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Marylebone Road ('Supersite')
Annual Report 1999

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Marylebone Road ('Supersite') Annual Report 1999

1.0 Introduction

The Marylebone Road monitoring site, commissioned by the London local authorities and the Department of the Environment, Transport and Regions (DETR), was installed by SEIPH in June 1997.

The aims of the site were to:

1. Assess levels of air pollutants at a kerbside location using automatic and non-automatic techniques.
2. Investigate the relationship between these pollutants.
3. Compare the measurement of these pollutants using different monitoring methods.
4. Feed the data collected back into the London First Phase Air Quality Review and Assessment to aid the validation of the computer modelling.

The location of the site and the monitoring methods used are laid out in Appendix I. The site is operated as part of the London Air Quality Network (LAQN) and the Automatic Urban and Rural Network (AURN) for the inorganic analysers and as part of the National Hydrocarbon Monitoring Network for the automatic gas chromatograph. The non-continuous monitoring is operated to national network standards where applicable.

The objectives of this project, as set out by the DETR, were:

'To investigate the relationship between pollutants monitored at the roadside/kerbside station' and 'to compare the measurement of pollutants using different methodologies'.

This report details the results from the Marylebone Road monitoring site and covers the period 1 January 1999 to 31 December 1999. Time series graphs of the results can be found in Appendix II. Correlation coefficients and linear regression have been used to highlight the relationships between pollutants and methods. The results of the correlation coefficient analysis can be seen in Appendix III.

The annual report for 1998 highlighted questions concerning the equivalence of the different methods used to monitor the same pollutant. These relationships are examined again for the 1999 data set. The comparisons presented are:

NO_2 diffusion tubes	vs	Continuous NO_x analyser
Benzene diffusion tubes	vs	Automatic gas chromatograph
TEOM PM10	vs	Gravimetric PM10
Black Smoke	vs	TEOM PM10
TEOM PM10	vs	TEOM PM2.5
SO_2 Bubbler	vs	Continuous SO_2 analyser

Data for 1999 has been examined using the relevant standards and objectives set down by the UK and EU Governments.

2.0 Results and Discussion

The various monitoring methods produce data over a range of averaging periods. For example, NO_2 diffusion tubes have been exposed for 2 and 4 week periods, whereas the automatic analysers produced hourly average concentrations. Data analysis is carried out on hourly and daily averages where available and over longer periods where the resolution is reduced. Comparisons are only made when there is a representative data capture.

All data from the continuous analysers has been ratified by the national network QA/QC Unit. Only obvious outliers have been removed from the non-continuous data set.

It is important to consider the accuracy and precision of techniques when comparing results. Levels of uncertainty in air quality data are discussed in the AURN Local Site Operators Manual, the London Air Quality Manual and the Fourth Report of the London Air Quality Network. An uncertainty of ±10% is suggested as a good working figure for high values and long term averages from automatic inorganic analysers. The nitrogen dioxide diffusion tubes, when compared to nitrogen oxides analysers, show overall systematic differences of ≤10%. However, the precision of these individual tubes is estimated at ±35-37% (SSE, 1998).

2.1 Correlation Matrices

Appendix III contains the results of the correlation analysis for the continuous data (hourly), non-continuous data (daily), diffusion tubes (fortnightly / monthly), lead (weekly) and PAH (fortnightly). These results indicate the degree to which the two pollutants / measurement methods (variables) / traffic parameters are related to one another. The correlation coefficient (r) is one means of testing the strength of this relationship; values close to 1 indicate that the two variables are closely positively related (i.e. high values of *x* are likely to give high values of *y*) and those close to -1 indicate a close inverse relationship. Methods that correlate well are highlighted.

Variables in Appendix III that show good correlation are those that have the same sources / monitor the same pollutant. For example, the primary pollutants such as NO_x and CO are well correlated, as are PM10, PM2.5 and gravimetric PM10. The inverse correlations with ozone indicate the scavenging effects of the primary pollutants such as NO. The high correlation coefficient for the relationship between PAH and PM10 is explored in more detail in Section 2.6.

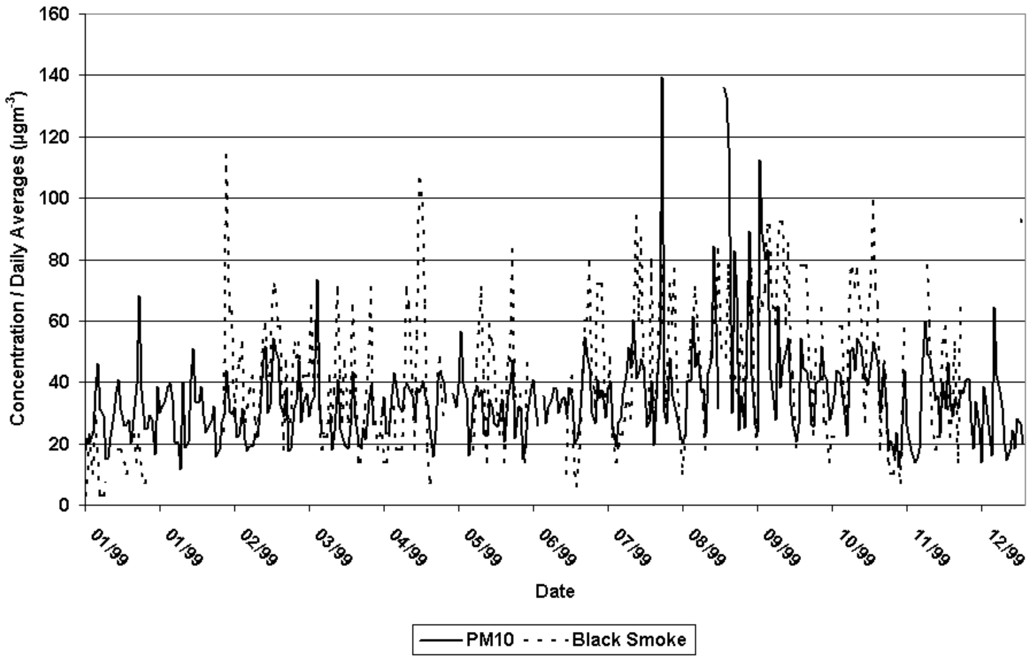
2.2 Particulate Matter

Particulate matter concentrations at Marylebone Road were affected by construction work on the adjacent University of Westminster during 1999, especially during the summer months. This resulted in concentrations of PM10 and PM2.5 reaching hourly maximums of $801 \mu gm^{-3}$ and $285 \mu gm^{-3}$ respectively. The concentrations measured reflect ambient conditions as experienced by the public at this location and are therefore retained in the data set for analysis. However, the dust emitted by this work will have a different composition from that normally found in urban areas where emissions are dominated by combustion sources. It will also differ in composition from particulate matter monitored at this location in previous years. The effect that these elevated concentrations have on the relationships between different methods is marked when compared to previous years.

2.2.1 Comparison of Black Smoke and TEOM PM10

Black smoke analysis uses the optical properties of the particulate collected to assess mass concentration. The black smoke method has been shown to approximate PM3.2 and is essentially a measurement of diesel emissions (A.Reponen *et al*, 1996).

Figure 2.1 Black Smoke and TEOM PM10 Measurements from Marylebone Road



The relationship between the TEOM PM10 and black smoke measurements differs from that found during 1998. Regression analysis highlights this difference; the results are shown in Figure 2.2. The change in the relationship between these methods is due to the high concentrations of PM10 resulting from the construction work described earlier. This may have affected the black smoke analysis in two ways. Firstly, the colour of this material will differ from that which the black smoke analysis was designed to measure and the calibration curve may therefore not accurately reflect the mass. Secondly, the sample inlet will not sample particulate matter in a similar way to the PM10 inlet on the TEOM,

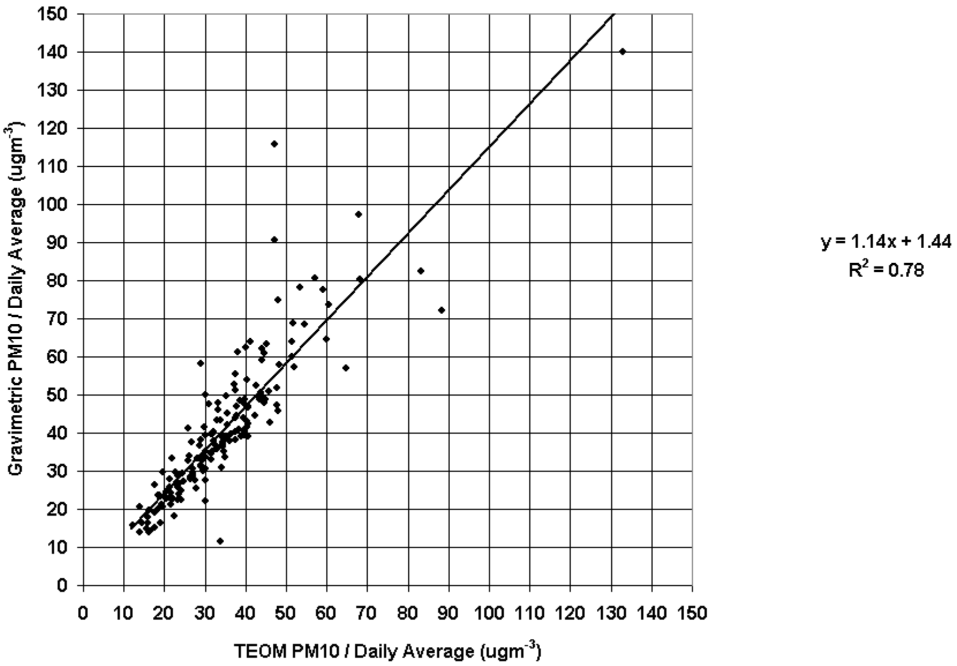
Figure 2.2 Regression analysis of Black Smoke and TEOM PM10 Measurements from Marylebone Road

	Slope	Intercept	R^2
1998	1.2	-1.9	0.3
1999	0.7	17.1	0.3

2.2.2 Comparison of Gravimetric PM10 and TEOM PM10

The correlation between these methods for mass measurement has been explored by many studies (Salter *et al.*, 1999; APEG, 1999; Laxen, 1998; Allen *et al.*, 1997; Smith *et al.*, 1997), which assign differences in results to the 50°C sampling conditions employed by the TEOM and the subsequent volatilisation of a fraction of the PM10. Therefore, the magnitude of the discrepancy depends on the amount of material in PM10 that is volatile at 50°C. It has also been suggested that the relationship between TEOM and Partisol instruments is curvilinear due to the loss of volatile species by the TEOM that characterise periods of high PM10 concentration around the UK (APEG, 1999). It should be noted that gravimetric samplers also have the potential to lose some volatile species, depending on the sampling duration and the environmental conditions that the filter is exposed to during sampling and prior to weighing. The regression analysis between the TEOM PM10 and gravimetric PM10 shown is in Figure 2.3.

Figure 2.3 Regression Analysis of TEOM PM10 and Gravimetric PM10



Local authorities in the UK have been advised to apply a 'correction factor' to the results of their TEOM PM10 monitoring; multiplying by a factor of 1.3 when assessing the likelihood of areas exceeding the EU limit values (DETR, 1999). This factor was derived from previous co-location studies in the UK, which concluded that TEOM instruments underestimated the gravimetric PM10 by 15 – 30% at concentrations around the air quality standard of 50µgm^{-3} (APEG, 1999). The results of applying this correction factor for 1998 and 1999 are shown in Figure 2.4 and compared to the results from the gravimetric PM10.

From September 1998 gravimetric sampling was alternated between PTFE and glass fibre filters. The results from the mass analysis of the PTFE filters are reported here, the glass fibre filters were used for subsequent thermal desorption analysis for PAH. To allow an assessment against the EU limit value the number of exceedence days has been corrected for data capture by multiplying by 1/data capture rate.

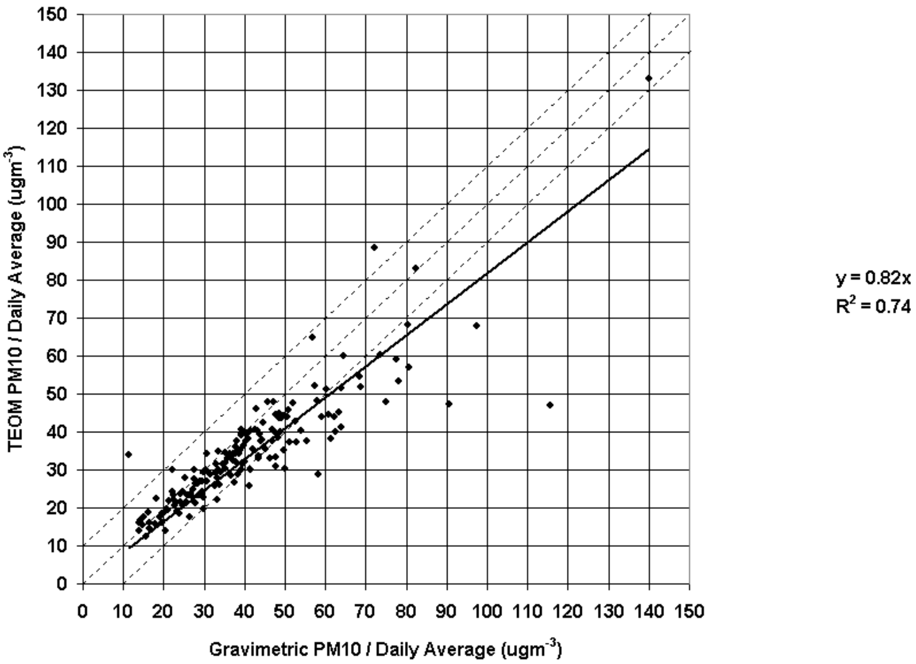
Figure 2.4 EU Limit Values for PM10 Monitoring at Marylebone Road

	TEOM PM10 1998	TEOM PM10 1998 x 1.3	Gravimetric PM10 1998	TEOM PM10 1999	TEOM PM10 1999 x 1.3	Gravimetric PM10 1999
Annual Average (µgm^{-3})	32	42	38	35	46	41
Number of days greater than 50µgm^{-3}	20	90	46	38	116	36
Data Capture (%)	100	100	77	98	98	47
Number of days greater than 50µgm^{-3} corrected for data capture	20	90	57	39	118	55

Figure 2.4 shows the degree to which using the 1.3 factor leads to an overestimation of the gravimetric PM10 concentration. After applying the 1.3 factor the TEOM PM10 data exceeded the EU limit value 37% more than the gravimetric PM10 in 1998 and 53% more in 1999.

European countries are required to assess the equivalence of PM10 sampling instruments under the European Standard prEN 12341. This requires the relationship between the sampler to be shown alongside the ideal reference function (y=x) and the two-sided acceptance envelope (±10µgm^{-3}).

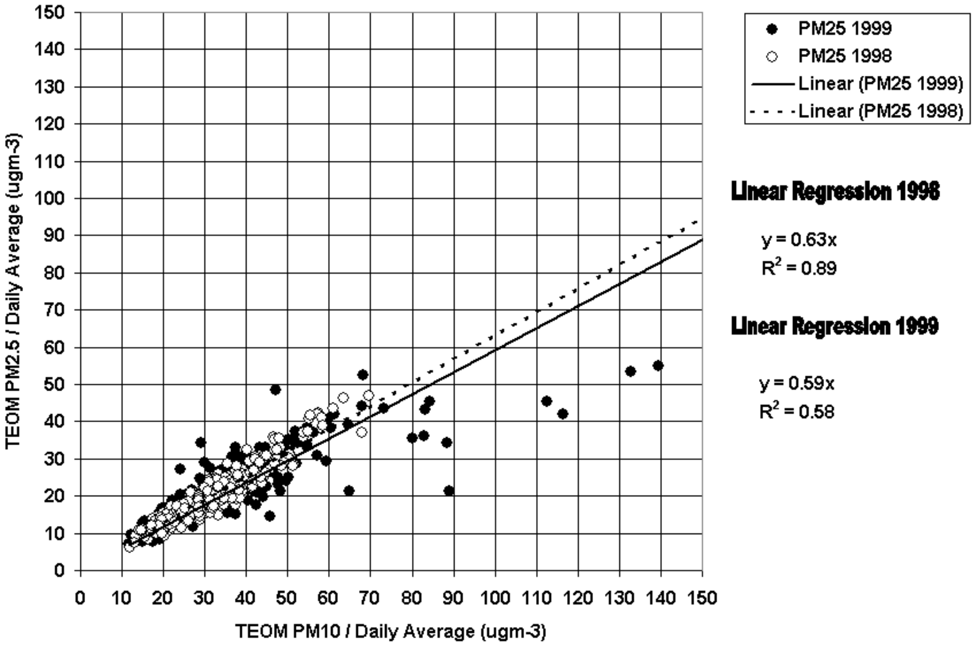
Figure 2.5 Test for Equivalence of PM10 Sampling Instruments under prEN 12341



2.2.3 Comparison of TEOM PM10 and TEOM PM2.5

The TEOM PM2.5 analyser is installed at Marylebone Road as part of the DETR's 'Airborne Particulate Concentrations and Numbers in the United Kingdom' project.

Figure 2.6 Regression Analysis of TEOM PM2.5 and TEOM PM10 during 1999 at Marylebone Road



The regression analysis in Figure 2.6 shows that the two measurements were better correlated during 1998 than 1999. Although the relationship between the two particulate fractions is similar in both years, the correlation coefficient in 1999 is much lower. This is a reflection of the high concentrations of PM10 that resulted from the nearby construction work at the University of Westminster and shows that the composition of the dust produced by this work differs from that normally monitored here. The high concentrations of PM10 during 1999 can be seen to fall well below the linear regression line in Figure 2.6 indicating that a greater proportion of the PM10 was larger than PM2.5.

2.3 Nitrogen Dioxide

The data produced by the nitrogen dioxide diffusion tubes offers a range of comparisons with the continuous nitrogen oxides analyser. Two sets of tubes are exposed:

- 3 tubes every two weeks
- 3 tubes every four weeks

These triplicate exposures can be averaged to increase the precision of the technique for each exposure period.

Three different comparisons can be made with the analyser:

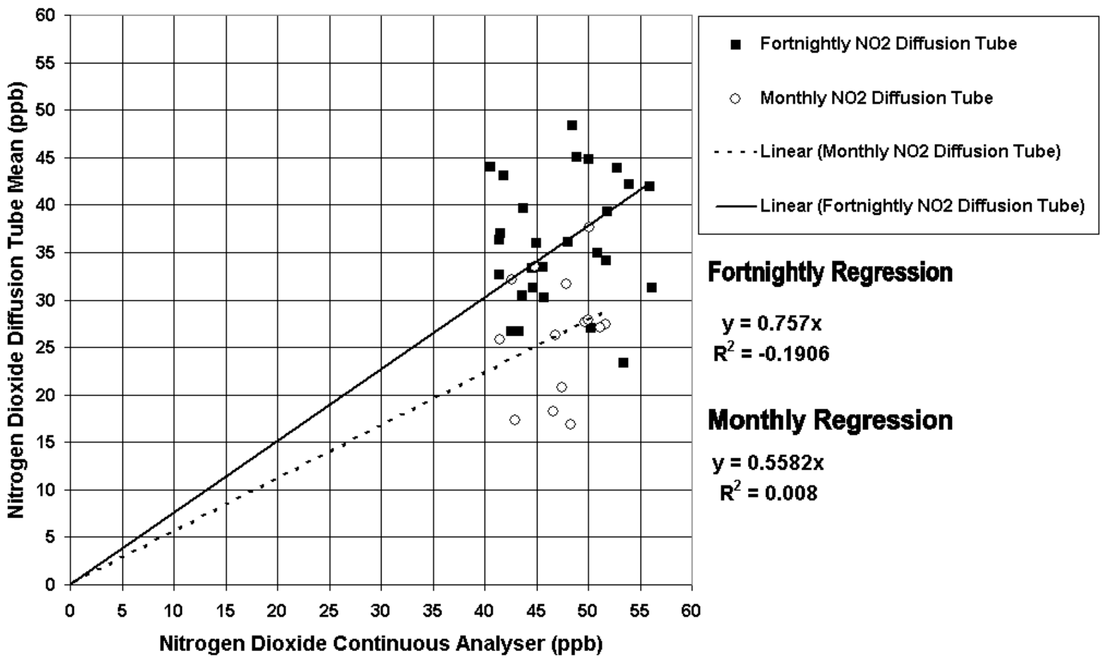
- **Accuracy.** The analyser results have been compared to each of the different periods of tube exposure (either 2 or 4 week) over the entire monitoring period. This assesses the accuracy of the diffusion tube technique over each monitoring period.
- **Precision.** Each individual tube from the triplicate exposures is compared to assess the precision of the technique. Local authorities often expose diffusion tubes individually around an area to highlight any geographical variation. An estimate of the precision of an individual tube is therefore desirable.

- **Length of Exposure Period.** The analyser and diffusion tube data are averaged according to the 4 week diffusion tube exposure period and compared. This assesses the most accurate period (either 2 or 4 weeks) over which to expose diffusion tubes.

2.3.1 Accuracy

The accuracy of the diffusion tube technique is assessed by comparing the mean of the three diffusion tubes exposed over each period with the corresponding result from the continuous analyser. The results are displayed in Figure 2.7 and show that there is little or no correlation between the two techniques when examined in this way. It is clear that both exposure times underestimate the ambient nitrogen dioxide concentration when compared to the continuous analyser. The fortnightly exposure measures an average of 76% of the available nitrogen dioxide whereas the monthly exposure measures only 56%.

Figure 2.7 Regression Analysis of NO_2 Diffusion Tubes and NO_2 Continuous Analyser During 1999



2.3.2 Precision

The variation between each individual tube is illustrated in Figures 2.8 and 2.9 that show the result of each individual tube against its associated nitrogen dioxide analyser mean. The range of percentage difference between the diffusion tubes and the analyser suggests that if a local authority exposed a single tube for two weeks the result could vary between -73% and +61% of the result that would be produced in the same location by a continuous analyser. Similarly, if a single tube were exposed for a four week period the result could vary between –78% and -10%. These results are consistent with those reported for 1998.

Figure 2.8 Nitrogen Oxides Analyser Results and Individual 2 Week Diffusion Tube Exposures

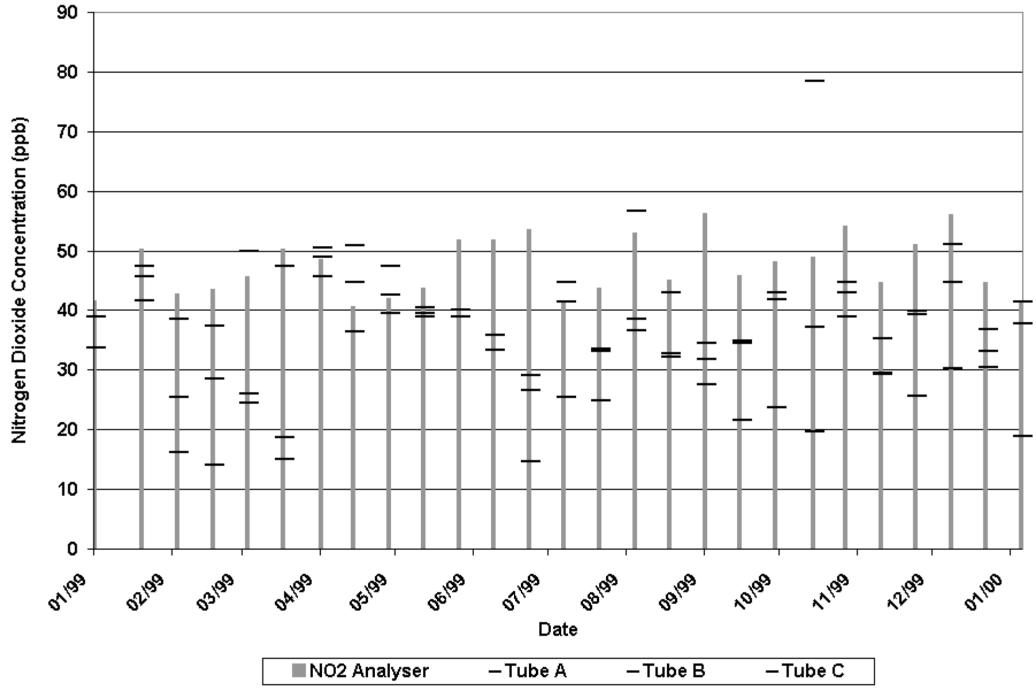
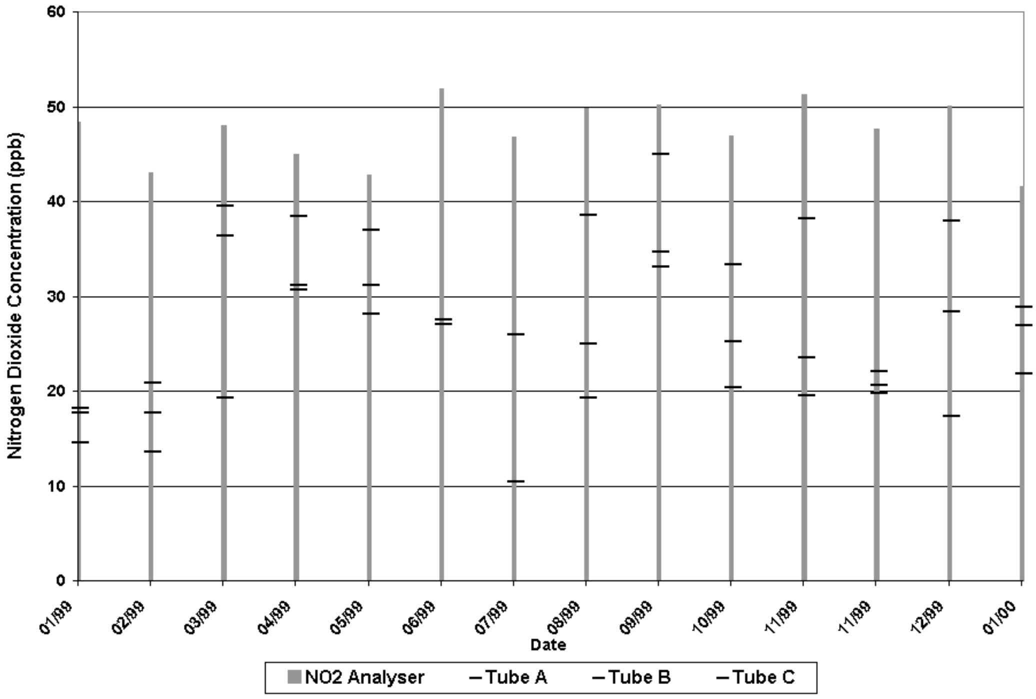


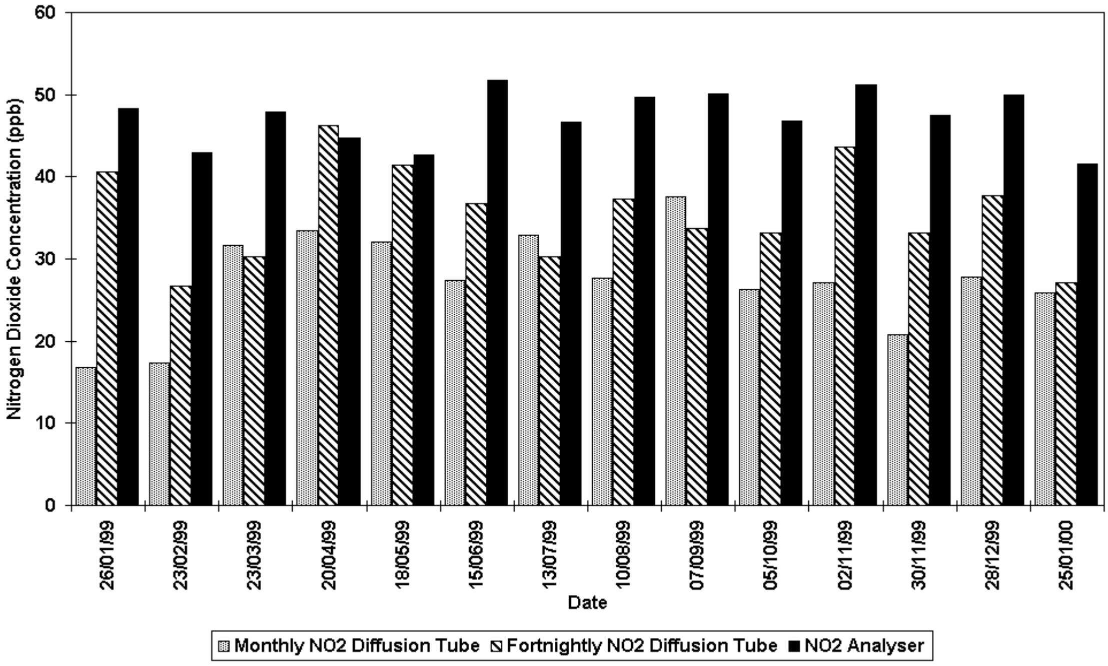
Figure 2.9 Nitrogen Oxides Analyser Results and Individual 4 Week Diffusion Tube Exposures



2.3.3 Length of Exposure Period

Figure 2.10 shows the 2 and 4 week diffusion tube exposures alongside the analyser results, all averaged over the corresponding 4 week periods. This indicates an apparent time dependent accuracy of the diffusion tube technique.

Figure 2.10 2 and 4 week Diffusion Tube Exposures and Nitrogen Oxides Analyser Results Averaged to the 4 Week Exposure Periods



This study shows that the nitrogen dioxide diffusion tubes are inaccurate and imprecise. Increasing the length of exposure deceases the accuracy. These results do not agree with a previous DETR study that shows that diffusion tubes tend to overestimate chemiluminescent analyser results by approximately 10% (SSE, 1998). However, a similar study at the nearby Bloomsbury AURN urban background site has produced similar results to those at Marylebone Road (Rickard, 2000). At Bloomsbury, diffusion tubes, exposed for 2 week periods between November 1999 and May 2000, have been shown to underestimate the co-located NO_2 analyser results by 20%. This may indicate that the affect is only significant at the high concentrations found in London. Further work is needed to find the cause of these discrepancies.

2.4 Benzene

The gas chromatograph measures 27 hydrocarbon species (including benzene and 1,3 butadiene) on an hourly basis. The instrument is operated as part of the National Hydrocarbon Network, benzene and 1,3 butadiene are quantified automatically and disseminated to the National Air Quality Archive but are subject to later ratification. The other species are ratified and published at a later date.

The results of the benzene diffusion tubes can be examined in the same way as those from the nitrogen dioxide diffusion tubes. The accuracy of the technique can be assessed by comparing the diffusion tube results with the gas chromatograph results over the same period. The precision of the technique can be assessed by comparing the result of each individual tube exposures.

Figure 2.11 shows the correlation between the benzene results produced by the gas chromatograph and those produced by the benzene diffusion tubes. This indicates that the diffusion tubes produce results that are, on average, 10% below those of the gas chromatograph. The correlation between the two techniques is poor.

Figure 2.11 Regression Analysis of Gas Chromatograph and Benzene Diffusion Tubes

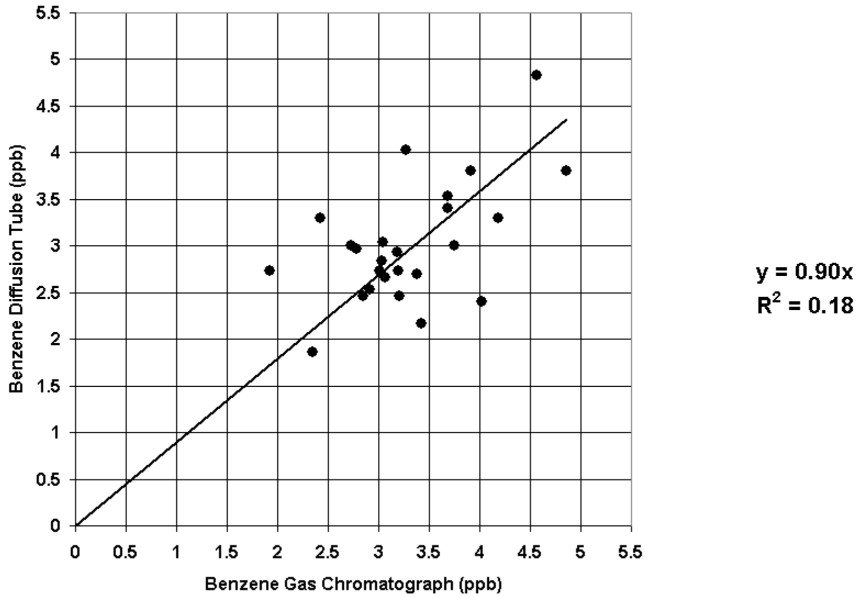
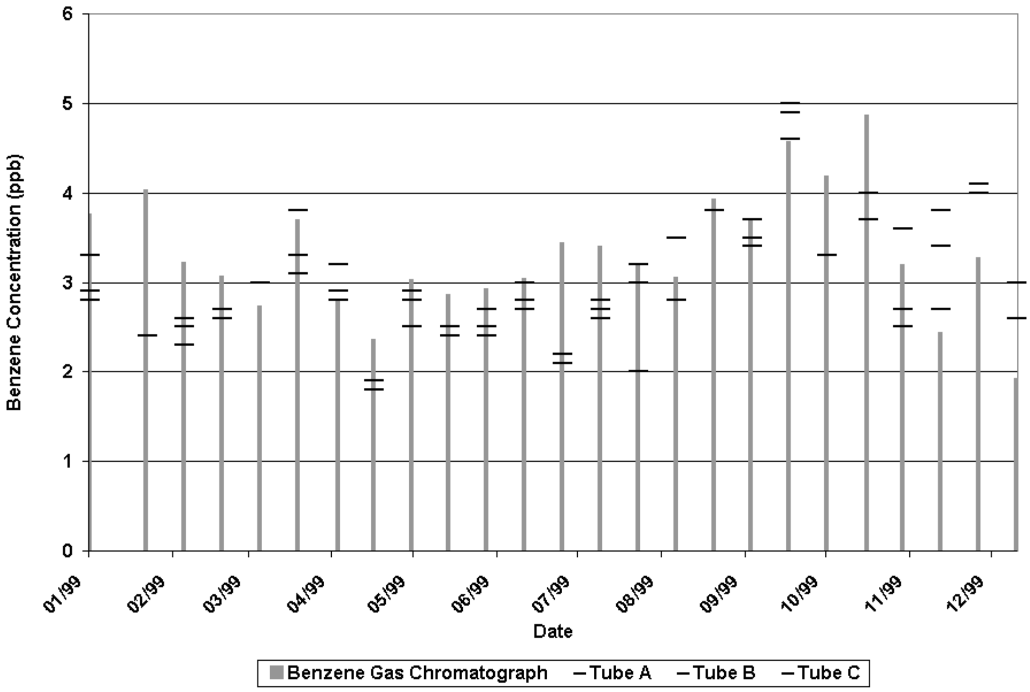


Figure 2.12 shows the individual diffusion tube measurements against the gas chromatograph average. The precision of the benzene diffusion tubes is very good.

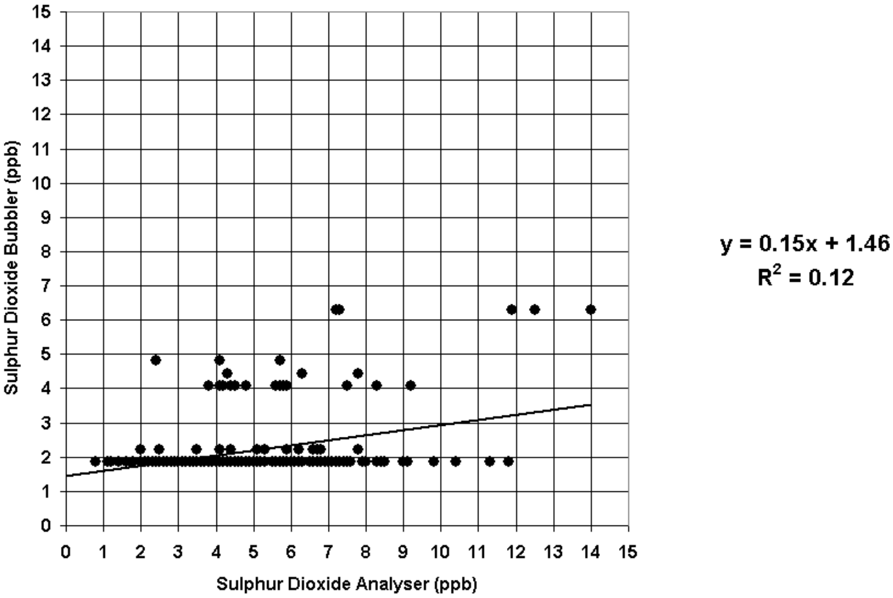
Figure 2.12 Gas Chromatograph Results and Individual 2 Week Diffusion Tube Exposures



2.5 SO_2 Bubbler

Comparison of the continuous SO_2 analyser and the SO_2 bubbler shows that the agreement is poor. The bubbler method is acidimetric and may therefore be subject to interferences from other acidic or alkali gases at this location leading to the poor correlation. Additionally, daily average concentrations are very low and close to the limit of detection for the bubbler method.

Figure 2.13 Regression Analysis of SO_2 Analyser and SO_2 Bubbler



2.6 Poly Aromatic Hydrocarbons (PAH)

The particulate phase of PAH is monitored at Marylebone Road. This method (Smith *et al*, 1996) is efficient in assessing the heavier (4-5 ring) compounds. Only these compounds are included in this analysis. All the results from the PAH monitoring are included in Appendix II.

The Expert Panel on Air Quality Standards (EPAQS) has recommended that benzo[a]pyrene is used as a marker for the UK Air Quality Standard for PAH (EPAQS, 1999). EPAQS recommended an Air Quality Standard of 0.25ngm^{-3} as an annual average. The annual average benzo[a]pyrene from the monitoring at Marylebone Road is 0.34ngm^{-3}, which is double the 1998 annual average of 0.17ngm^{-3}. Figure 2.14 shows how the levels of benzo[a]pyrene compare to the levels of all PAH’s measured at Marylebone Road.

Figure 2.14 PAH Concentrations at Marylebone Road

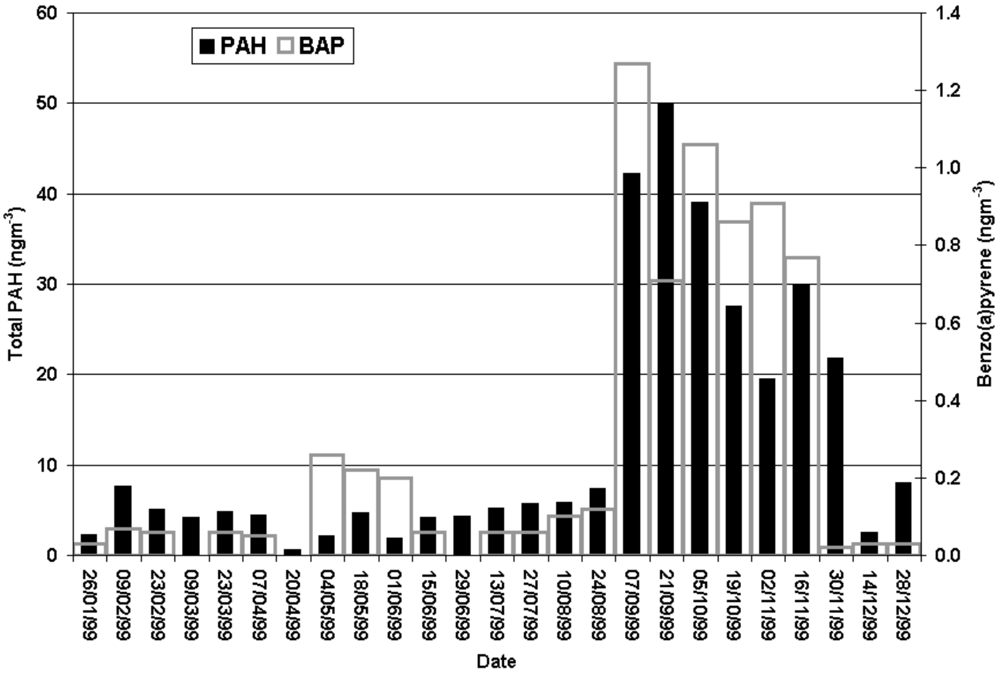


Figure 2.14 shows that concentrations of PAH increased significantly between September and December 1999, this is the period when some of the major construction work was being carried out. A correlation between PAH and PM10 was identified in the analysis detailed in Section 2.1, this is shown in more detail in Figure 2.15.

The elevated PAH concentration during construction work is unexpected because the dominant source of PAH in this location would be vehicle emissions. There are two possible explanations for this unexpected rise in concentrations:

- The increase may be due to increased PM10 concentration providing a larger area for adsorbing PAH once deposited onto the filter. The increased mass / surface area which the PM10 provides on the filter may therefore act to increase the efficiency of the collection method. Smith *et al* (1996) estimated that this type of filter sampling had a sampling efficiency of greater than 90% for the higher molecular weight PAHs. However, during the construction work period at Marylebone Road the concentration of PAHs has been up to 800% greater than the average of the period preceding this work.

- Construction work on the University may have included a source of PAH’s such as bitumen.

The relationship between each PAH compound and the PM10 mean for each monitoring period was examined for any obvious trends. Each PAH compound responded to the increase in PM10 concentrations in a different way, this is shown in Figure 2.16. There is no clear trend, although the lightest

PAH's do not show an increase in concentration with PM10. Further work would need to be carried out to investigate the cause of these elevated concentrations.

Figure 2.15 Regression Analysis of benzo[a]pyrene, PAH and PM10 during 1999 at Marylebone Road

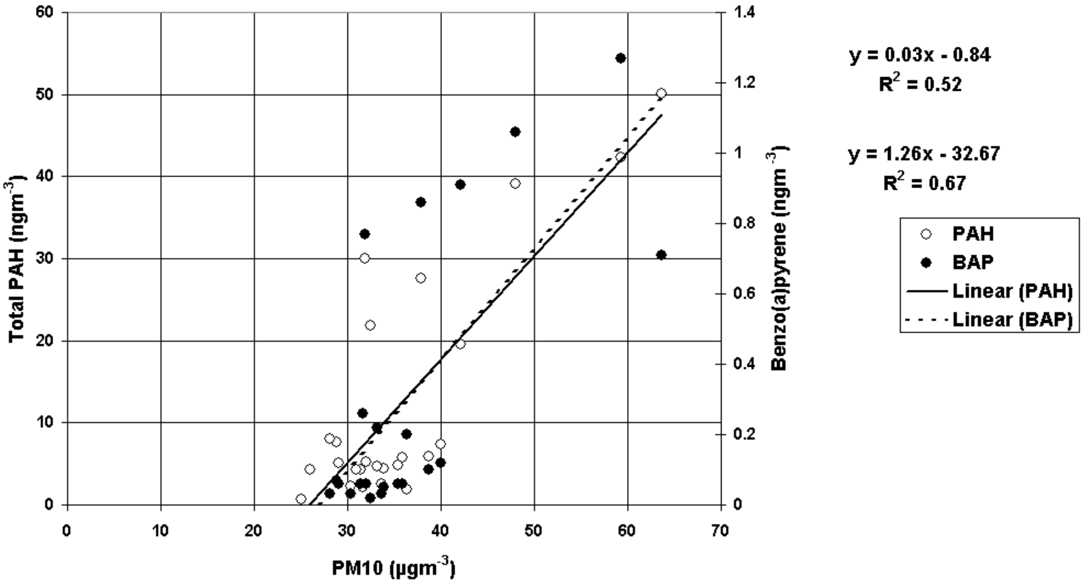
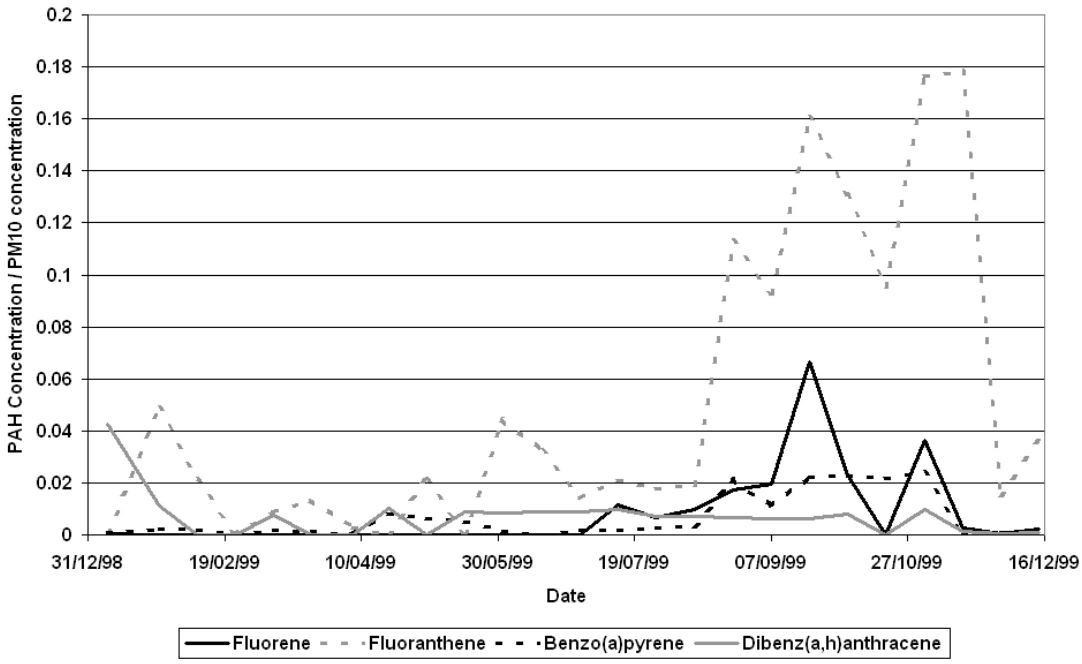


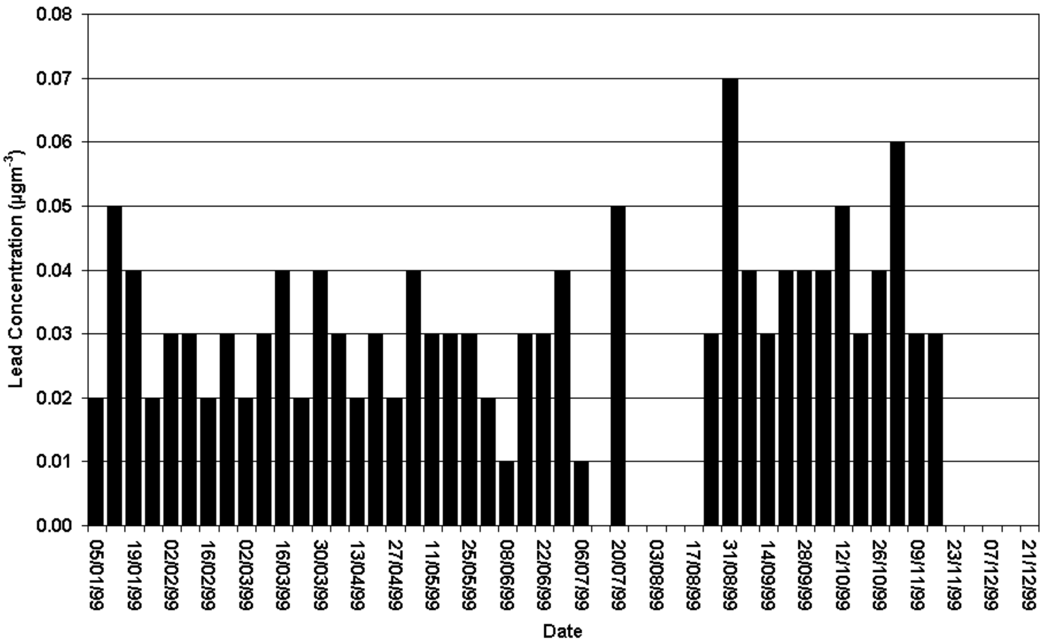
Figure 2.16 PAH measurements from Marylebone Road during 1999



2.7 Lead

The results from 1999 can be seen Figure 2.17, lead concentrations stay within the 0.01 - 0.07µgm^{-3} range. The average for this period is 0.03µgm^{-3} (identical to 1998) and is below the National Air Quality Standard and 2005 Objective of 0.5µgm^{-3} and the 2009 Objective of 0.25µgm^{-3}. These findings therefore provide further evidence that the NAQS Objective will not be exceeded solely as a result of traffic emissions.

Figure 2.17 Lead Concentrations at Marylebone Road



3.0 Air Quality Standards

3.1 UK National Air Quality Standards and Objectives for 1999

Figure 3.1 Local Air Quality Management Objectives

Pollutant	Objective		Date to be achieved by	1999 Result
	Concentration	Measured as		
Benzene	5ppb	Running annual mean	31 December 2003	3.34ppb
1,3-Butadiene	1ppb	Running annual mean	31 December 2003	0.84ppb
Carbon monoxide	10ppm	Running 8 hour mean	31 December 2003	No Exceedences
Lead	0.5µgm^{-3}	Annual mean	31 December 2004	0.03µgm^{-3}
	0.25µgm^{-3}	Annual mean	31 December 2008	0.03µgm^{-3}
Nitrogen Dioxide	105ppb not to be exceeded more than 18 times a year	1 hour mean	31 December 2005	61 hours
	21ppb	Annual mean	31 December 2005	47ppb
Particles* (PM10)	50µgm^{-3} not to be exceeded more than 35 days a year	24 hour mean	31 December 2004	111 days
	40µgm^{-3}	Annual mean	31 December 2004	45.5µgm^{-3}
Sulphur Dioxide	132ppb not to be exceeded more than 24 times a year	1 hour mean	31 December 2004	No Exceedences
	47ppb not to be exceeded more than 3 times a year	24 hour mean	31 December 2004	No Exceedences
	100ppb not to be exceeded more than 35 times a year	15 minute mean	31 December 2005	No Exceedences
Objectives for the Protection of Human Health				
Ozone	50ppb not to be exceeded more than 10 times a year	Daily Maximum of running 8 hour mean	31 December 2005	No Exceedences

*Particles (PM10) relates to gravimetric or gravimetric equivalent, in this case TEOM multiplied by 1.3

3.2 EC Directive 80/779: Smoke and SO_2 Directive

OECD smoke concentrations have been calculated from the British Standard Smoke concentrations using the following equation:

OECD concentration = BS concentration divided by 0.85

Figure 3.2 OECD Smoke Concentration 1999

EC Directive Limit Values for Smoke in µgm^{-3}		
Reference Period	**Limit Value**	**1999 Value**
Year (median)	68	6
Winter (median)	111	6
Year (98th percentile)	213	16.7
EC Directive Guide Values for Smoke in µgm^{-3}		
Reference Period	**Guide Value**	**1999 Value**
Year (mean)	34 to 51	7
24 hours (mean)	85 to 128	20

4.0 Conclusions

Marylebone Road continues to supply valuable data for the LAQN, AURN and Hydrocarbons Monitoring Networks. It is also the focus of a range of research work for the DETR, NERC and other projects.

This report has continued to examine the relationships between monitoring methods and pollutants in the light of a larger data set. The main conclusions that can be drawn from the results are summarised below:

- Building works in the neighbouring University affected the particulate monitoring at Marylebone Road during 1999. This affected many of the comparisons between the particulate matter monitoring techniques.

- The relationship between the TEOM PM10 and the gravimetric sampler results has continued to be investigated. A linear regression yields the following relationship:

$$\text{Gravimetric PM10} = 1.14 \text{ TEOM PM10} + 1.44 \ (R^2 = 0.78)$$

- The 1.3 factor which local authorities are advised to use when scaling TEOM PM10 to gravimetric PM10 has been shown to overestimate the number of exceedences of the EU Air Quality Daughter Directive Limit Value, measured using the co-located gravimetric sampler, by 55% at this location.

- PM2.5 contributes 59% to PM10 as measured by the TEOMs.

- Annual average levels of the Poly Aromatic Hydrocarbon benzo(a)pyrene are $0.34ngm^{-3}$, above the EPAQS recommended level of $0.25ngm^{-3}$. This may be due to the effect of the local construction work.

- The nitrogen dioxide diffusion tubes have been shown to underestimate the nitrogen oxides analyser by 23% for a 2 week exposure period and 44% for a 4 week exposure. Precision has also been shown to be poor.

- Benzene diffusion tubes have shown good agreement with the gas chromatograph, averaging 90% of the GC measurement over a 2 week exposure period.

- The SO_2 bubbler results have shown a poor correlation with the continuous SO_2 analyser.

- Annual average levels of lead are $0.03\mu gm^{-3}$, well below the National Air Quality Standard standard of $0.5\mu gm^{-3}$.

- Analysis of the data from 1999 has shown that the National Air Quality Standard of 104.6ppb for Nitrogen Dioxide was exceeded on 51 occasions.

- Analysis of the data from 1999 has shown that the National Air Quality Objective of $50\mu gm^{-3}$ for PM10 was exceeded on 115 occasions by the TEOM.

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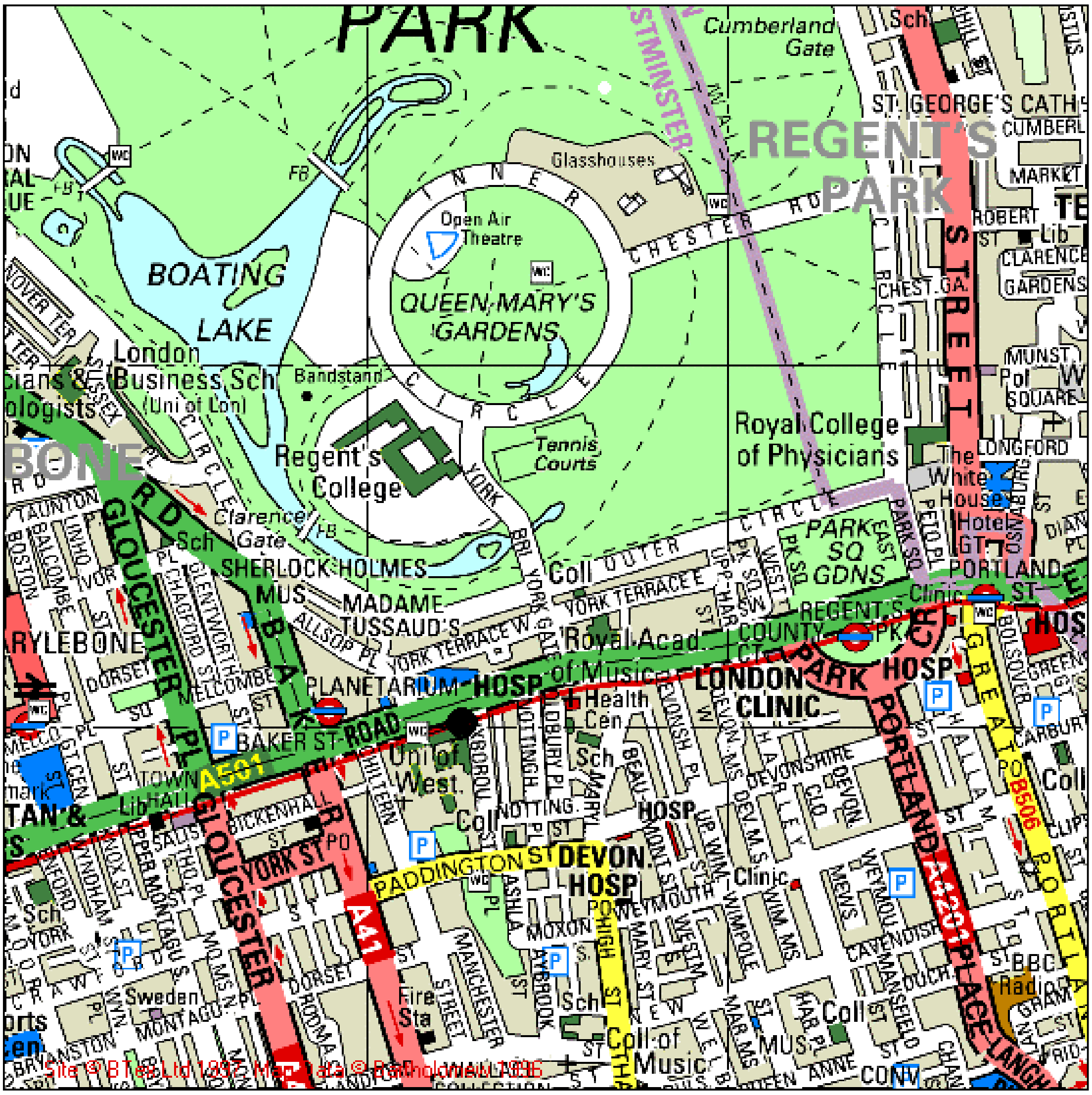
APPENDIX I

Marylebone Monitoring Site - Location

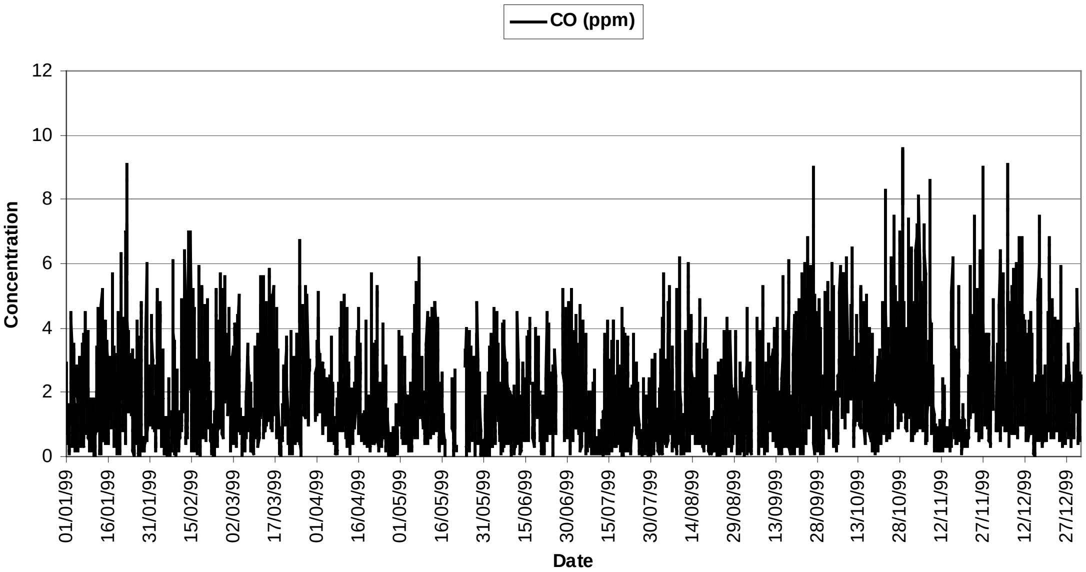


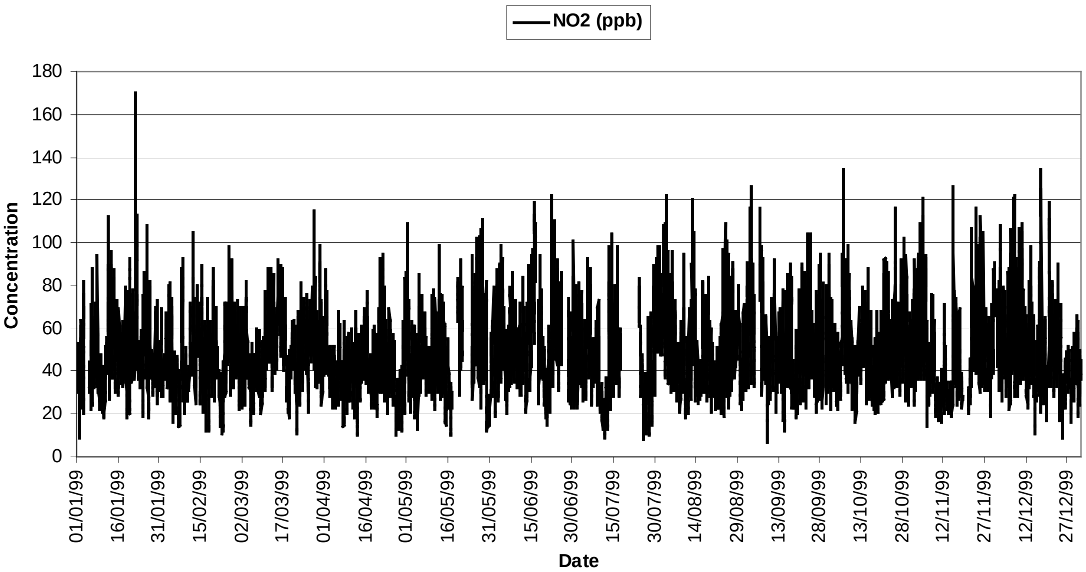
Monitoring Methods

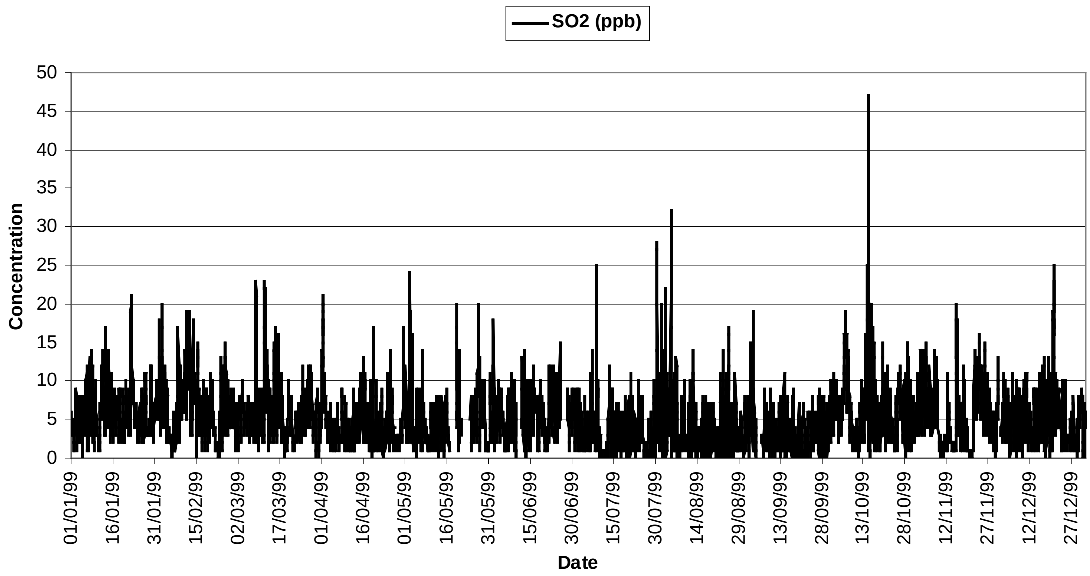
Species	Method
PM10 (continuous)	TEOM
PM10 (non-continuous)	Gravimetric Sampler
Black Smoke	British smoke stain method
Nitrogen Oxides	Ozone chemiluminescence
Nitrogen Dioxide	Passive diffusion tubes exposed in triplicate
Carbon Monoxide	Infra-red absorption
Sulphur Dioxide	UV fluorescence
Sulphur Dioxide	Bubbler method
Ozone	UV absorption
27 Hydrocarbons	Automatic gas chromatography
Benzene (non-continuous)	Passive diffusion tubes exposed in triplicate
Poly Aromatic Hydrocarbons	Filter collection, HPLC determination
Lead	Filter collection, AAS determination

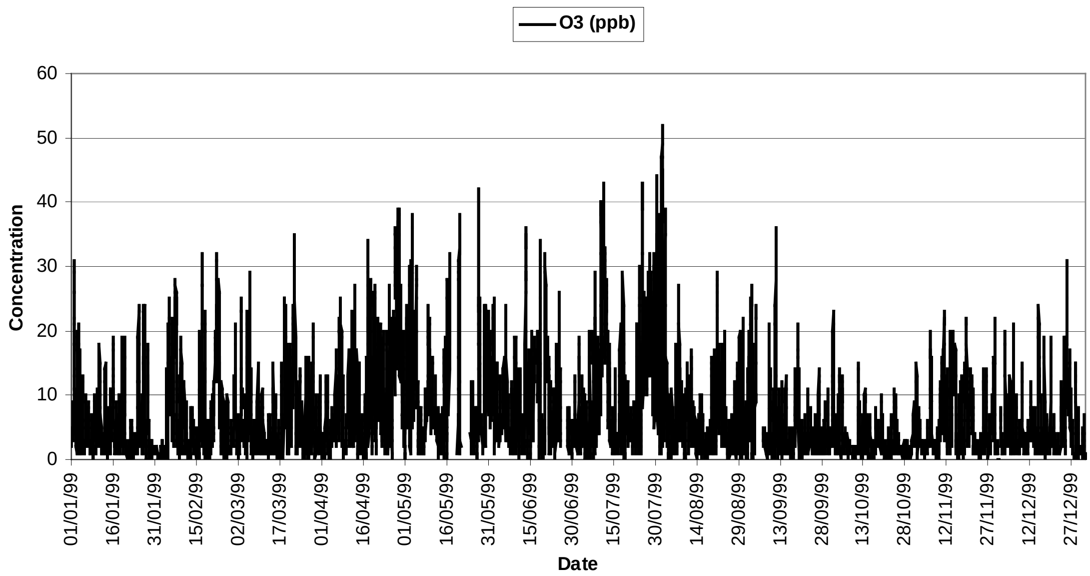
Time Series Graphs

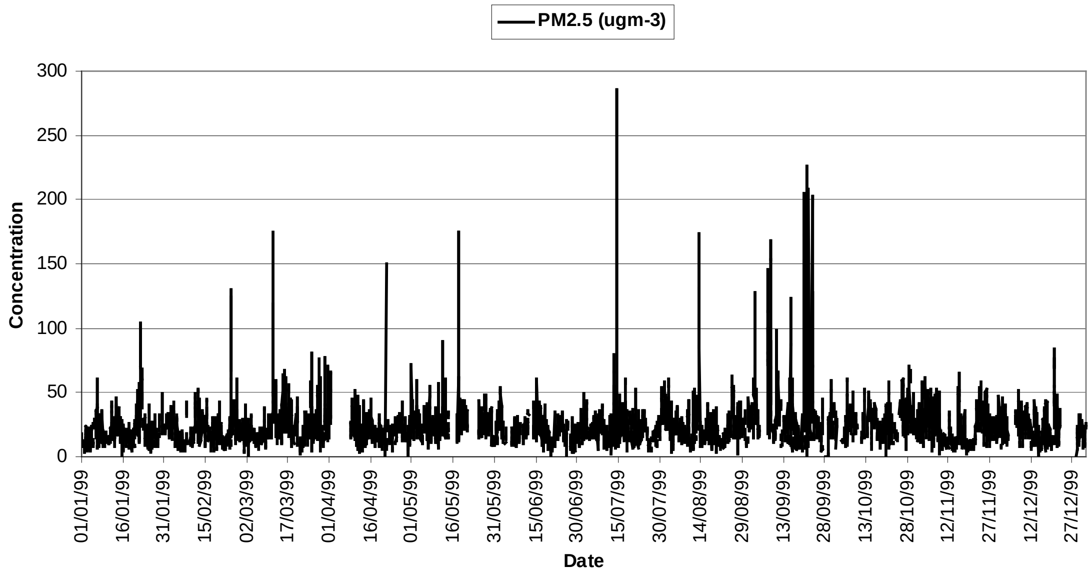
APPENDIX II

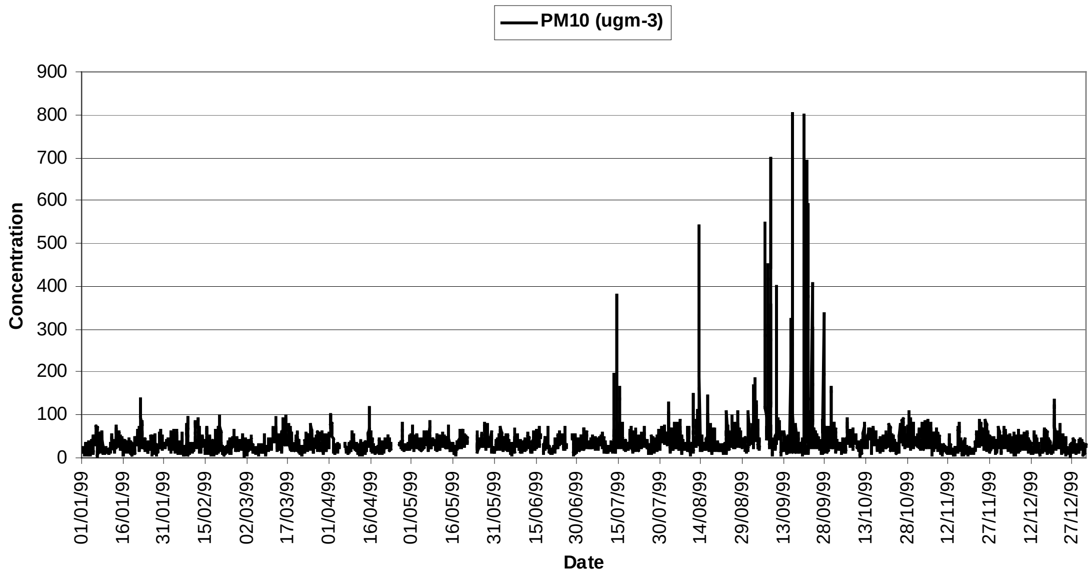





SO2 (ppb)
Concentration
Date
50
45
40
35
30
25
20
15
10
5
0
01/01/99
16/01/99
31/01/99
15/02/99
02/03/99
17/03/99
01/04/99
16/04/99
01/05/99
16/05/99
31/05/99
15/06/99
30/06/99
15/07/99
30/07/99
14/08/99
29/08/99
13/09/99
28/09/99
13/10/99
28/10/99
12/11/99
27/11/99
12/12/99
27/12/99


O3 (ppb)
Concentration
Date
60
50
40
30
20
10
0
01/01/99
16/01/99
31/01/99
15/02/99
02/03/99
17/03/99
01/04/99
16/04/99
01/05/99
16/05/99
31/05/99
15/06/99
30/06/99
15/07/99
30/07/99
14/08/99
29/08/99
13/09/99
28/09/99
13/10/99
28/10/99
12/11/99
27/11/99
12/12/99
27/12/99


PM2.5 (ugm-3)
Concentration
Date
0
50
100
150
200
250
300
01/01/99
16/01/99
31/01/99
15/02/99
02/03/99
17/03/99
01/04/99
16/04/99
01/05/99
16/05/99
31/05/99
15/06/99
30/06/99
15/07/99
30/07/99
14/08/99
29/08/99
13/09/99
28/09/99
13/10/99
28/10/99
12/11/99
27/11/99
12/12/99
27/12/99


PM10 (ugm-3)
Concentration
Date
0
100
200
300
400
500
600
700
800
900
01/01/99
16/01/99
31/01/99
15/02/99
02/03/99
17/03/99
01/04/99
16/04/99
01/05/99
16/05/99
31/05/99
15/06/99
30/06/99
15/07/99
30/07/99
14/08/99
29/08/99
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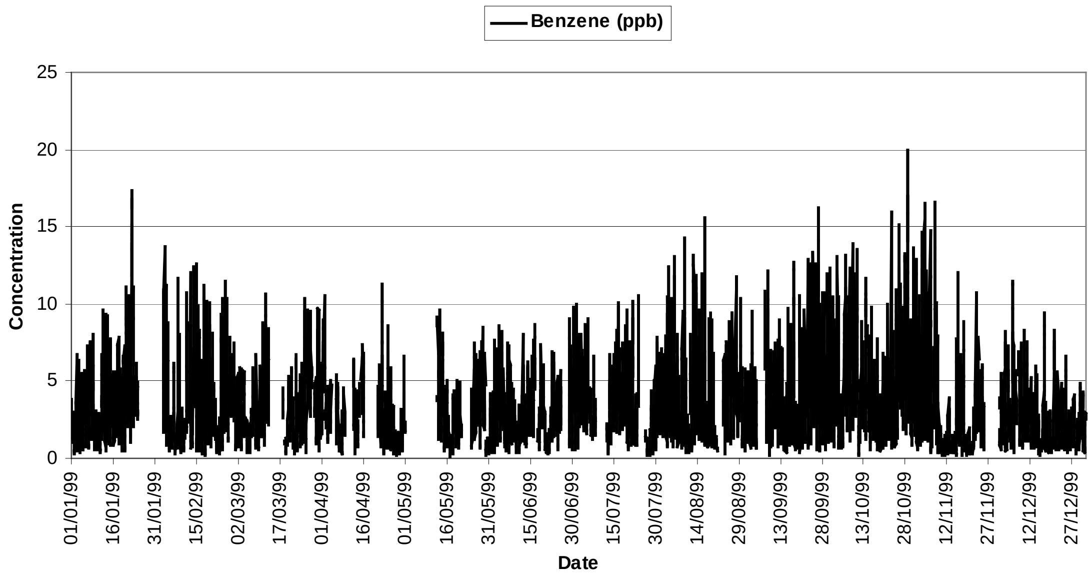
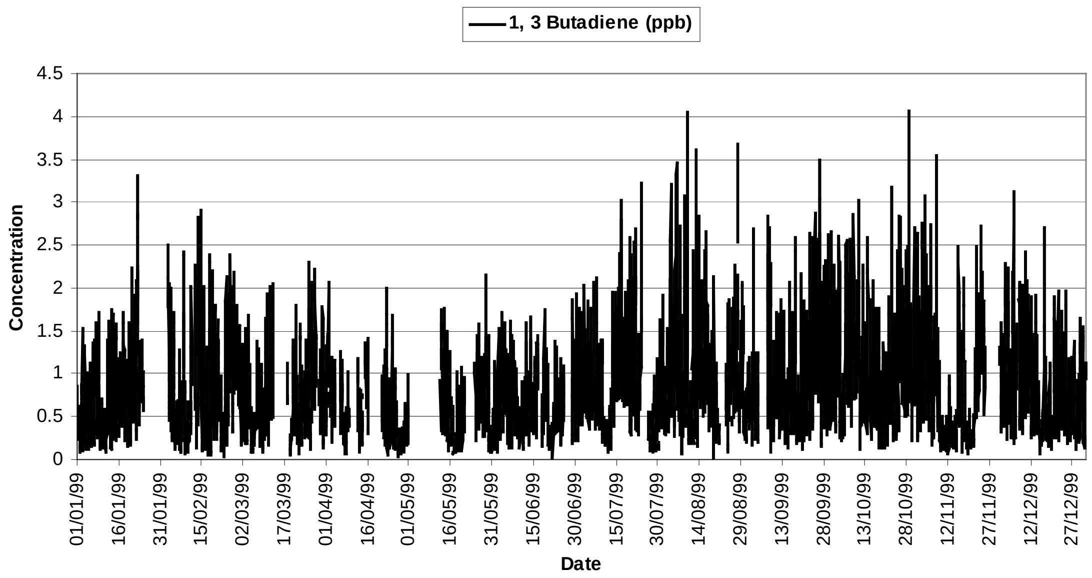
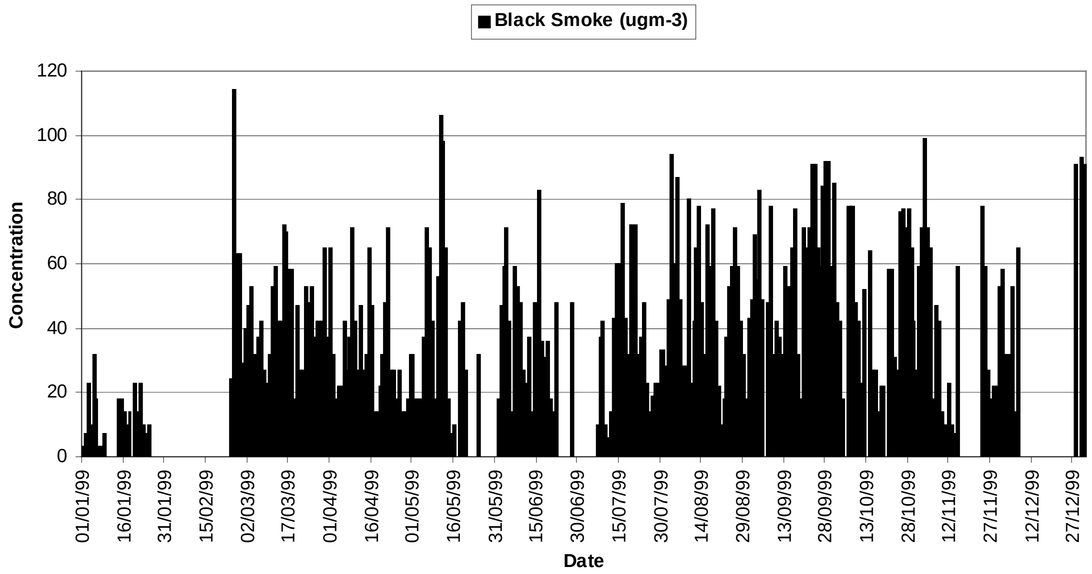
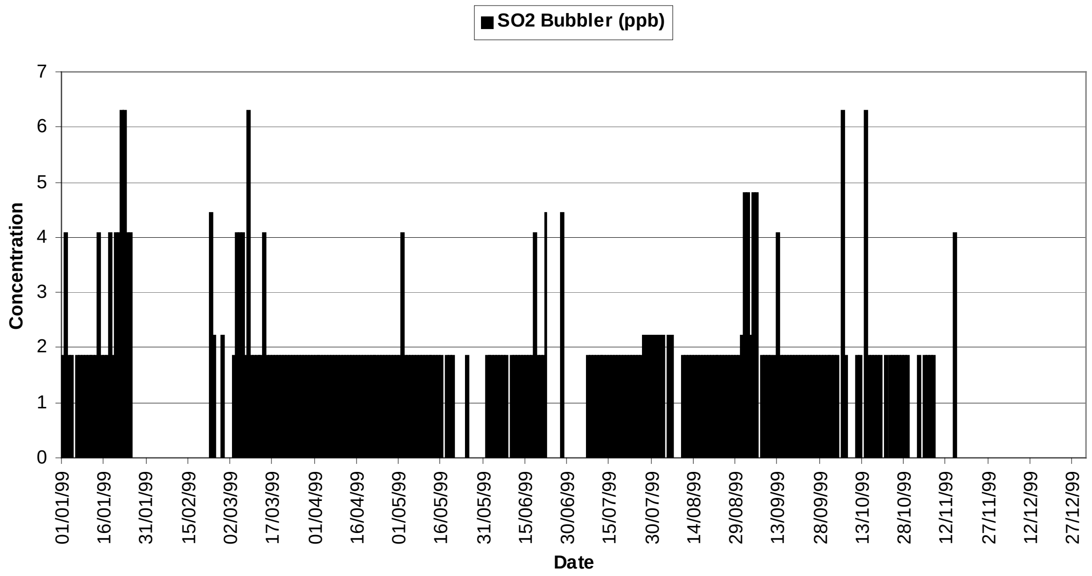
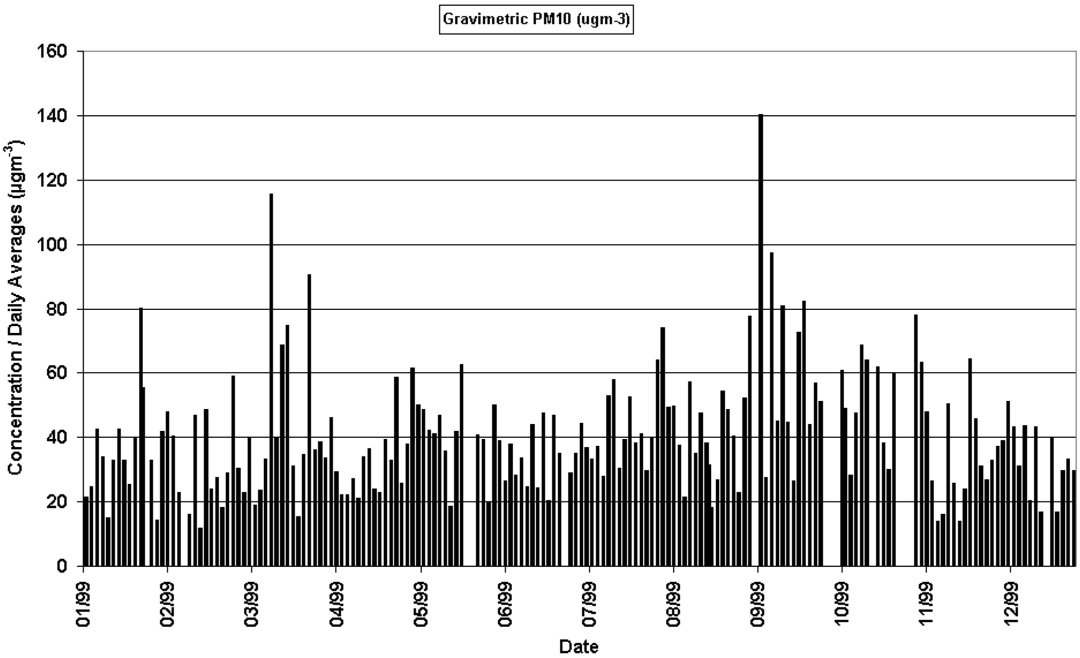
28/09/99
13/10/99
28/10/99
12/11/99
27/11/99
12/12/99
27/12/99


Benzene (ppb)
Concentration
25
20
15
10
5
0
01/01/99
16/01/99
31/01/99
15/02/99
02/03/99
17/03/99
01/04/99
16/04/99
01/05/99
16/05/99
31/05/99
15/06/99
30/06/99
15/07/99
30/07/99
14/08/99
29/08/99
13/09/99
28/09/99
13/10/99
28/10/99
12/11/99
27/11/99
12/12/99
27/12/99
Date


1, 3 Butadiene (ppb)
Concentration
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
01/01/99
16/01/99
31/01/99
15/02/99
02/03/99
17/03/99
01/04/99
16/04/99
01/05/99
16/05/99
31/05/99
15/06/99
30/06/99
15/07/99
30/07/99
14/08/99
29/08/99
13/09/99
28/09/99
13/10/99
28/10/99
12/11/99
27/11/99
12/12/99
27/12/99
Date


Black Smoke (ugm-3)
120
100
80
60
40
20
0
Concentration
01/01/99
16/01/99
31/01/99
15/02/99
02/03/99
17/03/99
01/04/99
16/04/99
01/05/99
16/05/99
31/05/99
15/06/99
30/06/99
15/07/99
30/07/99
14/08/99
29/08/99
13/09/99
28/09/99
13/10/99
28/10/99
12/11/99
27/11/99
12/12/99
27/12/99
Date


SO2 Bubbler (ppb)
7
6
5
4
3
2
1
0
Concentration
01/01/99
16/01/99
31/01/99
15/02/99
02/03/99
17/03/99
01/04/99
16/04/99
01/05/99
16/05/99
31/05/99
15/06/99
30/06/99
15/07/99
30/07/99
14/08/99
29/08/99
13/09/99
28/09/99
13/10/99
28/10/99
12/11/99
27/11/99
12/12/99
27/12/99
Date


Gravimetric PM10 (ugm-3)
Concentration / Daily Averages (µgm-3)
160
140
120
100
80
60
40
20
0
01/99
02/99
03/99
04/99
05/99
06/99
07/99
08/99
09/99
10/99
11/99
12/99
Date

Tabular Data

Nitrogen Dioxide Diffusion Tubes (ppb), 2 week exposures

Start Date	End Date	Tube A	Tube B	Tube C
22/12/98 13:00	07/01/99 12:00	33.8	39.0	
07/01/99 12:00	26/01/99 14:00	45.8	47.3	41.6
26/01/99 14:00	09/02/99 14:00	38.5	16.1	25.5
09/02/99 14:00	23/02/99 13:00	14.0	37.4	28.6
23/02/99 13:00	09/03/99 12:00	49.9	24.4	26.0
09/03/99 12:00	23/03/99 11:00	18.7	15.1	47.3
23/03/99 11:00	07/04/99 14:00	50.4	45.8	48.9
07/04/99 14:00	20/04/99 15:00	44.7	51.0	36.4
20/04/99 15:00	04/05/99 14:00	47.3	39.5	42.6
04/05/99 14:00	18/05/99 14:00	39.5	40.6	39.0
18/05/99 14:00	01/06/99 10:00	39.0	39.0	40.0
01/06/99 10:00	15/06/99 13:00	33.3	35.9	33.3
15/06/99 13:00	29/06/99 13:00	26.5	29.1	14.6
29/06/99 13:00	13/07/99 12:00	41.4	25.4	44.6
13/07/99 12:00	27/07/99 12:00	33.2	33.5	24.9
27/07/99 12:00	10/08/99 12:00	38.5	56.6	36.6
10/08/99 12:00	24/08/99 14:00	32.3	32.8	42.9
24/08/99 14:00	07/09/99 12:00	34.5	31.9	27.5
07/09/99 12:00	21/09/99 15:00	21.6	34.9	34.4
21/09/99 15:00	05/10/99 11:00	42.9	41.8	23.6
05/10/99 11:00	20/10/99 15:00	37.2	78.4	19.6
20/10/99 15:00	02/11/99 12:00	39.0	44.8	42.9
02/11/99 12:00	16/11/99 13:00	35.2	29.5	29.2
16/11/99 13:00	30/11/99 12:00	25.6	39.4	39.8
30/11/99 12:00	14/12/99 13:00	44.8	30.2	51.1
14/12/99 13:00	28/12/99 14:00	30.4	36.8	33.1
28/12/99 14:00	11/01/00 14:00	37.8	18.9	41.4
11/01/00 14:00	25/01/00 11:00	24.3	19.9	20.3

Nitrogen Dioxide Diffusion Tubes (ppb), 4 week exposures

Start Date	End Date	Tube A	Tube B	Tube C
22/12/98 13:00	26/01/99 14:00	18.2	14.6	17.7
26/01/99 14:00	23/02/99 12:00	20.8	13.5	17.7
23/02/99 12:00	23/03/99 11:00	39.5	19.2	36.4
23/03/99 11:00	20/04/99 15:00	30.7	38.5	31.2
20/04/99 15:00	18/05/99 14:00	28.1	36.9	31.2
18/05/99 14:00	15/06/99 13:00	27.6	27.6	27.0
15/06/99 13:00	13/07/99 12:00	10.4		26.0
13/07/99 12:00	10/08/99 12:00	38.6	24.9	19.3
10/08/99 12:00	07/09/99 12:00	33.1	45.0	34.6
07/09/99 12:00	05/10/99 11:00	20.4	33.3	25.3
05/10/99 11:00	02/11/99 11:40	23.6	19.5	38.1
02/11/99 11:40	30/11/99 12:00	19.8	22.0	20.6
30/11/99 12:00	28/12/99 15:00	37.9	17.3	28.4
28/12/99 15:00	25/01/00 11:00	21.8	26.9	28.8

Benzene Diffusion Tubes (ppb), 2 week exposures

Date	Tube A	Tube B	Tube C
05/01/99	2.9	2.8	3.3
26/01/99	2.4	2.4	2.4
09/02/99	2.3	2.6	2.5
23/02/99	2.7	2.7	2.6
09/03/99	3.0		3.0
23/03/99	3.3	3.8	3.1
07/04/99	2.8	2.9	3.2
20/04/99	1.8	1.9	1.9
04/05/99	2.5	2.8	2.9
18/05/99	2.5	2.5	2.4
01/06/99	2.5	2.7	2.4
15/06/99	2.7	2.8	3.0
29/06/99	2.1	2.2	2.2
13/07/99	2.7	2.6	2.8
27/07/99	3.0	2.0	3.2
10/08/99	3.5	2.8	2.8
24/08/99	3.8	3.8	3.8
07/09/99	3.4	3.5	3.7
21/09/99	4.9	4.6	5.0
05/10/99		3.3	3.3
20/10/99	3.7	4.0	3.7
02/11/99	3.6	2.7	2.5
16/11/99	3.4	2.7	3.8
30/11/99	4.1	4.0	4.0
14/12/99	2.6	2.6	3.0
28/12/99	3.3	3.2	3.1
11/01/00	3.2	6.9	3.3

Particulate Lead Concentrations

Start Date	End Date	Pb (μgm^{-3})
05/01/99	12/01/99	0.02
12/01/99	19/01/99	0.05
19/01/99	26/01/99	0.04
26/01/99	02/02/99	0.02
02/02/99	09/02/99	0.03
09/02/99	16/02/99	0.03
16/02/99	23/02/99	0.02
23/02/99	02/03/99	0.03
02/03/99	09/03/99	0.02
09/03/99	16/03/99	0.03
16/03/99	23/03/99	0.04
23/03/99	30/03/99	0.02
30/03/99	06/04/99	0.04
06/04/99	13/04/99	0.03
13/04/99	20/04/99	0.02
20/04/99	27/04/99	0.03
27/04/99	04/05/99	0.02
04/05/99	11/05/99	0.04
11/05/99	18/05/99	0.03
18/05/99	25/05/99	0.03
25/05/99	01/06/99	0.03
01/06/99	08/06/99	0.02
08/06/99	15/06/99	0.01
15/06/99	22/06/99	0.03
22/06/99	29/06/99	0.03
29/06/99	06/07/99	0.04
06/07/99	13/07/99	0.01
13/07/99	20/07/99	
20/07/99	27/07/99	0.05
27/07/99	03/08/99	
03/08/99	10/08/99	
10/08/99	17/08/99	
17/08/99	24/08/99	
24/08/99	31/08/99	0.03
31/08/99	07/09/99	0.07
07/09/99	14/09/99	0.04
14/09/99	21/09/99	0.03

21/09/99	28/09/99	0.04
28/09/99	05/10/99	0.04
05/10/99	12/10/99	0.04
12/10/99	19/10/99	0.05
19/10/99	26/10/99	0.03
26/10/99	02/11/99	0.04
02/11/99	09/11/99	0.06
09/11/99	16/11/99	0.03
16/11/99	23/11/99	0.03
23/11/99	30/11/99	
30/11/99	07/12/99	
07/12/99	14/12/99	
14/12/99	21/12/99	
21/12/99	28/12/99	

Particulate PAH Concentrations (ngm^{-3})

Date On	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene	Dibenz(a,h)anthracene	Benzo(g,h,i)perylene	Total PAH
07/01/99	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.58	0.02	0.07	0.02	0.03	0.02	1.29	0.08	2.27
26/01/99					1.86	0.11	1.41	0.93	0.87	0.48	0.11	0.13	0.07	1.4	0.32		7.69
09/02/99					0.87		0.62	1.47	0.62	0.4	0.11	0.08	0.06	0.92			5.15
23/02/99					1			0.81	0.81	0.21	0.39	0.19		0.73		0.13	4.27
09/03/99					1.03		0.32	0.99	0.47	0.26	0.37	0.09	0.06	0.77	0.26	0.17	4.79
23/03/99					0.45		0.45	1.2	0.8	0.35	0.31	0.07	0.05	0.62		0.12	4.42
07/04/99					0.06		0.08	0.14	0.08	0.04	0.22						0.62
20/04/99					0.81					0.15	0.19		0.26	0.23	0.32	0.15	2.11
04/05/99					0.95		0.71	1.73	0.07	0.2	0.24	0.06	0.22	0.22		0.3	4.7
18/05/99								0.8	0.07				0.2	0.15	0.32	0.35	1.89
01/06/99						0.41	1.39	1.04		0.26	0.56	0.07	0.06		0.26	0.22	4.27
15/06/99						0.02	1	1.96	0.23	0.08	0.26			0.09	0.28	0.4	4.32
29/06/99					0.04	0.96	0.45	1.47	0.29	0.18	0.12	0.96	0.06	0.16	0.29	0.29	5.27
13/07/99				0.41	0.5	0.02	0.76	2.1	0.45	0.27	0.25	0.04	0.06	0.19	0.35	0.39	5.79
27/07/99			0.72	0.25	0.31		0.68	2.06	0.45	0.27	0.21	0.1	0.1	0.1	0.27	0.35	5.87
10/08/99			0.71	0.39	0.37	0.14	0.77	2.61	0.54	0.41	0.27	0.12	0.12	0.21	0.29	0.44	7.39
24/08/99			0.28	1.03	1.79	0.69	6.71	7.63	4.21	8.03	3.97	2.78	1.27	2.25	0.39	1.25	42.27
07/09/99	0.04			1.24	13.03	4.65	5.91	6.68	1.55	6.9	3.59	2.87	0.71	1.28	0.4	1.24	50.1
21/09/99			0.11	3.18	3.67	0.92	7.69	5.78	2.88	3.07	3.91	2.05	1.06	3.17	0.3	1.29	39.08
05/10/99	0.19		0.18	0.88	3.18	1.08	4.95	5.26	1.8	3.68	1.36	1.14	0.86	1.34	0.3	1.35	27.55
19/10/99							4.01	4.46	1.3	4.1	1.47	1.71	0.91	0.66		0.91	19.52
02/11/99			0.32	1.16	4.07	1.5	5.63	5.85	0.79	4.29	1.3	1.76	0.77	0.81	0.31	1.51	30.05
16/11/99	0.18	0.05	0.05	0.08	4.04	0.2	5.8	7.61	0.78	0.92	0.6	0.46	0.02	0.47	0.05	0.54	21.85
30/11/99	0.14	0.02	0.02	0.01	0.39	0.02	0.5	0.58	0.1	0.23	0.11	0.05	0.03	0.13	0.02	0.2	2.57
14/12/99	0.32	0.35	0.08	0.06	3.08	0.07	1.01	1.44	0.19	0.43	0.2	0.15	0.03	0.26	0.02	0.36	8.03
28/12/99	**0.2**	**0.28**	**0.09**	**0.14**	**3.7**	**0.32**	**2.67**	**3.58**	**1.3**	**1.7**	**0.89**	**0.59**	**0.84**	**1.23**	**0.12**	**0.94**	**18.59**

Black Smoke and SO_2 Bubbler

DateTime	Black Smoke (μgm^{-3})	SO_2 Bubbler (ppb)
01/01/99	3	1.85
02/01/99	7	4.07
03/01/99	23	1.85
04/01/99	10	1.85
05/01/99	32	0
06/01/99	18	1.85
07/01/99	3	1.85
08/01/99	3	1.85
09/01/99	7	1.85
10/01/99		1.85
11/01/99		1.85
12/01/99		1.85
13/01/99		1.85
14/01/99	18	4.07
15/01/99	18	1.85
16/01/99	14	1.85
17/01/99	10	1.85
18/01/99	14	4.07
19/01/99		1.85
20/01/99	23	4.07
21/01/99	14	4.07
22/01/99	23	6.29
23/01/99	10	6.29
24/01/99	7	4.07
25/01/99	10	4.07
26/01/99		
27/01/99		
28/01/99		
29/01/99		
30/01/99		
31/01/99		
01/02/99		
02/02/99		
03/02/99		
04/02/99		
05/02/99		
06/02/99		
07/02/99		
08/02/99		
09/02/99		
10/02/99		
11/02/99		
12/02/99		
13/02/99		
14/02/99		
15/02/99		
16/02/99		
17/02/99		
18/02/99		
19/02/99		
20/02/99		
21/02/99		
22/02/99		
23/02/99		4.44
24/02/99	24	2.22
25/02/99	114	
26/02/99	63	
27/02/99	63	2.22
28/02/99	29	
01/03/99	40	
02/03/99	47	
03/03/99	53	1.85
04/03/99	27	4.07
05/03/99	32	4.07
06/03/99	37	4.07
07/03/99	42	1.85
08/03/99	27	6.29
09/03/99	23	1.85
10/03/99	32	1.85

DateTime	Black Smoke (μgm^{-3})	SO_2 Bubbler (ppb)
01/07/99		
02/07/99		
03/07/99		
04/07/99		
05/07/99		
06/07/99		
07/07/99	10	1.85
08/07/99	37	1.85
09/07/99	42	1.85
10/07/99	10	1.85
11/07/99	6	1.85
12/07/99	14	1.85
13/07/99	43	1.85
14/07/99	60	1.85
15/07/99	60	1.85
16/07/99	79	1.85
17/07/99	43	1.85
18/07/99	32	1.85
19/07/99	72	1.85
20/07/99	72	1.85
21/07/99	72	1.85
22/07/99	32	1.85
23/07/99	37	1.85
24/07/99	48	1.85
25/07/99	23	1.85
26/07/99	14	1.85
27/07/99	19	2.22
28/07/99	23	2.22
29/07/99	23	2.22
30/07/99	33	2.22
31/07/99	33	2.22
01/08/99	28	2.22
02/08/99	49	2.22
03/08/99	94	2.22
04/08/99	60	
05/08/99	87	2.22
06/08/99	49	2.22
07/08/99	28	
08/08/99	28	
09/08/99	80	
10/08/99	23	1.85
11/08/99	42	1.85
12/08/99	65	1.85
13/08/99	78	1.85
14/08/99	48	1.85
15/08/99	32	1.85
16/08/99	72	1.85
17/08/99	59	1.85
18/08/99	77	1.85
19/08/99	42	1.85
20/08/99	22	1.85
21/08/99	10	1.85
22/08/99	18	1.85
23/08/99	37	1.85
24/08/99	53	1.85
25/08/99	59	1.85
26/08/99	71	1.85
27/08/99	59	1.85
28/08/99	42	1.85
29/08/99	32	1.85
30/08/99	18	1.85
31/08/99	43	2.22
01/09/99	49	4.81
02/09/99	69	4.81
03/09/99	55	2.22
04/09/99	83	4.81
05/09/99	49	4.81
06/09/99		
07/09/99	48	1.85

11/03/99	53	1.85
12/03/99	59	1.85
13/03/99	42	1.85
14/03/99	42	4.07
15/03/99	72	1.85
16/03/99	70	1.85
17/03/99	58	1.85
18/03/99	58	1.85
19/03/99	18	1.85
20/03/99	47	1.85
21/03/99	27	1.85
22/03/99	27	1.85
23/03/99	53	1.85
24/03/99	48	1.85
25/03/99	53	1.85
26/03/99	37	1.85
27/03/99	42	1.85
28/03/99	42	1.85
29/03/99	42	1.85
30/03/99	65	1.85
31/03/99	37	1.85
01/04/99	65	1.85
02/04/99	32	1.85
03/04/99	18	1.85
04/04/99	22	1.85
05/04/99	22	1.85
06/04/99	42	1.85
07/04/99	27	1.85
08/04/99	37	1.85
09/04/99	71	1.85
10/04/99	42	1.85
11/04/99	27	1.85
12/04/99	47	1.85
13/04/99	27	1.85
14/04/99	32	1.85
15/04/99	65	1.85
16/04/99	47	1.85
17/04/99	14	1.85
18/04/99	14	1.85
19/04/99	22	1.85
20/04/99	32	1.85
21/04/99	48	1.85
22/04/99	71	1.85
23/04/99	27	1.85
24/04/99	27	1.85
25/04/99	18	1.85
26/04/99	27	1.85
27/04/99	14	1.85
28/04/99	14	1.85
29/04/99	18	1.85
30/04/99	32	1.85
01/05/99	32	1.85
02/05/99	18	4.07
03/05/99	18	1.85
04/05/99	18	1.85
05/05/99	37	1.85
06/05/99	71	1.85
07/05/99	65	1.85
08/05/99	42	1.85
09/05/99	18	1.85
10/05/99	56	1.85
11/05/99	106	1.85
12/05/99	98	1.85
13/05/99	65	1.85
14/05/99	18	1.85
15/05/99	7	1.85
16/05/99	10	1.85
17/05/99		
18/05/99	42	1.85
19/05/99	48	1.85
20/05/99	27	1.85
21/05/99		
08/09/99	78	1.85
09/09/99	32	1.85
10/09/99	42	1.85
11/09/99	37	
12/09/99	32	1.85
13/09/99	59	4.07
14/09/99	32	1.85
15/09/99	53	1.85
16/09/99	65	1.85
17/09/99	77	1.85
18/09/99	32	1.85
19/09/99	18	1.85
20/09/99	71	1.85
21/09/99	65	1.85
22/09/99	71	1.85
23/09/99	91	1.85
24/09/99	91	1.85
25/09/99	65	1.85
26/09/99	59	1.85
27/09/99	84	1.85
28/09/99	92	1.85
29/09/99	92	1.85
30/09/99	59	1.85
01/10/99	85	1.85
02/10/99	48	1.85
03/10/99	42	1.85
04/10/99	18	1.85
05/10/99		
06/10/99	78	6.29
07/10/99	78	1.85
08/10/99	78	
09/10/99	48	
10/10/99	42	
11/10/99	23	1.85
12/10/99	52	1.85
13/10/99		
14/10/99	64	6.29
15/10/99	27	1.85
16/10/99	27	1.85
17/10/99	14	1.85
18/10/99	22	1.85
19/10/99	22	1.85
20/10/99		
21/10/99	58	1.85
22/10/99	58	
23/10/99	31	1.85
24/10/99	27	1.85
25/10/99	76	1.85
26/10/99	77	1.85
27/10/99	71	1.85
28/10/99	77	1.85
29/10/99	65	1.85
30/10/99	42	
31/10/99	27	
01/11/99	59	
02/11/99	71	1.85
03/11/99	99	
04/11/99	71	1.85
05/11/99	65	1.85
06/11/99	18	1.85
07/11/99	47	1.85
08/11/99	42	
09/11/99	14	
10/11/99	10	
11/11/99	10	
12/11/99	23	
13/11/99	10	
14/11/99	7	
15/11/99	59	4.07
16/11/99		
17/11/99		
18/11/99		

22/05/99		
23/05/99		
24/05/99		
25/05/99	32	1.85
26/05/99		
27/05/99		
28/05/99		
29/05/99		
30/05/99		
31/05/99		
01/06/99	18	1.85
02/06/99	47	1.85
03/06/99	59	1.85
04/06/99	71	1.85
05/06/99	42	1.85
06/06/99	14	1.85
07/06/99	59	1.85
08/06/99	53	1.85
09/06/99	48	
10/06/99	27	1.85
11/06/99	23	1.85
12/06/99	37	1.85
13/06/99	14	1.85
14/06/99	48	1.85
15/06/99	47	1.85
16/06/99	83	1.85
17/06/99	36	1.85
18/06/99	31	4.07
19/06/99	36	1.85
20/06/99	18	1.85
21/06/99	14	1.85
22/06/99	48	4.44
23/06/99		
24/06/99		
25/06/99		
26/06/99		
27/06/99		
28/06/99	48	4.44
29/06/99		
30/06/99		

19/11/99	
20/11/99	
21/11/99	
22/11/99	
23/11/99	
24/11/99	78
25/11/99	59
26/11/99	27
27/11/99	18
28/11/99	22
29/11/99	22
30/11/99	53
01/12/99	58
02/12/99	32
03/12/99	22
04/12/99	32
05/12/99	53
06/12/99	14
07/12/99	65
08/12/99	
09/12/99	
10/12/99	
11/12/99	
12/12/99	
13/12/99	
14/12/99	
15/12/99	
16/12/99	
17/12/99	
18/12/99	
19/12/99	
20/12/99	
21/12/99	
22/12/99	
23/12/99	
24/12/99	
25/12/99	
26/12/99	
27/12/99	
28/12/99	91
29/12/99	
30/12/99	93
31/12/99	91

APPENDIX III

Hourly Data

	CO	NO	NO_X	NO_2	SO_2	O_3	PM2.5	PM10	Benzene	1, 3 Butadiene	Traffic Flow
CO	1.000										
NO	**0.870**	1.000									
NO_X	**0.875**	0.995	1.000								
NO_2	0.677	0.704	**0.770**	1.000							
SO_2	0.648	0.717	0.733	0.651	1.000						
O_3	-0.416	-0.501	-0.491	-0.296	-0.324	1.000					
PM25	0.461	0.555	0.572	0.531	0.502	-0.226	1.000				
PM10	0.327	0.401	0.418	0.421	0.326	-0.164	**0.828**	1.000			
Benzene	0.696	0.604	0.610	0.489	0.458	-0.352	0.356	0.275	1.000		
Butadiene	0.678	0.621	0.620	0.458	0.405	-0.413	0.327	0.258	**0.923**	1.000	
Traffic Flow	0.451	0.358	0.390	0.495	0.395	-0.036	0.274	0.267	0.284	0.208	1.000

	CO	NO	NO_X	NO_2	SO_2	O_3	PM2.5	PM10	Benzene	1, 3 Butadiene	Traffic Flow	Black Smoke	SO_2 Bubbler	Gravimetric PM10
CO	1.000													
NO	**0.929**	1.000												
NO_X	**0.926**	**0.996**	1.000											
NO_2	0.670	0.721	**0.779**	1.000										
SO_2	0.596	0.668	0.684	0.625	1.000									
O_3	-0.643	-0.682	-0.672	-0.447	-0.432	1.000								
PM25	0.535	0.581	0.609	0.664	0.531	-0.319	1.000							
PM10	0.441	0.463	0.495	0.596	0.290	-0.318	**0.832**	1.000						
Benzene	**0.793**	**0.781**	**0.789**	0.649	0.543	-0.544	0.593	0.540	1.000					
1, 3 Butadiene	**0.788**	**0.795**	**0.798**	0.618	0.445	-0.570	0.543	0.513	**0.901**	1.000				
Traffic Flow	0.119	0.141	0.155	0.219	0.186	-0.064	0.105	0.174	0.067	-0.032	1.000			
Black Smoke	0.544	0.583	0.597	0.553	0.311	-0.461	0.431	0.504	0.580	0.623	0.070	1.000		
SO_2 Bubbler	0.140	0.190	0.196	0.186	0.339	-0.059	0.105	0.030	0.116	0.031	0.023	-0.049	1.000	
Gravimetric PM10	0.455	0.547	0.559	0.578	0.626	-0.309	**0.883**	**0.849**	0.537	0.454	0.227	0.398	0.131	1.000

Diffusion Tubes

	CO	NO	NO_x	NO_2	SO_2	O_3	PM25	PM10	Benzene	1, 3 Butadiene	Traffic Flow
NO2 Diffusion Tube - 2 week exposure	0.261	0.180	0.182	0.105	0.052	0.040	0.229	-0.014	0.240	0.142	0.098
NO_2 Diffusion Tube - 4 week exposure	-0.282	-0.355	-0.325	0.204	-0.510	0.286	0.194	0.232	0.076	-0.040	0.014
Benzene Diffusion Tube4	0.711	0.660	0.680	0.485	-0.070	-0.700	0.521	0.577	0.572	0.690	0.214

Lead - Weekly Exposure

	Lead	CO	NO	NO_x	NO_2	SO_2	O_3	PM25	PM10	Benzene	1, 3 Butadiene	Traffic Flow	Black Smoke	SO_2 Bubbler	Gravimetric PM10
Lead	1.000	0.435	0.365	0.377	0.327	0.059	-0.337	0.448	0.543	0.140	0.225	-0.059	0.310	0.102	0.424

Poly Aromatic Hydrocarbons (PAH) and Benzo(a)pyrene – Fortnightly Exposure

	BAP	PAH	CO	NO	NO_x	NO_2	SO_2	O_3	PM2.5	PM10	Benzene	1, 3 Butadiene	Traffic Flow	Black Smoke	SO2 Bubbler	Gravimetric PM10
BAP	1.000	**0.847**	0.330	0.214	0.232	0.274	-0.132	-0.382	0.625	0.720	0.613	0.471	0.246	0.297	0.002	0.654
PAH		1.000	0.308	0.264	0.273	0.198	-0.245	-0.473	0.599	**0.816**	0.481	0.512	0.196	0.358	-0.030	0.526