Winchester City Council
Stage 2 and 3 Assessment

(Front cover stored separately)

Summary

This report has been produced as part of Winchester City Council's statutory duties under the Air Quality Regulations 2000 to assess the air quality within its' District. The Department of the Environment, Transport and Regions (DETR) has issued guidance regarding these duties, which specifies a three staged approach for predicting the levels of 7 key pollutants against air quality standards. This report covers the stage 2 and 3 assessments for the three pollutants that were identified as requiring further evaluation within the stage 1 assessment. These pollutants were, carbon monoxide (CO), particulates (PM_{10}) and nitrogen dioxide (NO_2).

Initial modelling using the methodology set out in the Design Manual for Roads and Bridges (DMRB) showed that a stage three assessment was required for NO_2 but not CO. Based on existing real time data for PM_{10} it was decided to progress straight to a stage 3 assessment for this pollutant.

Stage 3 assessments were thus performed for PM_{10} and NO_2 using a combination of real time monitoring data and dispersion modelling using the AAQuIRE 2000 regional air quality model. This report summarises the work performed with all the data and supporting reports being included on a supporting CD ROM.

It was concluded that compliance with the first series of standards set within the Air Quality Regulations 2000 will be achieved and currently no Air Quality Management Areas (AQMA's) need to be declared.

Contents

Information on the CD

A CD ROM with all supporting reports and data has been included with this report where it has been requested. All this information is stored using Microsoft Office 97 Software (Word and Excel) if you do not have this software then a reader for Word and Excel has been included on the CD. *(Folder = Viewers and Converters for Word and Excel)*

The CD has the following information *(Folder name in brackets)*

- All the data from the real time monitoring performed within Winchester City town centre from 1997-99. *(Results from Winchester Monitoring Stations)*

- Results of Diffusion tube monitoring performed across Winchester's District *(Diffusion Tube Data – subfolders for NO_2 , Benzene and Ozone results)*

- A Copy of the Stage 1 Air Quality Report for Winchester's District *(Other Documentation)*

- A scanned copy the AAQuIRE 2000 dispersion monitoring report performed by external Consultants CES. The report is stored in two formats one includes the full report including all maps but is a large 49.2MB file, the other version excludes all the maps but makes reference to each individual map that are stored in a folder as a series of separate JPEGS. *(CES Stage 3 Dispersion Assessment)*

- DMRB Modelling and reports for CO and NO_2 performed as part of stage 2 assessments. *(DMRB stage 2 modelling)*

- Results of short term PM_{10} monitoring performed adjacent to the A34, M3 and M27. *(PM10 data background v mobile)*

1.0 Introduction

This report is a follow up report from Winchester City Council's Stage 1 Air quality assessment of it's District, a copy of which is included on the CD ROM. It thus focuses on the three pollutants that were identified as requiring further assessment i.e.

Carbon Monoxide (CO)
Particulates (PM_{10})
Nitrogen Dioxide (NO_2)

Since the production of the stage 1 report new air quality objectives have been introduced by the Air Quality (England) Regulations 2000. These objectives have to be met by a combined programme of national and local government actions. The objectives for these three pollutants are now:

Pollutant	Objective	Measured as	To be Achieved by
Carbon Monoxide	11.6mg/m^3 (10ppm)	Running 8 Hr Mean	31/12/2003
Nitrogen Dioxide	200μg/m^3 (105ppb) Not to be exceeded more than 18 times per year	1 Hour Mean	31/12/2005
	40μg/m^3 (21ppb)	Annual Mean	31/12/2005
Particles (PM_{10})	50μg/m^3 (Gravimetric) Not to be exceeded more than 35 times per year	24 Hour Mean	31/12/2004
	40μg/m^3	Annual Mean	31/12/2004

Table 1 – Revised Air Quality Standards

In conducting this assessment reference has been made to the Department of the Environment Transport and Regions (DETR) technical guidance series (The TG series). These have been revised recently, but in accordance with DETR advice for the purposes of this assessment the original guidance has been used. Particular reference has been made to:

TG1(98) -Monitoring for air quality reviews and assessments.
TG3(98) - Selection and use of dispersion models.
TG4(98) - Review and assessment, pollutant specific guidance.

Guidance note TG4(98) sets out a three staged approach to air quality assessments. The initial screening survey or stage 1 assessment has already been conducted and sent to the DETR and is included on the CD ROM. This additional assessment follows the approach detailed below:

> **Stage 2** – The use of simple emission inventories, dispersion models and indicative or lower accuracy quantitative monitoring devices to obtain further information on the pollutant of concern. This should enable a better understanding of the likely extent, if any, of the problem. Where failures in the air quality objectives are still likely then a stage 3 assessment has to be performed. On occasion, a

combination of stage 2 and 3 methodologies will be required to obtain sufficient information.

Stage 3 – This is the use of detailed modelling, emission inventories and monitoring to obtain accurate information on the level and extent of current failures. This will allow detailed projection as the likelihood of failures occurring without additional intervention. Where such is predicated then an Air Quality Management Area (AQMA) will have to be declared for that pollutant. The stage 3 investigations have thus to be sufficiently detailed in order to draw up such an action plan.

Rather than deal with each pollutant separately this report is divided into sections which deal with the different approaches used to perform the overall assessment. These were:

Real Time Monitoring for PM_{10}, NO_2 and CO within Winchester Town Centre at a roadside and background location. This has been performed since May 1996 and was thus not specifically set up for the purposes of conducting this assessment. In fact, in accordance with the guidance within TG4(98) the town centre of Winchester City did not need to be included within the stage 2/3 assessment. However, existing monitoring data from these sites suggested otherwise and thus the town centre has also been assessed. Short term monitoring for PM_{10} levels adjacent to the A34, M3 and M27 was also performed in 1999.

Diffusion Tube Surveys. Diffusion tube data at various sites is available from 1996 onwards. The diffusion tube survey was not specifically set up for the purposes of conducting this assessment. Recently the location of these sites has been changed to obtain additional data for sites near to the M3 and M27.

DMRB Modelling. The Design Manual for Roads and Bridges was used to predict levels of NO_2 and CO expected at locations adjacent to the M3, M27 and A34.

AAqUIRE 2000 Modelling. Winchester City Council acted as a co-ordinator for the regional modelling of air quality for the whole of South Hampshire. This was a joint project that involved 10 local authorities with the co-operation of Hampshire County Council and the Environment Agency. The contract was awarded to Consultants in Environmental Sciences Ltd (CES).

2.0 Real Time Monitoring

2.1 Location

The roadside site is located 2.8 metres from the kerb and samples at a height of 2.0 metres whilst the urban background site is located 18 metres from the kerb and samples at the slightly higher height of 2.8 metres. The difference in sampling heights was recognised but was a function of the different cabinets chosen for the sites. The larger urban background hut was chosen to provide working and storage space for equipment associated with the project and for its better aesthetic and noise insulation properties due to the proximity of housing. The necessity to sample directly above the cabinets in accordance with the requirements for particulate monitoring (i.e. the shortest possible straight line from the instrument to the sampling point) thus resulted in different sampling heights. The locations of the monitoring stations are shown in figure 1 and pictures of the monitors are shown in figures 2 and 3

FIGURE 1 – LOCATION OF WINCHESTER'S REAL TIME MONITORS

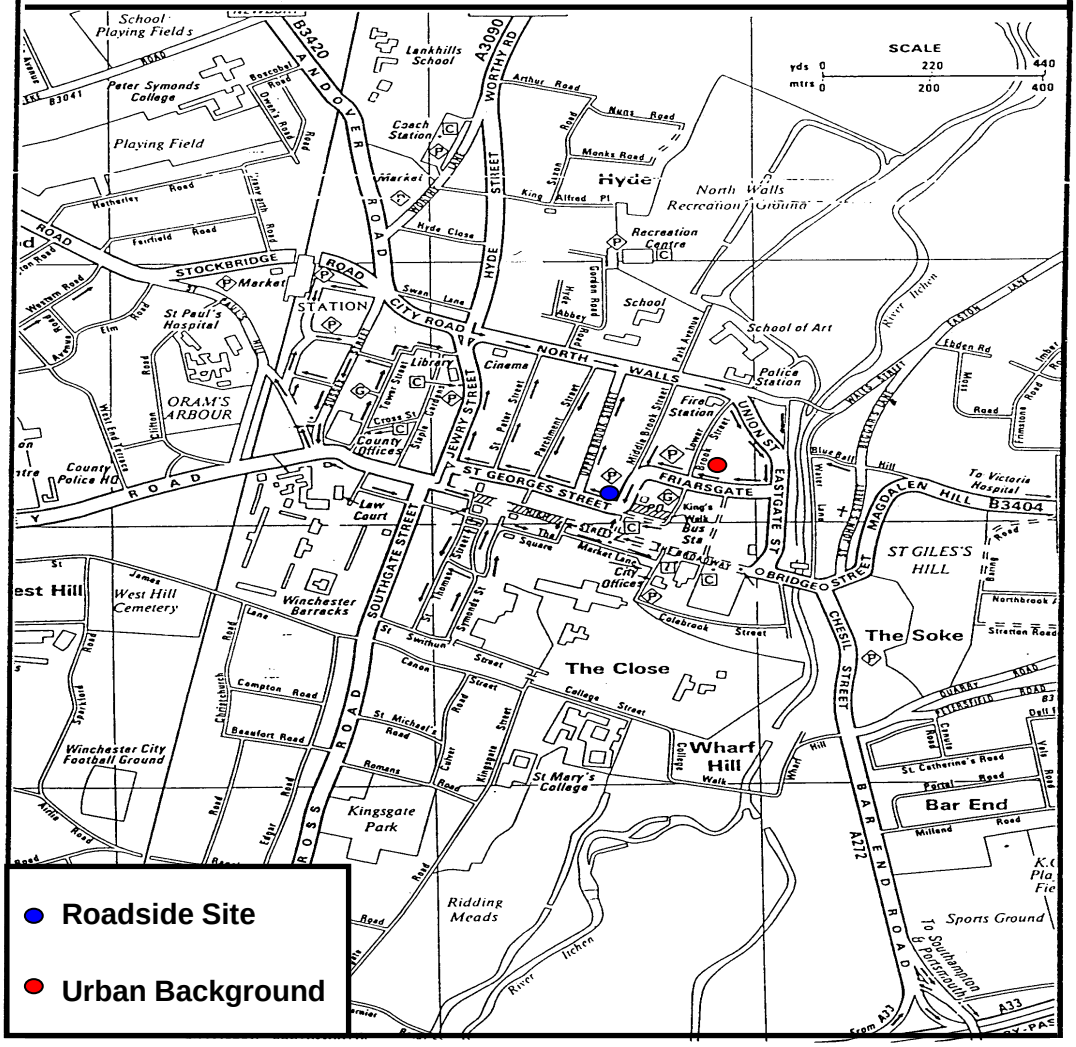

Figure 2 – Photograph of Roadside Monitor

Figure 3 – Photograph of Urban Background Monitor

The main limitations in the sites chosen were that neither were in fully open environments. The roadside site being in close proximity to shops and offices of 3 to 4 storeys tall at a minimum distance of 4.5 metres away and therefore is considered to be typical of an enclosed roadside location or street canyon. This was not considered to be unacceptable, as this was likely to measure a worst case scenario when compared with more open streets within the town centre. The urban background site although open is within 10 metres of 3 storey retirement flats, which shelters the site from the Northeast.

2.2 Equipment Specification

Following a tendering process a contract was awarded to Enviro Technology Services PLC of Stroud to provide, install and commission two of the following in May 1996:

- Met One Instruments Model BAM 1020 Beta attenuation mass monitor, for the monitoring of particles (PM_{10}).
- API Model 200A Chemiluminescent $NO/NO_2/NO_x$ Analyser
- API Model 300 Gas Filter Correlation CO analyser
- Odessa Engineering DSM 3260 Datalogger including the Envaid/Envicom software for communication and data manipulation.
- Public displays updating by modem direct from the dataloggers once per hour on a 24 hour loop.
- Ancillary equipment including housing, air conditioning units and modems

Basic meteorological monitoring equipment was added to the urban background site in May 1997 to monitor, wind speed, direction, temperature and humidity. This equipment was installed and commissioned by Enviro Technology Services using a Vector Instruments Low power anemometer and wind vane plus a Skye Instruments Ltd SKH 2013/3 Humidity and Temperature probe. These were connected to the Vector Instruments SCU326 signal conditioner which converted inputs into electrical signals for transmission direct to the Odessa dataloggers. The wind speed and direction is measured at 6 metres from ground level on a mast exiting the roof of the hut, whilst temperature and humidity readings are taken from the probe mounted at 4 metres from ground level.

A GK Instruments Ltd 6000 series traffic flow counter and datalogger was installed across the road directly adjacent to the Roadside location in January 1997 by Hampshire County Council.

2.21 Met One Instruments, Beta attenuation mass monitor

This analyser uses a principle that is different to most real time PM_{10} analysers. An external vacuum pump draws the sample through a PM_{10} head, which uses a cyclone effect to separate out the PM_{10} fraction. This is then passed onto the automatic filter paper strip where the collected dust is filtered out. The instrument then measures the amount of dust collected on the filter paper by passing beta radiation from a Carbon 14 source through the sample. The instrument works on a one hour sampling period by measuring the amount of beta particles absorbed by the blank filter paper, then collecting a sample and finally measuring again the amount absorbed by the now dust covered filter paper. During the cycle the instrument also performs an auto-calibration of the plain filter paper against a built in reference membrane of

known standard material. The difference between the two readings is the amount of beta absorption or attenuation caused by the dust, which is proportional to the mass density of the dust collected. The hourly average dust concentration is thus calculated from the total air volume filtered, which is monitored by the instrument and the known total mass of material collected. It is an important point that it is only the PM_{10} head fitted to the instrument that ensures the PM_{10} fraction is sampled.

2.22 API Model 200A Chemiluminescent $NO/NO_2/NO_x$ analyser

This analyser works on the principle of chemiluminescence where nitric oxide (NO) in the sample reacts with ozone to produce activated or high energy state NO_2 which then emits energy as light as it drops to a lower energy state:

$$NO + O_3 \longrightarrow NO_2^* + O_2$$

$$NO_2^* \longrightarrow NO_2 + h\nu$$

The total light emitted is thus proportional to the concentration of NO present; this is measured using a photomultiplier tube (PMT) which converts the result into a digital signal. The ozone required for this reaction is generated internally by the application of a high voltage AC electric supply to a pre-dried air supply. Having analysed the NO concentration the sample is passed over a heated molybdenum catalyst at 315°C which reduces all NO_2 present to NO by the following reaction:

$$3NO_2 + Mo \xrightarrow{315^oC} 3NO + MoO_3$$

This is then re-routed by switchable valves back through the analyser with the resultant concentration being the total of NO and NO_2 (converted to NO) referred to as the NOx concentration. The concentration of NO_2 is then calculated by the difference between the two readings.

The air is now drawn through the analyser using externally fitted vacuum pumps that have recently been installed to replace the unreliable internal pumps originally provided.

2.23 API Model 300 Gas Filter Correlation CO analyser

This analyser works on the principle of the absorption of infrared (IR) light at wavelengths close to 4.7 microns. In practice the instrument generates a broad band IR light source using a high energy heated element. This is then passed using a rotating gas filter wheel at 30 cycles per second alternately through one of two gas cells, one filled with nitrogen (The Measure Cell) and one filled with a CO/nitrogen mixture (The Reference Cell). During the reference phase the light is effectively stripped of absorbable light by the CO in the reference cell whilst in the measure cycle the nitrogen in the measure cell does not affect the light which can then be adsorbed by any CO in the sample cell. After the gas filter wheel the IR beam enters a multi-pass sample cell which uses optics to increase the length of the absorption path to increase the maximum sensitivity. The beam is then passed through a filter which only allows light of the wavelength of interest thorough. This is passed to a thermoelectrical cooled solid state photoconductor, which measures the light intensity striking it, which is converted into an electric signal. The reading

during the reference cycle is displayed as CO REF and during the measurement cycle as MEAS. The concentration of CO is thus proportional to the amount of light absorbed during the measurement cycle with the reference cycle being used as the calibration reference point.

2.24 Odessa Datalogger

This collects the hourly averaged data from the CO, PM_{10} and NO analysers as well as information from the automatic calibration results and meteorological equipment. It is fitted with a data cartridge, with a five day battery backup, which stores up to 64K (Approximately 3-4 months) of raw data on an overwrite basis. Both dataloggers are connected via modem to the public display systems as well as to a computer within the Environmental Health Department. The software originally used was Envaid/Envicom which was not Y2K compliant and was thus replaced with EMD, supplied by Siemens, in February 1999. Due to the limitations of the initial software all data processing was performed by manually exporting the data into an Excel spreadsheets set up for each month. Since the installation of EMD initial data processing has been performed within the software package exporting to Excel as and when necessary for additional processing.

2.3 Quality Control/Assurance

2.31 Daily Checks

The Envaid software was set-up to automatically download air quality data, by modem, twice per day at 7.00am and 7.00pm to the polling PC within the Environmental Protection office. An automatic daily printout was also set up to download the data once per day following the 7.00 am polling. This was then reviewed on the next working day, or on occasion as time allowed, which provided a quick check of results to spot any obvious errors and possible problems. Since the installation of the EMD software the system has been set up to poll once per hour during the daytime in order to update the public display and then at 2.00 am following AZS results. The API Model 300 Gas Filter Correlation CO analysers and the API Model 200A Chemiluminescent $NO/NO_2/NO_x$ analysers are all fitted with AZS (Automatic Zero and Span) capability performing an automatic check between 01.45-02.15 each night. All such instruments are thus fitted with an external zero air scrubber which is automatically routed during the auto zero check. The CO analysers perform auto spanning by routing a calibration gas through the instrument whilst the NOx analysers use a permeation tube (voltage generated NO source) which is only a secondary standard. All such AZS readings are thus used only to check for long-term instrument stability, any long-term trends in instrument readings, as well as obvious instrument failures. The AZS readings were also automatically printed out daily and reviewed as per the data. Since installation of the EMD software this data is now stored and a calibration report run as required. The Met One Instruments, Beta attenuation mass monitor performs an auto calibration check to an in-built reference membrane mass density during every reading and flags any data with a greater than 5 percent variation between the start and end cycle reference readings.

Any suspect results are investigated by visiting the site and recording all instrument parameters. Although the raw data reports include auto bad data flags, this does not trap all possible errors that could result in bad data. Any obvious or possible faults are then discussed with Enviro Technology

Services, unless they were simple to rectify such as blown fuses, broken PM_{10} tapes etc. If necessary a site visit was then made by them to rectify any outstanding matters. All such occurrences are recorded on a site inspection sheet and also on a site data book for reference when performing subsequent data manipulation.

2.32 Calibration Gases

The following calibration gases are used, which were initially supplied by Linde gas and latterly by Messr UK Ltd:

- L10 nominal 20vppm CO in Nitrogen at 150 bar, certified by AEA Technology to traceable primary standard – Roadside Cabinet.
- L40 nominal 20vppm CO in Nitrogen at 150 bar, certified by AEA Technology to traceable primary standard – Background Hut.
- L10 nominal 500vppb NO in Nitrogen at 150 bar, certified by AEA Technology to traceable primary standard – Stored in Background Hut
- L10 nominal 500vppb NO_2 in Air at 150 bar certified by AEA Technology – Stored in Background Hut.

The reason for the different sized CO cylinders is simply that space restriction at the roadside cabinet meant there was only room for an L10 sized cylinder. The CO cylinders are used both for the daily automatic AZS checks and also for the fortnightly manual gas checks. The NO and NO_2 cylinders are used only for fortnightly manual gas checks and are transported between sites using a welder's trolley. All gases are dated on receipt with a use by date, as the CO and NO cylinders are only certified stable for 12 months and the NO_2 for 6 months. In practice the CO gas, which is used every day for AZS checks, always runs out long before its' use by date. However, the NO and NO_2 gases are replaced every 12 and 6 months respectively despite the fact they are not empty.

2.33 Site Inspections and Calibration

Site inspections are performed every two-weeks in accordance with the main operational procedures of the AEA Air quality monitoring handbook for local authorities. The following lists the main activities performed, all of which are recorded on a site sheet:

- All instruments checked for flagged alarms and current readings noted.
- Operational parameters for NOx and CO instruments recorded and checked that all are within operational limits.
- Flow rate for PM_{10} analyser checked and altered if necessary.
- Pre-filters to NOx and CO instruments changed (after manual gas calibration).
- Temperatures on Max/Min thermometer noted and air conditioning units checked.
- Amount of tape on PM_{10} analysers checked and replaced if necessary (approximately once every 3 months).
- PM10 heads inspected and cleaned when necessary (at least once every 3 months).
- Manual gas calibration performed on the NOx and CO analysers, using NO and CO gases respectively and recorded once stable (3 consistent

readings). Instrument respaned and rezeroed using “zero air source” if greater than 5 per cent drift.

- NO_2 gas used to check NO_2 readings and thus molybdenum tube efficiency.
- All breakdowns reported to Enviro Technology Services of Stroud (who have a repair contract for all instruments with a 5 working day response).

The main deviation from the AEA protocol was the rezeroing and respanning of the CO and NOx instruments where a greater than 5 percent deviation from calibration gas values was noted. In practice the instruments were rezeroed and respanned when readings approached a 5 percent deviation, in order to ensure that an error greater than 5 percent did not occur. This methodology was adopted due to an initial lack of software capability to automatically adjust the raw data, using zero and span readings entered into the computer polling software. The national DETR network uses this system allowing up to a 20 percent deviation in the instruments before respanning, which ensures the instrument remain within the linear response range. However, such software applies a step change to the raw data using the newest correction factors to all subsequent raw data. This does not therefore account for the gradual decrease in sensitivity on many gas instruments, due to dirt build up, between subsequent zero and span readings. The collected raw data at Winchester is used in real time to update public displays with software, which also initially had no zero or span data correction capability. There was thus little choice other than to rezero and respan the instruments more frequently than recommended for long term instrument reliability. Such rezeroing and respanning is found to be most necessary soon after servicing, which is thought to be due to the higher impacts on sensitivity by the first “layer” of dust deposited on the detection cells.

Applying this methodology to all CO and NOx readings results in such data automatically having an in built error of up to 5 percent from the true reading. This was not considered excessive considering applying step changes to raw data will at times generate comparable errors. This approach is not considered unreasonable, as it is the standard methodology in other countries such as the USA.

2.34 Six Monthly Servicing

Enviro Technology Services of Stroud service all instruments in accordance with manufacture’s instructions every six months. A full service record of all such work is provided. On no occasions did the six monthly service identify an error in the instruments which would have compromised the accuracy of the results obtained in the previous six months.

2.4 Summary of Results

The results of all monitoring are summarised in Table 2. This shows the number of exceedances of the relevant air quality objective on a month by month and site by site basis.

Table 2 – Failures of Air Quality Standards, Winchester Town Centre

MONTH	PM10 Standard = 50ug/m3 (24 Hr Average)		NO2 Standard = 105ppb (1 Hr Average)		CO Standard = 10ppm (8Hr running Mean)	
	Background	Roadside	Background	Roadside	Background	Roadside
Jan-97	5	13	0	121	0	0
Feb-97	0	0	0	2	0	0
Mar-97	4	4	0	0	0	0
Apr-97	1	5	0	4	0	0
May-97	1	2	0	4	0	0
Jun-97	0	1	0	1	0	0
Jul-97	0	0	0	0	0	0
Aug-97	3	6	0	0	0	0
Sep-97	3	6	0	0	0	0
Oct-97	1	3	0	49	0	0
Nov-97	0	1	0	46	0	0
Dec-97	0	0	0	72	0	0
Jan-98	1	5	0	0	0	0
Feb-98	3	7	0	0	0	0
Mar-98	1	3	0	0	0	0
Apr-98	0	0	0	3	0	0
May-98	3	4	0	3	0	0
Jun-98	0	0	0	0	0	0
Jul-98	0	0	0	0	0	0
Aug-98	0	2	0	0	0	0
Sep-98	3	7	0	0	0	0
Oct-98	0	0	0	0	0	0
Nov-98	0	2	0	0	0	0
Dec-98	1	2	0	0	0	0
Jan-99	0	3	0	0	0	0
Feb-99	0	0	0	0	0	0
Mar-99	1	1	0	0	0	0
Apr-99	1	1	0	1	0	0
May-99	0	6	0	0	0	0
Jun-99	0	0	0	0	0	0
Jul-99	0	0	0	0	0	0
Aug-99	2	1	0	0	0	0
Sep-99	4	5	0	0	0	0
Oct-99	1	1	0	7	0	0
Nov-99	0	0	0	0	0	0
Dec-99	0	0	0	0	0	0

Failures						
1997	18	41	0	299	0	0
1998	12	32	0	6	0	0
1999	9	18	0	8	0	0

Average Conc						
1997	22.1ug/m3	31.8ug/m3	18.5ppb	43.3ppb	0.6ppm	1.1ppm
1998	20.6ug/m3	26.2ug/m3	20.8ppb	30.4ppb	0.4ppm	1.1ppm
1999	21.4ug/m3	24.9ug/m3	16.3ppb	31.5ppb	0.4ppm	1.0ppm

More detailed data sets are available on the CD ROM within the *Results for Winchester Monitoring Stations* folder. These detailed data sets are stored in yearly subfolders and present all the raw data and more detailed chart summaries and collection efficiencies.

2.41 Carbon monoxide (CO)

It can be seen from table 2 that between 1997-99 there have never been any failures for CO at either roadside or background locations.

2.42 Particles (PM_{10})

The PM_{10} standard is gravimetric based, whilst the monitoring data has been collected using a Beta attenuation based method (BAM). Although guidance has been issued on the conversion of TEOM based measurements to gravimetric using a correction factor of 1.3 there is no such advice for BAM results. This has been discussed with both The National Environmental Technology Centre (NETCEN) using the DETR funded helpline and the original equipment manufacturer. Both the BAM and gravimetric methods do not use heated heads, which has been suggested to be the main cause of the relative under reading of the TEOM instrument. Thus in conclusion the BAM results can be used for direct comparison with the gravimetric based standard.

Thus at the background site the monitoring results for the town centre meet the required daily and yearly objectives between 1997-99. As it is predicted that levels of PM_{10} should decrease, due to improvements in technology reducing emissions from road vehicles and industry, then compliance is currently predicted within Winchester town centre by the end of 2004. For further information on the regression analysis prediction of future PM_{10} concentrations see DETR report, Stedman JR & Linehan E et al - Predicting PM_{10} concentrations, National Environmental Technology Centre (copy on the CD ROM on *other documentation* folder).

The roadside site is not considered an appropriate location for comparison with a daily or yearly standard, as persons are not exposed over the relevant averaging periods. However, compliance has been achieved even at this location for the daily and yearly averages, except for the 1997 daily average, which recorded 41 exceedances compared to the 35 allowed by the objective. Further monitoring at the roadside location is thus required to ensure this trend continues.

2.43 Nitrogen dioxide (NO_2)

The background location between 1997-99 meets both the hourly and yearly required averages. At the roadside location compliance with the hourly standard was achieved in 1998 and 1999 but failed significantly in 1997 due to sustained high readings in January 1997. The annual average objective was exceeded significantly at the roadside location but this is not a location where persons are going to be exposed to over this averaging period.

As levels of NO_2 are currently predicted to decrease then compliance is currently expected at relevant locations within Winchester town centre by the end of 2004. Further monitoring at the roadside location will need to be performed to ensure hourly averages at roadside locations continue to follow

the 1998 and 1999 trends. For further information on predicted reductions on NO_2 levels see the DETR report, Stedman JR and Bush T et al - An empirical model for estimating roadside nitrogen dioxide concentrations in the UK, National Environmental Technology Centre (copy on CD ROM on *other documentation* folder).

3 Other Monitoring Exercises

3.1 Diffusion Tubes

All diffusion tube results are stored in yearly files under the folder *diffusion tube data*. Winchester City Council has been monitoring levels of NO_2 at various locations across its District since 1995. Initial monitoring was performed within the town centre as part of the assessment for the siting of real time monitoring equipment. In subsequent years monitoring was widened to include other smaller town/village centres and latterly locations close to the M3 and M27.

Sampling heights were approximately 3.0 metres in 1995/96. This was reduced to approximately 2.5 metres for subsequent years. The only exception is the diffusion tube currently located at Highways, Otterbourne, which is at 1 metre. All sampling sites are within 2 metres of the nearest kerb. Grid references for all sites sampled within this period are detailed below:

Chesil St, Winchester –	SU 488292
Winchester Road, Bishops Waltham	SU 554174
Broad St, New Alresford	SU 588328
Highways Rd, Otterbourne	SU 464243
Solent Business Park, Whiteley	SU 530088
Wickham Square, Wickham	SU 573115
Winchester Rd, Denmead	SU 659121
Longwood Dean	SU 545239
Alresford Rd, Winchester	SU 496295
City Rd, Winchester	SU 480298
Friarsgate/Eastgate St	SU 485296
Echo Offices, Winchester	SU 483295
Upper High St, Winchester	SU 478297

Diffusion tubes adsorb nitrogen dioxide where upon it is converted to nitrite by reacting with the triethanolamine present in the tube. The nitrogen dioxide is then determined by analysing the amount of nitrite present colourimetrically after it has been reacted with the colour-forming reagent sulphonamide. The tubes were changed usually on a fortnightly basis although on occasion a 3-week duration had to be used due to time restraints.

These tubes were supplied by Gradko International of Winchester who take part in the NETCEN QC/QA exercise but are not currently NAMAS accredited. Recently tubes have been co-located adjacent to the Roadside site and the results compared to the real time average over the same period. It has been concluded that the tubes tend to under read in comparison with real time data. When this was explored with the company no evidence could be found for error in the production or analysis of the tubes. Gradko International, with Winchester City Council's co-operation, are currently undertaking field trials to investigate alternative designs and chemical dosing agents.

It is thus considered that these results cannot be used to compare directly with the annual average standard without the use of a questionable correction factor. However, these tubes should be consistent with each other and thus provide comparative results between the monitoring sites.

SAMPLE PERIOD	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
	ALL RESULTS IN PPB								
25/03/99 - 12/04/99	12.8	11.0	16.0	14.0	16.8	29.3	14.1	28.9	18.7
12/04/99 - 23/04/99	7.9	8.5	6.2	7.5	9.7	21.0	10.8	9.7	missing
23/04/99 - 06/05/99	6.6	12.6	13.1	10.1	14.1	10.1	7.9	21.3	21.5
06/05/99 - 20/05/99	9.9	13.1	17.4	10.5	21.5	16.0	11.8	16.6	missing
20/05/99 - 04/06/99	10.9	13.1	15.4	9.8	19.7	25.5	9.1	15.5	21.1
04/06/99 - 18/06/99	7.0	12.1	17.2	10.8	15.3	28.6	10.2	21.7	24.1
18/06/99 - 01/07/99	11.0	6.9	8.8	5.5	9.1	9.9	5.5	missing	missing
01/07/99 - 14/07/99	9.0	13.5	19.4	9.7	18.9	23.9	9.7	19.9	25.2
14/07/99 - 30/07/99	9.2	12.5	15.7	13.6	15.5	23.3	missing	14.6	21.7
30/07/99 - 13/08/99	12.0	19.1	19.1	15.1	17.1	30.1	15.3	24.1	25.7
13/08/99 - 26/08/99	8.6	14.0	15.4	14.1	18.0	missing	11.9	19.3	21.9
26/08/99 - 13/09/99	10.6	14.4	19.6	14.9	missing	29.4	14.4	20.6	23.3
13/09/99 - 23/09/99	13.8	14.7	19.0	15.6	13.8	21.6	15.6	18.2	22.5
23/09/99 - 07/10/99	9.8	9.2	12.7	8.6	13.8	21.9	5.2	9.8	17.3
07/10/99 - 21/10/99	11.1	9.9	12.4	11.7	17.4	14.8	13.0	13.0	16.1
21/10/99 - 03/11/99	14.0	10.0	13.9	11.3	14.6	21.3	11.3	14.0	16.0
03/11/99 - 16/11/99	7.9	12.6	15.9	11.9	19.9	18.6	12.6	17.9	21.9
16/11/99 - 08/12/99	8.7	8.3	13.4	13.0	9.4	18.9	13.0	11.4	missing
08/12/99 - 22/12/99	12.3	9.9	11.1	11.7	14.2	20.4	15.4	missing	28.7
22/12/99 - 06/01/00	10.5	10.0	14.0	11.2	13.0	4.5	13.4	13.3	14.0
06/01/00 - 19/01/00	16.2	15.4	20.7	18.0	17.7	23.9	16.2	15.6	22.6
19/01/00 - 02/02/00	9.7	10.6	8.3	10.2	missing	18.0	10.6	missing	13.8
02/02/00 - 16/02/00	16.1	16.1	14.8	12.4	18.5	31.0	16.7	missing	14.9
16/02/00 - 01/03/00	8.6	12.3	10.5	14.2	15.4	24.1	12.9	12.3	20.4
01/03/00 - 23/03/00	8.3	10.6	10.6	10.6	18.5	missing	11.4	13.4	16.9
23/03/00 - 17/04/00	10.4	12.1	19.4	10.7	24.2	15.6	12.8	13.5	19.4
17/04/00 -									
YEARLY AVERAGE	10.5	12.0	14.6	11.8	16.1	20.9	12.0	16.6	20.3

SITE 1 - Winchester Rd, Denmead
SITE 2 - Wickham Square, Wickham
SITE 3 - Winchester Rd, B.Waltham
SITE 4 - Broad St, New Alresford
SITE 5 - Highways Road, Otterbourne
SITE 6 - City Road, Winchester
SITE 7 - Solent Business Park
SITE 8 - Alresford Rd, Winchester
SITE 9 - Roadside Site, Winchester

Table 3 – Nitrogen Dioxide Diffusion Tube Results 1999-2000

SAMPLE PERIOD	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9
	ALL RESULTS IN PPB								
27/03/98 - 08/04/98	17.0	17.0	21.5	14.8	24.5	30.4	24.2	21.3	
08/04/98 - 23/04/98	9.8	9.8	11.5	13.2	19.5	20.7	17.8	16.7	
23/04/98 - 12/05/98	9.1	11.8	17.7	10.9	21.8	16.8	20.9	19.1	
12/05/98 - 22/05/98	11.8	15.3	29.2	13.4	22.4	23.2	33.0	24.6	
22/05/98 - 03/06/98	9.6	STOLEN	17.6	11.9	21.7	22.5	25.2	23.7	
03/06/98 - 17/06/98	8.9	11.0	17.2	12.0	18.0	20.4	15.0	14.5	
17/06/98 - 01/07/98	7.2	9.4	12.2	8.6	14.7	21.5	16.5	13.4	18.3
01/07/98 - 21/07/98	8.0	11.4	12.7	11.4	14.3	17.3	12.7	STOLEN	18.1
21/07/98 - 30/07/98	9.6	10.5	14.3	12.4	18.2	22.1	15.6	11.6	20.1
30/07/98 - 12/08/98	10.7	14.0	23.2	16.6	18.6	22.6	18.6	14.6	STOLEN
12/08/98 - 27/08/98	8.6	STOLEN	16.0	13.2	22.5	24.8	17.0	16.5	STOLEN
27/08/98 - 09/09/98	10.0	14.0	17.3	12.7	21.9	20.6	20.7	18.1	STOLEN
09/09/98 - 23/09/98	11.0	10.4	17.1	15.3	25.2	20.9	19.2	15.5	STOLEN
23/09/98 - 08/10/98	11.5	14.8	20.3	14.6	23.2	27.2	27.2	21.3	STOLEN
08/10/98 - 22/10/98	9.5	11.2	14.2	3.2	24.1	23.5	17.6	15.2	21.6
22/10/98 - 03/11/98	10.5	12.6	16.0	14.0	23.0	25.1	15.3	9.8	18.1
03/11/98 - 18/11/98	12.1	15.6	17.9	13.8	18.4	25.9	18.4	14.4	24.2
18/11/98 - 03/12/98	16.2	17.4	20.7	16.8	24.1	25.2	24.6	19.5	23.0
03/12/98 - 16/12/98	16.6	18.6	20.5	17.9	24.5	25.8	23.2	19.2	STOLEN
16/12/98 - 31/12/98	13.9	16.8	16.2	12.7	20.2	24.8	16.9	16.3	STOLEN
31/12/98 - 14/01/99	14.7	STOLEN	19.0	15.4	18.5	STOLEN	17.2	16.9	21.5
14/01/99 - 28/01/99	12.4	15.5	17.3	16.1	18.0	28.5	16.1	19.8	14.2
28/01/99 - 10/02/99	11.3	17.3	21.9	15.3	25.9	21.9	11.3	14.0	37.2
10/02/99 - 24/02/99	10.5	11.1	16.7	STOLEN	19.1	26.5	14.2	5.6	21.6
24/02/99 - 10/03/99	13.8	10.8	37.7	19.2	20.2	25.7	14.7	12.5	STOLEN
10/03/99 - 25/03/99	10.4	12.1	22.5	11.0	22.8	23.6	9.8	STOLEN	17.5
YEARLY AVERAGE	11.3	13.4	18.8	13.5	20.9	23.5	13.2	16.4	21.3
					* 21.2		* 19.5		

SITE 1 - Winchester Rd, Denmead
SITE 2 - Wickham Square, Wickham
SITE 3 - Winchester Rd, B.Waltham
SITE 4 - Broad St, New Alresford
SITE 5 - Echo Office, Winchester
***SITE 5 - Highways Rd, Otterbourne (From Jan 99 onwards)**
SITE 6 - City Road, Winchester
SITE 7 - Chesil St, Winchester
***** **SITE 7 - Solent Business Park (From Jan 99 onwards)**
SITE 8 - Alresford Rd, Winchester
SITE 9 - Roadside Site, Winchester

Table 4 – Nitrogen Dioxide Diffusion Tube Results 1998/99

Tables 3 and 4 show the results for years 1999/2000 and 1998/99. Importantly these show that Winchester town centre (sites 6 and 9) produces results higher than other town/village locations (sites 1 to 4). The town centre results are also higher than those adjacent to the M3 or M27 (sites 5, 7 and 8). These results thus support the continuation of real time monitoring within Winchester Town Centre as a worst case scenario for levels of NO_2 across the District.

Also included on the CD ROM are the results for limited Ozone and Benzene monitoring that is outside the scope of this assessment. The results are considered of questionable accuracy and have only been included to avoid criticism of selective data presentation.

3.2 PM_{10} Monitoring Adjacent Motorways

The stage 1 report on PM_{10}'s identified that the main area for further investigation was adjacent to the A34, M3 and M27. A short duration project was thus organised to monitor levels at such locations for 1 month at each location, in order to obtain a comparison with results recorded within the town centre. The objective was to obtain a set of results to ascertain levels comparative to the town centre for which a longer-term data set is available. An instrument identical to those located in the real time monitoring stations within Winchester town centre was placed in the rear gardens of domestic residences identified as being close to the relevant roads.

The full results from this monitoring are stored on the CD ROM under the folder titled *PM_{10} data background v mobile*. Summaries of these results are presented in table 5 below.

Location	Mobile Station		Background (Town Centre)	
	Average of 1Hr readings	Median - Daily Averages	Average of 1Hr readings	Median - Daily Averages
Winchester M3	20.8	19.0	19.4	17.9
Whiteley M27	26.1	24.1	26.4	27.4
Otterbourne M3	25.2	24.8	25.5	24.7
Kingsworthy M3	22	20.9	19.4	17.5
Mislingford (Rural)	22.5	21.3	19.1	16.8
Co-location Study	20.2	19.3	17.3	15.1

Location	Relative Ratios	
	Averages - Mobile/Town	Medians - Mobile/Town
Winchester M3	1.07	1.06
Whiteley M27	0.99	0.88
Otterbourne M3	0.99	1.00
Kingsworthy M3	1.13	1.19
Mislingford (Rural)	1.18	1.27
Co-location Study	1.17	1.28

Location	Distance to Road	
	Edge (m)	Centre (m)
Kingsworthy (A33)	29.9	41.6
Winchester (M3)	93.4	127
Otterbourne (M3)	50.3	66.2
Whiteley (M27)	32.1	63.9
Mislingford (Background)	N/A	N/A

Table 5 – Summary of Monthly PM_{10} Monitoring Adjacent to Major Roads

The results obtained were not as predicted with one of the highest relative ratios being obtained during the co-location trial. Upon receipt of these results both the analysers were fully checked by Enviro Technology Services who could find no operating errors with either instrument. The only known difference between the instruments was thus the sampling heights, with the

mobile head being at 1.9 metres whilst the background site samples at 2.8 metres. In addition, the next highest set of results was obtained at a rural location, which was included for a comparison with locations adjacent to major roads. The only suggested reason for this observation was the domestic burning coal/wood burning at and near this property.

As all other ratios are below that obtained during the co-location study this suggests that the monitoring within Winchester town centre provides a worst case scenario for the whole of the District. Ensuring compliance with the air quality objectives within the town centre should ensure compliance across the district.

4.0 DMRB Dispersion Modelling

4.1 Carbon Monoxide and Nitrogen Dioxide

These reports are included on the CD ROM under the DMRB *Stage 2 Modelling* folder. This work concluded that a further stage 3 assessment was required for NO_2 but not CO. This modelling used the revised version of DMRB, which has been subsequently criticised for the accuracy of results predicted, especially with reference to NO_2.

This DMRB modelling was subsequently superseded by the more detailed modelling performed by external consultants detailed in the next section.

5.0 CES Regional Dispersion Modelling

5.1 Objective

Many local authorities within Southern Hampshire have common road links such as the M3 and M27 as well as being affected by large point source industrial emissions such as the oil refinery in Fawley. It was thus concluded that a consistent regional model of air quality from such sources was required to avoid discrepancies that could arise if all Local Authorities performed separate assessment using different methodologies.

Winchester City Council thus co-ordinated the use of external consultants to perform such a study across South Hampshire. The objective was to produce one consistent report for the whole area that met the requirements of the DETR guidance on the selection and use of dispersion models.

5.2 Data Provided

The following data sources were made available to the consultants.

Local authorities – Known industrial sources and emission data based on the register of processes authorised for air pollution control ("Part B processes"). The unitary authorities of Portsmouth and Southampton also provided traffic flow data. Authorities with monitoring data also provided this data together with QC/QA details so modelling ratification could be performed.

Hampshire County Council – Traffic data for all roads with an average daily flow greater than 5,000 vehicles.

Environment Agency – Emission data from processes prescribed for Integrated Pollution Control ("Part A processes"). Arrangements were also made for CES to meet with the Environment Agency to obtain this data and also discuss integration of this study with industrial dispersion modelling being proposed for the Fawley area.

5.3 Conclusions

The full CES report is included on the CD ROM on the *CES Stage 3 Air Quality Assessment* folder. Two formats of this report are included, one which includes all the dispersion model plots which results in a 49.2MB file. The other format is text only with reference to the dispersion plots, which are stored as separate JPEGS. A copy of this report is also available for Inspection at the Council offices upon prior arrangement.

This report is a regional assessment of air quality and so is not considered to be accurate in micro-environments, such as Winchester town centre which has numerous small road inputs not included within the model. Compliance within the town centre has thus been based on the actual air quality modelling detailed in the previous section. However, this model is considered appropriate for modelling impacts from industrial point sources and major line sources from the link roads including the A34, M3 and M27.

Using the review and assessment guidance, it was these main link roads that were identified within the stage 1 report as being locations where failures for PM_{10}, CO and NO_2 were most likely to occur.

The report concludes that compliance with the air quality objectives will be achieved for NO_2, CO or PM_{10} across all of Winchester City Council's District.

6.0 Definitions and Terminology

PM_{10} – Particles with an average aerodynamic diameter of less than 10 microns. Often referred to as fine particles.

CO – Carbon monoxide, a gaseous pollutant mainly from road vehicles.

NO_2 – Nitrogen dioxide, a gaseous pollutant mainly from combustion processes including road vehicles (NOx is the sum of Nitrogen dioxide and Nitrogen monoxide NO).

BAM - Beta Attenuation Mass – a technique for measuring PM_{10} used in Winchester.

TEOM – Another methodology used in the UK for measuring PM_{10} levels.

DMRB model – A basic 'pen and paper' dispersion model used to predict future pollutant concentrations (from the Design Manual for Roads and Bridges).

DETR – Department of the Environment, Transport and the Regions.

AAqUIRE 2000 – A complex computer dispersion model used to predict more accurately future pollutant concentrations.

CES – a consultancy used in Hampshire to run the AAqUIRE 2000 modelling.

AQMA's – Air Quality Management Areas, a declared zone where additional measures are required locally/nationally to meet air quality objectives. None are currently proposed in Winchester's area.

AUN – Automatic Urban Network – the UK network of DETR owned monitoring stations (nearest to Winchester is at Southampton).

PPB – Parts per Billion, a way of expressing pollutant concentrations.

PPM – Parts per Million, a way of expressing pollutant concentrations.

WCC – Winchester City Council.

HCC – Hampshire County Council.

EA – Environment Agency.

Stage 1, 2 or 3 – Makes reference to an increasing complexity of assessment for a pollutant as recommend by DETR guidance. Stage 3 being the most complex.

7.0 References and Further Information

If you have any specific queries regarding this report then please do not hesitate to contact Winchester City Council Environmental Health and Housing Department and specifically Mr Phil Tidridge on 01962 848519 or Miss Sara Hayes on 01962 848146.

Further information can also be obtained from the following publications:

Department of the Environment Transport & Regions The Air Quality Strategy for England, Scotland Wales and Northern Ireland, ISBN 0 10 145482-1

Department of the Environment - Expert Panel on Air Quality Standards, Benzene, HMSO, ISBN 0 11 752859 5

Department of the Environment - Expert Panel on Air Quality Standards, Particles, HMSO, ISBN 0 11 753199 5

Department of the Environment - Expert Panel on Air Quality Standards, Ozone, HMSO, ISBN 0 11 752873 0

Department of the Environment - Expert Panel on Air Quality Standards, Nitrogen Dioxide, HMSO, ISBN 0 11 753352 1

Department of the Environment - Expert Panel on Air Quality Standards, Carbon Monoxide, HMSO, ISBN 0 11 753035 2

Department of the Environment - Expert Panel on Air Quality Standards, Sulphur Dioxide, HMSO, ISBN 0 11 753135 9

Department of the Environment - Expert Panel on Air Quality Standards, 1,3-Butadiene, HMSO, ISBN 0 11 753034 4

The Air Quality Regulations 1997, SI 1997 3043, ISBN 0 11 065315

The Air Quality (England) Regulations 2000

Environment Act 1995-Chapter 25, HMSO, ISBN 0 10 542595 8

Department of the Environment Transport & Regions - Air Quality and Traffic Management, The Stationery Office, ISBN 0 11 753427 7

Department of the Environment Transport & Regions - Air Quality and Land Use Planning, The Stationery Office, ISBN 0 11 753424 2

Department of the Environment Transport & Regions - Framework for Review and Assessment of Air Quality, The Stationery Office, ISBN 0 11 753426 9

Department of the Environment Transport & Regions - Developing Local Air Quality Action Plans and Strategies: The Principal Considerations, The Stationery Office, ISBN 0 11 753425 0

Department of the Environment Transport & Regions – Selection and Use of Dispersion Models, The Stationery Office, ISBN 0 11 753435 8

Department of the Environment Transport & Regions – Preparation and Use of Atmospheric Emissions inventories, ISBN 0 11 753434 X

Department of the Environment Transport & Regions – Monitoring for Air Quality Reviews and Assessments, The Stationery Office, ISBN 0 11 753429 3

Department of the Environment Transport & Regions – Review and Assessment: Pollutant Specific Guidance LAQM.TG4(98) – Loose Leaf Publication

DETR – Report of the Airborne Particles Expert Group, Source Apportionment of Airborne Particulate Matter in the United Kingdom, January 1999, ISBN 0-7058-1771-7.

DETR – Report of the Airborne Particles Expert Group, Source Apportionment of Airborne Particulate Matter in the United Kingdom, January 1999, ISBN 0-7058-1771-7.

DETR – Report of the Airborne Particles Expert Group, Source Apportionment of Airborne Particulate Matter in the United Kingdom, January 1999, ISBN 0-7058-1771-7.

Department of Health – Committee on the medical effects of air pollution. Handbook on air pollution and health, August 1997, ISBN 0-11-322096-0.

Department of Health – Committee on the medical effects of air pollution. Handbook on air pollution and health, August 1997, ISBN 0-11-322096-0.

AEA Technology - Air Quality Monitoring: A Handbook for Local Authorities, AEA Technology, August 1996, AEA/RAMP/20029001/01.

DETR Monitoring Helpline – Operated by the National Environmental Technology Centre, aqm.helpline@aeat.co.uk (Tel 01235 463356).

DETR – Report of the Airborne Particles Expert Group, Source Apportionment of Airborne Particulate Matter in the United Kingdom, January 1999, ISBN 0-7058-1771-7.

Stanger Science /National Environmental Technology Centre – Assistance with the review and assessment of PM10 concentrations in relation to the proposed EU Stage 1 Limit Values, March 1999 unpublished but available on www.aeat.co.uk/netcen/airqual/welcome

Stedman John, Linehan Emma et al (AEA Technology plc) – Predicating PM10 concentrations in the UK, Report 20440109/003 for DETR, 1999, unpublished but available on www.aeat.co.uk/netcen/airqual/welcome

Stedman John and Bush Tony (AEA Technology plc) - An empirical model for estimating roadside nitrogen dioxide concentrations in the UK, Report AEAT-4921 for DETR, December 1998, unpublished but available on www.aeat.co.uk /netcen /airqual/welcome.

Department of the Environment - First Report of the Quality of Urban Air Review Group (QUARG), Urban Air Quality in the United Kingdom, January 1993, ISBN 0 9520771 1 6

Department of the Environment - Second Report of the Quality of Urban Air Review Group (QUARG), Diesel Vehicle Emissions and Urban Air Quality, December 1993, ISBN 0 9520771 2 4

Department of the Environment - Third Report of the Quality of Urban Air Review Group (QUARG), Airborne Particulate Matter in the United Kingdom, May 1996, ISBN 0 9520771 3 2

Department of the Environment Transport and the Regions - National Air Quality Information at www.aeat.co.uk/netcen/airqual/welcome

CIEH/AEA – Air Quality, Guidance Manual on the Application of Procedures Prescribed for Local Authority Air Quality Management, Volumes 1 & 2