Air Pollution in the UK: 2004

Part 2

In this part of the report, we provide a detailed summary of the measurements made for each pollutant within the Automatic Urban and Rural Network (AURN) and Automatic Hydrocarbon Network. We also present information on measurement techniques, site locations and relevant UK, European and WHO pollutant criteria.

We then provide for each pollutant a table summarising measurements and exceedences of the UK Air Quality objectives during 2004. Finally, we include graphs to show variations in pollutant concentrations throughout the day and over the year as a whole, as well as time series showing long-term changes in concentrations over many years.

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8. Benzene-Measurement Sites, Instrumentation and Statistics

8.1 Measurement Method

Benzene is measured using automated Gas Chromatograph or BTEX monitors; these measure concentrations of benzene, toluene, ethylbenzene and xylene isomers as well as 1,3-butadiene. This type of instrument uses an adsorption tube for sample collection.

8.2 Instrumentation

The following instrument types* are currently deployed in the AURN:

- Environnement VOC 71M
- Perkin Elmer OPA

*Defra does not give approval or endorsement for any products or equipment

8.3 Data Quality Requirements of EC Directive 2000/69/EC

Uncertainty 15%
Minimum data capture 90%

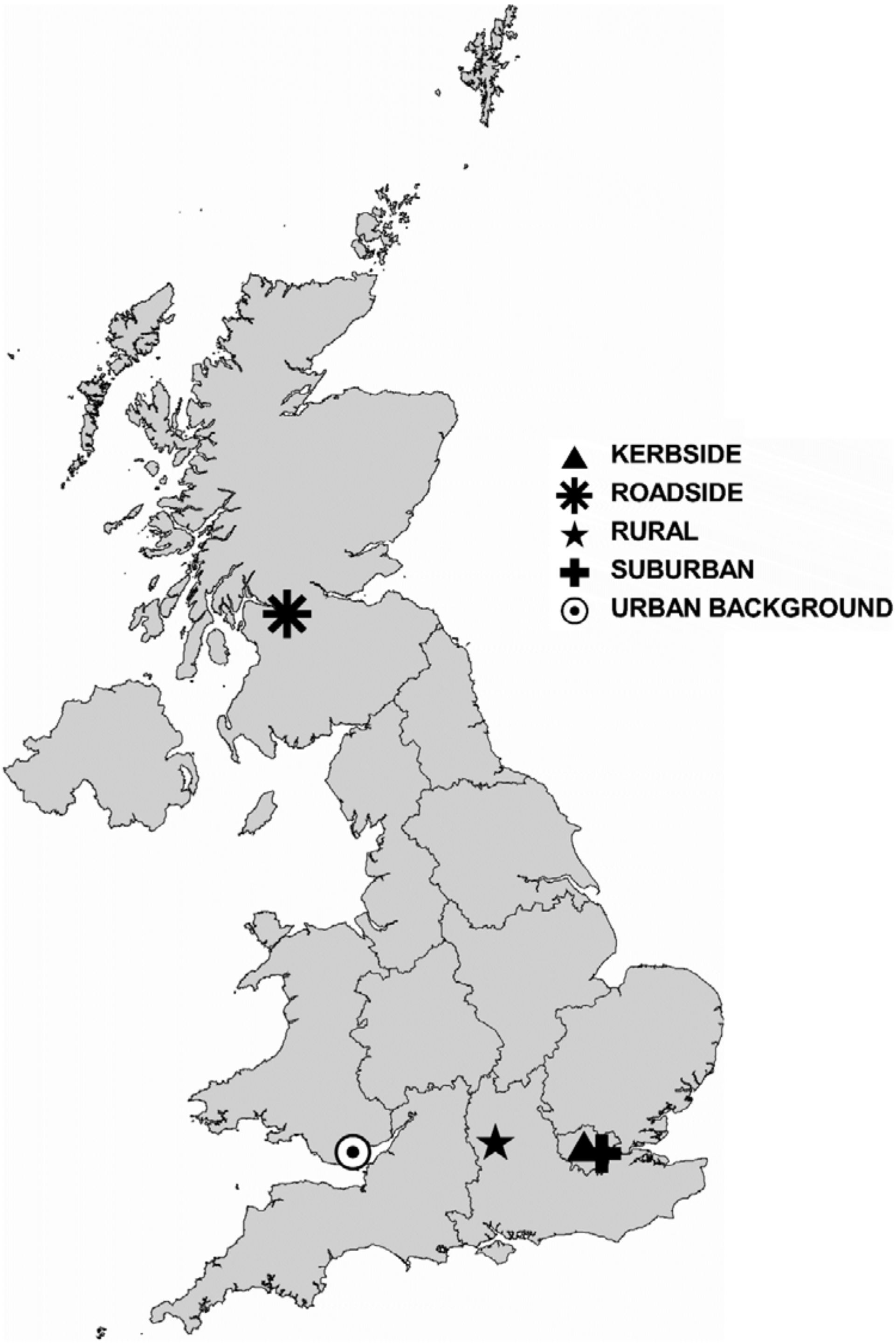
8.4 Objectives and Bandings

Summary of objectives of Air Quality Strategy			
	Objective*	**Measured as**	**To be achieved by**
Benzene	16.25 µg m^3	Running Annual Mean	31 December 2003
England and Wales only	5 µg m^{-3}	Annual Mean	31 December 2010
Scotland and Northern Ireland only	3.25 µg m^{-3}	Maximum Running Annual Mean	31 December 2010

No bandings are set for benzene, as there are no known short-term health effects for this pollutant.

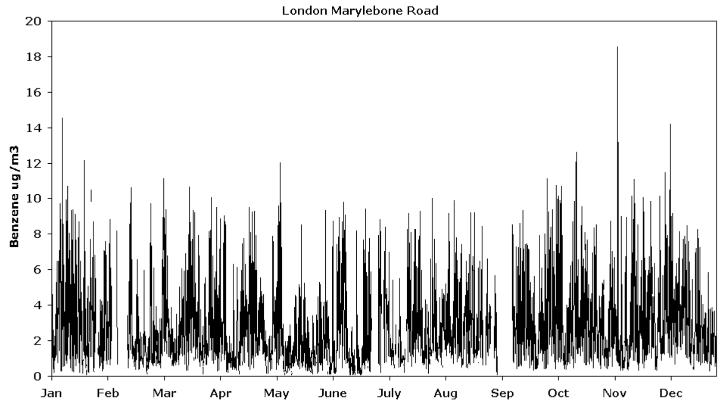
8.5 Site Locations

UK Automatic Benzene Monitoring Sites 2004

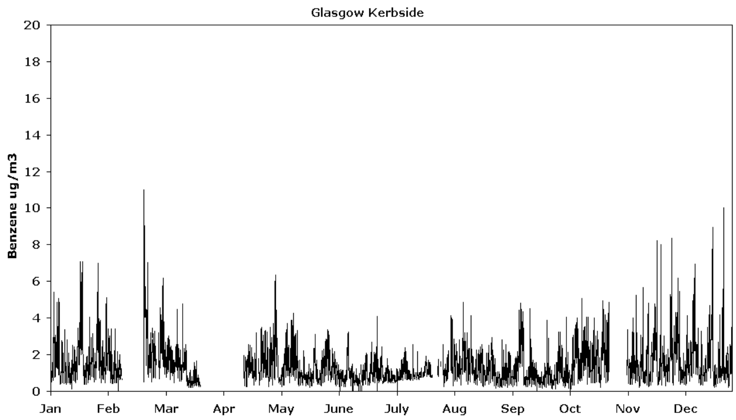


8.6 Hourly Average Concentrations

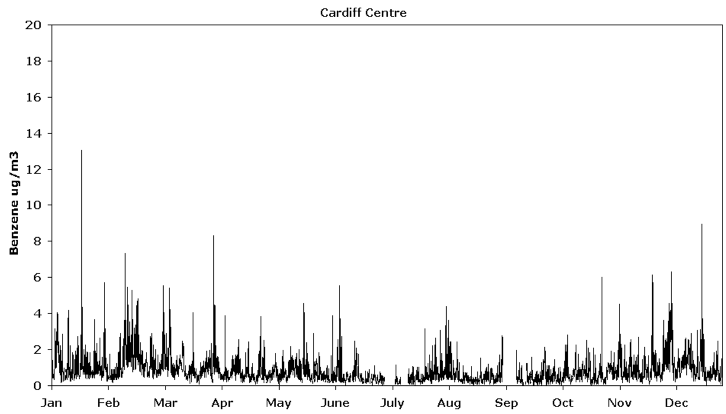
These figures show time series graphs of hourly average benzene concentrations at four *typical* site types for 2004.



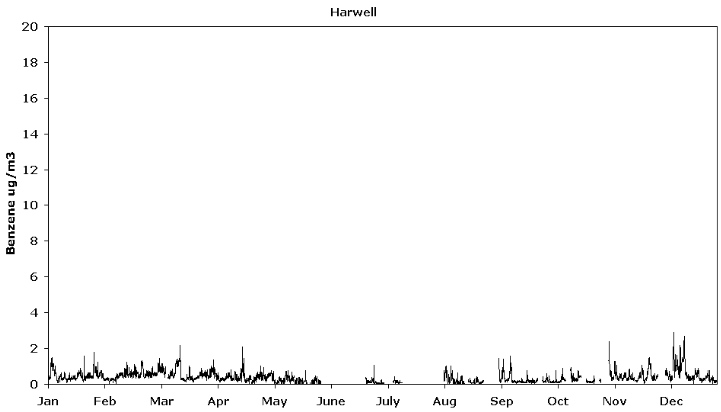
Kerbside Site
(Marylebone Road)



Roadside Site
(Glasgow)



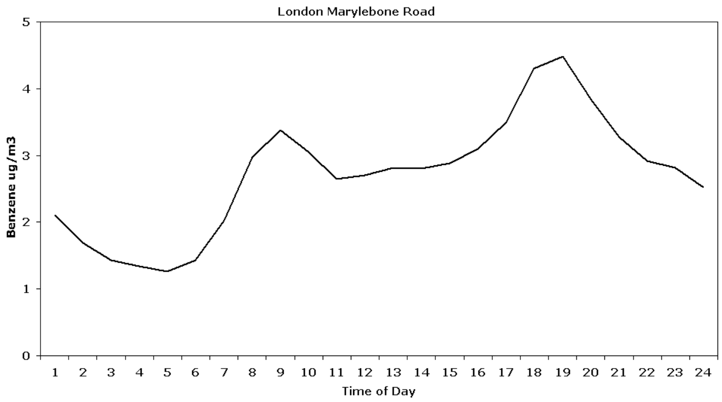
Urban Centre Site
(Cardiff)



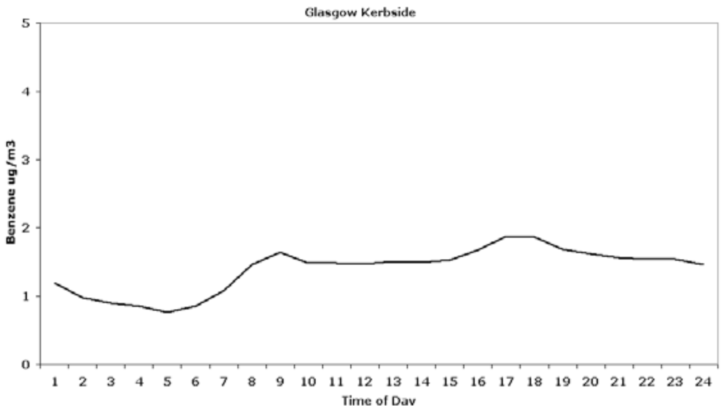
Rural Site
(Harwell)

8.7 Diurnal Variations

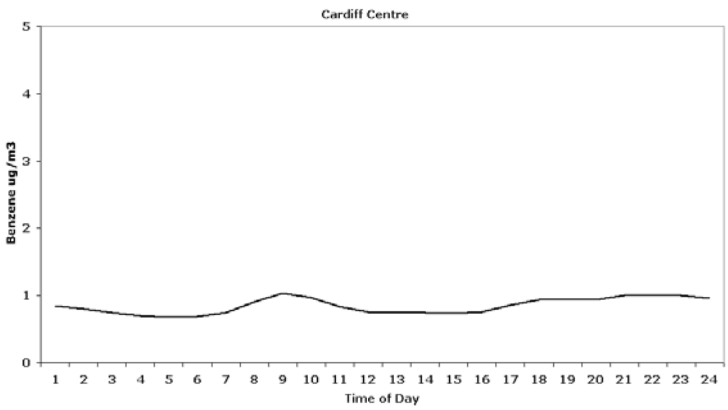
These figures show how benzene concentrations vary on average for each hour of day during 2004, at a number of selected *typical* monitoring site types. Local time is used, rather than GMT, since this will more closely reflect the daily cycle of man-made emissions.



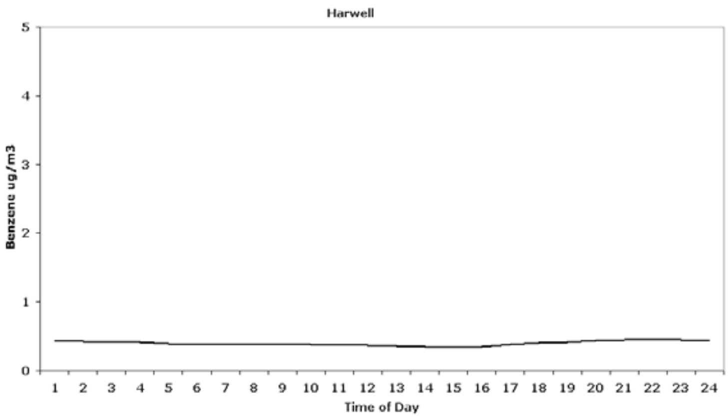
Kerbside Site
(Marylebone Road)



Roadside Site
(Glasgow)



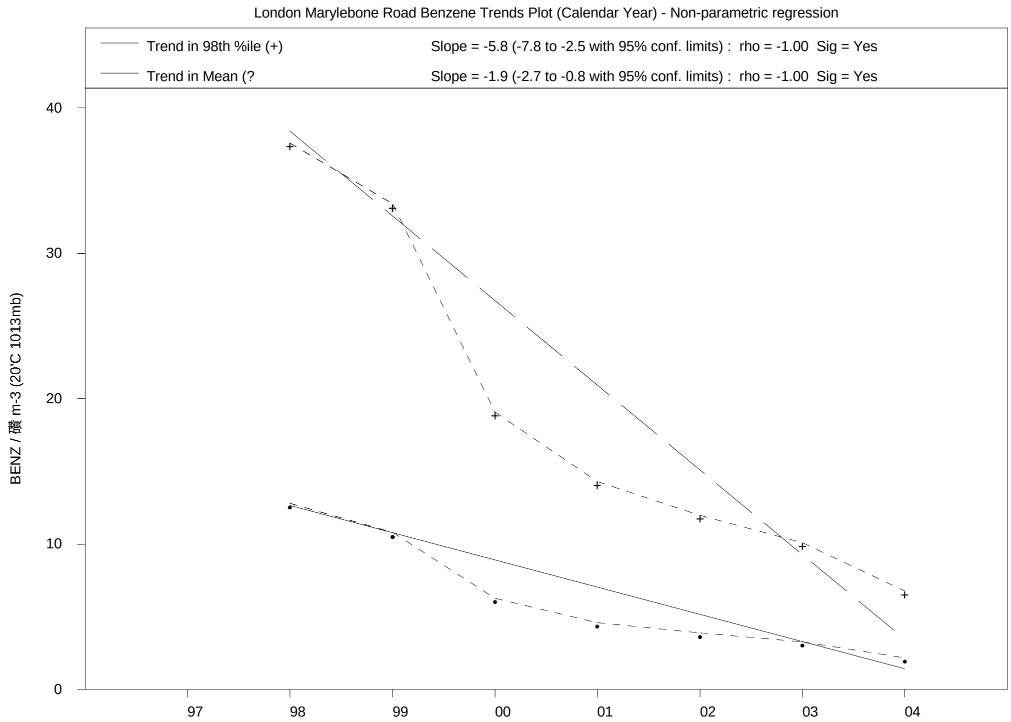
Urban Centre Site (Cardiff)



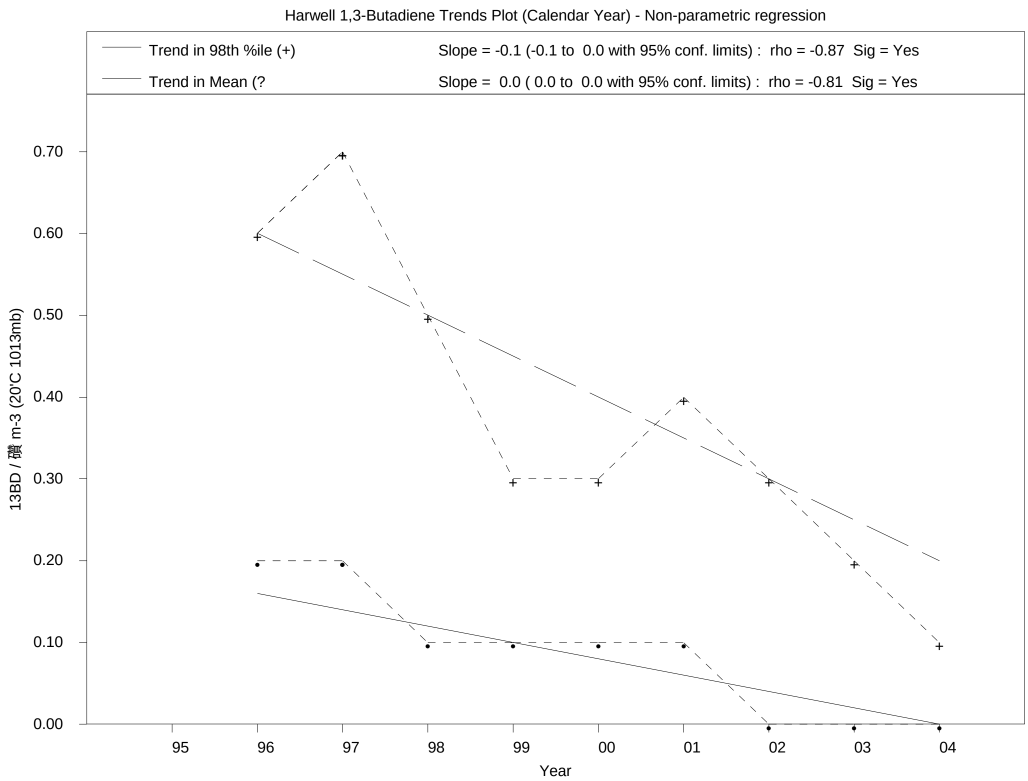
Rural Site
(Harwell)

8.8 Trends in annual concentrations

Statistically significant trends in concentrations are shown for sites with at least ≥5 years of measurement.



Kerbside Site (*Marylebone Road*)



Rural Site (*Harwell*)

8.9 Benzene Statistical Summary 2004

i) Annual Statistics

Site	Site Type	Annual Average of hourly means	Annual data capture of hourly means %	Maximum hourly mean
England				
Harwell	RU	0.4	74.6	2.9
London Eltham	SU	0.8	82.3	15.2
London Marylebone Road	KB	2.8	85.1	18.5
Scotland				
Glasgow Kerbside	KB	1.4	82.5	11.0
Wales				
Cardiff Centre	UC	0.9	91.4	13.1

ii) Exceedence Statistics

Site	Air Quality Standard	Days	Daughter Directive and Air Quality Standard (England and Wales)	Annual Mean Standard Scotland
England				
Harwell	0	0	0	0
London Eltham	0	0	0	0
London Marylebone Road	0	0	0	0
Scotland				
Glasgow Kerbside	0	0	0	0
Wales				
Cardiff Centre	0	0	0	0

9. 1,3-Butadiene- Measurement Sites, Instrumentation and Statistics

9.1 Measurement Method

1,3-Butadiene is measured using automated GC or BTEX monitors; these measure concentrations of benzene, toluene, ethylbenzene and xylene isomers as well as 1,3-butadiene. This type of instrument uses an adsorption tube for sample collection.

9.2 Instrumentation

The following instrument types* are currently deployed in the AURN:

- Environnement VOC 71M
- Perkin Elmer OPA

*Defra does not give approval or endorsement for any products or equipment

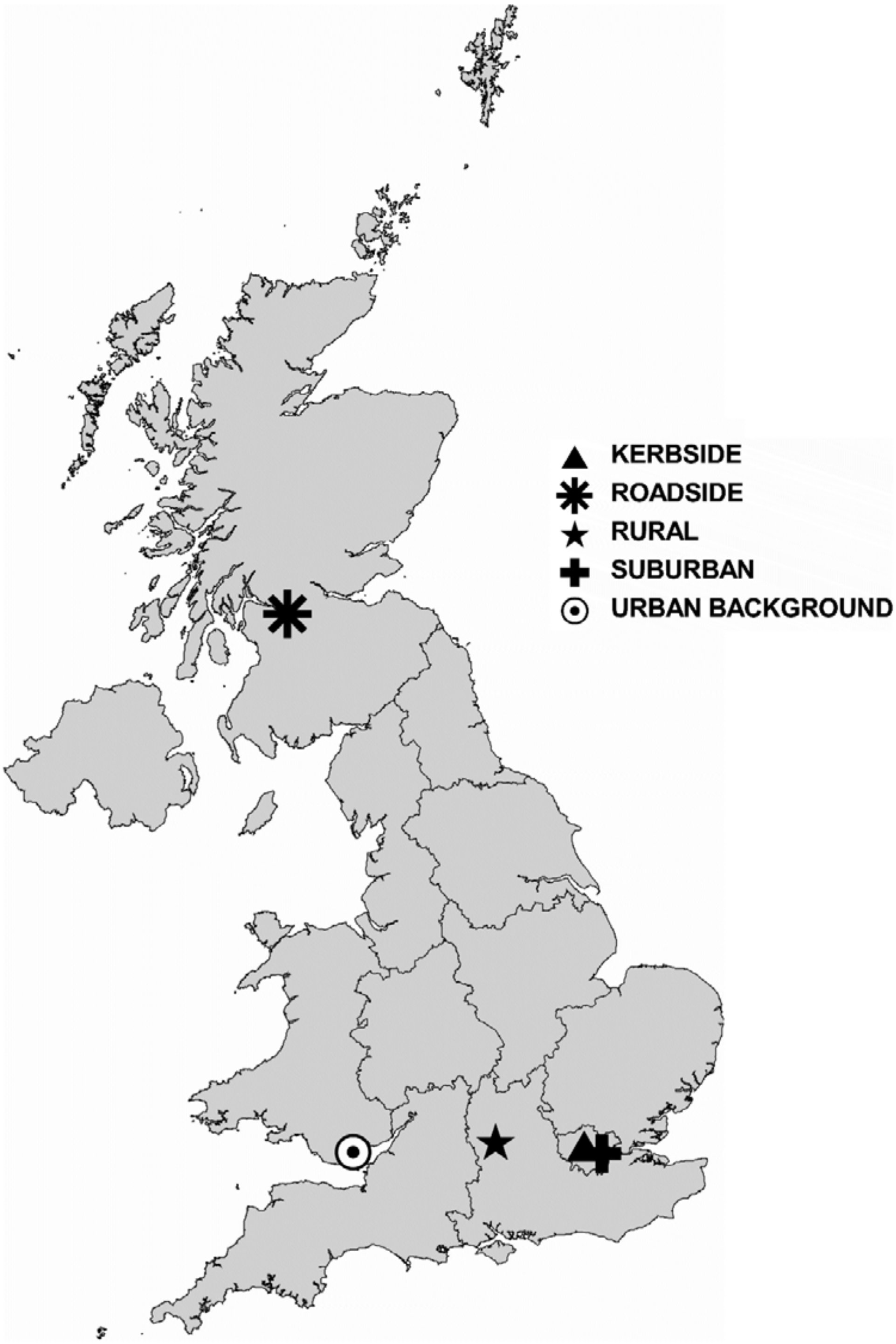
9.3 Objectives and Bandings

Summary of objectives of the Air Quality Strategy			
	Objective	**Measured as**	**To be achieved by**
1,3-Butadiene	2.25 µg m^{-3}	Maximum Running Annual Mean	31 December 2003

No bandings are set for 1,3-Butadine, as there are no known short-term effects of this pollutant.

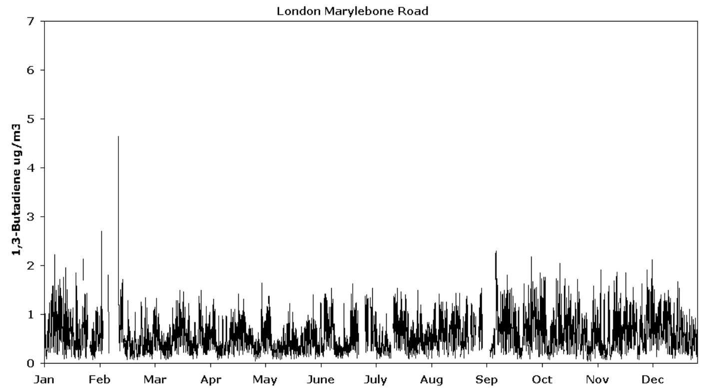
9.4 Site Locations

UK Automatic 1,3-Butadiene Monitoring Sites 2004

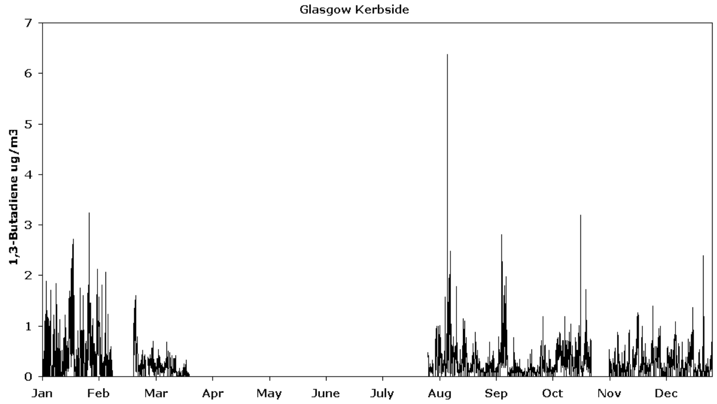


9.5 Hourly Average Concentrations

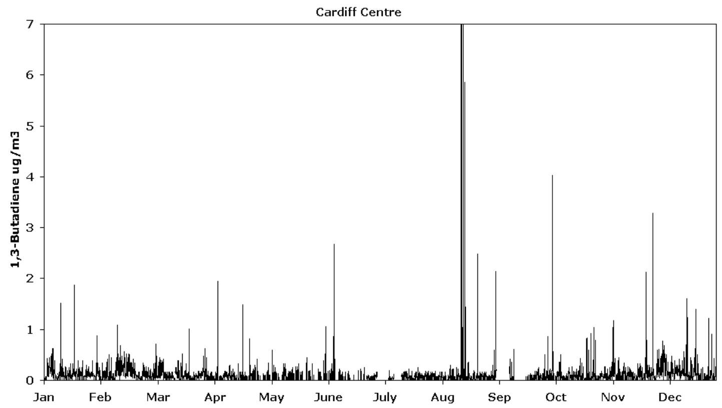
These figures show time series graphs of hourly average 1,3-Butadiene concentrations at four *typical* site types for 2004.



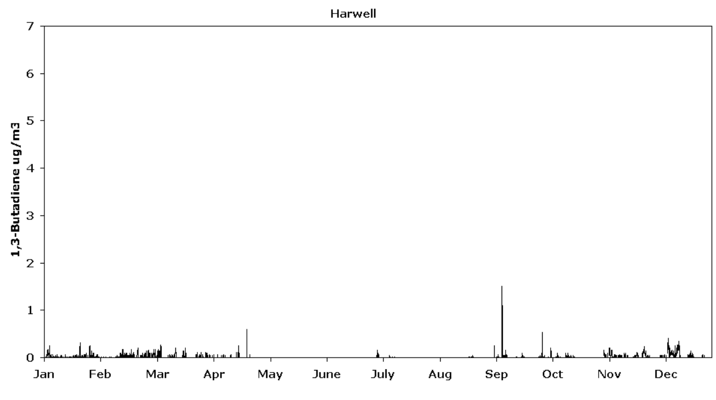
Kerbside Site
(*Marylebone Road*)



Roadside Site
(*Glasgow*)



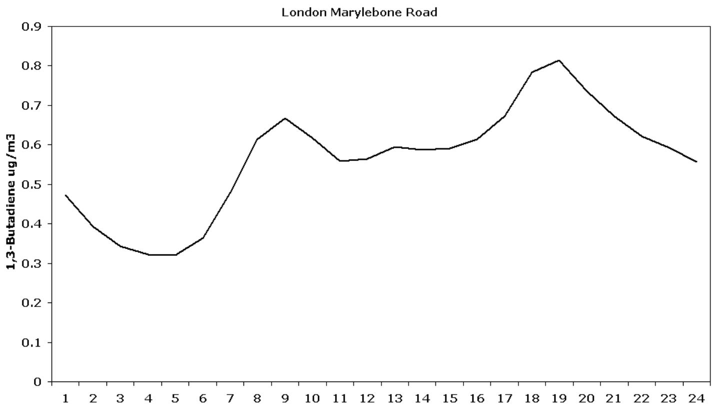
Urban Centre Site
(*Cardiff*)



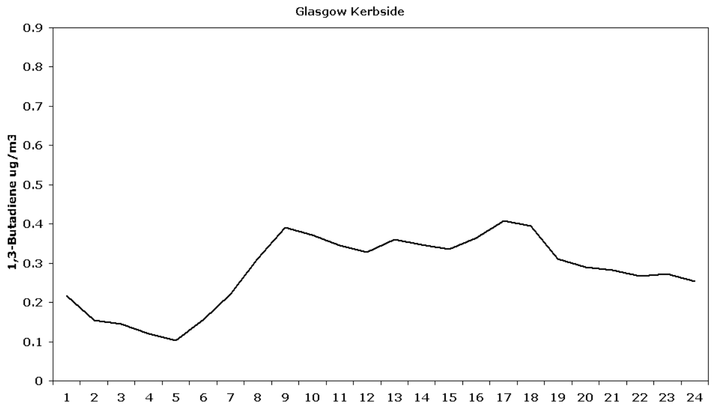
Rural Site
(*Harwell*)

9.6 Diurnal Variations

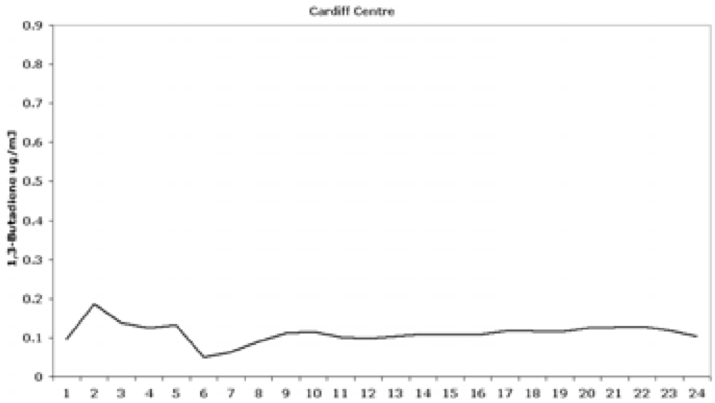
These figures show how nitrogen dioxide concentrations vary on average for each hour of day during 2004, at a number of selected *typical* monitoring site types. Local time is used, rather than GMT, since this will more closely reflect the daily cycle of man-made emissions.



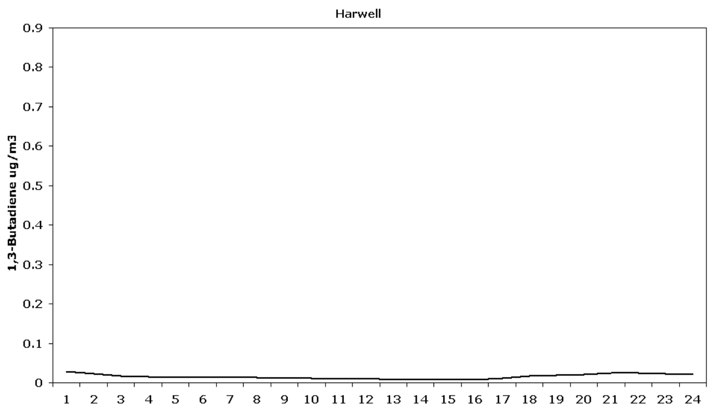
Kerbside Site
(Marylebone Road)



Kerbside Site
(Glasgow)



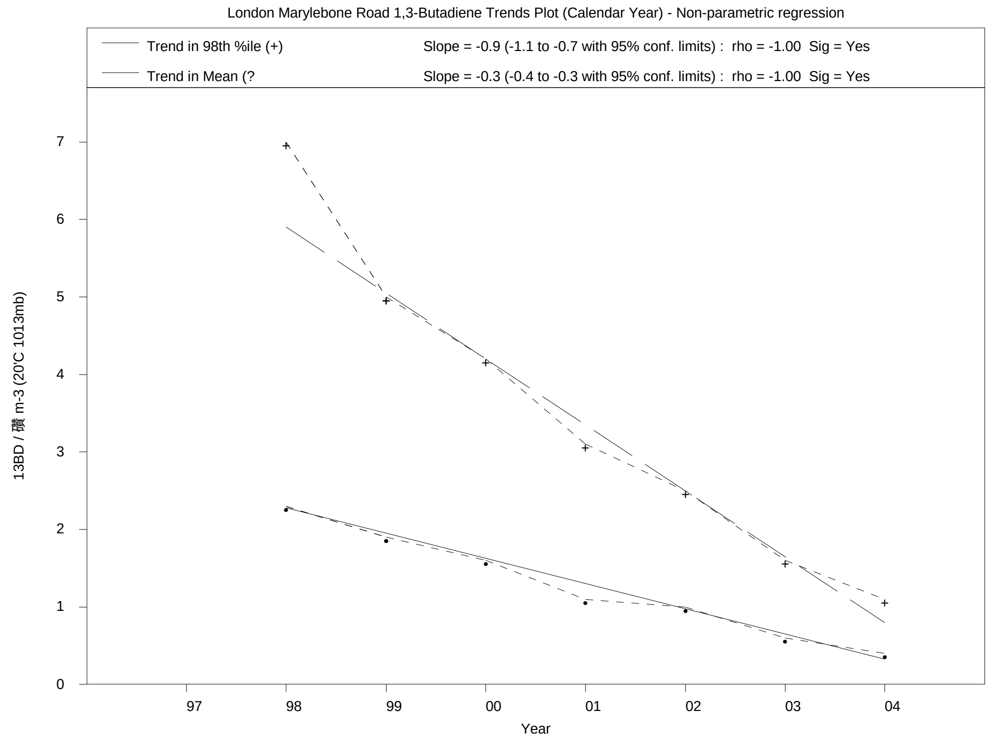
Urban Centre Site
(Cardiff)



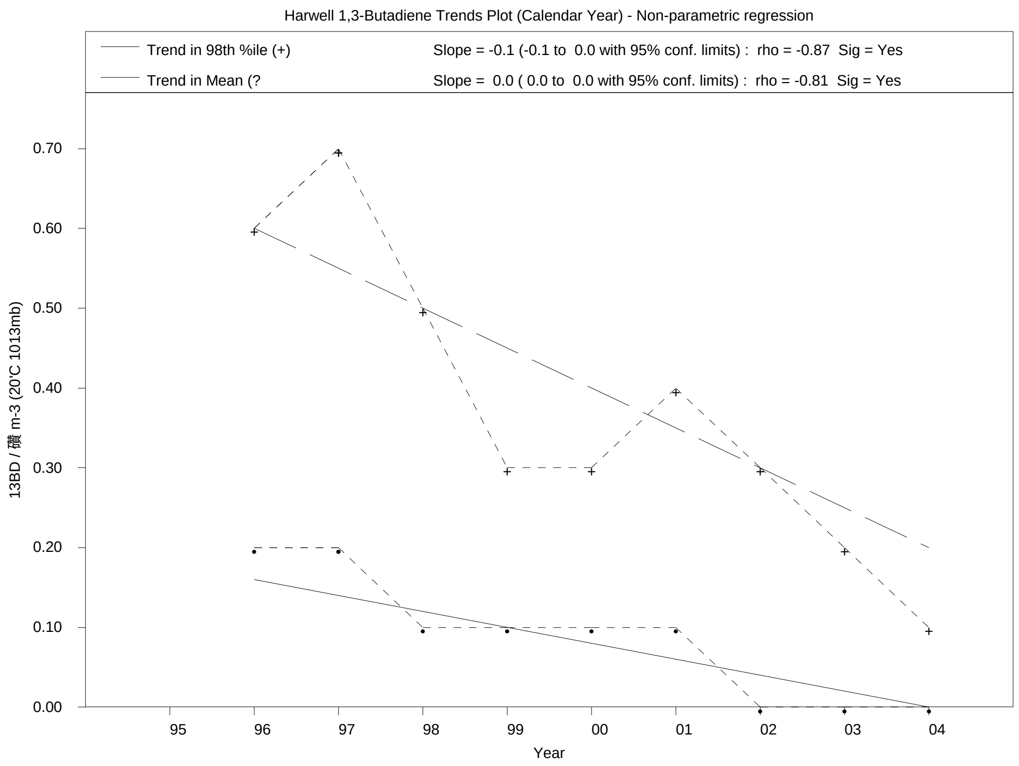
Rural Site
(Harwell)

9.7 Trends in annual concentrations

Statistically significant trends in concentrations are shown for sites with at least ≥5 years of measurement.



Kerbside Site
(*Marylebone Road*)



Rural Site
(Harwell)

9.8 1,3-Butadiene Statistical Summary 2004

i) Annual Statistics

Site	Site Type	Annual Average of hourly means	Annual data capture of hourly means %	Maximum hourly mean
England				
Harwell	RU	0.02	74.7	1.5
London Eltham	SU	0.2	80.8	1.6
London Marylebone Road	KB	0.6	91.4	4.6
Scotland				
Glasgow Kerbside	KB	0.3	57.2	6.4
Wales				
Cardiff Centre	UC	0.1	91.7	37.0

ii) Exceedence Statistics

Site	Air Quality Standard	Days
England		
Harwell	0	0
London Eltham	0	0
London Marylebone Road	0	0
Scotland		
Glasgow Kerbside	0	0
Wales		
Cardiff Centre	0	0

10. CO - Measurement Sites, Instrumentation and Statistics

10.1 Measurement Method

CO concentrations in ambient air are measured by the absorption of infrared radiation at 4.5 to 4.9 μm wavelength. A reference detection system is used to alternately measure absorption due to CO in the sampled air stream and absorption by interfering species. An infrared detector and amplification system produces output voltages proportional to the CO concentration.

10.2 Instrumentation

The following instrument types* are currently deployed in the AURN:

- Ambirak CO
- API M300
- Environnement SA 11M
- Horiba APMA 350E
- Horiba APMA 360
- Monitor Labs 9830
- Rotork 416
- Thermo Electron 48

*Defra does not give approval or endorsement for any products or equipment

10.3 Data Quality Requirements of EC Directive 2000/69/EC

Uncertainty 15%
Minimum data capture 90%

10.4 Objectives and Bandings

Summary of objectives of the Air Quality Strategy			
	Objective	**Measured as**	**To be achieved by**
Carbon Monoxide England and Wales	10.0 mg m^{-3}	Maximum daily running 8 Hour Mean	31 December 2003
Scotland only	10.0 mg m^{-3}	Running 8 Hour Mean[a]	31 December 2003
Northern Ireland only	10.0 mg m^{-3}	Maximum daily running 8 Hour Mean	1 January 2005

a. The Quality Objective in Scotland has been defined in Regulations as the running 8-hour mean, in practice this is equivalent to the maximum daily running 8-hour mean

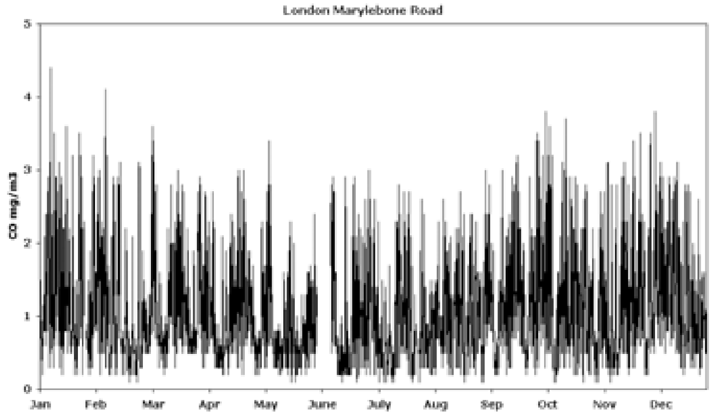
Air Quality Bands and Index Values		
Band	Index	Carbon Monoxide mg m^{-3}
Low	1	0-3.8
	2	3.9-7.6
	3	7.7-11.5
Moderate	4	11.6-13.4
	5	13.5-15.4
	6	15.5-17.3
High	7	17.4-19.2
	8	19.3-21.2
	9	21.3-23.1
Very High	10	23.2 or more

10.5 Site Locations

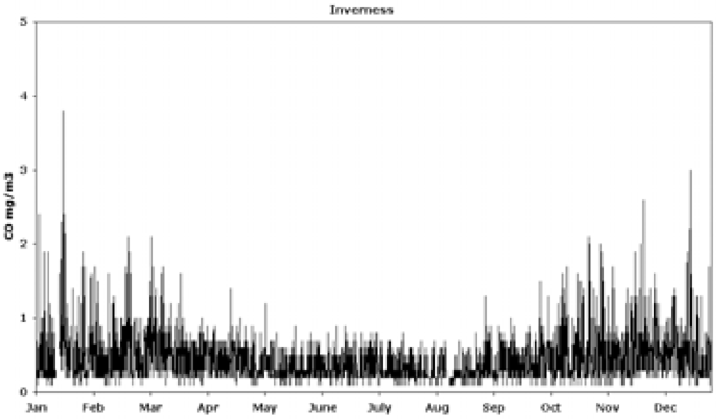
UK Automatic Carbon Monoxide Monitoring Sites 2004

10.6 Hourly Average Concentrations

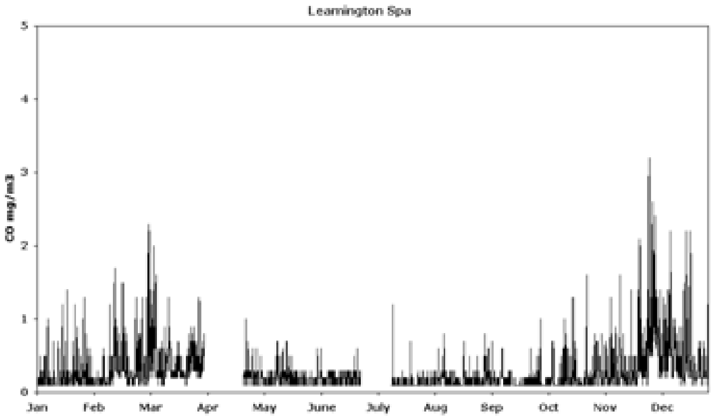
These figures show time series graphs of hourly average carbon monoxide concentrations at four *typical* site types for 2004.



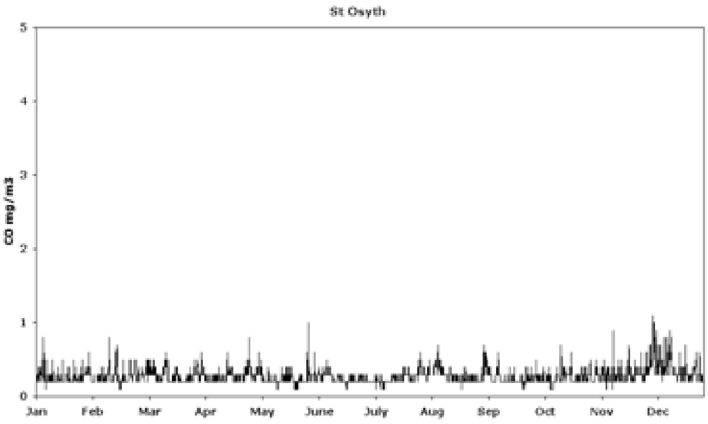
Kerbside Site
(*Marylebone Road*)



Roadside Site
(*Inverness*)



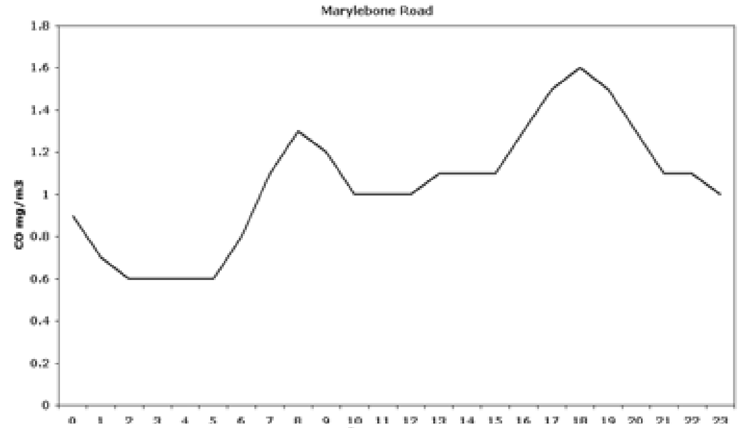
Urban Background Site
(*Leamington Spa*)



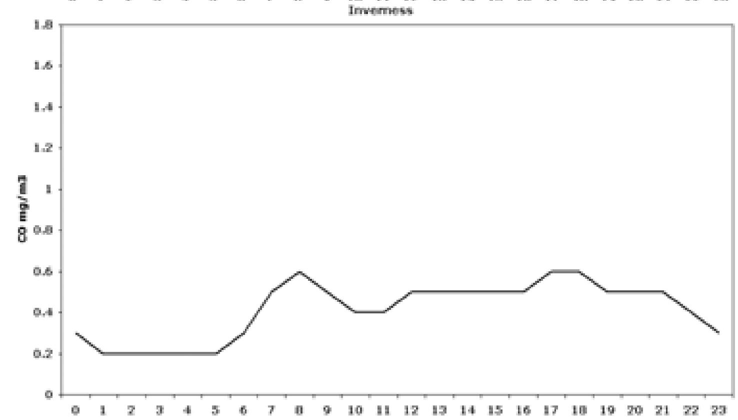
Rural Site
(*St Osyth*)

10.7 Diurnal Variations

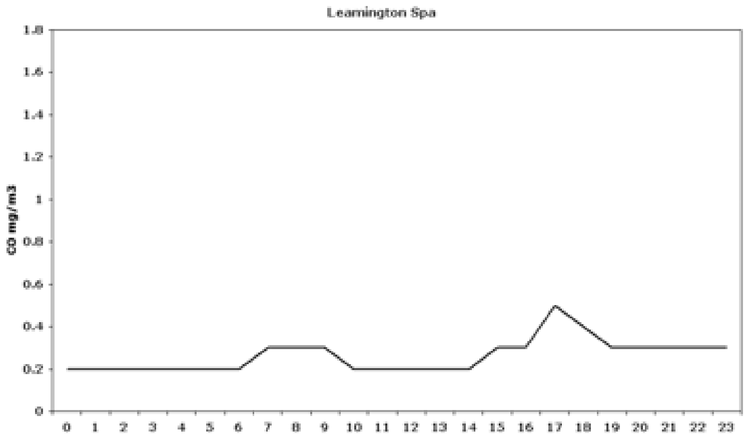
These figures show how carbon monoxide concentrations vary on average for each hour of day during 2004, at a number of selected *typical* monitoring site types. Local time is used, rather than GMT, since this will more closely reflect the daily cycle of man-made emissions.



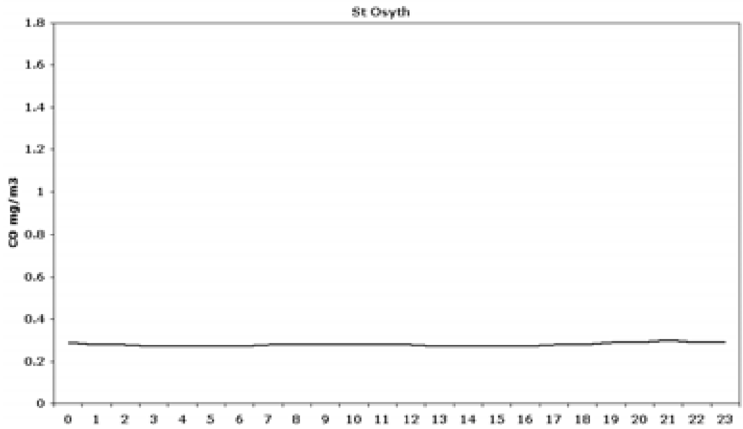
Kerbside Site
(London Marylebone Road)



Roadside Site
(Inverness)



Urban Background Site
(Leamington Spa)

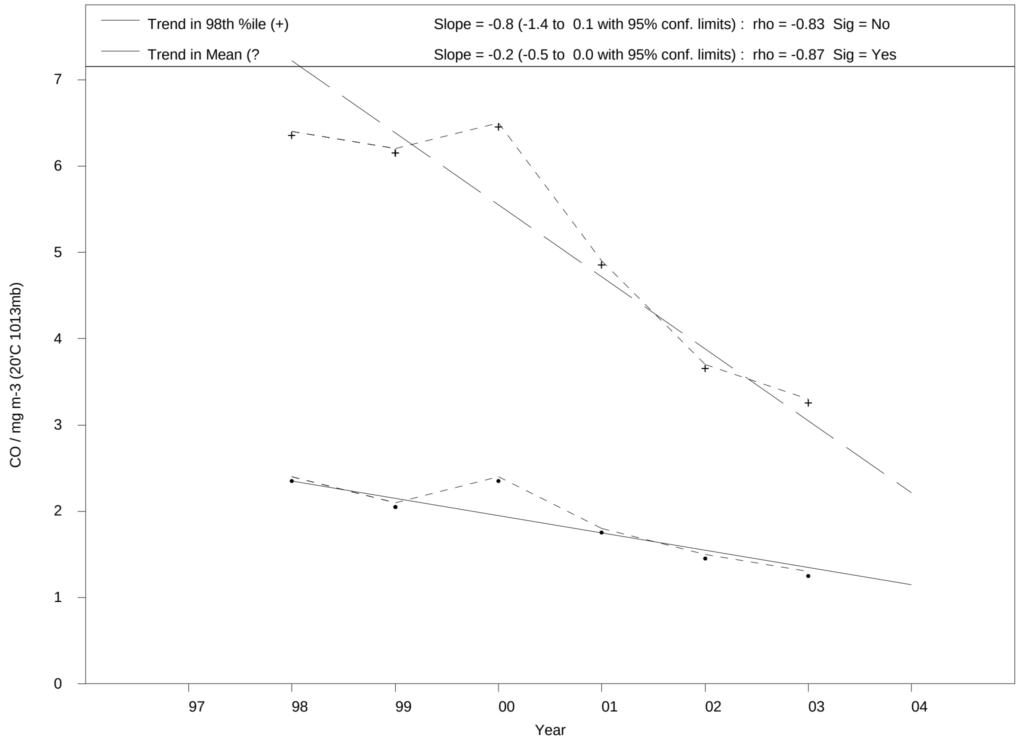


Rural Site
(St Osyth)

10.8 Trends in annual concentrations

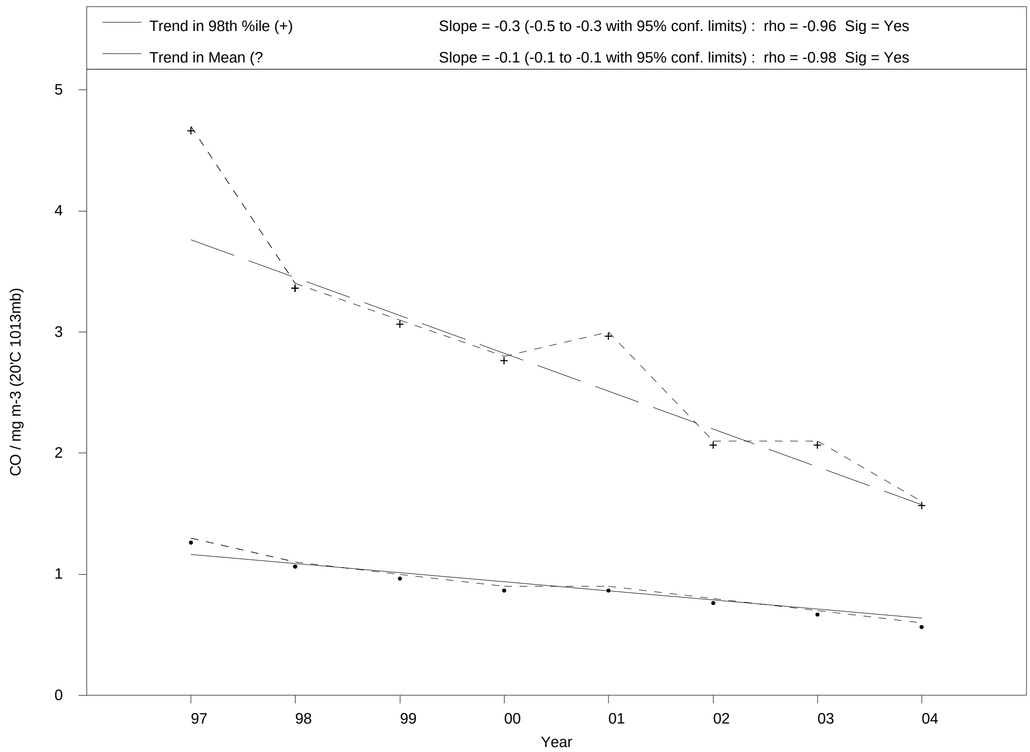
Statistically significant trends in concentrations are shown for sites with at least ≥5 years of measurement.

London Marylebone Road Carbon Monoxide Trends Plot (Calendar Year) - Non-parametric regression

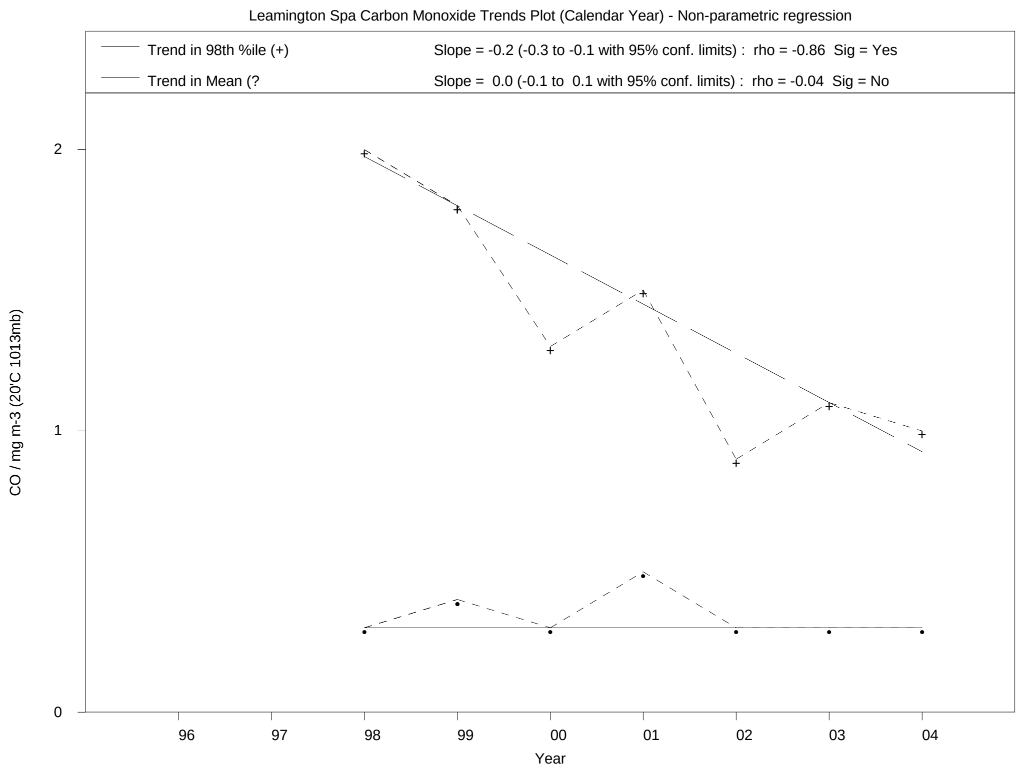


Kerbside Site
(*Marylebone Road*)

London A3 Roadside Carbon Monoxide Trends Plot (Calendar Year) - Non-parametric regression



Roadside Site
(*London A3 Roadside*)



Urban Background Site (*Leamington Spa)*

There are no rural CO measurement sites with sufficient data to determine annual trends

10.9 Carbon Monoxide Statistical Summary 2004

i) ANNUAL STATISTICS I

Site	Site Type	Annual average of hourly means mg m^{-3}	Annual data capture of hourly means %	Maximum hourly mean mg m^{-3}	Maximum running 8-hour mean mg m^{-3}	Date of Maximum running 8-hour mean
England						
Barnsley Gawber	UB	0.2	96.5	2.0	1.5	20/11/2004
Bath Roadside	RD	0.9	99.0	4.3	2.8	03/12/2004
Birmingham Centre	UC	0.3	91.6	2.8	1.6	19/12/2004
Birmingham East	UB	0.2	58.4	3.2	2.6	02/03/2004
Birmingham Tyburn	UB	---	37.6	4.8	3.0	29/11/2004
Blackpool	UB	0.3	82.4	3.2	1.3	09/02/2004
Bolton	UB	0.3	97.5	4.4	3.0	29/11/2004
Bournemouth	UB	0.3	98.6	4.5	2.3	10/02/2004
Bradford Centre	UC	0.5	94.5	3.5	3.1	07/12/2004
Brentford Roadside	RD	0.8	95.2	5.1	4.1	09/03/2004
Brighton Roadside	RD	0.5	98.9	5.2	3.0	03/12/2004
Bristol Centre	UC	0.4	97.7	4.4	2.9	02/12/2004
Bristol Old Market	RD	0.8	71.9	5.2	3.0	02/12/2004
Bury Roadside	RD	0.4	93.6	3.5	2.5	02/12/2004
Coventry Memorial Park	UB	0.2	98.3	1.7	1.2	29/11/2004
Exeter Roadside	RD	0.9	87.4	7.1	4.4	03/12/2004
Hove Roadside	RD	0.5	98.5	3.2	1.8	07/12/2004
Hull Freetown	UC	0.2	95.9	3.2	2.0	07/12/2004
Leamington Spa	UB	0.3	88.8	3.2	2.1	02/12/2004
Leeds Centre	UC	0.7	79.4	3.7	3.3	08/12/2004
Leicester Centre	UC	0.3	84.9	3.2	1.5	29/11/2004
Liverpool Speke	UB	0.2	98.2	2.7	2.0	03/12/2004
London A3 Roadside	RD	0.6	96.9	3.9	3.2	30/11/2004
London Bexley	SU	0.3	94.9	3.6	2.5	01/12/2004
London Bloomsbury	UC	0.3	97.0	2.9	1.7	11/12/2004
London Brent	UB	0.2	86.2	4.8	3.3	19/10/2004
London Bromley	RD	0.5	96.1	3.4	2.6	30/11/2004
London Cromwell Road 2	RD	0.8	97.7	2.9	2.2	11/12/2004
London Hackney	UC	0.5	94.7	4.6	3.9	02/03/2004
London Harlington	A	0.4	92.2	4.4	3.2	01/12/2004
London Hillingdon	SU	0.5	97.8	4.8	3.1	01/12/2004
London Marylebone Road	KB	1.0	96.2	4.4	3.0	03/12/2004
London N. Kensington	UB	0.5	98.9	2.8	2.3	02/03/2004
London Southwark	UC	0.4	94.6	3.1	2.0	02/03/2004
London Westminster	UB	0.3	90.4	2.6	1.6	02/03/2004
Manchester Piccadilly	UC	0.5	97.2	9.3	6.3	23/12/2004
Manchester Town Hall	UB	0.5	81.0	2.7	1.9	02/12/2004
Market Harborough	RU	0.3	93.2	0.8	0.7	17/05/2004
Middlesbrough	I	0.3	91.7	2.3	1.4	26/01/2004
Newcastle Centre	UC	0.2	85.0	2.0	1.3	10/12/2004
Northampton	UB	0.2	90.4	2.8	1.7	29/11/2004
Norwich Centre	UC	0.3	94.2	5.3	3.5	07/12/2004
Nottingham Centre	UC	0.5	91.3	3.2	2.2	11/12/2004
Oxford Centre Roadside	RD	0.3	97.2	2.4	1.6	30/11/2004
Plymouth Centre	UC	0.4	88.8	4.1	1.7	07/12/2004
Portsmouth	UB	0.3	96.7	3.9	2.1	10/02/2004
Preston	UB	0.3	93.0	3.5	1.9	08/12/2004
Reading New Town	UB	0.3	94.4	2.6	1.9	30/11/2004
Redcar	UB	0.2	97.0	2.6	0.9	11/02/2004
Salford Eccles	SU	0.2	93.9	3.7	2.0	07/12/2004
Sandwell West Bromwich	I	0.2	97.8	1.7	1.2	29/11/2004
Sheffield Centre	UB	0.4	98.1	2.1	1.7	07/12/2004
Sheffield Tinsley	UC	0.5	97.3	2.7	2.1	21/11/2004
Southampton Centre	I	0.3	91.0	3.8	2.3	03/12/2004
Southend-on-Sea	UC	0.4	51.6	3.4	1.4	30/11/2004
Southwark Roadside	UB	0.8	98.6	4.9	3.2	02/03/2004
St Osyth	RD	0.28	98.9	1.10	1.00	04/12/2004
Stockport Shaw Heath	RU	0.2	78.3	2.8	1.7	01/12/2004
Stockton-on-Tees Yarm	UB	0.6	93.9	4.8	2.7	14/01/2004
Stoke-on-Trent Centre	RD	0.5	94.2	4.2	2.9	02/12/2004

iii) EXCEEDENCE STATISTICS I

Site	Moderate band	Days	High band	Days	Very High band	Days	Daughter Directive and Air Quality Standard	Days	Air Quality Standard (Scotland)	Days
England										
Barnsley Gawber	0	0	0	0	0	0	0	0	0	0
Bath Roadside	0	0	0	0	0	0	0	0	0	0
Birmingham Centre	0	0	0	0	0	0	0	0	0	0
Birmingham East	0	0	0	0	0	0	0	0	0	0
Birmingham Tyburn	0	0	0	0	0	0	0	0	0	0
Blackpool	0	0	0	0	0	0	0	0	0	0
Bolton	0	0	0	0	0	0	0	0	0	0
Bournemouth	0	0	0	0	0	0	0	0	0	0
Bradford Centre	0	0	0	0	0	0	0	0	0	0
Brentford Roadside	0	0	0	0	0	0	0	0	0	0
Brighton Roadside	0	0	0	0	0	0	0	0	0	0
Bristol Centre	0	0	0	0	0	0	0	0	0	0
Bristol Old Market	0	0	0	0	0	0	0	0	0	0
Bury Roadside	0	0	0	0	0	0	0	0	0	0
Coventry Memorial Park	0	0	0	0	0	0	0	0	0	0
Exeter Roadside	0	0	0	0	0	0	0	0	0	0
Hove Roadside	0	0	0	0	0	0	0	0	0	0
Hull Freetown	0	0	0	0	0	0	0	0	0	0
Leamington Spa	0	0	0	0	0	0	0	0	0	0
Leeds Centre	0	0	0	0	0	0	0	0	0	0
Leicester Centre	0	0	0	0	0	0	0	0	0	0
Liverpool Speke	0	0	0	0	0	0	0	0	0	0
London A3 Roadside	0	0	0	0	0	0	0	0	0	0
London Bexley	0	0	0	0	0	0	0	0	0	0
London Bloomsbury	0	0	0	0	0	0	0	0	0	0
London Brent	0	0	0	0	0	0	0	0	0	0
London Bromley	0	0	0	0	0	0	0	0	0	0
London Cromwell Road 2	0	0	0	0	0	0	0	0	0	0
London Hackney	0	0	0	0	0	0	0	0	0	0
London Harlington	0	0	0	0	0	0	0	0	0	0
London Hillingdon	0	0	0	0	0	0	0	0	0	0
London Marylebone Road	0	0	0	0	0	0	0	0	0	0
London N. Kensington	0	0	0	0	0	0	0	0	0	0
London Southwark	0	0	0	0	0	0	0	0	0	0
London Westminster	0	0	0	0	0	0	0	0	0	0
Manchester Piccadilly	0	0	0	0	0	0	0	0	0	0
Manchester Town Hall	0	0	0	0	0	0	0	0	0	0
Market Harborough	0	0	0	0	0	0	0	0	0	0
Middlesbrough	0	0	0	0	0	0	0	0	0	0
Newcastle Centre	0	0	0	0	0	0	0	0	0	0
Northampton	0	0	0	0	0	0	0	0	0	0
Norwich Centre	0	0	0	0	0	0	0	0	0	0
Nottingham Centre	0	0	0	0	0	0	0	0	0	0
Oxford Centre Roadside	0	0	0	0	0	0	0	0	0	0
Plymouth Centre	0	0	0	0	0	0	0	0	0	0
Portsmouth	0	0	0	0	0	0	0	0	0	0
Preston	0	0	0	0	0	0	0	0	0	0
Reading New Town	0	0	0	0	0	0	0	0	0	0
Redcar	0	0	0	0	0	0	0	0	0	0
Salford Eccles	0	0	0	0	0	0	0	0	0	0
Sandwell West Bromwich	0	0	0	0	0	0	0	0	0	0
Sheffield Centre	0	0	0	0	0	0	0	0	0	0
Sheffield Tinsley	0	0	0	0	0	0	0	0	0	0
Southampton Centre	0	0	0	0	0	0	0	0	0	0
Southend-on-Sea	0	0	0	0	0	0	0	0	0	0
Southwark Roadside	0	0	0	0	0	0	0	0	0	0
St Osyth	0	0	0	0	0	0	0	0	0	0
Stockport Shaw Heath	0	0	0	0	0	0	0	0	0	0
Stockton-on-Tees Yarm	0	0	0	0	0	0	0	0	0	0
Stoke-on-Trent Centre	0	0	0	0	0	0	0	0	0	0

ii) ANNUAL STATISTICS II

Site	Site Type	Annual average of hourly means mg m^{-3}	Annual data capture of hourly means %	Maximum hourly mean mg m^{-3}	Maximum running 8-hour mean mg m^{-3}	Date of Maximum running 8-hour mean
Thurrock	UC	0.3	96.1	3.8	2.2	30/11/2004
Tower Hamlets Roadside	UB	0.5	83.8	2.0	1.6	02/03/2004
West London	RD	0.4	98.8	2.7	1.9	02/03/2004
Wigan Centre	UC	---	23.0	3.0	2.0	03/12/2004
Wigan Leigh	UB	0.3	72.0	2.8	1.7	02/03/2004
Wirral Tranmere	UB	0.2	94.9	2.3	1.5	03/12/2004
Wolverhampton Centre	UC	0.5	93.4	3.7	2.1	19/12/2004
N Ireland						
Belfast Centre	UC	0.2	96.4	4.1	2.9	01/03/2004
Derry	UB	0.3	97.4	2.4	1.4	26/01/2004
Scotland						
Aberdeen	UB	0.3	93.0	2.4	1.5	15/01/2004
Dumfries	RD	0.6	98.5	4.3	2.2	21/12/2004
Edinburgh St Leonards	UB	0.3	98.1	1.6	1.3	12/02/2004
Glasgow Centre	UC	0.4	92.1	5.6	3.0	12/12/2004
Glasgow City Chambers	UB	0.4	98.9	2.4	1.7	17/01/2004
Glasgow Kerbside	KB	0.4	98.2	2.3	1.9	18/01/2004
Grangemouth	I	0.2	81.2	1.6	1.4	21/11/2004
Inverness	RD	0.4	98.5	3.8	2.2	20/12/2004
Wales						
Cardiff Centre	UC	0.3	96.0	3.4	1.8	20/12/2004
Cwmbran	UB	0.2	98.0	3.0	1.9	23/11/2004
Swansea	UC	0.3	97.7	3.2	2.7	03/12/2004
Wrexham	RD	0.5	98.4	4.1	1.8	11/02/2004

iv) EXCEEDENCE STATISTICS- II

Site	Moderate band	Days	High band	Days	Very High band	Days	Daughter Directive and Air Quality Standard	Days	Air Quality Standard (Scotland)	Days
Thurrock	0	0	0	0	0	0	0	0	0	0
Tower Hamlets Roadside	0	0	0	0	0	0	0	0	0	0
West London	0	0	0	0	0	0	0	0	0	0
Wigan Centre	0	0	0	0	0	0	0	0	0	0
Wigan Leigh	0	0	0	0	0	0	0	0	0	0
Wirral Tranmere	0	0	0	0	0	0	0	0	0	0
Wolverhampton Centre	0	0	0	0	0	0	0	0	0	0
N Ireland										
Belfast Centre	0	0	0	0	0	0	0	0	0	0
Derry	0	0	0	0	0	0	0	0	0	0
Scotland										
Aberdeen	0	0	0	0	0	0	0	0	0	0
Dumfries	0	0	0	0	0	0	0	0	0	0
Edinburgh St Leonards	0	0	0	0	0	0	0	0	0	0
Glasgow Centre	0	0	0	0	0	0	0	0	0	0
Glasgow City Chambers	0	0	0	0	0	0	0	0	0	0
Glasgow Kerbside	0	0	0	0	0	0	0	0	0	0
Grangemouth	0	0	0	0	0	0	0	0	0	0
Inverness	0	0	0	0	0	0	0	0	0	0
Wales										
Cardiff Centre	0	0	0	0	0	0	0	0	0	0
Cwmbran	0	0	0	0	0	0	0	0	0	0
Swansea	0	0	0	0	0	0	0	0	0	0
Wrexham	0	0	0	0	0	0	0	0	0	0

11. NO_2 - Measurement Sites, Instrumentation and Statistics

11.1 Measurement Method

The determination of oxides of nitrogen is based on the chemiluminescent energy emitted when nitric oxide (NO) is reacted with ozone (O_3) in an evacuated chamber to form chemiluminescent nitrogen dioxide (NO_2).

11.2 Instrumentation

The following instrument types* are currently deployed in the AURN:

- Ambirak NO2
- API M200
- Environnement AC 31M
- Horiba APNA 360
- Monitor Labs 9841
- Rotork 447
- Thermo Electron 42

*Defra does not give approval or endorsement for any products or equipment

11.3 Data Quality Requirements of EC Directive 1999/30/EC

Uncertainty 15%
Minimum data capture 90%

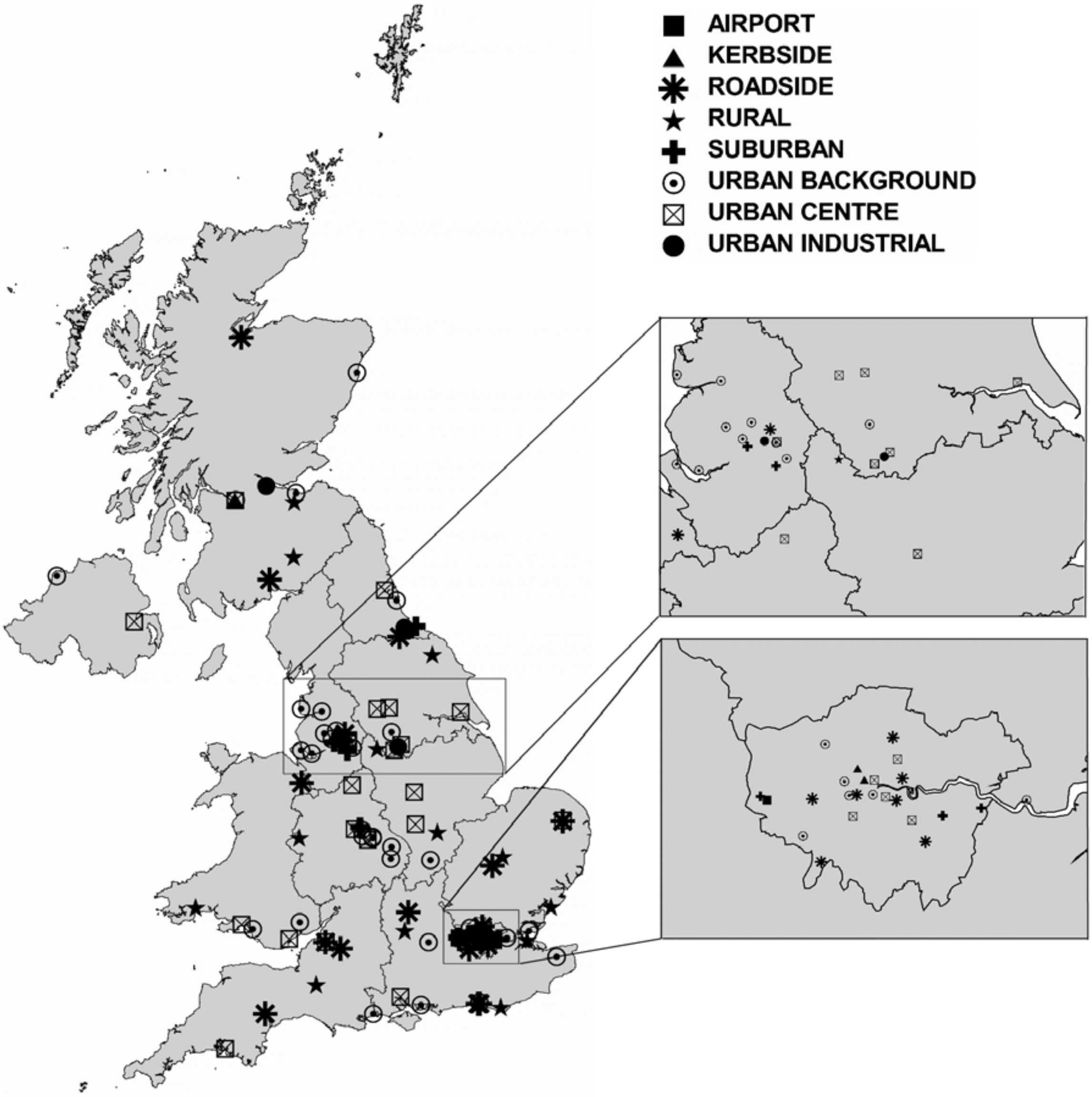
11.4 Objectives and Bandings

Summary of objectives of the Air Quality Strategy			
	Objective	**Measured as**	**To be achieved by**
Nitrogen Dioxide	200 µg m^{-3} Not to be exceeded more than 18 times per year	1 Hour Mean	31 December 2005
	40 µg m^{-3}	Annual Mean	31 December 2005

Air Quality Bands and Index Values		
Band	Index	Nitrogen Dioxide µg m^{-3}
Low	1	0-95
	2	96-190
	3	191-286
Moderate	4	287-381
	5	382-477
	6	478-572
High	7	573-635
	8	363-700
	9	701-763
Very High	10	764 or more

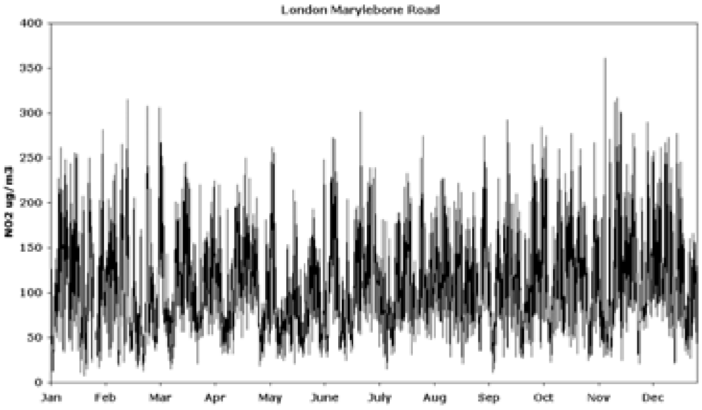
11.5 Site Locations

UK Automatic Nitrogen Dioxide Monitoring Sites 2004

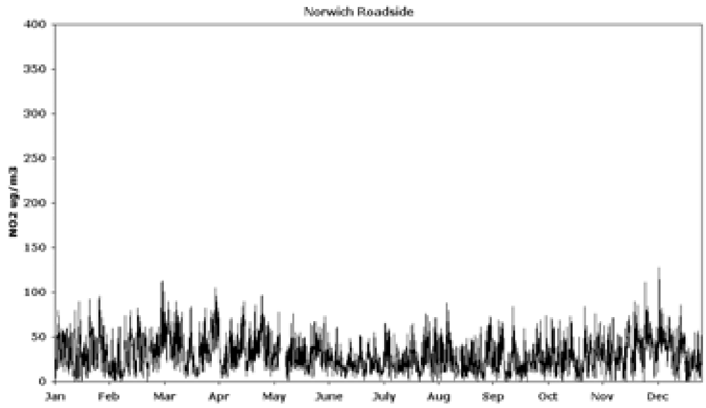


11.6 Hourly Average Concentrations

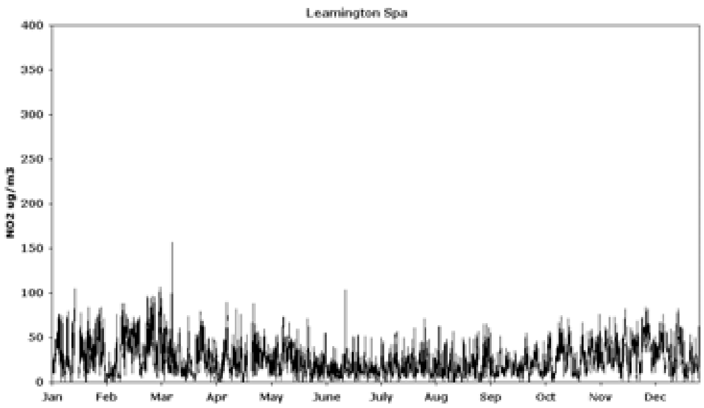
These figures show time series graphs of hourly average nitrogen dioxide concentrations at four *typical* site types for 2004.



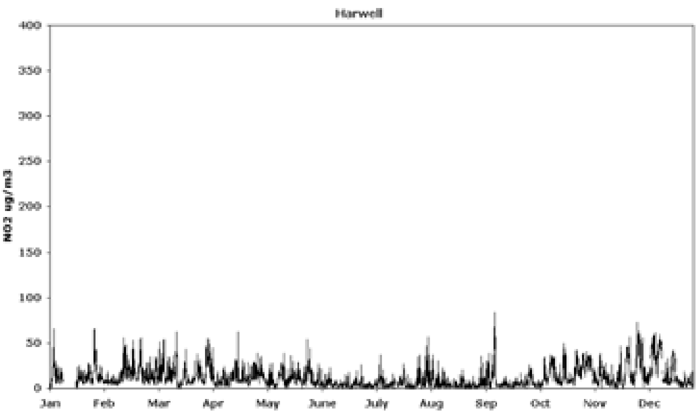
Kerbside Site
(Marylebone Road)



Roadside Site
(Norwich)



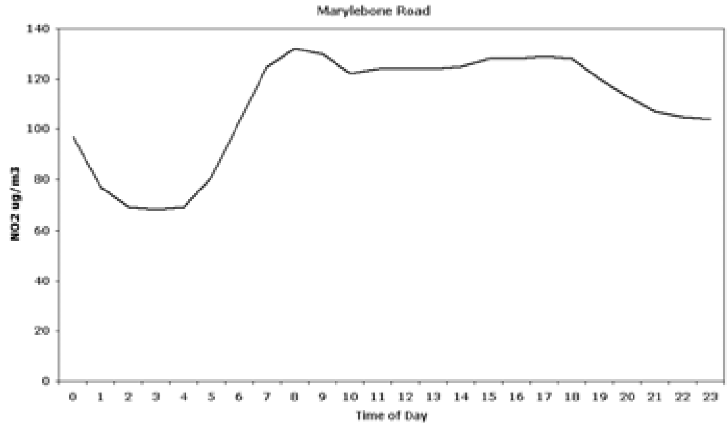
Urban Background Site
(Leamington Spa)



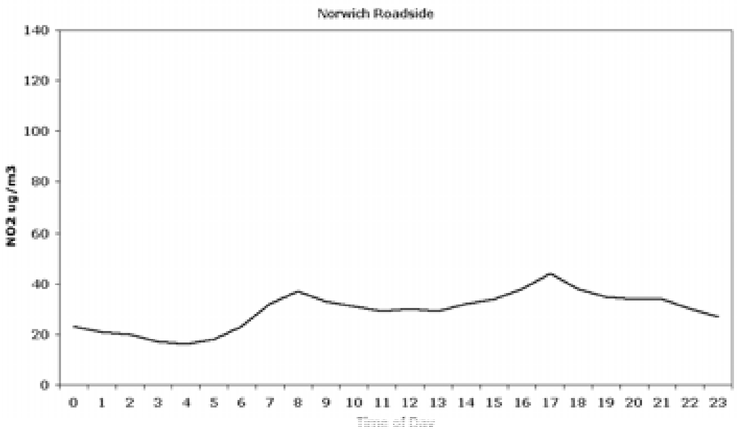
Rural Site
(Harwell)

11.7 Diurnal Variations

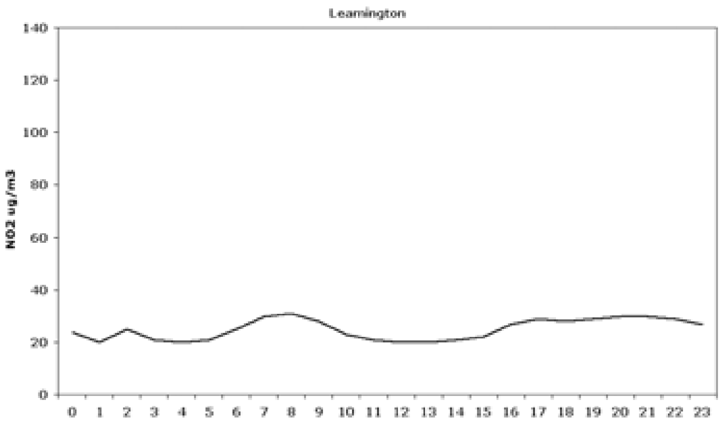
These figures show how nitrogen dioxide concentrations vary on average for each hour of day during 2004, at a number of selected *typical* monitoring site types. Local time is used, rather than GMT, since this will more closely reflect the daily cycle of man-made emissions.



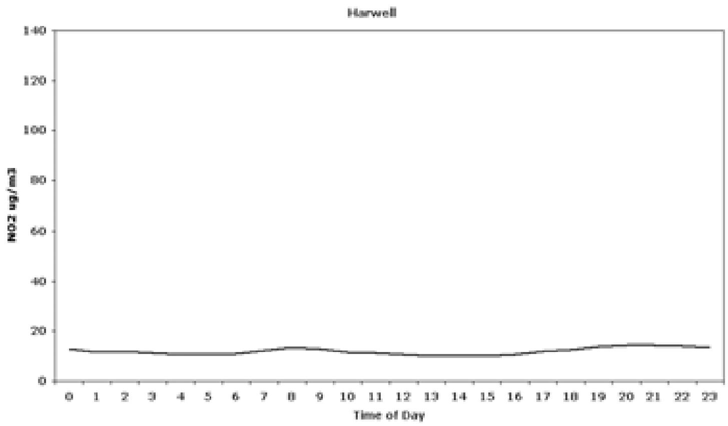
Kerbside Site
(*Marylebone Road*)



Roadside Site
(*Norwich*)



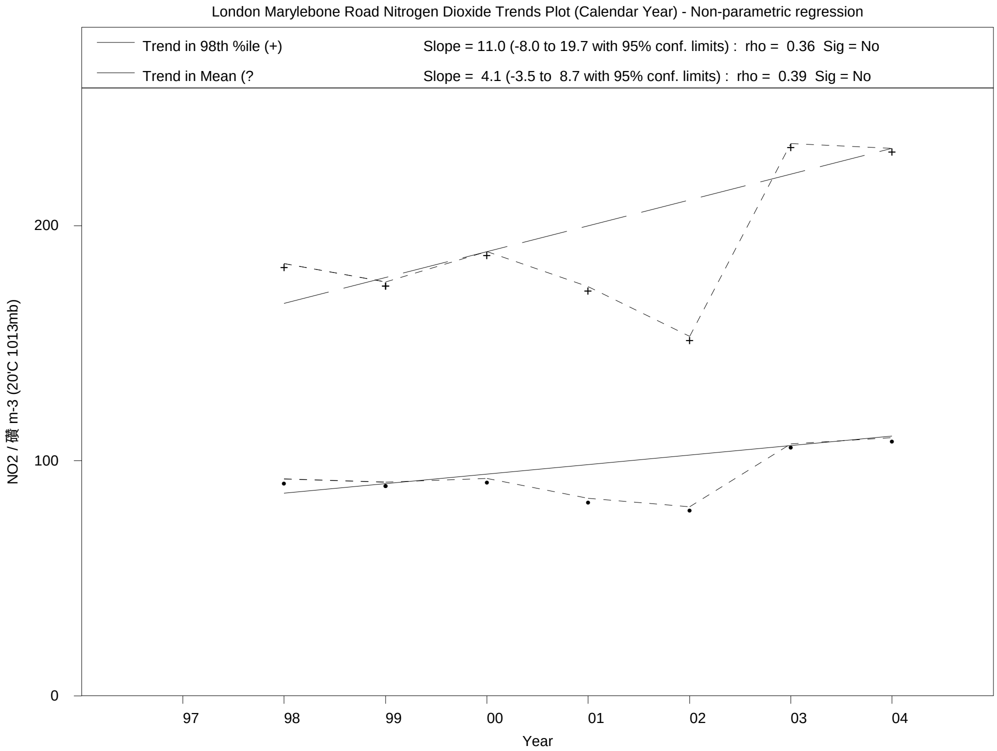
Urban Background Site
(*Leamington Spa*)



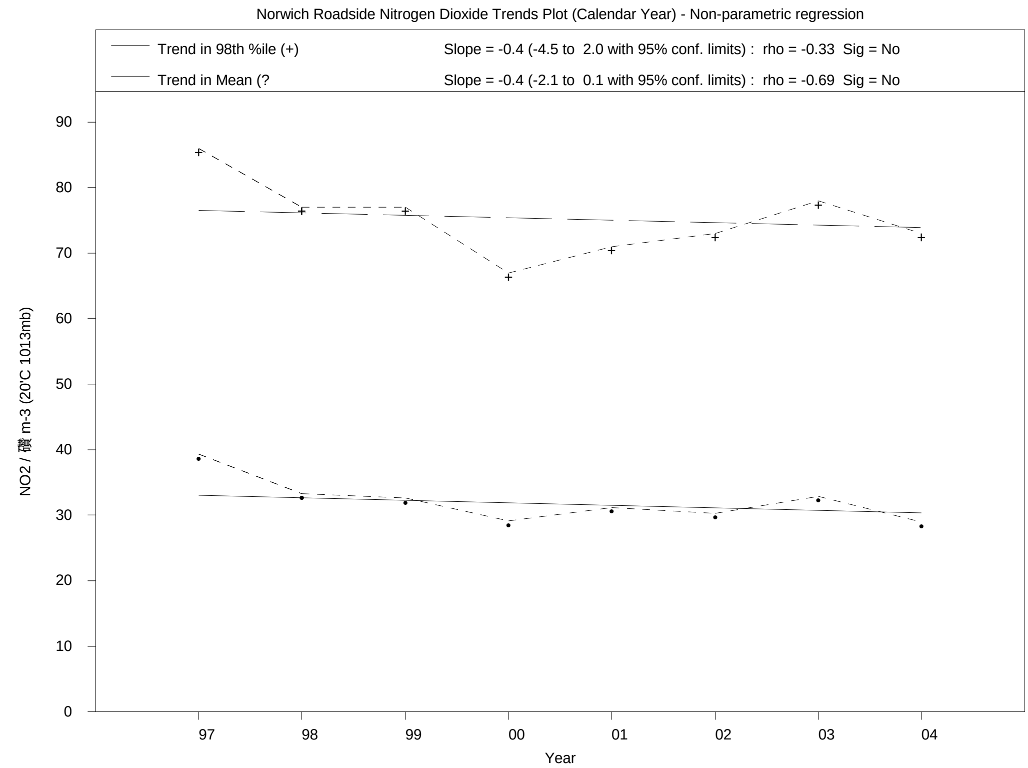
Rural Site
(*Harwell*)

11.8 Trends in annual concentrations

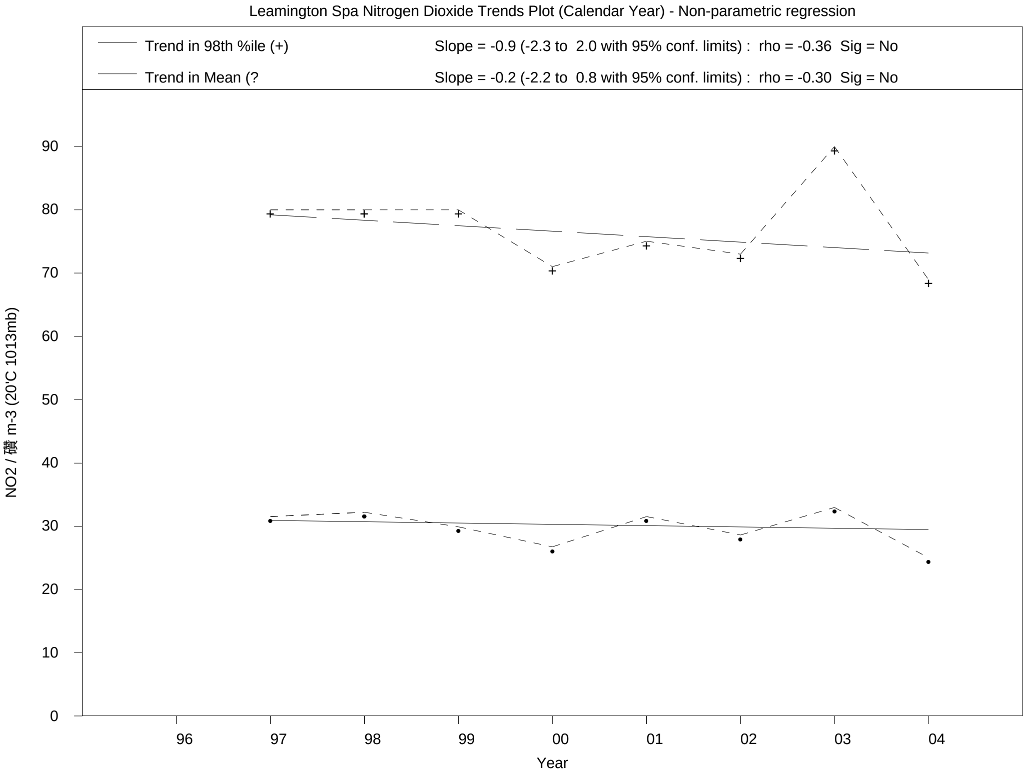
Statistically significant trends in concentrations are shown for sites with at ≥5 years of measurement.



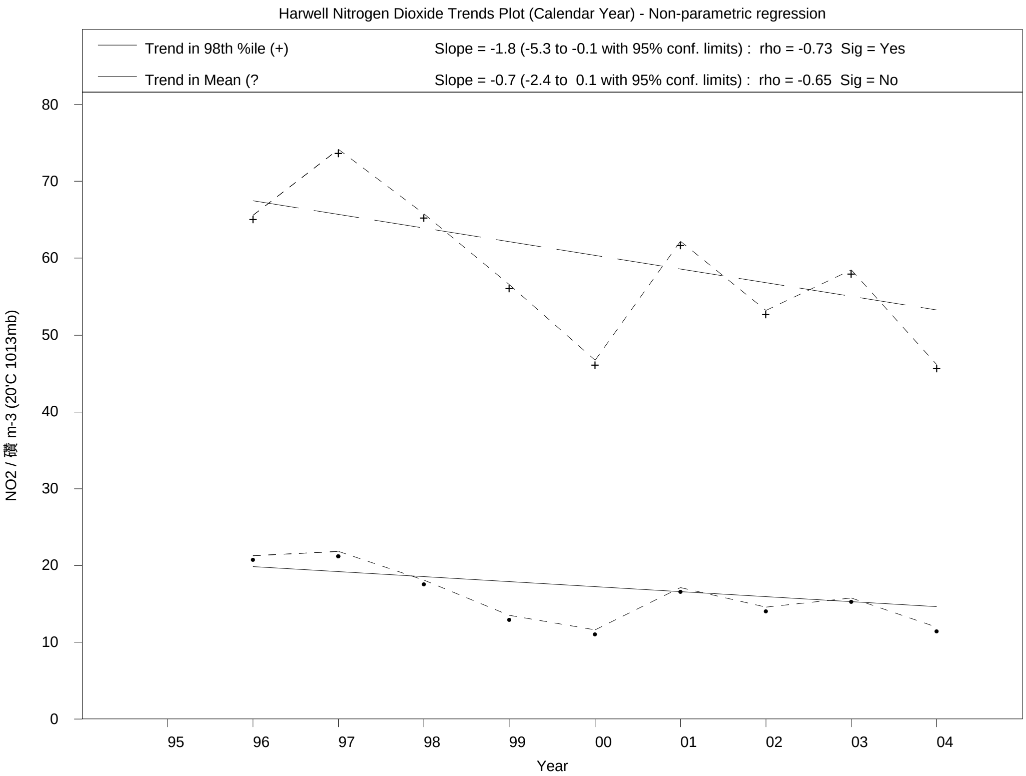
Kerbside Site
(Marylebone Road)



Roadside Site
(Norwich)



Urban Background Site
(Leamington Spa)



Rural Site
(Harwell)

11.9 Nitrogen Dioxide Statistical Summary 2004

i) ANNUAL STATISTICS- I

Site	Site Type	Annual average of hourly means µg m^{-3}	Annual data capture of hourly means %	Maximum hourly mean µg m^{-3}	99.8%ile of hourly means µg m^{-}
England					
Barnsley Gawber	UB	22	95.9	107	88
Bath Roadside	RD	55	98.3	193	145
Billingham	I	29	99.1	288	147
Birmingham Centre	UC	35	88.9	117	101
Birmingham East	UB	31	53.8	138	109
Birmingham Tyburn	UB	---	36.5	159	---
Blackpool	UB	15	77.7	94	67
Bolton	UB	29	94.1	181	109
Bournemouth	UB	19	96.4	128	90
Bradford Centre	UC	31	95.8	153	109
Brentford Roadside	RD	54	92.0	227	172
Brighton Preston Park	UB	---	15.7	92	---
Brighton Roadside	RD	41	98.9	174	120
Bristol Centre	UC	35	96.7	143	113
Bristol Old Market	RD	54	98.7	185	159
Bury Roadside	RD	69	91.6	197	166
Cambridge Roadside	RD	42	96.5	130	105
Camden Kerbside	KB	---	39.4	241	---
Canterbury	UB	18	96.9	88	71
Coventry Memorial Park	UB	22	97.6	92	78
Exeter Roadside	RD	40	95.8	164	128
Glazebury	SU	17.7	87.3	111.4	84.0
Haringey Roadside	RD	46	98.2	166	128
Harwell	RU	12.0	95.7	83.5	62.5
High Muffles	RU	9.0	70.1	71.8	57.7
Hove Roadside	RD	38	94.3	181	126
Hull Freetown	UC	27	89.3	124	92
Ladybower	RU	9.2	89.9	89.2	60.4
Leamington Spa	UB	25	93.8	157	94
Leeds Centre	UC	31	92.1	178	128
Leicester Centre	UC	36	85.5	118	99
Liverpool Speke	UB	23	98.1	132	97
London A3 Roadside	RD	66	96.8	435	178
London Bexley	SU	35	96.1	241	109
London Bloomsbury	UC	58	97.5	172	130
London Brent	UB	29	91.0	168	124
London Bromley	RD	47	98.4	162	126
London Cromwell Road 2	RD	80	98.7	229	172
London Eltham	SU	32	97.2	139	99
London Hackney	UC	48	99.4	239	191
London Harlington	A	38	99.0	183	113
London Hillingdon	SU	47	97.6	197	134
London Lewisham	UC	49	97.8	212	149
London Marylebone Road	KB	110	98.3	361	281
London N. Kensington	UB	40	98.9	170	136
London Southwark	UC	51	88.1	193	126
London Teddington	UB	24.5	93.8	113.8	94.7
London Wandsworth	UC	54	99.3	216	155
London Westminster	UB	46	78.3	330	117
Lullington Heath	RU	10.2	92.8	77.5	51.0
Manchester Piccadilly	UC	43	93.8	166	132
Manchester South	SU	19	87.4	90	74
Manchester Town Hall	UB	40	94.7	141	115
Market Harborough	RU	12.8	90.4	82.3	62.6
Middlesbrough	I	24	64.5	109	74
Newcastle Centre	UC	29	81.9	126	92
Northampton	UB	20	87.1	96	76
Norwich Centre	UC	21	90.7	103	76
Norwich Roadside	RD	29	97.7	128	96

ii) EXCEEDENCE STATISTICS- I

Site	Moderate band	Days	High band	Days	Very High band	Days	Air Quality Standard (Annual Mean)	Daughter Directive Hourly Mean and Air Quality Standard	Days
England									
Barnsley Gawber	0	0	0	0	0	0	0	0	0
Bath Roadside	0	0	0	0	0	0	**1**	0	0
Billingham	1	1	0	0	0	0	0	**1**	**1**
Birmingham Centre	0	0	0	0	0	0	0	0	0
Birmingham East	0	0	0	0	0	0	0	0	0
Birmingham Tyburn	0	0	0	0	0	0	---	0	0
Blackpool	0	0	0	0	0	0	0	0	0
Bolton	0	0	0	0	0	0	0	0	0
Bournemouth	0	0	0	0	0	0	0	0	0
Bradford Centre	0	0	0	0	0	0	0	0	0
Brentford Roadside	0	0	0	0	0	0	1	8	3
Brighton Preston Park	0	0	0	0	0	0	---	0	0
Brighton Roadside	0	0	0	0	0	0	1	0	0
Bristol Centre	0	0	0	0	0	0	0	0	0
Bristol Old Market	0	0	0	0	0	0	1	0	0
Bury Roadside	0	0	0	0	0	0	1	0	0
Cambridge Roadside	0	0	0	0	0	0	1	0	0
Camden Kerbside	0	0	0	0	0	0	---	6	4
Canterbury	0	0	0	0	0	0	0	0	0
Coventry Memorial Park	0	0	0	0	0	0	0	0	0
Exeter Roadside	0	0	0	0	0	0	0	0	0
Glazebury	0	0	0	0	0	0	0	0	0
Haringey Roadside	0	0	0	0	0	0	1	0	0
Harwell	0	0	0	0	0	0	0	0	0
High Muffles	0	0	0	0	0	0	0	0	0
Hove Roadside	0	0	0	0	0	0	0	0	0
Hull Freetown	0	0	0	0	0	0	0	0	0
Ladybower	0	0	0	0	0	0	0	0	0
Leamington Spa	0	0	0	0	0	0	0	0	0
Leeds Centre	0	0	0	0	0	0	0	0	0
Leicester Centre	0	0	0	0	0	0	0	0	0
Liverpool Speke	0	0	0	0	0	0	0	0	0
London A3 Roadside	4	1	0	0	0	0	1	8	2
London Bexley	0	0	0	0	0	0	0	1	1
London Bloomsbury	0	0	0	0	0	0	1	0	0
London Brent	0	0	0	0	0	0	0	0	0
London Bromley	0	0	0	0	0	0	1	0	0
London Cromwell Road 2	0	0	0	0	0	0	1	3	2
London Eltham	0	0	0	0	0	0	0	0	0
London Hackney	0	0	0	0	0	0	1	11	5
London Harlington	0	0	0	0	0	0	0	0	0
London Hillingdon	0	0	0	0	0	0	1	0	0
London Lewisham	0	0	0	0	0	0	1	1	1
London Marylebone Road	15	10	0	0	0	0	1	542	128
London N. Kensington	0	0	0	0	0	0	0	0	0
London Southwark	0	0	0	0	0	0	1	0	0
London Teddington	0	0	0	0	0	0	0	0	0
London Wandsworth	0	0	0	0	0	0	1	2	2
London Westminster	2	2	0	0	0	0	1	3	2
Lullington Heath	0	0	0	0	0	0	0	0	0
Manchester Piccadilly	0	0	0	0	0	0	**1**	0	0
Manchester South	0	0	0	0	0	0	0	0	0
Manchester Town Hall	0	0	0	0	0	0	**1**	0	0
Market Harborough	0	0	0	0	0	0	0	0	0
Middlesbrough	0	0	0	0	0	0	0	0	0
Newcastle Centre	0	0	0	0	0	0	0	0	0
Northampton	0	0	0	0	0	0	0	0	0
Norwich Centre	0	0	0	0	0	0	0	0	0
Norwich Roadside	0	0	0	0	0	0	0	0	0

iii) ANNUAL STATISTICS- II

Site	Site Type	Annual average of hourly means µg m^{-3}	Annual data capture of hourly means %	Maximum hourly mean µg m^{-3}	99.8%ile of hourly means µg m^{-}
England					
Nottingham Centre	UC	35	90.9	138	94
Oxford Centre Roadside	RD	68	86.5	264	189
Plymouth Centre	UC	27	89.1	113	88
Portsmouth	UB	24	98.1	107	84
Preston	UB	25	94.3	139	86
Reading New Town	UB	25	93.2	138	107
Redcar	SU	22	97.7	88	76
Rochester	RU	20.5	96.4	115.2	75.8
Rotherham Centre	UC	35	96.9	189	111
Salford Eccles	I	34	96.2	210	157
Sandwell West Bromwich	UB	27	98.2	147	103
Sheffield Centre	UC	31	97.1	118	84
Sheffield Tinsley	I	40	95.7	136	118
Somerton	RU	8.7	88.8	68.0	55.2
Southampton Centre	UC	33	95.2	130	99
Southend-on-Sea	UB	24	91.5	107	80
Southwark Roadside	RD	62	75.4	176	130
St Osyth	RU	16.2	91.0	101.0	73.7
Stockport Shaw Heath	UB	36	90.9	130	101
Stockton-on-Tees Yarm	RD	37	98.7	136	113
Stoke-on-Trent Centre	UC	30	93.2	153	96
Sunderland Silksworth	UB	---	6.3	63	---
Thurrock	UB	35	89.8	134	103
Tower Hamlets Roadside	RD	61	96.3	212	151
Walsall Alumwell	UB	42	93.0	201	130
Walsall Willenhall	SU	27	92.1	151	101
West London	UB	51	98.8	206	139
Wicken Fen	RU	11.3	73.1	68.6	57.5
Wigan Centre	UB	---	22.2	103	---
Wigan Leigh	UB	25	71.4	107	86
Wirral Tranmere	UB	19	94.0	92	78
Wolverhampton Centre	UC	29	80.4	138	109
Yarner Wood	RU	7.8	98.5	57.1	47.9
N Ireland					
Belfast Centre	UC	28	91.8	153	105
Derry	UB	15	92.0	86	69
Scotland					
Aberdeen	UB	26	90.0	134	103
Bush Estate	RU	8.1	93.6	66.5	51.4
Dumfries	RD	37	96.6	160	126
Edinburgh St Leonards	UC	25	91.0	94	84
Eskdalemuir	RU	---	5.9	52.9	---
Glasgow Centre	UC	36	88.5	189	143
Glasgow City Chambers	UB	49	98.0	193	143
Glasgow Kerbside	KB	68	96.0	254	193
Grangemouth	I	17	98.5	90	76
Inverness	RD	23	98.1	157	105
Wales					
Aston Hill	RU	6.1	87.0	62.1	44.9
Cardiff Centre	UC	30	97.5	260	94
Cwmbran	UB	17	99.4	103	84
Narberth	RU	5.3	89.4	55.6	44.5
Port Talbot	UB	21	83.9	96	76
Swansea	UC	37	91.5	143	113
Wrexham	RD	21	95.7	118	84

iv) EXCEEDENCE STATISTICS- II

Site	Moderate band	Days	High band	Days	Very High band	Days	Air Quality Standard (Annual Mean)	Daughter Directive Hourly Mean and Air Quality Standard	Days
England									
Nottingham Centre	0	0	0	0	0	0	0	0	0
Oxford Centre Roadside	0	0	0	0	0	0	1	6	5
Plymouth Centre	0	0	0	0	0	0	0	0	0
Portsmouth	0	0	0	0	0	0	0	0	0
Preston	0	0	0	0	0	0	0	0	0
`Reading New Town	0	0	0	0	0	0	0	0	0
Redcar	0	0	0	0	0	0	0	0	0
Rochester	0	0	0	0	0	0	0	0	0
Rotherham Centre	0	0	0	0	0	0	0	0	0
Salford Eccles	0	0	0	0	0	0	0	2	2
Sandwell West Bromwich	0	0	0	0	0	0	0	0	0
Sheffield Centre	0	0	0	0	0	0	0	0	0
Sheffield Tinsley	0	0	0	0	0	0	0	0	0
Somerton	0	0	0	0	0	0	0	0	0
Southampton Centre	0	0	0	0	0	0	0	0	0
Southend-on-Sea	0	0	0	0	0	0	0	0	0
Southwark Roadside	0	0	0	0	0	0	1	0	0
St Osyth	0	0	0	0	0	0	0	0	0
Stockport Shaw Heath	0	0	0	0	0	0	0	0	0
Stockton-on-Tees Yarm	0	0	0	0	0	0	0	0	0
Stoke-on-Trent Centre	0	0	0	0	0	0	0	0	0
Sunderland Silksworth	0	0	0	0	0	0	---	0	0
Thurrock	0	0	0	0	0	0	0	0	0
Tower Hamlets Roadside	0	0	0	0	0	0	1	3	2
Walsall Alumwell	0	0	0	0	0	0	1	1	1
Walsall Willenhall	0	0	0	0	0	0	0	0	0
West London	0	0	0	0	0	0	1	1	1
Wicken Fen	0	0	0	0	0	0	0	0	0
Wigan Centre	0	0	0	0	0	0	---	0	0
Wigan Leigh	0	0	0	0	0	0	0	0	0
Wirral Tranmere	0	0	0	0	0	0	0	0	0
Wolverhampton Centre	0	0	0	0	0	0	0	0	0
Yarner Wood	0	0	0	0	0	0	0	0	0
N Ireland									
Belfast Centre	0	0	0	0	0	0	0	0	0
Derry	0	0	0	0	0	0	0	0	0
Scotland									
Aberdeen	0	0	0	0	0	0	0	0	0
Bush Estate	0	0	0	0	0	0	0	0	0
Dumfries	0	0	0	0	0	0	0	0	0
Edinburgh St Leonards	0	0	0	0	0	0	0	0	0
Eskdalemuir	0	0	0	0	0	0	---	0	0
Glasgow Centre	0	0	0	0	0	0	0	0	0
Glasgow City Chambers	0	0	0	0	0	0	1	0	0
Glasgow Kerbside	0	0	0	0	0	0	1	14	9
Grangemouth	0	0	0	0	0	0	0	0	0
Inverness	0	0	0	0	0	0	0	0	0
Wales									
Aston Hill	0	0	0	0	0	0	0	0	0
Cardiff Centre	0	0	0	0	0	0	0	**2**	**1**
Cwmbran	0	0	0	0	0	0	0	0	0
Narberth	0	0	0	0	0	0	0	0	0
Port Talbot	0	0	0	0	0	0	0	0	0
Swansea	0	0	0	0	0	0	0	0	0
Wrexham	0	0	0	0	0	0	0	0	0

12. NO_x- Measurement Sites, Instrumentation and Statistics

12.1 Measurement Method

The determination of oxides of nitrogen is based on the chemiluminescent energy emitted when nitric oxide (NO) is reacted with ozone (O_3) in an evacuated chamber to form chemiluminescent nitrogen dioxide (NO_2).

12.2 Instrumentation

The following instrument types* are currently deployed in the AURN:

- Ambirak NO_2
- API M200
- Environnement AC 31M
- Horiba APNA 360
- Monitor Labs 9841
- Rotork 447
- Thermo Electron 42

*Defra does not give approval or endorsement for any products or equipment

12.3 Data Quality Requirements of EC Directive 1999/30/EC

Uncertainty 15%
Minimum data capture 90%

12.4 Objectives and Bandings

Summary of objectives of the National Air Quality Strategy			
	Objective*	**Measured as**	**To be achieved by**
	30 µg m^{-3}	Annual Mean	31 December 2000

*Assuming NO_x is taken as NO_2

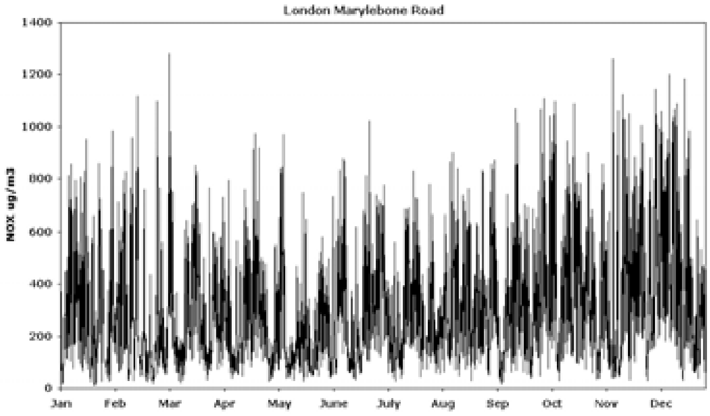
No bandings are set for oxides of nitrogen as there are no known short-term effects of this pollutant.

12.5 Site Locations

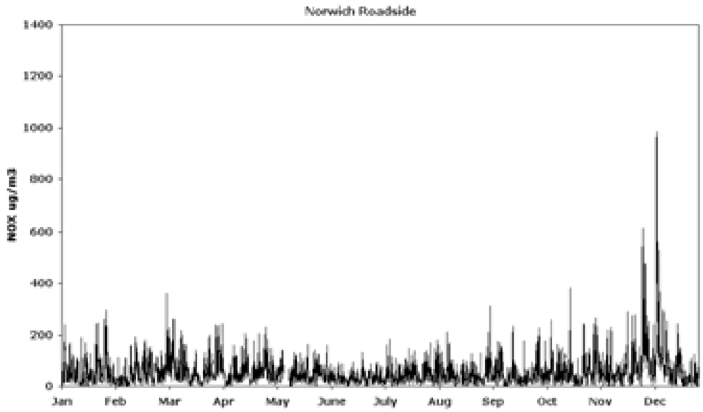
UK Automatic Nitrogen Oxides Monitoring Sites 2004

12.6 Hourly Average Concentrations

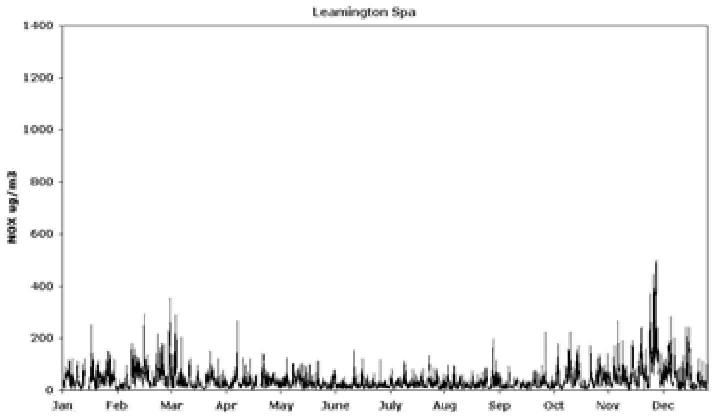
These figures show time series graphs of hourly average nitrogen oxides concentrations at four *typical* site types for 2004.



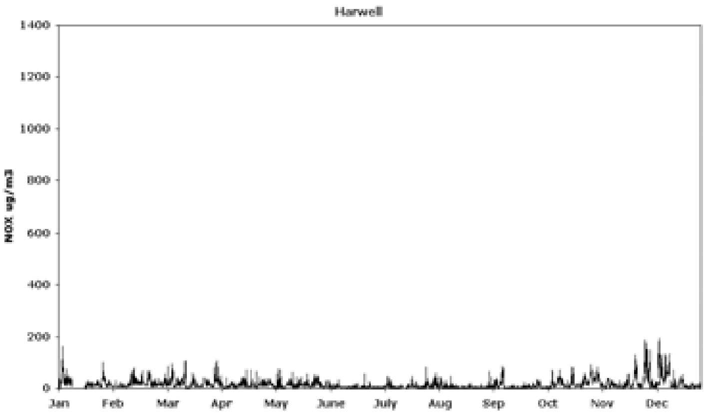
Kerbside Site
(Marylebone Road)



Roadside Site
(Norwich)



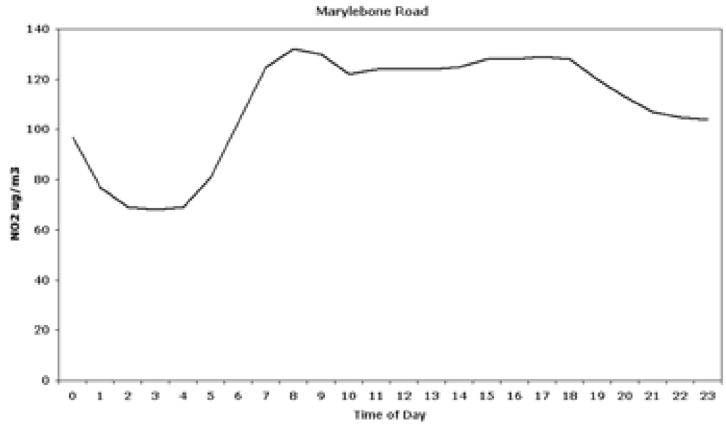
Urban Background Site
(Leamington Spa)



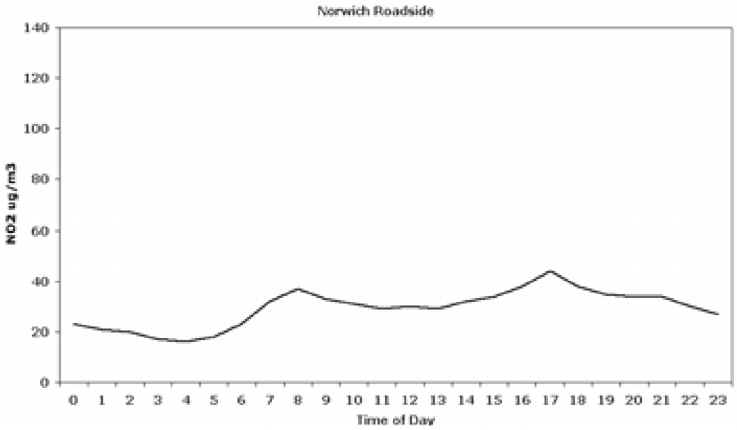
Rural Site
(Harwell)

12.7 Diurnal Variations

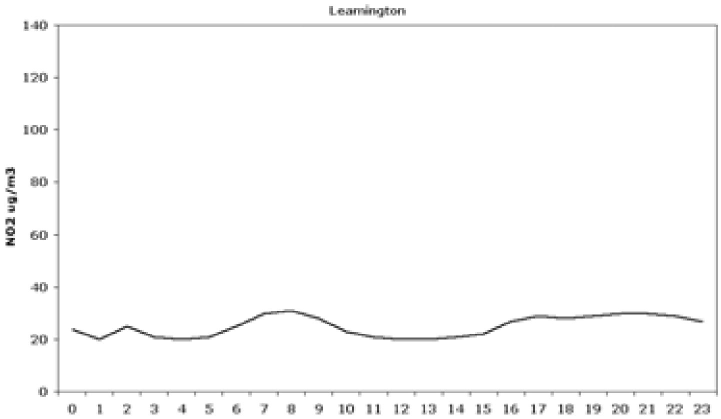
These figures show how nitrogen oxides concentrations vary on average for each hour of day during the year, at a number of selected *typical* monitoring site types. Local time is used, rather than GMT, since this will more closely reflect the daily cycle of man-made emissions.



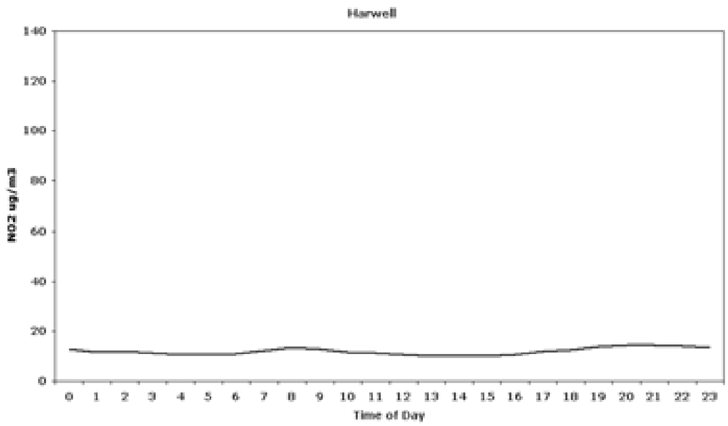
Kerbside Site
(Marylebone Road)



Roadside Site
(Norwich)



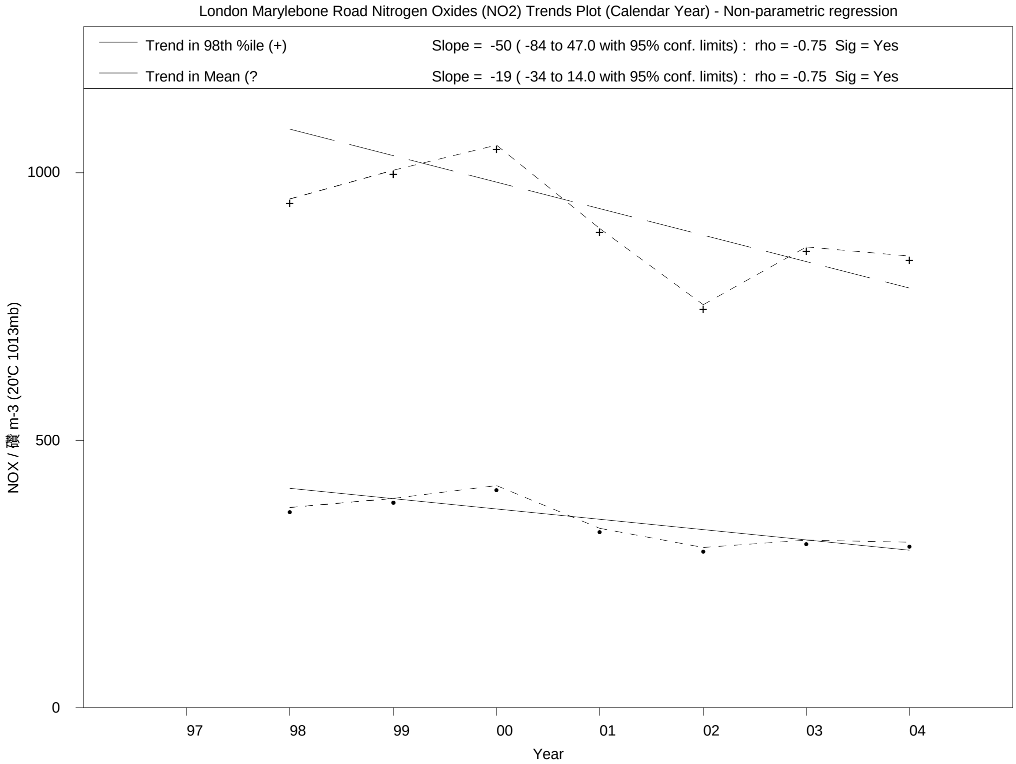
Urban Background Site
(Leamington Spa)



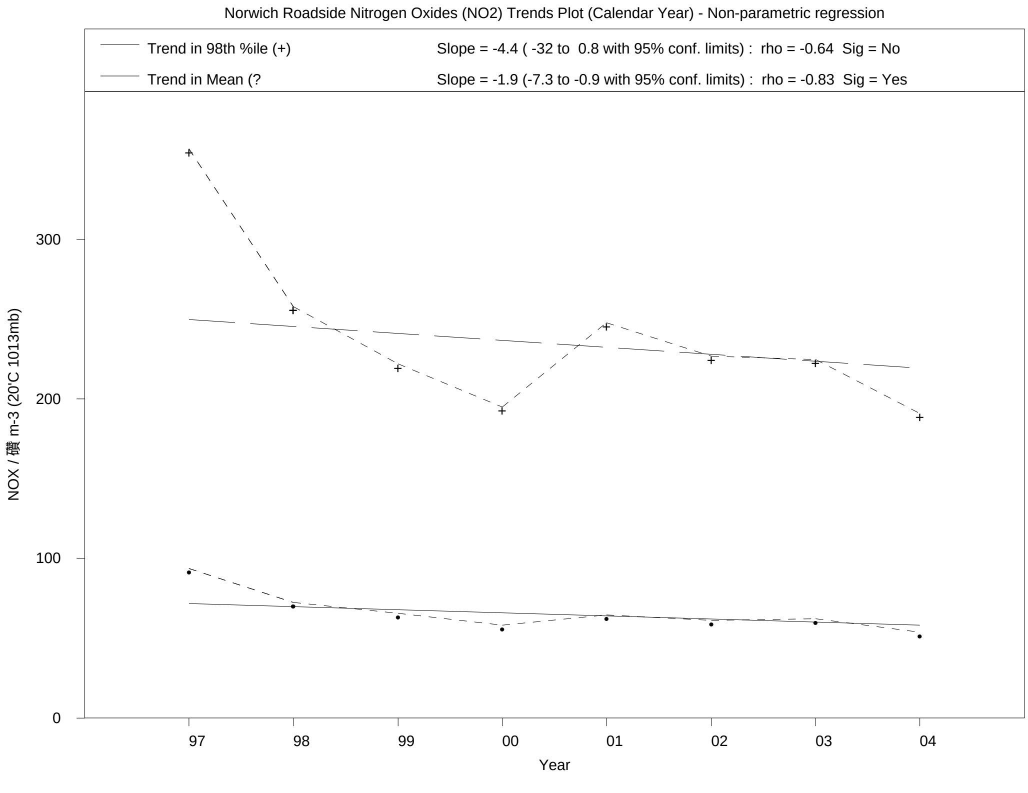
Rural Site
(Harwell)

12.8 Trends in annual concentrations

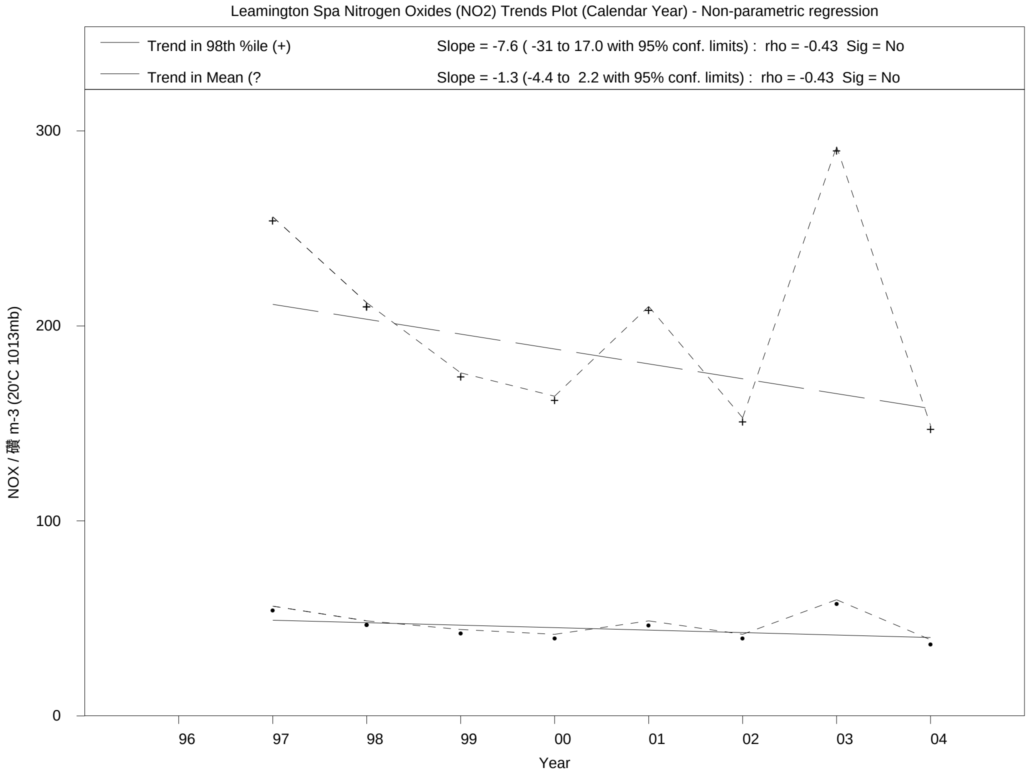
Statistically significant trends in concentration are shown for sites with at least ≥5 years of measurement.



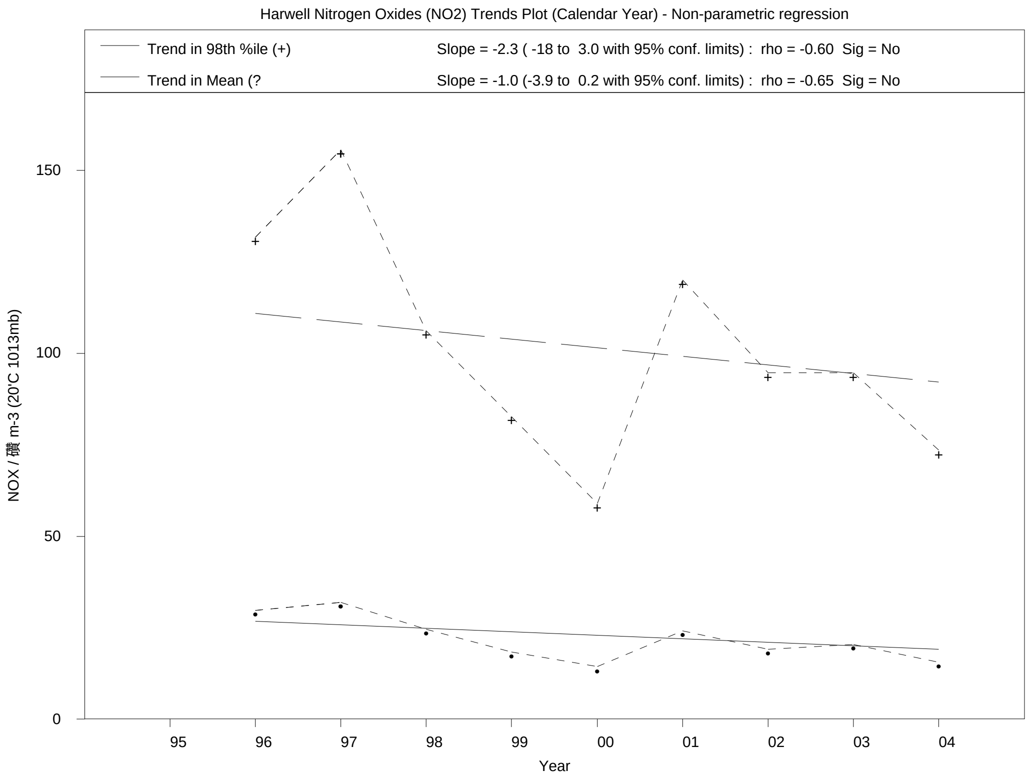
Kerbside Site
(*Marylebone Road*)



Roadside site
(*Norwich Roadside*)



Urban Background Site
(Leamington Spa)



Rural Site
(Harwell)

12.9 Nitrogen Oxides Statistical Summary 2004

i) ANNUAL STATISTICS- I

Site	Site Type	Annual average of hourly means µg m^{-3}	Annual data capture of hourly means %	Maximum hourly mean µg m^{-3}
England				
Barnsley Gawber	UB	35	95.9	548
Bath Roadside	RD	151	98.3	753
Billingham	I	53	99.1	1119
Birmingham Centre	UC	53	88.9	581
Birmingham East	UB	45	53.8	762
Birmingham Tyburn	UB	---	36.5	1396
Blackpool	UB	23	77.7	351
Bolton	UB	50	94.1	775
Bournemouth	UB	27	96.4	565
Bradford Centre	UC	70	95.8	1012
Brentford Roadside	RD	155	92.0	1299
Brighton Preston Park	UB	---	15.7	636
Brighton Roadside	RD	82	98.9	907
Bristol Centre	UC	79	96.7	1448
Bristol Old Market	RD	150	98.7	1270
Bury Roadside	RD	218	91.6	1240
Cambridge Roadside	RD	111	96.5	592
Camden Kerbside	KB	---	39.4	1133
Canterbury	UB	29	96.9	378
Coventry Memorial Park	UB	34	97.6	479
Exeter Roadside	RD	98	95.8	905
Glazebury	SU	30.9	87.3	617.3
Haringey Roadside	RD	97	98.2	1094
Harwell	RU	15.6	95.7	193.1
High Muffles	RU	11.7	70.1	134.7
Hove Roadside	RD	73	94.3	701
Hull Freetown	UC	45	89.3	667
Ladybower	RU	10.8	89.9	133.5
Leamington Spa	UB	39	93.8	500
Leeds Centre	UC	63	92.1	953
Leicester Centre	UC	64	85.5	655
Liverpool Speke	UB	37	98.1	766
London A3 Roadside	RD	180	96.8	1333
London Bexley	SU	58	96.1	921
London Bloomsbury	UC	98	97.5	804
London Brent	UB	49	91.0	1054
London Bromley	RD	84	98.4	609
London Cromwell Road 2	RD	193	98.7	865
London Eltham	SU	47	97.2	772
London Hackney	UC	94	99.4	1173
London Harlington	A	72	99.0	1045
London Hillingdon	SU	112	97.6	1037
London Lewisham	UC	100	97.8	1093
London Marylebone Road	KB	309	98.3	1282
London N. Kensington	UB	64	98.9	944
London Southwark	UC	92	88.1	768
London Teddington	UB	36.5	93.8	681.9
London Wandsworth	UC	113	99.3	1077
London Westminster	UB	78	78.3	1045
Lullington Heath	RU	12.4	92.8	136.0
Manchester Piccadilly	UC	80	93.8	879
Manchester South	SU	31	87.4	607
Manchester Town Hall	UB	66	94.7	739
Market Harborough	RU	15.3	90.4	189.1
Middlesbrough	I	37	64.5	441
Newcastle Centre	UC	52	81.9	596
Northampton	UB	33	87.1	571
Norwich Centre	UC	35	90.7	909
Norwich Roadside	RD	54	97.7	984
Nottingham Centre	UC	62	90.9	945
Oxford Centre Roadside	RD	189	86.5	1354
Plymouth Centre	UC	44	89.1	732

ii) EXCEEDENCE STATISTICS- I

Site	Daughter Directive Ecosystem and Air Quality Standard (Annual Mean)
England	
Barnsley Gawber	1
Bath Roadside	1
Billingham	1
Birmingham Centre	1
Birmingham East	1
Birmingham Tyburn	---
Blackpool	0
Bolton	1
Bournemouth	0
Bradford Centre	1
Brentford Roadside	1
Brighton Preston Park	---
Brighton Roadside	1
Bristol Centre	1
Bristol Old Market	1
Bury Roadside	1
Cambridge Roadside	1
Camden Kerbside	---
Canterbury	0
Coventry Memorial Park	1
Exeter Roadside	1
Glazebury	1
Haringey Roadside	1
Harwell	0
High Muffles	0
Hove Roadside	1
Hull Freetown	1
Ladybower	0
Leamington Spa	1
Leeds Centre	1
Leicester Centre	1
Liverpool Speke	1
London A3 Roadside	1
London Bexley	1
London Bloomsbury	1
London Brent	1
London Bromley	1
London Cromwell Road 2	1
London Eltham	1
London Hackney	1
London Harlington	1
London Hillingdon	1
London Lewisham	1
London Marylebone Road	1
London N. Kensington	1
London Southwark	1
London Teddington	1
London Wandsworth	1
London Westminster	1
Lullington Heath	0
Manchester Piccadilly	1
Manchester South	1
Manchester Town Hall	1
Market Harborough	0
Middlesbrough	1
Newcastle Centre	1
Northampton	1
Norwich Centre	1
Norwich Roadside	1
Nottingham Centre	1
Oxford Centre Roadside	1
Plymouth Centre	1

iii) ANNUAL STATISTICS- II

Site	Site Type	Annual average of hourly means µg m^{-3}	Annual data capture of hourly means %	Maximum hourly mean µg m^{-3}
England				
Portsmouth	UB	38	98.1	881
Preston	UB	44	94.3	730
Reading New Town	UB	41	93.2	628
Redcar	SU	28	97.7	313
Rochester	RU	28.2	96.4	349.0
Rotherham Centre	UC	65	96.9	747
Salford Eccles	I	63	96.2	1051
Sandwell West Bromwich	UB	43	98.2	613
Sheffield Centre	UC	60	97.1	525
Sheffield Tinsley	I	85	95.7	858
Somerton	RU	10.5	88.8	135.6
Southampton Centre	UC	66	95.2	900
Southend-on-Sea	UB	36	91.5	586
Southwark Roadside	RD	138	75.4	823
St Osyth	RU	20.0	91.0	226.3
Stockport Shaw Heath	UB	59	90.9	655
Stockton-on-Tees Yarm	RD	120	98.7	840
Stoke-on-Trent Centre	UC	58	93.2	798
Sunderland Silksworth	?	---	6.3	139
Thurrock	UB	62	89.8	817
Tower Hamlets Roadside	RD	159	96.3	1152
Walsall Alumwell	UB	82	93.0	1198
Walsall Willenhall	SU	43	92.1	898
West London	UB	81	98.8	882
Wicken Fen	RU	15.7	73.1	198.6
Wigan Centre	UB	---	22.2	625
Wigan Leigh	UB	44	71.4	625
Wirral Tranmere	UB	28	94.0	346
Wolverhampton Centre	UC	48	80.4	732
Yarner Wood	RU	9.3	98.5	105.2
N Ireland				
Belfast Centre	UC	52	91.8	938
Derry	UB	22	92.0	342
Scotland				
Aberdeen	UB	44	90.0	558
Bush Estate	RU	10.2	93.6	198.1
Dumfries	RD	92	96.6	733
Edinburgh St Leonards	UC	36	91.0	388
Eskdalemuir	RU	---	5.9	62.1
Glasgow Centre	UC	70	88.5	1190
Glasgow City Chambers	UB	101	98.0	896
Glasgow Kerbside	KB	263	96.0	1853
Grangemouth	I	27	98.5	550
Inverness	RD	48	98.1	690
Wales				
Aston Hill	RU	8.0	87.0	96.7
Cardiff Centre	UC	48	97.5	705
Cwmbran	UB	25	99.4	447
Narberth	RU	7.0	89.4	111.7
Port Talbot	UB	32	83.9	552
Swansea	UC	98	91.5	846
Wrexham	RD	40	95.7	409

iv) EXCEEDENCE STATISTICS- II

Site	Daughter Directive Ecosystem and Air Quality Standard (Annual Mean)
England	
Portsmouth	1
Preston	1
Reading New Town	1
Redcar	0
Rochester	0
Rotherham Centre	1
Salford Eccles	1
Sandwell West Bromwich	1
Sheffield Centre	1
Sheffield Tinsley	1
Somerton	0
Southampton Centre	1
Southend-on-Sea	1
Southwark Roadside	1
St Osyth	0
Stockport Shaw Heath	1
Stockton-on-Tees Yarm	1
Stoke-on-Trent Centre	1
Sunderland Silksworth	---
Thurrock	**1**
Tower Hamlets Roadside	**1**
Walsall Alumwell	**1**
Walsall Willenhall	**1**
Wicken Fen	0
Wigan Centre	---
Wigan Leigh	**1**
Wirral Tranmere	0
Wolverhampton Centre	**1**
Yarner Wood	0
N Ireland	
Belfast Centre	**1**
Derry	0
Scotland	
Aberdeen	**1**
Bush Estate	0
Dumfries	**1**
Edinburgh St Leonards	**1**
Eskdalemuir	---
Glasgow Centre	**1**
Glasgow City Chambers	**1**
Glasgow Kerbside	**1**
Grangemouth	0
Inverness	**1**
Wales	
Aston Hill	0
Cardiff Centre	**1**
Cwmbran	0
Narberth	0
Port Talbot	**1**
Swansea	**1**
Wrexham	**1**

13. PM_{10} - Measurement Sites, Instrumentation and Statistics

13.1 Measurement Methods

The tapered element oscillating microbalance (**TEOM**) system determines particulate concentration by continuously weighing particles deposited on a filter.
The **beta-gauge** (BAM) monitor consists of a paper band filter located between a source of beta rays and a radiation detector. A pump draws ambient air through the filter and the reduction in intensity of beta-radiation measured at the detector is proportional to the mass of particulate deposited on the filter.
The **Partisol** is a gravimetric sampler which collects daily samples onto a filter for subsequent weighing to determine the PM_{10} concentration.

13.2 Instrumentation

The following instrument types* are currently deployed in the AURN:

- R&P TEOM 1400
- R&P Partisol
- Met One BAM 1020

*Defra does not give approval or endorsement for any products or equipment

Please also see detailed information on particle measurements and conversion factors used in this report (Appendix 6).

13.3 Data Quality Requirements of EC Directive 1999/30/EC

Uncertainty 25%
Minimum data capture 90%

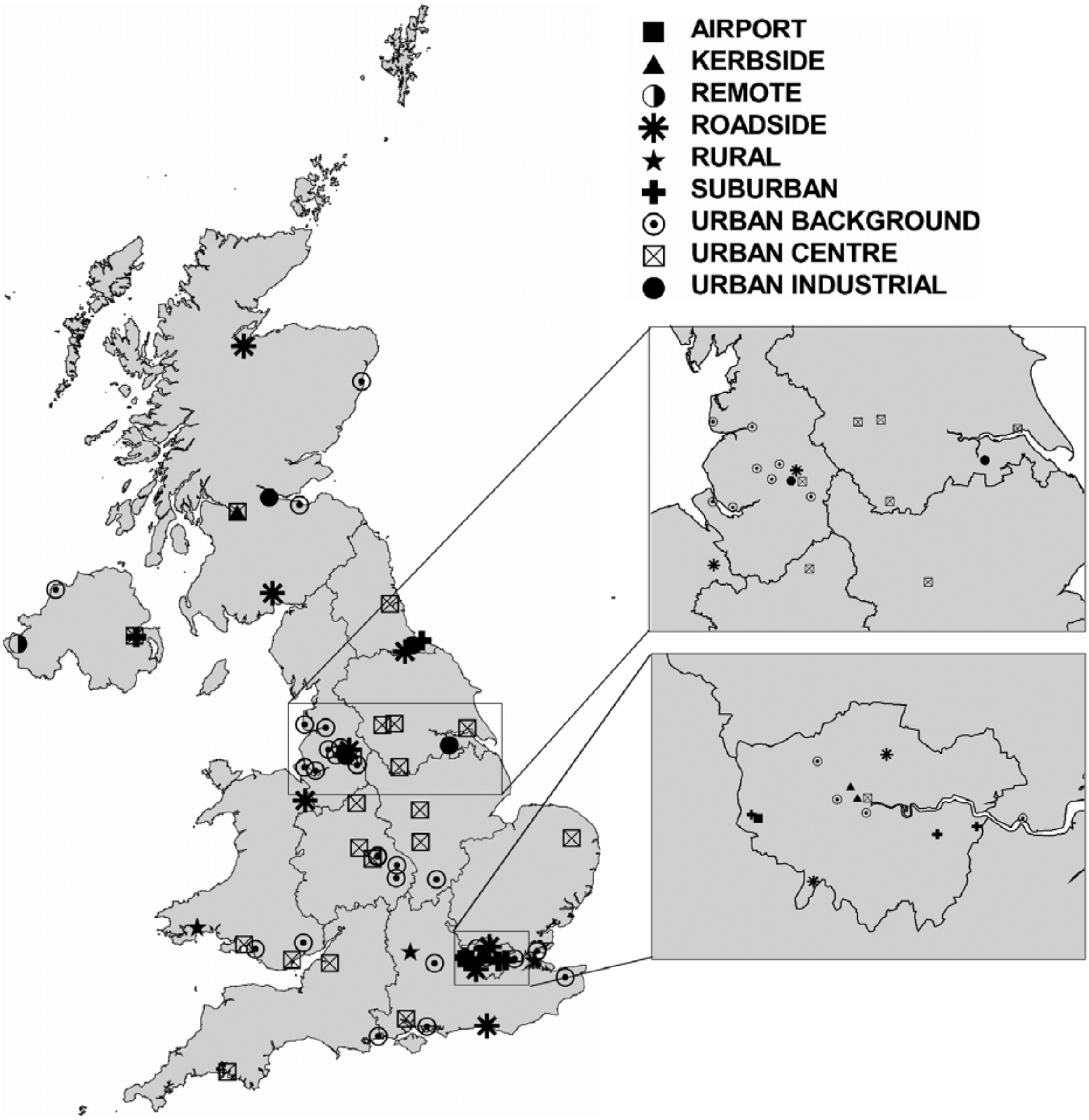
13.4 Objectives and Bandings

Summary of objectives of the Air Quality Strategy			
	Objective	**Measured as**	**To be achieved by**
Particles (PM_{10}) (gravimetric) All authorities	50 µg m^{-3} Not to be exceeded more than 35 times per year	Daily Mean	31 December 2004
	40 µg m^{-3}	Annual Mean	31 December 2004
Particles (PM_{10}) Authorities in Scotland only	50 µg m^{-3} Not to be exceeded more than 7 times per year	Daily Mean	31 December 2010
	18 µg m^{-3}	Annual Mean	31 December 2010

Air Quality Bands and Index Values		
Band	Index	PM_{10} µg m^{-3} (Gravimetric)
Low	1	0-21
	2	22-42
	3	43-64
Moderate	4	65-74
	5	75-86
	6	87-96
High	7	97-107
	8	108-118
	9	119-129
Very High	10	130 or more

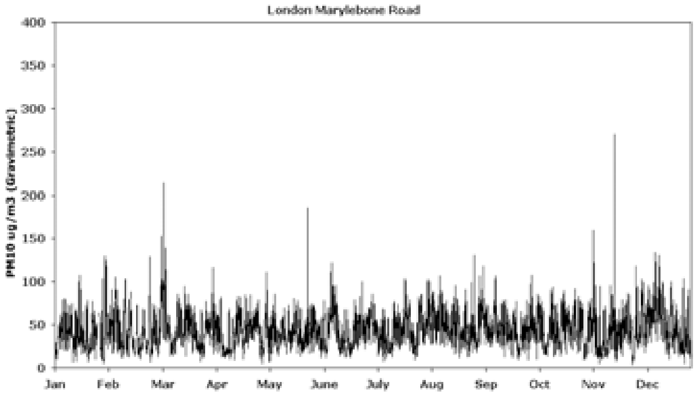
13.5 Site Locations

UK PM_{10} Monitoring Sites 2004

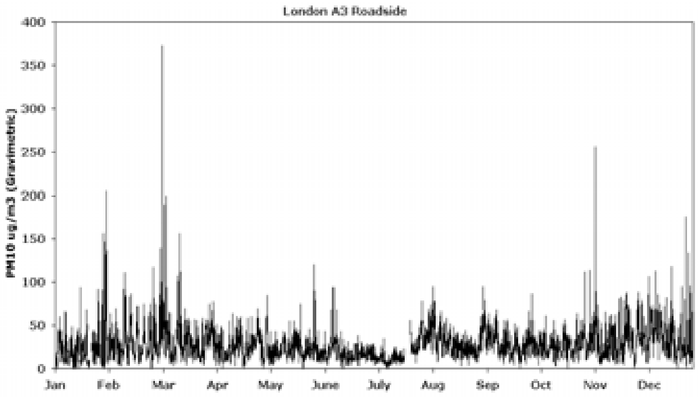


13.6 Hourly Average Concentrations

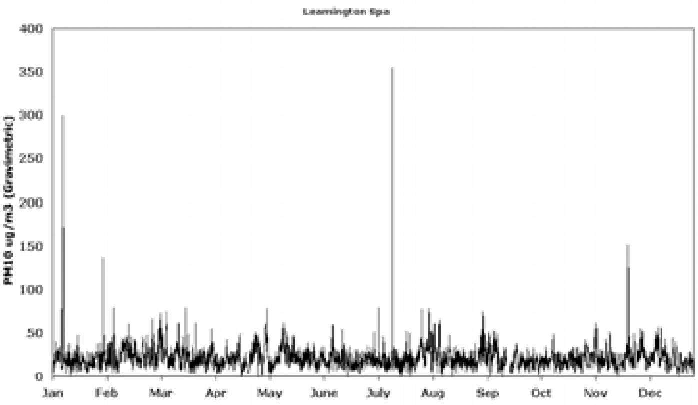
These figures show time series graphs of hourly average PM_{10} concentrations at four *typical* site types for 2004. Units are gravimetric equivalent (TEOM*1.3).



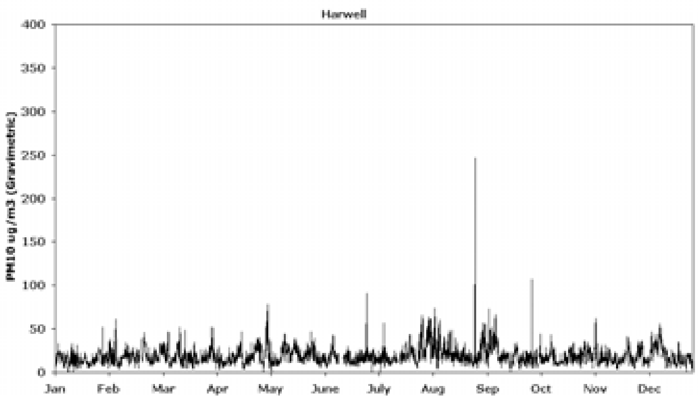
Kerbside Site
(London Marylebone Road)



Roadside Site
(*London A3*)



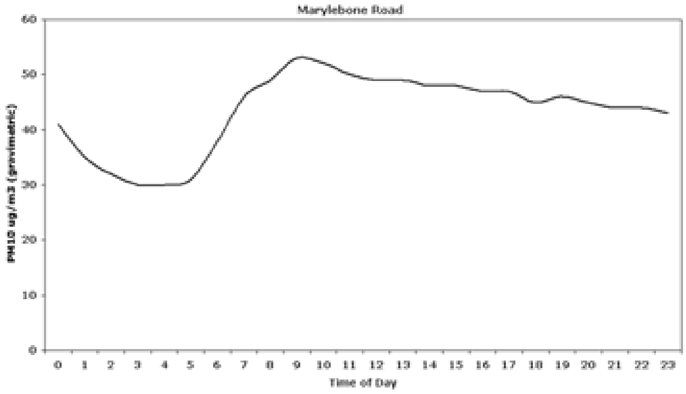
Urban Background Site
(*Leamington Spa*)



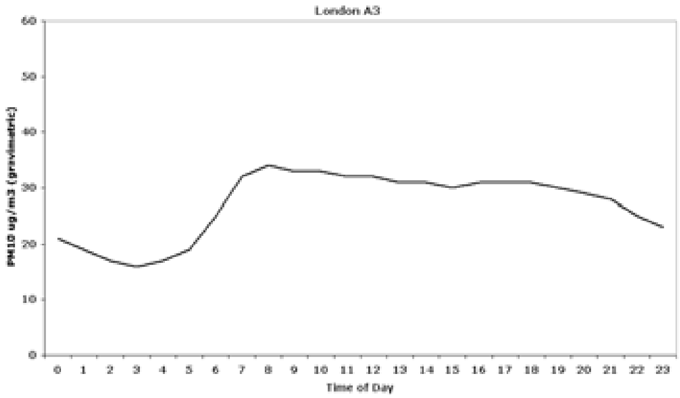
Rural Site
(*Harwell)*

13.7 Diurnal Variations

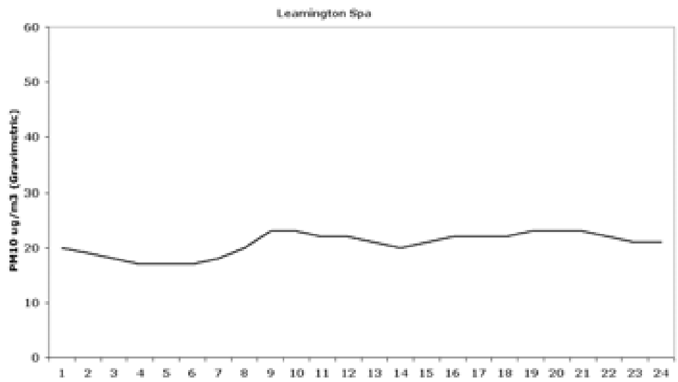
These figures show how PM_{10} concentrations vary on average for each hour of day during the year, at a number of selected *typical* monitoring site types. Local time is used, rather than GMT, since this will more closely reflect the daily cycle of man-made emissions.



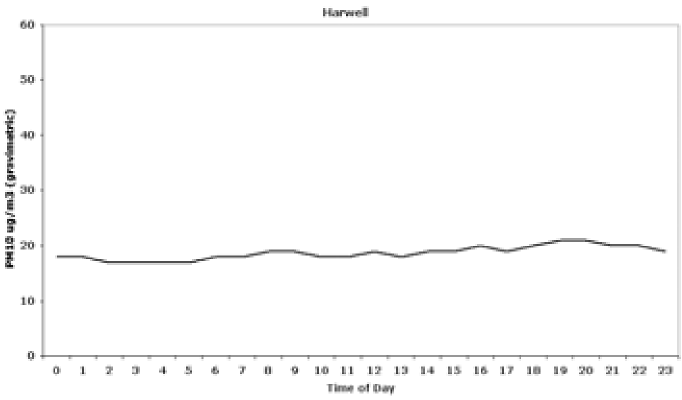
Kerbside Site
(*Marylebone Road*)



Roadside Site
(*London A3*)

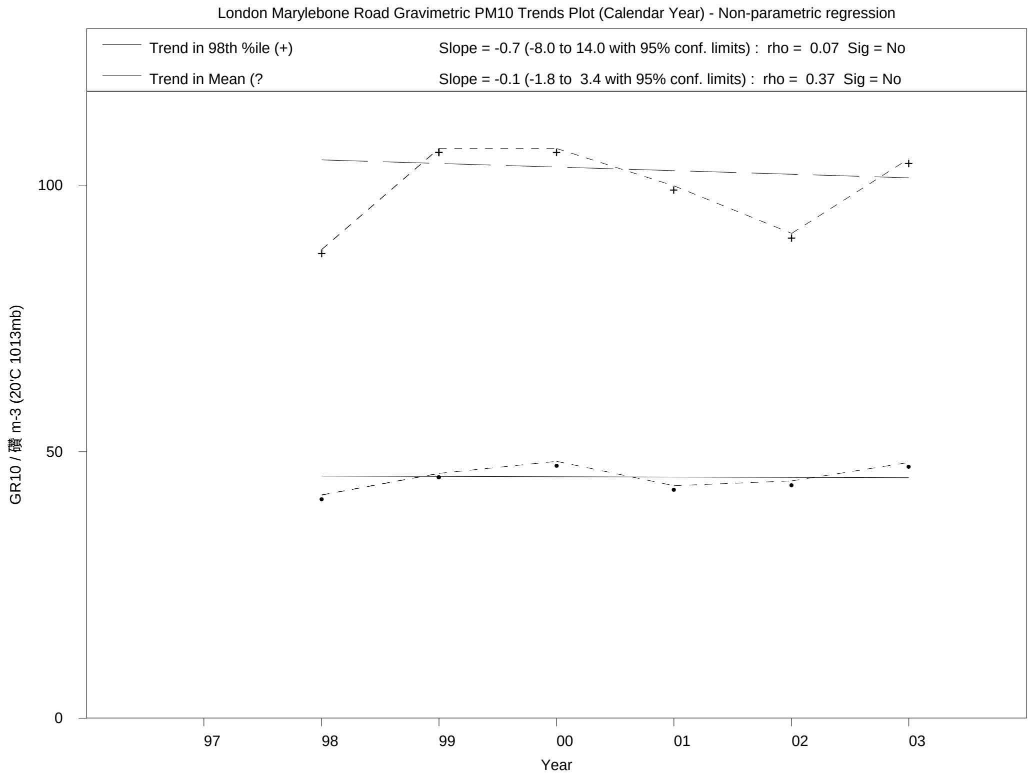


Urban Background Site
(*Leamington Spa*)

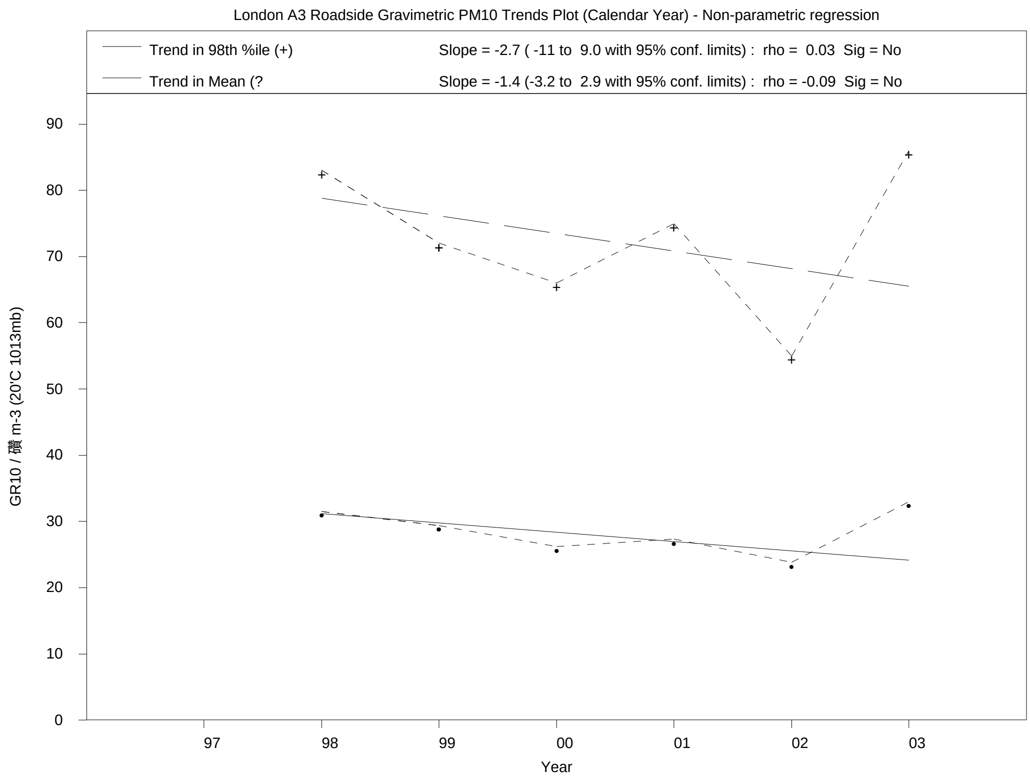


Rural Site
(*Harwell*)

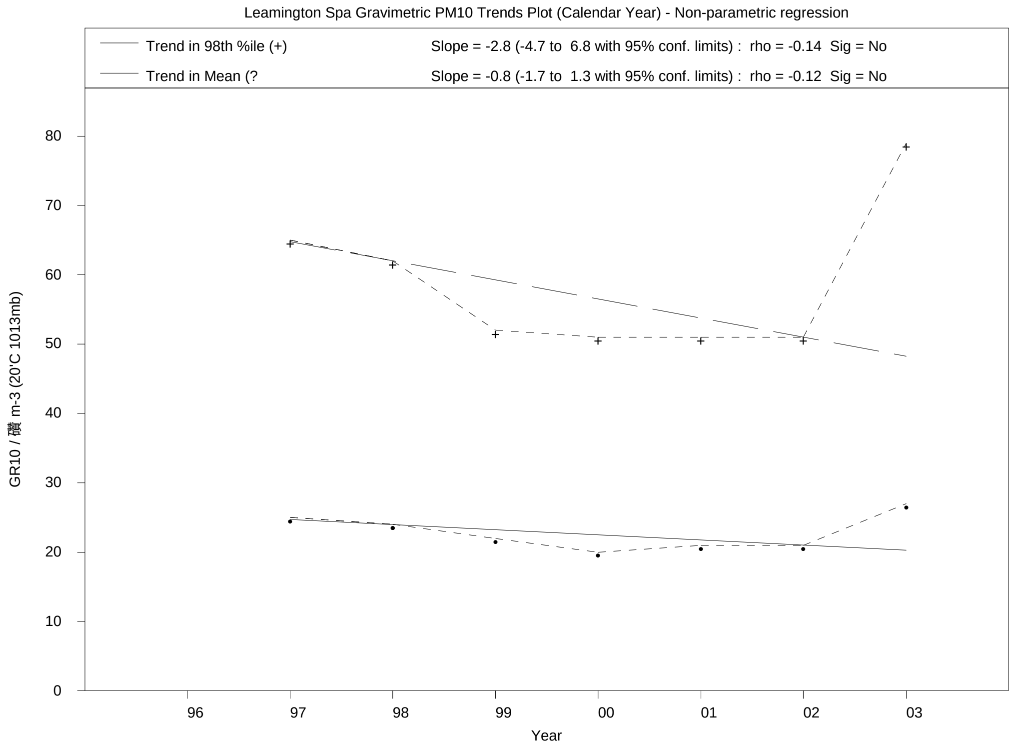
13.8 Trends in annual concentrations



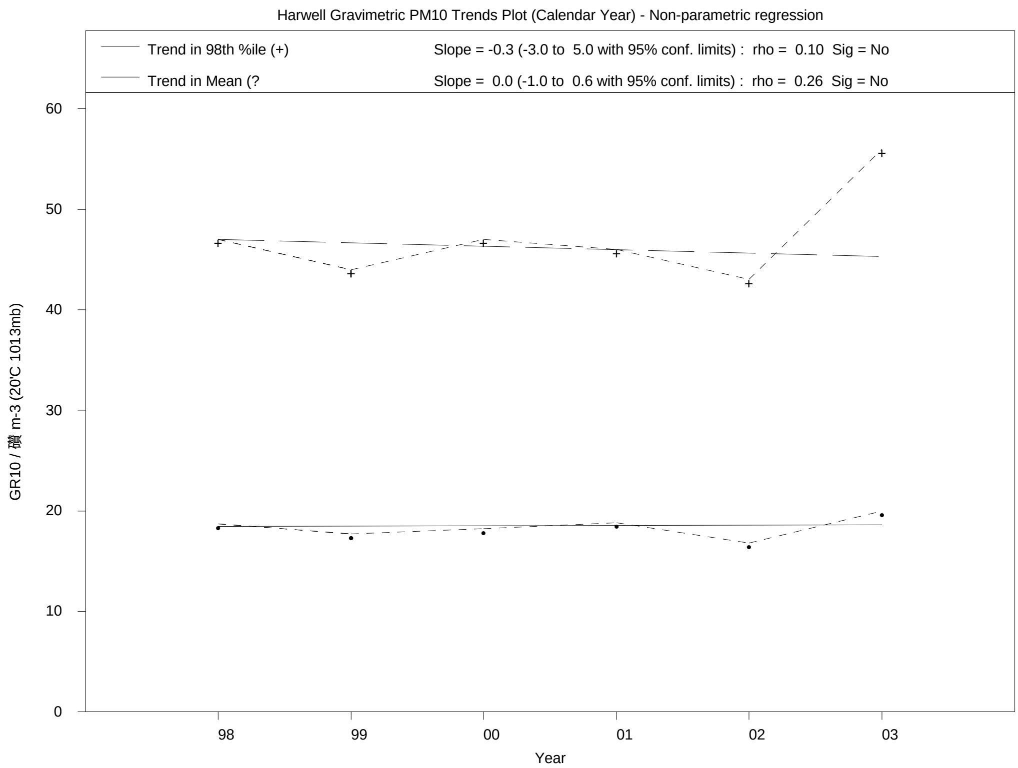
Kerbside Site
(*Marylebone Road*)



Roadside Site
(*London A3*)



Background Site
(Thurrock)



Rural Site
(Harwell)

13.9 PM_{10} Statistical Summary 2004

i) ANNUAL STATISTICS- I

Site	Site Type	Annual average µg m-3	Annual data capture of hourly means %	Maximum Hourly mean µg m-3	Maximum running 24-hour mean µg m-3	Date of Maximum running 24-hour mean	90%ile of daily means µg m-3	98%ile of daily means µg m-
England								
Birmingham Centre	UC	22	94.4	334	57	01/05/2004	35	48
Birmingham East	UB	n/a	57.7	n/a	64	05/03/2004	32	46
Birmingham Tyburn	UB	n/a	37.6	n/a	65	06/11/2004	---	---
Blackpool	UB	28	83.5	114	59	01/04/2004	40	48
Bolton	UB	19	97.0	241	59	10/12/2004	31	41
Bournemouth*	UB	23	---	---	---	---	40	56
Bradford Centre	UC	27	95.9	324	91	28/05/2004	42	62
Brighton Roadside $_{PM10}$*	RD	32	---	---	---	---	49	61
Bristol Centre	UC	24	97.6	281	82	02/03/2004	38	55
Bury Roadside	RD	30	92.2	326	94	10/09/2004	48	63
Camden Kerbside	KB	35	95.7	192	85	02/03/2004	51	66
Canterbury	UB	22	98.3	131	64	13/12/2004	34	39
Coventry Memorial Park	UB	16	92.4	69	40	06/03/2004	25	33
Haringey Roadside	RD	25	98.9	733	69	24/04/2004	38	47
Harwell	RU	19	97.7	246	49	01/05/2004	28	41
Hull Freetown	UC	22	95.6	150	56	01/04/2004	34	47
Leamington Spa	UB	21	98.2	354	57	07/01/2004	31	42
Leeds Centre	UC	22	97.8	161	85	08/12/2004	36	48
Leicester Centre	UC	21	95.6	139	56	02/03/2004	33	46
Liverpool Speke	UB	24	95.3	645	127	15/06/2004	38	60
London A3 Roadside	RD	27	98.0	373	90	06/11/2004	44	55
London Bexley	SU	24	92.6	322	96	06/11/2004	36	47
London Bloomsbury	UC	26	98.1	142	62	13/12/2004	39	50
London Brent	UB	22	94.3	585	66	06/11/2004	35	44
London Eltham	SU	23	91.4	257	90	11/12/2004	34	46
London Harlington	A	26	99.4	514	83	11/09/2004	40	54
London Hillingdon	SU	27	98.0	985	117	06/11/2004	42	53
London Marylebone Road	KB	43	98.0	270	98	02/03/2004	60	71
London N. Kensington	UB	24	95.8	169	68	06/11/2004	37	49
London Westminster*	UB	27	---	---	---	---	42	58
Manchester Piccadilly	UC	25	97.6	220	82	02/12/2004	37	50
Middlesbrough	I	21	97.8	306	82	01/04/2004	34	49
Newcastle Centre	UC	17	92.6	140	56	02/04/2004	28	41
Northampton	UB	19	89.8	129	57	01/05/2004	28	38
Northampton PM_{10*}*	UB	21	---	---	---	---	36	52
Norwich Centre	UC	22	97.2	212	59	01/05/2004	32	41
Nottingham Centre	UC	23	97.1	228	62	02/03/2004	35	48
Plymouth Centre	UC	22	97.3	463	92	06/11/2004	36	55
Portsmouth	UB	19	93.1	179	62	06/11/2004	29	35
Preston	UB	18	98.0	1119	142	11/09/2004	27	42
Reading New Town	UB	19	96.2	228	51	01/05/2004	29	37
Redcar	UB	23	97.7	187	62	02/04/2004	36	48
Rochester	SU	21	98.1	218	64	06/11/2004	32	40
Salford Eccles	RU	21	96.0	246	74	02/12/2004	35	44
Scunthorpe	I	n/a	20.5	n/a	121	12/03/2004	---	---
Scunthorpe Town	I	n/a	54.4	n/a	143	09/08/2004	52	72
Sheffield Centre	UC	22	98.0	121	65	01/04/2004	36	48
Southampton Centre	UC	25	96.7	242	65	04/12/2004	39	48
Southend-on-Sea	UB	18	95.7	81	55	13/12/2004	29	35
Stockport Shaw Heath	UB	23	88.7	313	68	02/12/2004	34	49
Stockton-on-Tees Yarm	RD	27	96.9	350	78	01/04/2004	41	52
Stoke-on-Trent Centre	UC	23	78.2	113	72	02/03/2004	35	48
Thurrock	UB	25	95.3	489	98	06/11/2004	38	50

* Measurements made using the Partisol gravimetric sampler– the se provide daily averages only

ii) EXCEEDENCE STATISTICS- I

Site	Moderate band	Days	High band	Days	Very High band	Days	Daughter Directive Limit Value Daily Mean and Air Quality Standard (Daily Mean)	Days	Daughter Directive Limit Value Annual Mean and Air Quality Standard (Annual Mean)	Annual Mean Standard (Scotland)
England										
Birmingham Centre	0	0	0	0	0	0	4	4	0	1
Birmingham East	0	0	0	0	0	0	2	2	0	1
Birmingham Tyburn	2	1	0	0	0	0	1	1	---	---
Blackpool	0	0	0	0	0	0	4	4	0	1
Bolton	0	0	0	0	0	0	1	1	0	1
Bournemouth*	-	-	-	-	-	-	13	13	0	1
Bradford Centre	97	10	0	0	0	0	16	16	0	1
Brighton Roadside PM_{10}*	-	-	-	-	-	-	30	30	0	1
Bristol Centre	59	7	0	0	0	0	10	10	0	1
Bury Roadside	177	14	0	0	0	0	30	30	0	1
Camden Kerbside	185	18	0	0	0	0	42	42	0	1
Canterbury	0	0	0	0	0	0	1	1	0	1
Coventry Memorial Park	0	0	0	0	0	0	0	0	0	0
Haringey Roadside	7	1	0	0	0	0	4	4	0	1
Harwell	0	0	0	0	0	0	0	0	0	1
Hull Freetown	0	0	0	0	0	0	3	3	0	1
Leamington Spa	0	0	0	0	0	0	2	2	0	1
Leeds Centre	22	2	0	0	0	0	4	4	0	1
Leicester Centre	0	0	0	0	0	0	2	2	0	1
Liverpool Speke	89	10	73	6	0	0	14	14	0	1
London A3 Roadside	54	5	0	0	0	0	16	16	0	1
London Bexley	27	2	0	0	0	0	4	4	0	1
London Bloomsbury	0	0	0	0	0	0	7	7	0	1
London Brent	6	1	0	0	0	0	5	5	0	1
London Eltham	42	2	0	0	0	0	5	5	0	1
London Harlington	39	4	0	0	0	0	11	11	0	1
London Hillingdon	26	4	23	2	0	0	13	13	0	1
London Marylebone Road	511	42	2	1	0	0	97	97	**1**	1
London N. Kensington	14	2	0	0	0	0	6	6	0	1
London Westminster*	-	-	-	-	-	-	18	18	0	1
Manchester Piccadilly	34	3	0	0	0	0	7	7	0	1
Middlesbrough	36	5	0	0	0	0	7	7	0	1
Newcastle Centre	0	0	0	0	0	0	2	2	0	0
Northampton	0	0	0	0	0	0	1	1	0	1
Northampton $_{PM10}$*	-	-	-	-	-	-	8	8	0	1
Norwich Centre	0	0	0	0	0	0	1	1	0	1
Nottingham Centre	0	0	0	0	0	0	5	5	0	1
Plymouth Centre	76	9	0	0	0	0	12	12	0	1
Portsmouth	0	0	0	0	0	0	1	1	0	1
Preston	32	5	29	5	37	6	5	5	0	0
Reading New Town	0	0	0	0	0	0	0	0	0	1
Redcar	0	0	0	0	0	0	5	5	0	1
Rochester	0	0	0	0	0	0	1	1	0	1
Salford Eccles	19	2	0	0	0	0	4	4	0	1
Scunthorpe	40	5	23	2	0	0	6	6	---	---
Scunthorpe Town	146	14	15	2	17	**2**	24	24	0	1
Sheffield Centre	2	1	0	0	0	0	4	4	0	1
Southampton Centre	2	1	0	0	0	0	3	3	0	1
Southend-on-Sea	0	0	0	0	0	0	0	0	0	0
Stockport Shaw Heath	5	1	0	0	0	0	5	5	0	1
Stockton-on-Tees Yarm	37	3	0	0	0	0	10	10	0	1
Stoke-on-Trent Centre	18	1	0	0	0	0	4	4	0	1
Thurrock	26	3	**7**	**1**	0	0	7	7	0	1

iii) ANNUAL STATISTICS- II

Site	Site Type	Annual average µg m-3	Annual data capture of hourly means %	Maximum Hourly mean µg m-3	Maximum running 24-hour mean µg m-3	Date of Maximum running 24-hour mean	90%ile of daily means µg m-3	98%ile of daily means µg m-
Wigan Centre	UB	n/a	23.1	n/a	53	02/12/2004	---	---
Wigan Leigh	UB	n/a	72.4	n/a	70	01/04/2004	33	47
Wirral Tranmere	UB	19	97.8	153	52	01/04/2004	29	39
Wolverhampton Centre	UC	20	97.8	306	56	12/02/2004	33	44
Northern Ireland								
Belfast Centre	UC	21	96.1	995	88	13/05/2004	35	54
Belfast Clara St +	SU	13	92.4	945	91	28/05/2004	29	46
Derry	UB	20	97.0	246	85	17/01/2004	30	46
Lough Navar	RE	10	99.3	72	36	01/04/2004	15	21
Scotland								
Aberdeen	UB	19.0	93.3	127	91	02/04/2004	30	53
Dumfries*	RD	18	---	---	---	---	29	45
Edinburgh St Leonards	UC	19	98.7	261	62	06/01/2004	29	40
Glasgow Centre	UC	n/a	66.6	n/a	52	01/04/2004	31	39
Glasgow Kerbside	KB	27	94.9	166	77	19/12/2004	48	63
Grangemouth	I	16	98.3	160	49	02/04/2004	26	34
Inverness*	RD	15	---	---	---	---	24	38
Wales								
Cardiff Centre	UC	26	93.9	876	90	17/01/2004	37	47
Cwmbran	UB	18	99.4	153	53	01/05/2004	28	37
Narberth	RU	n/a	55.1	n/a	35	01/05/2004	20	27
Port Talbot	UB	31	96.1	257	117	01/02/2004	53	73
Swansea	UC	n/a	23.5	n/a	75	04/12/2004	---	---
Wrexham*							38	55

+ Measurements made using BAM beta-gauge monitor

iv) EXCEEDENCE STATISTICS- II

Site	Moderate band	Days	High band	Days	Very High band	Days	Daughter Directive Limit Value Daily Mean and Air Quality Standard (Daily Mean)	Days	Daughter Directive Limit Value Annual Mean and Air Quality Standard (Annual Mean)	Annual Mean Standard (Scotland)
Wigan Centre	0	0	0	0	0	0	2	2	---	---
Wigan Leigh	17	2	0	0	0	0	2	2	0	1
Wirral Tranmere	0	0	0	0	0	0	0	0	0	1
Wolverhampton Centre	0	0	0	0	0	0	2	2	0	1
N Ireland										
Belfast Centre	52	6	0	0	0	0	10	10	0	1
Belfast Clara St	137	13	0	0	0	0	5	5	0	0
Derry	25	3	0	0	0	0	3	3	0	1
Lough Navar	0	0	0	0	0	0	0	0	0	0
Scotland										
Aberdeen	40	4	0	0	0	0	9	9	0	1
Dumfries	-	-	-	-	-	-	4	4	0	0
Edinburgh St Leonards	0	0	0	0	0	0	0	0	0	1
Glasgow Centre	0	0	0	0	0	0	0	0	0	1
Glasgow Kerbside	133	12	0	0	0	0	31	31	0	1
Grangemouth	0	0	0	0	0	0	0	0	0	0
Inverness	-	-	-	-	-	-	1	1	0	0
Wales										
Cardiff Centre	30	3	0	0	0	0	6	6	0	1
Cwmbran	0	0	0	0	0	0	1	1	0	0
Narberth	0	0	0	0	0	0	0	0	0	0
Port Talbot	344	31	28	5	0	0	38	38	0	1
Swansea	10	1	0	0	0	0	3	3	---	---
Wrexham							13	13	0	1

14. $PM_{2.5}$ - Measurement Sites, Instrumentation and Statistics

14.1 Measurement Method

The tapered element oscillating microbalance (TEOM) system determines particulate concentration by continuously weighing particles deposited on a filter.

14.2 Instrumentation

The following instrument types* are currently deployed in the AURN:

- R&P TEOM 1400

*Defra does not give approval or endorsement for any products or equipment

Please also see detailed information on particle measurements and conversion factors used in this report (Appendix 6).

14.3 Data Quality Requirements of EC Directive 1999/30/EC

Uncertainty 25%
Minimum data capture 90%

14.4 Objectives and Bandings

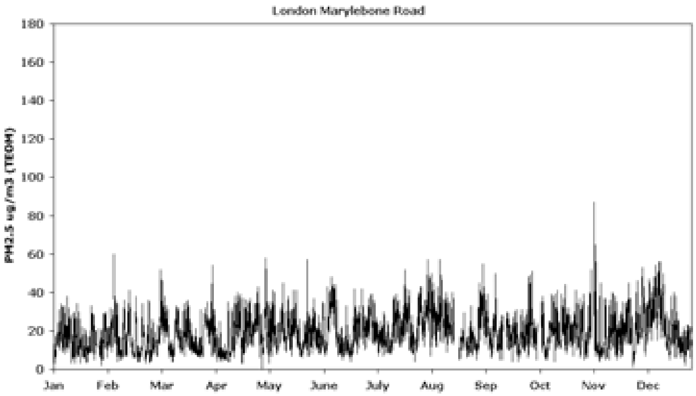
No Objectives or Bandings have yet been set for $PM_{2.5}$

14.5 Site Locations

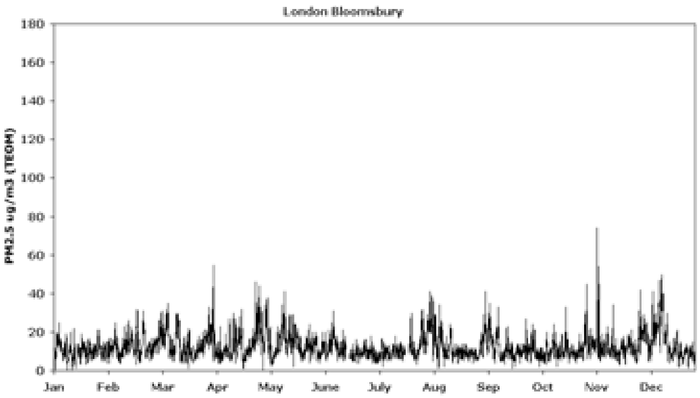
UK Automatic $PM_{2.5}$ Monitoring Sites 2004

14.6 Hourly Average Concentrations

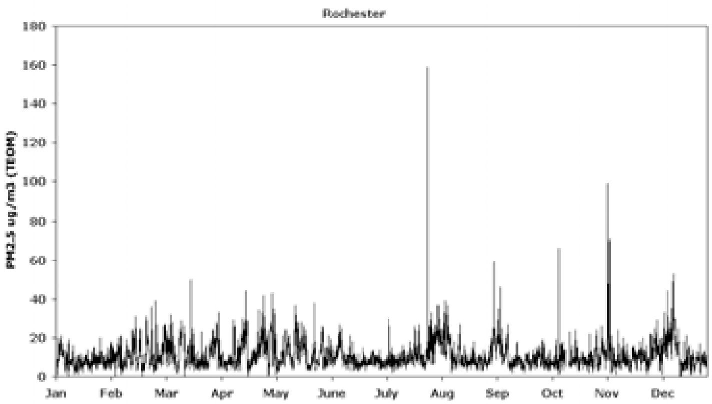
These figures show time series graphs of hourly average $PM_{2.5}$ concentrations at four *typical* site types for 2004.



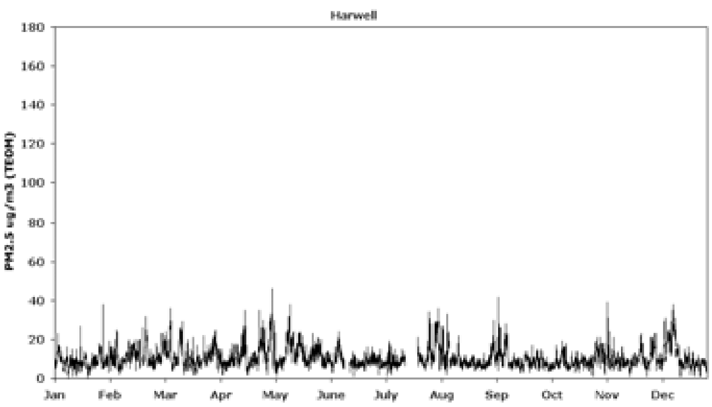
Kerbside Site
(London Marylebone Road)



Urban Centre Site
(London Bloomsbury)



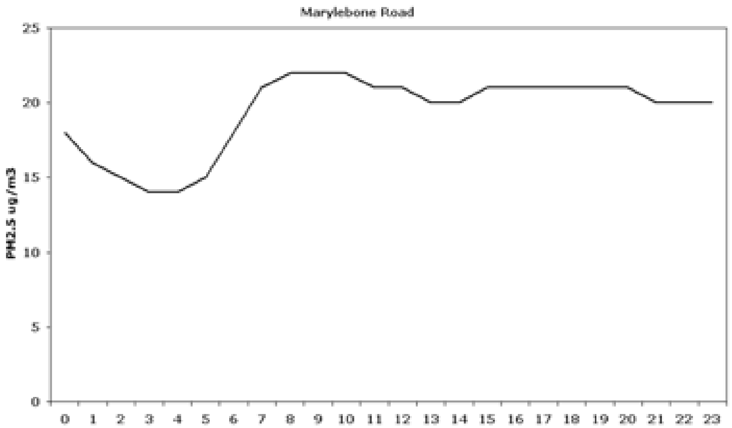
Rural Site
(Rochester)



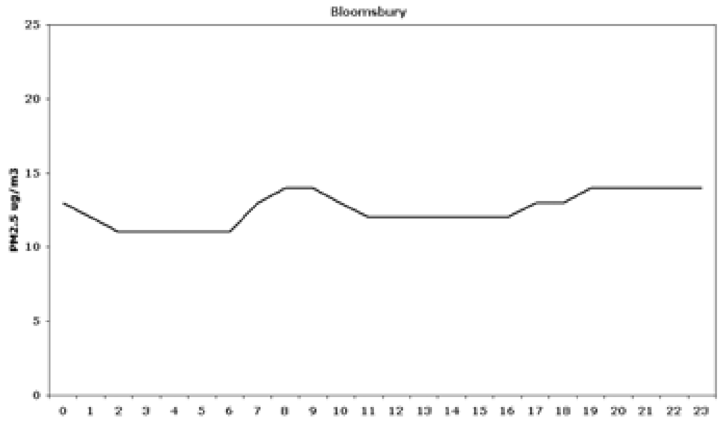
Rural Site
(Harwell)

14.7 Diurnal Variations

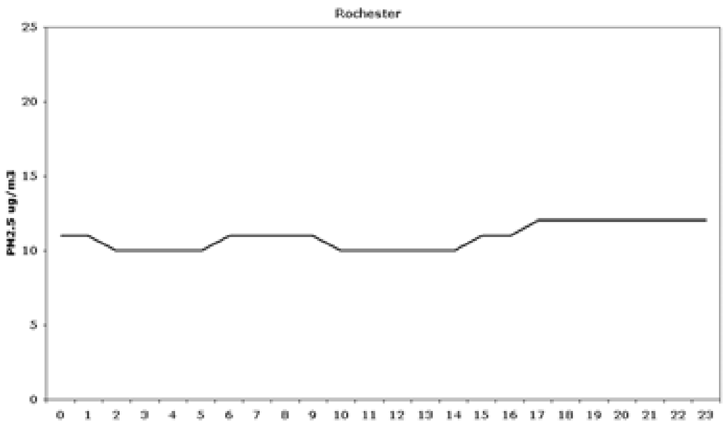
These figures show how $PM_{2.5}$ concentrations vary on average for each hour of day during 2004, at a number of selected *typical* monitoring site types. Local time is used, rather than GMT, since this will more closely reflect the daily cycle of man-made emissions.



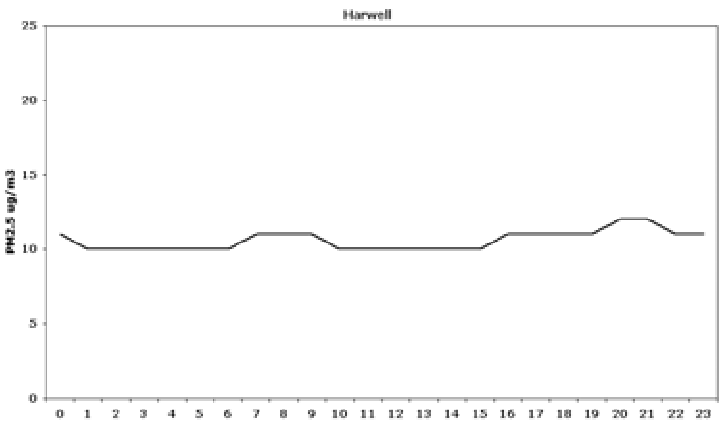
Kerbside Site
(Marylebone Road)



Jrban Centre Site
London Bloomsbury)

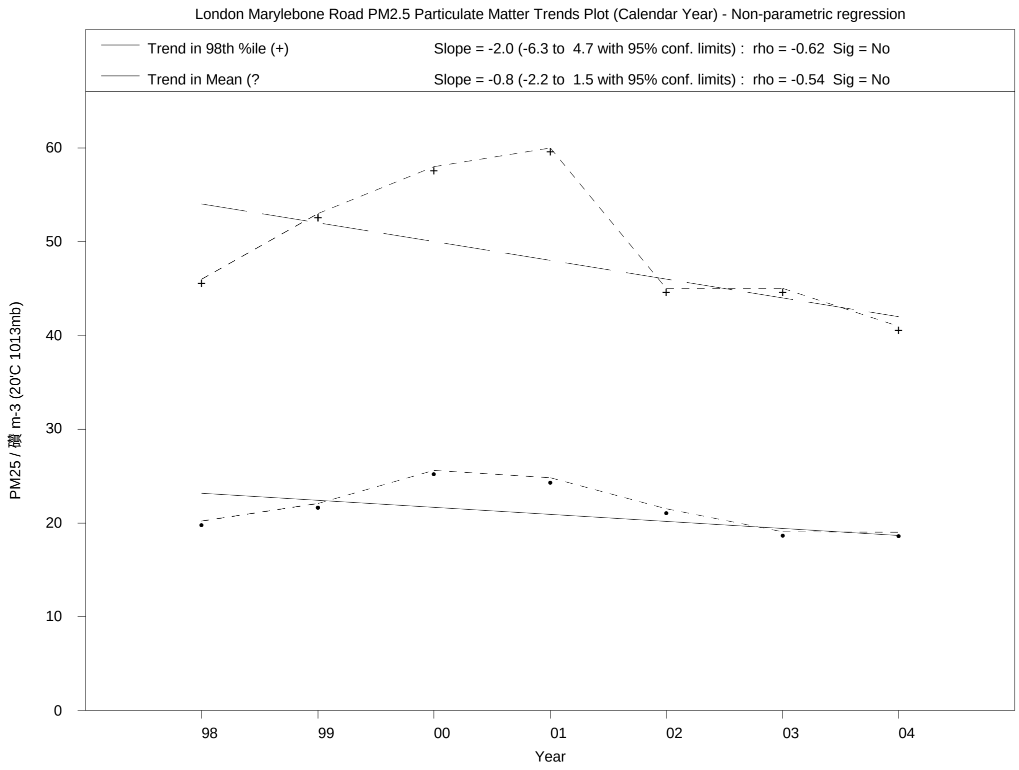


Rural Site
(Rochester)

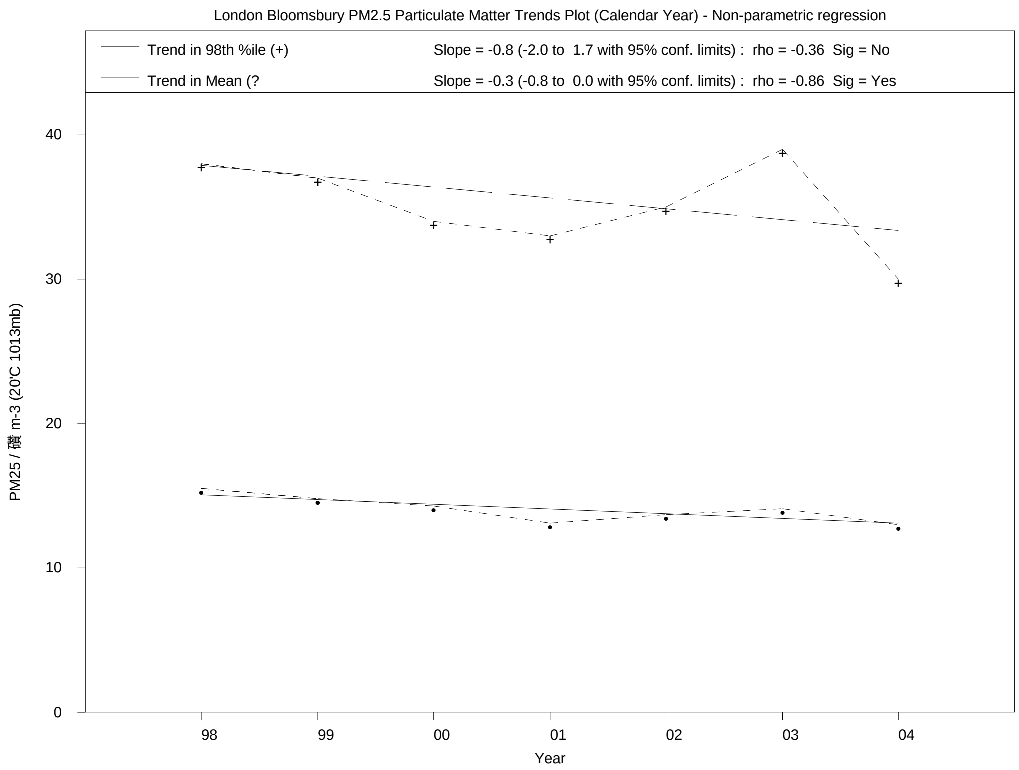


Rural Site
(Harwell)

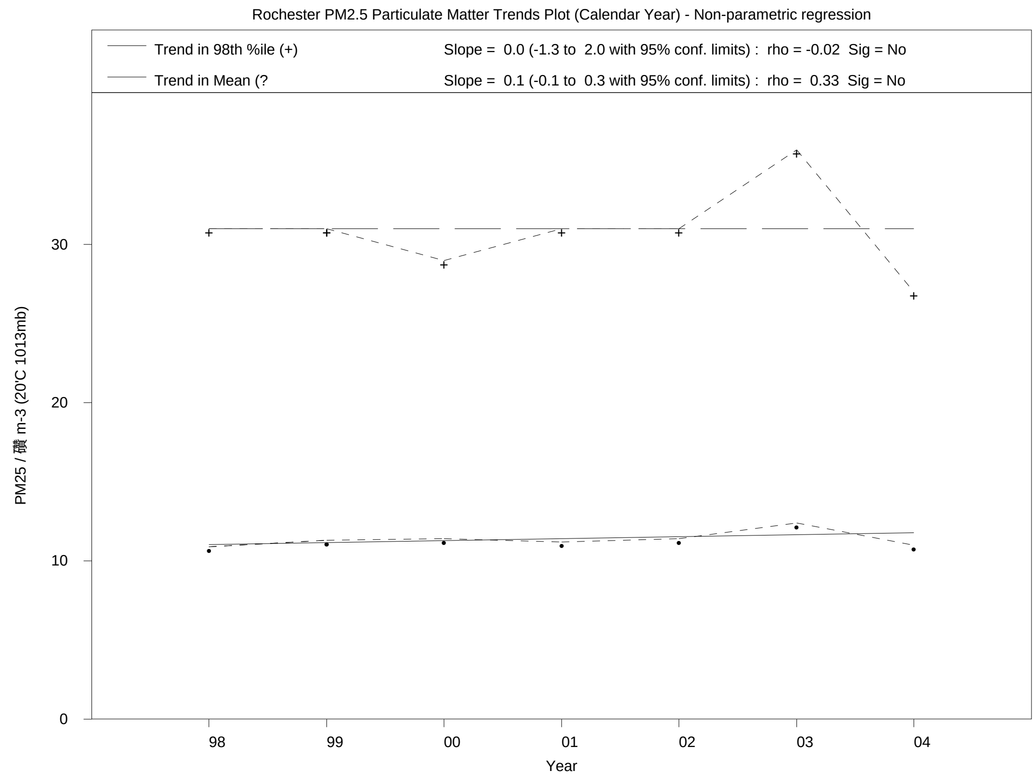
14.8 Trends in annual concentrations



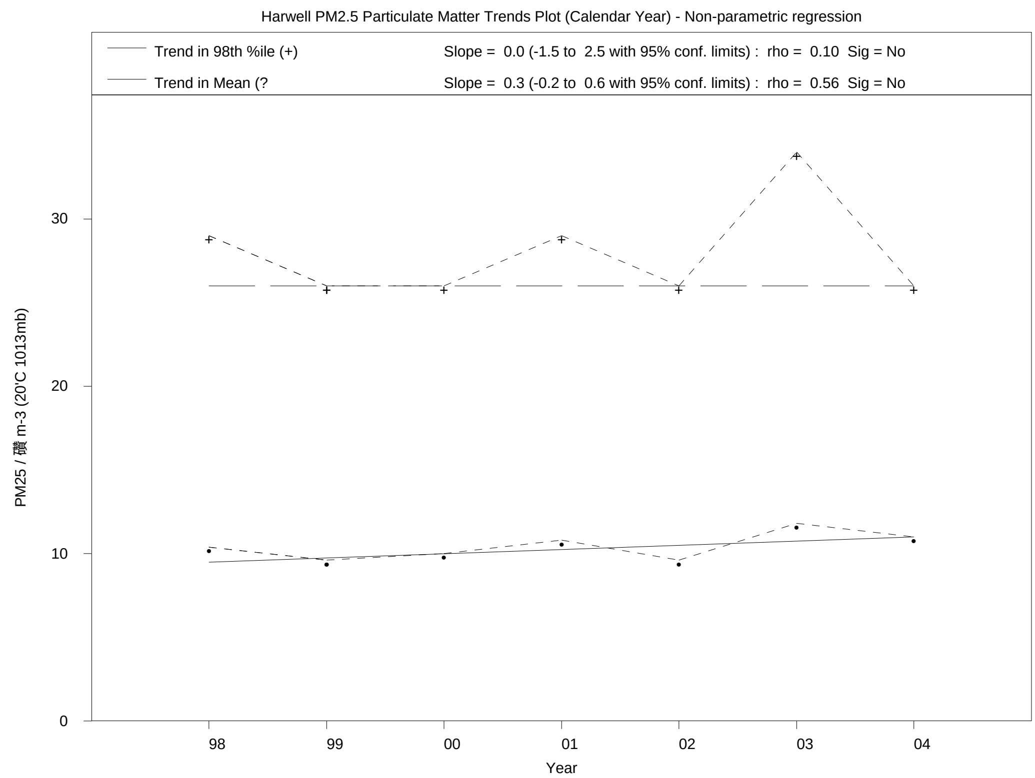
Kerbside Site
***(London Marylebone Road*)**



Urban Centre Site
(*London Bloomsbury)*



Rural Site
(Rochester)



Rural Site
(Harwell)

14.9 $PM_{2.5}$ Statistical Summary 2004

i) ANNUAL STATISTICS- I

Site	Site Type	Annual average of hourly means µg m^{-3}	Annual data capture of hourly means %	Maximum hourly mean µg m^{-3}
England				
Harwell	Rural	11	96.2	46
London Bloomsbury	Urban Background	13	98.0	74
London Marylebone Road	Kerbside	19	95.9	87
Rochester	Rural	11	98.7	159

ii) Exceedence Statistics-

There are no exceedences statistics for $PM_{2.5}$ Particulate Matter

15. SO_2 - Measurement Sites, Instrumentation and Statistics

15.1 Measurement Method

The sulphur dioxide analyser works on the principle of ultra violet (UV) fluorescence. SO_2 molecules are excited to energy states by UV radiation. These energy states decay causing an emission of secondary fluorescent radiation with intensity proportional to the concentration of SO_2 in the sample.

15.2 Instrumentation

The following instrument types* are currently deployed in the AURN:

- Ambirak SO_2
- API M100
- Environnement AF 21M
- Horiba APSA 360
- Monitor Labs 9850
- Rotork 477
- Thermo Electron 43

*Defra does not give approval or endorsement for any products or equipment

15.3 Data Quality Requirements of EC Directive 1999/30/EC

Uncertainty 15%
Minimum data capture 90%

15.4 Objectives and Bandings

Summary of objectives of the Air Quality Strategy			
	Objective	**Measured as**	**To be achieved by**
Sulphur Dioxide	266 µg m^{-3} Not to be exceeded more than 35 times per year	15 Minute Mean	31 December 2005
	350 µg m^{-3} Not to be exceeded more than 24 times per year	1 Hour Mean	31 December 2004
	125 µg m^{-3} Not to be exceeded more than 3 times per year	24 Hour Mean	31 December 2004
	(V) 20 µg m^{-3}	Annual Mean	31 December 2000
	(V) 20 µg m^{-3}	Winter Mean (01 October - 31 March)	31 December 2000

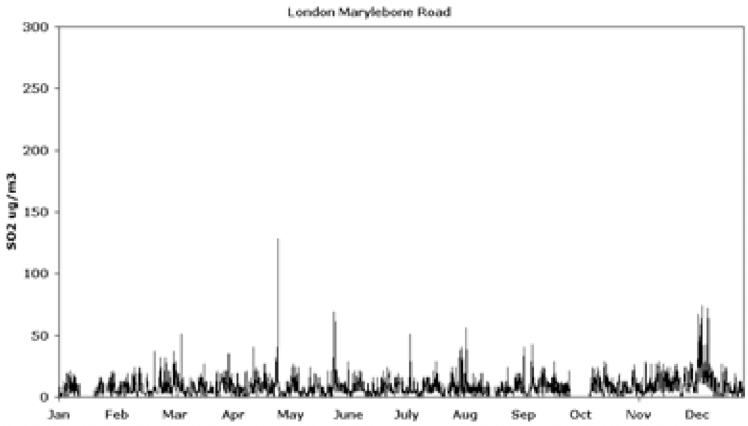
Air Quality Bands and Index Values		
Band	Index	Sulphur Dioxide µg m^{-3}
Low	1	0-88
	2	89-176
	3	177-265
Moderate	4	266-354
	5	355-442
	6	443-531
High	7	532-708
	8	709-886
	9	887-1063
Very High	10	1064 or more

15.5 Site Locations

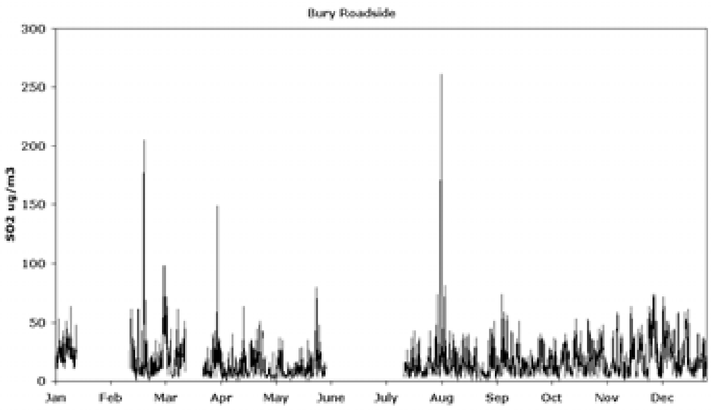
UK Automatic Sulphur Dioxide Monitoring Sites 2004

15.6 Hourly Average Concentrations

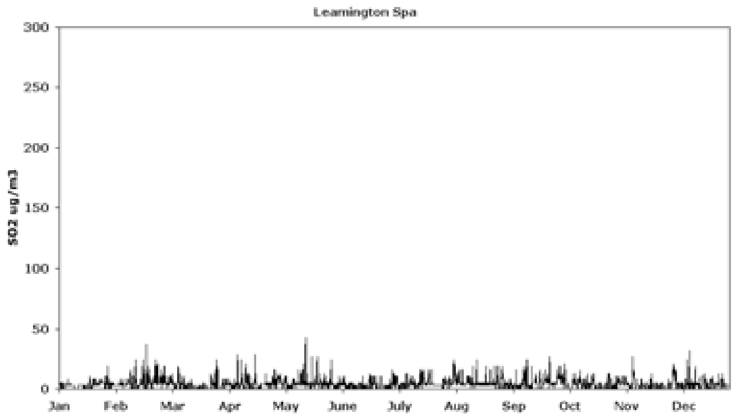
These figures show time series graphs of hourly average carbon monoxide concentrations at four *typical* site types for 2004.



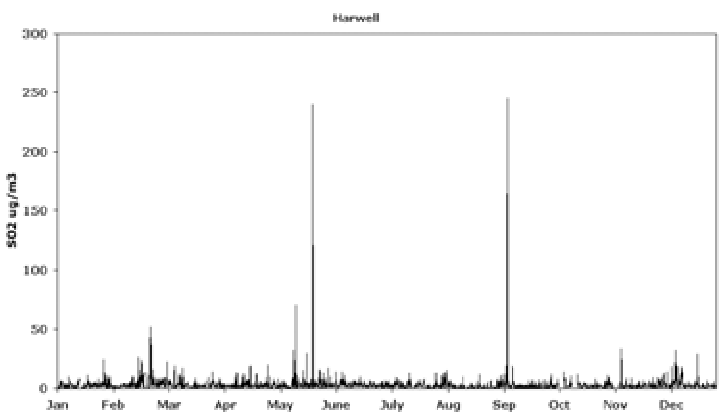
Kerbside Site
(London Marylebone Road)



Roadside Site
(*Bury*)



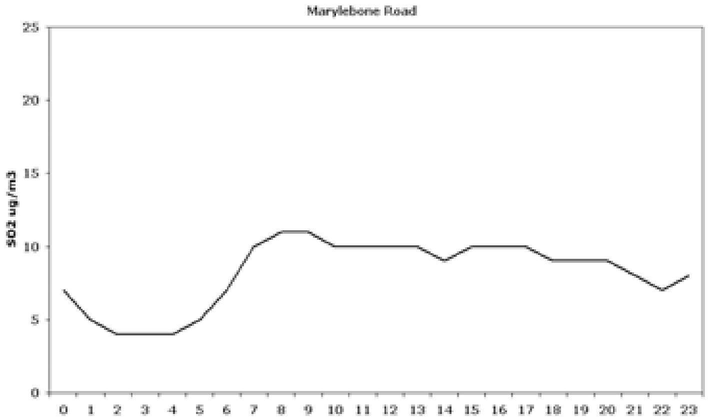
Urban Background Site
(*Leamington Spa*)



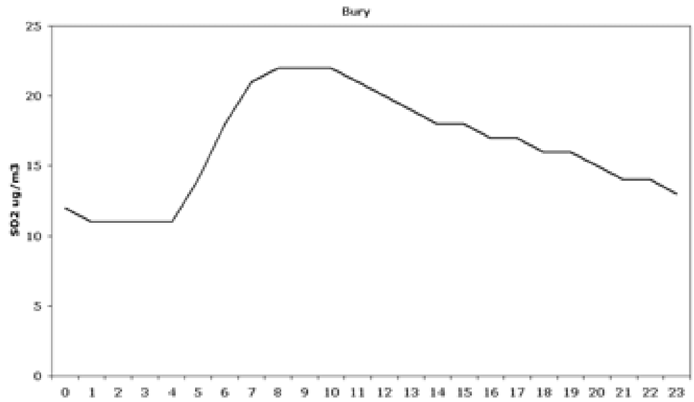
Rural Site
(*Harwell*)

15.7 Diurnal Variations

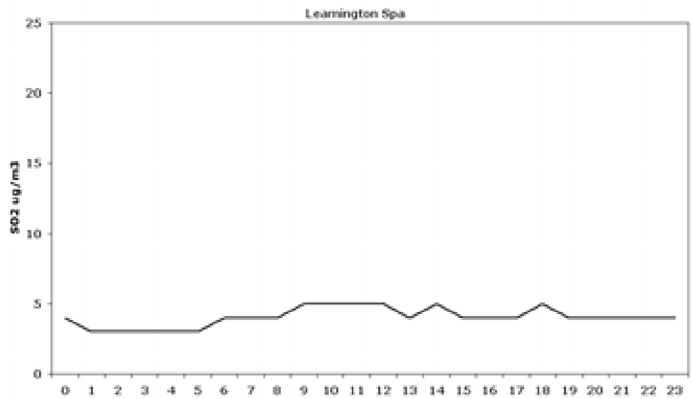
These figures show how sulphur dioxide concentrations vary on average for each hour of day during 2004, at a number of selected *typical* monitoring site types. Local time is used, rather than GMT, since this will more closely reflect the daily cycle of man-made emissions.



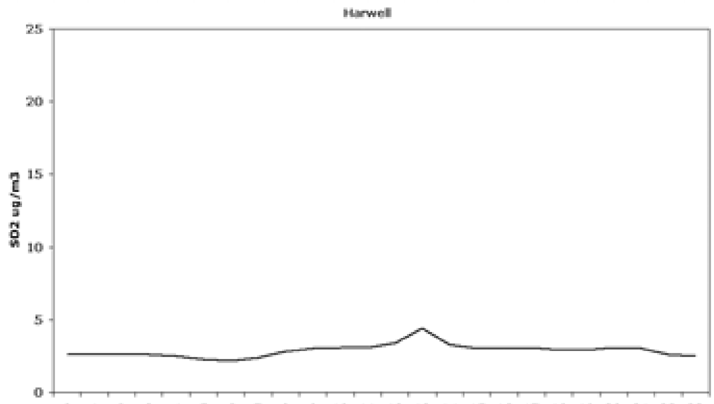
Kerbside Site
(Marylebone Road)



Roadside Site
(Bury)

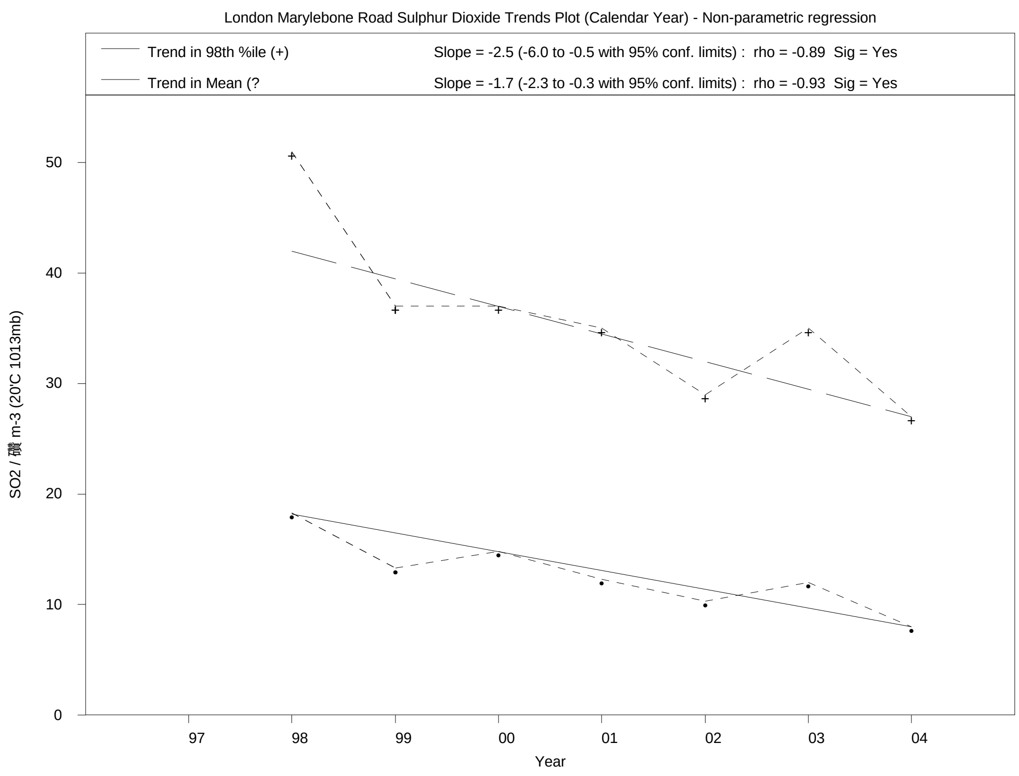


Urban Background Site
(Leamington Spa)

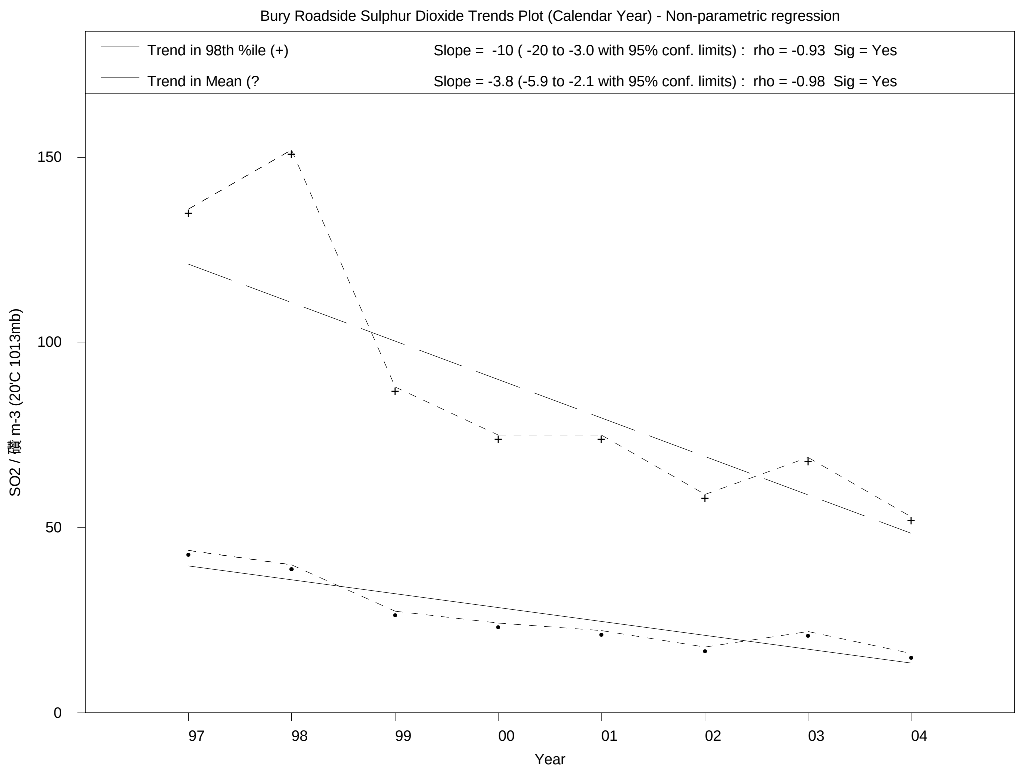


Rural Site
(Harwell)

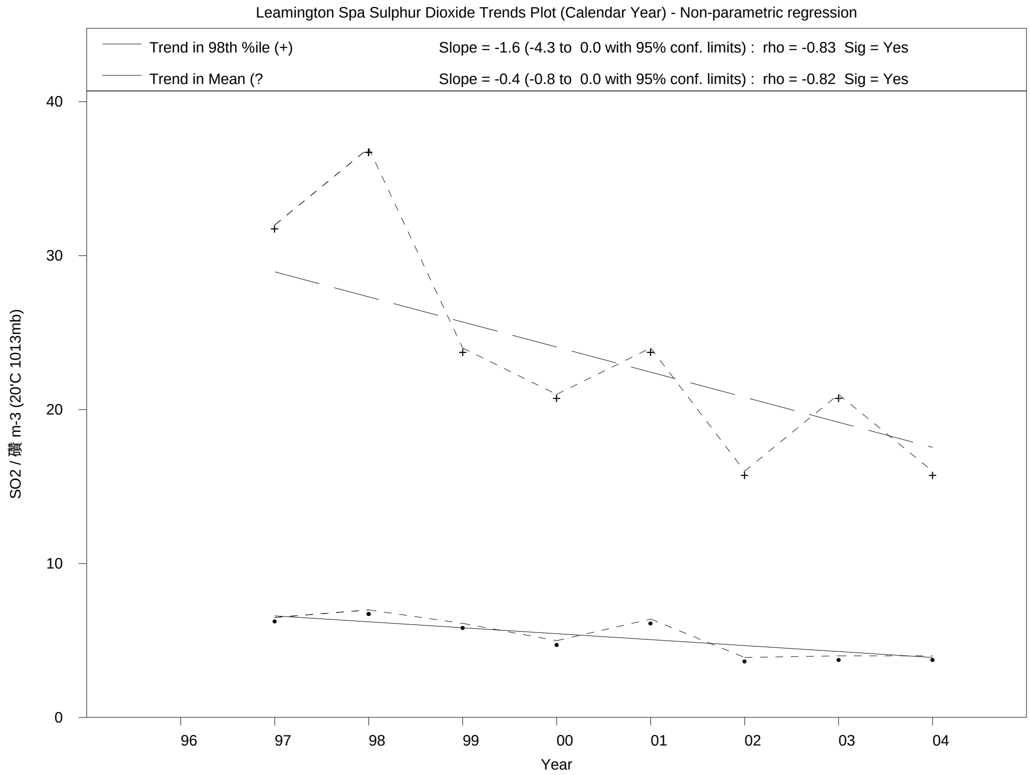
15.8 Trends in annual concentrations



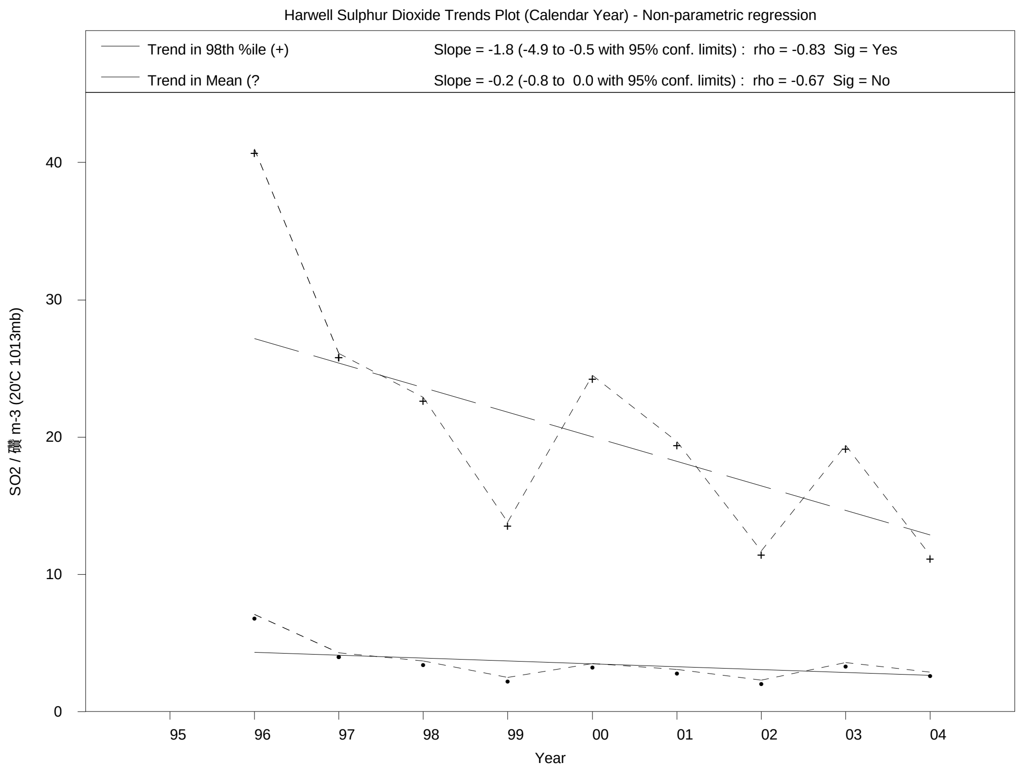
Kerbside Site
(*Marylebone Road*)



Roadside Site
(*Bury Roadside*)



Urban Background Site (*Leamington Spa*)



Rural Site (*Harwell*)

15.9 Sulphur Dioxide Statistical Summary 2004

i) ANNUAL STATISTICS- I

Site	Site Type	Annual average of hourly means µg m-3	Annual data capture of hourly means %	Maximum hourly mean µg m-3	Maximum 15-minute mean µg m-3	Date of maximum 15-minute mean	99.9 %ile of 15-minute mean	99.7 %ile of hourly mean	99 %ile of daily mean
England									
Barnsley 12	UB	7	98.9	138	178	05/08/2004	72	56	26
Barnsley Gawber	UB	16	96.6	173	200	05/08/2004	82	64	41
Birmingham Centre	UC	6	86.0	88	133	11/05/2004	61	40	17
Birmingham East	UB	3	58.4	77	109	13/04/2004	48	32	11
Birmingham Tyburn	UB	---	37.5	27	43	06/09/2004	---	---	---
Blackpool	UB	3	60.4	51	61	21/10/2004	53	48	23
Bolton	UB	3	97.6	104	154	04/08/2004	48	35	15
Bournemouth	UB	2	97.6	35	37	30/03/2004	27	19	9
Bradford Centre	UC	12	96.0	152	178	05/08/2004	80	45	28
Bristol Centre	UC	4	95.8	82	120	14/10/2004	48	29	14
Bury Roadside	RD	16	75.9	261	274	04/08/2004	114	74	47
Coventry Memorial Park	UB	3	98.3	74	117	24/05/2004	48	32	12
Exeter Roadside	RD	2	84.9	24	27	27/01/2004	16	13	7
Harwell	RU	2.9	96.4	245.3	556.7	21/05/2004	83.3	31.7	12.7
Hove Roadside	RD	4	96.0	43	51	24/04/2004	27	21	13
Hull Freetown	UC	6	88.1	106	128	10/12/2004	64	40	16
Ladybower	RU	3.2	97.1	91.0	118.4	09/04/2004	68.1	40.4	14.6
Leamington Spa	UB	4	98.4	43	53	14/05/2004	27	21	11
Leeds Centre	UC	6	85.5	144	194	05/08/2004	88	40	19
Leicester Centre	UC	4	97.3	133	144	05/03/2004	48	32	13
Liverpool Speke	UB	5	97.9	104	224	25/04/2004	69	48	18
London Bexley	SU	5	95.8	128	181	03/08/2004	106	69	34
London Bloomsbury	UC	5	97.6	85	128	26/04/2004	69	51	22
London Brent	UB	3	88.7	72	106	09/12/2004	45	29	15
London Cromwell Road 2	RD	5	98.6	122	130	26/04/2004	43	32	17
London Eltham	SU	5	99.0	146	250	05/09/2004	80	61	27
London Hillingdon	SU	3	97.9	80	101	26/05/2004	35	27	11
London Lewisham	UC	4	97.8	133	194	05/09/2004	69	48	22
London Marylebone Road	KB	8	92.0	128	213	26/04/2004	67	48	26
London N. Kensington	UB	4	97.3	120	152	26/04/2004	59	43	17
London Southwark	UC	7	94.8	144	178	26/04/2004	67	48	25
London Teddington	UB	3.7	96.1	133.8	169.0	05/09/2004	63.3	38.0	23.2
London Westminster	UB	4	90.7	298	373	11/09/2004	69	40	21
Lullington Heath	RU	3.0	89.1	58.3	66.0	26/04/2004	33.0	23.7	11.1
Manchester Piccadilly	UC	17	95.0	189	208	01/03/2004	69	48	27
Manchester South	SU	11	85.8	114	128	01/03/2004	51	35	20
Middlesbrough	I	4	98.6	104	136	19/02/2004	93	64	19

ii) EXCEEDENCE STATISTICS- I

Site	Moderate band	Days	High band	Days	Very High band	Days	Air Quality Standard (15-Minute Mean)	Days	Daughter Directive Hourly Mean and Air Quality Standard (Hourly Mean)	Days	Daughter Directive Daily Mean and Air Quality Standard (Daily Mean)	Days
England												
Barnsley 12	0	0	0	0	0	0	0	0	0	0	0	0
Barnsley Gawber	0	0	0	0	0	0	0	0	0	0	0	0
Birmingham Centre	0	0	0	0	0	0	0	0	0	0	0	0
Birmingham East	0	0	0	0	0	0	0	0	0	0	0	0
Birmingham Tyburn	0	0	0	0	0	0	0	0	0	0	0	0
Blackpool	0	0	0	0	0	0	0	0	0	0	0	0
Bolton	0	0	0	0	0	0	0	0	0	0	0	0
Bournemouth	0	0	0	0	0	0	0	0	0	0	0	0
Bradford Centre	0	0	0	0	0	0	0	0	0	0	0	0
Bristol Centre	0	0	0	0	0	0	0	0	0	0	0	0
Bury Roadside	1	1	0	0	0	0	**1**	**1**	0	0	0	0
Coventry Memorial Park	0	0	0	0	0	0	0	0	0	0	0	0
Exeter Roadside	0	0	0	0	0	0	0	0	0	0	0	0
Harwell	1	1	**1**	**1**	0	0	**2**	**2**	0	0	0	0
Hove Roadside	0	0	0	0	0	0	0	0	0	0	0	0
Hull Freetown	0	0	0	0	0	0	0	0	0	0	0	0
Ladybower	0	0	0	0	0	0	0	0	0	0	0	0
Leamington Spa	0	0	0	0	0	0	0	0	0	0	0	0
Leeds Centre	0	0	0	0	0	0	0	0	0	0	0	0
Leicester Centre	0	0	0	0	0	0	0	0	0	0	0	0
Liverpool Speke	0	0	0	0	0	0	0	0	0	0	0	0
London Bexley	0	0	0	0	0	0	0	0	0	0	0	0
London Bloomsbury	0	0	0	0	0	0	0	0	0	0	0	0
London Brent	0	0	0	0	0	0	0	0	0	0	0	0
London Cromwell Road 2	0	0	0	0	0	0	0	0	0	0	0	0
London Eltham	0	0	0	0	0	0	0	0	0	0	0	0
London Hillingdon	0	0	0	0	0	0	0	0	0	0	0	0
London Lewisham	0	0	0	0	0	0	0	0	0	0	0	0
London Marylebone Road	0	0	0	0	0	0	0	0	0	0	0	0
London N. Kensington	0	0	0	0	0	0	0	0	0	0	0	0
London Southwark	0	0	0	0	0	0	0	0	0	0	0	0
London Teddington	0	0	0	0	0	0	0	0	0	0	0	0
London Westminster	5	1	0	0	0	0	**5**	**1**	0	0	0	0
Lullington Heath	0	0	0	0	0	0	0	0	0	0	0	0
Manchester Piccadilly	0	0	0	0	0	0	0	0	0	0	0	0
Manchester South	0	0	0	0	0	0	0	0	0	0	0	0
Middlesbrough	0	0	0	0	0	0	0	0	0	0	0	0

iii) ANNUAL STATISTICS- II

Site	Site Type	Annual average of hourly means µg m-3	Annual data capture of hourly means %	Maximum hourly mean µg m-3	Maximum 15-minute mean µg m-3	Date of maximum 15-minute mean	99.9 %ile of 15-minute mean	99.7 %ile of hourly mean	99 %ile of daily mean
Newcastle Centre	UC	4	83.7	104	202	30/04/2004	74	45	14
Northampton	UB	4	89.3	200	205	16/04/2004	93	48	15
Norwich Centre	UC	15	96.4	56	72	06/06/2004	45	37	25
Nottingham Centre	UC	17	95.7	117	178	24/02/2004	74	59	32
Oxford Centre Roadside	RD	3	99.1	29	72	04/03/2004	21	16	9
Plymouth Centre	UC	2	67.6	21	27	03/06/2004	13	8	5
Portsmouth	UB	4	90.7	64	69	04/08/2004	32	24	10
Preston	UB	3	98.2	186	250	08/12/2004	56	29	12
Reading New Town	UB	7	88.9	114	165	16/06/2004	61	37	18
Redcar	SU	9	97.7	207	285	13/03/2004	120	80	31
Rochester	RU	6.9	98.6	137.0	191.1	13/12/2004	111.2	71.6	19.5
Rotherham Centre	UC	15	75.5	109	117	05/08/2004	69	40	26
Salford Eccles	I	9	90.1	543	830	01/03/2004	101	61	33
Sandwell West Bromwich	UB	4	98.1	72	88	09/03/2004	53	37	13
Scunthorpe	I	---	20.8	154	216	04/03/2004	---	---	---
Scunthorpe Town	I	10	55.5	234	295	22/07/2004	146	106	53
Sheffield Centre	UC	7	80.1	82	106	02/08/2004	40	29	15
Southampton Centre	UC	6	96.4	85	112	07/08/2004	59	43	15
Southend-on-Sea	UB	11	95.2	293	319	13/12/2004	114	67	37
Southwark Roadside	RD	4	95.4	138	165	26/04/2004	51	35	15
Stockport Shaw Heath	UB	---	45.8	120	138	01/03/2004	---	---	---
Stoke-on-Trent Centre	UC	11	86.6	69	96	02/03/2004	59	37	24
Sunderland	UB	2	92.1	24	35	26/07/2004	19	11	6
Thurrock	UB	5	97.8	197	279	09/12/2004	90	48	20
Wicken Fen	RU	3.3	93.5	58.8	74.0	26/02/2004	42.3	28.7	11.2
Wigan Centre		---	22.2	45	56	09/12/2004	---	---	---
Wigan Leigh	UB	2	51.4	69	85	04/08/2004	43	27	7
Wirral Tranmere	UB	6	95.8	74	104	04/08/2004	53	40	17
Wolverhampton Centre	UC	4	97.8	90	146	12/05/2004	59	40	14
N Ireland									
Belfast Centre	UC	7	95.1	117	122	18/02/2004	90	74	34
Belfast East	UB	6	96.5	125	144	25/01/2004	90	67	28
Derry	UB	11	95.8	106	144	25/01/2004	72	53	27
Scotland									
Aberdeen	UB	4	93.0	133	322	09/08/2004	82	40	14
Edinburgh St Leonards	UB	3	98.5	149	279	30/07/2004	101	61	18
Glasgow Centre	UC	2	86.6	64	82	23/10/2004	32	19	8
Grangemouth	I	7	98.6	524	788	08/06/2004	356	152	49
Wales									
Cardiff Centre	UC	3	97.0	122	170	21/07/2004	53	29	11
Cwmbran	UB	3	96.9	53	98	24/05/2004	32	19	9
Narberth	RU	2.7	90.5	39.6	54.6	26/04/2004	31.1	20.5	9.4
Port Talbot	UB	6	97.2	154	210	02/07/2004	98	61	20
Swansea	UC	3	97.6	72	90	07/06/2004	48	35	11
Wrexham	RD	3	89.0	40	45	30/03/2004	35	24	11

EXCEEDENCE STATISTICS- II

Site	Moderate band	Days	High band	Days	Very High band	Days	Air Quality Standard (15-Minute Mean)	Days	Daughter Directive Hourly Mean and Air Quality Standard (Hourly Mean)	Days	Daughter Directive Daily Mean and Air Quality Standard (Daily Mean)	Days
England												
Newcastle Centre	0	0	0	0	0	0	0	0	0	0	0	0
Northampton	0	0	0	0	0	0	0	0	0	0	0	0
Norwich Centre	0	0	0	0	0	0	0	0	0	0	0	0
Nottingham Centre	0	0	0	0	0	0	0	0	0	0	0	0
Oxford Centre Roadside	0	0	0	0	0	0	0	0	0	0	0	0
Plymouth Centre	0	0	0	0	0	0	0	0	0	0	0	0
Portsmouth	0	0	0	0	0	0	0	0	0	0	0	0
Preston	0	0	0	0	0	0	0	0	0	0	0	0
Reading New Town	0	0	0	0	0	0	0	0	0	0	0	0
Redcar	1	1	0	0	0	0	**1**	**1**	0	0	0	0
Rochester	0	0	0	0	0	0	0	0	0	0	0	0
Rotherham Centre	0	0	0	0	0	0	0	0	0	0	0	0
Salford Eccles	2	1	**2**	**1**	0	0	**4**	**1**	**1**	**1**	0	0
Sandwell West Bromwich	0	0	0	0	0	0	0	0	0	0	0	0
Scunthorpe	0	0	0	0	0	0	0	0	0	0	0	0
Scunthorpe Town	1	1	0	0	0	0	**1**	**1**	0	0	0	0
Sheffield Centre	0	0	0	0	0	0	0	0	0	0	0	0
Southampton Centre	0	0	0	0	0	0	0	0	0	0	0	0
Southend-on-Sea	4	1	0	0	0	0	**4**	**1**	0	0	0	0
Southwark Roadside	0	0	0	0	0	0	0	0	0	0	0	0
Stockport Shaw Heath	0	0	0	0	0	0	0	0	0	0	0	0
Stoke-on-Trent Centre	0	0	0	0	0	0	0	0	0	0	0	0
Sunderland	0	0	0	0	0	0	0	0	0	0	0	0
Thurrock	2	1	0	0	0	0	**2**	**1**	0	0	0	0
Wicken Fen	0	0	0	0	0	0	0	0	0	0	0	0
Wigan Centre	0	0	0	0	0	0	0	0	0	0	0	0
Wigan Leigh	0	0	0	0	0	0	0	0	0	0	0	0
Wirral Tranmere	0	0	0	0	0	0	0	0	0	0	0	0
Wolverhampton Centre	0	0	0	0	0	0	0	0	0	0	0	0
N Ireland												
Belfast Centre	0	0	0	0	0	0	0	0	0	0	0	0
Belfast East	0	0	0	0	0	0	0	0	0	0	0	0
Derry	0	0	0	0	0	0	0	0	0	0	0	0
Scotland												
Aberdeen	2	1	0	0	0	0	**2**	**1**	0	0	0	0
Edinburgh St Leonards	2	2	0	0	0	0	**2**	**2**	0	0	0	0
Glasgow Centre	0	0	0	0	0	0	0	0	0	0	0	0
Grangemouth	53	**18**	**8**	**3**	**0**	**0**	**60**	**18**	**6**	**3**	**1**	**1**
Wales												
Cardiff Centre	0	0	0	0	0	0	0	0	0	0	0	0
Cwmbran	0	0	0	0	0	0	0	0	0	0	0	0
Narberth	0	0	0	0	0	0	0	0	0	0	0	0
Port Talbot	0	0	0	0	0	0	0	0	0	0	0	0
Swansea	0	0	0	0	0	0	0	0	0	0	0	0
Wrexham	0	0	0	0	0	0	0	0	0	0	0	0

16. Ozone - Measurement Sites, Instrumentation and Statistics

16.1 Measurement Method

The measurement of ozone is based on the absorption of ultra violet light by ozone. The absorption by an air path with no ozone present is measured to give a reference intensity. The absorption of the ozone containing sample is then measured. The ozone concentration is calculated using the Beer-Lamberts absorption equation.

16. 2 Instrumentation

The following instrument types* are currently deployed in the AURN:

- Ambirak O_3
- API M400
- Environnement O341M
- Horiba APOA 360
- Monitor Labs 9850
- Rotork 427
- Thermo Electron 49

*Defra does not give approval or endorsement for any products or equipment

16.3 Data Quality Requirements of EC Directive 2002/3/EC

Uncertainty 15%
Minimum data capture 90%

16.4 Objectives and Bandings

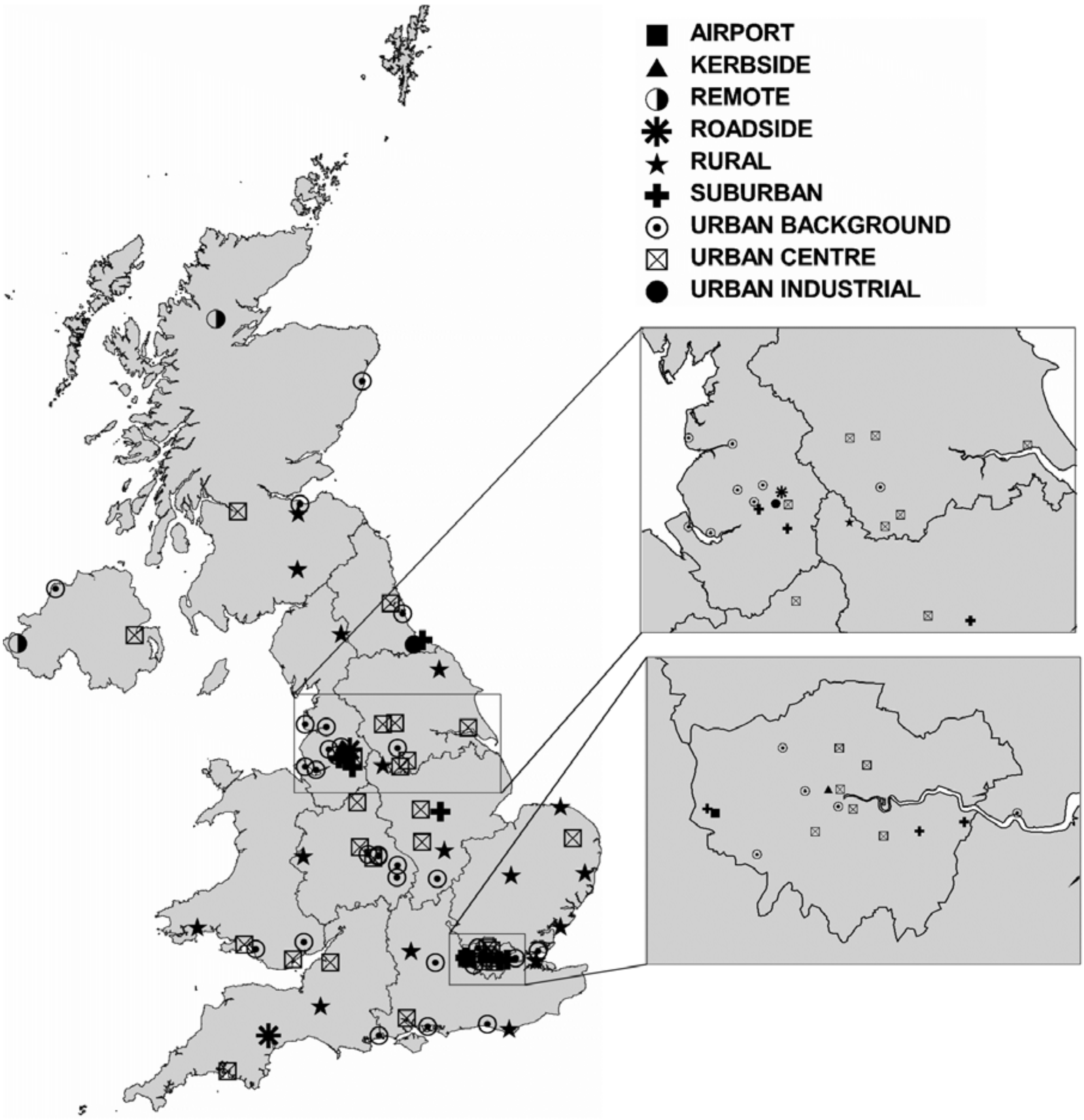
Summary of objectives of the Air Quality Strategy			
	Objective*	**Measured as**	**To be achieved by**
Ozone	100 µg m^{-3} Not to be exceeded more than 10 times per year	Daily maximum of running 8-hour mean	31 December 2005

*Not included in the Regulations for the purpose of Air Quality Management

Air Quality Bands and Index Values		
Band	Index	Ozone µgm^{-3}
Low	1	0-33
	2	34-65
	3	66-99
Moderate	4	100-125
	5	126-153
	6	154-179
High	7	180-239
	8	240-299
	9	300-359
Very High	10	360 or more

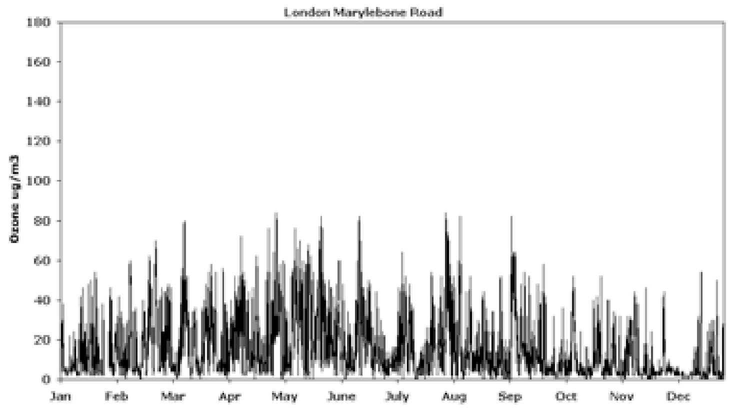
16.5 Site Locations

UK Automatic Ozone Monitoring Sites 2004

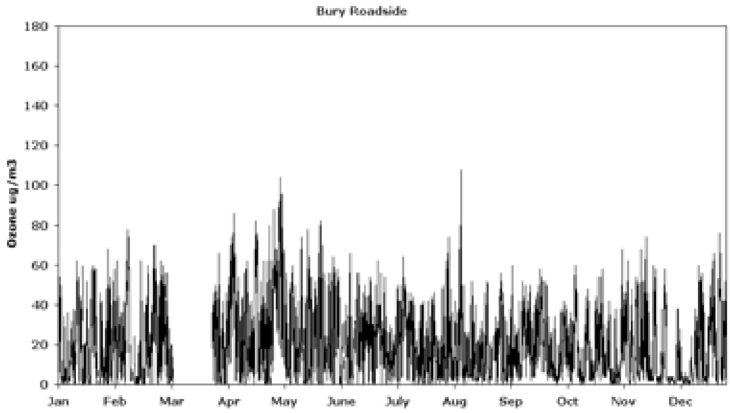


16.6 Hourly Average Concentrations

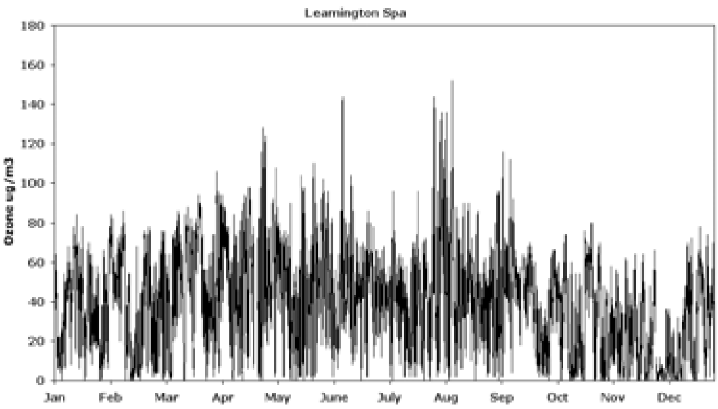
These figures show time series graphs of hourly average ozone concentrations at four *typical* site types for 2004.



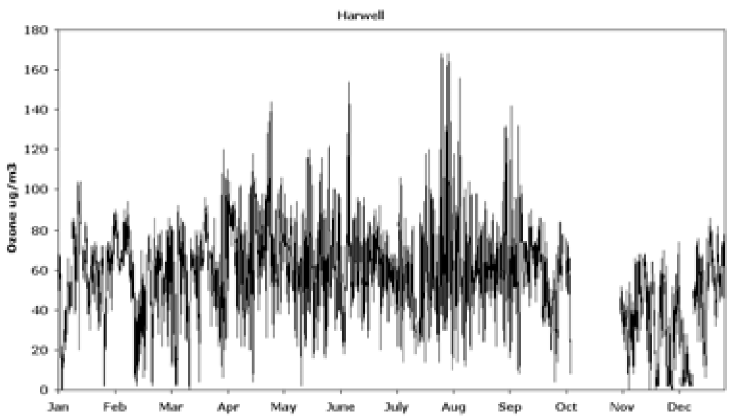
Kerbside Site
(*Marylebone Road*)



Roadside Site
(*Bury*)



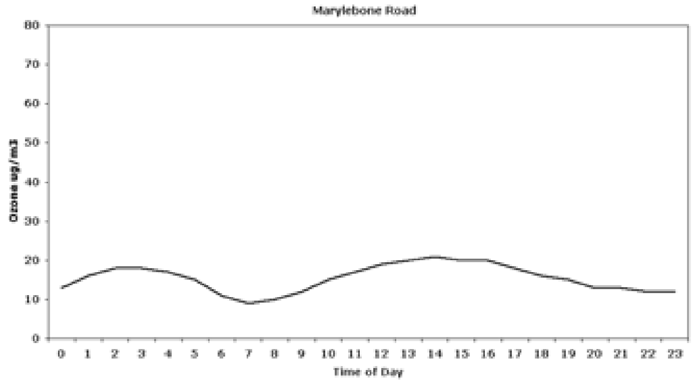
Urban Background Site
(*Leamington Spa*)



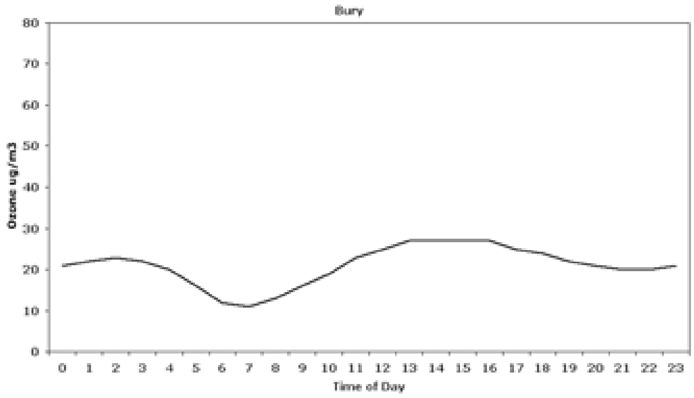
Rural Site
(*Harwell*)

16.7 Diurnal Variations

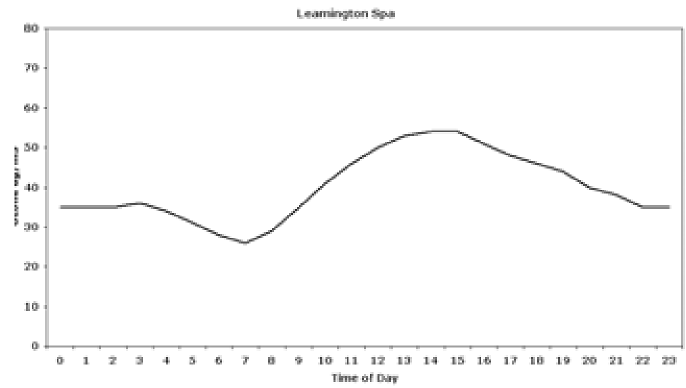
These figures show how ozone concentrations vary on average for each hour of day during the year, at a number of selected *typical* monitoring site types. Local time is used, rather than GMT, since this will more closely reflect the daily cycle of man-made emissions.



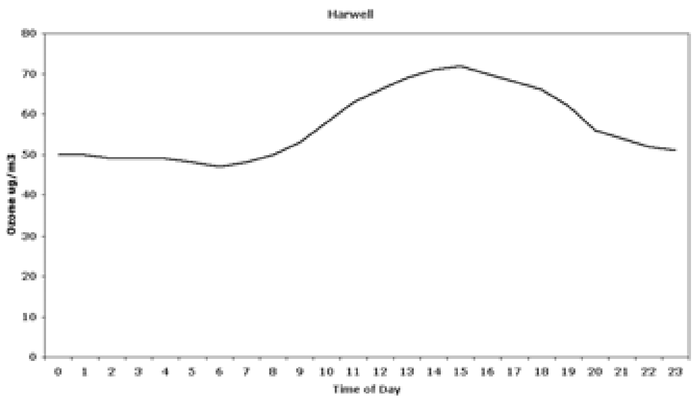
Kerbside Site
(*Marylebone Road*)



Roadside Site
(*Bury*)

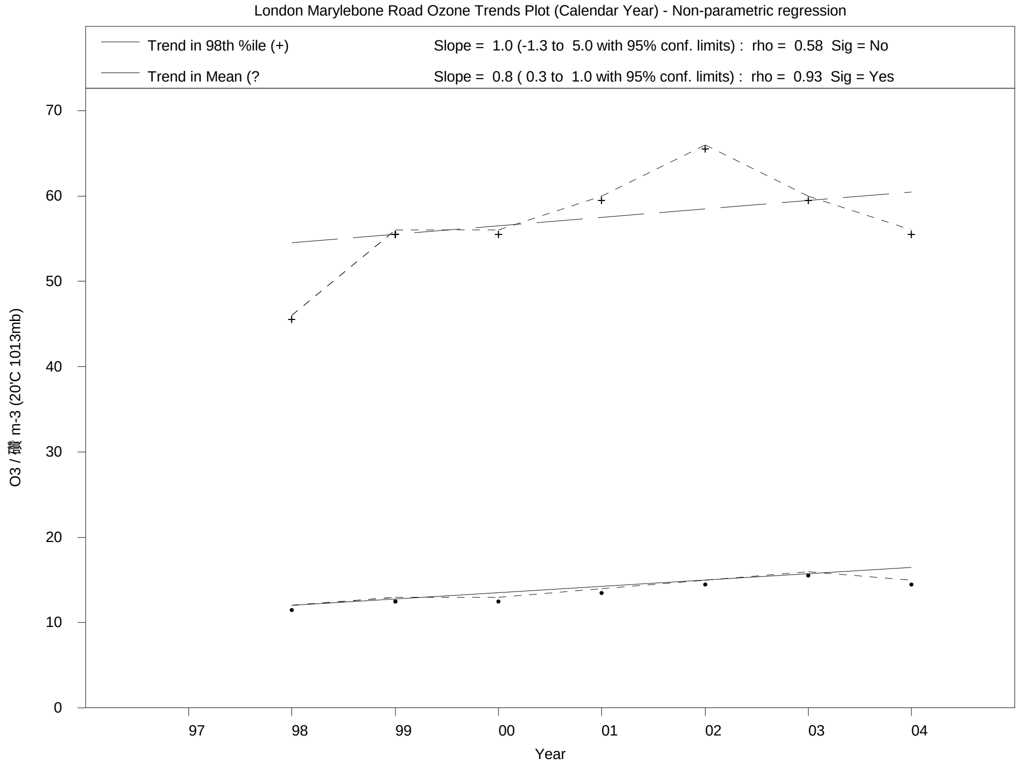


Urban Background Site
(*Leamington Spa*)

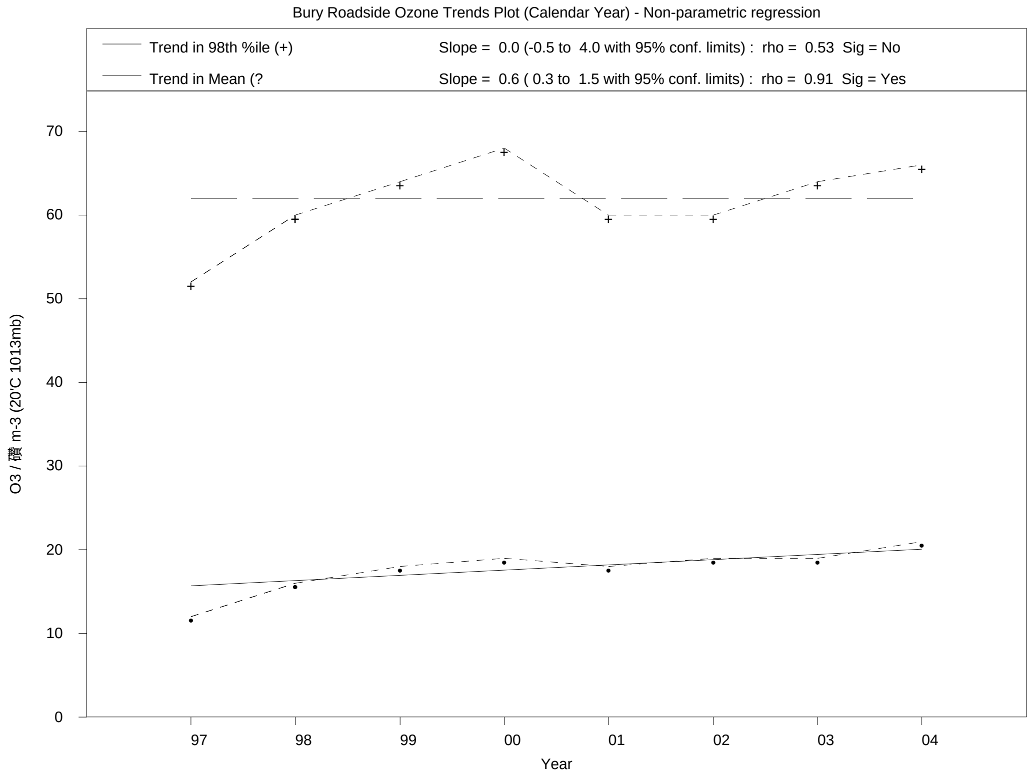


Rural Site
(*Harwell*)

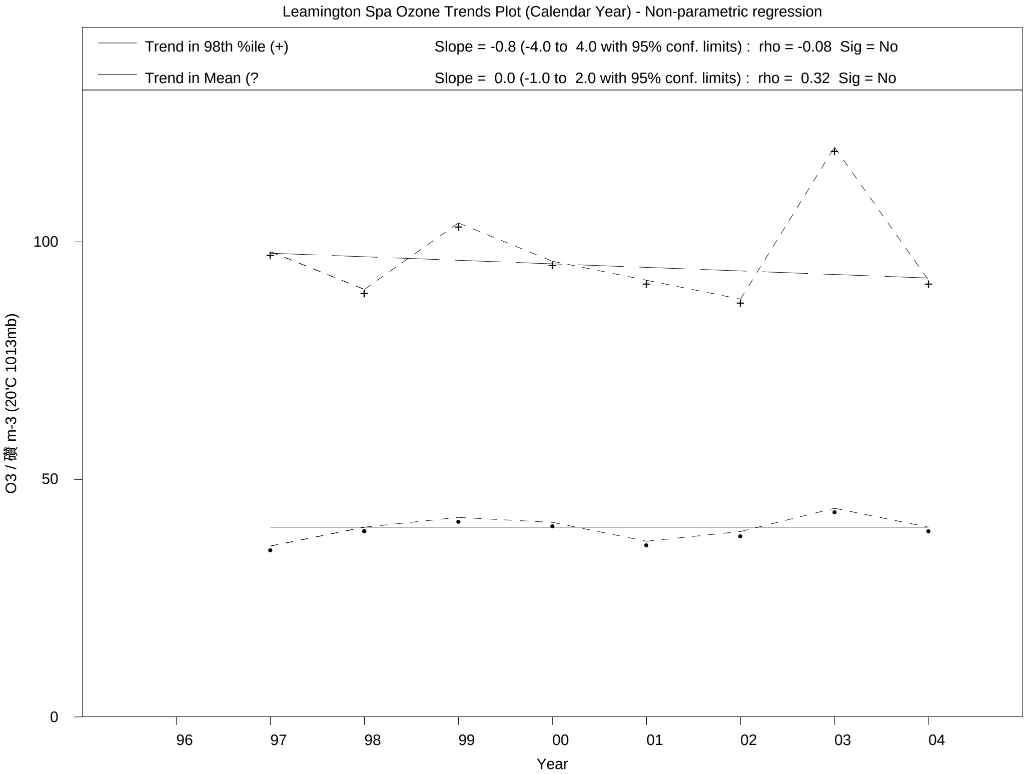
16.8 Trends in annual concentrations



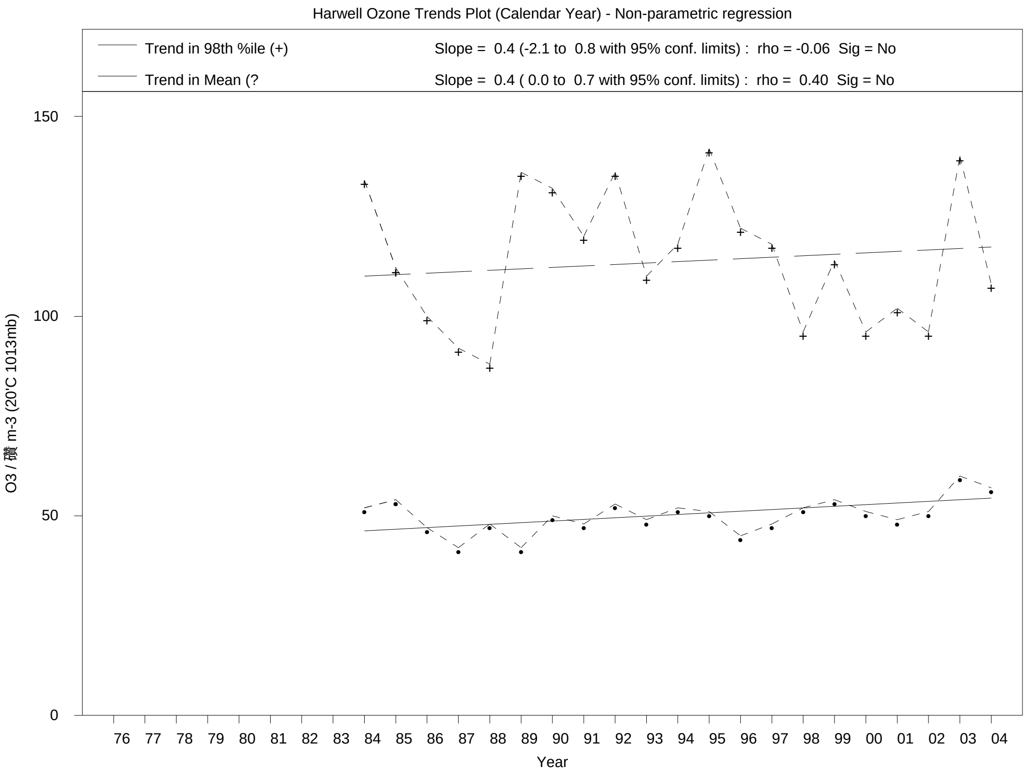
Kerbside Site
(Marylebone Road)



Roadside Site
(Bury)



Background Site
(*Leamington Spa*)



Rural Site
(*Harwell*)

16.9 Ozone Statistical Summary 2004

i) ANNUAL STATISTICS- I

Site	Site Type	Annual average of hourly means µg m-3	Annual data capture of hourly means %	Maximum hourly mean µg m-3	Maximum running 8-hour mean µg m-3	Date of maximum running 8-hour mean	97 %ile of daily max run 8hr µgm-3
England							
Barnsley Gawber	UB	48	96.2	158	130	08/06/2004	103
Birmingham Centre	UC	40	88.4	150	130	08/08/2004	93
Birmingham East	UB	41	58.0	124	113	29/07/2004	88
Birmingham Tyburn	UB	---	37.6	126	111	05/09/2004	---
Blackpool	UB	56	82.6	150	129	01/08/2004	97
Bolton	UB	44	97.6	152	140	08/08/2004	96
Bottesford	SU	46	98.7	166	155	08/08/2004	102
Bournemouth	UB	53	98.9	168	148	05/09/2004	110
Bradford Centre	UC	35	96.8	138	128	08/08/2004	88
Brighton Preston Park	RD	---	14.4	84	73	24/12/2004	---
Bristol Centre	UC	40	91.3	122	105	25/04/2004	87
Bury Roadside	RD	21	91.9	108	97	08/08/2004	70
Coventry Memorial Park	UB	46	98.0	180	165	29/07/2004	113
Exeter Roadside	RD	38	97.0	120	109	01/08/2004	81
Glazebury	SU	43	95.9	154	140	08/08/2004	99
Great Dun Fell	RU	62	99.0	138	133	08/08/2004	97
Harwell	RU	57	90.2	168	161	01/08/2004	114
High Muffles	RU	62	99.2	182	172	09/08/2004	111
Hull Freetown	UC	45	93.9	184	166	08/08/2004	103
Ladybower	RU	63	85.1	160	152	08/08/2004	112
Leamington Spa	UB	40	98.7	152	140	08/08/2004	102
Leeds Centre	UC	36	82.7	116	107	02/05/2004	86
Leicester Centre	UC	35	97.8	170	149	08/08/2004	95
Liverpool Speke	UB	48	97.8	150	129	08/08/2004	94
London Bexley	SU	39	95.5	158	148	29/07/2004	105
London Bloomsbury	UC	24	97.1	140	121	29/07/2004	80
London Brent	UB	35	95.0	160	135	05/09/2004	89
London Eltham	SU	39	96.4	156	148	29/07/2004	99
London Hackney	UC	30	88.4	146	131	29/07/2004	93
London Haringey	UC	34	94.2	158	141	08/06/2004	101
London Harlington	A	33	94.7	156	134	29/07/2004	96
London Hillingdon	SU	27	92.6	128	119	23/05/2004	89
London Lewisham	UC	29	87.8	120	112	08/08/2004	85
London Marylebone Road	KD	15	98.1	84	76	29/04/2004	59
London N. Kensington	UB	36	97.9	172	155	29/07/2004	107
London Southwark	UC	30	94.8	130	119	08/08/2004	86
London Teddington	UB	49	96.1	174	157	08/06/2004	114
London Wandsworth	UC	26	99.3	132	120	29/07/2004	81
London Westminster	UB	31	93.7	156	143	29/07/2004	94
Lullington Heath	RU	61	95.6	184	152	28/07/2004	117
Manchester Piccadilly	UC	30	97.6	152	123	08/08/2004	86
Manchester South	SU	35	95.4	112	93	29/07/2004	81
Market Harborough	RU	53	93.5	174	163	08/08/2004	107
Middlesbrough	I	49	99.1	182	170	09/08/2004	98
Newcastle Centre	UC	41	90.3	144	136	09/08/2004	89
Northampton	UB	47	87.2	182	171	29/07/2004	118
Norwich Centre	UC	41	97.2	188	175	08/08/2004	106
Nottingham Centre	UC	31	97.1	144	131	08/08/2004	83
Plymouth Centre	UC	38	97.8	166	147	05/09/2004	94
Portsmouth	UB	46	98.9	182	170	05/09/2004	106
Preston	UB	44	98.3	142	128	08/08/2004	89
Reading New Town	UB	44	86.0	172	148	29/07/2004	120
Redcar	SU	52	96.3	174	165	09/08/2004	111
Rochester	RU	51	98.6	176	155	29/07/2004	116
Rotherham Centre	UC	34	90.0	144	136	08/08/2004	83
Salford Eccles	I	33	87.4	134	124	08/08/2004	82
Sandwell West Bromwich	UB	45	97.9	156	136	08/08/2004	101
Sheffield Centre	UC	39	98.0	142	129	08/08/2004	92
Sibton	RU	55	96.3	212	185	08/08/2004	115

ii) EXCEEDENCE STATISTICS- I

Site	Moderate band [3]	Days	High band	Days	Very High band	Days	Air Quality Standard (Running 8-hour Mean)	Days
England								
Barnsley Gawber	253	53	0	0	0	0	90	16
Birmingham Centre	78	11	0	0	0	0	37	6
Birmingham East	36	8	0	0	0	0	10	3
Birmingham Tyburn	11	3	0	0	0	0	5	1
Blackpool	115	24	0	0	0	0	38	7
Bolton	108	16	0	0	0	0	47	6
Bottesford	168	33	0	0	0	0	74	12
Bournemouth	332	54	0	0	0	0	158	26
Bradford Centre	54	11	0	0	0	0	22	6
Brighton Preston Park	0	0	0	0	0	0	0	0
Bristol Centre	24	9	0	0	0	0	3	1
Bury Roadside	6	2	0	0	0	0	0	0
Coventry Memorial Park	271	42	**1**	**1**	0	0	124	21
Exeter Roadside	31	5	0	0	0	0	9	3
Glazebury	126	22	0	0	0	0	46	8
Great Dun Fell	138	21	0	0	0	0	91	10
Harwell	361	52	0	0	0	0	177	28
High Muffles	388	49	**3**	**1**	0	0	241	26
Hull Freetown	176	25	**1**	**1**	0	0	101	15
Ladybower	260	37	0	0	0	0	135	20
Leamington Spa	143	21	0	0	0	0	67	12
Leeds Centre	18	5	0	0	0	0	4	1
Leicester Centre	124	19	0	0	0	0	70	10
Liverpool Speke	75	15	0	0	0	0	28	5
London Bexley	184	29	0	0	0	0	82	17
London Bloomsbury	47	10	0	0	0	0	15	3
London Brent	73	11	0	0	0	0	32	7
London Eltham	151	28	0	0	0	0	67	11
London Hackney	97	15	0	0	0	0	43	8
London Haringey	147	22	0	0	0	0	69	11
London Harlington	127	23	0	0	0	0	49	8
London Hillingdon	65	18	0	0	0	0	16	5
London Lewisham	27	6	0	0	0	0	6	1
London Marylebone Road	0	0	0	0	0	0	0	0
London N. Kensington	205	37	0	0	0	0	91	18
London Southwark	69	13	0	0	0	0	27	5
London Teddington	354	58	0	0	0	0	156	27
London Wandsworth	39	6	0	0	0	0	19	3
London Westminster	88	13	0	0	0	0	39	7
Lullington Heath	435	62	**1**	**1**	0	0	215	30
Manchester Piccadilly	42	12	0	0	0	0	13	2
Manchester South	11	7	0	0	0	0	0	0
Market Harborough	224	36	0	0	0	0	107	20
Middlesbrough	157	29	**1**	**1**	0	0	80	10
Newcastle Centre	85	9	0	0	0	0	60	9
Northampton	268	33	**2**	**1**	0	0	156	24
Norwich Centre	167	22	**3**	**1**	0	0	107	13
Nottingham Centre	55	9	0	0	0	0	23	5
Plymouth Centre	80	14	0	0	0	0	37	7
Portsmouth	231	34	**1**	**1**	0	0	117	17
Preston	57	10	0	0	0	0	23	4
Reading New Town	325	46	0	0	0	0	161	27
Redcar	337	49	0	0	0	0	201	25
Rochester	478	75	0	0	0	0	199	34
Rotherham Centre	63	9	0	0	0	0	32	6
Salford Eccles	50	9	0	0	0	0	18	3
Sandwell West Bromwich	145	26	0	0	0	0	69	12
Sheffield Centre	78	15	0	0	0	0	28	6
Sibton	289	45	**8**	**1**	0	0	153	22

iii) ANNUAL STATISTICS- II

Site	Site Type	Annual average of hourly means µg m^{-3}	Annual data capture of hourly means %	Maximum hourly mean µg m^{-3}	Maximum running 8-hour mean µg m^{-3}	Date of maximum running 8-hour mean	97 %ile of daily max run 8hr µgm-^{3}
England							
Somerton	RU	55	95.6	150	140	01/08/2004	109
Southampton	UC	36	90.9	128	114	25/04/2004	89
Southend-on-Sea	UB	45	97.4	186	158	08/08/2004	116
St Osyth	RU	53	99.0	174	149	08/08/2004	111
Stoke-on-Trent	UC	42	98.0	138	125	08/08/2004	89
Sunderland	UB	---	6.3	80	78	19/12/2004	---
Thurrock	UB	39	98.4	156	139	29/07/2004	114
Weybourne	RU	64	97.1	202	178	08/08/2004	127
Wicken Fen	RU	52	93.2	182	173	29/07/2004	129
Wigan Centre	UB	---	23.1	90	85	18/11/2004	---
Wigan Leigh	UB	37	70.2	124	109	08/08/2004	82
Wirral Tranmere	UB	49	98.4	146	125	08/08/2004	91
Wolverhampton	UC	41	97.7	144	128	29/07/2004	87
Yarner Wood	RU	63	97.5	142	131	25/04/2004	112
N Ireland							
Belfast Centre	UC	43	96.4	124	108	01/05/2004	90
Derry	UB	57	97.5	120	116	02/08/2004	100
Lough Navar	RU	53	74.8	130	116	02/08/2004	94
Scotland							
Aberdeen	UB	54	94.0	146	139	09/08/2004	112
Bush Estate	RU	55	98.4	158	151	08/08/2004	92
Edinburgh St	UB	53	93.9	172	151	08/08/2004	101
Eskdalemuir	RU	53	90.5	144	137	08/08/2004	93
Glasgow Centre	UC	37	97.5	134	113	08/08/2004	83
Strath Vaich	RE	76	83.9	138	128	10/08/2004	109
Wales							
Aston Hill	RU	66	89.4	148	133	02/08/2004	104
Cardiff Centre	UC	41	91.1	162	153	01/08/2004	99
Cwmbran	UB	51	99.5	146	138	01/08/2004	97
Narberth	RU	---	0.0	---	---	---	---
Port Talbot	UB	53	97.2	146	132	01/08/2004	101
Swansea	UC	41	97.0	152	136	01/08/2004	96

iv) EXCEEDENCE STATISTICS- II

Site	Moderate band	Days	High band -3	Days	Very High 3	Days	Air Quality Standard (Running 8-hour Mean)	Days
England								
Somerton	225	27	0	0	0	0	118	18
Southampton Centre	34	10	0	0	0	0	4	1
Southend-on-Sea	360	55	**1**	**1**	0	0	187	28
St Osyth	268	50	0	0	0	0	121	19
Stoke-on-Trent Centre	47	9	0	0	0	0	21	3
Sunderland Silksworth	0	0	0	0	0	0	0	0
Thurrock	231	37	0	0	0	0	120	17
Weybourne	719	78	**4**	**1**	0	0	476	46
Wicken Fen	484	67	**2**	**1**	0	0	265	40
Wigan Centre	0	0	0	0	0	0	0	0
Wigan Centre	0	0	0	0	0	0	0	0
Wigan Leigh	20	5	0	0	0	0	5	1
Wirral Tranmere	63	12	0	0	0	0	25	4
Wolverhampton Centre	52	7	0	0	0	0	27	5
Yarner Wood	366	53	0	0	0	0	172	29
N Ireland								
Belfast Centre	41	8	0	0	0	0	18	5
Derry	171	27	0	0	0	0	62	10
Lough Navar	46	6	0	0	0	0	17	3
Scotland								
Aberdeen	325	41	0	0	0	0	198	24
Bush Estate	63	13	0	0	0	0	27	3
Edinburgh St Leonards	194	26	0	0	0	0	114	12
Eskdalemuir	58	12	0	0	0	0	21	5
Glasgow Centre	30	4	0	0	0	0	13	2
Strath Vaich	488	54	0	0	0	0	279	29
Wales								
Aston Hill	180	21	0	0	0	0	100	12
Cardiff Centre	120	21	0	0	0	0	53	10
Cwmbran	110	17	0	0	0	0	54	9
Narberth	---	---	---	---	---	---	---	---
Port Talbot	153	23	0	0	0	0	83	12
Swansea	108	20	0	0	0	0	52	9

Air Pollution in the UK: 2004

Part 3 - Appendices

1- The Major Air Pollutants measured in the UK

2- Regional Maps of UK Automatic Air Monitoring Sites

3- The UK's Automatic and Sampler-based Air Monitoring Networks

4- Analysis of statistically significant trends in UK air pollution levels

5- Listing of current UK, European and WHO Air Quality Criteria

6- Calculation methods, statistical methods and measurement uncertainty

Appendix 1- The Major Air Pollutants measured in the UK

We describe major sources and effects of these pollutants, together with typical UK-wide patterns of exposure.

Measured Pollutants

The principal air pollutants measured in UK National Air Monitoring networks are:

- Nitrogen oxides, and primarily nitrogen dioxide (NO_2)
- Sulphur Dioxide (SO_2)
- Carbon Monoxide (CO)
- Ozone (O_3)
- Particles- primarily measured as PM_{10} at the present time
- Benzene (C_6H_6)
- 1,3-butadiene (C_4H_6)

The first five of these are measured in the AURN, whilst the two volatile organic compounds- benzene and 1,3-butadiene- are measured in the automatic hydrocarbon network. The various pollutants have different sources and behave very differently once emitted into the atmosphere. As a result, spatial and temporal patterns can differ markedly between the pollutants.

In this appendix, we briefly examine the sources, effects and distributions of these major pollutants. For more detail, please refer to the authoritative series of pollutant-specific analyses and guidelines produced by EPAQS (the UK Expert Panel on Air Quality Standards)[18-25] and World Health Organisation[26].

Nitrogen Oxides

Nitrogen oxides (NO_x) are formed during high temperature combustion processes from the oxidation of nitrogen in the air or fuel. The principal source of nitrogen oxides - nitric oxide (NO) and nitrogen dioxide (NO_2), collectively known as NO_x - is road traffic. For the UK as a whole, approximately 45% of all oxide of nitrogen emission originates from this source, with most of the remainder arising from power stations and other industrial sources. Since power station and industrial emissions are usually from elevated sources (i.e. high chimneys), motor vehicles represent by far the largest source of low-level NOx emission and therefore make the largest contribution (75% or greater) to long-term ground level concentrations in urban areas.

Nitric oxide is not generally considered to be harmful to health at the concentrations found in the ambient atmosphere. However, nitrogen dioxide has a variety of environmental and health impacts. Its direct health impact as a respiratory irritant may be significant. In the presence of sunlight, it can react with Volatile Organic Compounds (VOCs) to produce photochemical pollutants including ozone. Nitrogen dioxide can also be further oxidised in air to acid gases such as nitric acid, which contribute to the production of acid rain over regional scales.

The highest NOx levels in UK cities are generally observed at kerbside locations. However, since much of the NO_2 is formed from primary emissions of NO by time-dependent oxidation processes in the atmosphere, the relative decline in NO_2 concentration away from the kerbside is slower than for NO.

Modelling and monitoring studies- for example with diffusion tube samplers- have shown that NO_2 concentrations tend to be greatest in central urban areas. However, this cannot always be assumed to be the case, especially where major road systems, industrial areas or other large sources are located away from city centre areas.

Sulphur Dioxide

Sulphur dioxide (SO_2) is an acid gas which acts as an irritant to the respiratory system and may exacerbate or initiate symptoms in asthmatics. It also contributes to acid rain over a regional (for example European) scale.

This pollutant is formed by the oxidation of sulphur impurities in fuels during combustion processes. A very high proportion (approximately 85%) of UK SO_2 emissions originate from power stations and industrial sources. As the use of coal for domestic heating has decreased, its emissions and atmospheric concentrations in urban areas have decreased considerably over the last 20-30 years.

Geographically, SO_2 concentrations in the UK are highest in urban areas such as mining regions in the north of England and in Northern Ireland, where there is still significant use of coal for domestic heating. Modelling studies have indicated that the highest SO_2 concentrations in cities usually occur in the central areas.

Carbon Monoxide

Carbon monoxide (CO) is a toxic gas produced by incomplete combustion of fossil fuels. At worst-case ambient levels (in congested streets, car-parks or tunnels), exposure may reduce the oxygen-carrying capacity of the blood and impair oxygen delivery to the brain and other organs, particularly affecting adults with angina and diseases of the coronary arteries.

Carbon monoxide in urban areas results almost entirely from vehicle emissions. The emission rate for individual vehicles depends critically on vehicle speed, being higher at low speeds.

Since CO is a primary pollutant, its ambient concentrations closely follow emissions. In urban areas, concentrations are therefore highest at the kerbside and decrease rapidly with increasing distance from the road. Since traffic is by far the most important source of CO, its spatial distribution will follow that of traffic: this will generally result in the highest levels being observed in the city centre, where most congested areas tend to be found.

Ozone

Ozone (O_3) is a highly reactive oxidising agent, with a wide range of material, vegetation and human health impacts. Acute health effects of ozone may include eye/nose irritation, respiratory problems and airway inflammation.

A natural background ozone concentration exists in the atmosphere due to mixing of ozone from the stratosphere and its generation in the troposphere. The background concentration depends on latitude and time of year: in the UK, measurements show the resulting annual average background concentration to be about 70 $\mu g/m^3$.

Ozone is not emitted directly into the atmosphere in any significant quantity and its presence in the lower atmosphere at concentrations exceeding background results primarily from a complex series of reactions involving NO_x and hydrocarbon precursors in the presence of sunlight and high temperatures. The reactions producing ozone occur in air containing these precursors as it moves downwind; ozone formation can occur over a timescale of a few hours to several days. As a result, ozone concentrations are decoupled temporally and spatially from precursor sources and ambient concentrations are strongly dependent on meteorological conditions, together with scavenging and deposition rates.

In urban areas, chemical scavenging by NO_x emissions results in ozone concentrations that are generally lower than in rural areas. Moreover, urban ozone concentrations tend to be highly variable over small spatial scales, with concentrations lowest where corresponding levels of other pollutants such as NO are highest. In cities, therefore, ozone concentrations will tend to be lower in central areas and increase in the suburbs, although the spatial variation will be complex and, in open spaces in urban areas, levels of ozone may approach those found in nearby rural areas.

Particulate Matter

Particulate Matter (PM) is a generic descriptor covering a wide range of particle size fractions, morphologies and chemical compositions. Although coarse (large) particle size ranges may cause significant local nuisance or soiling impacts, it is the finer (small) fractions that are capable of deep lung/airway penetration. This is why these fractions such as PM_{10} and $PM_{2.5}$ are measured in UK national monitoring networks.

Particles are produced from a variety of natural and man-made sources. Natural sources include sea salt, soil blowoff, Saharan dust, forest fires and volcanic activity. Man-made sources include incomplete combustion processes (e.g. coal and diesel smoke), industry and construction activity. Particles may be either directly emitted into the atmosphere (primary particles) or formed there by chemical reactions (secondary particles). Both particle size, usually expressed in terms of its aerodynamic diameter, and chemical composition are greatly influenced by its origin.

The principal source of PM_{10} (the mass fraction of particles collected by a sampler with a 50% inlet cut-off at aerodynamic diameter 10µm) in many cities is road traffic emissions, particularly from diesel vehicles. As well as creating dirt, odour and visibility problems, PM_{10} particles are associated with health effects including increased risk of heart and lung disease. In addition, they may carry surface- absorbed carcinogenic compounds into the lungs. Concern about the potential health impacts of fine particulate matter has increased over recent years.

Existing PM_{10} data show that daily average concentrations are usually highest in the winter months and lowest in the summer. During winter episode periods, PM_{10} levels increase together with other traffic-related pollutants such as oxides of nitrogen. During the spring and summer, the photochemical oxidation of sulphur dioxide and oxides of nitrogen to particulate sulphate and nitrate is another important source.

Benzene

Benzene (C_6H_6) is a fat-soluble volatile toxic organic compound with a range of potential effects. Acute exposure to benzene at occupational levels can cause narcotic, anaesthetic or fatal consequences. Benzene is a proven genotoxic carcinogen, and ambient long-term exposure is implicated in the formation of a range of types of leukaemia in the general population.

Benzene has no significant natural sources, so that ambient exposure results primarily from petrol combustion in road transport emissions or evaporation of petrol (which contains benzene) from filling stations. Benzene is naturally broken down by chemical reactions in the atmosphere, although these reactions can take several days. As a result, outdoor benzene concentrations tend to closely follow road networks and traffic density patterns.

1,3-Butadiene

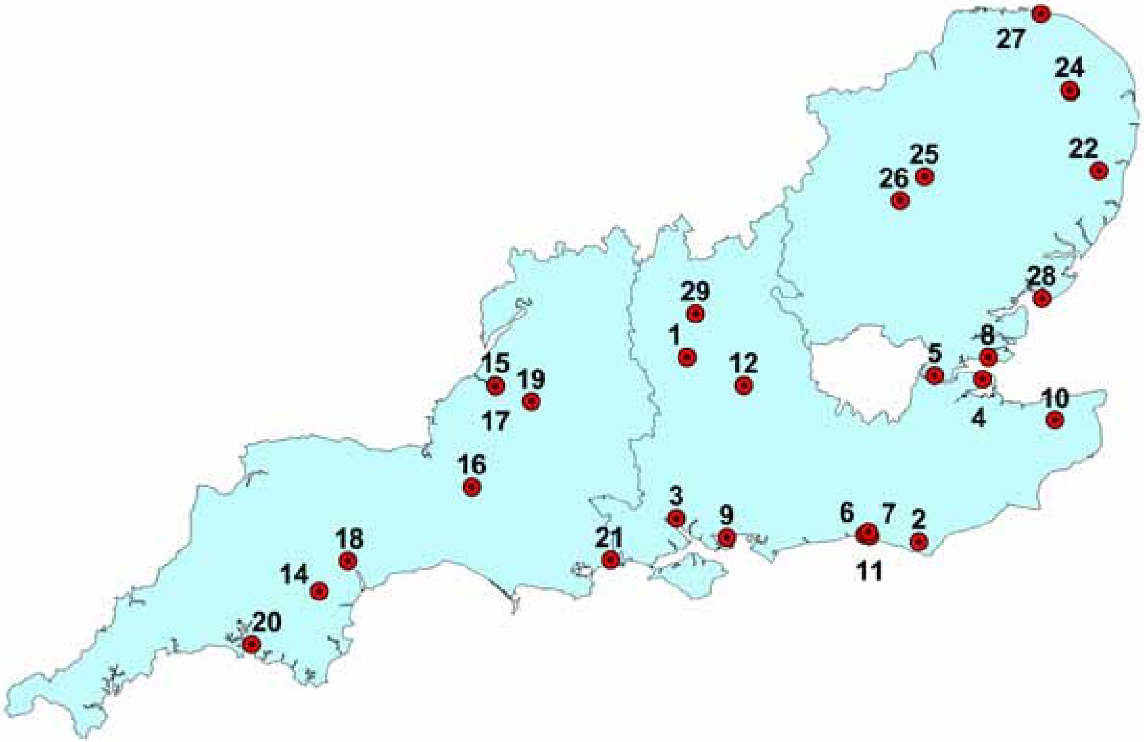
Evidence from occupational human exposure and laboratory studies on animals shows 1,3-butadiene (C_4H_6) to be a carcinogen, exposure to which can cause a range of cancers of the lymphoid system, blood-forming tissues, lymphomas and leukaemias.

This substance is used in some industrial sectors, primarily in the production of synthetic rubber. However, ambient exposure of the general population results primarily from fuel combustion- mainly from petrol-fuelled motor vehicles, but also from other fossil fuels, accidental fires and industrial releases.

Unlike benzene, this is not a constituent of petrol, so evaporative or fugitive emissions are not a significant source. Although 1,3-butadiene is removed by catalytic converters and not produced from diesel engines, spatial and temporal exposure patterns in the UK are dominated by road transport.

Appendix 2- Regional Maps of UK Automatic Air Monitoring Stations

These maps show Automatic Urban and Rural Network (AURN) and Hydrocarbon air monitoring sites in different parts of the UK.



	Site Name
1	Harwell
2	Lullington Heath
3	Southampton Centre
4	Rochester
5	Thurrock
6	Hove Roadside
7	Brighton Roadside
8	Southend-on-Sea
9	Portsmouth
10	Canterbury
11	Brighton Roadside PM_{10}
12	Reading New Town
13	Brighton Preston Park
14	Yarner Wood
15	Bristol Centre
16	Somerton
17	Bristol Old Market
18	Exeter Roadside
19	Bath Roadside
20	Plymouth Centre
21	Bournemouth
22	Sibton
23	Norwich Roadside
24	Norwich Centre
25	Wicken Fen
26	Cambridge Roadside
27	Weybourne
28	St Osyth
29	Oxford Centre Roadside

Figure 2.1 Automatic Sites, Southern England

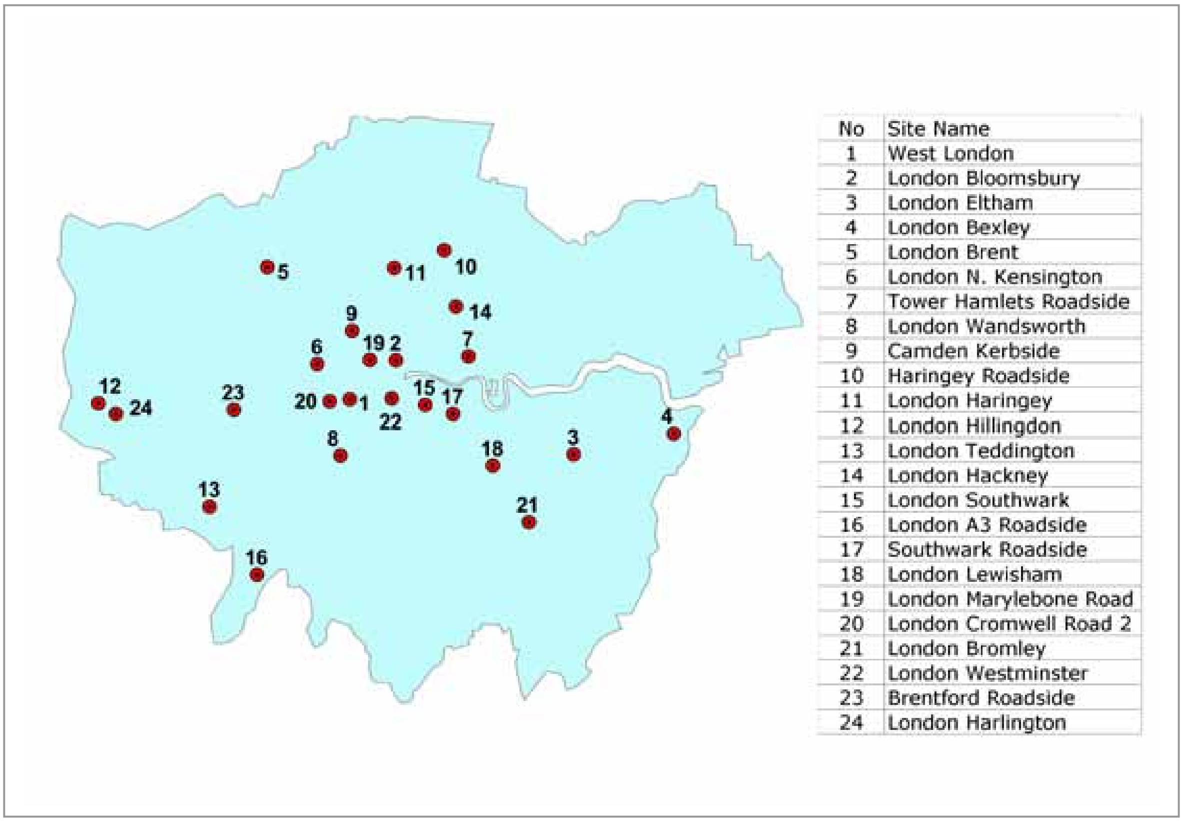


Figure 2.2 Automatic Sites, London

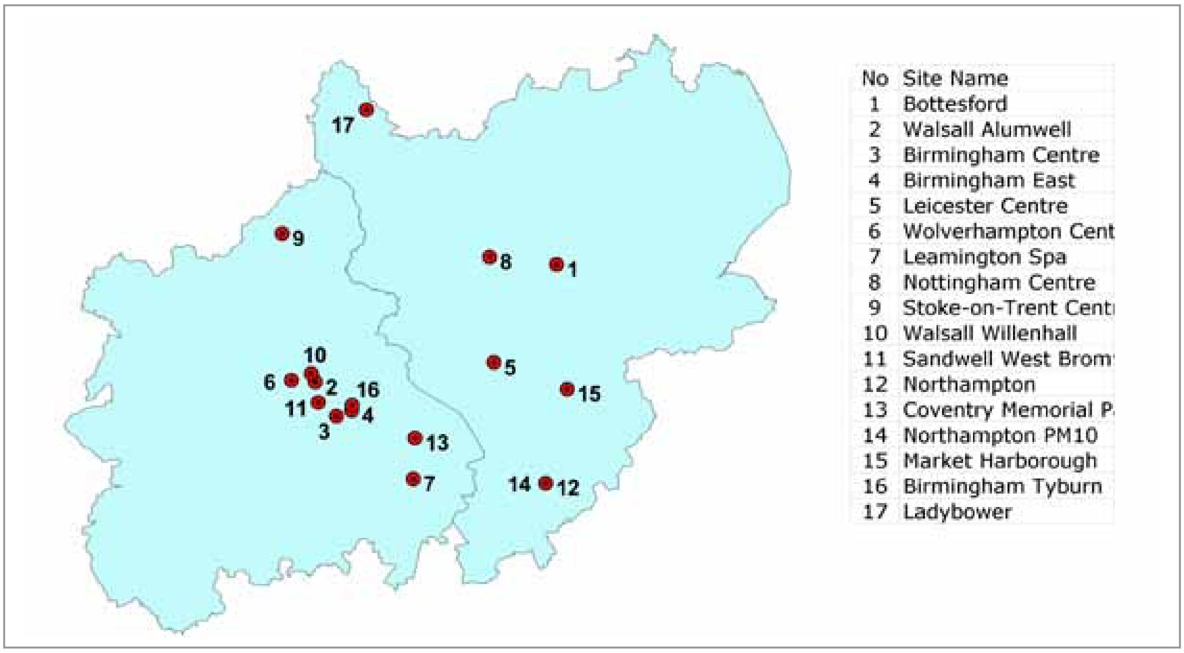


Figure 2.3 Automatic Sites, Midlands

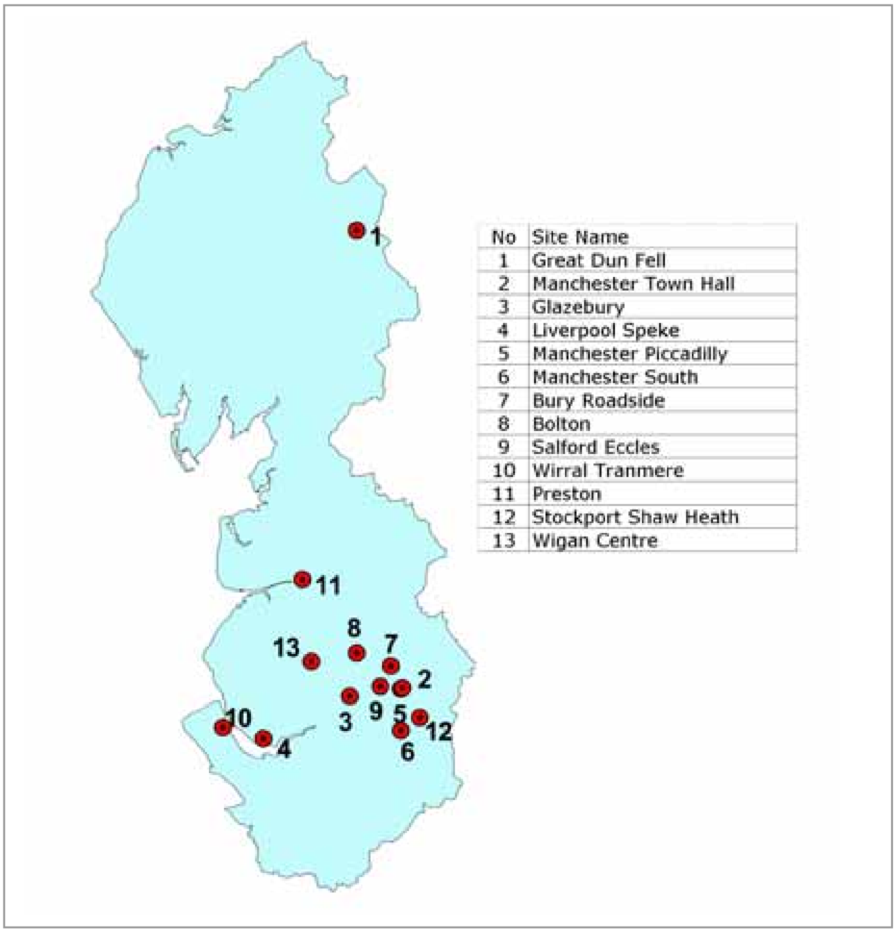


Figure 2.4 Automatic Sites, NW England

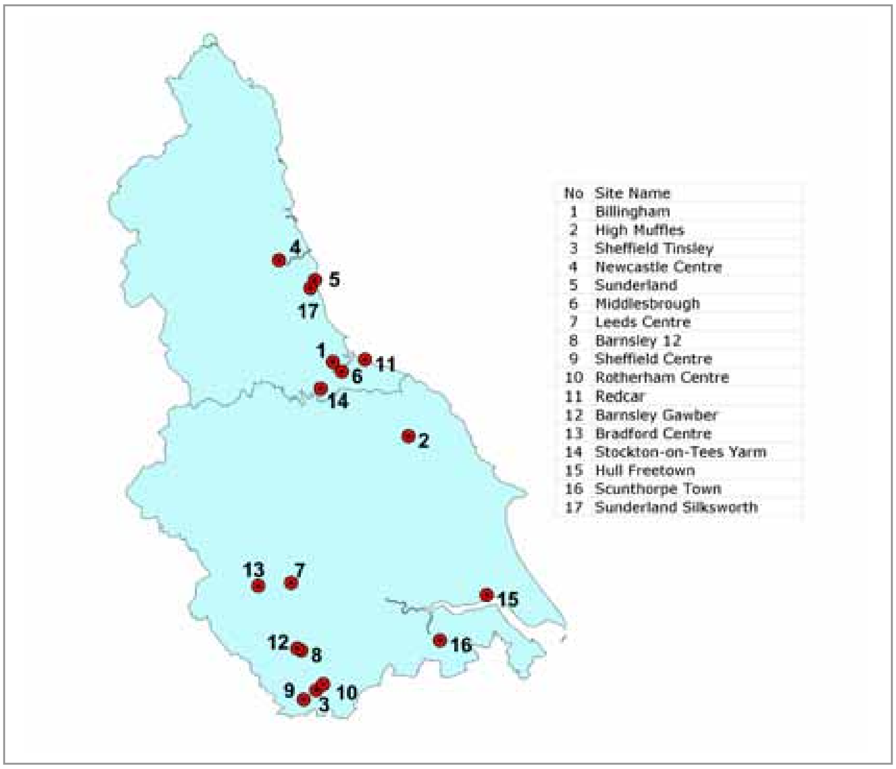


Figure 2.5 Automatic Sites, NE England

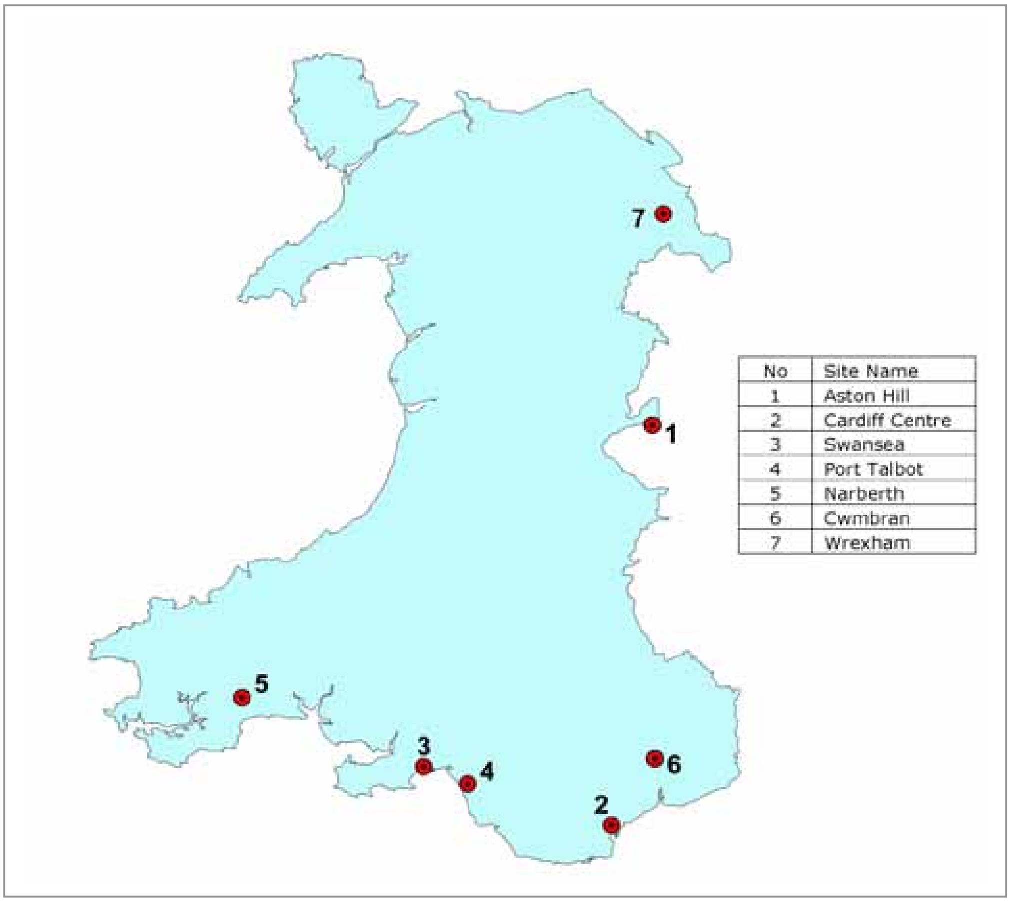


Figure 2.6 Automatic Sites, Wales

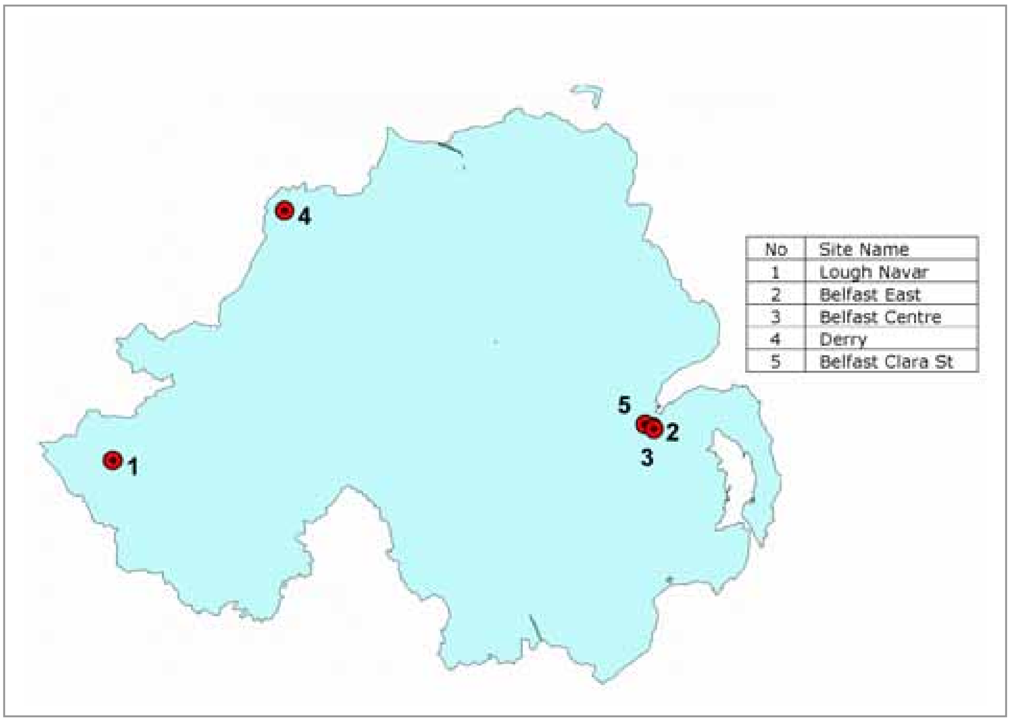


Figure 2.7 Automatic Sites, Northern Ireland

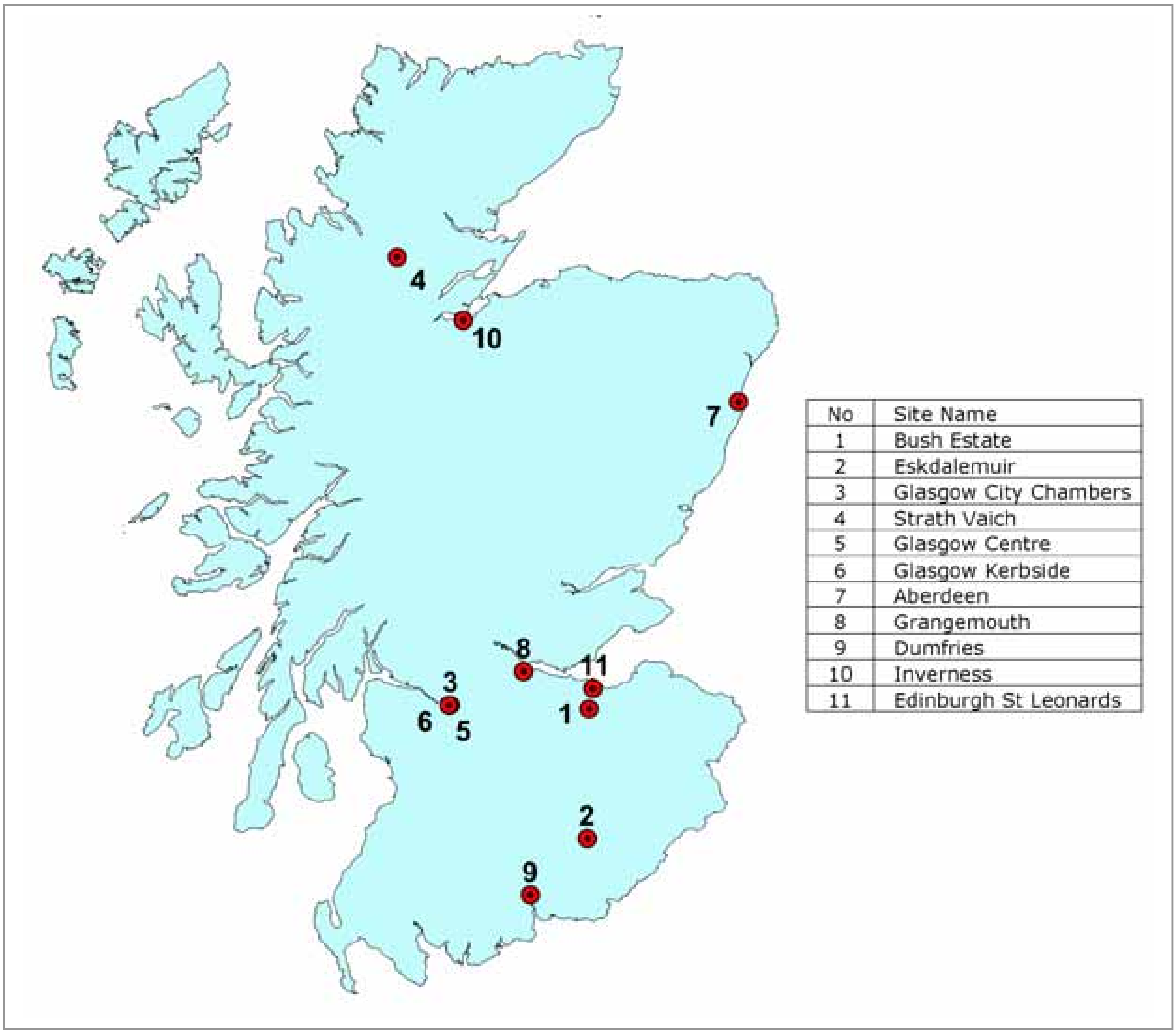


Figure 2.8 Automatic Sites, Scotland

Appendix 3- The UK's Automatic and Sampler-based Air Monitoring Networks

Here we provide a concise guide to the different UK air monitoring networks, their objectives and methodologies.

A 3.1 The Smoke and SO_2 Network

(Network managed and quality assured for Defra and the DAs by Netcen)

The Smoke and SO_2 Network was set up in 1961, to monitor progress in compliance with the Clean Air Acts, and formed the backbone of the UK's Air Quality monitoring for many years, prior to the widespread implementation of automatic monitoring techniques in the 1990s.

The objectives of the network are as follows:

- To monitor compliance with EC Directives relating to these pollutants
- To provide a representative assessment and analysis covering major population centres throughout the UK, with a wide spatial coverage
- To provide a long-term database, for the purposes for assessing trends and spatial distribution

The network uses well-established and reliable sampler methods to measure daily average concentrations of suspended particulate matter and sulphur dioxide. Suspended particulate matter is measured using the standard black smoke method. Sampled air is drawn through a filter paper, forming a smoke stain. The darkness of the smoke stain is measured using a reflectometer, and the ambient concentration determined from a standard calibration.

Sulphur dioxide is measured indicatively using the net acidity method. The sampled air is bubbled through dilute, acidified hydrogen peroxide solution, for absorption of sulphur dioxide. The ambient concentration is determined by titration of the solution back to its original pH of 4.5.

At the present time (June 2005), there are 101 sites located in urban areas of the UK.

There is a particularly long historical dataset from this network, with some sites operating since the early 1960s. It has provided an invaluable record of pollutant concentrations throughout the UK over four decades. Smoke data, in particular, are still widely used in health effect studies and other scientific work. As a record of the progress of the Clean Air Acts, the Network provides a clear example of how policy can successfully improve air quality nationwide.

A 3.2 The Nitrogen Dioxide Diffusion Tube Network

(Network managed and quality assured for Defra and the DAs by Netcen)

This large-scale sampler network was established in 1993. Its objective is to assess the spatial and temporal distribution of NO_2 concentrations in a variety of urban areas of the UK, ranging from the major cities to smaller towns.

Monthly average measurements are made using simple but cost-effective NO_2 diffusion tubes; these low-cost passive samplers ideal for indicative monitoring.

Diffusion tubes exposed by Local Authorities are analysed by analytical laboratories and the results forwarded to Netcen for central collation and processing. Netcen provides a centrally-managed system for the monitoring of NO_2 on a national scale.

There are currently 1213 sites in the Network, operated by 324 Local Authorities. All are in urban areas. Monthly measurements are routinely performed at four locations within each local authority:

- **Roadside**, 1-5m from the kerb of a busy road (2 sampling locations).

- **Urban Background** (2 sampling locations), >50m from any busy road and typically in a residential area.

The NO_2 Network forms a useful supplement to the AURN, offering excellent spatial coverage of this important traffic-related pollutant throughout the UK. In addition, this technique is useful for 'hot spot' identification; areas of high NO_2 concentration identified by this network may be prioritised for further monitoring, with more sophisticated automatic techniques.

A 3.3 The Automatic Urban and Rural Network (AURN)

(Network managed for Defra and the DAs by Casella Stanger and quality assured by Netcen)

The AURN is the largest UK automatic monitoring programme. It consists of automatic air quality monitoring stations measuring oxides of nitrogen (NOx), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO) and particles (PM_{10}). These are monitored on an hourly basis at measurement sites throughout the UK.

As of August 2005, the AURN consists of 123 monitoring sites. Of these, 60 are directly funded by Defra and the devolved administrations, and a further 63 affiliated sites are owned and operated by local authorities; 14 of these sites are also in the London Air Quality Network (LAQN). The network has grown dramatically since it was first established in 1992 (see Figure 1)

The major objectives of the network are as follows:

- Checking if statutory air quality standards and targets are met (e.g. EU Directives)
- Informing the public about air quality
- Providing information for local air quality review and assessments within the UK Air Quality Strategy
- Identifying long-term trends in air pollution concentrations
- Assessing the effectiveness of policies to control pollution

A number of organisations are involved in the day-to-day running of the network. Currently, the role of Central Management and Co-ordination Unit (CMCU) for the AURN is contracted to Casella Stanger, whilst the Environmental Research Group (ERG) of King's College London has been appointed as Management Unit for the London Air Quality Network (LAQN). AEA Technology's Netcen undertakes the role of Quality Assurance and Control Unit (QA/QC Unit) for the AURN. The responsibility for operating individual monitoring sites is assigned to local organisations, such as local authority Environmental Health Officers with relevant experience in the field. Calibration gases for the network are supplied by Air Liquide Ltd and are provided with a UKAS certificate of calibration by AEA Technology, Netcen.

The techniques used for monitoring within the AURN are summarised overleaf. These techniques represent the current state-of-the-art for automated monitoring networks and, with the exception of the automatic PM_{10} analysers, are the reference methods of measurement defined in the relevant EU Directives.

Additional monitors for NO_2, SO_2 and PM_{10} particulate matter were added to the AURN in 2001 and further monitors for CO were introduced in 2002. Additional monitors for O_3 and rural NOx have recently been installed to comply with the third Daughter Directive on Ozone. As $PM_{2.5}$ measurements are also required under the first Daughter Directive, 4 automatic analysers for $PM_{2.5}$ monitoring were incorporated into the AURN during 2003.

AURN Measurement Techniques (considered in greater detail in Part 2)

O_3	UV absorption
NO/NOx	Chemiluminescence
SO_2	UV fluorescence
CO	IR Absorption
PM_{10}	Tapered Element Oscillating Microbalance Beta Attenuation monitor Gravimetric monitor

There have been considerable changes in European air quality legislation in the last few years and the AURN has successfully expanded and evolved to conform to these new requirements.

A 3.4 The Acid Deposition and Rural SO_2 Monitoring Networks

(Managed and operated for Defra and the DAs by a consortium of CEH and Netcen)

These are closely related and share common sites; the two programmes are therefore discussed together here.

(i) The Acid Deposition Monitoring Network

The Acid Deposition Monitoring network (ADMN) was established in 1986 to monitor the composition of precipitation and hence to provide information on deposition of acidifying compounds in the United Kingdom. Its main emphasis has always been the assessment of potential impacts on UK ecosystems. Other measurements are also made within the programme - sulphur dioxide, nitrogen dioxide, particulate sulphate - to provide a more complete understanding of precipitation chemistry in the United Kingdom.

This network has evolved substantially over time. It was originally based on two sub-programmes- a ‘primary’ network providing high quality and high frequency data, which could be used to identify trends over time- and a ‘secondary’ network providing information on the spatial distribution of acid deposition in the UK. Originally, there were 9 primary and 59 secondary sampling sites. Subsequent changes made to the programme, including the incorporation of new measurement techniques for trace rural gases and altered sampling frequencies, have made this distinction less clearcut.

In 1999, 7 new sites were established to monitor rainwater composition in ecologically-sensitive areas and a new denuder-based sampler network of 12 sites was established to monitor nitric acid, other acid gases and aerosol components.

In 2003/4, the network covers the following measurements and sites:

The Acid Deposition Monitoring Network- site numbers and measured parameters

Precipitation Composition	– Rainwater sampling using a bulk collector on a ***fortnightly*** basis at 38 sites – Rainwater sampling using a bulk collector on a ***daily*** basis at one site
Sulphur Dioxide	– Sampled on a ***monthly*** basis at 8 sites
Particulate Sulphate	– Sampled on a ***daily*** basis at 5 sites
Nitrogen Dioxide	– Diffusion tube measurements on a ***monthly*** basis at 32 sites
Nitric Acid and Other Acid Gases	– Denuder measurements on a ***monthly*** basis at 12 sites

(ii) The Rural Sulphur Dioxide (SO_2) Network

The Rural Sulphur Dioxide (SO_2) network was established in 1991 to provide additional information on the spatial distribution of SO_2 at rural sites across the UK. The network originally comprised 31 sites at which concentrations of SO_2 were measured on a weekly basis using a hydrogen peroxide bubbler instrument and one site (Bush) at which daily measurements were made. Measurements were also made at a further 8 sites, which form part of the programme of measurements of the Acid Deposition Monitoring Network (see above).

The SO_2 concentrations which were measured in the late 1990s at some of the sites, especially the daily sites in remote areas, were at or below the Limit of Detection (LoD) of the hydrogen peroxide bubbler method. A new sampling method was required with a lower Limits of Detection while retaining data integrity and consistency. Following an intercomparison exercise at the Auchencorth Moss site near Edinburgh between September 1998 and May 1999, the choice of samplers to replace the bubbler method was limited to the denuder or the filter pack methods on the grounds of cost, improved sensitivity, method robustness, ease of operation and the quality of the measurements.

For practical reasons, it was decided to replace the bubbler method with the filter pack method and to make fortnightly measurements. The filter pack method was introduced into the network during 2001. At the end of 2003, the sampling period was changed from fortnightly to monthly at all SO_2 monitoring sites in the Rural SO_2 and Acid Deposition Monitoring Networks.

A 3.5 The Hydrocarbon monitoring networks

i) The Automatic Hydrocarbon Network

(Network managed and quality assured for Defra and the DAs by Netcen)

Automatic hourly measurements of speciated hydrocarbons, made using an advanced automatic gas chromatograph (VOCAIR), started in the UK in 1991. By 1995, monitoring had expanded considerably with the formation of a 13-site dedicated network measuring 26 species continuously at urban, industrial and rural locations. The focus in this measurement programme was two-fold: firstly to assess ambient concentrations of a range of Volatile Organic Compounds (VOCs) with significant photochemical oxidant formation potential, and secondly to measure two known genotoxic carcinogens (benzene and 1,3-butadiene) for comparison against emerging UK Air Quality Objectives. Data on these 'air toxics' was also regularly reported to the public.

The automatic hydrocarbon monitoring network, as originally constituted, used state-of-the-art measurement techniques, combined with advanced software techniques for signal processing and validation. It was the first network of its kind in the world. The Automatic Hydrocarbon Network operated successfully for 10 years before the programme was re-focussed, re-designed and simplified in 2002.

The UK Automatic Hydrocarbon Network currently consists of five sites, located at Cardiff, Glasgow, Harwell, London Eltham and London Marylebone Road. Three of these sites – Cardiff, Glasgow and Harwell- utilise an Environnment VOC71M analyser configured to measure and report the concentrations of 1,3-butadiene, benzene, toluene, ethylbenzene, (m+p)-xylene and o-xylene. Benzene data are used for comparison with the UK Air Quality Objectives and are also reported to the European Commission to fulfil requirements of the Benzene Daughter Directive; 1,3-butadiene data are used for comparison with UK Objectives.

The two London sites are fitted with automatic Perkin Elmer gas chromatographs measuring a wider range of VOCs, equivalent to that studied under the original measurement programme. Both instruments are capable of measuring and reporting at least 27 hydrocarbons. Measurements from all five sites will be reported to the European Commission, satisfying new requirements under the Ozone Daughter Directive for monitoring photochemical ozone precursors. Corresponding benzene and the 1,3-butadiene data are used for comparison with the UK Air Quality Objectives, whilst benzene data are reported to the European Commission.

Hourly benzene and 1,3-butadiene data from all sites continue to be reported to the public at large through a range of web, electronic, text and broadcast media.

ii) The Non-Automatic Hydrocarbon Network

(Managed and operated for Defra and the DAs by the National Physical Laboratory)

The UK Non-Automatic Hydrocarbon Network measures ambient benzene concentrations at 35 sites around the United Kingdom, as well as 1,3-butadiene at 10 of these locations. 1,3-Butadiene is measured at sites expected to have high concentrations of this carcinogenic pollutant, in order to assess compliance with the UK Air Quality Strategy Objective (2.25 $\mu g/m^3$ expressed as a running annual mean).

Benzene is also monitored to assess compliance with UK Objectives (between 3.25 and 16.25 $\mu g/m^3$ depending on area and compliance date, expressed as a running annual mean), as well as with the corresponding EC Air Quality Directive Limit Value (5 $\mu g/m^3$ annual average). Note that both species have Objectives and Limit Values expressed in the form of an annual average concentration, so that high time resolution is not required from the measurements.

Sampling is therefore undertaken for periods of a fortnight onto sorbent tubes containing Carbopack X. For benzene, the air is pumped through the sampling tubes using purpose-built pump units that switch between two tubes to produce two nominally identical samples covering each fortnight. For 1,3-butadiene, pairs of sorbent tubes sample the air passively (by diffusive processes) over the fortnight of sample exposure.

Every fortnight the tubes are changed, and the instruments checked by Local Site Operators, who send the exposed tubes to the network management unit for analysis.

Currently, all samplers are located at monitoring stations operated within the Automatic Urban and Rural Network (AURN)- discussed separately in Section A 3.3. Measurements began over the period December 2001 to August 2002, following the decommissioning of the first generation Automatic Hydrocarbon Network, which provided on-line measurements of hourly data for 26 hydrocarbon species at 13 sites (see A 3.5). The data obtained now provide a useful addition to automatic measurements undertaken in the current 5-site programme.

The fortnightly pumped measurement method for benzene was developed specifically for this network, following the requirement of the EU Directive that, in view of their inherently lower measurement uncertainty, measurements for reporting purposes be made by pumped sampling rather than by diffusive sampling. Previously, pumped sampling for benzene had been geared to short periods of a day or less. The combination of a suitable sorbent material and sound engineering in the pump control box has led to a very successful method.

The EU instructs CEN, the European Committee for Standardisation, to set out standard methods to be used to comply with Directives. The CEN benzene standards (prEN 14662, 5 parts) are nearing publication, and will include the pumped method used in this network.

A 3.6 The PAH and TOMPs Networks

(Networks managed and operated for Defra and the DAs by Netcen and Lancaster University respectively since March 2004)

These two programmes are highly integrated, being based on a 24-site sampler network covering a broad range of representative urban, industrial, semi-rural and rural location types; 18 of these are operated wholly within the PAHs programme, whilst a further 6 sites are operated as part of the PAH and TOMPS monitoring networks.

i) PAHs

Polycyclic aromatic hydrocarbons (PAHs) are a large group of persistent bioaccumulative organic compounds with toxic or human carcinogenic effects; they are produced through industrial, chemical and combustion processes.

There are three major policy drivers and data uses for this programme:

- The establishment of a UK Air Quality Objective for PAHs, based in turn on the recommendations of the Expert Panel on Air Quality Standards (EPAQS) for an annual air quality standard of 0.25 ng benzo[a]pyrene /m^3.
- The European Community’s fourth Air Quality Daughter Directive (2005/107/EC), which includes a target value for benzo[a]pyrene as a representative PAH as an annual average of 1 ng /m^3.
- The UK’s decision to sign, and ratify when possible, the UNECE protocol on Persistent Organic Pollutants (POPs), which includes PAHs. Under the protocol, there is a requirement for signatories to control and assess the long-range transport of specified PAHs.

All these policy imperatives require sound data on ambient concentrations, trends and distributions of PAHs in the environment.

Modified Anderson GP1-S pesticide samplers, capturing both gas and particle-phase PAHs on glass fibre and polyurethane filters, are deployed at all 18 UK network locations. Careful extraction of the filter and foam media and subsequent analysis by Gas Chromatography/Mass Spectroscopy (GC/MS) provides data on 16 PAH species.

ii) TOMPs

Toxic Organic Micropollutants (TOMPs)- conventionally including Polychlorinated Dibenzo-*p*-Dioxins, Polychlorinated Dibenzofurans (PCDD/Fs), PAHs as above, and Polychlorinated Biphenyls (PCBs). PCDD/Fs and PAHs are formed as unwanted by-products during various chemical, industrial and combustion processes. The PCBs were previously manufactured for use in a wide range of electrical and other products until the mid 1980s. These highly toxic and persistent species are ubiquitous in the environment, but normally at extremely low concentrations.

The TOMPs network provides data to inform the public of air quality and information to support the development of policy to protect the environment. The specific aims of the TOMPs programme are:

- To identify sources of TOMPs in the UK’s atmosphere
- To quantify sources that are regarded as potentially significant
- To measure concentrations of TOMPs in ambient air in UK cities, in order to assess both human exposure and the relationship between source emissions and levels in the ambient atmosphere.
- The UK’s decision to sign, and ratify when possible, the UNECE protocol on Persistent Organic Pollutants (POPs), which includes PAHs. Under the protocol,

there is a requirement for signatories to control and assess the long-range transport of specified PAHs
- The network is also used to investigate the behaviour of newly identified persistent organic pollutants such as brominated flame retardants and other industrial chemicals.

The TOMPS network measures concentrations of these trace organic species at six sites. Samples from these sites are then analysed for PAHs as part of the PAH network. The sampling method is again based around the use of a modified Andersen GPS-1 sampler, with subsequent chemical analysis requiring the use of a range of sophisticated chemical analysis techniques including gas chromatography coupled with high-resolution mass spectrometry.

A 3.7 UK Heavy Metals Monitoring Networks

(i) UK urban/industrial network (previously the Lead, Multi-element and Industrial Metals Networks)

(Network managed and operated for Defra and the DAs by the National Physical Laboratory)

The UK Government has in the past funded separate long-term monitoring programmes responding to specific needs of EC Directives in relation to toxic and industrial metals. These originally included:

- Five urban multi-element monitoring sites providing measurements of 9 important trace elements (Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn and V)
- Eight sites for the monitoring of lead-in-petrol (2 rural, 3 urban and 3 kerbside) and
- Eight sites operating in three industrial areas monitoring lead - Walsall (IMI and Brookside works) and Newcastle (Elswick works).

The EU Framework Directive (96/62/EC)[3] establishes a framework under which, by means of Daughter Directives, the EU can establish limit and target values for concentrations in ambient air of certain pollutants. The First Daughter Directive (99/30/EC)[28] sets a Limit Value for lead in air concentrations at 0.5 $\mu g/m^3$, expressed as an annual mean to be achieved by 1st January 2005.

The agreement reached between the European Parliament and the Environment Council on the Directive on the Quality of Petrol and Diesel Fuels led to the ban of sales of leaded petrol in the UK with effect from 1 January 2000. This has, in turn, led to a dramatic decline in ambient lead levels in many UK environments. As a consequence, some monitoring sites, which only measured lead concentrations, have since been closed.

In 2000, a year-long monitoring network was established at 30 industrial site locations across the UK in order to establish the UK's position with respect to the requirements of the 4th Daughter Directive which was then being drafted with the aim of setting limit values for arsenic, cadmium, nickel and mercury. Results of this programme showed that further monitoring at a number of sites was required in order to establish compliance with the proposed Target Values. Monitoring continues currently at five of these sites – Avonmouth, Hallen Village, Swansea, Sheffield and Runcorn.

The 4th Daughter Directive (2004/107/EC) was published in the Official Journal of the European Commission on 26th January 2005. The 4th Daughter Directive sets 'target values' for arsenic, cadmium, nickel (and polycyclic aromatic hydrocarbons) in the PM_{10} particulate fraction of ambient air.

Member States must transpose the 4th Daughter Directive into national law by 15th February 2007. The European Commission will report on its implementation by 31st December 2010. Governments must report to the Commission on zones and agglomerations where the target values are exceeded with the first such reports being required by 30th September 2008. The 4th Daughter Directive also requires monitoring of mercury although no limit or target values have been set.

The disparate nature of the historic monitoring networks for heavy metals in the UK, which have individually responded to specific Directive needs, resulted in differences in practice between networks and did not permit UK-wide reporting in a consistent manner. In 2003, all monitoring was rationalised into a single integrated network (with the exception of the Rural Trace Element sites), referred to as the UK Heavy Metals Monitoring Network. Sampling is now undertaken for weekly periods at sites on the PM_{10} fraction of particulates using R&P Partisol 2000 samplers. Analysis of samples occurs with UKAS-accredited ICP-MS analysis, with acid digest techniques consistent with the draft CEN WG14 reference method, which has now been sent out to Member States for final vote. Consistency in approach has been achieved with historical data collection and analyses through thorough equivalence exercises.

Since September 2004, the number of elements measured at the old Industrial Metals sites has been increased to ensure there is consistency across the Network. All 17 sites now monitor for As, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Pt, V and Zn. Additionally, measurements are made for ambient vapour phase mercury concentrations at 13 sites.

(ii) The Rural Heavy Metals and Mercury Network

(Network managed and operated for Defra and the DAs by Centre for Ecology and Hydrology)

The Rural Trace Element monitoring has been expanded to 10 sites where the PM_{10} fraction of particulates have been collected weekly using Thermo FH95 single or FH95SEQ sequential samplers, together with monthly collections of precipitation for accredited ICP-MS analysis. In addition a further three sites collect precipitation samples only and two more sites collect precipitation and cloud water samples.

At the 10 primary sites, newly designed samplers have also been set up to collect Mercury in air and in Mercury in precipitation. The Mercury in air samples are analysed using a TEKRAN system that is also continuously operating at the Auchencorth site to provide speciation data for the different forms of Mercury in the atmosphere. The Mercury in precipitation is analysed using a Cold Vapour Atomic Fluorescence Spectrometer (PSA Ltd) with a Analytical detection limit = 0.8ng l^{-1} (99% confidence)

A 3.8 The National Ammonia Monitoring Network

(Managed and operated for Defra and the DAs by CEH- Centre for Ecology and Hydrology

The National Ammonia Monitoring Network (NAMN) was established with approximately 70 sites in 1996. Its objective is to provide long-term estimates of the spatial distribution of ammonia concentrations across the UK, which may be used for:

- Estimating dry deposition fluxes of ammonia, and
- Assessment of models.

A 2-tiered approach was used, which consisted of a baseline network of around 50 sites sampling ammonia using the active DELTA (DEnuder for Long-Term Atmospheric sampling) system (where power is available), while a secondary network of passive diffusion tubes explored air concentration variability in high concentration areas, with the method calibrated at 10 sites against the DELTA approach. In both cases, sampling is performed on a monthly basis.

Further methodological improvements were introduced over time. In 1999, the DELTA method was extended to allow sampling of ammonium aerosol at all active sites. This was followed by the establishment of the Nitric Acid Monitoring Network at 12 of the active sites, using an extension of the DELTA method to additionally sample gaseous $HNO_3/SO_2/HCl$, aerosol $NO_3^-/SO_4^{2-}/Cl^-$ and the base cations $Ca^{2+}/Mg^{2+}/Na^+$, also on a monthly basis.

In 2000, a new improved passive sampling method was developed and introduced; the Adapted Low-cost, Passive High Absorption (ALPHA) sampler (LOD = 0.02 µg NH3 m-3) replaced the less sensitive diffusion tube (LOD = 1 µg NH3 m-3) in the network.

Accompanying these changes has been an increase in the number of monitoring sites to 94 - to improve the interpolated concentration field for NH_3 - and a reduction in the number of sites monitoring NH_4^+, as this is a secondary pollutant with less spatial variability than NH_3.

Overall, the network structure currently consists of:

Site type	**Number**
DELTA Sites	57
Sampling aerosol NH_4^+	43
ALPHA sites	49
Intercomparison sites with both DELTA & ALPHA samplers	12
Total number of sites	94

Appendix 4- Analysis of statistically significant trends in UK air pollution levels

Here we summarise those measurement sites with over five years of measurements having statistically significant trends; long-running sites with trends extending over a period of 10 years or more are highlighted.

Pollutant	Site	Type	Parameter	Start Year	End Year	Slope	Low Range	High Range	No. Years
1,3-Butadiene µg m-^{3} / yr									
No trends									
Benzene µg m-^{3} / yr									
	Harwell	Rural	Annual mean	1995	2004	-0.11	-0.13	-0.07	10
	Harwell	Rural	98 %ile	1995	2004	-0.4	-0.58	-0.3	10
Carbon Monoxide mg m-^{3} / yr									
	Belfast Centre	Urban Centre	Annual mean	1992	2004	-0.1	-0.1	-0.1	13
	Belfast Centre	Urban Centre	98 %ile	1992	2004	-0.3	-0.3	-0.2	13
	Birmingham Centre	Urban Centre	Annual mean	1992	2004	0	-0.1	0	13
	Birmingham Centre	Urban Centre	98 %ile	1992	2004	-0.2	-0.2	-0.1	13
	Birmingham East	Urban Backgr.	Annual mean	1994	2004	0	-0.1	0	11
	Birmingham East	Urban Backgr.	98 %ile	1994	2004	-0.2	-0.2	-0.1	11
	Bristol Centre	Urban Centre	Annual mean	1993	2004	0	-0.1	0	12
	Bristol Centre	Urban Centre	98 %ile	1993	2004	-0.2	-0.2	-0.1	12
	Cardiff Centre	Urban Centre	Annual mean	1992	2004	0	-0.1	0	13
	Cardiff Centre	Urban Centre	98 %ile	1992	2004	-0.2	-0.2	-0.1	13
	Glasgow City Chambers	Urban Backgr.	Annual mean	1990	2004	-0.1	-0.1	0	15
	Glasgow City Chambers	Urban Backgr.	98 %ile	1990	2004	-0.3	-0.4	-0.2	15
	Leeds Centre	Urban Centre	Annual mean	1993	2004	0	-0.1	0	12
	Leeds Centre	Urban Centre	98 %ile	1993	2004	-0.2	-0.2	-0.1	12
	Leicester Centre	Urban Centre	98 %ile	1994	2004	-0.1	-0.2	-0.1	11
	London Bexley	Suburban	Annual mean	1994	2004	0	0	0	11
	London Bexley	Suburban	98 %ile	1994	2004	-0.2	-0.2	-0.1	11
	London Bloomsbury	Urban Centre	Annual mean	1992	2004	0	-0.1	0	13
	London Bloomsbury	Urban Centre	98 %ile	1992	2004	-0.2	-0.2	-0.1	13
	Manchester Town Hall	Urban Backgr.	Annual mean	1992	2004	0	-0.1	0	12
	Manchester Town Hall	Urban Backgr.	98 %ile	1992	2004	-0.1	-0.3	-0.1	12
	Middlesbrough	Urban Backgr.	98 %ile	1995	2004	-0.1	-0.1	0	10
	Newcastle Centre	Urban Centre	Annual mean	1992	2004	-0.1	-0.1	0	13
	Newcastle Centre	Urban Centre	98 %ile	1992	2004	-0.2	-0.2	-0.1	13
	Sheffield Tinsley	Urban Ind.	98 %ile	1992	2004	-0.2	-0.2	-0.1	13
	Southampton Centre	Urban Centre	Annual mean	1994	2004	-0.1	-0.1	0	11
	Southampton Centre	Urban Centre	98 %ile	1994	2004	-0.2	-0.3	-0.2	11
	Swansea	Urban Centre	Annual mean	1995	2004	0	-0.1	0	10
	Swansea	Urban Centre	98 %ile	1995	2004	-0.2	-0.2	-0.1	10
	West London	Urban Backgr.	Annual mean	1990	2004	-0.1	-0.1	-0.1	15
	West London	Urban Backgr.	98 %ile	1990	2004	-0.3	-0.4	-0.2	15
Nitrogen Dioxide µg m-^{3} / yr									
	Belfast Centre	Urban Centre	Annual mean	1992	2004	-1.2	-1.5	-1	13
	Belfast Centre	Urban Centre	98 %ile	1992	2004	-2.5	-3.5	-1.3	13
	Billingham	Urban Ind.	Annual mean	1987	2004	-0.6	-0.9	-0.4	18
	Billingham	Urban Ind.	98 %ile	1987	2004	-0.2	-2	-0.1	18
	Birmingham Centre	Urban Centre	Annual mean	1993	2004	-1.8	-2	-1	12
	Birmingham Centre	Urban Centre	98 %ile	1993	2004	-3.5	-4.5	-2	12
	Birmingham East	Urban Backgr.	98 %ile	1994	2004	-2.7	-5	0	11
	Bristol Centre	Urban Centre	Annual mean	1993	2004	-1.5	-1.6	-1	12
	Bristol Centre	Urban Centre	98 %ile	1993	2004	-3	-3.6	-1.9	12
	Cardiff Centre	Urban Centre	Annual mean	1992	2004	-1.3	-1.6	-1	13
	Cardiff Centre	Urban Centre	98 %ile	1992	2004	-2.4	-2.9	-1.2	13
	Glasgow City Chambers	Urban Backgr.	Annual mean	1987	2004	-0.1	-0.6	0	18
	Ladybower	Rural	Annual mean	1991	2004	-0.8	-1.1	-0.4	14
	Ladybower	Rural	98 %ile	1991	2004	-2	-3	-0.5	14
	Leeds Centre	Urban Centre	Annual mean	1993	2004	-2.3	-2.6	-1.2	12
	Leeds Centre	Urban Centre	98 %ile	1993	2004	-2.4	-3.5	0	12
	Leicester Centre	Urban Centre	Annual mean	1994	2004	-1.2	-1.4	-0.5	11
	Leicester Centre	Urban Centre	98 %ile	1994	2004	-2.3	-2.8	-0.5	11
	London Bexley	Suburban	Annual mean	1994	2004	-1	-1.6	-0.4	11
	London Bexley	Suburban	98 %ile	1994	2004	-2.2	-4	0	11
	London Bloomsbury	Urban Centre	98 %ile	1992	2004	-3.2	-5.7	-0.5	12
	Lullington Heath	Rural	Annual mean	1991	2004	-0.5	-0.7	-0.2	14
	Lullington Heath	Rural	98 %ile	1991	2004	-1.8	-2.5	-1.1	14
	Manchester Town Hall	Urban Backgr.	Annual mean	1987	2004	-0.7	-1.2	-0.5	18
	Manchester Town Hall	Urban Backgr.	98 %ile	1987	2004	-3.3	-4	-1.5	18

Pollutant	Site	Type	Parameter	Start Year	End Year	Slope	Low Range	High Range	No. Years
	Middlesbrough	Urban Ind.	Annual mean	1995	2004	-1	-1.5	-0.3	10
	Middlesbrough	Urban Ind.	98 %ile	1995	2004	-2.2	-2.7	-0.3	10
	Newcastle Centre	Urban Centre	Annual mean	1992	2004	-1.9	-2.8	-1.3	13
	Newcastle Centre	Urban Centre	98 %ile	1992	2004	-3.3	-6.5	-1.6	13
	Sheffield Tinsley	Urban Ind.	Annual mean	1991	2004	-1.3	-1.6	-0.8	14
	Sheffield Tinsley	Urban Ind.	98 %ile	1991	2004	-3	-5.1	-1.9	14
	Southampton Centre	Urban Centre	Annual mean	1994	2004	-1.2	-1.8	-0.7	11
	Southampton Centre	Urban Centre	98 %ile	1994	2004	-2.8	-4.2	-2	11
	Walsall Alumwell	Urban Backgr.	Annual mean	1987	2004	-1	-1.3	-0.6	18
	Walsall Alumwell	Urban Backgr.	98 %ile	1987	2004	-2.3	-2.6	-0.8	18
	West London	Urban Backgr.	Annual mean	1987	2004	-1.4	-1.8	-1	18
	West London	Urban Backgr.	98 %ile	1987	2004	-4.2	-5.6	-3	18
Nitrogen Oxides µg m-^{3} / yr									
	Belfast Centre	Urban Centre	Annual mean	1992	2004	-3.2	-4.4	-2	13
	Belfast Centre	Urban Centre	98 %ile	1992	2004	-14.5	-27.8	-7.5	13
	Billingham	Urban Ind.	Annual mean	1987	2004	-2	-2.3	-1.1	18
	Billingham	Urban Ind.	98 %ile	1987	2004	-7.4	-12	-3.9	18
	Birmingham Centre	Urban Centre	Annual mean	1993	2004	-4	-4.5	-3	12
	Birmingham Centre	Urban Centre	98 %ile	1993	2004	-16.7	-18	-8.8	12
	Birmingham East	Urban Backgr.	Annual mean	1994	2004	-3.3	-4.7	-1	11
	Birmingham East	Urban Backgr.	98 %ile	1994	2004	-22.3	-31.3	-7.7	11
	Bristol Centre	Urban Centre	Annual mean	1993	2004	-4	-6.8	-1.7	12
	Bristol Centre	Urban Centre	98 %ile	1993	2004	-14.7	-31.5	-3.8	12
	Cardiff Centre	Urban Centre	Annual mean	1992	2004	-4.1	-5.1	-2.5	13
	Cardiff Centre	Urban Centre	98 %ile	1992	2004	-19.3	-23	-12	13
	Glasgow City Chambers	Urban Backgr.	Annual mean	1987	2004	-5.3	-5.3	-3.4	18
	Glasgow City Chambers	Urban Backgr	98 %ile	1987	2004	-26.1	-36	-17	18
	Ladybower	Rural	Annual mean	1991	2004	-1	-1.5	-0.5	14
	Ladybower	Rural	98 %ile	1991	2004	-4.7	-6.4	-1.8	14
	Leeds Centre	Urban Centre	Annual mean	1993	2004	-6.6	-8.4	-4.3	12
	Leeds Centre	Urban Centre	98 %ile	1993	2004	-24.3	-32	-6.8	12
	Leicester Centre	Urban Centre	Annual mean	1994	2004	-2.8	-3.7	-1	11
	Leicester Centre	Urban Centre	98 %ile	1994	2004	-12.7	-23.3	-4.1	11
	London Bexley	Suburban	Annual mean	1994	2004	-4.5	-5.5	-2	11
	London Bexley	Suburban	98 %ile	1994	2004	-26.7	-36.5	-6.8	11
	London Bloomsbury	Urban Centre	Annual mean	1992	2004	-5.4	-6.7	-2.3	13
	London Bloomsbury	Urban Centre	98 %ile	1992	2004	-16.6	-21.3	-10	13
	Lullington Heath	Rural	Annual mean	1991	2004	-0.6	-0.8	-0.3	14
	Lullington Heath	Rural	98 %ile	1991	2004	-3.5	-4	-2	14
	Manchester Town Hall	Urban Backgr.	Annual mean	1987	2004	-5	-5	-3.1	18
	Manchester Town Hall	Urban Backgr.	98 %ile	1987	2004	-23.8	-30	-15.2	18
	Newcastle Centre	Urban Centre	Annual mean	1992	2004	-5.6	-8	-4.4	13
	Newcastle Centre	Urban Centre	98 %ile	1992	2004	-22.4	-34.4	-15.6	13
	Sheffield Tinsley	Urban Ind.	Annual mean	1991	2004	-7.1	-9	-5.7	14
	Sheffield Tinsley	Urban Ind.	98 %ile	1991	2004	-27.4	-42	-12.9	14
	Southampton Centre	Urban Centre	Annual mean	1994	2004	-5	-6	-3	11
	Southampton Centre	Urban Centre	98 %ile	1994	2004	-23.3	-31.4	-12.2	11
	Walsall Alumwell	Urban Backgr.	Annual mean	1987	2004	-5.3	-6.3	-4	18
	Walsall Alumwell	Urban Backgr.	98 %ile	1987	2004	-25.9	-31.8	-16.3	18
	West London	Urban Backgr.	Annual mean	1987	2004	-6.8	-8.3	-5.6	18
	West London	Urban Backgr.	98 %ile	1987	2004	-25.4	-42.1	-20	18
Ozone µg m-^{3} / yr									
	Belfast Centre	Urban Centre	Annual mean	1992	2004	1.1	0	1.1	13
	Birmingham Centre	Urban Centre	Annual mean	1992	2004	1.2	0.6	1.3	13
	Birmingham East	Urban Backgr	Annual mean	1994	2004	1	0	1.2	11
	Bottesford	Suburban	Annual mean	1981	2004	0.5	0	0.7	24
	Bristol Centre	Urban Centre	Annual mean	1993	2004	0.5	0	1	12
	Bush Estate	Rural	Annual mean	1986	2004	0.3	0	0.6	19
	Cardiff Centre	Urban Centre	Annual mean	1992	2004	1.2	0.7	1.5	13
	Great Dun Fell	Rural	Annual mean	1987	2004	0.4	0.1	0.6	14
	High Muffles	Rural	98 %ile	1988	2004	-1.4	-2.3	-0.2	17
	Leeds Centre	Urban Centre	Annual mean	1993	2004	1	0.5	1.5	12
	Leeds Centre	Urban Centre	98 %ile	1993	2004	1.2	0	2	12
	Leicester Centre	Urban Centre	Annual mean	1994	2004	0.3	0	1	11
	London Bexley	Suburban	Annual mean	1995	2004	0.8	0.3	1.3	10
	London Bloomsbury	Urban Centre	Annual mean	1992	2004	0.6	0.3	1	13
	Lough Navar	Remote	98 %ile	1987	2004	-0.9	-0.9	0	18
	Newcastle Centre	Urban Centre	Annual mean	1992	2004	0.9	0.7	1.3	11
	Newcastle Centre	Urban Centre	98 %ile	1992	2004	1.3	0	2.3	11
	Sibton	Rural	98 %ile	1977	2004	-0.9	-2	-0.2	26
	Southampton Centre	Urban Centre	Annual mean	1994	2004	0.5	0	1.2	11
	Strath Vaich	Remote	Annual mean	1987	2004	0.1	0.1	0.8	18

Pollutant	Site	Type	Parameter	Start Year	End Year	Slope	Low Range	High Range	No. Years
PM10 Particulate Matter µg m-3 / yr									
	Belfast Centre	Urban Centre	Annual mean	1992	2004	-1	-1.3	-0.8	13
	Belfast Centre	Urban Centre	98 %ile	1992	2004	-3.6	-7	-2.7	13
	Birmingham Centre	Urban Centre	Annual mean	1992	2004	-0.9	-1	-0.5	13
	Birmingham Centre	Urban Centre	98 %ile	1992	2004	-3.1	-4.4	-2	13
	Birmingham East	Urban Backgr.	Annual mean	1994	2004	-0.8	-1.2	0	10
	Birmingham East	Urban Backgr.	98 %ile	1994	2004	-3.6	-4.8	-0.8	10
	Bristol Centre	Urban Centre	Annual mean	1993	2004	-0.8	-1	-0.3	12
	Bristol Centre	Urban Centre	98 %ile	1993	2004	-2.3	-3.9	-1.3	12
	Cardiff Centre	Urban Centre	Annual mean	1993	2004	-0.8	-1.5	-0.2	12
	Cardiff Centre	Urban Centre	98 %ile	1993	2004	-2.6	-5.7	-0.8	12
	Leeds Centre	Urban Centre	Annual mean	1993	2004	-1.2	-1.3	-0.5	12
	Leeds Centre	Urban Centre	98 %ile	1993	2004	-4.1	-5.5	-2	12
	Leicester Centre	Urban Centre	Annual mean	1994	2004	-0.5	-1.2	-0.1	11
	Leicester Centre	Urban Centre	98 %ile	1994	2004	-1.7	-4.2	-0.3	11
	London Bexley	Suburban	Annual mean	1994	2004	-0.8	-1	0	11
	London Bexley	Suburban	98 %ile	1994	2004	-2.7	-3.9	-0.5	11
	London Bloomsbury	Urban Centre	Annual mean	1992	2004	-1	-1.2	-0.5	12
	London Bloomsbury	Urban Centre	98 %ile	1992	2004	-3.8	-4.6	-2	12
	Newcastle Centre	Urban Centre	Annual mean	1992	2004	-1.4	-2	-1	13
	Newcastle Centre	Urban Centre	98 %ile	1992	2004	-4.9	-6.4	-3	13
	Southampton Centre	Urban Centre	Annual mean	1994	2004	-0.5	-0.8	0	11
	Southampton Centre	Urban Centre	98 %ile	1994	2004	-2	-3	-0.3	11
PM2.5 Particulate Matter µg m-3 / yr									
No trends									
Sulphur Dioxide µg m-3 / yr									
	Barnsley 12	Urban Backgr.	Annual mean	1994	2004	-1.7	-2.9	-1	11
	Barnsley 12	Urban Backgr.	98 %ile	1994	2004	-7.8	-10.6	-2.5	11
	Belfast Centre	Urban Centre	Annual mean	1992	2004	-4.3	-4.7	-3	13
	Belfast Centre	Urban Centre	98 %ile	1992	2004	-19.7	-20.6	-12.2	13
	Belfast East	Urban Backgr.	Annual mean	1990	2004	-5.5	-6	-4.9	15
	Belfast East	Urban Backgr.	98 %ile	1990	2004	-25.6	-31.7	-20.3	15
	Birmingham Centre	Urban Centre	Annual mean	1992	2004	-1.8	-2.5	-1.3	13
	Birmingham Centre	Urban Centre	98 %ile	1992	2004	-8.6	-11.2	-6.8	13
	Birmingham East	Urban Backgr.	Annual mean	1994	2004	-1.2	-1.5	-0.6	11
	Birmingham East	Urban Backgr.	98 %ile	1994	2004	-5.7	-7.9	-3.4	11
	Bristol Centre	Urban Centre	Annual mean	1993	2004	-1.2	-1.7	-1	12
	Bristol Centre	Urban Centre	98 %ile	1993	2004	-3.8	-6.8	-2.5	12
	Cardiff Centre	Urban Centre	Annual mean	1992	2004	-1.2	-1.3	-1	13
	Cardiff Centre	Urban Centre	98 %ile	1992	2004	-4.8	-5.5	-4	13
	Ladybower	Rural	Annual mean	1989	2004	-1.4	-1.8	-1	16
	Ladybower	Rural	98 %ile	1989	2004	-6.7	-9.4	-5.7	16
	Leeds Centre	Urban Centre	Annual mean	1993	2004	-1.6	-2.4	-1.2	12
	Leeds Centre	Urban Centre	98 %ile	1993	2004	-7.5	-12.3	-5	12
	Leicester Centre	Urban Centre	Annual mean	1994	2004	-1	-2	-0.8	11
	Leicester Centre	Urban Centre	98 %ile	1994	2004	-5.8	-6.9	-4.3	11
	London Bexley	Suburban	Annual mean	1994	2004	-1.5	-2.3	-0.7	11
	London Bexley	Suburban	98 %ile	1994	2004	-10.2	-11.2	-1.7	11
	London Bloomsbury	Urban Centre	Annual mean	1992	2004	-2.2	-2.5	-2	13
	London Bloomsbury	Urban Centre	98 %ile	1992	2004	-9.7	-10.8	-9	13
	Lullington Heath	Rural	Annual mean	1988	2004	-0.4	-0.6	-0.2	14
	Lullington Heath	Rural	98 %ile	1988	2004	-2.3	-3.3	-1.3	14
	Middlesbrough	Urban Ind.	Annual mean	1995	2004	-1.2	-1.5	-1	10
	Middlesbrough	Urban Ind.	98 %ile	1995	2004	-4.4	-7.3	-3.8	10
	Newcastle Centre	Urban Centre	Annual mean	1992	2004	-1.6	-1.8	-1	13
	Newcastle Centre	Urban Centre	98 %ile	1992	2004	-8.9	-9.3	-5.5	13
	Southampton Centre	Urban Centre	Annual mean	1994	2004	-0.7	-1	-0.2	11
	Southampton Centre	Urban Centre	98 %ile	1994	2004	-3.5	-4	-0.7	11
	Sunderland	Urban Backgr.	Annual mean	1993	2004	-1	-1.3	-0.7	11
	Sunderland	Urban Backgr.	98 %ile	1993	2004	-5.4	-8	-3.9	11
	Swansea	Urban Centre	Annual mean	1995	2004	-2	-2.2	-1	10
	Swansea	Urban Centre	98 %ile	1995	2004	-7.6	-10	-4.3	10

Appendix 5- Listing of current UK, European and WHO Air Quality Criteria

Here we summarise the UK Air Quality Strategy Standards and Objectives, together with corresponding European Community Directive Limit and Target Values and World Health Organisation advisory Guidelines for the major pollutants.

Nitrogen Dioxide

Guideline Set By	Description		Criteria Based On	Value(1) / μgm^{-3} (ppb)
UK Government Air Pollution Index	LOW	1	1-hour mean	0-95 (0-49)
		2		96-190 (50-99)
		3		191-286 (100-149)
	MODERATE	4	1-hour mean	287-381 (150-199)
		5		382-477 (200-249)
		6		478-572 (250-299)
	HIGH	7	1-hour mean	573-635 (300-332)
		8		636-700 (333-366)
		9		701-763 (367-399)
	VERY HIGH	10	1-hour mean	≥ 764 (≥ 400)
The Air Quality Strategy(2)	Objective for Dec. 31st 2005, for protection of human health		1-hour mean	200 (105) Not to be exceeded more than 18 times per calendar year.
Set in regulations(3) for all UK:	Objective for Dec. 31st 2005, for protection of human health		Annual mean	40 (21)
Not intended to be set in regulations:	Objective for Dec. 31st 2000, for protection of vegetation.		Annual mean NO_x (NO_x as NO_2)	30 (16)
European Community 1985 NO2 Directive (4) *Limit remains in force until fully repealed 01/01/2010.*	Limit Value		Calendar year of data: 98%ile of hourly means.	200 (105)
1st Daughter Directive(5)	Limit Value for protection of human health. To be achieved by Jan. 1st 2010		1-hour mean	200 (105) not to be exceeded more than 18 times per calendar year
	Limit Value for protection of human health. To be achieved by Jan. 1st 2010		Calendar year mean	40 (21)
	Limit Value (total NO_x) for protection of vegetation. To be achieved by Jul. 19th 2001		Calendar year mean	30 (16)
World Health Organisation(6) *(Non-Mandatory Guidelines)*	Health Guideline		1-hour mean	200
	Health Guideline		Annual mean	40

(1) Conversions between $\mu g\ m^{-3}$ and ppb are as used by the EC, i.e. 1ppb NO_2 = 1.91 $\mu g\ m^{-3}$ at 20°C and 1013 mB.
(2) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1 & Addendum 2003.
(3) Air Quality (England) Regulations 2000 (SI 2000/928), Air Quality (Scotland) Regulations 2000 (SSI 2000/97), Air Quality (Wales) Regulations 2000 (SI 2000/1940 (W138)).
(4) Council Directive 85/203/EEC.
(5) Council Directive 1999/30/EC. Transposed into UK Air Quality Regulations in England by SI 2001/2315, in Scotland by SSI 2001/224, in Wales by SI 2001/2683 (W224), and by Statutory Rule 2002 (94) in Northern Ireland.
(6) WHO Guidelines for Air Quality WHO/SDE/OEH/00.02 (2000).

Sulphur Dioxide

Guideline Set By	Description		Criteria Based On	Value(1) / μgm^{-3} (ppb)
UK Government Air Pollution Index	LOW	1	15-minute mean	0-88 (0-32)
		2		89-176 (33-66)
		3		177-265 (67-99)
	MODERATE	4	15-minute mean	266-354 (100-132)
		5		355-442 (133-166)
		6		443-531 (167-199)
	HIGH	7	15-minute mean	532-708 (200-266)
		8		709-886 (267-332)
		9		887-1063 (333-399)
	VERY HIGH	10	15-minute mean	≥ 1064 (≥ 400)
The Air Quality Strategy(2) *Set in regulations(3) for all UK.*	Objective for Dec. 31st 2005, for protection of human health.		15-minute mean	266 (100) Not to be exceeded > 35 times per calendar year.
	Objective for Dec. 31st 2004, for protection of human health		1-hour mean	350 (132) Not to be exceeded > 24 times per calendar year.
	Objective for Dec. 31st 2004, for protection of human health		24-hour mean	125 (47) Not to be exceeded > 3 times per calendar year.
Not intended to be set in regulations.	Objective for Dec. 31st 2000, for protection of vegetation.		Annual mean & winter (1st October – 31st March) mean	20 (8)
1st Daughter Directive(4)	Objective for Jan 1st 2005, for protection of human health		1-hour mean	350 (132) Not to be exceeded more than 24 times per calendar year.
	Objective for Jan 1st 2005, for protection of human health		Daily 24-hour mean	125 (47) Not to be exceeded more than 3 times per calendar year.
	Objective for Jul 19th 2001, for protection of vegetation.		Annual mean & winter (1st October – 31st March) mean	20 (8)
World Health Organisation(5) *(Non-Mandatory Guidelines)*	Health Guideline		10-minute mean	500
	Health Guideline		24-hour mean	125
	Health Guideline		Annual mean	50

(1) Conversions between *μ*g m^{-3} and ppb are as used by the EC, i.e. 1ppb SO_2 = 2.66 *μ*g m^{-3} at 20°C and 1013 mB.
(2) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1 & Addendum 2003.
(3) Air Quality (England) Regulations 2000 (SI 2000/928), Air Quality (Scotland) Regulations 2000 (SSI 2000/97), Air Quality (Wales) Regulations 2000 (SI 2000/1940 (W138)).
(4) Council Directive 1999/30/EC. Transposed into UK Air Quality Regulations in England by SI 2001/2315, in Scotland by SSI 2001/224, in Wales by SI 2001/2683 (W224), and by Statutory Rule 2002 (94) in Northern Ireland.
(5)WHO Guidelines for Air Quality WHO/SDE/OEH/00.02 (2000).

Ozone

Guideline Set By	Description		Criteria Based On	Value(1) / μgm^{-3} (ppb)
UK Government Air Pollution Index	LOW	1	Max 1-hour and 8-hour mean	0-32 (0-16)
		2		33-66 (17-32)
		3		67-99 (33-49)
	MODERATE	4	Max 1-hour and 8-hour mean	100-126 (50-62)
		5		127-152 (63-76)
		6		153-179 (77-89)
	HIGH	7	Max 1-hour and 8-hour mean	180-239 (90-119)
		8		240-299 (120-149)
		9		300-359 (150-179)
	VERY HIGH	10	Max 1-hour and 8-hour mean	≥ 360 (≥ 180)
The Air Quality Strategy(2) All UK. *Not currently set in regulations.*	Objective for Dec. 31st 2005		Daily max. running 8-hour mean	100 (50) Not to be exceeded more than 10 times per calendar year.
European Community 3rd Daughter Directive(4)	Target Value To be achieved by 3-year period beginning 2010.		Max. daily 8-hour mean.	120 $\mu g\ m^{-3}$ Not to be exceeded on more than 25 days per year, averaged over 3 years.
	Target Value for protection of vegetation. To be achieved by 5 years, beginning 2010		AOT40[5] calculated from 1h values May-July.	18,000 $\mu g\ m^{-3}\ h$ averaged over 5 years.
	Information threshold		1-hour mean	180
	Alert threshold		1-hour mean	240
World Health Organisation(6) *(Non-Mandatory Guidelines)*	Health Guideline		8-hour mean	120

(1) Conversions between $\mu g\ m^{-3}$ and ppb are as used by the EC, i.e. 1ppb O_3 = 2.00 $\mu g\ m^{-3}$ at 20°C and 1013 mB.
(2) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1 & Addendum 2003.
(3) Directive 92/72/EEC. To be repealed 9 Sep 2003.
(4) Directive (2002/3/EC)
(5) AOT40 statistic is the sum of the differences between hourly concentrations greater than 80 $\mu g\ m^{-3}$ (=40ppb) and 80 $\mu g\ m^{-3}$, over a given period using only the 1-hour averages measured between 0800 and 2000.
(6) WHO Guidelines for Air Quality WHO/SDE/OEH/00.02 (2000).
(7) Growing season is defined as April to September for WHO guidelines, but is daytime (0900-1500) April to September for UNECE guidelines.

Carbon Monoxide

Guideline Set By	Description		Criteria Based On	Value[(1)] / mg m^{-3} (ppm)
UK Government Air Pollution Index	LOW	1	8-hour mean	0-3.8 (0-3.2)
		2		3.9-7.6 (3.3-6.6)
		3		7.7-11.5 (6.7-9.9)
	MODERATE	4	8-hour mean	11.6-13.4 (10.0-11.5)
		5		13.5-15.4 (11.6-13.2)
		6		15.5-17.3 (13.3-14.9)
	HIGH	7	8-hour mean	17.4-19.2 (15.0-16.5)
		8		19.3-21.2 (16.6-18.2)
		9		21.3-23.1 (18.3-19.9)
	VERY HIGH	10	8-hour mean	≥ 23.2 (≥ 20)
The Air Quality Strategy[(2,3)] (Except Scotland)	Objective for Dec. 31st 2003		Max. Daily Running 8-hour mean	10 (8.6)
Scotland only[4]:	Objective for Dec. 31st 2003		Running 8-hour mean	10 (8.6)
European Community 2nd Daughter Directive[(5)]	Limit Value. To be achieved by Jan 1st 2005		Max. daily 8-hour mean	10 (8.6)
World Health Organisation[(6)] *(Non-Mandatory Guidelines)*	Health Guideline		15-minute mean	100
	Health Guideline		30-minute mean	60
	Health Guideline		1-hour mean	30
	Health Guideline		8-hour mean	10

(1) Conversions between μg m^{-3} and ppb are those used by the EC, i.e. 1ppm CO = 1.16 mg m^{-3} at 20^{o}C and 1013 mB, except where specified.
(2) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1 & Addendum 2003.
(3) Air Quality (England) Regulations 2000 (SI 2000/928), Air Quality (Scotland) Regulations 2000 (SSI 2000/97), Air Quality (Wales) Regulations 2000 (SI 2000/1940 (W138)).
(4) Air Quality (Scotland) Amendment Regulations 2002 (SSI 2002/297).
(5) Council Directive 2000/69/EC. Transposed into UK Air Quality Regulations in England by SI 2002/3117, in Scotland by SSI 2002/556, in Wales by SI 2002/3183 (W299), and by Statutory Rule 2002 (357) in Northern Ireland.
(6) WHO Guidelines for Air Quality WHO/SDE/OEH/00.02 (2000).

Benzene

Guideline Set By	Description	Criteria Based On	Value[(1)] / μgm^{-3} (ppb)
The Air Quality Strategy[(2,3)] All UK	Objective for Dec. 31st 2003	Running annual mean	16.25 (5)
England[(4)] & Wales[(5)] only:	Objective for Dec. 31st 2010	Annual mean	5 (1.54)
Scotland[(6)] & Northern Ireland	Objective for Dec. 31st 2010	Running annual mean	3.25 (1.0)
European Community 2nd Daughter Directive[(8)]	Limit Value. To be achieved by Jan 1st 2010	Annual calendar year mean	5 (1.5)

(1) Conversions between $\mu g\ m^{-3}$ and ppb are those used by the EC, i.e. 1ppb benzene = 3.25 $\mu g\ m^{-3}$ at 20°C and 1013 mB.
(2) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1 & Addendum 2003.
(3) Air Quality (England) Regulations 2000 (SI 2000/928), Air Quality (Scotland) Regulations 2000 (SSI 2000/97), Air Quality (Wales) Regulations 2000 (SI 2000/1940 (W138)).
(4) Air Quality (Amendment) (England) Regulations 2002 (SI 2002/3043)
(5) Air Quality (Amendment) (Wales) Regulations 2002 (SI 2002/3182 (W298))
(6) Air Quality (Amendment) (Scotland) Regulations 2002 (SI 2002/297)
(7) Council Directive 2000/69/EC. Transposed into UK Air Quality Regulations in England by SI 2002/3117, in Scotland by SSI 2002/556, in Wales by SI 2002/3183 (W299), and by Statutory Rule 2002 (357) in Northern Ireland.

1,3 Butadiene

Guideline Set By	Description	Criteria Based On	Value[(1)] / μgm^{-3} (ppb)
The Air Quality Strategy[(2,3)] All UK	Objective for Dec. 31st 2003	Running annual mean	2.25 (1)

(1) Conversions between $\mu g\ m^{-3}$ and ppb are those used by the EC, i.e. 1ppb benzene = 2.25 $\mu g\ m^{-3}$ at 20°C and 1013 mB.
(2) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1. & Addendum 2003.
(3) Air Quality (England) Regulations 2000 (SI 2000/928), Air Quality (Scotland) Regulations 2000 (SSI 2000/97), Air Quality (Wales) Regulations 2000 (SI 2000/1940 (W138)).

Polycyclic Aromatic Hydrocarbons (PAH)

Guideline Set By	Description	Criteria Based On	Value / ngm^{-3}
The Air Quality Strategy[(1)] England, Wales, Scotland and Northern Ireland. *Not set in regulations.*	Objective for Dec. 31st 2010	Annual mean *(using B(a)P as an indicator)*	0.25

(1) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1 & Addendum 2003.

Particulate Matter as PM_{10}

Guideline Set By	Description		Criteria Based On	Value / μgm^{-3}
UK Government Air Pollution Index	LOW	1	24-hour mean	0-16
		2		17-32
		3		33-49
	MODERATE	4	24-hour mean	50-57
		5		58-66
		6		67-74
	HIGH	7	24-hour mean	75-82
		8		83-91
		9		92-99
	V. HIGH	10	24-hour mean	≥ 100
The Air Quality Strategy(1) **Set in regulations for all UK(2).**	Objective for Dec. 31st 2004		24-hour mean	50 Not to be exceeded more than 35 times per calendar year.
	Objective for Dec. 31st 2004		Annual mean	40
Set in regulations Scotland only(3)	Objective for Dec. 31st 2010		24-hour mean	50 Not to be exceeded more than 7 times per calendar year.
	Objective for Dec. 31st 2010		Annual mean	18
The Air Quality Strategy(1) *Not set in regulations: London only*	Objective for Dec. 31st 2010		24-hour mean	50 Not to be exceeded more than 10 times per calendar year.
	Objective for Dec. 31st 2010		Annual mean	23
The Air Quality Strategy(1) *Not set in regulations: Rest of England, Wales, & Northern Ireland.*	Objective for Dec. 31st 2010		24-hour mean	50 Not to be exceeded more than 7 times per calendar year.
	Objective for Dec. 31st 2010		Annual mean	20
1st Daughter Directive(4) **STAGE 1 – Confirmed.**	Limit Value to be achieved by Jan 1st 2005		24-hour mean	50 Not to be exceeded more than 35 times per calendar year.
	Limit Value to be achieved by Jan 1st 2005		Annual mean	40
1st Daughter Directive(4) **STAGE 2 – To be confirmed.**	Limit Value to be achieved by Jan 1st 2010		24-hour mean	50 Not to be exceeded more than 7 times per calendar year.
	Limit Value to be achieved by Jan 1st 2010		Annual mean	20

(1) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1 & Addendum 2003.
(2) Air Quality (England) Regulations 2000 (SI 2000/928), Air Quality (Scotland) Regulations 2000 (SSI 2000/97), Air Quality (Wales) Regulations 2000 (SI 2000/1940 (W138)).
(3) Air Quality (Amendment) (Scotland) Regulations 2002 (SI 2002/297)
(4) Council Directive 1999/30/EC. Transposed into UK Air Quality Regulations in England by SI 2001/2315, in Scotland by SSI 2001/224, in Wales by SI 2001/2683 (W224), and by Statutory Rule 2002 (94) in Northern Ireland.

Lead (Pb)

Guideline Set By	Description	Criteria Based On	Value / $\mu g m^{-3}$
The Air Quality Strategy[1] **Set in regulations for all UK.**	Objective for Dec. 31st 2004	Annual mean	0.5 (= 500 ng m^{-3})
	Objective for Dec. 31st 2008	Annual mean	0.25 (= 250 ng m^{-3})
1st Daughter Directive (1999/30/EEC)[2]	Limit Value to be achieved by Jan 1st 2005	Annual mean	0.5 (= 500 ng m^{-3})
	Limit Value to be achieved by Jan 1st 2010 in the immediate vicinity of industrial sources	Annual mean	0.5 (= 500 ng m^{-3})
World Health Organisation[3] *(Non-Mandatory Guidelines)*	Health-Based Guideline	Annual Mean	0.5 (= 500 ng m^{-3})

(1) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1 & Addendum 2003.
(2) Council Directive 1999/30/EC
(3) WHO Guidelines for Air Quality WHO/SDE/OEH/00.02 (2000).

Metallic Elements Arsenic (As), Cadmium (Cd), Mercury (Hg) and Nickel (Ni), and hydrocarbon Benzo (a) Pyrene

Guideline Set By	Description	Criteria Based On	Value / ng m^{-3}
Daughter Directive (205/107/EC)	Target Value for As	Calendar year mean	6
	Target Value for Cd	Calendar year mean	5
	Target Value for Hg	Calendar year mean	Not set
	Target Value for Ni	Calendar year mean	20
	Target Value for B(a)P	Calendar year mean	1

Target values to be non-mandatory.

Description of UK Government Pollution Indices

Old "Band"	New Index	Health Descriptor
LOW	1	Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants.
	2	
	3	
MODERATE	4	Mild effects unlikely to require action may be noticed amongst sensitive individuals.
	5	
	6	
HIGH	7	Significant effects may be noticed by sensitive individuals and action to avoid or reduce these effects may be needed (e.g. reducing exposure by spending less time in polluted areas outdoors). Asthmatics will find that their "reliever" inhaler is likely to reverse the effects on the lung.
	8	
	9	
VERY HIGH	10	The effects on sensitive individuals described for "High" levels of pollution may worsen.

Air Quality Regulations: Statutory Instruments

Date	Country	S.I. No.	Purpose
30/03/2000	England	SI 2000 No. 928	Inclusion of original Air Quality Strategy Objectives into regulations in England
19/07/2000	Wales	SI 2000 No. 1940 (W138)	Inclusion of original Air Quality Strategy Objectives into regulations in Wales
31/03/2000	Scotland	SSI 2000 No. 97	Inclusion of original Air Quality Strategy Objectives into regulations in Scotland
09/06/2001	Scotland	SSI 2001 No. 224	Transposition of 1st Daughter Directive into Air Quality Limit Values Regulations for Scotland.
25/06/2001	UK	SI 2001 No. 2315	Transposition of 1st Daughter Directive into Air Quality Limit Values Regulations for England.
17/07/2001	Wales	SI 2001 No. 2683 (W224)	Transposition of 1st Daughter Directive into Air Quality Limit Values Regulations for Wales.
08/03/2002	Northern Ireland	Statutory Rule 2002 (94)	Implementation of 1st Daughter Directive in NI.
11/06/2002	Scotland	SSI 2002 297	Amendment of Air Quality Regulations to include more stringent objectives for PM_{10}, CO and benzene, specifically for Scotland.
21/11/2002	Northern Ireland	Statutory Rule 2002 (357)	Transposition of 2nd Daughter Directive into Air Quality Limit Values Regulations for Scotland
11/12/2002	England	SI 2002 No 3043	Amendment of Air Quality Regulations to include more stringent objectives for CO and benzene, in England.
16/12/2002	England	SI 2002 No 3117	Transposition of 2nd Daughter Directive into Air Quality Limit Values Regulations for England
17/12/2002	Scotland	SSI 2002 556	Transposition of 2nd Daughter Directive into Air Quality Limit Values Regulations for Scotland
17/12/2002	Wales	Welsh SI 2002 3182 (W298)	Amendment of Air Quality Regulations to include more stringent objectives for CO and benzene, in Wales
17/12/2002	Wales	Welsh SI 2002 3183 (W299)	Transposition of 1st and 2nd Daughter Directives into Air Quality Limit Values Regulations for Wales.

Appendix 6- Calculation methods, statistical methods and measurement uncertainty

Here we provide boring but essential information on measurement accuracy, trend calculation and the mathematical methods used to calculate measurement statistics.

A 6.1 Statement on Accuracy of Air Quality Measurements

The EU Air Quality Directives now specify a required level of data accuracy (uncertainty). The accuracy requirements for the various parameters are summarised in Table 1 below. Please note that there is also a requirement for 90% data capture in each year.

A common approach to determining measurement uncertainty for all pollutants is provided by a CEN (The European Centre for Standardisation) report entitled: 'Air quality – approach to uncertainty estimation for ambient air reference methods'. CEN has produced a series of standards setting out how National Networks in Member States should operate analysers in order to meet the required uncertainty of ±15% for NO_2, SO_2, CO and O_3 and ±25% for benzene (at the 95% confidence level).

The standards include a set of performance characteristics against which analysers need to be assessed for official approval, as well as activities required for ongoing Quality Assurance and Control (QA/QC). Although the current situation is not entirely clear (for example, no analysers commonly used in the UK have been put through a complete set of performance tests), it is likely that the great majority of UK National Network measurements will meet the uncertainty requirement.

The situation with particulate measurements is more complicated. This is because of the widescale use of analysers that do not conform to the EU Reference Method for PM_{10} monitoring. Much work is being undertaken- both within Member States and at the EU level- to assess the performance of the different analysers and techniques used for measurement of PM_{10}.

Table 1 – Measurement uncertainty objectives given in EU Air Quality Directives

Pollutant	Uncertainty for Continuous Measurement (listed as accuracy in the Directive)
NO_2, NO_X	15%
SO_2	15%
Particulate Matter	25%
CO	15%
Benzene	25%
O_3	15%

Note: The percentages given in the table are for individual measurements averaged over the period considered by the limit or target value, at concentrations close to the limit or target value, for a 95% confidence interval.

A 6.2 Calculation Methods

A 6.2.1 Introduction

The intention of this section is to provide all the information required to reproduce the statistics contained in this report from the original hourly dataset. This dataset is now widely available from the UK National Air Quality Archive on the World Wide Web- www.airquality.co.uk.

The definition of standard statistical functions, such as means, percentiles, regressions and standard errors can be obtained from a number of statistical references. A description of log-normal distributions and related statistics has also been provided elsewhere[28].

Various air quality guidelines and statistics are defined in the documentation published by the UK Government[2,10,11], the European Community[3,,29-31], the World Health Organisation[26,32-34] and The Expert Panel on Air Quality Standards (EPAQS) [18-25]. This section describes how these statistics are calculated from the original dataset. All exceedence statistics in this report are calculated using methods that are compliant with the requirements of each air quality standard.

Where the exact method of calculation of a statistic has not been precisely defined by the above bodies, a method has generally been chosen that leads to a more stringent air quality guideline.

These calculation methods have been developed over time and are not necessarily those that were used in previous reports of this series.

A 6.2.2 Definitions

Basic Reporting Unit

The basic reporting unit for the National automatic monitoring networks is the hourly average (the terms “mean” and “average” are taken to be equivalent in this report). All statistics of greater than one hour duration are based on hourly averages. For example, the annual mean is the arithmetic mean of the hourly means during the year. Hourly means that are invalid, for any reason, are ignored.

Hourly averages are derived from:

- At least three 15-minute averages per hour in the AURN
- 30-minutes of sampling in the Hydrocarbon Network

Although 15-minute averages are used in the UK National Air Quality standard for SO_2 and the WHO CO guidelines, 15-minute averages are not the basic reporting unit. Annual means, for example, based on 15-minute average may not be equal to those based on hourly averages since there may be, on occasion, insufficient 15-minute data to make a valid hourly mean. 15-minute data are only used to calculate hourly means and any statistic specifically related to 15-minute means.

Mass Units

The units that used to measure the concentrations are not always the same as those used to calculate and report statistics. For example, ozone is measured by the instrumentation in parts per billion (ppb) and the statistics are reported here in terms of the µg m^{-3} mass units. Particulate matter PM_{10}, on the other hand, is measured and reported in terms of µg m^{-3}.

To calculate statistics, therefore, the measured data are first converted into the reporting units, then the statistics are calculated. Comparison with any limit values are only performed in terms of mass units. This method will give slightly different results, due to rounding errors, to calculations using data in ppb and comparing with limit values converted into ppb.

Dates and Times

All data are recorded as Greenwich Mean Time (GMT). Please note that diurnal variations are calculated in local time.

Daily means are defined as midnight to midnight; 24-hour running means are means over any 24-hour period, for example 0800 to 0759.

Data Precision

All concentrations are recorded and reported to a number of decimal places that is greater than or equal to the measurement precision of individual hourly means. For example:

- Ozone is measured to 2 ppb and are reported to 1 ppb or 2 µg m^{-3}
- Benzene is measured to 0.1 ppb and are reported to 0.1 ppb or 0.3 µg m^{-3}

Note that 15-minutes means, where available, are also recorded to the same data precision as hourly means.

Percentiles

Percentiles of SO_2 daily means are calculated using the method described in the European Community SO_2 Directive[29]. All other percentiles use the European Community NO_2 Directive[30] method. For example: after sorting the data into ascending numerical order, the 98th percentiles are at the following ranks:

SO_2	0.98 times the number of valid means rounded up to the nearest integer
NO_2	0.98 times the number of valid means rounded to the nearest integer

For example, the 98th percentile of 365 daily means (rank 357.7) is the 8th highest concentration using the SO_2 Directive method and also the 8th highest concentration using the NO_2 Directive method.

Data Capture Threshold

A 75% data capture threshold is set for all short-term averages of up to the duration of a month. For example:

- An hourly mean requires at least three 15-minute means
- A monthly mean requires at least 75% of daily means and each daily mean requires at least 18 hours of data

Note that it is possible to have a month with 75% data capture for hourly means, but with less than 75% daily means.

Annual and seasonal statistics, such as the summer mean and the annual 98th percentile of hourly means, should be interpreted with respect to the quoted data capture. These statistics are generally not shown if the data capture is less than 25%. However, some short-term values such as the date of the annual maximum hourly mean are shown, since these may still be of interest.

Air Quality Standards and Guidelines

Air quality guidelines used in this report are those defined in the documentation published by the UK Government[2,10,11], the European Community[29-31], the World Health Organisation[26].

The following conversion factors from measured units to mass units defined in the EU Decision on Exchange of Information[6].

Conversion Factors Between ppb and $\mu g\ m^{-3}$ and ppm and $mg m^{-3}$

Pollutant	WHO 25°C and 1013mb	EC 20°C and 1013mb
Ozone	1 ppb = 1.9622 $\mu g\ m^{-3}$	1 ppb = 1.9957 $\mu g\ m^{-3}$
Nitrogen dioxide	1 ppb = 1.8804 $\mu g\ m^{-3}$	1 ppb = 1.9125 $\mu g\ m^{-3}$
Carbon monoxide	1 ppm = 1.1447 mg m^{-3}	1 ppm = 1.1642 mg m^{-3}
Sulphur dioxide	1 ppb = 2.6163 $\mu g\ m^{-3}$	1 ppb = 2.6609 $\mu g\ m^{-3}$
Benzene	1 ppb = 3.189 $\mu g\ m^{-3}$	1 ppb = 3.243 $\mu g\ m^{-3}$
1,3-butadiene	1 ppb = 2.2075 $\mu g\ m^{-3}$	1 ppb = 2.2452 $\mu g\ m^{-3}$

Additional conversion factors used in the UK are as follows:

- NO_x in $\mu g\ m^{-3}$ is expressed as NO_2, i.e. (NO ppb + NO_2 ppb)* 1.91 = NO_x $\mu g\ m^{-3}$
- In the UK, gravimetric equivalent PM_{10} data are calculated from TEOM monitoring data by applying a conversion factor of 1.3

Note that the minimum data period that can be compared to a guideline is fifteen minutes, since this is currently the time resolution of most UK automatic data. The WHO 10-minute SO_2 guideline is not, therefore, reported.

Running Means

Wherever possible, running means, rather than simple means, are used for comparison with air quality standards.

For example: the Air Quality Standard CO 8-hour standard in this report is based on all possible 8-hour means during a year. Calculating all possible means can produce twenty-four possible exceedences every day. This is a more stringent method than taking simple, non-overlapping, means (e.g. three 8-hours means in a day).

Please note that in this report:

- The WHO 30-minute guideline is calculated as a running mean based on 15-minute averages
- The UK National Air Quality standard running annual means for benzene and 1,3-butadiene requires a 75% data capture. Newly established sites cannot, therefore, report the running annual mean.

Exceedence

An exceedence of an air quality guideline is defined in this report as a concentration **greater than** the guideline threshold. This definition was changed from "**greater than or equal"** the guideline threshold, in order to be consistent with EC Directives.

Exceedence Counting

The following method is used where an air quality guideline is based on an average:

1. Calculate the average

2. Apply the 75% data capture threshold
3. Round the average to the data precision
4. Compare with the guideline

For example: at stage 3, an 8-hour average ozone concentration of 100.4999 µg m^{-3} is rounded to 100 µg m^{-3}. This does not exceed the UK National Air Quality standard running 8-hour ozone mean of 100 µg m^{-3}.

However, if no rounding occurs, the concentration would exceed the standard. Also, if this value is the highest running 8-hour during the year, an anomaly would occur in the report since the maximum would be reported as 100 µg m^{-3} yet there would be an exceedence.

To calculate the number of days with an exceedence, the date (in GMT) of the last hour of the running mean is used.

Cumulative Frequency Distributions

Cumulative frequency distributions in this report are graphed on log-normal axes. A reasonably straight line indicates that pollutant concentrations are log-normally distribution and can be predicted from the geometric mean and the standard geometric deviation[29]. The y-axis shows the logarithm to base 10 of the percentile concentrations, while points on the x-axis are normally distributed.

The geometric mean and standard geometric mean are calculated by use of logarithms and, therefore, can only include concentrations greater than zero.

Diurnal Variations

Diurnal variations are the average concentration for each hour of day during the period of interest. Local time is used, rather than GMT, since this will more closely reflect the daily cycle of manmade emissions.

Long-Term Trends

Long-term trends reported here are based a non-parametric linear regression method[29] which has the following stages:

- The gradient is calculated by “Theil’s incomplete” method[37]
- The null hypothesis (i.e. the statistical significance of the trend) is tested by the Spearman’s rank correlation coefficient[38]
- The 95th confidence interval for the gradient is given by Kendall's Tau[39]

Values for the Spearman’s rank correlation coefficient used in this report are as published by Conover[36].

This method does not assume that the errors on the data points are normally distributed and is, therefore, more appropriate than simple linear regression by least squares. However, the results obtained have been demonstrated to be broadly similar[40].

Exponential regressions may be appropriate for some time series, e.g. SO_2 in London, but for the majority of cases a linear trend over recent years is of most interest. Only linear trends are provided in this report.

Trends are reported for sites where there are at least five valid measurements. A valid measurement requires a data capture of at least 50%.

Where a site has a statistically significant trend of more than five years, the five-year trend and the trend over the full monitoring period are reported. Ten-year trends are highlight in the summary table in Appendix 4.

Particulate measurements and conversion factors used in this report

With gaseous pollutants, it is possible to express concentrations as an amount fraction – the ratio of pollutant molecules to the total number of air molecules – for example, parts per billion (ppb). This is not possible for PM, and measurements are always given in units of particulate mass per unit volume of air (typically μgm^{-3}). When these units are used without specifying the temperature and pressure of the air, the same 'packet' of air will have a different concentration as these properties of the air change. The European legislation for PM measurement therefore requires that the air volume used must be at the same ambient air temperature and pressure as at the time of sampling. In practice, this means that appropriate corrections need to be made if the flow rate used to calculate the sampled volume is not based on the actual volume of sampled air.

Different measurement techniques, although nominally measuring the same PM, may treat the airstream in different ways, leading to significantly different results. For clarity, all mass measurements of PM_{10} and $PM_{2.5}$ in this report are expressed as $\mu g\ m^{-3}$ for both gravimetric and TEOM analysers.

The EU First Air Quality Daughter Directive (1999/30/EC) specifies that measurements of PM_{10} should be carried out using the reference method, as defined in European Standard EN12341. This standard refers to three sampling devices that may be used:

- Superhigh volume sampler – the WRAC (Wide Range Aerosol Classifier);
- High-volume sampler – the HVS PM10 sampler (68 $m^3\ h^{-1}$);
- Low-volume sampler – the LVS PM10 sampler (2.3 $m^3\ h^{-1}$).

None of these instruments can provide real-time (continuous hourly) measurements. As a result, the TEOM analyser is widely used in both the UK and throughout the rest of the world for measuring continuous concentrations of PM. The instrument is based on the principle that the frequency of oscillation of a glass, tapered tube (element) changes by an amount that is directly proportional to the mass of the tube Therefore, any change in mass of the tube, due to the deposition of particles onto a small filter affixed to one end, will result in a change in the resonant frequency that is proportional to the additional mass.

In order for the TEOM to be used as a USEPA-equivalent method for PM_{10} measurement, a default adjustment factor (1.03 * TEOM reading + 3 μgm^{-3}) must be applied to the raw data. This adjustment factor was derived to account for moisture equilibration differences between the TEOM and the HI-vol sample media. The adjustment factor was determined at sites where non-volatile PM dominated and is intended to reflect the filter character more than the PM. It is understood that USEPA has no general policy on the use of this empirical adjustment factor for PM2.5 measurements. All TEOM analysers in the UK measuring both PM_{10} and $PM_{2.5}$ are currently set up with this default adjustment factor included. In addition, TEOM analysers within the UK networks are set to report concentrations corrected to 293K and 101.3 kPa.

Due to the need to eliminate the effect of changing humidity on the mass measurement, the TEOM is required to maintain the sample filter at an elevated temperature. This has led to reported differences in concentrations of PM between the TEOM and the European reference sampler (Allen *et al*., 1997; APEG, 1999; Ayers *et al*., 1999; Soutar *et al*., 1999; Salter and Parsons, 1999; Cyrys *et al*., 2001; Williams and Bruckmann, 2001). This is largely attributed to the loss of volatile species such as ammonium nitrate. As an interim measure, a default 'scaling factor' (also known as correction factor) of 1.3 has been applied to all TEOM PM_{10} data reported here, as recommended by the EC Working Group on Particulate Matter (2001).

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How to find out more

Current and forecast air quality (national & local)

This is rapidly available in a user-friendly form from:

Teletext: page 156

The Air Pollution Information Service:
freephone 0800 556677

The UK Air Quality Archive:
www.airquality.co.uk

General information on Air Quality

The UK Air Quality Information Archive:
www.airquality.co.uk

The National Atmospheric Emissions Inventory:
www.naei.org.uk

The Defra air quality information web resource:
www.defra.gov.uk/environment/airquality/index.htm

The Scottish Executive Air Quality pages:
www.scotland.gov.uk/about/ERADEN/ACEU-AQT/00016215/homepage.aspx

The Welsh Assembly Government Environment link:
www.wales.gov.uk/subienvironment/index.htm

The Northern Ireland Environment and Heritage Service website:
www.ehsni.gov.uk/environment/environment.shtml

A companion brochure to this report entitled:
UK Air Pollution is available from Defra at:

Defra Publications
Admail 6000
London SW1A 2XX
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e-mail: defra@iforcegroup.com

Health Effects of Air Pollution

A concise brochure entitled: Air Pollution, what it means for your health is available to download from the Defra air quality information web resource listed above or free of charge from Defra publications.

Local Air Quality Issues

For further information on air quality issues in your area, please contact:
The Environmental Health Department at your local District Council office.

Further information on Local Air Quality Management may also be found at:
www.defra.gov.uk/environment/airquality/laqm.htm *and*
www.airquality.co.uk/archive/laqm/laqm.php
www.scotland.gov.uk

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