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Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2005

March 2006

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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 ninth consecutive year of monitoring, calendar year 2005 – covered by the monitoring period 4th January 2005 to 3rd January 2006.

Diffusion tube samplers were used to monitor nitrogen dioxide (NO_2) at 23 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 two of the 11 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 31st 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 Weighbridge site.

Annual mean concentrations at urban and residential background sites were all well below 40μg m^{-3} in 2005.

Ambient NO_2 concentrations at most of the sites in Jersey were on average slightly lower than those measured in the previous year (2004).

Ambient concentrations of NO_2 still show no clear trends, although there have been year-to-year fluctuations. There is no statistically significant 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 3.3μg 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).

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 2005. This is the ninth 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 23 sites on the island, and BTEX at six sites.

This report presents the results obtained in the 2005 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 2004[1-8]. 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. The monitoring sites used during 2005 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 ($\mu g\ m^{-3}$). Some earlier 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 $\mu g\ m^{-3}$. In this report, concentrations of benzene are expressed in microgrammes per cubic metre ($\mu g\ m^{-3}$). Previous reports in the series used parts per billion (ppb): to convert to ppb to if necessary, the following relationship should be used:

1 $\mu g\ m^{-3}$ = 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 $\mu g\ m^{-3}$ in rural areas, up to 204 $\mu g\ m^{-3}$ 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[9]. The best estimate for the odour threshold of toluene has been reported[10] as 0.16ppm (613$\mu g\ m^{-3}$). In this report, concentrations are expressed in microgrammes per cubic metre ($\mu g\ m^{-3}$). Previous reports in the series used parts per billion (ppb): to convert to ppb to if necessary, the following relationship should be used:

1 $\mu g\ m^{-3}$ = 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[9], 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 μg m^{-3})[10].

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

1 μg 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[11] 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 [12,13] 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[14]. 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)[15] 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” for 2005 of **0.70**. (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.

Two NO_2 monitoring sites changed during the course of the year. At the beginning of April 2005, the two roadside sites at the Taxi Rank and Camera Shop, both in La Columberie, St Helier, were replaced by two new roadside sites in the same town: Union Street and New Street. The total remains at 21.

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 *(until Apr 2005)*	657 484	Kerbside in St Helier
N21	Taxi Rank, La Columberie *(until Apr 2005)*	657 484	Kerbside in St Helier
N22	Union Street *(from Apr 2005)*	653 486	Kerbside in St Helier – corner of Union St. & New St.
N23	New Street *(from Apr 2005)*	653 485	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.

Figure 1a. Site Locations Outside St Helier

Figure 2a. Sites in St Helier town

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. New Street
21. Springfield Garage
22. Union Street
23. Airport
24. Handsford Lane

BTEX hydrocarbons were monitored at six sites during 2005. 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 subsequent 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 3.9 $\mu g\ m^{-3}$ (in July at the rural Rue des Raisies site), to 51.4 $\mu g\ m^{-3}$ (in September at the kerbside Beaumont site).

There were nine occasions when no valid value was obtained. Five of these were tubes that went missing from their sites during the exposure period (in one case the tube was found on the ground).

The other four were cases where the coloured end-cap of the tube had developed a split during the exposure period. If this happens, moisture and contamination can enter, and the tube result is not valid. The number of occurrences of split end caps was high in 2005 compared to previous years. The situation should be monitored and the laboratory informed if the problem continues.

One unusually high value was recorded: at Jane Sandeman Road, the monthly mean for September was 31.5 $\mu g\ m^{-3}$. While this would not be unusual at an urban kerbside site, it was unusually high for the rural Jane Sandeman site. However, in the absence of any evidence to suggest that it is spurious, the value has not been rejected.

Annual mean NO_2 concentrations ranged from 6.8 $\mu g\ m^{-3}$ (at Rue des Raisies) to 43.9 $\mu g\ m^{-3}$ at the Weighbridge site. The latter is a location in the centre of St Helier which is used as a central stopping point for buses.

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[11] for NO_2 is that the annual mean should not exceed 40 $\mu g\ m^{-3}$. The EC 1st Daughter Directive[12] 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).

2005 was thus a significant year for NO_2, as the AQS Objective was to be achieved by the end of this period.

Annual mean NO_2 at two sites exceeded 40μg m^{-3}; these were Weighbridge and Beaumont, both urban kerbside sites that have recorded relatively high annual mean NO_2 concentrations in previous years of this survey.

However, as explained in Section 2.3, it is necessary to take into account any systematic bias when comparing annual mean NO_2 concentrations based on diffusion tube results with the AQS Objective[15]. 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 (for 2005) of 0.70, 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 40μg m^{-3}. The highest annual mean (at Weighbridge) is reduced from 43.9 μg m^{-3} (unadjusted) to 30.8μg m^{-3} (adjusted). Application of the bias adjustment factor reduced the annual mean NO_2 concentrations at the 12 background sites to well below 40 μg m^{-3}. All Jersey sites met the AQS Objective for annual mean NO_2 by the due date.

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 2005, Jersey. Concentrations in $\mu g\ m^{-3}$.

Site	From - To:	4 Jan 05 - 2 Feb	2 Feb – 2 Mar	2 Mar – 30 Mar	30 Mar- 3 May	3 May – 1 Jun	1 Jun – 30 Jun	30 Jun – 4 Aug	4 Aug – 1 Sep	1 Sep – 6 Oct	6 Oct – 2 Nov	2 Nov – 30 Nov	30 Nov – 3 Jan 06	2005 Annual Mean	*Bias adj. AM 2005*
First Tower (K)		35.8	36.1	43	33.5	34.2	28.6	36.5	34.6	37.9	39.3	34.7	34.8	35.8	*25.0*
Weighbridge (K)		39.5	41.6	48.5	***SC***	34	46.8	46.3	40.5	49.6	43.1	43.7	49.8	43.9	*30.8*
Georgetown (K)		31.1	38.3	***SC***	30.2	36	36.9	34.9	27	42.3	38.4	44.4	42.8	36.6	*25.6*
Beaumont (K)		36.6	33.7	50.9	***SC***	30.8	45.5	37.5	45.4	51.4	40.9	48.5	***TM***	42.1	*29.5*
The Parade (K)		30.9	30.6	39.4	25.6	21.4	27.3	31.6	31.8	34.2	30.5	36.4	33.5	31.1	*21.8*
Broad Street (K)		30.9	39.2	44.5	***TM***	***TM***	35	33	34.3	37.2	42.7	41.1	39.7	37.8	*26.4*
La Pouquelaye (K)		36.9	39	41.9	38.3	44.6	37.2	***SC***	28.6	39.2	38.7	41.5	39.4	38.7	*27.1*
Camera Shop (R)		28	28.6	35.1										-	
Taxi Rank (R)		35.8	34.2	42.5										-	
New St (R)					33.7	28.4	22.7	17.8	18.1	23.6	25.5	30.4	32.2	25.8	*18.1*
Union St (R)					33.7	28.4	33.7	27.3	25.5	39.6	44.2	38	27.9	33.1	*23.2*
Le Bas Centre (UB)		26.2	25.7	32.7	23.5	20.9	22.3	21	20.6	27.6	27.5	27.7	29	25.4	*17.8*
L'Avenue et Dolmen (UB)		21.5	17.5	27.4	18.7	18.4	20	18.7	19.1	20.9	21.2	27.7	29.4	21.7	*15.2*
Robin Place (UB)		25.7	21.8	32.3	28.1	21.2	23.5	20.6	20.6	26.1	32.9	31.4	29.5	26.1	*18.3*
Jane Sandeman (UB)		14.5	16.1	19.6	10	10	10.1	8.3	10.2	31.6	14.5	19.1	19.4	15.3	*10.7*
Saville Street (UB)		27.3	27.5	33.7	25.3	23.5	26	24.2	27.1	25.2	23.3	33.4	29	27.1	*19.0*
Beresford Street (UB)		35.7	36	45.6	35.5	***TM***	34.5	27.9	29.6	36.9	37.5	37.8	37.2	35.8	*25.1*
Mont Felard (Res B)		25.6	27.6	31.5	***TM***	24.1	20.9	23	24.9	29.2	24.9	27.9	28	26.1	*18.3*
Les Quennevais (Res B)		13.6	10.8	17.5	6.7	10.5	11.5	8.9	9.1	9.5	14.2	13.6	18	12.0	*8.4*
Langley Park (UB)		15	16.4	20.5	12.2	11.9	15.6	12.9	13.5	16.4	17.9	20.5	18.7	16.0	*11.2*
Clos St.Andre (Res B)		18.4	17.4	21	12.7	10.4	14.4	10.8	11.5	12.7	18.3	16.2	19.4	15.3	*10.7*
Maufant (Res B)		9.1	10.4	11.4	7.6	8.3	10.2	6.4	7.3	7.9	7.9	10.2	12.4	9.1	*6.4*
Rue Des Raisies (Rur B)		8	8.2	9.6	4.4	6.9	6.4	3.9	5	5.6	7.9	6.8	9	6.8	*4.8*

K = Kerbside, R = Roadside, UB = Urban Background, Res B = Residential Background, Rur B = Rural Background. TM = tube missing, SC = split end cap.

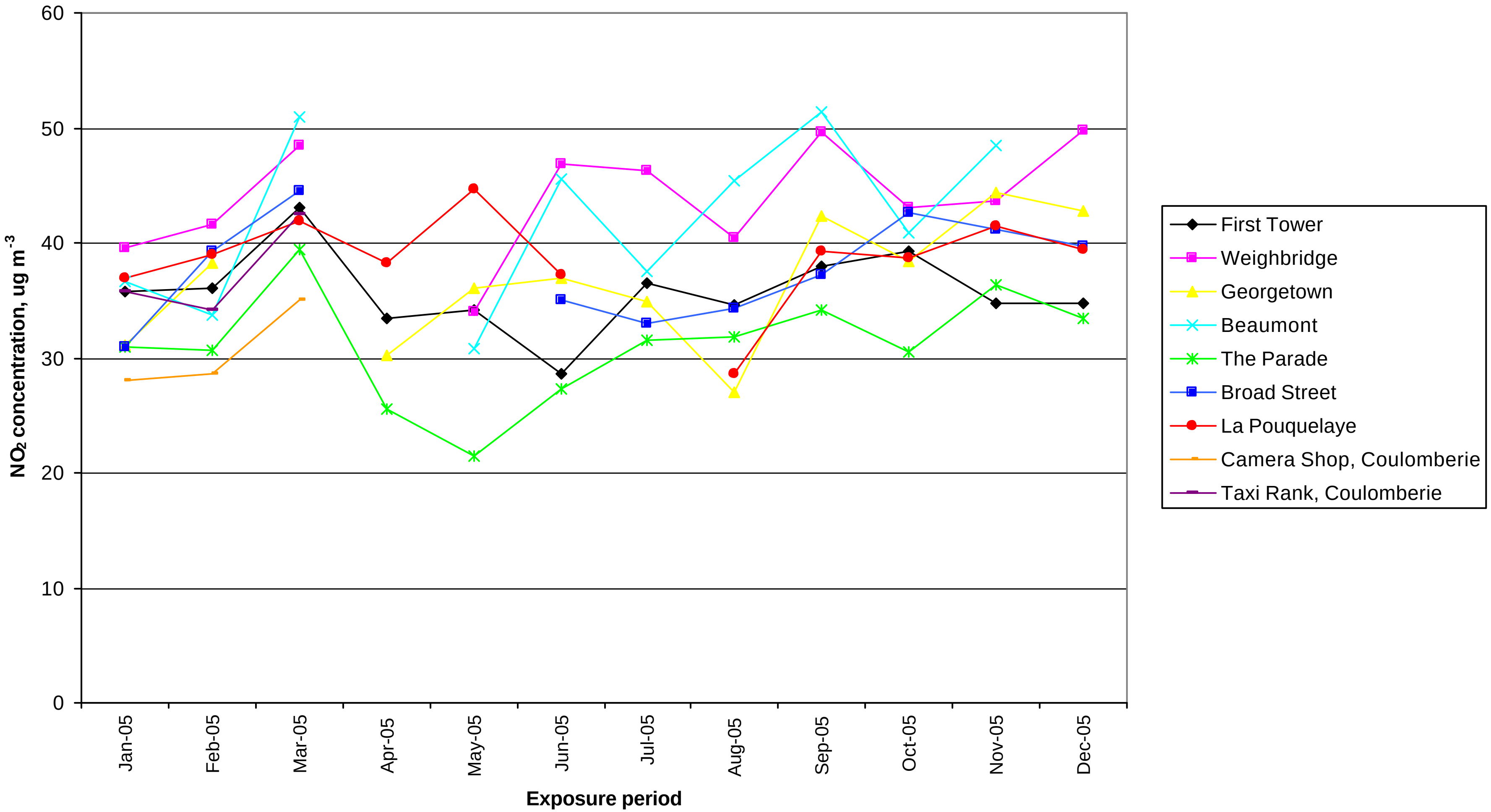

Figure 2. Monthly Mean Nitrogen Dioxide Concentrations at Roadside and Kerbside Sites, 2005

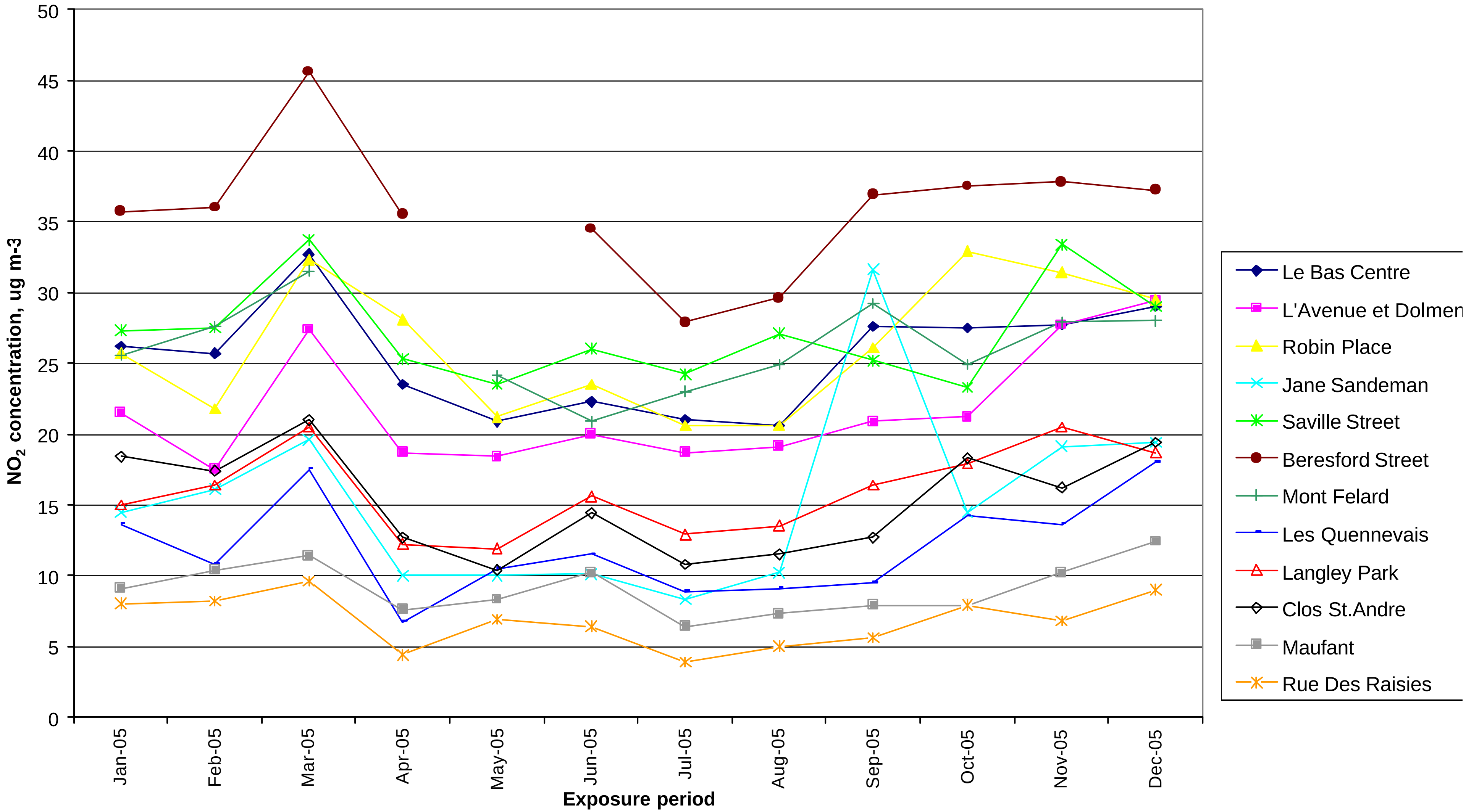

Figure 3. Monthly Nitrogen Dioxide Concentrations at Background Sites, 2005

Figure 3 clearly shows the unusually high monthly mean of 31μg m^{-3} measured at Jane Sandeman Road in September. 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 2005, using diffusion tubes. This survey, which ceased at the end of 2005, concentrated mainly 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 2005 (which are provisional at present, pending full data ratification) were 38 μg m^{-3} for roadside sites and 21 μg m^{-3} for urban background sites (unadjusted for bias). The unadjusted 2005 annual means for the Jersey survey were comparable: 36 μg m^{-3} for kerbside and roadside sites combined, and 21μg 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	2005 Annual average NO_2, μg m^{-3}
Exeter Roadside	43
Plymouth Centre	25
Lullington Heath	10
Harwell	12

The bias adjusted annual mean NO_2 concentrations measured at the kerbside and roadside sites in Jersey ranged from 18 to 31μg m^{-3}. The annual mean at Exeter Roadside was therefore considerably higher than these. The Jersey urban background sites had (bias adjusted) annual mean NO_2 concentrations ranging from 11 μg m^{-3} to 25 μg m^{-3}; mostly somewhat 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 bias-adjusted annual mean NO_2 ranging from 6 μg m^{-3} to 18 μg m^{-3}, and thus were more comparable with rural sites such as Lullington Heath and Harwell. The bias-adjusted annual mean of 4.8 μg 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. The majority of the sites in this survey have been in operation since 2000, thereby meeting this requirement. However, the survey includes three long-running sites, which have been in operation since 1993, as part of the UK Nitrogen Dioxide Network.

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 between the mid 1990s and 2005, despite an increase (attributed to meteorological factors) in 2003. None of the three long-running Jersey sites show any significant downward trend (based on Theil's non-parametric analysis), although in the case of the Maufant and Jane Sandeman sites it does appear that NO_2 concentrations are lower than they were in the early 1990s.

The average NO_2 concentration for all roadside and kerbside sites appears to have no statistically significant downward trend in the long-term for any of the three categories shown (roadside and kerbside, urban background and urban residential). However, there appears to be a short-term decrease at many sites since 2003.

The fact that there is no clear downward trend long-term suggests that sites currently at risk of exceeding AQS objectives or EC limit are likely to remain so.

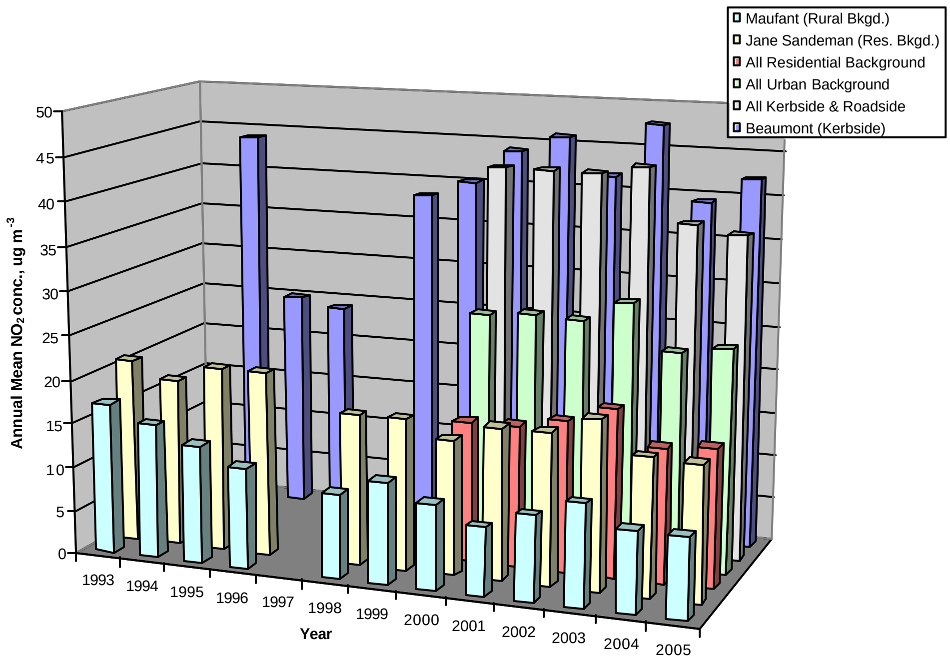

Figure 4. Trends in Annual Mean NO_2 Concentrations (not corrected for diffusion tube bias).

Table 5 Annual mean NO_2 concentrations, $\mu g\ m^{-3}$ (not bias adjusted)

Site	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Beaumont (Kerbside)		44	25	24	-	38	40	44	46	42	48	39	42
Jane Sandeman (Res. Bkgd.)	21	19	21	21	-	17	17	15	17	17	19	16	15
Maufant (Rural Bkgd.)	17	15	13	11	-	10	11	10	8	10	11	9	9
All Kerbside & Roadside	-	-	-	-	-	-	-	43	43	43	44	38	37
All Urban Background	-	-	-	-	-	-	-	27	27	27	30	25	25
All Residential Background	-	-	-	-	-	-	-	16	16	17	19	15	16

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, particularly at the airport site, 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, 2005

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	1.7	8.9	1.8	5.3	1.9
Le Bas Centre	1.3	5.3	1.1	3.4	1.2
Handsford Lane *(paint spraying)*	1.0	3.7	2.1	7.1	2.2
Springfield Garage *(petrol station)*	3.3	22.8	3.6	11.2	4.0
Clos St Andre	0.7	2.2	0.5	1.3	0.5
Airport	0.6	1.6	0.2	0.6	0.2

All sites achieved full data capture, except Handsford Lane, where no April or May result was obtained.

Springfield Garage measured the highest annual mean concentrations of all five BTEX compounds in 2005, as it typically has in previous years. However, ethylbenzene concentrations appear to have returned to their pre-2004 levels, following the increase measured in 2004.

Handsford Lane (near the paint spraying process) measured slightly higher levels of ethylbenzene and m+p xylene compared with the other sites. However, ambient concentrations of toluene at this site have fallen from 16.1μgm^{-3} in 2004 to just 3.7μgm^{-3} in 2005.

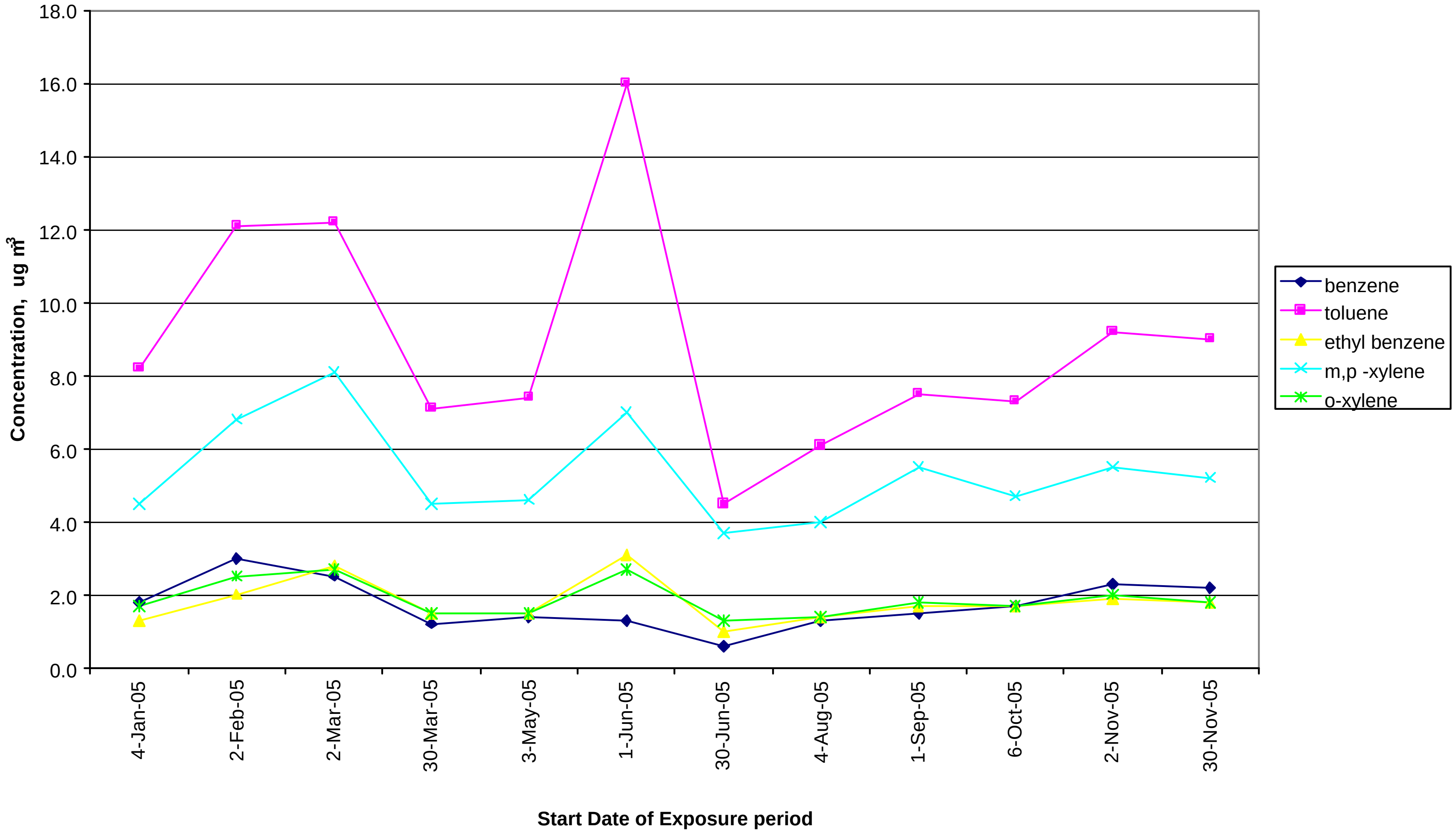

Figure 5. Monthly mean hydrocarbon concentrations at Beresford Street, 2005

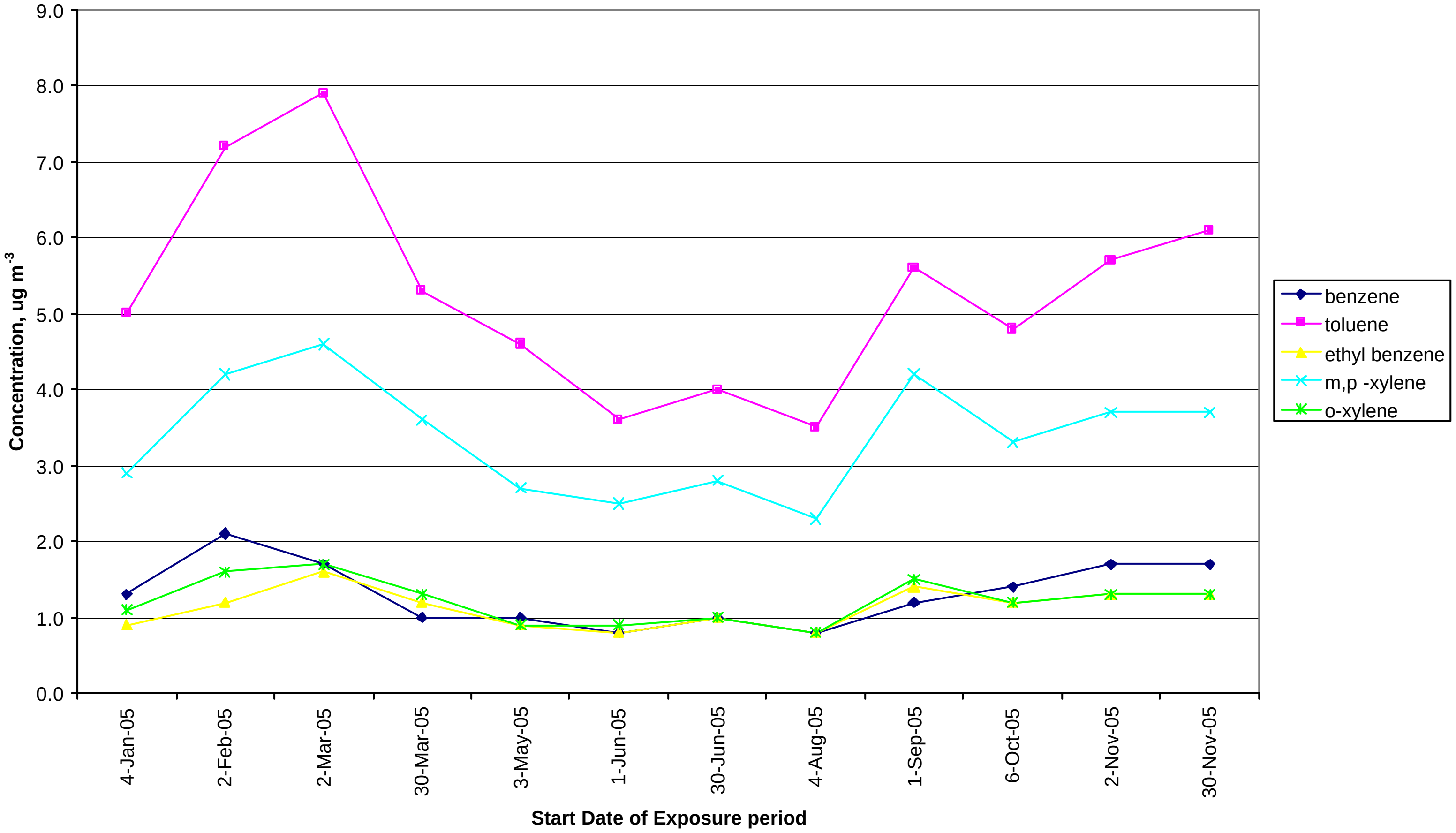

Figure 6. Monthly mean hydrocarbon concentrations at Le Bas Centre, 2005

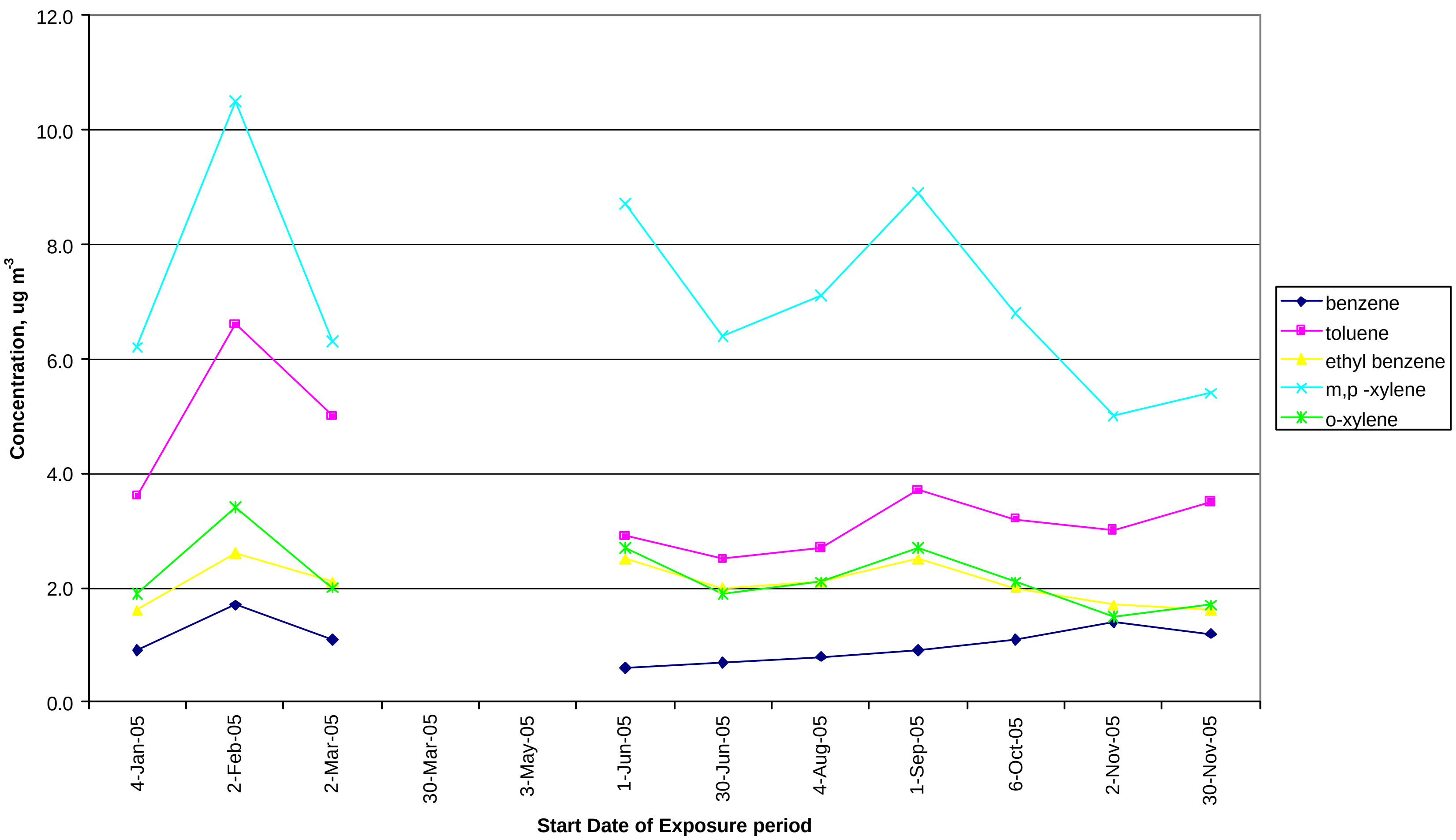

Figure 7. Monthly mean hydrocarbon concentrations at Handsford Lane, 2005

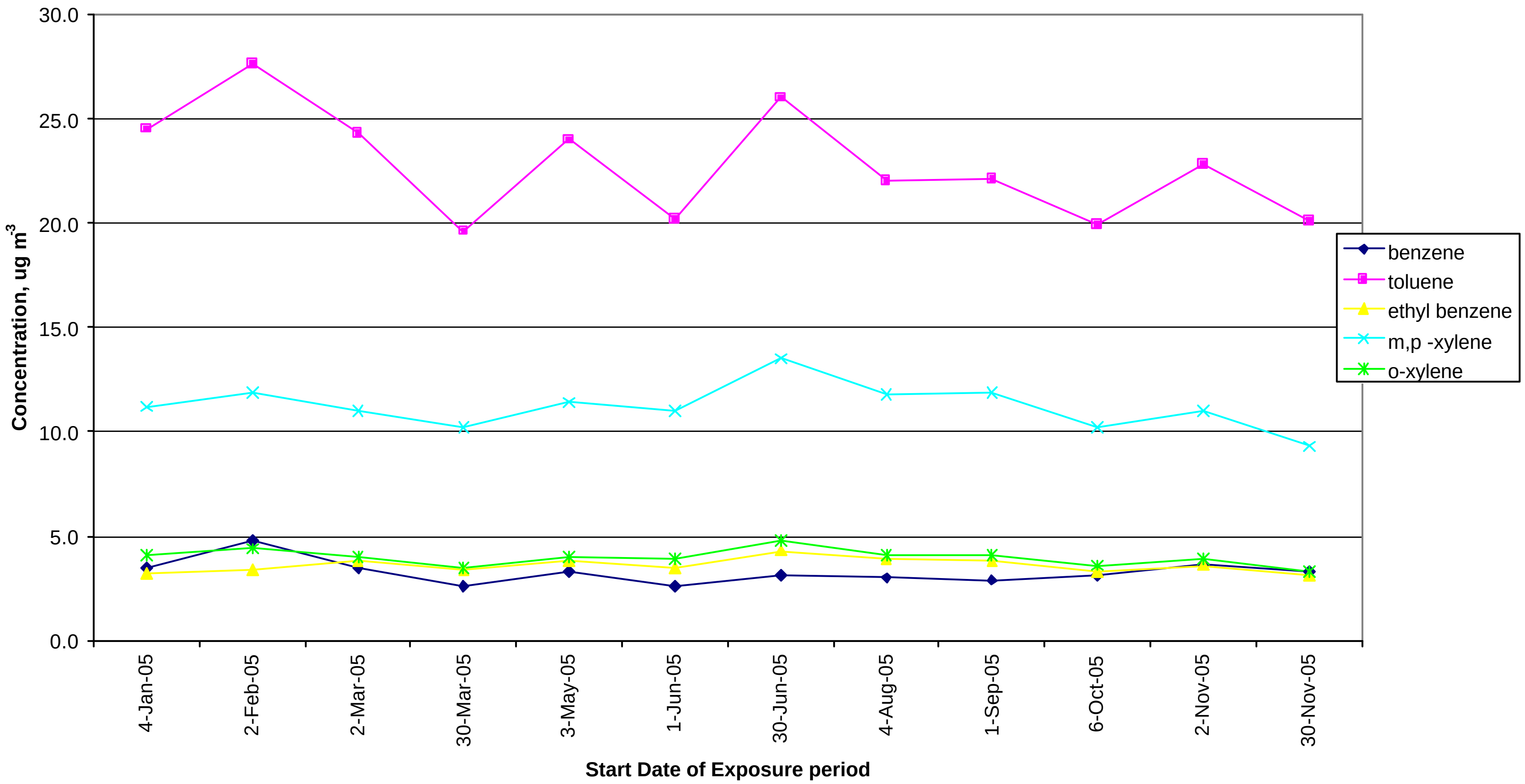

Figure 8. Monthly mean hydrocarbon concentrations at Springfield Garage, 2005

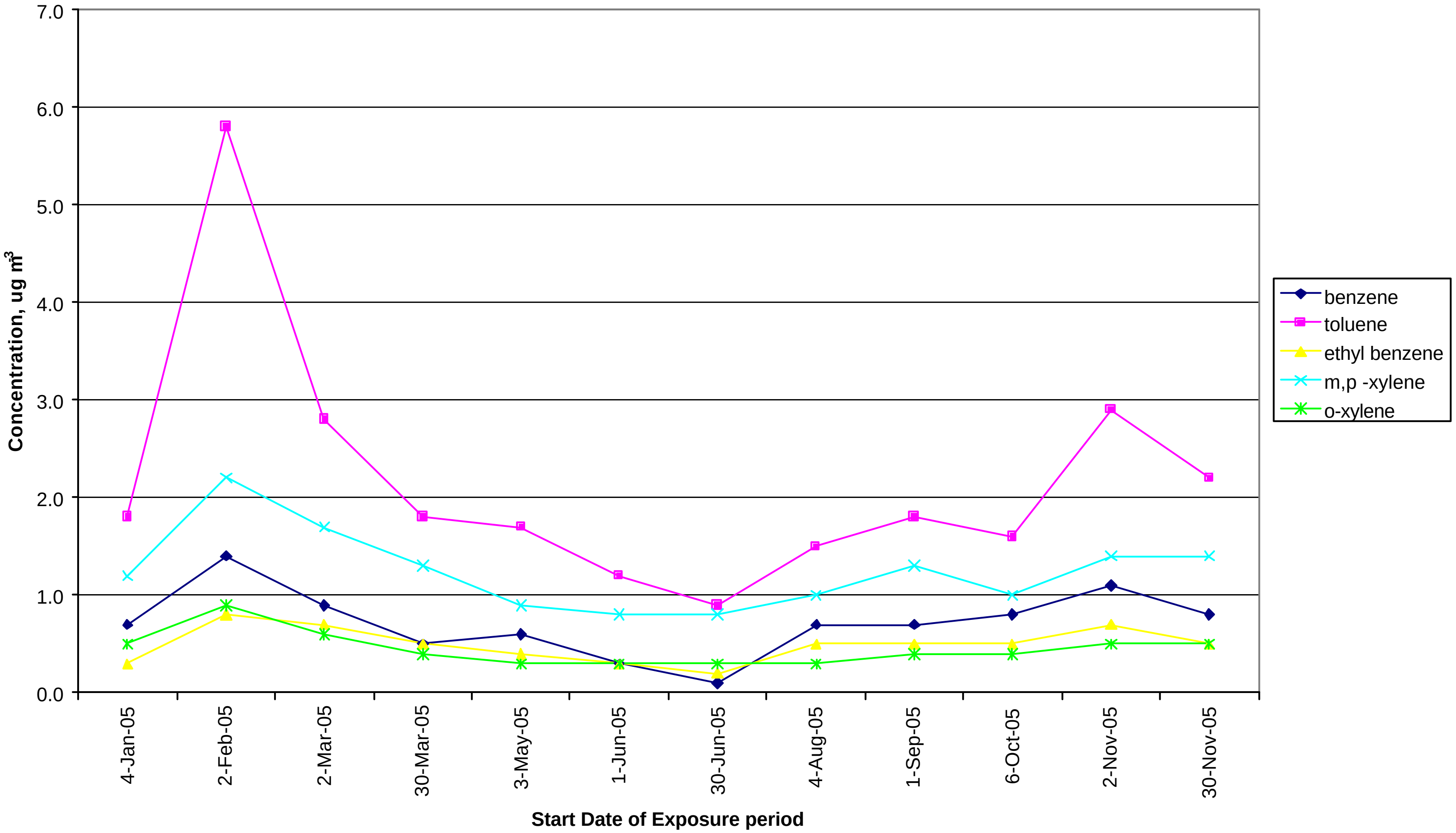

Figure 9. Monthly mean hydrocarbon concentrations at Clos St Andre, 2005

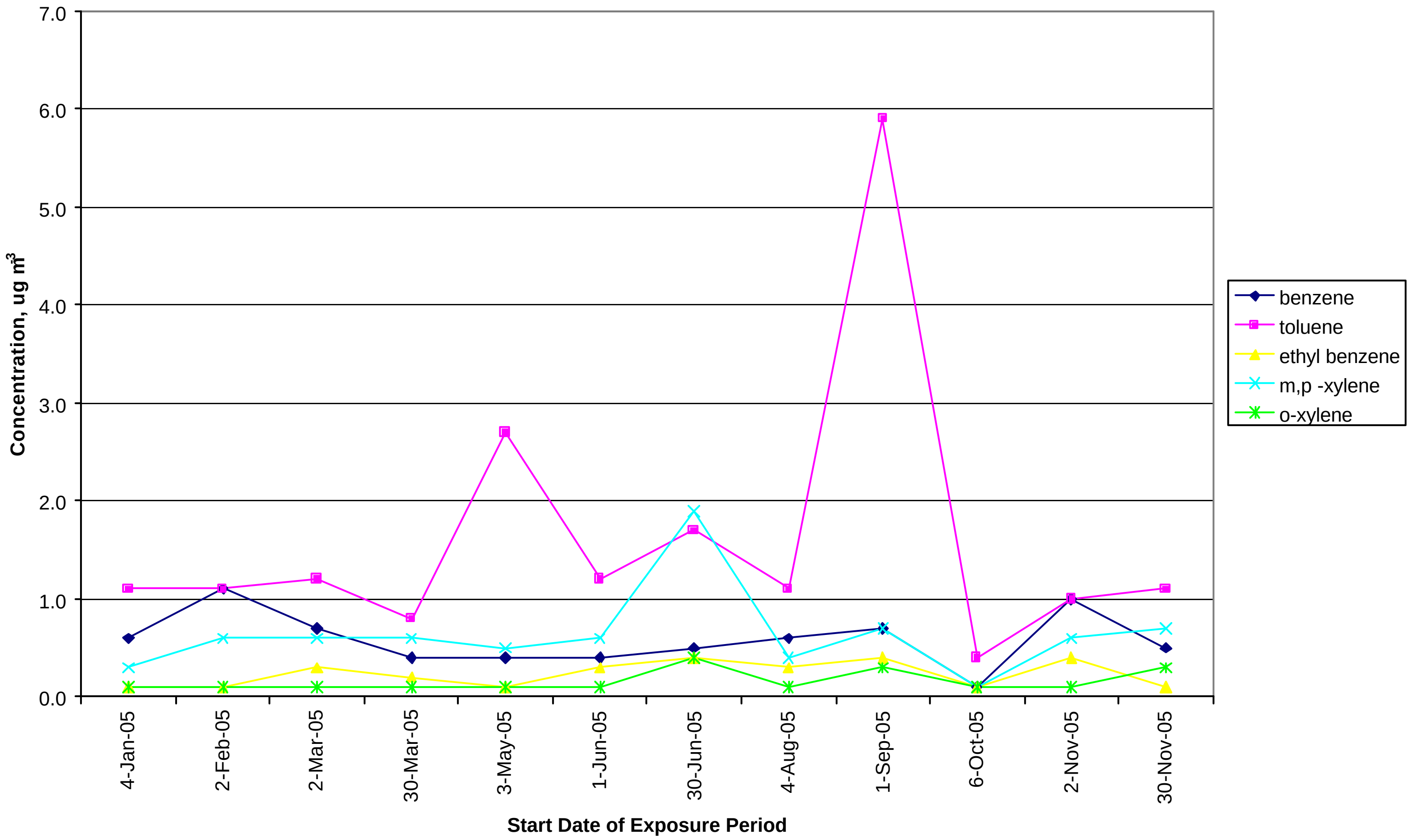

Figure 10. Monthly mean hydrocarbon concentrations at the Airport, 2005

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 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 3.25 μg m^{-3}, at all sites except Springfield Garage.

The EC 2nd Daughter Directive[13] sets a limit of 5μg m^{-3} for annual mean benzene, to be achieved by 2010. All sites met this limit.

3.2.3 Comparison with UK Data

Table 7 compares hydrocarbon data from the 2005 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.
- London Eltham – an urban background site in south east London, in parkland over 25m from the nearest road.
- 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 30 UK sites in 2005. Annual mean concentrations ranged from 0.86 μg m^{-3} (at Coventry's Memorial Park) to 4.47 μg m^{-3} (at Gawber, Barnsley), but were typically in the range of 1-3 μg m^{-3} at most urban sites.

Table 7. Comparison with Hydrocarbon Concentrations at Other UK Sites, Calendar Year 2005 (With data capture in brackets).

Site	Benzene, μg m^{-3}	Toluene, μg m^{-3}
Jersey Sites		
Beresford Street	1.7	8.9
Le Bas Centre	1.3	5.3
Handsford Lane *(paint spraying)*	1.0	3.7
Springfield Garage *(petrol station)*	3.3	22.8
Clos St Andre	0.7	2.2
Airport	0.6	1.6
Mainland UK sites		
London Eltham	0.84 (84%)	n/a
Glasgow Kerbside	1.13 (91%)	n/a
Harwell	0.73 (95%)	n/a
London Marylebone Road	2.17 (86%)	n/a

n/a = not available.

The annual mean benzene concentration 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), or Glasgow Kerbside. 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 Eltham 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. 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.

No annual mean toluene concentrations have been reported for the mainland UK sites, as insufficient data capture was achieved in 2005.

3.2.4 Comparison with Previous Years' Hydrocarbon Results

Table 8 shows annual mean hydrocarbon concentrations for these sites, for years 1997 – 2005. Figures 12 to 16 illustrate how annual mean concentrations of these hydrocarbons have changed over the years of monitoring.

As well as the six sites currently in operation, Table 8 also shows previous years' results from a site at Elizabeth Lane. This site was located close to a paint spraying process: when the process closed down, monitoring was re-located to Handsford Lane, which is close to another similar process.

With a few exceptions, levels of all five hydrocarbon species were lower during 2005 than in the previous year. In particular, concentrations of ethylbenzene have reduced in 2005 after the increase reported (particularly at Springfield Garage) in 2004.

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 some reduction in concentrations of BTEX compounds compared with the 2003 values, though it is not known whether this can be attributed to the use of vapour recovery.

Table 8. Comparison of Hydrocarbon Concentrations, Jersey, 1997 - 2005.

	benzene, µg m^{-3}	toluene, µg m^{-3}	ethylbenzene 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
2005	1.7	8.9	1.8	5.3	1.9
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
2005	1.3	5.3	1.1	3.4	1.2
Elizabeth Lane (ceased site)					
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
2005	3.3	22.8	3.6	11.2	4.0
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
2005	0.7	2.2	0.5	1.3	0.5
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
2005	0.6	1.6	0.2	0.6	0.2
Handsford Lane					
2004	1.0	16.1	7.3	8.5	2.0

2005	1.0	3.7	2.1	7.1	2.2

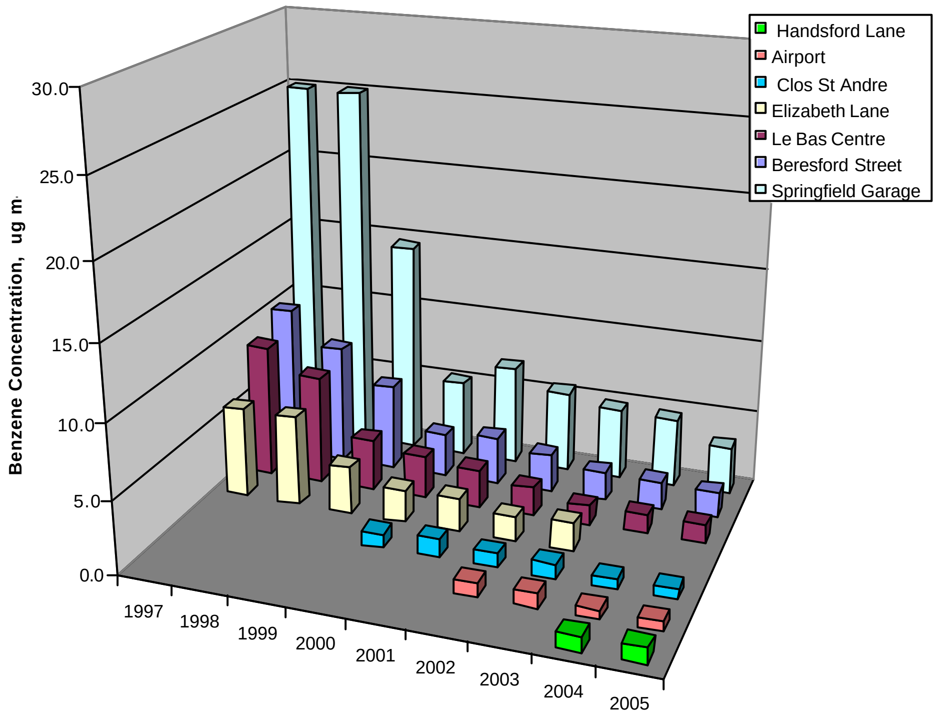

Figure 12. Trends in Benzene Concentration

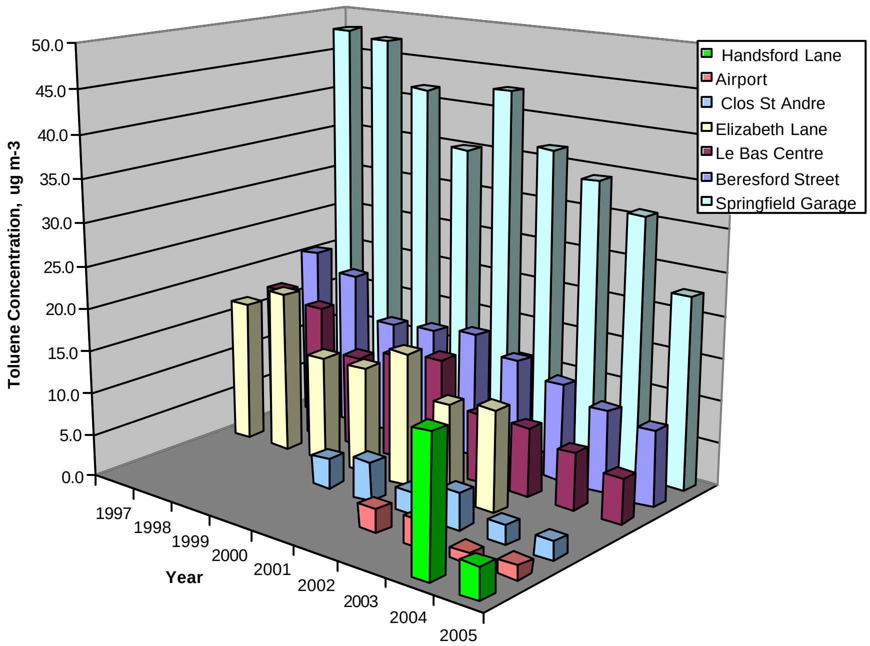

Figure 13. Trends in Toluene Concentration

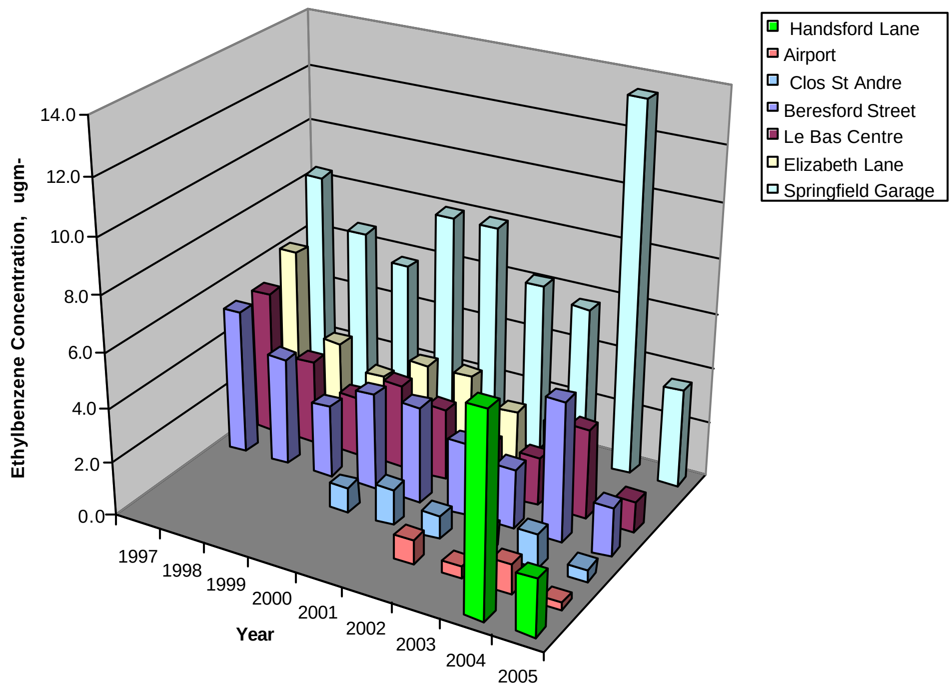

Figure 14. Trends in Ethylbenzene Concentration

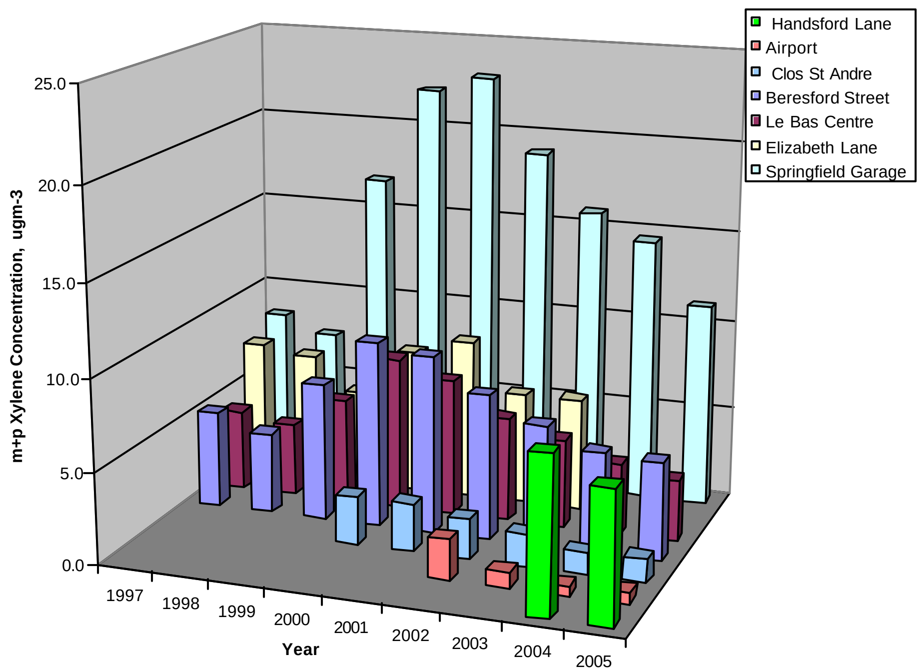

Figure 15. Trends in m+p- Xylene Concentration

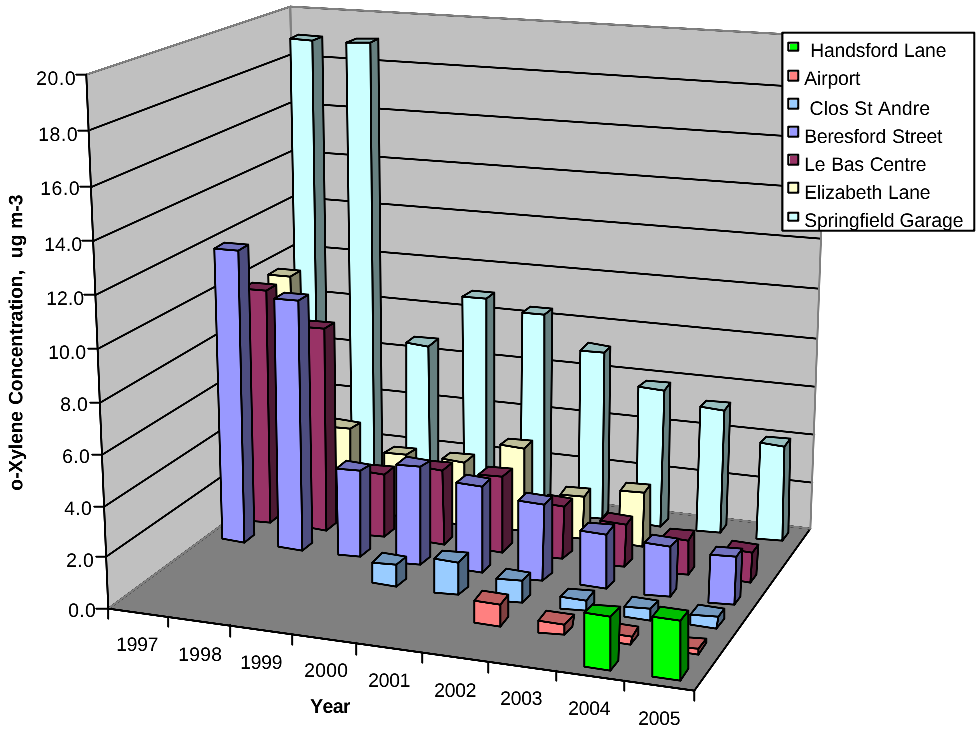

Figure 16. Trends in o-Xylene Concentration

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 but steady downward trend over the complete period of the survey (1997-2005).
- Ethylbenzene concentrations do not show a clear trend. Concentrations appear to have returned to their pre-2004 levels, after an unexplained increase in 2004.
- Concentrations of m+p xylene increased during the early years of the survey; however, since 2001, concentrations of this pollutant have steadily decreased.
- O xylene levels have also decreased.

4 Conclusions

- Netcen has undertaken a year-long diffusion tube monitoring study in Jersey during 2005, on behalf of the States of Jersey Public Health Services and Planning and Environment Department. This was the ninth consecutive year of monitoring.
- Diffusion tubes were used to monitor NO_2 at 23 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.
- Two new roadside sites were set up, to monitor NO_2 at Union Street and New Street in St Helier. These sites replaced the Taxi Rank and Camera Shop sites (which were both located in La Columberie) in April 2005.

NO_2 results

- Annual mean (uncorrected) NO_2 concentrations at two kerbside sites (Weighbridge and Beaumont Street) 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 reduced 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 all below the EC Limit Value – in most cases by a substantial margin.
- Annual mean NO_2 concentrations at the monitoring sites were in most cases very slightly lower than those measured in 2004.
- Although the data suggest a small decrease in the past two years, there are no statistically significant downward trends in NO_2 concentration at the three long-running sites, which have operated since 1993 as part of the UK NO_2 Network.
- Also, there are (as yet) no statistically significant downward trends in the average annual mean NO_2 concentrations for all kerbside and roadside sites, all urban background sites, or all residential sites (six years' data are available).
- 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 slightly greater than the UK Air Quality Strategy Objective of 3.25 μg m^{-3}, which is to be achieved by January 2010.
- Annual mean concentrations of BTEX hydrocarbons were mostly comparable with, or slightly lower than, those measured in 2004.
- Concentrations of most BTEX hydrocarbons are decreasing slightly year on year. The annual mean concentration of toluene at Handsford Lane (near a paint spraying process) showed a particularly marked decrease this year.

5 Recommendations

Results of the diffusion tube survey indicate that all monitoring sites in Jersey have met the UK Air Quality Strategy Objective of 40μg m^{-3} for the annual mean NO_2 concentration by the due date of 31^{st} December 2005. However, some kerbside and roadside locations remain fairly close to this objective. As there is no clear downward trend annual mean NO_2 concentration, this situation is likely to continue.

Measurements from diffusion tube surveys inevitably carry a high uncertainty. Previous years' reports have recommended that the States of Jersey consider using a mobile automatic analyser, for more accurate monitoring where needed: 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.

7 References

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15. 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 µg m^{-3} and ppb are those used by the EC, i.e. 1ppb benzene = 3.25 µg 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 start	benzene	Toluene	ethyl benzene	m,p -xylene	o-xylene
4-Jan-05	1.8	8.2	1.3	4.5	1.7
2-Feb-05	3.0	12.1	2.0	6.8	2.5
2-Mar-05	2.5	12.2	2.8	8.1	2.7
30-Mar-05	1.2	7.1	1.5	4.5	1.5
3-May-05	1.4	7.4	1.5	4.6	1.5
1-Jun-05	1.3	16.0	3.1	7.0	2.7
30-Jun-05	0.6	4.5	1.0	3.7	1.3
4-Aug-05	1.3	6.1	1.4	4.0	1.4
1-Sep-05	1.5	7.5	1.7	5.5	1.8
6-Oct-05	1.7	7.3	1.7	4.7	1.7
2-Nov-05	2.3	9.2	1.9	5.5	2.0
30-Nov-05	2.2	9.0	1.8	5.2	1.8
Average	**1.7**	**8.9**	**1.8**	**5.3**	**1.9**

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

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
4-Jan-05	1.3	5.0	0.9	2.9	1.1
2-Feb-05	2.1	7.2	1.2	4.2	1.6
2-Mar-05	1.7	7.9	1.6	4.6	1.7
30-Mar-05	1.0	5.3	1.2	3.6	1.3
3-May-05	1.0	4.6	0.9	2.7	0.9
1-Jun-05	0.8	3.6	0.8	2.5	0.9
30-Jun-05	1.0	4.0	1.0	2.8	1.0
4-Aug-05	0.8	3.5	0.8	2.3	0.8
1-Sep-05	1.2	5.6	1.4	4.2	1.5
6-Oct-05	1.4	4.8	1.2	3.3	1.2
2-Nov-05	1.7	5.7	1.3	3.7	1.3
30-Nov-05	1.7	6.1	1.3	3.7	1.3
Average	**1.3**	**5.3**	**1.1**	**3.4**	**1.2**

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
4-Jan-05	0.9	3.6	1.6	6.2	1.9
2-Feb-05	1.7	6.6	2.6	10.5	3.4
2-Mar-05	1.1	5.0	2.1	6.3	2.0
30-Mar-05	-	-	-	-	-
3-May-05	-	-	-	-	-
1-Jun-05	0.6	2.9	2.5	8.7	2.7
30-Jun-05	0.7	2.5	2.0	6.4	1.9
4-Aug-05	0.8	2.7	2.1	7.1	2.1
1-Sep-05	0.9	3.7	2.5	8.9	2.7
6-Oct-05	1.1	3.2	2.0	6.8	2.1
2-Nov-05	1.4	3.0	1.7	5.0	1.5
30-Nov-05	1.2	3.5	1.6	5.4	1.7
Average	**1.0**	**3.7**	**2.1**	**7.1**	**2.2**

Reasons for missing March -Apr data?

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
4-Jan-05	3.5	24.5	3.2	11.2	4.1
2-Feb-05	4.8	27.6	3.4	11.9	4.4
2-Mar-05	3.5	24.3	3.8	11.0	4.0
30-Mar-05	2.6	19.6	3.4	10.2	3.5
3-May-05	3.3	24.0	3.8	11.4	4.0
1-Jun-05	2.6	20.2	3.5	11.0	3.9
30-Jun-05	3.1	26.0	4.3	13.5	4.8
4-Aug-05	3.0	22.0	3.9	11.8	4.1
1-Sep-05	2.9	22.1	3.8	11.9	4.1
6-Oct-05	3.1	19.9	3.3	10.2	3.6
2-Nov-05	3.7	22.8	3.6	11.0	3.9
30-Nov-05	3.3	20.1	3.1	9.3	3.3
Average	**3.3**	**22.8**	**3.6**	**11.2**	**4.0**

Table A2.5 Monthly Hydrocarbon Concentrations at Clos St Andre (µg m^{-3})

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
4-Jan-05	0.7	1.8	0.3	1.2	0.5
2-Feb-05	1.4	5.8	0.8	2.2	0.9
2-Mar-05	0.9	2.8	0.7	1.7	0.6
30-Mar-05	0.5	1.8	0.5	1.3	0.4
3-May-05	0.6	1.7	0.4	0.9	0.3
1-Jun-05	0.3	1.2	0.3	0.8	0.3
30-Jun-05	*BDL*	0.9	0.2	0.8	0.3
4-Aug-05	0.7	1.5	0.5	1.0	0.3
1-Sep-05	0.7	1.8	0.5	1.3	0.4
6-Oct-05	0.8	1.6	0.5	1.0	0.4
2-Nov-05	1.1	2.9	0.7	1.4	0.5
30-Nov-05	0.8	2.2	0.5	1.4	0.5
Average	**0.7**	**2.2**	**0.5**	**1.3**	**0.5**

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

Table A2.6 Monthly Hydrocarbon Concentrations at the Airport (µg m^{-3})

Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
4-Jan-05	0.6	1.1	BDL	0.3	BDL
2-Feb-05	1.1	1.1	BDL	0.6	BDL
2-Mar-05	0.7	1.2	0.3	0.6	BDL
30-Mar-05	0.4	0.8	0.2	0.6	BDL
3-May-05	0.4	2.7	BDL	0.5	BDL
1-Jun-05	0.4	1.2	0.3	0.6	BDL
30-Jun-05	0.5	1.7	0.4	1.9	0.4
4-Aug-05	0.6	1.1	0.3	0.4	BDL
1-Sep-05	0.7	5.9	0.4	0.7	0.3
6-Oct-05	BDL	0.4	BDL	BDL	BDL
2-Nov-05	1.0	1.0	0.4	0.6	BDL
30-Nov-05	0.5	1.1	BDL	0.7	0.3
Average	**0.6**	**1.6**	**0.2**	**0.6**	**0.2**

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