Appendix 1

Detailed Assessment of Air Quality in Wyre Forest District Council

Document Control

Client	Wyre Forest District Council	**Principal contact**	Richard Williams

Job Number	J633

Document prepared by:	Dr Nicky Woodfield and Dr Denise Welch

Document Status and Review Schedule

Issue No.	Report No.	Date	Status	Reviewed by
1	633/1/F1	20 September 2007	Final Draft Report	Prof. Duncan Laxen
2	633/1/F2	14 November 2007	Final Report	Prof. Duncan Laxen
3				

Air Quality Consultants Ltd
23 Coldharbour Road, Bristol BS6 7JT Tel: 0117 974 1086
12 Airedale Road, London SW12 8SF Tel: 0208 673 4313
aqc@aqconsultants.co.uk

Registered Office: 12 St Oswalds Road, Bristol, BS6 7HT
Companies House Registration No: 2814570

Contents

1 Introduction

1.1 Air Quality Consultants has been commissioned by Wyre Forest District Council to undertake a Detailed Assessment of air quality. This report covers a Detailed Assessment for nitrogen dioxide from traffic emissions in the vicinity of Coventry Street in Kidderminster.

1.2 Wyre Forest District Council is also required to undertake a Detailed Assessment for sulphur dioxide in the vicinity of Bewdley Station. However, as a result of flooding across large areas of Worcestershire and surrounding areas in the summer of 2007, part of the Severn Valley Railway Line in the vicinity of Bewdley has been badly damaged. As a result of this, the heritage railway line remains closed and unserviceable until further notice. Further information with regards to proposals for future assessment is provided in Section 2 of this report.

Introduction to the Second and Third Rounds of Review and Assessment

1.3 The Government's most recent Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Defra, 2007a) sets out a framework for air quality management, which includes a number of air quality objectives. National and international measures are expected to achieve these objectives in most locations, but where areas of poor air quality remain, air quality management at a local scale has a particularly important role to play. Part IV of the Environment Act 1995 requires local authorities to periodically review and assess the current, and likely future air quality in their areas. The role of this process is to identify areas where it is unlikely that the air quality objectives will be achieved by the due date. These locations must be designated as AQMAs and a subsequent Air Quality Action Plan developed in order to reduce pollutant emissions in pursuit of the objectives.

1.4 Review and Assessment is a long-term, ongoing process, structured as a series of 'rounds'. Local authorities in England, Scotland and Wales have now largely completed the first two rounds of Review and Assessment and the third round is underway.

1.5 Local Air Quality Management Technical Guidance (LAQM.TG(03)) (Defra, 2003a) sets out a phased approach to the second and third rounds of Review and Assessment. This prescribes an initial Updating and Screening Assessment (USA), which all authorities must undertake. It is based on a checklist to identify any matters that have changed since the first round. If the USA identifies any areas where there is a risk that the objectives may be exceeded, which were not identified in the previous round, then the local authority should progress to a Detailed Assessment.

1.6 The purpose of the Detailed Assessment is to determine whether an exceedence of an air quality objective is likely and the geographical extent of that exceedence. If the outcome of the Detailed Assessment is that one or more of the air quality objectives is being or is likely to be exceeded, then an Air Quality Management Area must be declared. Subsequent to the declaration of an Air Quality Management Area, a Further Assessment should be carried out to confirm that the Air Quality Management Area declaration is justified; that the appropriate area has been declared; to ascertain the sources contributing to the exceedence; and to calculate the magnitude of reduction in emissions required to achieve the objective. This information can be used to inform an Air Quality Action Plan, which will identify measures to improve local air quality.

1.7 This report represents a Detailed Assessment within the third Round of Review and Assessment, following findings from Wyre Forest District Council's Updating and Screening Assessment published in 2006 (Wyre Forest District Council, 2006).

The Air Quality Objectives

1.8 The Government's Air Quality Strategy (Defra, 2007a) provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. It also sets out how the different sectors: industry, transport and local government, can contribute to achieving the air quality objectives. The objectives are prescribed within The Air Quality (England) Regulations 2000 (The Stationery Office, 2000) and The Air Quality (England) (Amendment) Regulations 2002 (The Stationery Office, 2002). This latter publication set more stringent objectives for benzene and carbon monoxide. The 'standards' are set as concentrations below which health effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of a particular pollutant. The 'objectives' set out the extent to which the Government expects the standards to be achieved by a certain date. Table 1 summarises the objectives which are relevant to this report, which covers nitrogen dioxide and sulphur dioxide.

1.9 The air quality objectives only apply where members of the public are likely to be regularly present for the averaging time of the objective (i.e. where people will be exposed to pollutants). For annual mean objectives, relevant exposure is limited to residential properties, schools and hospitals. The 1-hour objective applies at these locations as well as at any outdoor location where a member of the public might reasonably be expected to stay for 1 hour or more, such as shopping streets, parks and sports grounds, as well as bus stations and railway stations that are not fully enclosed. The 15-minute sulphur dioxide objective applies to those locations where a member of the public might reasonably be expected to remain for 15 minutes or more, such as those described above for the short-term nitrogen dioxide objective.

1.10 Measurements across the UK have shown that the 1-hour nitrogen dioxide objective is unlikely to be exceeded unless the annual mean nitrogen dioxide concentration is greater than 60µg/m^3 (Laxen and Marner, 2003). Thus, exceedences of 60µg/m^3 as an annual mean nitrogen dioxide concentration may be used as an indicator of potential exceedences of the 1-hour mean nitrogen dioxide objective.

1.11 The European Union has also set limit values for nitrogen dioxide. Achievement of these values is a national obligation rather than a local one. The limit values for nitrogen dioxide are the same levels as the UK objective, but are to be achieved by 2010.

Table 1 Air Quality Objectives for Nitrogen Dioxide and Sulphur Dioxide.

Pollutant	Status	Time Period	Objective / Value	To be Achieved by[a]
Sulphur Dioxide	Statutory UK Objective	1-hour mean	350 µg/m^3 not to be exceeded more than 24 times a year	2004
		24-hour mean	125 µg/m^3 not to be exceeded more than 3 times a year	2004
		15-minute mean	266 µg/m^3 not to be exceeded more than 35 times a year	2005
Nitrogen Dioxide	Statutory UK Objective	1-hour mean	200 µg/m^3 not to be exceeded more than 18 times a year	2005
		Annual mean	40 µg/m^3	2005
	EU Limit Value	1-hour mean	200 µg/m^3 not to be exceeded more than 18 times a year	2010
		Annual mean	40 µg/m^3	2010

[a] The achievement dates for the UK objectives are the end of the specified year; achievement dates for the EU limit values are the start of the specified year.

Report Structure and Issues Addressed

1.12 Section 2 sets out the methodology for the assessment. Section 3 reviews relevant monitoring data and provides the results of the detailed dispersion modelling for nitrogen dioxide. These data are then used to determine the likelihood of exceedences of the nitrogen dioxide objectives within the study area. Section 4 of this report provides conclusions and recommendations with respect to the outcomes of the assessment in relation to the nitrogen dioxide air quality objectives.

Key findings of the Updating and Screening Assessment and previous Review and Assessment work

1.13 As part of the first round of assessment work, Wyre Forest District Council submitted a Stage 3 Assessment for nitrogen dioxide in June 2002. This assessment concluded that the nitrogen dioxide annual mean objective would be exceeded in two locations. The Council therefore declared Air Quality Management Areas in Welch Gate in Bewdley and at the Horsefair (Blackwell Street) in Kidderminster in 2002. Both Air Quality Management Areas remain in place, and are shown in Figure 1 and Figure 2.

Figure 1 Horsefair AQMA, Blackwell Street, Kidderminster (© Crown copyright. Defra Licence No. GD272361 2002)

Figure 2 Welch Gate AQMA, Kidderminster (© Crown copyright. Defra Licence No. GD272361 2002)

1.14 Wyre Forest District Council's nitrogen dioxide diffusion tube monitoring network has been expanded following a recommendation in the 2003 Stage 3 report. This has included an additional diffusion tube site at 69 Coventry Street in Kidderminster. In 2006 the monitoring network was rationalised, with a number of tubes being moved away from the kerbside to the façade of relevant properties and the overall number of tubes being reduced. Wyre Forest District Council's 2006 USA identified exceedences of the nitrogen dioxide annual mean objective along Coventry Street, and therefore a requirement to undertake a Detailed Assessment at this location.

1.15 The Council's 2006 USA also identified a need to proceed to a Detailed Assessment for sulphur dioxide on the basis of a potential risk of exceedences of the 15-minute mean objective in relation to emissions from idling locomotives at Bewdley station. The line is part of the Severn Valley Railway, which is classed as an historic railway. Relevant exposure exists at a distance of approximately 15m from where idling locomotives stand at the platform.

2 Assessment Methodology

2.1 Air pollutant concentrations in the vicinity of an emission source will be related to both the source strength and the background concentration to which the local source is added. Background concentrations of nitrogen dioxide have been taken from the national maps of background concentrations available from the Air Quality Archive (Defra, 2007b).

Nitrogen dioxide monitoring

2.2 Monitoring for nitrogen dioxide is carried out within the study area using passive diffusion tubes, which are exposed for a month at a time, before being returned to the laboratory for analysis. Wyre Forest District Council has a network of 37 diffusion tubes located across the district, and uses diffusion tubes supplied and analysed by Gradko International Ltd. (20% TEA in water).

2.3 Real-time monitoring for nitrogen dioxide is undertaken within the Welch Gate Air Quality Management Area in Kidderminster. The continuous analyser is located at a roadside location. There is no co-located diffusion tube alongside the analyser, however Wyre Forest District Council does co-locate three diffusion tubes alongside Herefordshire Council's continuous analyser located in a roadside enclosure beside the Elgar Street roundabout in Hereford. Problems with the analyser during 2006 mean that only 9 months data are available with which to calculate a local bias adjustment factor in 2006. Whilst this is acceptable, it is considered more robust to use the national factor from the database provided on the Review and Assessment Helpdesk website (spreadsheet version 03/07)[1] which for 2006 is 0.98. All of the data presented in this report have been adjusted using this factor.

2.4 Monitoring locations within the study area are described in Table 2, and shown in Figure 3.

Table 2 Monitoring locations within the study area.

Site Reference	Site Description	Site Type
(F) 69 Cov	Façade of 69 Coventry Street, Kidderminster	Roadside
(F) SGC	Façade of 6/7 St George's Court, Kidderminster	Roadside
69 Cov	Kerbside location adjacent to 69 Coventry Street	Kerbside
SGC	Kerbside location St George's Court	Kerbside

[1] For information about diffusion tube bias adjustment see http://www.uwe.ac.uk/aqm/review/guidance.html

Figure 3 Monitoring Locations and Study Area. (© Copyright OS License 100018317.2006)

Sulphur dioxide monitoring

2.5 In lieu of the requirement to undertake a Detailed Assessment for sulphur dioxide, Wyre Forest District Council had initiated proposals for a 3-month ambient air quality monitoring programme in the vicinity of Bewdley Station. A number of local residents had been contacted with a view to locating the proposed monitoring equipment (a UV fluorescence monitor) within their property. However, before securing a preferred monitoring location, local flooding caused the Severn Valley railway line to be damaged along some of its length. As a consequence of this, the historic railway line is no longer in use. There are no immediate plans for the reinstatement of the line, and as such all proposals for monitoring sulphur dioxide have ceased.

2.6 Once a normal railway service along the Severn Valley railway line commences, Wyre Forest District Council intend to reinstate proposals for monitoring. Until then, no further assessment of sulphur dioxide in the vicinity of Bewdley Station will be undertaken.

Nitrogen dioxide modelling work

2.7 Annual mean concentrations of nitrogen dioxide during 2005 have been modelled using the Atmospheric Dispersion Modelling System for Roads (ADMS Roads). ADMS Roads is one of the dispersion models accepted for modelling within the Government's Technical Guidance (Defra, 2003a). The model has been run using a full year of meteorological data for 2006 from the meteorological station near Birmingham Airport. Concentrations have been modelled for diffusion

tube monitoring locations for the purpose of model verification (Figure 2). They have also been modelled across the study area to allow contours to be produced. The modelling methodology and the input data utilised are described in Appendix 1. The model has been verified against the 2005 diffusion tube measurements and adjusted accordingly.

Uncertainty

2.8 There is an element of uncertainty in all measured and modelled data. All values presented in this report are the best possible estimates, but uncertainties in the results might cause over-predictions or under-predictions. All of the measurements presented have an intrinsic margin of error. Defra (2007c) suggest that this is of the order of plus or minus 20% for diffusion tube data and plus or minus 10% for automatic measurements. The model results rely on traffic count data, which has been factored for the appropriate assessment year, and thus any uncertainties inherent in these data will carry into this assessment.

2.9 There will be additional uncertainties introduced because the modelling has simplified real-world processes into a series of algorithms. For example, it has been assumed that:

- during each year, the vehicle fleet within the study area will conform to the national (UK) average composition;
- the emissions per vehicle conform to the factors published in DMRB 11.3;
- wind conditions measured at Birmingham airport during 2006 were representative of wind conditions in Kidderminster during 2006, and
- the subsequent dispersion of emitted pollutants will conform to a Gaussian distribution over flat terrain.

2.10 An important step in the assessment is verifying the dispersion model against the measured data. By comparing the model results with measurements, data have been corrected for any overall under- or over-prediction.

2.11 The UK Government's Air Quality Expert Group (AQEG) has published a draft report on trends in primary nitrogen dioxide in the UK (AQEG, 2006). This examines evidence that shows that while NOx emissions have fallen in line with predictions made a decade previously, the composition of NOx has, in some urban environments, changed. This may have caused nitrogen dioxide levels at some locations to fall less rapidly than was expected. The latest guidance from Defra has been

followed regarding NOx to NO_2 relationships, but there is still uncertainty as to whether these relationships will continue to apply in 2010 and 2015. Any effect is likely to be greatest close to major roads, where future baseline concentrations may have been underestimated.

3 Assessment Results

Monitoring results

3.1 Monitoring data for the sites within the study area are presented in Table 3. The results indicate that the annual mean nitrogen dioxide objective is continuing to be exceeded at locations representing relevant exposure alongside Coventry Street in 2006. Roadside monitoring sites 69 Cov and SGC were discontinued in 2006 as they are not representative of relevant exposure, whilst tubes (F) 69 Cov and (F) SGC are representative.

Table 3 Annual Mean Nitrogen Dioxide concentrations (µg/m3) measured using Diffusion Tubes

Site Reference	Site	2005[a]	2006[b]
(F) 69 Cov	Façade of 69 Coventry Street, Kidderminster	**47.0**	**51.2**
(F) SGC	Façade of 6/7 St George's Court, Kidderminster	**41.0**	35.7
69 Cov	Kerbside location adjacent to 69 Coventry Street	**61.5**	-
SGC	Kerbside location St George's Court	33.0	-

[a] Bias adjusted using a bias adjustment factor of 0.97, taken from the database of factors provided on the Review and Assessment Helpdesk website (spreadsheet version 03/07).
[b] Bias adjusted using a bias adjustment factor of 0.98, taken from the database of factors provided on the Review and Assessment Helpdesk website (spreadsheet version 03/07).

Modelling results

3.2 Concentrations have been predicted by modelling over the wider study area. Modelled contours of nitrogen dioxide concentrations in 2006 at 40µg/m^3 and 36µg/m^3 are shown in Figure 4. This indicates that exceedences of the annual mean nitrogen dioxide objective are likely at the closest properties to the junction of Coventry Street and the Ringway during 2006. To take account of the uncertainty inherent in the model results, any AQMA is recommended to include any residential properties which lie within the 36µg/m^3 contour, which represents one standard deviation of the model.

3.3 No exceedences of 60μg/m^3, as an annual mean nitrogen dioxide concentration, have been identified at locations relevant to the 1-hour objective and thus exceedences of the 1-hour objective are unlikely.

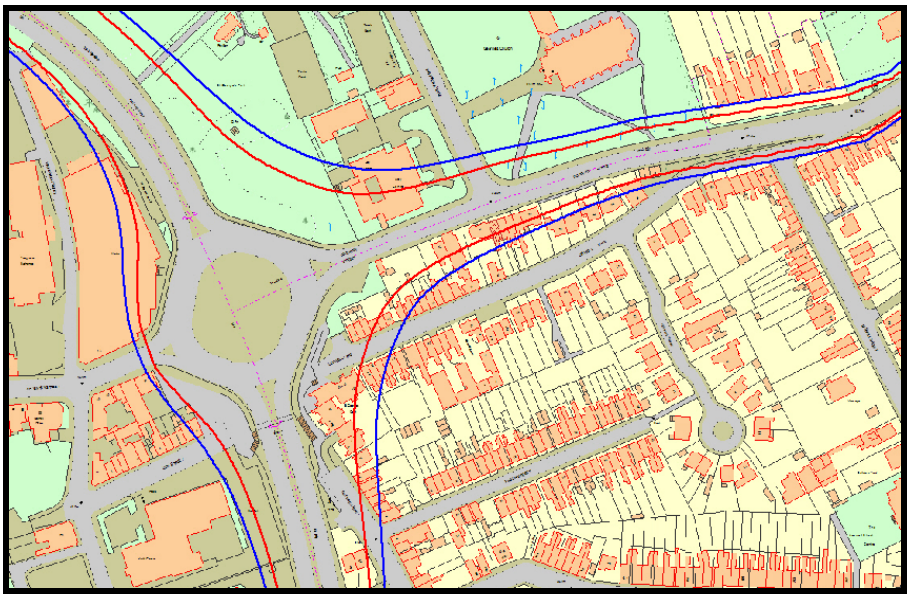

Figure 4 Modelled Annual Mean Nitrogen Dioxide contours in 2006. The Red Line represents the 40μg/m3 contour; the Blue Line represents the 36μg/m3 contour. (© Copyright OS License 100018317.2006)

4 Conclusions and Recommendations

4.1 A Detailed Assessment of air quality has been carried out for properties located in close proximity to the junction of Coventry Street with the Ringway roundabout in Kidderminster. These areas were identified as being at risk of exceeding the annual mean air quality objective for nitrogen dioxide in the Updating and Screening Assessment (Wyre Forest District Council, 2006).

4.2 The Detailed Assessment has been carried out using a combination of monitoring data and modelled concentrations. Concentrations of pollutants have been modelled using the dispersion model ADMS Roads for 2005 at specific monitoring locations (for the purposes of model verification) and for the wider study area for 2006.

4.3 Monitoring has confirmed that the annual mean objective is being exceeded. Modelling shows the objective is being exceeded at properties alongside Coventry Street and the Ringway, closest to the roundabout in 2006. The declaration of the AQMA should include all residential properties which lie within the 40µg/m^3 contour as a minimum, and consideration should be given to declaring those properties which lie within the 36µg/m^3 contour, to allow for any uncertainty within the model.

4.4 It is recommended that further diffusion tube monitoring is carried out at the closest residential properties to the Roundabout, and at additional residential locations alongside Coventry Street and the Ringway to determine the extent of the AQMA boundary. Additional up-to-date count data, including annual average speed data, would allow more accurate modelling to be carried out as part of the Further Assessment required once the AQMA has been declared.

5 References

Air Quality Expert Group, 2006. Trends in Primary Nitrogen Dioxide in the UK. Draft report for comment. August 2006.

Defra, 2003a. Review & Assessment: Technical Guidance LAQM.TG(03).

Defra, 2007a. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. July 2007. Cmd Paper No. 7169.

Defra, 2007b. Air Quality Archive via the internet www.airquality.co.uk.

Defra, 2007c. Air Quality Review and Assessment Helpdesk website. Available at: www.uwe.ac.uk/aqm/review/

Defra, 2007d. National Atmospheric Emissions Inventory. www.naei.org.uk.

Defra, 2007e. FAQ - Is there a new NO_x to NO_2 calculator available to allow for the recent increase in primary NO_2 from traffic? Available at www.uwe.ac.uk/aqm/review

DETR, 1997. National Road Traffic Forecasts (Great Britain). Available at http://www.dft.gov.uk/stellent/groups/dft_econappr/documents/page/dft_econappr_610548.pdf

DETR, 2000. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, January 2000.

DfT, 2007. TEMPRO (Version 5) System. Available at www.tempro.org.uk

Laxen and Marner, 2003. Analysis of the Relationship Between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbside Monitoring Sites. Available from Defra, 2007b.

Stationery Office, 2000. Air Quality Regulations, 2000, Statutory Instrument 928.

Stationery Office, 2002. The Air Quality (England) (Amendment) Regulations 2002. Statutory Instrument 3043

Wyre Forest District Council, 2004. Stage 4 Air Quality review and Assessment. Faber Maunsell, March 2004. 28pp.

Wyre Forest District Council, 2006. Updating and Screening Assessment. Bureau Veritas, May 2006. 23pp.

6 Glossary

Standards	A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal.
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date, taking into account costs, benefits, feasibility and practicality. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides.
Exceedence	A period of time where the concentration of a pollutant is greater than the appropriate air quality objective.
AQMA	Air Quality Management Area
ADMS Roads	Atmospheric Dispersion Modelling System for Roads.
PM_{10}	Small airborne particles, more specifically particulate matter less than 10 micrometers in aerodynamic diameter.
NO_2	Nitrogen dioxide.
$\mu g/m^3$	Microgrammes per cubic metre.
HDV	Heavy Duty Vehicles >3.5 tonnes
AADT	Annual Average Daily Traffic

7 Appendix 1 – Dispersion Modelling Methodology

7.1 Annual mean concentrations of nitrogen dioxide during 2006 have been modelled using the Atmospheric Dispersion Modelling System for Roads (ADMS Roads). ADMS Roads if one of the dispersion models accepted for modelling within the Government's Technical Guidance (Defra, 2003a).

Meteorological Data:

7.2 The model has been run using a full year of meteorological data for 2006 from the meteorological station near Birmingham Airport, which is approximately 35km east of the study area.

Horizontal Road Alignment:

7.3 Road alignment was based around Ordnance Survey road centreline data. Those roads not explicitly included have been accounted for via the background component of the modelled results.

Traffic Data:

7.4 Data provided by the Department for Transport for 2005 for count point locations along the Ringway and Birmingham Road in close proximity to the study area have been utilised for the assessment. Growth factors, derived from National Road Traffic Forecast (NRTF) factors (DETR, 1997), adjusted to local conditions using the TEMPRO System v5 (DfT, 2007), have been applied to the 2005 AADT to adjust the data to the assessment year of 2006. Traffic data used in the assessment are presented in Table A1.1. They are presented as AADT flows for all traffic and separately for HDV AADT flows.

Table A1.1 Summary of Traffic Flows used in the Assessment[a]

Road Link	2005		2006	
	AADT	HDV AADT	AADT	HDV AADT
The Ringway	30,753	2,266	30,999	2,284
St Mary's Ringway	29,138	1,426	29,371	1,437
Birmingham Road	15,793	1,188	15,919	1,198

[a] AADT – Annual Average Daily Traffic flow

Background Concentrations:

7.5 Background concentrations of nitrogen dioxide have been taken from the national maps of background concentrations available from the Air Quality Archive (Defra, 2007b).

Model Verification:

7.6 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides (NOx = NO + NO_2). The model has been run to predict annual mean road-NOx concentrations during 2005 at the diffusion tube monitoring locations within the study area.

7.7 The model outputs of road-NOx (i.e. the component of total NOx coming from road traffic) have been compared with the 'measured' road-NOx. Total measured NOx was calculated from the measured NO_2 concentrations at each of the monitoring location using the recently updated NOx from NO_2 calculator[2] available on the Air Quality Archive website (Defra, 2007b). The measured road-NOx contribution was then calculated as the difference between the total and the background value.

7.8 A primary adjustment factor was then determined as the inverse of the slope of the best fit line between the calculated (measured) road contribution and the model derived road contribution, forced through zero. This adjustment factor was applied to the modelled road-NOx concentration for each receptor to provide an adjusted modelled road-NOx concentration. The appropriate background concentration was added to these concentrations to determine the adjusted total modelled NOx concentration. The road contribution to the total annual mean nitrogen dioxide concentration was then determined from these adjusted modelled concentrations, following the method set out by Defra (2003a), taking into account the most recent guidance (Defra, 2007c):

$$NO_2 \text{ (road)} = NOx \text{ (road)} \times (-0.0719 * LN(NOx(total)) + 0.6248$$

7.9 The total nitrogen dioxide concentration was then determined by adding the background NO_2 concentration to this calculated road contribution. A secondary adjustment factor was finally calculated as the inverse of the slope of the best fit line applied to the adjusted data and forced through zero.

7.10 The following primary and secondary adjustment factors have been applied to all modelled nitrogen dioxide data presented in this report:

[2] http://www.airquality.co.uk/archive/laqm/tools/NOxfromNO2calculator2007.xls

Primary adjustment factor: 8.30

Secondary adjustment factor: 0.97

7.11 The results imply that the model was under-predicting the road-NOx contribution. This is a common experience with this and most other models. The final NO_2 adjustments are minor. Figure A1.1 compares the modelled concentrations at each diffusion tube, after all adjustments have been made, to the measured concentrations at these locations.

Figure A1.1 Comparison of measured NO_2 to fully adjusted modelled NO_2 concentrations