1 Introduction

1.1 BACKGROUND

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 2001. This is the fifth in a series of extensive annual monitoring programmes that began in 1997. These supplemented the monitoring undertaken as part of the UK national diffusion tube studies, that have been undertaken since 1992.

The pollutants measured were nitrogen dioxide (NO_2), sulphur dioxide (SO_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 19 sites on the island, SO_2 was measured at just one site (previous year's surveys having established that levels of SO_2 on Jersey are low), and BTEX at 6 sites.

This report presents the results obtained in the 2001 survey, and compares the data from Jersey with relevant air quality standards 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 2000[1,2,3,4]. The objective, as in the 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 were the same as those used in the 2000 study. These consisted of a mixture of some background sites investigated during previous studies, together with some locations where higher pollutant concentrations might be expected, such as roadside sites, or those 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.

2.1.2 SO_2

Sulphur dioxide (SO_2) is formed during the combustion of fuels containing sulphur. The most significant source of this pollutant is fossil fuelled power generation, although diesel engines, domestic solid fuel burners and a number of chemical processes also produce SO_2.

SO_2 is a respiratory irritant, and is toxic at high concentrations. It is also damaging to ecosystems and a major precursor in the formation of acid rain.

2.1.3 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 5 ppb.

(ii) Toluene
Toluene is also found in petrol in small concentrations. Its primary use is as a solvent in paints and inks, and is a constituent of tobacco smoke. It has been found to adversely affect human health. Typical ambient concentrations range from trace to 3.8 $\mu g\ m^{-3}$ (1.0 ppb) in rural areas, up to 204 $\mu g\ m^{-3}$ (54 ppb) 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[5]: the occupational 8-hour exposure limit (OEL) is 50ppm (50,000ppb).
The best estimate for the odour threshold of toluene has been reported[6] as 0.16ppm (160ppb).

(iii)ethyl benzene
Again, there are no limits for ambient concentration of ethyl benzene, although there are occupational limits relating to workplace exposure[5], of 100 ppm over 8 hours, and 125 ppm over 10 minutes. Ambient concentrations are highly unlikely to approach these levels.

(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)[6].

2.2 AIR QUALITY STANDARDS AND GUIDELINES

2.2.1 World Health Organisation

In 2000, the World Health Organisation published revised air quality guidelines[7] for SO_2 and NO_2. These revised guidelines 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 SO_2 (10-minute, 24-hour and annual means), and 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 SO_2, NO_2 and benzene [8,9] 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 contains standards and objectives for a range of pollutants including SO_2, NO_2 and benzene[10]. These are also summarised in Appendix 1.

2.3 METHODOLOGIES

The survey was carried out using diffusion tubes for SO_2, 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 SO_2 and NO_2 consist of a small plastic tube, approximately 7 cm long. During sampling, one end is "open" (or covered by a thin membrane in the case of SO_2) and the other closed. The closed end contains an absorbent for the gaseous species to be monitored, in this case SO_2 or NO_2. The tube is mounted vertically with the open (or membrane) end at the bottom. Ambient SO_2 or NO_2 diffuses up the tube during exposure, and is absorbed as sulphate or nitrate respectively. 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 SO_2 and 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 AEA Technology for analysis. In this study, SO_2, NO_2 and BTEX tubes were exposed in 4- or 5- weekly batches, corresponding to the calendar of exposure periods used in the UK NO_2 Network.

The diffusion tube methodologies provide data that are accurate to $\pm$ 20% for SO_2, $\pm$ 25% for NO_2, and $\pm$ 20% for BTEX. The limits of detection are 0.4 ppb for SO_2, 0.2 ppb for NO_2 and 0.1 ppb 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.

2.4 MONITORING SITES

Monitoring of NO_2 was started in 1999 with just 3 sites. During 2000, this was expanded to the present total of 19 sites. 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.

*The Parade has been moved is now a roadside site.

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 1 - Site Locations

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. Springfields Garage
22. Stopford Road


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ST. HELIER

SO_2 monitoring was carried out at just one site during 2000 and 2001. Results from 1999 and earlier years, based on a total of 13 sites, indicated that SO_2 levels in Jersey were not likely to be high enough to constitute a problem. The single site at Clos St Andre was retained because it is in a residential area near the Bellozanne Valley waste incinerator (a potential source of SO_2).

Table 2 SO_2 Monitoring site

Site number	Site Name	Grid Reference	Description
S13	Clos St Andre	638 499	Residential area near Bellozanne Valley refuse incinerator.

The 2001 survey monitored BTEX at six of the same seven BTEX sites used in 1999. These are shown in Table 3. 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 Elizabeth Lane site is close to a paint spraying process, and the Springfields Garage site is located by a fuel filling station, both possible sources of hydrocarbon emissions. The Stopford Road site is located at a house between two petrol stations. (During the 1999 survey, this site was actually located inside the house to investigate reports of odours by residents; it has since been moved outside). The Clos St Andre site is located near the Bellozanne Valley waste incinerator.

Table 3. BTEX Monitoring sites

Site number	Site Name	Description
BTEX 1	Beresford Street	Urban roadside
BTEX 2	Le Bas Centre	Urban background
BTEX 3	Elizabeth Lane	Urban background near paint spraying process
BTEX 4	Springfields Garage	Urban background near fuel filling station
BTEX 6	Stopford Road (outdoors)	Outdoor urban background site, at house between two petrol stations.
BTEX 7	Clos St Andre	Residential area near Bellozanne Valley refuse incinerator.

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 4, and Figures 2 (roadside sites) and 3 (background sites). Individual monthly mean NO_2 results ranged from 2.1ppb (measured in August at the rural background site at Rue des Raisies), to 32.0 ppb, (measured in January 2001 at the kerbside Georgetown site). Annual mean NO_2 concentrations ranged from 3.9 ppb (at Rue des Raisies) to 25.9ppb at the kerbside Weighbridge site. The latter is at a bus station.

3.1.2 Comparison with NO_2 Standards and Guidelines

The standards and guidelines for NO_2 are shown in Appendix 1. Many of the limits for NO_2 are based on short averaging periods, such as 15-minute or 24-hour means. As diffusion tubes have a much longer sampling period, it is only possible to compare the results from this study against limits relating to longer periods, such as the annual mean.

The WHO guideline[7] for NO_2 is that the annual mean should not exceed 21 ppb. The guideline of 21ppb was exceeded at 4 Jersey sites (all roadside) in 2001.

The EC 1st Daughter Directive contains limits for NO_2 as follows:

- 105 ppb (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.
- 21 ppb (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 total oxides of nitrogen (NO_X), of 16 ppb (30 $\mu g\ m^{-3}$) as an annual mean, for protection of vegetation (relevant in rural areas).

The UK Air Quality Strategy contains standards 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. These are as follows:

- 105 ppb (200 $\mu g\ m^{-3}$) as an hourly mean, not to be exceeded more than 18 times per calendar year. To be achieved by 31 December 2004.
- 21 ppb (40 $\mu g\ m^{-3}$) as an annual mean, for protection of human health. To be achieved by 31 December 2004.
- 16 ppb (30 $\mu g\ m^{-3}$) as an annual mean, for total oxides of nitrogen (NO_X), for protection of vegetation (relevant in rural areas). To be achieved by 31 December 2000.

The annual mean NO_2 concentrations at four roadside sites exceeded 21ppb; Weighbridge, Georgetown, Beaumont and La Pouquelaye. All seven kerbside or roadside sites had annual mean NO_2 concentrations greater than 19ppb, and therefore appear to be close to the limit. The 16ppb limit for protection of vegetation is only applicable at the one rural background site, Rue des Raisies. However, the annual mean NO_2 concentration at this site was well within the limit.

Table 4.NO_2 Diffusion Tube Results 2001, Jersey. Concentrations in ppb.

Site From - To:	3 Jan - 31Jan	31 Jan - 28 Feb	28 Feb - 4 Apr	4 Apr - 2 May	2 May - 30 May	30 May - 4 Jul	4 Jul - 1 Aug	1 Aug - 5 Sep	5 Sep - 3 Oct	3 Oct - 31 Oct	31 Oct - 5 Dec	5 Dec - 3 Jan	**Average**
Le Bas Centre	19.4	17.6	18.1	16.4	15.1	13.7	16.0	15.2	15.9	16.2	17.1	15.9	**16.4**
Mont Felard	17.1	16.4	15.5	14.1	13.6	5.6	12.3	10.0	13.3	12.9	16.7	10.6	**13.2**
Les Quennevais	9.5	7.5	5.8	3.3	6.4	4.0	3.9	3.1	4.0	No data	6.3	7.7	**5.6**
Rue Des Raisies	8.5	5.9	4.2	2.4	4.2	2.5	2.6	2.1	2.6	3.4	4.3	No data	**3.9**
First Tower	24.7	23.2	25.8	20.2	18.7	16.9	22.4	15.4	20.5	20.6	21.7	19.6	**20.8**
Weighbridge	27.6	27.6	28.6	27.6	22.6	21.2	28.6	24.0	29.2	26.0	28.0	19.9	**25.9**
Langley Park	17.2	13.5	10.9	8.6	8.1	7.3	8.3	7.8	8.4	10.5	11.8	11.7	**10.3**
Georgetown	32.0	25.9	22.8	22.1	20.3	17.9	22.5	18.1	21.2	20.9	26.4	28.3	**23.2**
Clos St.Andre	13.6	11.2	9.0	6.4	5.2	5.4	6.3	6.0	6.4	8.7	9.5	3.3	**7.6**
L'Avenue et Dolmen	No data	15.3	12.2	8.4	8.3	7.8	9.7	7.4	9.4	11.8	14.5	14.2	**10.8**
Robin Place	21.2	17.8	15.3	13.3	12.8	9.7	13.5	12.3	13.1	17.8	17.2	13.9	**14.8**
Beaumont	27.2	No data	22.3	24.4	22.2	24.3	25.0	21.4	24.9	23.3	25.7	19.7	**23.7**
The Parade	25.7	21.6	19.2	19.1	18.5	15.1	20.3	15.1	19.2	19.1	22.4	19.5	**19.6**
Maufant	9.5	6.8	4.6	3.9	5.5	4.6	4.1	3.5	3.9	4.2	6.8	7.5	**5.4**
Jane Sandeman	14.3	12.4	10.5	7.9	8.1	5.5	7.3	5.2	8.0	8.4	12.6	11.1	**9.3**
Saville Street	20.4	18.5	19.0	18.3	17.4	12.2	16.7	12.2	15.5	15.3	19.6	16.1	**16.8**
Broad Street	No data	11.4	24.3	23.4	24.0	21.4	23.7	11.3	23.2	No data	23.6	20.4	**20.7**
Beresford Street	23.1	20.8	21.4	17.7	18.0	13.6	16.9	12.6	17.0	18.0	20.3	18.1	**18.1**
La Pouquelaye	28.0	24.6	28.4	23.2	21.0	21.7	23.6	15.4	21.1	20.9	25.8	23.8	**23.1**

Figure 2. Monthly mean nitrogen dioxide concentrations for Kerbside and Roadside sites, 2001

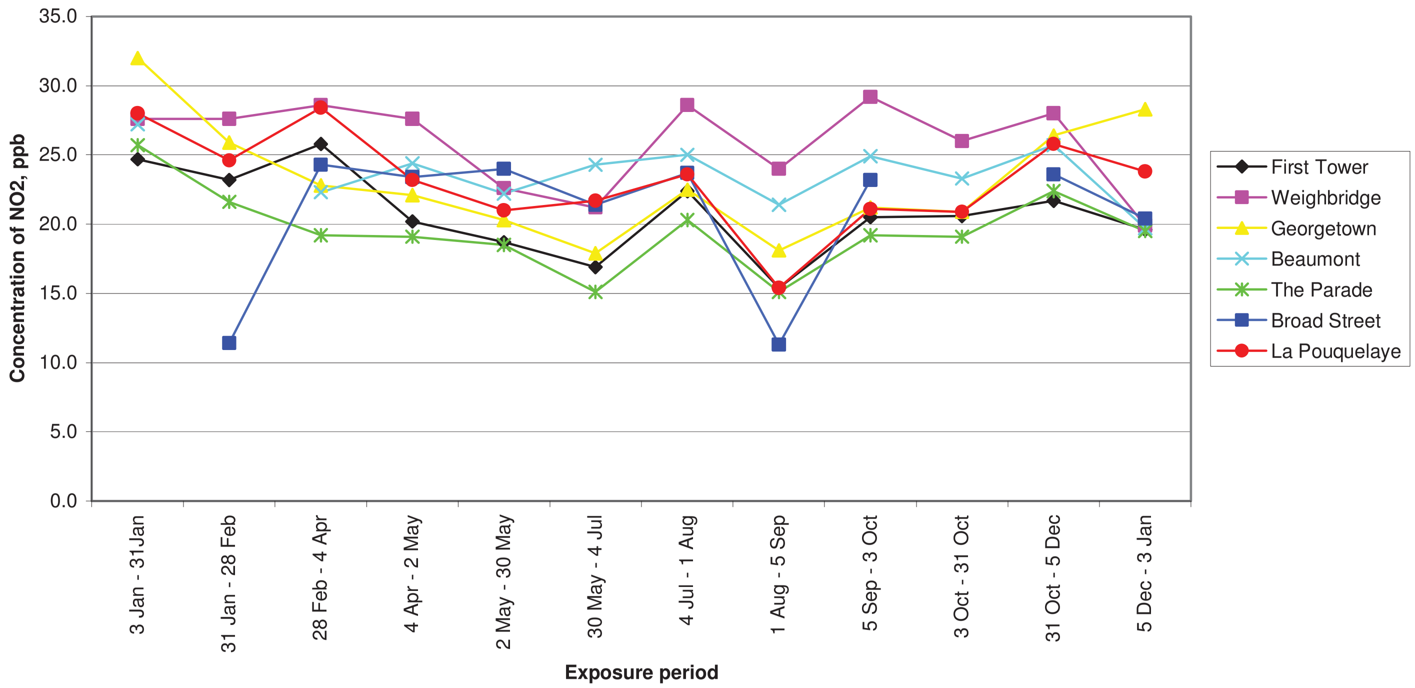
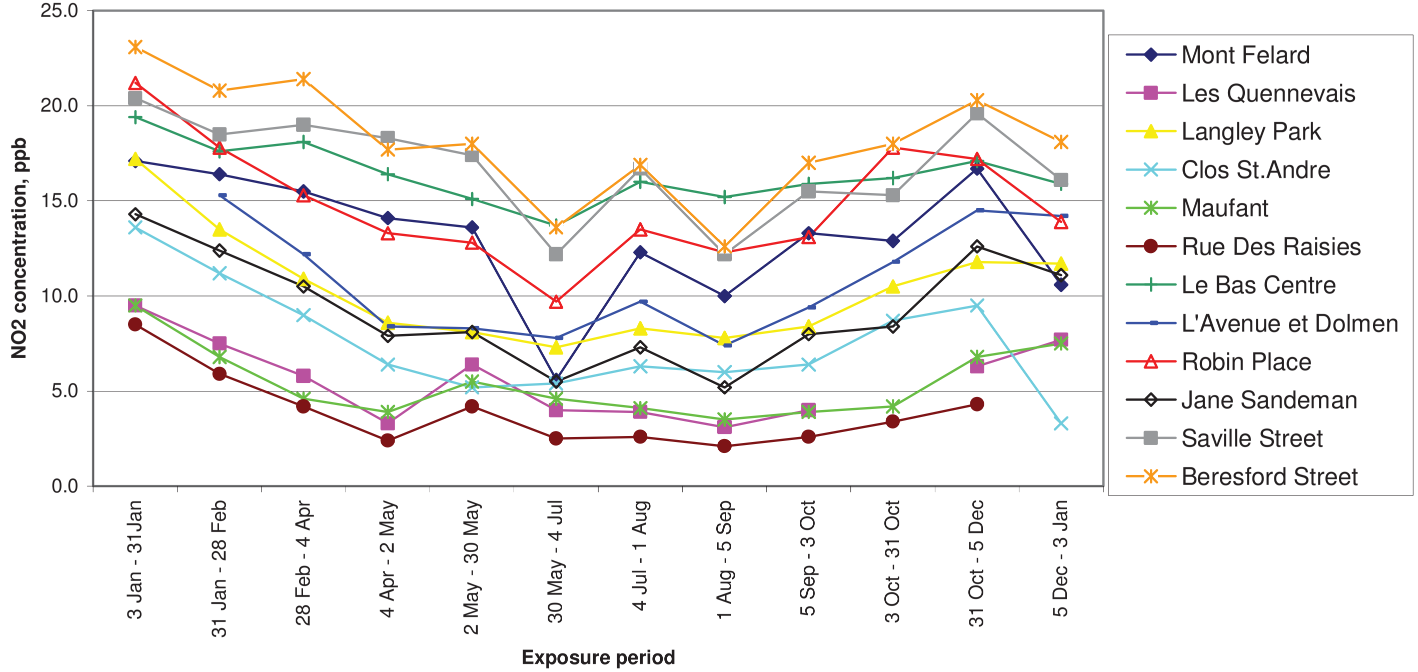


Figure 3 Monthly mean NO2 concentrations at background sites, 2001



As well as having typically lower NO_2 concentrations, the urban background sites show more seasonal variation than the roadside sites. This is likely to reflect the fact that the background sites are more affected by sources such as domestic heating, which increase during the winter. By contrast, NO_2 concentrations at the roadside sites are dominated by traffic emissions, which do not generally increase during winter.

3.1.3 Comparison with UK NO_2 data

The UK Nitrogen Dioxide Survey monitored this pollutant at around 1300 sites across the UK during 2001, 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 national annual averages for 2001 are not yet available. However, data for 2000 are useful for comparison, as these are unlikely to have changed substantially. National UK NO_2 Network averages for 2000 were 20ppb for kerbside sites and 11ppb for urban background sites. These are consistent with the 2001 averages for Jersey; 22ppb for roadside sites and 11ppb for background sites.

Table 5 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 5 - Comparison of NO_2 in Jersey with UK Automatic Sites

Site	2001 Annual average NO_2, ppb
Exeter Roadside	22
Plymouth Centre	17
Lullington Heath	6.6
Harwell	8.9

The annual mean NO_2 concentration at most of the roadside sites in Jersey were comparable with that measured at Exeter Roadside site. The annual mean at the Jersey Weighbridge site was somewhat higher, but this site is located at a bus station. Most of the urban background sites had annual mean NO_2 concentrations comparable with, or lower than, Plymouth Centre. Background sites well outside Jersey's larger towns (e.g. Les Quennevais, Clos St Andre, Maufant) were more comparable with rural sites such as Harwell. The annual mean from the rural background site, Rue des Raisies, was somewhat lower than at Harwell or Lullington Heath.

3.1.4 Trends in nitrogen dioxide concentrations

Most of the sites have been operating for only two years. Annual mean concentrations for 2001 were within ± 1ppb of those measured during 2000 for 12 of the 19 sites, with no consistent pattern of increase or decrease. Of the other seven sites, three increased, three decreased, and one (the Parade) had been moved to a roadside location, so the comparison was not valid.

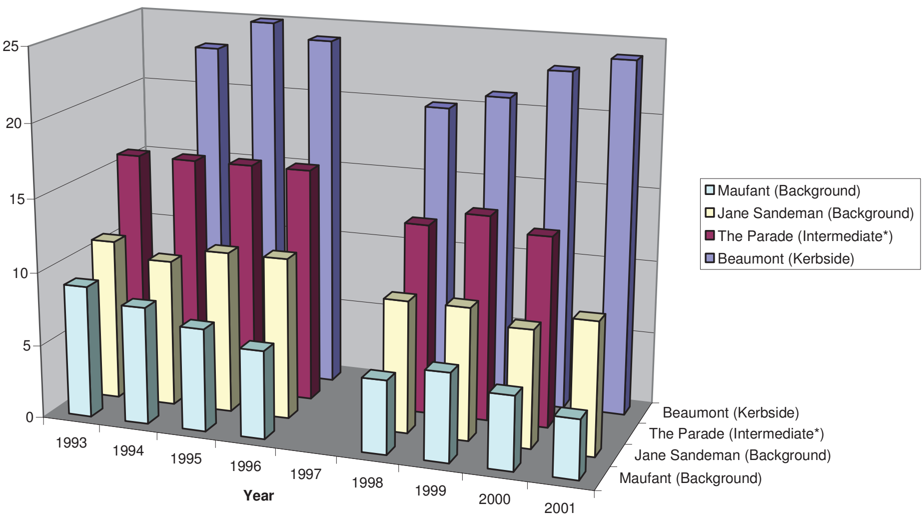
However, there are four sites that have been in operation since 1993, as part of the UK Nitrogen Dioxide Network. Annual mean concentrations are shown in Table 6 and Figure 4. These data show that NO_2 concentrations have remained relatively stable over the period, with a small decrease since the mid-1990s. The Beaumont site is an exception, as it shows an increasing trend in recent years.

Table 6 Annual mean NO_2 concentrations at Long-Term Sites

Site	1993	1994	1995	1996	1997	1998	1999	2000	2001
Beaumont (Kerbside)	-	23	25	24	No data	20	21	23	24
The Parade (Intermediate*)	16	16	16	16	No data	13	14	13	Site moved
Jane Sandeman (Background)	11	10	11	11	No data	9	9	8	9
Maufant (Background)	9	8	7	6	No data	5	6	5	5

**Intermediate sites were discontinued at the end of 2000. This site was replaced by a Roadside site, also at the Parade.*

Figure 4. Trends in NO2 Concentration, long-term sites, 1993 - 2001 (ppb)



3.2 SULPHUR DIOXIDE

3.2.1 Summary of SO_2 Results

As from 2000, SO_2 monitoring has been carried out at single site, Clos St Andre. The monthly results for SO_2 at this site are shown in Table 7.

Ambient SO_2 concentrations at Clos St Andre were low during 2001, less than 3ppb during all months except December, when concentrations rose to over 8ppb. The annual mean SO_2 concentration at Clos St Andre was 2.6ppb.

3.2.2 Comparison with SO_2 Standards and Guidelines

The standards and guidelines for SO_2 are presented in Appendix 1. Most of the limits for SO_2 are based on short averaging periods, such as 15-minute or 24-hour means. It is only possible to compare diffusion tube results with limits relating to longer periods, such as the annual mean.

The WHO guidelines contain a guideline of 17ppb for the annual mean. The 2001 annual mean SO_2 result for Clos St Andre was well within this value.

EC Directive 1999/30/EEC [8](the first Daughter Directive) contains a limit of 8ppb for the annual (calendar year) and winter (October to March) mean SO_2 concentration, for the protection of ecosystems. This is only applicable in rural areas, and therefore strictly does not apply to Clos St Andre. However, the annual mean of 2.6ppb was well below this limit.

The UK Air Quality Strategy contains standards for SO_2 similar to those contained in the EC Directive above; a limit of 8ppb for the annual (calendar year) and winter (October to March) mean SO_2 concentration, for the protection of ecosystems. Again, this is only applicable in rural areas but the Clos St Andre annual mean was well within this limit.

Table 7. SO_2 Diffusion Tube Results 2001, Jersey. Concentrations in ppb.

Site	From - To:	3 Jan - 31Jan	31 Jan - 28 Feb	28 Feb - 4 Apr	4 Apr - 2 May	2 May - 30 May	30 May - 4 Jul	4 Jul - 1 Aug	1 Aug - 5 Sep	5 Sep - 3 Oct	3 Oct - 31 Oct	31 Oct - 5 Dec	5 Dec - 3 Jan	**Average**
Clos St.Andre		2.7	2.6	1.6	1.6	2.6	2.5	1.9	1.1	2.6	1.1	2.8	8.2	**2.6**

3.2.3 Comparison with UK SO_2 Data

Table 8 shows how the 2001 SO_2 data from Clos St Andre compares with a selection of UK air quality monitoring stations using automatic (UV fluorescence) SO_2 analysers. The automatic sites used for comparison are the same as used in the case of NO_2; the descriptions are given in section 3.1.3.

Table 8 - Comparison of SO_2 at Clos St Andre with UK Sites

Site	Annual average SO_2, ppb
Diffusion Tubes	
Clos St Andre	2.6
UK Automatic Sites	
Exeter Roadside	1.0
Plymouth Centre	2
Lullington Heath	1.0
Harwell	1.1

The annual mean SO_2 concentration at Clos St Andre appears to be comparable with that measured at the Plymouth Centre urban site in the UK, but higher than roadside or rural sites.

3.2.4 Comparison with previous years' SO_2 results

The 2001 annual mean of 2.6ppb was consistent with the 2000 annual mean of 2.2ppb, and the 1999 annual mean of 2.7ppb, measured at this site.

3.3 HYDROCARBONS

3.3.1 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.

The diffusion tube results show that average outdoor hydrocarbon concentrations in Jersey remain generally low. A summary of annual average hydrocarbon concentrations is shown in Table 9.

Table 9. Summary of Average Hydrocarbon Concentrations, Jersey, 2001

Site	Benzene, ppb	Toluene, ppb	Ethyl Benzene, ppb	m+p Xylene, ppb	o Xylene, ppb
Beresford Street	1.0	3.9	0.8	2.2	0.8
Le Bas Centre	0.8	3.5	0.6	1.7	0.7
Elizabeth Lane *(near paint spraying)*	0.7	4.1	0.7	2.0	0.8
Springfields Garage *(petrol station)*	2.1	11.2	1.8	5.2	1.9
Stopford Road *(petrol stations)*	1.8	12.2	2.2	6.8	2.6
Clos St Andre	0.4	1.2	0.3	0.6	0.3

Highest average concentrations of benzene were found at Springfields Garage and Stopford Road. Average concentrations were low - less than 3ppb at all sites.

Toluene concentrations were mostly less than 6ppb; however, concentrations exceeded 10ppb at the majority of sites during November.

Figure 5. Monthly mean hydrocarbon concentrations at Beresford Street, 2001

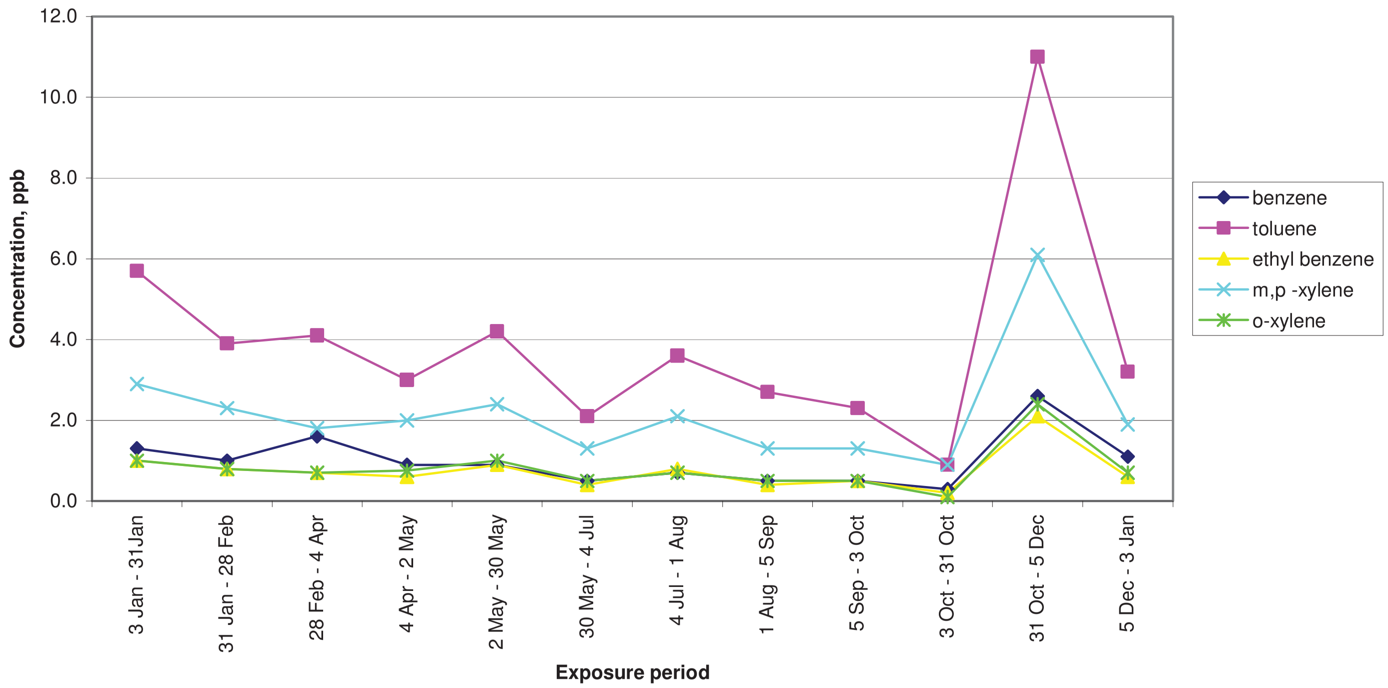


Figure 6. Monthly mean hydrocarbon concentrations at Le Bas Centre, 2001

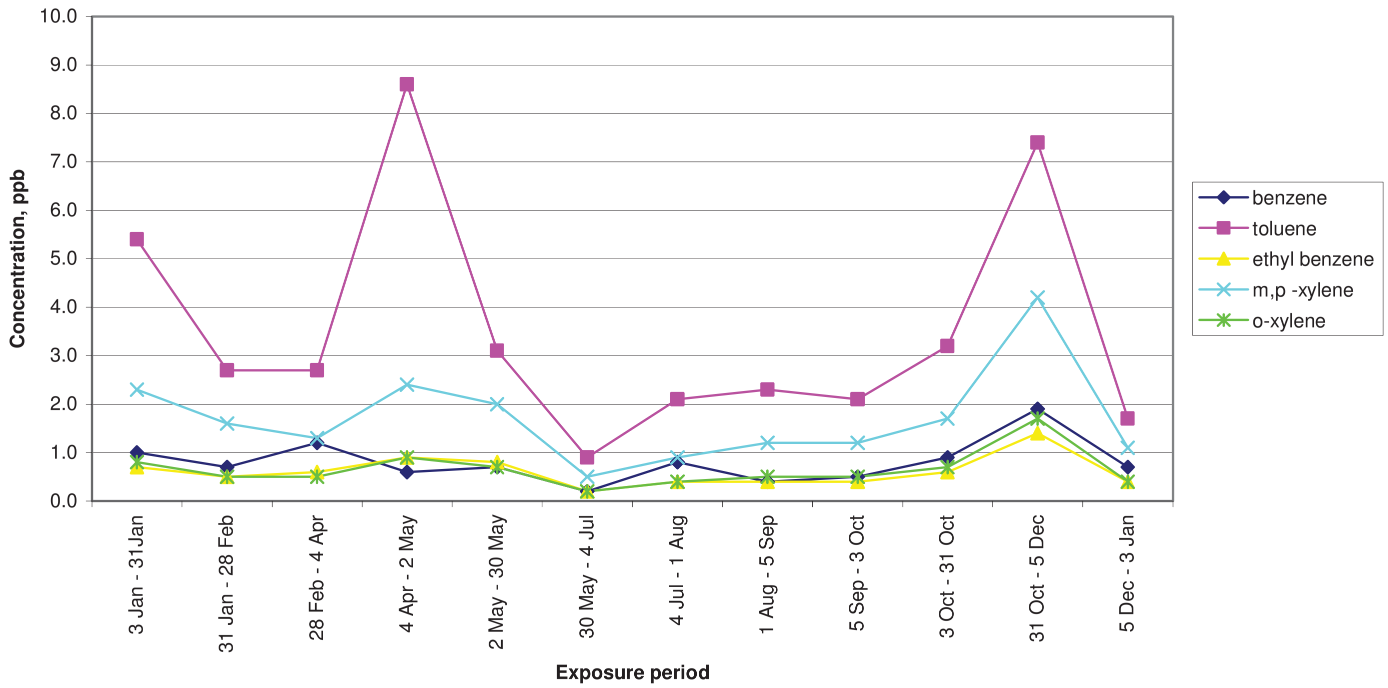


Figure 7. Monthly mean hydrocarbon concentrations at Elizabeth Lane, 2001

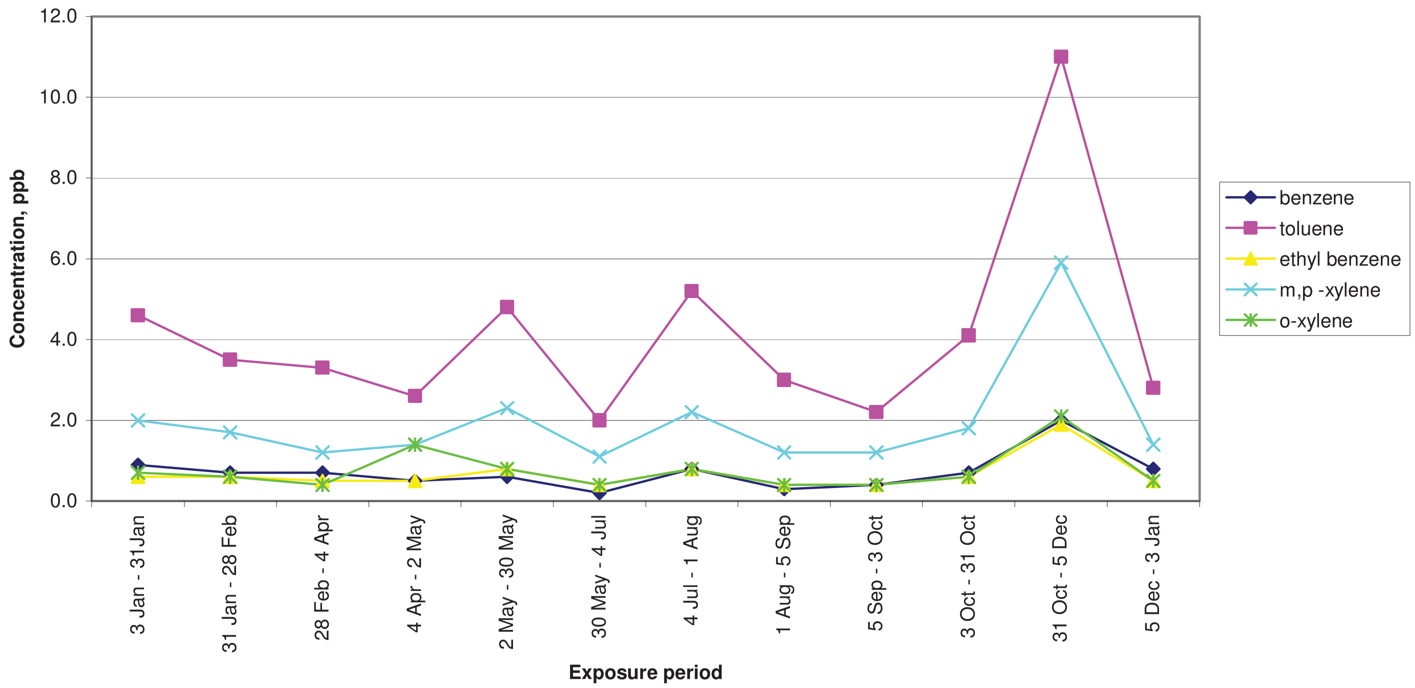


Figure 8. Monthly mean concentrations of hydrocarbon concentrations at Springfields Garage

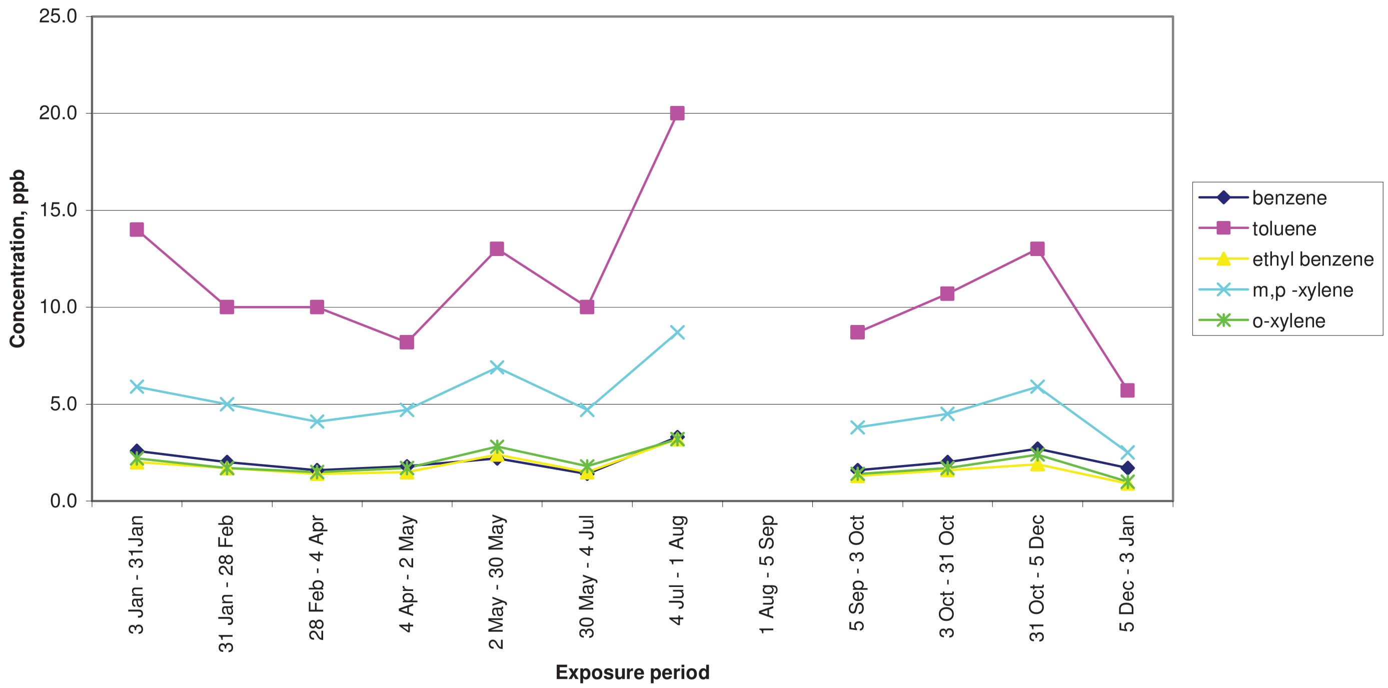


Figure 9. Monthly mean hydrocarbons at Stopford Road (outdoors) 2001

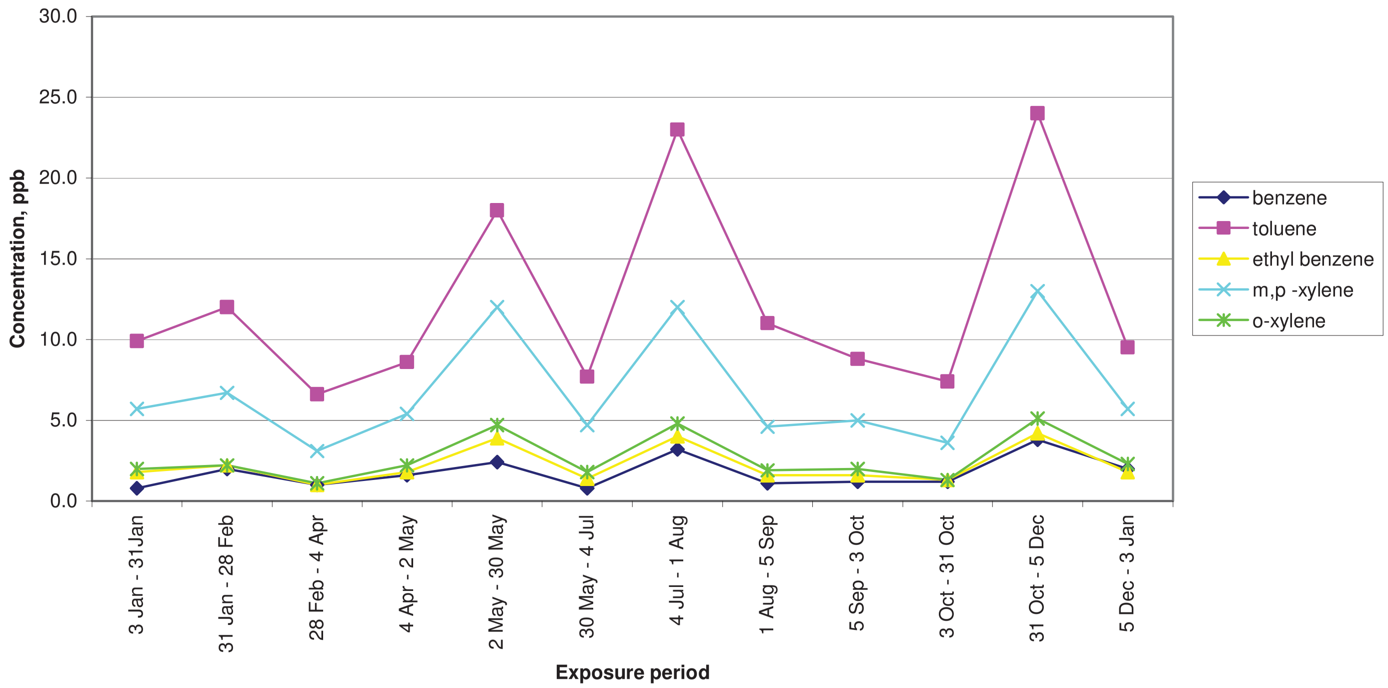
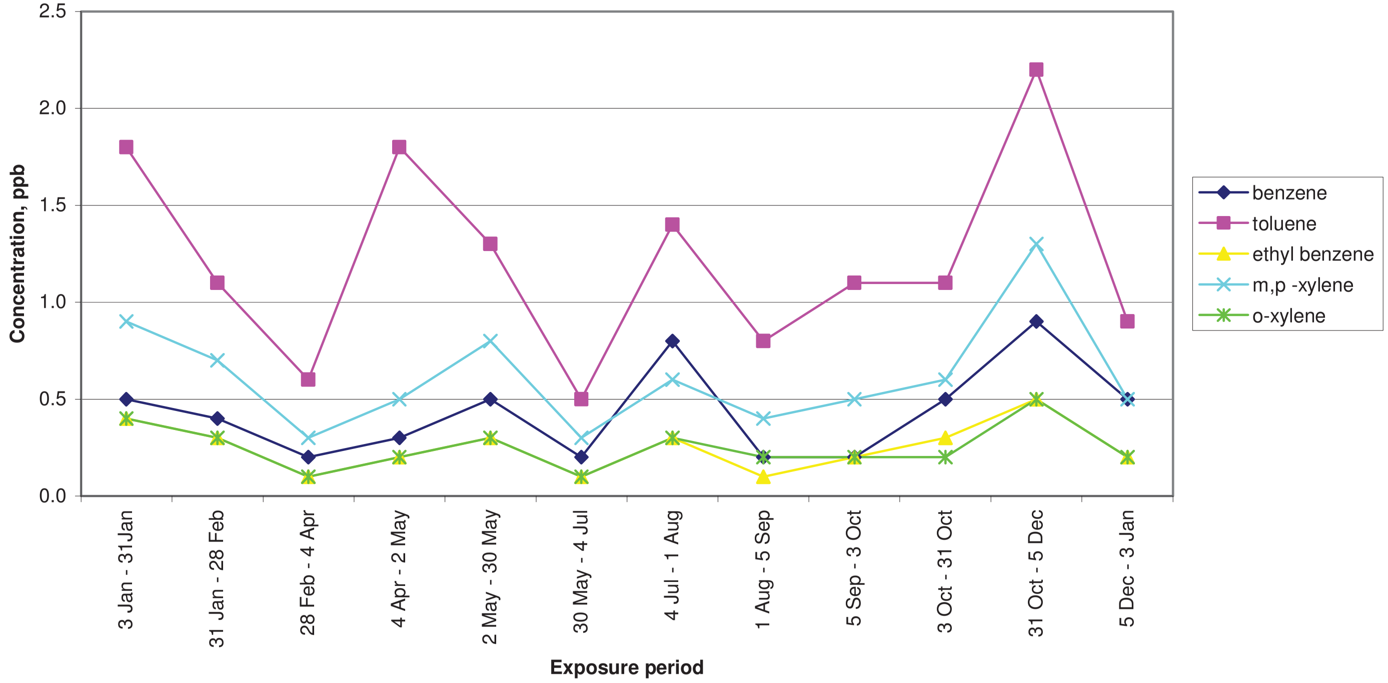


Figure 10 Monthly mean hydrocarbon concentration at Clos St Andre 2001



3.3.2 Comparison with Hydrocarbon Standards and Guidelines

Of the range of hydrocarbon species monitored, only benzene is the subject of any applicable air quality standards. The UK Air Quality Strategy sets an objective for the running annual mean of 5ppb, to be achieved by 31 December 2003. The annual mean benzene concentration (which can be considered a good indicator of the running annual mean), did not exceed 5ppb at any of the sites.

The EC 2nd Daughter Directive[9] sets a limit of 5μg m^{-3} (1.5ppb) to be achieved by 2010. This limit value was exceeded at Springfields Garage and Stopford Road. Both these sites are near petrol stations.

3.3.3 Comparison with UK Benzene Data

Table 10 compares the benzene data from the 2001 Jersey survey with a selection of automatic UK air quality monitoring stations. (Unfortunately, changes to the UK Hydrocarbon Network mean that not all of the sites used for comparison in 2000 are still in operation). The sites used for comparison are as follows:

- London Marylebone Road - an urban kerbside site, located on a major route into Central London. Heavily traffic, and surrounded by tall buildings.
- Edinburgh Medical School - an urban centre site, located in a street “canyon” in central Edinburgh, also surrounded by heavy traffic and tall buildings.
- Cardiff East - a residential site to the east of the city.
- Harwell - a rural site in the south of England, within 10km of a power station.

Table 10 - Comparison of benzene in Jersey with UK Sites

Site	Annual average benzene, ppb
Diffusion Tubes	
Beresford Street	1
Le Bas Centre	0.8
Elizabeth Lane	0.7
Springfields Garage	*2.1*
Stopford Road (outdoor)	*1.8*
Clos St Andre	0.4
UK Automatic Sites - calendar year 2001	
London Marylebone Rd	1.6
Edinburgh Medical Sch.	0.5
Cardiff East	0.5
Harwell	0.2

Results from the urban background sites on Jersey are broadly similar to urban measurements from the UK.

Elizabeth Lane, Springfields Garage and Stopford Road are shown in *italics*, as they are close to specific benzene sources, and therefore not comparable with any of the UK automatic sites. The Springfield Garage annual mean benzene concentration was substantially higher than those measured at UK automatic sites. Most automatic sites are deliberately sited well away from petrol stations etc.

3.3.4 Comparison with Previous Years' Hydrocarbon Data

Four of the sites (Beresford Street, Le Bas Centre, Elizabeth Lane and Springfields Garage) have been operating since 1997. The 2001 hydrocarbon concentrations were consistent with the previous year, and in some cases lower. There has been a significant reduction in benzene concentrations at all sites since monitoring began in 1997. Table 11 illustrates the trends for these sites, also Stopford Road (outdoor) and Clos St Andre. The Stopford Road site has not been included as a long-running site, as prior to 2000 it was located indoors.

Table 11. Comparison of Hydrocarbon Concentrations, Jersey, 1997 - 2001.

	benzene, ppb	toluene, ppb	Ethyl benzene, ppb	m+p xylene, ppb	o-xylene, ppb
Beresford Street					
1997	3.2	5.4	1.2	1.2	2.7
1998	2.5	4.9	0.9	1.0	2.3
1999	1.8	3.6	0.6	1.7	0.8
2000	0.9	3.7	0.8	2.3	0.9
2001	1.0	3.9	0.8	2.2	0.8
Le Bas Centre					
1997	2.8	4.5	1.2	1.0	2.2
1998	2.3	4.2	0.7	0.9	1.9
1999	1.1	2.9	0.5	1.3	0.6
2000	0.9	3.3	0.7	1.9	0.7
2001	0.8	3.5	0.6	1.7	0.7
Elizabeth Lane					
1997	1.9	4.4	1.4	1.7	2.2
1998	1.9	5.0	0.7	1.6	0.8
1999	1.0	3.3	0.5	1.2	0.6
2000	0.7	3.3	0.7	1.8	0.6
2001	0.7	4.1	0.7	2.0	0.8
Springfields Garage					
1997	7.7	12.5	1.9	1.9	4.3
1998	7.7	12.3	1.5	1.7	4.3
1999	4.5	10.9	1.3	3.8	1.5
2000	1.6	9.2	1.8	5.0	2.0
2001	2.1	11.2	1.8	5.2	1.9
Stopford Road Outdoor					
2000	1.2	8.4	1.8	5.3	2.2
2001	1.8	12.2	2.2	6.8	2.6
Clos St Andre					
2000	0.3	0.9	0.2	0.6	0.2
2001	0.4	1.2	0.3	0.6	0.3

Annual mean concentrations of most hydrocarbon species have decreased over the five years of monitoring. The exception appears to be m+p xylene, which has shown an increase at all sites except Elizabeth Lane. This is illustrated in Figures 11 to 15.

Figure 11. Trends in Benzene Concentration

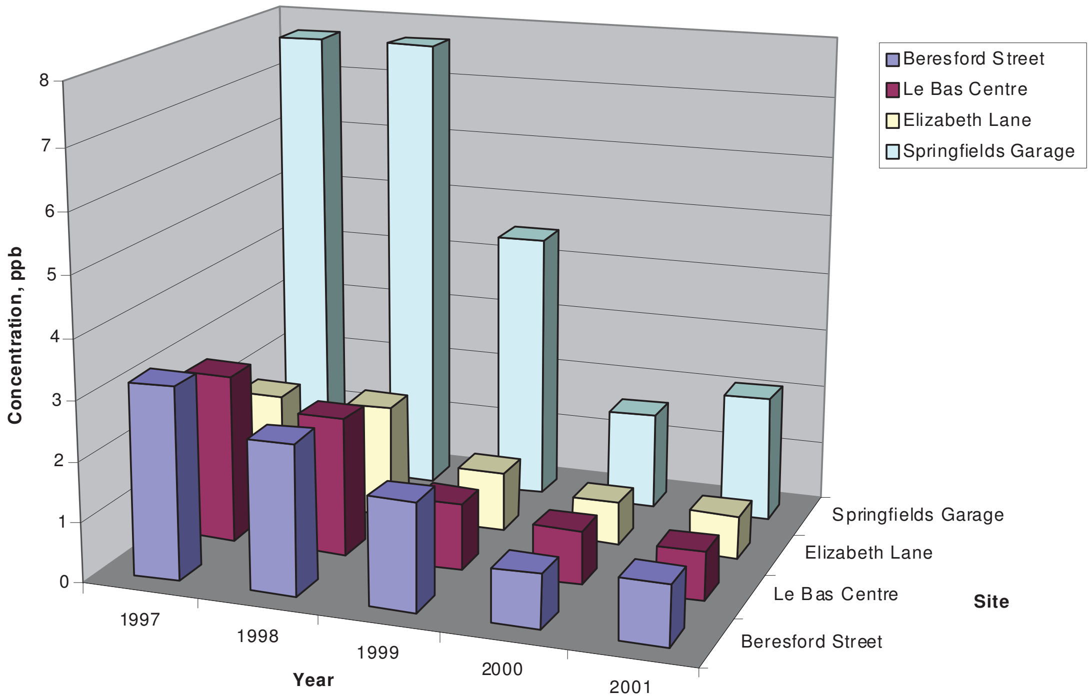


Figure 12 Trends in toluene concentration

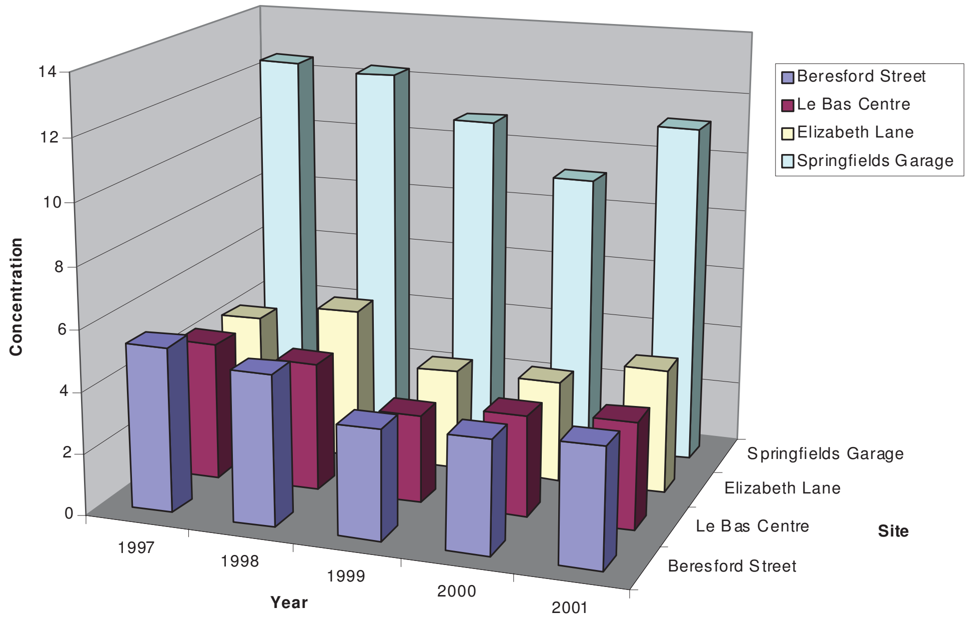


Figure 13 Trends in Ethylbenzene concentration

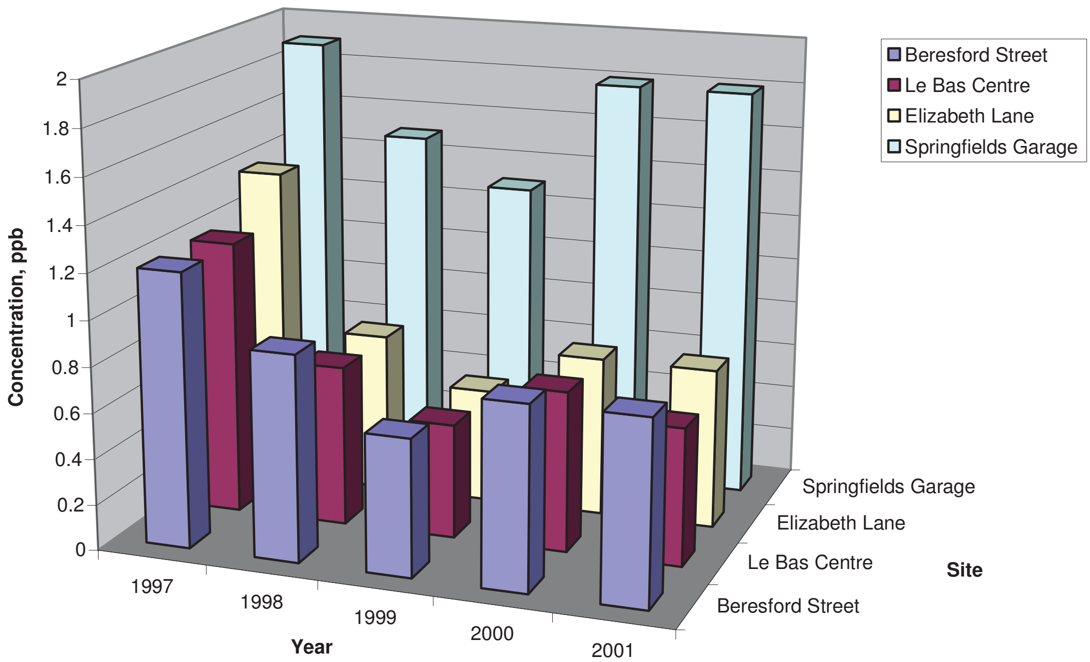


Figure 14 Trends in m+p Xylene concentration

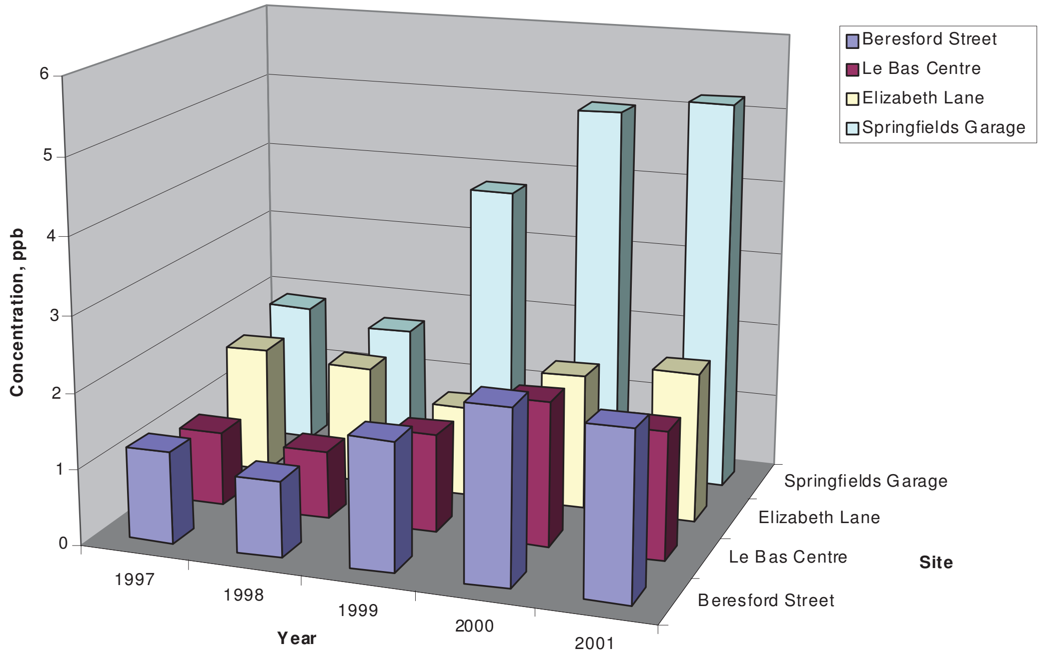
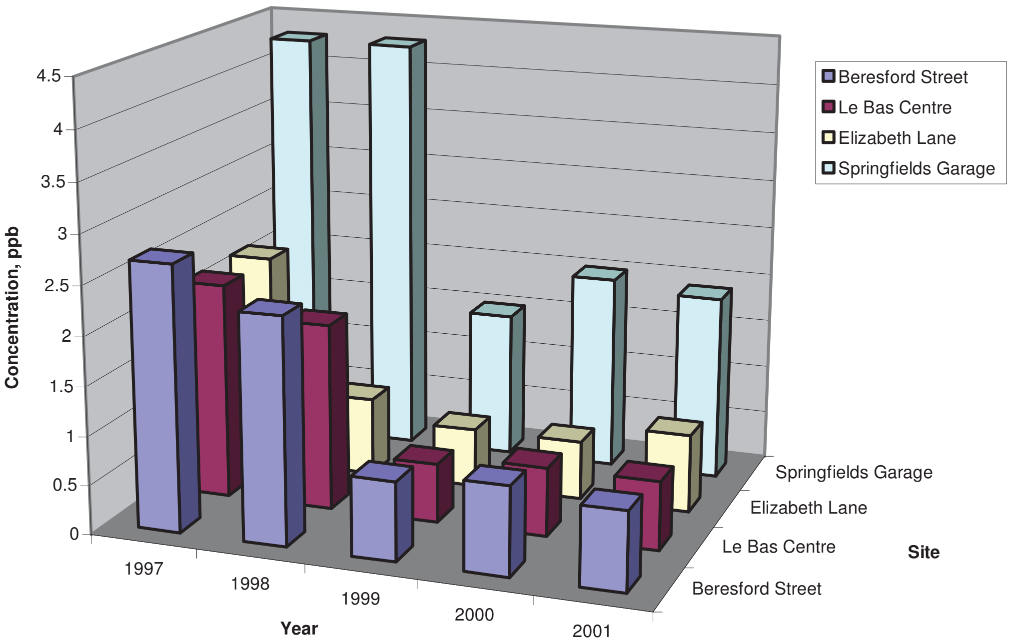


Figure 15 Trends in o-Xylene concentration



3.3.5 Concentration Ratio Analysis

In 1993, the Photochemical Oxidant Review Group (PORG)[11] identified that where the main source of organic pollutants is vehicle exhaust, the ratios of the concentrations were as follows:

- Toluene: benzene - 2.0
- m+p xylene: benzene - 1.8.

Where the main source is petrol evaporation, the ratios of the concentrations were different:

- Toluene: benzene - 2.4
- m+p xylene: benzene - 1.6.

However, in January 2000, the maximum permitted benzene content of petrol was reduced from 2% in unleaded (5% in super unleaded), to 1% in all petrol sold in the UK. The toluene content has not substantially changed. Therefore, it is likely that the ratios of toluene and xylene to benzene are higher now than in 1993.

As a more up-to- date indication, data from the UK Hydrocarbon Network's roadside site at Marylebone Road in central London, where the dominant source of hydrocarbons is vehicle exhaust, indicate that the toluene: benzene ratio has risen from 2.0-2.3 in 1997-1999, to about 3.8 in 2000-2001.

Table 12 Ratios of Hydrocarbon Concentrations

Ratios of Hydrocarbons	**Toluene:benzene**	**m+p xylene: benzene**
Beresford Street	3.90	2.20
Le Bas Centre	4.38	2.13
Elizabeth Lane	*5.71*	*2.72*
Springfields Garage	*5.33*	*2.48*
Stopford Road (outdoor)	*6.94*	*3.86*
Clos St Andre	3.00	1.50
Typical for vehicle exhaust (1993)	2	1.8
Typical for petrol evaporation (1993)	2.4	1.6
Marylebone Road 2000-2001	3.8	-

The background sites on Jersey (Beresford Street, Le Bas and Clos St Andre) have toluene: benzene ratios comparable with that observed in recent years at Marylebone Road: the mean toluene to benzene ratio for these 3 sites alone is 3.8. At Elizabeth Lane (near a paint spraying process), Springfield Garage and Stopford Road (both near petrol stations), the ratios are much higher.

4 Conclusions

- AEA Technology Environment has undertaken a year-long diffusion tube monitoring study in Jersey during 2001, on behalf of the States of Jersey Public Health Services and Planning and Environment Department. This was the fifth such extended study, and continued from the end of the 2000 study, running from 3rd January 2001 to 3rd January 2002.
- Diffusion tubes were used to monitor NO_2 at 19 sites, SO_2 at 1 site, and hydrocarbons (benzene, toluene, ethyl benzene and xylenes, collectively termed BTEX) at 6 sites. The sites were located at a range of different locations on the island, mainly those that had been used in 2000.
- All tubes were exposed for 4- or 5-week periods, in line with the "months" of the UK NO_2 Network calendar.

NO_2 tube results

- The annual mean NO_2 concentrations at four roadside and kerbside sites (Weighbridge, Georgetown, Beaumont and La Pouquelaye) exceeded 21ppb. It is therefore likely that these four sites currently exceed the annual mean Limit Value of 21ppb contained in the 1st Daughter Directive, 1999/30/EEC. However, the sites have until 2010 to meet this limit.
- The results also indicate that these four sites do not currently meet the UK Air Quality Strategy standard of 21ppb for the annual mean, which is to be achieved by 31 December 2005.
- All seven roadside and kerbside sites in this survey had annual mean NO_2 concentrations greater than 19ppb, and therefore appear to be close to the above limit values. Annual mean NO_2 concentrations at all background sites were well below the limit.
- Trends in NO_2 concentration were investigated using four long-running sites, which have operated since 1993 as part of the UK NO_2 Network. While NO_2 concentrations at the two urban background sites (Jane Sandeman and Maufant) have remained stable or decreased slightly, the kerbside site (Beaumont) shows an increasing trend.
- At most of the 19 sites in this study, annual mean concentrations have remained steady when compared to those measured during 2000.

SO_2 tube results

- The annual mean SO_2 concentration at the single site, Clos St Andre, was 2.6ppb. This is comparable with UK sites and consistent with the two previous years.

Hydrocarbon tube results

- Two sites had annual mean benzene concentrations greater than the EC 2nd Daughter Directive Limit of 1.5ppb. These were at Springfields Garage and Stopford Road (both near petrol stations). This limit is to be achieved by 2010.

- No sites had annual mean benzene concentrations greater than the Air Quality Strategy standard of 5ppb, which is to be achieved by the end of 2003.
- Four of the BTEX sites (Beresford Street, Le Bas Centre, Elizabeth Lane, and Springfields Garage) have been in operation since 1997, and therefore yield some information on trends. Results from these sites appear to show a decreasing trend in BTEX hydrocarbon concentrations, with the exception of m+p xylene, which has increased at all sites.

5 Recommendations

1. 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, there appear to be some roadside locations that may fail to do so. Measurements from diffusion tube surveys inevitably carry a high uncertainty, and are not sufficient on their own for determining compliance with Objectives and Directives. It is recommended that the States of Jersey consider using a mobile automatic analyser, to investigate such sites further.

2. The series of diffusion tube surveys has proved very effective in providing information on spatial distribution of pollutant concentrations, and on trends. However, these data are retrospective, and they are unable to clearly highlight short-term pollution episodes. The States of Jersey should consider funding a permanent monitoring station, the results of which will offer the Island Government many advantages:

- Islanders can be provided with rapid information about air quality. Dissemination of this information could be helpful to people who are particularly sensitive to pollution exposure (e.g. asthma sufferers).
- The data from automatic analysers can be directly compared with data from EC Member States monitoring networks, subject to suitable data quality control procedures.
- Data can be used to monitor compliance with Objectives and Directives, and for determining policy.

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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3. Air Quality Monitoring in Jersey; Diffusion Tube Surveys 1999. B Stacey, A Loader, report no. AEAT-EQ0191, March 2000.
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5. EH40/97. Occupational Exposure Limits 1997. Health & Safety Executive. HMSO, ISBN 0-7176-1315-1.
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7. Guidelines for Air Quality, WHO, Geneva, 2000, WHO/SDE/OEH/00.02. www.who.int/peh/air/airqualitygd.htm
8. Council Directive 1999/30/EEC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air. 22 April 1999.
9. Council Directive 2000/69/EC relating to limit values for benzene and carbon monoxide in ambient air. 16 Nov 2000.
10. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Department of the Environment, Transport and the Regions. January 2000, ISBN 0 10 145482-1
11. PORG (1993) Ozone in the United Kingdom 1993, Third Report of the UK Photochemical Oxidants Review Group, ISBN 0-7058-1683-4.

Appendices

CONTENTS

Appendix 1
Air Quality Standards

Air Pollution Guidelines Used in this Report.

Nitrogen Dioxide

			Value / ppb (μgm^{-3})
UK Government	LOW Air Pollution		< 150 (287)
- Air Pollution Bandings	MODERATE Air Pollution	1-hour mean	150 - 299 (287 - 572)
	HIGH Air Pollution		300 - 399 (573 - 763)
	V HIGH Air Pollution		>= 400 (764)
- The Air Quality Strategy(1)	Objective for Dec. 31st 2005	1-hour mean	105 (200) not to be exceeded more than 18 times per calendar year
	Objective for Dec. 31st 2005	Annual mean	21 (40)
	Objective for Dec. 31st 2000	Annual mean NO_x Vegetation Guideline	16 (30)
European Community(2)	Limit Value	Calendar year of data: 98%ile of hourly means.	104.6 (200)
	Guide Value	98%ile of hourly means.	70.6 (135)
	Guide Value	50%ile of hourly means.	26.2 (50)
Daughter Directive(3)	Limit Value	1 hour mean	105 (200) not to be exceeded more than 18 times per calendar year
	Limit Value	Calendar year annual mean	21 (40)
	Limit Value (NO_x)	Calendar year annual mean	16 (30)
World Health Organisation(4) (Revised Guidelines)	Health Guideline	1-hour mean	110 (200)
	Health Guideline	Annual mean	21 (40)
United Nations Economic Commission for Europe	Vegetation Guideline	Annual mean	15 (29)

(1) The Air Quality Strategy.for England, Scotland, Wales and Northern Ireland. January 2000. ISBN 0-10-145482-1
(2) Council Directive 85/203/EEC
(3) Council Directive 1999/30/EC
(4) Conversions between $\mu g\ m^{-3}$ and ppb given by WHO

Benzene

			Value / ppb ($\mu g\ m^{-3}$)
UK Government - Air Pollution Bandings	-	-	-
- The Air Quality Strategy(1)	Objective for Dec. 31st 2003	Running annual mean	5 (16.25)
	Target for Dec. 31st 2005	Running annual mean	1 (3.25)
European Community	-	-	-
World Health Organisation	-	-	-
United Nations Economic Commission for Europe	-	-	-

Sulphur Dioxide

			Value / ppb (μgm^{-3})
UK Government **- Air Pollution Bandings**	LOW Air Pollution	15-minute mean	< 100 (266)
	MODERATE Air Pollution		100 - 199 (266 - 531)
	HIGH Air Pollution		200 - 399 (532 - 1063)
	V HIGH Air Pollution		>= 400 (1064)
- The Air Quality Strategy(1)	Objective for Dec. 31st 2005	15-minute mean	100 (266) not to be exceeded more than 35 times per calendar year
	Objective for Dec. 31st 2004	1 hour mean	132 (350) not to be exceeded more than 24 times per calendar year
	Objective for Dec. 31st 2004	24 hours (daily mean)	47 (125) not to be exceeded more than 3 times per calendar year
	Objective for Dec. 31st 2000	Calendar year annual mean Vegetation Guideline	8 (20)
	Objective for Dec. 31st 2000	Winter mean Vegetation Guideline	8 (20)
European Community(5)	Limit Value	Pollution Year (median of daily values)	30 (80) if smoke(6) > 34 45 (120)if sm. <= 34
	Limit Value	Winter (median of daily values Oct-Mar)	49 (130)if sm. > 51 68 (180)if sm. <= 51
	Limit Value(7)	Pollution Year (98%ile of daily values)	94 (250)if sm. > 128 131 (350)if sm. <= 128
	Guide Value	Pollution Year (mean of daily values)	15 - 23 (40 - 60)
	Guide Value	24 Hours (daily mean value)	38 - 56 (100 – 150)
Daughter Directive(8)	Limit Value	1 hour mean	132 (350) not to be exceeded more than 24 times per calendar year
	Limit Value	24 hours (daily mean)	47 (125) not to be exceeded more than 3 times per calendar year
	Limit Value	Calendar year annual mean vegetation guideline	8 (20)
	Limit Value	Winter mean vegetation guideline	8 (20)
World Health Organisation(4) **(Revised Guidelines)**	Health Guideline	10-minute mean	175 (500)
	Health Guideline	24-hour mean	44 (125)
	Health Guideline	Annual Mean	17 (50)
United Nations Economic Commission for Europe	Vegetation Guideline	Daily mean	26 (70)
	Vegetation Guideline	Annual mean	7.5 (20)

(5) Council Directive 80/779/EEC
(6) Limits for black smoke are given in 1gm^{-3} for the BSI method as used in the UK.
The limits stated in the EC Directive relate to the OECD method, where OECD = BSI / 0.85.
(7) Member states must take all appropriate steps to ensure that three consecutive days do not exceed this limit value.
(8) Council Directive 1999/30/EC

Appendix 2
Hydrocarbon Results

Table A2.1 Monthly Hydrocarbon concentrations at Beresford Street (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan – 31Jan 01	1.3	5.7	1.0	2.9	1.0
31 Jan - 28 Feb	1.0	3.9	0.8	2.3	0.8
28 Feb - 4 Apr	1.6	4.1	0.7	1.8	0.7
4 Apr - 2 May	0.9	3.0	0.6	2.0	0.8
2 May - 30 May	0.9	4.2	0.9	2.4	1.0
30 May - 4 Jul	0.5	2.1	0.4	1.3	0.5
4 Jul - 1 Aug	0.7	3.6	0.8	2.1	0.7
1 Aug - 5 Sep	0.5	2.7	0.4	1.3	0.5
5 Sep - 3 Oct	0.5	2.3	0.5	1.3	0.5
3 Oct - 31 Oct	0.3	0.9	0.2	0.9	0.1
31 Oct - 5 Dec	2.6	11.0	2.1	6.1	2.4
5 Dec01 - 3 Jan 02	1.1	3.2	0.6	1.9	0.7
Average	1.0	3.9	0.8	2.2	0.8

Table A2.2 Monthly Hydrocarbon concentrations at Le Bas Centre (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan – 31Jan 01	1.0	5.4	0.7	2.3	0.8
31 Jan - 28 Feb	0.7	2.7	0.5	1.6	0.5
28 Feb - 4 Apr	1.2	2.7	0.6	1.3	0.5
4 Apr - 2 May	0.6	8.6	0.9	2.4	0.9
2 May - 30 May	0.7	3.1	0.8	2.0	0.7
30 May - 4 Jul	0.2	0.9	0.2	0.5	0.2
4 Jul - 1 Aug	0.8	2.1	0.4	0.9	0.4
1 Aug - 5 Sep	0.4	2.3	0.4	1.2	0.5
5 Sep - 3 Oct	0.5	2.1	0.4	1.2	0.5
3 Oct - 31 Oct	0.9	3.2	0.6	1.7	0.7
31 Oct - 5 Dec	1.9	7.4	1.4	4.2	1.7
5 Dec01 - 3 Jan 02	0.7	1.7	0.4	1.1	0.4
Average	0.8	3.5	0.6	1.7	0.7

Table A2.3 Monthly Hydrocarbon concentrations at Elizabeth Lane (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan – 31Jan 01	0.9	4.6	0.6	2.0	0.7
31 Jan - 28 Feb	0.7	3.5	0.6	1.7	0.6
28 Feb - 4 Apr	0.7	3.3	0.5	1.2	0.4
4 Apr - 2 May	0.5	2.6	0.5	1.4	1.4
2 May - 30 May	0.6	4.8	0.8	2.3	0.8
30 May - 4 Jul	0.2	2.0	0.4	1.1	0.4
4 Jul - 1 Aug	0.8	5.2	0.8	2.2	0.8
1 Aug - 5 Sep	0.3	3.0	0.4	1.2	0.4
5 Sep - 3 Oct	0.4	2.2	0.4	1.2	0.4
3 Oct - 31 Oct	0.7	4.1	0.6	1.8	0.6
31 Oct - 5 Dec	2.0	11.0	1.9	5.9	2.1
5 Dec01 - 3 Jan 02	0.8	2.8	0.5	1.4	0.5
Average	0.7	4.1	0.7	2.0	0.8

Table A2.4 Monthly Hydrocarbon Concentrations at Springfields Garage (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan - 31Jan 01	2.6	14.0	2.0	5.9	2.2
31 Jan - 28 Feb	2.0	10.0	1.7	5.0	1.7
28 Feb - 4 Apr	1.6	10.0	1.4	4.1	1.5
4 Apr - 2 May	1.8	8.2	1.5	4.7	1.7
2 May - 30 May	2.2	13.0	2.4	6.9	2.8
30 May - 4 Jul	1.4	10.0	1.5	4.7	1.8
4 Jul - 1 Aug	3.3	20.0	3.2	8.7	3.2
1 Aug - 5 Sep					
5 Sep - 3 Oct	1.6	8.7	1.3	3.8	1.4
3 Oct - 31 Oct	2.0	10.7	1.6	4.5	1.7
31 Oct - 5 Dec	2.7	13.0	1.9	5.9	2.4
5 Dec 01 - 3 Jan 02	1.7	5.7	0.9	2.5	1.0
Average	2.1	11.2	1.8	5.2	1.9

Table A2.5 Monthly Hydrocarbon Concentrations at Stopford Road (outdoor) (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan - 31Jan 01	0.8	9.9	1.8	5.7	2.0
31 Jan - 28 Feb	2.0	12.0	2.2	6.7	2.2
28 Feb - 4 Apr	1.0	6.6	1.0	3.1	1.1
4 Apr - 2 May	1.6	8.6	1.8	5.4	2.2
2 May - 30 May	2.4	18.0	3.9	12.0	4.7
30 May - 4 Jul	0.8	7.7	1.4	4.7	1.8
4 Jul - 1 Aug	3.2	23.0	4.0	12.0	4.8
1 Aug - 5 Sep	1.1	11.0	1.6	4.6	1.9
5 Sep - 3 Oct	1.2	8.8	1.6	5.0	2.0
3 Oct - 31 Oct	1.2	7.4	1.3	3.6	1.3
31 Oct - 5 Dec	3.8	24.0	4.2	13.0	5.1
5 Dec01 - 3 Jan 02	2.0	9.5	1.8	5.7	2.3
Average	1.8	12.2	2.2	6.8	2.6

Table A2.6 Monthly Hydrocarbon Concentrations at Clos St Andre (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan - 31Jan 01	0.5	1.8	0.4	0.9	0.4
31 Jan - 28 Feb	0.4	1.1	0.3	0.7	0.3
28 Feb - 4 Apr	0.2	0.6	0.1	0.3	0.1
4 Apr - 2 May	0.3	1.8	0.2	0.5	0.2
2 May - 30 May	0.5	1.3	0.3	0.8	0.3
30 May - 4 Jul	0.2	0.5	0.1	0.3	0.1
4 Jul - 1 Aug	0.8	1.4	0.3	0.6	0.3
1 Aug - 5 Sep	0.2	0.8	0.1	0.4	0.2
5 Sep - 3 Oct	0.2	1.1	0.2	0.5	0.2
3 Oct - 31 Oct	0.5	1.1	0.3	0.6	0.2
31 Oct - 5 Dec	0.9	2.2	0.5	1.3	0.5
5 Dec01 - 3 Jan 02	0.5	0.9	0.2	0.5	0.2
Average	0.4	1.2	0.3	0.6	0.3

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Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2002

March 2003

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netcen
Culham Science Centre
ABINGDON
Oxfordshire
OX14 3ED
Telephone 01235 463177
Facsimile 01235 463011

netcen is an operating division of AEA Technology plc
AEA Technology is certificated to BS EN ISO9001:(1994)

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

Executive Summary

Netcen (an operating division of AEA Technology Environment) has undertaken a 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 sixth consecutive year of monitoring, the period 3rd January 2002 to 3rd January 2003.

Diffusion tube samplers were used to monitor nitrogen dioxide (NO_2) at nineteen sites, sulphur dioxide (SO_2) at one site, and hydrocarbons at seven 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.

SO_2, NO_2 and hydrocarbon diffusion tubes were exposed for periods of 4 or 5 whole weeks, corresponding to the monthly exposure periods 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.

The highest annual mean of 25ppb was measured at the Weighbridge bus station site. Annual mean NO_2 concentrations at six of the seven kerbside and roadside sites in built-up areas were greater than the Limit Value of 21ppb, 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. Most of these exceedences were marginal, and after application of a correction factor for known diffusion tube bias, all sites were below 21ppb. However, given the uncertainty in diffusion tube measurements, exceedence cannot be ruled out, and further monitoring using more accurate automatic techniques is recommended.

By contrast, annual mean concentrations at urban and residential background sites were mostly well below 21ppb.

Ambient NO_2 concentrations at most sites have remained stable over the past three years. However, while NO_2 levels are not increasing, nor are they decreasing: the implication is that sites which currently approach or exceed the Limit Value and AQS Objective will continue to do so, unless action is taken.

SO_2 was measured at a single monitoring site, at Clos St Andre (near the Bellozanne Valley waste incinerator). The annual mean was 3.0ppb, slightly higher than the 2001 annual mean of 2.6ppb. However, concentrations remain low, and consistent with those measured by the more extensive surveys of earlier years.

Annual mean benzene concentrations were less than the UK Air Quality Strategy Objective of 5ppb (which applies to the running mean and is to be achieved by the end of 2003) at all sites, including those near petrol stations. However, the EC 2nd Daughter Directive annual mean Limit Value of 1.5ppb (which is to be achieved by 2010) was exceeded at Springfield Garage, which is located at a petrol station. Benzene concentrations at the four sites not associated with petrol stations were broadly similar to those measured at comparable sites in the UK.

Four of the hydrocarbon sites have been in operation since 1997. The six years' data from these four long-running hydrocarbon sites appear to show a decreasing trend in ambient concentrations of all the measured species except m+p xylene, which by contrast appears to be increasing at most sites.

Contents

Appendices

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 2002. This is the sixth in a series of extensive annual monitoring programmes that began in 1997.

The pollutants measured were nitrogen dioxide (NO_2), sulphur dioxide (SO_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 19 sites on the island, SO_2 was measured at just one site (previous years' surveys having established that levels of SO_2 on Jersey are low), and BTEX at seven sites.

This report presents the results obtained in the 2002 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 2001[1,2,3,4,5]. The objective, as in the 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 were the same as those used in the 2000 and 2001 studies. These consisted of a mixture of some background sites investigated during previous studies, together with some locations where higher pollutant concentrations might be expected, such as roadside sites, or those 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. For consistency with previous years' reports, the units used for NO_2 in this report are parts per billion (ppb). To convert from ppb to microgrammes per cubic metre (μg m^{-3}) if required, the following relationship should be used:

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

2.1.2 SO_2

Sulphur dioxide (SO_2) is formed during the combustion of fuels containing sulphur. The most significant source of this pollutant is fossil fuelled power generation, although diesel engines, domestic solid fuel burners and a number of chemical processes also produce SO_2.

SO_2 is a respiratory irritant, and is toxic at high concentrations. It is also damaging to ecosystems and a major precursor in the formation of acid rain. For consistency with previous years' reports, the units used for SO_2 in this report are parts per billion (ppb). To convert from ppb to microgrammes per cubic metre ($\mu g\ m^{-3}$) if required, the following relationship should be used:

1 $\mu g\ m^{-3}$ = 0.376 ppb for sulphur dioxide at 293K (20°C) and 1013mb.

2.1.3 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 5 ppb. In this report, concentrations of benzene are expressed in parts per billion (ppb). To convert from ppb to microgrammes per cubic metre ($\mu g\ m^{-3}$) 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 $\mu g\ m^{-3}$ (1.0 ppb) in rural areas, up to 204 $\mu g\ m^{-3}$ (54 ppb) 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[6]: the occupational 8-hour exposure limit (OEL) is 50ppm (50,000ppb). The best estimate for the odour threshold of toluene has been reported[7] as 0.16ppm (160ppb).

(iii)ethyl benzene
Again, there are no limits for ambient concentration of ethyl benzene, although there are occupational limits relating to workplace exposure[6], of 100 ppm over 8 hours, and 125 ppm over 10 minutes. Ambient concentrations are highly unlikely to approach these levels.

(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)[7].

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[8] for SO_2 and NO_2. These revised guidelines 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 SO_2 (10-minute, 24-hour and annual means), and 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 SO_2, NO_2 and benzene [9,10] 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 SO_2, NO_2 and benzene[11]. 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 SO_2, 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 SO_2 and NO_2 consist of a small plastic tube, approximately 7 cm long. During sampling, one end is "open" (or covered by a thin membrane in the case of SO_2) and the other closed. The closed end contains an absorbent for the gaseous species to be monitored, in this case SO_2 or NO_2. The tube is mounted vertically with the open (or membrane) end at the bottom. Ambient SO_2 or NO_2 diffuses up the tube during exposure, and is absorbed as sulphate or nitrite respectively. 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 SO_2 and 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. In this study, SO_2, NO_2 and BTEX tubes were exposed in 4- or 5- weekly batches, corresponding to the calendar of exposure periods used in the UK NO_2 Network.

The diffusion tube methodologies provide data that are accurate to $\pm$ 20% for SO_2, $\pm$ 25% for NO_2, and $\pm$ 20% for BTEX. The limits of detection are 0.4 ppb for SO_2, 0.2 ppb for NO_2 and 0.1 ppb 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)[12] 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 correction factor of 0.78. (This applies only to NO_2 diffusion tubes, not SO_2 or BTEX tubes). ***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 3 sites. During 2000, this was expanded to the present total of 19 sites. These same sites were used in 2002, and 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.

*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

SO_2 monitoring has been carried out at just one site since 2000. Results from 1999 and earlier years, based on a total of 13 sites, indicated that SO_2 levels in Jersey were not likely to be high enough to constitute a problem. The single site at Clos St Andre was retained because it is in a residential area near the Bellozanne Valley waste incinerator (a potential source of SO_2).

Table 2. SO_2 Monitoring site

Site number	Site Name	Grid Reference	Description
S13	Clos St Andre	638 499	Residential area near Bellozanne Valley refuse incinerator.

BTEX hydrocarbons were monitored at a total of seven sites during 2002. Six of these were those used in 2001; these are shown in Table 3. 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 Elizabeth Lane site is close to a paint spraying process, and the Springfield Garage site is located by a fuel filling station, both possible sources of hydrocarbon emissions. The Stopford Road site is located at a house between two petrol stations. (During the 1999 survey, this site was actually located inside the house to investigate reports of odours by residents; it was moved outdoors for the 2001 and 2002 studies). The Clos St Andre site is located near the Bellozanne Valley waste incinerator.

At the end of May 2002, monitoring ceased at the Stopford Road site, which was replaced by a new site at the Airport.

Table 3. 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 3	Elizabeth Lane	648 491	Urban background near paint spraying process
BTEX 4	Springfield Garage	656 495	Urban background near fuel filling station
BTEX 6	Stopford Road (outdoors)	655 491	Outdoor urban background site, at house between two petrol stations.
BTEX 7	Clos St Andre	638 499	Residential area near Bellozanne Valley refuse incinerator.
BTEX 8	Airport	587 509	Jersey Airport, overlooking airfield

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 4, and Figures 2 (kerbside and roadside sites) and 3 (background sites). Individual monthly mean NO_2 results ranged from 1.9ppb (in June at the rural Rue des Raisies site), to 32.1 ppb, (in October at the kerbside Weighbridge site, located in a bus station). Annual mean NO_2 concentrations ranged from 4.0 ppb (at Rue des Raisies) to 25.0ppb at Weighbridge.

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[8] for NO_2 is that the annual mean should not exceed 21 ppb. The EC 1st Daughter Directive[9] contains Limit Values for NO_2 as follows:

- 105 ppb (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.
- 21 ppb (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 16 ppb (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 six of the seven kerbside and roadside sites exceeded 21ppb; First Tower, Weighbridge, Georgetown, Beaumont, Broad Street and La Pouquelaye. In three of these cases, the annual mean was less than 22ppb. The seventh kerbside site, La Pouquelaye, had an annual mean NO_2 concentration greater than 19ppb, and was therefore very close to the EC Limit Value and AQS Objective.

As discussed in Section 2.3, Harwell Scientifics' NO_2 diffusion tubes typically overestimate NO_2 concentration. Harwell Scientifics have quantified this overestimation, by a series of field tests in 2002, and provided a bias correction factor of 0.78, 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 21ppb. The highest annual mean (at Weighbridge) is reduced from 26ppb (uncorrected) to 20ppb (bias corrected). However, given the uncertainty on diffusion tube measurements, it remains likely that some roadside and kerbside sites are currently "borderline" with respect to the Limit Value and AQS Objective for annual mean NO_2.

By contrast, the annual mean NO_2 concentrations at the 12 background sites were in most cases well below 21ppb. The 16ppb limit for protection of vegetation is only applicable at the one rural background site, Rue des Raisies, where the annual mean NO_2 concentration at this site was well within the limit.

Table 4. NO_2 Diffusion Tube Results 2002, Jersey. Concentrations in ppb.

Site — From - To:	3 Jan - 31 Jan 02	31 Jan - 26 Feb	26 Feb – 3 Apr	3 Apr - 30 Apr	30 Apr – 6 Jun	6 Jun - 3 Jul	3 Jul - 31 Jul	31 Jul - 4 Sep	4 Sep - 2 Oct	2 Oct - 30 Oct	30 Oct - 3 Dec	3 Dec 02 - 3 Jan 03	Average
Le Bas Centre	18.7	18.0	17.4	14.5	14.5	14.5	13.7	15.1	14.2	19.2	19.4	16.5	16.3
Mont Felard	13.7	12.8	14.8	12.6	12.0	10.9	12.1	14.5	12.3			16.6	13.2
Les Quennevais	6.8	4.5	5.8	5.3	3.3	2.4	4.4	6.1	7.5	6.2	5.1	9.3	5.6
Rue Des Raisies	5.1	4.6	4.3	2.8	2.3	1.9	2.6	3.8	3.8	4.7	4.2	7.4	4.0
First Tower	25.1	19.3	24.4	19.8	17.5	19.0	20.9	21.6	20.3	24.1	19.6	21.5	21.1
Weighbridge	29.6	28.5	27.6	25.4	21.7	30.0	26.9	24.1	10.1	32.1	21.0	23.1	25.0
Langley Park	14.3	13.1	11.9	8.7	6.8	7.0	8.1	6.8	9.8	11.4	11.8	13.4	10.3
Georgetown	23.0	19.4	24.5	23.3	17.9	17.0	18.4	21.5	21.8	24.0	23.1	26.2	21.7
Clos St.Andre	10.3	10.3	8.7	7.0	6.0	6.2	5.7	6.1	9.8	6.7	12.1	10.2	8.3
L'Avenue et Dolmen	15.3	15.1	13.4	10.8	9.1	6.2	10.0	8.8	2.8	14.8	14.4	14.9	11.3
Robin Place	20.6	19.2	16.1	14.1	12.1	12.6	13.4	13.2	15.5	18.6	17.6	17.8	15.9
Beaumont	22.2	20.1		22.6	19.7	19.5	21.1	25.3	21.9	22.3	22.0	23.2	21.8
The Parade	19.2	18.8	19.9	17.6	14.7	17.6	19.1	20.4	19.4	22.7	21.4	22.0	19.4
Maufant	6.8	6.3	5.4	4.9	3.4	3.2	4.0	4.9	4.1	6.0	4.9	8.1	5.2
Jane Sandeman	13.1	10.7	10.1	8.2	6.2	6.1	7.0	7.3	7.5	10.5	8.8	11.9	9.0
Saville Street	17.2	14.1	15.7	4.5	13.5			15.5		19.3	16.4	16.3	14.7
Broad Street	25.3	25.4	23.3	21.8	21.7	21.7	21.8	22.8	22.4	23.3	23.5	22.0	22.9
Beresford Street	20.1	20.3	20.1	16.2	16.6	15.2	15.7	16.9	14.9	22.0	21.0	19.1	18.2
La Pouquelaye	27.1	24.1	26.7	23.8	20.2	21.8	22.3	22.8	25.5	29.1	25.9	23.7	24.4

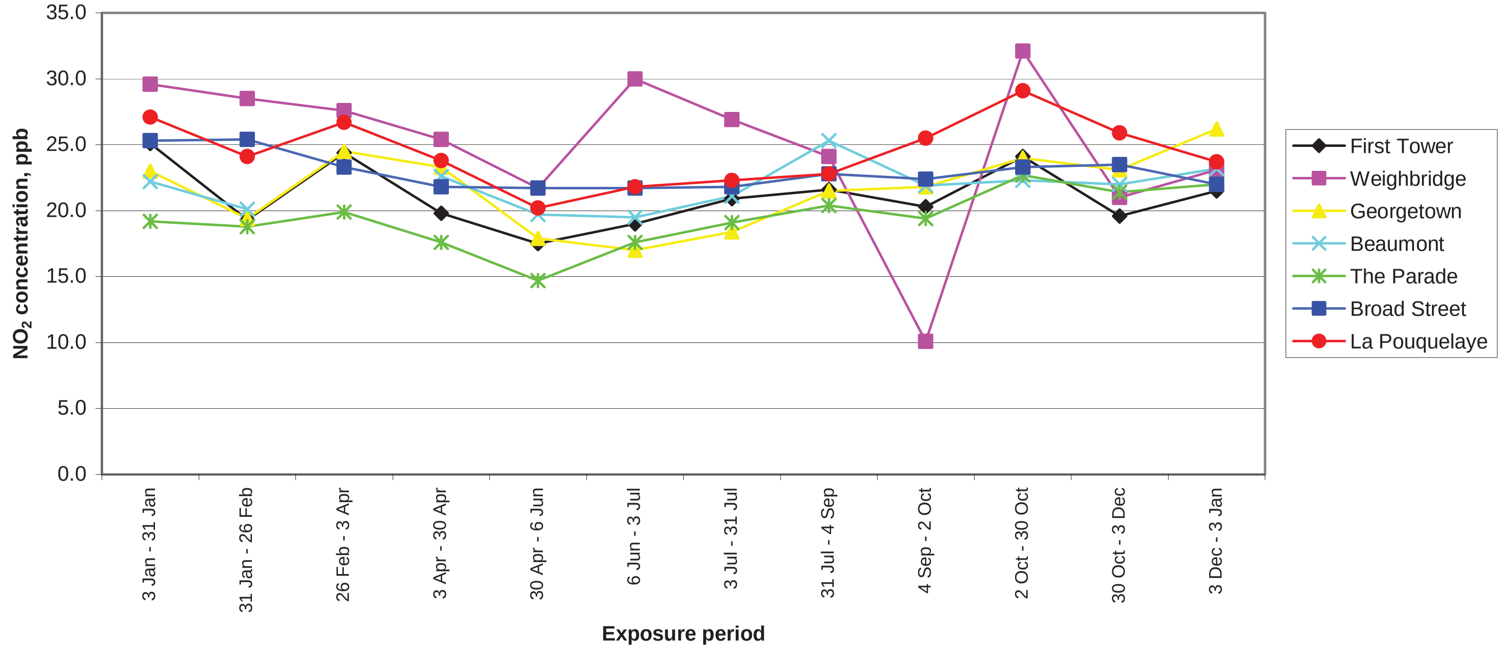

Figure 2. Monthly Mean Nitrogen Dioxide Concentrations at Roadside and Kerbside Sites, 2002

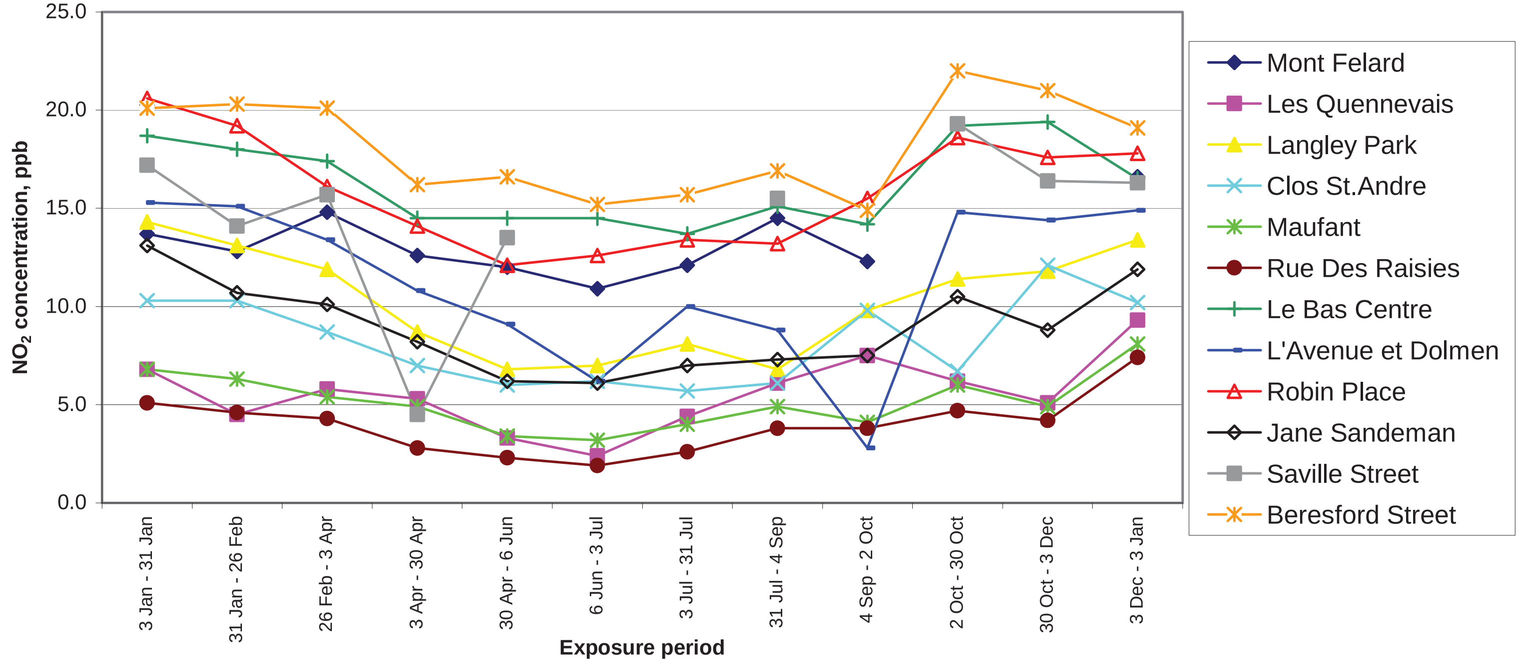

Figure 3. Monthly Nitrogen Dioxide concentrations at Background Sites, 2002

As well as having typically lower NO_2 concentrations, the urban background sites show slightly more seasonal variation than the roadside sites. This is likely to reflect the fact that the background sites are more affected by sources such as domestic heating, which increase during the winter. By contrast, NO_2 concentrations at the roadside sites are dominated by traffic emissions, which do not generally increase during winter.

3.1.3 Comparison with UK NO_2 data

The UK Nitrogen Dioxide Survey monitored this pollutant at around 1220 sites across the UK during 2002, 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 national annual averages for 2002 are provisional at present, pending full data ratification. Estimated UK NO_2 Network averages for 2002 were 20 ppb for roadside sites and 11 ppb for urban background sites. These are consistent with the 200 averages for Jersey; 22 ppb for kerbside and roadside sites and 11 ppb for background sites.

Table 5 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 5 - Comparison of NO_2 in Jersey with UK Automatic Sites

Site	2002 Annual average NO_2, ppb
Exeter Roadside	20
Plymouth Centre	14
Lullington Heath	6
Harwell	8

The annual mean NO_2 concentrations measured at the kerbside and roadside sites in Jersey ranged from 19ppb to 25ppb. The annual mean at Exeter Roadside was therefore comparable with these. The Jersey urban background sites had annual mean NO_2 concentrations ranging from 9ppb to 18ppb, thus consistent with 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 3.2ppb to 11ppb, and thus were more comparable with rural sites such as Lullington Heath and Harwell. The annual mean of 1.9ppb 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

Most of the sites have been operating for only three years, which is not long enough to identify trends. However, very little change has been observed at most of these sites over the past three years. 2002 annual mean concentrations at 13 of the 19 sites were within $\pm$ 1ppb of those measured during 2001, with no consistent pattern of increase or decrease. Of the other six sites, two increased and three decreased. This is similar to the pattern observed last year: very little change was apparent. Thus, it appears that those kerbside and roadside sites currently exceeding the Limit Value and Objective for the annual mean are likely to continue to do so, unless action is taken.

There are four sites that have been in operation since 1993, forming part of the UK Nitrogen Dioxide Network. Annual mean concentrations for these long-running sites are shown in Table 6 and Figure 4. These data show that NO_2 concentrations have remained relatively stable over the period, with a small decrease since the mid-1990s. The Beaumont site showed consistent increases between 1998 and 2001; however, the mean for 2002 at this site was lower.

Table 6 Annual mean NO_2 concentrations at Long-Term Sites

Site	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Beaumont (Kerbside)	-	23	25	24	No data	20	21	23	24	22
The Parade (Intermediate*)	16	16	16	16	No data	13	14	13	Site moved	-
Jane Sandeman (Background)	11	10	11	11	No data	9	9	8	9	9
Maufant (Background)	9	8	7	6	No data	5	6	5	5	5

**Intermediate sites were discontinued at the end of 2000. This site was replaced by a Roadside site, also at the Parade.*

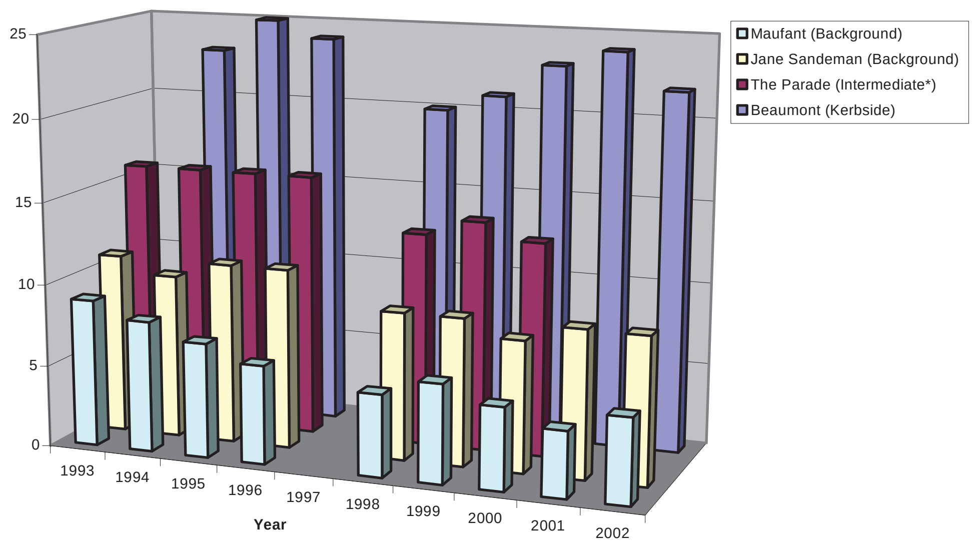

Figure 4. Trends in Annual Mean NO_2 Concentrations at Four Long-Term Sites

3.2 SULPHUR DIOXIDE

3.2.1 Summary of SO_2 Results

As from 2000, SO_2 monitoring has been carried out at single site, Clos St Andre. Previous year's monitoring had established that concentrations on Jersey are generally low. The monthly results for SO_2 at this site are shown in Table 7.

Ambient SO_2 concentrations at Clos St Andre were low during 2002: less than 3ppb during all but three months. The highest individual result was 11.2ppb (measured in October). This result is unusually high. Occasionally, spurious high results can be caused by damage to the membrane at the end of the diffusion tube, which allows particulate phase sulphate to enter the tube during exposure. However, the analyst did not find evidence of this, so this result must be treated as genuine.

The annual mean SO_2 concentration at Clos St Andre was 3.0ppb –slightly higher than the 2001 annual mean of 2.6ppb, but still low. The unusually high result for October is largely responsible for this apparent increase; if this result is rejected the annual mean is 2.2ppb.

3.2.2 Comparison with SO_2 Guidelines, Limit Values and Objectives

The guidelines, EC Limit Values and AQS objectives for SO_2 are presented in Appendix 1. However, most of the limits for SO_2 that relate to human health are based on short averaging periods, such as 15-minute, 1-hour or 24-hour means. Thus, diffusion tube data, based on much longer sampling periods, is not directly comparable with these. It is only possible to compare diffusion tube results with limits relating to longer periods, such as the annual mean.

The WHO has set a guideline of 17ppb for the annual mean. The 2001 annual mean SO_2 result for Clos St Andre was well within this value.

EC Directive 1999/30/EEC[9] (the first Daughter Directive) contains Limit Values for protection of human health, but these are based on the 1-hour and 24-hour mean. However, there is also a Limit Value of 8ppb for the annual (calendar year) and winter (October to March) mean SO_2 concentration, for the protection of ecosystems. This is only applicable in rural areas, and therefore strictly does not apply to Clos St Andre. However, the annual mean of 3.0ppb was well below this limit.

The UK Air Quality Strategy contains Objectives for SO_2 similar to those contained in the EC Directive above. Those set for protection of human health are based on the 15-minute, 1-hour and 24-hour means. There is also a limit of 8ppb for the annual (calendar year) and winter (October to March) mean SO_2 concentration, for the protection of ecosystems. Again, this is only applicable in rural areas but the Clos St Andre annual mean was well within this limit.

Table 7. SO_2 Diffusion Tube Results 2002, Jersey. Concentrations in ppb.

Site	From - To:	3 Jan - 31 Jan	31 Jan - 26 Feb	26 Feb - 3 Apr	3 Apr - 30 Apr	30 Apr - 6 Jun	6 Jun - 3 Jul	3 Jul - 31 Jul	31 Jul - 4 Sep	4 Sep - 2 Oct	2 Oct - 30 Oct	30 Oct - 3 Dec	3 Dec - 3 Jan	Average
Clos St.Andre		2.6	1.6	3.1	2.8	1.8	1.1	1.8	1.9	5.2	11.2	0.5	2.1	**3.0**

3.2.3 Comparison with UK SO_2 Data

Table 8 shows how the 2002 SO_2 data from Clos St Andre compares with a selection of UK air quality monitoring stations using automatic (UV fluorescence) SO_2 analysers. The automatic sites used for comparison are the same as used in the case of NO_2; the descriptions are given in section 3.1.3.

Table 8. Comparison of SO_2 at Clos St Andre with UK Sites

Site	Annual average SO_2, ppb
Diffusion Tubes	
Clos St Andre	3.0
UK Automatic Sites *(reported to nearest ppb)*	
Exeter Roadside	1
Plymouth Centre	2
Lullington Heath	1
Harwell	1

The annual mean SO_2 concentration at Clos St Andre this year is slightly higher than that measured at the Plymouth Centre urban site, and roadside or rural sites in the UK. However, as mentioned in Section 3.2.2, the Clos St Andre dataset for 2002 contained one uncharacteristically high measurement in October, which increased the average.

3.2.4 Comparison with Previous Years' SO_2 Results

The 2001 annual mean of 3.0ppb was consistent with the annual means measured in 2001 (2.6ppb), 2000 (2.2ppb), and 1999 (2.7ppb), at this site. It is slightly higher: the increase is not large and would only be a cause for concern if future year's monitoring indicates it is continuing to increase. Again, the apparent increase is largely due to the unusually high monthly average measured in October 2002.

3.3 HYDROCARBONS

3.3.1 Summary of Hydrocarbon Results

Results of the hydrocarbon survey for the seven sites are shown in Appendix 2, Tables A2.1 to A2.7 respectively. Graphical representations are shown in Figures 5 to 11.

The diffusion tube results show that average outdoor hydrocarbon concentrations in Jersey remain generally low. A summary of annual average hydrocarbon concentrations is shown in Table 9.

Table 9. Summary of Average Hydrocarbon Concentrations, Jersey, 2002

Site	Benzene, ppb	Toluene, ppb	Ethyl Benzene, ppb	m+p Xylene, ppb	o Xylene, ppb
Beresford Street	0.8	3.4	0.6	1.8	0.7
Le Bas Centre	0.6	2.1	0.4	1.3	0.5
Elizabeth Lane *(near paint spraying)*	0.5	2.9	0.5	1.4	0.4
Springfield Garage *(petrol station)*	1.7	9.6	1.4	4.3	1.6
Stopford Road *(petrol stations) Jan-May only*	1.1	6.8	1.2	3.8	1.4
Clos St Andre	0.3	0.7 *	0.2	0.5	0.2
Airport *(Jun-Dec only)*	0.3	0.4	0.1	0.2	0.1

**One outlying value rejected: July 2002.*

Highest average concentrations of benzene were found at Springfield Garage, followed by Stopford Road, as in previous years. However, average benzene concentrations were low - less than 3ppb at all sites. Springfield Garage showed some reduction compared with its 2001 mean benzene concentration of 2.1ppb.

Toluene concentrations were mostly less than 5ppb except at Springfield Garage, where monthly average concentrations ranged from 4.1ppb to 17ppb. At Clos St Andre, all monthly average toluene concentrations were less than 1ppb, with the exception of one unusually high value (21ppb) during July 2002. There was no obvious reason why such a high concentration should have occurred; it was suspected that the tube in question had become contaminated, and the result was therefore rejected.

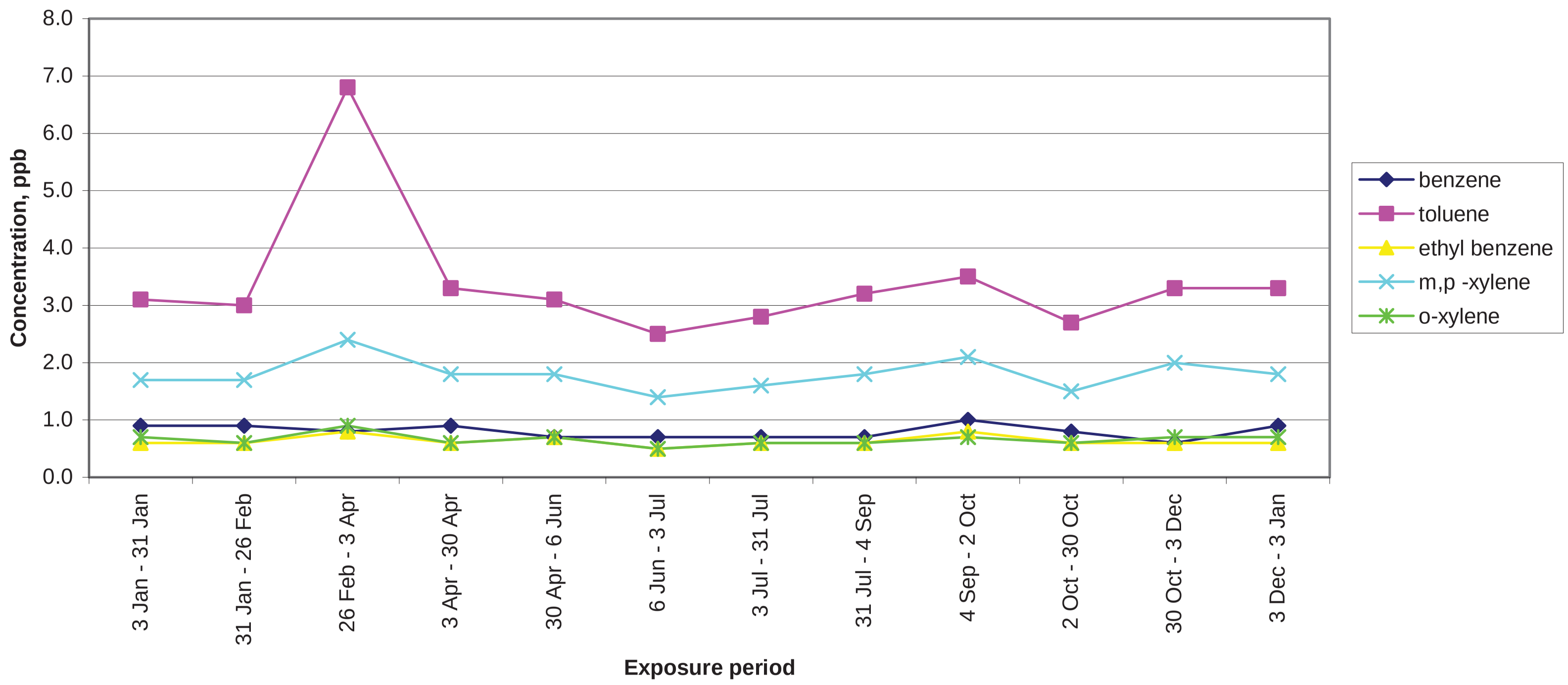

Figure 5. Monthly mean hydrocarbon concentrations at Beresford Street, 2002

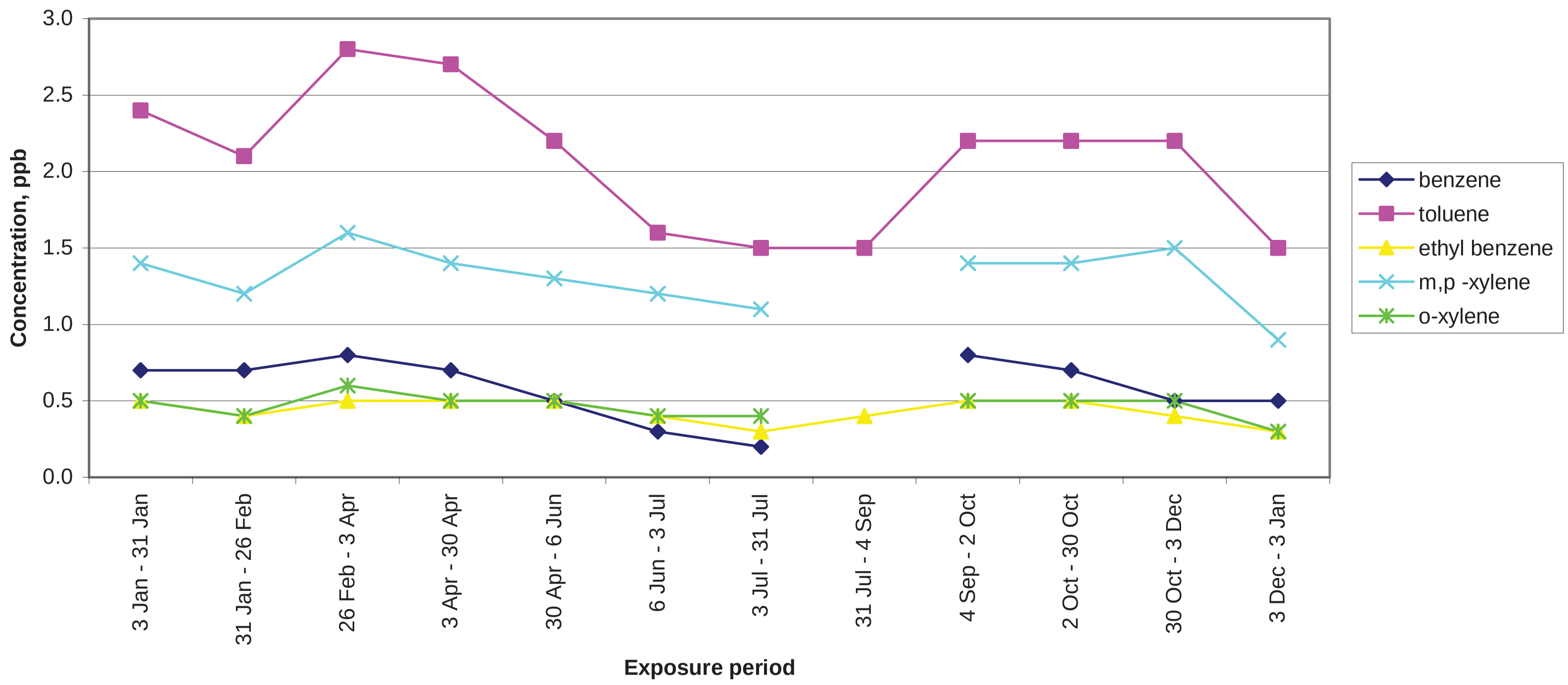

Figure 6. Monthly mean hydrocarbon concentrations at Le Bas Centre, 2002

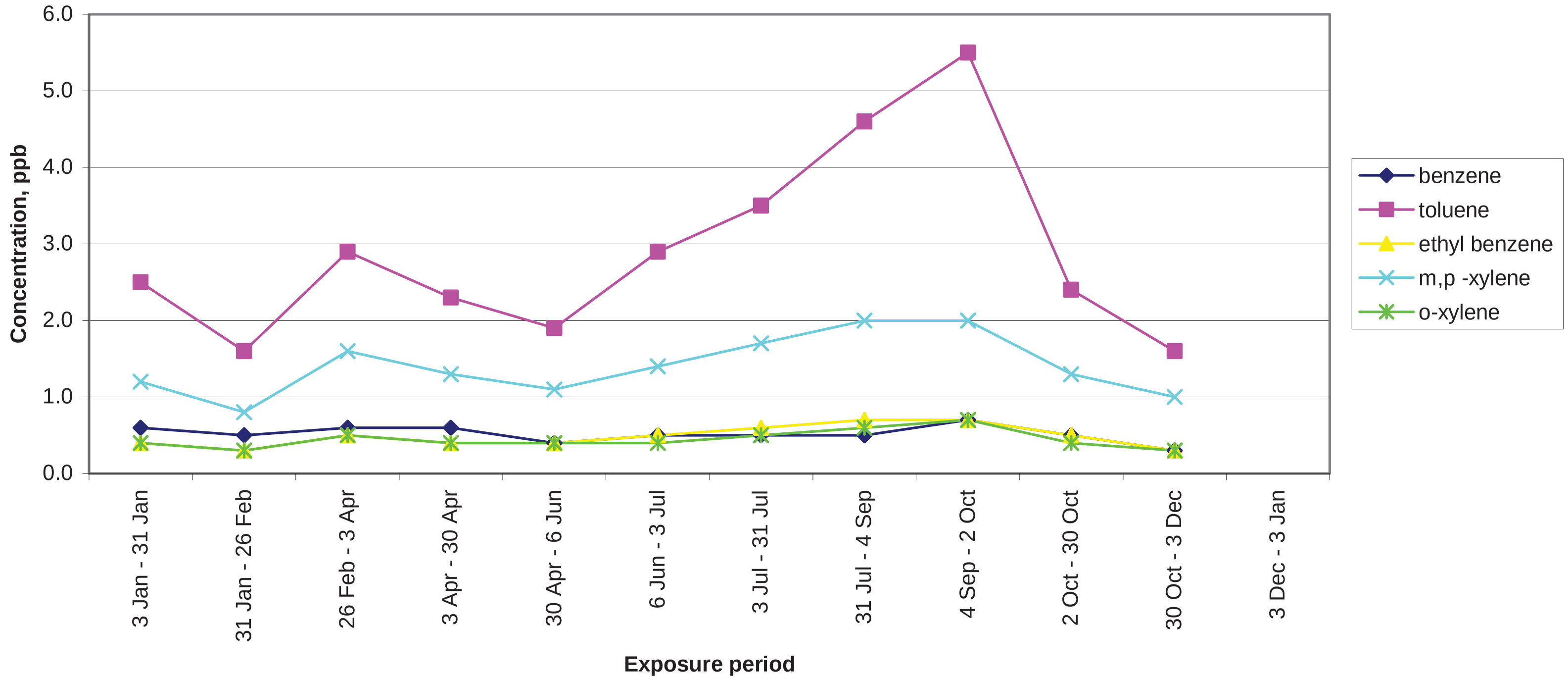

Figure 7. Monthly mean hydrocarbon concentrations at Elizabeth Lane, 2002

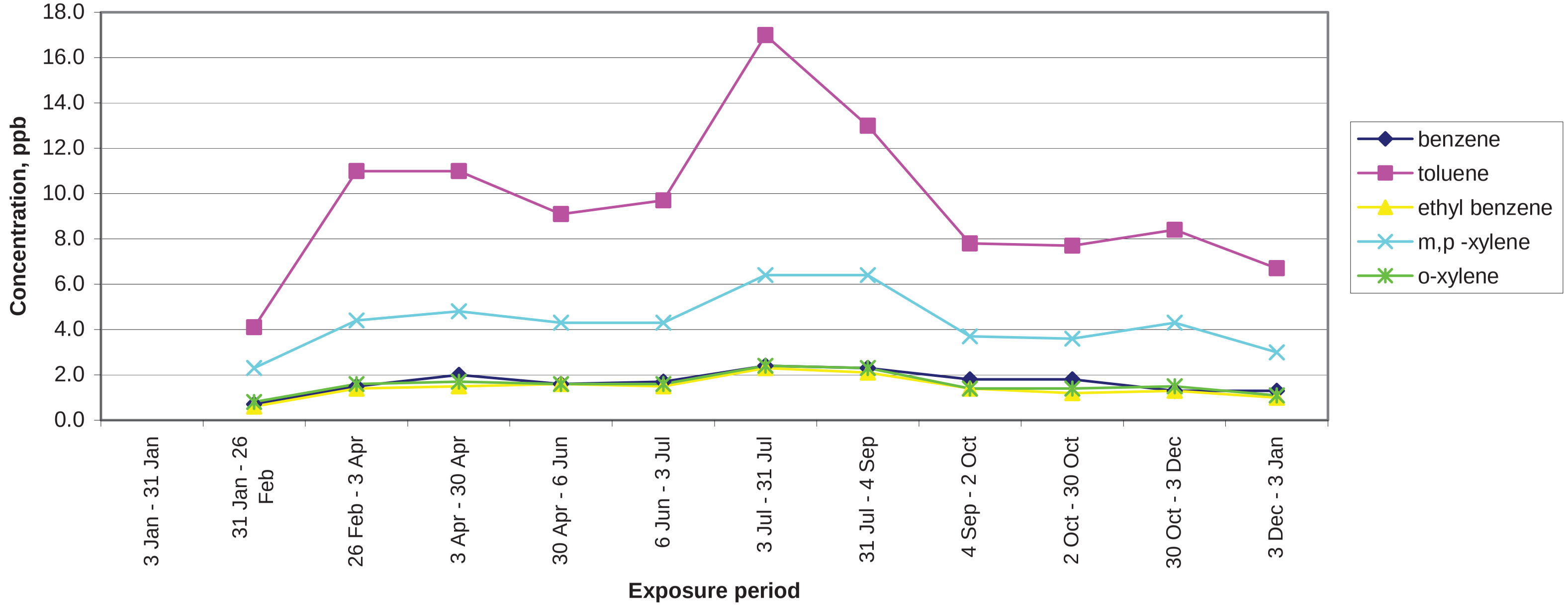

Figure 8. Monthly mean hydrocarbon concentrations at Springfield Garage, 2002

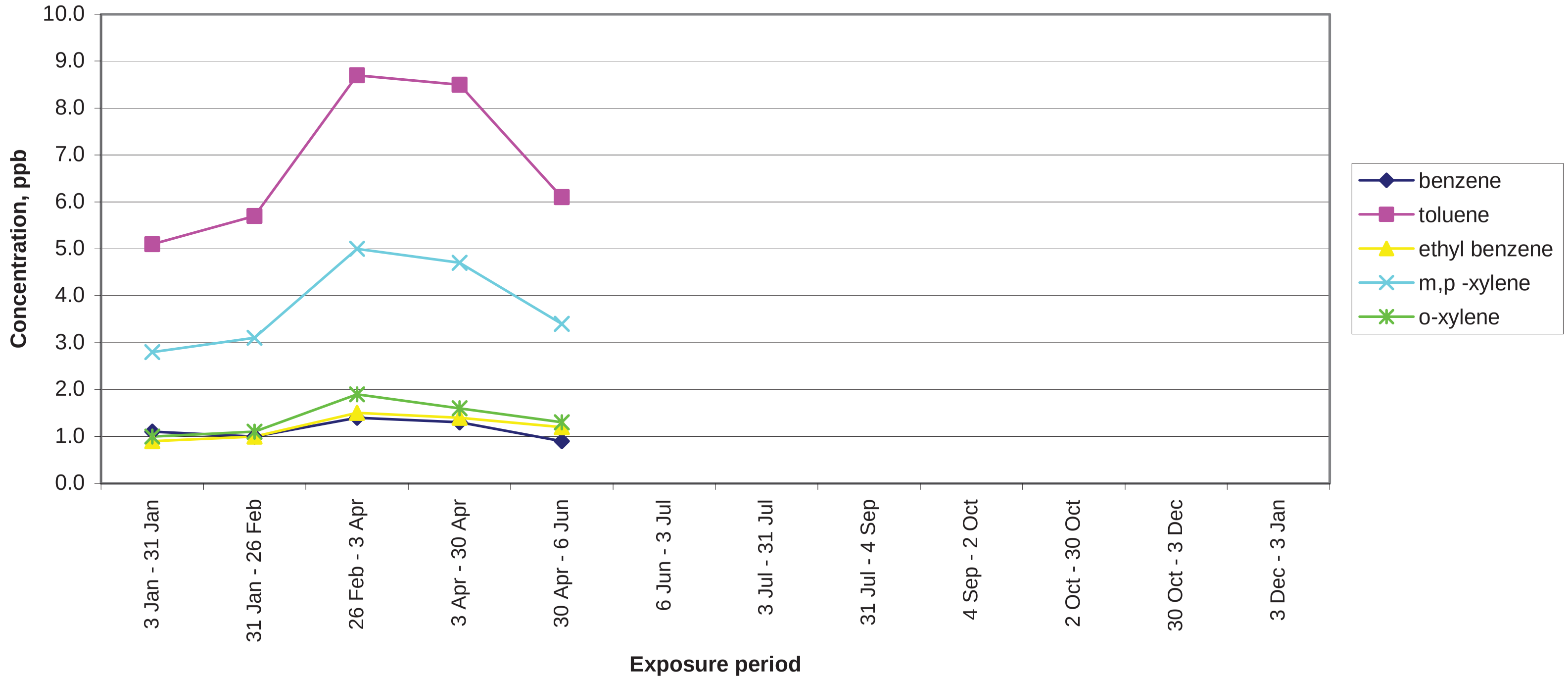

Figure 9. Monthly mean hydrocarbon concentrations at Stopford Road, 2002

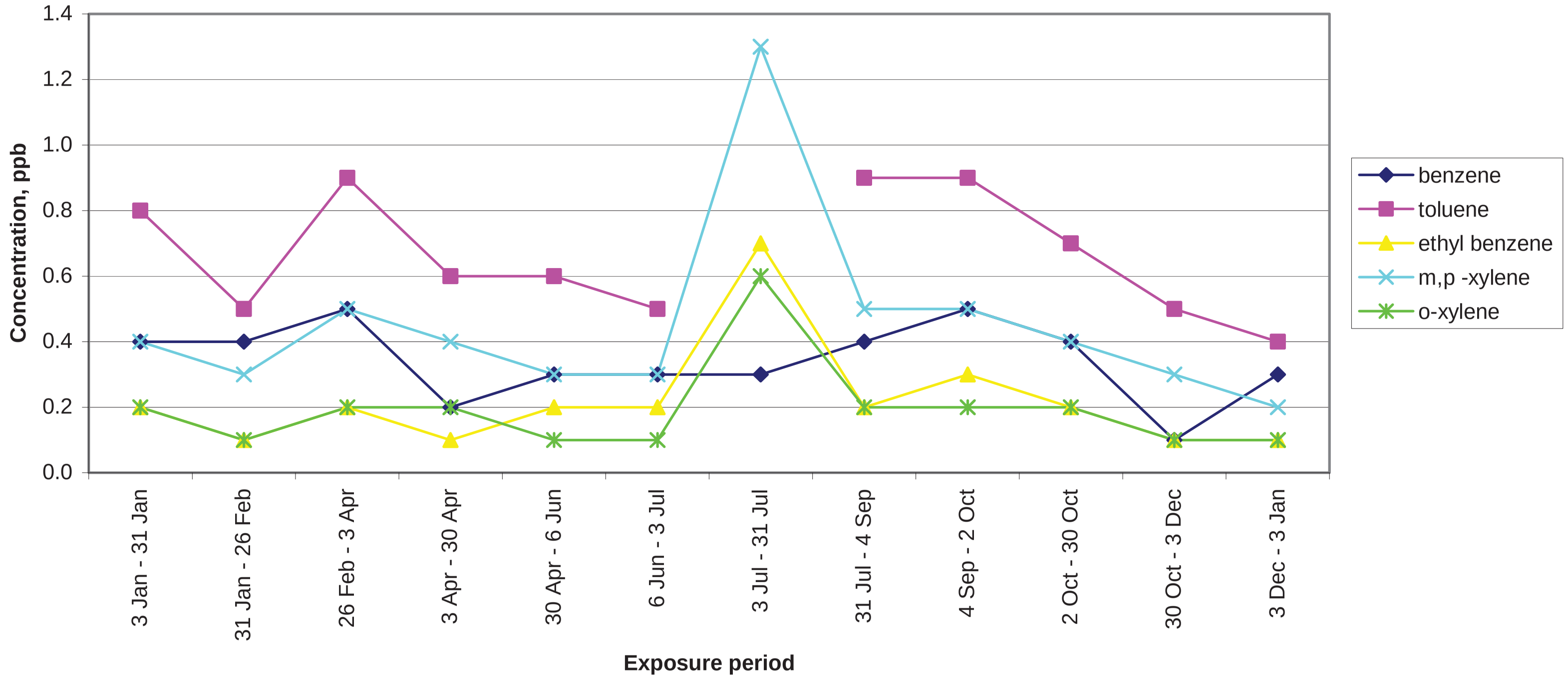

Figure 10. Monthly mean hydrocarbon concentrations at Clos St Andre, 2002

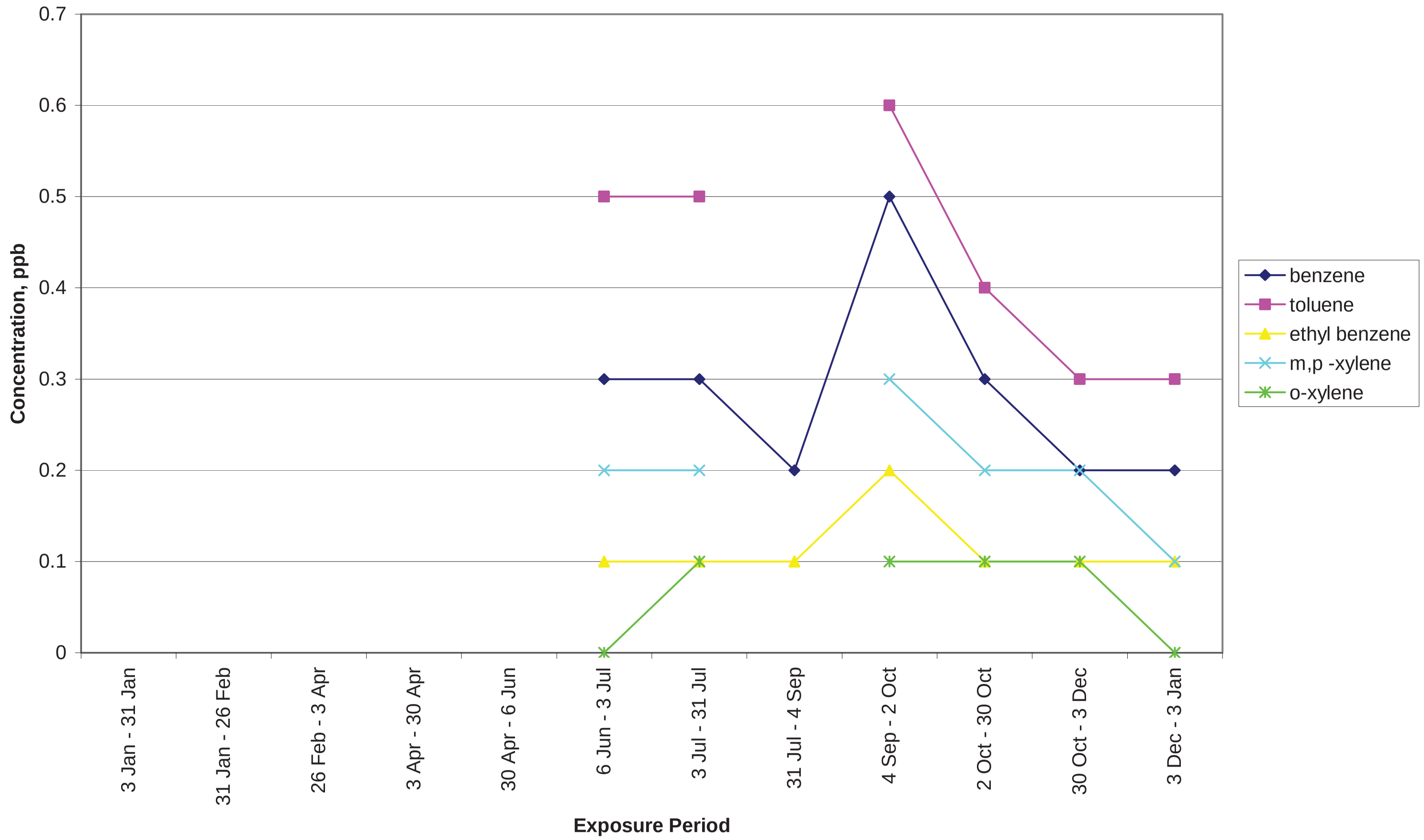

Figure 11. Monthly mean hydrocarbon concentrations at the Airport, 2002

3.3.2 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 an objective for the running annual mean of 5ppb, to be achieved by 31 December 2003, and applicable to the whole UK. (Tighter standards apply to England, Wales and Scotland). The annual mean benzene concentration (which can be considered a good indicator of the running annual mean) did not exceed 5ppb at any of the Jersey sites.

The EC 2nd Daughter Directive[10] sets a limit of 5μg m^{-3} (1.5ppb) to be achieved by 2010. This Limit Value was exceeded at Springfield Garage (a petrol station), where the annual mean benzene concentration was 1.7ppb. Monitoring was carried out for 5 months only at Stopford Road, before the site was re-located to Jersey Airport. However, the 5-month mean of 1.1ppb is sufficiently close to the Limit Value that exceedence at this site cannot be ruled out. At the new monitoring, Jersey Airport, monitoring was carried out from June to December 2002. The average of 0.3ppb for this period was well below the Limit Value.

3.3.3 Comparison with UK Data

Table 10 compares hydrocarbon data from the 2002 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.
- Edinburgh Medical School – a city centre site, in a street “canyon”, with heavy traffic and tall buildings.
- Harwell - a rural site in the south of England, within 10km of a power station.

Note: the full 2002 dataset is not yet available for the automatic sites; only January to September data averages are available. Therefore, Table 2 compares these with January to September 2002 averages for each of the Jersey sites.

Table 10. Comparison with Hydrocarbon Concentrations at Other UK Sites, January to September 2002

Site	Benzene, ppb	Toluene, ppb	m+p Xylene, ppb
Jersey Diffusion Tube Sites: Jan – Sep 2002			
Beresford Street	0.8	*3.5*	1.8
Le Bas Centre	0.6	2.1	1.3
Elizabeth Lane *(near paint spraying)*	0.5	*3.1*	*1.5*
Springfield Garage *(petrol station)*	*1.8*	*10.3*	*4.6*
Stopford Road *(petrol stations)* *Jan-May only*	1.1	6.8	3.8
Clos St Andre	*0.4*	0.7	0.5
Airport *(Jun-Dec only)*	0.3	*0.5*	0.2
UK Automatic Sites: Jan – Sep 2002			
London Marylebone Road	1.2	4.4	2.5
Cardiff Centre	0.2	0.8	0.3
Edinburgh Medical School	0.2	0.7	0.4

Harwell	0.2	0.4	0.1

Highest hydrocarbon concentrations were measured at Springfield Garage and Stopford Road (where fuels are stored), and London Marylebone Road. Lower concentrations were measured at the background sites on Jersey; however, these sites had higher hydrocarbon levels that at Edinburgh or Cardiff (where hydrocarbon concentrations appear to have fallen since last year), or the rural site at Harwell. Hydrocarbon levels at Clos St Andre and the Airport were comparable with, although slightly higher than, the mean from the rural Harwell site over the same period. Concentrations at Elizabeth Lane were comparable to those at Beresford Street and Le Bas, despite the proximity of the paint spraying process.

3.3.4 Comparison with Previous Years' Hydrocarbon Results

Four sites (Beresford Street, Le Bas Centre, Elizabeth Lane and Springfield Garage) have been operating since 1997. The 2002 hydrocarbon concentrations were consistent with the previous year, and in some cases lower. Table 11 shows annual means for these sites, also Stopford Road (outdoor) and Clos St Andre. The Stopford Road site has not been included as a long-running site, as prior to 2000 it was located indoors.

Table 11. Comparison of Hydrocarbon Concentrations, Jersey, 1997 - 2002.

	benzene, ppb	toluene, ppb	Ethyl benzene, ppb	m+p xylene, ppb	o-xylene, ppb
Beresford Street					
1997	3.2	5.4	1.2	1.2	2.7
1998	2.5	4.9	0.9	1.0	2.3
1999	1.8	3.6	0.6	1.7	0.8
2000	0.9	3.7	0.8	2.3	0.9
2001	1.0	3.9	0.8	2.2	0.8
2002	0.8	3.4	0.6	1.8	0.7
Le Bas Centre					
1997	2.8	4.5	1.2	1.0	2.2
1998	2.3	4.2	0.7	0.9	1.9
1999	1.1	2.9	0.5	1.3	0.6
2000	0.9	3.3	0.7	1.9	0.7
2001	0.8	3.5	0.6	1.7	0.7
2002	0.6	2.1	0.4	1.3	0.5
Elizabeth Lane					
1997	1.9	4.4	1.4	1.7	2.2
1998	1.9	5.0	0.7	1.6	0.8
1999	1.0	3.3	0.5	1.2	0.6
2000	0.7	3.3	0.7	1.8	0.6
2001	0.7	4.1	0.7	2.0	0.8
2002	0.5	2.9	0.5	1.4	0.4
Springfield Garage					
1997	7.7	12.5	1.9	1.9	4.3
1998	7.7	12.3	1.5	1.7	4.3
1999	4.5	10.9	1.3	3.8	1.5
2000	1.6	9.2	1.8	5.0	2.0
2001	2.1	11.2	1.8	5.2	1.9
2002	1.7	9.6	1.4	4.3	1.6
Stopford Road Outdoor					
2000	1.2	8.4	1.8	5.3	2.2
2001	1.8	12.2	2.2	6.8	2.6
2002*	1.1	6.8	1.2	3.8	1.4
Clos St Andre					
2000	0.3	0.9	0.2	0.6	0.2
2001	0.4	1.2	0.3	0.6	0.3
2002	0.3	0.7	0.2	0.5	0.2

** 2002 data for Stopford Road based on 5 months data only.*

Figures 12 to 16 illustrate how annual mean concentrations of these hydrocarbons have changed over the years of monitoring.

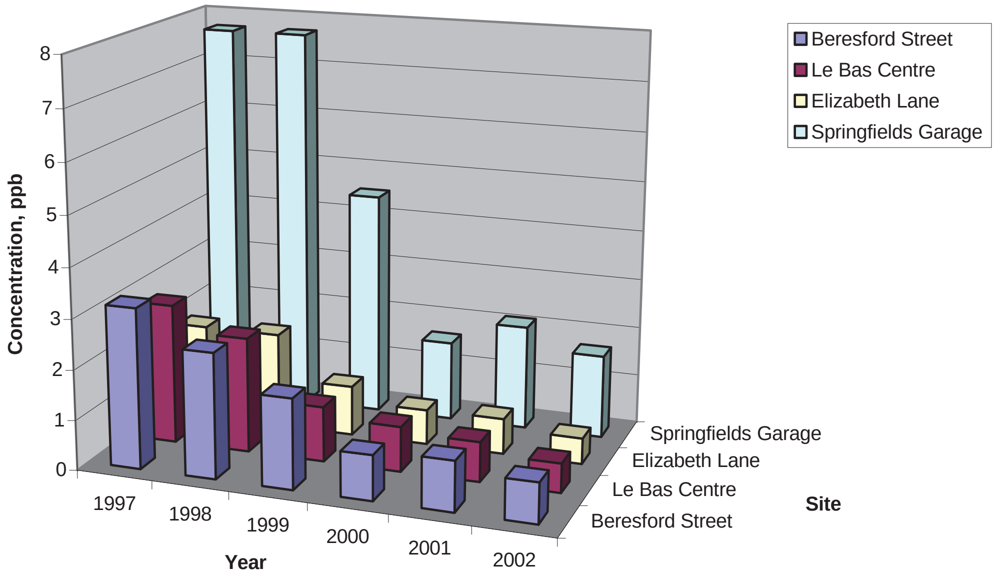

Figure 12. Trends in Benzene Concentration

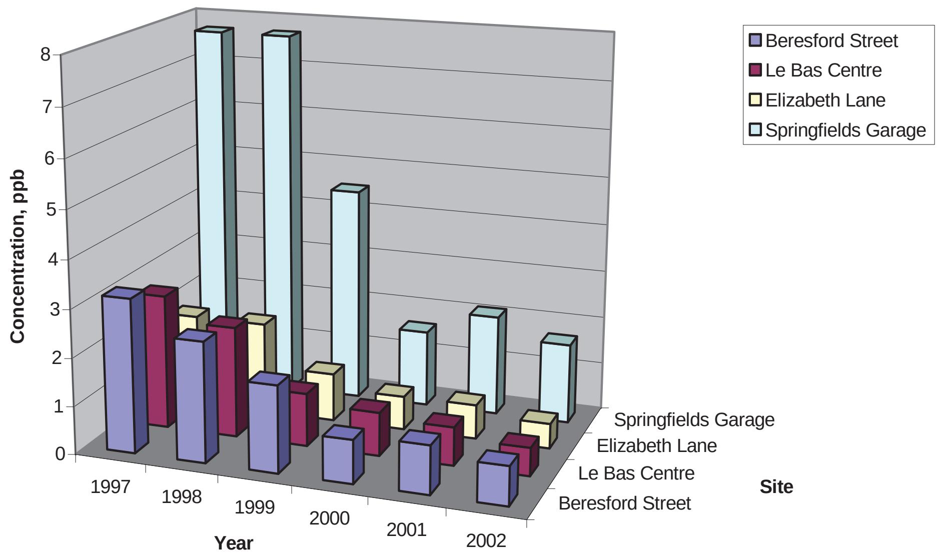

Figure 13. Trends in Toluene Concentration

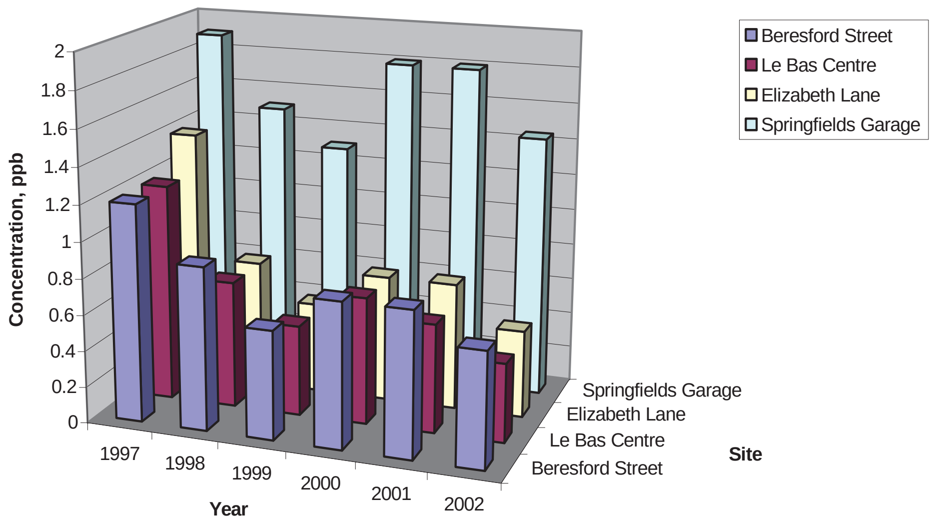

Figure 14. Trends in Ethylbenzene Concentration

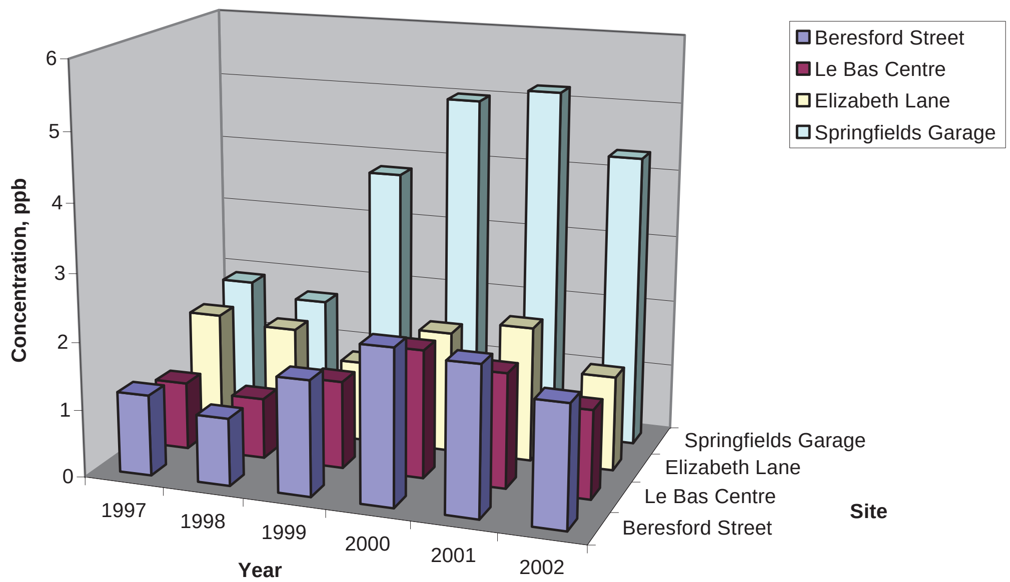

Figure 15. Trends in m+p- Xylene Concentration

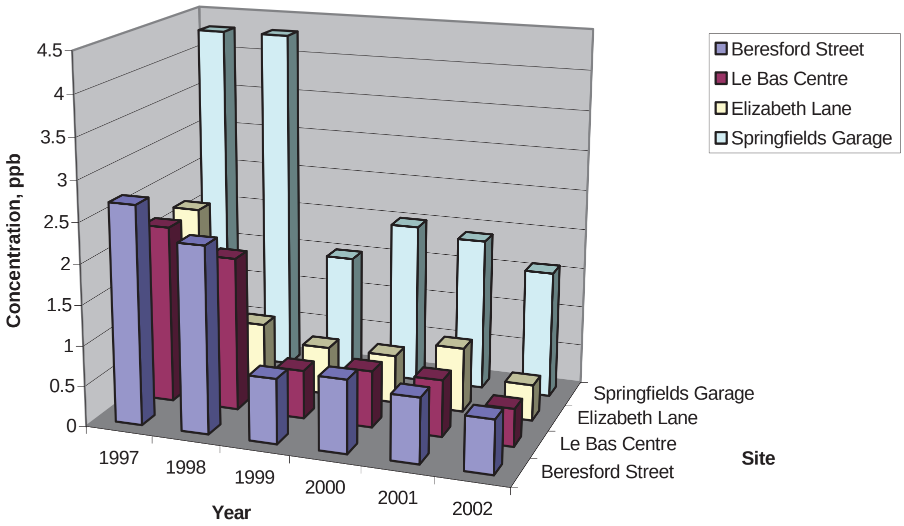

Figure 16. Trends in o-Xylene Concentration

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 in particular shows 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. Only m+p xylene has shown an increase in recent years, at all sites except Elizabeth Lane.

4 Conclusions

- Netcen has undertaken a year-long diffusion tube monitoring study in Jersey during 2002, on behalf of the States of Jersey Public Health Services and Planning and Environment Department. This was the sixth such extended study, and continued from the end of the 2001 study, running from 3rd January 2002 to 3rd January 2003.
- Diffusion tubes were used to monitor NO_2 at 19 sites, and SO_2 at 1 site. Hydrocarbons (benzene, toluene, ethyl benzene and xylenes, collectively termed BTEX) were measured at 7 sites, including a new site at the Airport, which replaced the old site at Stopford Road, as of June 2002. The sites were located at a range of different locations on the island, and in most cases have been used since the 2000 study.
- All tubes were exposed for 4- or 5-week periods, in line with the “months” of the UK NO_2 Network calendar.

NO_2 results

- Annual mean NO_2 concentrations at six of the seven kerbside and roadside sites (First Tower, Weighbridge, Georgetown, Beaumont, Broad Street and La Pouquelaye) were above the EC Directive Limit Value and AQS Objective of 21ppb. Three of the sites exceeded by less than 1ppb. The sites have until 31st December 2005 to meet the AQS Objective.
- Applying the analytical laboratory’s recommended correction factor for diffusion tube bias to these annual mean results reduces all of them to below 21ppb. However, given the uncertainty of $\pm$25% inherent in diffusion tube measurements, it is recommended that First Tower, Weighbridge, Georgetown, Beaumont, Broad Street and La Pouquelaye are at present considered “borderline” with respect to the EC Limit Value and AQS Objective.
- Annual mean NO_2 concentrations at all background sites were in most cases well below the Limit Value.
- Annual mean NO_2 concentrations at the 19 monitoring sites were very similar to those measured in 2001: within 1ppb of the 2001 average in many cases. Concentrations of this pollutant appear to be stable at most sites, having changed little in the years 2000-2002.
- Trends in NO_2 concentration were investigated using three long-running sites, which have operated since 1993 as part of the UK NO_2 Network. While NO_2 concentrations at the two urban background sites (Jane Sandeman and Maufant) have remained stable or decreased slightly. The kerbside site (Beaumont) showed an increasing trend until 2001, but in 2002 decreased slightly.
- One implication of the apparent stability of NO_2 concentrations, is that sites currently close to or above the Limit Value and AQS Objective of 21ppb for annual mean NO_2 concentration may remain so, unless action is taken to reduce urban roadside NO_2 levels.

SO_2 tube results

- The annual mean SO_2 concentration at the single site, Clos St Andre, was 3.0ppb. This is slightly higher than in the two previous years, possibly due to one unusually high result for October. However, it is still relatively low. Future monitoring should identify if there is any increasing trend.

Hydrocarbon tube results

- One site, Springfield Garage (near a petrol station), had an annual mean benzene concentration of 1.7ppb, which is greater than the EC 2nd Daughter Directive Limit Value of 1.5ppb (which is to be achieved by 2010). However, the annual mean was slightly lower than that measured in 2001.

- At Stopford Road, monitoring was carried out from January to May only. The average benzene concentration over this 5-month period was 1.1ppb: exceedence of the EC Limit Value can therefore not be ruled out.
- No sites had annual mean benzene concentrations greater than the UK Air Quality Strategy Objective of 5ppb, which is to be achieved by the end of 2003.
- Four of the BTEX sites (Beresford Street, Le Bas Centre, Elizabeth Lane, and Springfield Garage) have been in operation since 1997, and therefore yield some information on trends. Results from these sites appear to show a decreasing trend in BTEX hydrocarbon concentrations, with the exception of m+p xylene, which has increased at all sites except Elizabeth Lane.

5 Recommendations

1. 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.
2. However, some kerbside and roadside locations are currently "borderline" with respect to this objective, and importantly there is no evidence of a downward trend. Measurements from diffusion tube surveys inevitably carry a high uncertainty, and are not sufficient on their own for determining compliance with Objectives and Directives. It is strongly recommended that the States of Jersey consider using a mobile automatic analyser, to investigate such sites further.
3. The series of diffusion tube surveys has proved very effective in providing information on spatial distribution of pollutant concentrations, and on trends. However, these data are retrospective, and they are unable to clearly highlight short-term pollution episodes. The States of Jersey should consider funding a permanent monitoring station, the results of which will offer the Island Government many advantages:

- Islanders can be provided with rapid information about air quality. Dissemination of this information could be helpful to people who are particularly sensitive to pollution exposure (e.g. asthma sufferers).
- The data from automatic analysers can be directly compared with data from EC Member States monitoring networks, subject to suitable data quality control procedures.
- Data can be used to monitor compliance with Objectives and Directives, and for determining policy.

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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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

			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 μg m^{-3} and ppb are as used by the EC, i.e. 1ppb NO_2 = 1.91 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) Council Directive 85/203/EEC.
(5) Council Directive 1999/30/EC. Transposed into UK Air Quality Regulations in England by SI 2001/2315, in Scotland by SSI 2001/224, in Wales by SI 2001/2683 (W224), and by Statutory Rule 2002 (94) in Northern Ireland.
(6) WHO Guidelines for Air Quality WHO/SDE/OEH/00.02 (2000).

Sulphur Dioxide

			Value[1] / µgm^{-3} (ppb)
The Air Quality Strategy[2] **Set in regulations[3] for all UK.**	Objective for Dec. 31st 2005, for protection of human health.	15-minute mean	266 (100) Not to be exceeded > 35 times per calendar year.
	Objective for Dec. 31st 2004, for protection of human health	1-hour mean	350 (132) Not to be exceeded > 24 times per calendar year.
	Objective for Dec. 31st 2004, for protection of human health	24-hour mean	125 (47) Not to be exceeded > 3 times per calendar year.
Not intended to be set in regulations.	Objective for Dec. 31st 2000, for protection of vegetation.	Annual mean & winter (1st October – 31st March) mean	20 (8)
European Community Smoke & SO_2 Directive[4]	Limit Value	Pollution Year (median of daily values)	80 (30) if smoke[5] > 34 120 (45)if sm. <= 34
	Limit Value	Winter (median of daily values Oct-Mar)	130 (49)if sm. > 51 180 (68)if sm. <= 51
	Limit Value[6]	Pollution Year (98%ile of daily values)	250 (94)if sm. > 128 350 (131)if sm. <= 128
1st Daughter Directive[7]	Objective for Jan 1st 2005, for protection of human health	1-hour mean	350 (132) Not to be exceeded more than 24 times per calendar year.
	Objective for Jan 1st 2005, for protection of human health	Daily 24-hour mean	125 (47) Not to be exceeded more than 3 times per calendar year.
	Objective for Jul 19th 2001, for protection of vegetation.	Annual mean & winter (1st October – 31st March) mean	20 (8)
World Health Organisation[8] **(Non-Mandatory Guidelines)**	Health Guideline	10-minute mean	500
	Health Guideline	24-hour mean	125
	Health Guideline	Annual mean	50

(1) Conversions between µg m^{-3} and ppb are as used by the EC, i.e. 1ppb SO_2 = 2.66 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) Council Directive 80/779/EEC. Limit Values shown remain in force until fully repealed 1st Jan 2005.
(5) Limits for black smoke are given in µg m^{-3} for the BS method as used in the UK. The limits stated in the EC Directive relate to the OECD method, where OECD = BS / 0.85.
(6) Member states must take all appropriate steps to ensure that three consecutive days do not exceed this Limit Value.
(7) 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.
(9)WHO Guidelines for Air Quality WHO/SDE/OEH/00.02 (2000).

Benzene

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

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

Appendix 2
Hydrocarbon Results

Table A2.1 Monthly Hydrocarbon concentrations at Beresford Street (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan - 31 Jan	0.9	3.1	0.6	1.7	0.7
31 Jan - 26 Feb	0.9	3.0	0.6	1.7	0.6
26 Feb - 3 Apr	0.8	6.8	0.8	2.4	0.9
3 Apr - 30 Apr	0.9	3.3	0.6	1.8	0.6
30 Apr - 6 Jun	0.7	3.1	0.7	1.8	0.7
6 Jun - 3 Jul	0.7	2.5	0.5	1.4	0.5
3 Jul - 31 Jul	0.7	2.8	0.6	1.6	0.6
31 Jul - 4 Sep	0.7	3.2	0.6	1.8	0.6
4 Sep - 2 Oct	1.0	3.5	0.8	2.1	0.7
2 Oct - 30 Oct	0.8	2.7	0.6	1.5	0.6
30 Oct - 3 Dec	0.6	3.3	0.6	2.0	0.7
3 Dec - 3 Jan	0.9	3.3	0.6	1.8	0.7
Average	**0.8**	**3.4**	**0.6**	**1.8**	**0.7**

Table A2.2 Monthly Hydrocarbon concentrations at Le Bas Centre (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan - 31 Jan	0.7	2.4	0.5	1.4	0.5
31 Jan - 26 Feb	0.7	2.1	0.4	1.2	0.4
26 Feb - 3 Apr	0.8	2.8	0.5	1.6	0.6
3 Apr - 30 Apr	0.7	2.7	0.5	1.4	0.5
30 Apr - 6 Jun	0.5	2.2	0.5	1.3	0.5
6 Jun - 3 Jul	0.3	1.6	0.4	1.2	0.4
3 Jul - 31 Jul	0.2	1.5	0.3	1.1	0.4
31 Jul - 4 Sep		1.5	0.4		
4 Sep - 2 Oct	0.8	2.2	0.5	1.4	0.5
2 Oct - 30 Oct	0.7	2.2	0.5	1.4	0.5
30 Oct - 3 Dec	0.5	2.2	0.4	1.5	0.5
3 Dec - 3 Jan	0.5	1.5	0.3	0.9	0.3
Average	**0.6**	**2.1**	**0.4**	**1.3**	**0.5**

Table A2.3 Monthly Hydrocarbon concentrations at Elizabeth Lane (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan - 31 Jan	0.6	2.5	0.4	1.2	0.4
31 Jan - 26 Feb	0.5	1.6	0.3	0.8	0.3
26 Feb - 3 Apr	0.6	2.9	0.5	1.6	0.5
3 Apr - 30 Apr	0.6	2.3	0.4	1.3	0.4
30 Apr - 6 Jun	0.4	1.9	0.4	1.1	0.4
6 Jun - 3 Jul	0.5	2.9	0.5	1.4	0.4
3 Jul - 31 Jul	0.5	3.5	0.6	1.7	0.5
31 Jul - 4 Sep	0.5	4.6	0.7	2.0	0.6
4 Sep - 2 Oct	0.7	5.5	0.7	2.0	0.7
2 Oct - 30 Oct	0.5	2.4	0.5	1.3	0.4
30 Oct - 3 Dec	0.3	1.6	0.3	1.0	0.3
3 Dec - 3 Jan					
Average	**0.5**	**2.9**	**0.5**	**1.4**	**0.4**

Table A2.4 Monthly Hydrocarbon Concentrations at Springfield Garage (ppb)

Exposure period	benzene	toluene	Ethyl benzene	m,p -xylene	o-xylene
3 Jan - 31 Jan					
31 Jan - 26 Feb	0.7	4.1	0.6	2.3	0.8
26 Feb - 3 Apr	1.5	11.0	1.4	4.4	1.6
3 Apr - 30 Apr	2.0	11.0	1.5	4.8	1.7
30 Apr - 6 Jun	1.6	9.1	1.6	4.3	1.6
6 Jun - 3 Jul	1.7	9.7	1.5	4.3	1.6
3 Jul - 31 Jul	2.4	17.0	2.3	6.4	2.4
31 Jul - 4 Sep	2.3	13.0	2.1	6.4	2.3
4 Sep - 2 Oct	1.8	7.8	1.4	3.7	1.4
2 Oct - 30 Oct	1.8	7.7	1.2	3.6	1.4
30 Oct - 3 Dec	1.3	8.4	1.3	4.3	1.5
3 Dec - 3 Jan	1.3	6.7	1.0	3.0	1.1
Average	**1.7**	**9.6**	**1.4**	**4.3**	**1.6**

Table A2.5 Monthly Hydrocarbon Concentrations at Stopford Road (outdoor) (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan - 31 Jan	1.1	5.1	0.9	2.8	1.0
31 Jan - 26 Feb	1.0	5.7	1.0	3.1	1.1
26 Feb - 3 Apr	1.4	8.7	1.5	5.0	1.9
3 Apr - 30 Apr	1.3	8.5	1.4	4.7	1.6
30 Apr - 6 Jun	0.9	6.1	1.2	3.4	1.3
6 Jun - 3 Jul					
3 Jul - 31 Jul					
31 Jul - 4 Sep					
4 Sep - 2 Oct					
2 Oct - 30 Oct					
30 Oct - 3 Dec					
3 Dec - 3 Jan					
Average	**1.1**	**6.8**	**1.2**	**3.8**	**1.4**

Table A2.6 Monthly Hydrocarbon Concentrations at Clos St Andre (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan - 31 Jan	0.4	0.8	0.2	0.4	0.2
31 Jan - 26 Feb	0.4	0.5	0.1	0.3	0.1
26 Feb - 3 Apr	0.5	0.9	0.2	0.5	0.2
3 Apr - 30 Apr	0.2	0.6	0.1	0.4	0.2
30 Apr - 6 Jun	0.3	0.6	0.2	0.3	0.1
6 Jun - 3 Jul	0.3	0.5	0.2	0.3	0.1
3 Jul - 31 Jul	0.3	rejected	0.7	1.3	0.6
31 Jul - 4 Sep	0.4	0.9	0.2	0.5	0.2
4 Sep - 2 Oct	0.5	0.9	0.3	0.5	0.2
2 Oct - 30 Oct	0.4	0.7	0.2	0.4	0.2
30 Oct - 3 Dec	0.1	0.5	0.1	0.3	0.1
3 Dec - 3 Jan	0.3	0.4	0.1	0.2	0.1
Average	**0.3**	**0.7**	**0.2**	**0.5**	**0.2**

July 2002 Toluene mean of 21ppb was rejected.

Table A2.7 Monthly Hydrocarbon Concentrations at the Airport (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3 Jan - 31 Jan					
31 Jan - 26 Feb					
26 Feb - 3 Apr					
3 Apr - 30 Apr					
30 Apr - 6 Jun					
6 Jun - 3 Jul	0.3	0.5	0.1	0.2	0.0
3 Jul - 31 Jul	0.3	0.5	0.1	0.2	0.1
31 Jul - 4 Sep	0.2		0.1		
4 Sep - 2 Oct	0.5	0.6	0.2	0.3	0.1
2 Oct - 30 Oct	0.3	0.4	0.1	0.2	0.1
30 Oct - 3 Dec	0.2	0.3	0.1	0.2	0.1
3 Dec - 3 Jan	0.2	0.3	0.1	0.1	nd
Average	**0.3**	**0.4**	**0.1**	**0.2**	**0.1**

Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2003

March 2004

Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2003

March 2004

Title	Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2003
Customer	Public Health Services, States of Jersey
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netcen
Culham Science Centre
ABINGDON
Oxfordshire
OX14 3ED
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) has undertaken a 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 seventh consecutive year of monitoring, the period 31st December 2002 to 30th December 2003.

Diffusion tube samplers were used to monitor nitrogen dioxide (NO_2) at 21 sites, and hydrocarbons at seven 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 six of the nine kerbside and roadside sites in built-up areas were greater than the Limit Value of 21ppb, 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. After application of a correction factor for known diffusion tube bias, all sites were below 21ppb. The highest annual mean of 19.5ppb (after bias correction) was measured at the Weighbridge site. However, given the uncertainty in diffusion tube measurements, exceedence cannot be ruled out, and further monitoring using more accurate automatic techniques is recommended.

By contrast, annual mean concentrations at urban and residential background sites were all well below 21ppb.

Ambient NO_2 concentrations at most of the sites in Jersey were on average slightly higher in 2003 than the previous year. This is consistent with the findings of automatic and non-automatic monitoring networks throughout the rest of the UK, which also recorded increased NO_2 concentrations in 2003.

Ambient concentrations of NO_2 at the long-running sites show no clear trends, and despite some year-to-year fluctuations they remain generally stable. Unlike the UK as a whole, there is no apparent downward trend in Jersey's NO_2 concentrations. Sites that are currently close to the AQS Objective are likely to remain so, unless action is taken.

The highest annual mean benzene concentration of 1.5ppb 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 1.0ppb. All sites therefore met the UK Air Quality Strategy Objective of 5ppb (which applies to the running annual mean) by the end of 2003 as required. All sites also met the EC 2nd Daughter Directive annual mean Limit Value of 1.5ppb (which is to be achieved by 2010). 2003 was the first year in which Springfield Garage did not exceed this limit.

Three of the hydrocarbon sites have been in operation since 1997. The seven years' data from these long-running hydrocarbon sites appear to show a consistent decreasing trend in ambient concentrations of all the measured species except m+p xylene. This pollutant, by contrast, increased at most sites until around 2001 but also now appears to be falling.

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 2003. This is the seventh 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 seven sites.

Previous surveys also measured sulphur dioxide (SO_2), at a single monitoring site, Clos St Andre (near the Bellozanne Valley waste incinerator). However, the results established that concentrations were low, and very unlikely to cause a problem. Therefore, SO_2 monitoring was discontinued at the end of 2002 and SO_2 was not included in the 2003 study.

This report presents the results obtained in the 2003 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]. 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. Most of the monitoring sites were the same as those used in the 2002 study, (although some changes were necessary during the course of the year). 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. For consistency with previous years’ reports, the units used for NO_2 in this report are parts per billion (ppb). To convert from ppb to microgrammes per cubic metre ($\mu g\ m^{-3}$) 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 5 ppb. In this report, concentrations of benzene are expressed in parts per billion (ppb). To convert from ppb to microgrammes per cubic metre ($\mu g\ m^{-3}$) 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 $\mu g\ m^{-3}$ (1.0 ppb) in rural areas, up to 204 $\mu g\ m^{-3}$ (54 ppb) 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 occupational 8-hour exposure limit (OEL) is 50ppm (50,000ppb). The best estimate for the odour threshold of toluene has been reported[8] as 0.16ppm (160ppb).

(iii)ethyl benzene
Again, there are no limits for ambient concentration of ethyl benzene, although there are occupational limits relating to workplace exposure[7], of 100 ppm over 8 hours, and 125 ppm over 10 minutes. Ambient concentrations are highly unlikely to approach these levels.

(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)[8].

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 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. However, this was not always possible, due to late arrival of tubes.

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 0.2 ppb for NO_2 and 0.1 ppb 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 correction factor of 0.78. (This applies only to NO_2 diffusion tubes, not BTEX tubes). ***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. These are shown in Table 1 and Figure 1.

The two new sites that started in 2003 are located at a taxi rank and a camera shop, both in La Colomberie in St Helier. They were set up to investigate possible changes in NO_2 concentrations as a result of traffic flow changes on the adjacent street.

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 NEED TO UPDATE

BTEX hydrocarbons were monitored at a total of eight sites during 2003. 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 Elizabeth Lane site was close to a paint spraying process – a potential source of hydrocarbon emissions, especially toluene and xylenes. This process closed down in October 2003, so the monitoring site was replaced. The new site is in Handsford Lane, near to a similar paint-spraying process.

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 is anticipated that the 2004 results for this site will 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 3	Elizabeth Lane	648 491	Urban background near paint spraying process
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	(Replaced Elizabeth Lane site): 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 2.4ppb (in June at the rural Rue des Raisies site), to 34.8ppb, (in March at the kerbside Georgetown site). Annual mean NO_2 concentrations ranged from 5.2ppb (at Rue des Raisies) to 26.0ppb at the Weighbridge 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 21 ppb. The EC 1st Daughter Directive[10] contains Limit Values for NO_2 as follows:

- 105 ppb (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.
- 21 ppb (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 16 ppb (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 six of the nine kerbside and roadside sites exceeded 21ppb; these were Weighbridge, Beaumont, Georgetown, Broad Street, La Pouquelaye, and the Taxi Rank. The other three kerbside and roadside sites (the Camera Shop, the Parade, and First Tower) had annual mean NO_2 concentrations greater than 20ppb, and were therefore very close to the EC Limit Value and AQS Objective.

Harwell Scientifics' NO_2 diffusion tubes typically overestimate NO_2 concentration. Harwell Scientifics have quantified this overestimation, by a series of field tests in 2003, and provided a bias correction 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 21ppb. The highest annual mean (at Weighbridge) is reduced from 26.0ppb (uncorrected) to 19.5ppb (bias corrected). However, given the uncertainty on diffusion tube measurements, often around +/- 25%, it remains likely that some roadside and kerbside sites are currently "borderline" with respect to the Limit Value and AQS Objective for annual mean NO_2. The annual mean NO_2 concentrations at the 12 background sites were in most cases well below 21ppb, with the exception of Beresford Street, where the annual mean (uncorrected) was 20.0ppb.

The 16ppb limit for protection of vegetation is only applicable at the one rural background site, Rue des Raisies, where the annual mean NO_2 concentration at this site was well within the limit.

Table 3. NO_2 Diffusion Tube Results 2003, Jersey. Concentrations in ppb. =

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	2003 Annual Mean	*Bias corr. AM 2003*
Le Bas Centre	11.7	18.7	17	15	17.4	13.9	16	16.3	17.7	16.3	19.1	17	16.3	*12.3*
Mont Felard	11.7	16.4	17.4	16.9	14.5	15.4	13.9	11	19.6	15.1	14.5	16.7	15.3	*11.4*
Les Quennevais	4.9	7.8	9.3	7.3	3.5	5.3	5	7.7	5.6	8.8	10.7	12.3	7.4	*5.5*
Rue Des Raisies	3.9	5.4	7.7	3.9	2.6	2.4	3.6	6.5	3.7	5.7	5.4	11	5.2	*3.9*
First Tower	14.1	24.6	24.9	7.5	21.7	20.8	20.1	24.1	24.4	21.5	21.9	21.7	20.6	*15.5*
Weighbridge	23.3	21.9	21.5	24.3	30.6	28.6	31.2	27.6	24.1	25.9	27.1	25.4	26.0	*19.5*
Langley Park	8.9	10.5	13.5	8.9	8.1	7.7	8.6	10.6	9.2	11.6	13.9	14.8	10.5	*7.9*
Georgetown	21.7	17.7	34.8	24.2	21.9	21.2	22	30.5	26.1	24.5	26.2	26.1	24.7	*18.6*
Clos St.Andre	8.7	12.2	12.1	22.1	7.6	6.1	6.6	8.9	8.9	8.9	13.4	15.6	10.9	*8.2*
L'Avenue et Dolmen	13.5	14.5	17	12.8	10.8	9	11.2	-	10.2	15	15.9	17.2	13.4	*10.0*
Robin Place	15.4	19.5	19.1	15.3	14.8	12.3	15.1	15.2	17.2	16.4	19.7	17.3	16.4	*12.3*
Beaumont	21.4	25.1	27.2	24	24.7	20.5	26.4	29.6	23.9	21.7	26.4	25.4	24.7	*18.5*
The Parade	19.2	20.6	21.7	18.1	17.3	19.9	20.6	23.6	21.3	20.1	21.8	22	20.5	*15.4*
Maufant	5.6	6.2	7.9	4.9	3.8	3.5	4.1	5.5	4.5	6.6	6.8	8.9	5.7	*4.3*
Jane Sandeman	10.9	12.3	12.7	8.8	6.4	6.4	7.8	9.1	8.3	10.6	11.6	12.6	9.8	*7.3*
Saville Street	15.6	19.5	19	17.4	14.3	14.4	14.3	18.4	16.9	16.2	17.3	17.1	16.7	*12.5*
Broad Street	20.2	19.7	23.9	21.9	22.3	20.9	23.3	24.5	23.3	21.5	22.8	21.4	22.1	*16.6*
Beresford Street	17.4	22.4	23.6	20.2	17.3	17.4	18.8	21.2	21.6	17.5	21.1	20.9	20.0	*15.0*
La Pouquelaye	20.9	25.8	27.7	22.3	28.4	25.7	25.9	29.2	24.7	22.8	26.3	24.7	25.4	*19.0*
Camera Shop, Colomberie	19.1	23.2	22.6	20.1	22.7	15.2	21.4	19.8	21	17.2	23.1	19.8	20.4	*15.3*
Taxi Rank, Colomberie	21.9	21.9	27	21.8	20.4	18.3	21.5	22.2	25.5	11.3	24.9	21.9	21.6	*16.2*

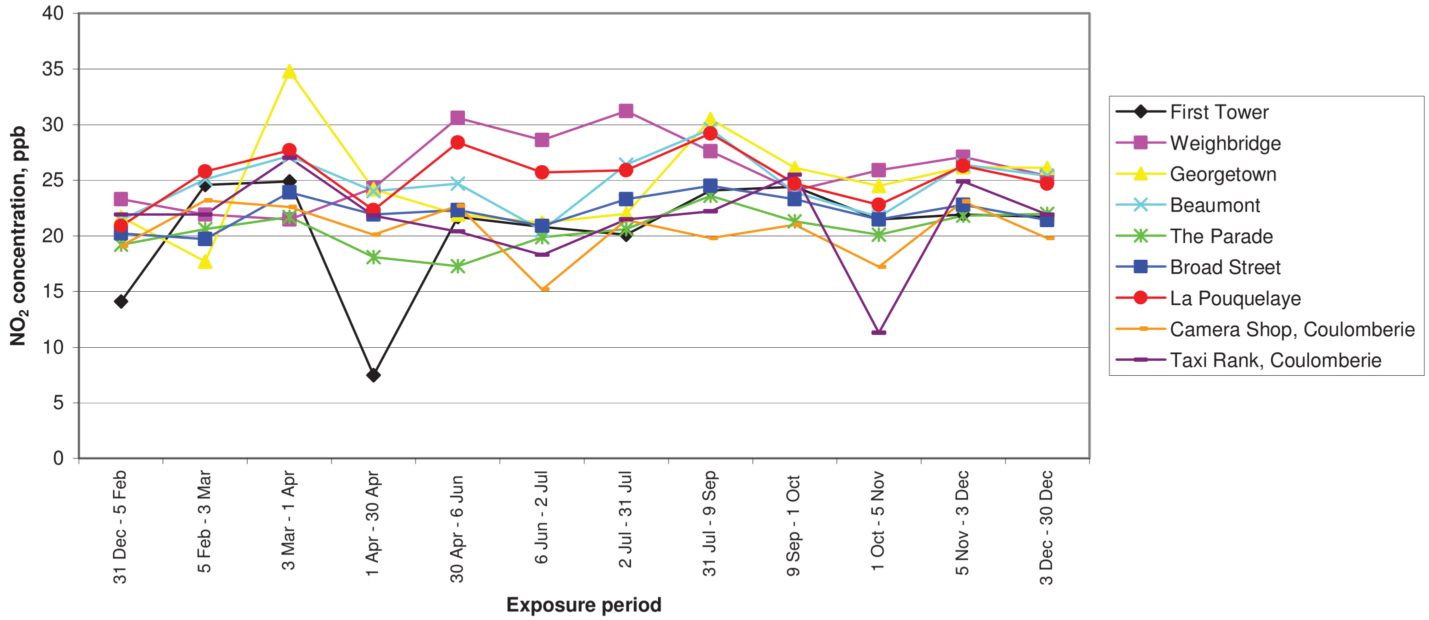

Figure 2. Monthly Mean Nitrogen Dioxide Concentrations at Roadside and Kerbside Sites, 2003=

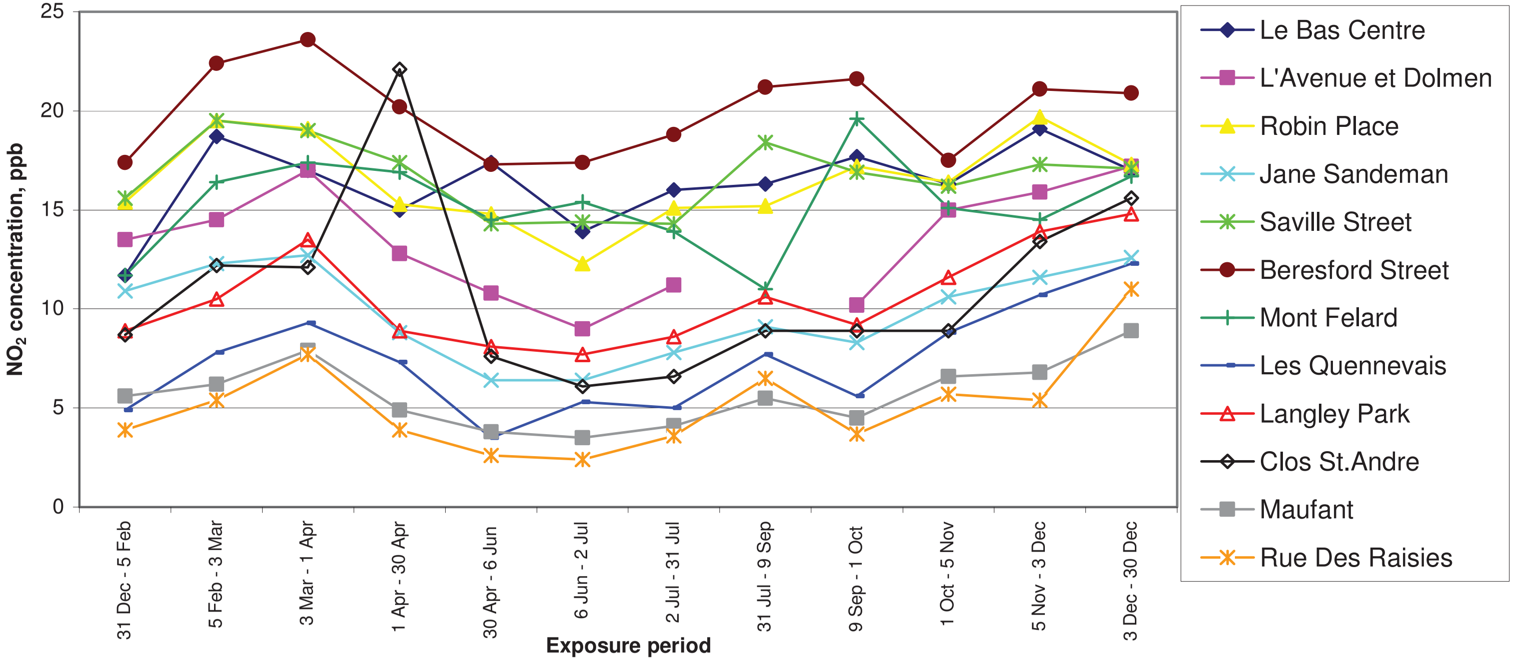

Figure 3. Monthly Nitrogen Dioxide Concentrations at Background Sites, 2003

Two anomalies are apparent: during April, an unusually high result for the background site Clos St Andre coincided with an unusually low result for the kerbside First Tower. These two sites are nearby, and are usually visited one after the other when tubes are changed. Having checked with the analyst that the results had been correctly reported, Netcen investigated the possibility that the April tubes for these two sites (which are labelled with the site numbers) may have been accidentally interchanged. The States of Jersey thought that this was indeed possible. However, in the absence of any evidence that such an error did occur, these two results must be accepted as they stand.

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 2003, 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 national annual averages for 2003 are provisional at present, pending full data ratification. Estimated UK NO_2 Network averages for 2003 were 23 ppb for roadside sites and 13 ppb for urban background sites. Both these average values are higher than those measured in 2002; both the Automatic Urban and Rural Network, and the NO_2 diffusion tube network recorded increases in 2003 compared with 2002. They are also slightly higher than the bias corrected 2003 averages for Jersey; 17 ppb for roadside and roadside sites and 9 ppb for background sites.

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	2003 Annual average NO_2, ppb
Exeter Roadside	22
Plymouth Centre	15
Lullington Heath	7
Harwell	8

The bias corrected annual mean NO_2 concentrations measured at the kerbside and roadside sites in Jersey ranged from 15ppb to 20ppb. The annual mean at Exeter Roadside was therefore slightly higher than these. The Jersey urban background sites had annual mean NO_2 concentrations ranging from 7ppb to 15ppb – typically a little 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 4ppb to 11ppb, and thus were more comparable with rural sites such as Lullington Heath and Harwell. The annual mean of 3.2ppb 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 =

Most of the sites have been operating for only four years, which is not long enough to identify trends. Very little change was observed at most of these sites for the previous three years, 2000 to 2002. It was observed in last year's report that those kerbside and roadside sites close to the AQS Objective for the annual mean are likely to remain so, unless action is taken.

Most of the NO_2 monitoring sites in Jersey showed a small increase in annual mean NO_2 in 2003, compared to 2002. This is consistent with the UK as a whole, where both automatic and non-automatic monitoring networks recorded an average increase in ambient NO_2 concentrations in 2003, compared to 2002.

Three sites have been in operation since 1993, as part of the UK Nitrogen Dioxide Network. Annual mean concentrations for these long-running sites are shown in Table 5 and Figure 4. ***These data are not bias corrected; prior to 2002 there was no reliable information on which to carry out bias correction, so for consistency, uncorrected data are used in this section.*** NO_2 concentrations have remained relatively stable over the period. NO_2 concentrations in Jersey do not appear to follow the downward trend observed for the UK as a whole.

Table 5 Annual mean NO_2 concentrations at Long-Term Sites =
(Not bias corrected) =
=

Site =	1993 =	1994 =	1995 =	1996 =	1997 =	1998 =	1999 =	2000 =	2001 =	2002=	2003 =
Beaumont (Kerbside)	-	23	25	24	ND	20	21	23	24	22	25
The Parade (Intermediate*)	16	16	16	16	ND	13	14	13	-	-	-
Jane Sandeman (Background)	11	10	11	11	ND	9	9	8	9	9	10
Maufant (Background)	9	8	7	6	ND	5	6	5	5	5	6

**Intermediate sites were discontinued at the end of 2000. This site was replaced by a Roadside site, also at the Parade.*

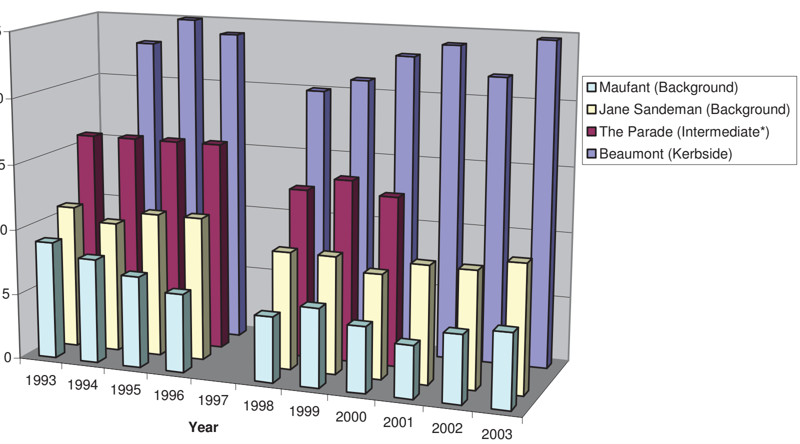

Figure 4. Trends in Annual Mean NO_2 Concentrations at Four Long-Term Sites = (not corrected for diffusion tube bias). =

3.2 HYDROCARBONS

3.2.1 Summary of Hydrocarbon Results

Results of the hydrocarbon survey for the seven sites are shown in Appendix 2, Tables A2.1 to A2.7 respectively. Graphical representations are shown in Figures 5 to 11.

The diffusion tube results show that average outdoor hydrocarbon concentrations in Jersey remain generally low. A summary of annual average hydrocarbon concentrations is shown in Table 6.

Table 6. Summary of Average Hydrocarbon Concentrations, Jersey, 2003

Site	Benzene, ppb	Toluene, ppb	Ethyl Benzene, ppb	m+p Xylene, ppb	o Xylene, ppb
Beresford Street	0.6	3.0	0.5	1.5	0.5
Le Bas Centre	0.4	2.1	0.4	1.1	0.4
Elizabeth Lane * *(Jan-Oct)*	0.6	3.1	0.5	1.4	0.5
Handsford Lane * *(Nov-Dec only)*	(0.9)	(7.2)	(1.1)	(3.1)	(0.9)
Springfield Garage# *(petrol station)*	1.5	8.9	1.3	3.6	1.3
Clos St Andre	0.3	1.1	0.2	0.4	0.1
Airport	0.3	0.8	0.1	0.2	0.1

**Elizabeth Lane site was replaced by Handsford Lane in November 2003.*
 # Data for January, July and November rejected as suspiciously low. April tube missing.

The following sites did not achieve full data capture:
(i) Elizabeth Lane, which closed at the end of October 2003, when the nearby paint spraying process shut down.
(ii) Handsford Lane, which replaced it in November.
(iii) Springfield Garage: the April tube was stolen from this site. In addition, suspiciously low concentrations (below detection levels or an order of magnitude below those measured at the background sites) were measured in January, July and November 2003. After careful consideration these were rejected. Eight months' valid data remain for Springfield Garage.
(iv) Airport: the October tube was exposed for two months: the result was therefore rejected.

Highest average concentrations of benzene were found at Springfield Garage, as in previous years. However, average benzene concentrations were less than 3ppb at all sites. Levels at Springfield Garage showed some reduction compared with its 2002 mean benzene concentration of 1.7ppb.

Annual mean toluene concentrations were less than 5ppb at all sites except Springfield Garage, where the annual mean was 8.9ppb. The two-month mean at the new Handsford Lane site was 7.2ppb.

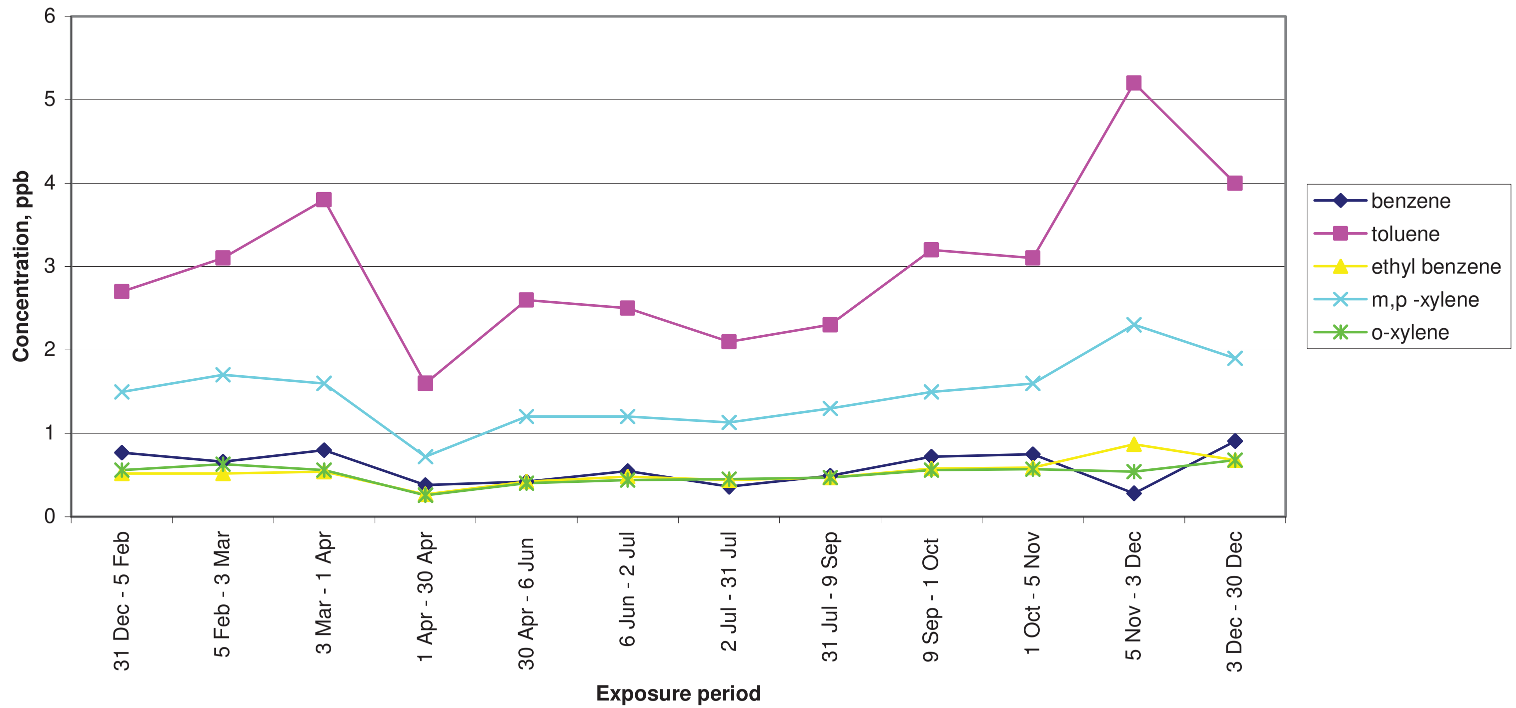

Figure 5. Monthly mean hydrocarbon concentrations at Beresford Street, 2003=

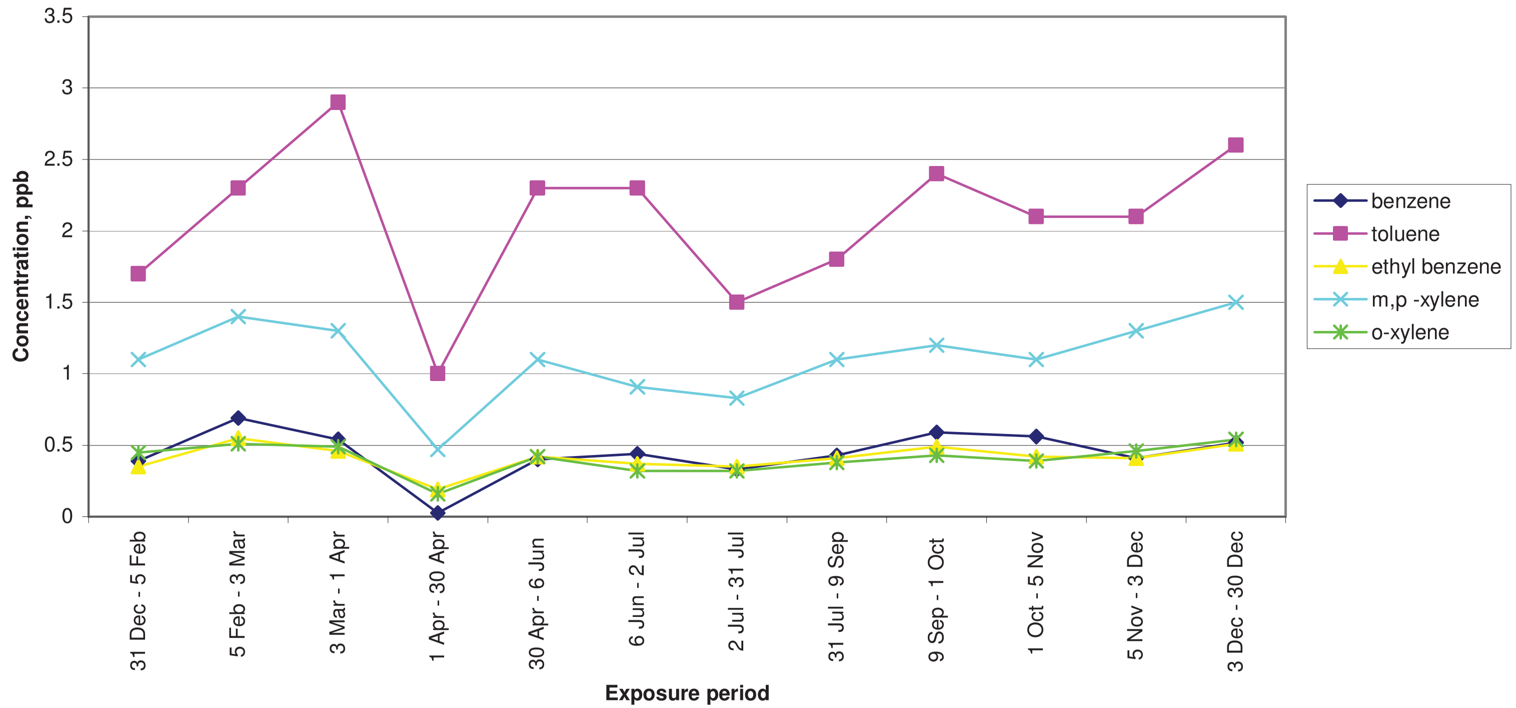

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Figure 6. Monthly mean hydrocarbon concentrations at Le Bas Centre, 2003=

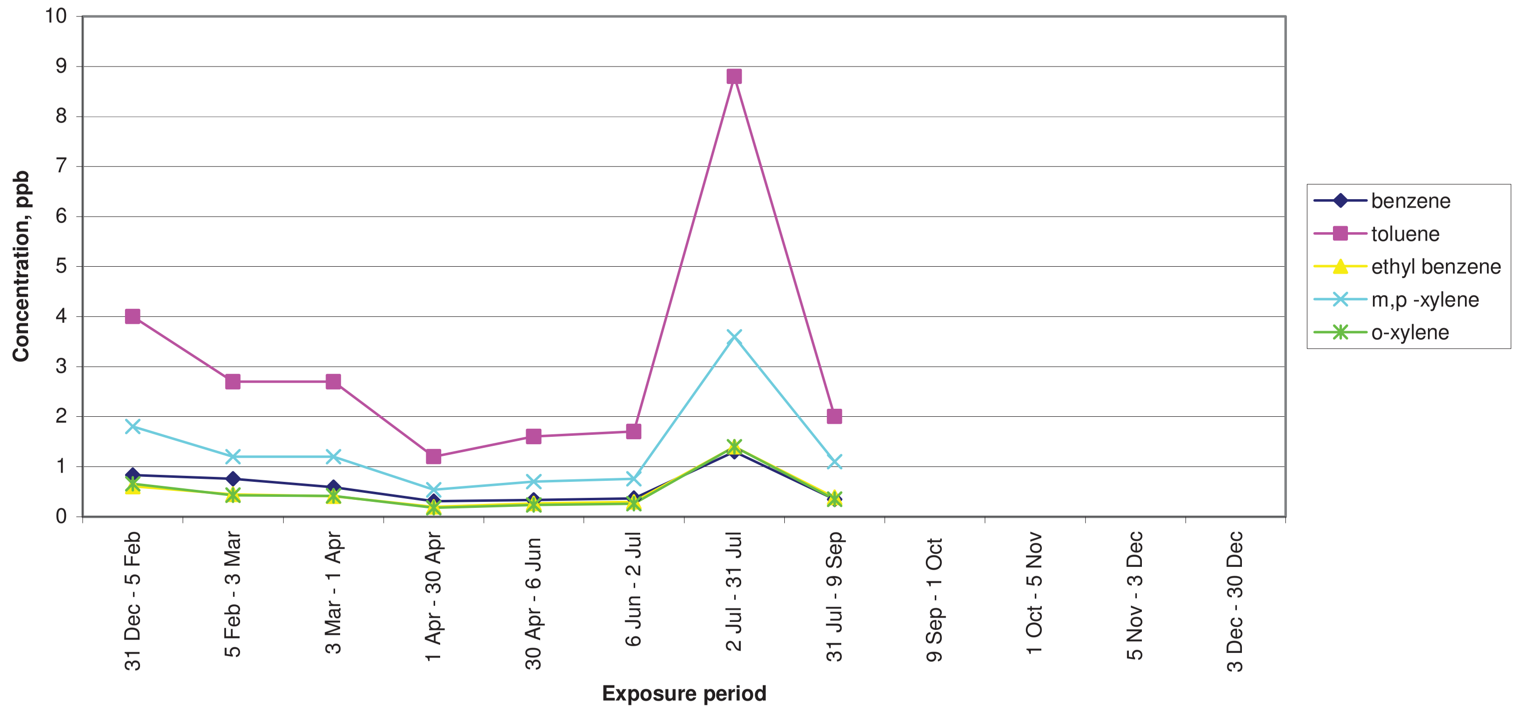

Figure 7. Monthly mean hydrocarbon concentrations at Elizabeth Lane, 2003

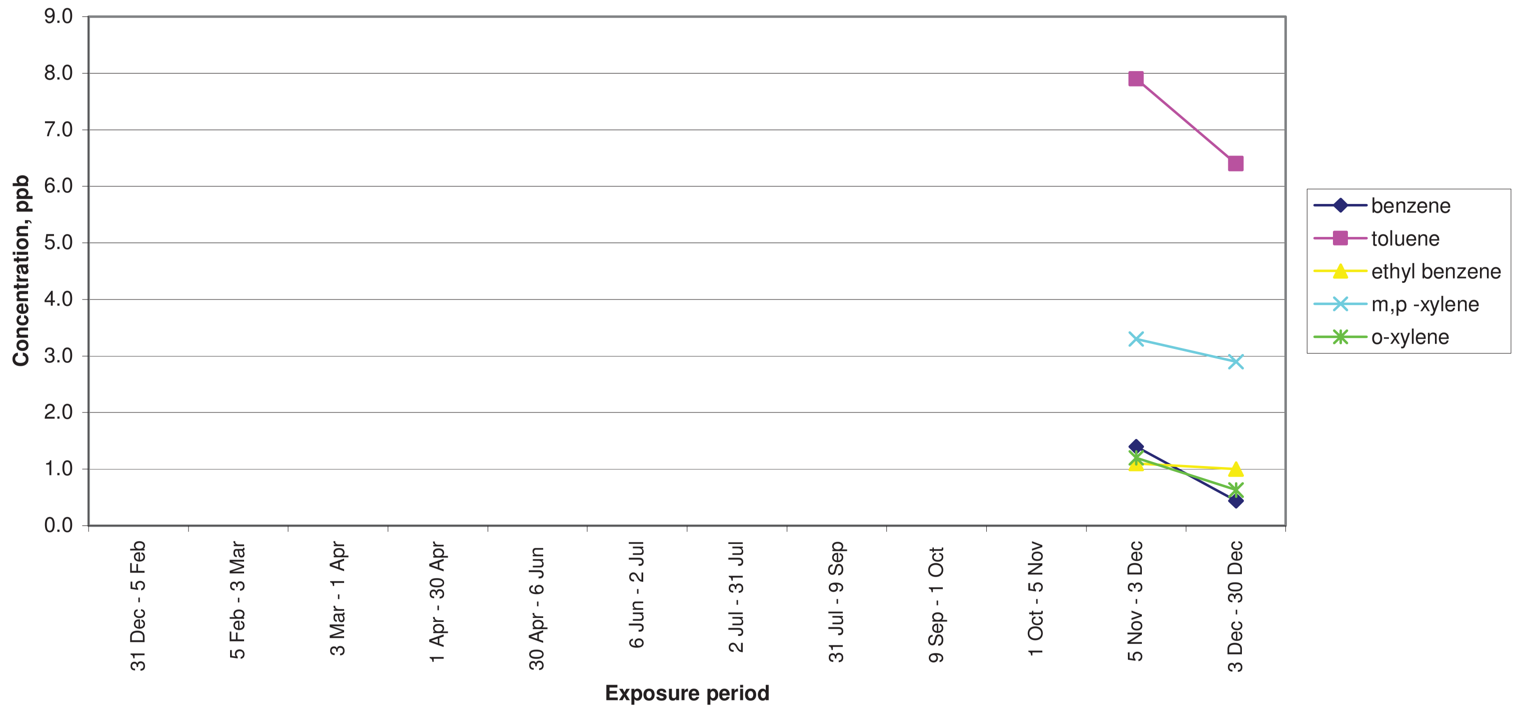

Figure 8. Monthly mean hydrocarbon concentrations at Handsford Lane, 2003

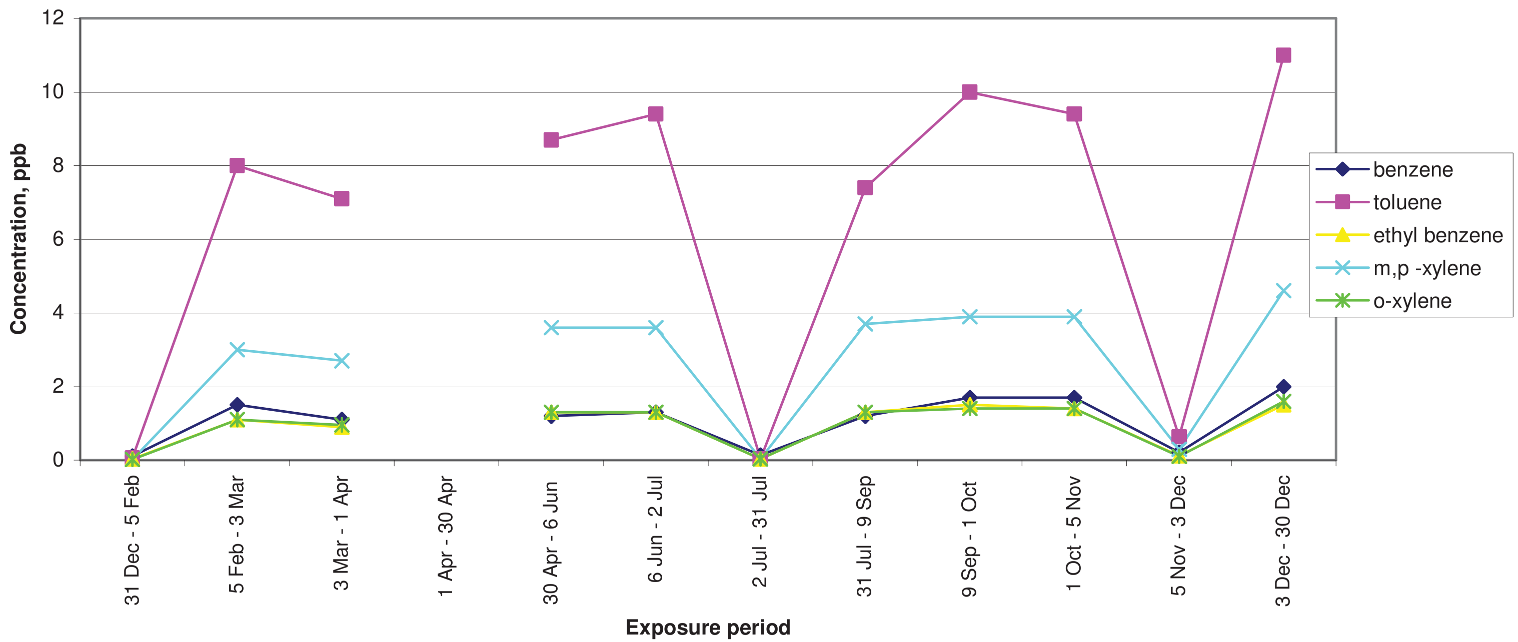

Figure 9. Monthly mean hydrocarbon concentrations at Springfield Garage, 2003
(Note: January, July and December results were rejected as they were suspiciously low. They are shown here for information, but were not included when calculating the annual means.)

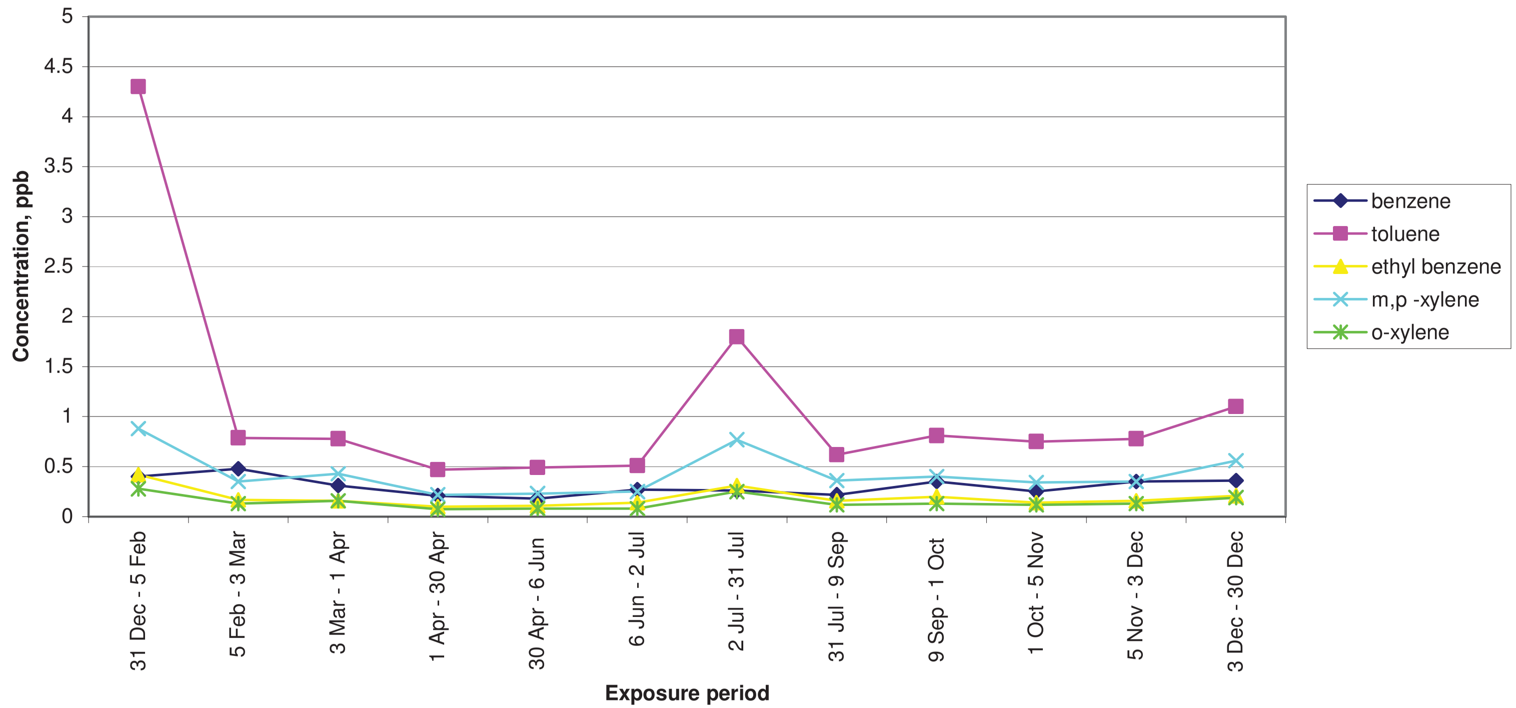

Figure 10. Monthly mean hydrocarbon concentrations at Clos St Andre, 2003

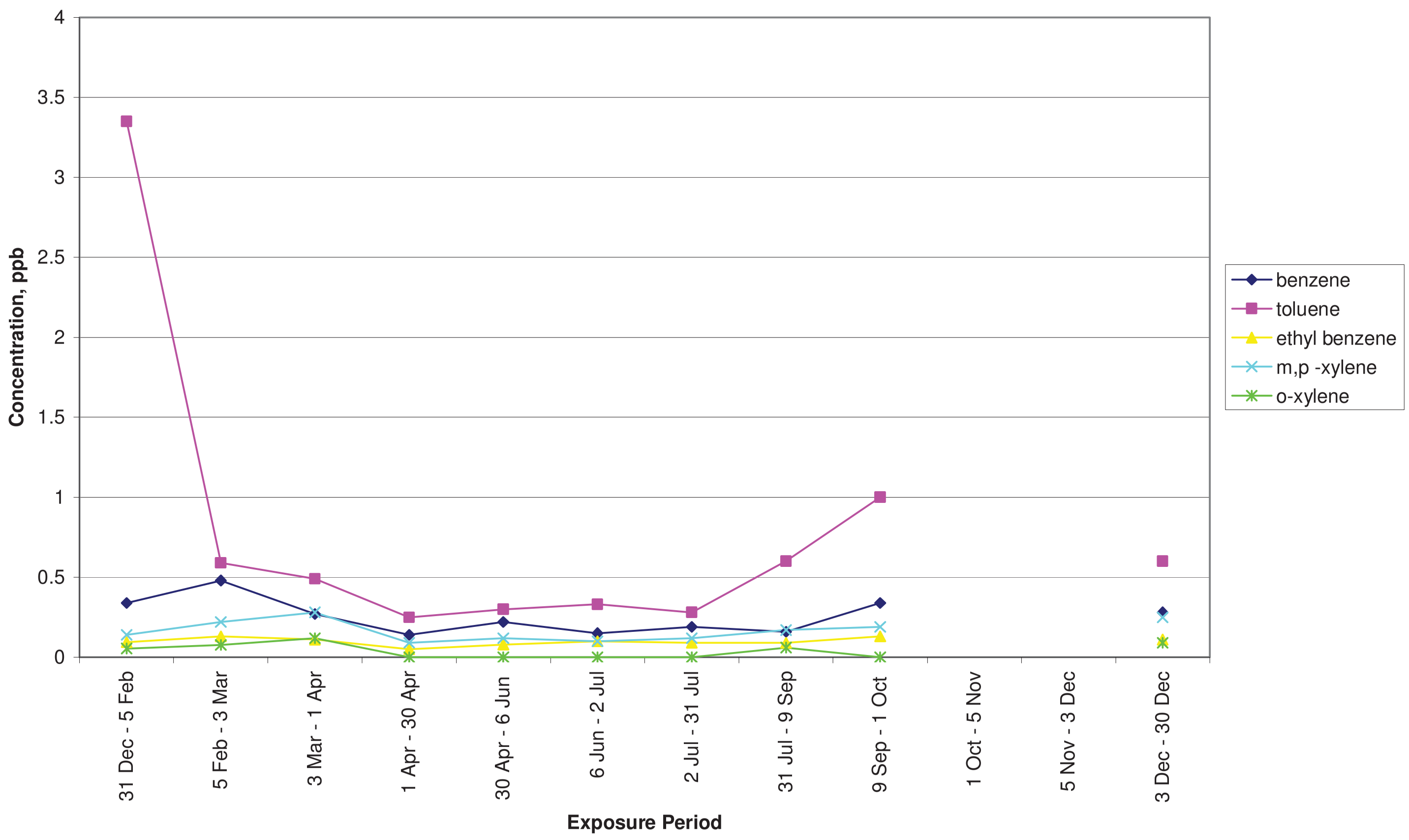

Figure 11. Monthly mean hydrocarbon concentrations at the Airport, 2003

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 an objective for the running annual mean of 5ppb, to be achieved by 31 December 2003, and 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 5ppb at any of the Jersey sites.

The EC 2nd Daughter Directive[10] sets a limit of 5μg m^{-3} (1.5ppb) for annual mean benzene to be achieved by 2010. The annual mean benzene concentration at Springfield Garage was 1.5ppb: at all other sites it was less than 1.0ppb. 2003 is the first year in which Springfield Garage has not exceeded this limit.

3.2.3 Comparison with UK Data

Table 7 compares hydrocarbon data from the 2003 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 roadside site.
- Harwell - a rural site in the south of England, within 10km of a power station.

Table 7. Comparison with Hydrocarbon Concentrations at Other UK Sites, Calendar Year 2003

Site	Benzene, ppb	Toluene, ppb	m+p Xylene, ppb
Jersey Diffusion Tube Sites			
Beresford Street	0.6	3.0	1.5
Le Bas Centre	0.4	2.1	1.1
Elizabeth Lane * *(near paint spraying: Jan-Oct)*	0.6	3.1	1.4
Handsford Lane * (Nov-Dec only)	-	-	-
Springfield Garage *(petrol station)*	1.5	8.9	3.6
Clos St Andre	0.3	1.1	0.4
Airport	0.3	0.8	0.2
UK Automatic Sites			
London Marylebone Road	1.02	3.45	2.08
Cardiff Centre	0.36	1.02	0.55
Glasgow Kerbside	0.56	1.76	1.00
Harwell	0.18	0.37	0.17

Highest benzene, toluene and m+p xylene concentrations were measured at Springfield Garage (where fuels are stored), closely followed by London Marylebone Road (beside a very busy city road). Lower concentrations were measured at the background sites on Jersey; hydrocarbon levels at these sites appear comparable with those at the other two automatic sites in Cardiff and Glasgow. (where hydrocarbon concentrations appear to have fallen since last year), or the rural site at Harwell. Hydrocarbon levels at Clos St Andre and the Airport remain comparable with, although slightly higher than, the mean from the rural Harwell site. Concentrations at Elizabeth Lane were comparable to those at Beresford Street and Le Bas, despite the proximity of the paint spraying process.

3.2.4 = Comparison with Previous Years Hydrocarbon Results =

Four sites (Beresford Street, Le Bas Centre, Elizabeth Lane and Springfield Garage) have been operating since 1997. The 2003 hydrocarbon concentrations were consistent with the previous year, though in most cases slightly lower. Table 8 shows annual means for these sites, also Clos St Andre.

Table 8. Comparison of Hydrocarbon Concentrations, Jersey, 1997 - 2003. =

	benzene, ppb =	toluene, = ppb =	Ethyl = benzene, ppb =	m+p xylene, = ppb =	o-xylene, = ppb =
Beresford Street =					
1997	3.2	5.4	1.2	1.2	2.7
1998	2.5	4.9	0.9	1.0	2.3
1999	1.8	3.6	0.6	1.7	0.8
2000	0.9	3.7	0.8	2.3	0.9
2001	1.0	3.9	0.8	2.2	0.8
2002	0.8	3.4	0.6	1.8	0.7
2003	0.6	3.0	0.5	1.5	0.5
Le Bas Centre =					
1997	2.8	4.5	1.2	1.0	2.2
1998	2.3	4.2	0.7	0.9	1.9
1999	1.1	2.9	0.5	1.3	0.6
2000	0.9	3.3	0.7	1.9	0.7
2001	0.8	3.5	0.6	1.7	0.7
2002	0.6	2.1	0.4	1.3	0.5
2003	0.4	2.1	0.4	1.1	0.4
Elizabeth Lane * =					
1997	1.9	4.4	1.4	1.7	2.2
1998	1.9	5.0	0.7	1.6	0.8
1999	1.0	3.3	0.5	1.2	0.6
2000	0.7	3.3	0.7	1.8	0.6
2001	0.7	4.1	0.7	2.0	0.8
2002	0.5	2.9	0.5	1.4	0.4
2003	0.6	3.1	0.5	1.4	0.5
Springfield Garage * =					
1997	7.7	12.5	1.9	1.9	4.3
1998	7.7	12.3	1.5	1.7	4.3
1999	4.5	10.9	1.3	3.8	1.5
2000	1.6	9.2	1.8	5.0	2.0
2001	2.1	11.2	1.8	5.2	1.9
2002	1.7	9.6	1.4	4.3	1.6
2003	1.5	8.9	1.3	3.6	1.3
Clos St Andre =					
2000	0.3	0.9	0.2	0.6	0.2
2001	0.4	1.2	0.3	0.6	0.3
2002	0.3	0.7	0.2	0.5	0.2
2003	0.3	1.1	0.2	0.4	0.1

** 2003 means for Elizabeth Lane and Springfield Garage based on 10 and 8 months' data respectively.*

Figures 12 to 16 illustrate how annual mean concentrations of these hydrocarbons have changed over the years of monitoring.

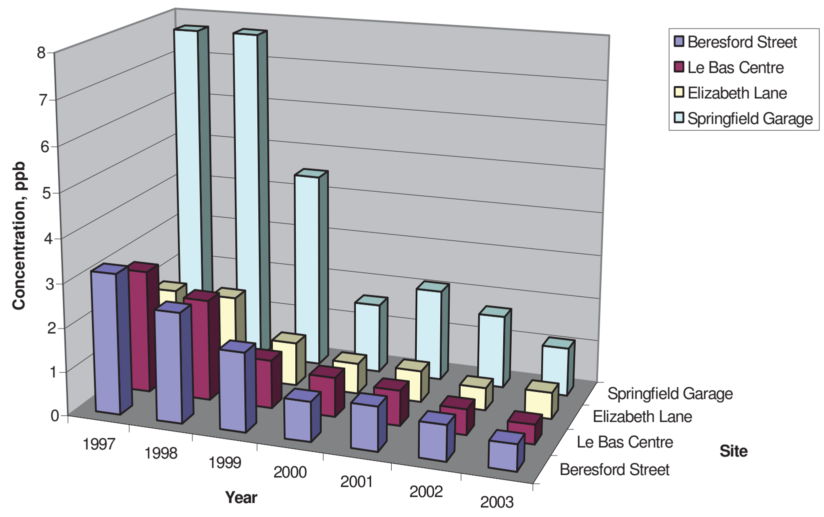

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Figure 12. Trends in Benzene Concentration =

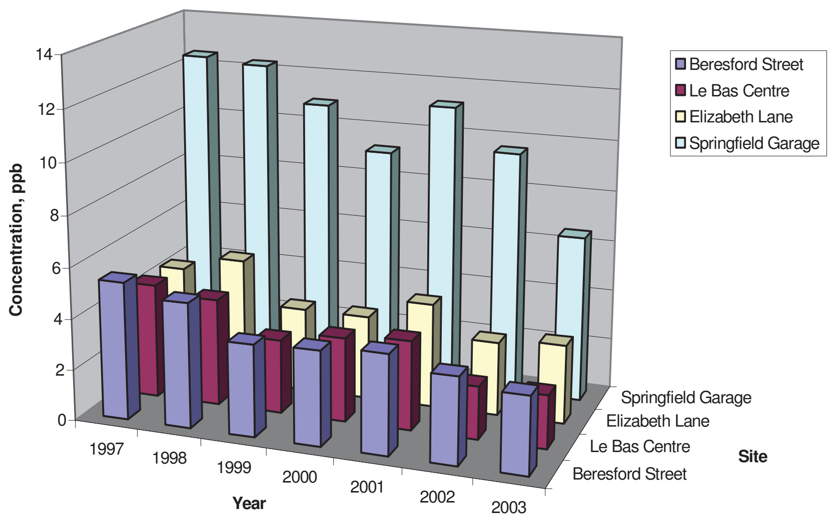

Figure 13. Trends in Toluene Concentration =

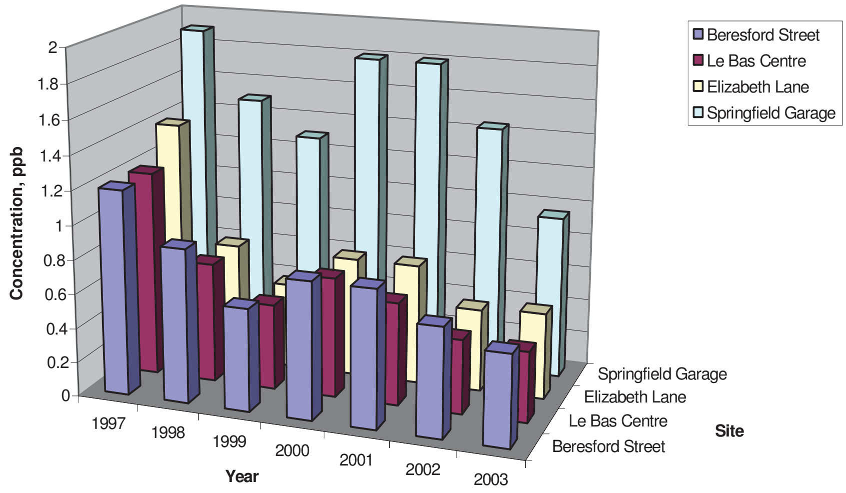

Figure 14. Trends in Ethylbenzene Concentration =

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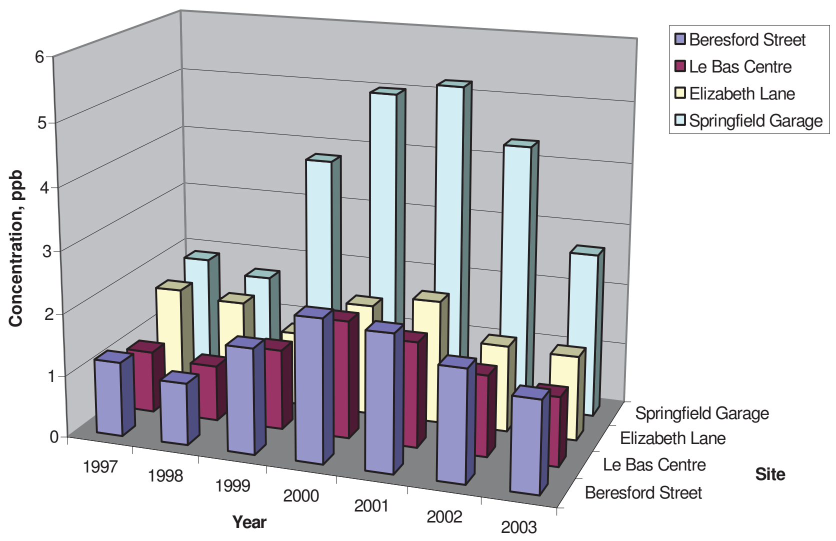

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Figure 15. Trends in m+p- Xylene Concentration

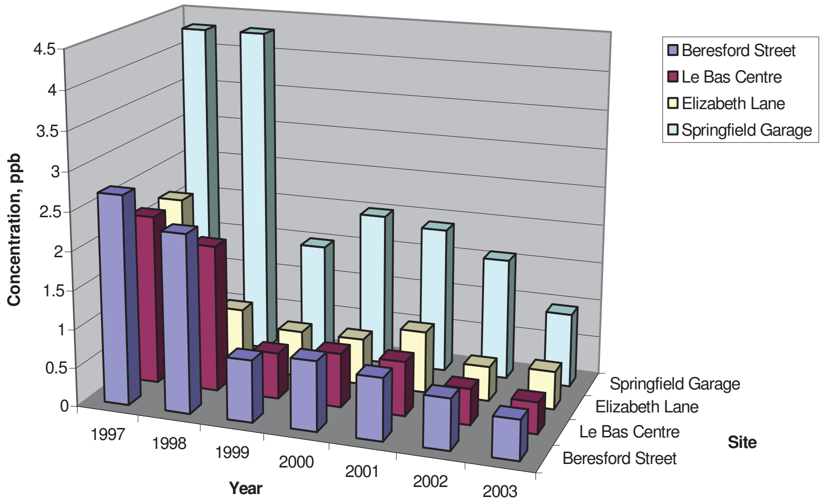

Figure 16. Trends in o-Xylene Concentration

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 in particular shows 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. In the earlier years of the survey, m+p xylene concentrations alone appeared to be increasing; however, since 2001, concentrations of this pollutant too have decreased.

4 Conclusions

- Netcen has undertaken a year-long diffusion tube monitoring study in Jersey during 2003, 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 7 sites, including a new site at Handsford Lane, which replaced Elizabeth Lane in November 2003.
- 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 six of the nine kerbside and roadside sites (Weighbridge, Beaumont, Georgetown, Broad Street, La Pouquelaye, and the Taxi Rank in La Colomberie) were above the EC Directive Limit Value and AQS Objective of 21ppb. The other three kerbside and roadside sites (the Camera Shop in La Colomberie, the Parade, and First Tower) had annual mean NO_2 concentrations greater than 20ppb, and were therefore very close to the EC Limit Value and AQS Objective.
- Applying the analytical laboratory's recommended correction factor for diffusion tube bias to these annual mean results reduces all of them to below 21ppb. However, given the uncertainty of $\pm$25% inherent in diffusion tube measurements, together with the apparent lack of any downward trend in NO_2 on Jersey, it is possible that Weighbridge, Beaumont, Georgetown, Broad Street, La Pouquelaye, and the Taxi Rank may remain close to 21ppb 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 slightly higher than those measured in 2002: this is consistent with the rest of the UK, where many monitoring sites showed increases in NO_2 concentration during 2003.
- Trends in NO_2 concentration were investigated using 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.
- One implication of the apparent stability of NO_2 concentrations, is that sites currently close to the Limit Value and AQS Objective of 21ppb 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 5ppb, which is to be achieved by the end of 2003.
- All sites had annual mean benzene concentrations less than the EC 2nd Daughter Directive Limit Value of 1.5ppb (which is to be achieved by 2010). This includes the Springfield Garage site: 2003 was the first year in which this site achieved the Limit Value.
- Annual mean concentrations of BTEX hydrocarbons were slightly lower than those measured in 2002.
- Four of the BTEX sites (Beresford Street, Le Bas Centre, Elizabeth Lane, and Springfield Garage) have been in operation since 1997, and therefore yield some information on trends. Results from these sites appear to show a decreasing trend in most BTEX hydrocarbon concentrations, in particular benzene.
- In the earlier years of this survey, m+p xylene concentrations increased at all sites except Elizabeth Lane; however, since 2001 this species too appears to be decreasing.

5 =Recommendations =

1. 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.
2. However, some kerbside and roadside locations remain "borderline" with respect to this objective, and there is no evidence of a downward trend. Measurements from diffusion tube surveys inevitably carry a high uncertainty, and are not sufficient on their own for determining compliance with Objectives and Directives. It is strongly recommended that the States of Jersey consider using a mobile automatic analyser, to investigate such sites further.
3. The series of diffusion tube surveys has proved very effective in providing information on spatial distribution of pollutant concentrations, and on trends. However, these data are retrospective, and they are unable to clearly highlight short-term pollution episodes. The States of Jersey should consider funding a permanent monitoring station, the results of which will offer the Island Government many advantages:

- Islanders can be provided with rapid information about air quality. Dissemination of this information could be helpful to people who are particularly sensitive to pollution exposure (e.g. asthma sufferers).
- The data from automatic analysers can be directly compared with data from EC Member States monitoring networks, subject to suitable data quality control procedures.
- Data can be used to monitor compliance with Objectives and Directives, and for determining policy.

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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Appendices

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Appendix 1 =
Air Quality Standards

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Air Pollution Guidelines Used in this Report. =

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

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Nitrogen Dioxide =

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			= 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

			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

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Table A2.1 Monthly Hydrocarbon concentrations at Beresford Street (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb	0.77	2.7	0.52	1.5	0.56
5 Feb - 3 Mar	0.66	3.1	0.52	1.7	0.63
3 Mar - 1 Apr	0.8	3.8	0.54	1.6	0.56
1 Apr - 30 Apr	0.38	1.6	0.27	0.72	0.26
30 Apr - 6 Jun	0.42	2.6	0.42	1.2	0.4
6 Jun - 2 Jul	0.55	2.5	0.48	1.2	0.44
2 Jul - 31 Jul	0.36	2.1	0.44	1.13	0.45
31 Jul - 9 Sep	0.49	2.3	0.47	1.3	0.47
9 Sep - 1 Oct	0.72	3.2	0.58	1.5	0.56
1 Oct - 5 Nov	0.75	3.1	0.59	1.6	0.57
5 Nov - 3 Dec	0.28	5.2	0.87	2.3	0.54
3 Dec - 30 Dec	0.91	4	0.68	1.9	0.68
Average	**0.6**	**3.0**	**0.5**	**1.5**	**0.5**

Table A2.2 Monthly Hydrocarbon concentrations at Le Bas Centre (ppb)

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb	0.39	1.7	0.35	1.1	0.45
5 Feb - 3 Mar	0.69	2.3	0.55	1.4	0.51
3 Mar - 1 Apr	0.54	2.9	0.46	1.3	0.49
1 Apr - 30 Apr	0.027	1	0.19	0.47	0.16
30 Apr - 6 Jun	0.4	2.3	0.42	1.1	0.42
6 Jun - 2 Jul	0.44	2.3	0.37	0.91	0.32
2 Jul - 31 Jul	0.33	1.5	0.35	0.83	0.32
31 Jul - 9 Sep	0.43	1.8	0.41	1.1	0.38
9 Sep - 1 Oct	0.59	2.4	0.49	1.2	0.43
1 Oct - 5 Nov	0.56	2.1	0.42	1.1	0.39
5 Nov - 3 Dec	0.41	2.1	0.41	1.3	0.46
3 Dec - 30 Dec	0.52	2.6	0.51	1.5	0.54
Average	**0.4**	**2.1**	**0.4**	**1.1**	**0.4**

Table A2.3 Monthly Hydrocarbon concentrations at Elizabeth Lane = (ppb) =

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb	0.83	4	0.61	1.8	0.66
5 Feb - 3 Mar	0.76	2.7	0.45	1.2	0.43
3 Mar - 1 Apr	0.59	2.7	0.41	1.2	0.42
1 Apr - 30 Apr	0.31	1.2	0.2	0.54	0.18
30 Apr - 6 Jun	0.34	1.6	0.27	0.7	0.24
6 Jun - 2 Jul	0.37	1.7	0.3	0.76	0.26
2 Jul - 31 Jul	1.3	8.8	1.4	3.6	1.4
31 Jul - 9 Sep	0.35	2	0.39	1.1	0.35
9 Sep - 1 Oct					
1 Oct - 5 Nov					
5 Nov - 3 Dec					
3 Dec - 30 Dec					
Average	**0.6**	**3.1**	**0.5**	**1.4**	**0.5**

Table A2.4 Monthly Hydrocarbon Concentrations at Handsford Lane = (ppb) =

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
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	1.4	7.9	1.1	3.3	1.2
3 Dec - 30 Dec	0.44	6.4	1	2.9	0.63
Average	**0.9**	**7.2**	**1.1**	**3.1**	**0.9**

Table A2.5 Monthly Hydrocarbon Concentrations at Springfield Garage (ppb) '=
'=

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb [R]	*0.11*	*0.05*	*0.032*	*<0.04*	*<0.04*
5 Feb - 3 Mar	1.5	8	1.1	3	1.1
3 Mar - 1 Apr	1.1	7.1	0.9	2.7	0.96
1 Apr - 30 Apr [R]	*lost*	*lost*	*lost*	*lost*	*lost*
30 Apr - 6 Jun	1.2	8.7	1.3	3.6	1.3
6 Jun - 2 Jul	1.3	9.4	1.3	3.6	1.3
2 Jul - 31 Jul [R]	*0.14*	*<0.06*	*<0.06*	*<0.06*	*<0.06*
31 Jul - 9 Sep	1.2	7.4	1.3	3.7	1.3
9 Sep - 1 Oct	1.7	10	1.5	3.9	1.4
1 Oct - 5 Nov	1.7	9.4	1.4	3.9	1.4
5 Nov - 3 Dec [R]	*0.21*	*0.64*	*0.12*	*0.3*	*0.1*
3 Dec - 30 Dec	2	11	1.5	4.6	1.6
Average	**1.5**	**8.9**	**1.3**	**3.6**	**1.3**

Average excludes rejected months marked R and shown in italics.
=

Table A2.6 Monthly Hydrocarbon Concentrations at Clos St Andre (ppb) =

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb	0.4	4.3	0.42	0.88	0.28
5 Feb - 3 Mar	0.48	0.79	0.17	0.35	0.13
3 Mar - 1 Apr	0.31	0.78	0.16	0.43	0.16
1 Apr - 30 Apr	0.21	0.47	0.1	0.22	0.075
30 Apr - 6 Jun	0.18	0.49	0.11	0.23	0.08
6 Jun - 2 Jul	0.27	0.51	0.14	0.25	0.08
2 Jul - 31 Jul	0.26	1.8	0.31	0.77	0.25
31 Jul - 9 Sep	0.22	0.62	0.16	0.36	0.12
9 Sep - 1 Oct	0.35	0.81	0.2	0.4	0.13
1 Oct - 5 Nov	0.25	0.75	0.14	0.34	0.12
5 Nov - 3 Dec	0.35	0.78	0.16	0.35	0.13
3 Dec - 30 Dec	0.36	1.1	0.21	0.56	0.19
Average	**0.3**	**1.1**	**0.2**	**0.4**	**0.1**

Table A2.7 Monthly Hydrocarbon Concentrations at the Airport (ppb) =

Exposure period	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
31 Dec - 5 Feb	0.34	3.35	0.095	0.14	0.054
5 Feb - 3 Mar	0.48	0.59	0.13	0.22	0.077
3 Mar - 1 Apr	0.27	0.49	0.11	0.28	0.12
1 Apr - 30 Apr	0.14	0.25	0.05	0.09	<.03
30 Apr - 6 Jun	0.22	0.3	0.08	0.12	<.04
6 Jun - 2 Jul	0.15	0.33	0.1	0.1	<.06
2 Jul - 31 Jul	0.19	0.28	0.09	0.12	<.06
31 Jul - 9 Sep	0.16	0.6	0.09	0.17	0.06
9 Sep - 1 Oct	0.34	1	0.13	0.19	<.08
1 Oct - 5 Nov *					
5 Nov - 3 Dec					
3 Dec - 30 Dec	0.28	0.6	0.11	0.25	0.09
Average	**0.3**	**0.8**	**0.1**	**0.2**	**0.1**

**Tube exposed for 2 months: invalid.*

Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2004

March 2005

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Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2004

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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

Appendices

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 $\mu g\ m^{-3}$. 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[7]. The best estimate for the odour threshold of toluene has been reported[8] 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[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 $\mu g\ m^{-3}$ for NO_2 and 0.2 $\mu g\ m^{-3}$ 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.

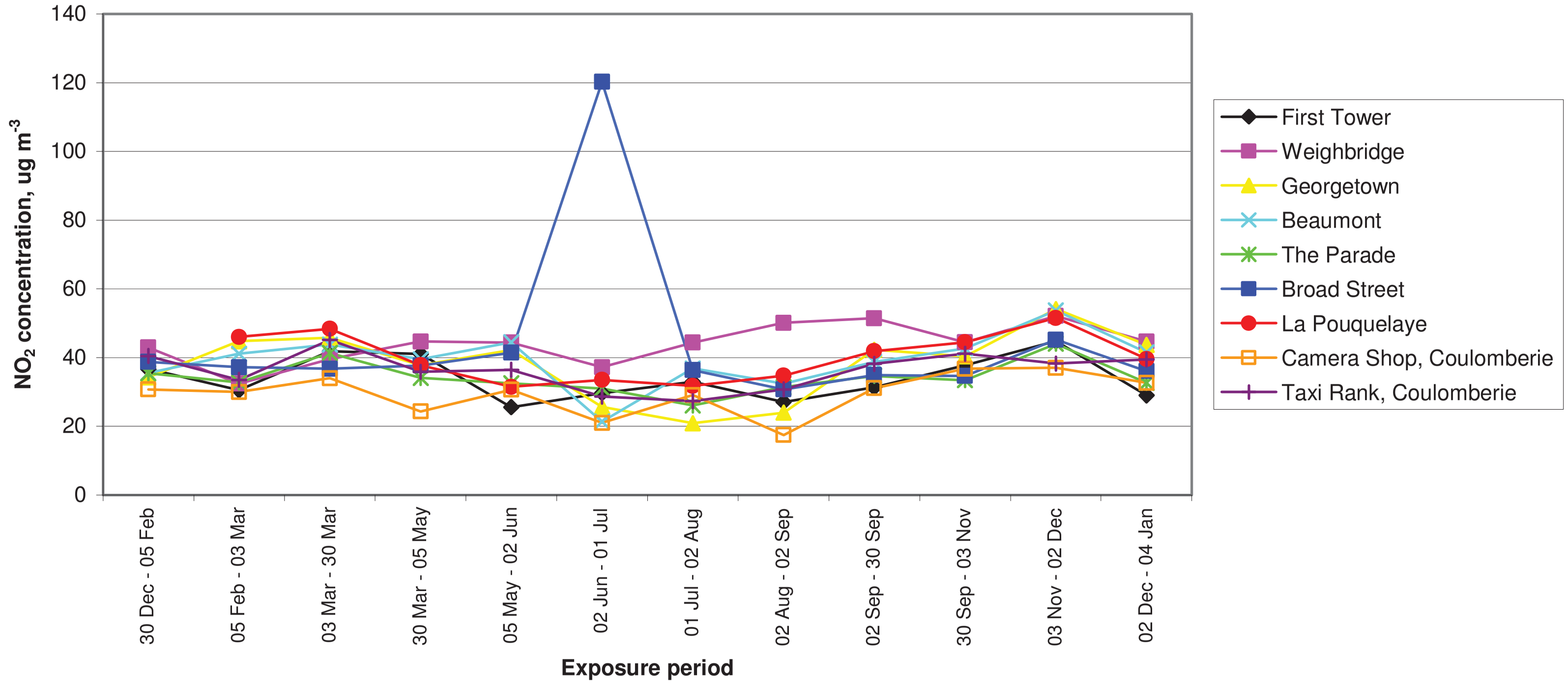

Figure 2. Monthly Mean Nitrogen Dioxide Concentrations at Roadside and Kerbside Sites, 2004

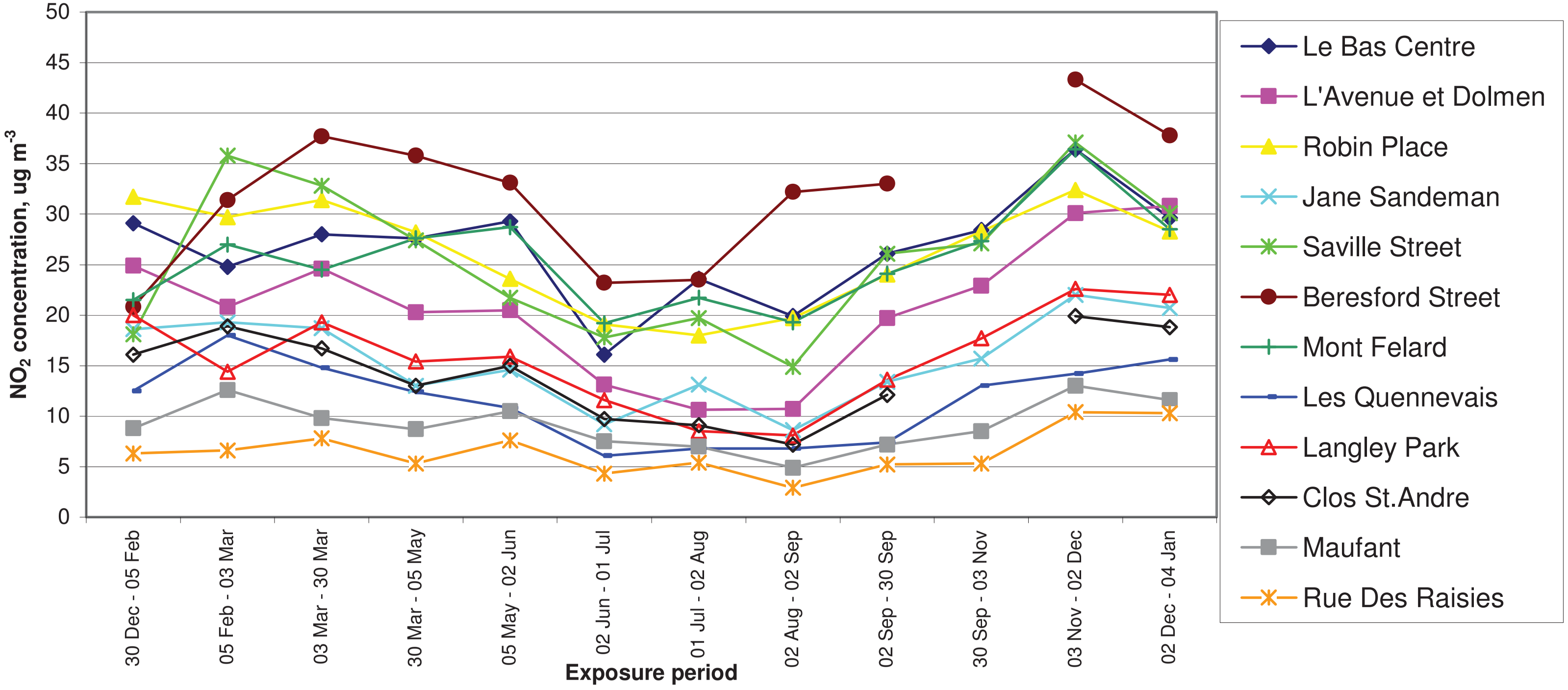

Figure 3. Monthly Nitrogen Dioxide Concentrations at Background Sites, 2004

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.

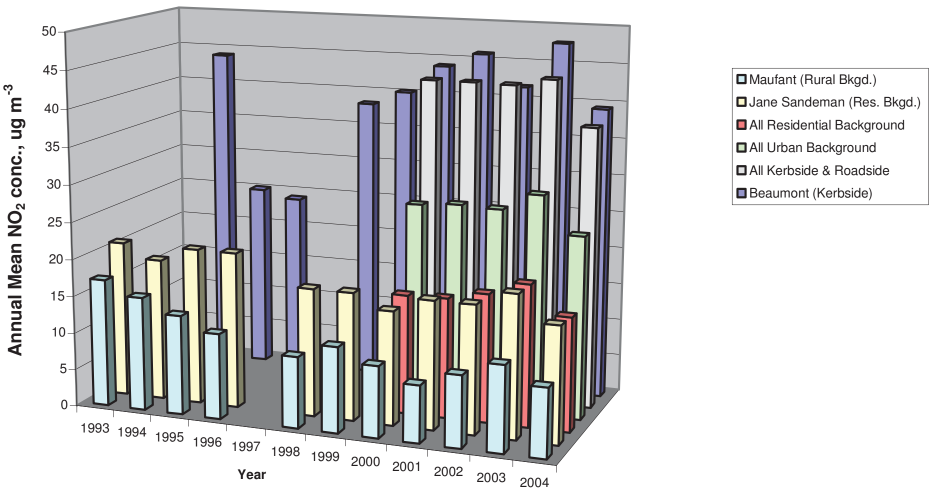

Figure 4. Trends in Annual Mean NO_2 Concentrations (not corrected for diffusion tube bias).

Table 5 Annual mean NO_2 concentrations, $\mu g\ m^{-3}$ (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.

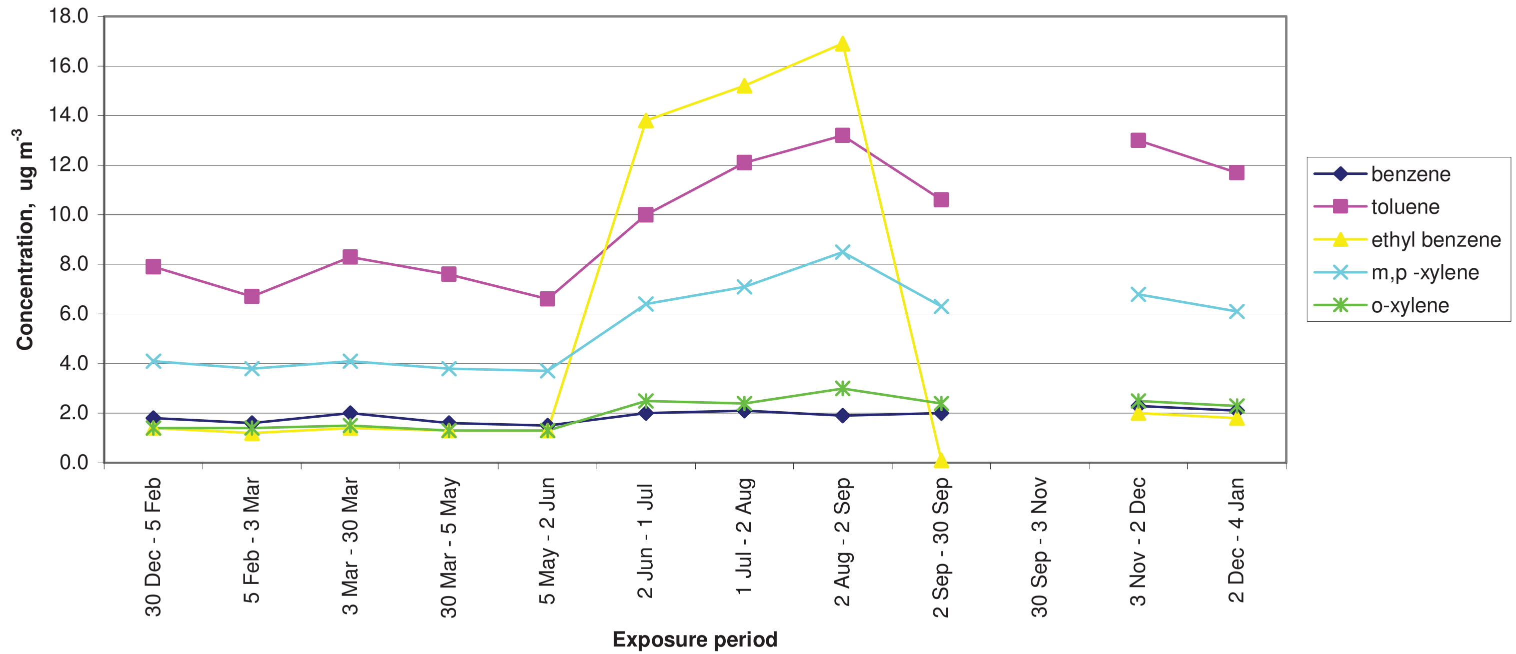

Figure 5. Monthly mean hydrocarbon concentrations at Beresford Street, 2004

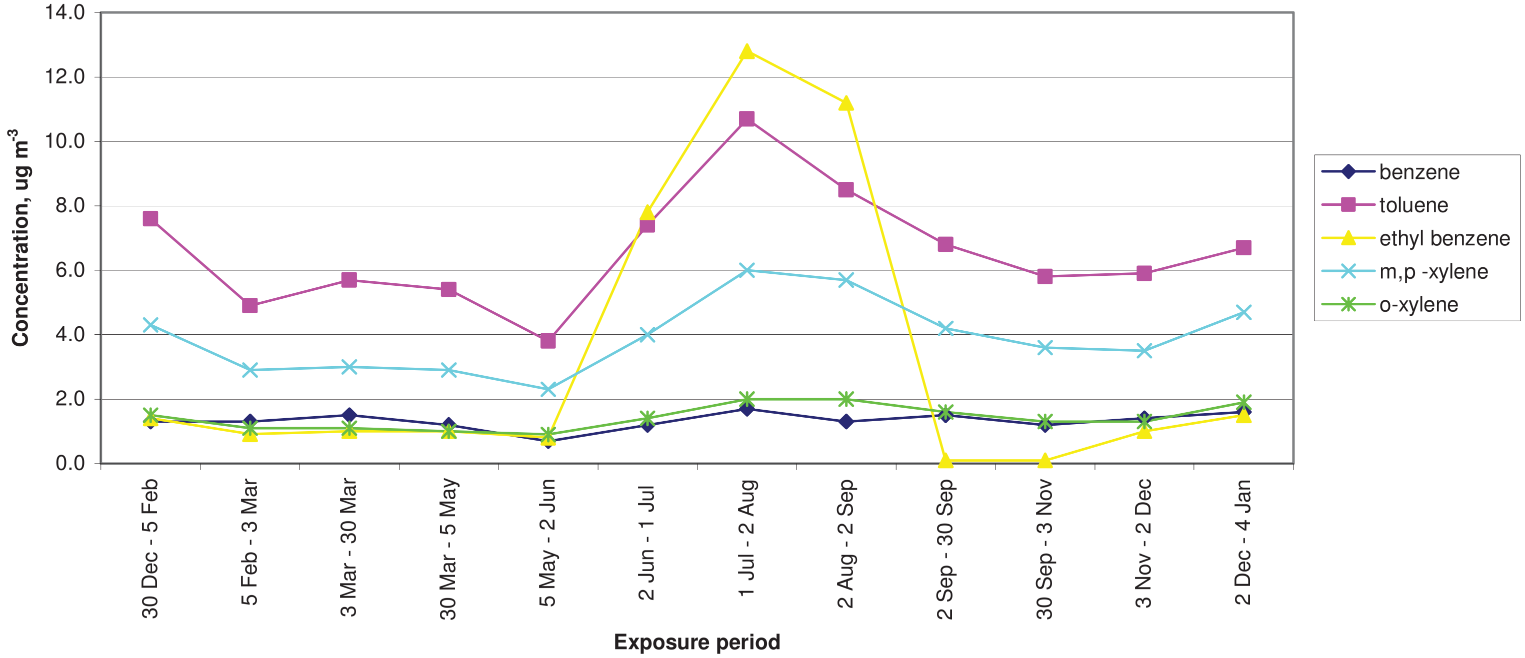

Figure 6. Monthly mean hydrocarbon concentrations at Le Bas Centre, 2004

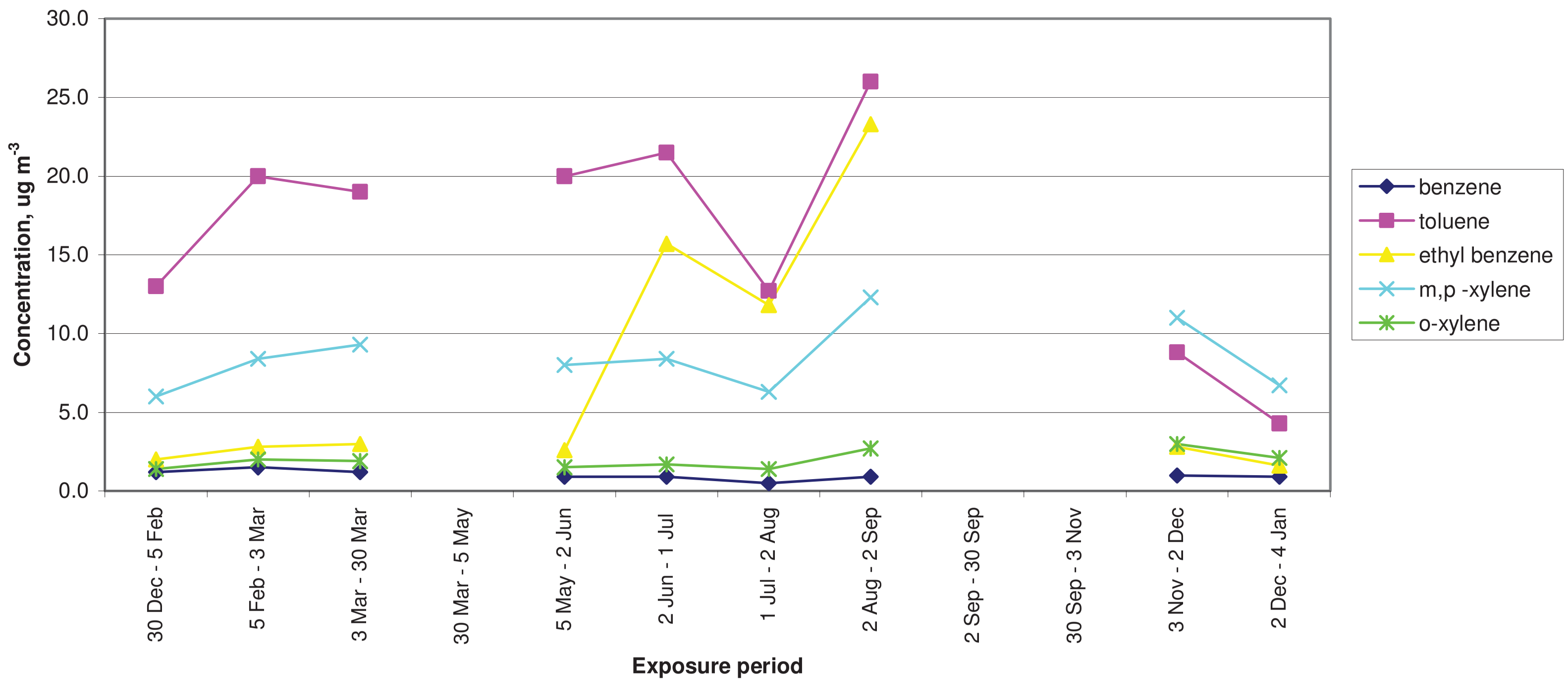

Figure 7. Monthly mean hydrocarbon concentrations at Handsford Lane, 2004

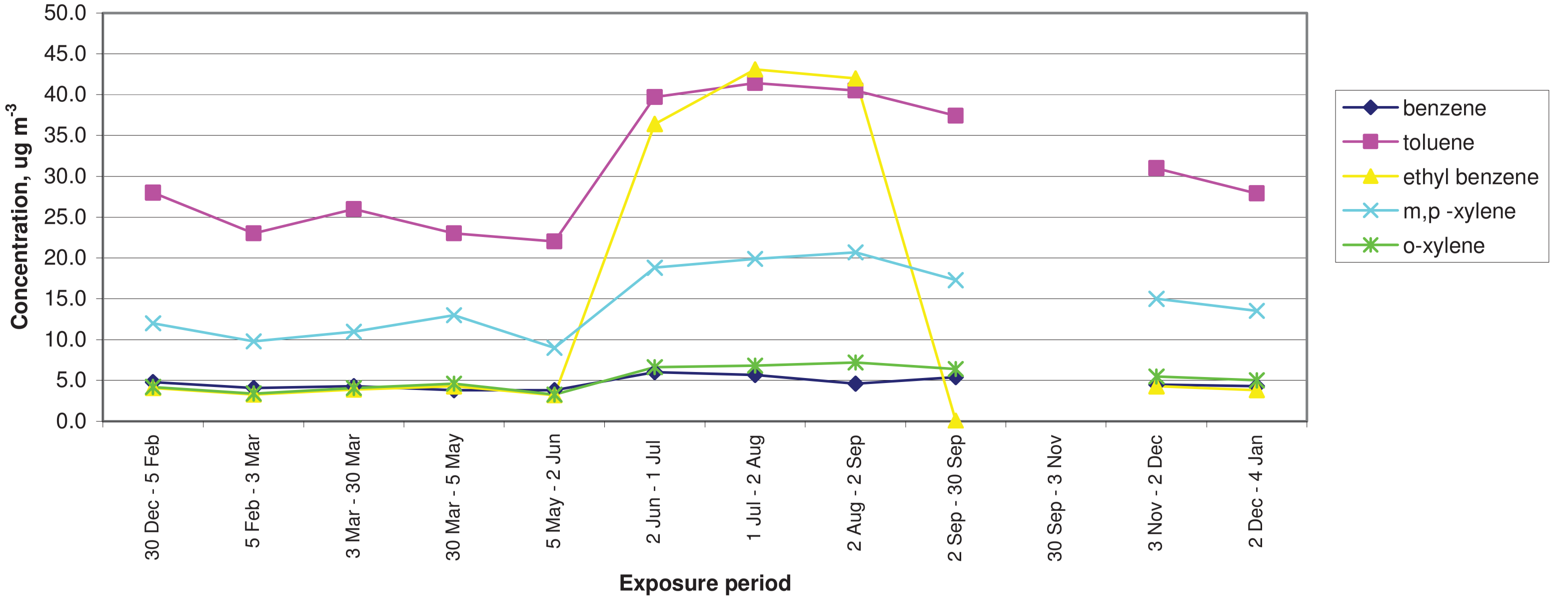

Figure 8. Monthly mean hydrocarbon concentrations at Springfield Garage, 2004

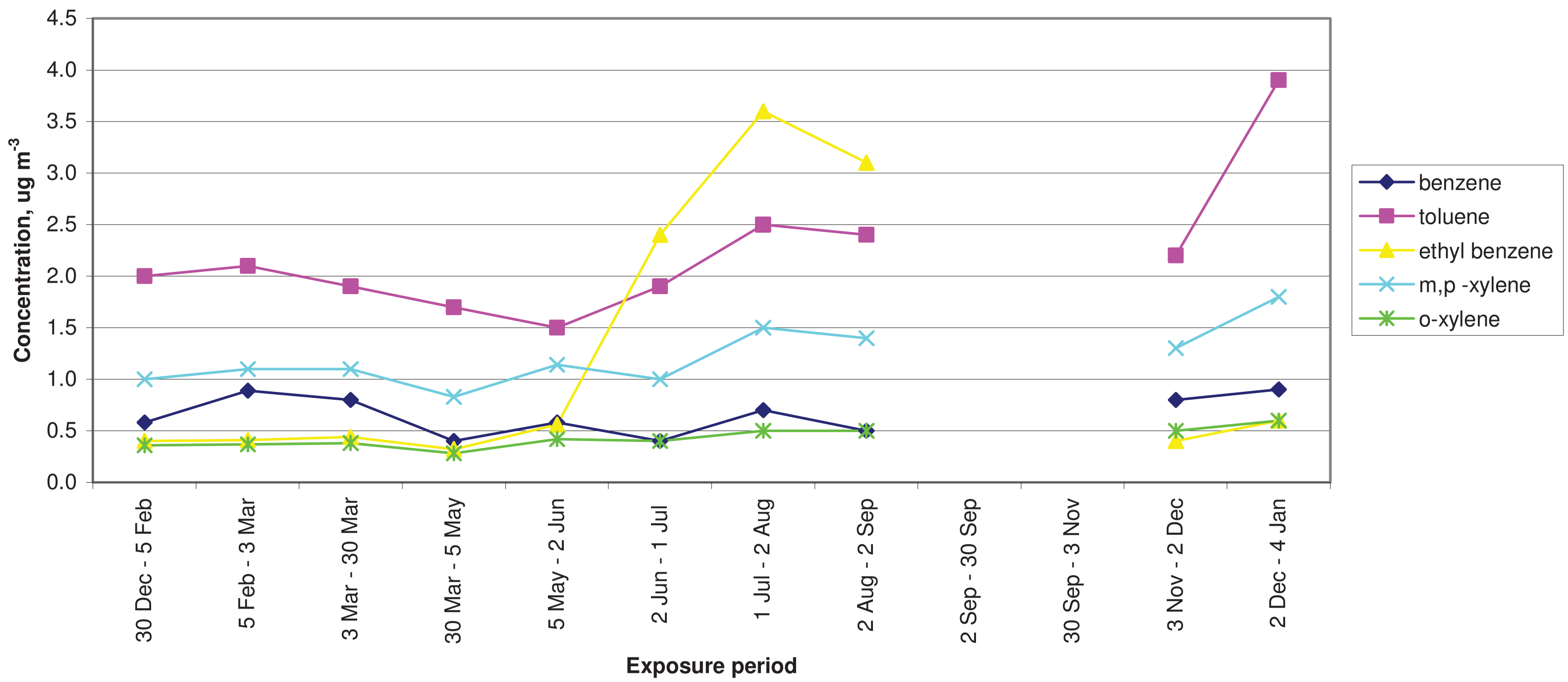

Figure 9. Monthly mean hydrocarbon concentrations at Clos St Andre, 2004

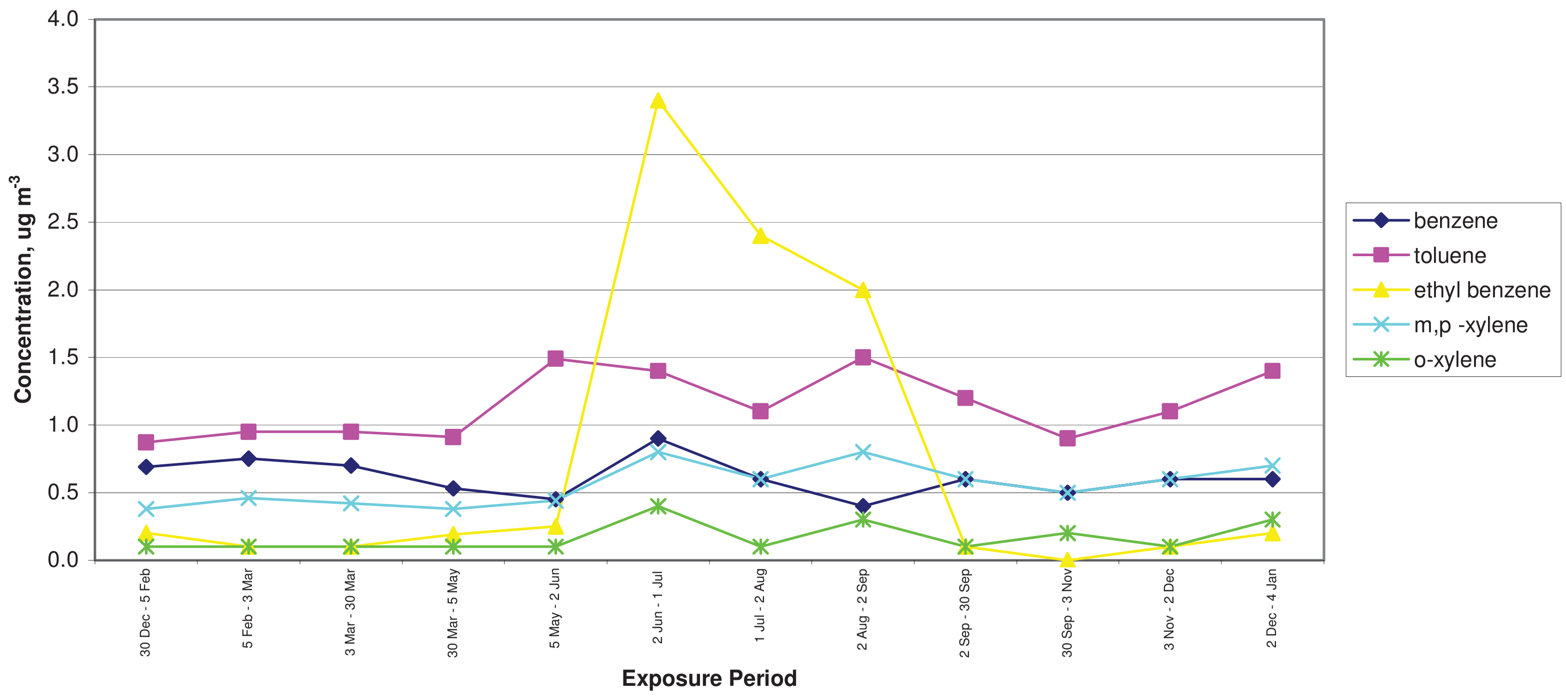

Figure 10. Monthly mean hydrocarbon concentrations at the Airport, 2004

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 μg 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

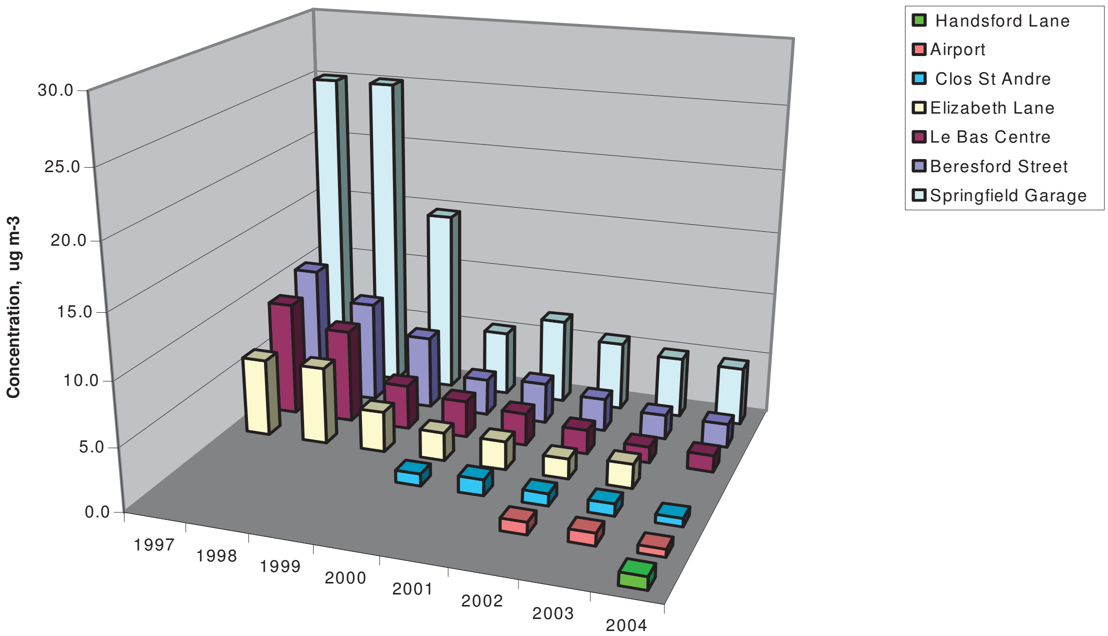

Figure 12. Trends in Benzene Concentration

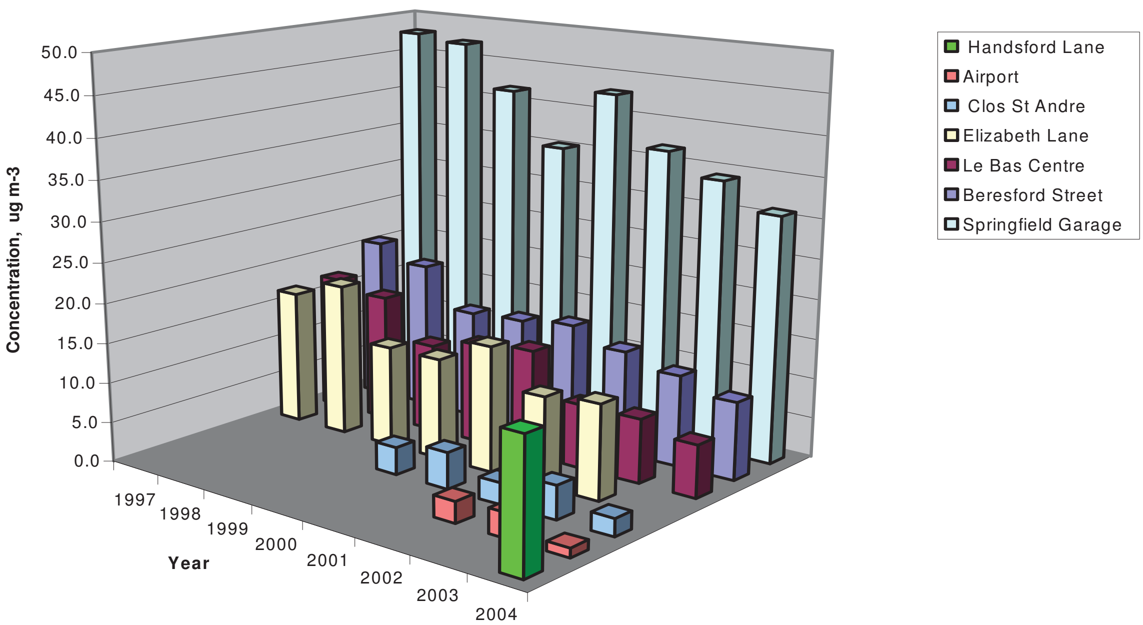

Figure 13. Trends in Toluene Concentration

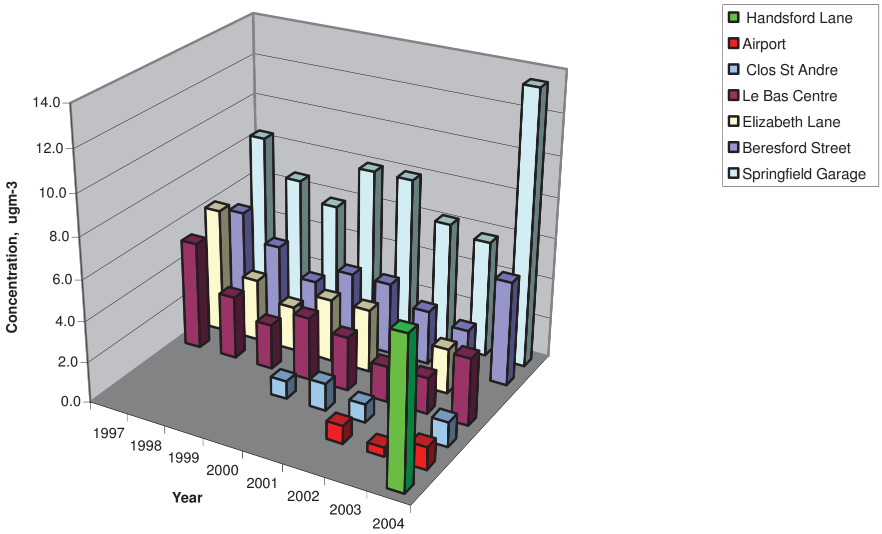

Figure 14. Trends in Ethylbenzene Concentration

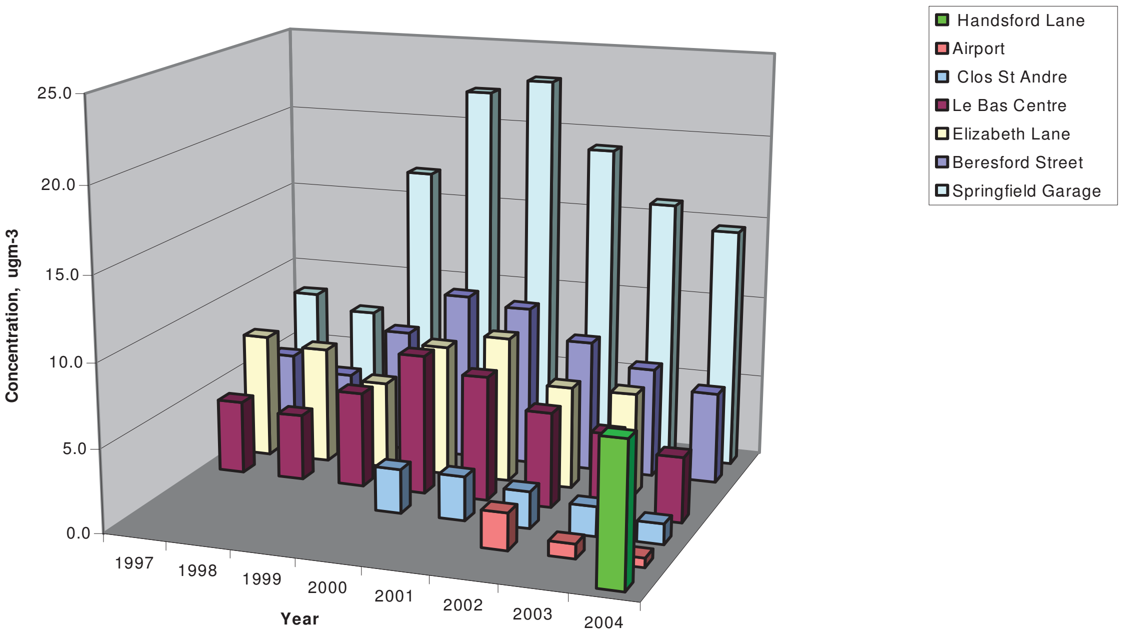

Figure 15. Trends in m+p- Xylene Concentration

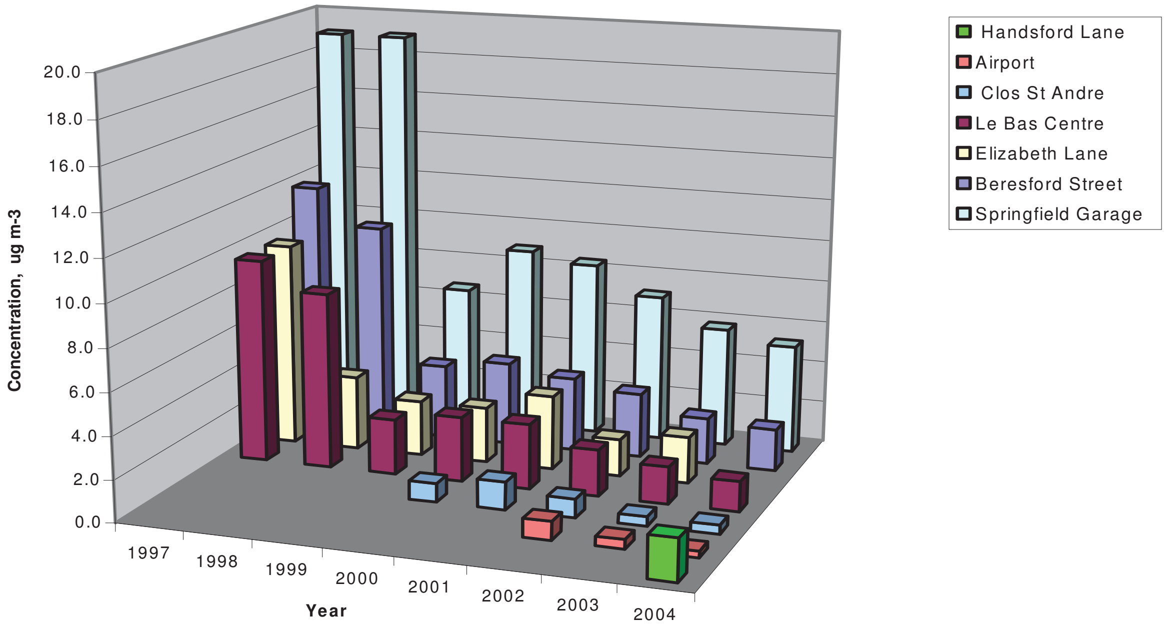

Figure 16. Trends in o-Xylene Concentration

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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Appendices

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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

			Value(1) / µgm^{-3} (ppb)
The Air Quality Strategy(2) **Set in regulations(3) for all UK:**	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.
	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 µg m^{-3} and ppb are as used by the EC, i.e. 1ppb NO_2 = 1.91 µg 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

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

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

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}

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AEAT/ENV/R/2165 Issue 1

Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2005

March 2006

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Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2005

March 2006

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

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AEA Technology is certificated to BS EN ISO9001:(1994)

	Name	Signature	Date
Author	A Loader B Stacey		
Reviewed by	B Stacey		
Approved by	P Willis		

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 $\mu g\ m^{-3}$ for NO_2 and 0.2 $\mu g\ m^{-3}$ 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

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

Figure 2a. Sites in St Helier town

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.

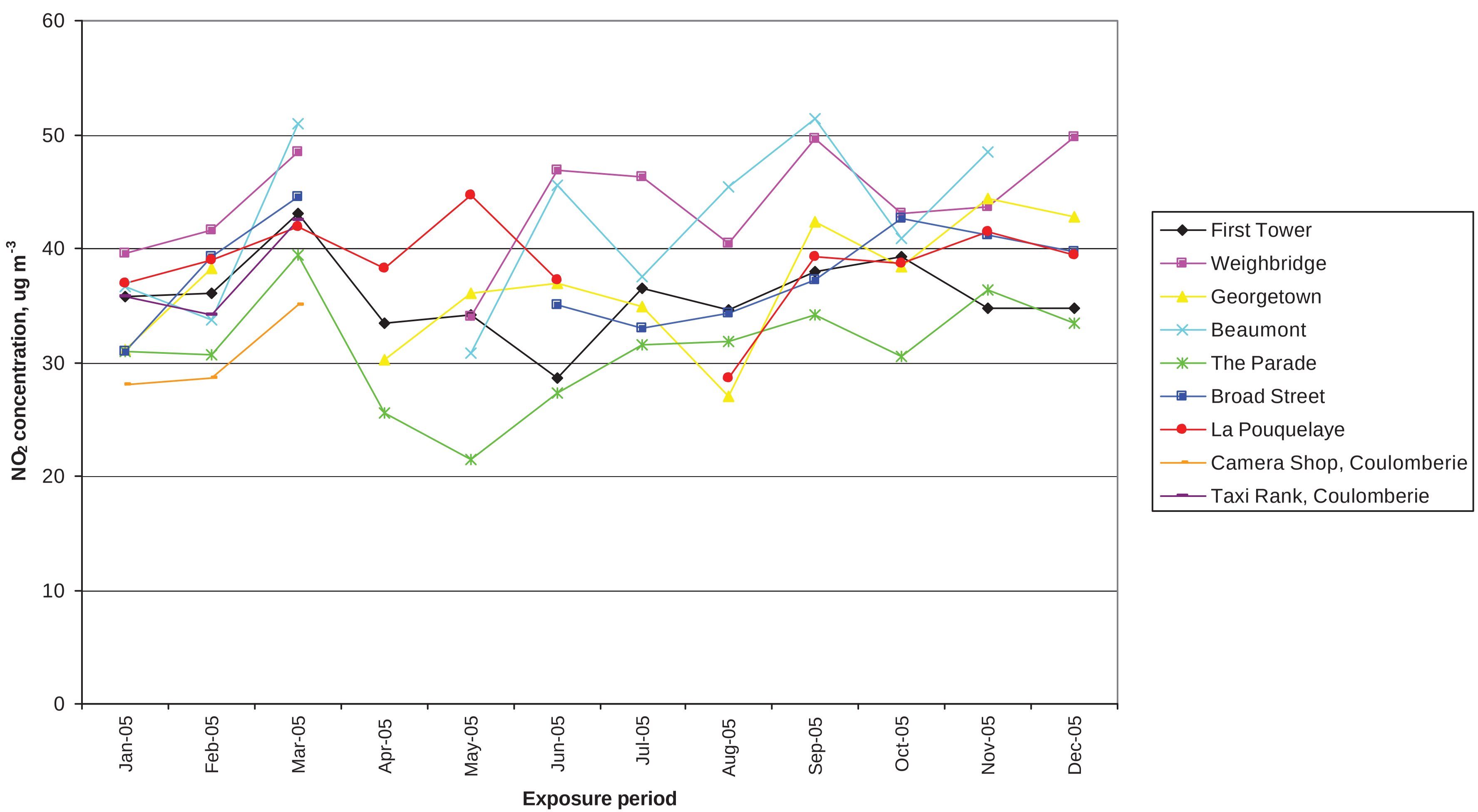

Figure 2. Monthly Mean Nitrogen Dioxide Concentrations at Roadside and Kerbside Sites, 2005

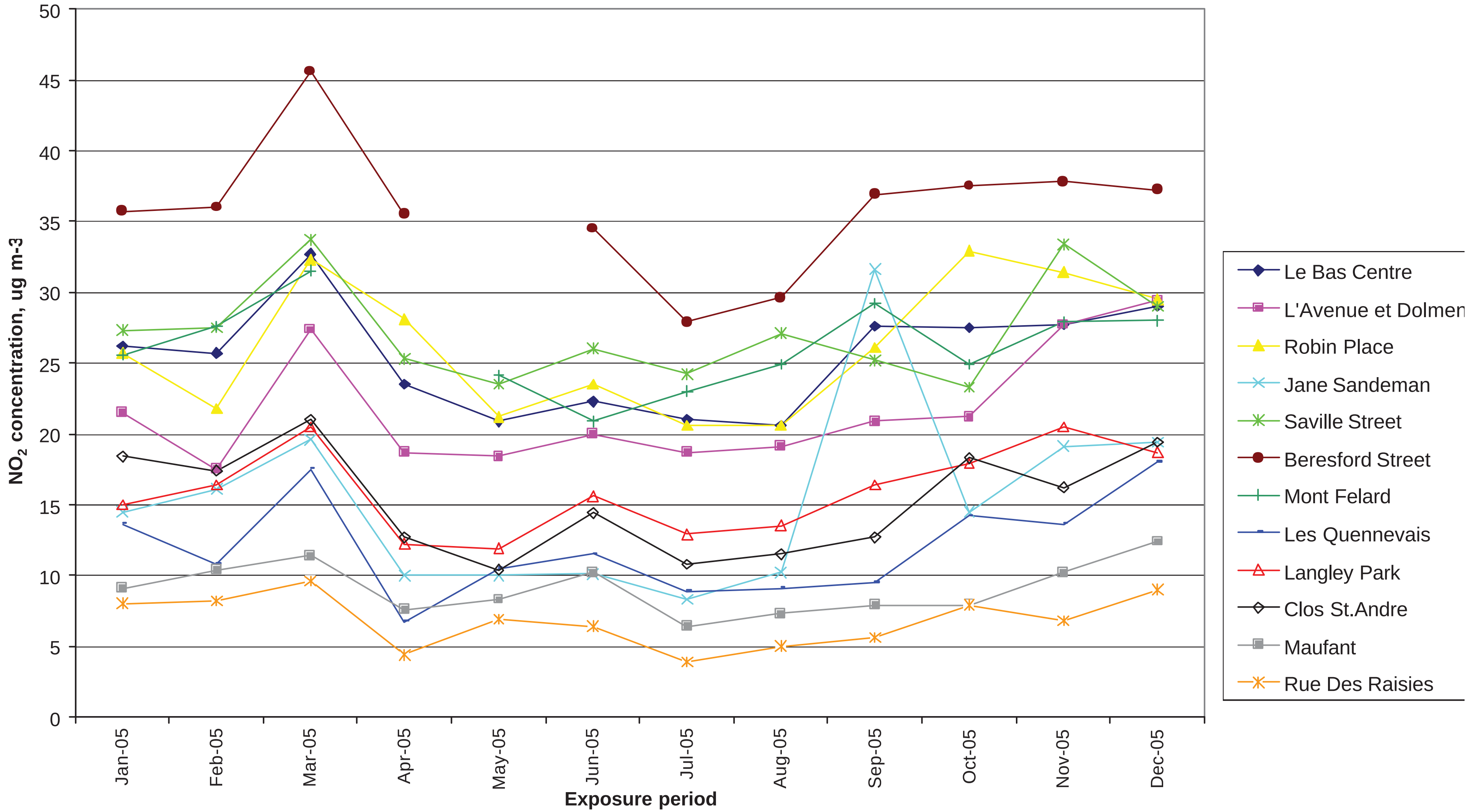

Figure 3. Monthly Nitrogen Dioxide Concentrations at Background Sites, 2005

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.

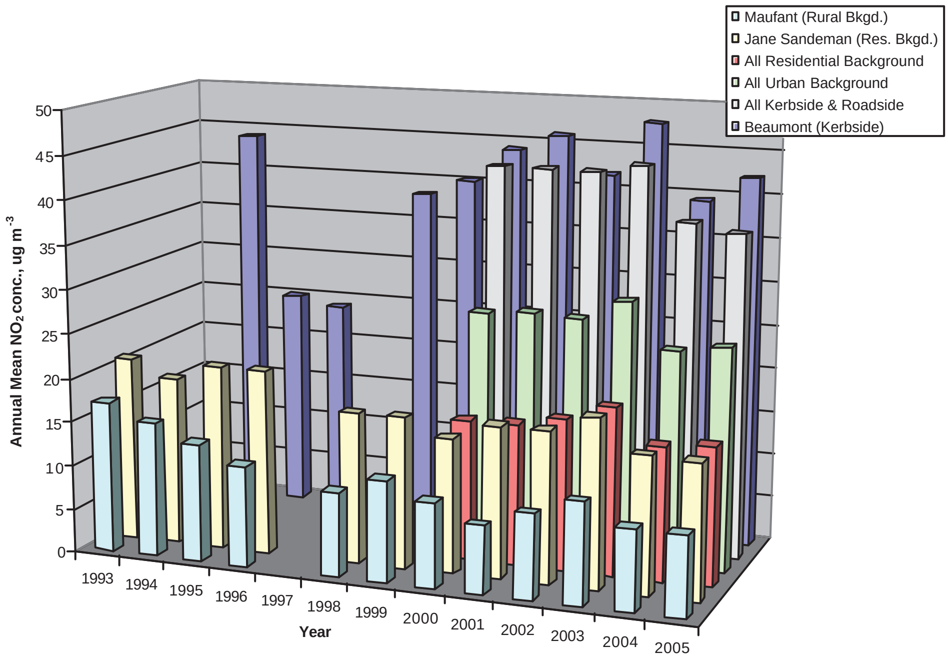

Figure 4. Trends in Annual Mean NO_2 Concentrations (not corrected for diffusion tube bias).

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.

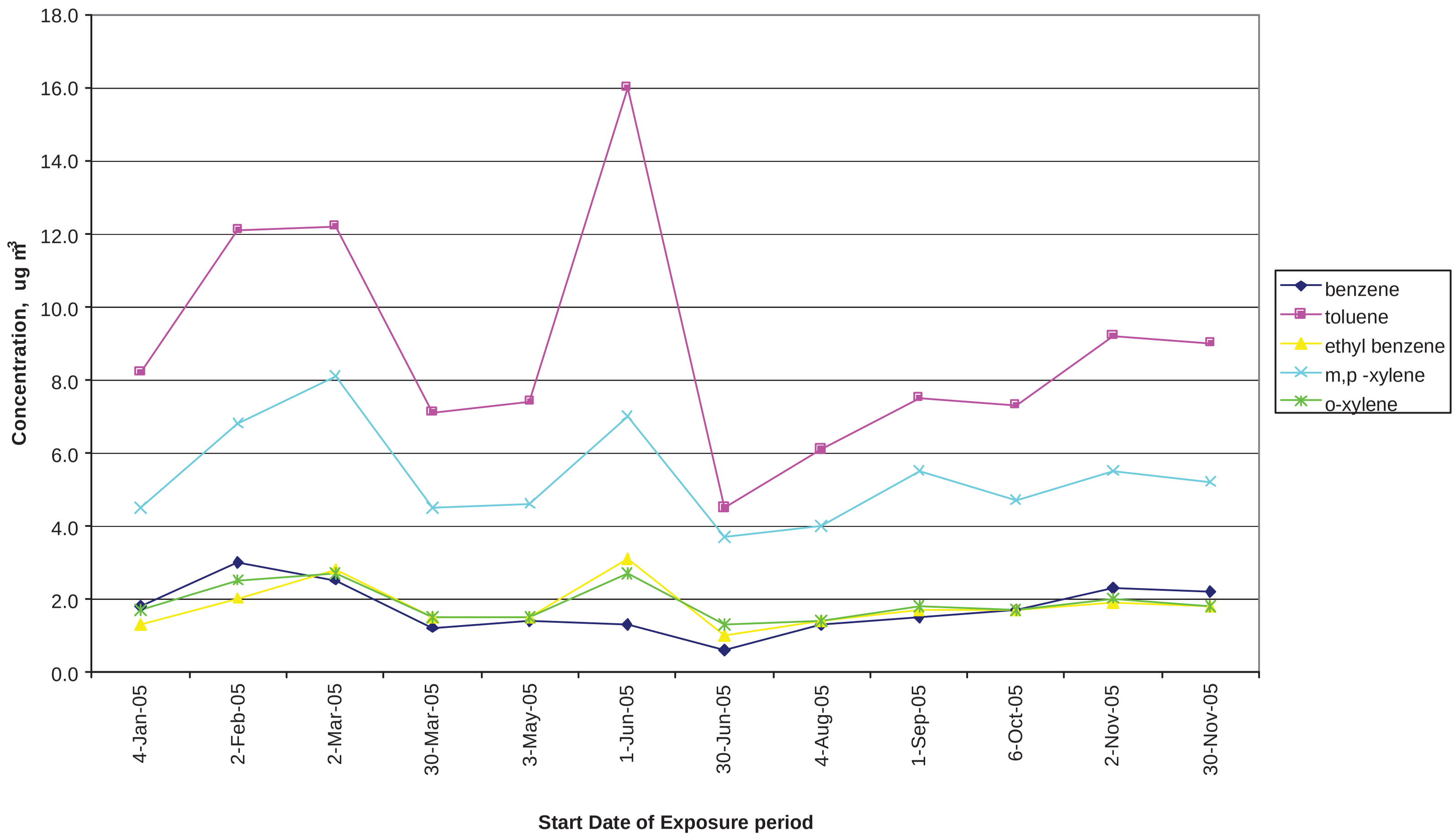

Figure 5. Monthly mean hydrocarbon concentrations at Beresford Street, 2005

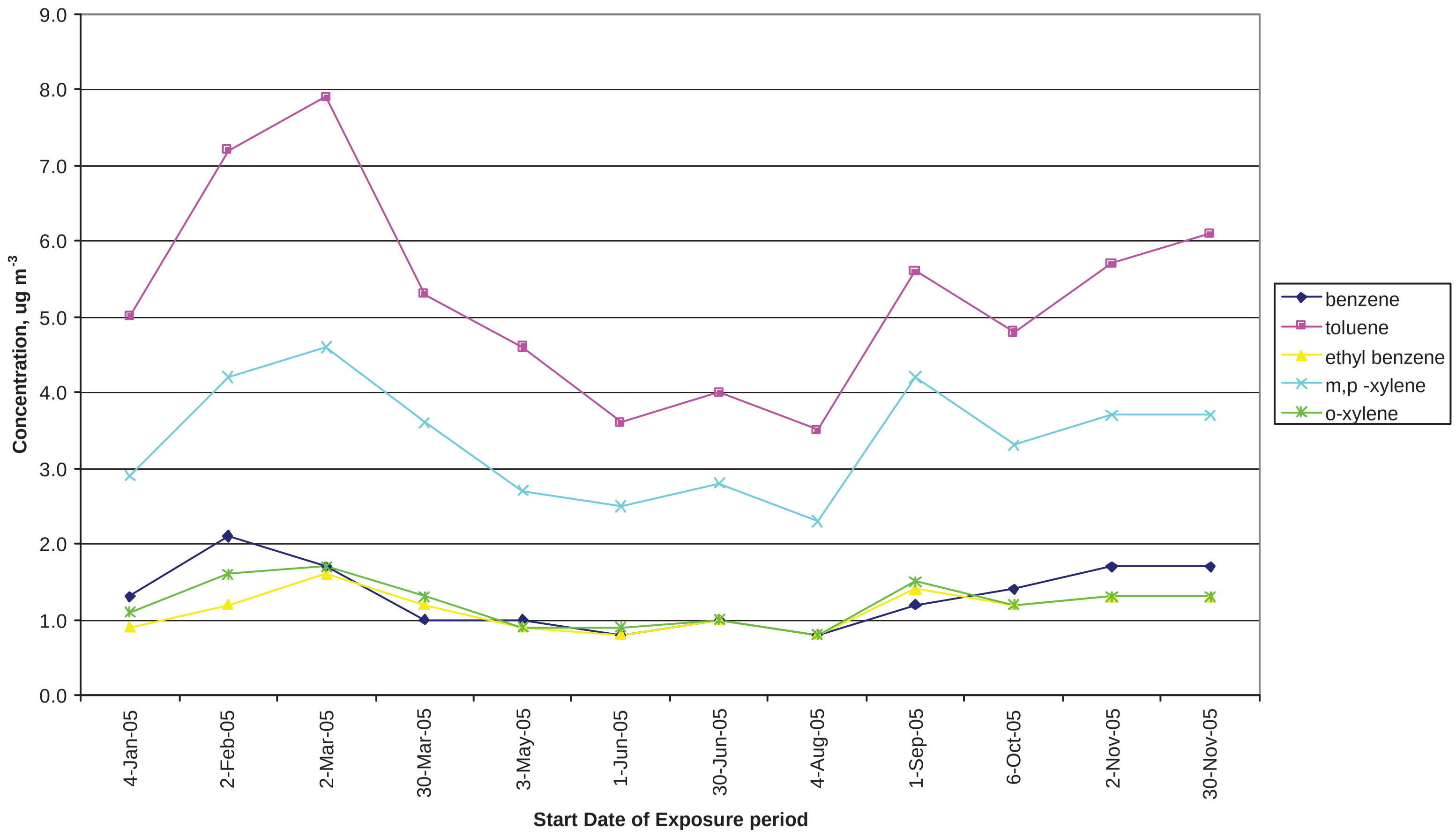

Figure 6. Monthly mean hydrocarbon concentrations at Le Bas Centre, 2005

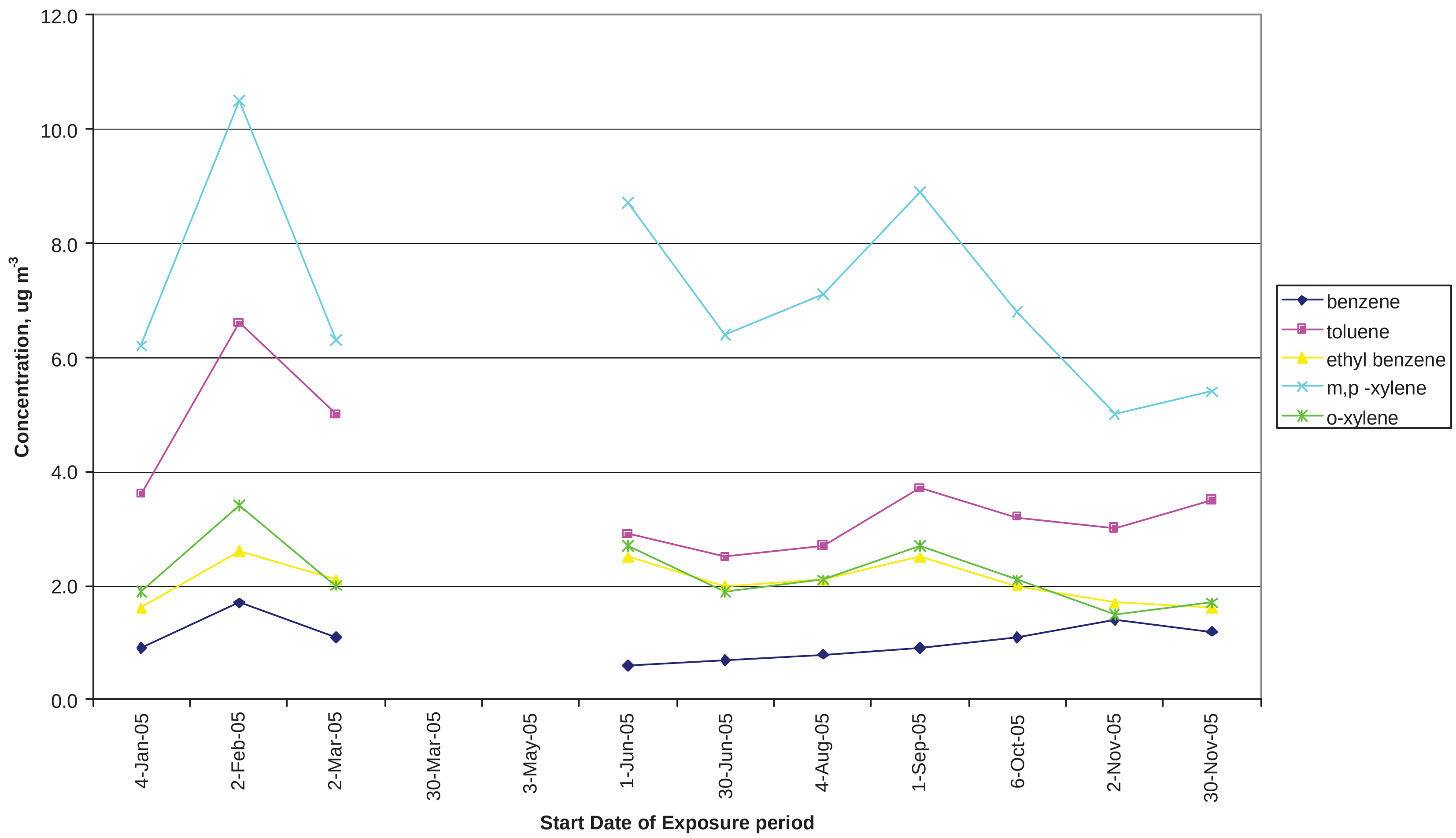

Figure 7. Monthly mean hydrocarbon concentrations at Handsford Lane, 2005

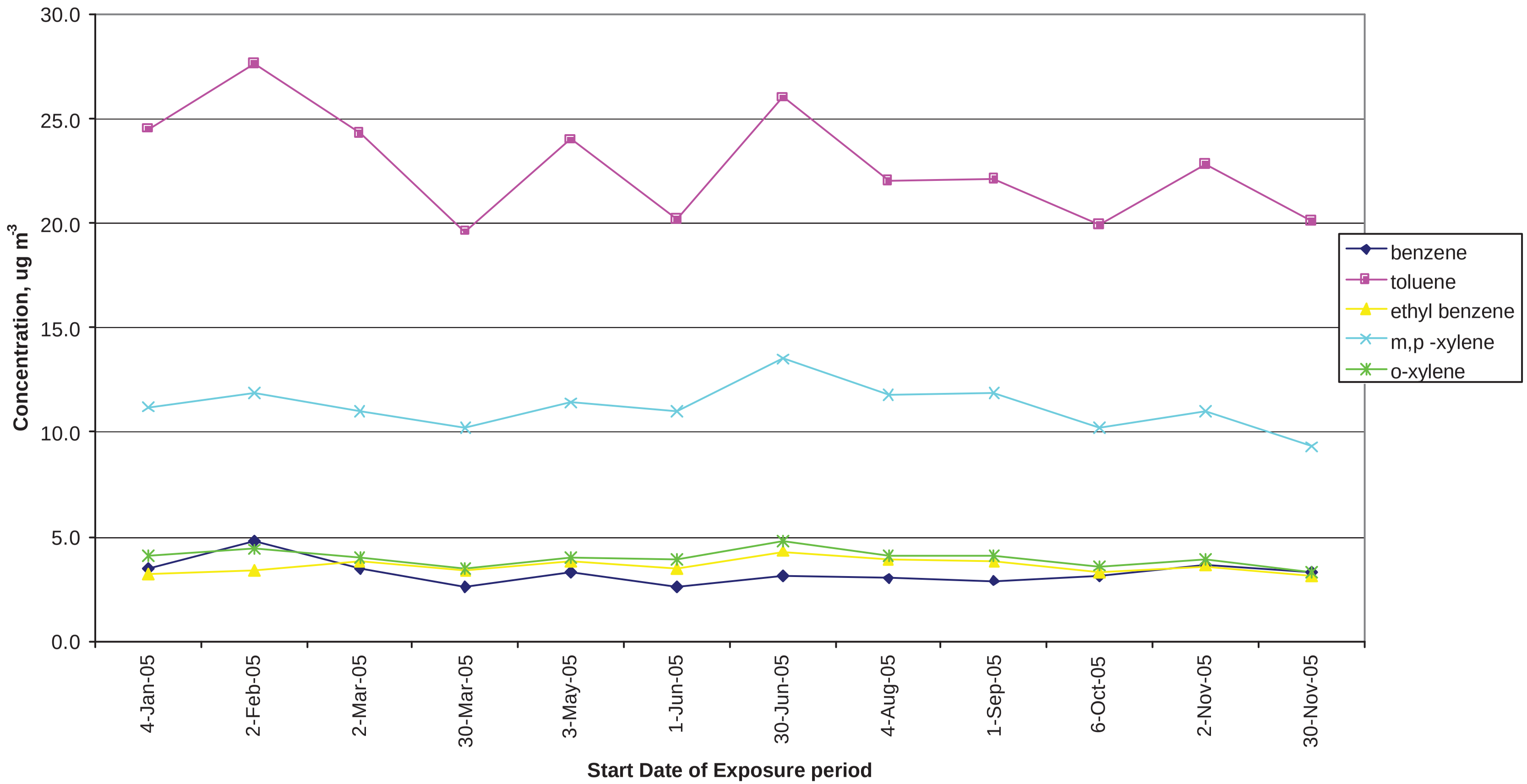

Figure 8. Monthly mean hydrocarbon concentrations at Springfield Garage, 2005

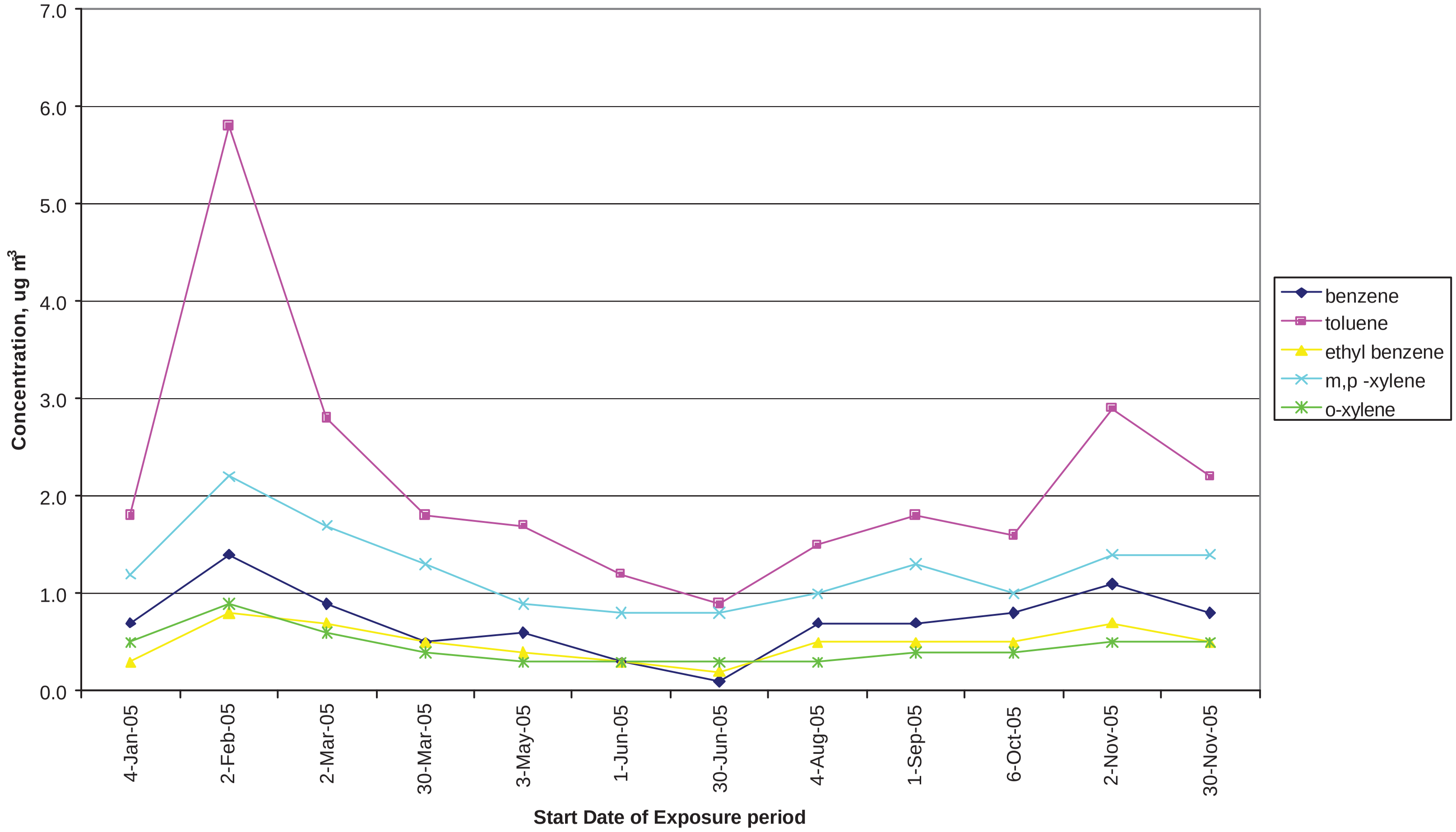

Figure 9. Monthly mean hydrocarbon concentrations at Clos St Andre, 2005

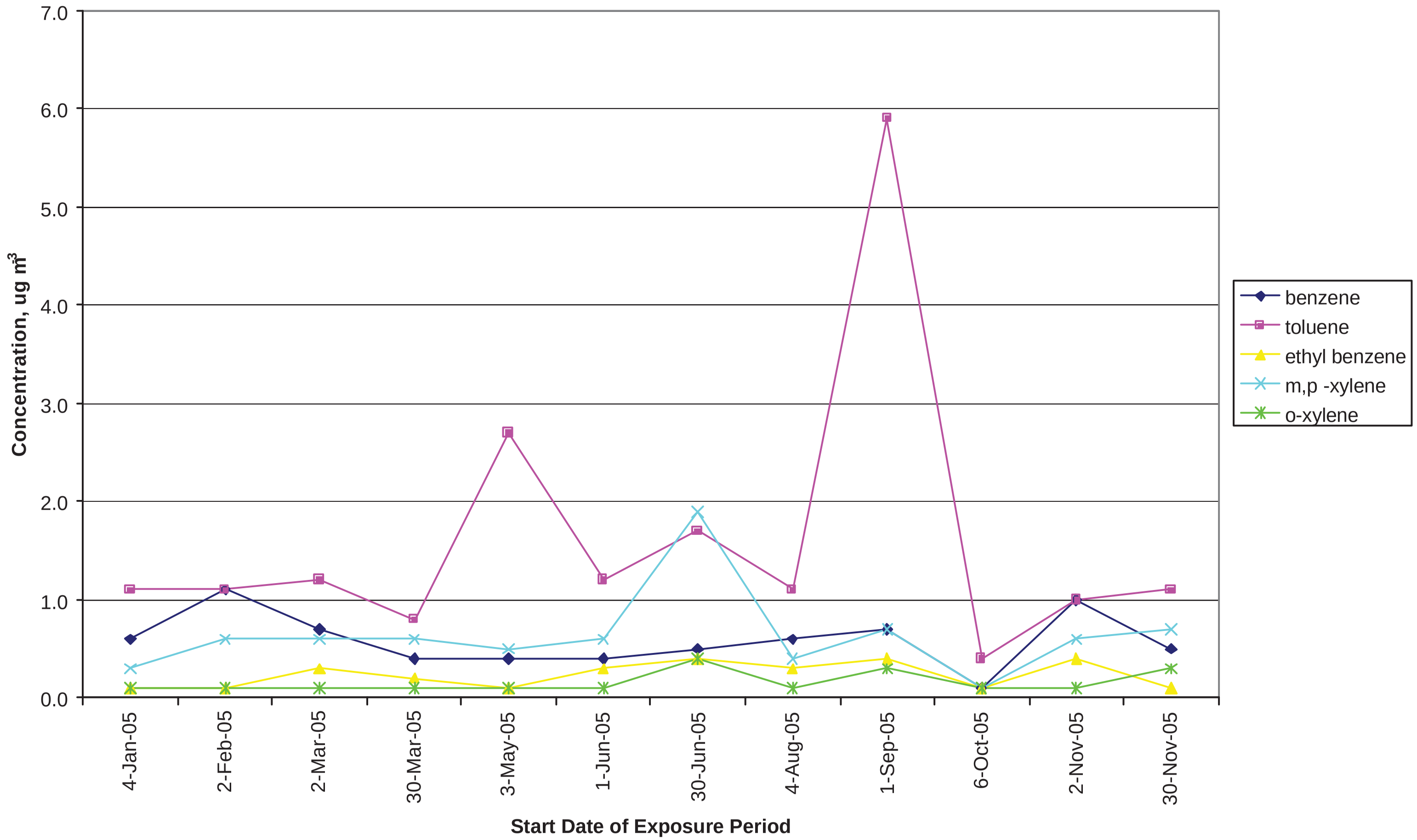

Figure 10. Monthly mean hydrocarbon concentrations at the Airport, 2005

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

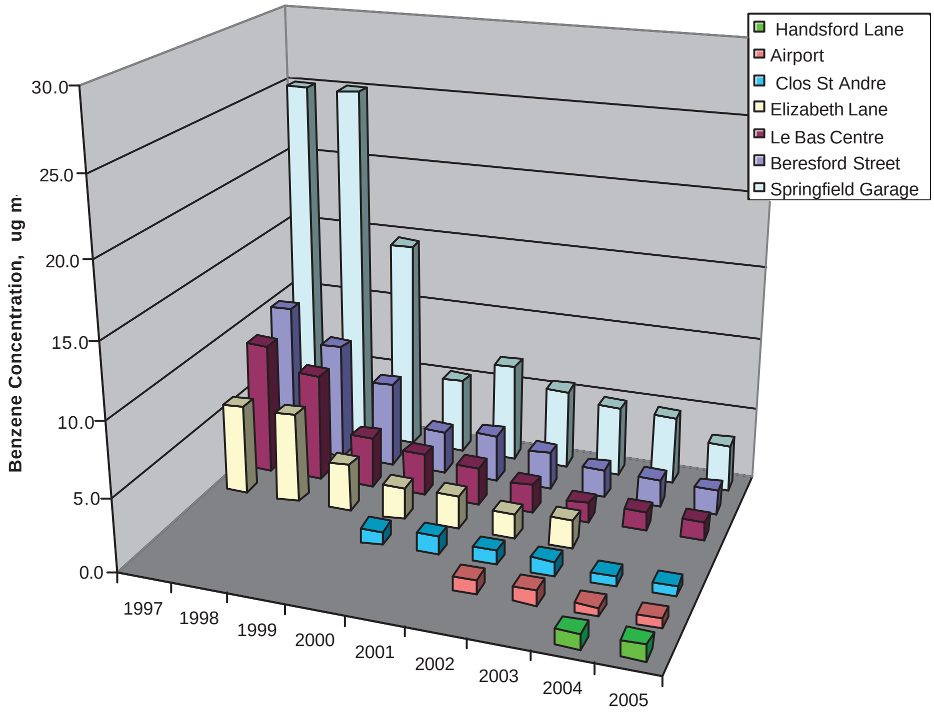

Figure 12. Trends in Benzene Concentration

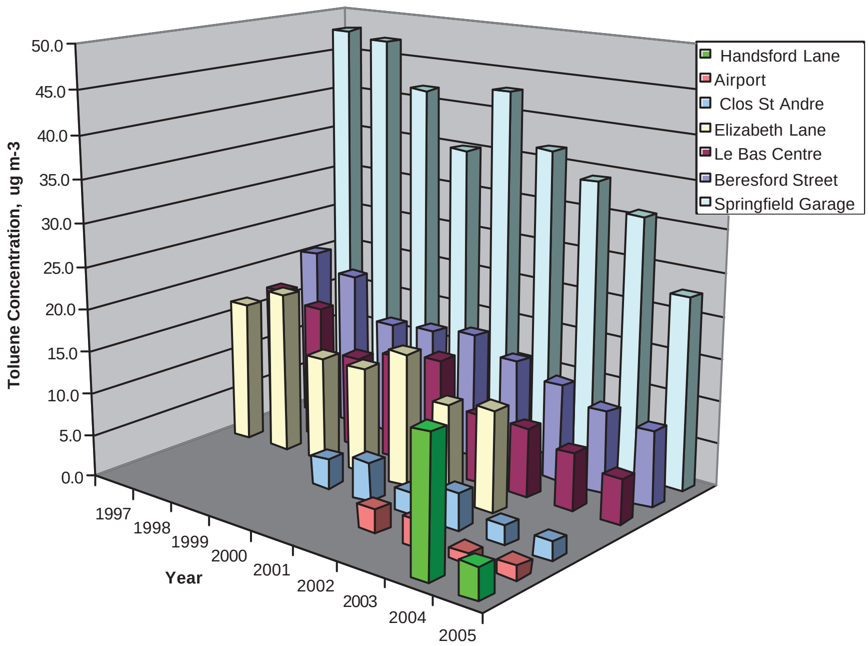

Figure 13. Trends in Toluene Concentration

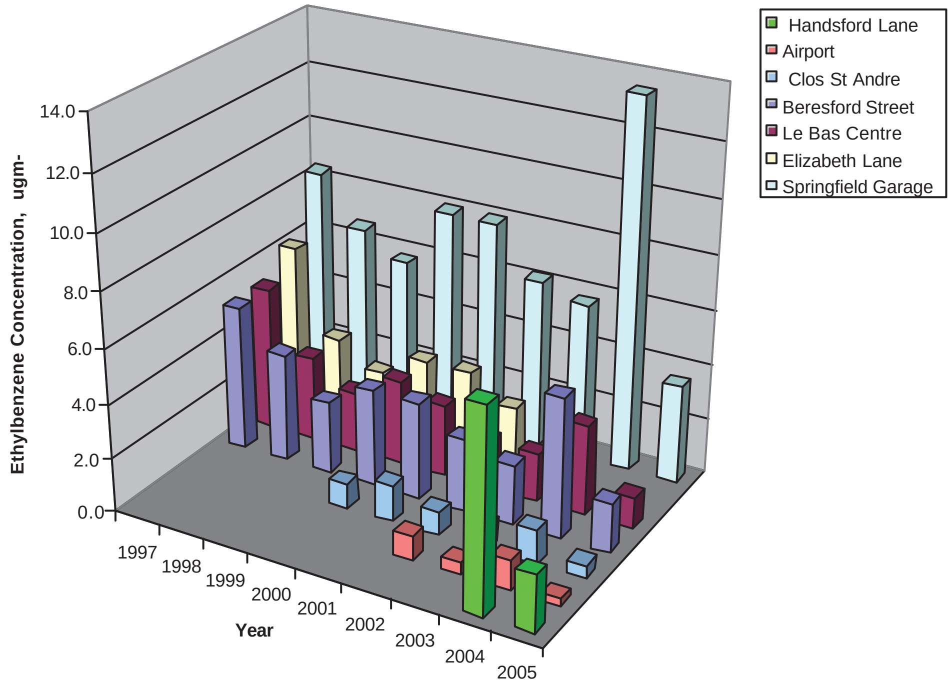

Figure 14. Trends in Ethylbenzene Concentration

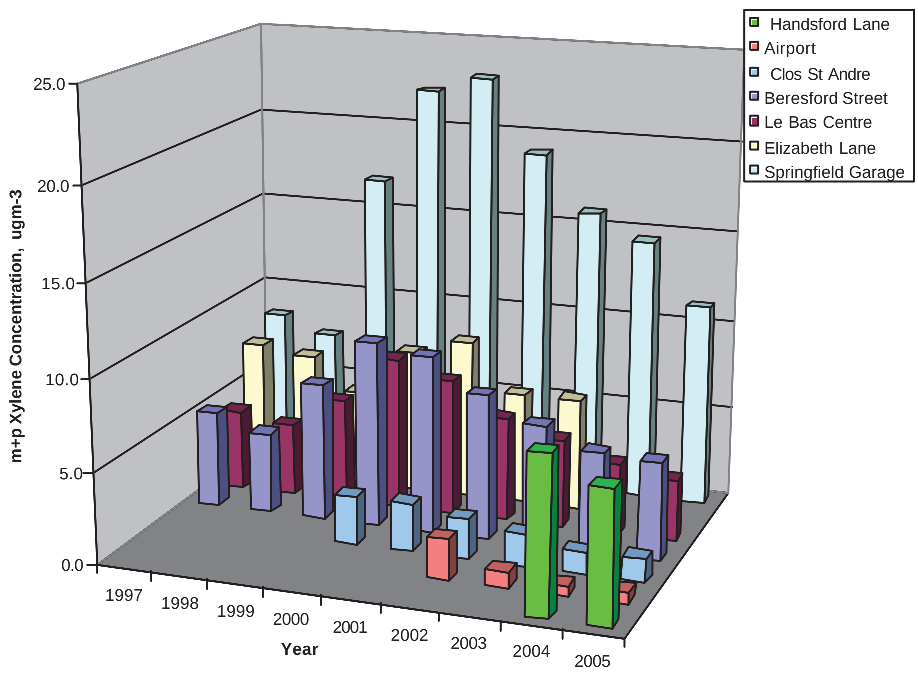

Figure 15. Trends in m+p- Xylene Concentration

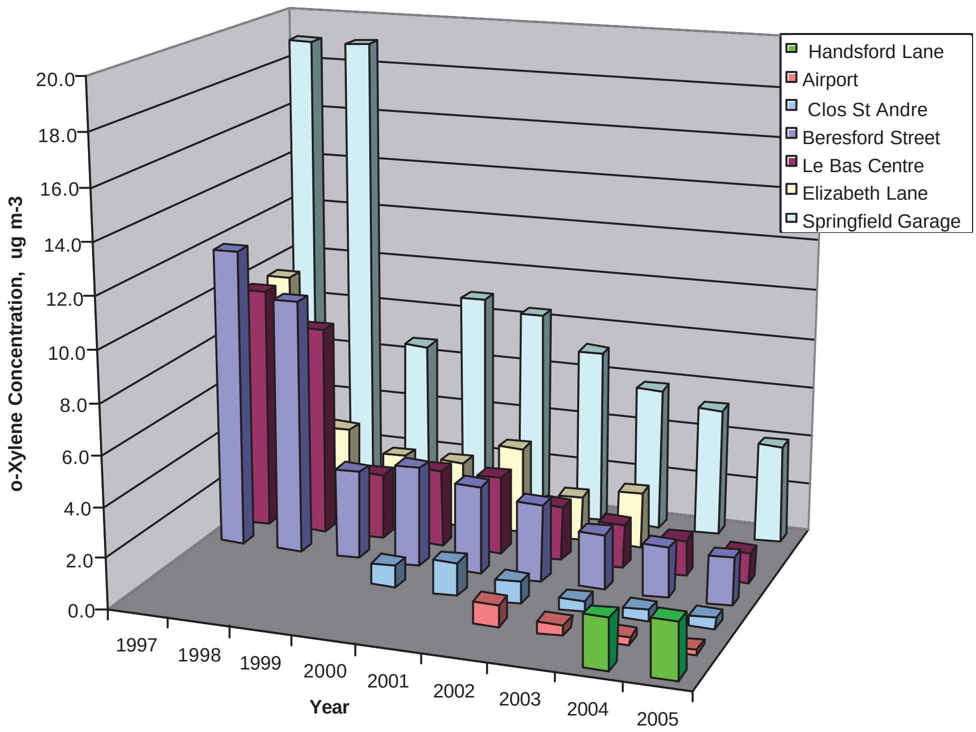

Figure 16. Trends in o-Xylene Concentration

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 31st 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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12. Council Directive 1999/30/EEC relating to Limit Values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air. 22 April 1999.
13. Council Directive 2000/69/EC relating to Limit Values for benzene and carbon monoxide in ambient air. 16 Nov 2000.
14. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Department of the Environment, Transport and the Regions. January 2000, ISBN 0 10 145482-1
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

			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 μg m^{-3} and ppb are as used by the EC, i.e. 1ppb NO_2 = 1.91 μg 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

			Value[1] / μgm^{-3} (ppb)
The Air Quality Strategy[2,3] All UK England[4] & Wales[5] only: Scotland[6] & Northern Ireland	Objective for Dec. 31st 2003	Running annual mean	16.25 (5)
	Objective for Dec. 31st 2010	Annual mean	5 (1.54)
	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 (μg 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 μg m^{-3}

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

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 ($\mu g\ m^{-3}$)

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}

Air Quality Monitoring in Jersey; Diffusion Tube Surveys, 2006

Report to Public Health Services, States of Jersey

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AEA Energy & Environment
551.11 Harwell Business Centre
Didcot
Oxfordshire
OX11 0QJ

t: 0870 190 6518
f: 0870 190 6377

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Author	Name	Alison Loader
Approved by	Name	Brian Stacey
	Signature	
	Date	23rd Jul 2007

This report is an electronic copy of a document signed by Brian Stacey on 23/7/07. Hard copies are available from the address above.

Executive Summary

AEA Energy & Environment is undertaking an ongoing programme of air quality monitoring on Jersey, on behalf of the Public Health Services Department of the States of Jersey. This report presents the results of the tenth consecutive year of monitoring, calendar year 2006 – covered by the monitoring period 3rd January 2006 to 3rd January 2007.

Diffusion tube samplers were used to monitor nitrogen dioxide (NO_2) at 23 sites, and hydrocarbons at six sites. Monitoring sites were selected to measure traffic emissions and 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 approximating to calendar months. 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 kerbside and roadside sites in built-up areas (Weighbridge, Georgetown and La Pouquelaye) 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 36 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 2006.

Ambient NO_2 concentrations at most of the sites in Jersey were similar to those measured in the previous year (2005); some fluctuation from year to year is to be expected, due to meteorological and other factors. Two sites (Georgetown and Weighbridge) showed slightly larger increases in 2006, and should be monitored closely to establish whether this continues.

Ambient concentrations of NO_2 at some sites are showing a small but steady year on year downward trend in NO_2 concentrations. However, this is not the case for all sites. 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).

Annual mean concentrations of the hydrocarbon species monitored in this study are showing a small decrease, year on year.

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Appendices

1 Introduction

1.1 Background

The States of Jersey are committed to achieving standards of ambient air quality as good as, or better than, those applying in the European Union. This includes meeting EU Limit Values for a range of air pollutants, within the next 3 years. In addition, the States of Jersey have international obligations under the Climate Change Convention to reduce emissions of greenhouse gases.

AEA Energy & 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 2006. This is the tenth 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 2006 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 2005[1,2,3,4,5,6,7,8,9]. 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 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.

2.2 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. Benzene is well known as one of the harmful compounds found in cigarette smoke, but it is also found in petrol and other liquid fuels, in small concentrations. In urban areas, the major source of benzene in ambient air 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 ($\mu g\ m^{-3}$). Some earlier 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[10]. The best estimate for the odour threshold of toluene has been reported[10] as 0.16ppm (613μg m^{-3}). In this report, concentrations are expressed in microgrammes per cubic metre (μg m^{-3}). Some earlier 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[10], 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. There are no limits for ambient concentration of xylenes, although (as in the case of toluene and ethyl benzene) there are occupational limits relating to workplace exposure. 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})[11].

In this report, concentrations of ethylbenzene and xylenes are expressed in microgrammes per cubic metre (μg m^{-3}). Some earlier reports in this series used parts per billion (ppb): to convert to ppb to if required, 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).

2.3 Air Quality Limit Values and Objectives

2.3.1 World Health Organisation

In 2000, the World Health Organisation published revised air quality guidelines[12] 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.

2.3.2 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 [13,14] have been published in recent years. The Limit Values are summarised in Appendix 1.

2.3.3 UK Air Quality Strategy

The UK Air Quality Strategy (AQS) contains standards and objectives for a range of pollutants including NO_2 and benzene[15]. 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.

2.4 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 (Figure 1). 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 (also shown in Figure 1) 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 Energy & Environment, 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. The year was divided into twelve exposure periods approximating to calendar months. The duration of the exposure periods varied between three and five weeks.

The diffusion tube methodologies provide data that are accurate to $\pm$ 25% for NO_2 and $\pm$ 20% for BTEX. The limits of detection vary from month to month, but are typically 0.4 $\mu g\ m^{-3}$ for NO_2 and 0.2 $\mu g\ m^{-3}$ 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)[16] 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 2006 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.***

Figure 1: Diffusion Tubes for Various Pollutants
from left to right: SO_2 tube *(not used in this study)*, BTEX tube (centre), and NO_2 tube.

2.5 Monitoring Sites

At the beginning of 2006, monitoring of NO_2 was being carried out at 21 sites, the majority of which had been in use since 2000. At the end of May / beginning of June 2006, two of the urban background sites (Robin Place and L'Avenue et Dolmen) were replaced by two roadside sites at Havre des Pas and Commercial Buildings. Havre des Pas and Commercial Buildings were added to assist Traffic and Transport Services (TTS) by providing screening data for the Health Impact Assessment associated with an Energy from Waste plant proposed for La Collette. Thus, the total number of sites in operation for part or all of 2006 was 23. The total number of NO_2 sites in operation at the end of 2006 remains at 21. The number of sites, and their locations, are to be reviewed for 2008.

Table 1. NO_2 Monitoring Sites in Jersey

			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 *(Closed end May 2006)*	656 490	Urban background close to ring road
N11	Robin Place *(Closed end May 2006)*	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.
N22	Union Street	653 486	Kerbside in St Helier – corner of Union St. New St.
N23	New Street	653 485	Kerbside in St Helier
N24	Havre des Pas *(from Jun 2006)*		Kerbside, beside main A4 in/out of St Helier
N25	Commercial Buildings *(from Jun 2006)*		Kerbside, Commercial Buildings, 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.

Figures 2a and 2b show the locations of the above sites. Figure 2b also shows the location of a new automatic monitoring site in Halkett Place, St Helier, started up at the start of 2007.

Figure 2a. Site Locations Outside St Helier

Figure 2b. Sites in St Helier town

Key:	*(both maps)*	
1	Le Bas Centre	NO_2, BTEX
2	Mont Felard	NO_2
3	Les Quennevais	NO_2
4	Rue Des Raisies	NO_2
5	First Tower	NO_2
6	Weighbridge	NO_2
7	Langley Park	NO_2
8	Georgetown	NO_2
9	Clos St Andre	NO_2, BTEX
10	Union Street	NO_2
11	New Street	NO_2
12	Beaumont	NO_2
13	The Parade	NO_2
14	Maufant	NO_2
15	Jane Sandeman	NO_2
16	Saville Street	NO_2
17	Broad Street	NO_2
18	Beresford Street	NO_2, BTEX
19	Le Pouquelaye	NO_2
20	Havre Des Pas	NO_2
21	Commercial Buildings	NO_2
22	Springfield Garage	BTEX
23	Airport	BTEX
24	Hansford Lane	BTEX
25	Halkett Place	NO_2, Auto
26	Robin Place	NO_2
27	L'Avenue et Dolmen	NO_2

BTEX hydrocarbons were monitored at six sites during 2006. 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. During 2006, a vapour recovery system was fitted, which should prevent discharge of fuel vapour when their tanks are filled: however, there will still be some releases of VOCs when customers fill their cars with fuel.

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

			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.

2.6 Calendar of Exposure Periods

The calendar of exposure periods used for the NO_2 and BTEX diffusion tubes is shown below. They were intended to approximate to calendar months.

		End Date
January	03-Jan-06	08-Feb-06
February	08-Feb-06	02-Mar-06
March	02-Mar-06	05-Apr-06
April	05-Apr-06	03-May-06
May	03-May-06	31-May-06
June	31-May-06	29-Jun-06
July	29-Jun-06	31-Jul-06
August	31-Jul-06	31-Aug-06
September	31-Aug-06	04-Oct-06
October	04-Oct-06	01-Nov-06
November	01-Nov-06	27-Nov-06
December	27-Nov-06	03-Jan-07

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 Figure 3 (kerbside and roadside sites), Figure 4 (background sites), and Figure 5 (residential and rural sites). Individual monthly mean NO_2 results ranged from 2.6 $\mu g\ m^{-3}$ (in October at the residential background Les Quennevais site), to 54.3 $\mu g\ m^{-3}$ (in April at the kerbside Weighbridge site).

There were two occasions when no valid value was obtained: no tube was returned from Beresford Street in August, and Langley Park in September.

Two unusually low values were recorded: at Les Quennevais, the monthly mean for October was 2.6 $\mu g\ m^{-3}$, unusually low compared to typical results for the site. However, in the absence of any evidence to suggest that it is spurious, the value has not been rejected. Also, the September result from Clos St Andre was below the detection limit (<0.04$\mu g\ m^{-3}$). This is suspiciously low and the result has been disregarded as most likely a faulty tube.

Annual mean NO_2 concentrations ranged from 6.3 $\mu g\ m^{-3}$ (at the rural Rue des Raisies site) to 48.2 $\mu g\ m^{-3}$ 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[12] for NO_2 is that the annual mean should not exceed 40 $\mu g\ m^{-3}$. The EC 1st Daughter Directive[13] 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 exceeded 40$\mu g\ m^{-3}$; these were Weighbridge, Georgetown and La Pouquelaye. All three are 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[16]. 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 2006) 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 40μg m^{-3}. The highest annual mean (at Weighbridge) is reduced from 48.2 μg m^{-3} (unadjusted) to 36.2 μg 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.

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 2006, Jersey. Concentrations in $\mu g\ m^{-3}$.

Site From - To:	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Average	*Bias adjusted*
First Tower (K)	35.9	39.5	34.4	34.1	33	39.9	35	34.5	43	35.8	37.7	30.3	36.1	27.1
Weighbridge (K)	44.7	43.4	41.1	54.3	48.5	46.1	43.1	54.2	49.8	48.3	52.5	52.9	**48.2**	36.2
Georgetown (K)	49.1	52.1	40.5	41.9	30.3	50.3	44.3	31.6	39.9	41.4	41.6	39.9	**41.9**	31.4
Beaumont (K)	40.3	14	29.8	42.9	40.3	47.4	49	38.4	44.9	43.6	40.9	41.2	39.4	29.5
The Parade (K)	13.6	37.5	34.1	33.3	29.3	28.1	25.8	25.6	30.6	30.2	31.4	33.3	29.4	22.1
Broad Street (K)	37.4	32.1	39.2	43.5	45.3	34.2	39.4	33.4	47.1	41.5	41.1	35.2	39.1	29.3
La Pouquelaye (K)	42.9	47.2	41	44.8	44.5	46.9	34.7	31.9	37	42.4	39	39	**40.9**	30.7
Havre des Pas (K)						26.2	27.4	19.3	23.5	22.2	22.1	21.6	23.2	17.4
Commercial B (K)						39.8	36.4	26.6	29.2	26.3	33.1	33.9	32.2	24.1
New Street (R)	34.8	31.5	22.9	27.7	23.1	22.9	20.1	20.1	24.5	25.4	24.7	29	25.6	19.2
Union Street (R)	38.1	41.6	40.1	41.5	38.7	33.5	31.7	33.2	37	43.5	42.6	42.9	38.7	29.0
Le Bas Centre (UB)	30.3	30	24.5	29	23.7	22.9	23.2	21.7	27.6	27.9	27.6	27.4	26.3	19.7
L'Avenue et Dolmen (UB)	31.9	26.1	22.7	22.7	17.6								24.2	18.2
Robin Place (UB)	32.3	29.2	27.4	27.3	25.4								28.3	21.2
Jane Sandeman (UB)	24	15.3	16.1	14.5	11.3	12.2	11.4	11	14.7	15	4.1	18.5	14.0	10.5
Saville Street (UB)	33.4	31.8	26.5	28.1	20.8	28.6	28.2	21	26.6	25.6	27	29.2	27.2	20.4
Beresford Street (UB)	39.5	39.5	34.2	36.2	33.1	35.5	35.6	27.2	TM	36.4	37.2	33.4	35.3	26.4
Mont Felard (Res B)	17.3	27.9	21.7	27	23.5	21.2	29.2	24.2	23.9	26.6	24.4	23.1	24.2	18.1
Les Quennevais (Res B)	10.9	14.6	12.6	11.5	9.5	11.6	8	6.6	10.9	10.6	2.6	13	10.2	7.7
Langley Park (UB)	24.7	19.3	18.2	16.4	15.2	15	12.4	TM	15.5	17	18	17.4	17.2	12.9
Clos St.Andre (Res B)	18.7	17.5	15	15.9	12.7	11.2	13	10.8	bdl	31.8	17.5	18.5	16.6	12.5
Maufant (Res B)	8.6	12.2	9.3	11.1	8.8	10.3	10.9	7.9	7.5	8.5	9.2	11	9.6	7.2
Rue Des Raisies (Rur B)	2.7	8.9	7.3	7.7	5.9	7	7.2	4.9	5.7	5.9	6.3	6.1	6.3	4.7

K = Kerbside, R = Roadside, UB = Urban Background, Res B = Residential Background, Rur B = Rural Background. TM = tube missing, bdl = below detection limit.
*Annual mean concentrations greater than 40µg m^{-3} highlighted in **bold**.*

Figure 3. Monthly Mean Nitrogen Dioxide Concentrations at Roadside and Kerbside Sites, 2006

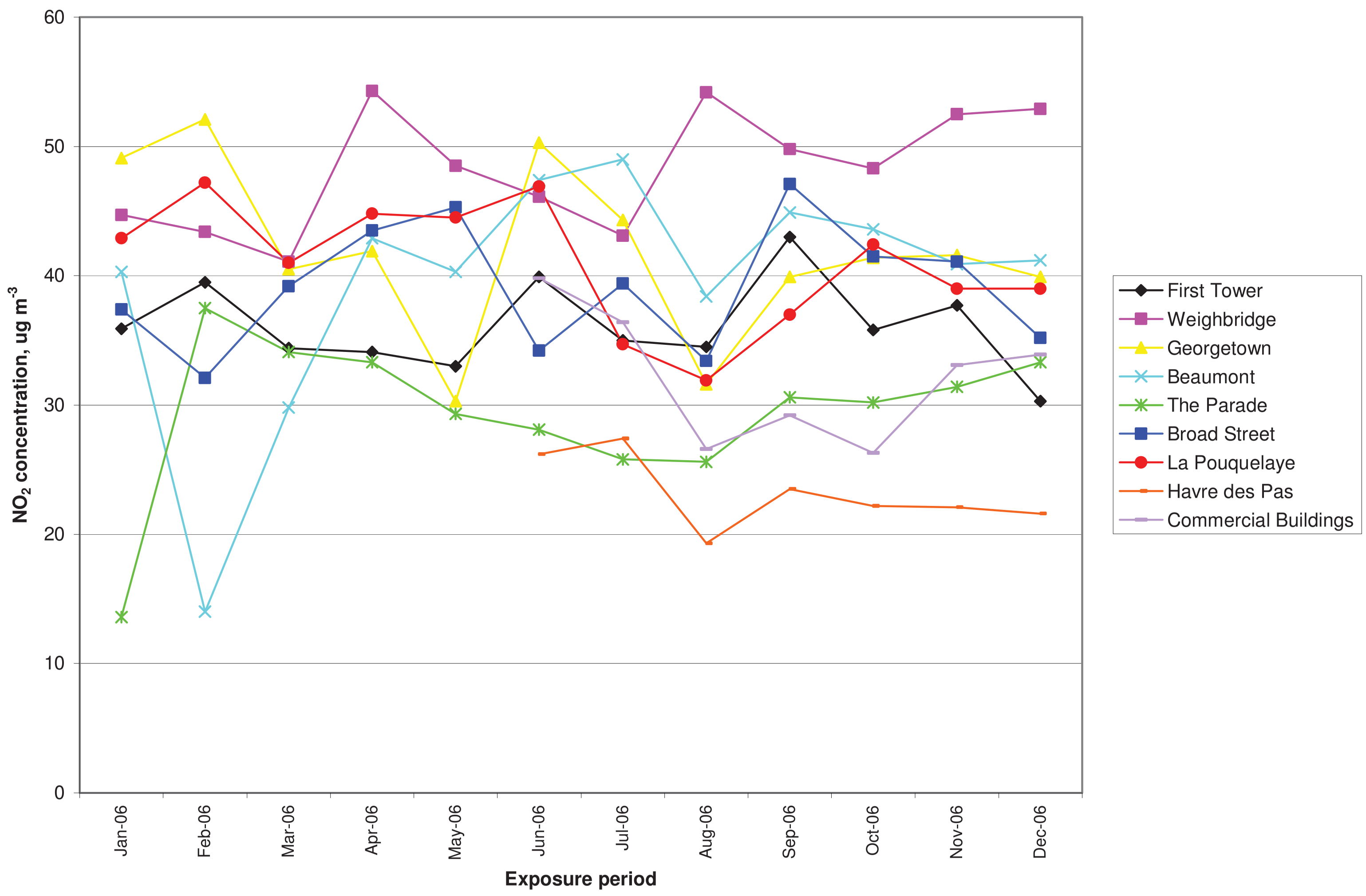


Figure 4. Monthly Mean Nitrogen Dioxide Concentrations at Urban Background Sites, 2006

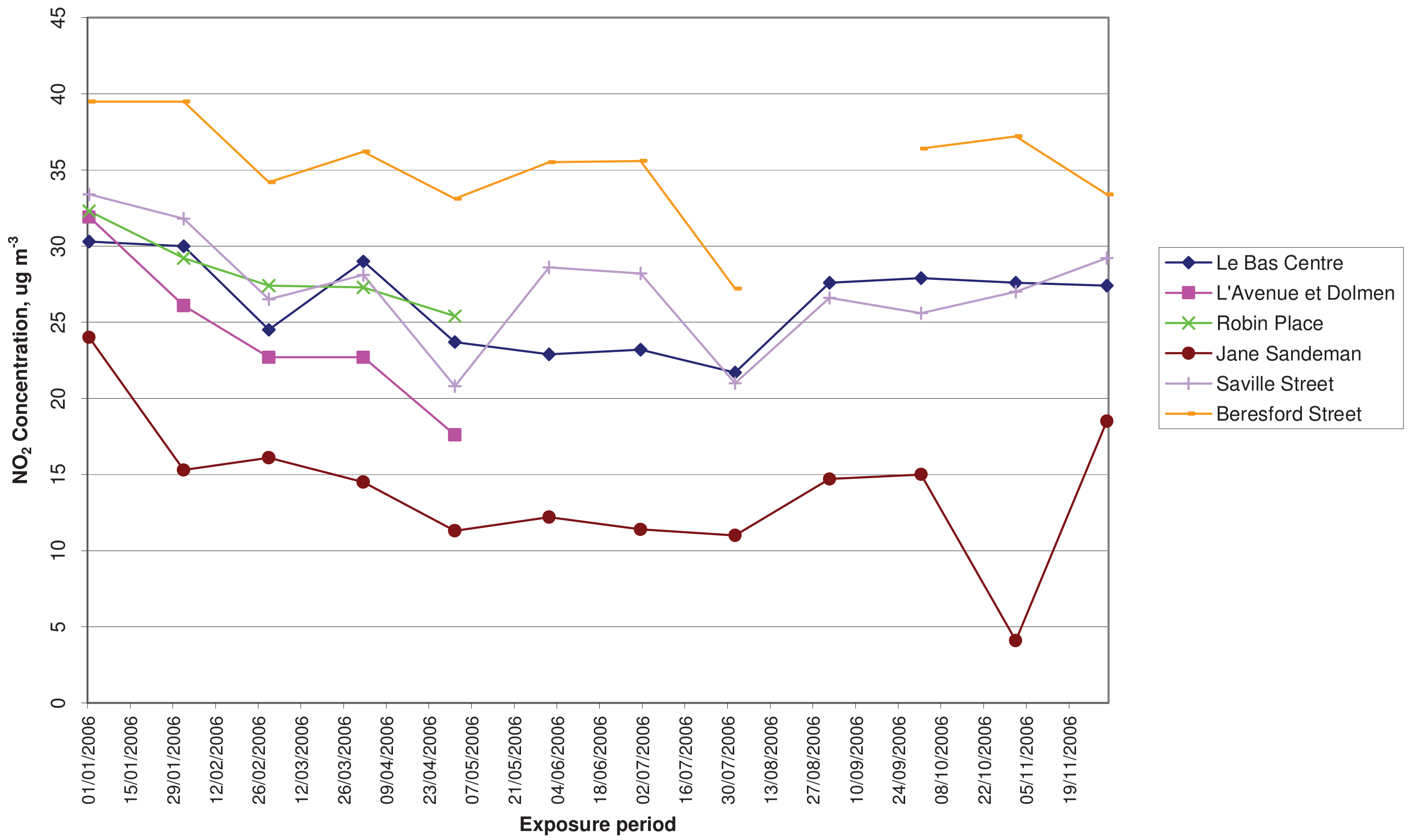
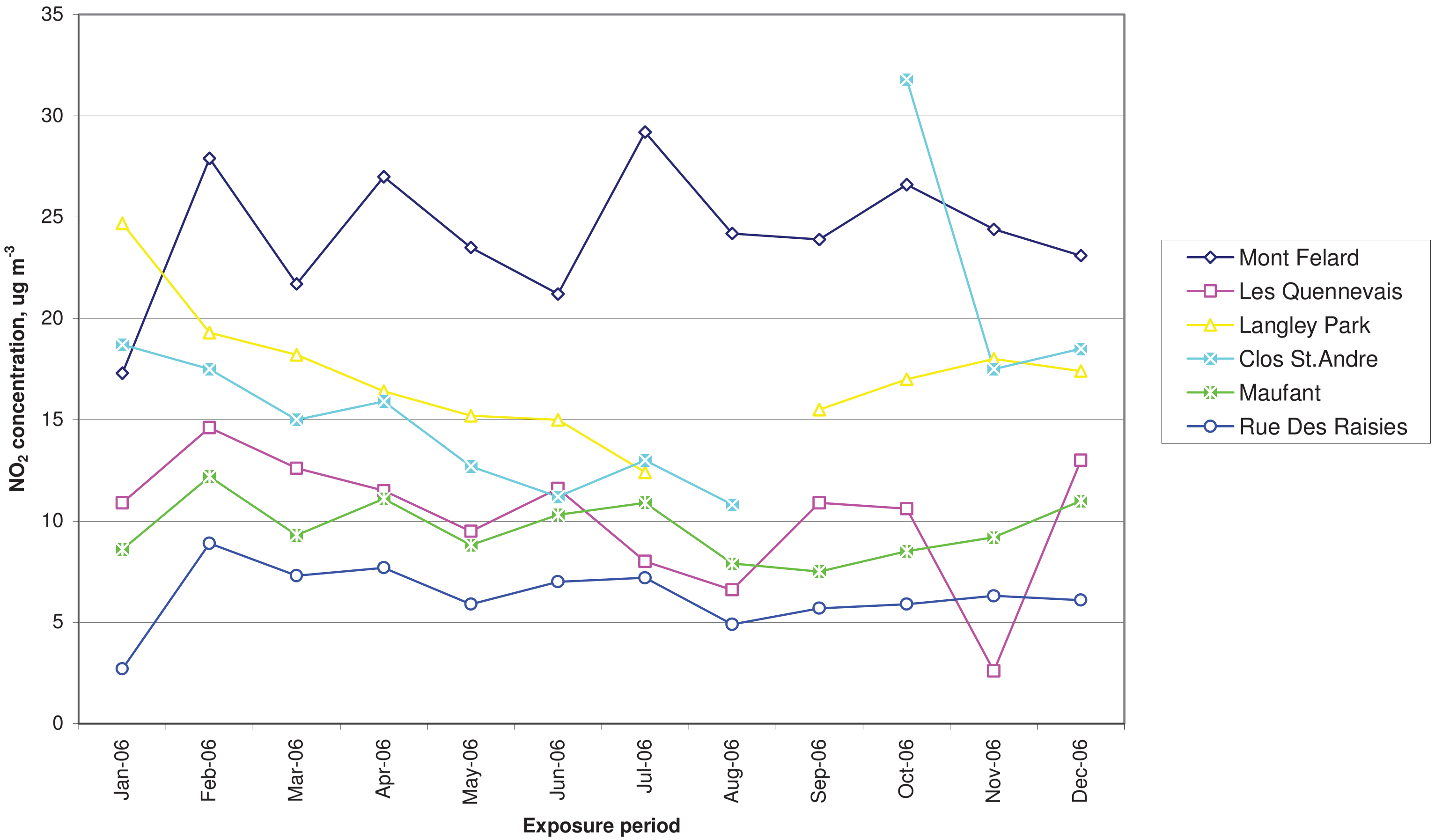


Figure 5. Monthly Mean Nitrogen Dioxide Concentrations at Residential and Rural Background Sites, 2006



3.1.3 Comparison with UK NO_2 data

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.
- Brighton Roadside – a roadside site in the coastal city of Brighton, Sussex.
- Brighton Preston Park – an urban background site in Brighton.
- Southend on Sea – an urban background site in the coastal town of Southend, Essex.
- 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	2006 Annual average NO_2, $\mu g\ m^{-3}$
Exeter Roadside	39
Brighton Roadside	39
Brighton Preston Park	21
Southend on Sea	20
Lullington Heath	10.8
Harwell	11.5

The bias adjusted annual mean NO_2 concentrations measured at the kerbside and roadside sites in Jersey ranged from 17 to 36$\mu g\ m^{-3}$. The annual means at Exeter Roadside and Brighton Roadside were slightly higher than these. The Jersey urban background sites had (bias adjusted) annual mean NO_2 concentrations ranging from 10 $\mu g\ m^{-3}$ to 26 $\mu g\ m^{-3}$; the urban background sites in Southend and Brighton were therefore within this range. 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 7 $\mu g\ m^{-3}$ to 18 $\mu g\ m^{-3}$, and thus were more comparable with rural sites such as Lullington Heath and Harwell. The bias-adjusted annual mean of 4.7 $\mu g\ m^{-3}$ 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

Annual mean NO_2 concentrations for 2006, at the majority of sites, were within 2$\mu g\ m^{-3}$ of the previous year's annual mean – some higher and some lower than last year. The exceptions were Weighbridge, which recorded an increase of 4 $\mu g\ m^{-3}$, and Georgetown, which recorded an increase of 5 $\mu g\ m^{-3}$. Some degree of fluctuation in annual mean concentrations is expected, due to meteorology.

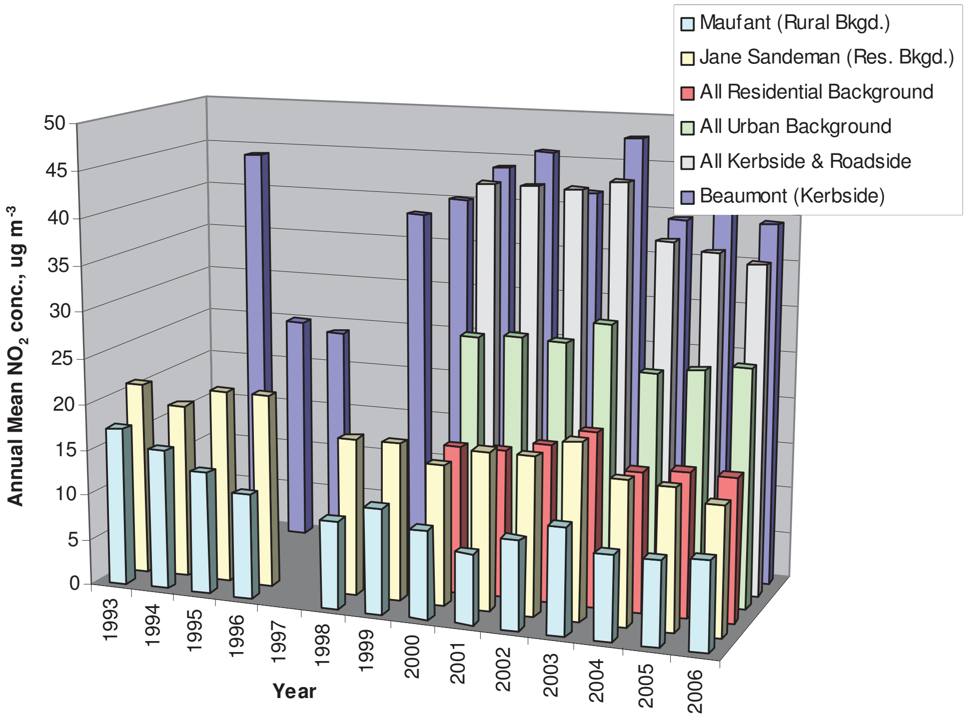
Long-term trends were also investigated. The majority of the NO_2 monitoring sites in this survey have been in operation since 2000. However, the survey includes three longer-running sites, which were part of the former UK Nitrogen Dioxide Network and have been in operation since 1993. These are Beaumont (kerbside), Jane Sandeman Road (urban residential) and Maufant (residential background, rural location).

Table 5 and Figure 6 show annual mean NO_2 concentrations for all sites in the kerbside and roadside, urban background and residential background categories. Also shown are annual means from 1993 onwards for the three long-running sites. ***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.***

Of the three long-running Jersey sites, only the residential background Jane Sandeman road site shows a small but consistent downward trend. In the case of the Maufant site, NO_2 concentrations are lower than they were in the early 1990s, but there is no clear trend in recent years. Nor is there any clear trend for the kerbside Beaumont site.

The average NO_2 concentration for all roadside and kerbside sites appears to show a small but consistent downward trend since 2000, with a particularly marked reduction since 2003 (which was a notably high year). There is no clear trend in the mean of all urban background sites, or all residential background sites.

Figure 6. Trends in Annual Mean NO_2 Concentrations (not corrected for diffusion tube bias).



Trends were investigated at each individual site. Many of the kerbside and roadside sites showed small but consistent downward trends (two exceptions being Weighbridge and Broad Street). There is some indication of increasing levels at two non-roadside sites, Clos St Andre and L'Avenue et Dolmen). At the many sites at which there is no clear downward trend, sites currently at risk of exceeding AQS objectives or EC limit are likely to remain so.

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	2006
Beaumont (Kerbside)		44	25	24	-	38	40	44	46	42	48	39	42	39
Jane Sandeman (Res. Bkgd.)	21	19	21	21	-	17	17	15	17	17	19	16	15	14
Maufant (Rural Bkgd.)	17	15	13	11	-	10	11	10	8	10	11	9	9	10
All Kerbside & Roadside	-	-	-	-	-	-	-	43	43	43	44	38	37	36
All Urban Background	-	-	-	-	-	-	-	27	27	27	30	25	25	26
All Residential Background	-	-	-	-	-	-	-	16	16	17	19	15	16	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 7 to 12.

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, 2006

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	2.2	7.4	1.3	4.6	1.6
Le Bas Centre	1.5	4.4	0.8	2.8	1.0
Handsford Lane *(paint spraying)*	1.3	4.8	1.3	5.1	1.6
Springfield Garage *(petrol station)*	3.9	21.7	2.6	10.2	3.7
Clos St Andre	1.0	2.0	0.4	1.2	0.4
Airport	1.0	1.4	0.5	0.9	0.3

All sites achieved full data capture, except the following:

(i) Beresford Street: the March tube recorded values below the detection limit for all BTEX compounds. This atypically low result was rejected as spurious, being more likely to result from a faulty diffusion tube than genuinely low results at this site.

(ii) Beresford Street: the September hydrocarbon tube went missing from the site, as did the NO_2 tube for the same month.

(iii) the Airport, where the January tube could not be changed and was left in place for two months. The two-month average obtained was rejected as unreliable.

The Springfield Garage monitoring site continues to record the highest annual mean concentrations of all five BTEX compounds, as it typically has in previous years. The Handsford Lane site (near a paint spraying process) has in previous years also measured slightly higher levels of toluene, ethylbenzene and xylenes than most of the other sites. However, in 2006 levels of these compounds were comparable with Beresford Street and Le Bas Centre. Ambient concentrations of toluene decreased substantially in 2005, and have remained less than $5\mu gm^{-3}$ in 2006. The Airport site, which is in rural surroundings, recorded the lowest annual mean concentrations of most of the BTEX hydrocarbons. However, relatively high levels of ethylbenzene and xylenes were measured in September.

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.

Figure 7. Monthly mean hydrocarbon concentrations at Beresford Street, 2006

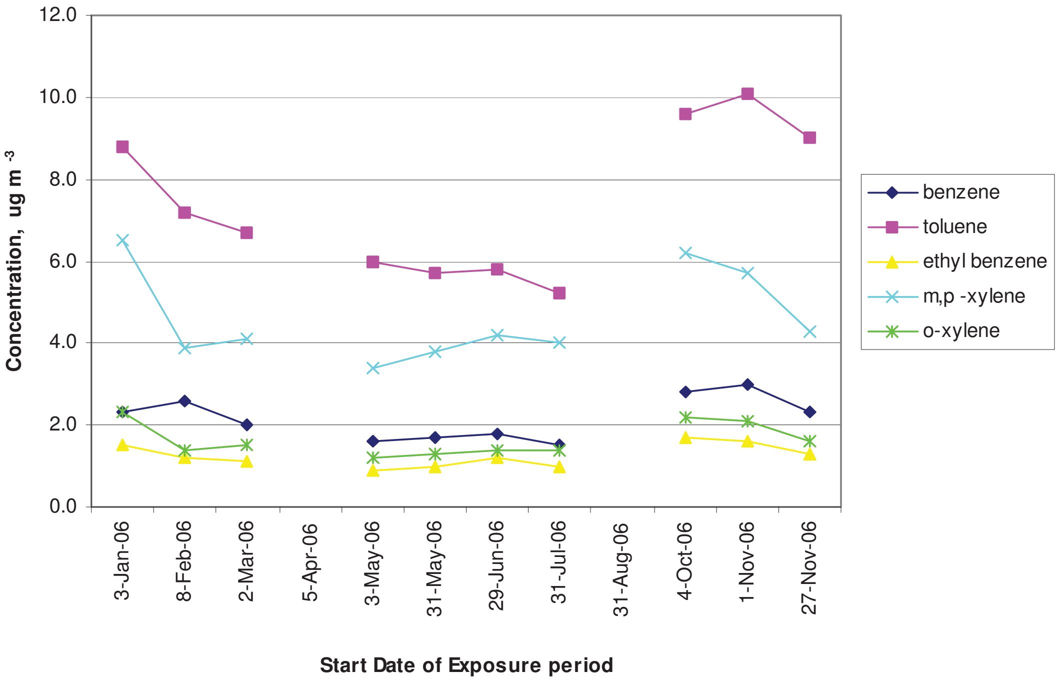


Figure 8. Monthly mean hydrocarbon concentrations at Le Bas Centre, 2006

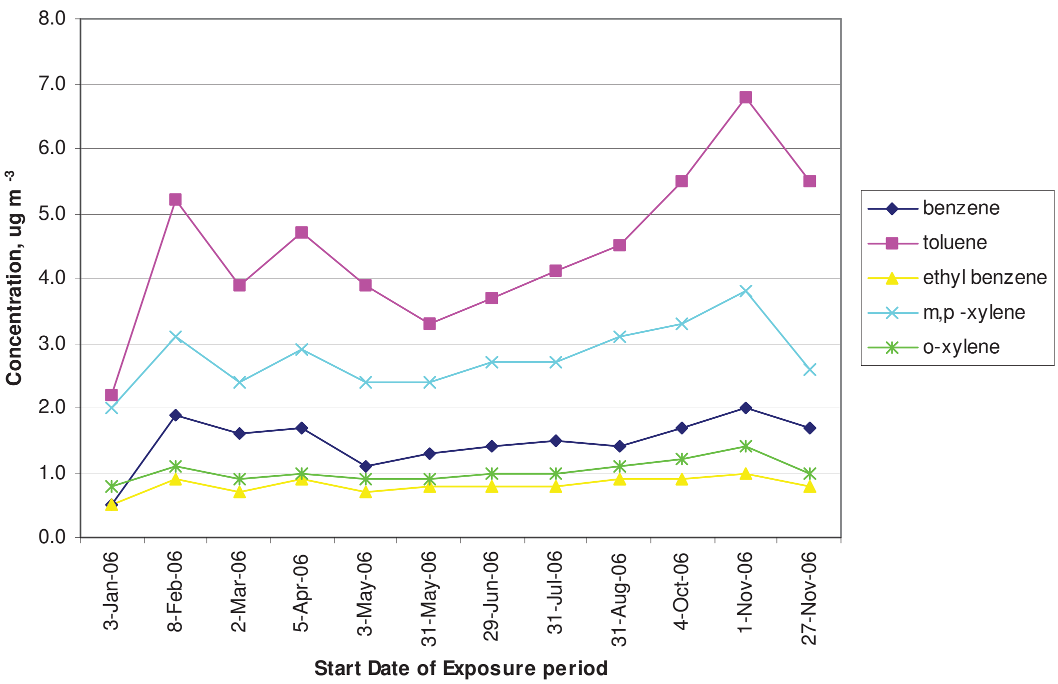


Figure 9. Monthly mean hydrocarbon concentrations at Handsford Lane, 2006

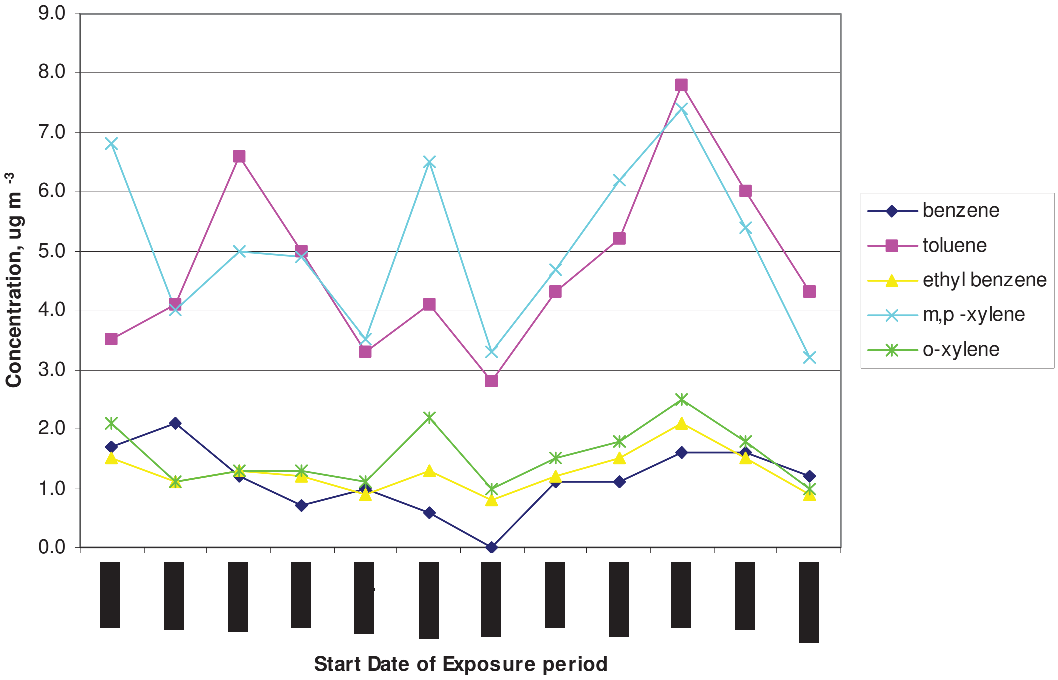


Figure 10. Monthly mean hydrocarbon concentrations at Springfield Garage, 2006

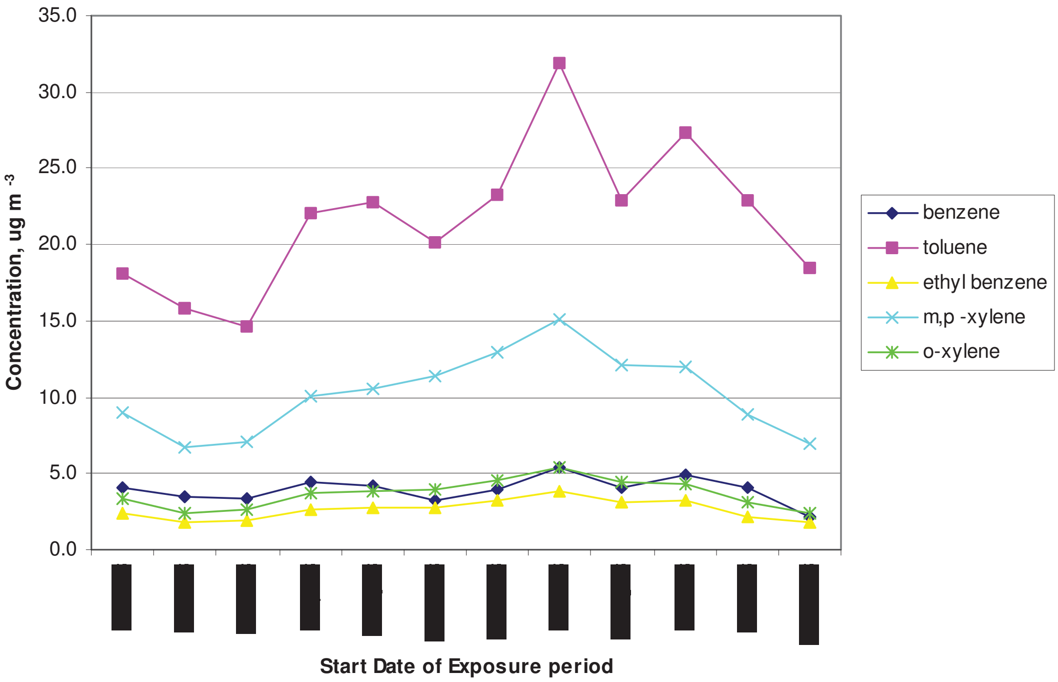


Figure 11. Monthly mean hydrocarbon concentrations at Clos St Andre, 2006

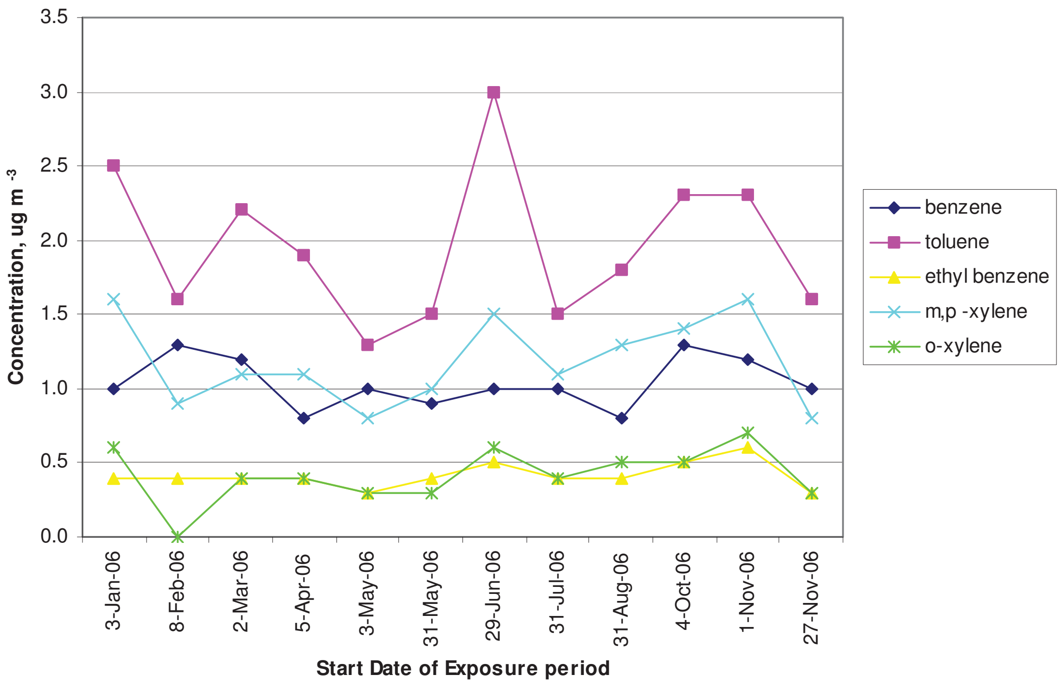
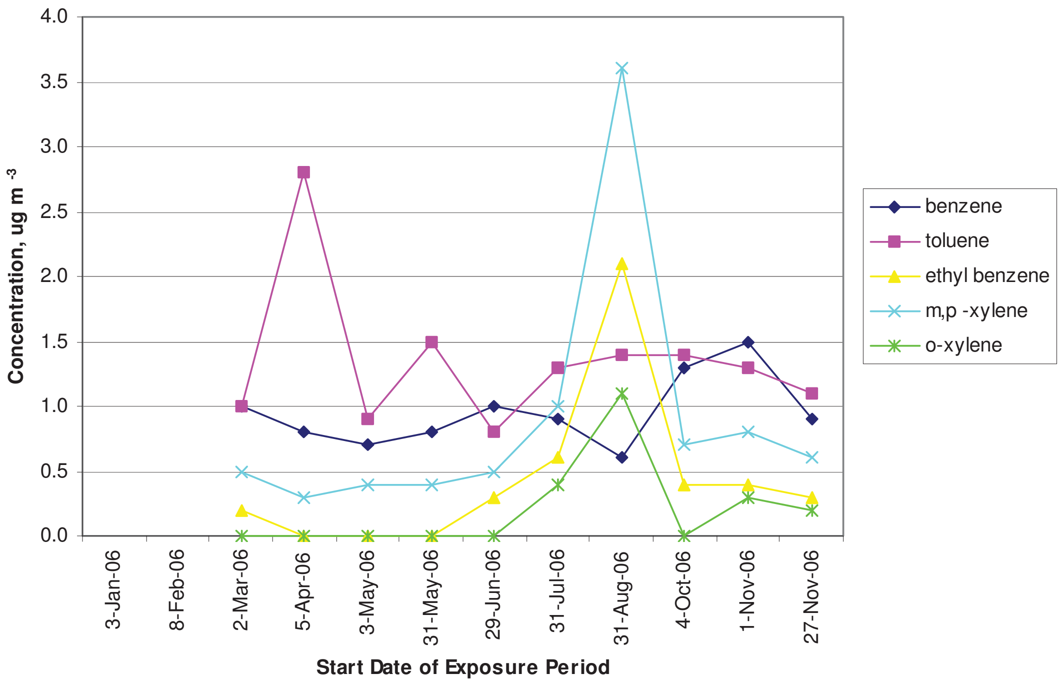


Figure 12. Monthly mean hydrocarbon concentrations at the Airport, 2006



3.2.2 Comparison With 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. Although they are not at present mandatory in Jersey, the States of Jersey are committed to meeting air quality standards at least as stringent as those applying throughout the EU.

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[14] 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 Benzene Data

Benzene was measured using pumped-tube samplers at a large UK-wide network of 30 UK sites in 2006. Annual mean concentrations ranged from 0.7 μg m^{-3} (at Coventry's Memorial Park) to 2.17 μg m^{-3} (at Birmingham Roadside), but were typically in the range of 1-2 μg m^{-3} at most urban sites.

Table 7 compares benzene data from the Jersey sites, with that from a selection of UK monitoring stations, located in cities on the south coast of England. The sites used for comparison are:

- Bournemouth – an urban background site in a coastal town.
- Hove Roadside – a roadside site in the coastal town of Hove, near Brighton, Sussex.
- Plymouth – an urban background site in the coastal city of Plymouth, Devon
- Portsmouth – an urban background site in Portsmouth , Hampshire
- Southampton – a roadside site in the city of Southampton
- Southend on Sea – an urban background site in Southend, Essex.

Table 7. Comparison with Benzene Concentrations at Other UK Sites, Calendar Year 2006 (with data capture in brackets).

Site	Benzene, μg m^{-3}
Jersey Sites	
Beresford Street	2.2
Le Bas Centre	1.5
Handsford Lane *(paint spraying)*	1.3
Springfield Garage *(petrol station)*	3.9
Clos St Andre	1.0
Airport	1.0
Mainland UK sites	
Bournemouth	0.75
Hove Roadside	1.13
Plymouth	0.92
Portsmouth	1.02
Southampton	1.45
Southend	0.98

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 the roadside sites at Southampton and Hove. In previous years it has been reported that benzene levels at Clos St Andre and the Airport were lower than typical UK urban levels; however, UK urban levels are decreasing and this is no longer the case. However, it should be noted that the UK measurements are made with a different technique (pumped tube samplers) than the BTEX tubes used in the Jersey study, so this observed difference may be due at least in part to the difference in measurement techniques.

(Toluene, ethlybenzene and xylenes are no longer part of the UK monitoring programme).

3.2.4 Comparison with Previous Years' Hydrocarbon Results

Table 8 shows annual mean hydrocarbon concentrations for these sites, for years 1997 – 2006. Figures 13 to 17 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.

Annual mean levels of benzene at all sites were very slightly higher in 2006 than in the previous year; this is in contrast to the UK, where annual mean concentrations of this pollutant were typically lower than the previous year.

Annual mean toluene concentrations at all sites except Handsford Lane were slightly lower in 2006 compared to 2005. Annual mean concentrations of ethylbenzene and xylenes were lower compared to 2005 at all sites except the Airport. However, it is important to remember that pollutant concentrations are expected to show considerable year-to-year variation, due to meteorological and other factors. Year-to year changes are therefore of less importance than the observation of long-term trends, which are discussed below.

Table 8. Comparison of Hydrocarbon Concentrations, Jersey, 1997 - 2006.

	benzene, $\mu g\ m^{-3}$	toluene, $\mu g\ m^{-3}$	ethylbenzene $\mu g\ m^{-3}$	m+p xylene, $\mu g\ m^{-3}$	o-xylene, $\mu g\ m^{-3}$
Beresford Street					
1997	10.4	20.7	5.3	11.9	5.3
1998	8.1	18.8	4.0	10.2	4.4
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
2006	2.2	7.4	1.3	4.6	1.6
Le Bas Centre					
1997	9.1	17.2	5.3	9.7	4.4
1998	7.5	16.1	3.1	8.4	4.0
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
2006	1.5	4.4	0.8	2.8	1.0
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	19.0	8.4
1998	25.0	47.1	6.6	19.0	7.5
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
2006	3.9	21.7	2.6	10.2	3.7

Table 8. Comparison of Hydrocarbon Concentrations, -*continued :* Jersey, 1997 - 2006.

	benzene, $\mu g\ m^{-3}$	toluene, $\mu g\ m^{-3}$	ethylbenzene $\mu g\ m^{-3}$	m+p xylene, $\mu g\ m^{-3}$	o-xylene, $\mu g\ m^{-3}$
Stopford Road Outdoor					
2000	3.9	32.2	8.0	23.4	9.7
2001	5.7	46.8	9.8	30.0	11.6
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
2006	1.0	2.0	0.4	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
2005	0.6	1.6	0.2	0.6	0.2
2006	1.0	1.4	0.5	0.9	0.3
Handsford Lane					
2004	1.0	16.1	7.3	8.5	2.0
2005	1.0	3.7	2.1	7.1	2.2
2006	1.2	4.8	1.3	5.1	1.6

Figure 13. Trends in Benzene Concentration

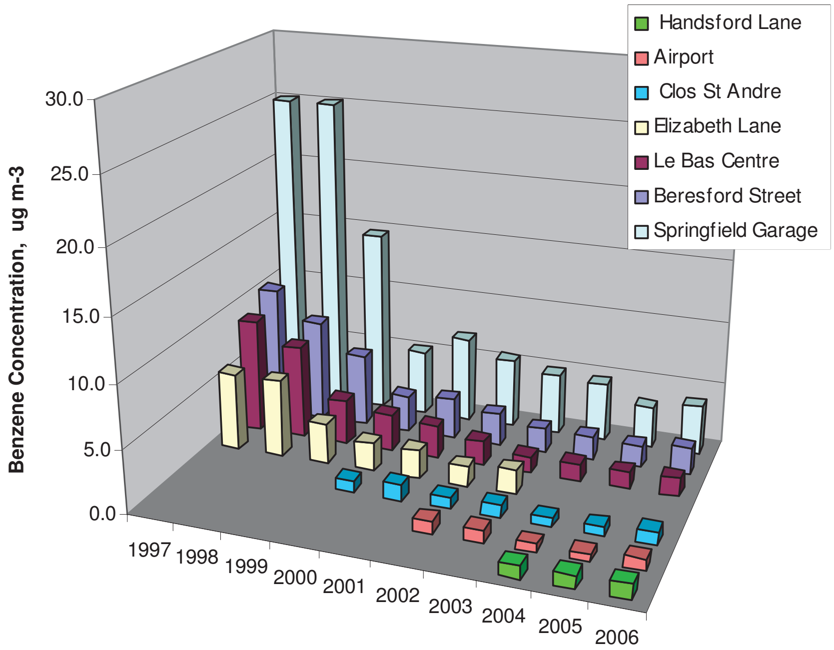


Figure 14. Trends in Toluene Concentration

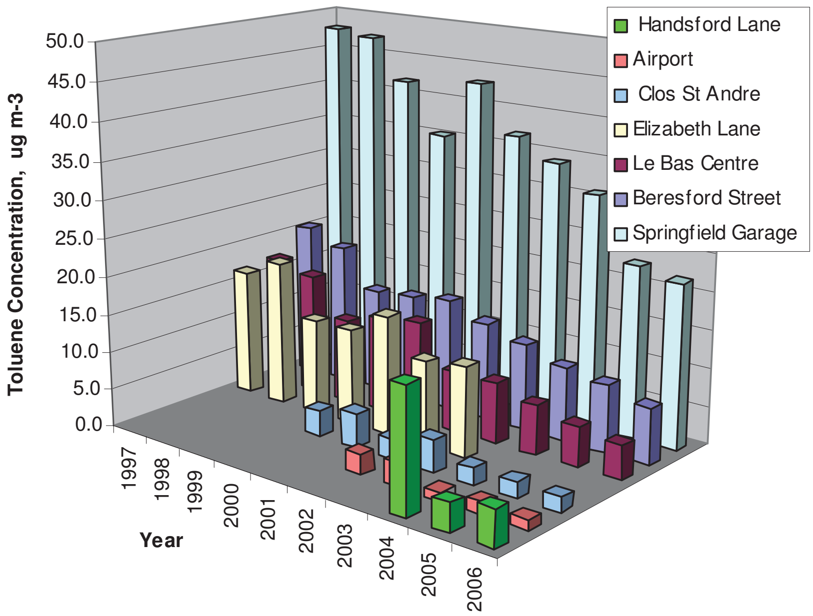


Figure 15. Trends in Ethylbenzene Concentration

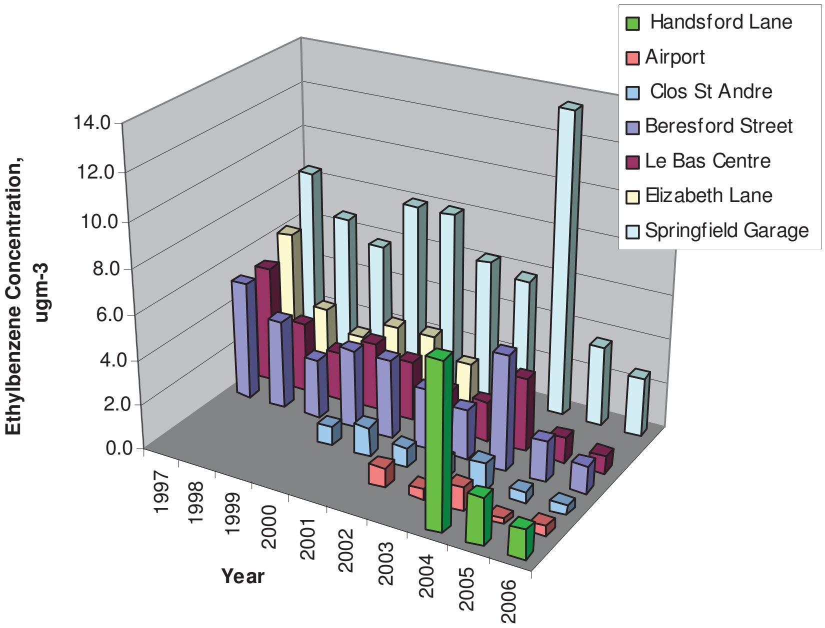


Figure 16. Trends in m+p- Xylene Concentration

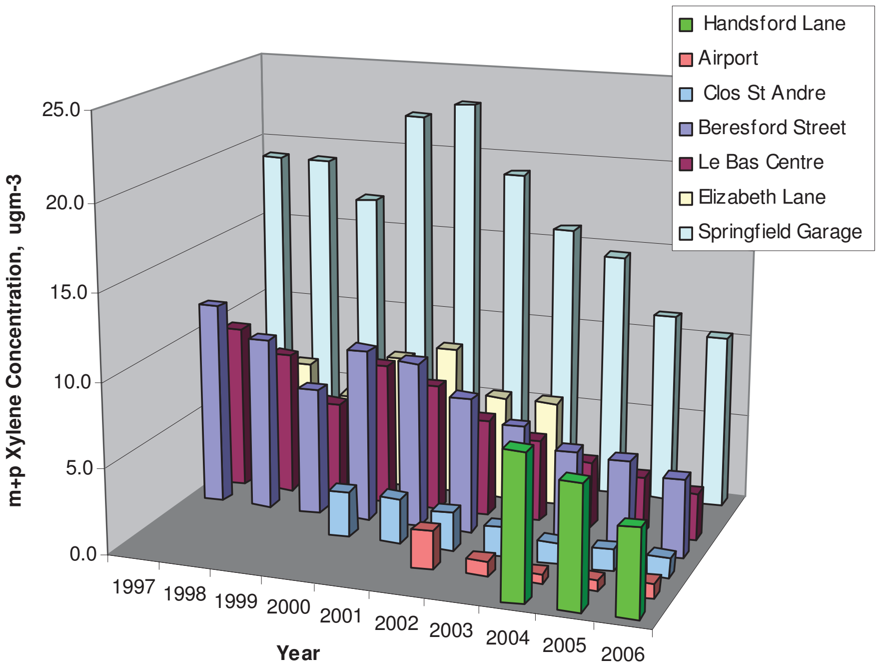
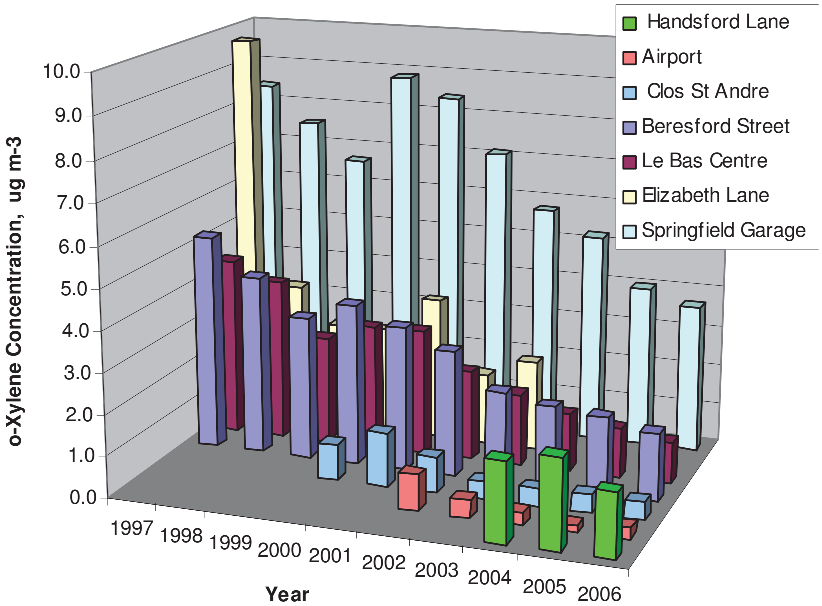


Figure 17. Trends in o-Xylene Concentration



Most hydrocarbon species appear to have decreased over the ten 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 10 years of the survey (1997-2006).
- Ethylbenzene concentrations have also generally decreased, despite an unexplained increase in 2004.
- Concentrations of m+p xylene, and of o-xylene, are also now generally lower than in the early years of the survey.

4 Conclusions

AEA Energy & Environment has undertaken a year-long diffusion tube monitoring study in Jersey during 2006, on behalf of the States of Jersey Public Health. This monitoring study has now been undertaken for ten consecutive years.

- 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, many of which have been in operation since 2000, and some since 1997.
- Two new kerbside sites were set up for monitoring of NO_2. These were located at Commercial Buildings and Havre des Pas. They replaced two urban background sites (Robin Place and L'Avenue et Dolmen) which were no longer required.

NO_2 results

- Annual mean (uncorrected) NO_2 concentrations at two kerbside sites (Weighbridge, Georgetown and La Pouquelaye) 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 lack of any clear downward trend in NO_2 concentrations 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 within of 4 μg m^{-3} of those measured the previous year, the exceptions being Georgetown and Weighbridge which recorded a larger increase.
- Of the three long-running sites, which have operated since 1993 as part of the UK NO_2 Network., only one (Jane Sandeman Rd) shows a clear downward trend in NO_2 concentration.
- There is a small but consistent downward trend in the average annual mean NO_2 concentrations for all kerbside and roadside sites, but not for all urban background sites, or all residential sites.
- Trends were briefly investigated for all sites: at most sites there was a slight downward trend or no clear trend. However, levels may possibly be increasing at Clos St Andre and L'Avenue et Dolmen.
- One implication of the apparent relative 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.
- Annual mean concentrations of BTEX hydrocarbons were mostly comparable with, or slightly lower than, those measured in 2005.
- Concentrations of most BTEX hydrocarbons are decreasing slightly year on year.

5 Recommendations

Results of the diffusion tube survey indicate that all monitoring sites in Jersey meet the UK Air Quality Strategy Objective of 40μg m^{-3} for the annual mean NO_2 concentration. 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: an automatic site has now been set up in St Helier (at the start of 2007) and data from this site will be included in the 2007 report.

It is recommended that NO_2 diffusion tubes (preferably in triplicate) be co-located with the real-time NO_2 analyser at the new automatic monitoring site at St Helier for comparative purposes.

It is understood that Jersey's Waterfront area will see an increase in traffic movements in the next few years associated with the proposed Castle Quays, new bus station and Island Quarter developments. It is recommended that diffusion tube surveys are carried out before and after the implementation of these developments to assess the changes in air pollution.

The diffusion tube survey for 2008 is currently being reviewed to ensure best value is being achieved both financially and from the point of view of air quality monitoring.

6 Acknowledgements

AEA Energy & Environment gratefully acknowledges the help and support of the staff of the States of Jersey Health Protection Unit, Planning and Environment and Traffic and Transport Services in the completion of this monitoring study. For more information on Air Pollution please visit www.gov.je and http://www.aea-energy-and-environment.com/

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Appendices

Appendix 1: Air Quality Limit Values and Objectives
Appendix 2: Monthly Mean Hydrocarbon Results

Appendix 1

Air Quality Limit Values and Objectives

Contents: Air Pollution Guidelines used in this Report

Air Pollution Guidelines Used in this Report.

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

Nitrogen Dioxide

			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 µg m^{-3} and ppb are as used by the EC, i.e. 1ppb NO_2 = 1.91 µg 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

			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°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

Monthly Mean Hydrocarbon Results

Contents

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
3-Jan-06	2.3	8.8	1.5	6.5	2.3
8-Feb-06	2.6	7.2	1.2	3.9	1.4
2-Mar-06	2.0	6.7	1.1	4.1	1.5
5-Apr-06	-	-	-	-	-
3-May-06	1.6	6.0	0.9	3.4	1.2
31-May-06	1.7	5.7	1.0	3.8	1.3
29-Jun-06	1.8	5.8	1.2	4.2	1.4
31-Jul-06	1.5	5.2	1.0	4.0	1.4
31-Aug-06	-	-	-	-	-
4-Oct-06	2.8	9.6	1.7	6.2	2.2
1-Nov-06	3.0	10.1	1.6	5.7	2.1
27-Nov-06	2.3	9.0	1.3	4.3	1.6
Average	**2.2**	**7.4**	**1.3**	**4.6**	**1.6**

5 Apr – 3 May: all values below detection limit: rejected as suspect.
Missing tube for 31 Aug – 4 Oct.

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
3-Jan-06	0.5	2.2	0.5	2.0	0.8
8-Feb-06	1.9	5.2	0.9	3.1	1.1
2-Mar-06	1.6	3.9	0.7	2.4	0.9
5-Apr-06	1.7	4.7	0.9	2.9	1.0
3-May-06	1.1	3.9	0.7	2.4	0.9
31-May-06	1.3	3.3	0.8	2.4	0.9
29-Jun-06	1.4	3.7	0.8	2.7	1.0
31-Jul-06	1.5	4.1	0.8	2.7	1.0
31-Aug-06	1.4	4.5	0.9	3.1	1.1
4-Oct-06	1.7	5.5	0.9	3.3	1.2
1-Nov-06	2.0	6.8	1.0	3.8	1.4
27-Nov-06	1.7	5.5	0.8	2.6	1.0
Average	**1.5**	**4.4**	**0.8**	**2.8**	**1.0**

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
3-Jan-06	1.7	3.5	1.5	6.8	2.1
8-Feb-06	2.1	4.1	1.1	4.0	1.1
2-Mar-06	1.2	6.6	1.3	5.0	1.3
5-Apr-06	0.7	5.0	1.2	4.9	1.3
3-May-06	1.0	3.3	0.9	3.5	1.1
31-May-06	0.6	4.1	1.3	6.5	2.2
29-Jun-06	*< 0.2*	2.8	0.8	3.3	1.0
31-Jul-06	1.1	4.3	1.2	4.7	1.5
31-Aug-06	1.1	5.2	1.5	6.2	1.8
4-Oct-06	1.6	7.8	2.1	7.4	2.5
1-Nov-06	1.6	6.0	1.5	5.4	1.8
27-Nov-06	1.2	4.3	0.9	3.2	1.0
Average	**1.2**	**4.8**	**1.3**	**5.1**	**1.6**

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
3-Jan-06	4.1	18.1	2.4	9.0	3.3
8-Feb-06	3.5	15.8	1.8	6.7	2.4
2-Mar-06	3.3	14.6	1.9	7.1	2.6
5-Apr-06	4.4	22.1	2.6	10.1	3.7
3-May-06	4.2	22.8	2.7	10.6	3.8
31-May-06	3.2	20.1	2.8	11.4	3.9
29-Jun-06	3.9	23.2	3.2	12.9	4.5
31-Jul-06	5.4	31.9	3.8	15.1	5.4
31-Aug-06	4.1	22.9	3.1	12.1	4.4
4-Oct-06	4.9	27.3	3.2	12.0	4.3
1-Nov-06	4.1	22.9	2.2	8.9	3.1
27-Nov-06	2.1	18.4	1.8	6.9	2.4
Average	**3.9**	**21.7**	**2.6**	**10.2**	**3.7**

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
3-Jan-06	1.0	2.5	0.4	1.6	0.6
8-Feb-06	1.3	1.6	0.4	0.9	*< 0.2*
2-Mar-06	1.2	2.2	0.4	1.1	0.4
5-Apr-06	0.8	1.9	0.4	1.1	0.4
3-May-06	1.0	1.3	0.3	0.8	0.3
31-May-06	0.9	1.5	0.4	1.0	0.3
29-Jun-06	1.0	3.0	0.5	1.5	0.6
31-Jul-06	1.0	1.5	0.4	1.1	0.4
31-Aug-06	0.8	1.8	0.4	1.3	0.5
4-Oct-06	1.3	2.3	0.5	1.4	0.5
1-Nov-06	1.2	2.3	0.6	1.6	0.7
27-Nov-06	1.0	1.6	0.3	0.8	0.3
Average	**1.0**	**2.0**	**0.4**	**1.2**	**0.4**

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

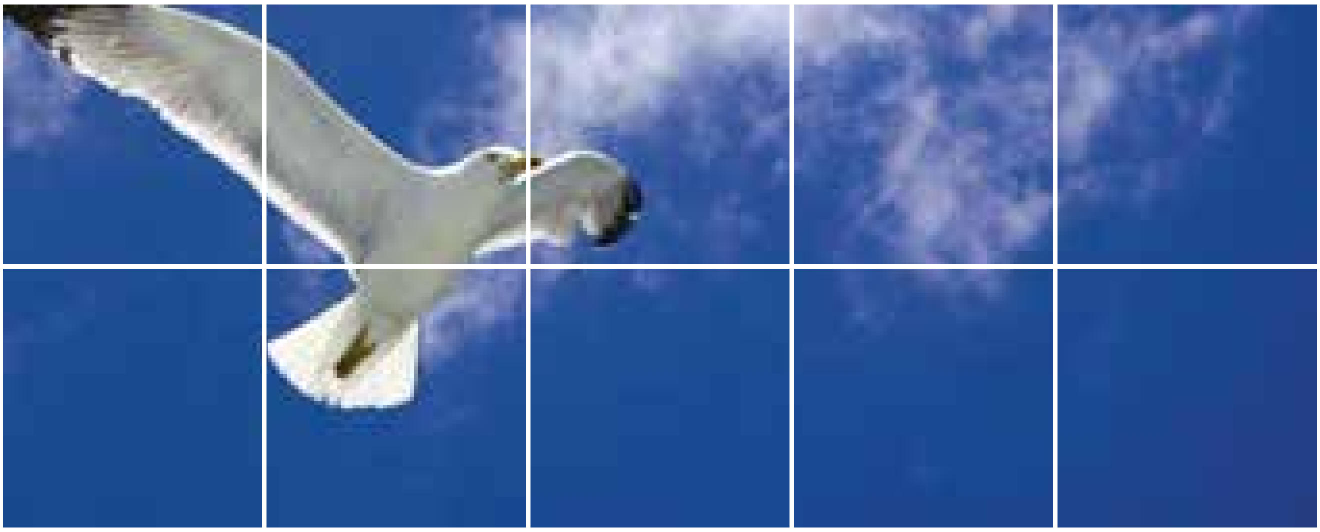
Exposure period start	benzene	toluene	ethyl benzene	m,p -xylene	o-xylene
3-Jan-06	-	-	-	-	-
8-Feb-06	-	-	-	-	-
2-Mar-06	1.0	1.0	0.2	0.5	*< 0.1*
5-Apr-06	0.8	2.8	*< 0.1*	0.3	*< 0.2*
3-May-06	0.7	0.9	*< 0.1*	0.4	*< 0.2*
31-May-06	0.8	1.5	*< 0.1*	0.4	*< 0.2*
29-Jun-06	1.0	0.8	0.3	0.5	*< 0.1*
31-Jul-06	0.9	1.3	0.6	1.0	0.4
31-Aug-06	0.6	1.4	2.1	3.6	1.1
4-Oct-06	1.3	1.4	0.4	0.7	*< 0.2*
1-Nov-06	1.5	1.3	0.4	0.8	0.3
27-Nov-06	0.9	1.1	0.3	0.6	0.2
Average	**1.0**	**1.4**	**0.5**	**0.9**	**0.3**

Tube not changed on 8 Feb.

AEA Energy & Environment
Building 551.11
Harwell Business Centre
Didcot
Oxfordshire
OX11 0QJ

Tel: 0870 190 6518
Fax: 0870 190 6377

AEA Energy & Environment
From the AEA group



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AEA Energy & Environment
Building 551.11
Harwell International Business Centre
Didcot
OX11 0QJ

t: 0870 190 6518
f: 0870 190 6377

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Author	Name	Alison Loader & Brian Stacey
Approved by	Name	Brian Stacey
	Signature	
	Date	24 April 2008

Executive summary

AEA Energy & Environment is undertaking an ongoing programme of air quality monitoring on Jersey, on behalf of the Public Health Services of the States of Jersey. This report presents the results of the 11th consecutive year of monitoring, calendar year 2007 – covered by the monitoring period 3rd January 2007 to 2nd January 2008.

Diffusion tube samplers were used for indicative monitoring of nitrogen dioxide (NO_2) at 24 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 twelve periods approximating to calendar months. The tubes were supplied and analysed by Gradko International Ltd, and changed by Technical Officers of Jersey's Health Protection Section.

The measured annual mean NO_2 concentration at one kerbside site (Weighbridge) in the centre of St Helier exceeded 40 $\mu g\ m^{-3}$. This is set as a Limit Value by EC Directive 1999/30/EEC (to be achieved by 2010), and as an Objective by the UK Air Quality Strategy (to have been achieved by 31st December 2005). However, application of an adjustment factor for known diffusion tube bias reduced the annual mean to 36 $\mu g\ m^{-3}$. Therefore this site has not exceeded the EC Limit Value and AQS Objective.

Annual mean NO_2 concentrations at all other sites were below 40$\mu g\ m^{-3}$ in 2007. In particular, annual mean concentrations at all the urban and residential background sites were well below 40$\mu g\ m^{-3}$ in 2007.

A statistically significant downward trend has been identified, in the average annual mean NO_2 concentrations for all kerbside and roadside sites. This is of particular interest, as it is sites of these types that are currently closest to the Limit Value and AQS Objective of 40$\mu g\ m^{-3}$ for annual mean NO_2 concentration.

Annual mean concentrations of benzene, toluene, ethylbenzene and xylenes were measured at the six hydrocarbon monitoring sites. However, data capture from these sites was adversely affected by a significant number of hydrocarbon diffusion tubes being returned to the analyst with their caps missing, thus invalidating the results.

The highest annual mean benzene concentration of 4.2 $\mu g\ m^{-3}$ 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 2.0$\mu g\ m^{-3}$. All sites therefore met the UK Air Quality Strategy Objective of 16.25 $\mu g\ m^{-3}$ for the running annual mean. All sites also met the EC 2nd Daughter Directive annual mean Limit Value of 5 $\mu g\ m^{-3}$ (which is to be achieved by 2010).