Detailed Assessment of Air Quality at Queens Avenue, Bicester

Cherwell District Council

Report for Cherwell District Council in fulfilment of Part IV of the Environment Act 1995

Ricardo-AEA/R/ED56980003
Issue Number 3
Date 04/04/2013

Customer:

Cherwell District Council

Customer reference:

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Ricardo-AEA reference:

Ref: ED56980003- Issue Number 3

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04 April 2013

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Executive summary

Ricardo-AEA has undertaken a Detailed Assessment of Air Quality at Queens Avenue, Bicester for Cherwell District Council. The assessment has been undertaken to investigate the potential scale and extent of exceedances of Air Quality Objectives in the study area. This Detailed Assessment will allow Cherwell District Council to decide whether or not an Air Quality Management Area is required at the location.

Atmospheric dispersion modelling of road traffic emissions has been conducted at ground level to assess nitrogen dioxide (NO_2) concentrations at this location. The study area extends from Kings End at the south of Bicester, along Queens Avenue and Field Street up to the roundabout at the northern end of Field Street. The assessment considers road traffic emissions where relevant human exposure is present close to the road.

The modelling study, which used traffic, monitoring and meteorological data for a calendar year of 2010 has indicated the following:

- NO_2 concentrations in excess of the annual mean objective are occurring at a large number of residential properties on Kings End, Queens Avenue and Field Street.
- Although uncertain, it is considered unlikely that the 1-hour mean NO_2 objective is being exceeded at locations where there is relevant exposure.

In light of this Detailed Assessment of Air quality which is based on the available monitoring data from 2010, **Cherwell District Council is required to declare an Air Quality Management Area at this time to include all residential properties that lie within the annual mean NO_2 exceedance areas**.

It should be however be noted that this assessment is based on 2010 monitoring data, and there is now two years of additional monitoring data which can provide an indication of long-term trends in measured NO_2 concentrations within the study area. It may be prudent to consider the results of this Detailed Assessment in context with the 2011 and 2012 measurements once available before determining the extent of the required AQMA.

The assessment also notes that road layout changes are also currently being implemented on Queens Avenue to help ease traffic congestion as this has been recognised as a problem at this location. Any measures to improve traffic flow will also likely lead to improvements in air quality.

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1 Introduction

Ricardo-AEA has been commissioned by Cherwell District Council to undertake a Detailed Assessment of Air Quality at Queens Avenue, Bicester. The assessment has been undertaken to investigate the scale and extent of potential exceedances of the Air Quality Objectives within the study area. The Detailed Assessment will allow Cherwell District Council to decide whether or not an Air Quality Management Area is required at this location.

1.1 Policy Background

The Environment Act 1995 placed a responsibility on UK Government to prepare an Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland. The most recent version of the strategy (2007) sets out the current UK framework for air quality management and includes a number of air quality objectives for specific pollutants.

The 1995 Act also requires that Local Authorities "Review and Assess" air quality in their areas following a prescribed timetable. The Review and Assessment process is intended to locate and spatially define areas where the AQS objectives are not being met. In such instances the Local Authority is required to declare an Air Quality Management Area (AQMA), carry out a Further Assessment of Air Quality, and develop an Air Quality Action Plan (AQAP) which should include measures to improve air quality so that the objectives may be achieved in the future. The timetables and methodologies for carrying out Review and Assessment studies are prescribed in Defra's Technical Guidance - LAQM.TG(09).

Table 1 lists the objectives relevant to this assessment that are included in the Air Quality Regulations 2000 and (Amendment) Regulations 2002 for the purposes of Local Air Quality Management (LAQM).

Table 1: NO_2 Objectives included in the Air Quality Regulations and subsequent Amendments for the purpose of Local Air Quality Management

Pollutant	Air Quality Objective	
	Concentration	Measured as
Nitrogen dioxide	200 µg.m^{-3} not to be exceeded more than 18 times a year	1 hour mean
	40 µg.m^{-3}	annual mean

1.2 Locations where the objectives apply

When carrying out the review and assessment of air quality it is only necessary to focus on areas where the public are likely to be regularly present and are likely be exposed over the averaging period of the objective. Table 2 summarises examples of where air quality objectives for NO_2 should and should not apply.

Table 2: Examples of where the NO_2 Air Quality Objectives should and should not apply

Averaging Period	Pollutant	Objectives *should* apply at …	Objectives should *not* generally apply at …
Annual mean	NO_2	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
1-hour mean	NO_2	All locations where the annual mean and 24 and 8-hour mean objectives apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks and railway stations etc. which are not fully enclosed. Any outdoor locations to which the public might reasonably be expected to have access.	Kerbside sites where the public would not be expected to have regular access.

1.3 Purpose of this Detailed Assessment

This study is a Detailed Assessment, which aims to assess the magnitude and spatial extent of any exceedances of the NO_2 objectives at locations where relevant human exposure may occur within the study area in Bicester.

1.4 Overview of the Detailed Assessment

The general approach taken to this Detailed Assessment was:

- Collect and interpret data from previous Review and Assessment reports.
- Collect and analyse recent traffic, monitoring, meteorological and background concentration data for use in a dispersion modelling study.
- Use dispersion modelling to produce numerical predictions of NO_2 concentrations at points of relevant exposure.
- Use dispersion modelling to produce contour plots of NO_2 concentrations;
- Recommend if Cherwell District Council should declare an AQMA at any location within the study area in Bicester and suggest its spatial extent.
- The modelling methodologies provided for Detailed Assessments outlined in Defra Technical Guidance LAQM.TG(09)[1] were used throughout this study.

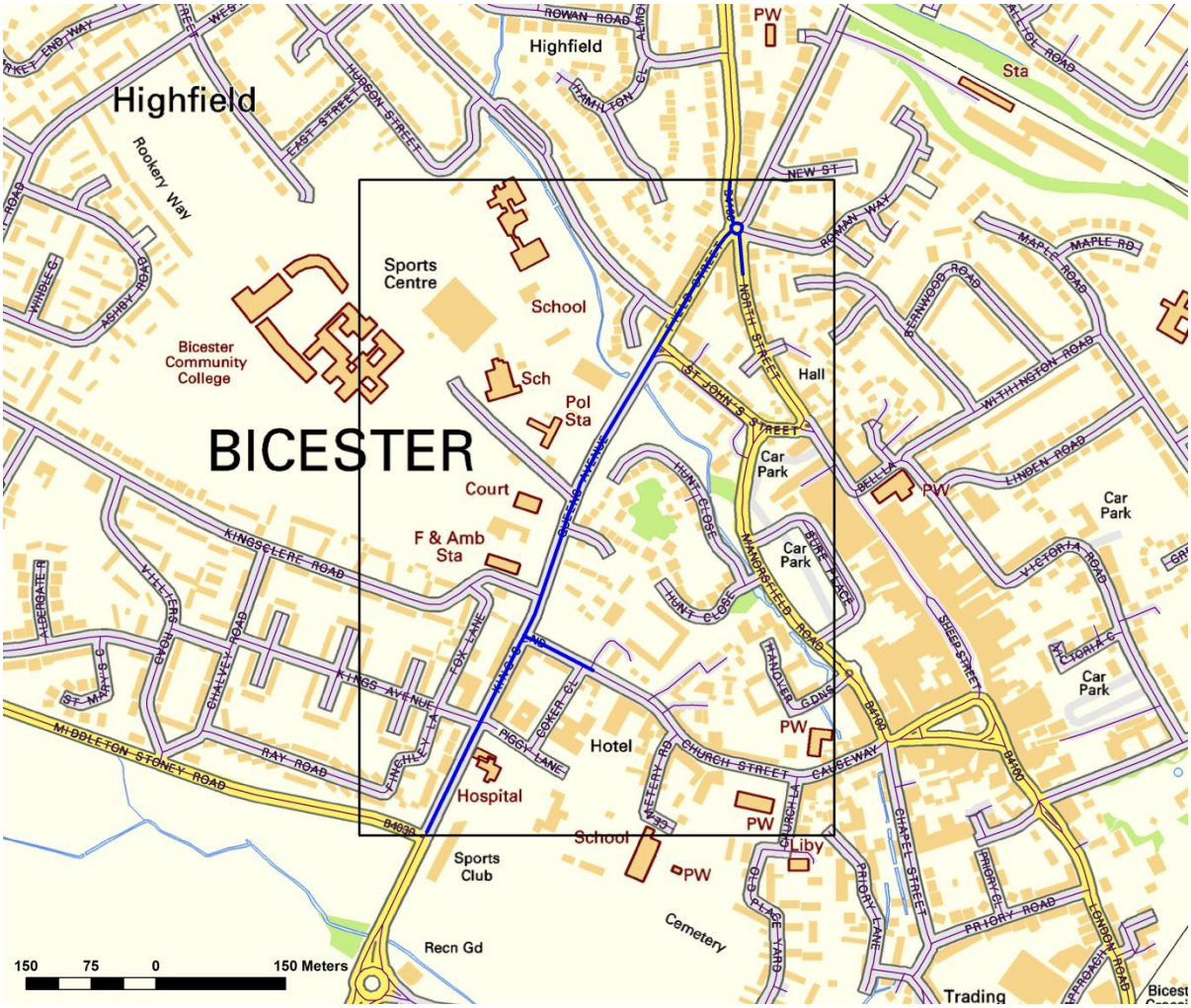
[1] Local Air Quality Management Technical Guidance LAQM.TG(09), Defra, 2009

2 Detailed Assessment study area

Bicester is a Market Town in the Cherwell District of the county of Oxfordshire, situated approximately 12 miles northeast of Oxford. The Detailed Assessment is concerned with a section of road that extends from Kings End at the south of Bicester, along Queens Avenue and Field Street up to the roundabout at the northern end of Field Street. The assessment will consider road traffic emissions where relevant exposure is present close to the road.

The study area mainly comprises of residential properties with some commercial properties, schools and a college. The study area, including the roads modelled and the extent of the detailed assessment is presented in Figure 1 below. The size of the study area is approximately 560 m by 765 m.

Figure 1: Detailed Assessment Study Area



3 Information used to support this assessment

3.1 Maps

Ordnance Survey based GIS data of the model domain and a road centreline GIS dataset were used in the assessment. This enabled accurate road widths and the distance of the housing to the kerb to be determined in ArcMap.

3.2 Road traffic data

3.2.1 Average flow, speed and fleet split

Traffic count data collected by Oxfordshire County Council were used for the assessment, this included weekly count and vehicle classification split data.

Appendix 1 summarises all of the traffic flow data used and the road links modelled.

It should be noted that traffic patterns in urban locations are complex and it is not possible to fully represent these in atmospheric dispersion models. By attempting to describe these complex traffic patterns using quite simple metrics (AADT, average speed and vehicle split composition) a degree of uncertainty is introduced into the modelling.

3.2.2 Congestion

Traffic can become congested at times within the study area. Traffic heading south on Field Street/Queens Avenue sometimes queue for access to St Marys Primary School, Brookside Primary School on Bucknell Road, Bicester Community College and the local sports centre. There are also pedestrian crossings which can cause general slow moving/queuing traffic throughout the study area.

A method of modelling queuing traffic using ADMS-Roads proposed by model developers CERC has been used to represent the periodic congestion at the junction[2].

The method assumes that the vehicles are travelling at the lowest speed that can be modelled using ADMS-Roads (5 km/hr), with an average vehicle length of 4m, and are positioned close to each other during congested periods. The annual average hourly traffic (AAHT) flow is calculated by dividing the speed of the vehicles by the average vehicle length, which gives a representative AAHT of 1250 vehicles per hour during congested periods.

[2] CERC(2004) Modelling queuing traffic – Helpdesk note; Avaialble at http://www.cerc.co.uk/user-area/helpdesk-notes.html

3.2.3 Emissions factors

The most recent version of the Emissions Factors Toolkit[3] (EFT V5.3 August 2012 release) was used in this assessment to calculate pollutant emissions factors for each road link modelled. The calculated emission factors were then imported in to the ADMS-Roads model.

Parameters such as traffic volume, speed and fleet composition are entered into the EfT, and an emissions factor in grams of NOx/kilometre/second is generated for input into the dispersion model. In the the latest version of the EfT, NOx emissions factors previously based on DFT/TRL functions have been replaced by factors from COPERT 4 v8.1. These emissions factors were published in May 2011 through the European Environment Agency and are widely used for the purpose of calculating emissions from road traffic in Europe.

The latest version of the EFT also includes addition of road abrasion emission factors for particulate matter; and changes to composition of the vehicle fleet in terms of the proportion of vehicle km travelled by each Euro standard, technology mix, vehicle size and vehicle category.

Vehicle emission projections are based largely on the assumption that emissions from the fleet will fall as newer vehicles are introduced. Any inaccuracy in the emissions factors contained in the EFT will be unavoidably carried forward into this modelling assessment.

3.3 Ambient monitoring

Cherwell District Council currently undertakes monitoring of NO_2 within the study area in Bicester at two roadside, four kerbside, and one urban background diffusion tube site. Further details of these monitoring locations and recent measured concentrations are provided in Section 4.

3.4 Meteorological data

Hourly sequential meteorological data (wind speed, direction etc.) for 2010 from the Brize Norton site was obtained from a third party supplier and used for the modelling assessment. The meteorological measurement site is located approximately 20 km to the south west of the study area and has good data quality for the period of interest.

Meteorological measurements are subject to their own uncertainty which will unavoidably carry forward into this assessment.

3.5 Background concentrations

Background NOx concentrations for a dispersion modelling study can be accessed from either local monitoring data conducted at a background site or from the Defra background maps[4]. The Defra background maps are the outputs of a national scale dispersion model provided at a 1km x 1km resolution and are therefore subject to a degree of uncertainty.

In this case there is an urban background monitoring site located at Villiers Road in Bicester which is located approximately 400 m west of Kings End, NO_2 concentrations measured at this site are considered representative of the NO_2 attributable to local background sources in the area. An NO_2 annual mean concentration of 26.8 $\mu g.m^{-3}$ was measured during 2010 at this site. Using the Defra NOx to NO_2 calculator to convert the measured NO_2 annual mean, estimates a background total NOx annual mean concentration of 53.8 $\mu g.m^{-3}$ for the study area.

[3] http://laqm1.defra.gov.uk/documents/tools/EFT_Version_4_2.zip
[4] Defra (2012) http://laqm1.defra.gov.uk/review/tools/background.php (accessed September 2012)

4 Monitoring data 2010

Cherwell District Council currently monitors NO_2 within the study area in Bicester at two roadside, four kerb-side, and one urban background diffusion tube site. A map showing the location of the diffusion tube sites is presented in Figure 2.

Details of the NO_2 diffusion tube monitoring site and the annual mean NO_2 concentrations measured during 2010 are presented in Table 3.

Annual mean NO_2 concentrations in excess of the 40 $\mu g.m^{-3}$ objective were measured during 2010 at all of the diffusion tubes located on the main roads in the study area. The 'NO_2 distance from road calculator' was used in the 2011 Progress Report to determine the NO_2 annual mean concentrations at the nearest relevant exposure. The estimated concentrations were also in excess the objective at all of the locations of relevant exposure close to the diffusion tube sites.

Full details of bias adjustment factors applied to the diffusion tube results and QA/QC procedures are presented in Appendix 4.

Table 3: NO_2 Diffusion tube measurements 2010

Site	Type	OS Grid Ref.		Approximate tube height (m)	Data Capture 2010 (%)	Bias corrected annual mean 2010 ($\mu g.m^{-3}$)
		Easting	Northing			
Villiers Road	UB	457619	222535	2	83%	26.8
Kings End West	K	458071	222450	2	100%	36.5
Kings End South	R	458006	222404	2	100%	**51.3 (45.2)**
Kings End North	R	457943	222304	2	100%	**46.2 (42.4)**
Field Street	K	458214	222836	2	100%	**46.2 (42.4)**
North Street	K	458274	222935	2	100%	**44.1 (40.6)**
Queens Avenue (x3)	K	458028	222471	2	100%	**46 (42.2)**
Concentrations in brackets are predicted at the nearest relevant exposure using the 'NO_2 distance from road calculator' Exceedances of the annual mean objective in **bold**						
R – Roadside monitoring location, 1-5m from the kerb of a busy road UB – Urban Background, more than 50m from a busy road – residential						

Figure 2: Bicester Diffusion Tube Locations

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Legend:

Diffusion tube location

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5 Modelling

5.1 Modelling methodology

Annual mean concentrations of NO_2 during 2010 have been modelled within the study area using the atmospheric dispersion model ADMS Roads (version 3.1).

The model was verified by comparing the modelled predictions of road NO_x with local monitoring results. The available roadside diffusion tube measurement within the study area (described in Section 4 above) were used to verify the annual mean road NOx model predictions.

Following initial comparison of the modelled concentrations with the available monitoring data, refinements were made to the model input to achieve the best possible agreement with the diffusion tube measurements. Further information on model verification is provided in Section 5.1.3 and Appendix 3.

A surface roughness of 0.5 m was used in the modelling to represent the sub-urban conditions in the model domain. A limit for the Monin-Obukhov length of 10 m was applied to represent a small town.

The source-oriented grid option was used in ADMS-Roads, this option provides finer resolution of predicted pollutant concentrations along the roadside, with a wider grid spaced at approximately 5 metres being used to represent concentrations further away from the road. The predicted concentrations were interpolated to derive values between the grid points using the Spatial Analyst tool in the GIS software ArcMap 10. This allows contours showing the predicted spatial variation of pollutant concentrations to be produced and added to the digital base mapping.

Queuing traffic was treated in the model using the methodology described in Section 3.2.2 above as provided by the model developers. Queuing was assigned to specific road sections based on local knowledge following discussions with Cherwell District Council. A time varying emissions file was used in the model to account for daily variations in queuing traffic.

It should be noted that any dispersion modelling study has a degree of uncertainty associated with it; all reasonable steps have been taken to reduce this where possible.

5.1.1 Treatment of modelled NOx road contribution

It is necessary to convert the modelled NOx concentrations to NO_2 for comparison with the relevant objectives.

The Defra NOx/NO_2 model[5] was used to calculate NO_2 concentrations from the NOx concentrations predicted by ADMS-Roads. The model requires input of the background NOx, the modelled road contribution and accounts for the proportion of NOx released as primary NO_2. For the Cherwell area in 2010 with the "All other UK urban Traffic" option in the model, the NOx/NO_2 model estimates that 19.6% of NOx is released as primary NO_2.

5.1.2 Validation of ADMS-Roads

Validation of the model is the process by which the model outputs are tested against monitoring results at a range of locations and the model is judged to be suitable for use in specific applications; this is usually conducted by the model developer.

CERC have carried out extensive validation of ADMS applications by comparing modelled results with standard field, laboratory and numerical data sets, participating in EU workshops on short range dispersion models, comparing data between UK M4 and M25 motorway field monitoring data, carrying out inter-comparison studies alongside other modelling solutions such as DMRB and CALINE4, and carrying out comparison studies with monitoring data collected in cities throughout the UK using the extensive number of studies carried out on behalf of local authorities and Defra.

5.1.3 Verification of the model

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. This helps to identify how the model is performing at the various monitoring locations. The verification process involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in better agreement with the monitoring results. LAQM.TG(09) recommends making the adjustment to the road contribution of the pollutant only and not the background concentration these are combined with.

The approach outlined in Example 2 of LAQM.TG(09) has been used in this case

The modelled NOx concentrations in this study were verified using the available kerbside and roadside diffusion tube site.

Following various refinements to the model input; the modelled Road NOx contribution required adjustment by an average factor of 1.31 to bring the predicted NO_2 concentrations within close agreement of those results obtained from the monitoring data. This factor was applied to all Road NOx concentrations predicted by the model; the adjusted total NO_2 concentrations were then calculated using the Defra NOx/NO_2 calculator.

After the NOx/NO_2 model was run no further adjustments were made to the data. Model agreement for the NO_2 monitoring data after adjustment is presented in Table 4 and Figure 3. Full model verification data is provided in Appendix 3.

Model uncertainty can be estimated by calculating the root mean square error (RMSE). In this case the calculated RMSE was 1.2 $\mu g.m^{-3}$ after adjustment which is within the suggested value (10% of the objective being assessed) in LAQM.TG(09). The model has therefore been assessed to perform sufficiently well for use within this assessment.

Verifying modelling data with diffusion tube monitoring data will always be subject to uncertainty due to the inherent limitations in such monitoring data (even data from continuous analysers has

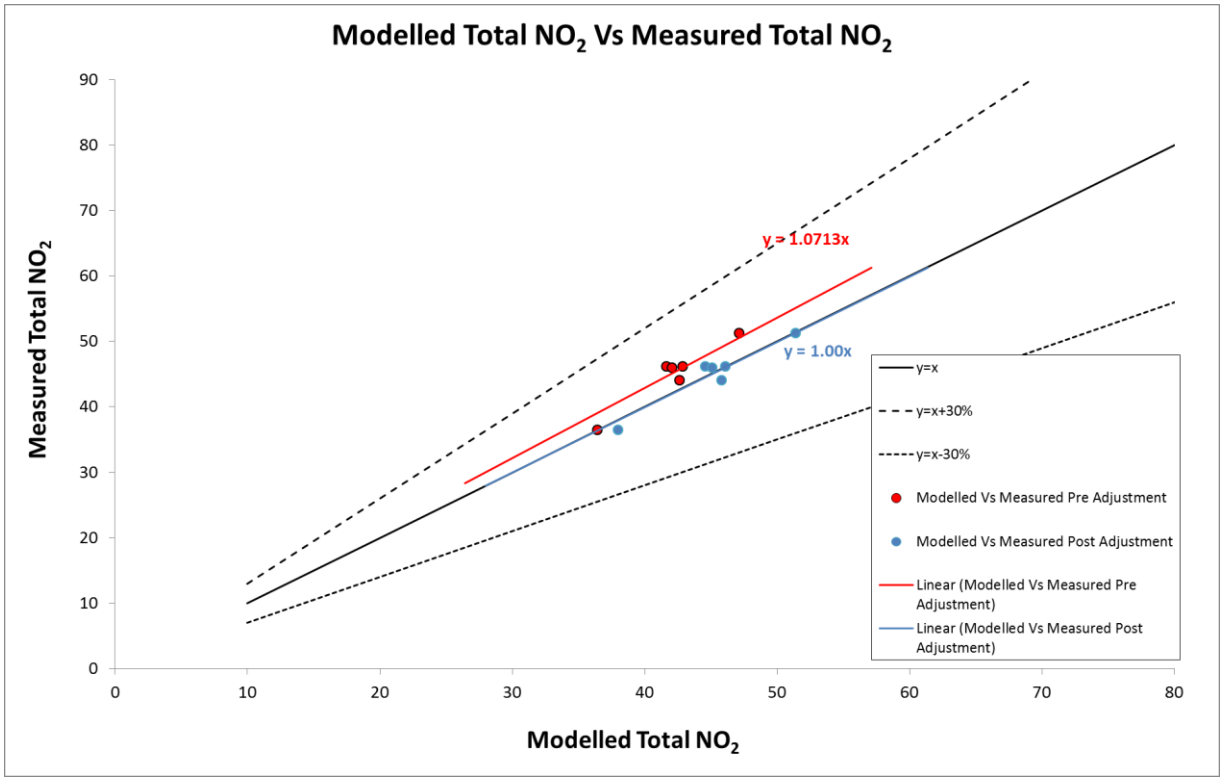
[5] Defra (2012) NOx NO_2 Calculator v3.2 released September 2012; Available at http://laqm.defra.gov.uk/tools-monitoring-data/no-calculator.html

notable uncertainty). The model results should be considered in this context. Further information on the verification process including the linear regression analysis is provided in Appendix 3.

Table 4: Modelled vs. measured annual mean NO_2 concentrations 2010

Site	NO_2 annual mean concentration ($\mu g.m^{-3}$)	
	Measured	Modelled
Kings End North DT	46.2	44.6
Kings End South DT	51.3	51.4
Queens Ave (trip) DT	46	45.1
Kings End West DT	36.5	38.0
Field Street DT	46.2	46.1
North Street DT	44.1	45.8
RMSE =		**1.2**

Figure 3: Linear regression analysis of modelled vs. monitored NO_2 annual mean 2010



5.2 Modelling results

5.2.1 Annual mean NO_2 concentrations

Annual mean NO_2 concentrations have been predicted across a grid of points. The grid resolution is approximately 5 m. The gridded point values have been interpolated to produce contour plots showing the spatial variation of predicted concentrations across the study area.

Contour plots showing the spatial variation of the predicted 2010 annual mean NO_2 concentrations across the study area at a height of 1.5m are presented in Figure 4. Close ups of the contours at the north and south of the study area are presented in Figure 5 and Figure 6.

The NO_2 annual mean contour plots indicate that the 40 $\mu g.m^{-3}$ objective is being exceeded at the facades of up to 60 residential properties within the study area on the north south route into Bicester at two locations:

- Field Street at the north of the study area
- Kings End at the south of the study area

The locations of the areas with residential properties close to the road are annotated on the contour plots in Figure 4.

5.2.2 Predicted NO_2 concentrations in comparison with the 1-hour short-term objective

It is difficult to accurately predict if the NO_2 1-hour mean objective is being exceeded using dispersion modelling. TG(09) states that if an annual mean NO_2 concentrations in excess of 60 $\mu g.m^{-3}$ is measured, an exceedance of the 1-hr mean objective may be occurring.

Annual mean NO_2 concentrations in excess of 60 $\mu g.m^{-3}$ are predicted at some locations on the pavement on the eastern side of Kings End at the southern end of the study area. There are no shops or other relevant establishments on that side of the road where anyone would spend an hour or more on the pavement; it is therefore considered unlikely that the short term NO_2 objective is being exceeded at locations where there is relevant exposure. Measurement of NO_2 using a continuous NOx analyser could confirm this.

Figure 4: Predicted annual mean NO_2 concentrations 2010 at 1.5 m height

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Legend:

NO_2 annual mean ($\mu g.m^{-3}$)

- < 36
- 36 - 40
- 40 - 44
- 44 - 50
- 50 - 60
- > 60

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Figure 5: Predicted annual mean NO_2 concentrations 2010 at 1.5 m - southern section of study area

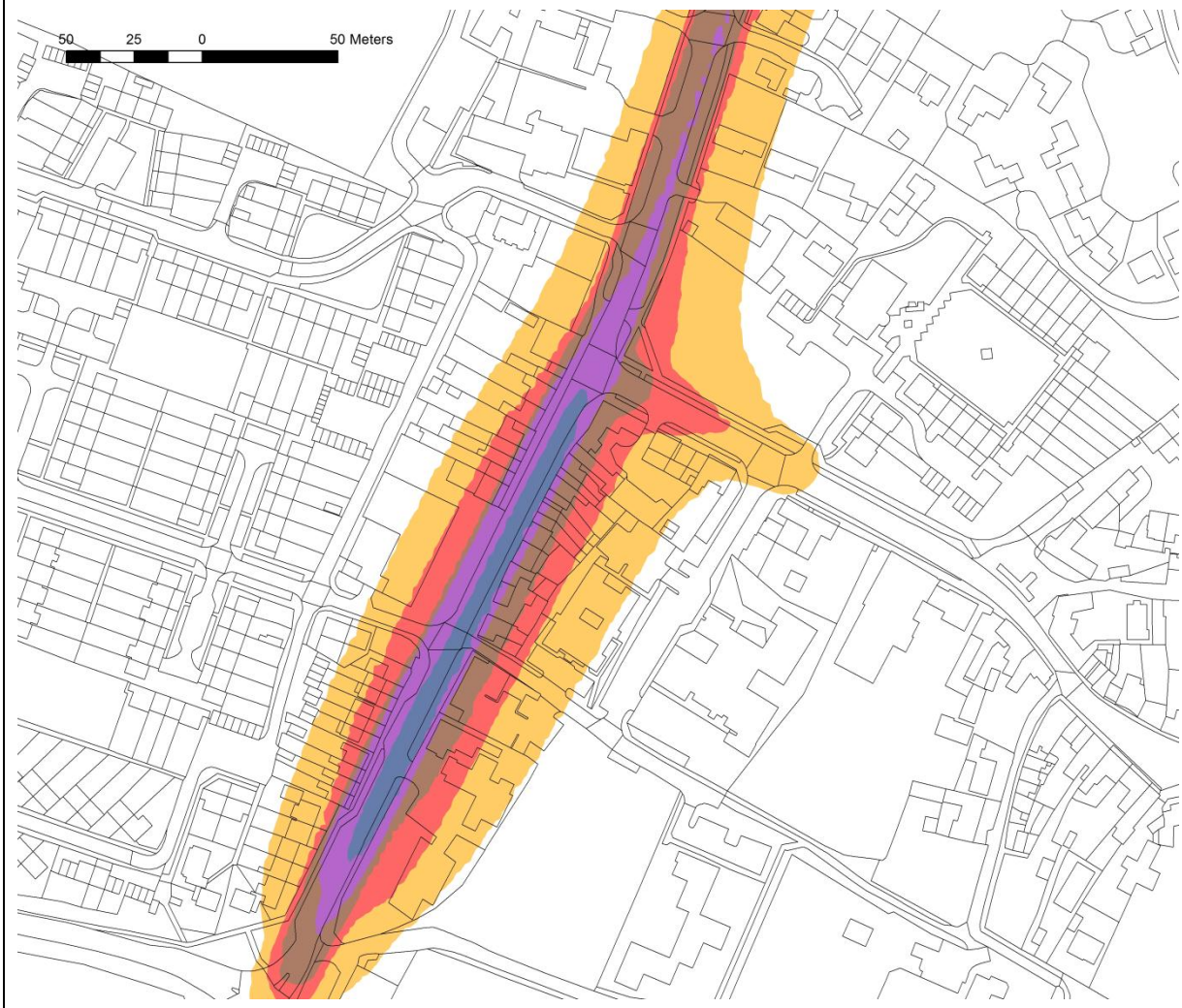

Figure 6: Predicted annual mean NO_2 concentrations 2010 at 1.5 m - northern section of study area

N

Legend:

NO_2 annual mean ($\mu g.m^{-3}$)

- < 36
- 36 - 40
- 40 - 44
- 44 - 50
- 50 - 60
- > 60

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6 Assessment timescales and current road traffic management measures

It should be noted that this assessment is based on 2010 monitoring data and was originally planned for completion in 2011. Due to unforeseen delays with data gathering the assessment has been completed in January 2013. There is now therefore two years of additional monitoring data which can provide more information regarding long-term trends in measured NO_2 concentrations within the study area.

It may be prudent to consider the results of this Detailed Assessment in context with the 2011 and 2012 measurements before determining the requirement for, and spatial extent of an AQMA. These results will be published in the 2012 Updating and Screening assessment and 2013 Progress Report for Cherwell District Council.

Road layout changes are also currently being implemented on Queens Avenue to help ease traffic congestion as this has been recognised as a problem at this location. Any measures to improve traffic flow will also likely lead to improvements in air quality.

New right-turn lane and bus stops are being introduced on Queens Avenue which aim to alleviate the queuing traffic, especially at peak school times (also leisure centre access). This is the start of wider improvements which include removing signalised crossings, and replacing with zebra crossings, and removing the signals at St John's St and replacing with a mini roundabout – this aims to help traffic flow along Field St and Queens Ave. North St will also be completely closed off from Banbury Rd/Buckingham Rd to create a 3-arm roundabout to replace the current 5-arm roundabout. All of these measures should help the traffic flow more smoothly and hence improve air quality at relevant locations.

7 Conclusion

A dispersion modelling study of road traffic emission in the area around Queens Avenue, Bicester has been conducted to allow a detailed assessment of nitrogen dioxide concentrations at this location.

The modelling study, which used traffic, monitoring and meteorological data for a calendar year of 2010 has indicated the following:

- NO_2 concentrations in excess of the annual mean objective are occurring at a large number of residential properties on Kings End, Queens Avenue and Field Street.
- Although uncertain, it is considered unlikely that the 1-hour mean NO_2 objective is being exceeded at locations where there is relevant exposure.

In light of this Detailed Assessment of Air quality which is based on the available monitoring data from 2010, **Cherwell District Council is required to declare an Air Quality Management Area at this time to include all residential properties that lie within the annual mean NO_2 exceedance areas**.

It should be however be noted that this assessment is based on 2010 monitoring data, and there is now two years of additional monitoring data which can provide an indication of long-term trends in measured NO_2 concentrations within the study area. It may be prudent to consider the results of this Detailed Assessment in context with the 2011 and 2012 measurements once available before determining the extent of the required AQMA.

Appendices

Appendix 1: Traffic Data

Appendix 2: Meteorological dataset

Appendix 3: Model Verification

Appendix 4: Diffusion Tube QA/QC and bias adjustment factors

Appendix 1 – Traffic data

Table A1.1 summarises the Annual Average Daily Flows (AADF) of traffic and fleet compositions used within the model for each road link. All traffic data was captured by Oxfordshire County Council during 2012. Fleet composition split data from 2012 was available for Queens Avenue only; this fleet split has therefore been applied across all of the road links modelled.

Table A1.1: Queens Avenue, Bicester - Annual Average Daily Flows

Street	Data source	%Cars	%Taxi (black)	%LGV	%HGV	%Bus	%2WM	AADF
Kings End	Oxfordshire County Council	91.8	0	5.5	0.4	2.0	0.4	18994
Kings End/Church St	Oxfordshire County Council	91.8	0	5.5	0.4	2.0	0.4	5452
Queens Ave	Oxfordshire County Council	91.8	0	5.5	0.4	2.0	0.4	17544
Field Street	Oxfordshire County Council	91.8	0	5.5	0.4	2.0	0.4	17544
North Street	Oxfordshire County Council	91.8	0	5.5	0.4	2.0	0.4	5511
Banbury Road	Oxfordshire County Council	91.8	0	5.5	0.4	2.0	0.4	7840

LGV – Light Goods Vehicles
HGV – Heavy Goods Vehicles (Articulate and Rigid)
2WM - Motorcycles

Queuing Traffic

CERC note[6] 60 was used for estimating emissions from queuing traffic, which defines a representative AADF for queuing traffic to be 30,000 at 5 km h^{-1}, assuming an average vehicle length of 4m. The emissions from this AADF figure with the traffic composition of the corresponding road were then input into the Emission Factor Toolkit to calculate and emission rate. The emission rates were then used within the dispersion model as a separate line emissions of pre-defined length representing each queue. Figure A1.1 shows the locations where queuing traffic was modelled.

Traffic Speeds

As stated in Technical Guidance LAQM.TG(09), the speed of traffic on a road will change approximately 50m from a junction. As such the speed of traffic was changed linearly between the maximum "open road" speed to the "close to a junction" speed approximately 50m from the junctions. As no traffic speed data were available, local speed limits were used for average "open road" speeds with speeds close to junctions and known congested areas varying from 5 km h^{-1} to 20km h^{-1}.

[6] Cambridge Environmental Research Consultants Ltd, Modelling Queuing Traffic – note 60, 20th August 2004

Figure A1.1 Modelled queue locations

N

Legend:

Modelled queue section

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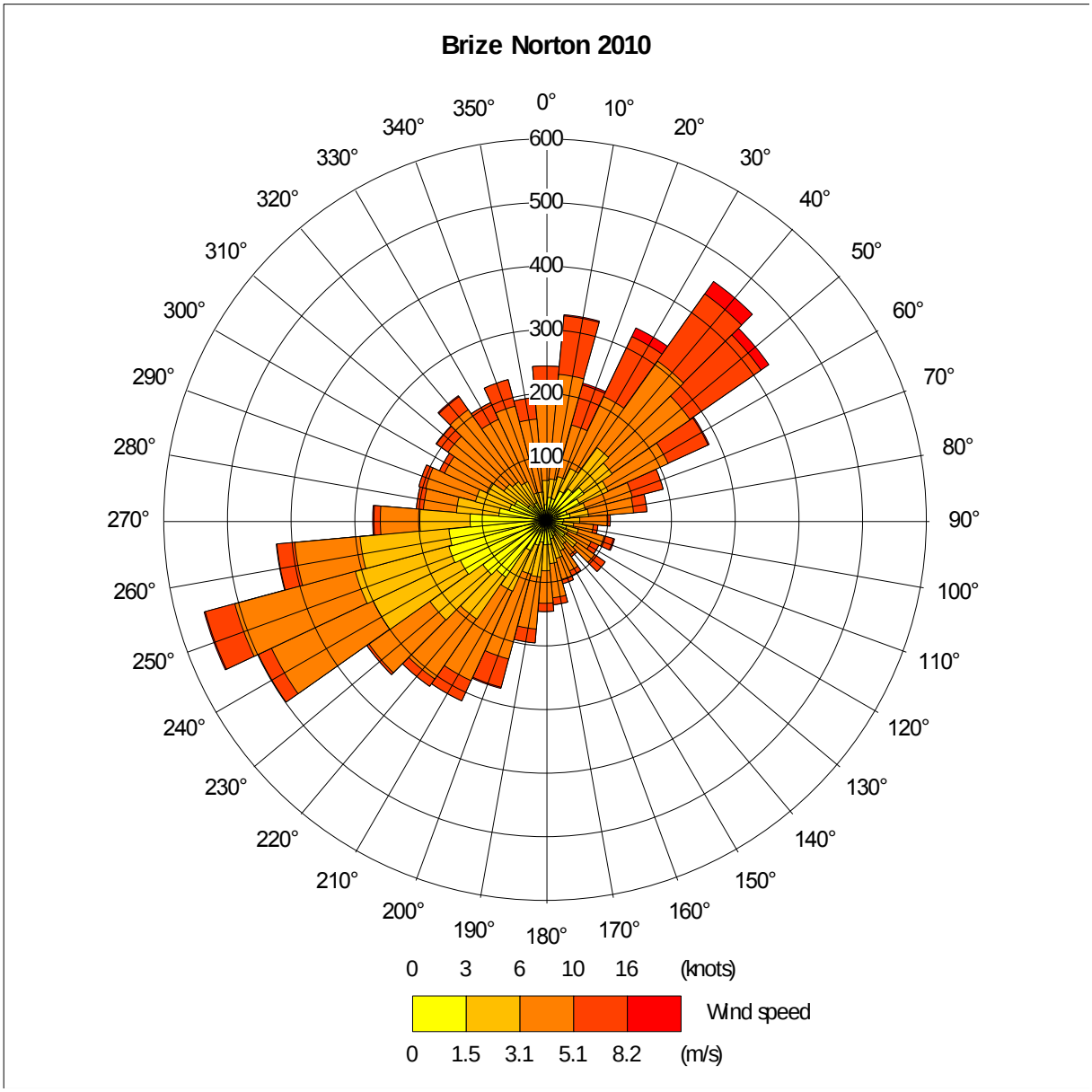
Appendix 2 – Meteorological dataset

The Wind Rose for the 2010 Brize Norton meteorological dataset is presented in Figure A2.1

Figure A2.1 Meteorological dataset windrose



Appendix 3 – Model verification

It is appropriate to verify the ADMS Roads model in terms of primary pollutant emissions of nitrogen oxides (NO_x = NO + NO_2). The model has been run to predict annual mean Road NO_x concentrations during the 2010 calendar year at the diffusion tube sites in the study area.

The model output of Road NO_x (the total NO_x originating from road traffic) has been compared with the measured Road NO_x, where the measured Road NO_x contribution is calculated as the difference between the total NO_x and the background NO_x value. Total measured NO_x for each diffusion tube was calculated from the measured NO_2 concentration using the 2012 version of the Defra NO_x/NO_2 calculator.

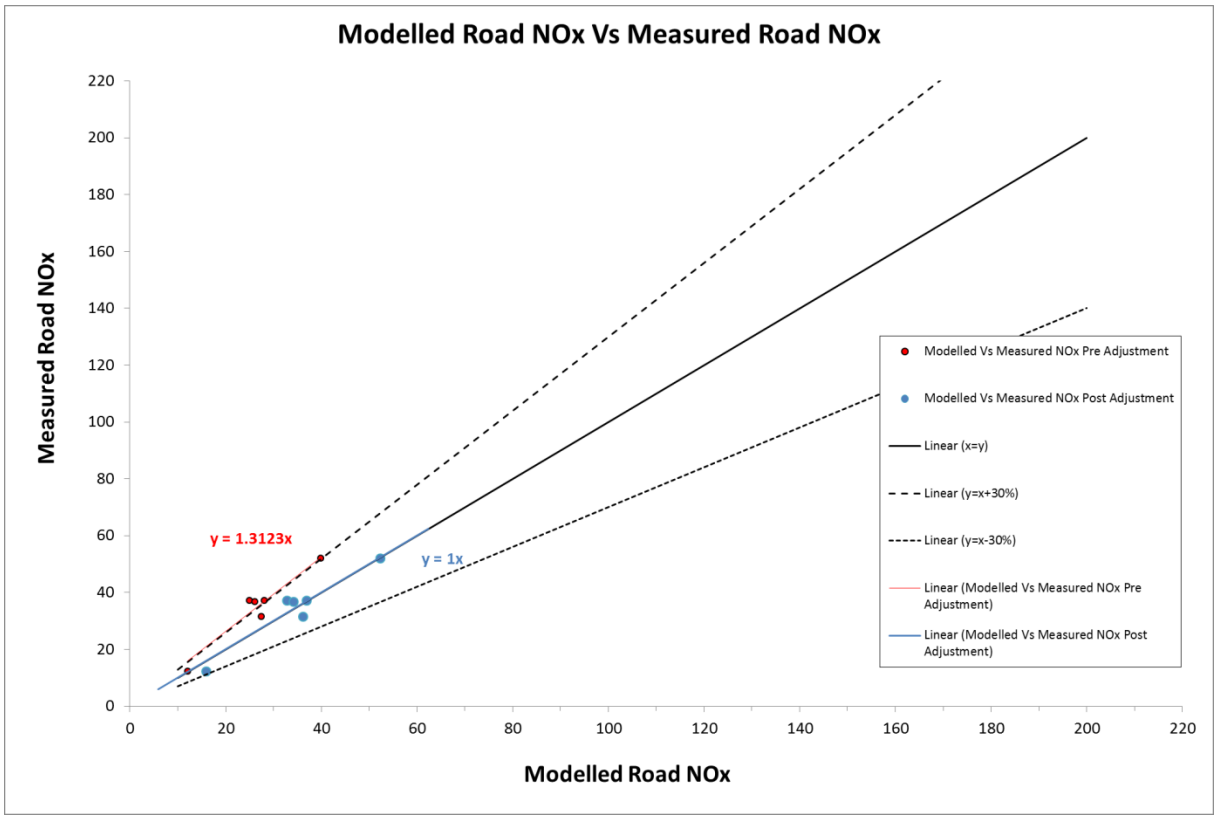
The initial comparison of the modelled vs measured Road NOx identified that the model was under-predicting the Road NOx contribution. Subsequently, various refinements were made to the model input to improve the overall model performance.

The gradient of the best fit line for the modelled Road NOx contribution vs. measured Road NOx contribution was then determined using linear regression and used as the adjustment factor. This factor was then applied to the modelled Road NOx concentration for each modelled point to provide adjusted modelled Road NOx concentrations. A linear regression plot comparing modelled and monitored Road NOx concentrations before and after adjustment is presented in Figure A3.1.

The background NOx concentration was then added to determine the adjusted total modelled NOx concentrations. The total annual mean NO_2 concentrations were then determined using the NOx/NO_2 calculator.

A primary adjustment factor (PAdj) of 1.31 was applied to all modelled Road NOx data.

Figure A3.1: Comparison of unadjusted modelled Road NO_x Vs Measured Road NO_x



Model uncertainty can be estimated by calculating the root mean square error (RMSE). In this case the calculated RMSE was 1.2 $\mu g.m^{-3}$ after adjustment which is within the suggested value (10% of the

objective being assessed) in LAQM.TG(09). The model has therefore been assessed to perform sufficiently well for use within this assessment.

Verifying modelling data with diffusion tube monitoring data will always be subject to uncertainty due to the inherent limitations in such monitoring data (even data from continuous analysers has notable uncertainty). The adjusted model output agrees well with available local monitoring but is based on one monitoring site only. The results should be considered in this context.

Appendix 4 - Diffusion Tube QA/QC

Diffusion Tube Bias Adjustment Factors

Cherwell District Council's diffusion tubes are prepared and analysed by Bristol City Council Scientific Services, 7 Redcross Street, Old Market, Bristol, BS2 0BA. The tubes are prepared using a solution of 20% tri-ethanolamine in water.

The bias adjustment factor used within this Detailed Assessment was derived from the national database of co-location studies (National Physical Laboratory, 2011). The results from this spreadsheet provided a national bias adjustment factor of 0.85.

QA/QC of diffusion tube monitoring

The Workplace Analysis Scheme for Proficiency (WASP) is an independent analytical performance-testing scheme, operated by the Health and Safety Laboratory (HSL). WASP formed a key part of the former UK NO_2 Network's QA/QC, and remains an important QA/QC exercise for laboratories supplying diffusion tubes to Local Authorities for use in the context of Local Air Quality Management (LAQM). The laboratory participants analyse four spiked tubes, and report the results to HSL. HSL assign a performance score to each laboratory's result, based on their deviation from the known mass of nitrite in the analyte.

The performance criteria are based upon the Rolling Performance Index (RPI) statistic.

Bristol Scientific Services participate in the Workplace Analysis Scheme for Proficiency (WASP) for nitrogen dioxide. According to the Annual Performance Criteria for NO_2 Diffusion Tubes used in the Local Air Quality Management (LAQM), during 2010, 100% of results submitted by Bristol Scientific Services were determined to be satisfactory by the WASP scheme.

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