Article 5 Assessment of nitrogen dioxide, PM10, sulphur dioxide and lead in the UK.

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AEA TECHNOLOGY
ENVIRONMENT

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1 Introduction

Directive 96/62/EC on Ambient Air Quality Assessment and Management (The Framework Directive) establishes a framework under which the EU will set limit values or target values for concentrations in ambient air of specified pollutants. Directive 1999/30/EC (The Daughter Directive) sets limit values to be achieved for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particles and lead, the first group of pollutants identified in the Framework Directive. The limit values set in the Daughter Directive for these four pollutants have been incorporated into UK's Air Quality Strategy (AQS) as national objectives.

Article 12 of the Daughter Directive specifies that the provisions of that Directive are to be transposed into national law by 19 July 2001. This is also the date by when the majority of the provisions of the Framework Directive are to be transposed. The UK will begin the assessment of ambient air quality, required by Article 6 of the Framework Directive, from 1 January 2001 to obtain a full year's compliance monitoring data for 2001.

Monitoring of air quality in the UK is carried out through a national network of air quality monitoring stations. Information from this national network is supplemented by information from the widespread monitoring networks operated by local authorities. This report describes how the national monitoring network is to be extended to meet the requirements of the Framework Directive and Daughter Directive. In many cases, this expansion will be achieved by the incorporation of local authority monitoring sites into the national network.

2 Article 5 Assessment

Under Article 5 of The Framework Directive, a requirement has been placed upon Member States to undertake a preliminary investigation of ambient air quality, prior to the implementation of Daughter Directives for nitrogen dioxide, sulphur dioxide, particulate matter (PM10) and lead, (see Appendix 1).

The objectives of these assessments are to establish estimates for the overall distribution and levels of pollutants, and to identify additional monitoring requirements, which may be necessary in order to fulfil obligations under the Framework and Daughter Directives. This report provides details of the number of additional monitoring locations, which are required for nitrogen dioxide, PM10, sulphur dioxide and lead.

This report provides a description of the methods of assessment which have been applied throughout the UK, by NETCEN on behalf of the DETR, the Scottish Executive, the National Assembly for Wales and the DoE in Northern Ireland.

3 General approach

For the purpose of this assessment, the UK has been divided into 16 zones, based on official Government Office boundaries within England and boundaries provided or authorised by the relevant offices within Scotland, Wales and Northern Ireland. A further 28 agglomeration zones (areas of urban population > 250,000) have also been agreed. These were based on DETR geographical information system (GIS) data on urban areas for England and Wales (Hyrenkiewicz, *pers comm,* 1998), urban localities information in Scotland (Gardner *pers comm,* 1998) and CORINE land cover information within Northern Ireland (CORINE, 1998). UK zones and agglomerations are presented in Figure 1. It will be noted from Figure 1 that Greater London is defined as both an agglomeration and a zone. This is a result of a specific Government Office region being assigned to this area and the urban population exceeding 250,000. For the purpose of this assessment, Greater London will be treated as an agglomeration only, as the area of the London agglomeration exceeds that of the Government Office region. Monitoring requirements within each zone and agglomeration have been assessed separately.

Estimates of the overall distribution of pollution concentrations within each zone and agglomeration have been derived from empirically modelled high resolution maps (Stedman and Bush, 2000) and dispersion modelling (Abbott and Vincent, 1998). The models used, draw heavily upon measurement data from the UK's automatic urban and rural network (AURN), and are as a result, calibrated to these networks. Additional data from the UK sampler based monitoring networks have been used in the assessments, where this is appropriate (NO_2 only, Bush *et al* 2000). Where possible, the most recently available national empirical and dispersion models (using the 1997 National Atmospheric Emissions Inventory and 1999 monitoring data) and best estimates of population totals and distribution have been applied within this assessment. This approach provides a comprehensive and robust means of estimating pollutant concentrations throughout the whole of the UK, utilising current best estimates and practises.

Estimated pollutant concentrations within each zone have been compared with the relevant Assessment Thresholds, Limit Values and the Margins of Tolerance as defined in the Daughter Directive (see Appendix 2). Areas requiring additional monitoring have been identified by an examination of the current automatic and non-automatic monitoring networks and their coverage of the areas with high estimated concentrations. The number of additional monitoring sites required has been calculated from the population of the individual zones and agglomerations and the incidence of exceedances of relevant Assessment Thresholds using Table I Annex VII of the Daughter Directive, (see Appendix 3). The availability of other methods of assessment (models, emissions inventories, indicative monitoring) has also been taken into account and has enabled a number of sites less than that defined in Table I Annex VII (which assumes fixed monitoring as the sole source of information) to be been identified for each zone and agglomeration.

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

1. The UK is comprised of 28 agglomeration zones and 16 non-agglomeration zones.

2. Where 'other sources of information' on pollutant concentrations are available, a number of sites less than that identified by Table I Annex VII of the Daughter Directive (which assumes fixed monitoring is the sole source of information) may enable compliance with the Daughter Directive (see Appendix 3).

3. For NO_2 and PM10 where 'other sources of information' are available and estimates of concentrations are in excess of the Upper Assessment Threshold, monitoring is only required at *either* a roadside *or* urban background location.

4. For nitrogen dioxide and PM10, the assessment has been based on the annual average assessment threshold.

5. For sulphur dioxide, the assessment has been based on the 24-hour assessment threshold.

6. For lead, the assessment has been based on the annual average assessment threshold.

7. Within vegetation and ecosystem areas, the assessment has been based upon the winter average for sulphur dioxide and annual average for oxides of nitrogen.

In order to check that the modelled exceedance statistics have not been systematically underestimated, a comparison with measured exceedance data has been performed at sites within the current AURN and lead networks. These comparisons are presented in Appendix 4 Tables A1-A8. Agreement between modelled exceedances at each monitoring location and measured exceedance statistics is generally good for all pollutants. However, at a small number of sites the models have not predicted the exceedance of the Upper Assessment Threshold, which have been identified in the measured data. The occurrence of such discrepancies does not affect the conclusions of the study, as exceedances are identified by modelling at other locations, either urban background or roadside, elsewhere in a zone or agglomeration, for all pollutants. Hence, all areas requiring additional monitoring have been identified and are included in this report.

4 Nitrogen dioxide

4.1 METHODOLOGY

Nitrogen dioxide concentrations throughout the UK have been assessed at urban background and roadside locations. Estimates of pollutant concentrations have been derived from empirically modelled data (Stedman and Bush, 2000) and measurement data from the UK NO_2 Diffusion Tube Network (Bush e*t al,* 2000). Automatic monitoring data are incorporated into the empirical model used. In addition exceedance data from the automatic networks are assessed in Appendix 4.

Figure 2 presents a map of annual average nitrogen dioxide concentrations at urban background locations in the UK. The figure consists of empirically modelled high resolution NO_2 maps on to which, annual average NO_2 concentrations (1999) from urban background diffusion tube sites have been plotted. Areas have been colour coded to indicate exceedance of the Upper Assessment Threshold (32 $\mu g/m^3$) and Lower Assessment Threshold (26 $\mu g/m^3$).

Figure 3 presents a map of annual average nitrogen dioxide concentrations at roadside locations in the UK. The figure consists of empirically modelled roadside high resolution NO_2 maps on to which annual average NO_2 concentrations (1999) from roadside diffusion tube sites have been plotted. Individual road-links and monitoring locations alongside built up urban roads, with annual average concentrations in excess of the Upper and Lower Assessment Threshold for NO_2 have been colour coded as in Figure 2. Kerbside NO_2 diffusion tube data from sites <1m from the kerb have not been included in this analysis.

Figures 4 and 5 present maps for 1999 of urban background areas and road-links with annual average NO_2 concentrations greater than the Upper Assessment for NO_2. The data underlying each map are as detailed in Figures 2 and 3. Locations of automatic monitoring sites are indicated.

4.2 OBSERVATIONS AND PROPOSALS

Exceedances of the Upper and Lower Assessment Thresholds for NO_2 at urban background locations and/or at the roadside of major roads are clearly identifiable in all zones and agglomerations of the UK (Figures 2 and 3). Monitoring is therefore mandatory, in all zones and agglomerations at urban background or roadside locations according to the Daughter Directive (Table I Annex VII). The number of monitors required within each agglomeration and zone is discussed below.

4.2.1 Requirements within agglomerations

The minimum number of monitoring sites required within agglomerations is defined by Table I Annex VII of the Daughter Directive (see Appendix 3) and assumes that fixed monitoring is the sole source of information. The number of monitoring locations required in UK agglomerations, based on the threshold exceedances presented in Figure 2 and 3, fixed

monitoring as the sole source of information and the population of the respective agglomerations, is presented in Table 1 by the *'Minimum Site Number A'* statistic.

Throughout the UK, other means of assessment (empirical modelling and sampler data) are available and therefore, a number of sites less than that defined by Table I Annex VII, will enable compliance with the Directive, (presented in Table 1 by the *'Minimum Site Number B'* statistic).

From Table 1, taking into account the current network of automatic monitoring sites and the availability other assessment methods, a total of 2 additional monitoring sites are required within agglomerations in England. No additional monitoring requirements are identifiable in the agglomerations of Scotland, Wales and Northern Ireland for minimum compliance with the Directive.

4.2.2 Requirements within non-agglomeration zones

Monitoring requirements in non-agglomerations zones throughout the UK, assuming fixed monitoring as the sole source of information, are presented in Table 2 by the *'Minimum Site Number A'* statistic. As for agglomeration zones, other means of assessment are available, and therefore, a smaller number of sites are required to enable compliance with the Daughter Directive (*'Minimum Site Number B'*).

From Table 2, taking into account the current network of automatic monitoring sites, and the availability other assessment methods a total of 3 additional monitoring sites are required in the non-agglomeration zones within England, 2 within Wales and 3 within Scotland. No additional monitoring requirements were identifiable within Northern Ireland for minimum compliance with the Directive.

Table 1 Nitrogen dioxide monitoring requirements in UK agglomerations

1. England

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Greater London Urban Area	7650944	UAT	R/UB	10	1	10	14	0
West Midlands Urban Area	2296180	UAT	R/UB	6	1	0	6	0
Greater Manchester Urban Area	2277330	UAT	R/UB	6	1	1 (atypical)	6	0
West Yorkshire Urban Area	1445981	UAT	R/UB	4	1	0	3	0
Tyneside	885981	UAT	R/UB	3	1	0	1	0
Liverpool Urban Area	837998	UAT	R/UB	3	1	0	1	0
Sheffield Urban Area	633362	UAT	R/UB	2	1	0	3	0
Nottingham Urban Area	613726	UAT	R/UB	2	1	0	1	0
Bristol Urban Area	522784	UAT	R/UB	2	1	1	1	0
Brighton/Worthing/Littlehampton	437592	UAT	R/UB	2	1	2	0	0
Leicester Urban Area	416601	UAT	R/UB	2	1	0	1	0
Portsmouth Urban Area	409341	UAT	R/UB	2	1	0	0	1
Teesside Urban Area	369609	UAT	R/UB	2	1	0	3	0
The Potteries	367976	UAT	R/UB	2	1	0	1	0
Bournemouth Urban Area	358321	UAT	R/UB	2	1	0	0	1
Reading/Wokingham Urban Area	335757	UAT	R/UB	2	1	0	1	0
Coventry/Bedworth	331248	UAT	R/UB	2	1	0	1	0
Kingston upon Hull	310636	UAT	R/UB	2	1	0	1	0
Southampton Urban Area	276752	UAT	R/UB	2	1	0	1	0
Birkenhead Urban Area	270207	UAT	R/UB	2	1	0	1	0
Southend Urban Area	266749	UAT	R/UB	2	1	0	1	0
Blackpool Urban Area	261355	UAT	R/UB	2	1	0	1	0
Preston Urban Area	256411	UAT	R/UB	2	1	0	1	0
Additional monitoring requirements in agglomerations in England:								2

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

(Table1 continued)

2. Wales

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Swansea	272456	UAT	R/UB	2	1	0	1	0
Cardiff	306904	UAT	R/UB	2	1	0	1	0

Additional monitoring requirements in agglomerations in Wales: 0

3. Scotland

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Edinburgh Urban Area	416232	UAT	R/UB	2	1	0	1	0
Glasgow Urban Area	1315544	UAT	R/UB	4	1	1 (kerbside)	2	0

Additional monitoring requirements in agglomerations in Scotland: 0

4. Northern Ireland

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Belfast	475987	UAT	R/UB	2	2	0	1	0

Additional monitoring requirements in agglomerations in Northern Ireland: 0

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

Table 2 Nitrogen dioxide monitoring requirements in UK zones

1. England

Zone	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Greater London	7650944	na	na	na	na	na	na	na
North East	1287979	UAT	R/UB	4	1	0	0	1
North West & Merseyside	2823559	UAT	R/UB	7	1	0	0	1
Yorkshire & Humberside	2446545	UAT	R/UB	6	1	0	1	0
East Midlands	2923045	UAT	R/UB	7	1	0	0	1
West Midlands	2154783	UAT	R/UB	6	1	0	1	0
Eastern	4788766	UAT	R/UB	9	1	2	2	0
South East	3702634	UAT	R/UB	7	1	1	0	0
South West	3728319	UAT	R/UB	7	1	2	1	0

Additional monitoring requirements in zones in England: 3

[Site nos. for Greater London area not calculated as this is completely covered by the London agglomeration]

2. Wales

Zone	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
South Wales	1623660	UAT	R/UB	5	1	0	0	1
North Wales	713762	UAT	R/UB	2	1	0	0	1

Additional monitoring requirements in zones in Wales: 2

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

(Table 2 continued)

3. Scotland

Zone	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Scottish Borders	246659	UAT	R	1	1	0	0	1
Central Scotland	1628460	UAT	R/UB	5	1	0	0	1
North East Scotland	933485	UAT	R/UB	3	1	0	1	0
Highland	364639	UAT	R	2	1	0	0	1

Additional monitoring requirements in zones in Scotland: 3

[no monitoring required in Highland as LAT and UAT not exceeded]

4. Northern Ireland

Zone	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Northern Ireland	1101868	UAT	R	4	1	0	1	0

Additional monitoring requirements in zones in Northern Ireland: 0

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

5 PM10

5.1 METHODOLOGY

PM10 concentrations have been assessed at urban background locations. Estimates of concentrations at these locations have been derived from empirically modelled data (Stedman and Bush, 2000). A scaling factor (1.30) has been applied to UK data to ensure results are comparable with the EU manual gravimetric reference method for PM10 defined in the Daughter Directive. Roadside levels of PM10 have not been assessed. A robust empirical model for estimating national, roadside annual average PM10 concentrations is not available. As with nitrogen dioxide, the modelled data have been calibrated with data from the automatic monitoring sites. However, automatic PM10 measurements are separately assessed in Appendix 4.

Figure 6 presents the empirically modelled high resolution PM10 map for 1999, which shows annual average PM10 concentrations at urban background locations for the UK. The map shows that there are urban background areas within all agglomerations and zones of the UK that exceed the Upper Assessment Threshold (14 $\mu g/m^3$).

Figure 7 presents an exceedance map for 1999 of the Stage 1 Limit Value for PM10, plus Margin of Tolerance (48 $\mu g/m^3$). This map shows that there are no areas exceeding the Stage 1 Limit Value and Margin of Tolerance.

Figure 8 presents those areas exceeding an arbitrary value of 15 $\mu g/m^3$ in 5 $\mu g/m^3$ steps and shows the areas of the UK with the highest estimated PM10 concentrations. The distribution of the current monitoring network for PM10 is also indicated. Urban background and roadside sites are also indicated.

5.2 OBSERVATIONS AND PROPOSALS

Figure 6 shows that the current best estimate of annual average PM10 concentrations at urban background locations is greater than the Upper Assessment Threshold (14 $\mu g/m^3$) throughout the UK, with the exception of some areas of the Highland region. Under the Daughter Directive therefore, monitoring for PM10 is mandatory within all zones and agglomerations in the UK. Monitoring requirements within agglomeration and zones are discussed below.

5.2.1 Requirements within agglomerations

As for NO_2, the minimum number of PM10 monitoring sites required within each agglomeration, defined by Annex VII, Table I of the Daughter Directive, assumes fixed monitoring is the sole source of information. The number of additional monitoring sites required for each agglomeration, based on the threshold exceedances presented in Figure 6, and the population of each agglomeration, is provided in Table 3 (*'Minimum Site Number A'*). However, owing to the availability of other assessment techniques a smaller number of sites will enable compliance with the Daughter Directive. These requirements are presented in Table 3 by the *'Minimum Site Number B'* statistic.

From Table 3, and taking into account the current network of automatic monitoring sites, and the availability other assessment methods, a total of 4 additional monitoring sites are required in agglomerations within England. No additional monitoring requirements are identifiable in the agglomerations of Scotland, Wales and Northern Ireland for minimum compliance with the Directive.

5.2.2 Requirements within non-agglomerations zones

The minimum number of PM10 monitoring sites required within each non-agglomeration zone, defined by Annex VII, Table I of the Daughter Directive, and assuming that fixed monitoring is the sole source of information is presented in Table 4 by the *'Minimum Site Number A'* statistic. The *'Minimum Site Number B'* statistic presents a smaller set of site numbers which will enable compliance with the Daughter Directive assuming other assessment techniques are available.

From Table 4, and taking into account the current network of automatic monitoring sites, and the availability other assessment methods a total of 4 additional monitoring sites are required within non-agglomeration zones within England, 2 within Wales and 3 within Scotland. No additional monitoring requirements were identifiable within Northern Ireland for minimum compliance with the Directive.

Table 3 PM10 monitoring requirements in UK agglomerations

1. England

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Greater London Urban Area	7650944	UAT	R/UB	10	1	10	14	0
West Midlands Urban Area	2296180	UAT	R/UB	6	1	0	6	0
Greater Manchester Urban Area	2277330	UAT	R/UB	6	1	1 (atypical)	6	0
West Yorkshire Urban Area	1445981	UAT	R/UB	4	1	0	3	0
Tyneside	885981	UAT	R/UB	3	1	0	1	0
Liverpool Urban Area	837998	UAT	R/UB	3	1	0	1	0
Sheffield Urban Area	633362	UAT	R/UB	2	1	0	1	0
Nottingham Urban Area	613726	UAT	R/UB	2	1	0	1	0
Bristol Urban Area	522784	UAT	R/UB	2	1	1	1	0
Brighton/Worthing/Littlehampton	437592	UAT	R/UB	2	1	0	0	1
Leicester Urban Area	416601	UAT	R/UB	2	1	0	1	0
Portsmouth Urban Area	409341	UAT	R/UB	2	1	0	0	1
Teesside Urban Area	369609	UAT	R/UB	2	1	0	3	0
The Potteries	367976	UAT	R/UB	2	1	0	1	0
Bournemouth Urban Area	358321	UAT	R/UB	2	1	0	0	1
Reading/Wokingham Urban Area	335757	UAT	R/UB	2	1	0	1	0
Coventry/Bedworth	331248	UAT	R/UB	2	1	0	0	1
Kingston upon Hull	310636	UAT	R/UB	2	1	0	1	0
Southampton Urban Area	276752	UAT	R/UB	2	1	0	1	0
Birkenhead Urban Area	270207	UAT	R/UB	2	1	0	1	0
Southend Urban Area	266749	UAT	R/UB	2	1	0	1	0
Blackpool Urban Area	261355	UAT	R/UB	2	1	0	1	0
Preston Urban Area	256411	UAT	R/UB	2	1	0	1	0

Additional monitoring requirements in agglomerations in England: 4

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

(Table 3 continued)

2. Wales

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Swansea	272456	UAT	R/UB	2	1	0	1	0
Cardiff	306904	UAT	R/UB	2	1	0	1	0

Additional monitoring requirements in agglomerations in Wales: 0

3. Scotland

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Edinburgh Urban Area	416232	UAT	R/UB	2	1	0	1	0
Glasgow Urban Area	1315544	UAT	R/UB	4	1	1 (kerbside)	2	0

Additional monitoring requirements in agglomerations in Scotland: 0

4. Northern Ireland

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Belfast	475987	UAT	R/UB	2	1	0	2	0

Additional monitoring requirements in agglomerations in Northern Ireland: 0

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

Table 4 PM10 monitoring requirements in UK zones

1. England

Zone	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Greater London	7650944	na	na	na	na	na	na	na
North East	1287979	UAT	R/UB	4	1	0	0	1
North West & Merseyside	2823559	UAT	R/UB	7	1	0	0	1
Yorkshire & Humberside	2446545	UAT	R/UB	6	1	0	1	0
East Midlands	2923045	UAT	R/UB	7	1	0	0	1
West Midlands	2154783	UAT	R/UB	6	1	0	1	0
Eastern	4788766	UAT	R/UB	9	1	0	2	0
South East	3702634	UAT	R/UB	7	1	0	0	1
South West	3728319	UAT	R/UB	7	1	0	1	0

Additional monitoring requirements in zones in England: 4

[Site nos. for Greater London area not calculated as this is completely covered by the London agglomeration]

2. Wales

Zone	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
South Wales	1623660	UAT	na	5	1	0	0	1
North Wales	713762	UAT	R/UB	2	1	0	0	1

Additional monitoring requirements in zones in Wales: 2

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

(Table 4 continued)

3. Scotland

Zone	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Scottish Borders	246659	UAT	na	1	1	0	0	1
Central Scotland	1628460	UAT	R/UB	5	1	0	0	1
North East Scotland	933485	UAT	R/UB	3	1	0	1	0
Highland	364639	UAT	R/UB	2	1	0	0	1

Additional monitoring requirements in zones in Scotland: 3

4. Northern Ireland

Zone	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Additional Sites (Roadside or Urban Background)
Northern Ireland	1101868	UAT	na	4	1	0	1	0

Additional monitoring requirements in zones in Northern Ireland: 0

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

6 Sulphur dioxide

6.1 METHODOLOGY

Sulphur dioxide concentrations throughout the UK have been assessed, using estimates of pollutant concentration derived from a combination of empirical and dispersion modelling (Abbott and Vincent, 1998). The model combines emissions from Part A and B processes, domestic fuel use, road transport, industrial and other commercial and institutional sources, and has been calibrated to measurement data from the AURN, Smoke and SO_2 and Joint Environment Programme network sites (run by National Power and PowerGen).

The modelling work utilised within this assessment was originally undertaken to provide estimates of the 99.9th percentile of 15-minute average SO_2 concentrations for the review of the National Air Quality Strategy. This averaging period is, however, incompatible with the assessment thresholds and limit values defined by the Daughter Directive.

In order to model the Daughter Directive assessment thresholds for SO_2, the 99.9th percentile modelled data have been converted using an empirical scaling factor to data equivalent to the 24-hour assessment threshold statistic (effectively the 99.2nd percentile of 24-hour averages). The conversion factor was identified by regression analysis of the 99.2nd percentile of daily average SO_2 concentrations against 99.9th percentile of 15 minutes average concentrations measured at urban and rural automatic locations between 1997 and 1999. Figure 9 presents these data. Forced (through origin) and unforced best fit lines have been applied, the equations for each are shown. The unforced line exhibits a negligible intercept and hence, the regression equation for the zero intercept regression line was selected for use as the scaling factor. Modelled 99.9th percentile of 15-minute average data was scaled as follows.

$$99.2\%ile\ daily\ average\ SO_2 = 99.9\%ile\ 15\ minute\ average\ SO_2 \times 0.3147$$

Figure 10 presents a map of 99.2nd percentile of daily average sulphur dioxide concentrations for the UK. Concentration data have been derived using the method described above. Areas have been colour coded to indicate exceedance of the Upper Assessment Threshold (75 $\mu g/m^3$) and Lower Assessment Threshold (50 $\mu g/m^3$).

Figure 11 presents a map of 99.2nd percentile of daily average sulphur dioxide concentrations in the UK for 1996, which are greater than the Upper Assessment and Limit Values for SO_2, (there is no Margin of Tolerance specified for SO_2). The locations of the current urban background automatic monitoring sites are also indicated.

Automatic SO_2 measurements are separately assessed in Appendix 4.

6.2 OBSERVATIONS AND PROPOSALS

Exceedances of the Upper and Lower Assessment Thresholds for SO_2 are identifiable throughout the UK (Figure 10). Figure 11, shows that major urban conurbations of the UK are

well serviced by automatic monitoring stations. However, there are significant areas of the UK, outside of agglomerations, which are estimated to have high percentile concentrations of SO_2 resulting from emissions from power stations, chemical and petrochemical refining industries and domestic fuel use. Monitoring is therefore mandatory in these zones under the Daughter Directive (Table I Annex VII). Monitoring requirements within agglomerations and zones are discussed below.

6.2.1 Requirements within agglomerations

The minimum number of monitoring sites required within agglomerations is defined Table I Annex VII of the Daughter Directive (see Appendix 3) and assumes that fixed monitoring is the sole source of information. The number of monitoring locations required in UK agglomerations, based on the threshold exceedances presented in Figure 11, fixed monitoring as the sole source of information and the population of the respective agglomerations, is presented in Table 5 by *'Minimum Site Number A'* statistic.

Throughout the UK, other means of assessment (modelled data and sampler data) are available and therefore, a number of sites less than that defined by Table I Annex VII, will enable compliance with the Directive, (presented in Table 5 by the *'Minimum Site Number B'* statistic).

From Table 5, and taking into account the current network of automatic monitoring sites, and the availability other assessment methods a total of 3 additional monitoring sites are required within agglomerations in England. No other additional monitoring requirements are identified for other agglomerations in the UK.

6.2.2 Requirements within non-agglomeration zones

Monitoring requirements in non-agglomerations zones throughout the UK assuming fixed monitoring as the sole source of information are presented in Table 6 by the *'Minimum Site Number A'* statistic. As for agglomeration zones, other means of assessment are available, and therefore, a smaller number of sites are required to enable compliance with the Daughter Directive (*'Minimum Site Number B'*).

From Table 6, and taking into account the current network of automatic monitoring sites, and the availability other assessment methods a total of 2 additional monitoring sites are required in the non-agglomeration zones within England, 2 within Wales and 2 within Scotland for compliance the Daughter Directive. No additional SO_2 monitoring requirements were identified for non-agglomerations zones within Northern Ireland.

Table 5 Sulphur dioxide monitoring requirements in UK agglomerations

1. England

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Existing Sites Industrial	Additional Sites
Greater London Urban Area	7650944	LAT - UAT	R/UB	5	1	3	10	0	0
West Midlands Urban Area	2296180	LAT - UAT	R/UB	3	1	0	4	0	0
Greater Manchester Urban Area	2277330	UAT	R/UB	6	1	1	4	0	0
West Yorkshire Urban Area	1445981	UAT	R/UB	4	1	0	2	0	0
Tyneside	885981	LAT - UAT	R/UB	1	1	0	0	1	0
Liverpool Urban Area	837998	UAT	R/UB	3	1	0	1	0	0
Sheffield Urban Area	633362	UAT	R/UB	2	1	0	2	0	0
Nottingham Urban Area	613726	UAT	R/UB	2	1	0	1	0	0
Bristol Urban Area	522784	None	-	1	1	0	1	0	0
Brighton/Worthing/Littlehampton	437592	None	-	1	1	0	0	0	1
Leicester Urban Area	416601	LAT - UAT	R/UB	1	1	0	1	0	0
Portsmouth Urban Area	409341	LAT - UAT	R/UB	1	1	0	0	0	1
Teesside Urban Area	369609	UAT	R/UB	2	1	0	2	0	0
The Potteries	367976	UAT	R/UB	2	1	0	1	0	0
Bournemouth Urban Area	358321	None	-	1	1	0	0	0	1
Reading/Wokingham Urban Area	335757	None	-	1	1	0	1	0	0
Coventry/Bedworth	331248	None	-	1	1	0	1	0	0
Kingston upon Hull	310636	UAT	R/UB	2	1	0	1	0	0
Southampton Urban Area	276752	LAT - UAT	R/UB	1	1	0	1	0	0
Birkenhead Urban Area	270207	UAT	R/UB	2	1	0	1	0	0
Southend Urban Area	266749	UAT	R/UB	2	1	0	1	0	0
Blackpool Urban Area	261355	None	-	1	1	0	1	0	0
Preston Urban Area	256411	LAT - UAT	R/UB	1	1	0	1	0	0

Additional monitoring requirements in agglomerations in England: 3

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

(Table 5 continued)

2. Wales

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Existing Sites Industrial	Additional Sites
Swansea	272456	UAT	R/UB	2	1	0	2	0	0
Cardiff	306904	None	-	1	1	0	1	0	0

Additional monitoring requirements in agglomerations in Wales: 0

3. Scotland

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Existing Sites Industrial	Additional Sites
Edinburgh Urban Area	416232	None	-	1	1	0	1	0	0
Glasgow Urban Area	1315544	LAT - UAT	R/UB	2	1	0	1	0	0

Additional monitoring requirements in agglomerations in Scotland: 0

4. Northern Ireland

Agglomeration	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Existing Sites Industrial	Additional Sites
Belfast	475987	UAT	R/UB	2	1	0	2	0	0

Additional monitoring requirements in agglomerations in Northern Ireland: 0

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

Table 6 Sulphur dioxide monitoring requirements in UK zones

1. England

Zone	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Existing Sites Industrial	Additional Sites
Greater London	7650944	na	na	na	na	na	na	na	na
North East	1287979	UAT	R/UB	4	1	0	0	1	0
North West & Merseyside	2823559	UAT	R/UB	7	1	0	0	0	1
Yorkshire & Humberside	2446545	UAT	R/UB	6	1	0	2	1	0
East Midlands	2923045	UAT	R/UB	7	1	0	0	0	1
West Midlands	2154783	UAT	R/UB	6	1	0	1	0	0
Eastern	4788766	UAT	R/UB	8	1	1	2	0	0
South East	3702634	UAT	R/UB	7	1	1	0	0	0
South West	3728319	UAT	R/UB	7	1	1	1	0	0

Additional monitoring requirements in zones in England: 2

[Site nos. for Greater London area not calculated as this is completely covered by the London agglomeration]

2. Wales

Zone	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Existing Sites Industrial	Additional Sites
South Wales	1623660	UAT	R/UB	5	1	0	0	0	1
North Wales	713762	UAT	R/UB	2	1	0	0	0	1

Additional monitoring requirements in zones in Wales: 2

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

(Table 6 continued)

3. Scotland

Zone	Population	Exceedence	Location of Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Existing Sites Industrial	Additional Sites
Scottish Borders	246659	None	-	0	0	0	0	0	0
Central Scotland	1628460	UAT	R/UB	5	1	0	0	0	1
North East Scotland	933485	UAT	R/UB	3	1	0	0	0	1
Highland	364639	None	-	0	0	0	0	0	0

Additional monitoring requirements in zones in Scotland: 2

4. Northern Ireland

Zone	Population	Exceedence	Minimum Site No.* A	Minimum Site No.* B	Existing Sites Roadside	Existing Sites Background	Existing Sites Industrial	Additional Sites
Northern Ireland	1101868	UAT	4	1	0	1	0	0

Additional monitoring requirements in zones in Northern Ireland: 0

Note:
*Minimum Site No. A, assumes fixed monitoring as the sole source of information.
*Minimum site number B, assumes other means of assessment are available.
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.
'R' indicates an exceedance at a roadside location 'UB' indicates an exceedance at an urban background location

7 Lead

7.1 METHODOLOGY

Annual average lead concentrations throughout the UK have been assessed at background locations for the 1996 calendar year. Estimates of concentrations have been derived from empirically modelled data (Stedman, 1998). It is important to note that these estimates are of road transport derived lead only. Industrial sources have not been considered.

Figure 12 presents, a lead exceedance map for annual average lead concentrations throughout the UK. Areas have been colour coded to indicate exceedance of the Upper and Lower Assessment Threshold for lead (0.35 $\mu g/m^3$ and 0.25 $\mu g/m^3$ respectively). The locations of current rural background, urban background, roadside and industrial lead monitoring sites are indicated.

Measured lead concentrations from the UK Lead in Petrol, Multi-element and EC Lead Directive Networks are assessed separately in Appendix 4.

7.2 OBSERVATIONS AND PROPOSALS

Figure 12 clearly shows that there are no urban background areas in the UK with estimated annual average lead concentrations greater than the Lower Assessment Threshold (0.25 $\mu g/m^3$). The highest estimated lead concentrations presented by Figure 12 are found in central London, where the measured annual average concentration during 1999 was 0.04 $\mu g/m^3$, (16% of the Daughter Directive Lower Assessment Threshold for lead). Measured lead concentrations at roadside locations in agglomerations are presented in Table A7 of Appendix 4. Concentrations during 1999 are shown to be well below the Lower Assessment Threshold for lead. In addition, as of the year 2000, the sale of leaded petrol in the UK ceased. As a result, it is estimated that, lead concentrations at roadside locations throughout the UK will decrease to near background levels.

7.2.1 Further monitoring at industrial locations

During 1999, DETR and the devolved administrations commissioned a network of 29 monitoring stations to measure levels of lead, nickel, arsenic, cadmium and mercury close to industrial installations. Monitors were located close to a cross section of the major industrial processes which were identified as likely significant sources of heavy metals. Information from this study will provide a better understanding of the concentrations of lead and other heavy metals in close proximity to industrial processes. This monitoring will identify the industrial sectors with the most significant emissions with regard to Upper and Lower Assessment Thresholds for lead. Where monitoring indicates that some processes are not significant in relation to emissions of lead and other elements, these monitors will be redeployed to other point sources in industrial sectors identified as significant by the current study.

Preliminary results from this network are presented in Appendix 5. Although the datasets are incomplete at present, the measured concentrations thus far indicate that only one monitoring location has measured concentrations greater than the Lower Assessment Threshold for lead

(0.25 μg/m^3). Assuming that current monitoring data are reasonably representative of the full annual mean, then monitoring at the IMI Walsall site will need to continue to comply with the Directive. This conclusion is consistent that drawn from measurements from the long-term UK EC Lead Directive Network. This network has measured lead at industrial locations since 1985. Recent data indicates that lead levels are above the Upper and Lower Assessment Thresholds for lead at the IMI Walsall site (see Table A7, Appendix 4).

7.2.2 Requirements within agglomerations

Additional monitoring at urban background and roadside locations in agglomerations is not considered necessary.

7.2.3 Requirements within non-agglomeration zones

Additional monitoring at urban background and roadside locations in non-agglomeration zones is not considered necessary.

7.2.4 Requirements close to industrial sources

Monitoring of lead close to the Walsall IMI site will continue. In addition, where existing measurements indicate that a processes is not significant in relation to emissions of lead and other elements, monitors will be redeployed to measure concentrations close to other point sources in industrial sectors identified as significant by the current monitoring network.

8 Ecosystem and vegetation areas

8.1 METHODOLOGY

Ecosystem and Vegetation Areas are defined in Annex VI of the Daughter Directive as areas, which are 20 km from agglomerations and 5 km from motorways, other urban areas and industrial installations. In defining these areas for the UK, appropriate buffers have been applied to the agglomerations presented in Figure 1, Part A industrial installations as identified in the NAEI (Goodwin *pers comm,* 2000), motorways as identified by the DETR road traffic census of major roads (Goodwin *pers comm,* 2000) and urban areas (Ordnance Survey Base Data GB). The processing of these data was performed using GIS. The Vegetation and Ecosystem areas identified as a result are presented in Figure 13. The location of the rural automatic SO_2 and NOx monitoring sites and the acid deposition SO_2 and NO_2 sampler sites are also indicated.

SO_2 and NOx concentrations within Ecosystem and Vegetation Areas have been assessed throughout the UK using interpolated sampler data from the DETR Acid Deposition Monitoring Network and the UK Rural Sulphur Dioxide Monitoring Network (Hasler *pers comm,* 2000). Analysis of the relationship between winter and annual average sulphur dioxide concentrations indicates that the winter average assessment threshold is likely to be more stringent than the annual average, (see Appendix 6). Hence, for the assessment of SO_2 within Ecosystem and Vegetation Areas, the continuous winter average assessment thresholds were applied. Annual average NOx concentrations were estimated by scaling measured rural NO_2 concentrations during 1999 by a factor of 1.2 (Stedman *et al,* 2000).

Figures 14 and 15 present the interpolated rural concentrations fields for SO_2 (winter 1998/9) and NOx (annual average 1999) respectively. Areas have been colour coded according to exceedance of respective Ecosystem Assessment Threshold. From Figure 14, it is possible to estimate that during the 1998-1999 winter season there were no areas of the UK with winter average SO_2 concentrations greater than the Lower Assessment Threshold (8 $\mu g/m^3$). Figure 15 shows that during 1999, areas of the East Midlands and Eastern region of England are estimated to have annual average NOx concentrations between the Lower and Upper Assessment Threshold (19.5 – 24 $\mu g/m^3$).

In Figures 16 and 17, Ecosystem and Vegetation Areas with average SO_2 and NOx concentrations greater than the Upper and Lower Assessment Thresholds are indicated by overlaying the rural concentration fields presented in Figures 14 and 15 on to the Ecosystem and Vegetation Areas map (Figure 13). Also shown are the locations of the current rural automatic monitoring network. 'Catchment' areas have been assigned to each of the rural monitoring sites based on the exceedance in 1998 and 1999 of the Upper and Lower Assessment Thresholds for Ecosystem and Vegetation Areas (Table II Annex VII). From Table II Annex VII of the Daughter Directive, one rural monitoring station is required for every 20000 km^2 where measurement or modelled data indicate an exceedance of the Upper Assessment Threshold, and one rural monitoring station is required for every 40000 km^2 where data indicate concentrations are between the Upper and Lower Assessment Thresholds. The rural automatic network exceedance data are presented in Table 7 below.

It should be noted that the Narbeth, Lullington Heath and Harwell sites suffered from low data capture for some pollutants during 1998-1999. As a result, they did not produced sufficient data to calculate a valid winter or annual average, indicated by n/a in Table 7. The 'catchment area' for these sites could not therefore be calculated. For the purposes of this analysis, however, a conservative approach has been adopted and it has been assumed that the sites with low data capture exceeded the ecosystem and vegetation area Upper Assessment Thresholds for the respective pollutants.

Table 7 Rural automatic network exceedance data 1998-1999

	Winter mean1998-1999		*Annual mean 1999*	
	Sulphur dioxide ($\mu g/m^3$)	*Exceedance*	*NOx ($\mu g/m^3$)*	*Exceedance*
Lullington Heath	1.3	None	n/a	UAT
Ladybower	1.8	None	6.5	None
Harwell	1	None	n/a	UAT
Narbeth	n/a	UAT	n/a	UAT
Rochester	3.4	None	15.9	None
Wicken Fen	1.8	None	10.1	None

n/a: indicates no data available, data capture <75%
For SO_2 Upper Assessment Threshold = 12 $\mu g/m^3$, Lower Assessment Threshold = 8 $\mu g/m^3$
For NOx Upper Assessment Threshold = 24 $\mu g/m^3$, Lower Assessment Threshold = 19.5 $\mu g/m^3$
UAT refers to the Upper Assessment Threshold, LAT to the Lower Assessment Threshold.

8.2 OBSERVATIONS AND PROPOSALS

Figure 16 indicates that there are no Ecosystem and Vegetation Areas in the UK with winter average SO_2 concentrations greater than the Ecosystem and Vegetation Areas Lower Assessment Threshold for this pollutant. Hence, it has been determined that no additional automatic monitoring is mandatory for this pollutant.

Figure 17 indicates that all of the of Ecosystem and Vegetation Areas which have annual average concentrations of NOx between the Upper and Lower Assessment Threshold are covered by one or more of the existing NOx monitors in the current automatic rural network. Therefore, no extra automatic monitoring is required for the assessment of NOx Ecosystem and Vegetation areas.

As part of the assessment of SO_2 and NOx concentrations in Ecosystem and Vegetation, it has been recognised that the combination the automatic rural monitoring networks (Figures 16 and 17) and the sampler network (Figure 13) provide excellent coverage of rural NOx and SO_2 levels in those areas of the UK where concentrations are likely to be highest. However, it is also recognised that there are significant areas of North Wales, Scotland and Northern Ireland with sensitive ecosystems that are unserviced by automatic monitoring. Hence, as a voluntary measure the UK is considering whether rural background monitoring stations should be installed in these areas to provide a balance to the distribution of automatic monitoring in rural areas throughout the UK.

9 Achieving compliance

Nitrogen dioxide, PM10, sulphur dioxide and lead levels have been assessed throughout the UK. On the basis of the assessments and analyses presented in this report, decisions have been made for the minimum number of additional automatic monitoring locations in areas with high estimated pollutant concentrations. These decisions are summarised in Table 8. Fixed monitoring is supplemented by information from other sources in all zones and agglomerations. Stations already available in the current monitoring network are also accounted for.

Table 8 Summary of the minimum additional number of monitoring sites required in the UK for compliance with the Daughter Directive

1. Nitrogen dioxide					
	England	Wales	Scotland	Northern Ireland	
Agglomerations	2	0	0	0	
Other Zones	3	2	3	0	
Total	**5**	**2**	**3**	**0**	**10**
2. PM10					
	England	Wales	Scotland	Northern Ireland	
Agglomerations	4	0	0	0	
Other Zones	4	2	3	0	
Total	**8**	**2**	**3**	**0**	**13**
3. Sulphur dioxide					
	England	Wales	Scotland	Northern Ireland	
Agglomerations	3	0	0	0	
Other Zones	2	2	2	0	
Total	**5**	**2**	**2**	**0**	**9**
4. Lead					
	England	Wales	Scotland	Northern Ireland	
Agglomerations	0	0	0	0	
Other Zones	0	0	0	0	
Total	**0**	**0**	**0**	**0**	**0**
5. Ecosystem & Vegetation Areas					
	England	Wales	Scotland	Northern Ireland	
Oxides of nitrogen	0	0	0	0	**0**
Sulphur dioxide	0	0	0	0	**0**

The additional monitoring needed for formal compliance with the Directive will be satisfied by a process of affiliation of existing local authority monitoring stations and also by direct funding of new monitoring sites from the UK Government. A survey of the monitoring activities performed by local authorities has been conducted. The results of this survey have enabled the most appropriate monitoring stations for meeting the requirements of the Daughter Directive to be identified with a view to affiliation into the AUN. Table 9 presents the local authority monitoring stations that have been identified for affiliation and also indicates where direct funding from Government is required to achieve compliance with the Daughter Directive's monitoring requirements.

Table 9 Monitoring sites identified for affiliation and new direct funded network sites for compliance with the Daughter Directive and provision of data for policy support

England

Agglomeration/Zone	Site	Pollutants	Site Status
Greater London Urban Area	No additional monitoring required		
West Midlands Urban Area	No additional monitoring required		
Greater Manchester Urban Area	No additional monitoring required		
West Yorkshire Urban Area	No additional monitoring required		
Tyneside	No additional monitoring required		
Liverpool Urban Area	No additional monitoring required		
Sheffield Urban Area	No additional monitoring required		
Nottingham Urban Area	No additional monitoring required		
Bristol Urban Area	No additional monitoring required		
Brighton/Worthing/Littlehampton	Hove	SO2 and PM10	Direct fund SO2 and PM10 for minimum compliance
Leicester Urban Area	No additional monitoring required		
Portsmouth Urban Area	Gosport	NO2, SO2 and PM10	Affiliate for minimum compliance
Teesside Urban Area	No additional monitoring required		
The Potteries	No additional monitoring required		
Bournemouth Urban Area	Bournemouth - Roadside	NO2, SO2 and PM10	Minimum compliance, direct fund SO2 and PM10
Reading/Wokingham Urban Area	No additional monitoring required		
Coventry/Bedworth		PM10	Affiliate for minimum compliance
Kingston upon Hull	No additional monitoring required		
Southampton Urban Area	No additional monitoring required		
Birkenhead Urban Area	No additional monitoring required		
Southend Urban Area	No additional monitoring required		
Blackpool Urban Area	No additional monitoring required		
Preston Urban Area	No additional monitoring required		
Greater London	No additional monitoring required		
North East	Yarm Roadside	NO2 and PM10	Affiliate for minimum compliance
North West & Merseyside	Wigan - Leigh Police Station	NO2, SO2 and PM10	Affiliate for minimum compliance
Yorkshire & Humberside	No additional monitoring required		
East Midlands	Northhampton	NO2, SO2 and PM10	Affiliate for minimum compliance direct fund PM10
West Midlands	No additional monitoring required		
South East	Canterbury - Chaucer Tech	PM10	Affiliate for minimum compliance
South West	No additional monitoring required		

Wales

Agglomeration/Zone	Site	Pollutants	Site Status
Swansea	No additional monitoring required		
Cardiff	No additional monitoring required		
South Wales	Cwmbran	NO2, SO2 and PM10	Affiliate for minimum compliance
North Wales	TBA	NO2, SO2, PM10 and site	Direct fund for minimum compliance

Scotland

Agglomeration/Zone	Site	Pollutants	Site Status
Edinburgh Urban Area	No additional monitoring required		
Glasgow Urban Area	Glasgow Kerbside		Alter manifold poistioning to comply with Directive
Scottish Borders	TBA (Roadside)	NO2, PM10 and site	Direct fund for minimum compliance
Central Scotland	Falkirk Urban Background	NO2, SO2 and PM10	Affiliate for minimum compliance
North East Scotland	Aberdeen	SO2	Direct fund for minimum compliance
Highland	Inverness	NO2, PM10 and site	Direct fund for minimum compliance

Northern Ireland

Agglomeration/Zone	Site	Pollutants	Site Status
Belfast	No additional monitoring required		
Northern Ireland	No additional monitoring required		

10 References

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Figure 1 Article 5 assessment zones and agglomerations in the UK

Ref. NETCEN/12012000/gloms.shp,art5zones.shp/v6/TB

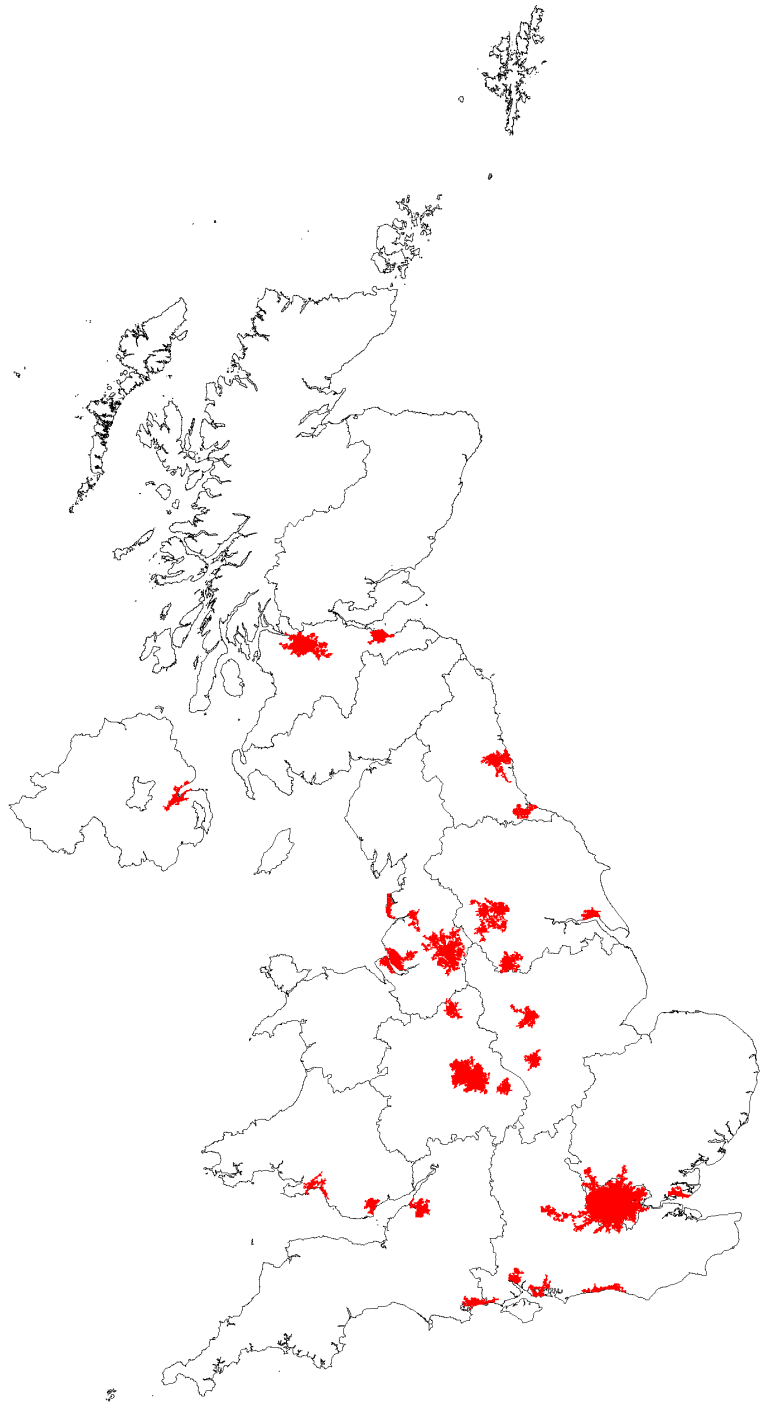


Figure 2 Nitrogen dioxide Article 5 assessment map for urban background areas (ug/m3)

Ref. NETCEN/08062000/uk1no219991/art5_v7.apr/tb

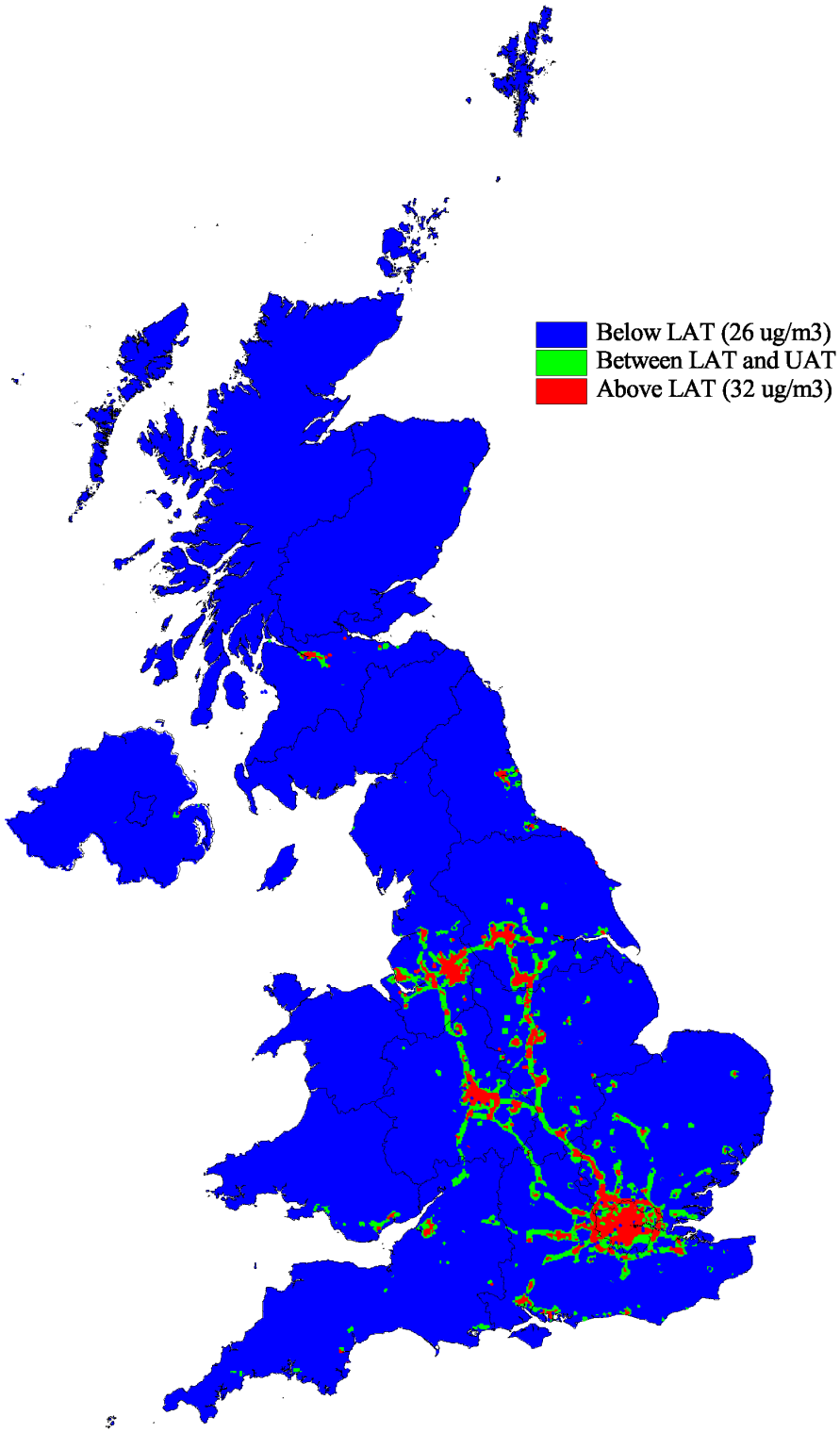


Figure 3 Nitrogen dioxide Article 5 assessment map for roadside locations (ug/m3)

Ref. NETCEN/08062000/rno2199910/art5_v7.apr/tb

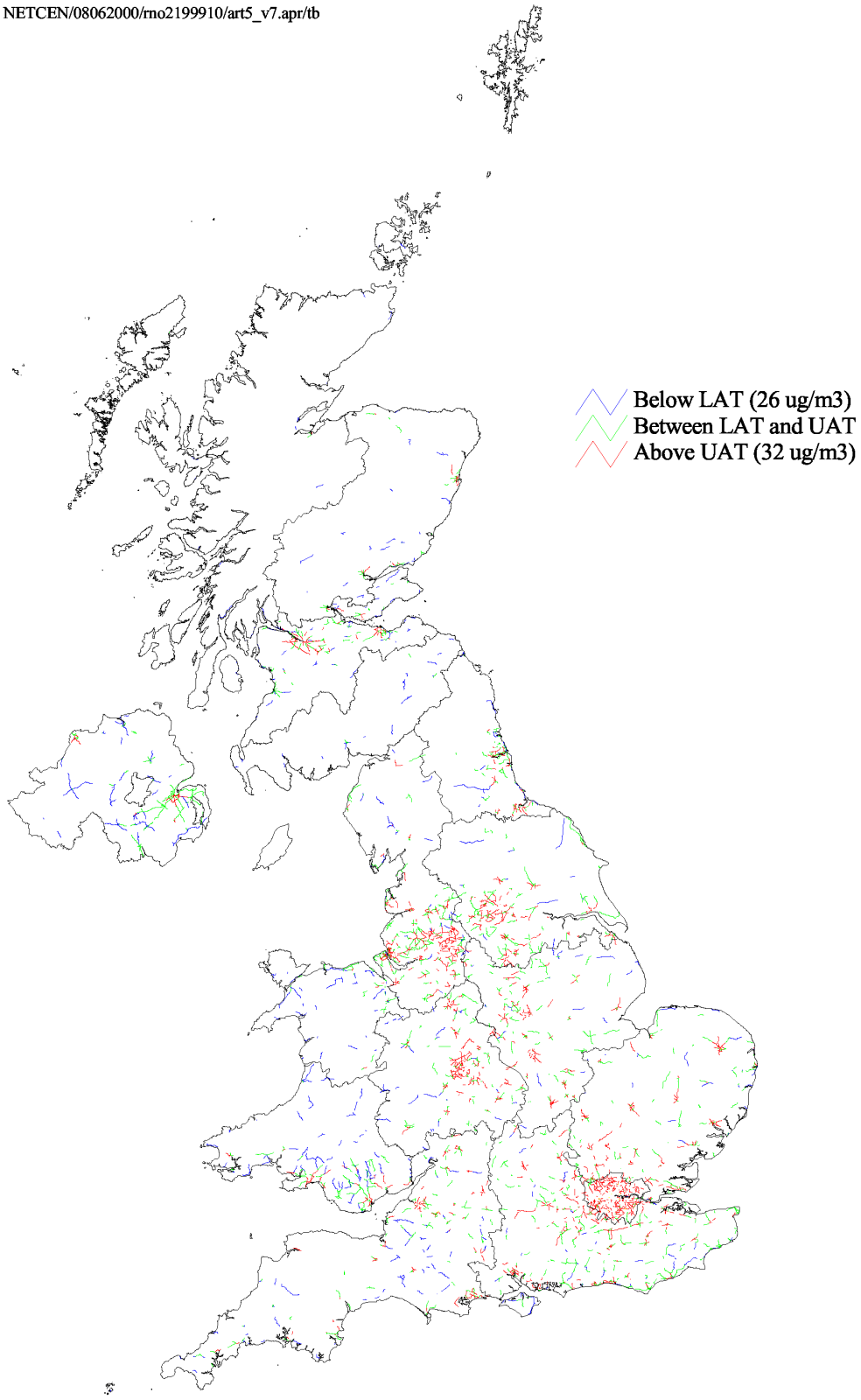


Figure 4 Urban background areas with annual average NO2 concentrations greater than the Upper Assessment Threshold

Ref. NETCEN/09062000/uk1no219991; no2sites2000.shp/art5_v7.apr/tb

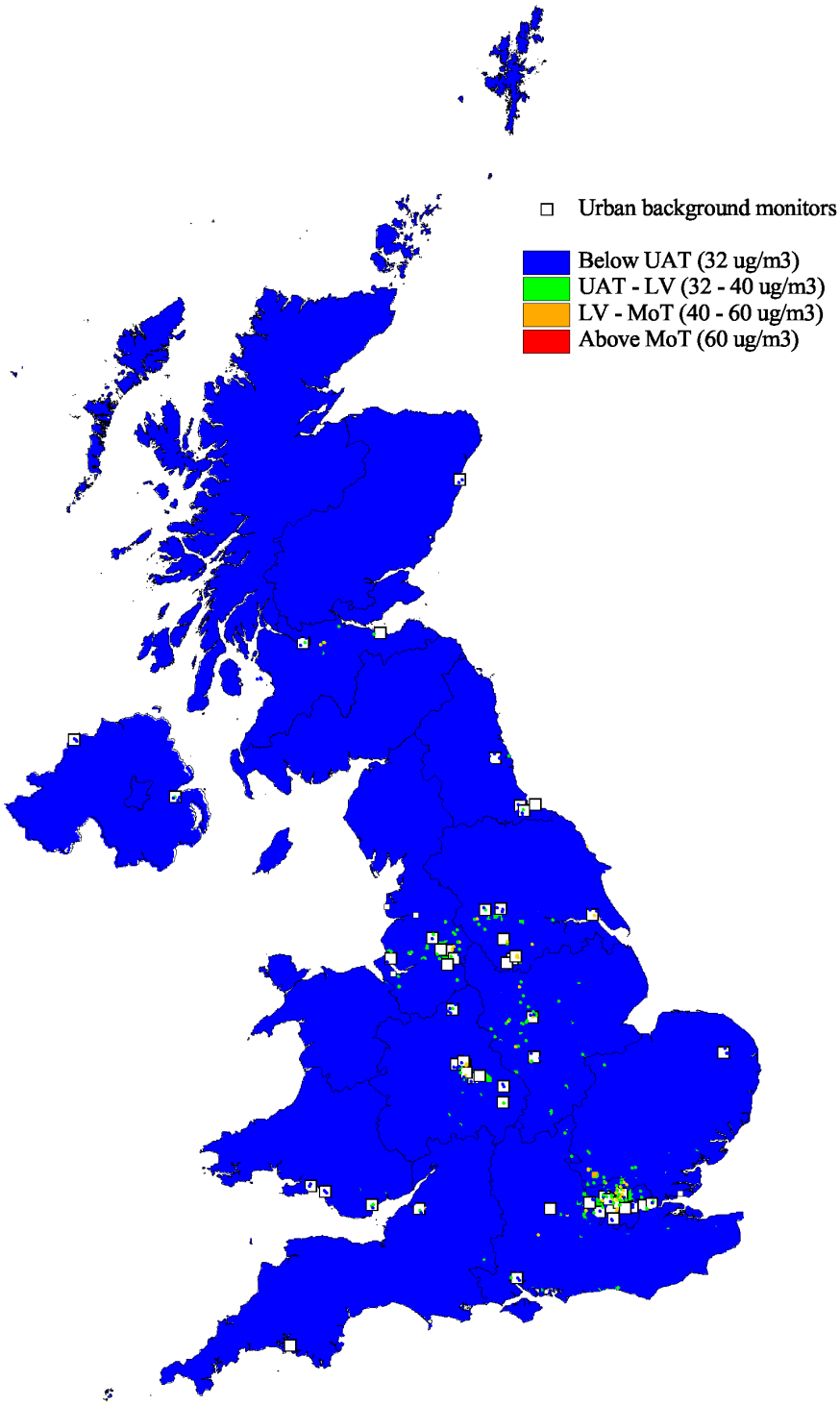


Figure 5 Annual average roadside NO2 concentrations greater than the Upper Assessment Threshold

Ref. NETCEN/10062000/uk1no219991; art4zones.shp; no2sites2000.shp/art5_v7.apr/tb

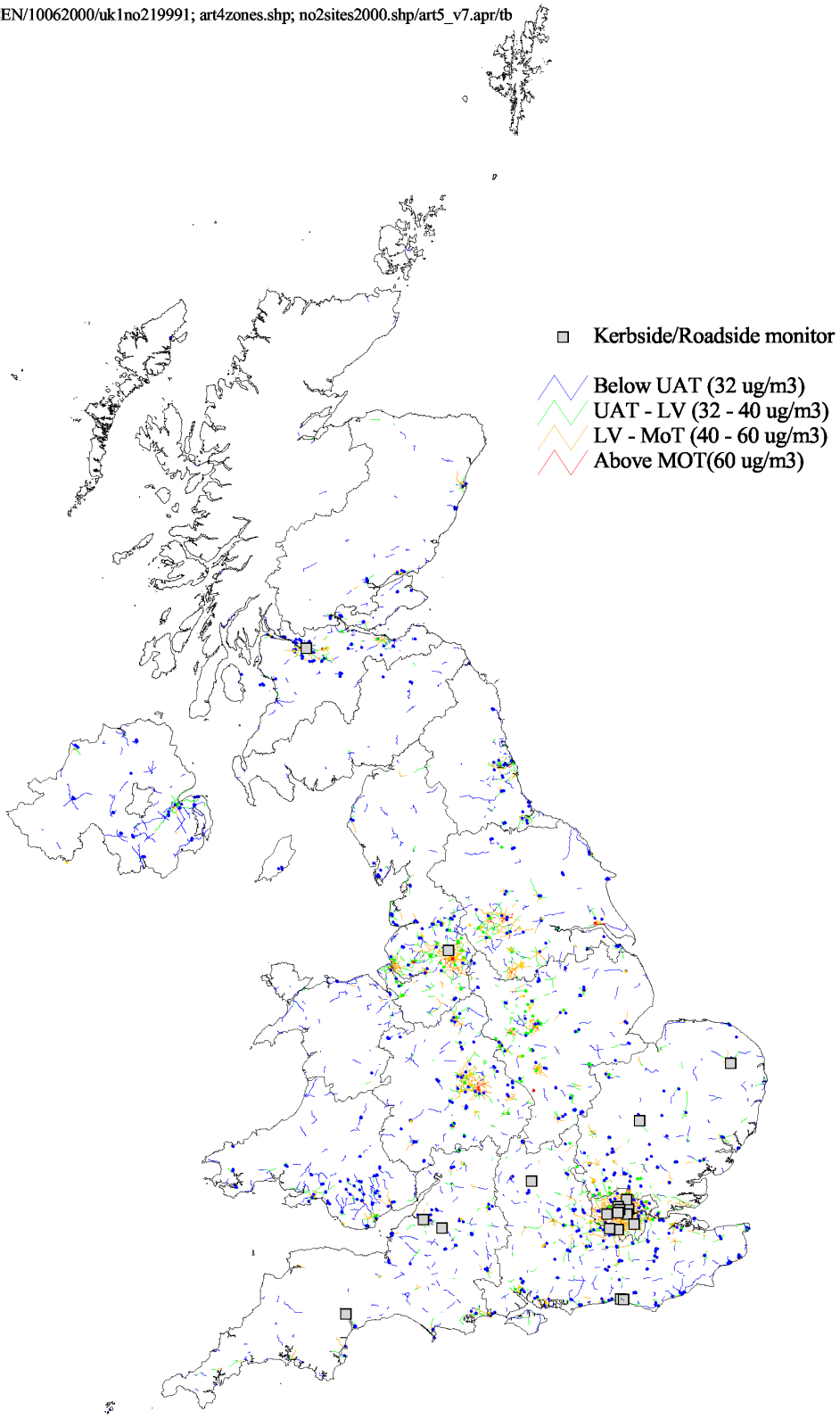


Figure 6 PM10 Article 5 assessment map for urban background area (ug/m3)

Ref. NETCEN/10062000/uk1_1999_10y1; art5zone.shp/art5_v7.apr/tb

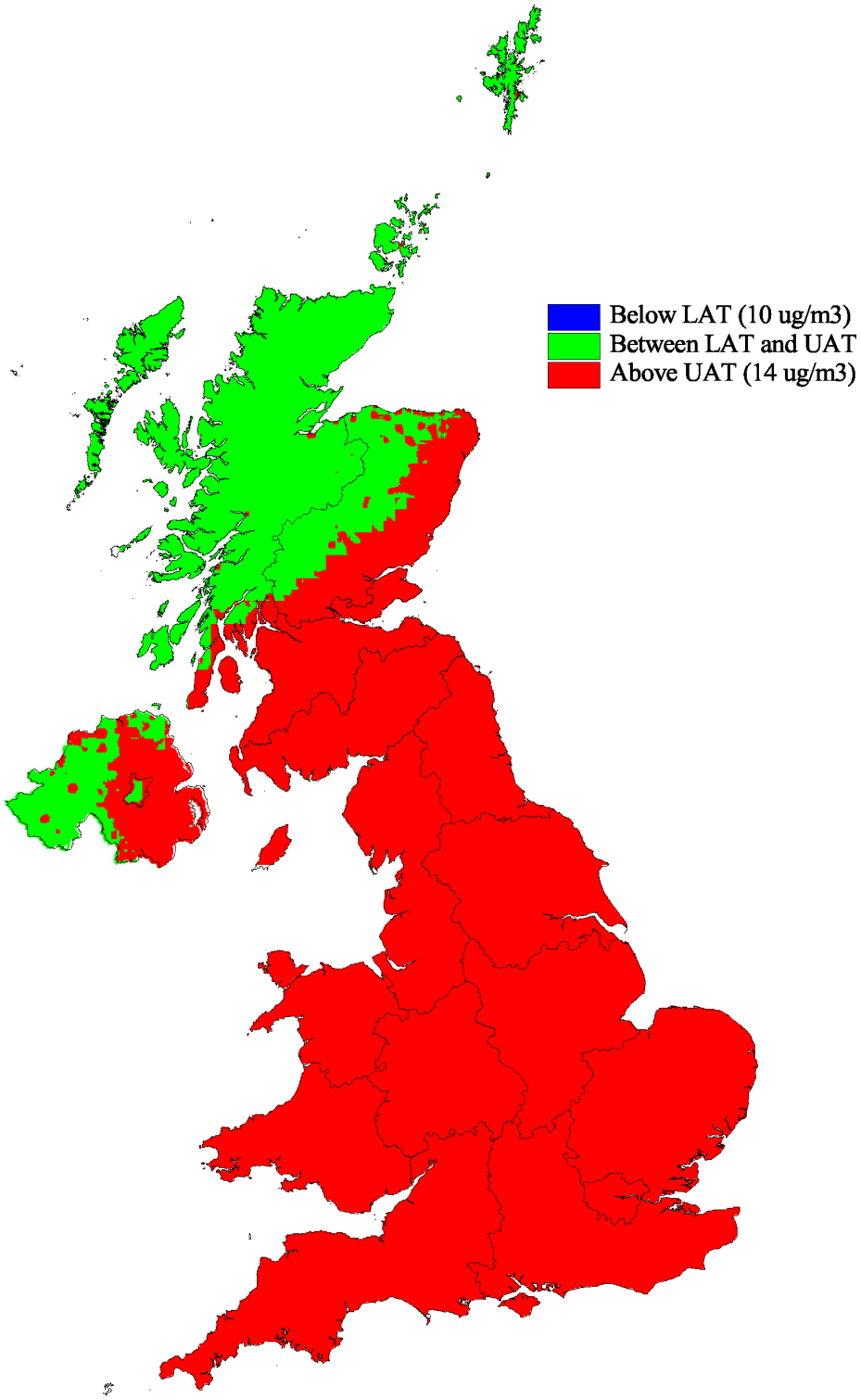


Figure 7 Annual average background PM10 greater than the Upper Assessment Threshold

Ref. NETCEN/10062000/uk1_1999_10y1; art5zone.shp/art5_v7.apr/tb

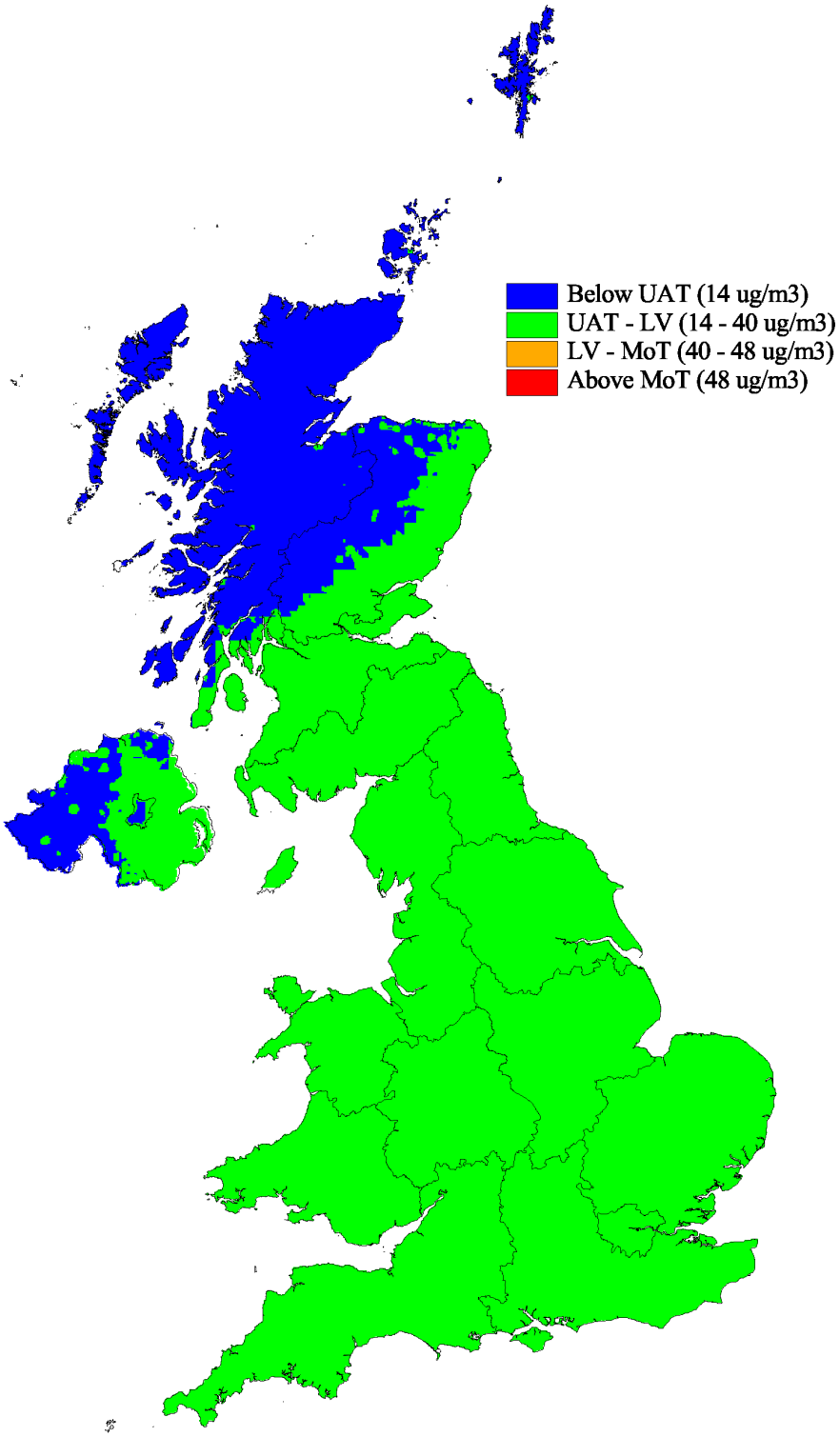


Figure 8 Annual average PM10 at background locations (ug/m3)

Ref. NETCEN/08062000/uk1199910y1_ug/art5_v7.apr/tb

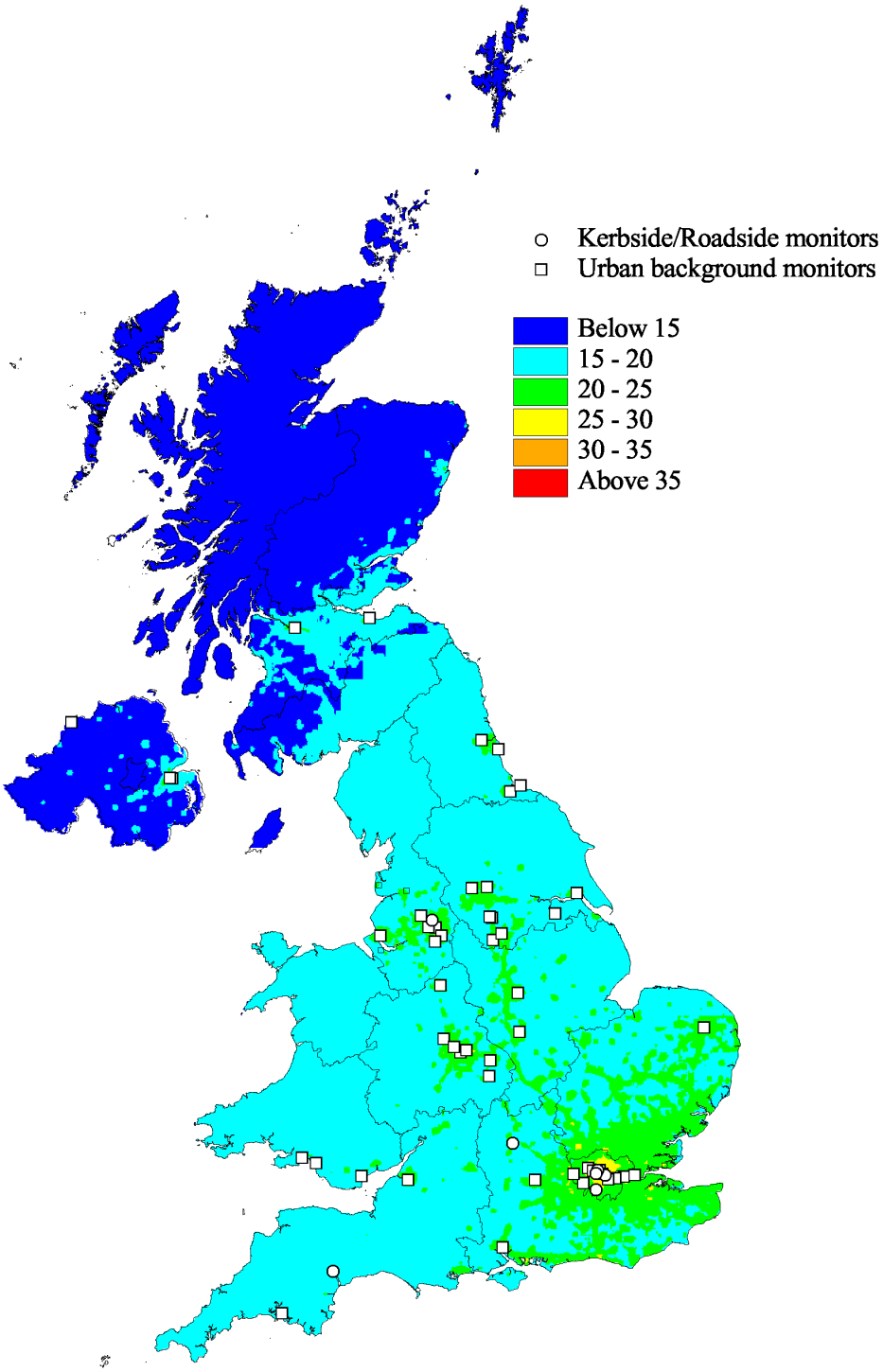


Figure 9 Relationship between the 99.2nd percentile of daily average SO_2 concentrations versus 99.9th percentile of 15 minute average SO_2 concentrations in the UK 1997 -1999

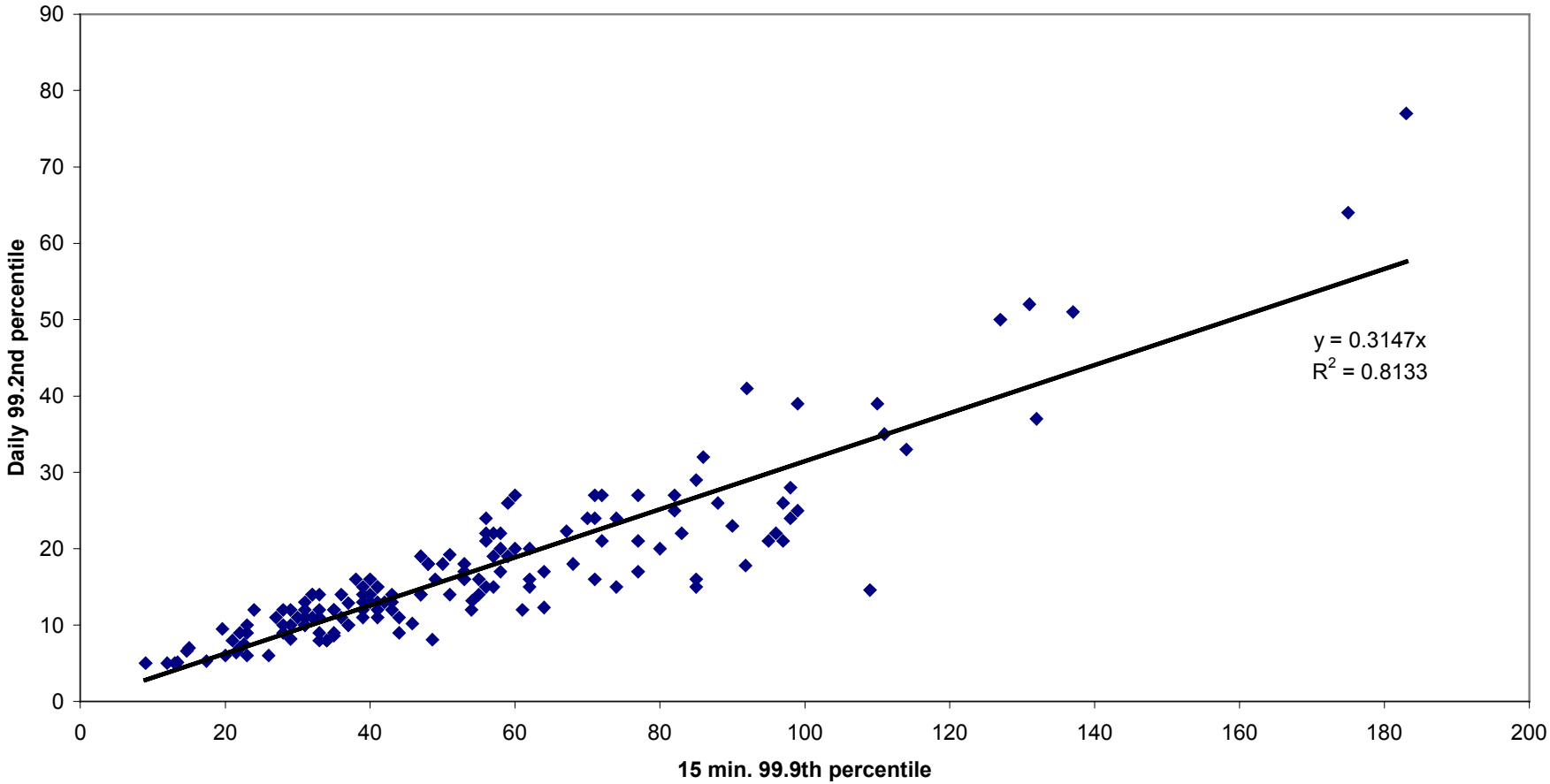


Figure 10 Estimated exceedence of the daily average assessment threshold for sulphur dioxide (ug/m3)

Ref. NETCEN/12072000/992so2ug96v8/art5so2_v8.shp/TB

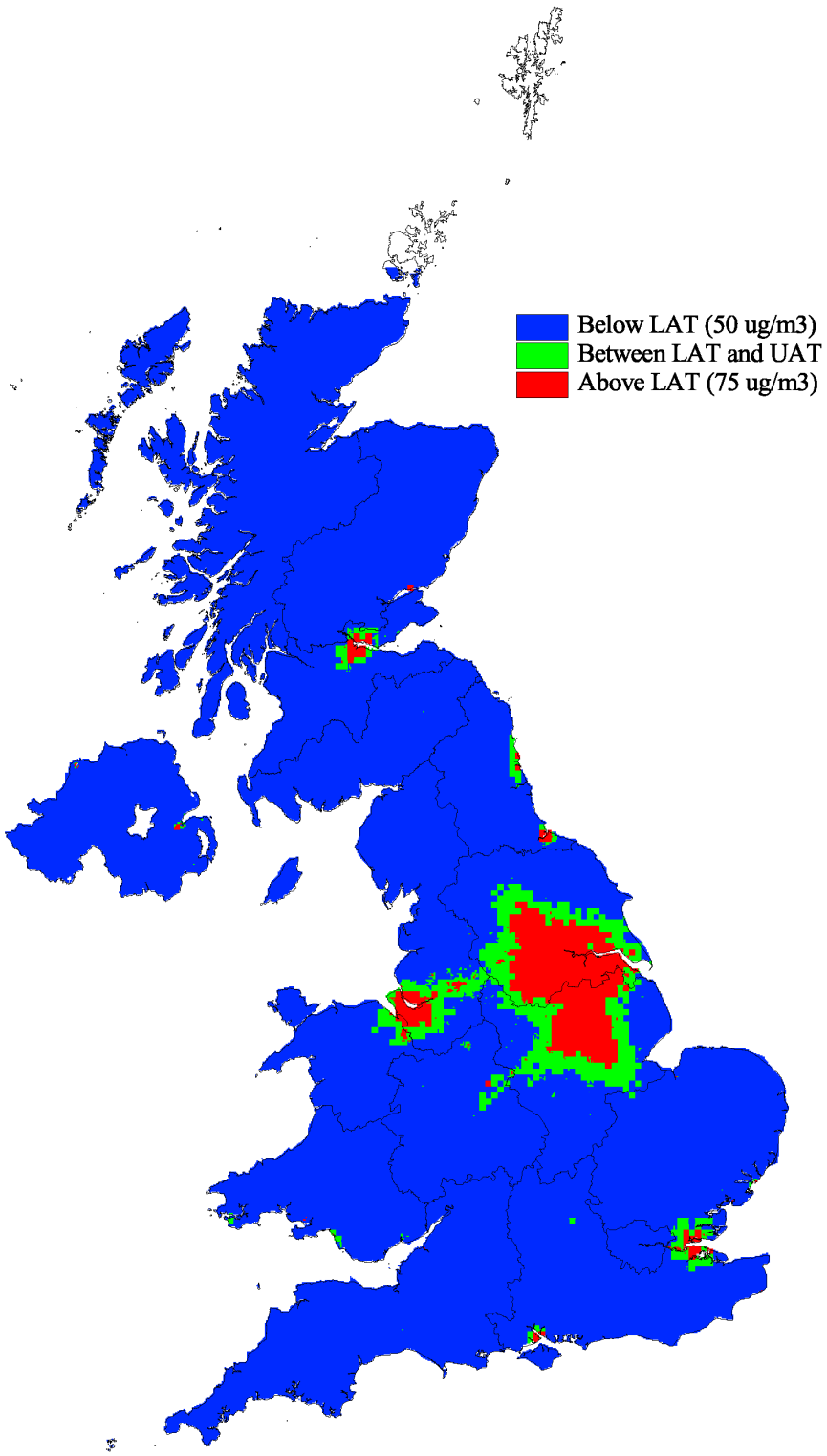


Figure 11 Estimated exceedence of the daily average assessment threshold and Limit Value for sulphur dioxide (ug/m3)

Ref. NETCEN/12072000/992so2ug96v8/art5so2_v8.shp/TB

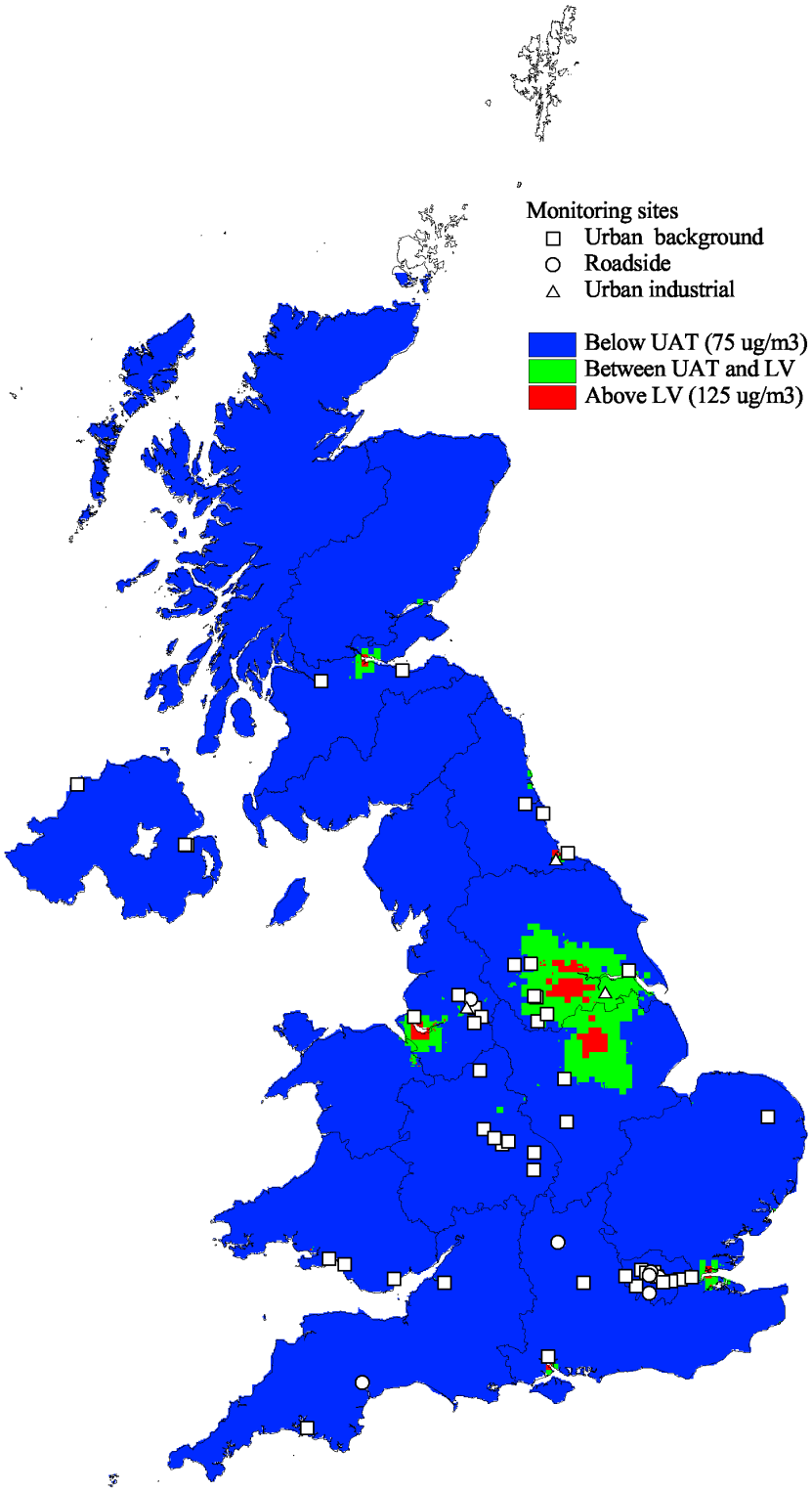


Figure 12 Estimated exccedence of the annual average upper assessment threshold for lead (ug/m3)

Ref. NETCEN/18072000/uk1km_lead2r/art5_v8.apr/TB

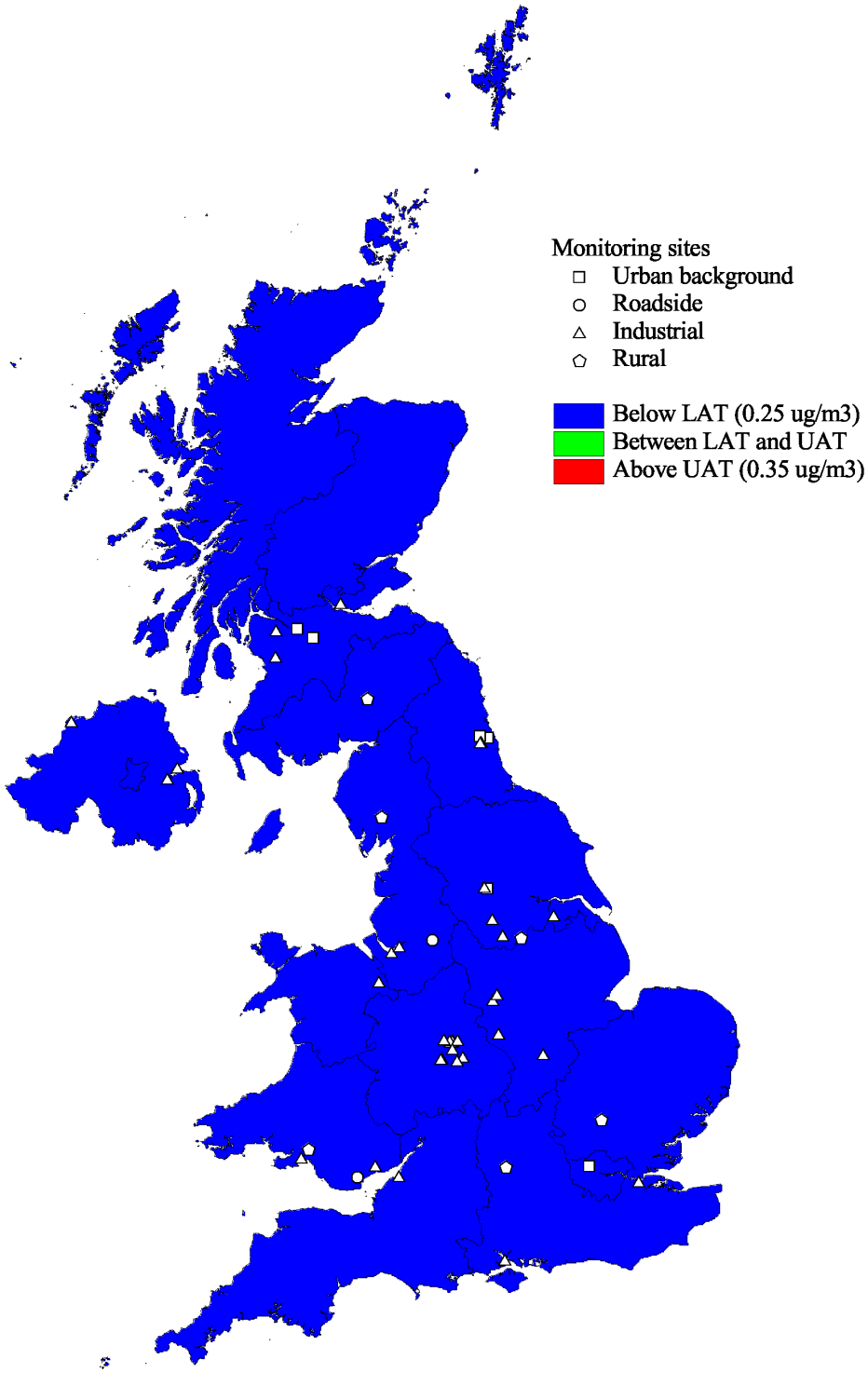


Figure 13 Ecosystem and Vegetation Areas and rural monitoring network locations in the UK

NETCEN/07072000/av3.2/ecoply_tb.shp/TB

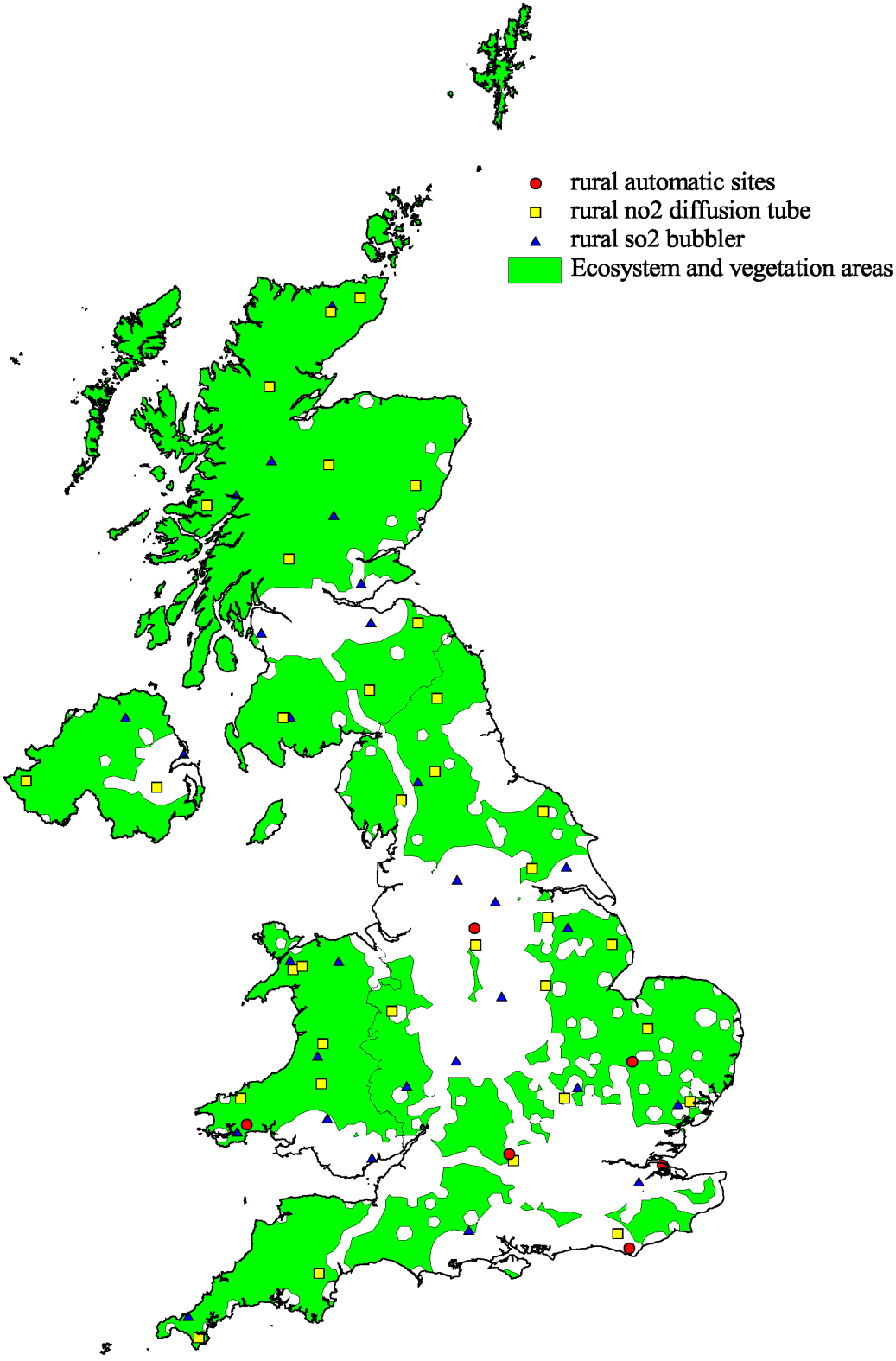


Figure 14 Interpolated rural winter average sulphur dioxide concentrations 1998/9 (ug/m3)

Ref. NETCEN/07072000/rso2win9899/art5maps.apr/TB

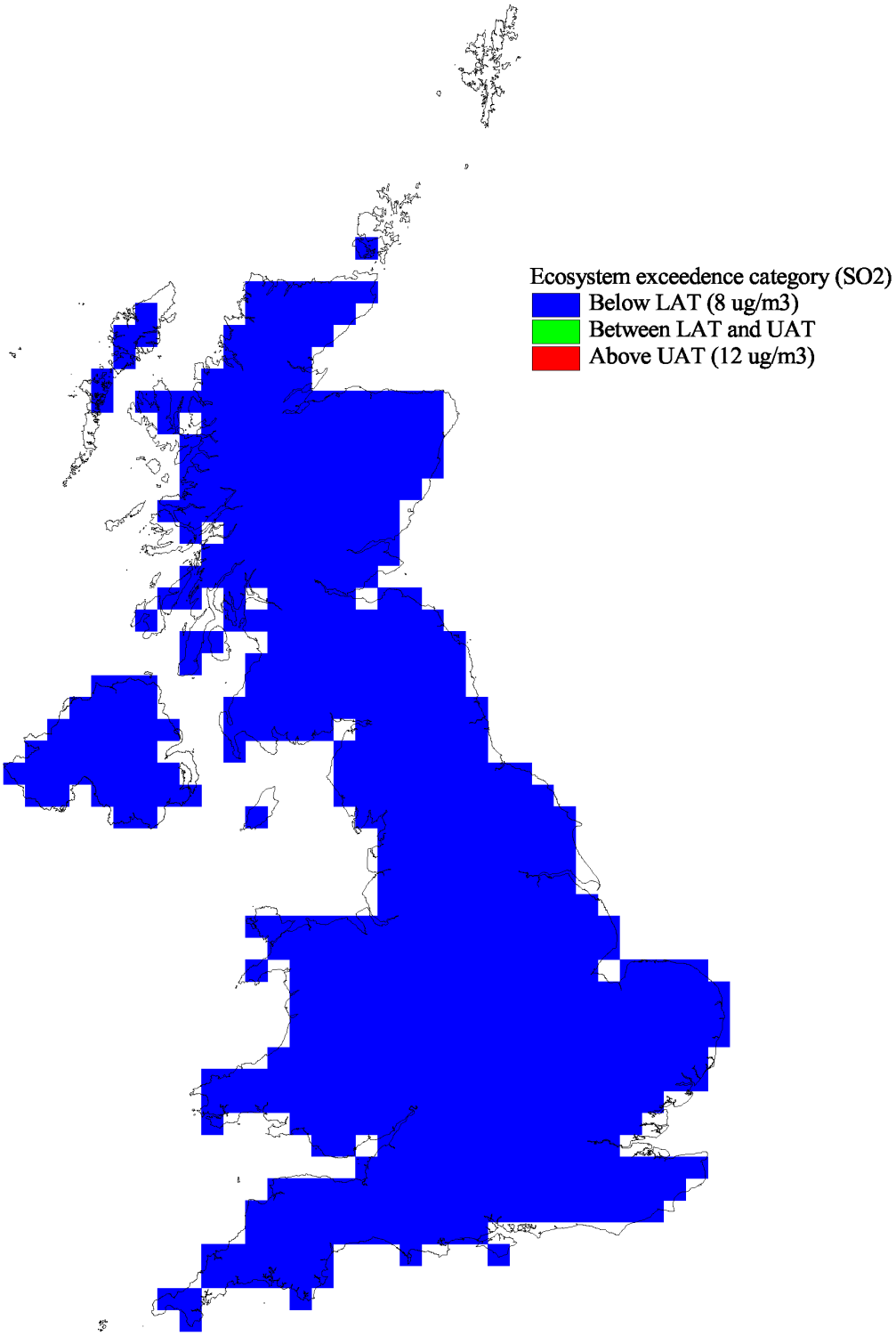


Figure 15 Interpolated rural annual average NOx concentrations 1999 (ug/m3)

Ref. NETCEN/07072000/rnox1999_1/art5maps.apr/TB

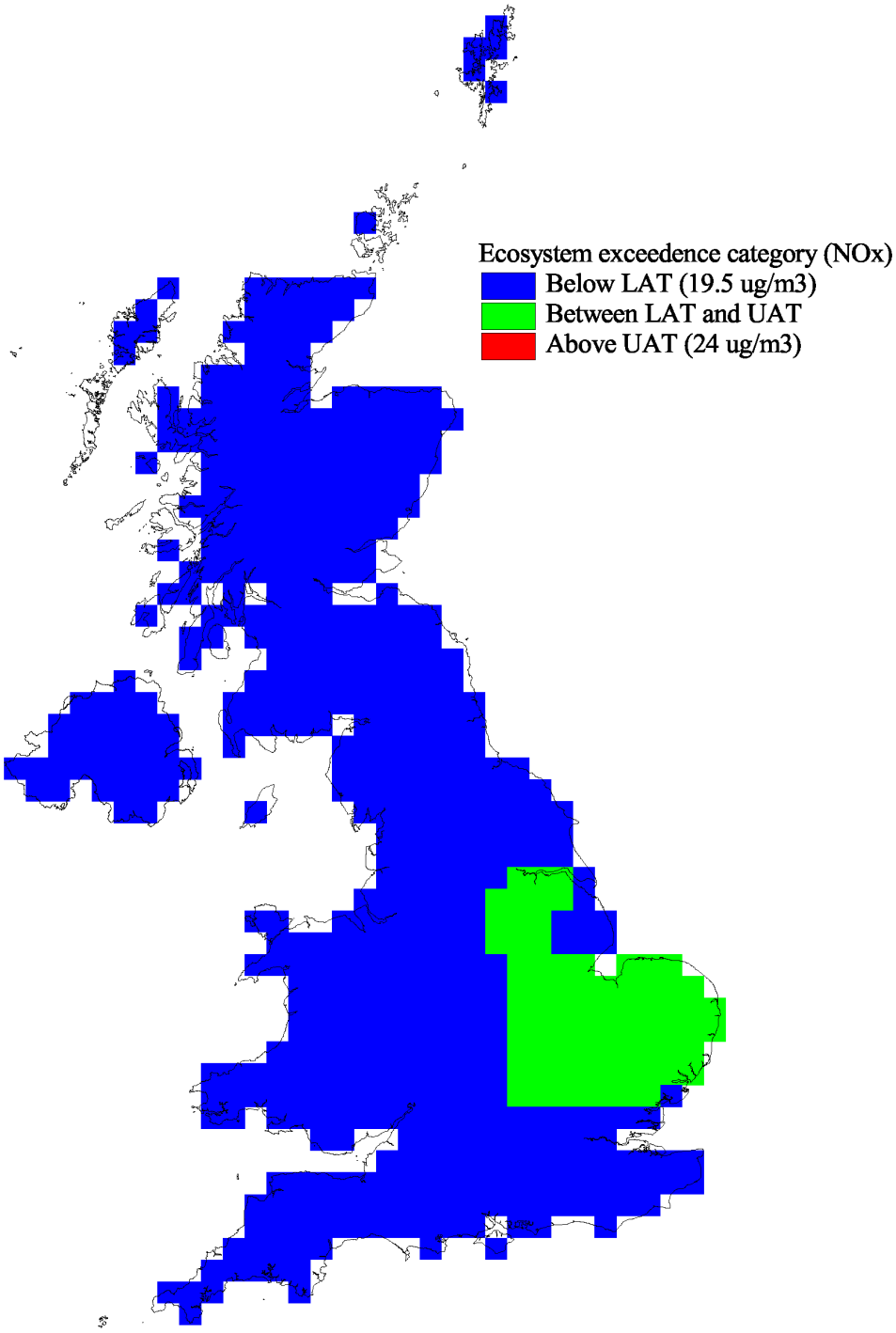


Figure 16 Rural automatic monitoring station catchment areas based on exceedence of the sulphur dioxide ecosystem assessment thresholds for the winter mean

Ref. NETCEN/12072000/ecoplytb_bk2.shp/TB

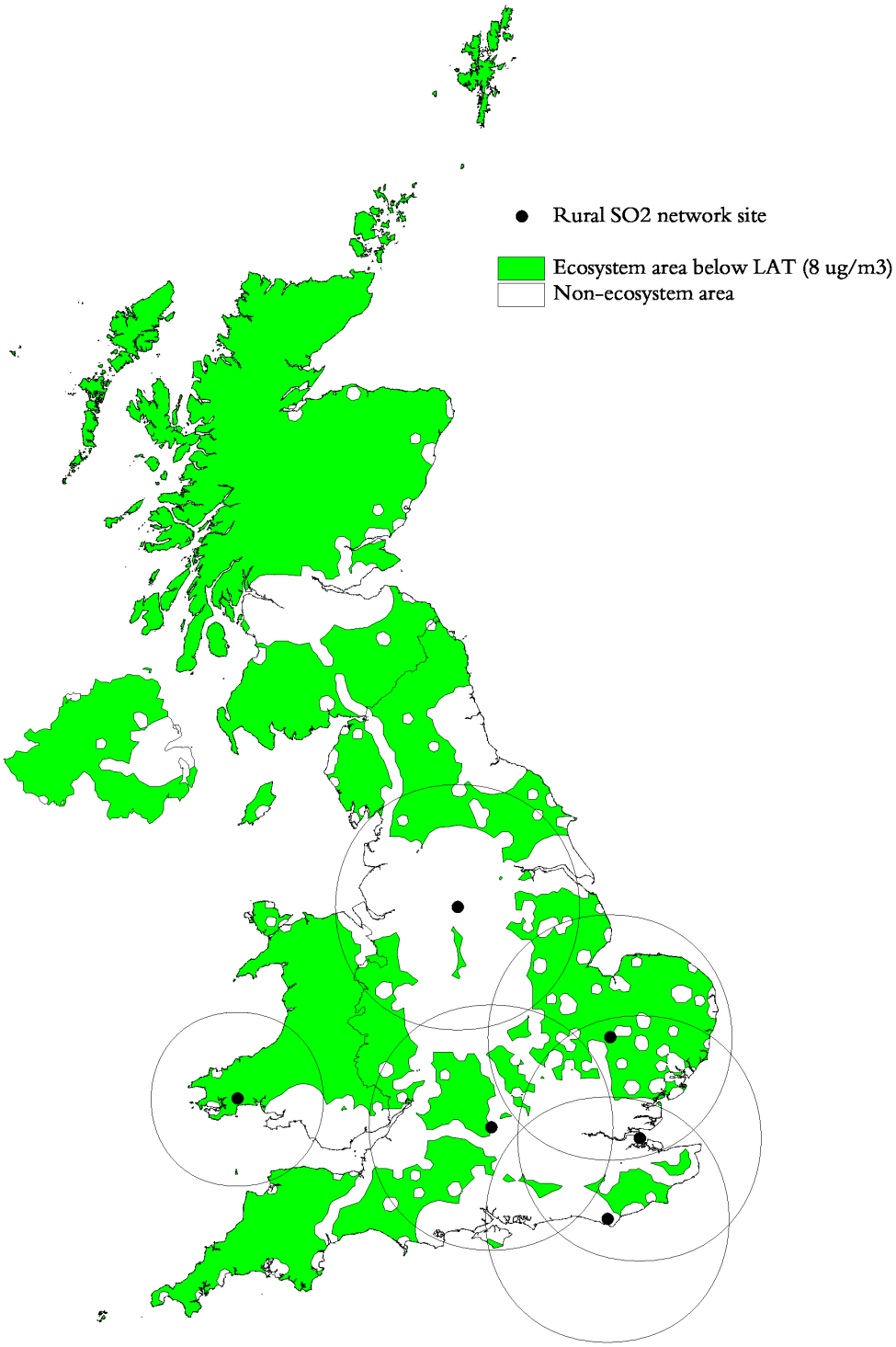
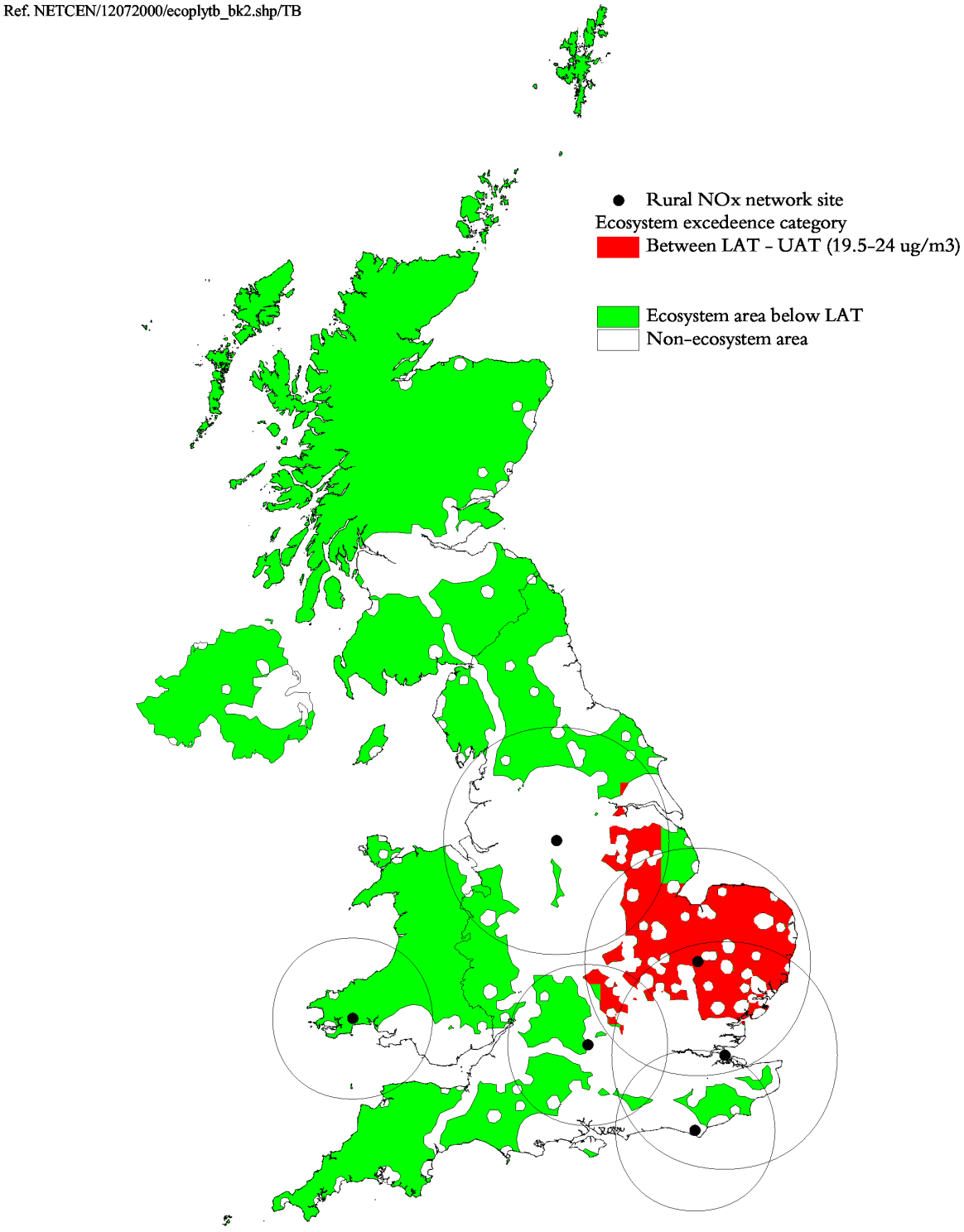


Figure 17 Rural automatic monitoring station catchment areas based on exceedence of the NOx ecosystem assessment thresholds



Appendices

CONTENTS

Appendix 1
Framework Directive: Article 5

Article 5, Preliminary assessment of ambient air quality

Member States which do not have representative measurements of the levels of pollutants for all zones and agglomerations shall undertake series of representative measurements, surveys or assessments to have data available in time for the implementation of the legislation referred to in Article 4 (1).

Appendix 2
Daughter Directive Limit Values and Assessment Thresholds

ANNEX I

LIMIT VALUES AND THE ALERT THRESHOLD FOR SULPHUR DIOXIDE

I. **Limit values for sulphur dioxide**

Limit values must be expressed in $\mu g/m^3$. The volume must be standardised at a temperature of 293 °K and a pressure of 101,3 kPa.

	Averaging period	Limit value	Margin of tolerance	Date by which limit value is to be met
1. Hourly limit value for the protection of human health	1 hour	350 $\mu g/m^3$, not to be exceeded more than 24 times a calendar year	150 $\mu g/m^3$ (43 %) on the entry into force of this Directive, reducing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2005	1 January 2005
2. Daily limit value for the protection of human health	24 hours	125 $\mu g/m^3$, not to be exceeded more than 3 times a calendar year	None	1 January 2005
3. Limit value for the protection of ecosystems	Calendar year and winter (1 October to 31 March)	20 $\mu g/m^3$	None	19 July 2001

II. **Alert threshold for sulphur dioxide**

500 $\mu g/m^3$ measured over three consecutive hours at locations representative of air quality over at least 100 km^2 or an entire zone or agglomeration, whichever is the smaller.

III. **Minimum details to be made available to the public when the alert threshold for sulphur dioxide is exceeded**

Details to be made available to the public should include at least:

— the date, hour and place of the occurrence and the reasons for the occurrence, where known;

— any forecasts of:

  — changes in concentrations (improvement, stabilisation, or deterioration), together with the reasons for those changes,

  — the geographical area concerned,

  — the duration of the occurence;

— the type of population potentially sensitive to the occurrence;

— the precautions to be taken by the sensitive population concerned.

Source: Council Directive 1999/30/EC

ANNEX II

LIMIT VALUES FOR NITROGEN DIOXIDE (NO_2) AND OXIDES OF NITROGEN (NO_x) AND THE ALERT THRESHOLD FOR NITROGEN DIOXIDE

I. Limit values for nitrogen dioxide and oxides of nitrogen

Limit values must be expressed in µg/m³. The volume must be standardised at a temperature of 293 °K and a pressure of 101,3 kPa.

	Averaging period	Limit value	Margin of tolerance	Date by which limit value is to be met
1. Hourly limit value for the protection of human health	1 hour	200 µg/m³ NO_2, not to be exceeded more than 18 times a calendar year	50 % on the entry into force of this Directive, reducing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2010	1 January 2010
2. Annual limit value for the protection of human health	Calendar year	40 µg/m³ NO_2	50 % on the entry into force of this Directive, reducing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2010	1 January 2010
3. Annual limit value for the protection of vegetation	Calendar year	30 µg/m³ NO_x	None	19 July 2001

II. Alert threshold for nitrogen dioxide

400 µg/m³ measured over three consecutive hours at locations representative of air quality over at least 100 km ² or an entire zone or agglomeration, whichever is the smaller.

III. Minimum details to be made available to the public when the alert threshold for nitrogen dioxide is exceedeed

Details to be made available to the public should include at least:

— the date, hour and place of the occurrence and the reasons for the occurrence, where known;

— any forecasts of:

  — changes in concentrations (improvement, stabilisation, or deterioration), together with the reasons for those changes,

  — the geographical area concerned,

  — the duration of the occurrence;

— the type of population potentially sensitive to the occurrence;

— the precautions to be taken by the sensitive population concerned.

Source: Council Directive 1999/30/EC

ANNEX III

LIMIT VALUES FOR PARTICULATE MATTER (PM_{10})

	Averaging period	Limit value	Margin of tolerance	Date by which limit value is to be met
STAGE 1				
1. 24-hour limit value for the protection of human health	24 hours	50 µg/m³ PM_{10}, not to be exceeded more than 35 times a calendar year	50 % on the entry into force of this Directive, reducing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2005	1 January 2005
2. Annual limit value for the protection of human health	Calendar year	40 µg/m³ PM_{10}	20 % on the entry into force of this Directive, reducing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2005	1 January 2005
STAGE 2 (1)				
1. 24-hour limit value for the protection of human health	24 hours	50 µg/m³ PM_{10}, not to be exceeded more than 7 times a calendar year	To be derived from data and to be equivalent to the Stage 1 limit value	1 January 2010
2. Annual limit value for the protection of human health	Calendar year	20 µg/m³ PM_{10}	50 % on 1 January 2005 reducing every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2010	1 January 2010

(1) Indicative limit values to be reviewed in the light of further information on health and environmental effects, technical feasibility and experience in the application of Stage 1 limit values in the Member States.

Source: Council Directive 1999/30/EC

ANNEX IV

LIMIT VALUE FOR LEAD

	Averaging period	Limit value	Margin of tolerance	Date by which limit value is to be met
Annual limit value for the protection of human health	Calendar year	0,5 µg/m³ (1)	100 % on the entry into force of this Directive, reducing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0 % by 1 January 2005, or by 1 January 2010 in the immediate vicinity of specific point sources, of which the Commission must be notified.	1 January 2005, or 1 January 2010 in the immediate vicinity of specific industrial sources situated on sites contaminated by decades of industrial activities. The Commission must be notified of those sources by 19 July 2001 (2). In such cases, the limit value as from 1 January 2005 will be 1,0 µg/m³.

(1) The process laid down in Article 10 for the review of this Directive will include consideration of the possibility of supplementing or replacing the limit value by a deposition limit value in the immediate vicinity of point sources.

(2) Such notification must be accompanied by appropriate justification. The area in which higher limit values apply must not extend further than 1 000 m from such specific sources.

Source: Council Directive 1999/30/EC

ANNEX V

DETERMINATION OF REQUIREMENTS FOR ASSESSMENT OF CONCENTRATIONS OF SULPHUR DIOXIDE, NITROGEN DIOXIDE (NO_2), AND OXIDES OF NITROGEN (NO_x), PARTICULATE MATTER (PM_{10}) AND LEAD IN AMBIENT AIR WITHIN A ZONE OR AGGLOMERATION

I. **Upper and lower assessment thresholds**

The following upper and lower assessment thresholds will apply:

(a) SULPHUR DIOXIDE

	Health protection	Ecosystem protection
Upper assessment threshold	60 % of 24-hour limit value (75 µg/m³, not to be exceeded more than 3 times in any calender year)	60 % of winter limit value (12 µg/m³)
Lower assessment threshold	40 % of 24-hour limit value (50 µg/m³, not to be exceeded more than 3 times in any calender year)	40 % of winter limit value (8 µg/m³)

(b) NITROGEN DIOXIDE AND OXIDES OF NITROGEN

	Hourly limit value for the protection of human health (NO_2)	Annual limit value for the protection of human health (NO_2)	Annual limit value for the protection of vegetation (NO_x)
Upper assessment threshold	70 % of limit value (140 µg/m³, not to be exceeded more than 18 times in any calender year)	80 % of limit value (32 µg/m³)	80 % of limit value (24 µg/m³)
Lower assessment threshold	50 % of limit value (100 µg/m³, not to be exceeded more than 18 times in any calender year)	65 % of limit value (26 µg/m³)	65 % of limit value (19,5 µg/m³)

(c) PARTICULATE MATTER

The upper and lower assessment thresholds for PM_{10} are based on the indicative limit values for 1 January 2010.

	24-hour average	Annual average
Upper assessment threshold	60 % of limit value (30 µg/m³, not to be exceeded more than seven times in any calender year)	70 % of limit value (14 µg/m³)
Lower assessment threshold	40 % of limit value (20 µg/m³, not to be exceeded more than seven times in any calender year)	50 % of limit value (10 µg/m³)

Source: Council Directive 1999/30/EC

(d) LEAD

	Annual average
Upper assessment threshold	70 % of limit value (0,35 μg/m³)
Lower assessment threshold	50 % of limit value (0,25 μg/m³)

II. **Determination of exceedances of upper and lower assessment thresholds**

Exceedances of upper and lower assessment thresholds must be determined on the basis of concentrations during the previous five years where sufficient data are available. An assessment threshold will be deemed to have been exceeded if during those five years the total number of exceedances of the numerical concentration of the threshold is more than three times the number of exceedances allowed each year.

Where fewer than five years' data are available Member States may combine measurement campaigns of short duration during the period of the year and at locations likely to be typical of the highest pollution levels with results obtained from information from emission inventories and modelling to determine exceedances of the upper and lower assessment thresholds.

Source: Council Directive 1999/30/EC

Appendix 3
Daughter Directive Annex VII

ANNEX VII

CRITERIA FOR DETERMINING MINIMUM NUMBERS OF SAMPLING POINTS FOR FIXED MEASUREMENT OF CONCENTRATIONS OF SULPHUR DIOXIDE (SO_2), NITROGEN DIOXIDE (NO_2) AND OXIDES OF NITROGEN, PARTICULATE MATTER AND LEAD IN AMBIENT AIR

I. Minimum number of sampling points for fixed measurement to assess compliance with limit values for the protection of human health and alert thresholds in zones and agglomerations where fixed measurement is the sole source of information

(a) *Diffuse sources*

Population of agglomeration or zone (thousands)	If concentrations exceed the upper assessment threshold	If maximum concentrations are between the upper and lower assessment thresholds	For SO_2 and NO_2, in agglomerations where maximum concentrations are below the lower assessment threshold
0-250	1	1	not applicable
250-499	2	1	1
500-749	2	1	1
750-999	3	1	1
1 000-1 499	4	2	1
1 500-1 999	5	2	1
2 000-2 749	6	3	2
2 750-3 749	7	3	2
3 750-4 749	8	4	2
4 750-5 999	9	4	2
> 6 000	10	5	3
	For NO_2 and particulate matter: to include at least one urban-background station and one traffic-orientated station		

(b) *Point sources*

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

Source: Council Directive 1999/30/EC

II. **Minimum number of sampling points for fixed measurements to assess compliance with limit values for the protection of ecosystems or vegetation in zones other than agglomerations**

If maximum concentrations exceed the upper assessment threshold	If maximum concentrations are between the upper and lower assessment thresholds
1 station every 20 000 km^2	1 station every 40 000 km^2

In island zones the number of sampling points for fixed measurement should be calculated taking into account the likely distribution patterns of ambient-air pollution and the potential exposure of ecosystems or vegetation.

Source: Council Directive 1999/30/EC

Appendix 4
Comparison of measured and modelled exceedance statistics

Table A1 Identified exceedances of the Upper Assessment Threshold (UAT) for nitrogen dioxide based upon measured and modelled data for UK agglomerations

		Annual Mean (ugm-3)					Modelled[1]	Exceedance of UAT		
Agglomeration	**Monitoring site**	**1995**	**1996**	**1997**	**1998**	**1999**	**NO2 (ugm-3)**	**Measured**	**Modelled**	**Article 5[2]**
Belfast Urban Area	Belfast Centre	40	38	38	34	34	29	Yes	No	Yes
Brighton/Worthing/Littlehampton	Hove Roadside				34		36	n/a	No	Yes
Bristol Urban Area	Bristol Centre	48	48	44	40	38	41	Yes	Yes	Yes
	Bristol Old Market Roadside			61	57	55	58	n/a	Yes	
Cardiff Urban Area	Cardiff Centre	42	40	38	40	32	33	Yes	Yes	Yes
Coventry/Bedworth	Coventry Centre				31		35	n/a	Yes	Yes
Edinburgh Urban Area	Edinburgh Centre	50	48	48	48	42	30	Yes	No	Yes
Glasgow Urban Area	Glasgow Centre			44		38	53	n/a	Yes	Yes
	Glasgow City Chambers	50	52	50	52	52	50	Yes	Yes	
	Glasgow Kerbside				71	69	56	n/a	Yes	
Greater London Urban Area	Camden Roadside			71	63	65	66	n/a	Yes	Yes
	Haringey Roadside			59	53	52	50	n/a	Yes	
	Hounslow Roadside				73	59	64	n/a	Yes	
	London A3 Roadside				57	59	n/a	n/a	Yes	
	London Bexley	42	44	42	40	36	31	Yes	No	
	London Bloomsbury	67	69	71	65	67	66	Yes	Yes	
	London Brent		40	40	34	36	40	Yes	Yes	
	London Bridge Place	65	63	59	57	63	57	Yes	Yes	
	London Bromley Roadside					65	52	n/a	No	
	London Cromwell Road 2					92	76	n/a	Yes	
	London Eltham		36	40	32	36	36	No	Yes	
	London Hackney			63	59	59	41	n/a	Yes	
	London Hillingdon			59	52		47	n/a	Yes	
	London Lewisham				52	53	38	n/a	Yes	
	London Marylebone Road				92	92	87	n/a	Yes	
	London N. Kensington			50	46	46	46	n/a	Yes	
	London Southwark				52	55	49	n/a	Yes	
	London Sutton			36	34	34	33	n/a	Yes	
	London Teddington			35	32	32	32	n/a	Yes	
	London Wandsworth			53	50	52	40	n/a	Yes	
	Southwark Roadside				55		70	n/a	Yes	
	Sutton Roadside			50	42	44	36	n/a	Yes	
	Tower Hamlets Roadside			71	65	71	62	n/a	Yes	
	West London	53	53	57	52	55	46	Yes	Yes	
Greater Manchester Urban Area	Bolton			36	34	32	36	n/a	Yes	Yes
	Bury Roadside				74	73	n/a	n/a	Yes	
	Manchester Piccadilly		55	42	40	44	45	Yes	Yes	
	Manchester South			25	25		31	n/a	No	
	Manchester Town Hall	44	53	52	42	42	46	Yes	Yes	
	Salford Eccles				42	42	43	n/a	Yes	
	Stockport			46	40	40	39	n/a	Yes	
Kingston upon Hull	Hull Centre	46	42	40	38	38	31	Yes	No	Yes
Leicester Urban Area	Leicester Centre	44	42	40	40	42	41	Yes	Yes	Yes
Liverpool Urban Area	Liverpool Centre	50	48	44	38	40	38	Yes	Yes	Yes
Nottingham Urban Area	Nottingham Centre				48	44	39	n/a	Yes	Yes
Reading/Wokingham Urban Area	Reading				42	38	35	n/a	Yes	Yes
Sheffield Urban Area	Rotherham Centre				36		35	n/a	Yes	Yes
	Sheffield Centre		46	46	38	36	41	Yes	Yes	
	Sheffield Tinsley	50	48	50	52	46	43	Yes	Yes	
Southampton Urban Area	Southampton Centre		46	44	38	42	32	Yes	Yes	Yes
Swansea Urban Area	Port Talbot			25	25	25	22	n/a	No	Yes
	Swansea	42	44	38	36	34	25	Yes	No	
Teesside Urban Area	Billingham		36	36	36	32	24	No	No	Yes
	Middlesbrough		32	31	27	25	32	No	Yes	
	Redcar				25	21	16	n/a	No	
The Potteries	Stoke-on-Trent Centre				32	34	37	n/a	Yes	Yes
Tyneside	Newcastle Centre	40	40	40	36	31	38	Yes	Yes	Yes
West Midlands Urban Area	Birmingham Centre	48	44	44		38	46	Yes	Yes	Yes
	Birmingham East	42	40	38	31	29	44	No	Yes	
	Sandwell West Bromwich					34	43	n/a	Yes	
	Walsall Alumwell	46	46	48	46	40	42	Yes	Yes	
	Walsall Willenhall				31	29	37	n/a	Yes	
	Wolverhampton Centre		40	38	31	31	45	No	Yes	
West Yorkshire Urban Area	Bradford Centre				42	40	38	n/a	Yes	Yes
	Leeds Centre	50	52	52	46	44	44	Yes	Yes	

1 indicates modelled annual average concentration at the location of the automatic monitor

2 indicates the exceedance statistic assigned to an agglomeration or zone as a whole; based on modelled or measured exceedances throughout the agglomeration or zone

n/a indicates insufficient data to calculate exceedance, sites in Southend, Birkenhead, Preston and Blackpool commenced in 2000

Table A2 Identified exceedances of the Upper Assessment Threshold (UAT) for nitrogen dioxide based upon measured and modelled data for UK non-agglomeration zones

		Annual Mean (ugm-3)					Modelled[1]	Exceedance of UAT		
Zone	**Monitoring site**	**1995**	**1996**	**1997**	**1998**	**1999**	**NO2 (ugm-3)**	**Measured**	**Modelled**	**Article 5[2]**
East Midlands	Ladybower			15	11	11	16	n/a	No	Yes
	Lincoln Roadside				73	69	41	n/a		
Eastern	Norwich Centre				25	27	32	n/a	Yes	Yes
	Norwich Roadside				32	32	41	n/a		
	Thurrock			36	34	38	28	n/a	No	
	Wicken Fen				15	14	18	n/a	No	
Northern Ireland	Derry				13	15	19	n/a	No	Yes
South East	Harwell		21		18		21	n/a	No	Yes
	Lullington Heath	14	16	14	14		14	No	No	
	Oxford Centre					55	48	n/a	Yes	
	Rochester		26	25	23	23	17	No	No	
South Wales	Narberth				6		6	n/a	No	Yes
South West	Bath Roadside			63	63	61	50	n/a		Yes
	Exeter Roadside			44	38	40	n/a	n/a		
	Plymouth Centre					23	26	n/a	No	
West Midlands	Leamington Spa				32	31	29	n/a	No	Yes
Yorkshire & Humberside	Barnsley Gawber					27	34	n/a	Yes	Yes

1 indicates modelled annual average concentration at the location of the automatic monitor
2 indicates the exceedance statistic assigned to an agglomeration or zone as a whole; based on modelled or measured exceedances throughout the agglomeration or zone
n/a indicates insufficient data to calculate exceedance, the Aberdeen site commenced in 1999

Table A3 Identified exceedances of the Upper Assessment Threshold (UAT) for PM10 based upon measured and modelled data for UK agglomerations

		Days > 24hr UAT					Modelled[1]	Exceedance of UAT		
Agglomeration	**Monitoring site**	**1995**	**1996**	**1997**	**1998**	**1999**	**PM10 (ugm-3)**	**Measured**	**Modelled**	**Article 5[2]**
Belfast Urban Area	Belfast Centre	77	79	91	49	37	29	Yes	Yes	Yes
Bristol Urban Area	Bristol Centre	76	95	79	61	43	26	Yes	Yes	Yes
Cardiff Urban Area	Cardiff Centre	87	79	97	52	48	23	Yes	Yes	Yes
Edinburgh Urban Area	Edinburgh Centre	41	36	25	12	5	23	Yes	Yes	Yes
Glasgow Urban Area	Glasgow Centre			47	46	26	27	Yes	Yes	Yes
	Glasgow Kerbside				108	74	29	Yes	Yes	
Greater London Urban Area	Camden Roadside			167	79	96	36	Yes	Yes	Yes
	Haringey Roadside			101	52	51	31	Yes	Yes	
	London A3 Roadside				78	62	n/a	Yes	Yes	
	London Bexley	77	75	65	39	42	24	Yes	Yes	
	London Bloomsbury	114	122	99	49	44	32	Yes	Yes	
	London Brent			60	34	31	26	Yes	Yes	
	London Eltham			50	25	24	25	Yes	Yes	
	London Hillingdon			103	42	45	24	Yes	Yes	
	London Marylebone Road				201	195	41	Yes	Yes	
	London N. Kensington		53	74	42	45	31	Yes	Yes	
	Sutton Roadside		67	79	51	39	26	Yes	Yes	
Greater Manchester Urban Area	Bolton			45	23	17	24	Yes	Yes	Yes
	Bury Roadside			137	96	75	n/a	Yes	Yes	
	Manchester Piccadilly		100	86	49	47	26	Yes	Yes	
	Salford Eccles				43	28	25	Yes	Yes	
	Stockport			53	41	34	25	Yes	Yes	
Kingston upon Hull	Hull Centre	79	79	65	55	46	23	Yes	Yes	Yes
Leicester Urban Area	Leicester Centre	45	54	55	26	19	27	Yes	Yes	Yes
Liverpool Urban Area	Liverpool Centre	104	91	90	59	37	24	Yes	Yes	Yes
Nottingham Urban Area	Nottingham Centre			71	50	32	26	Yes	Yes	Yes
Reading/Wokingham Urban Area	Reading				29	15	24	Yes	Yes	Yes
Sheffield Urban Area	Sheffield Centre		108	96	61	44	26	Yes	Yes	Yes
Southampton Urban Area	Southampton Centre		73	75	55	36	24	Yes	Yes	Yes
Swansea Urban Area	Port Talbot			103	110	109	18	Yes	Yes	Yes
	Swansea	100	77	91	49	10	21	Yes	Yes	
Teesside Urban Area	Middlesbrough		65	45	19	32	23	Yes	Yes	Yes
	Redcar				53	33	19	Yes	Yes	
The Potteries	Stoke-on-Trent Centre				47	25	24	Yes	Yes	Yes
Tyneside	Newcastle Centre	65	82	51	34	22	24	Yes	Yes	Yes
West Midlands Urban Area	Birmingham Centre	80	86	58	39	34	28	Yes	Yes	Yes
	Birmingham East	65	67	46	17	22	27	Yes	Yes	
	Wolverhampton Centre			77	43	30	25	Yes	Yes	
West Yorkshire Urban Area	Bradford Centre				73	49	25	Yes	Yes	Yes
	Leeds Centre	90	105	99	62	39	27	Yes	Yes	

1 indicates modelled annual average concentration at the location of the automatic monitor
2 indicates the exceedance statistic assigned to an agglomeration or zone as a whole; based on modelled or measured exceedances throughout the agglomeration or zone
n/a indicates insufficient data to calculate exceedance, sites in Southend, Birkenhead, Preston and Blackpool commenced in 2000

Table A4 Identified exceedances of the Upper Assessment Threshold (UAT) for PM10 based upon measured and modelled data for UK non-agglomerations zones

		Days > 24hr UAT					Modelled[1]	Exceedance of UAT		
Zone	**Monitoring site**	**1995**	**1996**	**1997**	**1998**	**1999**	**PM10 (ugm-3)**	**Measured**	**Modelled**	**Article 5[2]**
Eastern	Norwich Centre				28	24	26	Yes	Yes	Yes
Eastern	Thurrock			61	42	38	24	Yes	Yes	
Northern Ireland	Lough Navar			0	2	0	14	n/a	Yes	Yes
Northern Ireland	Derry				49	36	21	Yes	Yes	
South East	Rochester			40	16	13	21	Yes	Yes	Yes
South Wales	Narberth			5	9	5	16	n/a	Yes	Yes
South West	Plymouth Centre				26	16	20	Yes	Yes	Yes
West Midlands	Leamington Spa			35	24	17	22	Yes	Yes	Yes
Yorkshire & Humberside	Scunthorpe				68	87	22	Yes	Yes	Yes

1 indicates modelled annual average concentration at the location of the automatic monitor
2 indicates the exceedance statistic assigned to an agglomeration or zone as a whole; based on modelled or measured exceedances throughout the agglomeration or zone
n/a indicates insufficient data to calculate exceedance, the Aberdeen site commenced in 1999

Table A5 Identified exceedances of the Upper Assessment Threshold (UAT) for sulphur dioxide based upon measured and modelled data for UK agglomerations

		Days > 24hr UAT					Modelled[1]	Exceedance of UAT		
Agglomeration	**Monitoring site**	**1995**	**1996**	**1997**	**1998**	**1999**	**SO2 (ugm-3)**	**Measured**	**Modelled**	**Article 5[2]**
Belfast Urban Area	Belfast Centre	32	34	23	9	3	61	Yes	No	Yes
	Belfast East	48	75	56	21	21	85	Yes	Yes	
Bristol Urban Area	Bristol Centre	1	0		0	0	16	No	No	No
Cardiff Urban Area	Cardiff Centre	1	0	0	0	1	30	n/a	No	No
Coventry/Bedworth	Coventry Centre			1	0	0	41	n/a	No	No
Edinburgh Urban Area	Edinburgh Centre	3	0	0	0	0	47	No	No	No
Glasgow Urban Area	Glasgow Centre			0	0	0	43	n/a	No	No
Greater London Urban Area	London Bexley	10	8	3	0	0	46	Yes	No	No
	London Bloomsbury	8	8	1	6	0	39	Yes	No	
	London Brent		0	0	0	0	36	n/a	No	
	London Bridge Place	3	5	1	0	0	41	No	No	
	London Eltham			0	0	0	41	n/a	No	
	London Hillingdon			1	0	0	27	n/a	No	
	London Lewisham				0	0	40	n/a	No	
	London N. Kensington			1	0	0	38	n/a	No	
	London Southwark			1	0	0	39	n/a	No	
	London Teddington			0	0	0	27	n/a	No	
	London Cromwell Road 2					0	39	n/a	No	
	Southwark Roadside				0	0	39	n/a	No	
	Sutton Roadside			0	0	0	33	n/a	No	
	London Marylebone Road				0	0	41	n/a	No	
Greater Manchester Urban Area	Bolton			0	0	0	60	n/a	No	Yes
	Manchester Piccadilly		3	0		0	88	n/a	Yes	
	Manchester South				0	0	56	n/a	No	
	Salford Eccles				0	0	131	n/a	Yes	
	Stockport			1	0	0	72	n/a	No	
	Bury Roadside			34	29	4	61	Yes	No	
Kingston upon Hull	Hull Centre	3	2	1	0	0	84	No	Yes	Yes
Leicester Urban Area	Leicester Centre	1	0	0	1	0	69	No	No	No
Liverpool Urban Area	Liverpool Centre	17	22	5	3	0	121	Yes	Yes	Yes
Nottingham Urban Area	Nottingham Centre			0	3	0	72	n/a	No	Yes
Reading/Wokingham Urban Area	Reading				0	0	24	n/a	No	No
Sheffield Urban Area	Rotherham Centre				2	0	105	n/a	Yes	Yes
	Sheffield Centre		8	2	1	0	84	Yes	Yes	
Southampton Urban Area	Southampton Centre		0	0	0	0	50	n/a	No	No
Swansea Urban Area	Port Talbot			1	0		57	n/a	No	Yes
	Swansea	3	1	0	0	0	42	No	No	
Teesside Urban Area	Middlesbrough		2	2	1	1	109	n/a	Yes	Yes
	Redcar				5	1	61	n/a	No	
The Potteries	Stoke-on-Trent Centre			0	1	0	83	n/a	Yes	Yes
Tyneside	Newcastle Centre	4	4	0	1	0	58	No	No	No
West Midlands Urban Area	Birmingham Centre	4	2	0	2	0	43	No	No	No
	Birmingham East	2	0	0	0	0	39	No	No	
	Sandwell West Bromwich					0	53	n/a	No	
	Wolverhampton Centre		1	0	3	0	53	n/a	No	
West Yorkshire Urban Area	Bradford Centre				1	0	72	n/a	No	Yes
	Leeds Centre	5	4	5	3	0	81	Yes	Yes	

1 indicates modelled annual average concentration at the location of the automatic monitor
2 indicates the exceedance statistic assigned to an agglomeration or zone as a whole; based on modelled or measured exceedances throughout the agglomeration or zone
n/a indicates insufficient data to calculate exceedance, sites in Southend, Birkenhead, Preston and Blackpool commenced in 2000

Table A6 Identified exceedances of the Upper Assessment Threshold (UAT) for sulphur dioxide based upon measured and modelled data for UK non-agglomerations zones

		Days > 24hr UAT					Modelled[1]	Exceedance of UAT		
Zone	Monitoring site	1995	1996	1997	1998	1999	SO2 (ugm-3)	Measured	Modelled	Article 5[2]
East Midlands	Ladybower	3	4	1	0	0	66	No	No	Yes
Eastern	Norwich Centre				0	0	38	n/a	No	Yes
	Thurrock					0	97	n/a	Yes	
	Wicken Fen				0	0	23	n/a	No	
Highland	Strath Vaich	0	0				1	n/a	No	No
North East	Sunderland	1	3	0	1	0	45	No	No	Yes
South East	Harwell		0		0	0	28	n/a	No	Yes
	Lullington Heath	0	0	0	0	0	20	No	No	
	Oxford Centre					0	25	n/a	No	
	Rochester		0	1	0	0	79	n/a	Yes	
South Wales	Narberth			0	0		15	n/a	No	Yes
South West	Exeter Roadside				0	0	12	n/a	No	Yes
	Plymouth Centre				0	0	21	n/a	No	
West Midlands	Leamington Spa				0	0	29	n/a	No	Yes
Yorkshire & Humberside	Barnsley 12	11	12	19	6	1	102	Yes	Yes	Yes
	Scunthorpe				1	0	116	n/a	Yes	

1 indicates modelled annual average concentration at the location of the automatic monitor
2 indicates the exceedance statistic assigned to an agglomeration or zone as a whole; based on modelled or measured exceedances throughout the agglomeration or zone
n/a indicates insufficient data to calculate exceedance

Table A7 Identified exceedances of the Upper Assessment Threshold (UAT) for lead based upon measured and modelled data for UK agglomerations

			Measured annual average (ug/m3)					Modelled[1]	Exceedance of UAT		
Agglomeration	Monitoring site	Type	1995	1996	1997	1998	1999	Lead (ugm-3)	Measured	Modelled	Article 5[2]
Cardiff Urban Area	Cardiff	Roadside	0.17	0.17	0.17	0.11	0.07	n/a	No	n/a	No
Glasgow Urban Area	Glasgow	Urban background	0.05	0.05	0.04	0.03	0.02	0.05	No	No	No
	Motherwell	Urban background	0.05	0.03	0.05	0.02	0.02	0.02	No	No	No
Greater London Urban Area	Central London	Urban background	0.06	0.07	0.06	0.04	0.04	0.09	No	No	No
	Brent	Roadside		0.15	0.09	0.05	0.05	n/a	No	n/a	No
	Cromwell Rd London	Roadside	0.20	0.15		0.09	0.07	n/a	No	n/a	No
Greater Manchester Urban Area	Manchester	Roadside	0.13	0.12	0.10	0.07	0.05	n/a	No	n/a	No
Tyneside	Newcastle	Urban background	0.03	0.04	0.03	0.02	0.01	0.03	No	No	No
	Elswick 1	Industrial	0.48	0.55	0.08	0.06	0.04	n/a	No	n/a	No
	Elswick 2	Industrial	0.14	0.12	0.22	0.09	0.06	n/a	No	n/a	No
	Elswick 6	Industrial	0.19	0.22	0.18	0.96	0.14	n/a	No	n/a	No
West Midlands Urban Area	IMI 1	Industrial	0.70	0.58	0.37	0.51	0.37	n/a	Yes	n/a	Yes
	IMI 2	Industrial	1.02	0.88	1.37	1.27	1.43	n/a	Yes	n/a	Yes
	IMI 5	Industrial	0.66	0.47	0.60	0.60	0.59	n/a	Yes	n/a	Yes
	Brookside 1	Industrial	0.18	0.18	0.18	0.10	0.08	n/a	No	n/a	No
	Brookside 2	Industrial	0.47	0.36	0.48	0.42	0.20	n/a	No	n/a	No
West Yorkshire Urban Area	Leeds	Urban background	0.08	0.06	0.06	0.04	0.04	0.06	No	No	No

1 indicates modelled annual average concentration at the location of the automatic monitor
2 indicates the exceedance statistic assigned to an agglomeration or zone as a whole; based on modelled or measured exceedances throughout the agglomeration or zone
n/a indicates insufficient data to calculate exceedance

Table A8 Identified exceedances of the Upper Assessment Threshold (UAT) for lead based upon measured and modelled data for UK non-agglomeration zones

			Measured annual average (ug/m3)					Modelled[1]	Exceedance of UAT		
Zone	Monitoring site	Type	1995	1996	1997	1998	1999	Lead (ugm-3)	Measured	Modelled	Article 5[2]
East Midlands	Styrrup	Rural	0.04	0.04	0.04	0.03	0.03	0.02	No	No	No
Eastern	Cottered	Rural	0.02	0.03	0.03	0.02	0.02	0.01	No	No	No
North West & Merseyside	Windermere	Rural	0.01	0.01	0.01	0.00	0.00	0.01	No	No	No
Scottish Borders	Eskdalemuir	Rural	0.01	0.01	0.01	0.01	0.01	0.003	No	No	No
South East	Chilton	Rural	0.03	0.03	0.02	0.01	0.01	0.02	No	No	No
South Wales	Trebanos	Rural	0.04		0.03	0.02	0.02	0.01	No	No	No

1 indicates modelled annual average concentration at the location of the automatic monitor
2 indicates the exceedance statistic assigned to an agglomeration or zone as a whole; based on modelled or measured exceedances throughout the agglomeration or zone
n/a indicates insufficient data to calculate exceedance

Appendix 5

Preliminary estimates of lead concentrations close to industrial sources

Preliminary estimates of average lead concentrations in close proximity to significant industrial sources of lead in the UK, 1 December 1999 – 10 May 2000

Site Code	Process Name	Industrial Sector	Location	Average Lead conc. (ug/m3)	Data Capture (%)
2	IMI Refiners Ltd.	Copper and Copper Alloy	Walsall, West Midlands	0.709	59
7	British Steel Engineering	Steel Industry	Rotherham	0.151	100
3	Britannia Zinc Ltd.	Lead Producer/Recycle	Avonmouth, Bristol	0.125	92
1	A Cohen & Co Ltd.	Copper and Copper Alloy	Abbey Wood, Greenwich, London	0.122	73
6	British Steel Plc.	Steel Industry	Scunthorpe, NE Lincs	0.112	100
14	Cerro Extruded Metals	Copper and Copper Alloy - Non Ferrous Part B	West Bromwich	0.100	100
15	Walkers Galvanizing	Galvanising	Walsall, West Midlands	0.099	75
30	Wolverhampton MWI	Municipal Waste Incinerator	Wolverhampton	0.094	100
26	Bruhl UK Ltd.	Iron Foundary (Hot-Blast Cupola)	Tipton, West Midlands	0.078	100
4	Midland Lead Refiners	Lead Producer/Recycle	Swadlincote, Derbyshire	0.072	68
10	Paramount Batteries	Lead Acid Battery	Rotherham	0.046	100
27	Sidney Smith	Iron Foundary (Cold-Blast Cupola)	Stourbridge, West Midlands	0.043	92
8	British Steel, Llanwern	Integrated Steel	Newport, South Wales	0.042	96
5	Britannia Refined Metals	Lead Producer/Recycle	Gravesend, Kent	0.041	100
9	Tungsten Batteries Ltd.	Lead Acid Battery	Market Harborough, Leicestershire	0.031	96
22	White Rose Environmental	Clinical Waste Incinerator	Knostrop, Leeds	0.029	96
24	Glacier Vandervell Ltd.	Non-Ferrous Alloy	Kilmarnock, East Ayrshire	0.028	100
16	Castle Cement	Cement Manufacture	Wrexham	0.025	100
23	ICI Chemicals and Polymers Plc.	Chloroalkali	Runcorn, Cheshire	0.021	92
28	FE Mottram Ltd, Congleton	Non-Ferrous Part B	Congelton	0.021	100
17	Sutton Coldfield Crematorium	Crematoria	Sutton Coldfield	0.020	75
13	INCO Europe	Nickel Refinery	Swansea, South Wales	0.018	70
11	Associated Octel Company Ltd.	Lead Anti-Knock Ingredients	Ellesmere Port, Wirral	0.016	67
12	Esso Petroleum Company Ltd.	Oil Refinery	Fawley, Hampshire	0.015	100
21	National Power Plc. - Drax Power Station	Coal-Fired Power Station (with FGD)	Derby	0.014	100
25	Belfast Harbour Estate - Mixed Industrial Area	Mixed	Belfast, Northern Ireland	0.011	92
18	Scottish Power - Longannet Power Station	Coal-Fired Power Station (no FGD)	Fife	0.007	32
20	NIGEN Ltd. - Kilroot Power Station	Coal-Fired Power Station (proposal to burn Orimulsion)	Carrickfergus, Northern Ireland	0.004	100
19	Coolkeeragh Power Station	Oil-Fired Power Station	Derry, Northern Ireland	0.003	88

Appendix 6

Investigation of the relationship between winter and annual average rural SO_2

Relationship between split winter average and annual average sulphur dioxide concentrations from the UK Rural Sulphur Dioxide Monitoring Network 1996-1997