Analysis of the Relationship Between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites

Report by

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On Behalf of

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1 Introduction

1.1 The UK Government and the Devolved Administrations have adopted two Air Quality Objectives for nitrogen dioxide: an annual mean concentration of 40 μg/m^3; and a 1-hour mean concentration of 200 μg/m^3 not to be exceeded more than 18 times per year. The objectives are to be achieved by the end of 2005 and are only applicable at locations where members of the public are likely to be present for the time period of the objective. Relevant locations are different for the two objectives. Guidance to local authorities when carrying out their Review & Assessment of air quality states that the annual mean nitrogen dioxide objective should apply at building facades of residential properties, schools, hospitals, libraries, etc., while the 1-hour objective would also apply at kerbside sites (e.g. pavements of busy shopping streets). The 1-hour objective would thus potentially apply closer to traffic than the annual mean objective, and kerbside monitoring sites1 may be relevant for the assessment.

1.2 It is recognised that the annual mean objective is more likely to be exceeded than the 1-hour objective. Thus the focus of the first round of Review & Assessment was very much on locations where the annual mean objective was likely to be exceeded. The guidance for the second round of Review & Assessment still recognises the importance of the annual mean objective, but also specifically requires local authorities to give consideration to *"busy streets where people may spend 1-hour or more close to traffic."* (Defra 2003). The guidance for the Updating and Screening Assessment for such locations says that local authorities should proceed to a Detailed Assessment where the predicted annual mean is greater than 40 μg/m^3.

1.3 A Detailed Assessment is not straightforward for 1-hour concentrations. By its nature of being made up of short-lived peak values, exceedences of the 1-hour objective will be very variable from year to year and site to site. Models are inevitably poorer at predicting such events than they are at predicting annual mean concentrations. It is for this reason that the latest version of the Design Manual for Roads and Bridges (Highways Agency, 2003) does not include any calculation of the number of 1-hour exceedences of the 200 μg/m^3 objective level. If monitoring is to be relied upon, then it has to be over an extended period to ensure that the occurrence of occasional peaks has been adequately captured. This makes the detailed assessment against the 1-hour objective in busy streets difficult to carry out.

[1] Kerbside sites are 0-1m from the kerb.

1.4 To provide further guidance to local authorities, a detailed study has been carried out of the occurrence of 1-hour concentrations above the objective level of 200 μg/m^3. The aim has been to analyse the available monitoring data to:

- identify the frequency with which exceedences of the objective occur;
- identify the types of locations where exceedences of the objective occur;
- define the relationship between exceedences of the 1-hour objective and the annual mean concentrations, so as to see whether there might be a basis for using annual mean values as a surrogate for the likelihood of exceeding the objective.

1.5 The study is confined to data from roadside/kerbside monitoring sites, as these sites are the focus of the Review & Assessment guidance in relation to the risk of exceeding the 1-hour objective due to traffic sources. It is recognised that occasional widespread exceedences of the 1-hour objective can occur more widely, including at urban background sites, in major conurbations. One such episode was in London in December 1991, with a more recent one being experienced in Manchester in December 2001 (see Air Quality Expert Group, 2003). Such exceedences are infrequent and essentially impossible to predict. They will be minimised by national measures to reduce annual mean concentrations across urban areas. They are not considered further in this report, except in an introductory context.

2 Data Collection

2.1 Real-time chemiluminesence data, with 1-hour temporal resolution, has been collected across the UK for over two decades. During this time, the number of operational sites has risen steadily, with a period of particularly rapid increase during the mid-1990s. Table 1 summarises the data collected between 1980 and 2001 by a number of monitoring networks (e.g. the Automatic Urban and Rural Network and the London Air Quality Network) as well as some privately owned monitors (e.g. those operated by PowerGen). The roadside and kerbside sites that form the basis of this study are set out in Appendix A.

2.2 The 1-hour objective for nitrogen dioxide is no more than 18 exceedences of 200 $\mu g/m^3$ over a full year. A valid comparison of monitoring data against this criterion requires more than 90% data capture (LAQM TG(03)). For the purpose of this study a site with more than 18 hours above 200 $\mu g/m^3$ is counted as showing an exceedence regardless of the data capture. Other sites are only considered in the analysis if they meet the 90% data capture criteria.

3 Data Analysis

The frequency of 1-Hour Exceedences

3.1 Table 1 provides a summary of the data collected between 1980 and 2001 inclusive. The data have been divided into those from roadside and kerbside sites and those from the other, mostly urban background, sites. These data show that since 1997, the majority of exceedences of the 1-hour objective level have been at roadside/kerbside sites.

3.2 There are only two roadside/kerbside monitors that have experienced exceedences of the 18-hour criterion year after year, Redbridge and Marylebone Road, both in London. Redbridge is an exceptional site located on an island in the centre of the road, close to slow moving traffic, a high proportion of which is buses. This site does not represent relevant exposure[2]. Table 2 shows that in the period 1996 to 2001 only 25% of all roadside and kerbside sites reported one or more exceedence of the 18-hour criterion. The names of these sites are provided in Table 3, with the raw data set out in Table A1 in Appendix A. The converse of this is that three-quarters of

[2] Further details of the exceptional nature of this site are provided in AQEG, 2003.

roadside/kerbside sites have not reported any exceedences of the 18-hour criterion between 1996 and 2001. These sites are listed in Table A2 in Appendix A.

3.3 Exceedences of the 18-hour criterion are generally confined to locations within or close to Greater London. Two of the remaining three locations are all within urban areas, while the third is a site close to the hard shoulder of the M4 motorway. The many roadside/kerbside locations that have not reported any exceedences of the 18-hour criterion are detailed in Table A2 in Appendix A. They include sites in Greater London, as well as urban area spread widely across the country.

Table 1 The Number of Sites Recording > 18 Exceedences of 200 μg/m^3 Nitrogen Dioxide as a 1-Hour Mean, 1980-2001.

	All sites		**Non-Roadside or Kerbside Sites**		**Roadside and Kerbside Sites**	
Year	Total no. sites	No. sites > 18 hours >200 μg/m^3	Total no. sites	No. sites > 18 hours >200 μg/m^3	Total no. sites	No. sites > 18 hours >200 μg/m^3
1980	1	0	1	0	0	0
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	1	1	1	1	0	0
1984	1	1	1	1	0	0
1986	0	0	0	0	0	0
1987	3	3	3	3	0	0
1988	5	3	5	3	0	0
1989	7	4	6	3	1	1
1990	6	3	5	2	1	1
1991	9	4	8	3	1	1
1992	10	5	9	4	1	1
1993	15	4	14	3	1	1
1994	22	5	21	4	1	1
1995	21	5	20	4	1	1
1996	34	4	32	4	2	0
1997	59	16	45	10	14	6
1998	84	5	60	0	24	5
1999	94	5	66	1	28	4
2000	126	6	84	0	42	6
2001	157	12	102	5	55	7

See Para 2.2 for data capture criteria applied to the data.

Table 2 The Number of Individual Sites Recording > 18 Exceedences of 200 μg/m^3 Nitrogen Dioxide as a 1-Hour Mean, in Two Time Periods.

	All sites			Roadside and Kerbside Sites		
Time period[a]	Total No. indiv. sites	No. indiv. sites with ≥ 1 yr with > 18 hours > 200 μg/m^3	% of sites with ≥ 1 yr with > 18 hours > 200 μg/m^3	Total No. indiv. sites	No. indiv. sites with ≥ 1 yr with > 18 hours > 200 μg/m^3	% of sites with ≥ 1 yr with > 18 hours > 200 μg/m^3
1990-1995	29	12	**41**	1	1	**100**
1996-2001	202	34	**17**	68	17[b]	**25**

[a]Inclusive
[b]These sites are listed in Table 3

Table 3 Roadside and Kerbside Sites Recording > 18 hours > 200 μg/m^3 Between 1996 and 2001, and the Relative Frequency of These Exceedences

Site Name	Type	Frequency[a]
Sites Within Greater London		
London Marylebone Road	Kerbside	4/4
Redbridge 3 - Fullwell Cross	Roadside	2/2
Redbridge 2 - Ilford Broadway	Roadside	2/2
Brent - Ikea	Roadside	1/1
Bromley 4 -Town Centre Tweedy Rd	Roadside	1/1
Hammersmith Broadway	Roadside	2/3
Kens and Chelsea - Knightsbridge	Kerbside	2/3
Tower Hamlets Roadside	Roadside	1/4
Haringey Roadside	Roadside	1/4
Camden Kerbside	Kerbside	1/5
Ealing 2 - Acton Town Hall	Roadside	1/5
Croydon 2 - Purley Way , 5 Ways	Roadside	1/6
Sites Close to Greater London		
Dartford Roadside - St Clements	Kerbside	3/3
Watford Roadside	Roadside	1/5
Sites Elsewhere in the Country		
Glasgow Kerbside	Kerbside	3/4
Lincoln Roadside	Roadside	1/2
M4, near Reading	Rural kerbside	1/3

[a]The number of years with > 18 hours > 200μg/m^3, over the total number of years data provided by that site. The data capture criteria applied are set out in paragraph 2.2.

Table 4 The Proportion of Roadside and Kerbside Sites Recording > 18 hours > 200 μg/m^3 Between 1996 and 2001, Divided by Geographical Area

	Total Number of Sites	Site with at least one exceedence of the 18-Hour Criterion	% of Sites Exceeding the 18-Hour Criterion
Sites Within Greater London	39	12	31
Sites Close to Greater London	3	2	67
Sites Elsewhere in the Country	26	3	12
Sum	68	17	25

Relationships Between the 1-Hour and Annual Mean Data

3.4 Figure 1 shows the number of hours per year with a concentration greater than 200 μg/m^3 as a function of the annual mean concentration for all roadside/kerbside sites from Table 1, for the full period 1980-2001. Figure 2 shows the same analysis for data collected in the more recent period 1996-2001[3]. The data for Redbridge 2 have not been included in these plots because of the exceptional nature of this site, which does not represent relevant exposure. Redbridge 2 data are included in Table A1 and also in Table 5 and Figure 3 below.

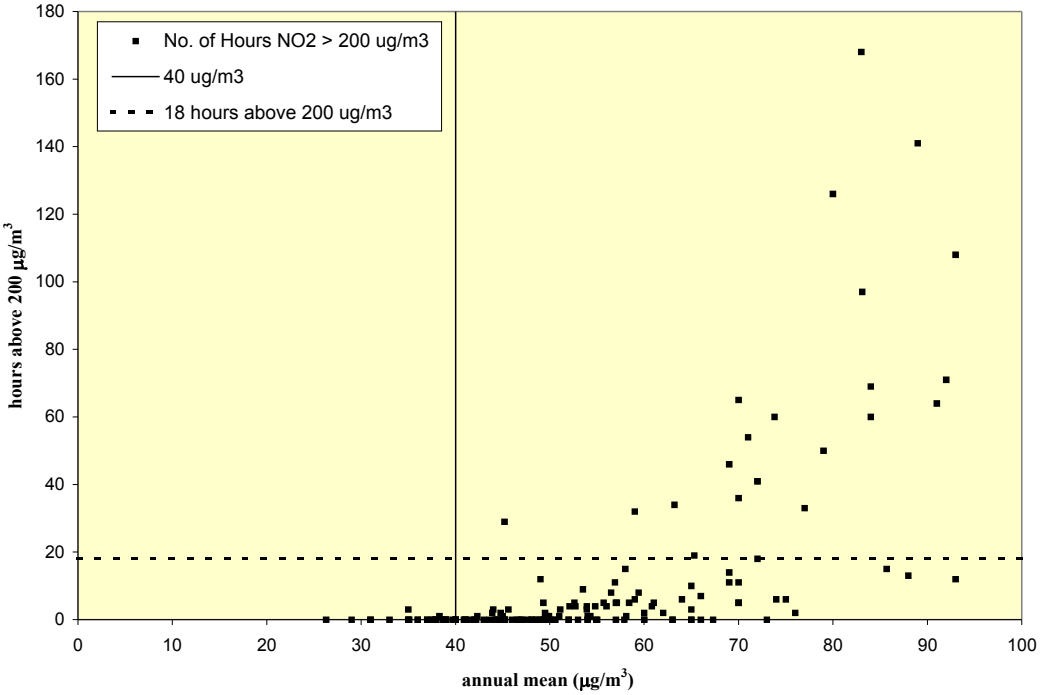
3.5 Figures 1 and 2 both show a general trend for the number of hours > 200 μg/m^3 to increase as the annual mean concentration increases. This trend is statistically significant in both data sets although there is still a large scatter. There is little apparent difference between the two periods, although it is evident that sites with more than 100 hours above 200 μg/m^3 were largely absent during the more recent period (cf Figure 2 with Figure 1). It is also evident that there were no exceedences of the 18-hour criterion when the annual mean was less than 40 μg/m^3. Moreover, since 1980 there has been just one exceedence of the 18-hour criterion when the annual mean was less than 50 μg/m^3 [4].

3.6 A more detailed analysis of the full data set has been carried out and the findings are presented in Appendix B, Figures B1-B10. This has involved examining the data for the following sets of conditions:

[3] The data for Redbridge 2 have not been included in these plots because of the exceptional nature of this site, which does not represent relevant exposure. Redbridge 2 data are included in Table A1 and also in the analysis carried out in Table 5 and Figure 3.

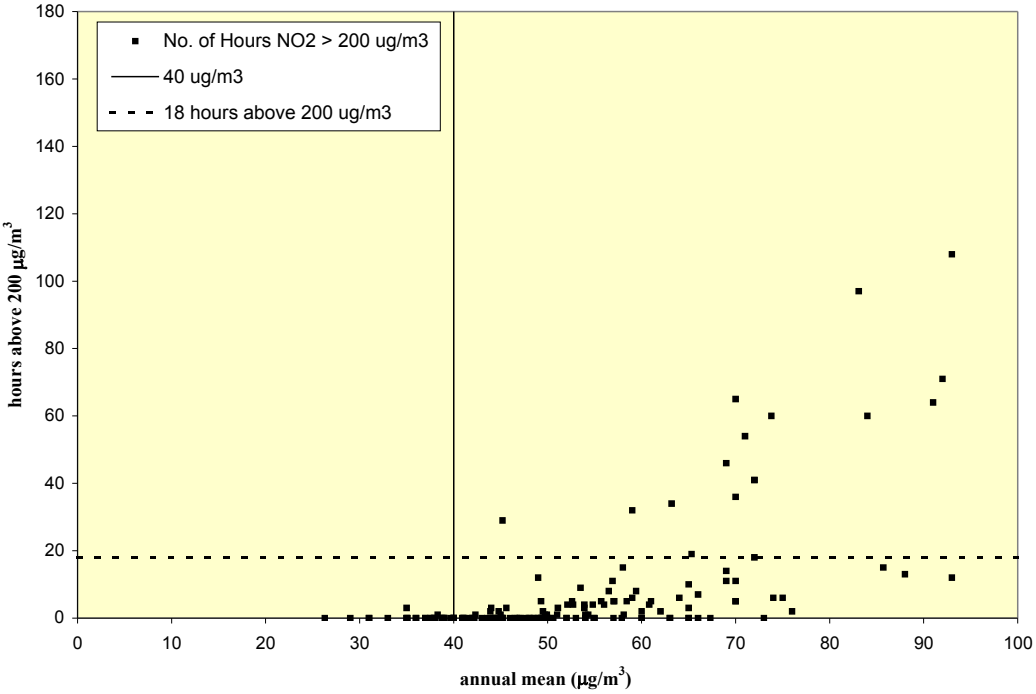
[4] There were, however, a number of exceedences of the 18-hour criterion corresponding with annual mean concentrations < 50 μg/m^3 at background sites. These are not included in this analysis for reasons given earlier.

Figure 1 Number of Hours per Year With > 200 μg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Roadside/Kerbside Sites, 1980-2001*.



* Only sites and years with > 90 % data capture have been included[3].

Figure 2 Number of Hours per Year With > 200 μg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Roadside/Kerbside Sites, 1996-2001*.



* Only sites and years with > 90 % data capture have been included[3].

1. Roadside sites (Figure B1) and kerbside sites (Figure B2)
2. Combined Roadside/Kerbside sites categorised by the nature of the site: sites with confined settings (Figure B3), sites with open settings (Figure B4), sites with intermediate settings (Figure B5), and finally sites that could not be characterised (Figure B6).
3. Sites with confined settings shown separately for kerbside sites (Figure B7) and roadside sites (Figure B8)
4. Sites with open settings shown separately for kerbside sites (Figure B9) and roadside sites (Figure B10)

This analysis shows that:

- exceedences occur at both kerbside and roadside sites,
- exceedences occur at all three site types – confined, open and intermediate.
- for kerbside sites all annual mean values above 68 μg/m^3, with one exception,[5] are associated with exceedences of the objective.
- kerbside sites experienced considerably more exceedences than roadside sites.

Owing to the different distributions of the data at roadside and kerbside sites, it is considered appropriate to analyse these data separately.

3.7 The range of annual mean concentrations measured has been divided into discrete bands. These bands are set out in Table 5 and were chosen to have a minimum of 5 data points in each. For each site type, Table 5 shows how many individual site-years fell into each band. It also shows for each band: the mean of all annual mean concentrations, the number of exceedences of the 18-hour criterion, and this latter figure as a percentage of the total number of site-years in the band. This final % value is thus the relative frequency of an exceedence for each annual mean concentration band.

3.8 Table 5 shows that all kerbside site-years with an annual mean in excess of 75 μg/m^3 reported an exceedence of the 18-hour criterion. Just over half of kerbside site-years with an annual mean between 65 and 75 μg/m^3 reported an exceedence. No kerbside site-years with an annual mean less than 65 μg/m^3 reported an exceedence. The pattern shown in Table 5 for roadside sites is very different to this. Only 38% of roadside site-years with an annual mean concentration between 70 and 75 μg/m^3 reported an exceedence and as the annual mean concentration increased above 75

[5] An annual mean concentration of 72 μg/m^3 gave 18 hours above 200 μg/m^3 at Marylebone Road in 2000.

$\mu g/m^3$, the number of exceedences fell. This fall probably reflects the relatively limited number of available data and is unlikely to be a causal relationship.

3.9 The frequency with which the 18-hour criterion has been exceeded in the past is considered to provide the best estimate of the probability of its exceedence in the future. In the following discussion, frequency is therefore used as a surrogate for probability. Figures 3 and 4 show the % frequency data from Table 5 plotted as a function of the mean annual mean concentration, for kerbside and roadside sites respectively. The % frequency of an exceedence is shown on the left-hand axis of these figures. On the right hand axis, descriptors of the likelihood of an exceedence have been plotted. These descriptors are directly related to the % chance (frequency) of an exceedence and are those used by netcen (e.g. 2000) and by Defra (2003).

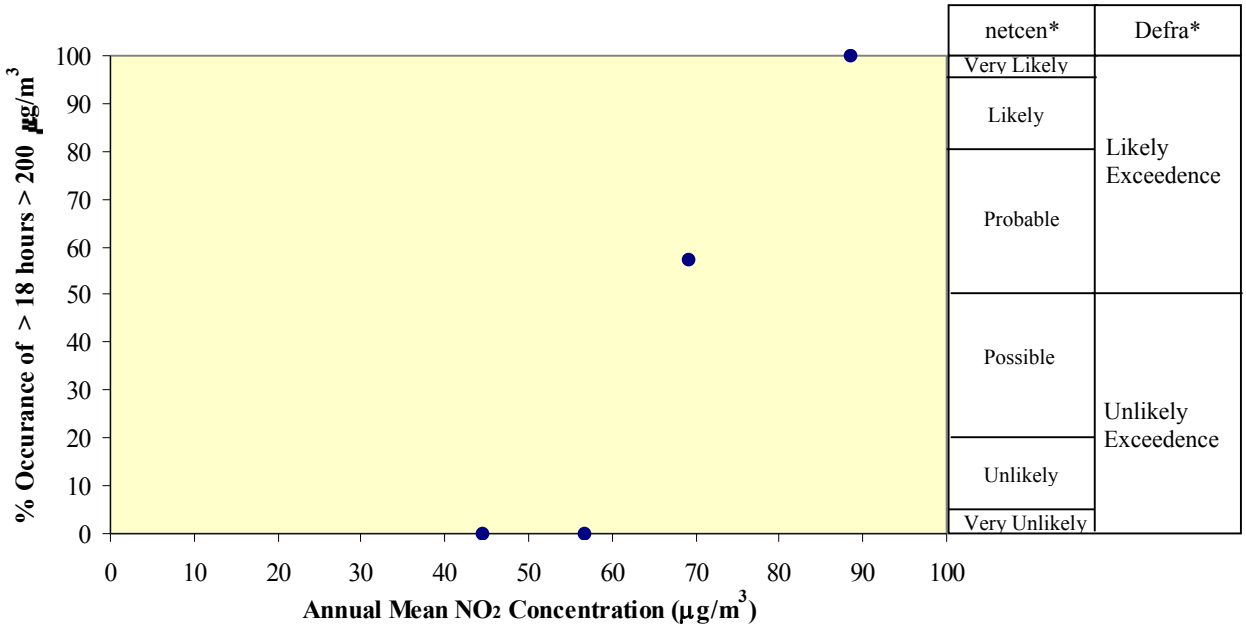
Table 5 The Number of Exceedences of the 18-Hour Criterion as a Function of the Annual Mean Nitrogen Dioxide Concentration.

Annual Mean Band ($\mu g/m^3$)	Number of Site-Years* Within band	Mean Annual Mean concentration ($\mu g/m^3$)	Site-Years* with >18 hours > 200 $\mu g/m^3$	% Of Site-Years* with >18 hours > 200 $\mu g/m^3$
Kerbside Sites				
>75	5	89	5	**100**
65-75	7	69	4	**57**
50-65	7	57	0	**0**
<50	5	45	0	**0**
Roadside Sites				
>75	6	90	1	**17**
70-75	8	72	3	**38**
65-70	8	66	1	**13**
60-65	8	61	1	**13**
55-60	14	57	1	**7**
50-55	16	53	0	**0**
45-50	25	48	1	**4**
40-45	21	42	0	**0**
>40	24	36	0	**0**

* Each site is counted repeatedly for each year that it was operational

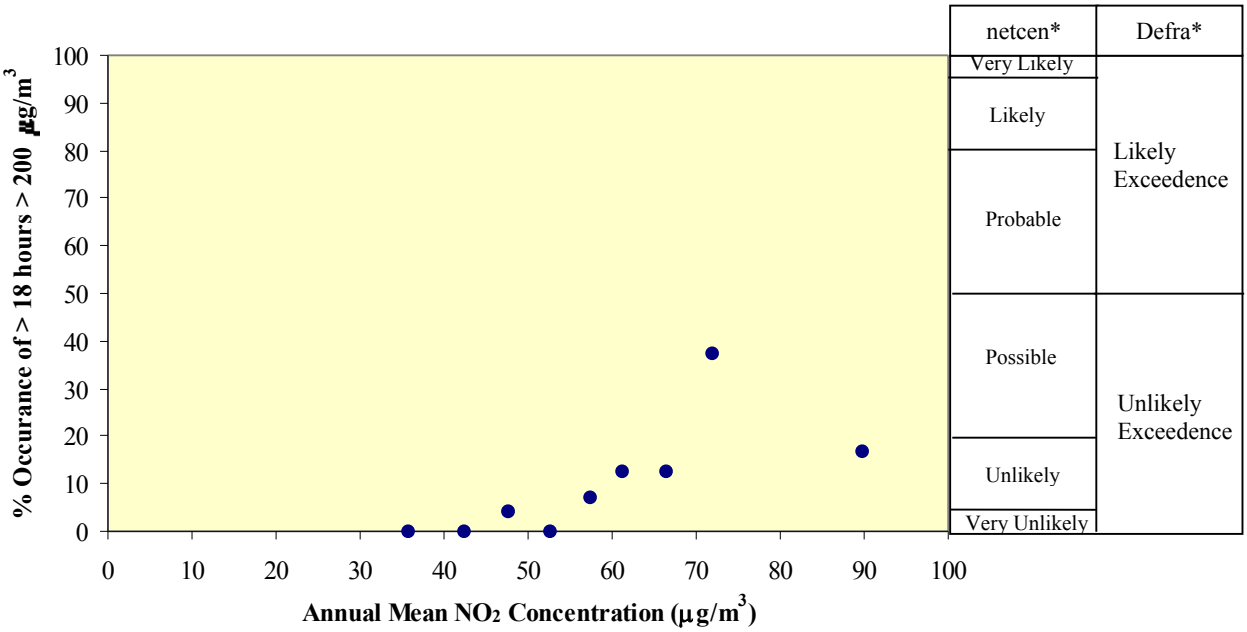
3.10 Figure 3 indicates that in order for an exceedence of the 1-hour Objective to be probable or likely at a kerbside location, the annual mean concentration must exceed 65 $\mu g/m^3$. Although the pattern shown by the roadside sites in Figure 4 is apparently very different from that in Figure 3, in practice what is shown is rather similar. At annual mean concentrations smaller than 65 $\mu g/m^3$ an exceedence of the 1-hour Objective is unlikely according to both sets of descriptors.

Figure 3 The Percentage Frequency of Exceedence of the 18-hour Criterion vs the Annual Mean Concentration at Kerbside Sites, 1996-2001[$].



[$] Only sites and years with > 90 % data capture have been included[3].
* Likelihood of an exceedence based on the descriptive terminology used by netcen (2000) and Defra (2003).

Figure 4 The Percentage Frequency of Exceedence of the 18-hour Criterion vs the Annual Mean Concentration at Roadside Sites, 1996-2001[$].



[$] Only sites and years with > 90 % data capture have been included[3].
* Likelihood of an exceedence based on the descriptive terminology used by netcen (2000) and Defra (2003).

4 Suggested Advice to Local Authorities

4.1 The stated aim of Review & Assessment is to "identify with **reasonable certainty** whether or not a **likely** exceedence will occur" (emphasis in original)(Defra, 2003). Likely is taken to be a 50% chance of the exceedence occurring. On the basis of the assessment set out above of monitoring data from sites throughout the UK, it is judged that an exceedence of the 1-hour objective is unlikely if the annual mean concentration is less than 65 μg/m^3. This value is applicable to both roadside and kerbside locations.

4.2 Given the difficulty of measuring exceedences of the 1-hour objective at roadside and kerbside locations[6] and of modelling peak 1-hour concentrations, it is suggested that **it would be appropriate for local authorities to base the decision of a likely exceedence of the 1-hour nitrogen dioxide objective on an exceedence of 60 μg/m^3 as an annual mean.** This is slightly more conservative than the value derived from the UK data, but is considered reasonable for a surrogate measure that would be suitable for use in a Detailed Assessment.

[6] As 1-hour exceedences occur infrequently, monitoring would have to be over a long period, potentially more than one year.

5 Conclusions

5.1 An analysis has been carried out of a large number of historic 1-hour and annual mean nitrogen dioxide data from roadside and kerbside automatic monitoring sites spread across the UK. The data show that three quarters of roadside and kerbside automatic monitoring sites in the UK did not record any exceedences of the 1-hour Objective value (i.e. >18-hours > 200 μg/m^3 in a calendar year) between 1996 and 2001. Of those roadside and kerbside sites that did experience such an exceedence, the vast majority were within, or close to Greater London.

5.2 Exceedences of the 1-hour objective have been found to occur at both kerbside and roadside sites, although the exceedences are significantly more frequent at the kerbside sites than the roadside sites. Exceedences have also been found at all the three categories of site-type defined for the analysis – confined, open and intermediate.

5.3 The results have been analysed separately for kerbside and roadside sites to determine the likelihood of an exceedence of the 1-hour objective as a function of the annual mean concentration. This has shown that a likely exceedence of the 1-hour objective can occur at a kerbside site when the annual mean concentration is above 65 μg/m^3.

5.4 In light of the analysis presented in this report, **it is suggested that local authorities could reliably base decisions on likely exceedences of the 1-hour objective for nitrogen dioxide alongside busy streets using an annual mean of 60 μg/m^3 and above**. It would clearly be sensible to re-evaluate the monitoring data from time to time to confirm that this remains appropriate advice.

Appendix A

Table A1 Roadside and Kerbside Site-Years With > 18 Exceedences of 200 μg/m^3 Nitrogen Dioxide as a 1-Hour Mean Within a Year Between 1996 and 2001

Year	Site Name	Site Type	No. of Hours > 200 μg/m^3 NO_2	Annual Mean NO_2 (μg/m^3)
2000	Redbridge 2 - Ilford Broadway	Roadside	849	121.4
2001	Redbridge 2 - Ilford Broadway	Roadside	826	(119.5)
1991	London Cromwell Road	Kerbside	168	83
1989	London Cromwell Road	Kerbside	142	(87.0)
1995	London Cromwell Road	Kerbside	141	89
1990	London Cromwell Road	Kerbside	126	80
2000	London Marylebone Road	Kerbside	108	93
2001	Kens and Chelsea - Knightsbridge	Kerbside	97	83.1
1998	M4	Rural kerbside	79	(49.1)
1998	London Marylebone Road	Kerbside	71	92
1994	London Cromwell Road	Kerbside	69	84
1998	Glasgow Kerbside	Kerbside	65	70
1999	London Marylebone Road	Kerbside	64	91
2000	Redbridge 3 - Fullwell Cross	Roadside	60	73.8
2001	London Marylebone Road	Kerbside	60	84
2001	Glasgow Kerbside	Kerbside	54	71
2000	Kens and Chelsea - Knightsbridge	Kerbside	52	((74.9))
1992	London Cromwell Road	Kerbside	50	79
2000	Dartford Roadside - St Clements	Kerbside	47	(65.2)
1999	Glasgow Kerbside	Kerbside	46	69
1997	Tower Hamlets Roadside	Roadside	41	72
1998	Lincoln Roadside	Roadside	41	72
1997	Camden Kerbside	Kerbside	36	70
1997	Ealing 2 - Acton Town Hall	Roadside	34	63.2
1993	London Cromwell Road	Kerbside	33	77
1998	Bromley 4 -Town Centre Tweedy Rd	Roadside	33	((45.3))
1997	Haringey Roadside	Roadside	32	59
1997	Croydon 2 - Purley Way , 5 Ways	Roadside	29	45.2
1999	Hammersmith Broadway	Roadside	27	((92.6))
1999	Dartford Roadside - St Clements	Kerbside	26	((65.1))
2001	Dartford Roadside - St Clements	Kerbside	25	(61.9)
2001	Brent - Ikea	Roadside	24	((65.3))
1997	Watford Roadside	Roadside	22	((50.7))
2000	Hammersmith Broadway	Roadside	20	(72.3)
2001	Redbridge 3 - Fullwell Cross	Roadside	19	65.3

Single brackets around the annual mean concentration indicates data capture between 75 and 90 %. Double brackets indicates data capture < 75%. Annual mean concentrations not shown in brackets represent > 90% data capture. These data capture criteria are different from the more rigorous criteria used elsewhere in the report.

Table A2 Roadside and Kerbside Sites With No Recorded Incidences of > 18 hours > 200 μg/m^3 Between 1996 and 2001

Site Name	Site type	Min annual mean (μg/m^3)	Max annual mean (μg/m^3)	No. years	No. years with > 90 % data capture
A2 Falconwood	Roadside	((42))	50.5	2	1
Baldock (RS)	Roadside	((39.7))	(40.7)	2	0
Barnet - Tally Ho Corner	Kerbside	52.7	((57.5))	3	2
Bath Roadside	Roadside	(55)	(63)	5	1
Bexley 4 - Erith	Roadside	((36.2))	((36.2))	1	0
Biggleswade (RS)	Roadside	((40.7))	((40.7))	1	0
Brighton Roadside	Roadside	36	36	1	1
Broxbourne Roadside	Roadside	((49.8))	((49.8))	1	0
Bury Roadside	Roadside	69	74	4	4
Cambridge Gonville Place	Roadside	35	37	3	3
Cambridge Parker Street	Roadside	42	49	3	3
Cambridge Roadside	Roadside	40	41	2	2
Cambridge Silver Street	Roadside	(40)	(47)	3	1
Camden - Shaftesbury Avenue	Roadside	((70.3))	75	2	1
Canterbury Roadside - St. Dunstans	Roadside	((25))	(31)	3	1
Chatham Roadside - A2	Roadside	37.5	(39.6)	5	4
Croydon 4 - George Street	Roadside	52	((58.1))	3	1
Croydon 5 - Norbury	Roadside	((60.1))	(68.6)	2	0
Crystal Palace	Roadside	47	51	3	2
Dover Roadside - Town Hall	Roadside	38.7	((51.7))	5	4
Dumfries	Roadside	(38)	(38)	1	0
E. Herts Roadside (Sawbridgeworth)	Roadside	((44))	((44))	1	0
Ealing Mobile - A40 East Acton	Roadside	((54))	((54))	1	0
Ealing Mobile - Hamilton Rd, UB1	Roadside	((59))	((59))	1	0
Ealing Mobile - Southall	Roadside	(54)	(65)	3	0
Enfield 2 - Church Street	Roadside	42	45	4	4
Enfield 4 - Derby Road, Upper Edmonton	Roadside	50	50	2	1
Exeter Roadside	Roadside	38	45	5	5
Gravesham Roadside - A2	Roadside	(51)	61	3	1
Greenwich 5 - Trafalgar Road	Roadside	49	55	3	2
Haringey 3 - Bounds Green	Roadside	50	((60.5))	3	1
Havering 1 - Rainham, A1306	Roadside	(40)	(58)	6	2
Havering 3 - Romford	Roadside	41	44	3	3
Hillingdon - South Ruislip	Roadside	44	((47))	3	2
Hounslow 4 - Chiswick High Rd	Roadside	(54)	56	3	1
Hounslow Roadside	Roadside	52	(72)	4	3
Hove Roadside	Roadside	35	39	3	2
Islington - Holloway Road	Roadside	((65))	67	2	1
Kingston 2 - Town Centre	Roadside	((45))	57	5	3
Lambeth - Christchurch Road	Roadside	58	((61))	2	1
London A3 Roadside	Roadside	54	59	4	4
London Bromley	Roadside	(61)	65	3	1
London Cromwell Road 2	Roadside	76	93	3	3
M25	Rural kerbside	(39)	57	6	4
M4	Rural kerbside	44	((57))	5	2
M60	Suburban roadside	38	(44)	3	1
Maidstone Roadside - Fairmeadow	Kerbside	49	59	3	2
N. Herts Roadside (Baldock)	Roadside	((32))	((40))	2	0
Newham Cam Road	Roadside	52	(56)	3	2
Norwich Roadside	Roadside	29	33	4	3
Oxford Centre	Roadside	56	60	3	3
Redbridge 4 - Gardner Close	Roadside	48	49	2	2
Richmond - Castlenau	Roadside	((37))	42	2	1
Richmond Mobile 3	Roadside	((41))	((61))	3	0
Richmond Mobile 4	Roadside	((36))	((59))	3	0
Richmond Mobile 5	Roadside	((45))	((45))	1	0
Richmond Mobile 6	Roadside	((51))	((51))	1	0
Salford M60	Roadside	58	58	2	1
Southwark Roadside	Roadside	63	65	2	2
Stert St, (Abingdon)	Roadside	(45)	(45)	1	0
Stockton-on-Tees Yarm	Roadside	40	40	1	1
Sutton Roadside	Roadside	(40)	49	5	4
Tonbridge Roadside - Town Centre	Roadside	48	58	5	4
Tower Hamlets Roadside	Roadside	65	70	4	3
Wandsworth 1 - Garett Lane	Roadside	((49))	((49))	1	0
Wandsworth 4 - High Street	Roadside	47	53	4	2
Watford Roadside	Roadside	40	47	4	4
York Clifton Moor	Roadside	(30)	(30)	1	0
York Fishergate	Roadside	31	35	3	2
York Rawcliffe	Roadside	37	37	1	1

Single brackets around the annual mean concentration indicates data capture between 75 and 90 %. Double brackets indicates data capture < 75%. Annual mean concentrations not shown in brackets represent > 90% data capture. These data capture criteria are different from the more rigorous criteria used elsewhere in the report.

Appendix B

Sites have been classified as either roadside or kerbside. This classification is based on the distance from the monitor to the road and was performed by the site operators. Figures B1 and B2 show the relationship between the annual mean NO_2 concentration and the number of exceedences of the 18-hour criterion at roadside and kerbside sites separately.

Sites have also been classified into three categories according to the characteristics of their surrounding environment. These categories are: **confined**, i.e. surrounded by buildings; **open**, i.e. are not confined by large local obstacles; and **intermediate**, i.e. there are buildings nearby, but at a sufficient distance to not confine the monitor. This classification is based on an analysis of published site photographs and on advice taken from people with first-hand knowledge. Figures B3 to B10 show the relationship between the annual mean NO_2 concentration and the number of exceedences of the 18-hour criterion for each category and combination of categories. A small number of sites have not been classified because information was not readily available. The data from these sites are presented in Figure B6

In all of the following figures, site-years with less than 90% data capture have been omitted.

Figure B1 Number of Hours per Year With > 200 µg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Roadside Sites, 1996-2001.

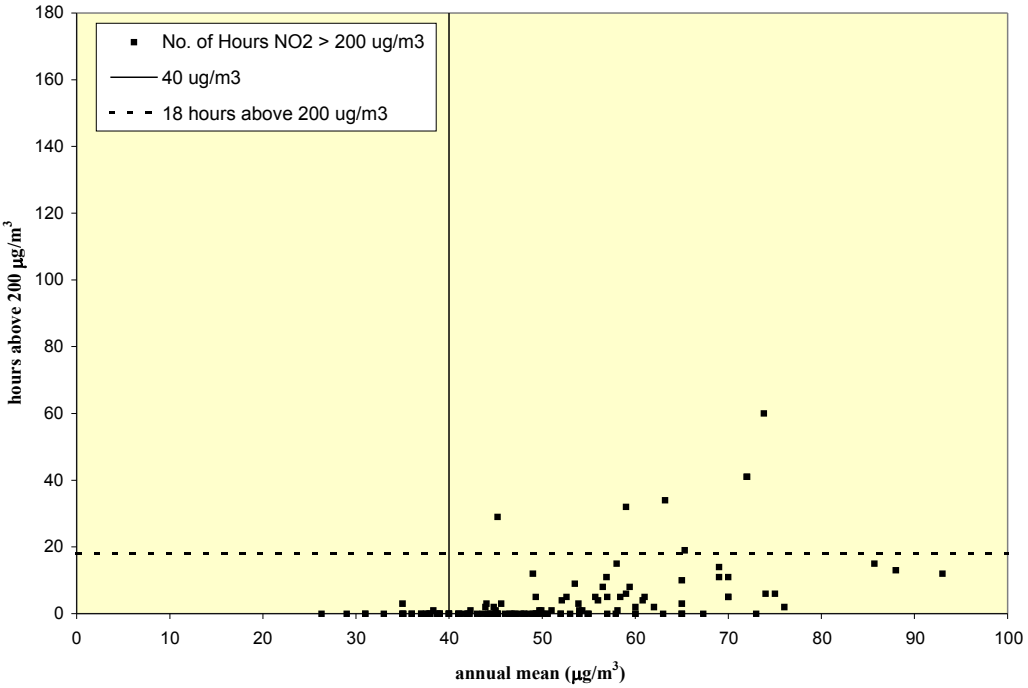


Figure B2 Number of Hours per Year With > 200 µg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Kerbside Sites, 1996-2001.

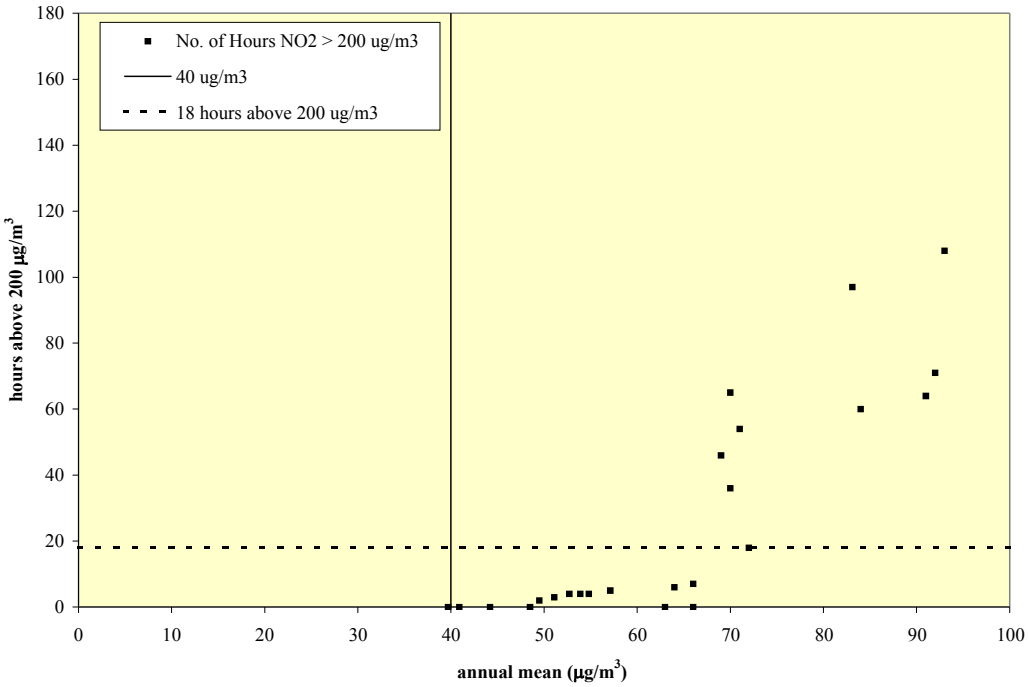


Figure B3 Number of Hours per Year With > 200 μg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Roadside and Kerbside Sites in Confined Locations, 1996-2001.

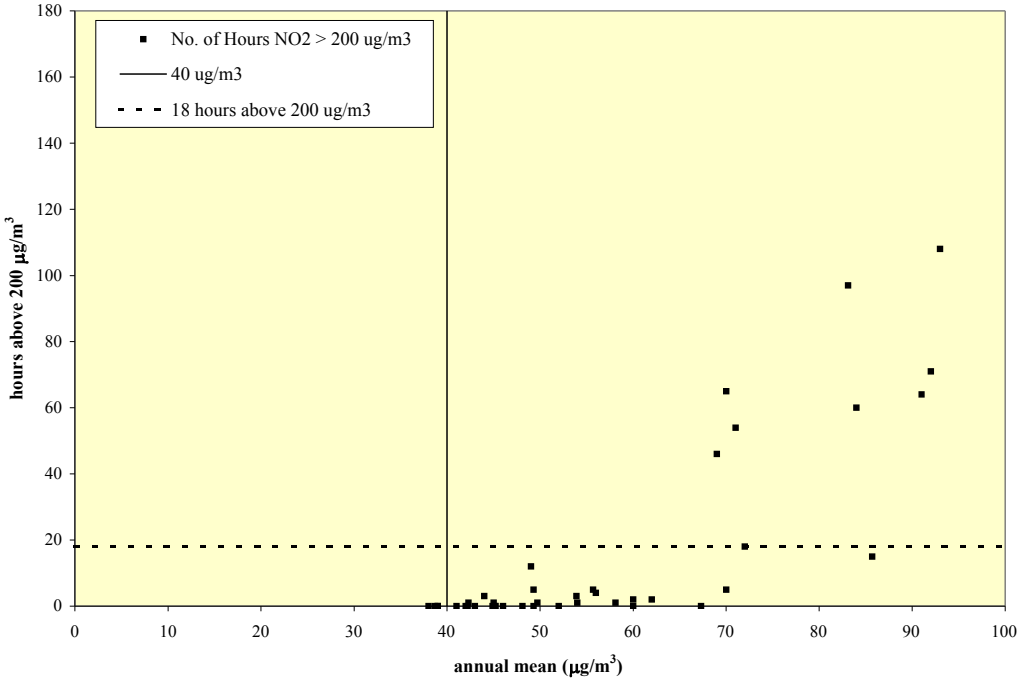


Figure B4 Number of Hours per Year With > 200 μg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Roadside and Kerbside Sites in Open Locations, 1996-2001.

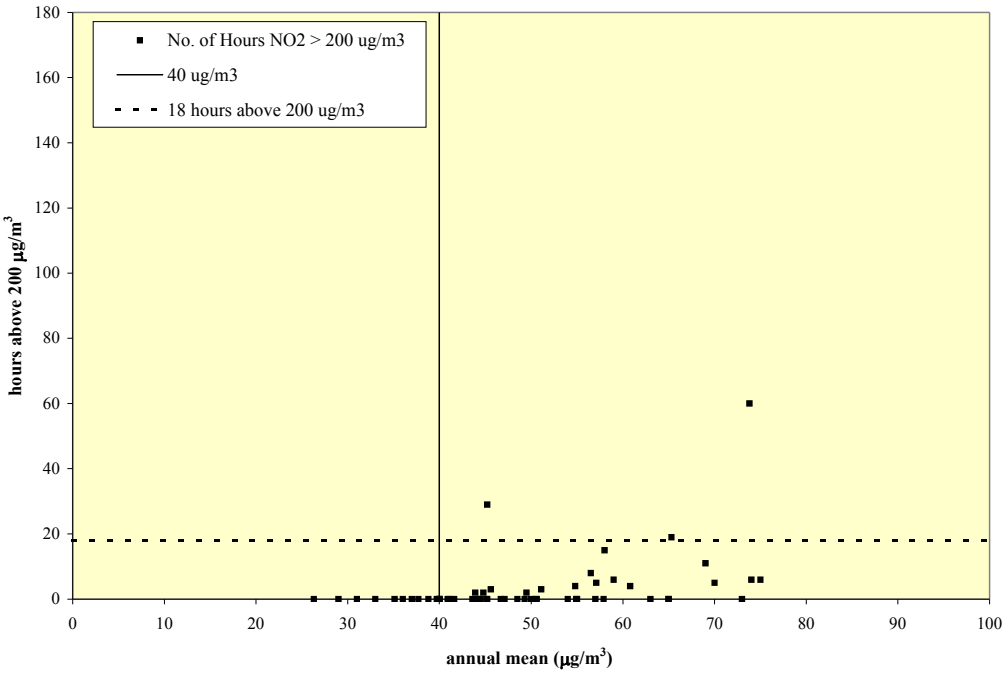


Figure B5 Number of Hours per Year With > 200 μg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Roadside and Kerbside Sites in Intermediate Locations, 1996-2001.

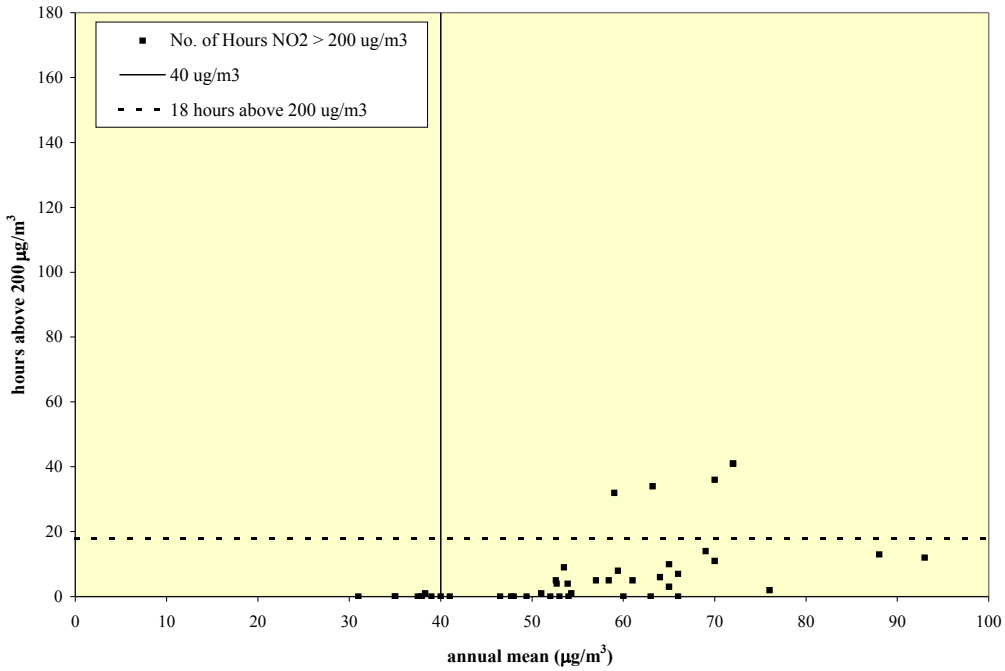
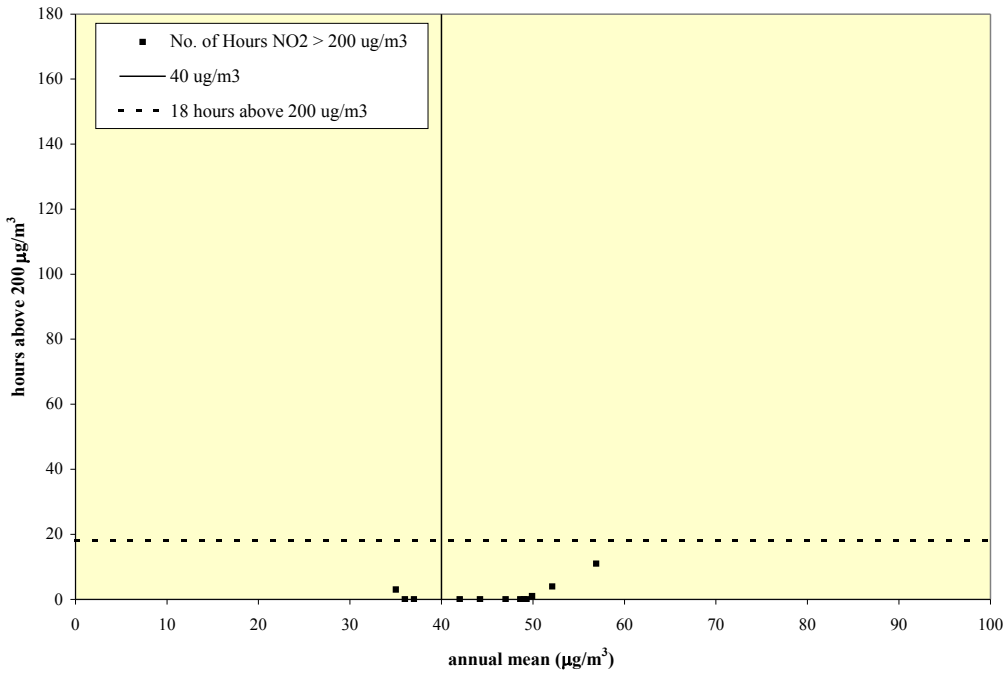


Figure B6 Number of Hours per Year With > 200 μg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Roadside and Kerbside Sites in Uncategorised Locations, 1996-2001*.



* Redbridge-2 has been excluded, see paragraph 3.4.

Figure B7 Number of Hours per Year With > 200 µg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Kerbside Sites in Confined Locations, 1996-2001.

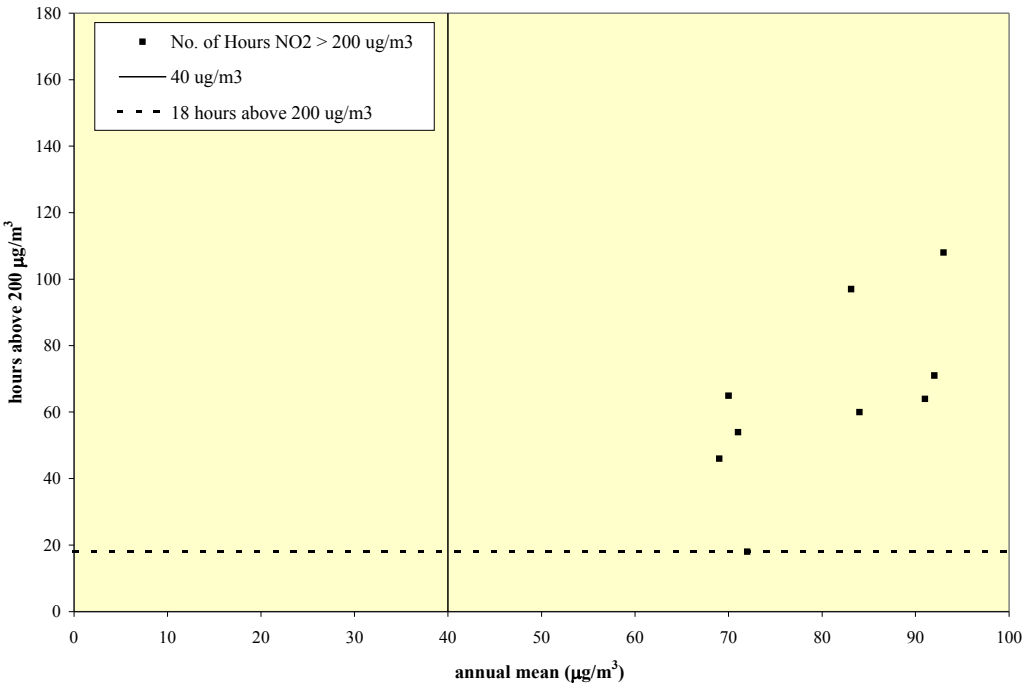


Figure B8 Number of Hours per Year With > 200 µg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Roadside Sites in Confined Locations, 1996-2001.

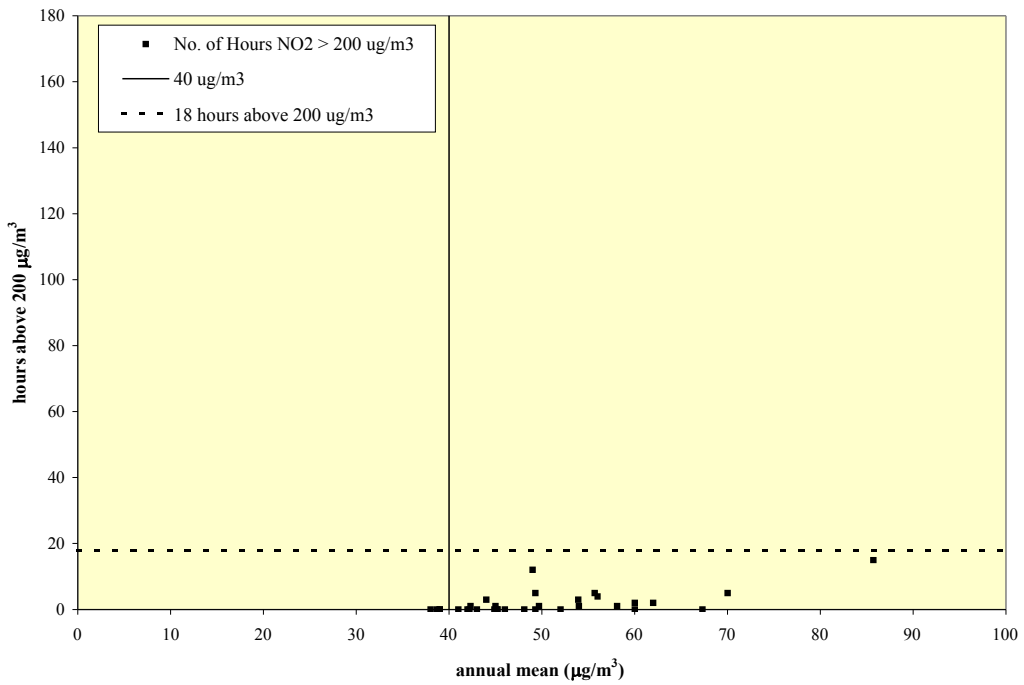


Figure B9 Number of Hours per Year With > 200 μg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Kerbside Sites in Open Locations, 1996-2001.

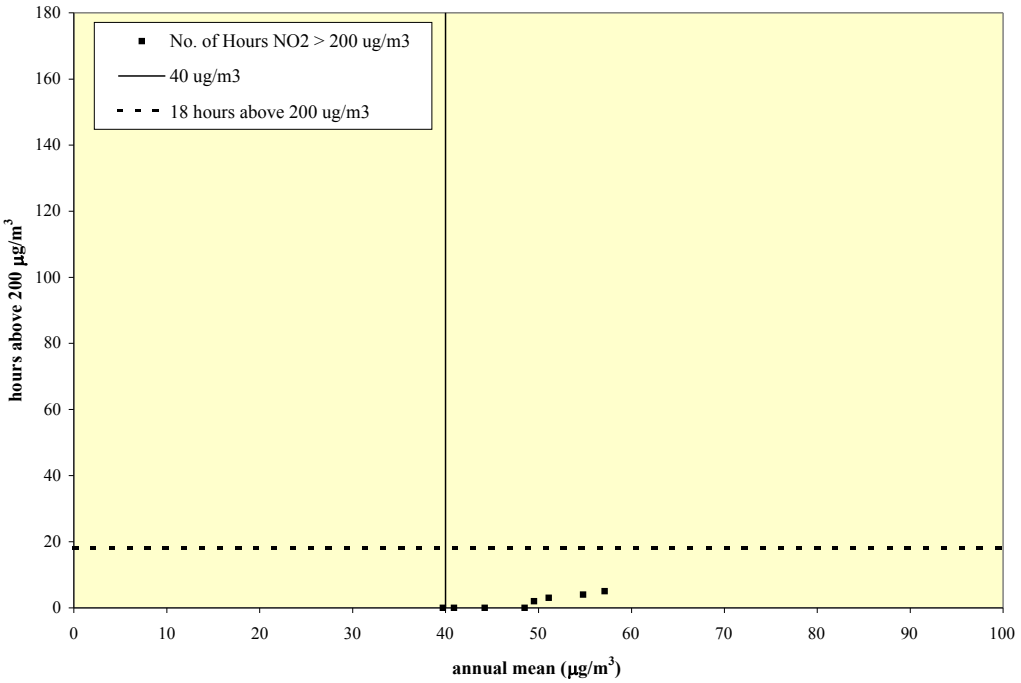
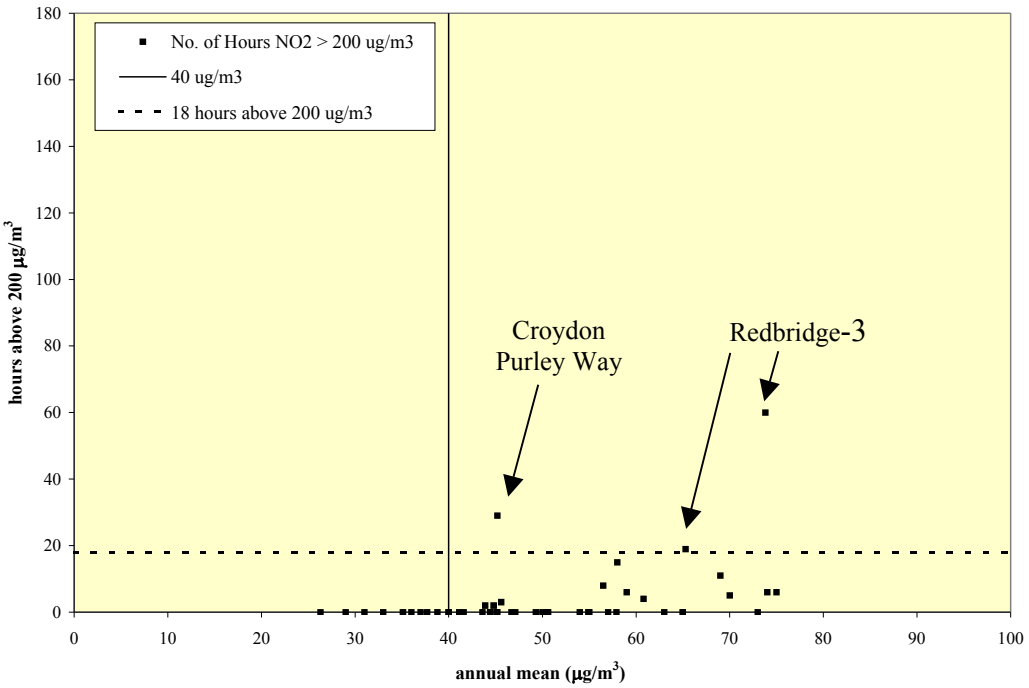


Figure B10 Number of Hours per Year With > 200 μg/m^3 of Nitrogen Dioxide as a Function of the Annual Mean Concentration at all Roadside Sites in Open Locations, 1996-2001.



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