Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2004

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Title	Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2004
Customer	Public Health Services, States of Jersey
Customer reference	
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File reference	ED 44628001
Report number	AEAT/ENV/R/1928
Report status	Issue 1

Netcen
551 Harwell Business Centre
DIDCOT
Oxfordshire
OX11 0QJ
Telephone 0870 190 6518
Facsimile 0870 190 6377

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	Name	Signature	Date
Author	R Goodwin A Loader B Stacey		
Reviewed by	K Stevenson		
Approved by	G Dollard		

Executive Summary

Netcen (an operating division of AEA Technology Environment) is undertaking an ongoing programme of air quality monitoring on Jersey, on behalf of the Public Health Services and Planning and Environment Department of the States of Jersey. This report presents the results of the eighth consecutive year of monitoring, calendar year 2004 – covered by the monitoring period 30th December 2003 to 4th January 2005.

Diffusion tube samplers were used to monitor nitrogen dioxide (NO_2) at 21 sites, and hydrocarbons at six sites. Monitoring sites were selected to include areas likely to be affected by specific emission sources (such as petrol stations or the waste incinerator), as well as general background locations.

NO_2 and hydrocarbon diffusion tubes were exposed for periods of typically 4 to 5 weeks. The exposure periods were based upon those used in the UK NO_2 Network. The tubes were supplied and analysed by Harwell Scientifics Ltd, and changed by Technical Officers of Jersey's Environmental Health Section.

Annual mean NO_2 concentrations at three of the nine kerbside and roadside sites in built-up areas were greater than the Limit Value of 40μg m^{-3}, set by Directive 1999/30/EEC (to be achieved by 2010), and as an Objective by the UK Air Quality Strategy, to be achieved by 31 December 2005. However, application of an adjustment factor for known diffusion tube bias reduced the annual means at all sites to below 40μg m^{-3}. The highest annual mean of 33 μg m^{-3} (after bias adjustment) was measured at the Broad Street site.

Annual mean concentrations at urban and residential background sites were all well below 40μg m^{-3} in 2004.

Ambient NO_2 concentrations at most of the sites in Jersey were on average slightly lower than those measured in the previous year (2003).

Ambient concentrations of NO_2 show no clear trends, although there have been year-to-year fluctuations. Unlike the UK as a whole, there is no apparent downward trend in Jersey's NO_2 concentrations. The implication of this is that some kerbside sites that are currently close to the AQS Objective may remain so, unless action is taken.

The highest annual mean benzene concentration of 4.7μg m^{-3} was measured at Springfield Garage, where the tube is located at a petrol station. At all other sites the annual mean benzene concentration was below 2.0μg m^{-3}. All sites therefore met the UK Air Quality Strategy Objective of 16.25 μg m^{-3} for the running annual mean. All sites also met the EC 2nd Daughter Directive annual mean Limit Value of 5 μg m^{-3} (which is to be achieved by 2010).

Concentrations of ethylbenzene at several sites were elevated during the period June – August 2004. As a result, annual mean ethylbenzene concentrations were slightly higher in 2004 than in the previous year at most sites. Springfield Garage showed a particularly large increase in levels of this hydrocarbon pollutant. The reason is not known at present.

Contents

1 Introduction

1.1 BACKGROUND

Netcen, (an operating division of AEA Technology Environment), on behalf of the States of Jersey Public Health Services, has undertaken a further programme of air quality monitoring on the island of Jersey in 2004. This is the eighth in a series of extensive annual monitoring programmes that began in 1997.

The pollutants measured were nitrogen dioxide (NO_2), and a range of hydrocarbon species (benzene, toluene, ethyl benzene and three xylene compounds), collectively termed BTEX. Average ambient concentrations were measured using passive diffusion tube samplers. NO_2 was measured at 21 sites on the island, and BTEX at six sites.

This report presents the results obtained in the 2004 survey, and compares the data from Jersey with relevant air quality Limit Values, Objectives and guidelines, data from selected UK monitoring stations and previous years' monitoring programmes.

1.2 OBJECTIVES

This survey follows on from those in the years 1997 to 2002[1,2,3,4,5,6,7]. The objective, as in previous surveys, was to monitor at sites where pollutant concentrations were expected to be high, and compare these with background locations. There were no changes to the monitoring sites during 2004. They consisted of a mixture of urban and rural background sites, together with some locations where higher pollutant concentrations might be expected, such as roadside and kerbside sites, and some close to specific emission sources.

2 Details of Monitoring Programme

2.1 POLLUTANTS MONITORED

2.1.1 NO_2

A mixture of nitrogen dioxide (NO_2) and nitric oxide (NO) is emitted by combustion processes. This mixture of oxides of nitrogen is termed NO_X. NO is subsequently oxidised to NO_2 in the atmosphere. NO_2 is an irritant to the respiratory system, and can affect human health. Ambient concentrations of NO_2 are likely to be highest in the most built-up areas, especially where traffic is congested, or buildings either side of the street create a "canyon" effect, impeding the dispersion of vehicle emissions. The units used for NO_2 concentration in this report are microgrammes per cubic metre ($\mu g\ m^{-3}$). Previous reports in this series have used parts per billion (ppb): to convert to ppb to if required, the following relationship should be used:

1 $\mu g\ m^{-3}$ = 0.523 ppb for nitrogen dioxide at 293K (20°C) and 1013mb.

2.1.2 Hydrocarbons

There are many sources of hydrocarbon emissions. Methane, for example, is a naturally occurring gas, while xylene compounds are synthetic and used in many applications, for example as a solvent in paint. A range of hydrocarbons is found in vehicle fuel, and occur in vehicle emissions. In most urban areas, vehicle emissions would constitute the major source of hydrocarbons, in particular benzene. Also, there is the potential that they may be released to the air from facilities where fuels are stored or handled (such as petrol stations).

A wide range of hydrocarbons is emitted from both fuel storage and handling, and from fuel combustion in vehicles. It is not easy to measure all of these hydrocarbon species (particularly the most volatile) without expensive continuous monitoring systems. However, there are four moderately volatile species, all of which may be associated with fuels and vehicle emissions, which are easy to monitor using passive samplers. These are benzene, toluene, ethyl benzene and xylene. They are not the largest constituents of petrol emissions, but due to their moderate volatility they can be monitored by diffusion tubes. Diffusion tubes are available for monitoring this group of organic compounds, and are known as “BTEX” tubes.

(i) Benzene
Of the organic compounds measured in this study, benzene is the one of most concern, as it is a known human carcinogen; long-term exposure can cause leukaemia. It is found in petrol and other liquid fuels, in small concentrations. In urban areas, the major source is vehicle emissions. Benzene concentrations in ambient air are generally between 1 and 15 μg m^{-3}. In this report, concentrations of benzene are expressed in microgrammes per cubic metre (μg m^{-3}). Previous reports in the series used parts per billion (ppb): to convert to ppb to if necessary, the following relationship should be used:

1 μg m^{-3} = 0.307 ppb for benzene at 293K (20°C) and 1013mb.
(only applicable to benzene).

(ii) Toluene
Toluene is also found in petrol in small concentrations. Its primary use is as a solvent in paints and inks; it is also a constituent of tobacco smoke. It has been found to adversely affect human health. Typical ambient concentrations range from trace to 3.8 μg m^{-3} in rural areas, up to 204 μg m^{-3} in urban areas, and higher near industrial sources. There are no recommended limits for ambient toluene concentrations, although there are occupational limits for workplace exposure[7]. The best estimate for the odour threshold of toluene has been reported[8] as 0.16ppm (613μg m^{-3}). In this report, concentrations are expressed in microgrammes per cubic metre (μg m^{-3}). Previous reports in the series used parts per billion (ppb): to convert to ppb to if necessary, the following relationship should be used:

1 μg m^{-3} = 0.261 ppb for toluene at 293K (20°C) and 1013mb.
(only applicable to toluene).

(iii)ethyl benzene
Again, there are no limits for ambient concentration of ethyl benzene, and although there are occupational limits relating to workplace exposure[7], as discussed in previous reports in this series, they are several orders of magnitude higher than typical outdoor ambient concentrations.

(iv)xylene

Xylene exists in ortho (o), para (p) and meta (m) isomers. Occupational limits relating to workplace exposure, are 100 ppm over 8 hours, and 150 ppm over 10 minutes. Xylene, like toluene, can cause odour nuisance near processes (such as vehicle paint spraying), which emit it. Its odour threshold varies according to the isomer, but the best estimate for the odour threshold of mixed xylenes is 0.016ppm (16 ppb or 70 $\mu g\ m^{-3}$)[8].

In this report, concentrations of ethylbenzene and xylenes are expressed in microgrammes per cubic metre ($\mu g\ m^{-3}$). To convert to ppb to if necessary for comparison with previous reports, the following relationship should be used:

1 $\mu g\ m^{-3}$ = 0.226 ppb for ethyl benzene or xylenes at 293K (20°C) and 1013mb.
(applicable to ethylbenzene, m-, p- and o-xylene).

2.2 AIR QUALITY LIMIT VALUES AND OBJECTIVES

2.2.1 World Health Organisation

In 2000, the World Health Organisation published revised air quality guidelines[9] for pollutants including NO_2. These were set using currently available scientific evidence on the effects of air pollutants on health and vegetation. The WHO guidelines are advisory only, and do not carry any mandatory status. They are summarised in Appendix 1. There are WHO guidelines for ambient NO_2 (hourly and annual means) but not benzene.

2.2.2 European Community

Throughout Europe, ambient air quality is regulated by EC Directives. These set Limit Values, which are mandatory, and other requirements for the protection of human health and ecosystems. EC Daughter Directives covering pollutants including NO_2 and benzene [10,11] have been published in recent years. The Limit Values are summarised in Appendix 1.

2.2.3 UK Air Quality Strategy

The UK Air Quality Strategy (AQS) contains standards and objectives for a range of pollutants including NO_2 and benzene[12]. These are also summarised in Appendix 1. Only those Objectives relating to the whole UK (as opposed to England, Wales, etc.) are applicable to Jersey, and the AQS does not at present have mandatory status in the States of Jersey.

2.3 METHODOLOGIES

The survey was carried out using diffusion tubes for NO_2 and BTEX. These are "passive" samplers, i.e. they work by absorbing the pollutants direct from the surrounding air and need no power supply.

Diffusion tubes for NO_2 consist of a small plastic tube, approximately 7 cm long. During sampling, one end is open and the other closed. The closed end contains an absorbent for the gaseous species to be monitored, in this case NO_2. The tube is mounted vertically with the open end at the bottom. Ambient NO_2 diffuses up the tube during exposure, and is absorbed as nitrite. The average ambient pollutant concentration for the exposure period is calculated from the amount of pollutant absorbed.

BTEX diffusion tubes are different in appearance to NO_2 tubes. They are longer, thinner, and made of metal rather than plastic. These tubes are fitted at both ends with brass

Swagelok fittings. A separate "diffusion cap" is supplied. Immediately before exposure, the Swagelok end fitting is replaced with the diffusion cap. The cap is removed after exposure, and is replaced with the Swagelok fitting. BTEX diffusion tubes are very sensitive to interference by solvents.

Diffusion tubes were prepared by Harwell Scientifics Ltd for AEA Technology, and supplied to local Technical Officers of Jersey's Public Health Services, who carried out the tube changing. The tubes were supplied in sealed condition prior to exposure. The tubes were exposed at the sites for a period of time. After exposure, the tubes were again sealed and returned to Harwell Scientifics for analysis. It was intended that where possible, the exposure periods should correspond (within $\pm$2 days) to those used in the UK NO_2 Network, as has been the case in previous years.

The diffusion tube methodologies provide data that are accurate to $\pm$ 25% for NO_2 and $\pm$ 20% for BTEX. The limits of detection are 0.4 μg m^{-3} for NO_2 and 0.2 μg m^{-3} for BTEX. It should be noted that tube results that are less than 10 x the limit of detection will have a higher level of uncertainty associated with them.

The Local Air Quality Management Technical Guidance LAQM.TG(03)[13] states that when using diffusion tubes for indicative NO_2 monitoring, correction should be made where applicable for any systematic bias (i.e. over-read or under-read compared to the automatic chemiluminescent technique, which is the reference method for NO_2). Harwell Scientifics state that their diffusion tubes typically exhibit a positive bias, and have provided a "bias adjustment factor" of 0.75. (This applies only to NO_2 diffusion tubes, not BTEX tubes, as the latter are not affected by the same sources of interference). ***The NO_2 diffusion tube results in this report are uncorrected except where clearly specified.***

2.4 MONITORING SITES

Monitoring of NO_2 was started in 1999 with just three sites. During 2000, this was expanded to 19 sites, all of which remain in operation; two further sites were added in 2003, taking the total to 21. The total remained at 21 sites throughout 2004. These are shown in Table 1 and Figure 1.

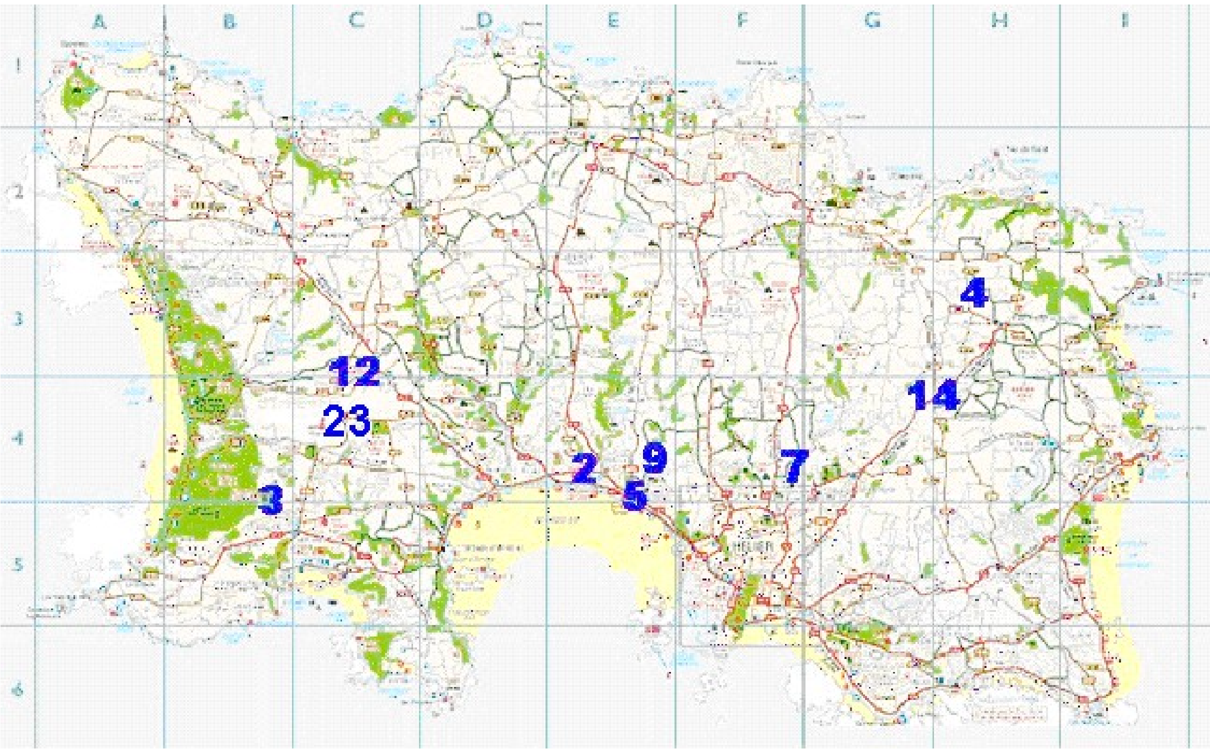
Table 1. NO_2 Monitoring Sites

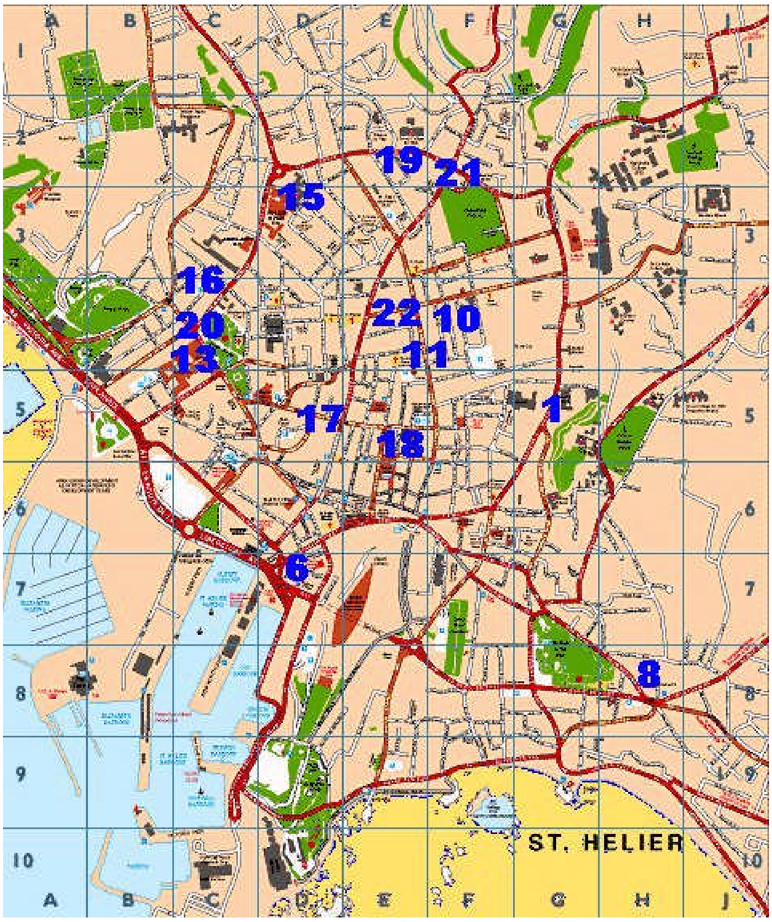
Site number	Site Name	Grid Reference	Description
N1	Le Bas Centre	658 489	Urban Background
N2	Mont Felard	629 501	Residential background, to SW of waste incinerator and 20m from busy road
N3	Les Quennevais	579 496	Residential Background
N4	Rue des Raisies	689 529	Rural Background
N5	First Tower	636 497	Kerbside on major road
N6	Weighbridge	651 483	Roadside at bus station near centre of St Helier
N7	Langley Park	660 501	Residential background
N8	Georgetown	661480	Kerbside on major road
N9	Clos St Andre	638 499	Residential area near Bellozanne Valley refuse Incinerator. Background
N10	L'Avenue et Dolmen	656 490	Urban background close to ring road
N11	Robin Place	656 489	Urban background
N12	Beaumont	597 516	Kerbside
N13	The Parade *	648 489	Roadside site at General Hospital
N14	Maufant	683 512	Background site in Maufant village
N15	Jane Sandeman	652 494	Urban background on housing estate
N16	Saville Street	648 492	Background
N17	Broad Street	652 486	Urban background
N18	Beresford Street	653 486	Urban background
N19	La Pouquelaye	654 496	Kerbside on St Helier ring road.
N20	Camera Shop, La Columberie	657 484	Kerbside in St Helier
N21	Taxi Rank, La Columberie	657 484	Kerbside in St Helier

*The Parade site was moved to its current roadside location at the end of 2000.

Kerbside: less than 1m from kerb of a busy road.
Roadside: 1-5m from kerb of a busy road.
Background: > 50m from the kerb of any major road.

Note: all grid references are from OS 1:25000 Leisure Map of Jersey and are given to the nearest 100m.





Key:

1. Le Bas Centre
2. Mont Felard
3. Les Quennevais
4. Rue Des Raisies
5. First Tower
6. Weighbridge
7. Langley Park
8. Georgetown
9. Clos St Andre
10. L'Avenue et Dolmen
11. Robin Place
12. Beaumont
13. The Parade
14. Maufant
15. Jane Sandeman
16. Saville Street
17. Broad Street
18. Beresford Street
19. La Pouquelaye
20. Elizabeth Lane
21. Springfield Garage
22. Stopford Road
23. Airport

Figure 1. Site Locations *NEEDS UPDATING?????*

BTEX hydrocarbons were monitored at six sites during 2004. These are shown in Table 2. The aim was to investigate sites likely to be affected by different emission sources, and compare these with background sites. The sites at Beresford Street and Le Bas Centre are intended to monitor hydrocarbon concentrations at an urban roadside and urban background location respectively.

The Handsford Lane site was close to a paint spraying process – a potential source of hydrocarbon emissions, especially toluene and xylenes. This site replaced a similar site in Elizabeth Lane, which ceased operation when the process closed down in October 2003.

The Springfield Garage site is located by a fuel filling station, a potential sources of hydrocarbon emissions including benzene. In December 2003, the fuel supplier began using vapour recovery when filling the tanks; it was anticipated that the 2004 results for this site would show a reduction in ambient concentrations of hydrocarbons.

The Clos St Andre site is located near the Bellozanne Valley waste incinerator, and the Airport site is located at Jersey Airport, overlooking the airfield.

Table 2. BTEX Monitoring sites

Site number	Site Name	Grid Reference	Description
BTEX 1	Beresford Street	653 486	Urban Roadside
BTEX 2	Le Bas Centre	658 489	Urban Background
BTEX 4	Springfield Garage	656 495	Urban background near fuel filling station
BTEX 7	Clos St Andre	638 499	Residential area near Bellozanne Valley refuse incinerator.
BTEX 8	Airport	587 509	Jersey Airport, overlooking airfield
BTEX 9	Handsford Lane	633 499	Urban background near a paint spraying process.

3 Results and Discussion

3.1 NITROGEN DIOXIDE

3.1.1 Summary of NO_2 Results

NO_2 diffusion tube results are presented in Table 3, and Figures 2 (kerbside and roadside sites) and 3 (background sites). Individual monthly mean NO_2 results ranged from 2.9 $\mu g\ m^{-3}$ (in August at the rural Rue des Raisies site), to 120 $\mu g\ m^{-3}$ (in June at the kerbside Broad Street site). The latter result at Broad Street was unusually high, as typical monthly means at the site ranged from 30 $\mu g\ m^{-3}$ to 45 $\mu g\ m^{-3}$. However, there was no evidence to indicate that the June result was spurious, so it has not been rejected from the dataset.

Annual mean NO_2 concentrations ranged from 6.5 $\mu g\ m^{-3}$ (at Rue des Raisies) to 44.2 $\mu g\ m^{-3}$ at the Broad Street site.

3.1.2 Comparison with NO_2 Guidelines, Limit Values, and Objectives

Limit Values, AQS Objectives and WHO guidelines for NO_2 are shown in Appendix 1. These are based on the hourly and annual means. Because of the long sampling period of diffusion tubes, it is only possible to compare the results from this study against limits relating to the annual mean.

The WHO non-mandatory guideline[9] for NO_2 is that the annual mean should not exceed 40 $\mu g\ m^{-3}$. The EC 1st Daughter Directive[10] contains Limit Values for NO_2 as follows:

- 200 $\mu g\ m^{-3}$ as an hourly mean, not to be exceeded more than 18 times per calendar year. To be achieved by 1 January 2010.
- 40 $\mu g\ m^{-3}$ as an annual mean, for protection of human health. To be achieved by 1 January 2010.
- There is also a limit for annual mean total oxides of nitrogen (NO_x), of 30 $\mu g\ m^{-3}$, for protection of vegetation (relevant in rural areas).

The UK Air Quality Strategy contains Objectives for NO_2, which are very similar to the EC Daughter Directive limits above: the only differences being the more stringent dates by which they must be attained (31 December 2005).

Annual mean NO_2 at three sites (all of which were kerbside) exceeded 40$\mu g\ m^{-3}$; these were Weighbridge, Broad Street and La Pouquelaye.

Harwell Scientifics' NO_2 diffusion tubes typically overestimate NO_2 concentration. Harwell Scientifics have quantified this overestimation, by participation in ongoing co-location studies, and provided a bias adjustment factor of 0.75, to be applied to the annual mean NO_2 concentration. Applying this factor reduces the annual means at all sites to below the AQS Objective of 40$\mu g\ m^{-3}$. The highest annual mean (at Broad Street) is reduced from 44.2 $\mu g\ m^{-3}$ (unadjusted) to 33.1$\mu g\ m^{-3}$ (adjusted). However, given the uncertainty on diffusion tube measurements, this site may still be "borderline" with respect to the Limit Value and AQS Objective for annual mean NO_2. Application of the bias adjustment factor reduced the annual mean NO_2 concentrations at the 12 background sites to well below 40 $\mu g\ m^{-3}$.

The 30μg m^{-3} limit for protection of vegetation is only applicable at the one rural background site, Rue des Raisies; the annual mean NO_2 concentration at this site was well within the limit.

Table 3. NO_2 Diffusion Tube Results 2004, Jersey. Concentrations in $\mu g\ m^{-3}$.

Site **From - To:**	31 Dec - 5 Feb	5 Feb - 3 Mar	3 Mar - 1 Apr	1 Apr - 30 Apr	30 Apr – 6 Jun	6 Jun - 2 Jul	2 Jul - 31 Jul	31 Jul - 9 Sep	9 Sep - 1 Oct	1 Oct - 5 Nov	5 Nov - 3 Dec	3 Dec - 30 Dec	2004 Annual Mean	*Bias corr. AM 2004*
First Tower (K)	36.6	30.5	41.9	41	25.6	29.7	32.9	27.1	31.3	37.8	44.8	29	34.0	25.5
Weighbridge (K)	42.9	32.4	39.5	44.7	44.4	37.2	44.4	50.1	51.4	44.5	52.1	44.7	**44.0**	33.0
Georgetown (K)	34.3	44.8	45.8	37.8	42.2	25.7	20.9	24	42.3	40.4	54.1	43.7	38.0	28.5
Beaumont (K)	35.5	41.1	43.8	39.5	44.5	21.4	36.8	32.4	38.7	42.7	53.7	41.5	39.3	29.5
The Parade (K)	35.4	32.7	41.3	34.1	32.5	31	26.1	31.4	34.6	33.4	44	32.6	34.1	25.6
Broad Street (K)	38.7	37.2	36.7	37.7	41.4	120.2	36.4	30.7	34.9	34.6	45.2	36.1	**44.2**	33.1
La Pouquelaye (K)	No data	46	48.4	37.8	31.5	33.5	31.8	34.7	41.9	44.5	51.5	39.6	**40.1**	30.1
Camera Shop, Coulomberie (R)	30.7	30	34	24.3	30.6	21	29.1	17.5	31.1	36.7	37	32.6	29.6	22.2
Taxi Rank, Coulomberie (R)	40.5	33.5	45.1	35.9	36.5	28.6	27.3	30.7	38.2	41.1	38.3	39.4	36.3	27.2
Le Bas Centre (UB)	29.1	24.8	28	27.6	29.3	16.1	23.6	19.9	26.1	28.4	36.4	29.6	26.6	19.9
L'Avenue et Dolmen (UB)	24.9	20.8	24.6	20.3	20.5	13.1	10.6	10.7	19.7	22.9	30.1	30.8	20.8	15.6
Robin Place (UB)	31.7	29.7	31.4	28.2	23.6	19.1	18	19.7	24	28.3	32.4	28.3	26.2	19.7
Jane Sandeman (UB)	18.6	19.3	18.7	13	14.6	9.2	13.1	8.6	13.4	15.7	22	20.7	15.6	11.7
Saville Street (UB)	18.1	35.8	32.8	27.4	21.7	17.8	19.7	14.9	26.1	27.1	37.1	30.1	25.7	19.3
Beresford Street (UB)	20.8	31.4	37.7	35.8	33.1	23.2	23.5	32.2	33	No data	43.3	37.8	32.0	24.0
Mont Felard (Res B)	21.5	27	24.5	27.6	28.7	19.2	21.7	19.3	24.1	27.3	36.4	28.5	25.5	19.1
Les Quennevais (Res B)	12.5	18	14.8	12.4	10.8	6.1	6.8	6.8	7.4	13	14.2	15.6	11.5	8.7
Langley Park (UB)	20	14.4	19.3	15.4	15.9	11.6	8.5	8.1	13.6	17.7	22.6	22	15.8	11.8
Clos St.Andre (Res B)	16.1	18.9	16.7	13	15	9.7	9.1	7.2	12.1	No data	19.9	18.8	14.2	10.7
Maufant (Res B)	8.8	12.6	9.8	8.7	10.5	7.5	7	4.9	7.2	8.5	13	11.6	9.2	6.9
Rue Des Raisies (Rur B)	6.3	6.6	7.8	5.3	7.6	4.3	5.4	2.9	5.2	5.3	10.4	10.3	6.5	4.8

K = Kerbside, R = Roadside, UB = Urban Background, Res B = Residential Background, Rur B = Rural Background.

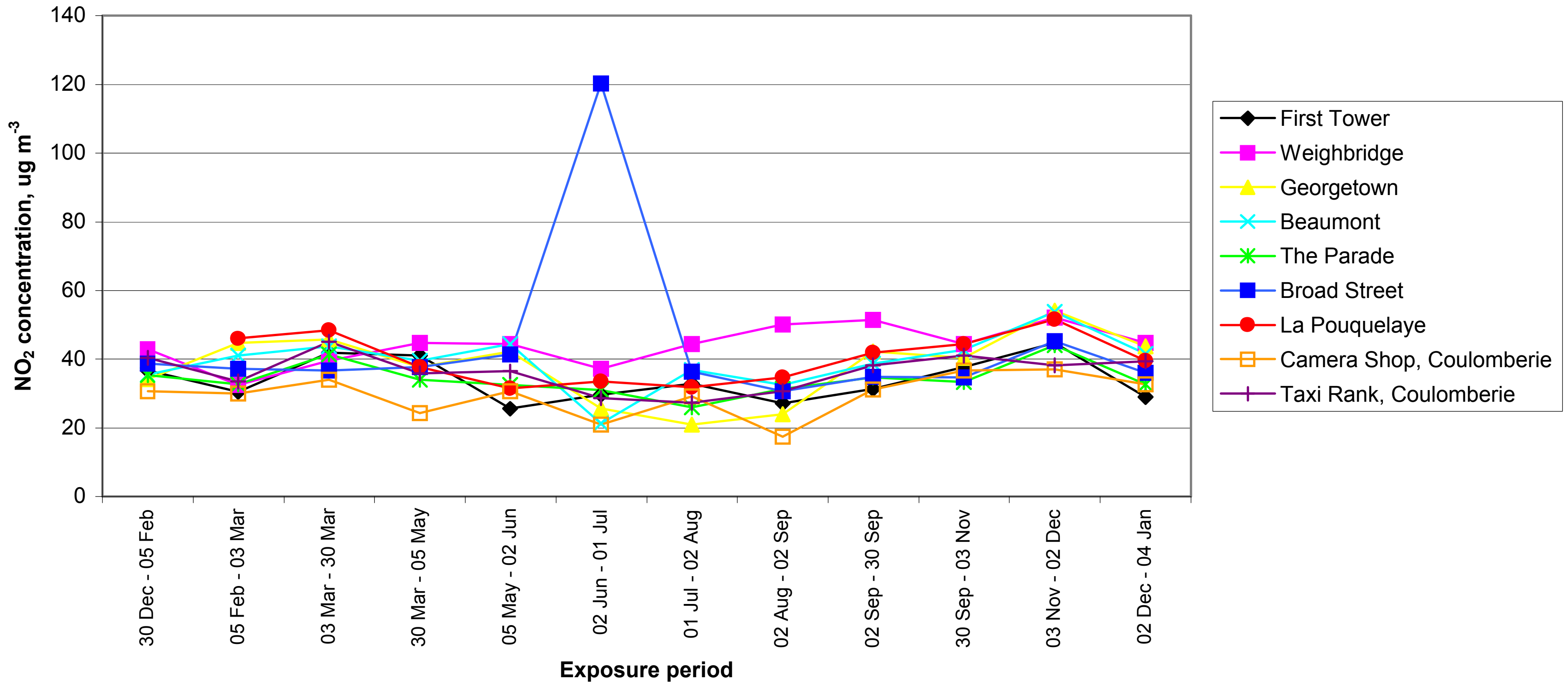


Figure 2. Monthly Mean Nitrogen Dioxide Concentrations at Roadside and Kerbside Sites, 2004

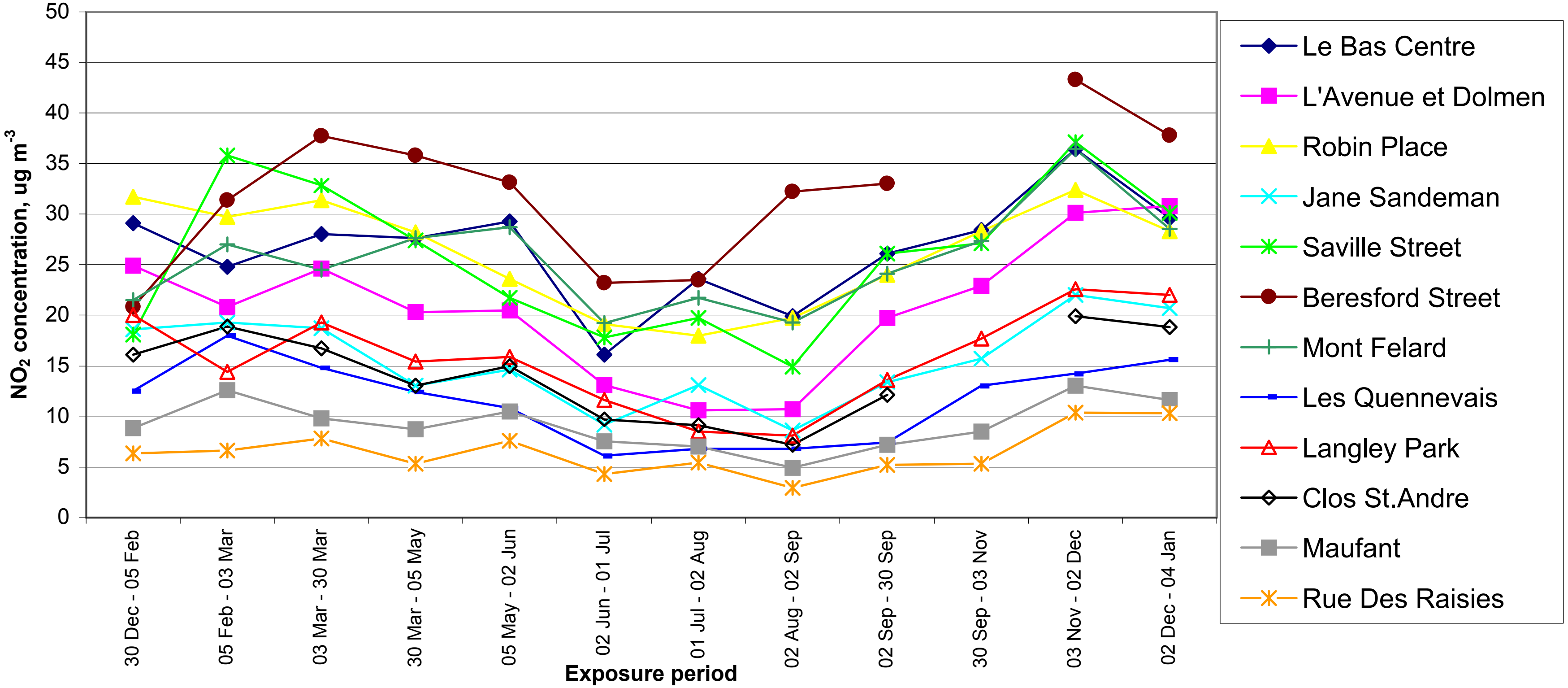


Figure 3. Monthly Nitrogen Dioxide Concentrations at Background Sites, 2004

Figure 3 clearly shows the unusually high monthly mean of 120 $\mu g\ m^{-3}$ measured at Broad Street in June. It may be that this result is due to a contaminated or damaged tube: however, no such anomaly was recorded. In the absence of any evidence that the result is spurious, it has been accepted.

3.1.3 Comparison with UK NO_2 data

The UK Nitrogen Dioxide Survey monitored this pollutant at around 1200 sites across the UK during 2004, using diffusion tubes. This survey concentrates on urban, not rural, areas. Sites are categorised as;

- Roadside, 1-5m from the kerb of a busy road
- Urban background, more than 50m from any busy road and typically in a residential area.

The UK Network annual means for 2004 (which are provisional at present, pending full data ratification) were 38 $\mu g\ m^{-3}$ for roadside sites and 21 $\mu g\ m^{-3}$ for urban background sites (unadjusted for bias). The unadjusted 2004 annual means for the Jersey survey were comparable: 38 $\mu g\ m^{-3}$ for kerbside and roadside sites combined, and 20$\mu g\ m^{-3}$ for urban and residential background sites combined.

Table 4 shows annual mean NO_2 concentrations measured at a selection of UK air quality monitoring stations using automatic (chemiluminescent) NO_2 analysers. The automatic data have been fully ratified. The sites used for comparison are as follows:

- Exeter Roadside – a roadside site in the centre of Exeter, Devon.
- Plymouth Centre - an urban non-roadside site, in the centre of a coastal city.
- Lullington Heath - a rural site on the South Coast of England near the town of Eastbourne.
- Harwell - a rural site in the south of England, within 10km of a power station.

Table 4 - Comparison of NO_2 in Jersey with UK Automatic Sites

Site	2004 Annual average NO_2, $\mu g\ m^{-3}$
Exeter Roadside	40
Plymouth Centre	27
Lullington Heath	10
Harwell	12

The bias adjusted annual mean NO_2 concentrations measured at the kerbside and roadside sites in Jersey ranged from 22 to 33$\mu g\ m^{-3}$. The annual mean at Exeter Roadside was therefore considerably higher than these. The Jersey urban background sites had annual mean NO_2 concentrations ranging from less than 10 $\mu g\ m^{-3}$ to 24 $\mu g\ m^{-3}$; typically lower than sites such as Plymouth Centre. Residential background sites well outside Jersey's larger towns (e.g. Les Quennevais, Clos St Andre, Maufant) had annual mean NO_2 ranging from 7 $\mu g\ m^{-3}$ to 23 $\mu g\ m^{-3}$, and thus were more comparable with rural sites such as Lullington Heath and Harwell. The annual mean of 6.5 $\mu g\ m^{-3}$ at the Jersey rural background site, Rue des Raisies, was considerably lower than that measured at either Harwell or Lullington Heath.

3.1.4 Comparison with Previous Years' Nitrogen Dioxide Results

It is generally considered that at least five years' data are required to assess long-term trends in air quality. Previous reports have therefore reported trends only for three long-running sites, which have been in operation since 1993, as part of the UK Nitrogen

Dioxide Network. Most of the other sites in this survey began operation in 2000, so 2004 was their fifth year of operation. It is therefore now possible to include the whole network in our assessment of trends. Annual mean concentrations for the three long-running sites are shown in Table 5 and Figure 4. Also included are overall means for the other sites in the kerbside and roadside, urban background and residential background categories. ***These data are not adjusted for diffusion tube bias; prior to 2002 there was no reliable information on which to carry out bias adjustment, so for consistency, uncorrected data are used in this section.***

NO_2 concentrations in the UK as a whole, as measured by the NO_2 diffusion tube network, have shown a small but statistically significant downward trend since the mid 1990s. The Jersey sites do not show any clear downward trend, although in the case of the Maufant site it does appear that NO_2 concentrations are lower than they were in the early 1990s.

The fact that there is no clear downward trend means that, where exceedences of AQS objectives and EC limit values are currently occurring, this is likely to continue in future years.

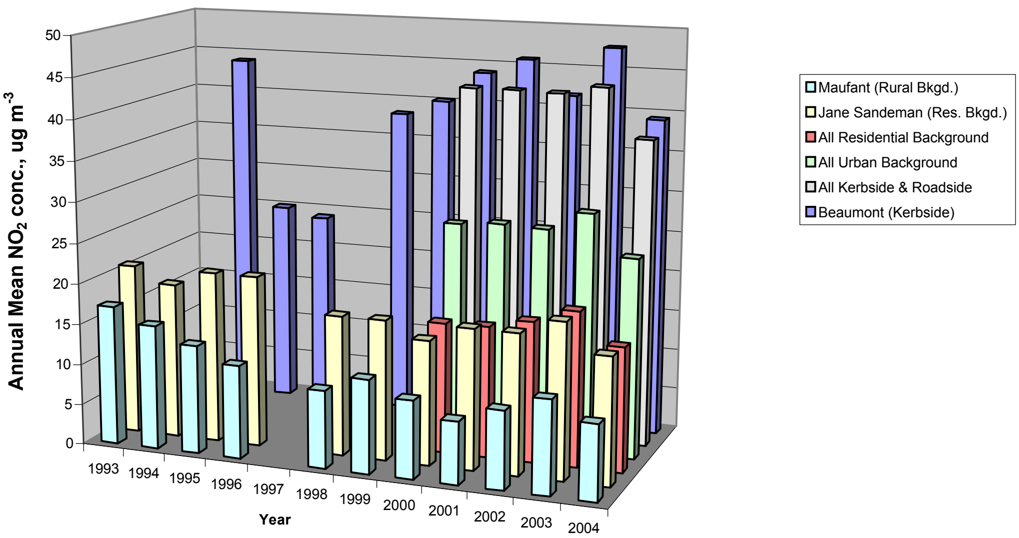


Figure 4. Trends in Annual Mean NO_2 Concentrations (not corrected for diffusion tube bias).

Table 5 Annual mean NO_2 concentrations, μg m^{-3} (not bias adjusted)

Site	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Beaumont (Kerbside)		44	25	24		38	40	44	46	42	48	39
Jane Sandeman (Res. Bkgd.)	21	19	21	21		17	17	15	17	17	19	16
Maufant (Rural Bkgd.)	17	15	13	11		10	11	10	8	10	11	9
All Kerbside & Roadside								43	43	43	44	38
All Urban Background								27	27	27	30	25
All Residential Background								16	16	17	19	15

3.2 HYDROCARBONS

3.2.1 Summary of Hydrocarbon Results

Results of the hydrocarbon survey for the six sites are shown in Appendix 2, Tables A2.1 to A2.6 respectively. Graphical representations are shown in Figures 5 to 10.

A summary of annual average hydrocarbon concentrations is shown in Table 6. Some measurements were below the detection limit. By convention, when calculating annual averages and plotting graphs, such results are assumed to be half the detection limit.

Table 6. Summary of Average Hydrocarbon Concentrations, Jersey, 2004

Site	Benzene, $\mu g\ m^{-3}$	Toluene, $\mu g\ m^{-3}$	Ethyl Benzene, $\mu g\ m^{-3}$	m+p Xylene, $\mu g\ m^{-3}$	o Xylene, $\mu g\ m^{-3}$
Beresford Street	1.9	9.8	5.1	5.5	2.0
Le Bas Centre	1.3	6.6	3.3	3.9	1.4
Handsford Lane *(paint spraying)*	1.0	16.1	7.3	8.5	2.0
Springfield Garage *(petrol station)*	4.7	30.9	13.5	14.5	5.2
Clos St Andre	0.7	2.2	1.2	1.2	0.4
Airport	0.6	1.1	0.8	0.6	0.2

The following sites did not achieve full data capture:
(i) Beresford Street: no data for October 2004, due to a failure of laboratory's analytical instrumentation which affected processing of tubes from some, though not all, the sites.
(ii) Springfield Garage: no data for October 2004, due to the failure of laboratory's instrumentation.
(iii) Clos St Andre: no data for September 2004 due to a contaminated tube, or October 2004, due to the failure of the laboratory's instrumentation.
(iv) Handsford Lane: the March tube went missing from the site. No data for September, as the tube cap was left on by the site operator, or October, due to the failure of the laboratory's analytical instrumentation.

Figures 5 – 10 show that highest concentrations of several hydrocarbon species, particularly ethylbenzene at Beresford Street, Le Bas, Springfield Garage and the Airport were measured during the period June to August 2004.
DO WE KNOW ANY REASON WHY THIS MIGHT BE???? TOURIST TRAFFIC???

Springfield Garage measured the highest annual mean concentrations of all five BTEX compounds in 2004. Hansford Lane (near the paint spraying process) also measured higher levels of toluene, ethylbenzene and m+p xylene compared with the other sites.

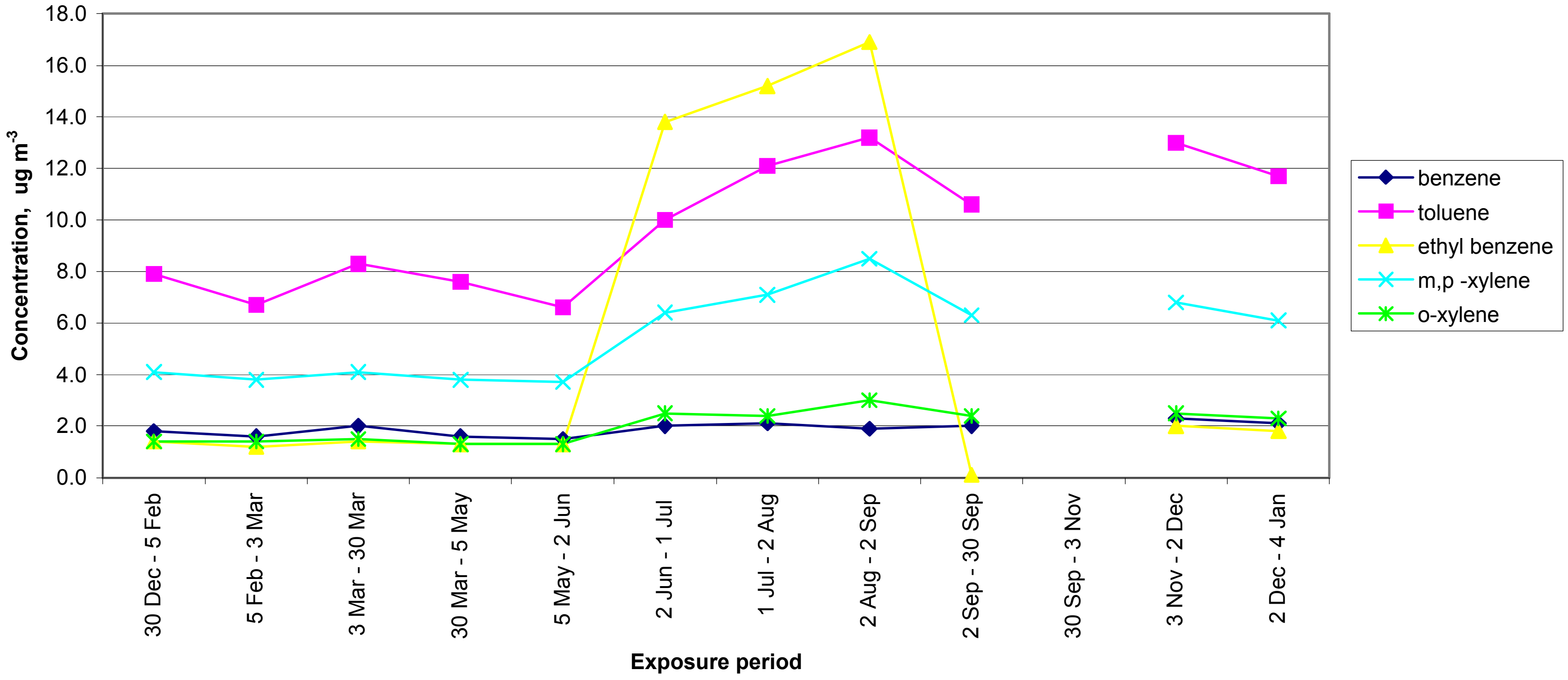


Figure 5. Monthly mean hydrocarbon concentrations at Beresford Street, 2004

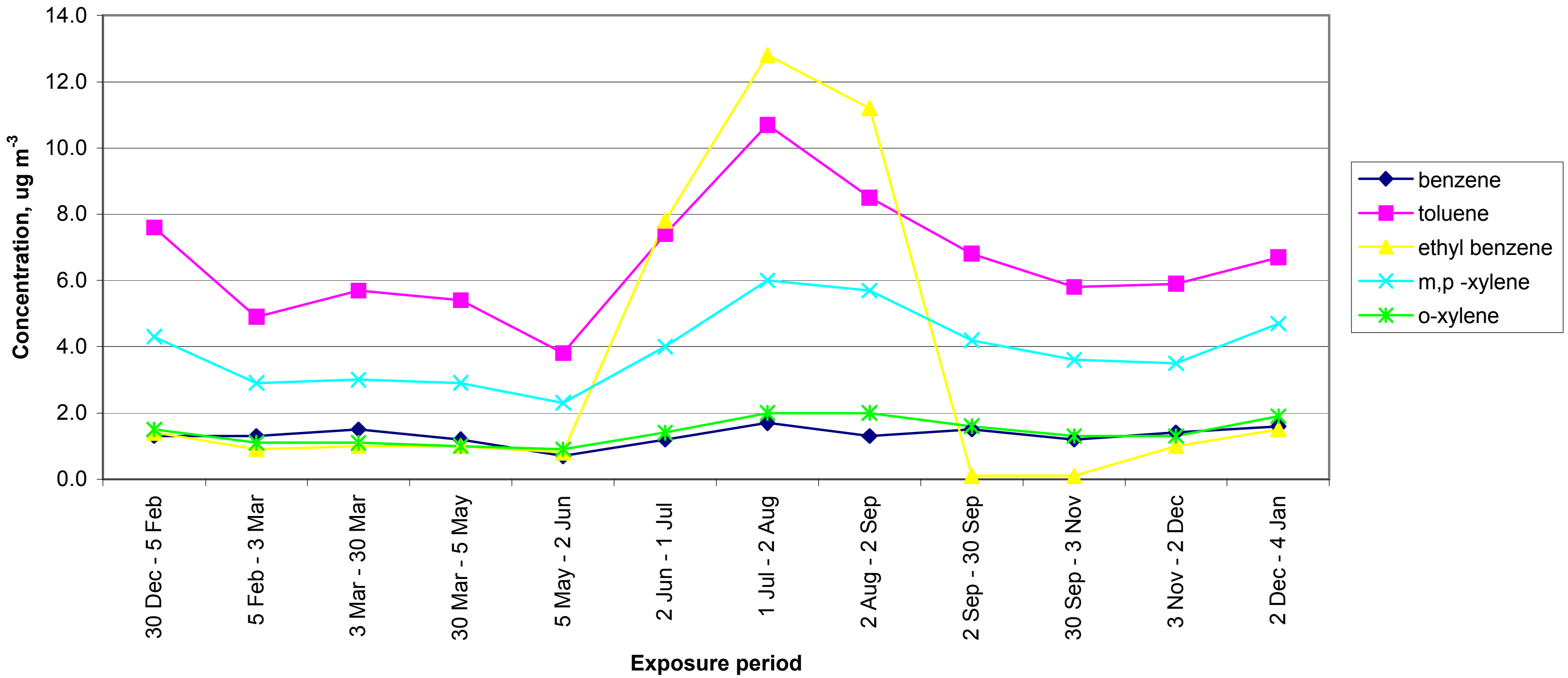


Figure 6. Monthly mean hydrocarbon concentrations at Le Bas Centre, 2004

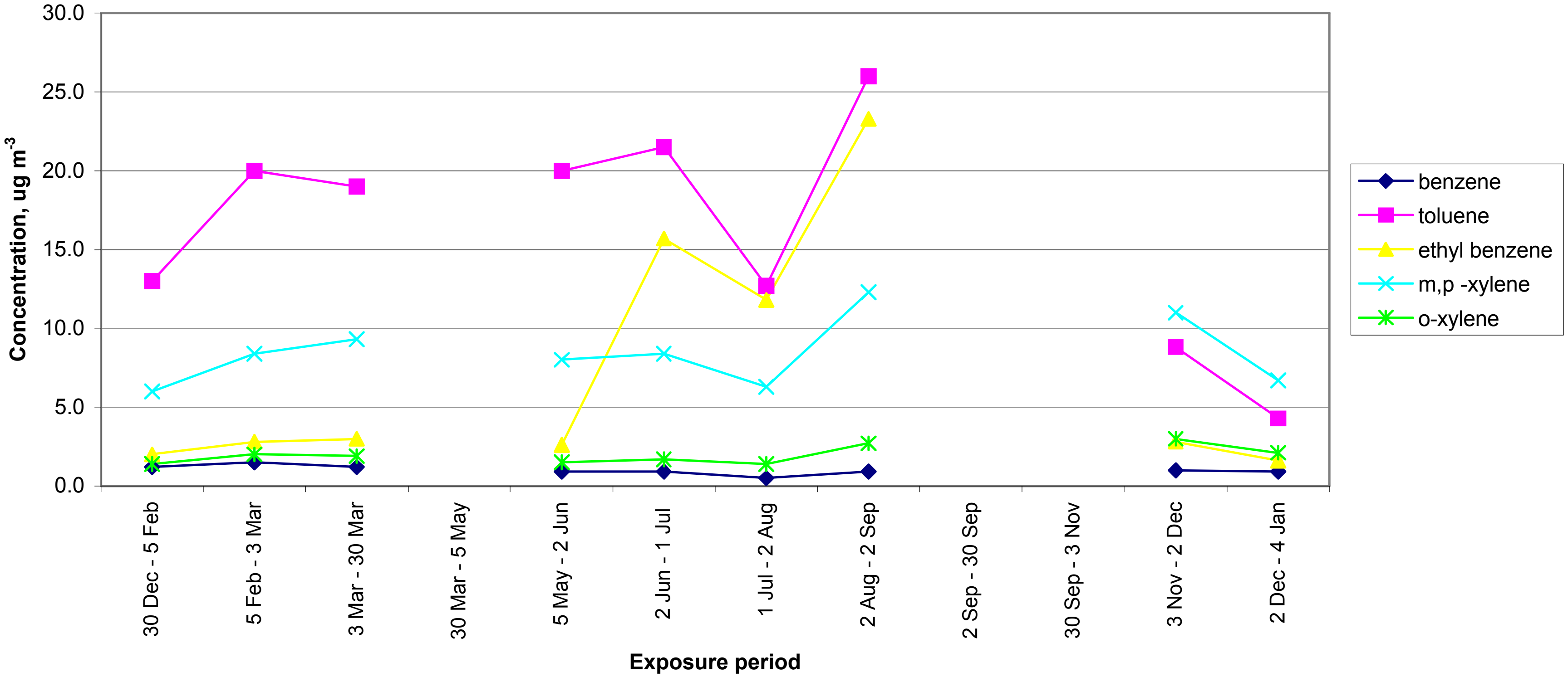


Figure 7. Monthly mean hydrocarbon concentrations at Handsford Lane, 2004

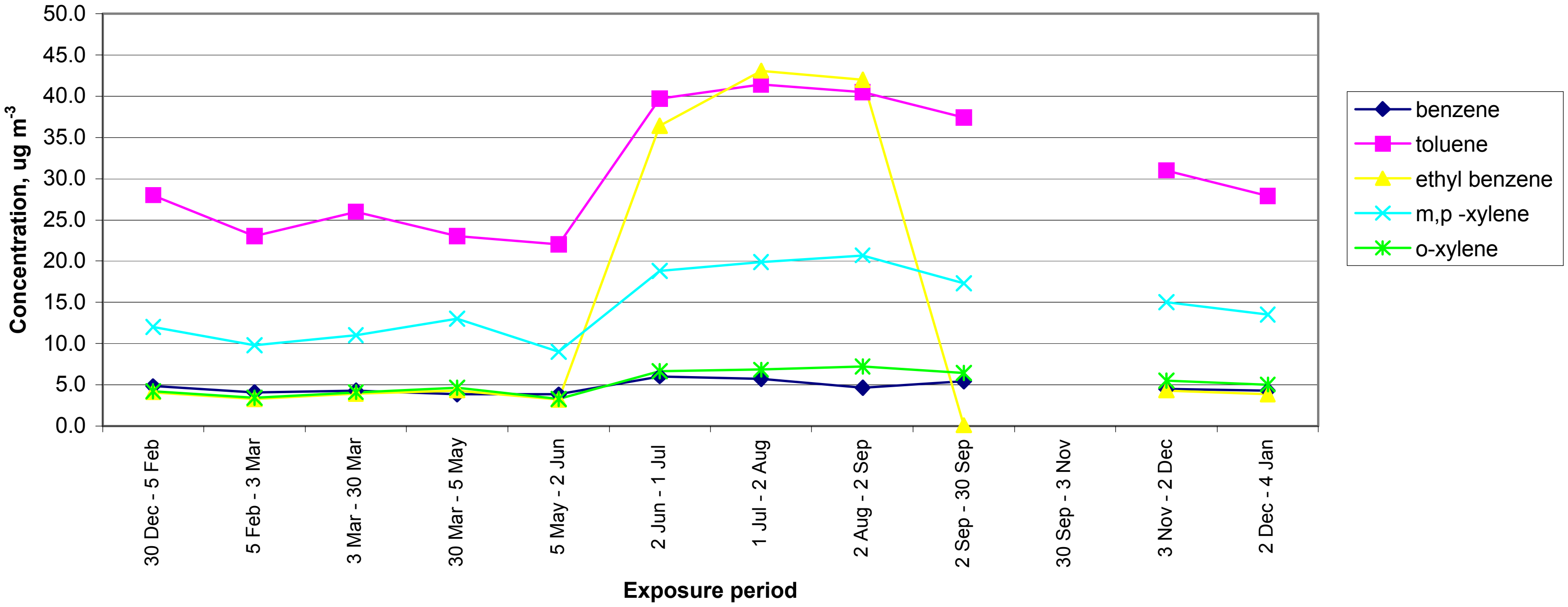


Figure 8. Monthly mean hydrocarbon concentrations at Springfield Garage, 2004

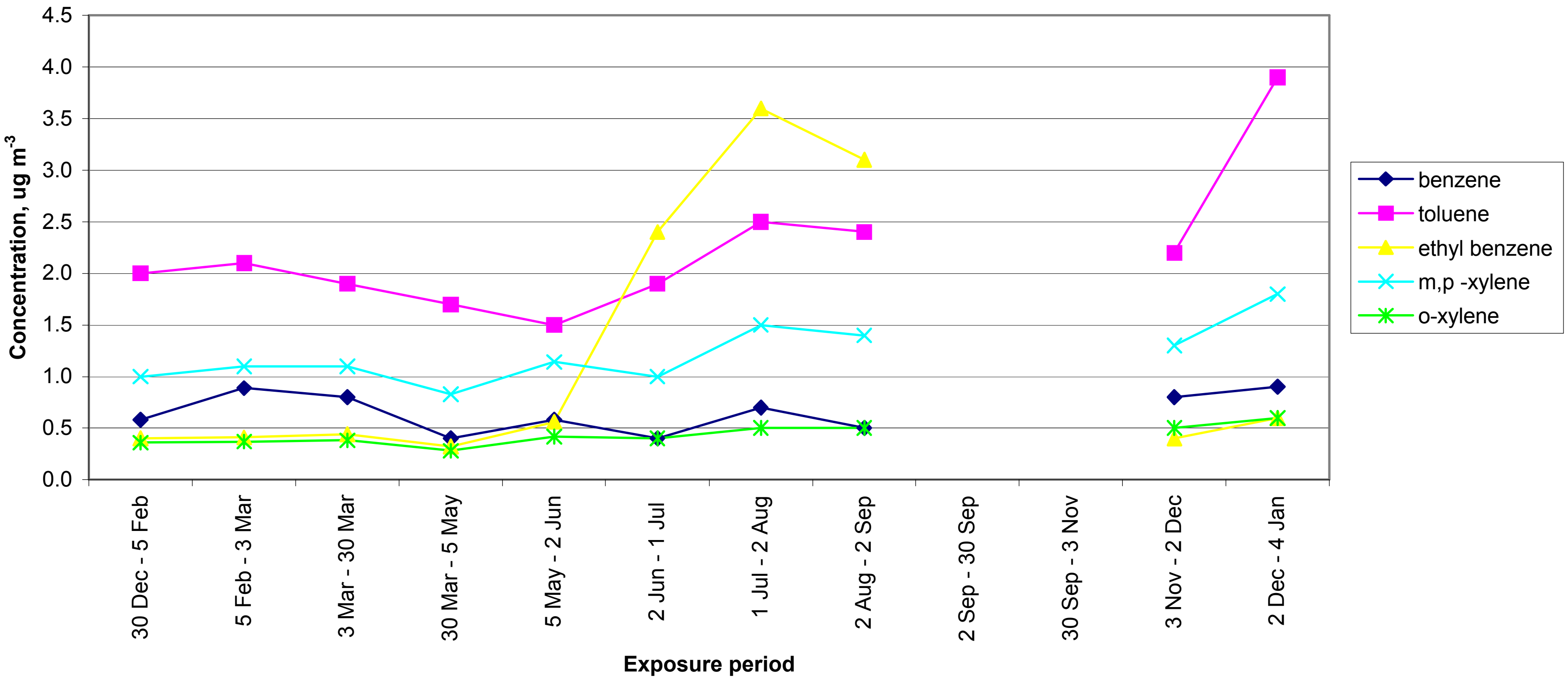


Figure 9. Monthly mean hydrocarbon concentrations at Clos St Andre, 2004

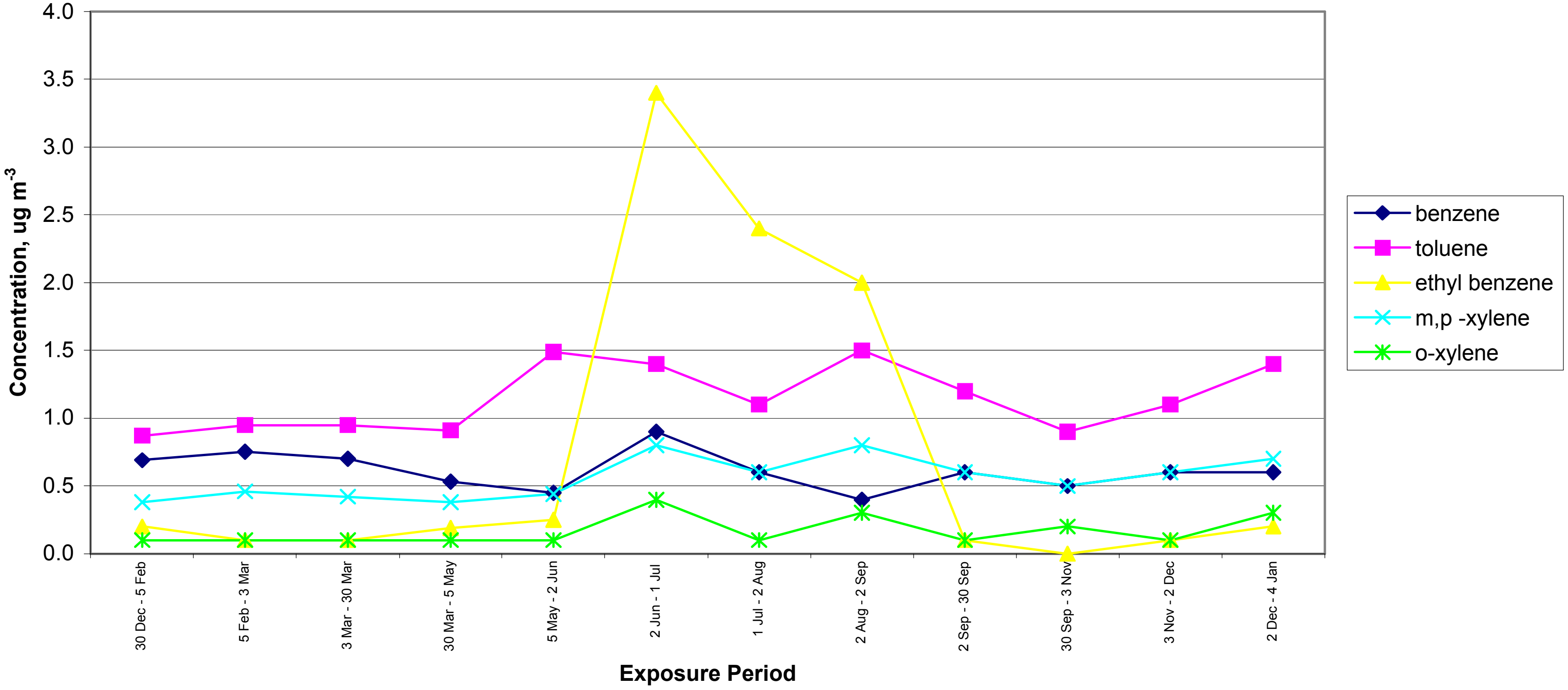


Figure 10. Monthly mean hydrocarbon concentrations at the Airport, 2004

3.2.2 Comparison with Hydrocarbon Guidelines, Limit Values and Objectives

Of the hydrocarbon species monitored, only benzene is the subject of any applicable air quality standards. The UK Air Quality Strategy sets the following objectives for benzene:

- 16.25μg m^{-3} (for the running annual mean), to be achieved by 31 December 2003
- 3.25 μg m^{-3} (for the calendar year mean), to be achieved by 31 December 2010.

These are applicable to the whole UK (though not at present mandatory in Jersey). The annual mean benzene concentration (which can be considered a good indicator of the running annual mean) did not exceed 16.25μg m^{-3} at any of the Jersey sites. The calendar year mean was less than the 2010 objective of and 3.25 μg m^{-3}, at all sites except Springfield Garage.

The EC 2nd Daughter Directive[10] sets a limit of 5μg m^{-3} for annual mean benzene, to be achieved by 2010. All sites met this limit, although the annual mean benzene concentration at Springfield Garage (4.7 μg m^{-3}) was very close to the limit.

3.2.3 Comparison with UK Data

Table 7 compares hydrocarbon data from the 2004 Jersey survey with a selection of automatic UK air quality monitoring stations, which measure hydrocarbons using pumped tube samplers. The sites used for comparison are:

- London Marylebone Road - an urban kerbside site, located on a major route into Central London. Heavy traffic, and surrounded by tall buildings.
- Cardiff East - a residential site to the east of the city.
- Glasgow Kerbside – a city centre kerbside site.
- Harwell - a rural site in the south of England, within 10km of a power station.

Benzene was also measured using pumped-tube samplers at a larger network of 36 UK sites in 2004. Annual mean concentrations ranged from 0.81 μg m^{-3} (at the coastal town of Bournemouth) to 3.25 μg m^{-3} (at Yarm near Stockton-on-Tees), but were typically in the range of 1-2 μg m^{-3} at most urban sites, and 2-3 μg m^{-3} at city centre roadside sites.

Table 7. Comparison with Hydrocarbon Concentrations at Other UK Sites, Calendar Year 2004 (With data capture in brackets).

Site	Benzene, μg m^{-3}	Toluene, μg m^{-3}
Jersey Sites		
Beresford Street	1.9	9.8
Le Bas Centre	1.3	6.6
Handsford Lane *(paint spraying)*	1.0	16.1
Springfield Garage *(petrol station)*	4.7	30.9
Clos St Andre	0.7	2.2
Airport	0.6	1.1
Mainland UK sites		
Cardiff Centre	0.8 (91%)	3.4 (95%)
Glasgow Kerbside	1.4 (82%)	4.5 (78%)
Harwell	0.4 (75%)	0.8 (69%)
London Marylebone Road	2.8 (85%)	11.8 (92%)

The annual mean benzene concentration was measured at Springfield Garage (where fuels are stored) was higher than any of the other Jersey or UK Network sites, including London Marylebone Road (which is beside a very busy city road). Lower concentrations were measured at the urban background sites on Jersey; benzene levels at these sites appear comparable with those at the other two automatic sites in Cardiff and Glasgow, and the UK pumped-tube sites. Benzene levels at Clos St Andre and the Airport remain lower than typical UK urban levels, and comparable with the mean from the rural Harwell site. Benzene concentrations at Handsford Lane were no higher than those at Beresford Street or Le Bas; the nearby paint spraying process is not a significant source of benzene.

The highest annual mean toluene concentration of 30 $\mu g\ m^{-3}$ was measured at the Springfield Garage. The second highest site was Handsford Lane; toluene concentrations here were higher than any other Jersey, or mainland UK sites.

3.2.4 Comparison with Previous Years' Hydrocarbon Results

Table 8 shows annual mean hydrocarbon concentrations for these sites, for years 1997 – 2004. Figures 12 to 16 illustrate how annual mean concentrations of these hydrocarbons have changed over the years of monitoring.

Most sites have shown reductions in 2004 compared with 2003: however, ethylbenzene increased at all sites (possibly due to the particularly high concentrations measured during June to August).

At Springfield Garage, the fuel supplier has used vapour recovery when filling the tanks since the end of 2003; it was thought that there might be a reduction in hydrocarbon concentrations at Springfield Garage as a result. Indeed, there has been a small reduction in concentrations of four of the five BTEX compounds, but it is not known whether this can be attributed to the vapour recovery. More noticeable is the particularly large increase in the annual mean ethylbenzene concentration at this site, resulting largely from the particularly high concentrations measured during June to August. The reason for this is not known.

Table 8. Comparison of Hydrocarbon Concentrations, Jersey, 1997 - 2004.

	Benzene, µg m^{-3}	Toluene, µg m^{-3}	Ethyl Benzene, µg m^{-3}	m+p Xylene, µg m^{-3}	o Xylene, µg m^{-3}
Beresford Street					
1997	10.4	20.7	5.3	5.3	11.9
1998	8.1	18.8	4.0	4.4	10.2
1999	5.9	13.8	2.7	7.5	3.5
2000	2.9	14.2	3.5	10.2	4.0
2001	3.3	14.9	3.5	9.7	3.5
2002	2.6	13.0	2.7	8.0	3.1
2003	2.0	11.5	2.2	6.6	2.2
2004	1.9	9.8	5.1	5.5	2.0
Le Bas Centre					
1997	9.1	17.2	5.3	4.4	9.7
1998	7.5	16.1	3.1	4.0	8.4
1999	3.6	11.1	2.2	5.7	2.7
2000	2.9	12.6	3.1	8.4	3.1
2001	2.6	13.4	2.7	7.5	3.1
2002	2.0	8.0	1.8	5.7	2.2
2003	1.3	8.0	1.8	4.9	1.8
2004	1.3	6.6	3.3	3.9	1.4
Elizabeth Lane					
1997	6.2	16.9	6.2	7.5	9.7
1998	6.2	19.2	3.1	7.1	3.5
1999	3.3	12.6	2.2	5.3	2.7
2000	2.3	12.6	3.1	8.0	2.7
2001	2.3	15.7	3.1	8.8	3.5
2002	1.6	11.1	2.2	6.2	1.8
2003	2.0	11.9	2.2	6.2	2.2
Springfield Garage					
1997	25.0	47.9	8.4	8.4	19.0
1998	25.0	47.1	6.6	7.5	19.0
1999	14.6	41.7	5.7	16.8	6.6
2000	5.2	35.2	8.0	22.1	8.8
2001	6.8	42.9	8.0	23.0	8.4
2002	5.5	36.8	6.2	19.0	7.1
2003	4.9	34.1	5.7	15.9	5.7
2004	4.7	30.9	13.5	14.5	5.2
Clos St Andre					
2000	1.0	3.4	0.9	2.7	0.9
2001	1.3	4.6	1.3	2.7	1.3
2002	1.0	2.7	0.9	2.2	0.9
2003	1.0	4.2	0.9	1.8	0.4
2004	0.7	2.2	1.2	1.2	0.4
Airport					
2002	1.0	2.7	0.9	2.2	0.9
2003	1.0	3.1	0.4	0.9	0.4
2004	0.6	1.1	1.1	0.6	0.3
Handsford Lane					
2004	1.0	16.1	7.3	8.5	2.0

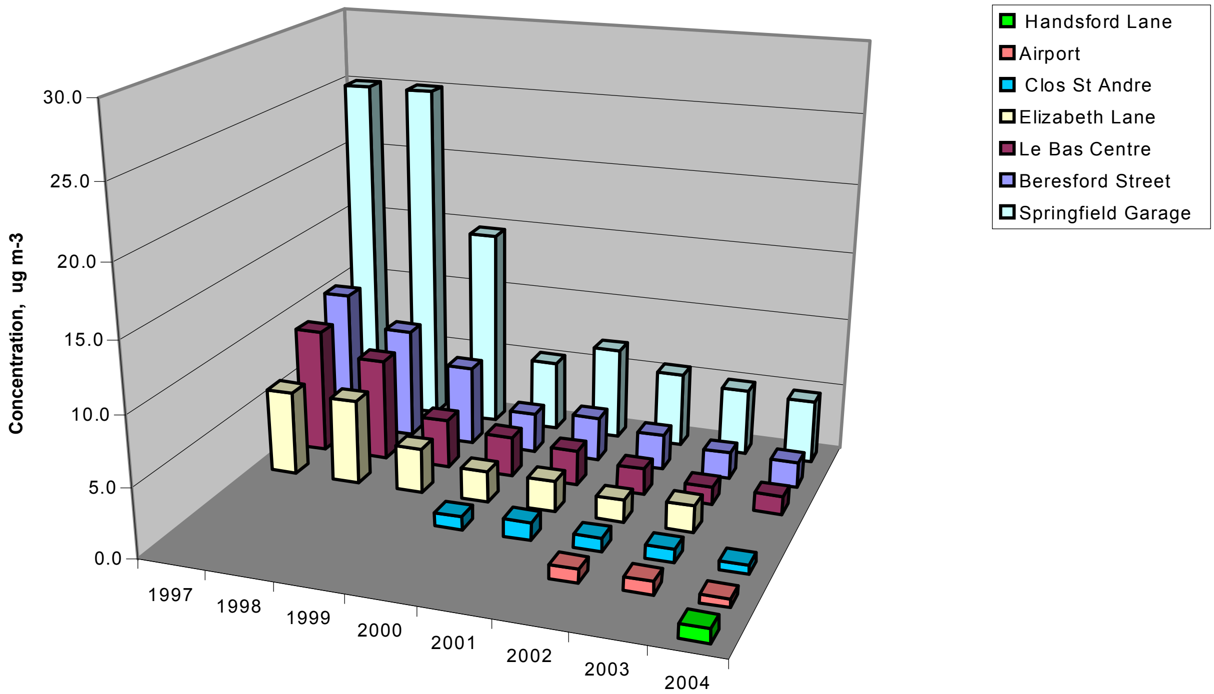


Figure 12. Trends in Benzene Concentration

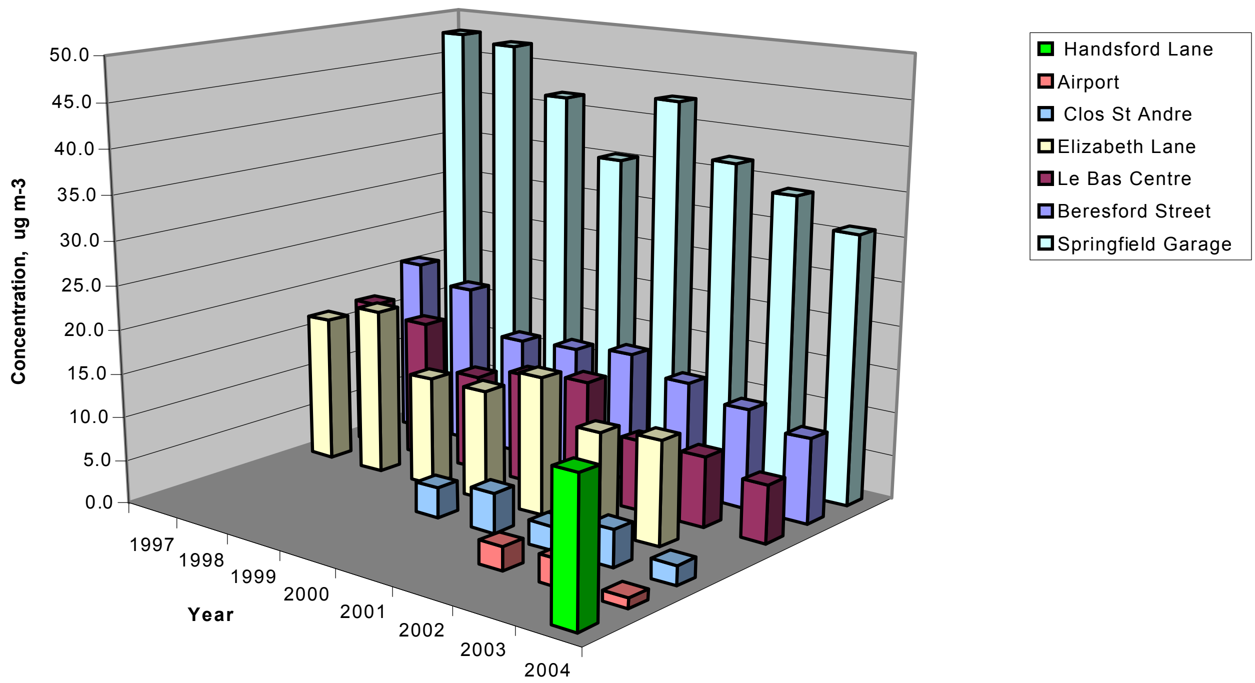


Figure 13. Trends in Toluene Concentration

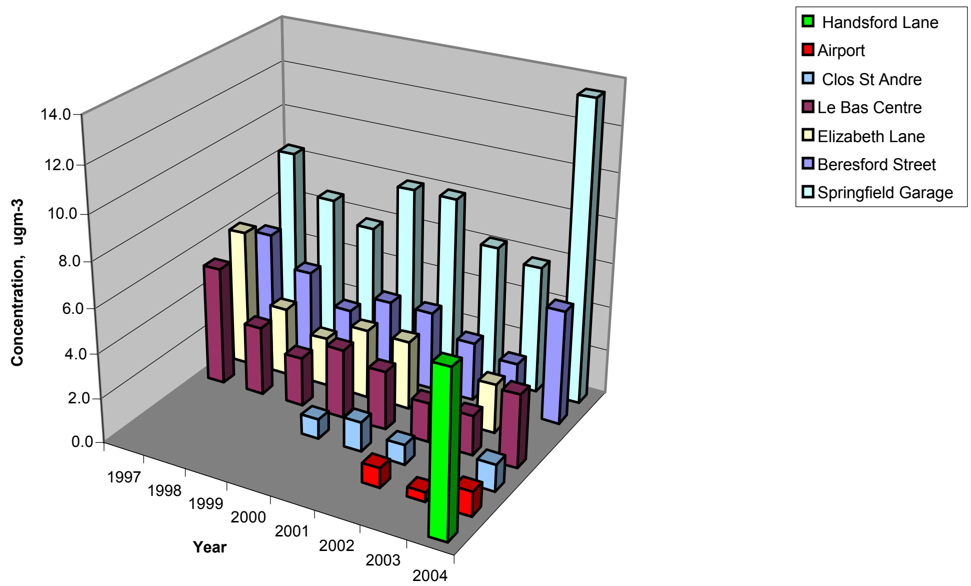


Figure 14. Trends in Ethylbenzene Concentration

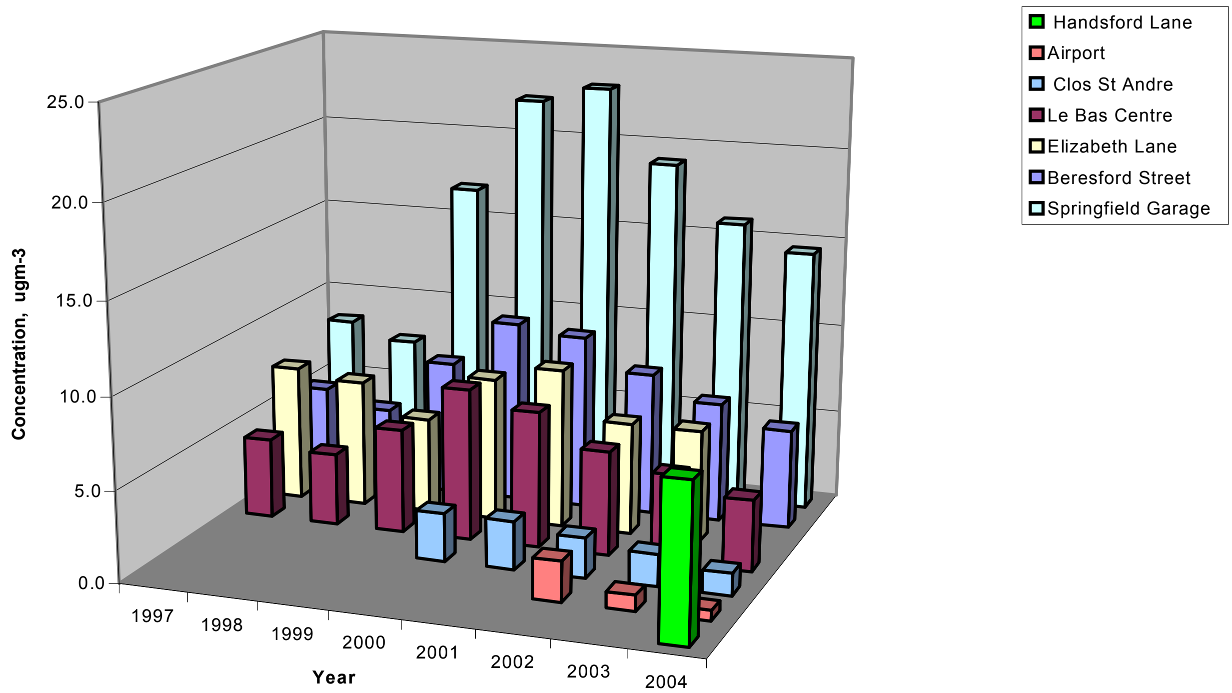


Figure 15. Trends in m+p- Xylene Concentration

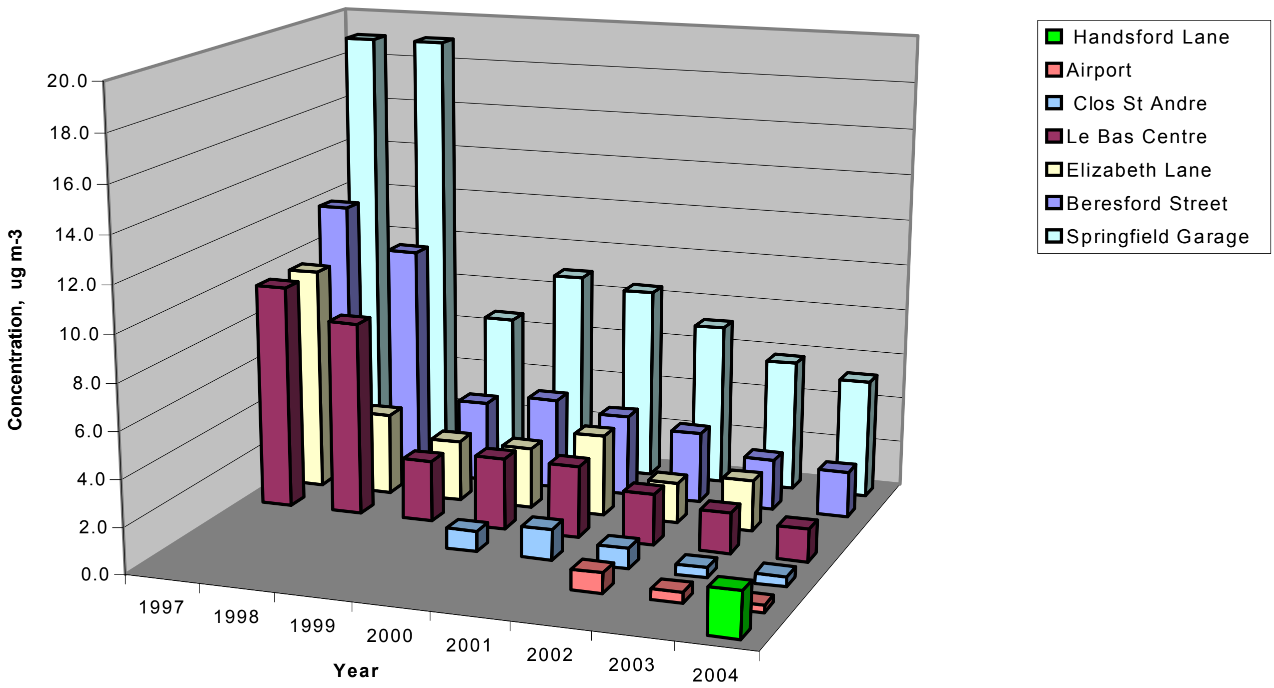


Figure 16. Trends in o-Xylene Concentration

Most hydrocarbon species appear to have decreased over the six years of monitoring, being in most cases lower now than in the late 1990s.

- Benzene showed a marked drop in 2000: this is due to the maximum permitted benzene content of petrol sold in the UK being reduced from 2% in unleaded (5% in super unleaded), to 1% as of 1st January 2000. Concentrations have continued to fall slightly year on year.
- Toluene concentrations show a small downward trend.
- Ethylbenzene concentrations do not show a clear trend, and increased in 2004 at most sites, in particular Springfield Garage.
- Concentrations of m+p xylene increased during the early years of the survey; however, since 2001, concentrations of this pollutant have decreased.
- O xylene levels have also decreased.

4 Conclusions

- Netcen has undertaken a year-long diffusion tube monitoring study in Jersey during 2004, on behalf of the States of Jersey Public Health Services and Planning and Environment Department. This was the seventh consecutive year of monitoring.
- Diffusion tubes were used to monitor NO_2 at 21 sites.
- Hydrocarbons (benzene, toluene, ethyl benzene and xylenes, collectively termed BTEX) were measured at 6 sites.
- The sites were located at a range of different locations on the island, and in many cases have been used for several years.

NO_2 results

- Annual mean (uncorrected) NO_2 concentrations at three kerbside sites (Weighbridge, Broad Street and La Pouquelaye, and the Taxi Rank in La Colomberie) were above the EC Directive Limit Value and AQS Objective of 40μg m^{-3}.
- Applying the analytical laboratory's recommended correction factor for diffusion tube bias to these annual mean results reduces all of them to below 40μg m^{-3}. However, given the uncertainty inherent in diffusion tube measurements, together with the apparent lack of any downward trend in NO_2 on Jersey, it is possible that some kerbside and roadside sites will continue to be close to the limit value in future years.
- Annual mean NO_2 concentrations at all urban, residential and rural background sites were in most cases well below the EC Limit Value.
- Annual mean NO_2 concentrations at the 21 monitoring sites were typically lower than those measured in 2003: this is consistent with the rest of the UK.
- Trends in NO_2 concentration were investigated at three long-running sites, which have operated since 1993 as part of the UK NO_2 Network. No distinct trends are apparent: NO_2 concentrations appear to have changed little from year to year.
- Most of the NO_2 sites have now been running for five years; on the basis of the average annual mean NO_2 concentrations for all ker bside and calculated for all kerbside and at
- One implication of the apparent stability of NO_2 concentrations, is that sites currently close to the Limit Value and AQS Objective of 40μg m^{-3} for annual mean NO_2 concentration may remain so, unless action is taken to reduce urban roadside NO_2 levels.

Hydrocarbon tube results

- No sites had annual mean benzene concentrations greater than the UK Air Quality Strategy Objective of 16.25 μg m^{-3}, which was to be achieved by the end of 2003.
- No sites had annual mean benzene concentrations greater than the EC 2nd Daughter Directive Limit Value of 5 μg m^{-3} (which is to be achieved by 2010).
- One site (Springfield Garage) had an annual mean benzene concentration greater than the UK Air Quality Strategy Objective of 3.25 μg m^{-3}, which is to be achieved by January 2010.
- Several sites showed elevated concentrations of ethylbenzene during the period June to August 2004. The reason for this is not known.
- Annual mean concentrations of BTEX hydrocarbons were mostly comparable with, or slightly lower than, those measured in 2003. The exception was ethylbenzene, which had increased at most sites, substantially so at Springfield Garage.
- Concentrations of most BTEX hydrocarbons are decreasing slightly year on year.

5 Recommendations

Results of the diffusion tube survey indicate that most background locations in Jersey are likely to meet the UK Air Quality Strategy Objective for the annual mean NO_2 concentration by the end of 2005. However, each year, some kerbside and roadside locations are identified as being above, or very close to, this objective. As there is no clear downward trend, it is possible that this will continue, and that there will be some exceedences. Measurements from diffusion tube surveys inevitably carry a high uncertainty, and are not sufficient on their own for determining compliance with Objectives and Directives. Previous years' reports have recommended that the States of Jersey consider using a mobile automatic analyser, to investigate such sites further: this recommendation still stands.

6 Acknowledgements

AEA Technology Environment gratefully acknowledges the help and support of the staff of the States of Jersey Environmental Health Services, Planning, Environment and Public Services, in the completion of this monitoring study.

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13. Part IV of the Environment Act 1995 Local Air Quality Management. Technical Guidance LAQM.TG(03).

Appendices

CONTENTS

Appendix 1
Air Quality Standards

Air Pollution Guidelines Used in this Report.

UK and International Ambient Air Quality Limit Values, Objectives and Guidelines

Nitrogen Dioxide

Guideline Set By	Description	Criteria Based On	Value(1) / μgm^{-3} (ppb)
The Air Quality Strategy(2)	Objective for Dec. 31st 2005, for protection of human health	1-hour mean	200 (105) Not to be exceeded more than 18 times per calendar year.
Set in regulations(3) for all UK:	Objective for Dec. 31st 2005, for protection of human health	Annual mean	40 (21)
Not intended to be set in regulations:	Objective for Dec. 31st 2000, for protection of vegetation.	Annual mean NO_x (NO_x as NO_2)	30 (16)
European Community 1985 NO_2 Directive (4) Limit remains in force until fully repealed 01/01/2010.	Limit Value	Calendar year of data: 98%ile of hourly means.	200 (105)
1st Daughter Directive(5)	Limit Value for protection of human health. To be achieved by Jan. 1st 2010	1 hour mean	200 (105) not to be exceeded more than 18 times per calendar year
	Limit Value for protection of human health. To be achieved by Jan. 1st 2010	Calendar year mean	40 (21)
	Limit Value (total NO_x) for protection of vegetation. To be achieved by Jul. 19th 2001	Calendar year mean	30 (16)
World Health Organisation(6) **(Non-Mandatory Guidelines)**	Health Guideline	1-hour mean	200
	Health Guideline	Annual mean	40

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

Benzene

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

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

Appendix 2
Hydrocarbon Results

Table A2.1 Monthly Hydrocarbon concentrations at Beresford Street ($\mu g\ m^{-3}$)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
30-Dec-03	1.8	7.9	1.4	4.1	1.4
5-Feb-04	1.6	6.7	1.2	3.8	1.4
3-Mar-04	2.0	8.3	1.4	4.1	1.5
30-Mar-04	1.6	7.6	1.3	3.8	1.3
5-May-04	1.5	6.6	1.3	3.7	1.3
2-Jun-04	2.0	10.0	13.8	6.4	2.5
1-Jul-04	2.1	12.1	15.2	7.1	2.4
2-Aug-04	1.9	13.2	16.9	8.5	3.0
2-Sep-04	2.0	10.6	*BDL*	6.3	2.4
30-Sep-04	-	-	-	-	-
3-Nov-04	2.3	13.0	2.0	6.8	2.5
2-Dec-04	2.1	11.7	1.8	6.1	2.3
Average	**1.9**	**9.8**	**5.1**	**5.5**	**2.0**

No analysis for 30 Sep – 03 Nov 04 tubes, due to equipment failure.
BDL = below detection limit, i.e. less than 0.2 μg m^{-3}

Table A2.2 Monthly Hydrocarbon concentrations at Le Bas Centre ($\mu g\ m^{-3}$)

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
30-Dec-03	1.3	7.6	1.4	4.3	1.5
5-Feb-04	1.3	4.9	0.9	2.9	1.1
3-Mar-04	1.5	5.7	1.0	3.0	1.1
30-Mar-04	1.2	5.4	1.0	2.9	1.0
5-May-04	0.7	3.8	0.8	2.3	0.9
2-Jun-04	1.2	7.4	7.8	4.0	1.4
1-Jul-04	1.7	10.7	12.8	6.0	2.0
2-Aug-04	1.3	8.5	11.2	5.7	2.0
2-Sep-04	1.5	6.8	*BDL*	4.2	1.6
30-Sep-04	1.2	5.8	*BDL*	3.6	1.3
3-Nov-04	1.4	5.9	1.0	3.5	1.3
2-Dec-04	1.6	6.7	1.5	4.7	1.9
Average	**1.3**	**6.6**	**3.3**	**3.9**	**1.4**

BDL = below detection limit, i.e. less than 0.2 μg m^{-3}

Table A2.3 Monthly Hydrocarbon Concentrations at Handsford Lane ($\mu g\ m^{-3}$)

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
30-Dec-03	1.2	13.0	2.0	6.0	1.4
5-Feb-04	1.5	20.0	2.8	8.4	2.0
3-Mar-04	1.2	19.0	3.0	9.3	1.9
30-Mar-04	-	-	-	-	-
5-May-04	0.9	20.0	2.6	8.0	1.5
2-Jun-04	0.9	21.5	15.7	8.4	1.7
1-Jul-04	0.5	12.7	11.8	6.3	1.4
2-Aug-04	0.9	26.0	23.3	12.3	2.7
2-Sep-04	-	-	-	-	-
30-Sep-04	-	-	-	-	-
3-Nov-04	1.0	8.8	2.8	11.0	3.0
2-Dec-04	0.9	4.3	1.6	6.7	2.1
Average	**1.0**	**16.1**	**7.3**	**8.5**	**2.0**

March tube went missing from site. September tube cap was left on by site operator.
No analysis for 30 Sep – 03 Nov 04 tubes, due to equipment failure.
BDL = below detection limit, i.e. less than 0.2 µg m^{-3}

Table A2.4 Monthly Hydrocarbon Concentrations at Springfield Garage ($\mu g\ m^{-3}$)

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
30-Dec-03	4.8	28.0	4.1	12.0	4.2
5-Feb-04	4.1	23.0	3.3	9.8	3.4
3-Mar-04	4.3	26.0	3.9	11.0	4.1
30-Mar-04	3.8	23.0	4.3	13.0	4.6
5-May-04	3.8	22.0	3.2	9.0	3.3
2-Jun-04	6.0	39.7	36.4	18.8	6.6
1-Jul-04	5.7	41.4	43.1	19.9	6.8
2-Aug-04	4.6	40.5	42.0	20.7	7.2
2-Sep-04	5.4	37.4	*BDL*	17.3	6.4
30-Sep-04					
3-Nov-04	4.5	31.0	4.3	15.0	5.5
2-Dec-04	4.3	27.9	3.8	13.5	5.0
Average	**4.7**	**30.9**	**13.5**	**14.5**	**5.2**

No analysis for 30 Sep – 03 Nov 04 tubes, due to equipment failure.
BDL = below detection limit, i.e. less than 0.2 µg m^{-3}

Table A2.5 Monthly Hydrocarbon Concentrations at Clos St Andre ($\mu g\ m^{-3}$)

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
30-Dec-03	0.6	2.0	0.4	1.0	0.4
5-Feb-04	0.9	2.1	0.4	1.1	0.4
3-Mar-04	0.8	1.9	0.4	1.1	0.4
30-Mar-04	0.4	1.7	0.3	0.8	0.3
5-May-04	0.6	1.5	0.6	1.1	0.4
2-Jun-04	0.4	1.9	2.4	1.0	0.4
1-Jul-04	0.7	2.5	3.6	1.5	0.5
2-Aug-04	0.5	2.4	3.1	1.4	0.5
2-Sep-04					
30-Sep-04					
3-Nov-04	0.8	2.2	0.4	1.3	0.5
2-Dec-04	0.9	3.9	0.6	1.8	0.6
Average	**0.7**	**2.2**	**1.2**	**1.2**	**0.4**

No analysis for 30 Sep – 03 Nov 04 tubes, due to equipment failure.
BDL = below detection limit, i.e. less than 0.2 μg m^{-3}

Table A2.6 Monthly Hydrocarbon Concentrations at the Airport ($\mu g\ m^{-3}$)

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
30-Dec-03	0.7	0.9	0.2	0.4	*BDL*
5-Feb-04	0.8	1.0	*BDL*	0.5	*BDL*
3-Mar-04	0.7	1.0	*BDL*	0.4	*BDL*
30-Mar-04	0.5	0.9	0.2	0.4	*BDL*
5-May-04	0.5	1.5	0.3	0.4	*BDL*
2-Jun-04	0.9	1.4	3.4	0.8	0.4
1-Jul-04	0.6	1.1	2.4	0.6	*BDL*
2-Aug-04	0.4	1.5	2.0	0.8	0.3
2-Sep-04	0.6	1.2	*BDL*	0.6	*BDL*
30-Sep-04	0.5	0.9	*BDL*	0.5	0.2
3-Nov-04	0.6	1.1	*BDL*	0.6	*BDL*
2-Dec-04	0.6	1.4	0.2	0.7	0.3
Average	**0.6**	**1.1**	**0.8**	**0.6**	**0.2**

BDL = below detection limit, i.e. less than 0.2 μg m^{-3}