglomeration	Population (2001)	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start date for NO ₂	UK Classification	EU classification: type_of_station	EU classification station_type_ of_area	Traffic Urban	Background urban	Background rural	industrial urban	Total	Sites in AURN to meet requirements	
North East	1269803	3	4	2	Stockton-on-Tees Eaglescliffe	21/01/2009	ROADSIDE	Traffic	urban	1	1	0	0	2	Y	
					Sunderland Silksworth	09/12/2004	URBAN BACKGROUND	Background	urban							
Central Scotland	1813314	3	5	3	Dumbarton Roadside	Not started	ROADSIDE	Traffic	urban	1	1	1	1	4	Y	
					Bush Estate	09/10/2003	RURAL	Background	rural							
					Grangemouth Moray	01/06/2009	URBAN BACKGROUND	Background	urban							
					Grangemouth	01/01/2001	URBAN INDUSTRIAL	Industrial	urban							
North East Scotland	1001499	3	4	2	Aberdeen Union Street	01/01/2008	ROADSIDE	Traffic	urban	1	1	0	0	2	Y	
					Roadside Aberdeen	18/09/1999	URBAN BACKGROUND	Background	urban							
Highlands	380062	1	0	0	Inverness	17/07/2001	ROADSIDE	Traffic	urban	1	1	0	0	2	Y	
					Fort William	22/06/2006	SUBURBAN	Background	rural							
Scottish Borders	254690	3	2	1	Dumfries	01/03/2001	ROADSIDE	Traffic	urban	1	1	1	0	3	Y	
					Peebles	06/11/2009	URBAN BACKGROUND	Background	urban							
					Eskdalemuir	09/12/2004	RURAL	Background	rural							
South Wales	1578773	3	5	3	Narberth	20/01/1997	REMOTE	Background	rural	1	2	1	0	4	Y	
					Chepstow A48	01/01/2008	ROADSIDE	Traffic	urban							
					Cwmbran	20/07/2001	URBAN BACKGROUND	Background	urban							
					Newport	01/01/2008	URBAN BACKGROUND	Background	urban							
North Wales	720022	3	2	1	Wrexham	06/03/2002	ROADSIDE	Traffic	urban	1	1	1	0	3	Y	
					Mold	02/12/2009	URBAN BACKGROUND	Background	urban							
					Aston Hill	21/10/2003	RURAL	Background	rural							
Northern Ireland	1104991	3	4	2	Armagh Roadside	01/01/2009	ROADSIDE	traffic	urban	1	1	0	2	Y		
					Derry	29/04/1997	URBAN BACKGROUND	Background	urban							
TOTAL				82				TOTAL Site Numbers		36	62	14	8	120		

Zone/ Agglomeration	Population (2001)	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start date for NO ₂	UK Classification	EU classification: type_of_station	EU classification station_type_ of_area	Traffic Urban	Background urban	Background rural	industrial urban	Total	Sites in AURN to meet requirements
								Urban background:traffic			1.7				

*1, 2, 3 are used to indicate the respective assessment thresholds, where:

1 =	<LAT
2 =	LAT – UAT
3 =>	UAT

¹The sampling site at Horley, although forming part of the AURN, is located within Reigate and Banstead Local Authority to assess what impact Gatwick Airport may have on local air quality.

4.3 Number of sites required for protection of vegetation and natural ecosystems

As for the health protection assessment thresholds the exceedance status of each zone relative to thresholds for vegetation and ecosystem protection has been determined in accordance with the protocol set out in Section 2 and based on guidance provided by the Directive. Table 4-4 summarises the exceedance status of each zone. Precedence is given to measured data as this is viewed as having lower uncertainty than modelled datasets. Modelled exceedances have only been declared where these are predicted to be higher than those based on measured data

Table 4-5 summarises which threshold exceedances have been assigned to each zone. As the vegetation and ecosystem areas was defined for locations which are more than 20 km from agglomerations and 5 km from motorways, other urban areas or industrial plant, by definition, the vegetation assessment is not applicable for agglomerations.

Measured exceedance of the UAT was observed for the South East zone and modelled exceedances for the Eastern, East Midlands and Yorkshire & Humberside zones. As at least one zone has a maximum concentration greater than the upper assessment threshold, Annex V, Paragraph C of the CAFE Directive requires that monitoring be carried out to a sampler density of at least one sampling station per 20,000 km² to assess compliance with limit values for the protection of vegetation. The land area in the UK relevant to protection of vegetation and ecosystems is 119,539 km², therefore six sampling sites are required to assess compliance with the directive ($119,529/20,000 \approx 6$).

Sampling sites measuring oxides of nitrogen located in areas where the critical level applies include: Eskdalemuir, High Muffles, Aston Hill, Charlton Mackrell and Yarner Wood. There are an additional eight rural sampling sites measuring oxides of nitrogen, several of these sites are very close to the areas where the critical level applies.

It should also be recognised that the modelling method for NO_x has changed since the four modelled years 2001, 2002, 2003 and 2004 and would likely result in lower concentrations in these zones.

-

Table 4.4: A comparison of measured and modelled concentration with assessment thresholds for oxides of nitrogen for the period 2000 to 2004 for protection of vegetation and natural ecosystems

Zone or agglomeration	Number of years of monitoring available	Number of years threshold was exceeded		Threshold classification based on measurement only	Modelled exceedance if higher than measured threshold
		LAT	UAT		
Greater London Urban Area	n/a			n/a	
West Midlands Urban Area	n/a			n/a	
Greater Manchester Urban Area	n/a			n/a	
West Yorkshire Urban Area	n/a			n/a	
Tyneside	n/a			n/a	
Liverpool Urban Area	n/a			n/a	
Sheffield Urban Area	n/a			n/a	
Nottingham Urban Area	n/a			n/a	
Bristol Urban Area	n/a			n/a	
Brighton/Worthing/Littlehampton	n/a			n/a	
Leicester Urban Area	n/a			n/a	
Portsmouth Urban Area	n/a			n/a	
Teesside Urban Area	n/a			n/a	
The Potteries	n/a			n/a	
Bournemouth Urban Area	n/a			n/a	
Reading/Wokingham Urban Area	n/a			n/a	
Coventry/Bedworth	n/a			n/a	
Kingston upon Hull	n/a			n/a	
Southampton Urban Area	n/a			n/a	
Birkenhead Urban Area	n/a			n/a	
Southend Urban Area	n/a			n/a	
Blackpool Urban Area	n/a			n/a	
Preston Urban Area	n/a			n/a	
Glasgow Urban Area	n/a			n/a	
Edinburgh Urban Area	n/a			n/a	
Cardiff Urban Area	n/a			n/a	
Swansea Urban Area	n/a			n/a	
Belfast Urban Area	n/a			n/a	
Eastern	5	1	0	-	>UAT
South West	1	0	0	n/a	<LAT
South East	5	5	5	UAT	
East Midlands	5	0	0	-	>UAT
North West & Merseyside	0	0	0	n/a	<LAT
Yorkshire & Humberside	0	0	0	n/a	>UAT
West Midlands	0	0	0	n/a	>LAT
North East	0	0	0	n/a	<LAT
Central Scotland	1	0	0	n/a	<LAT
North East Scotland	0	0	0	n/a	<LAT
Highland	0	0	0	n/a	<LAT
Scottish Borders	0	0	0	n/a	<LAT
South Wales	3	0	0	-	
North Wales	1	0	0	n/a	>LAT
Northern Ireland	0	0	0	n/a	<LAT

5 Particulate matter (PM₁₀ and PM_{2.5})

The CAFE Directive groups both PM₁₀ and PM_{2.5} under the banner of particulate matter (PM) for the purposes of determining monitoring requirements. PM₁₀ monitoring using automatic instrumentation began in 1992. The number of sampling sites increased during the 1990's with a more formalised network established following the preliminary assessment required for the First Daughter Directive (Bush, 2000).

In addition to monitoring PM₁₀ concentrations, the CAFE Directive requires finer particulate matter to be measured (PM_{2.5}, matter particulate with an aerodynamic diameter < 2.5 µm). Pre-existing network measurements and modelled data for PM_{2.5} which can be used as a baseline for a preliminary assessment is limited. PM_{2.5} monitoring was carried out at a small number of monitoring sites as required by the First Daughter Directive.

Monitoring for PM_{2.5} is required for two reasons:

- For assessment against target or limit values. Sampling sites may be located in traffic, background, urban and industrial locations;
- For calculation of the average exposure indicator for subsequent comparison with the exposure reduction target. Sampling sites shall be located in urban background locations.

The assessment thresholds for PM₁₀ and PM_{2.5} used to determine the exceedance status of each zone in the UK are presented in Table 5-1.

Table 5-1: Upper and Lower Assessment Thresholds for sulphur dioxide (adapted from Annex II, Section A, Table 3 of CAFE Directive)

Assessment threshold	24-hour average PM ₁₀	Annual average PM ₁₀	Annual average PM _{2.5} ⁽¹⁾
Upper Assessment Threshold (UAT)	70 % of limit value (35 µg m ⁻³ , not to be exceeded more than 35 times in any calendar year)	70 % of limit value (28 µg m ⁻³)	70 % of limit value (17 µg m ⁻³)
Lower Assessment Threshold (LAT)	50 % of limit value (25 µg m ⁻³ , not to be exceeded more than 35 times in any calendar year)	50 % of limit value (20 µg m ⁻³)	50 % of limit value (12 µg m ⁻³)

⁽¹⁾ The upper assessment threshold and the lower assessment threshold for PM_{2.5} do not apply to the measurements to assess compliance with the PM_{2.5} exposure reduction target for the protection of human health.

In calculating the number of PM sites required for compliance, our assessment has relied on PM₁₀ measurement and modelled data obtained from the annual assessments carried out during the years 2000 to 2004. There was no requirement to carry out full air quality assessments for PM_{2.5} during these years.

Although it is recognised that the assessment threshold for the PM₁₀ 24-hour average may be more stringent than those associated with PM₁₀ annual average limit value, modelled data used in the supplementary assessment shows that there was widespread exceedance of the annual average upper assessment threshold throughout the United Kingdom (see Table 5-2 below). Hence, we have determined that the monitoring network will be suitably configured to assess compliance against both the 24-hour and annual average limit values.

5.1 Supplementary data for PM₁₀

The supplementary data provided for the preliminary assessment provides sufficient information for assessment of air quality with regards to limit values. Using the data quality objectives (DQO) provided in Annex I of the CAFE Directive, the modelled concentrations estimates are shown to fall within the required DQO specification. As part of the annual assessment of air quality required for the First

Daughter Directive 1999/30/EC PM₁₀ concentrations were measured in the AURN network for the years 2000 to 2004. Mapped concentrations have been produced for the years 2001 to 2004.

5.1.1 Model description

The methodology employed in modelling PM₁₀ in 2004 was significantly different to previous years. Prior to 2004, modelling was undertaken in TEOM units, calibrated using TEOM measurements and then converted to a gravimetric equivalent using a factor of 1.3 for comparison with the legislative objectives.

In 2004, modelling was undertaken in gravimetric units and calibrated using gravimetric measurements. Further discussion of the modelling method is presented in the reports shown in column 4 of Table 2-3. An updated description of the modelling process can be found in the most recent annual assessment report (Grice *et al.*, 2009).

Briefly, the maps of background concentrations for 2004 are made up of contributions from:

- Large point sources of primary particles (modelled using ADMS)
- Small point sources of primary particles (modelled using the small points model)
- Area sources of primary particles (modelled using a dispersion kernel)
- Regional primary particles (from results from the TRACK model)
- Secondary inorganic aerosol (derived by scaling measurements of SO₄, NO₃ and NH₄)
- Secondary organic aerosol (from results from the HARM model)
- Sea salt (assumed to be a constant value)
- Residual (assumed to be a constant value)

A roadside component arising from road transport emissions is included for the assessment of concentrations close to roads.

5.1.2 Geographical description of PM₁₀ concentrations

Figure 5-1 shows modelled annual mean PM₁₀ concentration maps at background and roadside locations in 2004. Exceedances of the LAT (> 20 µg m⁻³) can be seen at background locations throughout England. Exceedances of the LAT can be seen at roadside locations throughout the major conurbation areas.

Figure 5-1 Maps of PM₁₀ concentration at background and roadside locations in 2004

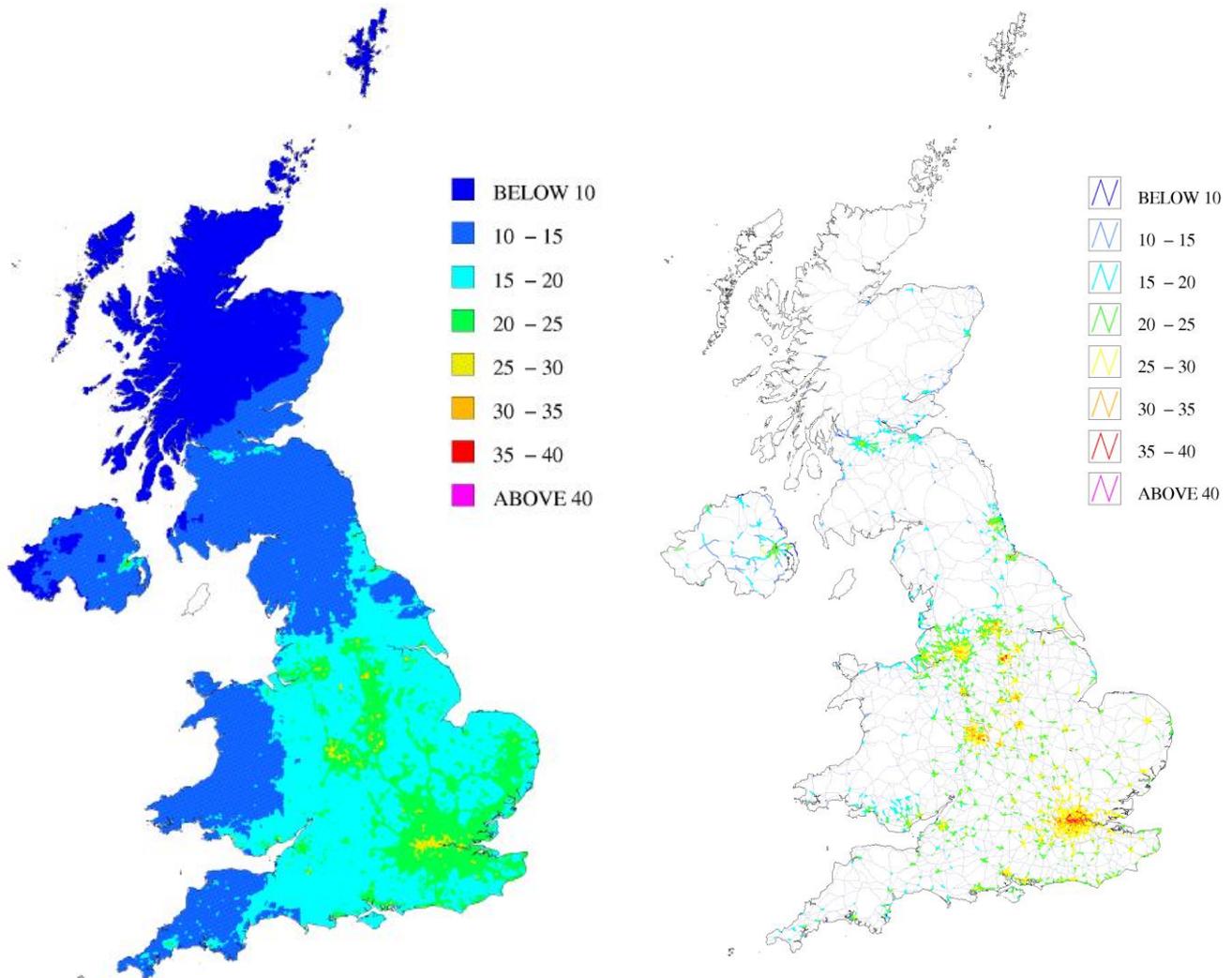


Figure 6.1a: Annual mean background PM₁₀ concentration, 2004 (µg m⁻³, gravimetric)

Figure 6.1b: Urban major roads, annual mean roadside PM₁₀ concentration, 2004 (µg m⁻³, gravimetric)

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The concentrations of many of the components have been estimated separately for the fine and coarse fraction. This enables a consistent method to be adopted for estimation of PM₁₀ (the sum of the fine and coarse fractions) and PM_{2.5} (fine fractions only). An additional roadside increment is added for roadside locations.

5.2 Number of sites required for compliance monitoring of particulate matter

The measurements and modelling of ambient PM₁₀ concentrations commissioned for compliance with the Framework and Daughter Directives have provided a baseline of data on which to base this preliminary assessment.

The exceedance status of each zone has been determined in accordance with the protocol set out in Section 2 and based on guidance provided by the Directive. Table 3-2 summarises which threshold has been assigned to each zone and agglomeration. The exceedance status for PM₁₀ has been used to calculate the required number of monitoring stations for PM (i.e. both PM₁₀ and PM_{2.5}) as specified

in Annex V, Paragraph 1 of the CAFE Directive. Five zones were shown to exceed the UAT based on the measured concentrations. Twenty six zones exceeded the UAT based on the modelled concentrations.

Table 5-3 presents the minimum number of sampling points required in each zone based on the availability of supplementary modelled data. Altogether PM sampling is required at 115 locations to meet the PM monitoring obligations for the CAFE Directive. Also presented is the number of background and roadside sites in place in 2005. This indicated that a significant increase in the number of sites was required to ensure compliance with the CAFE Directive. For example, in 2005 there were 56 background and 11 roadside sites, giving a total of total 67 sites, with 48 more required for minimum compliance. Table 5-3 also shows the reconfigured/optimised network commissioned post 2006 for compliance 2 with CAFÉ. This also takes into account monitoring requirements for United Kingdom specific research and policy initiatives. The total number of PM monitors in this optimised network is 144.

The CAFE Directive does not specify the relative proportion of PM_{10} and $PM_{2.5}$ sampling sites that exist within individual agglomerations or zones but requires that the ratio of $PM_{2.5}$ to PM_{10} sampling sites should not differ by more than a factor of 2.

Table 5-2: Summary of comparison of measured and modelled PM₁₀ concentration with assessment thresholds for the period 2000 to 2004

Zone or agglomeration	Years available			Threshold classification based on measurement only	Modelled exceedance if higher than measured threshold
	Number of years monitoring data available	Years threshold is exceeded			
		LAT	UAT		
Greater London Urban Area	5	5	5	>UAT	
West Midlands Urban Area	5	5	0	LAT-UAT	>UAT
Greater Manchester Urban Area	5	5	5	>UAT	
West Yorkshire Urban Area	5	5	0	LAT-UAT	>UAT
Tyneside	5	1	0	<LAT	>UAT
Liverpool Urban Area	1	1	0	n/a	>UAT
Sheffield Urban Area	5	5	0	LAT-UAT	>UAT
Nottingham Urban Area	5	5	0	LAT-UAT	>UAT
Bristol Urban Area	5	5	1	LAT-UAT	>UAT
Brighton/Worthing/Littlehampton	2	2	2	n/a	LAT-UAT
Leicester Urban Area	5	3	0	LAT-UAT	>UAT
Portsmouth Urban Area	4	3	0	LAT-UAT	>UAT
Teesside Urban Area	5	5	0	LAT-UAT	>UAT
The Potteries	4	3	0	LAT-UAT	>UAT
Bournemouth Urban Area	3	3	0	LAT-UAT	
Reading/Wokingham Urban Area	1	0	0	n/a	>UAT
Coventry/Bedworth	4	1	0	<LAT	>UAT
Kingston upon Hull	2	2	0	n/a	>UAT
Southampton Urban Area	5	5	0	LAT-UAT	>UAT
Birkenhead Urban Area	4	1	0	<LAT	LAT-UAT
Southend Urban Area	4	1	0	<LAT	LAT-UAT
Blackpool Urban Area	4	4	0	LAT-UAT	
Preston Urban Area	4	1	0	<LAT	LAT-UAT
Glasgow Urban Area	5	5	3	>UAT	
Edinburgh Urban Area	1	0	0	n/a	LAT-UAT
Cardiff Urban Area	5	5	1	LAT-UAT	>UAT
Swansea Urban Area	5	5	4	>UAT	
Belfast Urban Area	5	5	0	LAT-UAT	>UAT
Eastern	5	5	1	LAT-UAT	>UAT
South West	5	2	0	<LAT	>UAT
South East	5	5	0	LAT-UAT	>UAT
East Midlands	4	3	0	LAT-UAT	>UAT
North West & Merseyside	3	3	0	LAT-UAT	>UAT
Yorkshire & Humberside	4	4	3	>UAT	
West Midlands	5	4	0	LAT-UAT	>UAT
North East	3	3	2	LAT-UAT	>UAT
Central Scotland	3	0	0	<LAT	LAT-UAT
North East Scotland	4	1	0	<LAT	LAT-UAT
Highland	2	0	0	n/a	
Scottish Borders	3	2	0	<LAT	
South Wales	5	1	0	<LAT	>UAT
North Wales	3	2	0	<LAT	LAT-UAT
Northern Ireland	5	3	0	LAT-UAT	>UAT

Table 5-3: The minimum number of PM (PM_{2.5} + PM₁₀) sampling sites required by the CAFE Directive and number of sampling sites before and after the preliminary assessment

Code	Zone/Agglomeration	Minimum number of PM (PM ₁₀ + PM _{2.5}) sites based on supplementary data	Before preliminary assessment		After preliminary assessment								Total Number of PM sites in AURN
			PM ₁₀		PM ₁₀				PM _{2.5}				
			BG sites	RS sites	Traffic - Urban	BG Urban	BG Rural	Ind Urban	Traffic - Urban	BG Urban	BG Rural	Ind Urban	
1	Greater London Urban Area	8	8	4	4	2	0	1	3	7	0	1	18
2	West Midlands Urban Area	4	3	0	1	1	0	0	1	2	0	0	5
3	Greater Manchester Urban Area	4	4	1	1	0	0	1	1	2	0	0	5
4	West Yorkshire Urban Area	3	2	0	1	1	0	0	1	1	0	0	4
5	Tyneside	2	1	0	0	1	0	0	0	1	0	0	2
6	Liverpool Urban Area	2	1	0	0	1	0	0	0	1	0	0	2
7	Sheffield Urban Area	2	1	0	0	1	0	0	0	1	0	0	2
8	Nottingham Urban Area	2	1	0	0	1	0	0	0	1	0	0	2
9	Bristol Urban Area	2	1	0	0	1	0	0	0	1	0	0	2
10	Brighton/Worthing/Littlehampton	1	0	1	0	0	0	0	0	1	0	0	1
11	Leicester Urban Area	2	1	0	0	1	0	0	0	1	0	0	2
12	Portsmouth Urban Area	2	1	0	0	1	0	0	0	1	0	0	2
13	Teesside Urban Area	2	2	0	0	0	0	1	0	0	0	1	2
14	The Potteries	2	1	0	0	1	0	0	0	1	0	0	2
15	Bournemouth Urban Area	1	1	0	0	1	0	0	0	1	0	0	2
16	Reading/Wokingham Urban	2	1	0	0	1	0	0	0	1	0	0	2
17	Coventry/Bedworth	2	1	0	0	1	0	0	0	1	0	0	2
18	Kingston upon Hull	2	1	0	0	1	0	0	0	1	0	0	2
19	Southampton Urban Area	2	1	0	0	1	0	0	0	1	0	0	2
20	Birkenhead Urban Area	1	1	0	0	0	0	0	0	1	0	0	1
21	Southend Urban Area	1	1	0	0	0	0	0	0	1	0	0	1
22	Blackpool Urban Area	1	1	0	0	0	0	0	0	1	0	0	1
23	Preston Urban Area	1	1	0	0	0	0	0	0	1	0	0	1
24	Glasgow Urban Area	3	1	1	1	1	0	0	1	1	0	0	4
25	Edinburgh Urban Area	1	1	0	0	1	0	0	0	1	0	0	2
26	Cardiff Urban Area	2	1	0	0	1	0	0	0	1	0	0	2
27	Swansea Urban Area	2	2	0	1	1	0	0	1	0	0	1	4
28	Belfast Urban Area	2	2	0	0	1	0	0	0	1	0	0	2
29	Eastern	7	2	0	2	2	0	0	2	1	0	0	7
30	South West	6	1	0	2	1	0	0	2	1	0	0	6
31	South East	8	1	0	2	2	2	0	2	2	2	0	12
32	East Midlands	5	2	0	1	1	0	0	1	2	0	0	5
33	North West & Merseyside	5	1	0	1	1	0	0	1	2	0	0	5
34	Yorkshire & Humberside	4	1	0	1	1	1	0	1	1	0	0	5
35	West Midlands	4	1	0	1	1	0	0	1	1	0	0	4
36	North East	3	0	1	1	0	0	0	1	1	0	0	3
37	Central Scotland	2	1	0	0	0	1	1	0	0	1	1	4
38	North East Scotland	2	1	0	0	1	0	0	0	1	0	0	2
39	Highland	0	0	1	1	0	0	0	0	0	0	0	1
40	Scottish Borders	0	0	1	0	0	0	0	0	0	0	0	0
41	South Wales	4	1	0	1	1	1	0	1	1	0	0	5
42	North Wales	1	0	1	1	0	0	0	1	0	0	0	2
43	Northern Ireland	3	1	0	1	1	1	0	0	1	0	0	4
	TOTALS	115	56	11	24	34	6	4	21	48	3	4	144

5.3 Observations and proposals for national exposure reduction target

Section B, Annex V of the CAFE Directive specifies that the monitoring required for PM_{2.5} in relation to the assessment of the exposure reduction target shall be based on population totals within the respective agglomerations or zones. The specification is provided below:

From Section B, Annex V

Minimum number of sampling points for fixed measurement to assess compliance with the PM_{2.5} exposure reduction target for the protection of human health

One sampling point per million inhabitants summed over agglomerations and additional urban areas in excess of 100 000 inhabitants shall be operated for this purpose. Those sampling points may coincide with sampling points under Section A.

Using this guidance, Table 5-4 shows the required number of PM_{2.5} monitors for each zone. Forty seven PM_{2.5} monitors are required across the UK. PM_{2.5} monitors may be collocated with the PM₁₀ monitors shown in Table 5-3 above.

Table 5-4: Minimum number of sampling sites to derive exposure reduction target (based population within agglomerations or zones)

Zone code	Zone/Agglomeration	Minimum number of sites based on population	Number of conurbations with population greater than 100000	Population total for within conurbations in zones
1	Greater London Urban Area	8		
2	West Midlands Urban Area	2		
3	Greater Manchester Urban Area	2		
4	West Yorkshire Urban Area	1		
5	Tyneside	1		
6	Liverpool Urban Area	1		
7	Sheffield Urban Area	1		
8	Nottingham Urban Area	1		
9	Bristol Urban Area	1		
10	Brighton/Worthing/Littlehampton	1		
11	Leicester Urban Area	1		
12	Portsmouth Urban Area	1		
13	Teesside Urban Area	1		
14	The Potteries	1		
15	Bournemouth Urban Area	1		
16	Reading/Wokingham Urban Area	1		
17	Coventry/Bedworth	1		
18	Kingston upon Hull	1		
19	Southampton Urban Area	1		
20	Birkenhead Urban Area	1		
21	Southend Urban Area	1		
22	Blackpool Urban Area	1		
23	Preston Urban Area	1		
24	Glasgow Urban Area	1		
25	Edinburgh Urban Area	1		
26	Cardiff Urban Area	1		
27	Swansea Urban Area	1		
28	Belfast Urban Area	1		
29	Eastern	1	8	1126800
30	South West	1	6	862888
31	South East	1	10	1594871
32	East Midlands	1	7	1065679
33	North West & Merseyside	1	5	767341
34	Yorkshire & Humberside	1	4	611924
35	West Midlands	1	1	138241
36	North East	1	1	182974
37	Central Scotland	0		
38	North East Scotland	1	2	352002
39	Highland	0		
40	Scottish Borders	0		
41	South Wales	1	1	139298
42	North Wales	0		
43	Northern Ireland	0		
	TOTALS	47		

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Table 5-5 presents the sampling sites currently measuring PM_{2.5} and PM₁₀ as of April 2010. Each table provides the following information regarding the sampling sites in each zone:

- Zone/agglomeration
- Population in zone/agglomeration
- Assessment threshold (where 3 indicates >UAT; 2 indicates LAT_UAT; 1 indicates <LAT)
- Number of sites required from Annex V (monitoring data only)
- Number of sites required from Article 7 (monitoring data and supplementary information)
- PM₁₀ Sites
 - UK Classification
 - Start date for PM₁₀
 - EU classification: type_of_station
 - EU classification station_type_of_area
 - Traffic urban
 - Background urban
 - Background rural
 - industrial urban
 - Total number of PM₁₀ sites
- PM_{2.5} Sites
 - UK Classification
 - Start date for PM_{2.5}
 - EU classification: type_of_station
 - EU classification station_type_of_area
 - Traffic urban
 - Background urban
 - Background rural
 - industrial urban
 - Total number of PM_{2.5} sites
- Total number of PM₁₀ +PM_{2.5} sites
- Does number of sites with zone meet CAFE requirements?

As discussed in Section 2.3, each zone should have at least one urban background site and one traffic site measuring PM where this does not increase the number of stations. Where more than 2 sites are required, PM monitoring is required at a traffic (kerbside or roadside location) and a background location (urban, centre or industrial). However, when only two sites are required, (as in the majority of UK agglomerations), then both PM₁₀ and PM_{2.5} monitors are, in general, installed in background locations whereby the PM_{2.5} monitoring forms part of the average exposure indicator network.

New PM_{2.5} sites are required in the following agglomerations:

- Greater Manchester Urban Area. PM_{2.5} site to be installed beside existing PM₁₀ site at Bury roadside
- Glasgow Urban Area. PM_{2.5} site to be installed beside existing PM₁₀ site at Glasgow kerbside roadside

New sites are required in the following zones:

- South West zone. Three new sampling sites are required. PM_{2.5} sampling is due to commence at an urban centre location in Plymouth. PM_{2.5} and PM₁₀ monitoring is required at another site yet to be identified.
- South East zone. Two sites are required. PM₁₀ sampling is due to commence at Chatham roadside and the other PM_{2.5} at urban background location in Eastbourne.
- West Midlands zone. PM_{2.5} and PM₁₀ sampling is due to commence at a roadside location in Leamington Spa.
- East Midlands zone. PM_{2.5} sampling is due to commence alongside existing PM₁₀ site at Chesterfield.

For the majority of these sites the location of the site is known but sampling is yet to commence. Once operational the United Kingdom will be compliant with the PM monitoring requirements.

Table 5-6 presents the PM_{2.5} average exposure indicator sites in 2010. The table provides the following information regarding the PM_{2.5} sampling sites in each zone:

- Zone/ Agglomeration
- Population
- Number of conurbations
- Population summed over conurbations only
- Number of urban background sites required
- PM_{2.5} Background Sites AEI sites
- PM_{2.5} Start date
- UK Classification
- EU: type_of_station
- DEM - classification station_type_of_area
- urban and suburban background industrial
- Sites in AURN to meet requirement
- PM_{2.5} Sites Other
- UK Classification

The table shows that the UK is compliant with the requirements for the average exposure indicator.

In addition, Article 6 paragraph 5 of the Directive requires that speciation of the component constituents of PM_{2.5}, is carried out at two sampling sites within the United Kingdom (1 per 100,000 km²). PM_{2.5} speciation currently occurs at two sites (Harwell and Auchencorth Moss),.

Table 5-5: Detailed description of PM_{2.5} and PM₁₀ sampling sites in each zone and agglomeration in 2010

Zone/ Agglomeration	Population	Assessment threshold	Annex V	Article 7	PM ₁₀ Sites	UK Classification	Start date for PM10	EU classification: type_of_station	EU classification station_type_of_area	Traffic Urban	Background urban	Background rural	industrial urban	Total	PM _{2.5} Sites	UK Classification	Start date for PM2.5	EU classification: type_of_station	EU classification station_type_of_area	Traffic Urban	Background urban	Background rural	industrial urban	Total	Total PM10 +PM2.5	Directive satisfied				
Greater London Urban Area	8278251	3	15	8	London Harlington	AIRPORT	01/01/2004	Industrial	urban	4	2	0	1	7	London Harlington	AIRPORT	16/09/2008	Industrial	urban	3	7	0	1	11	18	Y				
					Camden Kerbside	KERBSIDE	16/05/1996	Traffic	urban									London Marylebone Road	KERBSIDE	01/04/1998	Traffic	urban								
					London Marylebone Road	KERBSIDE	17/07/1997	Traffic	urban									Camden Kerbside	KERBSIDE	19/02/2009	Traffic	urban								
					Haringey Roadside	ROADSIDE	16/05/1996	Traffic	urban									Haringey Roadside	ROADSIDE	18/02/2009	Traffic	urban								
					Southwark Roadside	ROADSIDE	Not started	Traffic	urban									London Bexley	SUBURBAN	25/02/2008	Background	suburban								
					London N. Kensington	URBAN BACKGROUND	01/04/1996	Background	urban									London Eltham	SUBURBAN	15/05/2008	Background	suburban								
					London Bloomsbury	URBAN CENTRE	23/01/1992	Background	urban									London Bloomsbury	URBAN CENTRE	26/03/1998	Background	urban								
																			London Teddington	URBAN BACKGROUND	08/12/2008	Background	urban							
																			London Harrow Stanmore	URBAN BACKGROUND	16/12/2008	Background	urban							
																			London N. Kensington	URBAN BACKGROUND	17/12/2008	Background	urban							
														London Westminster	URBAN BACKGROUND	25/12/2008	Background	urban												
West Midlands Urban Area	2284093	3	8	4	Birmingham Tyburn	URBAN BACKGROUND	16/08/2004	Background	urban	1	1	0	0	2	Birmingham Tyburn Roadside	ROADSIDE	11/02/2009	Traffic	urban	1	2	0	0	3	5	Y				
					Birmingham Tyburn Roadside	ROADSIDE	11/02/2009	traffic	urban									Birmingham Tyburn	URBAN BACKGROUND	15/12/2008	Background	urban								
																		Sandwell West Bromwich	URBAN BACKGROUND	Not started	Background	urban								
Greater Manchester Urban Area	2244931	3	8	4	Bury Roadside	ROADSIDE	20/01/1997	Traffic	urban	1	0	0	1	2	Bury Roadside	ROADSIDE	Not started	Traffic	urban	1	2	0	0	3	5	Y				
					Salford Eccles	URBAN INDUSTRIAL	20/03/1997	Industrial	urban									Manchester Piccadilly	URBAN CENTRE	15/01/2009	Background	urban								
																		Salford Eccles	URBAN INDUSTRIAL	26/11/2008	Industrial	urban								
West Yorkshire Urban Area	1499465	3	6	3	Leeds Headingley Kerbside	KERBSIDE	17/02/2008	Traffic	urban	1	1	0	0	2	Leeds Headingley Kerbside	KERBSIDE	06/04/2009	Traffic	urban	1	1	0	0	2	4	Y				
					Leeds Centre	URBAN CENTRE	04/01/1993	Background	urban									Leeds Centre	URBAN CENTRE	02/12/2008	Background	urban								
Tyneside	879996	3	4	2	Newcastle Centre	URBAN CENTRE	08/03/1992	Background	urban	0	1	0	0	1	Newcastle Centre	URBAN CENTRE	24/08/2008	Background	urban	0	1	0	0	1	2	Y				
Liverpool Urban Area	816216	3	4	2	Liverpool Speke	URBAN BACKGROUND	21/05/2003	Background	urban	0	1	0	0	1	Liverpool Speke	URBAN BACKGROUND	17/09/2008	Background	urban	0	1	0	0	1	2	Y				

Zone/ Agglomeration	Population	Assessment threshold	Annex V	Article 7	PM ₁₀ Sites	UK Classification	Start date for PM10	EU classification: type_of_station	EU classification station_type_of_area	Traffic Urban	Background urban	Background rural	Industrial urban	Total	PM _{2.5} Sites	UK Classification	Start date for PM2.5	EU classification: type_of_station	EU classification station_type_of_area	Traffic Urban	Background urban	Background rural	Industrial urban	Total	PM10 +PM2.5	Directive satisfied
Sheffield Urban Area	640720	3	3	2	Sheffield Centre	URBAN CENTRE	22/12/1995	Background urban	0	1	0	0	1	Sheffield Centre	URBAN CENTRE	10/12/2008	Background urban	0	1	0	0	1	2	Y		
Nottingham Urban Area	666358	3	3	2	Nottingham Centre		Not started	Background urban	0	1	0	0	1	Nottingham Centre	URBAN CENTRE	19/12/2008	Background urban	0	1	0	0	1	2	Y		
Bristol Urban Area	551066	3	3	2	Bristol St Paul's	URBAN BACKGROUND	15/06/2006	Background urban	0	1	0	0	1	Bristol St Paul's	URBAN BACKGROUND	12/08/2008	Background urban	0	1	0	0	1	2	Y		
Brighton/ Worthing/ Littlehampton	461181	2	2	1				0	0	0	0	0	0	Brighton Preston Park	URBAN BACKGROUND	30/05/2008	Background urban	0	1	0	0	1	1	Y		
Leicester Urban Area	441213	3	3	2	Leicester Centre	URBAN CENTRE	04/01/1994	Background urban	0	1	0	0	1	Leicester Centre	URBAN CENTRE	01/09/2008	Background urban	0	1	0	0	1	2	Y		
Portsmouth Urban Area	442252	3	3	2	Portsmouth	URBAN BACKGROUND	01/01/2001	Background urban	0	1	0	0	1	Portsmouth	URBAN BACKGROUND	23/12/2008	Background urban	0	1	0	0	1	2	Y		
Teeside Urban Area	365323	3	3	2	Middlesbrough	URBAN INDUSTRIAL	21/04/1995	Industrial urban	0	0	0	1	1	Middlesbrough	URBAN INDUSTRIAL	13/11/2008	Industrial urban	0	0	0	1	1	2	Y		
The Potteries	362403	3	3	2	Stoke-on-Trent Centre	URBAN CENTRE	11/03/1997	Background urban	0	1	0	0	1	Stoke-on-Trent Centre	URBAN CENTRE	05/11/2008	Background urban	0	1	0	0	1	2	Y		
Bournemouth Urban Area	383713	2	2	1	Bournemouth	URBAN BACKGROUND	18/07/2001	Background urban	0	1	0	0	1	Bournemouth Centre	URBAN CENTRE	Not started	Background urban	0	1	0	0	1	2	Y		
Reading/ Wokingham Urban Area	369804	3	3	2	Reading New Town	URBAN BACKGROUND	17/10/2003	Background urban	0	1	0	0	1	Reading New Town	URBAN BACKGROUND	25/09/2008	Background urban	0	1	0	0	1	2	Y		
Coventry/ Bedworth	336452	3	3	2	Coventry Memorial Park.	URBAN BACKGROUND		Background urban	0	1	0	0	1	Coventry Memorial Park	URBAN BACKGROUND	16/12/2008	Background urban	0	1	0	0	1	2	Y		
Kingston Upon Hull	301416	3	3	2	Hull Freetown	URBAN CENTRE	06/11/2002	Background urban	0	1	0	0	1	Hull Freetown	URBAN CENTRE	02/09/2008	Background urban	0	1	0	0	1	2	Y		
Southampton Urban Area	304400	3	3	2	Southampton Centre	URBAN CENTRE	04/01/1994	Background urban	0	1	0	0	1	Southampton Centre	URBAN CENTRE	05/11/2008	Background urban	0	1	0	0	1	2	Y		
Birkenhead Urban Area	319675	2	2	1				0	0	0	0	0	0	Wirral Tranmere	URBAN BACKGROUND	28/01/2009	Background urban	0	1	0	0	1	1	Y		

Zone/ Agglomeration	Population	Assessment threshold	Annex V	Article 7	PM ₁₀ Sites	UK Classification	Start date for PM10	EU classification: type_of_station	EU classification station_type_of_area	Traffic Urban	Background urban	Background rural	Industrial urban	Total	PM _{2.5} Sites	UK Classification	Start date for PM2.5	EU classification: type_of_station	EU classification station_type_of_area	Traffic Urban	Background urban	Background rural	Industrial urban	Total	PM10 +PM2.5	Directive satisfied
Southend Urban Area	269415	2	2	1						0	0	0	0	0	Southend-on-Sea	URBAN BACKGROUND	30/01/2009	Background urban	0	1	0	0	1	1	Y	
Blackpool Urban Area	261088	2	2	1						0	0	0	0	0	Blackpool Marton	URBAN BACKGROUND	28/01/2009	Background urban	0	1	0	0	1	1	Y	
Preston Urban Area	264601	2	2	1						0	0	0	0	0	Preston	URBAN BACKGROUND	27/01/2009	Background urban	0	1	0	0	1	1	Y	
Glasgow Urban Area	1168270	3	6	3	Glasgow Kerbside	KERBSIDE	10/03/1997	Traffic urban	1	1	0	0	2	Glasgow Kerbside	KERBSIDE	Not started	Traffic urban	1	1	0	0	2	4	Y		
					Glasgow Centre	URBAN CENTRE	26/07/1996	Background urban						Glasgow Centre	URBAN CENTRE	16/12/2008	Background urban									
Edinburgh Urban Area	452194	2	2	1	Edinburgh St Leonards	URBAN BACKGROUND	24/11/2003	Background urban	0	1	0	0	1	Edinburgh St Leonards	URBAN BACKGROUND	01/10/2008	Background urban	0	1	0	0	1	2	Y		
Cardiff Urban Area	327706	3	3	2	Cardiff Centre	URBAN CENTRE	12/05/1992	Background urban	0	1	0	0	1	Cardiff Centre	URBAN CENTRE	13/08/2008	Background urban	0	1	0	0	1	2	Y		
Swansea Urban Area	270506	3	3	2	Swansea Roadside	ROADSIDE	20/09/2006	Traffic urban	1	1	0	0	2	Swansea Roadside	ROADSIDE	29/09/2006	Traffic urban	1	0	0	1	2	4	Y		
					Port Talbot Margam	URBAN INDUSTRIAL	24/07/2007	Industrial urban						Port Talbot Margam	URBAN INDUSTRIAL	23/04/2008	Industrial urban									
Belfast Urban Area	580276	3	3	2	Belfast Centre	URBAN CENTRE	08/03/1992	Background urban	0	1	0	0	1	Belfast Centre	URBAN CENTRE	01/10/2008	Background urban	0	1	0	0	1	2	Y		
0																										
Eastern	5124072	3	13	7	Stanford-le-Hope Roadside	ROADSIDE	22/01/2008	Traffic urban	2	2	0	0	4	Sandy Roadside	ROADSIDE	27/01/2009	Traffic urban	2	1	0	0	3	7	Y		
					Sandy Roadside	ROADSIDE	28/07/2008	Traffic urban						Stanford-le-Hope Roadside	ROADSIDE	01/04/2009	Traffic urban									
					Norwich Lakenfield	URBAN BACKGROUND	08/10/2009	urban						Norwich Lakenfield	URBAN BACKGROUND	25/09/2009	Background urban									
					Thurrock	URBAN BACKGROUND	01/09/1996	Background urban																		
South West	3980991	3	11	6	Saltash Roadside	ROADSIDE	30/07/2008	Traffic urban	2	1	0	0	3	Saltash Roadside	ROADSIDE	23/02/2009	Traffic urban	2	1	0	0	3	6	Y		
					New Roadside site	ROADSIDE	Site required	Traffic urban						New Roadside Site	ROADSIDE	Not started	Traffic urban									
					Plymouth Centre	URBAN CENTRE	29/09/1997	Background urban						Plymouth Centre	URBAN BACKGROUND	Not started	Background urban									
South East	6392004	3	15	8	Chatham Roadside	ROADSIDE	Not started	Traffic urban	2	2	2	0	6	Chatham Roadside	ROADSIDE	Not started	Traffic urban	2	2	2	0	6	12	Y		
					Storrington Roadside	ROADSIDE	01/01/2010	Traffic urban						Storrington Roadside	ROADSIDE	Not started	Traffic urban									

Zone/ Agglomeration	Population Assessment threshold Annex V Article 7	PM ₁₀ Sites	UK Classification	Start date for PM10	EU classification: type_of_station	EU classification station_type_of_area	Traffic Urban	Background urban	Background rural	Industrial urban	Total	PM _{2.5} Sites	UK Classification	Start date for PM2.5	EU classification: type_of_station	EU classification station_type_of_area	Traffic Urban	Background urban	Background rural	Industrial urban	Total	Total PM10 +PM2.5	Directive satisfied	
		Harwell	RURAL	14/04/1998	Background rural							Harwell	RURAL	17/04/1998	Background rural									
		Rochester Stoke	RURAL	26/01/1996	Background rural							Rochester Stoke	RURAL	28/04/1998	Background rural									
		Eastbourne	URBAN BACKGROUND	01/01/2010	Background urban							Eastbourne	URBAN BACKGROUND	Not started	Background urban									
		Oxford St Ebbes	URBAN BACKGROUND	01/01/2008	Background urban							Oxford St Ebbes	URBAN BACKGROUND	18/12/2008	Background urban									
East Midlands	3084598	3	10	5	Chesterfield Roadside	ROADSIDE	11/03/2008	Traffic urban	1	1	0	0	2	Chesterfield Roadside	ROADSIDE	Not started	Traffic urban	1	2	0	0	3	5	Y
					Chesterfield	URBAN BACKGROUND	13/03/2008	Background urban				Northampton	URBAN BACKGROUND	05/09/2008	Background urban									
												Chesterfield	URBAN BACKGROUND	17/12/2008	Background urban									
North West & Merseyside	2826622	3	10	5	Carlisle Roadside	ROADSIDE	14/02/2008	Traffic urban	1	1	0	0	2	Carlisle Roadside	ROADSIDE	17/03/2009	Traffic urban	1	2	0	0	3	5	Y
					Warrington	URBAN BACKGROUND	01/11/2008	Background urban				Wigan Centre	URBAN BACKGROUND	27/11/2008	Background urban									
												Warrington	URBAN BACKGROUND	27/11/2008	Background urban									
Yorkshire & Humberside	2514947	3	8	4	York Fishergate	ROADSIDE	01/01/2008	Traffic urban	1	1	1	0	3	York Fishergate	ROADSIDE	Not started	Traffic urban	1	1	0	0	2	5	Y
					York Bootham	URBAN BACKGROUND	01/01/2008	Background urban				York Bootham	URBAN BACKGROUND	03/12/2008	Background urban									
					Scunthorpe Town	URBAN INDUSTRIAL	06/06/2004	Industrial urban																
West Midlands	2271650	3	8	4	Leamington Spa Roadside	ROADSIDE	Not started	Traffic urban	1	1	0	0	2	Leamington Spa Roadside	ROADSIDE	Not started	Traffic urban	1	1	0	0	2	4	Y
					Leamington Spa	URBAN BACKGROUND	26/07/1996	Background urban				Leamington Spa	URBAN BACKGROUND	22/12/2008	Background urban									
North East	1269803	3	6	3	Stockton-on-Tees Eaglescliffe	ROADSIDE	01/09/2008	Traffic urban	1	0	0	0	1	Stockton-on-Tees Eaglescliffe	ROADSIDE	01/09/2008	Traffic urban	1	1	0	0	2	3	Y
												Sunderland Silksworth	URBAN BACKGROUND	09/12/2008	Background urban									
Central Scotland	1813314	2	3	2	Auchencorth Moss	RURAL	14/08/2007	Background rural	0	0	1	1	2	Auchencorth Moss PM10 PM25	RURAL	01/12/2006	Background rural	0	0	1	1	2	4	Y
					Grangemouth	URBAN INDUSTRIAL	01/01/2001	Industrial urban	0	0	0	0	Grangemouth	URBAN INDUSTRIAL	03/12/2008	Industrial urban								
North East Scotland	1001499	2	3	2	Aberdeen	URBAN BACKGROUND	18/09/1999	Background urban	0	1	0	0	1	Aberdeen	URBAN BACKGROUND	Not started	Background urban	0	1	0	0	1	2	Y
Highlands	380062	1	0	0	Inverness	ROADSIDE	11/07/2001	Traffic urban	1	0	0	0	1	N/A	#N/A	#N/A	0	0	0	0	0	1	Y	

Zone/ Agglomeration	Population	Assessment threshold	Annex V	Article 7	PM ₁₀ Sites	UK Classification	Start date for PM10	EU classification: type_of_station	EU classification station_type_of_area	Traffic Urban	Background urban	Background rural	Industrial urban	Total	PM _{2.5} Sites	UK Classification	Start date for PM2.5	EU classification: type_of_station	EU classification station_type_of_area	Traffic Urban	Background urban	Background rural	Industrial urban	Total	PM10 + PM2.5	Directive satisfied	
Scottish Borders	254690	1	0	0	N/A	N/A	N/A	N/A	N/A	0	0	0	0	0	N/A	N/A	N/A	N/A	N/A	0	0	0	0	0	0	0	Y
South Wales	1578773	3	7	4	Narberth	REMOTE	20/01/1997	Background rural	1	1	1	0	3	Chepstow A48				Traffic urban	1	1	0	0	2	5	Y		
					Chepstow A48	ROADSIDE	01/01/2008	Traffic urban						Newport				URBAN BACKGROUND	12/12/2008	Background urban							
					Newport	URBAN BACKGROUND	01/01/2008	Background urban																			
North Wales	720022	2	2	1	Wrexham	ROADSIDE	01/03/2002	Traffic urban	1	0	0	0	1	Wrexham Roadside.				Not started	Note started	Traffic urban	1	0	0	0	1	2	Y
Northern Ireland	1104991	3	6	3	Armagh Roadside	ROADSIDE	01/01/2009	Traffic urban	1	1	1	0	3	Derry				URBAN BACKGROUND	21/02/2008	Background urban	0	1	0	0	1	4	Y
					Lough Navar	REMOTE	02/10/1996	Background rural																			
					Derry	URBAN BACKGROUND	29/04/1997	Background urban																			
TOTAL					115					24	34	6	4	68						21	48	3	4	75	144		

68

Total PM₁₀ + PM_{2.5}

144

Directive satisfied

Y

*1, 2, 3 are used to indicate the respective assessment thresholds, where:

1 = <LAT
2 = LAT – UAT
3 => UAT

Table 5-6: PM_{2.5} Average Exposure Indicator Site List

Zone/ Agglomeration	Population	Number of conurbations	Population summed over conurbations only	No. urban background sites required	PM _{2.5} Background Sites AEI sites	PM _{2.5} Start date	UK Classification	EU: type_of_station	DEM - classification station_type_of_area	urban and suburban background industrial	Sites in AURN to meet requirement	PM _{2.5} Sites Other	UK Classification
Greater London Urban Area	8278251	N/A	N/A	8	London Harlington	16/09/2008	AIRPORT	Industrial	urban	8	Y	London Marylebone Road	KERBSIDE
					London Bexley	25/02/2008	SUBURBAN	Background	suburban			Camden Kerbside	KERBSIDE
					London Eltham	15/05/2008	SUBURBAN	Background	suburban			Haringey Roadside	ROADSIDE
					London Bloomsbury	26/03/1998	URBAN CENTRE	Background	urban				
					London Teddington	08/12/2008	URBAN BACKGROUND	Background	urban				
					London Harrow Stanmore	16/12/2008	URBAN BACKGROUND	Background	urban				
					London N. Kensington	17/12/2008	URBAN BACKGROUND	Background	urban				
					London Westminster	25/12/2008	URBAN BACKGROUND	Background	urban				
West Midlands Urban Area	2284093	N/A	N/A	2	Birmingham Tyburn Roadside	11/02/2009	URBAN BACKGROUND	Background	urban	2	Y	Birmingham Tyburn Roadside	ROADSIDE
					Birmingham Tyburn	15/12/2008	URBAN BACKGROUND	Background	urban				
Greater Manchester Urban Area	2244931	N/A	N/A	2	Manchester Piccadilly	15/01/2009	URBAN CENTRE	Background	urban	2	Y	Bury Roadside	ROADSIDE
					Salford Eccles	26/11/2008	URBAN INDUSTRIAL	Industrial	urban				
West Yorkshire Urban Area	1499465	N/A	N/A	1	Leeds Centre	02/12/2008	URBAN CENTRE	Background	urban	1	Y	Leeds Headingley Kerbside	KERBSIDE
Tyneside	879996	N/A	N/A	1	Newcastle Centre	24/08/2008	URBAN CENTRE	Background	urban	1	Y		
Liverpool Urban Area	816216	N/A	N/A	1	Liverpool Speke	17/09/2008	URBAN BACKGROUND	Background	urban	1	Y		
Sheffield Urban Area	640720	N/A	N/A	1	Sheffield Centre	10/12/2008	URBAN CENTRE	Background	urban	1	Y		
Nottingham Urban Area	666358	N/A	N/A	1	Nottingham Centre	19/12/2008	URBAN CENTRE	Background	urban	1	Y		

Zone/ Agglomeration	Population	Number of conurbations	Population summed over conurbations only	No. urban background sites required	PM _{2.5} Background Sites AEI sites	PM _{2.5} Start date	UK Classification	EU: type_of_station	DEM - classification station_type_of_area	urban and suburban background industrial	Sites in AURN to meet requirement	PM _{2.5} Sites Other	UK Classification
Bristol Urban Area	551066	N/A	N/A	1	Bristol St Paul's	12/08/2008	URBAN BACKGROUND	Background	urban	1	Y		
Brighton/ Worthing/ Littlehampton	461181	N/A	N/A	1	Brighton Preston Park	30/05/2008	URBAN BACKGROUND	Background	urban	1	Y		
Leicester Urban Area	441213	N/A	N/A	1	Leicester Centre	01/09/2008	URBAN CENTRE	Background	urban	1	Y		
Portsmouth Urban Area	442252	N/A	N/A	1	Portsmouth	23/12/2008	URBAN BACKGROUND	Background	urban	1	Y		
Teeside Urban Area	365323	N/A	N/A	1	Middlesbrough	13/11/2008	URBAN INDUSTRIAL	Industrial	urban	1	Y		
The Potteries	362403	N/A	N/A	1	Stoke-on-Trent Centre	05/11/2008	URBAN CENTRE	Background	urban	1	Y		
Bournemouth Urban Area	383713	N/A	N/A	1	Bournemouth Centre		URBAN CENTRE	Background	urban	1	Y		
Reading/ Wokingham Urban Area	369804	N/A	N/A	1	Reading New Town	25/09/2008	URBAN BACKGROUND	Background	urban	1	Y		
Coventry/ Bedworth	336452	N/A	N/A	1	Coventry Memorial Park	16/12/2008	URBAN BACKGROUND	Background	urban	1	Y		
Kingston Upon Hull	301416	N/A	N/A	1	Hull Freetown	02/09/2008	URBAN CENTRE	Background	urban	1	Y		
Southampton Urban Area	304400	N/A	N/A	1	Southampton Centre	05/11/2008	URBAN CENTRE	Background	urban	1	Y		
Birkenhead Urban Area	319675	N/A	N/A	1	Wirral Tranmere	28/01/2009	URBAN BACKGROUND	Background	urban	1	Y		
Southend Urban Area	269415	N/A	N/A	1	Southend-on-Sea	30/01/2009	URBAN BACKGROUND	Background	urban	1	Y		
Blackpool Urban Area	261088	N/A	N/A	1	Blackpool Marton	28/01/2009	URBAN BACKGROUND	Background	urban	1	Y		

Zone/ Agglomeration	Population	Number of conurbations	Population summed over conurbations only	No. urban background sites required	PM _{2.5} Background Sites AEI sites	PM _{2.5} Start date	UK Classification	EU: type_of_station	DEM - classification station_type_of_area	urban and suburban background industrial	Sites in AURN to meet requirement	PM _{2.5} Sites Other	UK Classification
Preston Urban Area	264601	N/A	N/A	1	Preston	27/01/2009	URBAN BACKGROUND	Background	urban	1	Y		
Glasgow Urban Area	1168270	N/A	N/A	1	Glasgow Centre	16/12/2008	URBAN CENTRE	Background	urban	1	Y	Glasgow Kerbside	KERBSIDE
Edinburgh Urban Area	452194	N/A	N/A	1	Edinburgh St Leonards	01/10/2008	URBAN BACKGROUND	Background	urban	1	Y		
Cardiff Urban Area	327706	N/A	N/A	1	Cardiff Centre	13/08/2008	URBAN CENTRE	Background	urban	1	Y		
Swansea Urban Area	270506	N/A	N/A	1	Port Talbot Margam	23/04/2008	URBAN INDUSTRIAL	Industrial	urban	1	Y	Swansea Roadside	ROADSIDE
Belfast Urban Area	580276	N/A	N/A	1	Belfast Centre	01/10/2008	URBAN CENTRE	Background	urban	1	Y		
Eastern	5124072	8	1126800	1	Norwich Lakenfield	08/10/2009	URBAN BACKGROUND	Background	urban	1	Y	Sandy Roadside Stanford-le-Hope Roadside	ROADSIDE ROADSIDE
South West	3980991	6	862,888	1	Plymouth Centre	13/10/2009	URBAN BACKGROUND	Background	urban	1	Y	Saltash Roadside NYI	ROADSIDE ROADSIDE
South East	6392004	10	1594871	1	Eastbourne Oxford St Ebbes	01/01/2010 18/12/2008	URBAN BACKGROUND URBAN BACKGROUND	Background Background	urban urban	2	Y	Chatham Roadside Storrington Roadside Harwell Rochester Stoke	ROADSIDE ROADSIDE RURAL RURAL
East Midlands	3084598	7	1065679	1	Northampton Chesterfield	05/09/2008 17/12/2008	URBAN BACKGROUND URBAN BACKGROUND	Background Background	urban urban	2	Y	Chesterfield Roadside	ROADSIDE
North West & Merseyside	2826622	5	767,341	1	Wigan Centre Warrington	27/11/2008 27/11/2008	URBAN BACKGROUND URBAN BACKGROUND	Background Background	urban urban	2	Y	Carlisle Roadside	ROADSIDE
Yorkshire & Humberside	2514947	4	611,924	1	York Bootham	03/12/2008	URBAN BACKGROUND	Background	urban	1	Y	York Fishergate	ROADSIDE

Zone/ Agglomeration	Population	Number of conurbations	Population summed over conurbations only	No. urban background sites required	PM _{2.5} Background Sites AEI sites	PM _{2.5} Start date	UK Classification	EU: type_of_station	DEM - classification station_type_of_area	urban and suburban background industrial	Sites in AURN to meet requirement	PM _{2.5} Sites Other	UK Classification
West Midlands	2271650	1	138,241	1	Leamington Spa	22/12/2008	URBAN BACKGROUND	Background	urban	1	Y	Leamington Spa Roadside	ROADSIDE
North East	1269803	1	182,974	1	Sunderland Silksworth	09/12/2008	URBAN BACKGROUND	Background	urban	1	Y	Stockton-on-Tees Eaglescliffe	ROADSIDE
Central Scotland	1813314	0	N/A	0	Grangemouth	03/12/2008	Urban Industrial	Industrial	urban	0	Y	Auchencorth Moss PM10 PM25 Grangemouth	RURAL URBAN INDUSTRIAL
North East Scotland	1001499	2	352,002	1	Aberdeen	20/02/2009	URBAN BACKGROUND	Background	urban	1	Y		
Highlands	380062	0	N/A	0	N/A			N/A	N/A	0	Y		
Scottish Borders	254690	0	N/A	0	N/A			N/A	N/A	0	Y		
South Wales	1578773	1	139,298	1	Newport	12/12/2008	URBAN BACKGROUND	Background	urban	1	Y	Chepstow A48	
North Wales	720022	0	N/A	0	N/A			N/A	N/A	0	Y	Wrexham Roadside.	
Northern Ireland	1104991	0	N/A	0	Derry	21/02/2008	URBAN BACKGROUND	Background	urban	0	Y	Derry	URBAN BACKGROUND
TOTAL				47						50			

6 Lead

Lead emissions in the United Kingdom decreased by 98 % over the period 1970 to 2005 (Jackson *et al.*, 2009). There were a number of sampling networks in operation during this period to verify the consequent reduction in ambient lead concentrations. These included the UK Multi-Element Survey (Loader, 1994) in operation since the 1970's and the Lead in Petrol Network which started in the 1985 and assessed how ambient lead concentrations decreased in line with controls on the content of lead in petrol. In addition, a UK-wide twelve month monitoring campaign began in 1999 to improve knowledge of the spatial distribution of lead concentrations close to industrial emission sources (Maggs *et al.*, 2001).

The preliminary assessment for the First Daughter Directive carried out by Bush (2000) showed that:

- There were no measured exceedance of the lower assessment threshold at roadside or background locations;
- There was only one industrial location (IMI Refiners, Walsall, West Midlands) where measured concentrations may have exceeded the lower assessment threshold. However, it should be borne in mind that this assessment was based on data collected over the period 1st December 1999 to 10 May 2000 so calculation of a valid annual mean was not possible. The lead concentration over this period was $0.7 \mu\text{g m}^{-3}$ and the data capture was 59 %;
- There was no modelled exceedance of the lower assessment threshold.

Ambient lead concentrations have continued to be monitored since 2002 in two UK networks, these include:

- Rural Monitoring Network whose purpose is to provide a broad representation of ambient concentration and deposition patterns in the UK (Fowler *et al.*, 2006).
- Urban Monitoring Network whose purpose is to measure ambient concentrations against relevant air quality objectives and requirements of the First Daughter Directive (Brown *et al.*, 2007).

Neither network has reported a measured exceedance of the lower assessment threshold since 2002. Further descriptions of these networks and the trend in lead concentrations since 1999 are provided in Vincent and Passant (2008).

The assessment thresholds for lead which have been used to determine the exceedance status of each zone in the UK are presented in Table 6-1.

Table 6-1 : Upper and Lower Assessment Thresholds for lead(adapted from Annex II, Section A, Table 4 of CAFE Directive)

Assessment threshold	Annual average value
Upper Assessment Threshold (UAT)	70 % of limit value ($0.35 \mu\text{g m}^{-3}$)
Lower Assessment Threshold (LAT)	50 % of limit value ($0.25 \mu\text{g m}^{-3}$)

6.1 Supplementary assessment data

As the annual air quality assessments carried out since 2001 have shown no measured exceedance of the lower assessment threshold for lead there has been no requirement to provide supplementary or modelled data. However, modelled data for lead is now compiled alongside arsenic, cadmium and nickel which are routinely assessed for the Fourth Daughter Directive. The same methods have been used for all heavy metals. This work is reported for lead by Yap (2009) and shows that there are no exceedances of the lower assessment threshold for the modelled year of 2008.

6.1 Number of sites required for protection of human health

Monitoring continues at a total of 35 sampling sites within the networks described above in support of United Kingdom specific research and policy initiatives.

7 Carbon Monoxide

Carbon monoxide monitoring using automatic instrumentation began in the late 1970's. The number of sampling sites increased during the 1990's with a more formalised network established following the preliminary assessment required for the Second Daughter Directive (Bush, 2002).

The assessment thresholds for carbon monoxide which have been used to determine the exceedance status of each zone in the UK are presented in Table 7-1.

Table 7-1 : Upper and Lower Assessment Thresholds for carbon monoxide (adapted from Annex II, Section A, Table 6 of CAFE Directive)

Assessment threshold	Eight-hour average
Upper Assessment Threshold (UAT)	70 % of limit value (7 mg m ⁻³)
Lower Assessment Threshold (LAT)	50 % of limit value (5 mg m ⁻³)

7.1 Supplementary assessment data

As part of the annual assessment of air quality required for the second Daughter Directive 2000/69/EC carbon monoxide 8-hour concentration maps have been prepared for the years 2001 to 2004.

7.1.1 Model description

The 8-hour mean background and roadside concentration maps are derived from annual concentration maps using the relationship between measured annual mean CO concentrations and measured maximum of 8-hour concentrations from the national network. The annual CO concentration map is composed of contributions from large and small point sources and area sources. The roadside contribution is derived by regressing the roadside increment concentration onto the CO emission from the road link upon which the sampling site is located. Further details on the modelling process can be found in the reports shown in column 4 of Table 2-3. An updated description of the modelling process can be found in the most recent annual assessment report (Grice *et al.*, 2009).

7.1.2 Geographical description of carbon monoxide concentrations

Maps of maximum 8-hour mean CO concentrations at background and roadside locations in 2004 are presented in Figure 7.1 . At all locations the concentration is significantly below the limit value of 10 mg m⁻³ as the maximum daily eight hour mean.

Figure 7.1: Maps of carbon monoxide at background and roadside locations in 2004

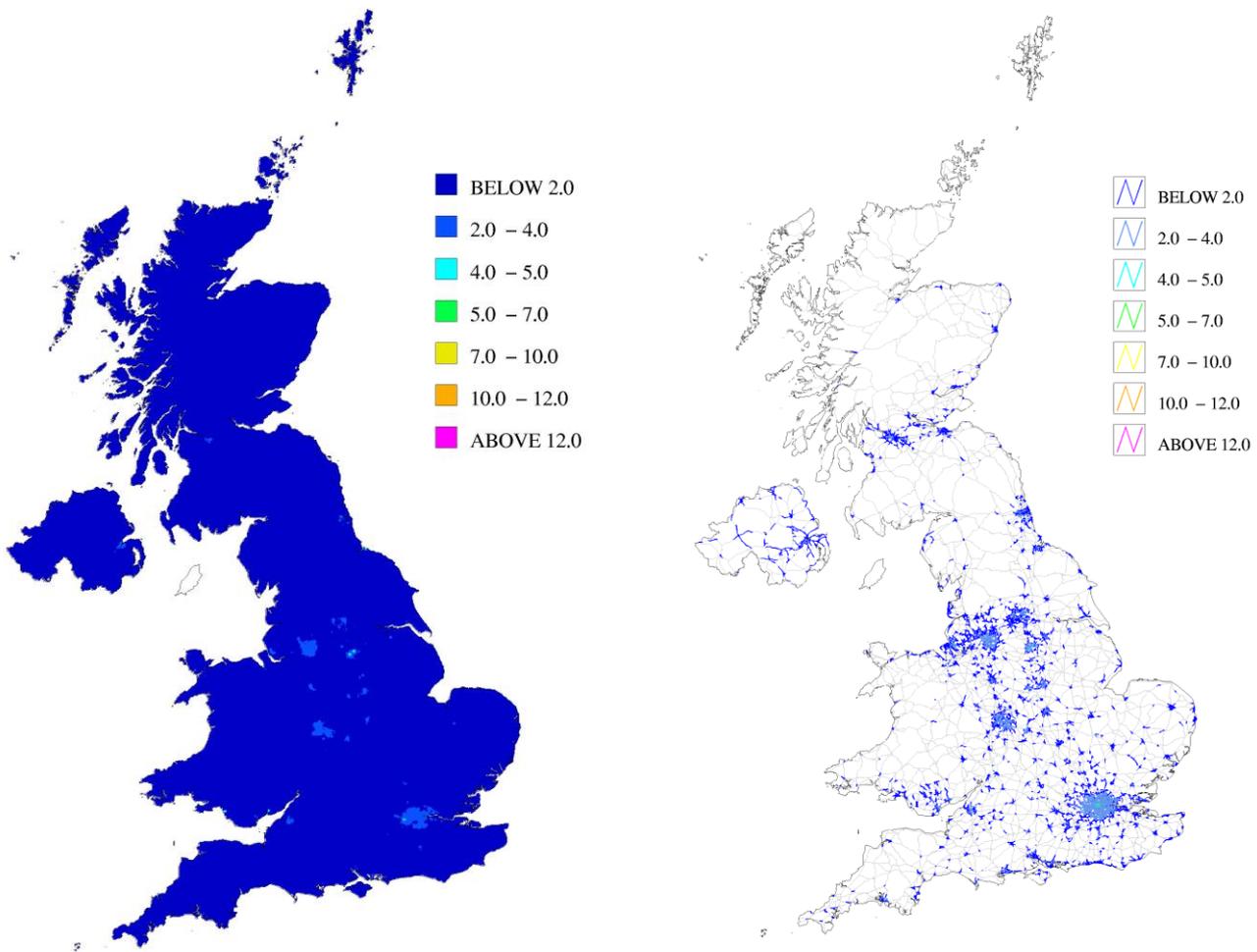


Figure 7.1a: Annual mean background 8-hour average CO concentration, 2004 (mg m^{-3})

Figure 7.1b: Urban major roads, 8-hour average CO concentration 2004, (mg m^{-3})

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7.2 Number of sites required for protection of human health

The measurements and modelling of ambient carbon monoxide concentrations commissioned for compliance with the Framework and Daughter Directives have provided a baseline of data on which to base this preliminary assessment.

The exceedance status of each zone has been determined in accordance with the protocol set out in Section 2 and based on guidance provided by the Directive. Table 3-2 summarises which threshold exceedance status has been assigned to each zone. There were no exceedances of the upper assessment threshold based on either measured or modelled data. Three zones measured concentrations in the LAT-UAT range. Table 7-3 shows that only five sampling sites are required for compliance with the CAFE Directive monitoring requirements; two sites in Greater London urban area, two in Greater Manchester urban area and one in Bristol urban area.

Table 7-2: Summary of comparison of measured and modelled carbon monoxide concentration with assessment thresholds for the period 2000 to 2004

Zone or agglomeration	Years available			Threshold classification based on measurement only	Modelled exceedance if higher than measured threshold
	Number of years monitoring data available	Years threshold is exceeded			
		LAT	UAT		
Greater London Urban Area	5	4	1	LAT-UAT	
West Midlands Urban Area	5	1	0	<LAT	
Greater Manchester Urban Area	5	3	1	LAT-UAT	
West Yorkshire Urban Area	5	2	1	<LAT	
Tyneside	5	0	0	<LAT	
Liverpool Urban Area	1	0	0	n/a	<LAT
Sheffield Urban Area	5	0	0	<LAT	
Nottingham Urban Area	5	1	0	<LAT	
Bristol Urban Area	5	4	0	LAT-UAT	
Brighton/Worthing/Littlehampton	5	0	0	<LAT	
Leicester Urban Area	5	0	0	<LAT	
Portsmouth Urban Area	3	0	0	<LAT	
Teesside Urban Area	5	0	0	<LAT	
The Potteries	5	1	1	<LAT	
Bournemouth Urban Area	2	0	0	n/a	<LAT
Reading/Wokingham Urban Area	1	0	0	n/a	<LAT
Coventry/Bedworth	3	0	0	<LAT	
Kingston upon Hull	2	0	0	n/a	<LAT
Southampton Urban Area	4	1	0	<LAT	
Birkenhead Urban Area	3	0	0	<LAT	
Southend Urban Area	3	0	0	<LAT	
Blackpool Urban Area	4	1	0	<LAT	
Preston Urban Area	4	0	0	<LAT	
Glasgow Urban Area	5	2	1	<LAT	
Edinburgh Urban Area	1	0	0	n/a	<LAT
Cardiff Urban Area	5	0	0	<LAT	
Swansea Urban Area	5	0	0	<LAT	
Belfast Urban Area	4	0	0	<LAT	
Eastern	5	1	0	<LAT	
South West	5	2	0	<LAT	
South East	5	1	0	<LAT	
East Midlands	2	0	0	n/a	<LAT
North West & Merseyside	1	0	0	n/a	<LAT
Yorkshire & Humberside	2	0	0	n/a	<LAT
West Midlands	5	0	0	<LAT	
North East	2	0	0	n/a	<LAT
Central Scotland	1	0	0	n/a	<LAT
North East Scotland	5	1	0	<LAT	
Highland	3	0	0	<LAT	
Scottish Borders	3	0	0	<LAT	
South Wales	2	0	0	n/a	<LAT
North Wales	3	0	0	<LAT	
Northern Ireland	5	0	0	<LAT	

Table 7-3: A comparison of the minimum number of sampling sites for carbon monoxide required by the CAFE Directive and number of sampling sites before and after the preliminary assessment

Zone code	Zone/Agglomeration	Minimum number of sites based on supplementary data	Number of sites before preliminary assessment		Number of sites after preliminary assessment				
			Background sites	Roadside sites	Traffic - Urban	Background Urban	Background Rural	Industrial Urban	Total Number of Sites in AURN
1	Greater London Urban Area	2	10	6	3	4	0	0	7
2	West Midlands Urban Area	0	4	0	0	0	0	0	0
3	Greater Manchester Urban Area	2	5	1	1	0	0	1	2
4	West Yorkshire Urban Area	0	2	0	0	1	0	0	1
5	Tyneside	0	1	0	0	1	0	0	1
6	Liverpool Urban Area	0	1	0	0	1	0	0	1
7	Sheffield Urban Area	0	2	0	0	1	0	0	1
8	Nottingham Urban Area	0	1	0	0	0	0	0	0
9	Bristol Urban Area	1	1	1	1	1	0	0	2
10	Brighton/Worthing/Littlehampton	0	0	2	0	0	0	0	0
11	Leicester Urban Area	0	1	0	0	1	0	0	1
12	Portsmouth Urban Area	0	1	0	0	0	0	0	0
13	Teesside Urban Area	0	2	0	0	0	0	1	1
14	The Potteries	0	1	0	0	0	0	0	0
15	Bournemouth Urban Area	0	1	0	0	0	0	0	0
16	Reading/Wokingham	0	1	0	0	0	0	0	0
17	Coventry/Bedworth	0	1	0	0	0	0	0	0
18	Kingston upon Hull	0	1	0	0	1	0	0	1
19	Southampton Urban Area	0	1	0	0	1	0	0	1
20	Birkenhead Urban Area	0	1	0	0	0	0	0	0
21	Southend Urban Area	0	1	0	0	0	0	0	0
22	Blackpool Urban Area	0	1	0	0	0	0	0	0
23	Preston Urban Area	0	1	0	0	0	0	0	0
24	Glasgow Urban Area	0	2	1	0	1	0	0	1
25	Edinburgh Urban Area	0	1	0	0	1	0	0	1
26	Cardiff Urban Area	0	1	0	0	1	0	0	1
27	Swansea Urban Area	0	1	0	0	0	0	1	1
28	Belfast Urban Area	0	1	0	0	1	0	0	1
29	Eastern	0	2	0	0	0	1	0	1
30	South West	0	1	2	0	0	0	0	0
31	South East	0	0	1	0	0	0	0	0
32	East Midlands	0	1	0	0	0	1	0	1
33	North West & Merseyside	0	1	0	0	0	0	0	0
34	Yorkshire & Humberside	0	1	0	0	0	0	0	0
35	West Midlands	0	1	0	0	0	0	0	0
36	North East	0	0	1	0	0	0	0	0
37	Central Scotland	0	1	0	0	0	0	0	0
38	North East Scotland	0	1	0	0	0	0	0	0
39	Highland	0	0	1	0	0	0	0	0
40	Scottish Borders	0	0	1	0	0	0	0	0
41	South Wales	0	1	0	0	0	0	0	0
42	North Wales	0	0	1	0	0	0	0	0
43	Northern Ireland	0	1	0	0	0	0	0	0
	TOTALS	5	58	18	5	16	2	3	26

Table 7-4 presents the carbon monoxide monitoring network in 2010. The table provides the following information regarding the carbon monoxide sampling sites in each zone:

- Zone/Agglomeration
- Population (2001)
- Exceedance classification
- Number of sites required per Annex V (monitoring data only)
- Number of sites required when Article 7 is applied (monitoring data and supplementary information)
- Site Name
- Start date for carbon monoxide
- UK Classification
- EU classification: type_of_station
- EU classification station_type_of_area
- Number of traffic or urban sites
- Number of background urban sites
- Number of background rural sites
- Number of industrial urban sites
- Total number of sites currently in operation
- Does number of sites within zone meet CAFE requirements? (Yes/No)

The number of stations monitoring carbon monoxide exceeds the minimum required for compliance (26 sites currently operational, five required). This is due to many of the sites forming long-term running data sets that are useful for policy evaluation purposes.

Table 7-4: Detailed description of carbon monoxide sampling sites in each zone and agglomeration in 2010

Zone/ Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start CO	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirements
Greater London Urban Area	8278251		4	2	London Marylebone Road	17/07/1997	KERBSIDE	Traffic	urban	3	4	0	0	7	Y
					Tower Hamlets Roadside	01/04/1996	ROADSIDE	Traffic	urban						
					London Cromwell Road 2	20/05/1998	ROADSIDE	Traffic	urban						
					London Bexley	01/05/1994	SUBURBAN	Background	suburban						
					London N. Kensington	01/04/1996	URBAN BACKGROUND	Background	urban						
					London Westminster	17/07/2001	URBAN BACKGROUND	Background	urban						
					London Bloomsbury	23/01/1992	URBAN CENTRE	Background	urban						
West Midlands Urban Area	2284093	1	0	0					0	0	0	0	0	Y	
Greater Manchester Urban Area	2244931	2	3	2	Bury Roadside	20/01/1997	ROADSIDE	Traffic	urban	1	0	0	1	2	Y
					Salford Eccles	20/03/1997	URBAN INDUSTRIAL	Industrial	urban						
West Yorkshire Urban Area	1499465	1	0	0	Leeds Centre	04/01/1993	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Tyneside	879996	1	0	0	Newcastle Centre	08/03/1992	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Liverpool Urban Area	816216	1	0	0	Liverpool Speke	21/05/2003	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y
Sheffield Urban Area	640720	1	0	0	Sheffield Centre	22/12/1995	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Nottingham Urban Area	666358	1	0	0						0	0	0	0	0	Y
Bristol Urban Area	551066	2	1	1	Bristol Old Market	01/07/1996	ROADSIDE	Traffic	urban	1	1	0	0	2	Y
					Bristol St Paul's	15/06/2006	URBAN BACKGROUND	Background	urban						

Zone/ Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start CO	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirements
Brighton/ Worthing/ Littlehampton	461181	1	0	0						0	0	0	0	0	Y
Leicester Urban Area	441213	1	0	0	Leicester Centre	04/01/1994	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Portsmouth Urban Area	442252	1	0	0						0	0	0	0	0	Y
Teeside Urban Area	365323	1	0	0	Middlesbrough	21/04/1995	URBAN INDUSTRIAL	Industrial	urban	0	0	0	1	1	Y
The Potteries	362403	1	0	0						0	0	0	0	0	Y
Bournemouth Urban Area	383713	1	0	0						0	0	0	0	0	Y
Reading/ Wokingham Urban Area	369804	1	0	0						0	0	0	0	0	Y
Coventry/ Bedworth	336452	1	0	0						0	0	0	0	0	Y
Kingston Upon Hull	301416	1	0	0	Hull Freetown	06/11/2002	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Southampton Urban Area	304400	1	0	0	Southampton Centre	04/01/1994	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Birkenhead Urban Area	319675	1	0	0						0	0	0	0	0	Y
Southend Urban Area	269415	1	0	0						0	0	0	0	0	Y
Blackpool Urban Area	261088	1	0	0						0	0	0	0	0	Y
Preston Urban Area	264601	1	0	0						0	0	0	0	0	Y

Zone/ Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start CO	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirements
Glasgow Urban Area	1168270	1	0	0	Glasgow Centre	26/07/1996	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Edinburgh Urban Area	452194	1	0	0	Edinburgh St Leonards	24/11/2003	URBAN BACKGROUND	Background	urban	0	1	0	0	1	Y
Cardiff Urban Area	327706	1	0	0	Cardiff Centre	12/05/1992	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Swansea Urban Area	270506	1	0	0	Port Talbot Margam	01/01/2008	URBAN INDUSTRIAL	Industrial	urban	0	0	0	1	1	Y
Belfast Urban Area	580276	1	0	0	Belfast Centre	08/03/1992	URBAN CENTRE	Background	urban	0	1	0	0	1	Y
Eastern	5124072	1	0	0	St Osyth	11/05/2002	RURAL	Background	rural	0	0	1	0	1	Y
South West	3980991	1	0	0						0	0	0	0	0	Y
South East	6392004	1	0	0						0	0	0	0	0	Y
East Midlands	3084598	1	0	0	Market Harborough	10/12/2003	RURAL	Background	rural	0	0	1	0	1	Y
North West & Merseyside	2826622	1	0	0						0	0	0	0	0	Y
Yorkshire & Humberside	2514947	1	0	0						0	0	0	0	0	Y
West Midlands	2271650	1	0	0						0	0	0	0	0	Y
North East	1269803	1	0	0						0	0	0	0	0	Y
Central Scotland	1813314	1	0	0						0	0	0	0	0	Y

Zone/ Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start CO	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirements
North East Scotland	1001499	1	0	0						0	0	0	0	0	Y
Highlands	380062	1	0	0						0	0	0	0	0	Y
Scottish Borders	254690	1	0	0						0	0	0	0	0	Y
South Wales	1578773	1	0	0						0	0	0	0	0	Y
North Wales	720022	1	0	0						0	0	0	0	0	Y
Northern Ireland	1104991	1	0	0						0	0	0	0	0	Y
TOTALS				5						5	16	2	3	26	

*1, 2, 3 are used to indicate the respective assessment thresholds, where:

1 = <LAT
2 = LAT – UAT
3 => UAT

8 Benzene

Benzene monitoring using automatic instrumentation began in the early 1990's as required to assess potential compliance against the then emerging EC Directive limit values on air quality. The monitoring methodology was revised in the early 2000's. Currently, benzene is monitored in the United Kingdom by the both automatic (Dumitrescu, 2008) and non- automatic methods (Butterfield, *et al.*, 2009).

The preliminary assessment for the Second Daughter Directive was described by Bush (2002).

The assessment thresholds for nitrogen dioxide which have been used to determine the exceedance status of each zone in the UK are presented in Table 8-1.

Table 8-1: Upper and Lower Assessment Thresholds for benzene (adapted from Annex II, Section A, Table 5 of CAFE Directive)

Assessment threshold	Eight-hour average
Upper Assessment Threshold (UAT)	70 % of limit value ($3.5 \mu\text{g m}^{-3}$)
Lower Assessment Threshold (LAT)	40 % of limit value ($2 \mu\text{g m}^{-3}$)

8.1 Supplementary assessment data

As part of the annual assessment of air quality required for the second Daughter Directive 2000/69/EC benzene annual mean concentration maps have been prepared for the years 2001, 2003 and 2004.

8.2 Model description

The annual benzene concentration map is composed of contributions from combustion point sources, fugitive point sources and area sources. The road side contribution is derived by regressing the roadside incremental concentration onto the benzene emission from each road link where the sampling site is located. Further details on the modelling process can be found in the reports shown in column 4 of Table 2-3. An updated description of the modelling process can be found in the most recent annual assessment report (Grice *et al.*, 2009).

8.2.1 Geographical description of benzene concentrations

Maps of benzene concentrations at background and roadside locations in 2004 are presented in Figure 8.1

Figure 8.1: Maps of benzene concentration at background and roadside locations in 2004

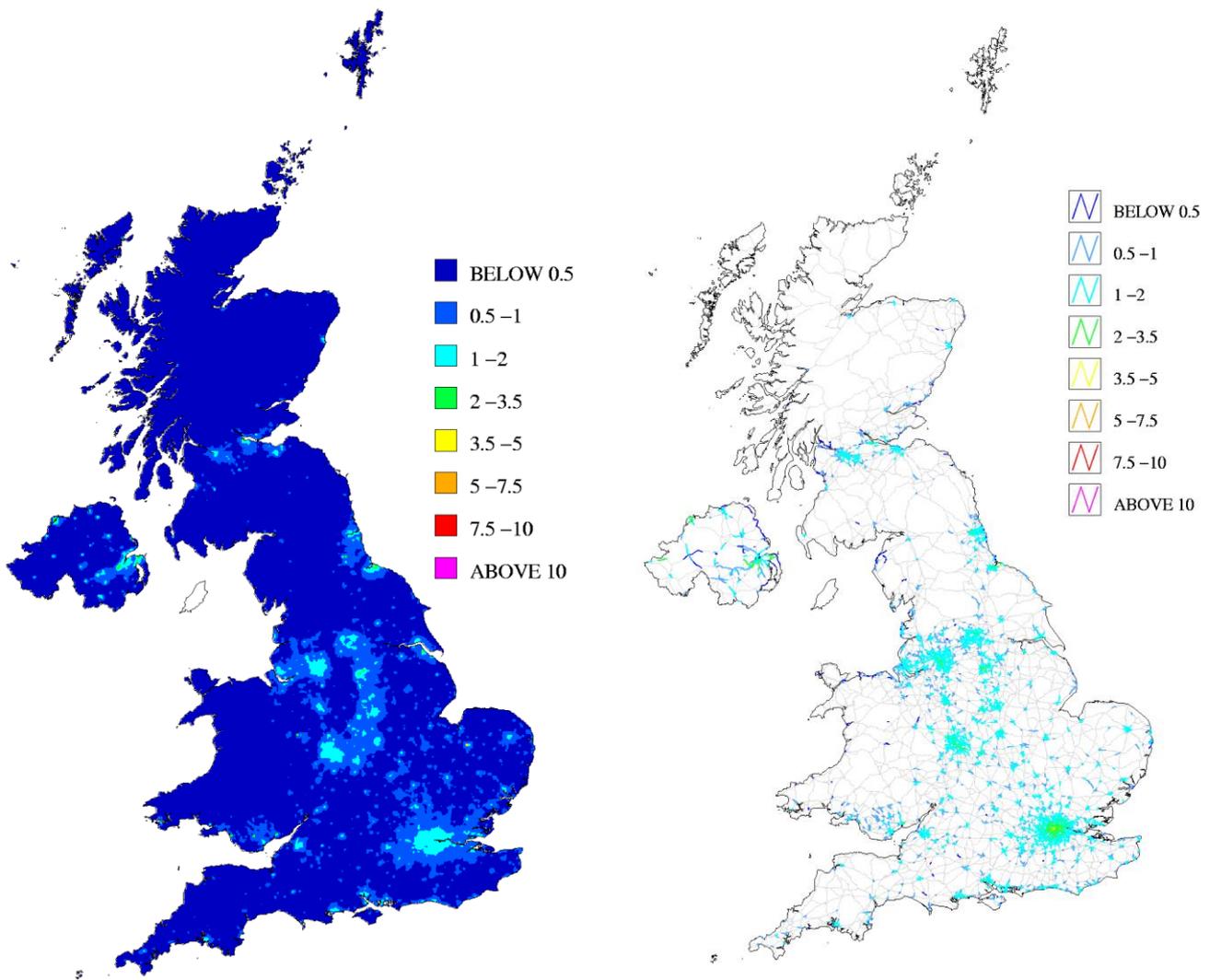


Figure 8.1a: Annual mean background benzene concentration, 2004 (mg m⁻³)

Figure 8.1b: Urban major roads, benzene concentration 2004, (mg m⁻³)

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8.3 Number of sites required for protection of human health

The measurements and modelling of ambient benzene concentrations commissioned for compliance with the Framework and Daughter Directives have provided a baseline of data on which to base this preliminary assessment.

The exceedance status of each zone has been determined in accordance with the protocol set out in Section 2 and based on guidance provided by the Directive. Table 8-2 summarises which threshold has been assigned to each zone and agglomeration. Only one zone (Greater London Urban Area) was shown to exceed the UAT based on the measured data. A further 13 zones exceeded the LAT based on modelled data.

Table 8-3 presents the minimum number of sampling sites required in each zone based on the supplementary modelled data available. Based on the availability of supplementary assessment data 21 sampling sites are required in the United Kingdom to meet the monitoring obligations for the CAFE Directive. Using the monitoring descriptions produced in the latest monitoring reports (Butterfield *et al.*,

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2009 and Dumitrean, 2008) benzene concentrations is currently monitored at 42 locations. Hence, the UK is compliant with the benzene requirements of the CAFE Directive.

Table 8-4 presents the benzene monitoring network in 2010. The table provides the following information regarding the benzene sampling sites in each zone:

- Zone/Agglomeration
- Population (2001)
- Exceedance classification
- Number of sites required per Annex V (monitoring data only)
- Number of sites required when Article 7 is applied (monitoring data and supplementary information)
- Site Name
- Start date for carbon monoxide
- UK Classification
- EU classification: type_of_station
- EU classification station_type_of_area
- Number of traffic or urban sites
- Number of background urban sites
- Number of background rural sites
- Number of industrial urban sites
- Total number of sites currently in operation
- Does number of sites within zone meet CAFE requirements? (Yes/No)

Table 8-2: Summary of comparison of measured and modelled benzene concentration with assessment thresholds for the period 2000 to 2004

Zone or agglomeration	Years available			Threshold classification based on measurement only	Modelled exceedance if higher than measured threshold
	Valid	LAT	UAT		
Greater London Urban Area	5	5	3	>UAT	
West Midlands Urban Area	3	2	1	<LAT	LAT-UAT
Greater Manchester Urban Area	2	0	0	n/a	LAT-UAT
West Yorkshire Urban Area	2	2	0	n/a	LAT-UAT
Tyneside	2	0	0	n/a	LAT-UAT
Liverpool Urban Area	1	0	0	n/a	LAT-UAT
Sheffield Urban Area	2	0	0	n/a	LAT-UAT
Nottingham Urban Area	2	0	0	n/a	LAT-UAT
Bristol Urban Area	2	2	0	n/a	LAT-UAT
Brighton/Worthing/Littlehampton	2	0	0	n/a	<LAT
Leicester Urban Area	2	0	0	n/a	LAT-UAT
Portsmouth Urban Area	1	0	0	n/a	<LAT
Teesside Urban Area	3	2	0	<LAT	
The Potteries	2	0	0	n/a	LAT-UAT
Bournemouth Urban Area	2	0	0	n/a	<LAT
Reading/Wokingham Urban Area	1	0	0	n/a	<LAT
Coventry/Bedworth	2	0	0	n/a	<LAT
Kingston upon Hull	2	0	0	n/a	<LAT
Southampton Urban Area	3	2	0	<LAT	LAT-UAT
Birkenhead Urban Area	0	0	0	n/a	<LAT
Southend Urban Area	2	0	0	n/a	<LAT
Blackpool Urban Area	0	0	0	n/a	<LAT
Preston Urban Area	0	0	0	n/a	<LAT
Glasgow Urban Area	2	0	0	n/a	LAT-UAT
Edinburgh Urban Area	4	0	0	<LAT	
Cardiff Urban Area	2	0	0	n/a	<LAT
Swansea Urban Area	0	0	0	n/a	<LAT
Belfast Urban Area	2	2	0	n/a	<LAT
Eastern	2	0	0	n/a	<LAT
South West	2	0	0	n/a	<LAT
South East	5	0	0	<LAT	
East Midlands	2	0	0	n/a	LAT-UAT
North West & Merseyside	0	0	0	n/a	<LAT
Yorkshire & Humberside	2	0	0	n/a	<LAT
West Midlands	2	0	0	n/a	<LAT
North East	2	2	1	n/a	<LAT
Central Scotland	2	0	0	n/a	<LAT
North East Scotland	0	0	0	n/a	<LAT
Highland	0	0	0	n/a	<LAT
Scottish Borders	0	0	0	n/a	<LAT
South Wales	2	0	0	n/a	<LAT
North Wales	0	0	0	n/a	<LAT
Northern Ireland	0	0	0	n/a	<LAT

Table 8-3: A comparison of the minimum number of sampling sites for benzene required by the CAFE Directive and number of sampling sites before and after the preliminary assessment

Zone code	Zone/Agglomeration	Minimum number of sites based on supplementary data	Number of sites before preliminary assessment		Number of sites after preliminary assessment				
			Background sites	Roadside sites	Traffic - Urban	Background Urban	Background Rural	Industrial Urban	Total Number of Sites
1	Greater London Urban Area	5	2	2	3	2			5
2	West Midlands Urban Area	2	0	1	1	1			2
3	Greater Manchester Urban Area	2	1	0	1	1			2
4	West Yorkshire Urban Area	1	1	1		1			1
5	Tyneside	1	1	0		1			1
6	Liverpool Urban Area	1	1	0		1			1
7	Sheffield Urban Area	1	1	0		1			1
8	Nottingham Urban Area	1	1	0		1			1
9	Bristol Urban Area	1	0	1	1				1
10	Brighton/Worthing/Littlehampton	0	0	1					0
11	Leicester Urban Area	1	1	0		1			1
12	Portsmouth Urban Area	0	1	0					0
13	Teesside Urban Area	0	1	0				1	1
14	The Potteries	1	1	0		1			1
15	Bournemouth Urban Area	0	1	0					0
16	Reading/Wokingham	0	1	0					0
17	Coventry/Bedworth	0	1	0		1			1
18	Kingston upon Hull	0	1	0					0
19	Southampton Urban Area	1	1	0		1			1
20	Birkenhead Urban Area	0	0	0					0
21	Southend Urban Area	0	1	0					0
22	Blackpool Urban Area	0	0	0					0
23	Preston Urban Area	0	0	0					0
24	Glasgow Urban Area	1	0	1	1				1
25	Edinburgh Urban Area	0	2	0					0
26	Cardiff Urban Area	0	1	0		1			1
27	Swansea Urban Area	0	0	0					0
28	Belfast Urban Area	0	1	1		1			1
29	Eastern	0	1	0	1	1			2
30	South West	0	1	0		2			2
31	South East	0	0	1	1	1	1		3
32	East Midlands	2	1	0	1	1			2
33	North West & Merseyside	0	1	0	1	1			2
34	Yorkshire & Humberside	0	1	0	1	1		1	3
35	West Midlands	0	1	0		1			1
36	North East	0	0	1		2			2
37	Central Scotland	0	1	0			1	1	2
38	North East Scotland	0	0	0					0
39	Highland	0	0	0					0
40	Scottish Borders	0	0	0					0
41	South Wales	0	1	0					0
42	North Wales	0	0	0					0
43	Northern Ireland	0	0	0					0
	TOTALS	21	30	10	12	25	2	3	42

Table 8-4: Detailed description of benzene sampling sites in each zone and agglomeration in 2010

Zone/Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start Benzene	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirement
Greater London Urban Area	8278251	3	10	5	Bloomsbury	28/05/2002	Urban Background	Background	Urban	3	2	0	0	5	
					Camden Kerbside	03/01/2008	Kerbside	Traffic	Urban						
					Eltham	17/10/2003	Urban Background	Background	Suburban						
					Haringey Roadside	22/03/2002	Roadside	Traffic	Urban						
					Marylebone Road	01/09/1997	Roadside	Traffic	Urban						
West Midlands Urban Area	2284093	2	3	2	Birmingham Tyburn	03/01/2008	Urban Background	Background	Urban	1	1	0	0	2	
					Birmingham Roadside	22/07/2009	Roadside	Traffic	Urban						
Greater Manchester Urban Area	2244931	2	3	2	Manchester Piccadilly	20/03/2002	Urban Background	Background	Urban	1	1	0	0	2	
					Bury Roadside	03/01/2008	Roadside	Traffic	Urban						
West Yorkshire Urban Area	1499465	2	2	1	Leeds Centre	26/02/2002	Urban Background	Background	Urban	0	1	0	0	1	
Tyneside	879996	2	1	1	Newcastle	05/03/2002	Urban Background	Background	Urban	0	1	0	0	1	
Liverpool Urban Area	816216	2	1	1	Liverpool Speke	25/04/2003	Urban Background	Background	Urban	0	1	0	0	1	
Sheffield Urban Area	640720	2	1	1	Sheffield	10/04/2002	Urban Background	Background	Urban	0	1	0	0	1	
Nottingham Urban Area	666358	2	1	1	Nottingham Centre	14/03/2002	Urban Centre	Background	Urban	0	1	0	0	1	
Birstol Urban Area	551066	2	1	1	Bristol Old Market	28/01/2002	Roadside	Traffic	Urban	1	0	0	0	1	
Brighton/ Worthing/ Littlehampton	461181	1	0	0						0	0	0	0	0	

Zone/Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start Benzene	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirement
Leicester Urban Area	441213	2	1	1	Leicester Centre	12/02/2002	Urban Background	Background	Urban	0	1	0	0	1	
Portsmouth Urban Area	442252	1	0	0						0	0	0	0	0	
Teeside Urban Area	365323	1	0	1	Middlesbrough	18/02/2002	Industrial	Industrial	Urban	0	0	0	1	1	
The Potteries	362403	2	1	1	Stoke Centre	09/05/2002	Urban Background	Background	Urban	0	1	0	0	1	
Bournemouth Urban Area	383713	1	0	0						0	0	0	0	0	
Reading/ Wokingham Urban Area	369804	1	0	0						0	0	0	0	0	
Coventry/ Bedworth	336452	1	0	1	Coventry Memorial Park	02/07/2002	Urban Background	Background	Urban	0	1	0	0	1	
Kingston Upon Hull	301416	1	0	0						0	0	0	0	0	
Southampton Urban Area	304400	2	1	1	Southampton	18/12/2001	Urban Background	Background	Urban	0	1	0	0	1	
Birkenhead Urban Area	319675	1	0	0						0	0	0	0	0	
Southend Urban Area	269415	1	0	0						0	0	0	0	0	
Blackpool Urban Area	261088	1	0	0						0	0	0	0	0	
Preston Urban Area	264601	1	0	0						0	0	0	0	0	
Glasgow Urban Area	1168270	2	2	1	Glasgow	01/08/2002	Roadside	Traffic	Urban	1	0	0	0	1	
Edinburgh Urban Area	452194	1	0	0						0	0	0	0	0	

Zone/Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start Benzene	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirement
Cardiff Urban Area	327706	1	0	0						0	0	0	0	0	
Swansea Urban Area	270506	1	0	0						0	0	0	0	0	
Belfast Urban Area	580276	1	0	0	Belfast Centre	07/05/2002	Urban Background	Background	Urban	0	1	0	0	1	
Eastern	5124072	1	0	0	Norwich Centre Cambridge Roadside	11/11/2009 03/01/2008	Urban Background Roadside	Background Traffic	Urban Urban	1	1	0	0	2	
South West	3980991	1	0	0	Plymouth Bath Roadside	20/06/2002 03/01/2008	Urban Background Roadside	Background Traffic	Urban Urban	1	1	0	0	2	
South East	6392004	1	0	0	Oxford Centre Oxford St Ebbes Harwell	12/03/2002 30/01/2008 01/01/1995	Roadside Urban Background Rural	Traffic Background Background	Urban Urban Rural	1	1	1	0	3	
East Midlands	3084598	2	3	2	Northampton Chesterfield	13/03/2002 04/06/2008	Urban Background Roadside	Background Traffic	Urban Urban	1	1	0	0	2	
North West & Merseyside	2826622	1	0	0	Wigan Centre Carlisle Caldewgate	08/10/2004 09/04/2008	Urban Background Roadside	Background Traffic	Urban Urban	1	1	0	0	2	
Yorkshire & Humberside	2514947	1	0	0	Barnsley Gawber York Fishergate South Killingholme	02/08/2002 03/01/2008 02/09/2008	Urban Background Roadside Urban Industrial	Background Traffic Industrial	Urban Urban Urban	1	1	0	1	3	
West Midlands	2271650	1	0	0	Leamington Spa	27/06/2002	Urban Background	Background	Urban	0	1	0	0	1	
North East	1269803	1	0	0	Eaglescliffe - Yarm	30/09/2008	Roadside	Traffic	Urban	1	0	0	0	1	

Zone/Agglomeration	Population	Concentration*	No of sites required per Annex V	No of sites required when Article 7 is applied	Site Name	Start Benzene	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirement
Central Scotland	1813314	1	0	0	Grangemouth	06/03/2002	Industrial	Industrial	Urban	0	0	1	1	2	
					Auchencorth Moss	04/09/2006	Rural	Background	Rural						
North East Scotland	1001499	1	0	0						0	0	0	0	0	
Highlands	380062	1	0	0						0	0	0	0	0	
Scottish Borders	254690	1	0	0						0	0	0	0	0	
South Wales	1578773	1	0	0						0	0	0	0	0	
North Wales	720022	1	0	0						0	0	0	0	0	
Northern Ireland	1104991	1	0	0						0	0	0	0	0	
				21						14	21	2	3	40	

*1, 2, 3 are used to indicate the respective assessment thresholds, where:

1 = <LAT
2 = LAT – UAT
3 => UAT

9 Ozone

Ozone monitoring in the UK began in the 1970's. Monitoring at this time formed part of a wider research effort that aimed to understand the role played by ozone in photochemical processes and also to assess the distribution of ozone throughout the UK.

Unlike the other pollutants considered in this preliminary assessment, there is no requirement to assess ozone levels against upper or lower assessment thresholds. This arises because there are no limit values for ozone. Instead target values and long-term objectives have been set. These are shown in Table 9-1 and Table 9-2, respectively. Fixed measurements are required if there are exceedances of the long term objectives (Article 9 of the CAFE Directive).

Table 9-1: Target Values for ozone (adapted from Annex VII, Section B, of CAFE Directive)

	Averaging period	Target Value	Date by which target value must be met
Protection of human health	Maximum daily eight-hour period ⁽²⁾	120 µg m ⁻³ , not to be exceeded more than 25 days per calendar year averaged over three years ⁽³⁾	1.1.2010
Protection of vegetation	May to July	AOT40 (calculated from 1 hour values) 18000 µg m ⁻³ .hour averaged over 5 years ⁽³⁾	1.1.2010

(1) Compliance with target values will be assessed as of this date. That is, 2010 will be the first year the data for which is used in calculating compliance over the following three or five years, as appropriate.

(2) The maximum daily eight-hour mean concentration shall be selected by examining eight-hour running averages, calculated from hourly data and updated each hour. Each eight -hour average so calculated shall be assigned to the day on which it ends. i.e. the first calculation period for any one day will be the period from 17:00 on the previous day to 01:00 on that day; the last calculation period for any one day will be the period from 16:00 to 24:00 on the day.

(3) If the three or five year averages cannot be determined on the basis of a full and consecutive set of annual data, the minimum annual data required for checking compliance with the target values will be as follows:

- for the target value for the protection of human health: valid data for one year,
- for the target value for the protection of vegetation: valid data for three years.

Table 9-2: Long Term Objectives for ozone (adapted from Annex VII, Section C, of CAFE Directive)

	Averaging period	Target Value	Date by which target value must be met ⁽¹⁾
Protection of human health	Maximum daily eight-hour mean within a calendar year	120 µg m ⁻³	Not defined
Protection of vegetation	May to July	AOT40 (calculated from 1 hour values) 6000 µg m ⁻³ .hour.	Not defined

9.1 Supplementary assessment data

The preliminary assessment for the Third Daughter Directive (2002/3/EC) was carried out in 2003 and utilised both measured data and supplementary assessment data provided by semi-empirical zone models. A summary of the UK's existing models supplying supplementary assessment data for this preliminary assessment and also for the annual air quality assessment under CAFE is provided in the following section.

9.1.1 Model description

The modelling method for the target value for protection of human health utilised interpolation of the number of days for which the average maximum daily 8-hour mean concentration exceeds 120 µg m⁻³,

over the three year period 2002 to 2004, (measured at rural locations). To take into account of the depleting effect of NO_x on ozone concentrations in urban areas, an empirically derived coefficient relating the decrement in ozone concentration to the NO_x concentration was used to reduce the ozone concentration in urban areas.

The modelling method for the AOT 40 Value for the protection of vegetation involved interpolating the AOT 40 concentrations over the five year period (2000 to 2004) and correcting for the depleting effect of NO_x in a similar way to the number of days greater than 120 $\mu\text{g m}^{-3}$. The modelling methods are described in more detail in Bush *et al.*, (2006), Yap *et al.*, (2009) and Kent *et al.*, (2009).

9.1.2 Geographical description of ozone concentrations

Figure 9.1 presents example maps of the average number of days the 8-hour maximum concentration exceeds 120 $\mu\text{g m}^{-3}$ over the three year period (2002 to 2004) and the average AOT40 over the five year period (2000 to 2004). The effect of NO_x emissions in reducing each respective metric in urban locations, particularly in the London conurbation, can clearly be seen.

Figure 9.1: Example maps of ozone related metrics

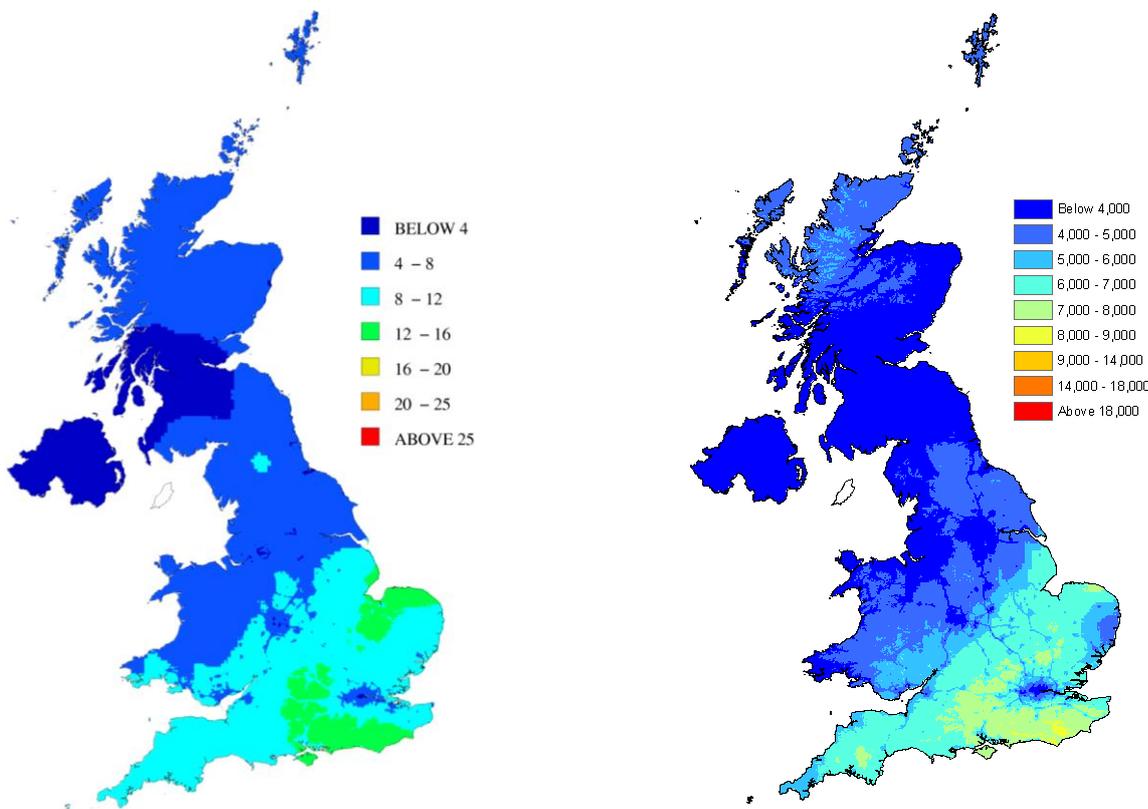


Figure 9.1a: Number of days exceeding 120 $\mu\text{g m}^{-3}$, expressed as a three years average over the period 2002 to 2004.

Figure 9.1b: Estimated AOT40 wheat crops, averaged 2000 to 2004 ($\mu\text{g m}^{-3}$.hours)

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9.2 Number of sites required for protection of human health and vegetation

The annual air quality assessment for ozone required by the Framework and the Third Daughter Directives (Bush *et al.*, 2006) has provided sufficient measurement data on which to base this preliminary assessment.

The annual assessment carried out for the ozone in 2004 showed no exceedance of the maximum daily 8-hour mean or the AOT40 target values. However, there were exceedances of the long-term objectives in 2004, and this triggered a requirement for fixed measurements in accordance with Article 9. Altogether 43 zones (36 measured and 7 modelled) exceeded the maximum daily 8-hour long-term objective and 7 zones (5 measured and 2 modelled) exceeded the AOT40 long-term objective. Further details can be found in Bush *et al.*, (2006).

Table 2-5 in Section 2, specifies the number of sites required to be compliant with the CAFE Directive. However according to Article 10 Paragraph 3 the number of sites may be reduced if modelling data is available. The size of this reduction is not specified but we have assumed this equates to 50 %. For the UK therefore, under these circumstances, Paragraph (3c) specifies that the minimum number of sampling points in each zone shall be one sampling point per two million inhabitants or one sampling point per 50,000 km², whichever produces the greater number of sampling points. There must also be not less than one sampling point in each zone or agglomeration.

Based on these criteria Table 9-3 presents the minimum of sampling sites required in each zone based on the availability of supplementary assessment data. Altogether 56 sampling sites are required in the UK to meet the monitoring obligations for the CAFE Directive.

Table 9-3: A comparison of the minimum number of sampling sites for ozone required by the CAFE Directive based on the availability of supplementary data and the number of existing background and roadside sites

Zone code	Zone/Agglomeration	Minimum number of sites based on supplementary data	Number of sites before preliminary assessment	Number of sites after preliminary assessment				
				Traffic - Urban	Background Urban	Background Rural	Industrial Urban	Total Number of Sites in AURN
1	Greater London Urban Area	4	14	1	7	0	1	9
2	West Midlands Urban Area	2	4	1	3	0	0	4
3	Greater Manchester Urban Area	2	5	0	2	0	1	3
4	West Yorkshire Urban Area	1	2	0	1	0	0	1
5	Tyneside	1	1	0	1	0	0	1
6	Liverpool Urban Area	1	1	0	1	0	0	1
7	Sheffield Urban Area	1	2	0	1	0	0	1
8	Nottingham Urban Area	1	1	0	1	0	0	1
9	Bristol Urban Area	1	1	0	1	0	0	1
10	Brighton/Worthing/Littlehampton	1	1	0	1	0	0	1
11	Leicester Urban Area	1	1	0	1	0	0	1
12	Portsmouth Urban Area	1	1	0	1	0	0	1
13	Teesside Urban Area	1	2	0	0	0	1	1
14	The Potteries	1	1	0	1	0	0	1
15	Bournemouth Urban Area	1	1	0	1	0	0	1
16	Reading/Wokingham Urban Area	1	1	0	1	0	0	1
17	Coventry/Bedworth	1	1	0	1	0	0	1
18	Kingston upon Hull	1	1	0	1	0	0	1
19	Southampton Urban Area	1	1	0	1	0	0	1
20	Birkenhead Urban Area	1	1	0	1	0	0	1
21	Southend Urban Area	1	1	0	1	0	0	1
22	Blackpool Urban Area	1	1	0	1	0	0	1
23	Preston Urban Area	1	1	0	1	0	0	1
24	Glasgow Urban Area	1	1	0	1	0	0	1
25	Edinburgh Urban Area	1	1	0	1	0	0	1
26	Cardiff Urban Area	1	1	0	1	0	0	1
27	Swansea Urban Area	1	2	0	0	0	1	1
28	Belfast Urban Area	1	1	0	1	0	0	1
29	Eastern	3	4	0	2	4	0	6
30	South West	2	4	1	1	2	0	4
31	South East	2	3	0	1	3	0	4
32	East Midlands	2	3	0	2	2	0	4
33	North West & Merseyside	2	2	0	2	1	0	3
34	Yorkshire & Humberside	2	2	0	1	1	0	2
35	West Midlands	2	2	0	2	0	0	2
36	North East	1	1	0	1	0	0	1
37	Central Scotland	1	1	0	0	2	0	2
38	North East Scotland	1	1	0	1	0	0	1
39	Highland	1	1	0	1	2	0	3
40	Scottish Borders	1	1	0	1	1	0	2
41	South Wales	1	2	0	1	1	0	2
42	North Wales	1	1	0	1	1	0	2
43	Northern Ireland	1	1	0	1	1	0	2
	TOTALS	56	81	3	53	21	4	81

Table 9-4 presents the sampling measuring ozone in 2010. The table provides the following information regarding the ozone sampling sites in each zone:

- Zone/Agglomeration
- Population (2001)
- Number of sites required per Annex V (monitoring only)
- No of sites required when Article 9 is applied (monitoring only)
- Site Name
- Start date for O₃
- UK Classification
- EU classification: type_of_station
- EU classification station_type_of_area
- EU classification station_ozone_classification
- Number of traffic urban sites
- Number of background urban sites
- Number of background rural sites
- Number of industrial urban sites
- Total
- Does number of sites within zone meet CAFE requirements? (Yes/No)

Table 9-3 and Table 9-4 show that the United Kingdom is compliant with the monitoring provision for ozone when supplementary data are available (in accordance with Article 7, Paragraph 3). In fact, the number of sites monitoring ozone is larger than the minimum specified. This is because many of the sites form long-term running data sets that are useful for policy evaluation purposes.

Table 9-4: Detailed description of ozone sampling sites in each zone and agglomeration in 2010

Zone/ Agglomeration	Population	No of sites required per Annex V	No of sites required when Article 9 is applied	Site Name	Start_O3	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	EU ozone_classification	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirements			
Greater London Urban Area	8278251	6	4	London Bloomsbury	23/01/1992	URBAN CENTRE	Background	urban	urban	1	7	0	1	9	Y			
				London Eltham	01/04/1996	SUBURBAN	Background	suburban	urban									
				London Haringey	16/05/1996	URBAN CENTRE	Background	urban	urban									
				London Harlington	01/01/2004	AIRPORT	Industrial	urban	urban									
				London Hillingdon	02/08/1996	SUBURBAN	Background	suburban	urban									
				London Marylebone Road	17/07/1997	KERBSIDE	Traffic	urban	urban									
				London N. Kensington	01/04/1996	URBAN BACKGROUND	Background	urban	urban									
				London Teddington	08/08/1996	URBAN BACKGROUND	Background	urban	urban									
				London Westminster	17/07/2001	URBAN BACKGROUND	Background	urban	urban									
West Midlands Urban Area	2284093	4	2	Birmingham Tyburn	16/08/2004	URBAN BACKGROUND	Background	urban	urban	1	3	0		4	Y			
				Sandwell West Bromwich	04/11/1998	URBAN BACKGROUND	Background	urban	urban									
				Birmingham Tyburn Roadside	11/02/2009	ROADSIDE	Traffic	urban	urban									
				Walsall Willenhall	Not started	URBAN BACKGROUND	Background	urban	urban									
Greater Manchester Urban Area	2244931	4	2	Manchester Piccadilly	18/12/1995	URBAN CENTRE	Background	urban	urban	0	2	0	1	3	Y			
				Manchester South	06/12/1996	SUBURBAN	Background	suburban	urban									
				Salford Eccles	20/03/1997	URBAN INDUSTRIAL	Industrial	urban	urban									
West Yorkshire Urban Area	1499465	3	1	Leeds Centre	04/01/1993	URBAN CENTRE	Background	urban	urban	0	1	0	0	1	Y			
Tyneside	879996	2	1	Newcastle Centre	08/03/1992	URBAN CENTRE	Background	urban	urban	0	1	0	0	1	Y			
Liverpool Urban Area	816216	2	1	Liverpool Speke	21/05/2003	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y			

Zone/ Agglomeration	Population	No of sites required per Annex V	No of sites required when Article 9 is applied	Site Name	Start_O3	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	EU station_ozone_classification	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirements
Sheffield Urban Area	640720	2	1	Sheffield Centre	22/12/1995	URBAN CENTRE	Background	urban	urban	0	1	0	0	1	Y
Nottingham Urban Area	666358	2	1	Nottingham Centre	02/09/1996	URBAN CENTRE	Background	urban	urban	0	1	0	0	1	Y
Birstol Urban Area	551066	2	1	Bristol St Paul's	15/06/2006	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Brighton/ Worthing/ Littlehampton	461181	1	1	Brighton Preston Park	03/11/2004	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Leicester Urban Area	441213	1	1	Leicester Centre	04/01/1994	URBAN CENTRE	Background	urban	urban	0	1	0	0	1	Y
Portsmouth Urban Area	442252	1	1	Portsmouth	15/04/2003	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Teeside Urban Area	365323	1	1	Middlesbrough	21/04/1995	URBAN INDUSTRIAL	Industrial	urban	urban	0	0	0	1	1	Y
The Potteries	362403	1	1	Stoke-on-Trent Centre	11/03/1997	URBAN CENTRE	Background	urban	urban	0	1	0	0	1	Y
Bournemouth Urban Area	383713	1	1	Bournemouth	27/02/2003	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Reading/ Wokingham Urban Area	369804	1	1	Reading New Town	17/10/2003	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Coventry/ Bedworth	336452	1	1	Coventry Memorial Park	26/02/2001	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Kingston Upon Hull	301416	1	1	Hull Freetown	06/11/2002	URBAN CENTRE	Background	urban	urban	0	1	0	0	1	Y
Southampton Urban Area	304400	1	1	Southampton Centre	04/01/1994	URBAN CENTRE	Background	urban	urban	0	1	0	0	1	Y
Birkenhead Urban Area	319675	1	1	Wirral Tranmere	14/05/2000	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y

Zone/ Agglomeration	Population	No of sites required per Annex V	No of sites required when Article 9 is applied	Site Name	Start_O3	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	EU station_ozone_classification	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirements
Southend Urban Area	269415	1	1	Southend-on-Sea	24/07/2000	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Blackpool Urban Area	261088	1	1	Blackpool Marton	14/06/2005	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Preston Urban Area	264601	1	1	Preston	06/06/2000	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Glasgow Urban Area	1168270	3	1	Glasgow Centre	26/07/1996	URBAN CENTRE	Background	urban	urban	0	1	0	0	1	Y
Edinburgh Urban Area	452194	1	1	Edinburgh St Leonards	24/11/2003	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Cardiff Urban Area	327706	1	1	Cardiff Centre	12/05/1992	URBAN CENTRE	Background	urban	urban	0	1	0	0	1	Y
Swansea Urban Area	270506	1	1	Port Talbot Margam	24/07/2007	URBAN INDUSTRIAL	Industrial	urban	urban	0	0	0	1	1	Y
Belfast Urban Area	580276	1	1	Belfast Centre	08/03/1992	URBAN CENTRE	Background	urban	urban	0	1	0	0	1	Y
Eastern	5124072	6	3	Sibton	01/07/1973	REMOTE	Background	rural	rural	0	2	4	0	6	Y
				St Osyth	11/05/2002	RURAL	Background	rural	rural						
				Thurrock	01/09/1996	URBAN BACKGROUND	Background	urban	urban						
				Weybourne	30/05/2001	RURAL	Background	rural	rural						
				Wicken Fen	15/10/1997	RURAL	Background	rural	rural						
				Norwich Lakenfield	25/09/2009	Awaits classification	Background	urban	urban						
South West	3980991	5	2	Charlton Mackrell	03/09/2008	RURAL	Background	rural	rural	1	1	2	0	4	Y
				Exeter Roadside	02/07/1996	ROADSIDE	Traffic	urban	urban						
				Plymouth Centre	29/09/1997	URBAN CENTRE	Background	urban	urban						
				Yarner Wood	26/06/1987	RURAL	Background	rural	rural						
South East	6392004	5	2	Harwell	22/06/1976	RURAL	Background	rural	rural	0	1	3	0	4	Y
				Lullington Heath	04/10/1986	RURAL	Background	rural	rural						

Zone/ Agglomeration	Population	No of sites required per Annex V	No of sites required when Article 9 is applied	Site Name	Start_O3	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	EU station_ozone_classification	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirements
				Rochester Stoke	26/01/1996	RURAL	Background	rural	rural						
				Canterbury	Not started	Awaits classification	Background	urban	urban						
East Midlands	3084598	5	2	Bottesford	01/10/1977	SUBURBAN	Background	suburban	urban	0	2	2	0	4	Y
				Ladybower	15/07/1988	RURAL	Background	rural	rural						
				Market Harborough	10/12/2003	RURAL	Background	rural	rural						
				Northampton	13/03/2003	URBAN BACKGROUND	Background	urban	urban						
North West & Merseyside	2826622	5	2	Glazebury	01/04/1988	SUBURBAN	Background	suburban	urban	0	2	1	0	3	Y
				Great Dun Fell	09/05/1986	REMOTE	Background	rural	rural						
				Wigan Centre	08/10/2004	URBAN BACKGROUND	Background	urban	urban						
Yorkshire & Humberside	2514947	4	2	Barnsley Gawber	07/07/1997	URBAN BACKGROUND	Background	urban	urban	0	1	1	0	2	Y
				High Muffles	16/07/1987	RURAL	Background	rural	rural						
West Midlands	2271650	4	2	Leamington Spa	26/07/1996	URBAN BACKGROUND	Background	urban	urban	0	2	0	0	2	Y
				Leominster	18/07/2005	SUBURBAN	Background	suburban	urban						
North East	1269803	3	1	Sunderland Silksworth	09/12/2004	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Central Scotland	1813314	3	1	Auchencorth Moss	29/10/2006	RURAL	Background	rural	rural	0	0	2	0	2	Y
				Bush Estate	01/04/1986	RURAL	Background	rural	rural						
North East Scotland	1001499	2	1	Aberdeen	01/08/2003	URBAN BACKGROUND	Background	urban	urban	0	1	0	0	1	Y
Highlands	380062	2	1	Fort William	22/06/2006	SUBURBAN	Background	rural	suburban	0	1	2	0	3	Y
				Lerwick	25/05/2005	RURAL	Background	rural	rural						
				Strath Vaich	18/03/1987	REMOTE	Background	rural	rural						
Scottish Borders	254690	1	1	Eskdalemuir	23/04/1986	RURAL	Background	rural	rural	0	1	1	0	2	Y

Zone/ Agglomeration	Population	No of sites required per Annex V	No of sites required when Article 9 is applied	Site Name	Start_O3	UK Classification	EU classification: type_of_station	EU classification station_type_of_area	EU station_ozone_classification	traffic Urban	background urban	Background rural	industrial urban	total	Sites in AURN to meet requirements
				Peebles	06/11/2009	Awaits classification			urban						
South Wales	1578773	3	1	Cwmbran	29/04/2003	URBAN BACKGROUND	Background	urban	urban	0	1	1	0	2	Y
				Narberth	20/01/1997	REMOTE	Background	rural	rural						
North Wales	720022	2	1	Aston Hill	26/06/1986	RURAL	Background	rural	rural	0	1	1	0	2	Y
				Mold	02/12/2009	Awaits classification			urban						
Northern Ireland	1104991	3	1	Derry	29/04/1997	URBAN BACKGROUND	Background	urban	urban	0	1	1	0	2	Y
				Lough Navar	02/04/1987	REMOTE	Background	rural	rural						
			56							3	53	21	4	81	

10 Other compliance requirements

In addition to defining the monitoring requirements for pollutants such as SO₂, NO₂, NO_x, PM₁₀, PM_{2.5}, lead, benzene, CO, and ozone, the CAFE Directive also requires additional information concerning the constituent components of PM_{2.5} and ambient concentrations of ozone precursors.

10.1 Chemical speciation of PM_{2.5}

Article 6, Paragraph 5 of the CAFE Directive, requests that each member state should have at least one monitor every 100,000 km² that would allow the chemical speciation of fine particulate matter (PM_{2.5}). The speciation would involve the determining the concentration of at least the following species (see Annex IV of the CAFE Directive):

SO₄²⁻, Na⁺, NH₄⁺, Ca²⁺, elemental carbon (EC), NO₃⁻, K⁺, Cl⁻, Mg²⁺ and organic carbon (OC).

In addition, Paragraph 5 requests that the chemical speciation is coordinated with the monitoring strategy and measurement programme of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP). Currently, monitoring is conducted at Auchencorth Moss (in southern Scotland) and Harwell (south central England). These two sites form part of the so-called EMEP super site network. PM_{2.5} speciation measurements currently occurs at two sites (Harwell and Auchencorth Moss), covering SO₄²⁻, Na⁺, NH₄⁺, Ca²⁺, NO₃⁻, K⁺, Cl⁻, Mg²⁺. Options for measurements of elemental and organic carbon are under evaluation.

10.2 Ozone precursor substances

Article 10, Paragraph 6 of the CAFE Directive requires that each member state should have at least one sampling site installed in its territory to measure the concentrations of the ozone precursor substances listed in Annex X of the CAFE Directive. A site at Eltham, London, was installed in 2004 to provide such information. There are three additional sites for which ozone precursor species are measured; Auchencorth Moss, Harwell, London Marylebone Road. Therefore the United Kingdom is compliant with the requirements of the CAFE Directive for supplying data on ozone precursors.

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