Air Quality Detailed and Further Assessment 2011: Slough Borough Council

Report for Slough Borough Council

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Executive summary

All local authorities are obliged to review and assess air quality under the Environment Act 1995. They are required to carry out a Detailed Assessment where there is a risk that pollutant concentrations will exceed air quality objectives and are then required to declare a Air Quality Management Area if the Detailed Assessment indicates the objectives will not be met at relevant locations. Slough Borough Council's 2009 Updating and Screening Assessment recommended that that the Council should proceed to a Detailed Assessment of nitrogen dioxide (NO_2) concentrations at residential properties that are located within 30m of the Great Western Line. This report provides a Detailed Assessment, which aims to assess the magnitude and spatial extent of any exceedences of the air quality objectives for NO_2 in the vicinity of the Great Western Mainline that runs through Slough.

Measured concentrations at monitoring sites closest to the railway in Slough and Hillingdon were less than the air quality objective. The monitoring data thus does not support the need for a declaration of an Air Quality Management Area. However, our modelling indicates the potential for exceedence of the air quality objective at residential properties within 32 m south of the centre of the trackbed to the south and within 39 m to the north. There are several residential properties within this buffer, particularly in the region of Burnham station. We therefore recommend that additional monitoring is carried out near residential properties closest to the railway.

In 2011, Slough Borough Council declared Air Quality Management Areas (AQMA) covering Tuns Lane and parts of the Town Centre as the result of a Detailed Assessment carried out in 2008. Local Authorities are required to carry out a Further Assessment within a year of declaration of an AQMA. This report provides a Further Assessment, which aims to confirm the findings of the 2008 Detailed Assessment, apportion sources of NO_x (and therefore NO_2), estimate the level of NO_x reduction required to achieve the NO_2 objective, and test selected abatement scenarios to help inform an Air Quality Action Plan (AQAP).

The results of modelling and measurements confirm that it was appropriate for Slough Borough Council to declare Tuns Lane and Slough Town centre as AQMAs.

We recommend that Slough Borough Council should consider extending the Tuns Lane AQMA to the east along Bath Road as far as Windmill Road. The Council should also consider extending the Town Centre AQMA northwards along Uxbridge Road to the parade of shops with flats above (e.g. A&A Newsagents).

The Council should continue to monitor concentrations at Sussex Place and Farnham Road and consider extending the AQMAs if these exceed the objective.

Road traffic provides the largest contribution to nitrogen dioxide concentrations at roadside sites throughout the AQMAs. Heavy duty vehicles contribute more than half of the traffic contribution. Traffic on the M4 motorway does not substantially affect concentrations at roadside locations in the Tuns Lane and Town Centre AQMAs.

We investigated various traffic reduction scenarios to help the Council in the development of its Air Quality Action Plan. A 41.3% reduction in emissions will be required at the William Street roundabout and a 54.4% reduction will be required at Yew Tree Road in order to meet the air quality objective for nitrogen dioxide. Our analysis indicates that the air quality objective will be met by 2014 at all the diffusion sites except Yew Tree Road without Action plan measures. The analysis indicates that the objective will not be met at Yew Tree Road until 2017.

Table of contents

1 Introduction

1.1 National Air Quality Strategy

All local authorities (LAs) are obliged to review and assess air quality under the Environment Act 1995. A requirement of the Act was that the UK Government prepare an Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland. The AQS was published in January 2000 with a revised version published in July 2007.

Within the AQS, national air quality objectives are set out and LAs are required to review and assess air quality against these objectives. Table 1 lists the objectives included in Regulations for the purposes of Local Air Quality Management (LAQM) with dates by which they should be achieved.

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

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene All authorities	16.25 µg.m^{-3}	running annual mean	31.12.2003
Authorities in England and Wales only	5 µg.m^{-3}	annual mean	31.12.2010
Authorities in Scotland and Northern Ireland only	3.25 µg.m^{-3}	running annual mean	31.12.2010
1,3-Butadiene	2.25 µg.m^{-3}	running annual mean	31.12.2003
Carbon monoxide Authorities in England, Wales and Northern Ireland only	10.0 mg.m^{-3}	maximum daily running 8-hour mean	31.12.2003
Authorities in Scotland only	10.0 mg.m^{-3}	running 8-hour mean	31.12.2003
Lead	0.5 µg.m^{-3} 0.25 µg.m^{-3}	annual mean annual mean	31.12.2004 31.12.2008
Nitrogen dioxide	200 µg.m^{-3} not to be exceeded more than 18 times a year	1 hour mean	31.12.2005
	40 µg.m^{-3}	annual mean	31.12.2005
Particles (PM_{10}) (gravimetric)[a] All authorities	50 µg.m^{-3} not to be exceeded more than 35 times a year	24 hour mean	31.12.2004
	40 µg m^{-3}	annual mean	31.12.2004
Authorities in Scotland only[b]	50 µg.m^{-3} not to be exceeded more than 7 times a year	24 hour mean	31.12.2010
	18 µg.m^{-3}	annual mean	31.12.2010
Sulphur dioxide	350 µg.m^{-3} not to be exceeded more than 24 times a year	1 hour mean	31.12.2004
	125 µg.m^{-3} not to be exceeded more than 3 times a year	24 hour mean	31.12.2004
	266 µg.m^{-3} not to be exceeded more than 35 times a year	15 minute mean	31.12.2005

a. Measured using the European gravimetric transfer sampler or equivalent.

b. These 2010 Air Quality Objectives for PM10 apply in Scotland only, as set out in the Air Quality (Scotland) Amendment Regulations 2002.

1.2 Purpose of the Detailed Assessment

This study includes a Detailed Assessment, which aims to assess the magnitude and spatial extent of any exceedences of the air quality objectives for NO_2 in the vicinity of Great Western Mainline which runs through Slough.

1.3 Purpose of the Further Assessment

Slough Borough Council declared two new Air Quality Management Areas (AQMAs) for nitrogen dioxide covering parts of Slough Town Centre and Tuns Lane following the 2008 Detailed Assessment. This study provides a Further Assessment, which aims to confirm the findings of the 2008 Detailed Assessment, apportion sources of NO_x (and therefore NO_2), estimate the level of NO_x reduction required to achieve the NO_2 objective, and test selected abatement scenarios to help inform an Air Quality Action Plan (AQAP).

1.4 Locations where the Air Quality 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 to 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	Objectives *should* apply at …	Objectives should *not* generally apply at …
Annual mean	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	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.

1.5 Overview of the approach taken

The general approach taken to this detailed and further assessment was to:

- Collect and interpret data from previous review and assessment reports
- Collect and analyse all available traffic data, air quality monitoring data and background concentration data for use in the models
- Identify potential hotspots where it is likely that the AQS objectives would not be met
- Model NO_2 concentrations surrounding these hotspots
- Produce contour plots of the modelled pollutant concentrations
- Recommend whether Slough Borough Council should declare an AQMA close to the great Western Mainline and provide guidance on its minimum extent
- Recommend whether Slough Borough Council should revise the boundaries of the new Town Centre and Tuns Lane AQMAs.
- Test selected abatement measures in order to provide information for Slough Borough Council's AQAP.

The methodologies outlined in Technical Guidance LAQM.TG(09)[1] were used throughout this detailed and further assessment.

1.6 Conclusions of previous reports for NO2

Slough Borough Council has undertaken the following rounds of Review and Assessment since 2004:

- Detailed Assessment (2004) and Further Assessment (2004)
- Progress Report (2005)
- Further Assessment (2005)
- Updating and Screening Assessment (2006)
- Progress Report (2007)
- Detailed Assessment (2008)
- Updating and Screening Assessment (2009)
- Progress Report (2010)

The first ***Further Assessment (2004)*** concluded that the major causes of air quality exceedences were found to relate mainly to road traffic. In most cases the majority of road contributions came from motorways, however, there were instances when major roads were found to be the main source. Exceedences of the annual mean objective for nitrogen dioxide were predicted at several locations in Slough. As a result, Slough Borough Council declared two Air Quality Management Areas (AQMAs) in June 2005, which relate primarily to stretches of the M4 and the A4. The Slough Local Transport Plan 2006-2011 (March 2006) contains the air quality action plan for the M4, A4 and also general actions for the Town Centre to improve air quality. The designation of the two AQMAs was supported by the conclusions reached in the first ***Progress Report (2005).***

The ***Further Assessment (2005)*** identified a number of sites showing exceedences of the NO_2 annual mean objective that were not currently in the designated Air Quality Management Areas: Tuns Lane, Lansdowne Avenue and Princess Street. These sites are close to the A4 in the Town Centre. However, the 2005 Further Assessment concluded that there was no requirement to declare an AQMA in the Town Centre along the A4 main road because the Tuns Road monitoring site was affected by construction works while the other two sites were borderline with respect to the air quality objective when adjusted to the nearest public exposure. Based on the findings of the 2005 Further Assessment the ***Updating and Screening Assessment***

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

(2006), recommended that monitoring sites in the Town Centre be closely and regularly reviewed to highlight quickly any need to declare an AQMA in the Town Centre.

The ***Progress Report (2007)*** highlighted the fact that NO_2 concentrations at the Tuns Lane, Lansdowne Avenue and Princess Street sites in the Town Centre continued to exceed the NO_2 annual mean objective. The report suggested that four new diffusion tube sites (namely, Wexham Road, Wellington Street – Stratfield, Blair Road – Victoria Court and Wellesley Road) would help to verify these town centre concentrations during 2007.

The ***Detailed Assessment (2008)*** considered NO_x and NO_2 concentrations in the Town Centre of Slough. It recommended that Slough Borough Council should consider the declaration of an AQMA along Tuns Lane from the junction with the M4 up to the junction with Bath Road. Slough Borough Council were also advised to consider declaring an AQMA in the Town Centre along the A4 stretching from William Street roundabout to the Uxbridge roundabout. Slough Borough Council declared these AQMAs in January 2011. In addition, the report recommended that the impact of the Great Western Railway line running through the Town Centre on annual mean NO_2 concentrations should be assessed further and monitored carefully in the future.

The ***Updating and Screening Assessment (2009)*** reviewed new monitoring data. Monitoring in 2008 identified exceedences of the annual mean NO_2 objective at the Chalvey automatic monitoring site and at seven diffusion tube monitoring locations. Five of these diffusion tube sites were within the AQMA's declared in 2005 and the other two were within the new Town Centre AQMAs declared in 2011. Based on 2008 monitoring results, the 2009 USA recommended, as a result of updated guidance, that the Council should proceed to a Detailed Assessment of NO_2 emission at residential properties that are located within 30m of the Great Western Line. The report also concluded that the council should maintain monitoring at existing sites within the borough.

The ***Progress Report (2010)*** reviewed new monitoring data for 2009 and new developments. The report concluded that Slough Borough Council is not required to proceed to a Detailed Assessment based on the available monitoring data. It confirmed that nitrogen dioxide concentrations continue to exceed the annual mean objective limit in each of the four AQMAs.

2 Study Location

2.1 Detailed Assessment

This Detailed Assessment is concerned with the impact of moving trains along the Great Western Mainline. Technical Guidance LAQM.TG(09) states that a Detailed Assessment of the impact of moving trains will need to examine the combined impact of locomotive emissions with those of local road traffic.

The guidance indicates that the annual mean objective may be exceeded where there is the potential for long-term exposure within 30m of the edge of the tracks.

Figure 1 shows the route of the Great Western Mainline, major roads and motorways through Slough. It also shows the AQMAs.

The study area for the detailed assessment corresponds to the area within 30 m of the edge of the Great Western Mainline.

2.2 Further Assessment – AQMA Locations

Figure 2 shows the location of the Further Assessment study area. The area includes the Town centre and Tuns Lane AQMAs and extends more than 1 km beyond the boundaries of these AQMAs in each direction.

Figure 1: Great Western Mainline Study Area, Slough

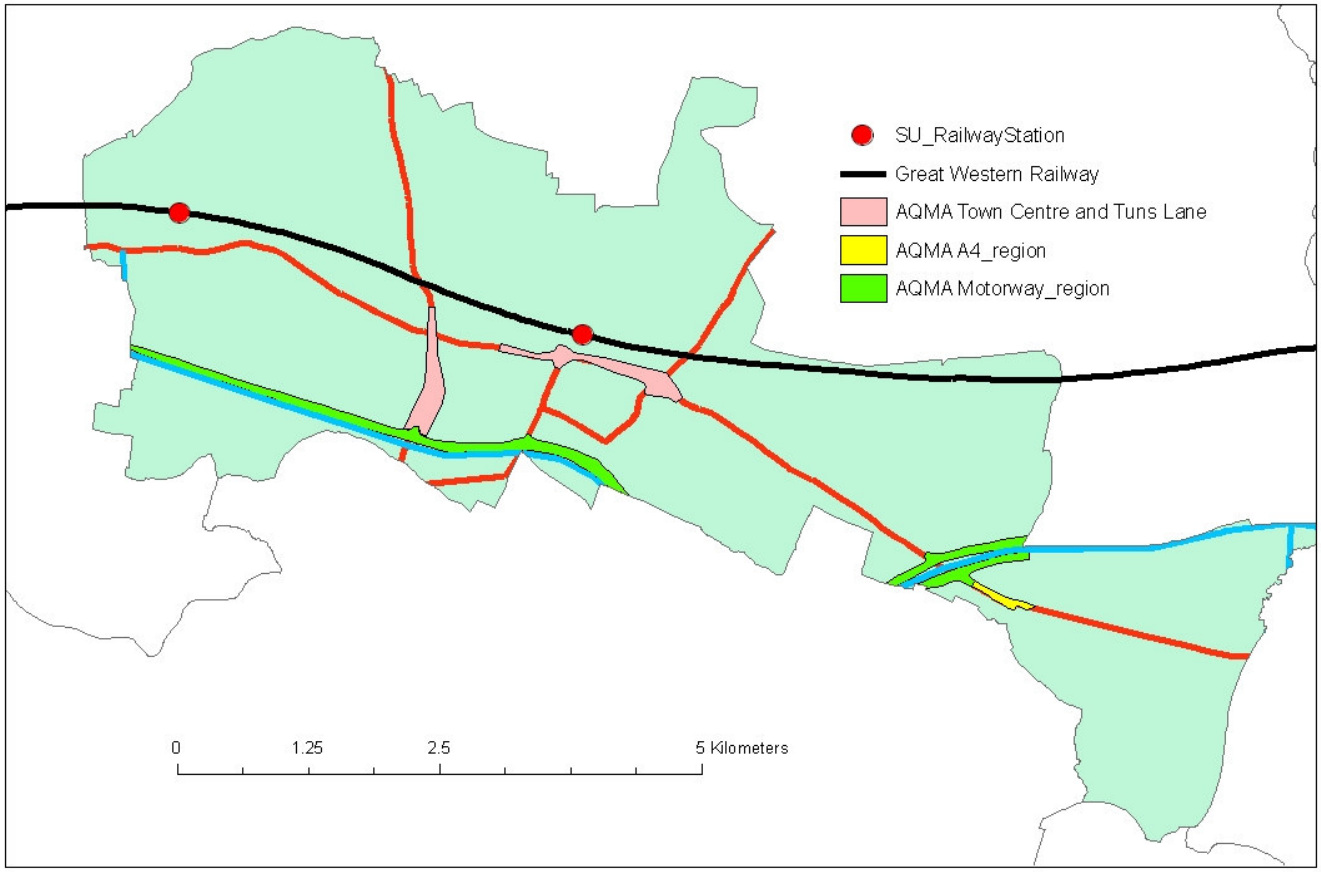
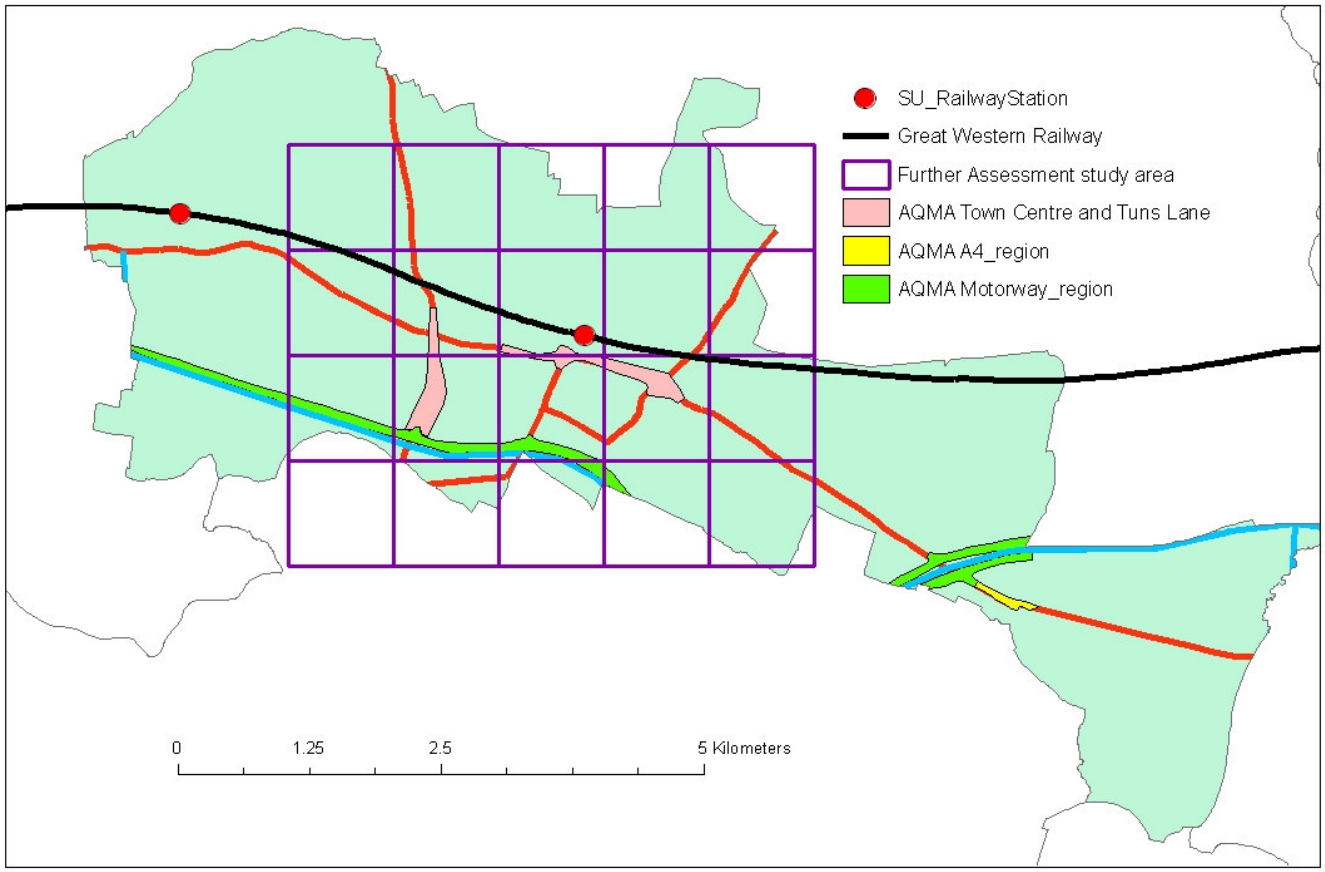


Figure 2: Further assessment study area



3 Information used to support this assessment

3.1 Maps

Maps in this report are based on the Meridian™ 2 and VectorMap™ District vector data sets provided by the Ordnance Survey under the terms of the Open Government Licence[2]. The following attribution statement accompanies each map:

Contains Ordnance Survey data © Crown copyright and database right 2011

3.2 Road traffic data

3.2.1 Average flow, speed and fleet split

The Slough 2008 Emissions Inventory provided estimates of the annual average daily traffic flow, vehicle fleet split and vehicle speed on each road link in the study areas.

Slough Borough Council provided SATURN modelled data for 2005 for the emission inventory. Slough Borough Council also provided 24–hour classified traffic counts for 21 sites throughout the Borough for 2009. The Highways Agency provided annual average daily traffic flows and fraction of vehicles greater than 6.6 m for 12 motorway sites for 2008. These data were used to update the SATURN modelled flows as described below.

The SATURN modelled data provided the Ordnance Survey coordinates of the end points of each of the links included in the road traffic model. In general, this road network provides an adequate spatial description when compared with more detailed maps. However, the SATURN network does not correspond to more detailed mapping of the M4 motorway between Junctions 5 and 6. This road link was reshaped to correspond to the route of the motorway between Junctions 5 and 6. Links corresponding to A412 Yew Tree Road, A4 Wellington Street and parts of the A332 were similarly reshaped to follow road centrelines defined by the Meridian 2 dataset. On and off ramps at M4 junction 6 were reshaped to road centrelines defined by the VectorMap District data set.

We identified the SATURN road links corresponding to the Slough Borough Council and Highways Agency traffic counts. The SATURN data provides modelled traffic flows in Passenger Car Units (PCU). The ratio of PCU flows to total traffic flows was estimated for each of these links using the following vehicle weightings:

Motorcycle	0.5 PCU
Car	1.0 PCU
Light Goods Vehicle	1.0 PCU
Rigid Heavy Goods Vehicle	1.9 PCU
Articulated Heavy Goods Vehicle	2.9 PCU
Buses	2.5 PCU

The fractions of each vehicle category were taken from the classified counts. The long vehicle fraction on the motorways was split between LGV, rigid HGV, artic HGV and buses according

[2] http://www.ordnancesurvey.co.uk/oswebsite/opendata/docs/os-opendata-licence.pdf

to the national split for motorways[3]. The short vehicle fraction was similarly split between cars and motorcycles. Where data did not contain a value for long vehicle fraction, the traffic was split according to national split. The average PCU/total traffic ratios were calculated for motorway, major and minor road sites separately.

The SATURN modelled data gives am, pm and daily interpeak hourly flows. We assumed that these correspond to 08:00-09:00, 17:00-18:00 and the average of 10:00-16:00 hrs. The non-motorway counts provide average weekly 2-way flows for each hour of the day and the average total flows. A scaling factor was derived for each count site as the ratio AADT: sum of flows for the modelled hours. For the motorways, the scaling factor was similarly derived from National Road Traffic Statistics (roadtraffdata08). Average scaling factors were calculated for motorway, major and minor sites separately.

The SATURN modelled traffic flows are for 2005. These were scaled to the current year according to National Road Traffic Forecasts[4] for the SE region adjusted using Tempro factors for Slough. Annual average daily traffic flows for 2008 were then estimated from the SATURN data using the appropriate average PCU: total traffic ratio, the AADT: sum of the am, pm and six interpeak hour flows ratio and the year factor. The measured traffic counts were then plotted against the flows estimated from the SATURN model. Fig.3 shows the measured and modelled counts for motorways. Fig. 4 similarly shows the counts for the other major roads and minor roads. The trend lines through the points have slopes 1.000 and 0.775 respectively. These factors were used to adjust the estimated flows throughout the whole network. The estimated flows were used for all links where actual count data was not available: actual counts were used where they were available.

[3] http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/pgr/statistics/datatablespublications/roadstraffic/speedscongestion/roadstatstsc/roadstats08tsc

[4] http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/pgr/economics/ntm/AF07_Annex_Baseline_summary.xls

Fig. 3: Comparison of modelled traffic estimates with actual counts for motorways

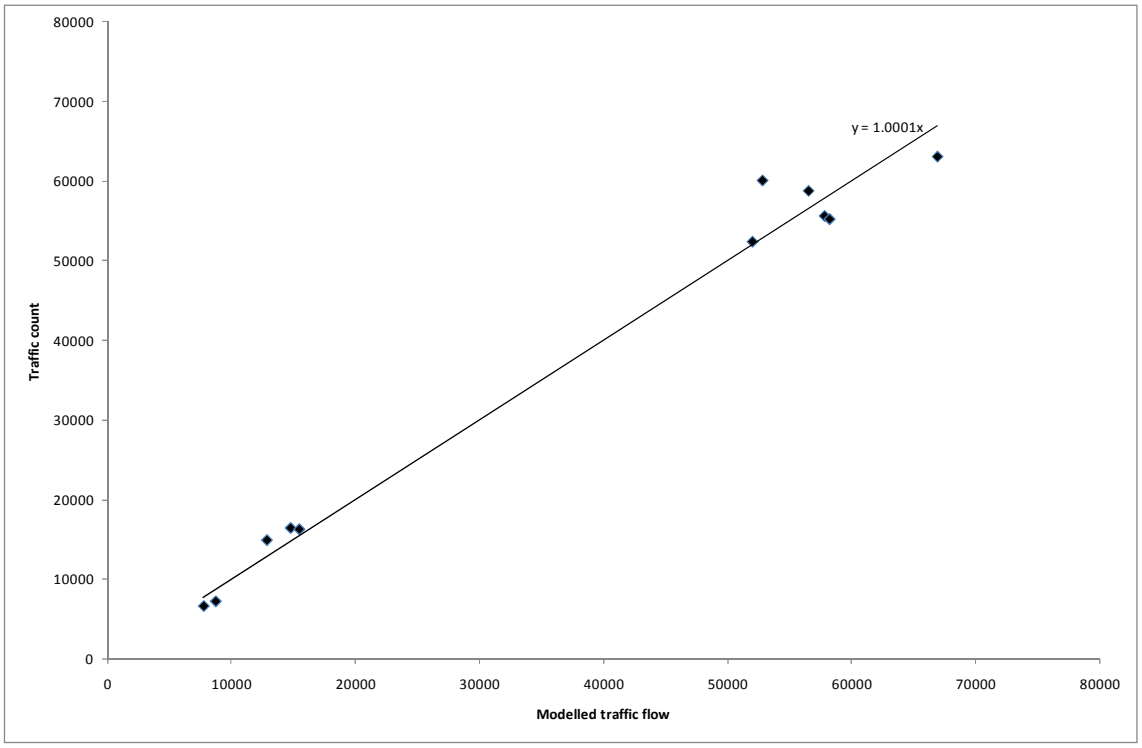
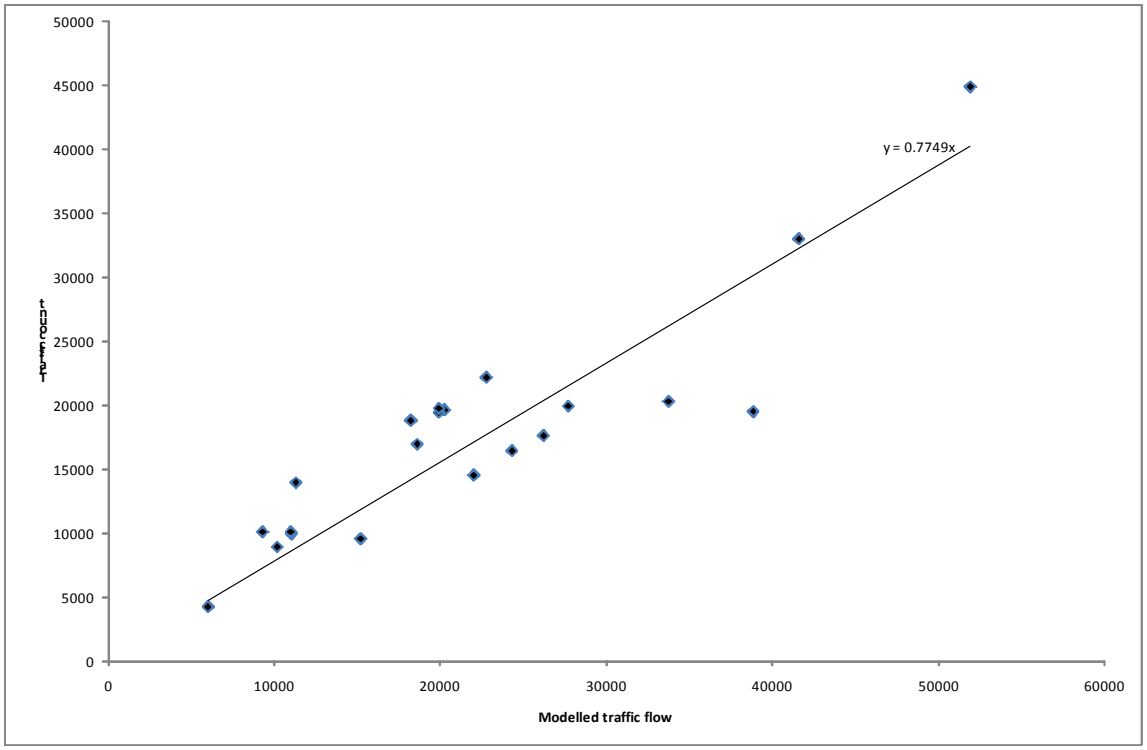


Fig. 4: Comparison of modelled traffic estimates with actual counts for other major roads and minor roads.



3.2.2 Emissions factors

This modelling study incorporates the latest emission factors published in 2009 by the Department for Transport.

3.3 Great Western Rail Data

Slough is located on the Great Western Line linking Reading with London. Both freight and passenger trains use the line on a daily basis. Estimates of the train movements on this line were taken from an Environmental Statement (ES) undertaken for Slough Trading Estate, which is situated on the railway line. The ES recorded 488 daily movements, of which 46 were freight, 194 intercity and 248 regional. Emissions for each train type were calculated using these railway movements and emission factors from the NAEI database.

The ES provided information on the number of trains stopping at Slough railway station. We assumed that these trains stopped for 2 minutes at the station and estimated emissions assuming that the idling emission rates were 10% of the emission rates for trains travelling at 100 kph. These emissions were distributed along a 120 m long part of the track at the station.

3.4 Ambient monitoring

3.4.1 Automatic Monitoring Sites

Four automatic monitoring sites for oxides of nitrogen and nitrogen dioxide are now operational in the borough. These sites are not affiliated to Defra's Automatic Urban and Rural Monitoring Network (AURN), but are part of the National Automatic Monitoring Calibration Club, whereby monitoring data are managed to the same procedures and standards as AURN sites. These procedures include:

- 3-weekly calibrations of the NOx analyser,
- 6-monthly audits and servicing of the monitoring site,
- Data ratification.

Calibrations of the NOx analyser were carried out using certified compressed gas standards (ISO17025). This ensured that the calibration gas was traceable to national and international standards. In addition to the 3 weekly calibration, visits included changing of the sample inlet filter and checking the analysers diagnostics for any faults. This in turn improved the data quality and minimised data loss.

Audits of the monitoring site consisted of a number of performance checks to identify any faults with the equipment. The calibration cylinder was also checked against another gas standard in order to confirm the gas concentration. Any identified faults were forwarded on to the service unit for repair.

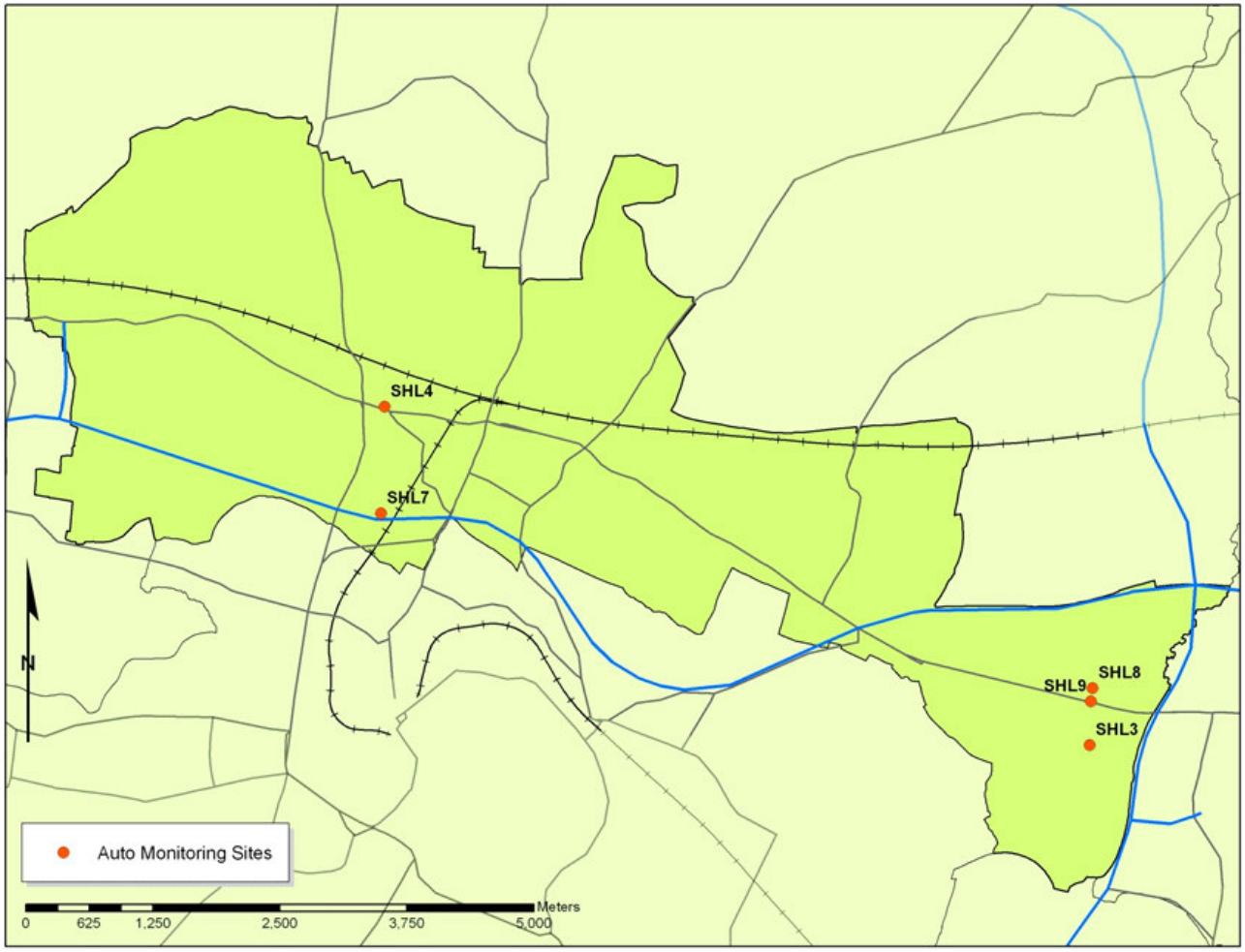
The final stage of the QA/QC process was to ratify the data. During ratification, all calibration, audit and service data are collated and the data is appropriately scaled. Any suspect data identified are deleted therefore ensuring that the data are of a high quality.

Table 3 and Figure 5 provide further details about the current automatic monitoring sites within the borough and their location.

Table 3 Details of Automatic Monitoring Sites

Site Code	Site Name	Site Type	OS Grid Ref		In AQMA?	Relevant Exposure? (Y/N with distance (m) to relevant exposure)	Distance to kerb of nearest road (N/A if not applicable)	Does this location represent worst-case exposure?
SHL4	Salt Hill (Slough town centre, A4)	Intermediate (Residential)	496599	180156	N	Y	10m	Y
SHL3	Slough Colnbrook (Pippins)	Urban Background (Residential)	503542	176827	N	Y	>50m	N
SHL7	Slough Chalvey, M4	Intermediate-Motorway (Residential)	496562	179109	Y (M4 AQMA)	Y	45m from M4	Y
SHL8	Slough Lakeside 2 (run by Lakeside Energy from Waste Ltd)	Urban Background (Industrial)	503569	177385	N	N	10m	N

Figure 5: Map of Automatic Monitoring Sites



3.4.2 Non-Automatic Monitoring

Diffusion tube monitoring of NO_2 is carried out at a thirty-seven sites in the borough. Diffusion tubes used by Slough Borough Council up to the end of 2009 were supplied and analysed by Gradko. Environmental Services Group (ESG) have supplied the diffusion tubes since the beginning of 2010. Both laboratories follow the procedures set out in the Practical Guidance document and participate in the Workplace Analysis Scheme for Proficiency (WASP). The tubes prepared by both Gradko and ESG have 50% v/v TEA in acetone.

Gradko achieved 'good' performance in the WASP based on old and new criteria for the January 2009 – January 2010 period. ESG achieved 'good' performance in the WASP based on old and new criteria for the April 2009 – April 2010 period.

Details of the diffusion tube monitoring locations are provided in Table 4 and Figure 6. The locations include kerbside, intermediate and urban background sites. Triplicate diffusion tubes at Salt Hill, Pippins and Chalvey are co-located with automatic monitoring sites.

Diffusion tubes may systematically under or over-read NO_2 concentrations when compared to reference chemiluminescence's analyser (automatic monitoring). This is described as "bias" and can be corrected for to improve the accuracy of diffusion tube results, using a suitable bias-adjustment factor. The 2010 Air Quality Progress Report for Slough Borough Council provided a bias adjustment factor of 0.98 for 2009 based on an average of the bias adjustment factors from the three co-location sites within the Borough: Salt Hill (0.97), Slough Colnbrook (Pippins) (1.00) and Slough Chalvey M4 (0.98). A bias adjustment factor of 0.816 was calculated for 2010 based on the average of the bias measured at Salt Hill (bias factor 0.77), Chalvey (0.85) and three sites reported by other local authorities for the national bias adjustment survey (0.75, 0.79, 0.94). Table 5 shows details of the calculation of the combined bias adjustment[5].

[5] http://laqm.defra.gov.uk/documents/NO2-Diffusion-Tube-Collocation-Methodology.pdf

Table 4 Details of Non- Automatic Monitoring Sites

Site ID	Site Name	Site Type	OS Grid Ref		In AQMA?	Relevant Exposure?	Distance to kerb of nearest road	Worst-case Location?
1	Hencroft Street 6N	UB	497925	179450	N	Y	N/A	Y
2	Kent Avenue 5N	UB	496450	181875	N	Y	N/A	Y
3	Essex Avenue	I	496200	181900	N	Y	1-5m	Y
4	Windsor Road 1N	K	497557	179825	N	Y	1-5m	Y
5	Mitchell Close	I(M)	495450	179480	Y	Y	90m	Y
6	Tweed Road	I	501518	177882	Y	Y	15m	Y
7	Colnbrook By-pass	K	503196	177349	N	N	5m	N
8	Horton Road (Caravan Park)	I	503136	175654	N	Y	17m	Y
9	Princess Street	I	498541	179815	N	Y	17m	Y
10	Paxton Avenue	I(M)	496050	179258	Y	Y	66m	Y
11	Winvale	K(M)	497488	179090	Y	Y	15m	Y
12	Lansdowne Avenue	I	497188	180050	N	Y	14m	Y
13	Brands Hill	K	501798	177659	Y	Y	3m	Y
14	Tuns Lane	I	496416	180126	N	Y	20m	Y
15	Elbow Meadows	UB(M)	503856	176538	N	Y	119m	Y
16	London Road	K	501733	177725	Y	Y	3m	Y
17	Grampian Way	UB	501382	178101	Y	Y	51m	Y
18	Ditton Road	I(M)	500851	177890	Y	Y	60m	Y
19 - 21	**Pippins ***	UB	503542	176827	N	Y	N/A	Y
22 - 24	**Salt Hill ***	I	496599	180156	N	Y	10m	Y
25	William Street roundabout	K	497646	180064	N	N	9m	N
26	Torridge Road	I (M)	501637	177999	Y	Y	95m	Y
27	Sussex Place	K	498784	179560	N	Y	6m	Y
28	Spackmans Way	I(M)	496272	179187	Y	Y	40m	Y
29	Farnham Road (2)	I	496397	180341	N	Y	20m	Y
30	Lakeside Road *	UB	503877	177459	N	N	N/A	N
31-33	**Chalvey (CAS) ***	I(M)	496562	179109	Y	Y	45m	Y
34	Wexham Road	K	498394	179849	N	Y	4m	Y

Site ID	Site Name	Site Type	OS Grid Ref		In AQMA?	Relevant Exposure?	Distance to kerb of nearest road	Worst-case Location?
35	Wellington Street - Stratfield	I	498168	179907	N	Y	13m	Y
36	Shelley Close	I	500981	178319	N	Y	20m	Y
37	Blair Road-Victoria Court	I	497105	180081	N	Y	13m	Y
38	Wellesley Road	I	498071	179949	N	Y	12m	Y
39	Rogans (Colnbrook by pass)	K	501941	177633	Y	Y	5m	Y
40	Yew Tree Road	K	498483	179707	N	Y	3m	Y
41	India Road	R	498681	179972	N	Y	2m	Y
43	The Myrke	(M)	497881	178831	N	Y	18m	Y
44	Winvale	(M)	497430	179094	Y	N	21m	Y

* Diffusion tube co-located with automatic monitor

Key to monitoring site type

K	Kerbside	1.5m from the kerb of a busy road - residential
I	Intermediate	Between 20-30m from a busy road - residential
UB	Urban Background	More than 50m from a busy road - residential
K(M)	Kerbside Motorway	Between 20-50m from Motorway Centre - residential
I(M)	Intermediate Motorway	Between 50-100m from Motorway centre - residential
UB(M)	Urban Background Motorway	Between 100-200m from Motorway centre - residential

Figure 6: Map of Non-Automatic Monitoring Sites

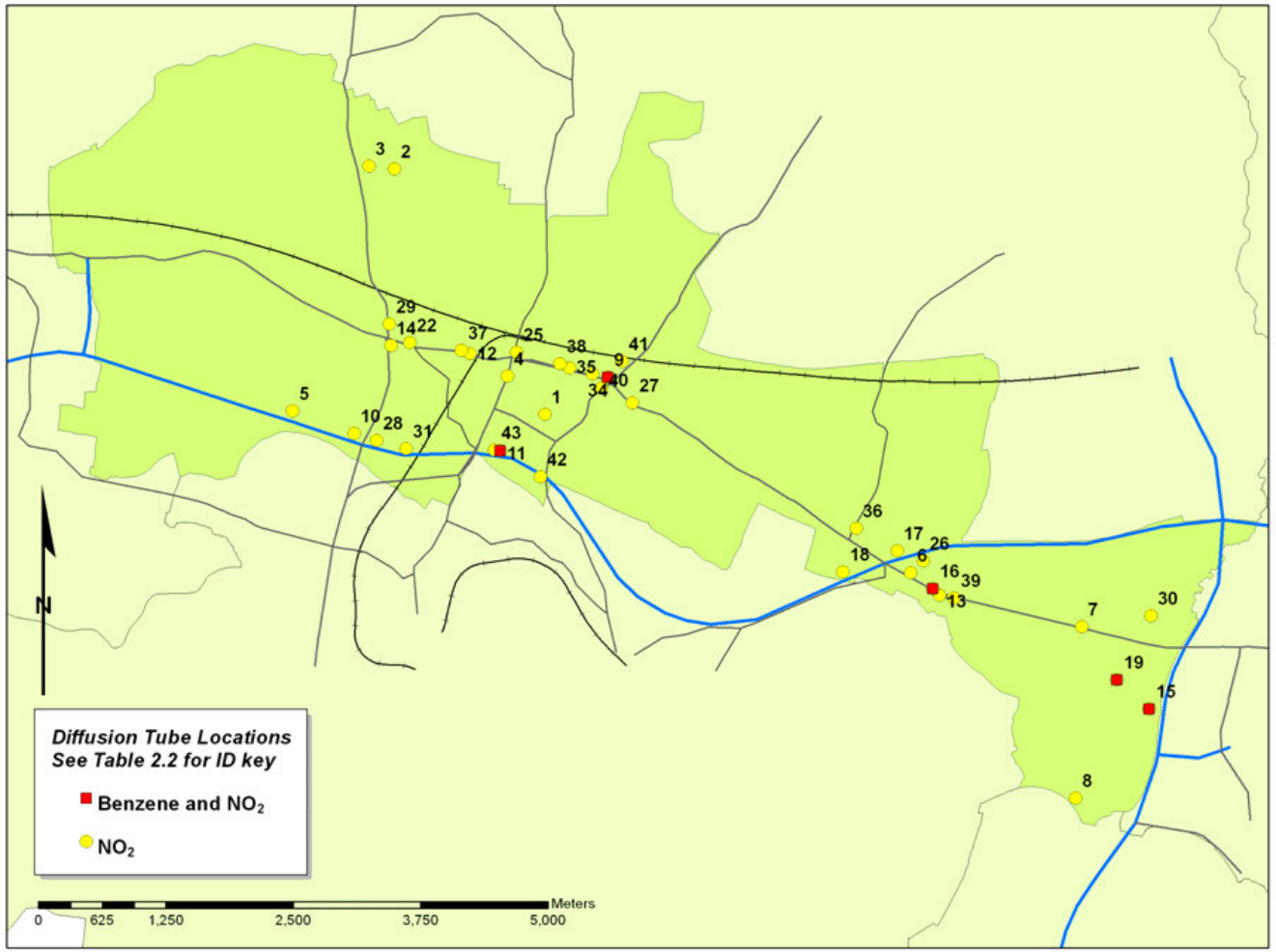


Table 5: calculation of the bias adjustment factor for 2010 diffusion tube results

Co-location site	Number of tubes	Concentration µg m^{-3}		Diffusion tube bias	Bias adjustment factor
		Diffusion tube	Reference analyser		
Salt Hill	36	42	32	31.3%	0.77
Chalvey	36	49	42	16.7%	0.85
Uttlesford DC	9	33	32	5.9%	0.94
Marylebone Road	11	119	94	25.8%	0.79
Rochford	12	62	47	33.2%	0.75
Average bias				22.6%	
Bias adjustment factor calculated from average bias					0.816

3.5 Background concentrations

Defra's 2008 background maps provided the basis of the estimates of background concentrations of NO_x and NO_2 used in this assessment.

4 Ambient monitoring

Table 6 presents the annual mean concentrations of NO_2 for 2007-2010 at each of the automatic monitoring sites within Slough. The annual mean NO_2 concentration exceeded the objective of 40 µg m^{-3} at 2 sites within the Borough in 2009; SHL4 Salt Hill (40.1 µg m^{-3}) and SHL7 Slough Chalvey M4 (44.4 µg m^{-3}). The concentration only exceeded the objective at Chalvey M4 in 2010.

Table 6 Results of Automatic Monitoring for NO_2: Comparison with Annual Mean Objective

Site ID	Location	Within AQMA?	Data Capture %		Annual mean concentrations (µg/m^3)			
			2009	2010	2007	2008	2009	2010
SHL4	Salt Hill (Slough Town Centre A4)	N	90.3	98.7	37	39*	**40.1**	32.5
SHL3	Slough Colnbrook (Pippins)	N	95.7	60.8	33	31	39.24	29.5*
SHL7	Slough Chalvey M4	Y	88.1	84.6	**51***	**44**	**44.4**	**41.9**
SHL8	Slough Lakeside 2	N	96.5	65.1	-	36**	35.45	38.8

* Adjusted due to poor data capture

** Data may be subject to further quality control

Bold Measured concentration exceeds the AQS objective

Table 7 presents information on all 1-hourly mean NO_2 objective at the continuous automatic monitoring sites over the last 4 years. In 2009 and 2010, the hourly objective was achieved at all sites. At Slough Chalvey there was one exceedence of the hourly mean in both 2009 and 2010, but this remains well within the air quality objective of 18 exceedences. There were no exceedences of the hourly NO_2 objective at the other automatic monitoring sites in the borough.

Table 7 Results of Automatic Monitoring for NO_2: Comparison with 1-hour Mean Objective

Site ID	Location	Within AQMA?	Number of Exceedances of hourly mean (200 µg/m^3)			
			2007	2008	2009	2010
SHL4	Salt Hill (Slough Town Centre A4)	N	0	0 (111)*	0	0
SHL3	Slough Colnbrook (Pippins)	N	0	0	0	0 (103)*
SHL7	Slough Chalvey M4	Y	0 (243)*	13	1 (128)*	1 (130)*
SHL8	Slough Lakeside 2	N	-	0**	0	0 (124)*
* Data capture less than 90%, 99.8th percentile of hourly mean provided in brackets						
** Data are provisional and may be subject to further quality control						

Table 8 shows the results of diffusion tube monitoring throughout the borough for 2007-2010. The monitoring results have been corrected for diffusion tube bias. The annual average concentration in 2010 exceeded the air quality objective at the following sites within the Town Centre and Tuns Lane AQMAs:

- Princess Street
- Lansdowne Avenue
- William Street roundabout
- Wexham Road
- Blair Road- Victoria Court
- Wellesley Road
- Yew Tree Road

Table 8: Results of NO_2 Diffusion Tubes

Site ID	Location	Within AQMA?	Within Study Area?	Data Capture, %		Annual mean concentrations ($\mu g/m^3$)			
				2009	2010	2007	2008	2009	2010
1	Hencroft Street 6N	N	Y	91.7	100	31	29	29.7	30.8
2	Kent Avenue 5N	N	Y	100	92	26	25	26.7	28.8
3	Essex Avenue	N	Y	91.7	58	34	30	33.5	39.6
4	Windsor Road 1N	N	Y	100	100	**43**	**43**	**44.9**	**43.2**
5	Mitchell Close	Y	Y	91.7	92	36	33	34.4	36.2
6	Tweed Road	Y	N	100	100	39	37	36.4	**41.2**
7	Colnbrook By-pass	N	N	100	100	**43**	39	39.5	**42.3**
8	Horton Road (Caravan Park)	N	N	100	100	33	31	30.9	37.7
9	Princess Street	Y#	Y	100	92	39	38	39.0	**42.3**
10	Paxton Avenue	Y	Y	75.0	92	**42**	38	**40.0**	38.0
11	Winvale	Y	Y	91.7	100	**44**	**44**	**42.1**	**40.9**
12	Lansdowne Avenue	Y#	Y	91.7	83	38	38	**40.4**	**45.1**
13	Brands Hill	Y	N	100	100	**60**	**58**	**57.9**	**67.0**
14	Tuns Lane	Y#	Y	91.7	100	37	34	35.8	39.0
15	Elbow Meadows	N	N	83.3	100	36	34	34.1	39.2
16	London Road	Y	N	91.7	92	**50**	**47**	**48.9**	**59.1**
17	Grampian Way	Y	N	100	100	**41**	**41**	**42.1**	**42.3**
18	Ditton Road	Y	N	66.7	100	39	39	38.6	**40.9**
19	Pippins *	N	N	91.7	100	30	28	28.6	30.8
20	Pippins *	N	N	100	100	30	28	28.7	32.8
21	Pippins *	N	N	100	100	29	28	28.9	31.1
22	Salt Hill *	N	Y	91.7	100	33	33	34.7	37.0
23	Salt Hill *	N	Y	91.7	100	34	33	35.2	34.2
24	Salt Hill *	N	Y	91.7	100	33	31	34.7	32.5
25	William Street roundabout	Y#	Y	100	100	**50**	**48**	**49.6**	**51.4**
26	Torridge Road	Y	N	100	100	**41**	38	36.6	**47.4**
27	Sussex Place	N	Y	100	92	38	36	37.6	**40.5**
28	Spackmans Way	Y	Y	100	100	**40**	37	39.6	**41.0**
29	Farnham Road (2)	Y#	Y	91.7	100	37	36	36.2	36.9
30	Lakeside Road *	N	N	100	92	39	39	35.3	39.7
31	Chalvey (CAS) *	Y	Y	100	92	39	39	**42.1**	39.9

Site ID	Location	Within AQMA?	Within Study Area?	Data Capture, %		Annual mean concentrations (μg/m^3)			
				2009	2010	2007	2008	2009	2010
32	Chalvey (CAS) *	Y	Y	100	100	39	37	**40.4**	**40.6**
33	Chalvey (CAS) *	Y	Y	91.7	100	39	37	**41.8**	**40.5**
34	Wexham Road	Y#	Y	100	100	**46**	**42**	**47.1**	**45.5**
35	Wellington Street - Stratfield	Y#	Y	100	100	38	38	37.6	39.4
36	Shelley Close	N	N	-		36	33	-	
37	Blair Road-Victoria Court	Y#	Y	100	100	**42**	**40**	**44.2**	**45.3**
38	Wellesley Road	Y#	Y	100	100	**40**	37	**40.4**	**40.4**
39	Rogans (Colnbrook by pass)	Y	N	83.3	100	-	**45**	**46.2**	**54.7**
40	Yew Tree Road	Y#	Y	66.7	75	-	**49**	**49.2**	**60.3**
41	India Road	N	Y	91.7	100	-	-	37.0	35.5
43	The Myrke (HA site)	N	N	83.3	100	**48**	39	31.8	
44	Winvale (HA site)	Y	Y	91.7	100	38	39	**42.0**	

Bold	Measured concentration exceeds the AQS objective
*	Diffusion tube co-located with automatic monitor
#	Located within new AQMAs

5 Dispersion modelling

5.1 Overview of Modelling

The air quality impact from roads has been assessed using our proprietary urban model (LADS Urban). There are two parts to this model:

- The *Local Area Dispersion System (LADS) model*. This model calculates background concentrations of oxides of nitrogen on a 1 km x 1 km grid. The estimates of emissions of oxides of nitrogen from road traffic for each 1 km x 1 km area grid square outside the study area were obtained from the 2008 National Atmospheric Emissions Inventory.
- The *DISP model*. This model is a tool for calculating atmospheric dispersion using a 10 m x 10 m x 3 m volume-source kernel derived from ADMS 4.2 to represent elements of roads. The volume source depth takes account of the initial mixing caused by the turbulence induced by the vehicles. The volume source depth was increased to 5 m to take account of the initial mixing for trains.

Concentrations of NO_2 from road traffic emissions were modelled with a resolution of 10 m close to the roads as recommended in the Technical Guidance LAQM.TG (09).

Particular attention was paid to the avoidance of "double counting" of the contribution from major roads in the modelled areas. Thus the emissions from sections of roads modelled using DISP were removed from the LADS inventory.

Hourly sequential meteorological data for 2009 from Heathrow Airport, approximately 10 km east of the study area was used. A surface roughness of 1 m was used in the modelling to represent the urban conditions corresponding to the most exposed sites. An intelligent gridding system was used with receptors at 10 m intervals on a rectangular grid within 150 m of the modelled roads and more widely spaced receptors elsewhere.

Defra's 2008 background maps provided the basis of the estimates of background concentrations of NO_x and NO_2 used in this assessment. The background maps provided estimates of the contribution made by various source categories to the total NO_x concentration in each 1 km square area for each year 2008-2020.

We removed the contribution from road traffic because we estimated this by dispersion modelling of the emissions. The road traffic emissions modelled included the emissions from the major and minor road links in the Further Assessment study area in the Slough Emissions Inventory. Emissions from road traffic outside this area were modelled as gridded area sources using LADS. The gridded area emissions for Windsor and Maidenhead, Hillingdon, South Buckinghamshire, Spelthorne, Hounslow, Runnymede, Bracknell Forest and Wycombe council areas were obtained from NAEI 2008 emissions maps.

We removed the contribution from railways because we estimated the contribution from the Great Western Mainline by dispersion modelling.

We modelled the contribution to annual average ground level oxides of nitrogen concentrations from Part A and Part B industrial emissions sources in Slough using the dispersion model ADMS4.2 based on the emissions and stack parameters taken from the 2008 Slough Emissions Inventory. However, the maximum contribution to ground level annual mean concentrations was less than 0.5 µg $m^{-3}$and so we made no adjustment to the estimates of the industrial contribution provided by the background maps.

We adjusted the background NO_2 map concentration estimates to take account of the removal of the contributions from road and rail traffic using the Background NO_2 calculator provided by Defra.

The primary NO_2 model recommended in Technical Guidance LAQM.TG(09) was used to calculate nitrogen dioxide concentrations from the oxides of nitrogen concentrations predicted by LADS Urban. The model takes into account the regional background ozone, nitrogen dioxide and nitric oxide concentrations, the proportion of the oxides of nitrogen released from vehicles as nitrogen dioxide, and the exposure of the site to sunlight.

All the models used in the assessment make a number of assumptions during the calculations. For example, we assumed that the local terrain was effectively flat. Modelling of pollutant concentrations on roads can sometimes provide misleading information on produced contour maps. For example, polygons and circles on certain areas of the contour maps, e.g. roundabouts or the centres of roads, can be generated. This is not a deficiency of the model; it is an artefact of the data and the use of discreet receptor points. As such, these additional features should be ignored and the wider context and implications of the contour maps be considered.

5.2 Verification of the model

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. The approach outlined in Example 2 of LAQM.TG(09) has been used here. Separate correction factors were applied to motorway road links and other road links.

The model generated in this study was verified using all available monitoring sites within the study area. The comparison of monitored against modelled NO_x revealed that the model under-predicted the Road NO_x component when compared with estimates based on the diffusion tube measurements in Slough town centre. As such, the modelled Road NO_x contribution from non-motorway links was multiplied by a factor of 3.18 and the contribution from motorway links was multiplied by 0.65. All reasonable steps were taken to minimise uncertainty in the model input data.

Fig. 7 shows the estimates of Road NO_x derived from the diffusion tube measurements plotted against the adjusted modelled estimates. Fig. 8 shows the measured nitrogen dioxide concentrations plotted against the modelled concentrations.

Adjusting modelling data to diffusion tubes 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 agrees well with available local monitoring and has therefore been assessed to perform sufficiently well for use within this assessment without further adjustment.

Fig. 7: Comparison of modelled and measured oxides of nitrogen concentrations

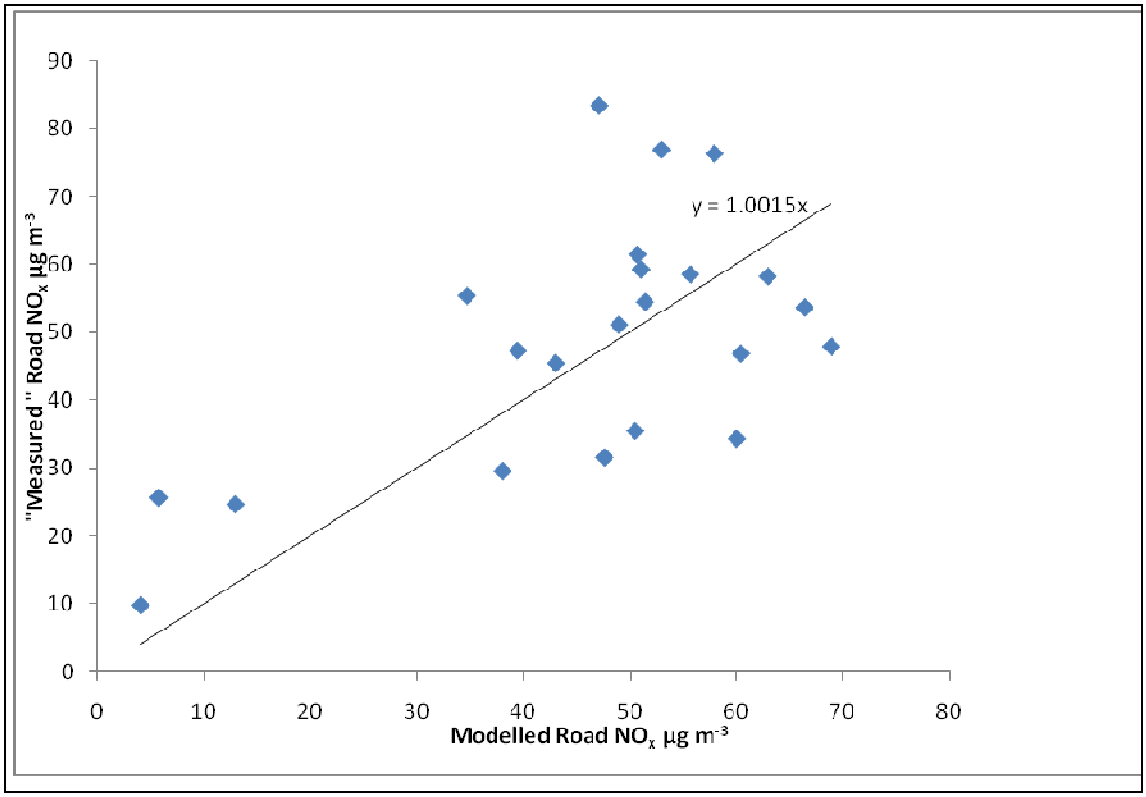
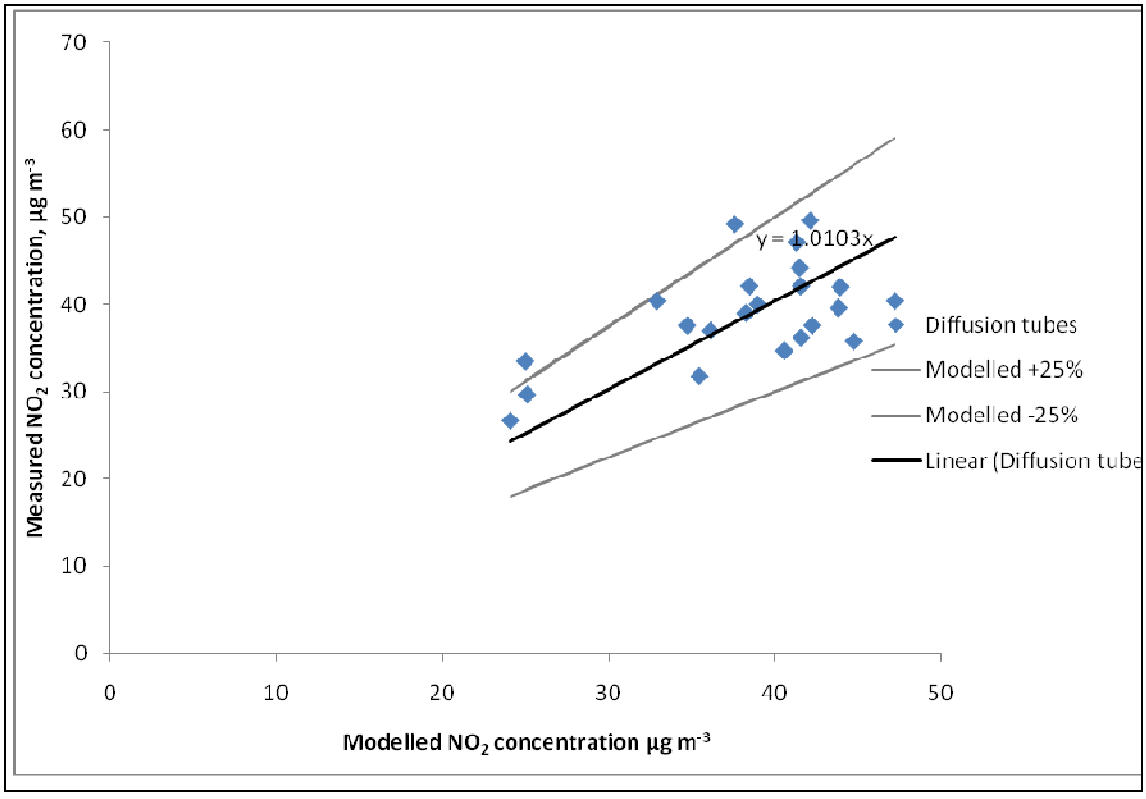


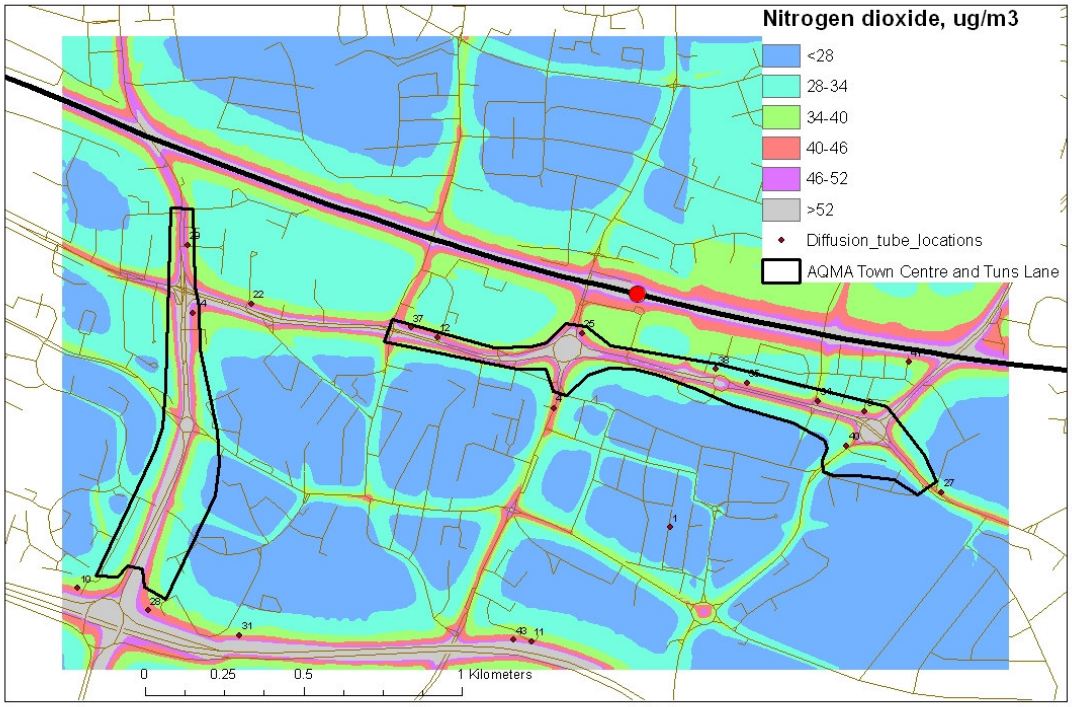
Fig. 8 : Comparison of modelled and measure nitrogen dioxide concentrations



5.3 Model outputs

Fig. 9 shows the predicted nitrogen dioxide concentrations in the region of the Town centre and Tuns Lane AQMAs. Generally, the modelling predicts that the concentration exceeds the objective of 40 µg m^{-3} near to roads in the AQMA areas in the Town Centre, around Tuns Lane and near the M4 motorway. It also predicts that the concentration exceeds the objective close to the Great Western Mainline. These areas are examined more closely in Sections 6 and 7.

Fig. 9: Modelled nitrogen dioxide concentrations for 2009 in the study area



6 Further assessment

6.1 Introduction

This section examines the predictions of nitrogen dioxide concentrations more closely in the region of the Town Centre and Tuns Lane AQMAs. It provides details of the relative contributions made by the major sources of emissions and examines possible measures to reduce emissions in order to inform the Air Quality Action Plan.

Concentrations of nitrogen dioxide close the Great Western Mainline are considered further in Section 7.

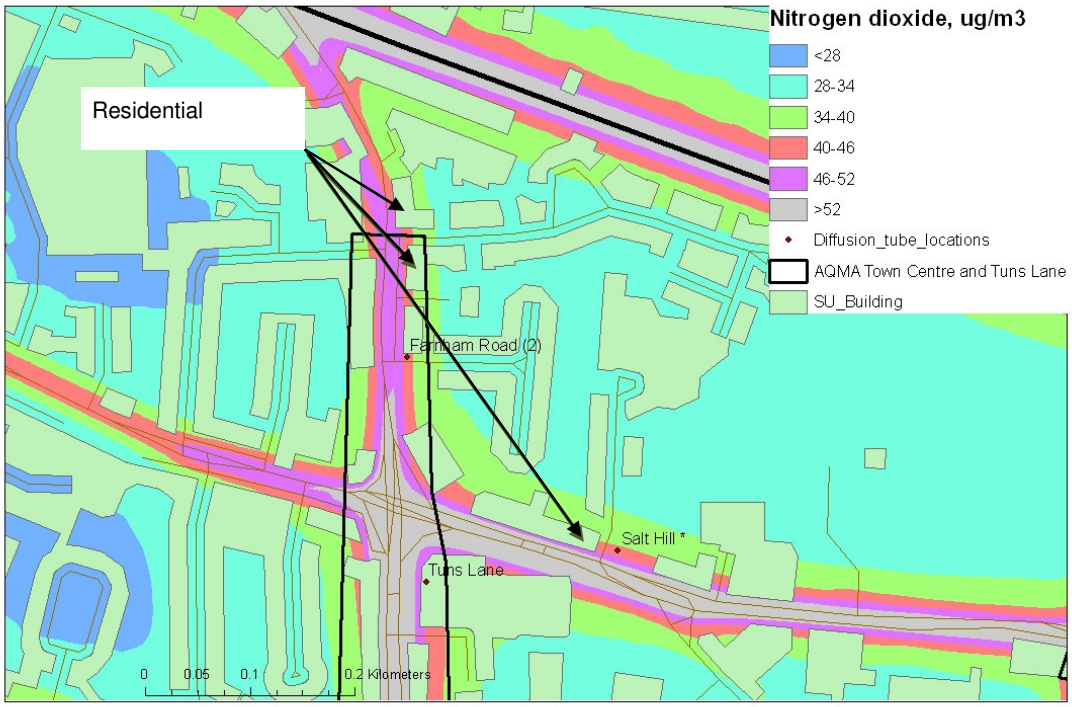
6.2 Closer examination of the AQMAs

6.2.1 Tuns Lane junction with Bath Road

Fig. 10 shows the predicted concentrations for 2009 at the junction of Tuns Lane and Bath Road. Farnham Road extends north of the junction. The model results indicate that the nitrogen dioxide concentration exceeds the air quality objective at several buildings in this area.

The area of the junction has mixed residential/commercial occupation. There are residential properties to the west of the junction along Bath Road, but these are sufficiently far back from the road that the predicted concentration is less than the objective. The model indicates that the concentration exceeds the objective at residential properties to the north of the junction along Farnham Road. However, measured concentrations at the Farnham Road diffusion tube site were less than the objective (36.2 µg m^{-3} in 2009 and 36.9 µg m^{-3} in 2010) and so we do not recommend that the AQMA should be extended in this direction. There are several residential properties along Bath Road to the east of the junction where the model predicts that the concentration exceeds the objective although measured concentrations at Salt Hill were less than the objective in 2009 and 2010. Slough Borough Council should consider extending the Tuns Lane AQMA eastwards as far as Windmill Road.

Fig. 10: Predicted concentrations for 2009 at the junction of Tuns Lane and Bath Road.



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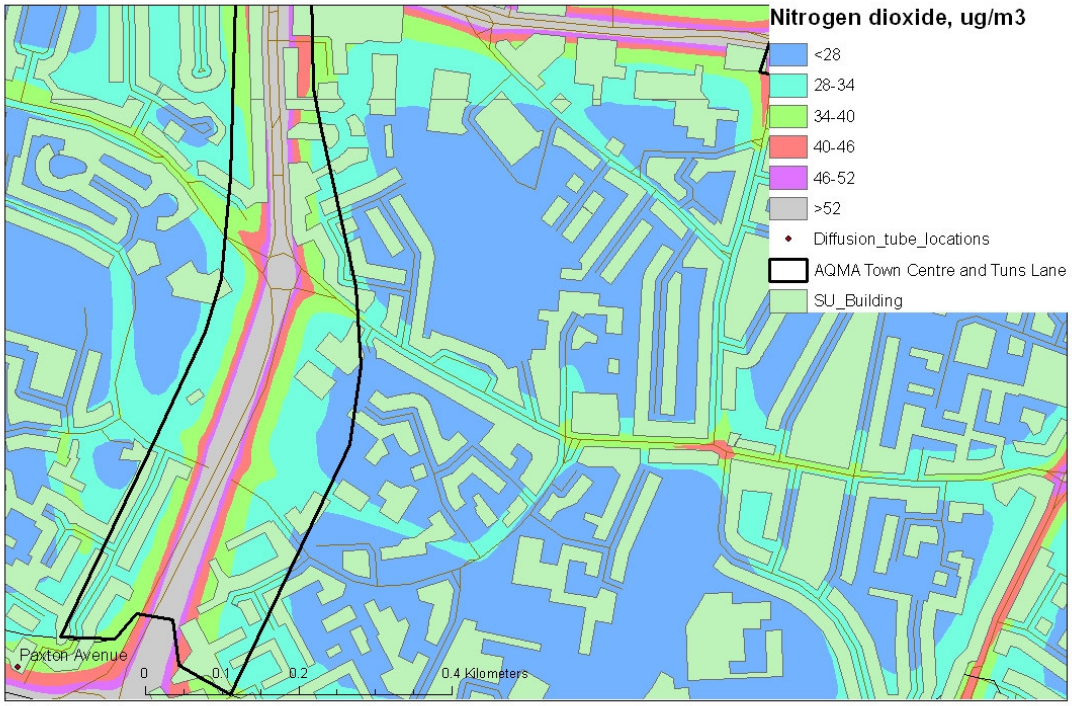
6.2.2 Tuns Lane junction with M4

Fig.11 shows the predicted concentrations for 2009 in the south part of the Tuns Lane AQMA extending to the M4 AQMA at the junction of Tuns Lane and the M4 motorway. The model results indicate that the nitrogen dioxide concentration exceeds the air quality objective at several residential buildings in this area north of the junction with Cippenham Lane and Church Street and in the south towards the M4 junction.

Fig.11: Predicted concentrations for 2009 in the south part of the Tuns Lane AQMA



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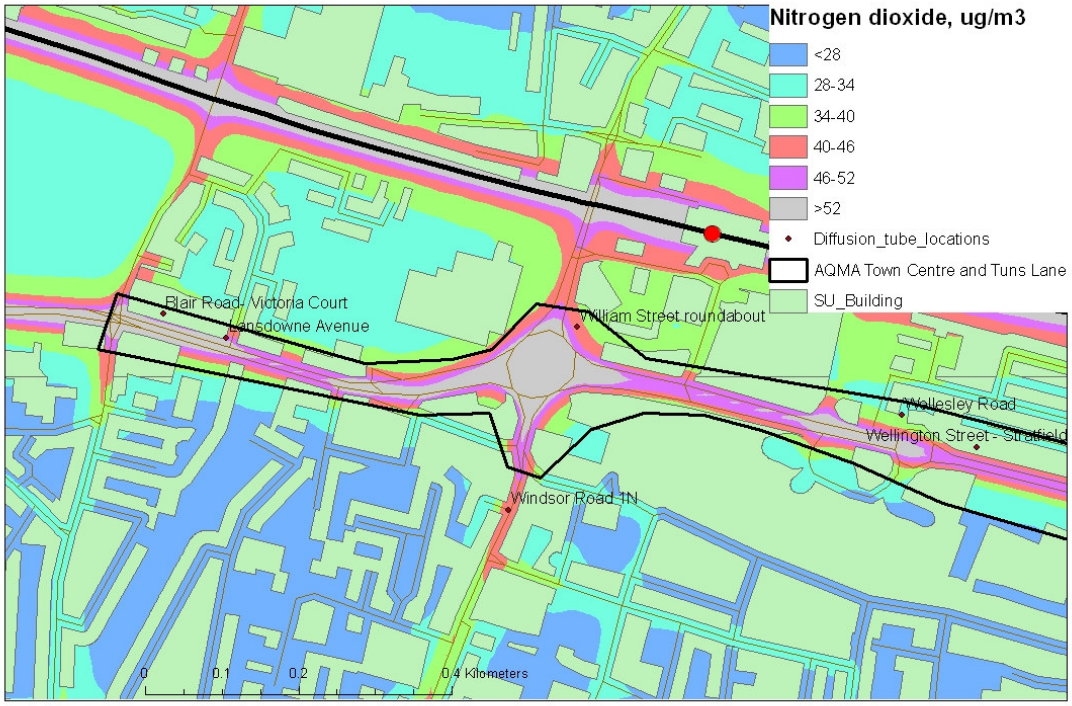
6.2.3 West end of Town Centre AQMA

Fig.12 shows the modelled nitrogen dioxide concentrations at the west end of the Town Centre AQMA from the junction of A4 Bath Road with Stoke Poges Lane and Ledger's Road, via the William Street roundabout onto the A4 Wellington Street. The model predicts that the nitrogen dioxide concentration exceeds the objective at buildings close to the roads. Measured concentrations in 2009 and 2010 exceeded the objective at Blair Road (44.2 µg m^{-3} and 45.3 µg m^{-3}) , Lansdowne Avenue (40.4 µg m^{-3} and 45.1 µg m^{-3}), William Street roundabout (49.6 µg m^{-3} and 51.4 µg m^{-3}) and Wellesley Road (40.4 µg m^{-3} and 40.4 µg m^{-3}). The measured concentration was slightly less than the objective at Wellington Street Stratfield (37.6 µg m^{-3} and 39.4 µg m^{-3})

The A4 Bath Road west of the junction with Stoke Poges Lane is generally open with some commercial buildings. Ledger Road, south of the junction also has commercial buildings set back from the road. The dispersion modelling indicates that the air quality objective is exceeded at distances up to 10 m from the road centreline on Stoke Poges Lane, north of the junction: residential buildings on this road are set further back.

The area north of William Street roundabout towards the railway line has car parks and commercial buildings. The modelled area of exceedence of the objective south of the roundabout extends along William Street into Windsor Road as far as Herschel Road. The buildings either side of the road are shops and offices.

Fig.12: Predicted nitrogen dioxide concentrations at the west end of the Town Centre AQMA, 2009



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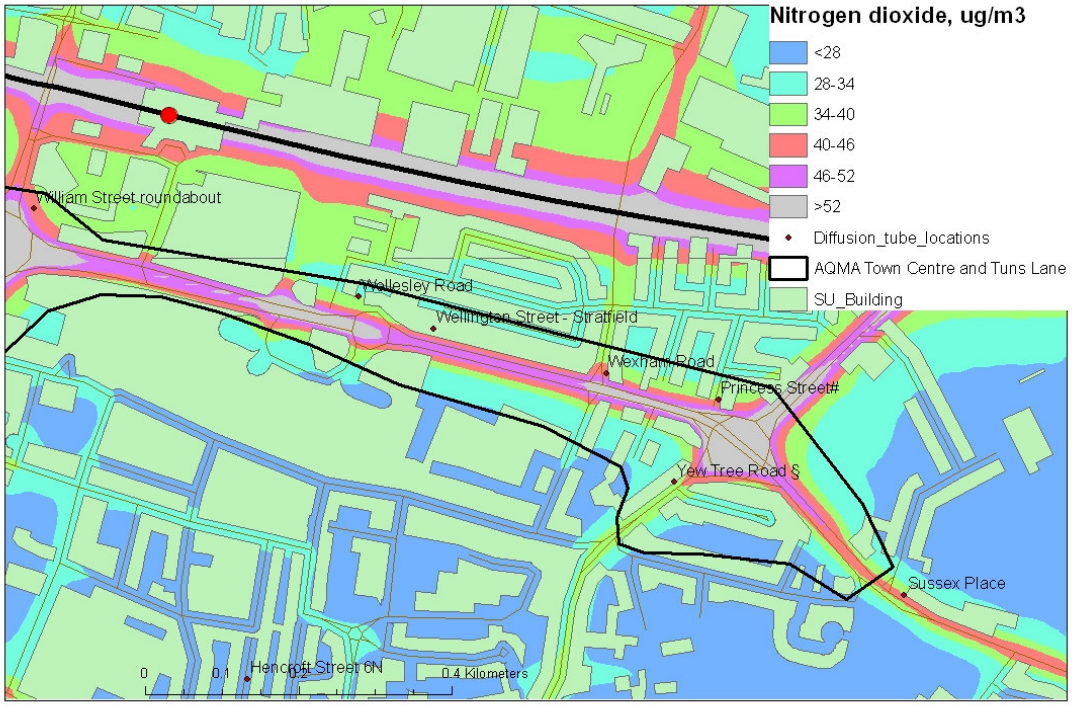
6.2.4 East end of Town Centre AQMA

Fig.13 shows the modelled nitrogen dioxide concentrations at the eastern part of the Town centre AQMA. The area extends from the William Street roundabout, along the A4 eastwards via the Uxbridge road roundabout as far as Sussex Place. The modelled concentrations exceed the objective at buildings throughout much of the AQMA. Measured concentrations exceeded the objective in both 2009 and 2010 at Wexham Road (47.1 µg m^{-3} and 45.5 µg m^{-3}) and Yew Tree Road (49.2 µg m^{-3} and 60.3 µg m^{-3}). Measured concentrations exceeded the objective in 2010 at Princess Street (42.3 µg m^{-3}) and Sussex Place (40.5 µg m^{-3}) in 2010.

The model indicates that the concentration exceeds the objective at the façade of a row of shops with flats above (e.g. A&A Newsagents) and at the Premier Inn on the Uxbridge Road north of the Uxbridge Road roundabout. Technical Guidance LAQM.TG(09) recommends that the air quality objective should not apply at hotels unless people live there as a permanent residence.

Predicted concentrations also approach the objective at the façade of houses east of the AQMA along A4 Wellington Road. The diffusion tube at Sussex Place is representative of the exposure. Measured concentrations were 37.6 µg m^{-3} in 2009 and 40.5 µg m^{-3} in 2010.

Fig.13 ; Predicted nitrogen dioxide concentrations at the eastern part of the Town Centre AQMA.



6.2.5 Recommendations

The results of modelling and measurements confirm that it was appropriate for Slough Borough Council to declare Tuns Lane and Slough Town Centre as AQMAs.

Slough Borough Council should consider extending the Tuns Lane AQMA to the east along Bath Road as far as Windmill Road. The Council should also consider extending the Town centre AQMA northwards along Uxbridge Road to the parade of shops with flats above (e.g. A&A Newsagents).

The Council should continue to monitor concentrations at Sussex Place and Farnham Road and consider extending the AQMAs if these exceed the objective.

The dispersion model does not explain the relatively high concentrations measured at the Yew Tree Road diffusion tube site. We recommend that the Council further investigate the particular circumstances at the site when developing their Action Plan.

6.3 Source apportionment

A baseline “source apportionment” will allow Slough Borough Council to identify the extent to which different sources contribute to the air quality exceedences that have been identified within the AQMAs. This will assist the Council to correctly target the most important sources, and to focus the principal measures within the Action Plan.

Table 9 show the source apportionment of the modelled concentrations for 2009. The source apportionment for nitrogen dioxide is complicated by the non-linearity of the relationship between oxides of nitrogen and nitrogen dioxide concentrations. Our source apportionment follows the method described in Technical Guidance LAQM.TG(09). Table 10 shows the

contribution from various source categories expressed as a percentage of the total nitrogen dioxide concentrations.

Road traffic makes the largest contribution to nitrogen dioxide at roadside sites. Non-motorway traffic makes the largest contribution at sites in the Tuns Lane and Town Centre AQMAs. For example, non-motorway traffic contributes 40.6% of the nitrogen dioxide concentrations at the Williams Street roundabout: heavy duty vehicles contribute more than half of the non-motorway contribution.

6.4 Action Plan Scenarios

We considered the following scenarios in order to assist Slough Borough Council in the development of an Action Plan for the Tuns Lane and Town Centre AQMAs:

- Base
- 10% reduction in all traffic
- 20% reduction in all traffic
- 30% reduction in all traffic
- 30% reduction in non-motorway traffic
- 30% reduction in motorway traffic
- 30% reduction in HDV
- 50% reduction in HDV
- 50% reduction in non-motorway HDV

Table 11 shows the predicted nitrogen dioxide concentrations at diffusion tube sites throughout the study area for 2009 for each scenario. A 30% reduction in traffic is not sufficient to reduce the predicted nitrogen dioxide concentrations sufficiently to meet the objective of 40 µg m^{-3} as an annual mean at all sites. Reducing motorway traffic has little effect on concentrations at monitoring sites in the Tuns Lane and Town Centre AQMAs. Reducing HDV traffic through the AQMAs is relatively effective in reducing concentrations. However, a 50% reduction in HDVs alone is not sufficient to meet the objective at all sites.

The Heart of Slough redevelopment is centred on the William Street roundabout, which is in the Town Centre AQMA. The scheme includes a mix of housing, commercial and civic development over an area of 11.4 hectares. The roundabout will be replaced by with a signalised junction. Development Securities plc submitted an Air Quality Assessment as part of the planning application (P2272-9) for the Brunel Place development, which forms part of the Heart of Slough scheme. The Air Quality Assessment took account of the highways configuration proposed for the wider Heart of Slough redevelopment. The Assessment concluded that the predicted change in road traffic emissions associated with the operation of the proposed development would not have a significant effect on any receptors that are sensitive to air quality. Emissions from road traffic associated with the development were predicted to increase the annual mean concentrations of nitrogen dioxide by less than 1 µg m^{-3} relative to baseline conditions for 2015. The Assessment predicted that the development would result in a reduction in concentrations at most receptor locations close to the existing roundabout. We have therefore not carried out additional modelling of the Heart of Slough redevelopment as part of this Further Assessment.

Slough Borough Council has reduced the speed limit in parts of the Tuns Lane AQMA: however, the average speed in the area used in the modelling was already less than the new speed limit and so the new speed limits are not expected to affect nitrogen dioxide concentrations significantly.

6.5 Required reduction in pollutant emissions

An assessment of the required reduction in pollutant emissions to attain the objectives will allow the Slough Borough Council to judge the scale of effort that is required within the Action Plan. Table 12 shows the reduction in oxides of nitrogen emissions required to meet the air quality objective, based on the modelled concentrations for 2009. Tables 13 and 14 similarly show the reduction required based on 2009 and 2010 diffusion tube measurements. A 41.3% reduction in emissions will be required at the William Street roundabout and a 54.4% reduction will be required at Yew Tree Road based on the 2010 measurements, which provide the most conservative assessment.

6.6 Predicted date of achievement of objectives

Table 15 shows estimated concentrations at the diffusion tube sites in the Tuns Lane and Town Centre AQMAs for each year 2010-2017. The estimated concentrations have been calculated based on the 2010 measurements and updated adjustment factors provided by Defra[6]. The analysis indicates that the air quality objective will be met by 2014 at all the diffusion sites except Yew Tree Road, though we would recommend treating this prediction with some caution. The analysis indicates that the objective will not be met at Yew Tree Road until 2017.

[6] http://laqm.defra.gov.uk/documents/Is_the_example_in_Box_2.1_TG09_correct.pdf

Table 9: Source apportionment of modelled nitrogen dioxide concentrations at diffusion tube sites in the study area, 2009

Diffusion tube site	Contribution to nitrogen dioxide concentrations, µg m^{-3}								
	Background	Total	Rural background	Local background	Rail	Non - motorway	Non-motorway HDV	Motorway	Motorway HDV
Paxton Avenue	17.6	38.9	6.4	11.2	0.3	3.5	1.9	17.5	10.7
Essex Avenue	22.3	25.0	6.1	16.2	0.5	2.0	1.0	0.1	0.1
Spackmans Way	17.5	43.8	6.4	11.1	0.3	8.6	4.9	17.4	10.6
Farnham Road (2)	21.1	41.6	6.1	15.0	1.9	18.1	9.6	0.4	0.3
Tuns Lane	21.1	44.7	6.1	15.0	1.1	22.0	12.8	0.6	0.4
Kent Avenue 5N	22.2	24.1	6.1	16.1	0.5	1.2	0.6	0.1	0.1
Chalvey (CAS) *	17.3	38.5	6.4	10.9	0.4	2.6	1.3	18.2	12.1
Salt Hill *	21.1	40.6	6.1	15.0	1.4	17.5	9.7	0.6	0.4
Blair Road- Victoria Court	20.8	41.5	6.2	14.6	1.9	18.2	9.5	0.6	0.4
Lansdowne Avenue	20.8	47.2	6.2	14.6	1.8	24.1	12.8	0.6	0.4
Winvale (HA site)	18.0	43.9	6.3	11.7	0.5	2.3	1.0	23.1	16.1
Winvale	18.0	41.5	6.3	11.7	0.5	2.1	0.9	20.9	14.6
William Street roundabout	20.8	42.1	6.2	14.6	3.7	17.1	9.1	0.6	0.4
The Myrke (HA site)	18.2	35.4	6.3	11.9	0.4	1.5	0.6	15.3	10.7
Hencroft Street 6N	18.0	25.1	6.3	11.7	1.1	4.2	1.8	1.7	1.2
Wellesley Road	17.7	32.9	6.4	11.4	3.5	11.1	6.5	0.6	0.4
Wellington Street - Stratfield	17.7	34.7	6.4	11.4	3.1	13.3	7.9	0.6	0.4
Wexham Road	17.8	41.3	6.4	11.4	2.7	20.3	10.5	0.5	0.3
Yew Tree Road	17.8	37.6	6.4	11.5	1.8	17.4	6.7	0.6	0.4
Princess Street	17.8	38.2	6.4	11.4	2.7	17.2	10.0	0.5	0.3
India Road	17.8	36.1	6.4	11.5	12.7	5.2	2.9	0.4	0.3
Sussex Place	17.9	42.2	6.3	11.6	1.3	22.5	10.4	0.5	0.3

Table 10: Source apportionment of modelled nitrogen dioxide concentrations at diffusion tube sites in the study area, 2009 as percentages of the total concentration

Diffusion tube site	Nitrogen dioxide concentration, µg m^{-3}		Percentage contributions to nitrogen dioxide concentrations						
	Background	Total	Rural background	Local background	Rail	Non - motorway	Non-motorway HDV	Motorway	Motorway HDV
Paxton Avenue	17.6	38.9	16.4%	28.8%	0.9%	8.9%	4.8%	45.0%	27.4%
Essex Avenue	22.3	25.0	24.4%	65.0%	2.0%	8.1%	4.0%	0.5%	0.3%
Spackmans Way	17.5	43.8	14.6%	25.3%	0.8%	19.7%	11.1%	39.7%	24.2%
Farnham Road (2)	21.1	41.6	14.7%	36.0%	4.5%	43.7%	23.1%	1.1%	0.7%
Tuns Lane	21.1	44.7	13.7%	33.5%	2.4%	49.1%	28.5%	1.3%	0.8%
Kent Avenue 5N	22.2	24.1	25.3%	66.9%	2.2%	5.1%	2.4%	0.6%	0.4%
Chalvey (CAS) *	17.3	38.5	16.6%	28.4%	0.9%	6.7%	3.4%	47.2%	31.6%
Salt Hill *	21.1	40.6	15.1%	36.9%	3.5%	43.1%	24.0%	1.5%	0.9%
Blair Road- Victoria Court	20.8	41.5	14.9%	35.2%	4.6%	43.8%	22.9%	1.5%	1.0%
Lansdowne Avenue	20.8	47.2	13.0%	30.9%	3.8%	51.0%	27.1%	1.3%	0.8%
Winvale (HA site)	18.0	43.9	14.4%	26.6%	1.1%	5.3%	2.3%	52.7%	36.7%
Winvale	18.0	41.5	15.2%	28.1%	1.2%	5.1%	2.2%	50.3%	35.1%
William Street roundabout	20.8	42.1	14.6%	34.7%	8.8%	40.6%	21.5%	1.3%	0.9%
The Myrke (HA site)	18.2	35.4	17.8%	33.5%	1.3%	4.1%	1.8%	43.3%	30.2%
Hencroft Street 6N	18.0	25.1	25.3%	46.6%	4.4%	16.9%	7.0%	6.8%	4.7%
Wellesley Road	17.7	32.9	19.3%	34.6%	10.7%	33.6%	19.8%	1.8%	1.2%
Wellington Street - Stratfield	17.7	34.7	18.3%	32.8%	9.0%	38.3%	22.8%	1.7%	1.1%
Wexham Road	17.8	41.3	15.4%	27.7%	6.6%	49.1%	25.5%	1.2%	0.8%
Yew Tree Road	17.8	37.6	16.9%	30.5%	4.7%	46.3%	17.9%	1.5%	1.1%
Princess Street	17.8	38.2	16.6%	29.9%	7.1%	45.1%	26.1%	1.3%	0.9%
India Road	17.8	36.1	17.6%	31.7%	35.2%	14.4%	8.0%	1.1%	0.8%
Sussex Place	17.9	42.2	15.0%	27.4%	3.1%	53.3%	24.6%	1.2%	0.8%

Table 11: Predicted nitrogen dioxide concentrations at diffusion tube sites throughout the study area for 2009 for each scenario.

Diffusion tube site	Nitrogen dioxide concentration, µg m^{-3}								
	Base	10% reduction in all traffic	20% reduction in all traffic	30% reduction in all traffic	30% reduction in non-motorway traffic	30% reduction in motorway traffic	30% reduction in HDV	50% reduction in HDV	50% reduction in non-motorway HDV
Paxton Avenue	38.9	37.2	35.3	33.4	38.1	34.3	35.7	33.4	38.2
Essex Avenue	25.0	24.7	24.5	24.3	24.4	24.9	24.6	24.4	24.5
Spackmans Way	43.8	41.7	39.5	37.2	41.7	39.5	40.0	37.2	41.8
Farnham Road (2)	41.6	40.0	38.3	36.7	36.8	41.5	39.0	37.2	37.4
Tuns Lane	44.7	42.9	40.9	38.9	39.1	44.6	41.4	39.1	39.3
Kent Avenue 5N	24.1	23.9	23.8	23.7	23.7	24.0	23.9	23.7	23.8
Chalvey (CAS) *	38.5	36.7	34.9	33.0	37.8	33.7	35.0	32.5	37.9
Salt Hill *	40.6	39.0	37.4	35.8	35.9	40.4	37.9	36.1	36.3
Blair Road- Victoria Court	41.5	39.9	38.2	36.5	36.7	41.3	38.9	37.2	37.3
Lansdowne Avenue	47.2	45.2	43.2	41.0	41.2	47.1	44.0	41.7	41.9
Winvale (HA site)	43.9	41.9	39.8	37.7	43.4	38.3	39.8	36.8	43.5
Winvale	41.5	39.7	37.8	35.8	41.0	36.4	37.7	35.1	41.2
William Street roundabout	42.1	40.6	39.1	37.5	37.7	42.0	39.7	38.0	38.2
The Myrke (HA site)	35.4	34.0	32.6	31.1	35.1	31.5	32.6	30.6	35.2
Hencroft Street 6N	25.1	24.6	24.1	23.6	24.0	24.6	24.3	23.9	24.3
Wellesley Road	32.9	31.8	30.8	29.7	29.9	32.7	31.0	29.7	29.9
Wellington Street - Stratfield	34.7	33.5	32.2	31.0	31.1	34.6	32.5	31.0	31.1
Wexham Road	41.3	39.6	37.8	35.9	36.0	41.2	38.5	36.6	36.8
Yew Tree Road	37.6	36.0	34.4	32.8	32.9	37.4	35.7	34.5	34.6
Princess Street	38.2	36.7	35.2	33.5	33.7	38.1	35.6	33.7	33.8
India Road	36.1	35.6	35.1	34.6	34.7	36.0	35.3	34.7	34.9
Sussex Place	42.2	40.3	38.3	36.3	36.4	42.1	39.5	37.7	37.8

Table 12: The reduction in oxides of nitrogen emissions required to meet the air quality objective, based on the modelled concentrations for 2009

Diffusion tube site	Modelled NO2 concentration, µg m^{-3}	Modelled NOx contribution from roads, µg m^{-3}	Required NOx contribution from roads, µg m^{-3}	Required reduction in emissions from roads
Farnham Road (2)	41.6	50.44	45.93	8.9%
Tuns Lane	44.7	59.98	45.85	23.6%
Salt Hill *	40.6	47.56	45.99	3.3%
Blair Road- Victoria Court	41.5	51	46.74	8.4%
Lansdowne Avenue	47.2	68.85	46.74	32.1%
William Street roundabout	42.1	52.92	46.77	11.6%
Wexham Road	41.3	57.89	54.07	6.6%

Table 13: The reduction in oxides of nitrogen emissions required to meet the air quality objective, based on the measured concentrations for 2009

Diffusion tube site	Measured NO_2 concentration, µg m^{-3}	NO_x contribution from roads, µg m^{-3}	Required NO_x contribution from roads, µg m^{-3}	Required reduction in emissions from roads
Blair Road- Victoria Court	44.2	59.23	46.74	21.1%
Lansdowne Avenue	40.4	47.89	46.74	2.4%
William Street roundabout	49.6	76.84	46.77	39.1%
Wellesley Road	40.4	55.36	54.18	2.1%
Wexham Road	47.1	76.27	54.07	29.1%
Yew Tree Road	49.2	83.32	53.98	35.2%

Table 14: The reduction in oxides of nitrogen emissions required to meet the air quality objective, based on the modelled concentrations for 2010

Diffusion tube site	Measured NO_2 concentration, µg m^{-3}	NO_x contribution from roads, µg m^{-3}	Required NO_x contribution from roads, µg m^{-3}	Required reduction in emissions from roads
Blair Road- Victoria Court	45.3	64.5	49.2	23.7%
Lansdowne Avenue	45.1	63.9	49.2	23.0%
William Street roundabout	51.4	83.8	49.3	41.3%
Wellesley Road	40.4	57.5	56.4	2.0%
Wexham Road	45.5	72.5	56.3	22.3%
Yew Tree Road	60.3	123.4	56.2	54.4%
Princess Street	42.3	62.8	56.2	10.5%

Table 15: Estimated concentrations at the diffusion tube sites in the Tuns Lane and Town Centre AQMAs for each year 2010-2017

Diffusion tube site	Concentration, µg m^{-3}							
	2010	2011	2012	2013	2014	2015	2016	2017
Blair Road- Victoria Court	45.3	42.6	40.0	37.4	34.8	32.2	30.3	28.5
Lansdowne Avenue	45.1	42.4	39.8	37.2	34.6	32.0	30.2	28.4
William Street roundabout	51.4	48.4	45.4	42.4	39.5	36.5	34.4	32.3
Wellesley Road	40.4	38.0	35.7	33.4	31.0	28.7	27.0	25.4
Wexham Road	45.5	42.8	40.2	37.6	34.9	32.3	30.5	28.6
Yew Tree Road	60.3	56.7	53.3	49.8	46.3	42.8	40.4	37.9
Princess Street	42.3	39.8	37.4	34.9	32.5	30.0	28.3	26.6
Adjustment factor	**0.832**	**0.783**	**0.735**	**0.687**	**0.639**	**0.591**	**0.557**	**0.523**

7 Detailed assessment

7.1 Introduction

This section provides a detailed assessment of the nitrogen dioxide concentrations near the Great Western Mainline.

7.2 Measured concentrations

Slough Borough Council monitor the concentration close to the railway at one location in the Borough- India Road. The measured concentration was 37.0 µg m^{-3} in 2009 and 35.5 µg m^{-3} in 2010 and was thus less than the air quality objective of 40 µg m^{-3}. The monitoring site is 40 m south of the centre of the trackbed.

The neighbouring borough of Hillingdon also monitored the concentration of nitrogen dioxide close to the Great Western Mainline for a short period in 2009 in the back garden of a residential property in Stourmont Drive,12 m from the railway and in an industrial area on the corner of Swallowfield Way and Kestrel Way, 36 m from the railway. The estimated concentrations for 2009 were 30.3 and 32.1 µg m^{-3} respectively. The measured concentrations are thus rather less than the objective of 40 µg m^{-3}, However, the railway passes the monitoring locations on an embankment, which may affect the dispersion of the train exhaust. The Stourmont Drive site is closest to an industrial branch line rather than the Great Western Mainline.

7.3 Modelled concentrations

Fig.9 shows the modelled nitrogen dioxide concentrations close to the Great Western Railway through Slough Town centre. The modelled concentrations exceed the objective close to the railway. Fig. 14 shows the modelled concentration in the region of the India Road monitoring site. The modelled concentration at this site is in reasonable agreement with the measured concentration.

We measured the extent of the modelled exceedence alongside the railway at easting 496750m, which is away from road junctions. The area of exceedence extended 32 m south and 39 m north from the centre of the trackbed. We then identified the following roads with residential properties within this buffer:

- Maplin Park
- Ravens Field
- Goodman Park
- Eastbridge
- Victoria Road
- India Road
- Canada Road
- Australia Road
- Colonial Road
- Salt Hill Way
- Burnham Lane
- Brook Crescent
- Sandringham Court
- Stanhope Road
- Maybury Close
- Walpole Road
- Mead Way
- Lawrence Way
- Lowestoft Drive
- Tudor Gardens
- Goldsworthy Way
- Windermere Way
- Westlands Avenue
- Crummock Close
- Averil Court
- Huntercombe Lane

Most of these roads are near Burnham railway station. Technical Guidance LAQM.TG(09) states that a Detailed Assessment will need to examine the combined impact of locomotive emissions with those of local road traffic. However, we could identify no residential properties in Slough that were within 50 m of both the Great Western Mainline and a major road. The simple assessment therefore provides an adequate assessment of the impact in the area of Burnham railway station.

Fig. 14:Modelled concentration in the region of the India Road monitoring site

7.4 Recommendation

Measured concentrations at monitoring sites closest to the railway in Slough and Hillingdon were less than the air quality objective. The monitoring data thus does not support the need for a declaration of an AQMA. However, our modelling indicates the potential for exceedence of the air quality objective at residential properties within 32 m south of the centre of the trackbed to the south and within 39 m to the north. There are several residential properties within this buffer, particularly in the region of Burnham station. We therefore recommend that additional monitoring is carried out near residential properties closest to the railway.

8 Conclusions

This report provides a Detailed Assessment, which aims to assess the magnitude and spatial extent of any exceedences of the air quality objectives for NO_2 in the vicinity of the Great Western Mainline that runs through Slough.

Measured concentrations at monitoring sites closest to the railway in Slough and Hillingdon were less than the air quality objective. The monitoring data thus does not support the need for a declaration of an Air Quality Management Area. However, our modelling indicates the potential for exceedence of the air quality objective at residential properties within 32 m south of the centre of the trackbed to the south and within 39 m to the north. There are several residential properties within this buffer, particularly in the region of Burnham station. We therefore recommend that additional monitoring is carried out near residential properties closest to the railway.

In 2011, Slough Borough Council declared Air Quality Management Areas (AQMA) covering Tuns Lane and parts of the Town Centre as the result of a Detailed Assessment carried out in 2008. Local Authorities are required to carry out a Further Assessment within a year of declaration of an AQMA. This report provides a Further Assessment, which aims to confirm the findings of the 2008 Detailed Assessment, apportion sources of NO_x (and therefore NO_2), estimate the level of NO_x reduction required to achieve the NO_2 objective, and test selected abatement scenarios to help inform an Air Quality Action Plan (AQAP).

The results of modelling and measurements confirm that it was appropriate for Slough Borough Council to declare Tuns Lane and Slough Town centre as AQMAs.

We recommend that Slough Borough Council should consider extending the Tuns Lane AQMA to the east along Bath Road as far as Windmill Road. The Council should also consider extending the Town Centre AQMA northwards along Uxbridge Road to the parade of shops with flats above (e.g. A&A Newsagents).

The Council should continue to monitor concentrations at Sussex Place and Farnham Road and consider extending the AQMAs if these exceed the objective.

Road traffic provides the largest contribution to nitrogen dioxide concentrations at roadside sites throughout the AQMAs. Heavy duty vehicles contribute more than half of the traffic contribution. Traffic on the M4 motorway does not substantially affect concentrations at roadside locations in the Tuns Lane and Town Centre AQMAs.

We investigated various traffic reduction scenarios to help the Council in the development of its Air Quality Action Plan. A 41.3% reduction in emissions will be required at the William Street roundabout and a 54.4% reduction will be required at Yew Tree Road in order to meet the air quality objective for nitrogen dioxide. Our analysis indicates that the air quality objective will be met by 2014 at all the diffusion sites except Yew Tree Road without Action plan measures. The analysis indicates that the objective will not be met at Yew Tree Road until 2017.

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