Compilation of New Roadside Monitoring Data Obtained by Local Authorities as Part of the Review and Assessment Process

UPDATE

Report by

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Update Summary

This report represents an update to the report ***Compilation of New Nitrogen Dioxide and PM_{10} Roadside Monitoring Data Obtained by Local Authorities as Part of the Review and Assessment Process*** prepared for DEFRA in October 2001. The conclusions are broadly similar, but this Update Report should be read instead of the previous report, as a number of changes have been made.

Changes in this Report

- Changed the 'London' category to a 'Major Conurbations' category. This includes the London, Birmingham and Manchester conurbations. A site alongside the M60 in Salford has been included in this category, as has the Bury AURN site and two monitoring sites near the M25.
- A correction has been made to the London Sutton data. The previous report had data for the background Sutton site, not the roadside site.
- The data plots now use the actual distance, not distance bands.
- Nitrogen oxides data have been added, although they are not available for all locations.
- A comparison with the pattern of concentrations versus distance from the road, as predicted by the DMRB model, is included.
- The *Summary and Conclusions* section has been substantially re-written to make it clearer.
- Numerous small changes have been made to the text, Tables and Figures.

Contents

1 Introduction

1.1 This report collates the results of monitoring for nitrogen dioxide, nitrogen oxides and PM_{10} at locations near to roads throughout the UK. New data obtained by Local Authorities whilst carrying out their Reviews & Assessments, as required under Part IV of the Environment Act 1995, are provided, together with data for monitoring carried out at Automatic Urban and Rural Network (AURN) sites, and Highways Agency motorway sites. The data are analysed in relation to general features of the monitoring location, including distance from the edge of the road. The key objective is to identify those locations where exceedances of the objective due to road traffic are likely, and conversely those locations where exceedance are unlikely. The aim is not to identify the distance to which emissions from a road still have a detectable effect on concentrations[1].

1.2 The local authorities' data have been collated from the published Review & Assessment Reports submitted to DEFRA and Devolved Administrations as part of the statutory consultation process. Where necessary, further clarification on the monitoring sites has been obtained by direct contact with the local authority. No specific consideration has been given to QA/QC, although the subjective view formed during the appraisal process is that it has been reasonable. The local authority data mostly cover the years 1999 and 2000. In the case of the AURN, data for 2000 have been used, while 1999 data are available for the Highways Agency sites.

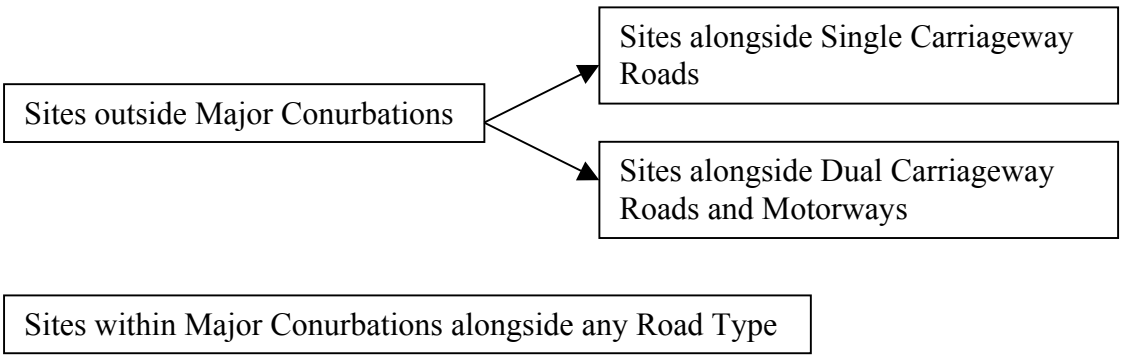
1.3 The focus has been on automatic monitoring. Nitrogen dioxide and nitrogen oxides data thus all relate to chemiluminesence monitors. For PM_{10}, data have been derived from monitoring using TEOMs and Beta Gauges (using BAM analysers), although in one case gravimetric results were available. Results from TEOM measurements have been adjusted using the 1.3 factor recommended in DEFRA technical guidance LAQM.TG4(00), to estimate their gravimetric equivalent values. This is only an approximation, as the factor varies from site to site in the range 1.0 to 1.4. The BAM instrument has an unheated inlet and the results have therefore been taken to be gravimetric equivalent without any adjustment. Measurements from diffusion tubes, optical particle monitors and wet chemical Roadside Pollution Monitors have not been collated.

1.4 Most of the local authority monitoring was carried out over relatively short time periods, typically 1, 3, 6 or 12 months, and therefore strict comparison of the results

[1] A study to identify this would require measurements at different distances for the road at one location, with a good definition of the background concentration.

with the objectives is often not valid. However, the data do provide a useful indication of the annual mean concentrations experienced near to roads.

1.5 An initial examination of the results suggested that they could usefully be grouped together as follows:



1.6 The category '*single carriageway roads outside major conurbations'* deals mostly with monitoring sites in built up areas, often with a confined setting, with houses close to the road. The traffic on these roads is typically 10,000-40,000 veh/day. The category '*dual carriageways and motorways outside major conurbations'* mostly covers roads in open rural settings, with traffic flows typically in the range 30,000-100,000 veh/day (the Sheffield Tinsley site is excluded from this analysis because it is affected by industrial sources as well as the M1 motorway[2]). The category *'major conurbations'*, covers all types of road in London, Manchester and Birmingham. These are the three principal major UK conurbations, with over 2 million people[3] (if a break point of >1 million had been used, then Leeds and Glasgow would have been included). Monitoring carried out up to 100m from the kerb of motorways or dual carriageways and up to 50m from single carriageways has been included.

1.7 Sites are considered likely to have concentrations above the annual mean nitrogen dioxide objective in 2005 if annual mean concentrations in 1999/2000 are above 46 μg/m^3. For PM_{10}, the 24-hour objective is likely to be exceeded in 2004 if annual mean concentrations in 1999/2000 are above 33 μg/m^3. These criteria are derived using the factors set out in DEFRA technical guidance LAQM.TG4(00).

[2] This site is 90 m from the motorway and had a nitrogen dioxide annual mean of 44 μg/m^3 in 2000.
[3] Statistics from http://www.citypopulation.de/Country.html?E+England$UK_(England)

2 Single Carriageway Roads Outside Major Conurbations

Nitrogen Dioxide

2.1 The details of local authority and AURN nitrogen dioxide monitoring carried out near to single carriageway roads are presented in Table A1 (Appendix). They represent results from 29 local authorities, some with multiple monitoring sites, together with those from 18 AURN sites.

2.2 The data are shown as a function of distance from the kerb of the nearby road in Figure 1. There is clear evidence that the occurrence of higher concentrations (>40 $\mu g/m^3$) is confined to locations close to the kerb. This is consistent with earlier work, which showed a sharp fall-off in nitrogen dioxide concentrations over the first few metres on moving away from the edge of the road[4,5].

2.3 Taking an annual mean concentration of >46 $\mu g/m^3$ measured in 1999/2000 to indicate a risk of exceeding the objective in 2005, then the results indicate 14 likely exceedances, all of which are for locations within 8.5 m of the kerb, 12 of which are within 5 m of the kerb. These 14 sites are summarised in Table 1 and represent 25% of the 56 sites in this category. They are mostly for roads with >20,000 vehicles per day, but not exclusively. It should also be noted that not all locations within 5 m of the kerb are likely to exceed the objective. In this sample, exceedances are only predicted for 12 of the 31 sites within 5 m of the kerb (39%).

Nitrogen Oxides

2.4 The results for nitrogen oxides (Table A1) follow a similar pattern to those for nitrogen dioxide (Figure 2). The national background maps available on the National Air Quality Archive[6] suggest that background nitrogen oxides in urban areas outside major conurbations in 1999/2000 are likely to be in the range 40-70 $\mu g/m^3$. This would suggest that concentrations are only slightly elevated above the background beyond about 10 m from the kerb, with significant increases only likely within 10 m, although these increases near the road clearly does not occur in every case.

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4 Laxen, D.P.H. & Noordally, E. (1987) Nitrogen Dioxide Distribution in Street Canyons, Atmos. Environ., 21, 1899-1903.

5 Laxen, D.P.H., Jensen, R.A. & Brooks, K. (1988) Nitrogen Dioxide at the Building Facade in Relation to Distance from Road Traffic, In "Indoor and Ambient Air Quality", Selper Ltd., London, 40-45

6 National Air Quality Archive at http://www.aeat.co.uk/netcen/airqual

Table 1 Sites with Likely Exceedances of the Annual Mean Objective for Nitrogen Dioxide in 2005

Authority	Concentration ($\mu g/m^3$)	Distance to Kerb (m)	Period (months)	Traffic Flow
Bath CC	54	3.5	12	28,400
Bristol CC	56	3	12	?
Gedling BC	48	8.3	6	35,000
Glasgow CC	72	1	12	12,000 [a]
Leeds CC	59	1	12	>30,000
Leicester CC	63	2.5	12	>20,000
Leicester CC	75	3.3	12	>20,000
Leicester CC	69	3.8	8	>20,000
Leicester CC	48	8	12	>20,000
Lincoln CC	68.6	2	12	34,000
Liverpool	58.6	5	6	31,235
Oxford CC	56.2	2	12	12,900
West Wilts DC	69	1	3	12,300
Winchester CC	69	2.8	12	?

[a] This value is based on discussions with the local authority.

PM_{10}

2.5 The results for PM_{10} are set out in Table A2. There has been less monitoring for PM_{10}, probably reflecting the lower risk of exceeding the current objectives. Data are presented for 15 local authorities, mostly covering just one monitoring station. They are shown in Figure 2 as a function of distance from the kerb of the nearby road. The data indicate higher concentrations (>30 $\mu g/m^3$) can occur within 8 m of the kerb.

2.6 If an annual mean concentration in 1999/2000 of >33 $\mu g/m^3$ is taken to indicate a likely exceedance of the 24-hour objective in 2004, then 5 out of 34 sites (15%) are likely to exceed the 24-hour objective. All of these are within 8 m of the kerb of single carriageway roads outside of major conurbations. It should be noted, however, that 4 of the 5 likely exceedances relate to results obtained using a BAM analyser. This suggests that unheated Beta Gauge (BAM) monitors may over-read in relation to gravimetric samplers (assuming a TEOM x 1.3 equates to a gravimetric sampler). It cautions against giving too much weight to these PM_{10} exceedance predictions.

2.7 The roadside enhancement is relatively small, but consistent with the 2-10 µg/m^3 elevation in annual mean values indicated by the analysis in the APEG report[7].

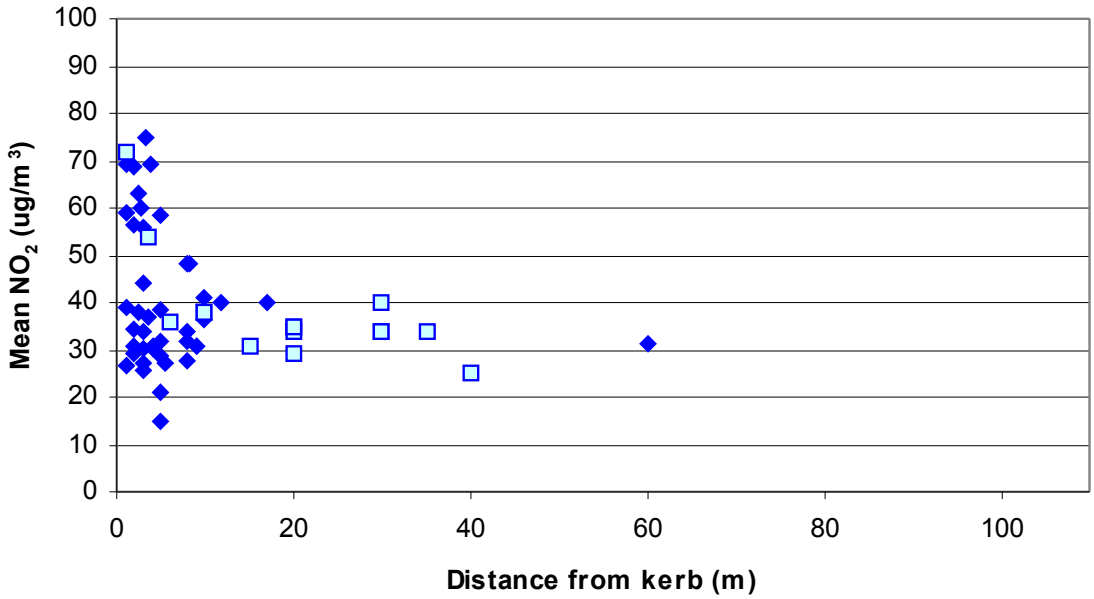

Figure 1 Measured Nitrogen Dioxide vs. Distance from Kerb, alongside Single Carriageway Roads Outside Major Conurbations ◆ = LA monitoring data, □ = AURN data. Monitoring represents periods ranging from 3 to 12 months.

[7] Source Apportionment of Airborne Particulate Matter in the United Kingdom, Report of the Airborne Particles Expert Group, January 1999.

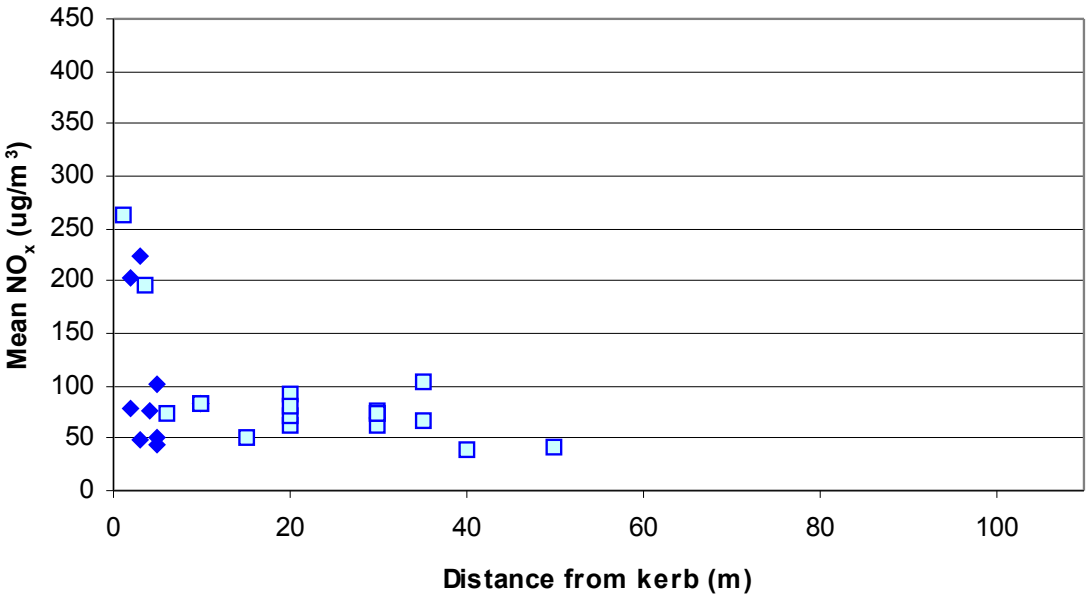

Figure 2 **Measured Nitrogen Oxides vs. Distance from Kerb, alongside Single Carriageway Roads Outside Major Conurbations** ◆ = LA monitoring data, ☐ = AURN data. Monitoring represents periods ranging from 3 to 12 months.

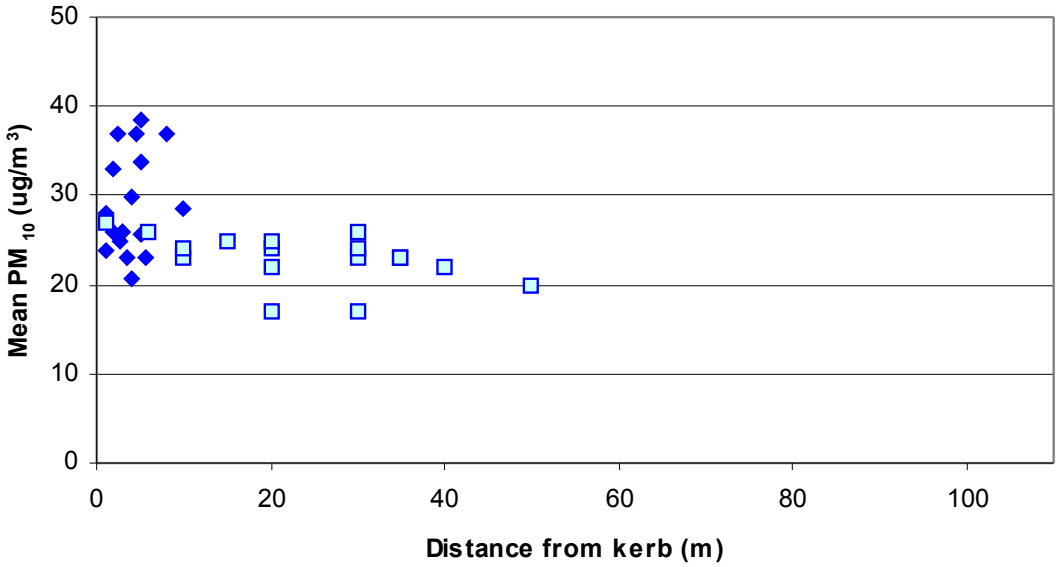

Figure 3 **Measured PM_{10} (gravimetric) vs. Distance from Kerb, alongside Single Carriageways Outside Major Conurbations.** ◆ = new monitoring data, ☐ = AURN data. Monitoring represents periods ranging from 3 to 12 months.

3 Dual Carriageways and Motorways Outside Major Conurbations

Nitrogen Dioxide

3.1 The details of new nitrogen dioxide monitoring carried out near to dual carriageways and motorways outside of major conurbations are set out in Table A3, and presented in Figure 4 as a function of distance from the edge of the road. Compared with the single carriageway roads (Figure 1), there are fewer sites very close to the road. This reflects that fact that there is less likely to be exposure within 10 m of such roads.

3.2 As with single carriageway roads, the concentrations mostly lie between 30-40 $\mu g/m^3$ away from the edge of the road. There is though less evidence of the strong roadside effect that was seen for single carriageway roads. The highest concentrations are in the range 50-60 $\mu g/m^3$, compared to 50-75 $\mu g/m^3$ alongside the single carriageway roads, despite the much higher traffic flows alongside the dual carriageways and motorways. This may reflect the generally more open nature of dual carriageways and motorways compared to single carriageway roads, which in towns often have a confined setting with houses either side.

3.3 Taking a concentration of >46 $\mu g/m^3$ as indicative of a likely exceedance of the annual mean objective in 2005, then only 2 of the 17 sites (12%) are likely to exceed the objective. These are: a site 5 m from the edge of the A14 in the Borough of St Edmundsbury; and a site 1 m from the hard-shoulder of the M4 near Reading. The M4 site is too close to the road to represent relevant exposure locations along the motorway. It is not known whether the St Edmundsbury site represents relevant exposure.

Nitrogen oxides

3.4 The nitrogen oxides concentrations are set out in Table A3 and shown as a function of distance from the road in Figure 5. Data are only available for 6 sites, so interpretation must be limited. The pattern is similar to that for single carriageway roads, with values of 50-100 $\mu g/m^3$ away from the road.

PM_{10}

3.5 The results for PM_{10} at sites alongside dual carriageways and motorways outside of major conurbations are set out in Table A4. Again, there has been less monitoring for PM_{10} than nitrogen dioxide, with new results only available for 6 local authorities. They are shown in Figure 6 as a function of distance from the road. There is no clear

evidence for higher concentrations on approaching the edge of the road. The highest concentration, at 31.6 µg/m^3, is for a site 80 m from the M1, measured over 132 days using a gravimetric sampler.

3.6 If an annual mean concentration in 1999/2000 of >33 µg/m^3 is taken to indicate a likely exceedance of the 24-hour objective in 2004, then none of the 13 sites is likely to exceed the objective. It should be noted that there is no evidence of the Beta Gauge (BAM) monitors giving unduly high results in this case (see para 2.6), although the monitoring using this instrument only covered a one-month period.

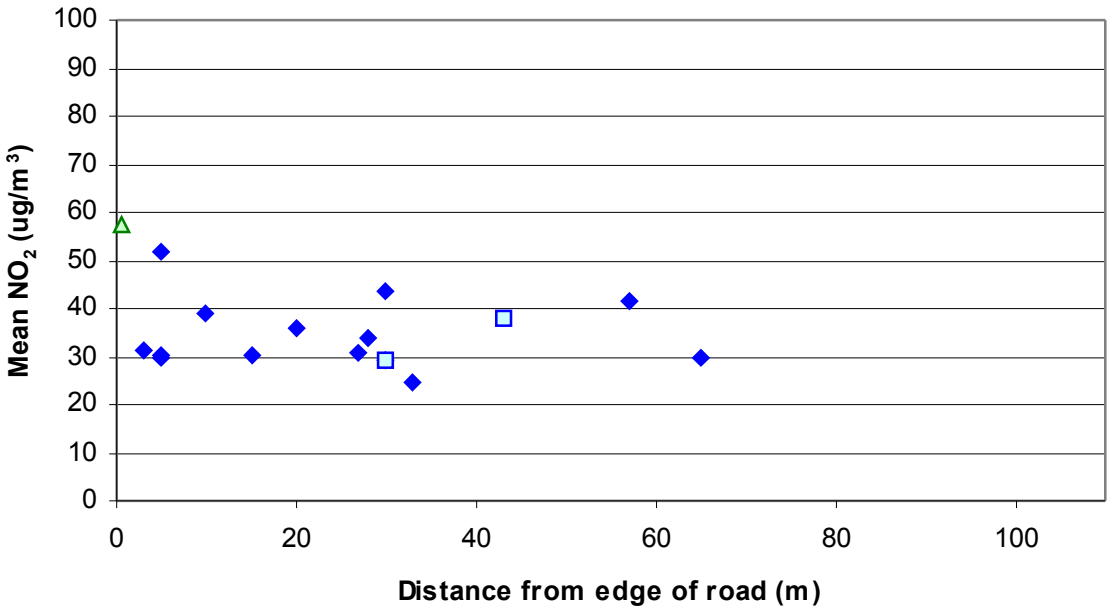

Figure 4 Measured Nitrogen Dioxide vs. Distance from Hard Shoulder / Kerb, alongside Motorways / Dual Carriageways Outside Major Conurbations.
◆ = LA monitoring data, □ = AURN data, Δ = TRL data. Monitoring represents periods ranging from 3 to 12 months.

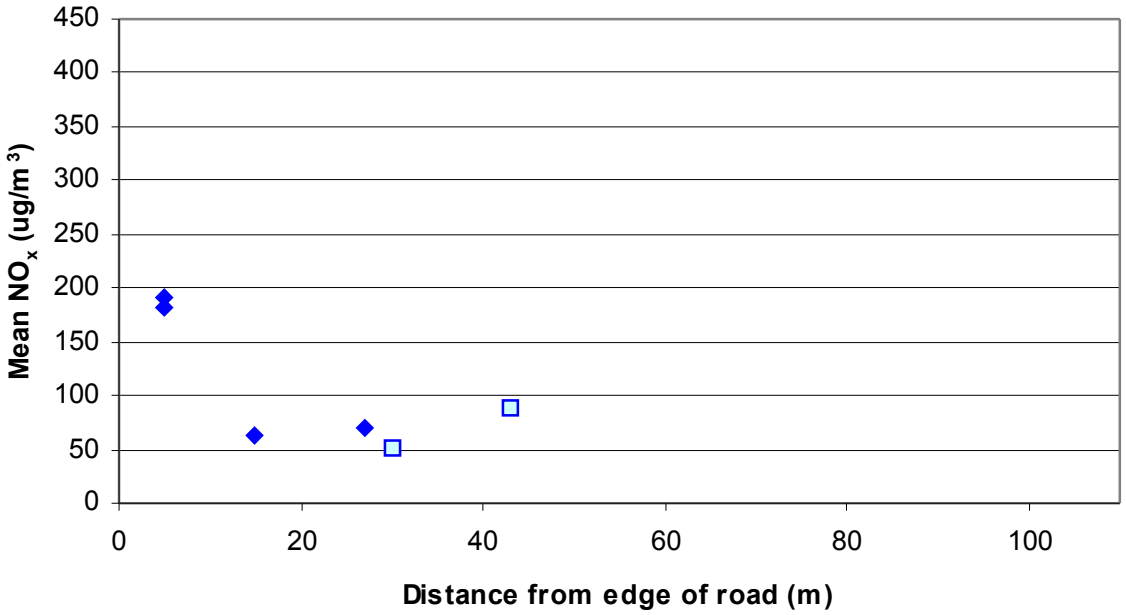

Figure 5 Measured Nitrogen Oxides vs. Distance from Hard Shoulder / Kerb, alongside Motorways / Dual Carriageways Outside Major Conurbations.
◆ = LA monitoring data, □ = AURN data, Δ = TRL data. Monitoring represents periods ranging from 3 to 12 months.

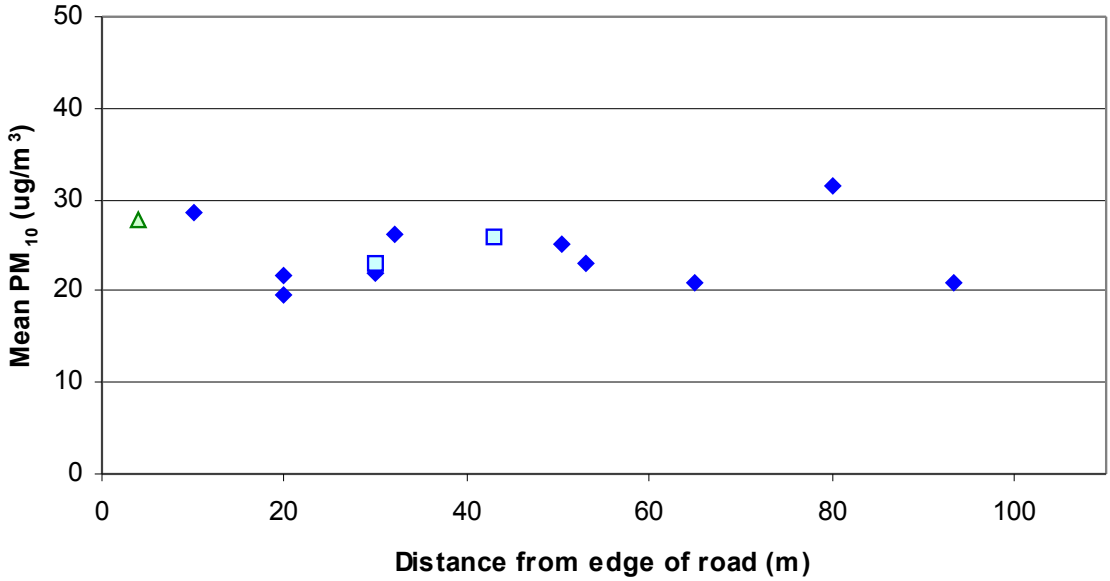

Figure 6 Measured PM_{10} (gravimetric) vs. Distance from Hard Shoulder / Kerb, alongside Motorways / Dual Carriageways Outside Major Conurbations.
◆ = LA monitoring data, □ = AURN data, Δ = TRL data. Monitoring represents periods ranging from 1 to 12 months.

4 All Roads in Major Conurbations

Nitrogen Dioxide

4.1 The monitoring data for major conurbations have been analysed separately, following an initial examination of the results, which showed that roadside concentrations are generally higher than at comparable sites outside major conurbations. This undoubtedly reflects the higher background values found in major conurbations. No distinction is made between single carriageways, dual carriageways and motorways given the smaller sample size. There are fewer new local authority data in this category, which probably reflects the greater number of national network monitoring sites in such areas. The full results are presented in Table A5 and illustrated as a function of distance from the kerb in Figure 7. There is some evidence of higher concentrations closer to the kerb, but the picture is not as distinctive as for single carriageway roads outside of major conurbations (*cf*. Figure 1).

4.2 Comparison of the results with those for single carriageway road outside of major conurbations reveals that concentrations away from the edge of the road, i.e.>20 m, are higher in the major conurbations, 35-60 $\mu g/m^3$, compared with typical values of 30-40 $\mu g/m^3$ outside major conurbations (*cf* Figure 7 with Figures 1 and 4). It is also apparent that concentrations close to the road, within 5 m, can be as high outside major conurbations as within. The one outlier in Figure 7 is the result for the kerbside site along Marylebone Road in London, at 92 $\mu g/m^3$. This supports the choice of this site to represent worst-case conditions in a major conurbation.

4.3 Taking a concentration of >46 $\mu g/m^3$ as indicative of a likely exceedance of the annual mean objective in 2005, then 13 of the 18 sites (72%) are at risk of exceeding the objective.

Nitrogen Oxides

4.4 Nitrogen oxides concentrations are set out in Table A5. They are generally higher closer to the road (Figure 7), but the pattern is different to that for roads outside of major conurbations (c.f. Figure 1 and Figure 4), with evidence of a roadside effect extending somewhat further, with high levels (>250 $\mu g/m^3$) observed at two sites 15 - 20 m from the road.

PM_{10}

4.5 The PM_{10} data for major conurbations are set out in Table A6 and shown as a function of distance from the road in Figure 8. Results are available for 12 sites, with higher

concentrations being found closer to the road. The highest annual mean of 48 µg/m^3 is for the Marylebone Road kerbside site, being 20 µg/m^3 above the background measured at the nearby London Bloomsbury site. The concentrations away from the road, >20 m, are in the range 20-30 µg/m^3 and are similar to those for roads outside major conurbations.

4.6 If an annual mean concentration in 1999/2000 of >33 µg/m^3 is taken to indicate a likely exceedance of the 24-hour objective in 2004, then 2 of the 12 sites (17%) are likely to exceed the objective. Both these sites, however, are only 1 m from the kerb, and are unlikely to represent relevant exposure.

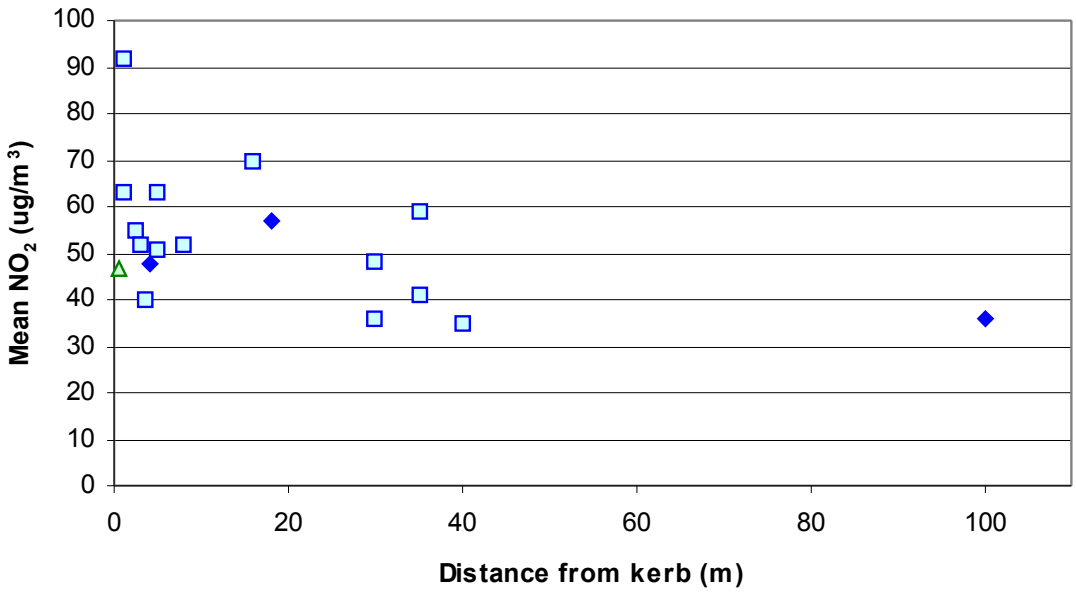

Figure 7 Measured Nitrogen Dioxide vs. Distance from Kerb, at Locations in Major Conurbations. ◆ = new monitoring data, ☐ = AURN data, Δ = TRL data. Monitoring represents periods ranging from 11 to 12 months.

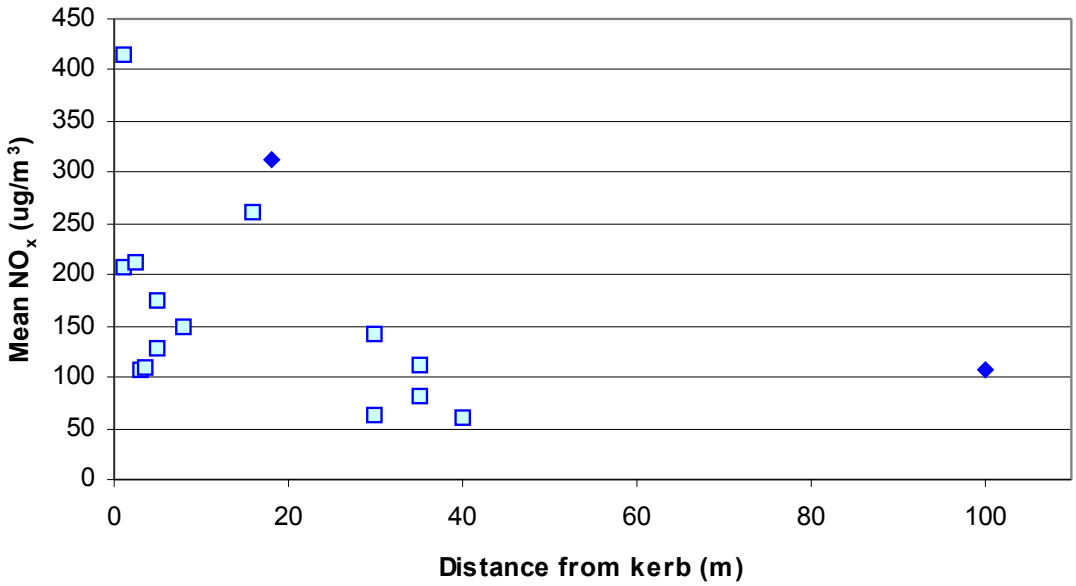

Figure 8 Measured Nitrogen Oxides vs. Distance from Kerb, at Locations in Major Conurbations. ◆ = new monitoring data, ☐ = AURN data. Monitoring represents periods ranging from 11 to 12 months.

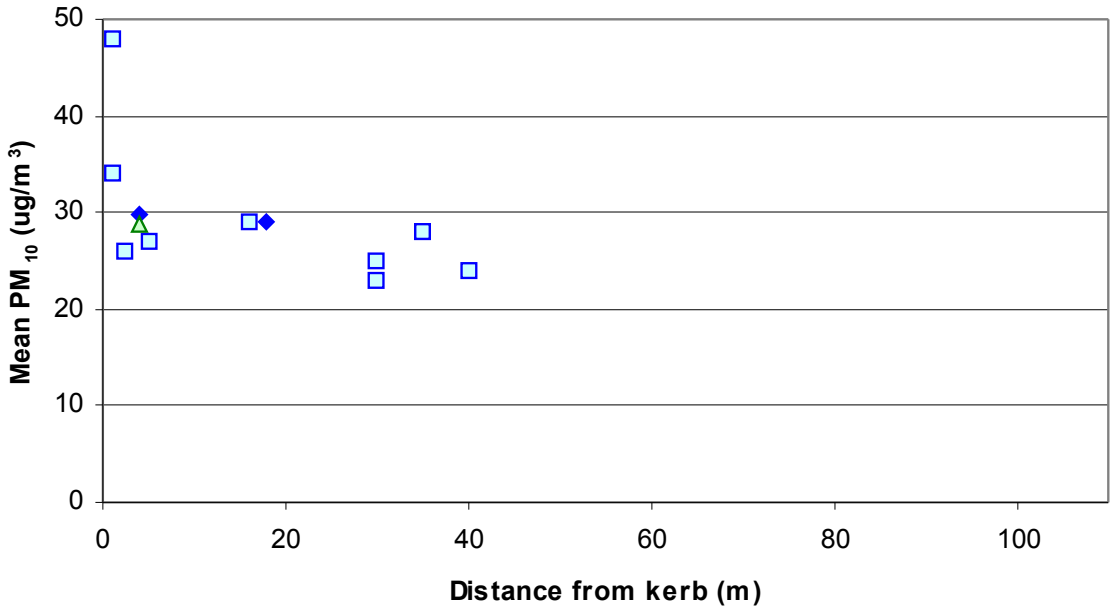

Figure 9 Measured PM_{10} (gravimetric) vs. Distance from Kerb, at Locations in Major Conurbations. ◆ = LA monitoring data, ☐ = AURN data, Δ = TRL data. Monitoring represents periods ranging from 11 to 12 months.

5 Summary and Conclusions

5.1 A number of local authorities have carried out new monitoring for nitrogen dioxide and/or PM_{10} at locations near to roads as part of their Reviews and Assessments. The opportunity has been taken to collate these new data, and combine them with data from other sources, with a view to identifying those conditions that lead to likely exceedances of the air quality objectives. The results have been examined as a function of distance from the road for three categories: 1) single carriageway roads outside major conurbations, 2) dual carriageways and motorways outside major conurbations and 3) all roads in major conurbations. In the context of this study major conurbations are taken to be London, Manchester and Birmingham.

5.2 The findings are summarised in Table 2. It is clear that **exceedances are more likely:**

- for nitrogen dioxide than PM_{10};
- in major conurbations;
- alongside single carriageway roads, rather than dual carriageways and motorways, outside major conurbations.

5.3 Exceedances of the nitrogen dioxide annual mean objective are **unlikely:**

- more than 9 m from the kerb of single carriageway roads outside major conurbations;
- more than 5 m from dual carriageways and motorways outside major conurbations.

5.4 Exceedances of the PM_{10} 24-hour objective are **unlikely:**

- more than 8 m from the kerb of any road;
- alongside any dual carriageway or motorway outside of major conurbations.

Table 2 Summary of Likely Exceedances in 2004/5

Location	NO_2 Proportion of Sites	Distance from Kerb	PM_{10} Proportion of Sites	Distance from Kerb
Outside Major Conurbations – Single Carriageway Roads	25%	0 – 9 m	15% [a]	0 – 8 m [a]
Outside Major Conurbations – Dual Carriageways and Motorways	12%	0 - 5 m	0%	0 m
In Major Conurbations – All Roads	72%	0 - 35 m	17%	0 - 1 m

[a] Four out of the five results on which this is based are from unheated beta-gauge instruments. Excluding these results brings the values come down to 3% and 0-5 m.

5.5 There are several caveats to add to the observations made above:

- the monitoring data cover the years 1999 and 2000. Results from the national monitoring network shows that nitrogen dioxide concentrations in 2001 were on average 5% higher than those in 2000 and 2% lower than in 1999, presumably due mainly to different meteorological conditions. The respective values for PM_{10} were 3% and 0% higher in 2001 than 2000 and 1999. Had 2001 data been used, then the distances out to which exceedances are likely could be slightly greater than identified, but the general findings would not change;
- the data mostly apply to measurements alongside a single road. No systematic assessment has been carried out of concentrations near to junctions, which are likely to be higher;
- there may be circumstances where industrial sources add to the roadside concentrations, extending the distance to which exceedances are likely. These circumstances apply to the Sheffield Tinsley monitoring site, which is 90 m from the M1, but which is also affected by industrial emissions. It has been excluded from this analysis, as the focus is on the generalised picture arising from road traffic.

5.6 Examination of the nitrogen dioxide and nitrogen oxides results suggests that there is a sharp decline over the first 5-10 m from the kerb, with concentrations appearing to be close to the local background beyond about 20 m. This is most evident alongside single carriageway roads outside of major conurbations (Figures 1 and 2). Current models do not predict this behaviour. This is illustrated in Figures 10 and 11, which reproduce the single carriageway results, together with a plot from the Casella Stanger version of the DMRB model. The model has been set up to reproduce the group of sites with high near-kerb nitrogen dioxide concentrations (taken to be 63 $\mu g/m^3$) and likely background nitrogen dioxide (taken to be 27 $\mu g/m^3$). The pattern for nitrogen dioxide is of steady concentrations for the first 20 m, followed by a slow decline out to 100 m and beyond. The steady levels over the first 20 m are due in part to the allowance for nitric oxide conversion to nitrogen dioxide. The nitrogen oxides also show a section of steady concentrations, but only out to about 10 m, and then a slow decline out to 100 m and beyond. There is no evidence in the model of an initial sharp decline. Clearly more work is required to confirm the behaviour along transects at single locations (the patterns in Figures 1 and 2 are from sites in a range of different locations, and can only be indicative of those at a single location, although experience with diffusion tube transects supports this observation). It will then be necessary to establish a model that reproduces the observed fall-off with distance.

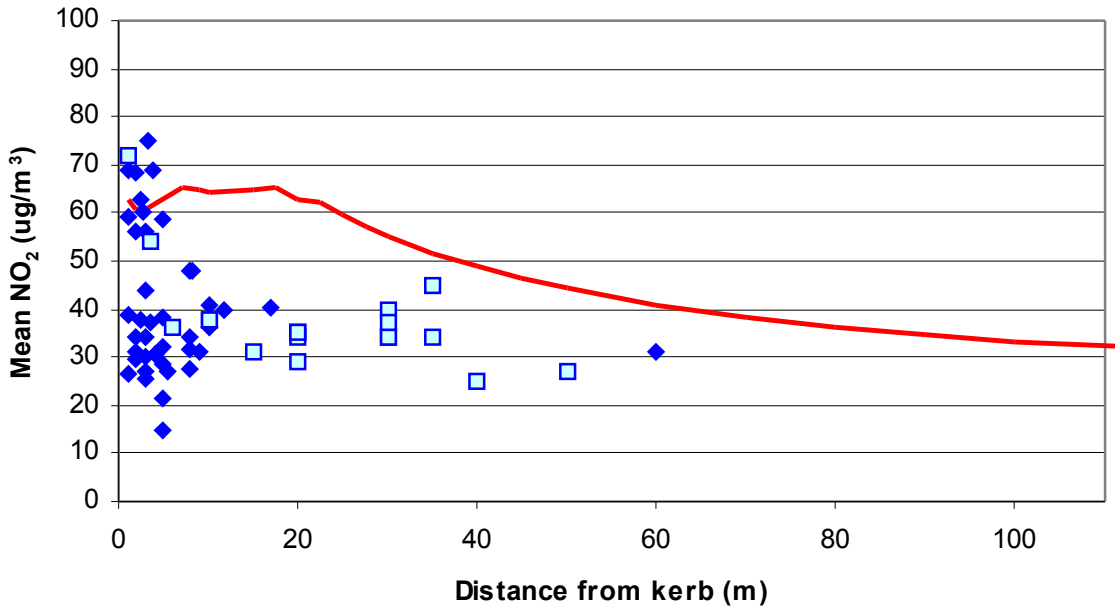

Figure 10 Measured Nitrogen Dioxide Concentrations Reproduced from Figure 1, together with the Pattern of Decline Derived from the DMRB Model.

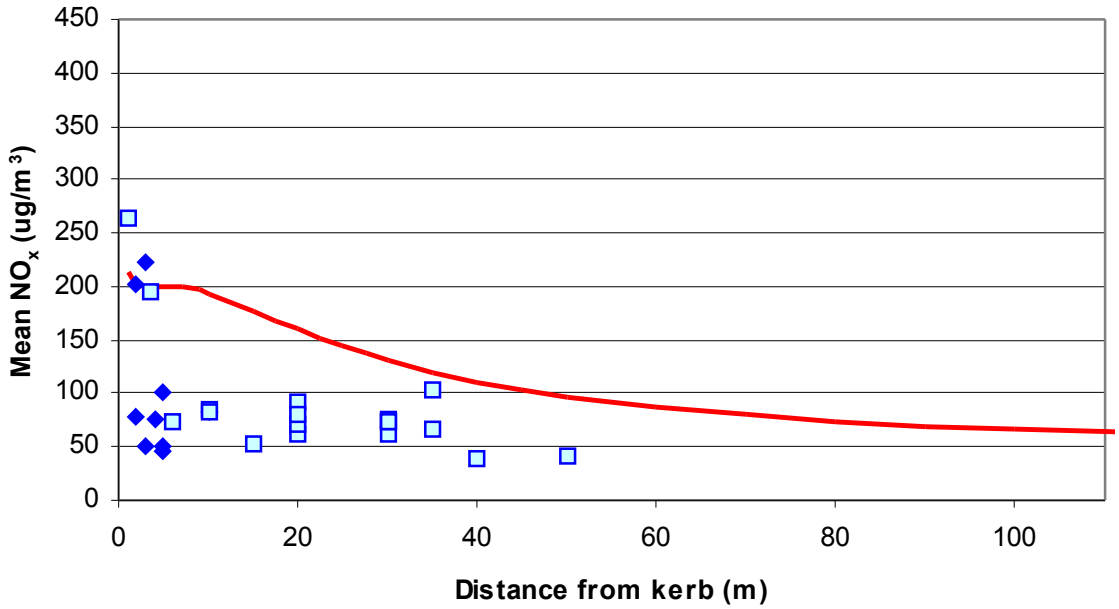

Figure 11 Measured Nitrogen Oxides Concentrations Reproduced from Figure 2, together with the Pattern of Decline Derived from the DMRB Model.

5.7 The findings of this study support the views being developed from the Review & Assessment appraisal process that exceedances of the nitrogen dioxide and PM_{10} objectives at locations with relevant exposure are generally unlikely alongside dual carriageways and motorways outside major conurbations. This probably reflects:

a) the greater distance of receptors (and hence monitors) from the kerb;
b) the more open setting of such roads, which will improve dispersion;
c) the lower background, as such roads are normally in rural areas, rather than in town centres.

5.8 It is clear that the greatest likelihood of exceedances outside major conurbations is alongside single carriageway roads. This probably reflects:

a) the receptors (and hence monitors) being close to the kerb of such roads;
b) the greater likelihood of air circulation being confined by buildings, with poorer dispersion;
c) the greater likelihood of slow moving and congested traffic along such roads;
d) the likelihood of higher background concentrations, as these roads are more likely to be in urban areas.

This is consistent with the finding that air quality management areas are being identified in town centres, even along streets with relatively low traffic flows. This is especially the case in market towns where residential properties are often within a few metres of the kerb.

5.9 In the case of PM_{10}, the monitoring data suggest exceedances at locations with relevant exposure are unlikely in major conurbations. The same does not appear to apply outside major conurbations, alongside single carriageway roads, but this may be due to an apparent over-estimation of concentrations from use of unheated Beta Gauge instruments. This apparent over-estimation is based on an indirect comparison of Beta Gauge results with TEOM measurements adjusted using a 1.3 factor, which is itself an uncertain factor. It is clearly necessary to carry out further work on validating PM_{10} measurements to ensure equivalence with gravimetric measurements on which the objective is based. The findings of higher concentrations alongside single carriageway roads outside major conurbations must therefore be treated with caution.

5.10 It is recommended that the findings of this study are reflected in guidance to local authorities when they undertake their second round of Review & Assessment. In particular, attention needs to be given to nitrogen dioxide in town centre locations, where properties lie within 5 m of the kerb of modestly trafficked roads, as these are locations that are not highlighted in current Guidance.

Table A1 Details of Nitrogen Oxides and Nitrogen Dioxide Monitoring Near Single Carriageway Roads outside Major Conurbations

Authority	Report Ref	Location	Grid Ref	Traffic flow (AADT)	% HGV	Distance from kerb	Pollutant	Method	NO2 Concentration (ug/m3)		NOx Concentration (ug/m3)	Monitoring Period	Length of monitoring	Data Capture (%)
									Mean	99.8th %ile	Mean			
Local Authority Sites														
Amber Valley BC	RA3-773	Belper library				8	NO2	Chemiluminesence	27.8			Sep-Dec 2000	3 months	
Bradford MBC	RA23-628	Shipley				3	NO2	Chemiluminesence	25.6	87	49.4	Feb-Dec 1999	11 months	
Bristol CC	DRA3-545	Parson St	ST 579 705			3	NO2	Chemiluminesence	56	145		2000	12 months	91
Bristol CC	DRA3-545	Brislington	ST 611 715	> 20 000		8-10	NO2	Chemiluminesence	34	114		1999	12 months	83
Broadland DC	DRA3-847	A140 Boundary Road		26800	9	9	NO2	Chemiluminesence	31	73.2		13/11/00 to 23/2/01	3 months	99.8
Canterbury CC	RA3-779	Kingsmead	615200 158500			2	NO2	Chemiluminesence	29.4	88.6		Jan-June 2000	6 months	
Canterbury CC	RA3-779	St Dunstans	614200 158400			1	NO2	Chemiluminesence	26.7	92.8		Jan-June 2000	6 months	
Canterbury CC	RA3-779	Lower Bridge Street	615200 157600			8	NO2	Chemiluminesence	31.7	102.6		Jan-June 2000	6 months	
Canterbury CC	RA3-779	Wincheap	614200 157000			5	NO2	Chemiluminesence	21.2	80.4		Jan-June 2000	6 months	
Canterbury CC	RA3-779	Sturry	617700 116000			3	NO2	Chemiluminesence	27.1	101.6		Jan-June 2000	6 months	
Cardiff CC	RA3-464	Briardene Centre		> 40 000		3	NO2	Chemiluminesence	30.1	88		1999	12 months	
East Devon DC	RA3-741	A376 Saddlers Arms		20000	4	4.2	NO2	Chemiluminesence	30.5			16/3/00 to 28/9/00	6 months	99.8
Gedling BC	RA3-778	Daybrook Babtist Chapel		35000	7	8.3	NO2	Chemiluminesence	48			Aug-Dec 2000	6 months	95.8
Guildford BC	RA23-596	Junction of York and Epsom Road		27000	3	5	NO2	Chemiluminesence	28.7			May 99 to March 00	10 months	
Herefordshire CC	RA3-812	Edgar St/Newmarket St Island	350776 240224			3	NO2	Chemiluminesence	44		223.8	2000	12 months	75
Kings Lynn & W Norfolk BC	RA12-774	London Road, King's Lynn				4	NO2	Chemiluminesence	30.6	84	76.4	1/4/99 to 31/3/00	12 months	90
Leeds CC	RA3 646	Headingly A660	427983 436051	>30000		1	NO2	Chemiluminesence	59			1999	12 months	
Leicester CC	DRA3-528	Bassett Street	SK 577 054	> 20 000		11.8	NO2	Chemiluminesence	40			1999	12 months	89
Leicester CC	DRA3-528	Saffron Lane	SK 585 019	> 20 000		2.5	NO2	Chemiluminesence	38	38		Jan-Feb 1999	3 months	100
Leicester CC	DRA3-528	Melton Road	SK 595 063	> 20 000		2.5	NO2	Chemiluminesence	63	63		1999	12 months	72
Leicester CC	DRA3-528	Imperial Avenue	SK 572 030	> 20 000		3.3	NO2	Chemiluminesence	75			1999	12 months	89
Leicester CC	DRA3-528	Glenhills Way	SK 570 001	> 20 000		3.8	NO2	Chemiluminesence	69			May-Dec1999	8 months	78
Leicester CC	DRA3-528	Abbey Lane	SK 558 068	> 20 000		8	NO2	Chemiluminesence	48			1999	12 months	95
Lincoln CC	DRA3-818	Drill Hall, Broadgate		34000		2	NO2	Chemiluminesence	68.6		202.9	1999	12 months	95.04
Liverpool CC	RA23-720	Islington	335394 390956	31235	7	5	NO2	Chemiluminesence	58.6		101.1	19/9/99 to 31/3/00	6 months	88
Milton Keynes CC	RA3 672	Wolverton Rd, Newport Pagnell				3.6	NO2	Chemiluminesence	37.1			5/5/99 to 29/11/99	6 months	
Milton Keynes CC	RA3 672	20 High St, Olney				1	NO2	Chemiluminesence	38.8			11/1198 to 11/2/99	3 months	
N Hertfordshire DC	RA3-431	Baldock Town Centre				< 10	NO2	Chemiluminesence	41			1999	12 months	95.6
North Lincolnshire C	RA2-797	Britannia Corner Public Conviniences				5.5	NO2	Chemiluminesence	27			Feb-Aug 2000	6 months	
Nuneaton & Bedworth BC	RA3 769	A5 Watling St		32712	12	17	NO2	Chemiluminesence	40.1			29/09/00 to 10/01/01	3 months	99.8
Oxford CC	RA3-686	Town Hall, St Adates	51350 06150	12900	35	2	NO2	Chemiluminesence	56.2			1999	12 months	93
Rother DC	RA3-418	A259				5	NO2	Chemiluminesence	32			Oct 99-Mar 2000	5 months	
Salisbury DC	RA3-593	Brown Street		16872	2.3	2	NO2	Chemiluminesence	34.4	137	78.4	23/2/00 to 4/9/00	6 months	98
Scarborough BC	RA2-764	Scarborough Railway Station (A64/A165 junction)	TA0394 8835			5	NO2	Chemiluminesence	14.9		45	june-dec 99	6 months	38
South Kesteven DC	RA3-679	Grantham Guildhall		15000	8	60	NO2	Chemiluminesence	31.1			1999	12 months	98.2
St Edmundsbury BC	DRA3-677	Bury St Edmunds Town Centre	585094 263689	12081	1	10	NO2	Chemiluminesence	36.3	101.2	82.1	July - Oct 2000	3 months	93
St Helens MBC	RA3-771	Linkway West A570, Town Centre				5	NO2	Chemiluminesence	38.5		50		12 months	93
West wilts DC		Masons Lane		12300	5	1	NO2	Chemiluminesence	69			Feb-May 2000	3 months	
Winchester CC	RA23-529	St George St	SU 483 294			2.8	NO2	Chemiluminesence	60			1999	12 months	
York CC	RA23-800	Fishergate				3	NO2	Chemiluminesence	34	96		1/4/99 to 31/3/00	12 months	
York CC	RA23-800	Clifton Moor				2	NO2	Chemiluminesence	31	92		1/4/99 to 31/3/00	12 months	
AURN Sites														
Bath Roadside		London Rd		28400		3.5	NO2	Chemiluminesence	54		195.1	2000	12 months	76
Belfast Centre		Lombard St/High St	J339744			15	NO2	Chemiluminesence	31		51.7	2000	12 months	81
Bradford Centre			SE166331			10	NO2	Chemiluminesence	38		84.2	2000	12 months	96
Edinburgh Centre		Princes Street	NT254738			35	NO2	Chemiluminesence	45		103.3	2000	12 months	95
Glasgow Kerbside		Hope St.	NS587651	>25,000		1	NO2	Chemiluminesence	72		264.0	2000	12 months	98
Hull Centre			TA097288	7000 (12hr)		6	NO2	Chemiluminesence	36		72.7	2000	12 months	96
Leamington Spa			SP319657			50	NO2	Chemiluminesence	27		42.1	2000	12 months	99
Leeds Centre			SE299343	21500/93500		30/150	NO2	Chemiluminesence	37		74.6	2000	12 months	97
Leicester Centre			SK590050	14500		30	NO2	Chemiluminesence	34		61.2	2000	12 months	96
Liverpool Centre			SJ349908			20	NO2	Chemiluminesence	35		91.8	2000	12 months	96
Newcastle Centre			NZ251649			20	NO2	Chemiluminesence	29		63.1	2000	12 months	98
Norwich Centre		St. George's St.	TG230089			40	NO2	Chemiluminesence	25		38.3	2000	12 months	97
Nottingham Centre			SK574400	24250		30	NO2	Chemiluminesence	40		74.6	2000	12 months	98
Reading Centre		A4	SU727733	30000		20	NO2	Chemiluminesence	34		70.8	2000	12 months	95
Sheffield Centre			SK352869	20000		20	NO2	Chemiluminesence	35		80.3	2000	12 months	97
Southampton Centre		Brintons Rd / Northern Rd	SU440130	25000		10	NO2	Chemiluminesence	38		82.3	2000	12 months	95
Swansea Centre			SS655931			30-40	NO2	Chemiluminesence	34		76.5	2000	12 months	98
Thurrock		London Rd	TQ611779	9000 (12hr)		35	NO2	Chemiluminesence	34		67.0	2000	12 months	93

Table A2 Details of PM_{10} Monitoring Near Single Carriageway Roads outside Major Conurbations

Authority	Report Ref	Location	Grid Ref	Traffic flow (AADT)	% HGV	Distance from kerb	Pollutant	Method	Concentration (ug/m3) Mean	Concentration (ug/m3) 90th %ile	Monitoring Period	Length of monitoring	Data Capture (%)
Local Authority Sites													
Bradford MBC	RA23-628	Shipley				3	PM10	TEOM*	26	47	Feb-Dec 1999	11 months	
Guildford BC	RA23-596	Junction of York and Epsom Road		27000	3	5	PM10	TEOM	33.8		May 99 to March 00	10 months	
Kings Lynn & W Norfolk BC	RA12-774	London Road, King's Lynn				4	PM10	TEOM	20.8		1/4/99 to 31/3/00	12 months	
Leeds CC	RA3 646	Headingly A660	427983 436051	>30000		1	PM10	TEOM	28		1999	12 months	
Leicester CC	DRA3-528	Melton Road	SK 595 063	> 20 000		2.5	PM10	BAM	37		1999	12 months	91
Leicester CC	DRA3-528	Abbey Lane	SK 558 068	> 20 000		8	PM10	BAM	37		1999	12 months	92
Liverpool CC	RA23-720	Islington	335394 390956	31235	7	5	PM10	TEOM	25.6		19/9/99 to 31/3/00	6 months	90
Mid Devon DC	RA3-751	Cullompton				4.5	PM10	BAM	37	65	16/3/00 to 16/6/00	3 months	94.4
Milton Keynes C	RA3 672	Wolverton Rd, Newport Pagnell				3.6	PM10	TEOM	23		5/5/99 to 29/11/99	6 months	
Milton Keynes C	RA3 672	20 High St, Olney				1	PM10	TEOM	23.8		11/1198 to 11/2/99	3 months	
N Hertfordshire DC	RA3-431	Baldock Town Centre				< 10	PM10	TEOM	28.6		1999	12 months	98.7
North Lincolnshire C	RA2-797	Britannia Corner Public Conveniences				5.5	PM10	TEOM	23		Feb-Aug 2000	6 months	
Salisbury DC	RA3-593	Brown Street		16872	2.3	2	PM10	TEOM	33		23/2/00 to 4/9/00	6 months	92
St Helens MBC	RA3-771	Linkway West A570, Town Centre				5	PM10	BAM	38.5				
Winchester CC	RA23-529	St George St	SU 483 294			2.8	PM10	BAM	25		1999	12 months	
York CC	RA23-800	Fishergate				3	PM10	TEOM	26	44.2	1/4/99 to 31/3/00	12 months	97
York CC	RA23-800	Clifton Moor				2	PM10	TEOM	26	44.2	1/4/99 to 31/3/00	12 months	94
AURN Sites													
Belfast Centre		Lombard St/High St	J339744			15	PM10	TEOM	25		2000	12 months	81.3
Bradford Centre			SE166331			10	PM10	TEOM	23		2000	12 months	96.6
Edinburgh Centre		Princes Street	NT254738			35	PM10	TEOM	23		2000	12 months	96.3
Glasgow Kerbside		Hope St.	NS587651	>25,000		1	PM10	TEOM	27		2000	12 months	97.7
Hull Centre			TA097288	7000 (12hr)		6	PM10	TEOM	26		2000	12 months	94.7
Leamington Spa			SP319657			50	PM10	TEOM	20		2000	12 months	98.1
Leeds Centre			SE299343	21500/93500		30/150	PM10	TEOM	23		2000	12 months	96.5
Leicester Centre			SK590050	14500		30	PM10	TEOM	17		2000	12 months	97.1
Liverpool Centre			SJ349908			20	PM10	TEOM	24		2000	12 months	91.1
Newcastle Centre			NZ251649			20	PM10	TEOM	17		2000	12 months	97.6
Norwich Centre		St. George's St.	TG230089			40	PM10	TEOM	22		2000	12 months	97.4
Nottingham Centre			SK574400	24250		30	PM10	TEOM	24		2000	12 months	98.5
Reading Centre		A4	SU727733	30000		20	PM10	TEOM	22		2000	12 months	94.6
Sheffield Centre			SK352869	20000		20	PM10	TEOM	25		2000	12 months	97
Southampton Centre		Brintons Rd / Northern Rd	SU440130	25000		10	PM10	TEOM	24		2000	12 months	96.5
Swansea Centre			SS655931			30-40	PM10	TEOM	26		2000	12 months	96.9
Thurrock		London Rd	TQ611779	9000 (12hr)		35	PM10	TEOM	23		2000	12 months	93.6

*All TEOM results have been multiplied by 1.3

Table A3 Details of Nitrogen Oxides and Nitrogen Dioxide Monitoring Near Motorways/Dual Carriageways outside Major Conurbations

	Report Ref.	Road	Location	Traffic flow (AADT)	% HGV	Distance	Pollutants	Method	NO2 Concentration (ug/m3)		NOx Concentration (ug/m3)	Monitoring Period	Length of monitoring	Data Capture (%)
									Mean	99.8th%ile	Mean			
Local Authority Sites														
Basingstoke & Deane BC	RA3-474	M3	The Portsmouth Arms, Cliddesden Lane (OS 461736,148746)	80927	9.4	27m from edge of hard sholder, 57m from centre of M3	NO2	Chemiluminesence	30.6	132	68.9	19/7/99 to 20/1/00	6 months	92
East Devon DC	RA3-741	M5	Clyst Break nr Junc 30	50000	13	28 (kerb)	NO2	Chemiluminesence	34			16/3/00 to 28/9/00	6 months	99.8
Gateshead MBC	RA3-649	A184	Felling By-Pass (427865 562389)			3 (kerb)	NO2	Chemiluminesence	31.2			April-Sep 200	5 months	92.2
Gateshead MBC	RA3-649	A1	Team Valley (423852 560693)	120000		30 (kerb)	NO2	Chemiluminesence	43.8			May-Oct 99	5 months	92
Gateshead MBC	RA3-649	A1	Dunston (422511 561928)	12000		5 (kerb)	NO2	Chemiluminesence	30			Jan-sep 00	8 months	96.6
Lichfield DC	DRA3-832	A38	Slip rd Alrewas (OS 461736, 148746)	31558		5m from edge of hard shoulder, 18m from centre of A38	NO2	Chemiluminesence	30.3		183	Oct 00 - Jan 01	3 months	76
Middlesborough C	RA23-547	A66	Middlesborough nr junc with A19 - residential area	85000		20 (kerb) on embankment	NO2	Chemiluminesence	36			Sep-Nov 99	3 months	
Milton Keynes C	RA3 672	M1	Miles Close, Blakelands			65	NO2	Chemiluminesence	29.9			11/2/99 to 5/5/99	3 months	
N Hertfordshire DC	RA3-431	A1	Grounds of Knebworth House			30 from nearest carriageway	NO2	Chemiluminesence	29					
N Hertfordshire DC	RA3-431	A1	Between Letchworth & Baldock	49819	11	10-15 (carriageway)	NO2	Chemiluminesence	39			2000		46
Nuneaton & Bedworth BC	RA3 769	M6	Tudor Court	106800	18	57 (main carriageway)	NO2	Chemiluminesence	41.7			29/9/00 to 10/01/01	3 months	99.8
St Edmundsbury BC	DRA3-677	A14	GR 585763 265388 A14	38504	15	5m from roadsisde	NO2	Chemiluminesence	51.6	158.5	191	Jul-Oct 2000	3 months	90
Taunton Deane BC	RA3-540	M5	Haygrove House, Shoreditch Road			33m from hardsholder	NO2	Chemiluminesence	24.6			Feb-July 2000	6 months	
Worthing BC	RA23 651	A27	Upper Brighton Rd	53000		15 (kerb)	NO2	Chemiluminesence	30.5		63	8/9/99 to 6/3/00	6 months	89
AURN Sites														
Bristol Centre			ST594732			43	NO2	Chemiluminesence	38		88.0	2000	12 months	96
Wolverhampton Centre			SO914989	35000		30	NO2	Chemiluminesence	29		51.7	2000	12 months	96
TRL Sites														
M4		M4				0.5			57.2					

Table A4 Details of PM_{10} Monitoring Near Motorways/Dual Carriageways outside Major Conurbations

	Report Ref.	Road	Location	Traffic flow (AADT)	% HGV	Distance	Pollutants	Method	Concentration (ug/m3)		Monitoring Period	Length of monitoring	Data Capture
									Mean	90th%ile			
Local Authority Sites													
Ashfield DC	RA3 786	M1	Pinxton			10m (hardshoulder)	PM10	gravimetric	28.7		Jun-Nov 2000	132 days	
Ashfield DC	RA3 786	M1	Selston			80m (hardshoulder)	PM10	gravimetric	31.6		Jan-jun 2000	132 days	
Gloucestershire Pollution Group	RA23 696	M5	Waterend Farm, Coaley, Nr Dursley 7561 0278	60000		20	PM10	TEOM	21.8		20/2/98 to 3/4/98	6 weeks	96.1
Kirklees MBC	RA3-783	M62	Nr Hartshead Moor Service Station			53 (hardshoulder)	PM10	TEOM	23		13/10/99 to 21/03/00	4 months	
Middlesborough C	RA23-547	A66	Middlesborough nr junc with A19 - residential area	85000		20 (kerb) on embankment	PM10	TEOM	19.5	41	Sep-Nov 99	3 months	
Milton Keynes C	RA3 672	M1	Miles Close, Blakelands			65	PM10	TEOM	20.8		11/2/99 to 5/5/99	3 months	
Winchester CC	RA23-529	M3	Kingsworthy	55382	10.6	29.9 (edge), 41.6 (centre)	PM10	BAM	22			1 month	
Winchester CC	RA23-529	M27	Whitely	82142	10.6	32.1 (edge), 63.9 (centre)	PM10	BAM	26.1			1 month	
Winchester CC	RA23-529	M3	Otterbourne	102031	10.6	50.3 (edge), 66.2 (centre)	PM10	BAM	25.2			1 month	
Winchester CC	RA23-529	M3	Winchester	87964	10.6	93.4 (edge), 127 (centre)	PM10	BAM	20.8			1 month	
AURN Sites													
Bristol Centre			ST594732			43	PM10	TEOM	26		2000	12 months	93.3
Wolverhampton Centre			SO914989	35000		30	PM10	TEOM	23		2000	12 months	97.7
TRL Sites													
M4		M4				4.1	PM10	TEOM	27.7		1999	12 months	

*All TEOM results have been multiplied by 1.3

Table A5 Details of Nitrogen Oxides and Nitrogen Dioxide Monitoring Near Roads in Major Conurbations

Authority	Report Ref	Location	Grid Ref	Traffic flow (AADT)	% HGV	Distance	Pollutant	Method	NO2 Concentration (ug/m3)		NOx Concentration (ug/m3)	Monitoring Period	Length of monitoring	Data Capture (%)
						from kerb			Mean	99.8th %ile	Mean			
Local Authority Sites														
Epping Forest DC	RA3-403	Grounds of Garnish Hall, nr M11/M25 jcn		80000(M11), 110000(M25)		100m from junction	NO2	Chemiluminesence	36		107	1/8/99-5/11/99	3 months	
LB of Bromley	RA3-757	Crystal Palace Parade	533911 171303	31000		4	NO2	Chemiluminesence	47.9			1/1/00 to 4/12/00	11 months	96.7
Salford CC		M60 St Marks School	374813 400853	140000		18	NO2	Chemiluminesence	57		312	2000	12 months	84
AURN Sites														
Camden Kerbside		Finchley Rd	TQ267843	37000		1	NO2	Chemiluminesence	63		206.6	2000	12 months	96
London A3 Roadside		A3	TQ193653	112000		2.5	NO2	Chemiluminesence	55		212.3	2000	12 months	97
London Bexley			TQ518763			40	NO2	Chemiluminesence	35		61.2	2000	12 months	97
London Bloomsbury			TQ302820	35000		35	NO2	Chemiluminesence	59		112.9	2000	12 months	96
London Brent				8000		30	NO2	Chemiluminesence	36		63.1	2000	12 months	98
London Bromley		A21	TQ405694	20000		5	NO2	Chemiluminesence	63		176.0	2000	12 months	82
London Haringey Roadside		A10	TQ339906	20000		5	NO2	Chemiluminesence	51		128.2	2000	12 months	88
London Hillingdon		M4	TQ069786			30	NO2	Chemiluminesence	48		141.6	2000	12 months	98
London Hounslow		A4 / M4	TQ175781	130000		8	NO2	Chemiluminesence	52		149.2	2000	12 months	97
London Marylebone Rd		Marylebone Rd	TQ281820	80000		1	NO2	Chemiluminesence	92		415.1	2000	12 months	96
London Southwark Roadside		A2	TQ346778	33000		3	NO2	Chemiluminesence	52		107.1	2000	12 months	96
London Sutton Roadside		St. Nicholas Way	TQ256646	20000		3.5	NO2	Chemiluminesence	40		109.0	2000	12 months	91
Bury Roadside		M62 / roundabout		169000 / 39800		16 / 21	NO2	Chemiluminesence	70		260.2	2000	12 months	97
Manchester Piccadilly			SJ843983			35	NO2	Chemiluminesence	41		82.3	2000	12 months	97
TRL Sites														
M25		M25				0.5			46.5					

Table A6 Details of PM_{10} Monitoring Near Roads in Major Conurbations

Authority	Report Ref	Location	Grid Ref	Traffic flow (AADT)	% HGV	Distance	Pollutant	Method	Concentration (ug/m3)		Monitoring Period	Length of monitoring	Data Capture (%)
									Mean	90th %ile			
Local Authority Sites													
LB of Bromley	RA3-757	Crystal Palace Parade	533911 171303	31000		4	PM10	TEOM	29.8		1/1/00 to 4/12/00	11 months	95.9
Salford CC		M60 St Marks School	374813 400853	140000		18	PM10	TEOM	29		2000	12 months	98
AURN Sites													
Camden Kerbside		Finchley Rd	TQ267843	37000		1	PM10	TEOM	34		2000	12 months	97.9
London A3 Roadside		A3	TQ193653	112000		2.5	PM10	TEOM	26		2000	12 months	98.2
London Bexley			TQ518763			40	PM10	TEOM	24		2000	12 months	97.3
London Bloomsbury			TQ302820	35000		35	PM10	TEOM	28		2000	12 months	97.1
London Brent				8000		30	PM10	TEOM	23		2000	12 months	98.4
London Haringey Roadside		A10	TQ339906	20000		5	PM10	TEOM	27		2000	12 months	93.7
London Hillingdon		M4	TQ069786			30	PM10	TEOM	25		2000	12 months	98.1
London Marylebone Rd		Marylebone Rd	TQ281820	80000		1	PM10	TEOM	48		2000	12 months	98.6
Bury Roadside		M62/roundabout		169000 / 39800		16 / 21	PM10	TEOM	29		2000	12 months	
Manchester Piccadilly			SJ843983			35	PM10	TEOM	28		2000	12 months	97.5
TRL Sites													
M25		M25				4.1	PM10	TEOM	28.9		1999	12 months	

*All TEOM results have been multiplied by 1.3