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Air quality in London 2004

London Air Quality Network
Report 12

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Introduction

The London Air Quality Network is a unique and valuable resource. Its inception and continued development would not have been possible without the support of the local authorities in London and the Home Counties, the Association of London Government, London's health authorities and the Association of London Environmental Health Managers. The support of the Department of the Environment, Food and Rural Affairs, the Environment Agency, the Greater London Authority and Transport for London is also gratefully acknowledged.

The measurements detailed in this report result from a team effort, undertaken by staff who are dedicated and committed to their work.

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Foreword

Professor Frank Kelly, Director of the Environmental Research Group (ERG)

Welcome to the twelfth annual report of the London Air Quality Network (LAQN). The report provides a strategic overview of air pollution across London during 2004. It is important both as a stand-alone document for comparison with other cities and as part of the ongoing annual air pollution record for London. This publication provides a vital resource for anyone interested in air quality, especially those working at local and national levels to help reduce the level of air pollution in the UK.

The LAQN is managed by the Air Quality Monitoring Group led by Gary Fuller at King's College London. The information in this report is enhanced by input from the Air Quality Management Group within the Environmental Research Group. The combined and complementary expertise of the individuals in these groups is further evident in the LAQN website **www.londonair.org.uk**. This excellent resource has summaries of air pollution across the London and a number of tools to allow the user to analyse and plot data. This resource will be of benefit to all those with an interest in air quality.

2004 proved to be another challenging year for air quality in London. The capital experienced widespread breaches of the Air Quality Strategy (AQS) Objectives. There are additional concerns regarding deteriorations in primary nitrogen dioxide (NO_2) and particle (PM_{10}) concentrations and medium term increases in annual mean ozone (O_3) concentration. The increase in primary NO_2 emissions in London was unexpected and has posed new problems that must be dealt with.

With traffic accounting for two thirds of the oxides of nitrogen (NO_X) emissions and nearly half of the PM_{10} emissions in London, measures to tackle the poor air quality in London have to focus on this underlying source. To his credit, the Mayor is approaching this task with vigour, introducing a raft of measures that target many aspects of London traffic. For example, to help meet the costs of introducing a cleaner taxi fleet, an environmental surcharge of 20p per journey was introduced in April 2005. Further improvements have been made to the London bus fleet, through both a vehicle replacement scheme and retro-fitting of particle traps. Together these changes have ensured that every London bus now meets the highest practical emission

standard. The London fire engine and police vehicle update programmes have also ensured that these public vehicles now meet the highest emissions standards.

Notwithstanding these changes, plans are progressing to extend the London Congestion Charging Scheme (CCS) westwards and although it was never introduced as an air quality improvement programme, it is likely that the CCS will make an important contribution to improving air quality in London. Further consultations are also underway regarding the introduction of a London-wide Low Emission Zone (LEZ), the purpose of which is to target the heaviest and most polluting diesel vehicles. Given the worldwide worries about diesel emissions and public health, especially children's health, these new initiatives should provide benefit to Londoners and those who work in and visit the capital.

The introduction of such an array of changes in one major urban setting has provided a unique opportunity to monitor their accrued benefit. To this end, the importance of London's air quality management initiatives has been recognised by the US Health Effects Institute, who are funding two major air pollution and health studies. These are being undertaken by a consortium composed of St. Georges Hospital, the London School of Hygiene & Tropical Medicine, Transport for London and King's College London. This interdisciplinary group of epidemiologists, toxicologists and air pollution scientists are providing new insights into the air pollution and health impacts of Europe's largest intervention in urban traffic management.

Even given these substantial ongoing changes, Londoners still undoubtedly face many difficulties with the quality of the air they breathe. The measures already, or soon to be in place, have focused attention across the globe as all large urban environments face similar problems. Hence, although containing some encouraging information, this report highlights how much more must be done at all levels, from the individual, local councils and Government, to combat the problem of air pollution.

Summary

Gary Fuller, Head of Air Quality Monitoring

The air pollution incidents experienced in London during 2003 were not repeated during 2004. As a consequence, there was substantial improvement in air quality in London during the year.

The London Air Quality Network (LAQN) annual mean index provides a useful tool to track the changes in air pollution in the capital relative to concentrations measured at the start of the index during 1996. During 2004, the LAQN annual mean index reduced for all pollutants. The largest reductions during the year (relative to 1996) were exhibited by PM_{10} (-15%), NO_2 (-11%), NO_X (-10%), O_3 (-9%) and SO_2 (-8%) with only a slight change (-2%) in CO. Despite these reductions, the Air Quality Strategy (AQS) Objectives were exceeded widely.

During 2004, the annual mean AQS NO_2 Objective was exceeded alongside the vast majority of major roads and also at background locations in inner and west London. Four kerbside and six roadside sites also exceeded the incident-based Objective for NO_2.

Despite the consistent reduction in the annual mean NO_X concentration since 1996, the reduction in the concentration of NO_2 has been more variable. By the end of 2003, the annual mean concentration of NO_2 was only 2% below 1996 concentrations. NO_2 concentration did, however, reduce during 2004 and by the end of the year the annual mean was 13% below that experienced during 1996. However, at this stage it is not known if the reduction in the annual mean NO_2 concentration indicates a longer-term trend or if the improvements during 2004 are part of the pattern of annual variability in annual mean NO_2. The 13% reduction in the annual mean NO_2 concentration was achieved by a 39% reduction in annual mean NO_X. The relative insensitivity of annual mean NO_2 to reduction in NO_X is partially to be expected as a consequence of the atmospheric chemistry that determines NO_2 concentrations. However, new research has pointed to the additional influence of increases in the emission of primary NO_2. This may be masking underlying reductions in the concentration of NO_2 brought about by NO_X reduction (Carslaw, 2005). Indeed, during 2003 and 2004, several roadside monitoring sites experienced substantial increases in annual mean NO_2 which may represent evidence of the effects of primary emissions of this pollutant.

The PM_{10} pollution incidents which affected London during 2003 were not repeated during 2004. The number of days per year with mean PM_{10} greater than 50 μgm^{-3} were reduced substantially at background sites during 2004, returning to levels that prevailed before the pollution incidents in 2003. However, at kerb and roadside sites in inner London, the annual number of daily means greater than 50 μgm^{-3} did not return to pre-2003 levels. The PM_{10} Objective was exceeded alongside major roads during 2004 and at the two sites adjacent to waste facilities. The annual mean concentration of PM_{10} reduced by 30% between 1996 and 2004. However, this reduction was achieved before the turn of the century and there is evidence of an increase in the mean concentration of PM_{10} since 2000.

During August 2003, O_3 concentrations in south east England reached their highest levels measured since 1990. During 2004, such pollution incidents were not repeated. However, the AQS Objective for O_3 was exceeded throughout suburban areas of London and in the Home Counties. The annual mean concentration of O_3 in London has risen by 33% since 1996.

All monitoring sites met the AQS Objectives for CO and SO_2. Since 1996 annual mean concentrations of CO and SO_2 reduced by over 50%.

During 2004 the LAQN continued to grow and adapt. Eight new monitoring sites were installed in the London Boroughs of Bexley, Brent, Greenwich and Ealing. Additional equipment was also installed at four monitoring sites. Furthermore, new automated PM_{10} measurement technology was installed at several sites, enabling the quantification of volatile PM_{10} across the capital. This expansion will allow the existing LAQN to begin to address the new research questions that are key to the future success of air quality management in London. These include the quantification of primary emissions of NO_2 and the improved source apportionment of PM_{10}.

Introduction

This report details measurements of air quality in London. The report updates the summary results for 2004 published during Spring 2005. Measurements have been analysed with specific reference to the Air Quality Strategy (AQS) Objectives which are detailed in Appendix 4. Full details of the sites in the London Air Quality Network (LAQN) are presented in *Appendix 1* and the detailed monitoring results are presented in *Appendix 3*.

The LAQN was formed in 1993 to coordinate and improve air pollution monitoring in London. Currently, 30 London boroughs are supplying measurements to the network. In addition, these data are being supplemented by measurements from local authorities surrounding London, thereby providing an overall perspective of air pollution in south east England. The LAQN is operated and managed by the Environmental Research Group (ERG) at King's College London (King's). Each borough funds air quality monitoring in its own area, whilst the core LAQN activities are funded by King's. The Department of Environment, Food and Rural Affairs (DEFRA) funds King's to operate the Marylebone Road site and to maintain 14 of the LAQN sites as affiliate sites to the UK Automatic Urban and Rural Network (AURN). This DEFRA support assists the operation of the overall LAQN.

Further monitoring sites have been supported by Transport for London to help assess the Congestion Charging Scheme. (CSS).

Analysis of LAQN measurements has been augmented by measurements from the directly-funded DEFRA sites in London. These 6 sites, listed in Appendix 2, provide further information concerning pollution in central and west London. Measurements from DEFRA sites were provided by AEAT plc from the National Air Quality Archive and are included within the LAQN database.

To understand air pollution in London it is necessary to understand air pollution in the surrounding area and vice-versa. To support this understanding, the LAQN also includes sites in Berkshire, Essex, Kent and Surrey. A more complete picture of air pollution in south east England can be obtained from the combined results of the LAQN, the Kent Air Quality Monitoring Network (KAQMN), the Hertfordshire and Bedfordshire Air Pollution Monitoring Network (HBAPMN) and the Sussex Air Quality Steering Group (SAQSG) network. Measurements from these networks are available from King's.

Hourly updated measurements from the LAQN and neighbouring networks are published by King's on the Internet at **www.londonair.org.uk**

Air quality measurements

Air quality measurements in the LAQN are made using a range of continuous air quality monitoring equipment. Measurements are subject to two quality assurance processes. Initially, measurements are validated using the best calibration and instrument performance information available at the time. Measurements are retrospectively examined during the ratification process, using long-term instrument histories and the results of further quality checks. Sites are classified into three quality standards. Measurements from sites affiliated to the AURN and London Standard sites have traceabilty to National Metrological Standards, whereas for the Locality Standard sites there is insufficient information to demonstrate such traceability. Equipment at AURN and London Standard sites are subject to independent UKAS accredited audits undertaken by the National Physical Laboratory and by AEAT plc. The final measurements for the AURN sites are published by DEFRA at **www.airquality.co.uk**

No scientific measurement is absolutely accurate or absolutely precise. The combination of accuracy and precision is termed the uncertainty. In order to place measurements in context, the uncertainty

PM_{10} correction factors

The EU Daughter Directive is based on a 'gravimetric' method where PM_{10} is collected on a filter that is then weighed in a laboratory (CEN, 1998). Currently, DEFRA is undertaking a comprehensive PM_{10} instrument comparison at several locations in the UK that should provide further information on the performance of the commonly deployed PM_{10} measurement methods.

However, there is ample evidence to suggest that the most common measurement methodology employed in the UK, the Tapered Element Oscillating Microbalance (TEOM), produces a result lower than the 'gravimetric' method (APEG, 1999; Green et al., 2000). DETR (1999) suggested that a correction factor of 1.3 be applied to TEOM results for comparison to the AQS Objective.

Beta Attenuation Monitors (BAM) are also used to measure PM_{10} in the LAQN. Research at Marylebone Road (Green, 1999) sought to compare the results from TEOM, 'gravimetric' and BAM instruments. The BAM instrument tested produced higher results than the 'gravimetric' method at this location during the test period. Based on the findings of Green (1999) and Local Air Quality Management guidance. **www.uwe.ac.uk/aqm/review/questions.html** all BAM measurements have been multiplied by 0.83 for comparison to the AQS Objective.

This report also includes PM_{10} measurements from TEOMs fitted with the Filter Dynamics Measurement System (FDMS). Analysis of PM_{10} measurements from FDMS (Green and Fuller, 2005) shows that the FDMS measures lower PM_{10} concentrations than the 'gravimetric' method and a correction factor between 1.0 and 1.3 is likely to be appropriate. However, no correction factor has been applied to the FDMS measurements presented in this report.

associated with each measurement has to be considered. Estimates of the uncertainty associated with air quality measurement are discussed in the 2001 LAQN Annual Report (Fuller et al., 2003). This suggests that a working uncertainty of around 10% (2σ) should be considered when discussing high values and long-term averages of CO, NO_2 and SO_2 measured at London Standard sites. This is justified on the basis of both mathematical modelling and equipment performance tests. However, due to the statistical distribution of the measurements, a 10% uncertainty in measurements does not imply a 10% uncertainty in the number of breaches of a threshold standard.

The uncertainty associated with the measurement of PM_{10} is more complex. PM_{10} is not a chemical compound but instead the composition of PM_{10} varies with location and time of year as well as during episodes. PM_{10} can be considered to comprise: primary particulates (mainly emitted from local sources), secondary particulates (mainly from distant sources), and coarse particulates whose origin can be local or further afield. The variation in composition affects each measurement technique differently and as such each produces systematically different results.

Concentration Units

The Air Quality Regulations (DETR 2000b) specify Objectives in terms of mass per unit volume for all pollutants. However, continuous gas analysers and the calibration standards used are measured in terms of mixing ratio. These are two entirely different bases of measurement with conversion between them being dependent on temperature and pressure conditions. Conversions have been made based on 293 K and 101.3 kPa, where appropriate, for comparison to the AQS Objectives, (DETR 2000c). Mass per unit volume NO_X concentrations are reported as NO_2 equivalent.

Air quality during 2004

The pollution incidents experience during 2003 were not repeated in 2004. The concentration of each of the AQS pollutants during 2004 is discussed below and concentrations during 2004 are also compared to 2003. Measurements are detailed in Appendix 3.

Carbon Monoxide – CO

CO emissions within the LAQN area are dominated by road transport sources and therefore concentrations are greatest close to major roads. All sites met the AQS Objective of 10 mgm^{-3} (8.6 ppm) as a rolling 8 hour mean. CO is a primary pollutant and its temporal distribution is easier to understand than that for NO_2, O_3 or PM_{10}. CO concentrations are determined by emission rates and dispersion only and are therefore generally highest during the winter months when atmospheric dispersion is weakest. This is evident in *Figure 1* which shows the temporal distribution of CO during 2003 and 2004 as measured at the roadside site Wandsworth 4. During 2004, CO concentrations were lower in the spring and autumn periods when compared to 2003. Elevated CO was measured during a primary pollution episode during December 2004.

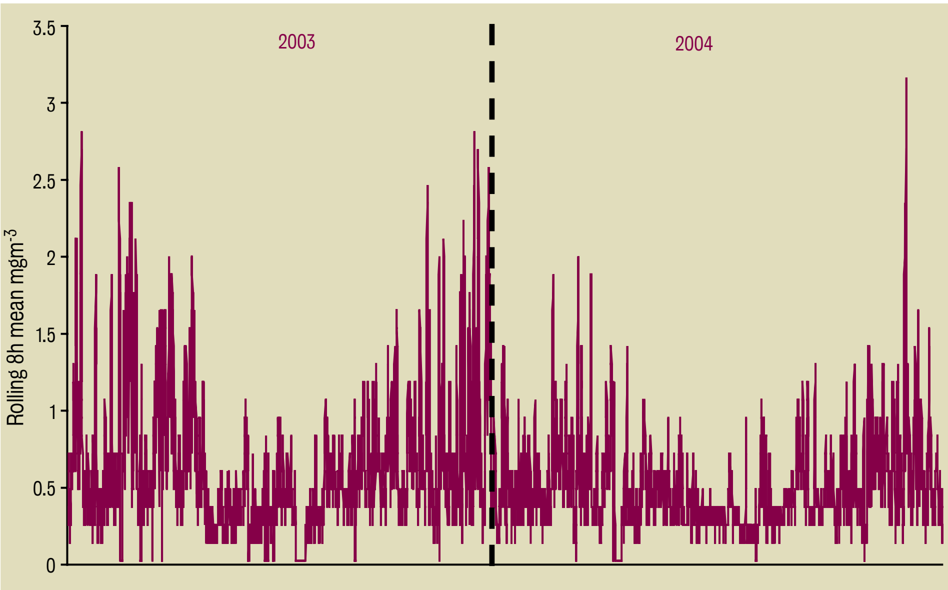

Figure 1 Rolling 8h mean CO at Wandsworth 4

Nitrogen dioxide – NO_2

NO_2 is largely a secondary pollutant formed by the oxidation of NO . Given that this process takes place over time in the atmosphere, to understand the concentration and sources of NO_2, it is necessary to consider the sum of NO and NO_2, which is termed NO_X. In the LAQN area, road transport is the dominant source of NO_X. This is reflected in the spatial distribution of NO_2, with the greatest annual mean concentrations being measured near roads and in central London locations. Lower concentrations are observed in background and suburban areas.

The temporal distribution of NO_2 during 2003 and 2004 is illustrated in *Figure 2*, which shows measurements from the background site Redbridge 1. At background sites, NO_2 concentrations are generally greatest during the wintertime when pollution dispersion is weakest and NO_X concentration is therefore elevated. Several NO_2 episodes are evident in the 2003 measurements. The frequency and severity of incidents during 2004 were less than those during 2003 although the NO_2 incidents

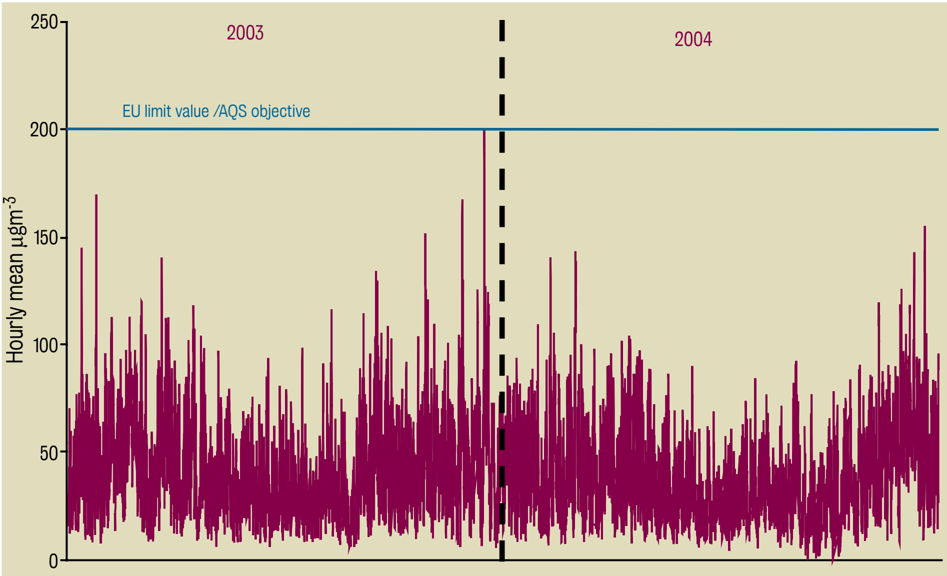

Figure 2 Hourly mean NO_2 at Redbridge 1

during late November and early December 2004 can be clearly seen in *Figure 2*.

The AQS stipulates two Objectives for NO_2: an annual mean of 40 µgm^{-3} (21 ppb) and an incident-based Objective of 200 µgm^{-3} (105 ppb), as an hourly mean, not to be exceeded more than 18 times per year.

During 2004, the annual mean NO_2 Objective was exceeded at all kerbside and roadside monitoring sites except for the outer London roadsides sites Enfield 2 and Havering 3. This Objective was also exceeded at background sites in inner London and the area where background sites exceeded the Objective also extended west beyond inner London to include Ealing 1 and Heathrow Airport.

All permanent kerbside sites measured hourly mean concentrations above 200 µgm^{-3} (105 ppb) during the year. The incident-based Objective for NO_2 was exceeded at the kerbside sites Barnet 1, Lambeth 4, Marylebone Road, and Sutton 4. The Lambeth 4 kerbside site measured an hourly mean NO_2 concentration above 200 µgm^{-3} on 3870 occasions and 529 occasions were measured at Marylebone Road. The hourly mean objective for NO_2 was also exceeded at the roadside sites Brent 3, Ealing 6, Hammersmith and Fulham 1, Hounslow 4, Kensington and Chelsea 3 and Kensington and Chelsea 4. Nine urban background sites measured hourly mean concentrations above 200 µgm^{-3}; the largest number (13) being measured at Hackney 4.

Ozone – O_3

O_3 is a seasonal pollutant with the highest concentrations being measured during the summer months when O_3 is formed by reactions between sunlight and other atmospheric pollutants. O_3 is a regional pollutant, with episodes extending over many thousands of square kilometres. In addition to this behaviour at the regional scale, O_3 exhibits local variation, for example, at the roadside, caused by the scavenging effect of NO close to NO_X emission sources. For this reason health-based standards are rarely exceeded at roadside and kerbside sites and O_3 monitoring is not generally undertaken in these locations. However, roadside monitoring of O_3 can lead to a

NO_2 and O_3 NAQS objectives exceeded widely

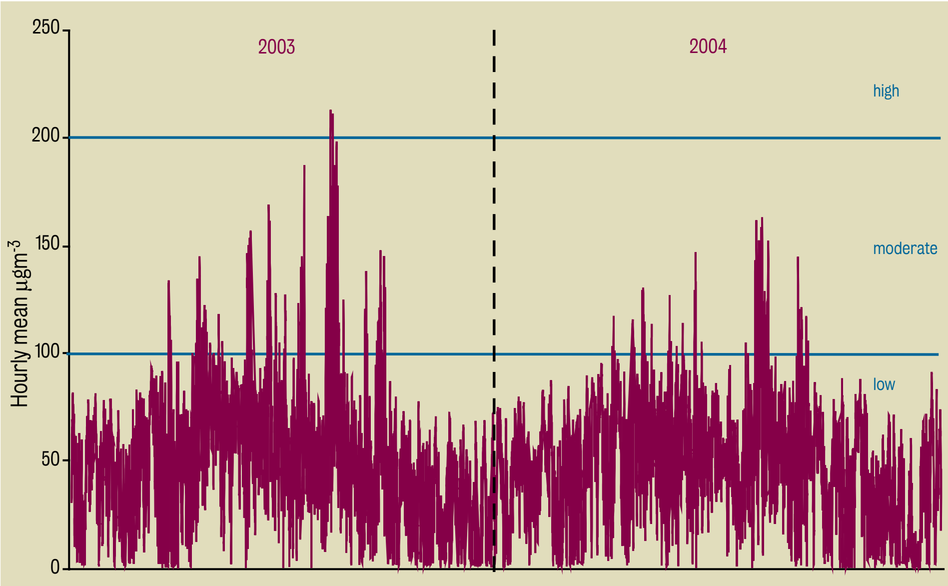

Figure 3 Hourly mean O_3; the mean of measurements at Bromley 5 and Kingston 1.

better understanding of the mechanisms that determine roadside NO_2 concentrations and primary emissions of NO_2. Further O_3 monitoring at roadside sites in London would therefore be welcome.

The temporal distribution of O_3 during 2003 and 2004 is illustrated in *Figure 3* which shows the mean of measurements at the suburban sites Bromley 5 and Kingston 1. O_3 concentrations are determined by a combination of emissions and meteorological circumstances at the global, European and local level. The highest background concentrations in the northern hemisphere are measured in the spring due to global emissions. During the summer months regional pollution incidents are superimposed upon the background causing concentrations to become 'moderate' or above. In terms of widespread 'moderate' O_3, the O_3 'season' during 2003 extended from 23rd March to 21st September; the longest 'season' measured during the 12 year operating period of the LAQN. During August 2003, O_3 concentrations in London reached their highest measured levels since 1990, though these concentrations were around half those measured during the summer of 1976 (PORG 1993). The O_3 'season' during 2004 was of comparable duration, extending from 31st March to 11th September. The main episode of the year was again during August. However the frequency and severity of the episodes during 2004 were far less than those measured during 2003. Local emissions of NO_X can cause O_3 concentrations to approach zero during primary pollution episodes. An example of such low O_3 concentrations can be seen in *Figure 3* during the primary pollution episode in December 2004.

The AQS has an Objective of 100 μgm^{-3} (50 ppb) for O_3, measured as a rolling 8 hour mean, which should not be exceeded on more than 10 days per year. The greatest concentrations of O_3 are generally measured at sites on the periphery of London and in the Home Counties. During the 3 years 2000 to 2002, the majority of sites in outer London and the Home Counties exceeded the Objective, whilst many sites in inner and west London met the Objective. During 2000 to 2002, outer

London sites typically experienced around 20 to 30 days per year with peak concentrations above 100 µgm^{-3}, measured as a rolling 8 hour mean. During 2003, several sites measured over 40 days above 100 µgm^{-3}, expressed as a rolling 8 hour mean; almost double the number of days measured annually during 2000 to 2002. During 2003 the AQS Objective was exceeded at all O_3 measurement sites in London except the kerbside site Marylebone Road. The sites exceeding the Objective during 2004 exhibited a similar spatial distribution to the years 2000 to 2002; the Objective being exceeded at the majority of outer suburban sites and LAQN sites around London but being achieved at many inner London background sites. Within the LAQN, the greatest number of days with peak 8 hourly mean O_3 concentrations above 100 µgm^{-3} was at Sevenoaks 2 (37 days) and Kingston 1 and Richmond 2 (24 days). Elsewhere in south east England, the greatest number of days with peak 8 hourly mean O_3 concentrations above 100 µgm^{-3} was measured at the Mid-Bedfordshire rural site (49 days).

The severe PM_{10} and O_3 episodes experienced during 2003 were not repeated during 2004

Particulate matter - PM_{10}

There are two AQS Objectives for PM_{10}: an incident-based Objective of 50 µgm^{-3}, measured as a daily mean, not to be exceeded on more than 35 days per year, and an annual mean Objective of 40 µgm^{-3}. These Objectives are in line with the EU Stage 1 Limit Value.

Figure 4 shows the daily mean PM_{10} measured at the inner London background site Kensington & Chelsea 1. During 2003, London experienced a series of PM_{10} episodes in February, March, April and August that were caused by the long-range transport of secondary PM_{10}. Lesser episodes were experienced during the 3rd quarter of the 2003. During 2004, the frequency and severity of PM_{10} episodes was less than that experienced during 2003. A PM_{10} episode is evident in *Figure 4* associated with the O_3 episode during August 2004 and a primary PM_{10} episode was measured during December.

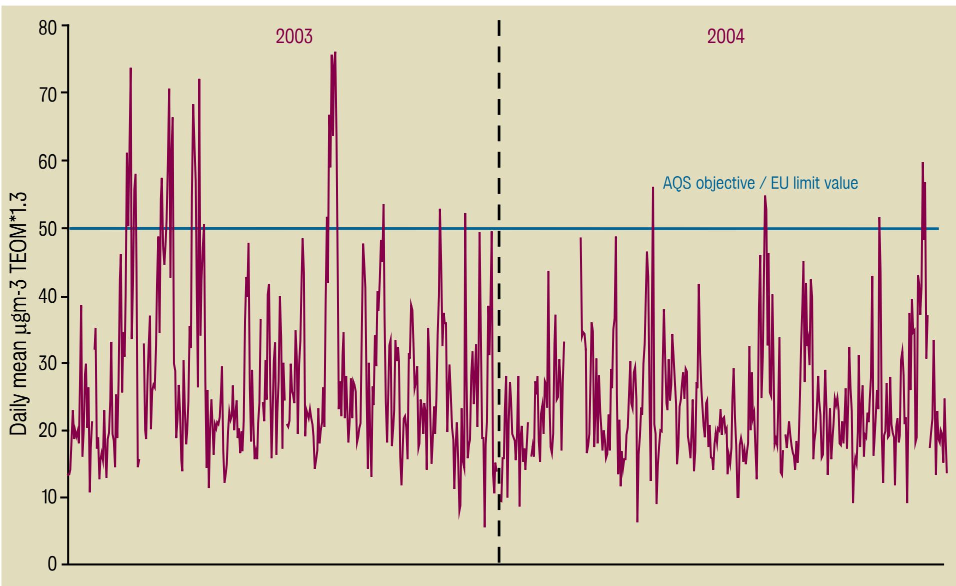

Figure 4 Daily Mean PM_{10} at Kensington and Chelsea 1

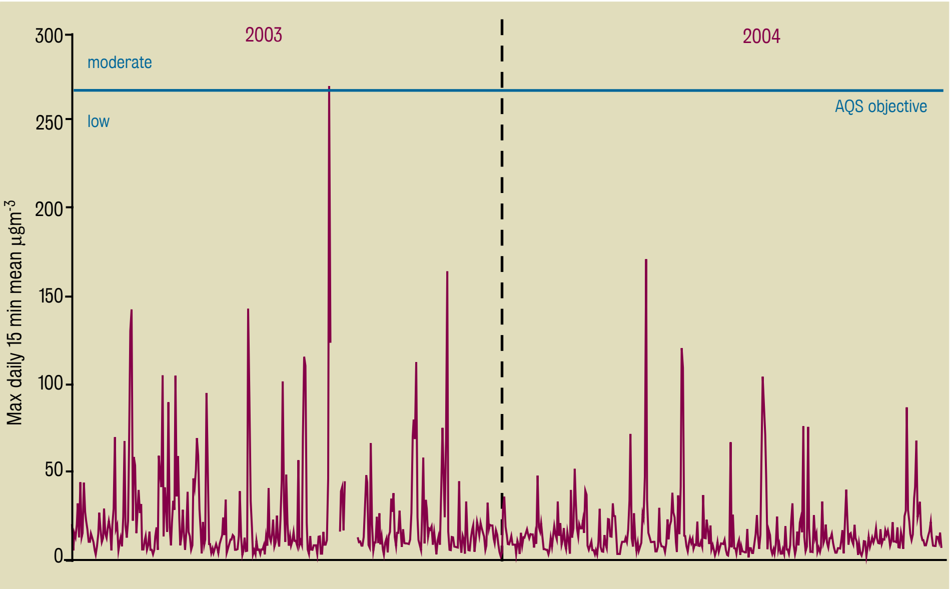

Figure 5 Daily maximum 15 minute mean SO_2 from Lewisham 2.

The annual mean Objective was exceeded at the Lambeth 4 (BAM) and Marylebone Road (TEOM) kerbside sites. The annual mean Objective was also exceeded at the Bexley 4 roadside site, which is located close to a waste transfer facility.

The incident-based Objective was exceeded at several road and kerbside monitoring sites. The greatest number of days with mean PM_{10} above 50 μgm^{-3} was measured at Bexley 4 (132 days) and Brent 5 (165 days) that are both located on haulage routes from waste transfer facilities. The road and kerbside sites Bexley 7, Brent 4, Camden 1, Enfield 4, Greenwich 8, Hounslow 5, Lambeth 4, and Marylebone Road also exceeded the incident-based Objective.

'Gravimetric' measurements of PM_{10} confirm that the incident-based Objective was exceeded at the Marylebone Road kerbside site and also at the roadside site Kensington and Chelsea 5.

SO_2

The spatial distribution of SO_2 concentrations is influenced by both road traffic and industrial point sources. Road traffic sources are the main factor influencing annual mean concentrations in London, whereas industrial point sources produce short-term high values due to plume grounding. The annual mean concentrations of SO_2 do not vary to any large degree over the network.

The AQS Objective for SO_2 is based on 35 breaches of a 15 minute mean of 266 μgm^{-3} (100 ppb). This was not approached at any site in the network, although Brent 1, Bexley 1, Enfield 3, Hounslow 2, Lewisham 1, Lewisham 2, and Thurrock 1 measured 15 minute means in excess of 266 μgm^{-3}. The AQS also has an hourly mean Objective of 350 μgm^{-3} (132 ppb) which should not be exceeded on more than 24 occasions per year. This was achieved at all sites.

The temporal distribution of SO_2 during the year is illustrated by measurements from the Lewisham 2 roadside site in south east London and is shown in *Figure 5*.

SO_2 incidents in London are mainly caused by plume grounding from large industry located in the east Thames area and are therefore associated with easterly winds. Pollution from continental sources is also transported into London by easterly winds and, therefore, SO_2 incidents often occur at the same time as secondary PM_{10} and O_3 episodes. Such incidents are evident in *Figure 5* where elevated SO_2 coincides with O_3 episodes during August 2003 and 2004, for example. The frequency and severity of SO_2 plume grounding events was less in 2004 when compared with 2003.

CO and SO_2 AQS Objectives were achieved at all sites.

Benzene and 1,3 Butadiene

The AQS Objectives for Benzene and 1,3 Butadiene are based on annual mean concentrations reflecting the long-term exposure concerns for these pollutants. The annual mean AQS Objective for Benzene is 5 μgm^{-3} and the AQS Objective for 1,3 Butadiene is 2.25 μgm^{-3}. Benzene and 1,3 butadiene are measured by DEFRA networks at the Marylebone Road kerbside site, the Haringey 1 roadside site and the Greenwich 4 background site. Benzene and 1,3 butadiene are also measured at the Tower Hamlets 2 roadside site. All sites met the AQS Objectives for these pollutants.

Medium-term changes in air pollution in London

Relative Results 1996 to 2005

Measurements from November 1996 to November 2004 were analysed to place the results from 2004 in context. To provide a perspective across the network as a whole, the mean from a sample of long-term sites was averaged to produce a LAQN mean. The LAQN network mean was set to 100 for each pollutant as at November 1996, thereby creating an index to illustrate relative change. The changes in index, relative to November 1996, are shown in *Table 1*.

LAQN annual mean index

Measurements from a range of site types were used to derive the LAQN annual mean index. However, due to measurement availability, different sites were used for each pollutant. The sites used in the index were reviewed in 2004 and again in 2005. The sites were revised to reflect the changing availability of pollution measurements. This was to ensure that the index for each pollutant is based on measurement sites with the longest datasets and that represent the range of pollution concentrations experienced in the network. Six long-term sites were used for the PM_{10} calculation, seven for CO, O_3 and SO_2, and 16 for NO_X and NO_2. It should be noted that measurements during 2005 are provisional and subject to ratification.

During 2004 the annual mean concentration of all pollutants decreased. The largest reductions during 2004 were exhibited by PM_{10} (-15%), NO_2 (-11%), NO_X (-10%), O_3 (-9%) and SO_2 (-8%) with only a slight change (-2%) in CO. *Table 1* also shows the results from provisional measurements made during the first ten months of 2005. Measurements from 2005 suggest that air quality concentrations remained relatively stable during the year with changes in the annual mean index of each pollutant being less than +/- 4%.

From November 1996 to the end of 2004, the LAQN annual mean index reduced for all pollutants except O_3. The greatest reductions were achieved in annual mean concentrations of SO_2 (-71%) and CO (-52%), with lesser reductions exhibited by PM_{10} (-30%) and NO_X (-39%).

Despite the 39% reduction in NO_X concentration, the annual mean concentration of NO_2 showed a lower decrease (-13%) during the period November 1996 to the end of 2004. The lower reduction in NO_2 concentration, when compared to reductions in NO_X concentration, illustrates the challenges of controlling the

Changes (%)	during 2004	First ten months of 2005*	Nov 1996 – Dec 2004	Nov 1996 – Nov 2005*
CO	-2	-4	-52	-56
NO_X	-10	-2	-39	-41
NO_2	-11	-1	-13	-14
O_3	-9	0	33	33
PM_{10}	-15	2	-30	-28
SO_2	-8	-2	-71	-73

*measurements during 2005 are provisional

Table 1 Changes in LAQN annual mean index, relative to November 1996

concentrations of this mainly secondary pollutant.

Worryingly, the annual mean concentrations of O_3 show a substantial increase during the period from November 1996 to the end of 2004 (33%). Although O_3 is not included in Local Air Quality Management (DEFRA, 2003), the continued measurement of O_3 is essential to quantify the changes in the concentration of this pollutant and to support the understanding of changes in the concentrations of NO_2.

Further insight into the relative changes in the concentration of air pollution in London can be gained from the time series of the annual mean values of the index for each pollutant. To produce a time series, the annual mean value of the index for each pollutant was calculated at monthly intervals from November 1996. The mean value for a particular date represented that for the preceding 12 months; for example, the value calculated for November 1996 represented the mean between November 1995 and November 1996.

The annual mean values for each pollutant shown in *Figure 6* and *Figure 7* allow the apparent reductions in air pollution during 2004 to be viewed in their correct context. During 2003, London experienced a series of pollution incidents, which caused increases in the annual mean concentrations of O_3, NO_2, PM_{10} and SO_2 (Fuller et al., 2005). Such pollution episodes were not repeated during 2004. The apparent reductions in the annual mean index values for O_3, NO_2, PM_{10} and SO_2 during 2004 are therefore an artefact of the pollution episodes during 2003 rather

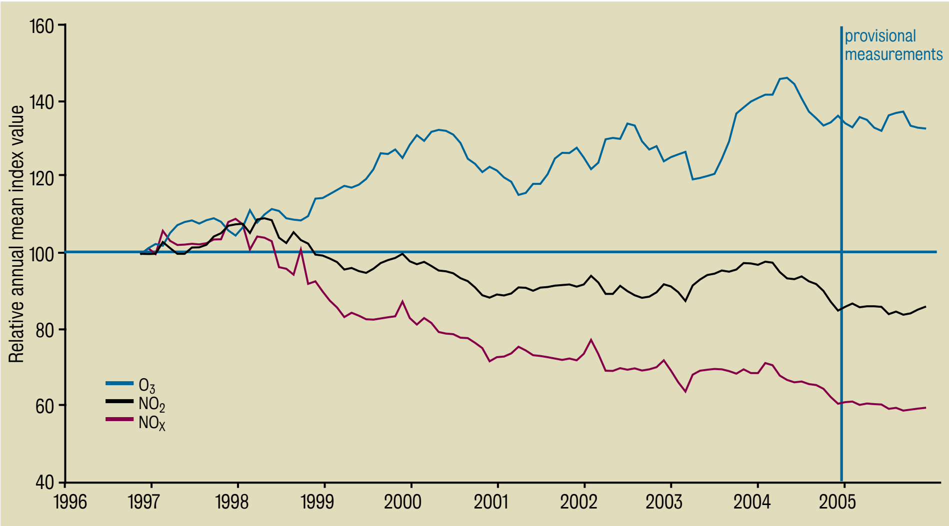

Figure 6 Relative annual mean concentrations of O_3, NO_X and NO_2

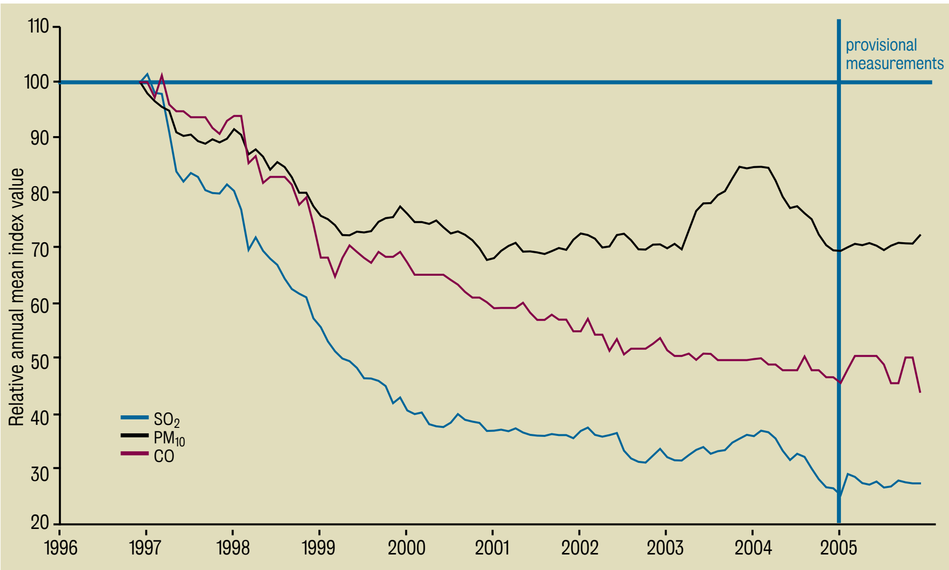

Figure 7 Relative annual mean concentrations of CO, PM_{10} and SO_2

than an indication of an underlying improvement in air pollution in London.

Figure 6 shows an overall fall of around 41% in the annual mean NO_X concentration over the period November 1996 to November 2005. This is the result of reduced NO_X emissions due to technological changes in the vehicle fleet. The effects of pollution incidents during October and November 1997 are clearly reflected in the NO_X concentration; causing a rise in annual mean index at this time and a consequential fall during winter 1998 as this incident drops from the rolling annual mean. Similar incidents are apparent during November 1999 and January 2002.

The annual mean O_3 index in *Figure 6* shows an overall rise of 33% from November 1996 to November 2005. The annual mean O_3 index in November 2005 is below the peak value of 146%, which was attained during spring 2004 as a consequence of the photochemical episodes during 2003.

Primary tail pipe emissions of NO_2

Local management of NO_2 focuses on reducing total emissions of NO_X. The majority of NO_X is emitted as NO, which is then oxidised to NO_2 in the atmosphere. The concentration of NO_2 is therefore limited by the oxidising capacity of the atmosphere. This is especially the case at roadside locations. However, NO_2 can also be emitted directly from vehicle exhausts without the need for atmospheric oxidation. The importance of primary emissions of NO_2 has been highlighted by a series of papers by Carslaw and Beevers (2004a, 2004b, 2005a and 2005b) that quantified the contribution of primary emissions of NO_2 to the total NO_2 concentration measured at roadside locations in London during 2000-02. Carslaw (2005) estimated that primary emissions of NO_2 ranged between 3% and 24% of the emissions of NO_X, with the directly emitted NO_2 being responsible for 21% of the annual mean NO_2 concentration (median estimate). Carslaw (2005) suggested that the proportion of directly emitted NO_2 at many roadside sites increased between 1997 and 2003, which masked underlying reductions in NO_2 being achieved as a consequence of NO_X reduction. Carslaw (2005) suggested that the increase in primary emissions of NO_2 may be due to the installation of diesel particulate filters, changes to the engine management systems on diesel vehicles and the increased proportion of diesel vehicles in the passenger car fleet. To strengthen the LAQN's ability to quantify primary emissions of NO_2, three roadside O_3 analysers have been recently installed by the London Boroughs of Bexley, Ealing and Greenwich.

From November 1996 to November 2005 the annual mean NO_2 index reduced by 14%. This reduction is not, however, consistent and fluctuations in annual mean NO_2 show influences of changes in annual mean NO_X and annual mean O_3. The annual mean NO_2 index showed a relative increase from November 1996 to November 1998, due in part to pollution incidents during autumn 1997. Despite reductions in annual mean NO_2 during 1998, the index returned to its original value again at the end of 1999. The index then reduced by 10% in 2000 during unsettled weather at this time and was relatively stable during 2001 and 2002. However, the annual mean concentration of NO_2 rose during 2003 and by the end of the year the NO_2 concentration index was within 2% of its value during November 1996. At this stage it is not possible to determine if the 11% decline in the annual mean NO_2 index during 2004 will herald a longer-term decline, or if it simply reflects the annual fluctuation exhibited by this pollutant.

The annual mean concentrations of CO and SO_2 declined by 56% and 73% respectively from November 1996 to November 2005. *Figure* 7 shows that annual mean CO and SO_2 indices fell relatively rapidly from November 1996 to 1999. However, from the start of 2000, the rate of change in annual mean CO and SO_2 has been more modest. Annual mean concentrations of CO in London are now approaching the limits of detection of analysers at many background sites and, as a consequence, artefacts from measurement uncertainty are apparent in the annual mean index during 2005.

Figure 7 also shows the annual mean PM_{10} index, which decreased by 28% between November 1996 and November 2005. However, this reduction was achieved in the period up to November 2000. Between November 2000 and November 2005, the annual mean PM_{10} index increased by 4% and PM_{10} incidents during 2003 (Fuller et al., 2005) caused the annual mean PM_{10} index to rise by 14% during the year. Source apportionment of PM_{10} in London suggests that the primary PM_{10} arising within London has increased since the turn of the century. (Fuller, 2006).

Progress towards the attainment of AQS Objectives

The LAQN annual mean index is effective at showing the relative change in annual mean concentration. However, the LAQN annual mean index does not show concentration relative to the AQS Objectives or progression towards the attainment of these Objectives. Progress towards the attainment of the AQS Objectives for PM_{10} and NO_2 is discussed below.

Nitrogen Dioxide – NO_2

Figure 8 compares the annual mean NO_2 at 3 different types of location in London using a sample of LAQN sites. Annual mean concentrations at typical background sites in outer London have been below the AQS Objective since 1998, whereas those at typical roadside and background sites in inner London have been consistently above the Objective. All location types showed an overall reduction and exhibited fluctuations due to the same factors; for example, the pollution episodes in autumn 1997 and, to a lesser extent, the photochemical episodes during 2003.

Pollution episodes during 2003 affected the annual mean concentrations of NO_2 with increases in the annual mean concentration being measured at all site types. Such pollution episodes were not repeated during 2004 and, as a consequence, the annual mean NO_2 concentration at background sites decreased by an average of 4 μgm^{-3} (-11%). This analysis is based on a sample of 11 background sites; 5 in outer London and 6 in inner London. However, similar decreases were not measured at the sample inner London kerb/roadside sites (5 sites) which show little overall change with an average increase of 1 μgm^{-3} (0.5%) during 2004.

Table 2 shows the change in annual mean NO_2 concentration at 25 kerb and roadside sites during 2003 and 2004. During 2003, 23 of the kerbside and roadside monitoring sites measured increases in the annual mean concentration of NO_2. An overall increase was also experienced at background sites, suggesting that meteorological conditions during 2003 had a part to play in these changes.

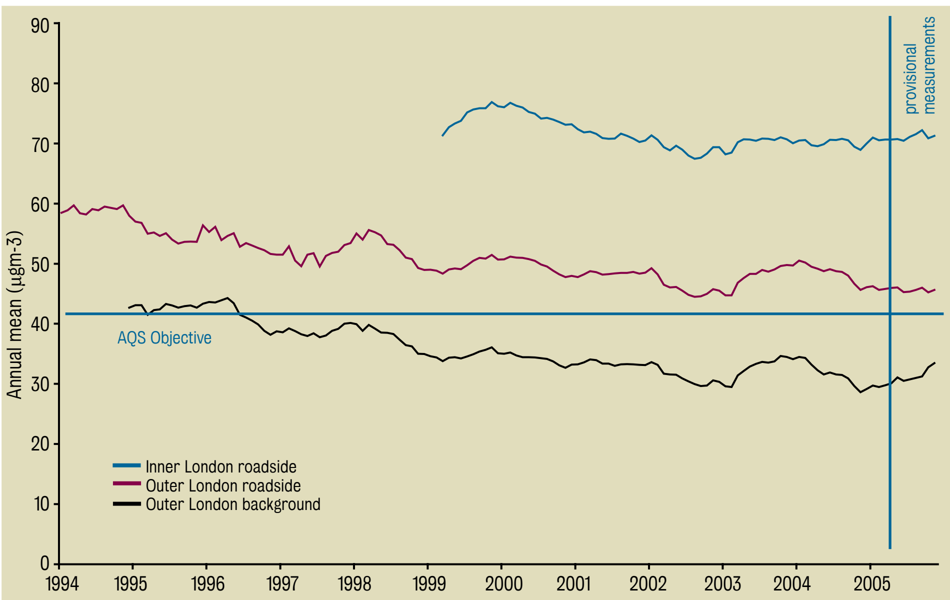

Figure 8 Annual mean NO_2

Kerbside & roadside sites			
	Change 2003 (μgm^{-3})	Change 2004 (μgm^{-3})	Net Change 2003 - 2004 (μgm^{-3})
Marylebone Road	27.1	2.5	29.6
Hounslow 4	23.9	-4.6	19.3
A3 Roadside	14.7	-6.5	8.2
Kensington & Chelsea 4	14.1	-6.1	8.0
Ealing 2	10.3	-7.3	3.0
Croydon 5	10.0	-10.3	-0.3
Croydon 2	9.0	-11.8	-2.8
Wandsworth 4	8.0	-5.3	2.7
Kensington & Chelsea 3	7.8	-5.5	2.3
Redbridge 4	6.6	-5.3	1.3
Croydon 4	6.6	-3.6	3.0
Greenwich Bexley 6	6.3	-10.7	-4.4
Haringey 1	5.7	-6.3	-0.6
Tower Hamlets 2	5.5	-6.1	-0.6
Richmond 1	4.4	-6.7	-2.3
Enfield 4	4.2	-4.2	0.0
Kensington & Chelsea 2	3.6	4.8	8.4
Enfield 2	2.3	-6.5	-4.2
Cystal Palace	2.1	-0.6	1.5
Havering 3	1.9	-4.0	-2.1
Camden 3	1.5	2.3	3.8
Bromley 7	0.9	4.4	5.3
Islington 2	-1.4	1.0	-0.4
Redbridge 3	-3.8	3.6	-0.2
Greenwich 5	-3.9	-3.0	-6.9

Table 2 Change in annual mean NO_2 concentrations at kerbside and roadside sites that achieved >75% data capture during each of the 3 years 2002 to 2004.

Importantly, the increases of greater than 10 μgm^{-3} that were measured at Marylebone Road, Hounslow 4, A3 Roadside, Kensington & Chelsea 4 and Ealing 2 during 2003 were not reversed during 2004, and it can therefore be concluded that the increased annual mean NO_2 concentration at these sites represents a change in road transport emissions at these locations.

Twelve of the 26 monitoring sites exhibited a net increase in annual mean NO_2 during 2003 and 2004. In addition to those sites that exhibited large increases during 2003, of particular note are Kensington & Chelsea 2 and Bromley 7 that each measured net increases of greater than 5 μgm^{-3}. Also of note is the Camden 1 kerbside site. Due to low data capture at Camden 1 during much of 2002 to 2004 the site is not featured in *Table 2*. However, provisional measurements during 2005 suggest that the annual mean NO_2 concentration at Camden 1 may have increased by 9 μgm^{-3} between March 2002 and October 2005. The only site measuring an overall reduction of greater than 5 μgm^{-3} over the 2 years was Greenwich 5 that measured a reduction of 6.9 μgm^{-3}. It is likely that the wide range of changes in annual mean NO_2 at roadside sites is linked to local changes in primary emissions of NO_2.

Particulate PM_{10}

Figure 9 shows the annual number of daily mean PM_{10} measurements above 50 μgm^{-3} (TEOM*1.3) at three different types of location. The long-term measurements at inner London background sites exhibit a downward trend from around 50 days above 50 μgm^{-3} (TEOM*1.3) in 1995 to around 10 days in 2002. The similar downward trend of all site types reflects a reduction in secondary and primary PM_{10} emissions, whilst the convergence in the number of daily means above 50 μgm^{-3} (TEOM*1.3) illustrates the reduction in traffic emissions of primary PM_{10}.

During 1995, typical inner London background sites exceeded the Objective, which implied a widespread breach of this Objective throughout London. The situation deteriorated in spring 1996 due to the substantial secondary episode at this time. As a consequence, 76 daily means above 50 μgm^{-3} (TEOM*1.3) were measured in inner London during the year ending April 1996; more than double the 2005 Objective of 35 days. A repetition of such an episode would clearly provide significant challenges for air quality management. The additional days above 50 μgm^{-3} (TEOM*1.3) caused by the spring 1996 episode left the running count in spring 1997. Other events affecting the number of daily means above 50 μgm^{-3} (TEOM*1.3) included the primary episode of autumn 1997 and the unsettled weather in late 2000. Inner London background sites have consistently achieved the Objective since 1998. The number of daily means above 50 μgm^{-3} (TEOM*1.3) measured at outer background London sites was only marginally less than those measured in inner London. A larger difference can be seen between the background and kerb/roadside sites in inner London than between outer and inner London background sites.

The number of daily means above 50 μgm^{-3} (TEOM*1.3) at the kerb/roadside sites in inner London followed a similar trend to background, albeit with additional days due to local traffic emissions. Inner London kerb/roadside sites generally achieved the Objective between 2000 and 2002. Measurements at Marylebone Road are not shown in *Figure 9*, but have been in the range 70-160 days per year since the site was installed and show variations in part due to local events such as building works (Fuller et al., 2002, Fuller and Green, 2005).

The measurements shown in *Figure 9* also show the impact of the PM_{10} episodes in 2003. Compared to 2002, background sites measured around 20 additional daily means above 50 μgm^{-3} (TEOM*1.3) during 2003, with kerb/roadside sites in inner London measuring around 30 such additional days. By the end of 2003, many road and kerbside TEOM sites in London had exceeded the AQS Objective. The majority of inner London background TEOM sites did not exceed the Objective; the exception being Tower Hamlets 1 where building works may have caused additional local PM_{10}.

The PM_{10} pollution events during 2003 were not repeated during 2004 and thus the annual number of days with mean PM_{10} greater than 50 μgm^{-3} (TEOM*1.3) was reduced. By the end of 2004, the annual number of days with mean PM_{10} greater than 50 μgm^{-3} (TEOM*1.3) at background sites in inner and outer London was comparable to that measured at the start of 2001. However, the PM_{10} measurements

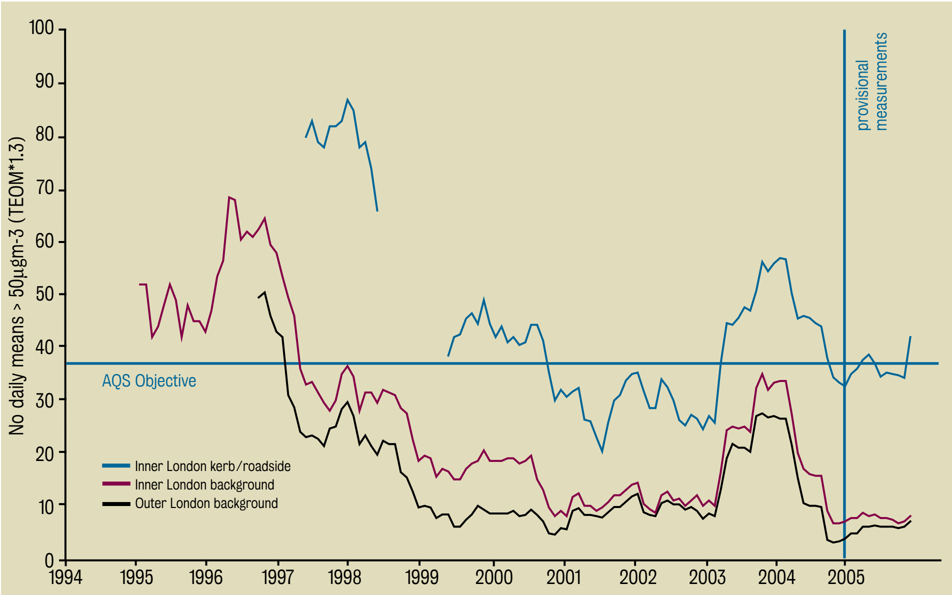

Figure 9 Annual number of days when daily mean PM_{10} exceeded 50 µgm^{-3} (TEOM*1.3)

at inner London kerb and roadside sites did not exhibit comparable reductions to those measured at background locations. Although PM_{10} at inner London kerb and roadside sites reduced during 2004, the annual number of days with mean PM_{10} greater than 50 µgm^{-3} (TEOM*1.3) at the end of the year was close to the Objective and above that measured at the start of 2001.

Provisional measurements for the first 10 months of 2005 show that background sites continued to remain below the Objective, with the annual number of daily means greater than 50 µgm^{-3} (TEOM*1.3) remaining at levels that prevailed before the pollution incidents in 2003. However, at kerb and roadside sites in inner London, the annual number of daily means greater than 50 µgm^{-3} (TEOM*1.3) continued to remain above pre-2003 levels. Of note is the Camden 1 kerbside site that measured daily mean concentrations greater than 50 µgm^{-3} (TEOM*1.3) on 16 days during 2002, rising to 43 days during 2004. During the first 10 months of 2005, 9 monitoring sites in the LAQN exceeded the AQS Objective.

Appendix 1: LAQN monitoring sites

Details of monitoring sites

The following tables detail the pollution monitoring sites in the LAQN at the end of 2004. The start date of each site is shown along with the pollutants monitored and the measurement quality. In some cases a monitoring site was not operating during the 12 month period. The availability of measurements from a site is indicated in the data column.

Sites are classified according to their location:

- Kerbside sites are those with sampling locations within 1 m of the kerbside and with a sampling height of 3m or less.
- Roadside sites are those with sampling locations within 1-5m of the roadside and with a sampling height of 3m or less.
- Urban background sites are located to represent pollution conditions in the centre of an urban area.
  Sampling locations are away from the influence of individual pollution sources; 25 m from major roads for example.
- Suburban sites are typical of residential locations on the edge of a built-up area. Sampling locations are away from the influence of individual pollution sources; 25m from major roads for example.
- Industrial sites are situated to assess air pollution from specific industrial sources.

Kerbside Sites

	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Barnet 1	Dec 98		•			T		Yes	**
Bromley 4	Feb 96	Closed Jul 98							
Camden 1	Apr 96		•			T		Yes	**A
Lambeth 4	Dec 03		•	•		B		Yes	*
Marylebone Road	Jun 97	•	•	•	•	TF Gx2	T	Yes	**A
Redbridge 2	Dec 99	Closed Apr 03							
Redbridge 3	Dec 99		•			B		Yes	*
Sutton 4	Jul 02		•			T		Yes	**

Key to tables

T TEOM
B Beta Attenuation
G Gravimetric
F FDMS
A Affiliated to UK AURN. Final data set published by DEFRA
* Locality Standard
** Traceability to National Standards

Roadside sites									
	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Bexley 7	Apr 04		•		•	TF	T	Yes	**
Bexley 8	Apr 04		•		•	T	T	Yes	**
Brent 2	Jun 01	Closed Sep 02							
Brent 3	Dec 01		•	•		T		Yes	**
Brent 4	Jun 03		•	•		T		Yes	**
Bromley 7	July 98	•	•			B		Yes	*/**A
Camden 3	Apr 00		•			T		Yes	**
Croydon 2	Sept 94		•					Yes	**
Croydon 4	Sept 99		•	•		T		Yes	**
Croydon 5	Oct 00		•					Yes	**
Crystal Palace	Oct 99	•	•	•		T		Yes	**
Ealing 2	Sept 96	•	•			T	T	Yes	**
Ealing 4	Dec 98	Closed Mar 99							
Ealing 5	Mar 99	Closed Jun 01							
Ealing 6	Aug 03		•					Yes	**
Enfield 2	Jan 98	•	•			B		Yes	**
Enfield 4	Mar 00		•	•		B		Yes	**
Greenwich 5	Sept 97		•			T		Yes	**
Greenwich 7	Mar 02		•			T		Yes	**
Greenwich 8	Jul 04		•			T		Yes	**
Greenwich 9	Nov 04		•			F	F	Yes	**
Greenwich 10	Sep 04		•			T		Yes	**
Greenwich Bexley 6	Oct 00		•		•	T	T	Yes	**
Hams & Fulham 1	Aug 99		•	•		T		Yes	**
Hackney 6	Nov 02		•			T		Yes	**
Haringey 1	Dec 94		•	•		T		Yes	** A
Haringey 3	Apr 99	Closed Mar 01							
Harrow 2	Jun 03		•			T		Yes	**
Havering 1	Dec 95		•					Yes	**
Havering 3	Dec 98		•	•		T		Yes	**
Hillingdon 1	Sept 99		•			T		Yes	**
Hillingdon 2	Sept 02		•			T		Yes	**
Hounslow 1	Apr 93	Closed Dec 02							
Hounslow 3	Mar 99	Closed Nov 02							
Hounslow 4	Aug 99		•	•		T		Yes	**
Hounslow 5	Aug 03	•	•			T		Yes	**A
Islington 2	Jul 00	•	•			T		Yes	**
Ken & Chelsea 2	May 98					T		Yes	**
Ken & Chelsea 3	Mar 00		•					Yes	**
Ken & Chelsea 4	Sep 00		•					Yes	**
Ken & Chelsea 5	May 02					G		Yes	*
Kingston 2	Apr 96		•			T		No	
Lambeth 1	Sep 00		•	•		B		Yes	*
Lambeth 2	Dec 01		•	•		B		Yes	*
Redbridge 4	Dec 99	•	•	•		B		Yes	*
Redbridge 5	Nov 03	•	•			B		Yes	*
Richmond 1	Jun 00		•			T		Yes	**
Southwark 2	Oct 94	•	•	•		T		Yes	*/**A
Sutton 1	May 95	Closed May 02							
Thurrock 2	May 03		•					Yes	**
Thurrock 3	Aug 03		•	•		T		Yes	**
Tower Hamlets 2	Mar 94	•	•					Yes	** A
Wandsworth 1	Sept 94	Closed Mar 96							
Wandsworth 4	Feb 98	•	•			T		Yes	**
Waltham Forest 3	Jul 03		•	•		T		Yes	**
Westminster 2	Jun 95	Last data 95							

Urban background sites									
	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Barnet 2	Aug 00		•			T		Yes	**
Barnet 3	Aug 00	Closed Mar 02							
Brent 1	Aug 95	•	•	•	•	T		Yes	** A
Bromley 1	Jan 93	Closed Feb 96							
Castle Point	May 96		•	•				Yes	**
City of London 1	Oct 01		•	•	•			Yes	*
Croydon 3	May 97				•	T		Yes	**
Ealing 1	Mar 95	(•)	•	•	•			Yes	**
Enfield 3	Nov 98	•	•	•	•	B		Yes	**
Greenwich 4	Sept 93		•	•	•	T		Yes	** A
Greenwich 12	Jul 04		•			F	F	Yes	**
Hackney 4	Oct 93	•	•		•		T	Yes	*/**A
Hams & Fulham 2	Aug 03		•			T		Yes	**
Heathrow Airport	Mar 99	•	•			T		Yes	**
Hillingdon (O)	Oct 94	Last Data Apr 95							
Ken & Chelsea 1	Mar 95	•	•	•	•	TG	G	Yes	**A
Islington 1	Sep 94	(•)	•			T		Yes	**
Lambeth 3	Dec 01		•	•		B		Yes	*
Lewisham 1	Jan 95		•	•	•			Yes	**A
Mole Valley 3	Oct 01		•			T		Yes	**
Redbridge 1	Dec 99		•		•	B		Yes	*
Sevenoaks 2	Feb 98	•	•	•	•	T		Yes	**
Southwark 1	Mar 93	•	•	•	•	T		Yes	*/**A
Thurrock 1	Feb 95	•	•	•	•	TG		Yes	**A
Tower Hamlets 1	Jan 94		•	•	•	T		Yes	**
Tower Hamlets 3	Oct 99		•	•		T		Yes	**
Waltham Forest 1	Jul 98		•	•		T		Yes	**
Wandsworth 2	Oct 94	•	•	•	•			Yes	**A
Westminster 1	Jan 93	Last Data 96							

Key to tables

T TEOM
B Beta Attenuation
G Gravimetric
F FDMS
A Affiliated to UK AURN. Final data set published by DEFRA
* Locality Standard
** Traceability to National Standards

Deployments of the Richmond mobile site (Richmond 3+) are not individually listed

Suburban sites									
	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Bark & Dag 1	Sep 93		•	•				Yes	**
Bark & Dag 2	Oct 99					T		Yes	**
Bexley 1	Jan 93	•	•	•	•	T	T	Yes	**A
Bexley 2	Jan 98		•			T	TF	Yes	**
Bexley 3	Jan 98					T	T	Yes	**
Bexley 5	Nov 99	•	•	•				Yes	**
Brentwood 1	Aug 95		•					Yes	**
Bromley 5	Mar 96				•			Yes	**
Croydon 6	Jan 01		•					Yes	**
Ealing 7	Jul 04		•			T		Yes	**
Enfield 1	Jul 95		•					Yes	**
Haringey 2	Apr 96		•		•	B		Yes	**A
Havering 2	Apr 98	Closed Nov 00							
Harrow 1	Apr 99		•	•		T		Yes	**
Hounslow 2	Apr 99		•	•	•	T		Yes	**
Kingston 1	Mar 96				•			Yes	**
Mole Valley 2	Apr 97		•			T		Yes	**
Reigate & Bans 1	Jul 00		•			T		Yes	**
Reigate & Bans 2	Aug 03		•					Yes	**
Richmond 2	Apr 01		•		•	T		Yes	**
Sutton 2	May 95	Closed May 02							
Sutton 3	May 95		•		•			Yes	**
Wandsworth 3	Oct 94	Closed Nov 00							

Industrial sites									
	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Bexley 4	May 99		•			T		Yes	**
Brent 5	Feb 04		•			T		Yes	**

Rural sites									
	Start	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$	Data	Quality
Mole Valley 1	Mar 96	Closed Mar 99							
S'oaks Scudders H	Sept 95	Closed Sept 97							

Network Changes

Eight new monitoring sites joined the LAQN during the year. These are shown in Figures 10-16. Additional equipment was installed at four further sites. These sites are shown in Figure 18 and Figure 20.

➔**Figure 10** The **Bexley 7** and **Bexley 8** monitoring sites began operation during April alongside the A206 in Crayford. The sites were installed to quantify emissions from the A206, before, during and after roadway widening to form a dual carriageway. Although both sites are 22m from the original A206; following the completion of the works the distance between the monitoring sites and the new A206 will be reduced. The location of the monitoring sites; on opposite sides of the road, provides the best possible opportunities to quantify emissions from the road itself. Both sites measure NO_X, O_3, PM_{10} and $PM_{2.5}$ by TEOM. Additionally the Bexley 7 site also measures PM_{10} by FDMS and meteorological parameters.

←**Figure 11** The **Brent 5** site joined the LAQN during February. The site is located on a residential road close to the entrance to several waste transfers facilities. Brent 5 was the second LAQN site to be located close to a waste transfer facility The first such site (Bexley 4) measures PM_{10} concentrations considerably in excess of the EU Limit Value. The Brent 5 site monitors NO_X, and PM_{10} (TEOM) and meteorological parameters

➔**Figure 12** During July, the **Ealing 7** monitoring site was installed at a suburban location in a school in Southall. Southall is the closest part of the borough to Heathrow and the installation of the monitoring site reflects concerns about air pollution arising from Heathrow airport. The site measures NO_X and PM_{10} by TEOM.

➔**Figure 13** The **Greenwich 8** monitoring site was installed in a roadside location alongside the Woolwich Flyover during July. The Woolwich Flyover carries the A102 over the junction between the A102, the A206 and several minor roads. The monitoring site is located to represent residential roadside exposure at the junction. The site measures NO_X and PM_{10} by TEOM, and frequently measures days with mean PM_{10} in excess of 50 μgm^{-3} (TEOM*1.3).

🡐**Figure 14** The **Greenwich 9** monitoring site joined the LAQN during November. The site is located on a residential section of the A205 south circular road and measures NO_X, PM_{10} and $PM_{2.5}$ by FDMS. In addition to the assessment of PM_{10} in this location, measurements from this instrument, when combined with those from other FDMS in London, will provide valuable insight into this new automated method for the measurement of airborne particulate.

← **Figure 15** **Greenwich 10** is located beside the A206 in Woolwich. The site is in a roadside location and measures NO_X and PM_{10} by TEOM. Measurements are available from September.

→ **Figure 16** The **Greenwich 12** monitoring site is located in a background location in the Millennium Village area, close to a potential industrial source of PM_{10}. The site measures NO_X, PM_{10} and $PM_{2.5}$ by FDMS. This combination of measurands is designed to allow the apportionment of PM_{10} emissions from the industrial source. Additionally, the deployment of FDMS equipment will assist in the characterisation of this measurement method. The site joined the LAQN during July.

← **Figure 17** An additional TEOM for the measurements of $PM_{2.5}$ was added to the **Bexley 1** site during April. This equipment will aid source apportionment of PM_{10} in Bexley and across London and the south east.

← **Figure 18** A PM_{10} FDMS was installed at the **Bexley 2** suburban site during April. The Bexley 2 site is located in an open area adjacent to a primary school. The installation of an FDMS at this location will provide background measurements for the roadside FDMS in both Greenwich and Bexley, and will provide valuable measurements in a London-wide assessment of FDMS performance.

→ **Figure 19** A NO_X analyser was added to the **Bexley 4** monitoring site. This additional equipment will aid the source apportionment of PM_{10} at this location and will lead to a better understanding of the factors that cause the site to routinely exceed the AQS Objective for PM_{10}.

← **Figure 20** During September, a O_3 analyser was installed at Greenwich **Bexley 6** which is located at the roadside by the A2. The installation of an O_3 analyser at this location will enable the quantification of primary NO_2 emissions at this site.

Appendix 2: DEFRA directly funded sites

Roadside sites					
	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$
A3	•	•			T
Cromwell Rd	•	•	•		#

A.2.1 Background Sites						
	CO	NO_2	SO_2	O_3	PM_{10}	$PM_{2.5}$
Bloomsbury	•	•	•	•	T	T
Harlington	•	•		•	T	
Hillingdon	•	•	•	•	T	
Teddington		•	•	•		
Westminster	•	•	•	•	G	
West London	•	•				

Key to tables
T TEOM
B Beta Attenuation
G Gravimetric
F FDMS

Reported as LAQN site Kensington & Chelsea 2

Appendix 3: monitoring results

Monitoring results have been compared to the AQS Objectives. Many AQS Objectives require measurements representative of the whole year. If insufficient measurements are available, then comparison with the Objective is not possible. This, for example, may be the case for sites installed during the year or those that experienced serious and prolonged instrument failure. A data capture objective of 90% is recommended in LAQM TG03 (DEFRA, 2003) in line with EU Directive requirements.

CO				
Site	Type	Data Capture %	8h mean <8.6 mgm^{-3} (10ppm)	Achieved?
Bexley 1	U	94	0	YES
Brent 1	U	86	0	NA
Bromley 7	R	95	0	YES
Crystal Palace 1	R	85	0	NA
Ealing 2	R	98	0	YES
Enfield 2	R	99	0	YES
Enfield 3	U	94	0	YES
Hackney 4	U	95	0	YES
Harlington	U	92	0	YES
Heathrow Airport	U	97	0	YES
Hounslow 5	R	94	0	YES
Islington 2	R	86	0	NA
Kens and Chelsea 1	U	98	0	YES
Kens and Chelsea 2	R	97	0	YES
Marylebone Rd	K	95	0	YES
Redbridge 4	R	95	0	YES
Redbridge 5	R	47	0	NA
Richmond 15	R	9	0	NA
Richmond 17	U	21	0	NA
Richmond 19	U	19	0	NA
Richmond 21	R	42	0	NA
Sevenoaks 2	U	89	0	NA
Southwark 1	U	94	0	YES
Southwark 2	R	98	0	YES
Thurrock 1	U	95	0	YES
Tower Hamlets 2	R	83	0	NA
Wandsworth 2	U	91	0	YES
Wandsworth 4	R	98	0	YES
Westminster	U	90	0	YES

K Kerbside
R Roadside
U Urban background
S Suburban
I Industrial

NO_2						
Site	Type	Data capture %	Annual mean < 40 μgm^{-3}	Annual mean achieved?	No more than 18 occurrences of hourly mean >=200 μgm^{-3} (104.6ppb)	Hourly mean achieved?
Barking & Dagenham 1	S	99	31	YES	0	YES
Barnet 1	K	17	77	NA	20	NO
Barnet 2	U	92	37	YES	5	YES
Bexley 1	U	95	34	YES	1	YES
Bexley 2	S	93	33	YES	0	YES
Bexley 4	I	27	37	NA	0	NA
Bexley 5	S	26	29	NA	0	NA
Bexley 7	R	70	40	NA	0	NA
Bexley 8	R	66	38	NA	0	NA
Brent 1	U	91	29	YES	0	YES
Brent 3	R	83	57	NA	24	NO
Brent 4	R	98	63	NO	10	YES
Brent 5	I	81	48	NA	0	NA
Brentwood 1	U	95	32	YES	0	YES
Bromley 7	R	97	46	NO	0	YES
Camden 1	K	58	67	NA	9	NA
Camden 3	R	95	72	NO	0	YES
Castle Point 1	U	94	26	YES	0	YES
City of London 1	U	74	49	NA	0	NA
Croydon 2	R	91	43	NO	0	YES
Croydon 4	R	91	52	NO	0	YES
Croydon 5	K	93	64	NO	4	YES
Croydon 6	S	84	36	NA	0	NA
Crystal Palace 1	R	85	48	NA	0	NA
Ealing 1	U	99	41	NO	0	YES
Ealing 2	R	92	55	NO	0	YES
Ealing 6	R	74	98	NA	93	NO
Ealing 7	U	24	39	NA	0	NA
Enfield 1	S	54	34	NA	0	NA
Enfield 2	R	99	39	YES	0	YES
Enfield 3	U	95	32	YES	0	YES
Enfield 4	R	98	47	NO	0	YES
Greenwich 10	R	28	54	NA	3	NA
Greenwich 12	U	41	38	NA	0	NA
Greenwich 4	U	96	30	YES	0	YES
Greenwich 5	R	99	47	NO	0	YES
Greenwich 7	R	88	50	NA	0	NA
Greenwich 8	R	45	78	NA	12	NA
Greenwich 9	R	11	51	NA	0	NA
Greenwich Bexley 6	R	99	44	NO	0	YES
Hackney 4	U	99	48	NO	13	YES
Hackney 6	R	99	60	NO	0	YES
Haringey 1	R	97	46	NO	0	YES
Haringey 2	S	97	34	YES	0	YES
Harlington	U	98	38	YES	0	YES
Harrow 1	U	93	28	YES	0	YES

NO_2						
Site	Type	Data Capture %	Annual mean < 40 ugm^{-3}	Annual mean Achieved?	No more than 18 occurrences of hourly mean >=200 μgm^{-3} (104.6ppb)	Hourly mean achieved?
Harrow 2	R	91	44	NO	0	YES
Havering 1	R	93	38	YES	0	YES
Havering 3	R	99	39	YES	0	YES
Heathrow Airport	U	98	55	NO	3	YES
Hillingdon 1	R	80	47	NA	7	NA
Hillingdon 2	R	51	38	NA	0	NA
Hounslow 2	S	86	36	NA	0	NA
Hounslow 4	R	99	78	NO	29	NO
Hounslow 5	R	92	54	NO	8	YES
H'smith and Fulham 1	R	59	79	NA	28	NO
H'smith and Fulham 2	U	97	40	NO	1	YES
Islington 1	U	92	47	NO	0	YES
Islington 2	R	99	70	NO	4	YES
Kens and Chelsea 1	U	98	40	NO	0	YES
Kens and Chelsea 2	R	98	80	NO	3	YES
Kens and Chelsea 3	R	99	87	NO	260	NO
Kens and Chelsea 4	R	84	92	NA	56	NO
Lambeth 1	R	99	54	NO	0	YES
Lambeth 3	U	92	38	YES	0	YES
Lambeth 4	K	94	197	NO	3870	NO
Lewisham 1	U	97	49	NO	1	YES
Lewisham 2	R	99	68	NO	4	YES
Marylebone Rd	K	97	110	NO	529	NO
Mole Valley 2	S	98	26	YES	0	YES
Mole Valley 3	U	99	24	YES	0	YES
Redbridge 1	U	99	37	YES	0	YES
Redbridge 3	K	95	67	NO	17	YES
Redbridge 4	R	94	49	NO	0	YES
Redbridge 5	R	91	53	NO	0	YES
Reigate and Banstead 1	S	99	31	YES	0	YES
Reigate and Banstead 2	S	88	34	NA	0	NA
Richmond 1	R	97	41	NO	0	YES
Richmond 15	R	9	50	NA	0	NA
Richmond 17	U	21	38	NA	0	NA
Richmond 19	U	22	25	NA	0	NA
Richmond 2	S	97	31	YES	0	YES
Richmond 21	R	41	35	NA	0	NA
Sevenoaks 2	U	89	22	NA	0	NA
Southwark 1	U	87	51	NA	0	NA
Southwark 2	R	74	62	NA	0	NA
Sutton 3	S	24	36	NA	0	NA
Sutton 4	K	93	80	NO	131	NO
Thurrock 1	U	88	35	NA	0	NA
Thurrock 2	R	95	70	NO	3	YES
Thurrock 3	R	99	39	YES	0	YES
Tower Hamlets 1	U	92	35	YES	0	YES
Tower Hamlets 2	R	95	61	NO	3	YES
Tower Hamlets 3	U	63	43	NA	0	NA
Waltham Forest 1	U	95	38	YES	2	YES
Waltham Forest 3	R	69	29	NA	0	NA
Wandsworth 2	U	98	54	NO	2	YES
Wandsworth 4	R	99	47	NO	0	YES
Westminster	U	77	46	NA	3	NA

NO_x			NO_x		
Site	Type	Annual mean μgm^{-3}	Site	Type	Annual mean μgm^{-3}
Barking & Dagenham 1	S	49	Harrow 2	R	127
Barnet 1	K	206	Hounslow 2	S	65
Barnet 2	U	66	Hounslow 4	R	175
Brent 1	U	49	Hounslow 5	R	154
Brent 3	R	124	Havering 1	R	87
Brent 4	R	250	Havering 3	R	90
Brent 5	I	131	Islington 1	U	76
Brentwood 1	U	46	Islington 2	R	169
Bexley 1	U	57	Kens and Chelsea 1	U	64
Bexley 2	S	51	Kens and Chelsea 2	R	193
Bexley 4	I	84	Kens and Chelsea 3	R	219
Bexley 5	S	42	Kens and Chelsea 4	R	223
Bexley 7	R	94	Lambeth 1	R	116
Bexley 8	R	83	Lambeth 3	U	65
Bromley 7	R	84	Lambeth 4	K	565
Camden 1	K	168	Harlington	U	71
Camden 3	R	158	Heathrow Airport	U	124
Castle Point 1	U	38	Lewisham 1	U	99
Croydon 2	R	130	Lewisham 2	R	156
Croydon 4	R	104	Mole Valley 2	S	40
Croydon 5	K	185	Mole Valley 3	U	41
Croydon 6	S	69	Marylebone Rd	K	309
City of London 1	U	83	Redbridge 1	U	63
Crystal Palace 1	R	123	Redbridge 3	K	163
Ealing 1	U	73	Redbridge 4	R	111
Ealing 2	R	143	Redbridge 5	R	133
Ealing 6	R	353	Reigate and Banstead 1	S	47
Ealing 7	U	85	Reigate and Banstead 2	S	56
Enfield 1	S	66	Richmond 1	R	81
Enfield 2	R	77	Richmond 2	S	47
Enfield 3	U	55	Richmond 21	R	84
Enfield 4	R	106	Richmond 22	R	93
Greenwich Bexley 6	R	121	Southwark 1	U	91
Greenwich 10	R	124	Southwark 2	R	125
Greenwich 12	U	82	Sutton 3	S	70
Greenwich 4	U	47	Sutton 4	K	194
Greenwich 5	R	97	Tower Hamlets 1	U	55
Greenwich 7	R	128	Tower Hamlets 2	R	158
Greenwich 8	R	273	Tower Hamlets 3	U	72
Greenwich 9	R	171	Thurrock 1	U	62
H'smith and Fulham 1	R	223	Thurrock 2	R	188
H'smith and Fulham 2	U	63	Thurrock 3	R	89
Haringey 1	R	97	Wandsworth 2	U	113
Haringey 2	S	57	Wandsworth 4	R	90
Hillingdon 1	R	122	Waltham Forest 1	U	64
Hillingdon 2	R	76	Waltham Forest 3	R	52
Hackney 4	U	94	Westminster	U	77
Hackney 6	R	145	Sevenoaks Background	U	34
Harrow 1	U	45			

O_3				
Site	Type	Data Capture %	No more than 10 days where maximum rolling 8hr mean >=100µgm^{-3} (50ppb)	Achieved?
Bexley 1	U	95	16	NO
Bexley 7	R	55	8	NA
Bexley 8	R	55	8	NA
Brent 1	U	94	7	YES
Bromley 5	S	93	23	NO
City of London 1	U	96	7	YES
Croydon 3	S	98	15	NO
Ealing 1	U	99	14	NO
Enfield 3	U	83	10	NA
Greenwich 4	U	95	11	NO
Greenwich Bexley 6	R	25	0	NA
Hackney 4	U	88	7	NA
Haringey 2	S	93	11	NO
Harlington	U	94	8	YES
Hounslow 2	S	76	6	NA
Kens and Chelsea 1	U	97	17	NO
Kingston 1	S	94	24	NO
Lewisham 1	U	87	1	NA
Marylebone Rd	K	97	0	YES
Redbridge 1	U	99	19	NO
Richmond 15	R	9	0	NA
Richmond 17	U	21	1	NA
Richmond 19	U	22	2	NA
Richmond 2	S	98	24	NO
Richmond 21	R	43	6	NA
Sevenoaks 2	U	92	37	NO
Southwark 1	U	94	5	YES
Sutton 3	S	73	12	NA
Thurrock 1	U	97	16	NO
Tower Hamlets 1	U	99	18	NO
Wandsworth 2	U	98	3	YES
Westminster	U	93	6	YES

$PM_{2.5}$			
Site	Type	Capture	Annual mean µgm^{-3}
Bloomsbury	U	98	12
Bexley 1	S	75	12
Bexley 2	S	99	12
Bexley 3	S	25	12
Bexley 7	R	73	14
Bexley 8	R	74	13
Ealing 2	R	88	16
Greenwich Bexley 6	R	99	14
Greenwich 9	R	3	10
Greenwich 12	R	31	13
Hackney 4	U	99	13
Marylebone Road 1	K	96	19

K Kerbside
R Roadside
U Urban background
S Suburban
I Industrial

PM$_{10}$						
Site	Type	Data Capture %	Annual mean less than 40µgm-	Annual mean Achieved?	No more than 35 days where daily mean >=50µgm^{-3}	Daily mean Achieved?
Barking & Dagenham 2	S	99	28	YES	15	YES
Barnet 1	K	17	28	NA	1	NA
Barnet 2	U	99	23	YES	4	YES
Bexley 1	U	93	24	YES	5	YES
Bexley 2	S	99	22	YES	4	YES
Bexley 2 (F)	S	58	22	NA	8	NA
Bexley 4	I	99	53	NO	132	NO
Bexley 7	R	68	33	NA	36	NO
Bexley 7 (F)	R	62	25	NA	17	NA
Bexley 8	R	68	28	NA	21	NA
Brent 1	U	94	22	YES	5	YES
Brent 3	R	90	30	YES	20	YES
Brent 4	R	96	39	YES	68	NO
Brent 5	I	82	65	NA	165	NO
Bromley 7	R	77	22	NA	5	NA
Camden 1	K	96	35	YES	43	NO
Camden 3	R	99	34	YES	33	YES
Croydon 3	S	93	24	YES	3	YES
Croydon 4	R	98	27	YES	9	YES
Crystal Palace 1	R	91	26	YES	4	YES
Ealing 2	R	99	30	YES	24	YES
Ealing 7	U	41	21	NA	2	NA
Enfield 2	R	92	26	YES	16	YES
Enfield 3	U	92	24	YES	9	YES
Enfield 4	R	93	31	YES	40	NO
Greenwich 10	R	23	25	NA	1	NA
Greenwich 12	U	36	26	NA	8	NA
Greenwich 4	U	91	22	YES	5	YES
Greenwich 5	R	99	26	YES	11	YES
Greenwich 7	R	90	31	YES	25	YES
Greenwich 8	R	47	47	NA	69	NO
Greenwich 9	R	3	17	NA	0	NA
Greenwich Bexley 6	R	99	28	YES	21	YES
Hackney 6	R	93	34	YES	31	YES
Haringey 1	R	99	24	YES	4	YES
Haringey 2	S	93	30	YES	18	YES
Harlington	U	99	25	YES	11	YES
Harrow 1	U	99	20	YES	0	YES
Harrow 2	R	96	30	YES	19	YES
Havering 3	R	98	23	YES	7	YES
Heathrow Airport	U	98	27	YES	13	YES
Hillingdon 1	R	81	28	NA	16	NA
Hillingdon 2	R	99	27	YES	10	YES
Hounslow 2	S	93	22	YES	4	YES
Hounslow 4	R	98	30	YES	22	YES

PM$_{10}$						
Site	Type	Data capture %	Annual mean less than 40µgm-	Annual mean Achieved?	No more than 35 days where daily mean >=50µgm^{-3}	Daily mean Achieved?
Hounslow 5	R	97	35	YES	43	NO
H'smith and Fulham 1	R	61	35	NA	29	NA
H'smith and Fulham 2	U	91	24	YES	6	YES
Islington 1	U	97	27	YES	9	YES
Islington 2	R	98	34	YES	32	YES
Kens & Chelsea 1 (Grav)	U	84	25	NA	11	NA
Kens and Chelsea 1	U	96	24	YES	6	YES
Kens and Chelsea 1 (F)	U	77	21	NA	7	NA
Kens and Chelsea 2	R	99	35	YES	29	YES
Kens & Chelsea 5	R	94	41	NO	67	NO
Lambeth 1	R	94	26	YES	22	YES
Lambeth 3	U	86	23	NA	6	NA
Lambeth 4	K	94	47	NO	115	NO
Lewisham 2	R	99	31	YES	19	YES
Marylebone Rd	K	98	43	NO	99	NO
Marylebone Rd FDMS	K	92	33	YES	38	NO
Marylebone Rd (KFG)	K	77	29	NA	23	NA
Marylebone Rd (Partisol)	K	84	41	NA	66	NO
Mole Valley 2	S	99	20	YES	1	YES
Mole Valley 3	U	91	22	YES	0	YES
Redbridge 1	U	93	25	YES	10	YES
Redbridge 4	R	91	29	YES	24	YES
Redbridge 5	R	60	35	NA	23	NA
Reigate and Banstead 1	S	99	22	YES	0	YES
Richmond 1	R	94	26	YES	10	YES
Richmond 15	R	9	25	NA	0	NA
Richmond 17	U	21	24	NA	1	NA
Richmond 19	U	22	22	NA	1	NA
Richmond 2	S	97	22	YES	5	YES
Richmond 21	R	43	27	NA	6	NA
Sevenoaks 2	U	97	21	YES	1	YES
Southwark 1	U	99	26	YES	7	YES
Southwark 2	R	99	32	YES	29	YES
Sutton 4	K	99	30	YES	9	YES
Thurrock 1	U	95	25	YES	7	YES
Thurrock 1 (Grav)	U	94	27	YES	23	YES
Thurrock 3	R	99	26	YES	10	YES
Tower Hamlets 1	U	98	25	YES	8	YES
Tower Hamlets 3	U	84	25	NA	2	NA
Waltham Forest 1	U	90	24	YES	5	YES
Waltham Forest 3	R	75	24	NA	1	NA
Wandsworth 4	R	95	28	YES	21	YES
Westminster	U	22	25	NA	3	NA

SO_2				
Site	Type	Data Capture %	No more than 35 occurrences of 15min mean >=266µgm^{-3}	Achieved?
Barking & Dagenham 1	S	99	0	YES
Bexley 1	U	95	0	YES
Bexley 5	S	26	0	NA
Brent 1	U	89	0	NA
Brent 3	R	85	0	NA
Brent 4	R	89	0	NA
Castle Point 1	U	94	0	YES
City of London 1	U	88	0	NA
Croydon 4	R	99	0	YES
Crystal Palace 1	R	85	0	NA
Ealing 1	U	98	0	YES
Enfield 3	U	94	1	YES
Enfield 4	R	99	0	YES
Greenwich 4	U	98	0	YES
Haringey 1	R	98	0	YES
Harrow 1	U	73	0	NA
Havering 3	R	100	0	YES
Hounslow 2	S	93	0	YES
Hounslow 4	R	97	0	YES
H'smith and Fulham 1	R	48	0	NA
Kens and Chelsea 1	U	96	0	YES
Kens and Chelsea 2	R	98	0	YES
Lambeth 1	R	99	0	YES
Lambeth 3	U	99	0	YES
Lambeth 4	K	95	0	YES
Lewisham 1	U	97	0	YES
Lewisham 2	R	100	0	YES
Marylebone Rd	K	91	0	YES
Redbridge 4	R	95	0	YES
Richmond 15	R	7	0	NA
Richmond 17	U	12	0	NA
Richmond 21	R	32	0	NA
Sevenoaks 2	U	88	0	NA
Southwark 1	U	93	0	YES
Southwark 2	R	95	0	YES
Thurrock 1	U	97	2	YES
Thurrock 3	R	99	0	YES
Tower Hamlets 1	U	99	0	YES
Tower Hamlets 3	U	91	0	YES
Waltham Forest 1	U	87	0	NA
Waltham Forest 3	R	60	0	NA
Wandsworth 2	U	92	0	YES
Westminster	U	90	5	YES

K Kerbside
R Roadside
U Urban background
S Suburban
I Industrial

Appendix 4: Air quality strategy objectives & UK Air quality information system

The following Objectives are set out in the Air Quality Regulations 2000 for the purposes of Local Air Quality Management.

Pollutant	Objective		Date to be achieved by
	Concentration	Measured as	
Benzene	5 μgm^{-3} (1 ppb)	Running Annual Mean	31 Dec 2010
1, 3 Butadiene	2.25 μgm^{-3} (1 ppb)	Running Annual Mean	31 Dec 2003
Carbon Monoxide	10 mgm^{-3} (8.6 ppb)	Running 8 hour mean	31 Dec 2003
Lead	0.5 μgm^{-3} 0.25 μgm^{-3}	Annual Mean Annual Mean	31 Dec 2003 31 Dec 2008
Nitrogen Dioxide (provisional)	200 μgm^{-3} (105 ppb) not to be exceeded more than 18 times a year	1 hour mean	31 Dec 2005
	40 μgm^{-3} (21 ppb)	Annual Mean	31 Dec 2005
Particles (PM_{10})	50 $\mu g/m^{-3}$ not to be exceeded more than 35 times a year	24 hour mean	31 Dec 2004
	40 μgm^{-3}	Annual Mean	31 Dec 2004
Sulphur Dioxide	350 μgm^{-3} (132 ppb) not to be exceeded more than 24 times a year	1 hour mean	31 Dec 2004
	125 μgm^{-3} (47 ppb) not to be exceeded more than 3 times a year	24 hour mean	31 Dec 2004
	266 μgm^{-3} (100 ppb) not to be exceeded more than 35 times a year	15 minute mean	31 Dec 2005

The following Objectives are not included in the Air Quality Regulations 2000 for the purposes of Local Air Quality Management.

Pollutant	Objective		Date to be achieved by
	Concentration	Measured as	
Objectives for the protection of human health			
Ozone (provisional)	100 μgm^{-3} (50 ppb) not to be exceeded more than 10 times per year	Daily maximum of running 8 hour mean	31 Dec 2005
Objectives for the protection of vegetation and ecosystems			
Nitrogen Oxides (assuming NO_X is taken as NO_2)	30 μgm^{-3} (16 ppb)	Annual mean	31 Dec 2000
Sulphur Dioxide	20 μgm^{-3} (8 ppb)	Annual mean	31 Dec 2000
	20 μgm^{-3} (8 ppb)	Winter mean (1 Oct-31 March)	31 Dec 2000

DETR 2000a, 2000b.

The thresholds for 'descriptors' applied to air pollution concentrations as defined by the UK Air Quality Information system.

Pollutant / Band	low	moderate	high	very high
Sulphur Dioxide	below 100ppb, averaged over 15 minutes	100ppb, averaged over 15 minutes	200ppb, averaged over 15 minutes	400ppb, averaged over 15 minutes
Ozone	below 50ppb, as an 8 hour running average and below 50ppb averaged over one hour	50ppb, as an 8 hour running average or 50ppb averaged over one hour	90 ppb, averaged over one hour	180 ppb, averaged over one hour
Carbon Monoxide	below 10 ppm, as an 8 hour running average	10 ppm, as an 8 hour running average	15 ppm, as an 8 hour running average	20 ppm, as an 8 hour running average
Nitrogen Dioxide	below 150 ppb, averaged over one hour	150 ppb, averaged over one hour	300 ppb, averaged over one hour	400 ppb, averaged over one hour
PM_{10} Particles (by TEOM)	below 50 ug/m^{-3}, as a 24 hour running average	50 ug/m^{-3}, as a 24 hour running average	75 ug/m^{-3}, as a 24 hour running average	100 ug/m^{-3}, as a 24 hour running average

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