Nottingham City Council

Local Air Quality Management

Detailed Assessment 2009

January 2010

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Summary

In 2008 Nottingham City Council undertook monitoring and modelling work for a Detailed Assessment for nitrogen dioxide and particles, PM_{10} to fulfil its responsibilities under the Local Air Quality Management process - as set out in Part IV of the Environment Act (1995) and the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007.

The results were reported in the Local Air Quality Management Detailed Assessment Consultation Document – May 2008. The report concluded that amendments to the existing AQMAs No.2 and No.3 for nitrogen dioxide were necessary due to monitored and modelled exceedences of the annual mean nitrogen dioxide Air Quality Objective and that no further action was required for PM_{10}. It was submitted to Defra in May 2008 for approval.

Defra's Review and Assessment Appraisal consultants accepted the findings for PM_{10} but their commentary about nitrogen dioxide stated that for the Detailed Assessment report to be completed satisfactorily - "The authority needs to address a) the exceedences identified outside of the proposed AQMAs and b) the verification of the model against the diffusion tube data, which may account for the model not identifying all exceedences." The exceedences referred to in a) relate to three diffusion tube monitoring sites.

A further investigation with the focus on these two aspects was undertaken and reported in the Detailed Assessment 2008 – Annex 1 Supplementary Information for Nitrogen Dioxide.

The 2007 and 2008 monitoring data presented in Annex 1 showed that levels in excess of the 40 $\mu g/m^3$ annual mean air quality objective for nitrogen dioxide were measured, at a number of monitoring sites, both within and outside the existing Air Quality Management Areas (AQMAs) No.2 and No.3.

Further modelling work and verification was undertaken using the methodology outlined in the technical guidance as recommended in the Review and Assessment appraisal. The modelling predicted exceedence of the nitrogen dioxide annual mean air quality objective along and nearby a number of the City's main traffic routes.

The Annex 1 report concluded that there are areas of the City, mostly near and within existing AQMAs, where both modelling and monitoring results demonstrate that the nitrogen dioxide annual mean objective has been exceeded at locations with relevant exposure of members of the public.

It also confirmed previous findings that it is necessary to amend the existing Air Quality Management Areas. The proposals being: AQMA No.2 - City Centre to extend it to the north, north-west and south of the city centre (and include the three diffusion tube sites) and to remove the south-west part where there is no relevant public exposure; AQMA No.3 - Dunkirk to re-align the boundary to extend it to the south-west and exclude the QMC hospital.

The Detailed Assessment 2008 – Annex 1 Supplementary Information for Nitrogen Dioxide was submitted to Defra in October 2009. On 31 December 2009 the Council were notified that the report had been accepted - Defra's response included the following comment:

"To provide further evidence that the proposed AQMA is correct, the Council should carry out additional monitoring in those areas of modelled exceedence with relevant exposure, and ensure that the AQMA boundary is sufficiently precautionary to avoid having to amend the

AQMA boundaries in the future. These can be dealt with in the Further Assessment which will be required 12 months after the amended AQMA boundaries are declared".

For purposes of clarity, Nottingham City Council took the decision to integrate the relevant information from the 'Detailed Assessment Consultation Document May 2008' and Detailed Assessment 2008 – Annex 1 Further Information for Nitrogen Dioxide September 2009'.

Therefore this report i.e. Detailed Assessment 2009 takes account of the particles, PM_{10} monitoring and modelling assessment from the 2008 Consultation document and the nitrogen dioxide monitoring and modelling assessment from Annex 1. No data has been changed and no additional information is given.

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Abbreviations

AADT	Annual Average Daily Traffic
ADMS	Atmospheric Dispersion Modelling System
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
AQMS	Air Quality Monitoring Station
AQO	Air Quality Objective
AURN	Automatic Urban and Rural Network
CERC	Cambridge Environmental Research Consultants
DA	Detailed Assessment
Defra	Department for Environment, Food and Rural Affairs
DT	Diffusion Tube
HGV	Heavy Goods Vehicles
LAQM	Local Air Quality Management
LAQM PG (03) **LAQM PG (09)**	Local Air Quality Management Policy Guidance
LAQM TG (03) **LAQM TG (09)**	Local Air Quality Management Technical Guidance
LGV	Light Goods Vehicles
LTP	Local Transport Plan
NO_2	Nitrogen dioxide
NOx	Oxides of nitrogen
$PM_{2.5}$	Particles 2.5 microns or less in diameter
PM_{10}	Particles 10 microns or less in diameter
PR	Progress Report
R & A	Review and Assessment
TG	Technical Guidance
USA	Update Screening and Assessment

Local Air Quality Management

Introduction

The Environment Act 1995 Part IV introduced the requirement for a National Air Quality Strategy and the concept of Local Air Quality Management (LAQM). The Strategy has to include statements on “standards relating to the quality of air” and “objectives for the restriction of the levels at which particular substances are present in the air”. Section 82 of the Environment Act 1995 requires Local Authorities to review the air quality in their area and assess whether air quality standards and objectives prescribed in regulations will be achieved by the specified attainment date for each pollutant of concern.

Standards and objectives required by European Directives or National legislation are implemented by means of Regulations. Current European Directive limit or target values are set out in The Air Quality Standards Regulations 2007 which came into force on 15th February 2007.

For the LAQM process, Local Authorities are expected to assess air quality against the National Air Quality Objectives and time scales stated in the National Air Quality Strategy and implemented by The Air Quality (England) Regulations 2000 and amendments. See Table 1 below.

The 2000 Regulations provide that ‘achievement or likely achievement of the Air Quality Objectives is to be determined by reference to the quality of the air at locations which are situated outside of buildings… … and where members of the public are regularly present.’ The Strategy requires that ‘… Local Authorities should have regard to those locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective.’

Where it is determined that an Air Quality Objective will not be achieved by the specified date, Section 83 of the Environment Act 1995 requires Local Authorities to designate Air Quality Management Areas (AQMAs) by order and formulate and publish corresponding Air Quality Action Plans (AQAPs).

Table 1

National Air Quality Objectives

Pollutant	Applies to	Objective	Concentration measured as	Date to be achieved by and maintained thereafter
Benzene	UK	16.25 μg/m^3	running annual mean	31 December 2003
	England & Wales	5 μg/m^3	annual average	31 December 2010
	Scotland, Northern Ireland	3.25 μg/m^3	running annual mean	31 December 2010
1,3 Butadiene	UK	2.25 μg/m^3	running annual mean	31 December 2003
Carbon monoxide	UK	10 mg/m^3	running 8-hour mean	31 December 2003
Lead	UK	0.5 μg/m^3	annual mean	31 December 2004
		0.25 μg/m^3	annual mean	31 December 2008
Nitrogen dioxide	UK	200 μg/m^3 not to be exceeded more than 18 times a year	1 hour mean	31 December 2005
	UK	40 μg/m^3	annual mean	31 December 2005
PM_{10}	UK	50 μg/m^3 not to be exceeded more than 35 times a year	24 hour mean	31 December 2004
	UK	40 μg/m^3	annual mean	31st December 2004
$PM_{2.5}$	UK (except Scotland)	25 μg/m^3 (target)	annual mean	2020
	Scotland	12 μg/m^3 (limit)	annual mean	2020
Sulphur dioxide	UK	125 μg/m^3 not to be exceeded more than 3 times a year	24 hr mean	31 December 2004
	UK	350 μg/m^3 not to be exceeded more than 24 times a year	1 hr mean	31 December 2004
	UK	266 μg/m^3 not to be exceeded more than 35 times a year	15 min mean	31 December 2005

(The Air Quality Strategy for England, Scotland, Wales and Northern Ireland Vol. 1 July 2007)

Indicative 2010 objectives for PM_{10} (from the 2000 Strategy and 2003 Addendum) have been dropped.

There is also a UK urban background exposure reduction target for $PM_{2.5}$ of a 15% cut (target) between 2010 and 2020.

Existing Air Quality Management Areas

Nottingham City Council completed its first round of review and assessment in September 2001 and subsequently declared three Air Quality Management Areas (AQMAs):

AQMA No1 – Sulphur dioxide area around the City Hospital. This has been revoked.
AQMA No 2- Nitrogen dioxide City centre area.
AQMA No 3- Nitrogen dioxide Dunkirk area.

Areas nearby AQMAs 2 and 3 have been included as part of this Detailed Assessment.

Section 84(1) of the Environment Act 1995 requires authorities to carry out a further assessment of existing and likely future air quality in an AQMA. LAQM.TG (03) advises 'The intention is that this further assessment will be used to define the relative contribution of different sources within the areas of exceedance, so as to allow a focused action plan to be prepared.'

The Stage 4 Review and Assessment 2003 concluded that the Air Quality Objectives in the three declared Air Quality Management Areas would be met by the due dates (mainly because of measures introduced by the Local Transport Plan) and the preparation of specific Air Quality Action Plans was unnecessary.

Revisions to the LAQM process, by guidance from Defra, allow AQAPs to be incorporated in the Local Transport Plan (LTP). Whilst Local Authorities with AQMAs have the choice about whether to integrate their AQAPs into the LTP, the policy guidance addendum, LAQM.PGA(05) recommends that this approach should be adopted, where for example local road traffic is the major source of predicted exceedances of AQOs.

Nottingham City Council's Local Transport Plan, LTP 2005/7-2010/11 (March 2006) contains measures and actions to improve air quality. The LTP is available on http://www.nottinghamcity.gov.uk/sitemap/services/transport_and_streets/transport_planning/cdt_local_transport_plan.htm

Future Air Quality Review and Assessments and Progress Reports

The Government and devolved administrations recognise that Local Air Quality Management is fundamental to helping it achieve the Air Quality Objectives (AQOs) in the Air Quality (England) Regulations 2000 (as amended), many of which reflect legally binding EU limit values.

Defra recommends that Local Authorities carry out their LAQM duties according to the programme and timescales detailed in Table 2 below and; that local authorities should prepare annual Progress Reports between subsequent rounds of review and assessment to ensure continuity in the LAQM process. Where, following the Updating and Screening Assessments in April 2006 and 2009, it is determined that Detailed Assessments are not required, authorities will be expected to submit Progress Reports in April 2007 and 2010.

Table 2

Recommended timescales for submission of Assessments and Progress Reports

LAQM Activity	Completion Date	Which Authorities?
Detailed Assessment	End of April 2007	Those authorities which identified the need for a DA in their April 2006 USA
Progress Report	End of April 2007	Those authorities which identified that there was no need for a DA in their April 2006 USA
Progress Report	End of April 2008	All authorities
Updating and Screening Assessment	End of April 2009	All authorities
Detailed Assessment	End of April 2010	Those authorities which have identified the need for one in their April 2009 USA
Progress Report	End of April 2010	All authorities regardless of whether they are undertaking a Detailed Assessment or not.

The Regulations and LAQM.TG (09) make clear that likely exceedances of the objectives should be assessed in relation to 'the quality of the air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present' and are likely to be exposed over the averaging period of the objective. Exceedances of the objectives at any location where relevant public exposure would not be realistic should not be considered.

When assessing likely exposure with respect to the long-term objectives LAQM. TG(09) cites 'in the case of the 24-hour objectives, a relevant location would be one where members of the public may be exposed for 8 hours or more in a day, while for the annual mean objectives this might be where people are exposed for a cumulative period of 6 months in a year'.

Table 3

Examples of where the Air Quality Objectives should/should not apply.

Averaging Period	***Objectives should apply at***	***Objectives should generally not apply at***
Annual mean	All locations where members of the public might be regularly exposed. Facades of residential properties, schools, hospitals, libraries	Building facades of offices or other places of work. Gardens of residential properties. Kerbside sites or locations where public exposure is likely to be short term.
24-hour mean, 8-hour mean	All locations where the annual mean objective would apply. Gardens of residential properties.	Kerbside sites 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, bus stations and railway stations etc. which are not fully enclosed, where the public might reasonably be expected to spend 1-hour or more. Any outdoor locations to which the public might reasonably be expected to spend 1-hour or longer.	Kerbside sites where the public would not be expected to have regular access.
15-mean	All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer	

Updating and Screening Assessment June 2006: Conclusions

The Updating and Screening Assessment was undertaken following the guidance and checklist scheme recommended in LAQM.TG (03). It is available on the Nottingham City Council website: www.nottinghamcity.gov.uk/

It was concluded unnecessary to proceed to a Detailed Assessment for:

Lead, carbon monoxide, benzene, 1, 3 butadiene and sulphur dioxide.

Sufficient information from continuous monitoring was available to show that Nottingham City AQMA No: 1 Sulphur dioxide required revocation. Defra concurred with this conclusion and AQMA No: 1 – sulphur dioxide was revoked by Order dated 5th April 2007. The Orders making the AQMAs and the Revocation Order for AQMA No: 1 can be viewed on the Council's website:
http://www.nottinghamcity.gov.uk/sitemap/services/environment/pollution/air_pollution/air_quality.htm

It was concluded that it was necessary to proceed to a Detailed Assessment for:

Nitrogen dioxide - for a number of roads and junctions with traffic flows meeting the guidance criteria and some of the diffusion tubes monitoring results indicate exceedance of the NO_2 annual mean objective.

Particles (PM_{10}) - for two roads that meet the criteria specified in the guidance.

Local Air Quality Management (LAQM) Reports

Information regarding previous Nottingham City Council Review and Assessments and LAQM reports is given in Appendix A.

All of Nottingham City Council's previous Review and Assessment and LAQM reports are available on the Council's website:
http://www.nottinghamcity.gov.uk/sitemap/services/environment/pollution/air_pollution/air_quality.htm

THE DETAILED ASSESSMENT

LAQM guidance states that the objective of a Detailed Assessment is "to provide an accurate assessment of the **likelihood** of an air quality objective being exceeded at locations with relevant exposure. This should be sufficiently detailed to allow the designation or amendment of any necessary AQMAs." Authorities should "use quality assured monitoring and validated modelling methods to determine current and future pollutant concentrations in areas where there is a significant risk of exceeding an air quality objective".

The Updating and Screening Assessment (USA) undertaken in 2006 concluded that it was necessary to undertake a Detailed Assessment (DA) for nitrogen dioxide and for particles, PM_{10} (2 roads).

Nottingham City Council undertook monitoring and modelling work for the DA and reported it in 'Local Air Quality Management Detailed Assessment Consultation Document May 2008' (DA 2008). The report concluded that no further action was required for PM_{10} and proposed that amendments to the existing AQMAs No.2 & No.3 for nitrogen dioxide were necessary due to monitored and modelled exceedences of the annual mean nitrogen dioxide Air Quality Objective (AQO).

In May 2008 the DA 2008 was submitted to the Department for Environment, Food and Rural Affairs (Defra) for approval. In Defra's response the PM_{10} findings were accepted whilst those for nitrogen dioxide were not.

The Review and Assessment Appraisal Report commentary stated that for the DA report to be completed satisfactorily "The authority needs to address a) the exceedences identified outside of the proposed AQMAs and b) the verification of the model against the diffusion tube data, which may account for the model not identifying all exceedences. The model verification should follow the procedure set out in TG (03), whereby the road contribution is verified separately from the background".

In February 2009 Technical Guidance TG (03) was replaced by Technical Guidance LAQM.TG (09) and this was used to inform the additional work that was undertaken to address these specific points.

A further report, Detailed Assessment 2008 – Annex 1 Supplementary Information for Nitrogen Dioxide (DA-Annex 1) was prepared which gives details and analysis of the 2007

and 2008 nitrogen dioxide monitoring results and of the additional modelling work that was carried out. The report includes proposals for amendments to the existing Air Quality Management Areas No.2 and No.3. It was submitted to Defra in October 2009. On 31 December 2009 the Council were notified that the report had been accepted - Defra's response included the following comment

"To provide further evidence that the proposed AQMA is correct, the Council should carry out additional monitoring in those areas of modelled exceedence with relevant exposure, and ensure that the AQMA boundary is sufficiently precautionary to avoid having to amend the AQMA boundaries in the future. These can be dealt with in the Further Assessment which will be required 12 months after the amended AQMA boundaries are declared".

Nottingham City Council recognises that having undertaken the detailed assessment over a period of time and; having two reports to consider means that it may be difficult for interested parties and consultees to be clear about the information presented. Consequently the decision was made to amalgamate the documents.

This report - Detailed Assessment 2009 (DA 2009) – integrates the relevant information from DA 2008 - the particles, PM_{10} monitoring and modelling assessment and DA-Annex 1 - the nitrogen dioxide monitoring and modelling assessment. No data has been altered and no additional information is given.

The original documents can be viewed on the Council's website.

Monitoring Sites Information

Continuous Automatic Monitoring

Nottingham City Council undertakes continuous monitoring at a number of locations in its area. It also provides local site operators, LSOs for Defra's Automatic Urban and Rural Network, AURN site on Clinton Street East.

Monitoring locations descriptions

To assist in identifying a monitoring locality and its appropriateness for use in air quality assessments, eight site types are described by LAQM.TG (09). The following three describe the continuous monitoring locations in Nottingham;-

Urban centre	an urban location representative of typical population exposure in towns or city centres.
Roadside	a site between 1m of the kerbside of a busy road and the back of the pavement. Typically this will be within 5m of the road, but could be up to 15m.
Other	Any special source-orientated or location category covering monitoring undertaken in relation to specific emission sources

Nottingham City Continuous Automatic Monitoring Sites

See Figure 2 for map locations of the continuous monitoring stations.

AURN - Clinton Street East

The AURN station is located in the city centre and classified as an 'Urban centre' site. The surrounding area comprises retail outlets and city centre business premises in an urban pedestrianised area. The nearest road, the A6008, approximately 30 metres from the site, is no longer a major through-route following completion of the City Centre Major Scheme to divert and redirect traffic around the City Centre and limit access to certain vehicles, particularly buses.

The monitoring equipment is housed in a self-contained, air-conditioned fixed unit; the manifold inlet is approximately 3 metres high and has continuous automatic analysers that measure carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO_2), oxides of nitrogen

(NOx), particles (PM_{10}), sulphur dioxide (SO_2) and ozone (O_3). Monitoring for CO ceased at this site in October 2007

AQMS - Queens Medical Centre, Derby Road

While the AQMS station is a mobile unit it has been in its current location since March 2002. The site is a suburban mixed industrial/commercial/residential area of the City adjacent to the A52. It is 25 metres from the A52 ring road and approximately 5 metres from a minor service road and is classed as an 'Other' site.

The self-contained, air-conditioned station has a sampling inlet approximately 2.5 metres high and has continuous automatic analysers that measure CO, NO, NO_2, NOx, PM_{10}, SO_2 and O_3. Temperature, wind speed and wind direction are also measured.

CG NOx - Carter Gate NOx Station – Carter Gate

This is a fixed unit and has been located at Carter Gate since December 2003. The site is a suburban mixed commercial/residential area of the City adjacent to the A60. It is approximately 10 metres from the A60 and approximately 2 metres from a minor road and is classed as a 'Roadside' site.

The sampling inlet for the self-contained, air-conditioned enclosure is approximately 2.5 metres high. NO, NO_2 and NOx are measured using a continuous automatic analyser.

LS NOx - Lace Street NOx Station – Lace Street, Dunkirk

This is a fixed unit located at Lace Street since March 2007. The site is a suburban mixed commercial/residential area of the City adjacent to the A6005 (a busy road traffic route). It is classed as a 'Roadside' site and is approximately 4 metres from the A6005 and approximately 1 metre from a minor road.

The sampling inlet for the self-contained, air-conditioned enclosure is approximately 1.5 metres high. NO, NO_2 and NOx are measured using a continuous automatic analyser. The NOx instrument at Lace Street is a Monitor Labs Europe chemiluminescence analyser similar to those located in the AQMS and at Carter Gate.

The QA/QC procedures carried out at all Local Authority sites are similar to those used for the AQMS.

Continuous Analyser Sites Monitoring Data

The guidance recommends the monitoring data is reported over the period of a calendar year. This gives clarity of measurement period and allows results over the range of yearly weather conditions to be reported. Where this is not the case the data has been annotated.

Summaries of continuous monitoring data are given in Tables 4 -9.

Nottingham City Council's Second and Third Stage Review and Assessment 2001 - Technical Annexe gives further information on the types of monitoring equipment operated and the QA/QC procedures used.

Nitrogen Dioxide (NO_2) Diffusion Tube Monitoring

Nottingham City participates in the National NO_2 diffusion tube study and has increased the number of diffusion tube monitoring sites as a result of previous rounds of the Review and Assessment process. Diffusion tubes are a simple and relatively cheap means of sampling for NO_2 at a wide range of locations. Tubes are exposed at site for a month before being sent for laboratory analysis.

Diffusion Tube Locations

The tubes are mostly located at building façades at a range of sites that can be classified as roadside and urban background.

The tube locations and monitored annual mean NO_2 concentrations for 2006, 2007 and 2008 are shown in Figure 2.

Co-location of three NO_2 diffusion tubes at each of the continuous monitoring sites i.e. AURN, AQMS and CG NOx to enable 'bias correction' factors to be determined commenced in 2005. See Appendix C.

Particles, PM_{10} Assessment

PM_{10} Monitoring Data

Table 4

Summary of AURN continuous monitoring - particles, PM_{10} data

2004 - 2006

Pollutant	2004	2005	2006
Particles (PM_{10})			
Annual mean concentration ($\mu g/m^3$)	23	23	24
Maximum 24 hr concentration ($\mu g/m^3$)			
(No of times 24hr value exceeded)	(6)	(6)	(9)
24 hour mean AQO exceeded?	No	No	No

Table 5

Summary of AQMS continuous monitoring - particles, PM_{10} data

2004 - 2006

Pollutant	2004	2005	2006
Particles (PM_{10})			
Annual mean concentration ($\mu g/m^3$)	25	25	26
Maximum 24 hr concentration ($\mu g/m^3$)			
(No of times 24hr value exceeded)	(8)	(9)	(13)
24 hour mean AQO exceeded?	No	No	No

All PM_{10} concentrations are gravimetric equivalent

PM_{10} Modelling Information

Dispersion models enable the user to predict the concentration of a substance at distances remote from the point of emission. Nottingham City used the Atmospheric Dispersion Modelling System (ADMS) by Cambridge Environmental Research Consultants, CERC to model emissions from a variety of sources and to predict pollutant concentrations over its geographical area for future years. ADMS-Urban version 2.2

ADMS-Urban is an advanced dispersion model. Information can be input on road traffic, traffic composition, flows and speeds; industrial and domestic sources, background pollutant data and meteorology. The model can be used for predicting concentrations for single point sources or for complex urban areas. The output can be displayed as contour plots and allows concentrations at specific locations to be predicted.

Comprehensive validation of the model has been carried out by CERC and others. See the CERC website www.cerc.co.uk for further information on this subject. Verification work was carried out by Nottingham City and a model adjustment factor derived. See Appendix B

ADMS-Urban v2.2 was used to model 2006 PM_{10} concentration predictions although from the findings of the Update Screening and Assessment only 2 roads in the City Centre met the criteria for further assessment.

The USA 2006 identified two road links that meet the guidance criteria for this pollutant in terms of roads with high flow of buses and/or HGVs i.e. having bus flows greater than 20% of the AADT flow and relevant exposure with 10 metres of the road. From the traffic data provided by Nottingham City Council's Transport Projects team, the flow of HGVs on these two links is in excess of 2000 vehicles per day and there are residents close by. Changes in City Centre traffic flows as a result of specific traffic schemes such as Turning Point (see Progress Report 2005 and USA 2006) may have led to these links meeting the criteria.

Having updated the emissions inventory the opportunity was taken to assess PM_{10} levels over the same area of the City as that covered for the nitrogen dioxide modelling.

The model output for PM_{10} annual mean Figure 1 shown on the next page suggests that the annual mean were not exceeded in 2006 at either of the identified roads that met the guidance criteria. Modelling results (not shown) also indicated that there was not an exceedance of the annual mean or 24 hour PM_{10} AQOs at any relevant location.

No significant changes that would affect PM_{10} levels are forecast therefore it is reasonable to expect the PM_{10} Air Quality Objectives will continue to be met in the future.

Figure 1 Modelled 2006 Annual Mean Particles, PM_{10} Concentrations



Nottingham City Centre - 2006 Modelled Annual Mean Particles, PM_{10} Concentrations

PM_{10} ug/m^3

- 22 - 23.5
- 23.5 - 24
- 24 - 26
- 26 - 29

Roads - bus/HGV flows greater than 20% AADT

Scale 1:3,500

N

Nottingham City Council

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Particles, PM_{10} - Detailed Assessment Conclusions

The Detailed Assessment of the 2004 -2006 monitoring and 2006 modelling results show that the annual mean Air Quality Objectives of 40µgm^{-3} by 31.12.2005 and 24 hour mean of 50µgm^{-3} not to be exceeded more than 35 times; have been and are likely to continue to be met at locations of 'relevant exposure' in the Nottingham City area.

It is not necessary to declare any Air Quality Management Areas for this pollutant.

Nitrogen Dioxide Assessment

Monitoring Data

The 2007 and 2008 nitrogen dioxide monitoring data measured at the continuous automatic sites are shown in Tables 6 to 9 below. The results are for 12 months ratified data unless otherwise stated.

Whilst the National Air Quality Objectives are given in Table 1, those for nitrogen dioxide are repeated here for ease of comparison with the monitored results.

Annual Mean 40 $\mu g/m^3$

I hour mean 200 $\mu g/m^3$ not to be exceeded more than 18 times a year.

Both objectives were to be achieved by 31 December 2005 (and maintained thereafter).

Table 6

2007 and 2008 Annual Summary Statistics for Nitrogen Dioxide Measured at AURN, Clinton Street East, City Centre

	NO_2 μgm^{-3}		Objective exceeded?
	2007	2008	
Annual mean	33.3	33	No
Maximum 1 hour mean	183	233 6 occurrences >= 200 μgm^{-3}	No
Data Capture %	96.7	97.8	

Table 7

2007 and 2008 Annual Summary Statistics for Nitrogen Dioxide Measured at AQMS, Queens Medical Centre, Clifton Boulevard

	NO_2 μgm^{-3}		Objective exceeded?
	2007	2008	
Annual mean	34	35	No
Maximum 1 hour mean	135.6	151	No
Data Capture %	98.8	92.7	

Table 8

2007 and 2008 Annual Summary Statistics for Nitrogen Dioxide Measured at CG NOx, Carter Gate, City Centre

	NO_2 µgm^{-3}		Objective exceeded?
	2007	2008	
Annual mean	42.4	44	**Yes**
Maximum 1 hour mean	406.8 3 occurrences >= 200 µgm^{-3}	179	No
Data Capture %	91.9	98.3	

Table 9

2007 and 2008 Annual Summary Statistics for Nitrogen Dioxide Measured at LS NOx, Lace Street, Dunkirk

	NO_2 µgm^{-3}		Objective exceeded?
	2007*	2008	
Annual mean	43.7	41	**Yes**
Maximum 1 hour mean	149	237 4 occurrences >= 200 µgm^{-3}	No
Data Capture %	79.5	93.9	

*9 months data 01.04.2007 to 31.12.2007 ratified

The 2007 and 2008 bias adjusted nitrogen dioxide diffusion tube monitoring data are shown in Table 10. The raw data and details of the bias adjustment factors applied are given in Appendix C.

The monitored annual mean NO_2 concentrations for 2006, 2007 and 2008 at continuous and diffusion tube sites are shown in Figure 2.

Table 10

2007 and 2008 Annual Mean Nitrogen Dioxide Concentrations - Diffusion Tube Measurement

Site Type	Tube Id	Site	2007 Bias Adjusted Annual Mean NO_2 μgm^{-3}	2008 Bias Adjusted Annual Mean NO_2 μgm^{-3}
R	A	Ilkeston Road (NS)	27.7	26
UB	B	Noel Street Baths (NS)	25.1	22
UB	W	Ransom Drive (NS)	6.1	5
R	C	Clifton Boulevard	29.6	31
R	D	Beeston Road (1)	**50.4**	**47**
R	F	Beeston Road (2)	**52.5**	**55**
R	G	Beeston Road (4)	39.4	**45**
R	H	Beeston Road (3)	**45.8**	38
Su	I	Derby Road (1)	33.1	33
R	J	Derby Road (2)	32.7	34
R	K	Castle Boulevard	**44.2**	**42**
R	M	Canning Terrace	**46.5**	**49**
R	N	Upper Parliament St.	**47.1**	**52**
R	O	Shakespeare St.	***54.0**	**51**
R	P	Mansfield Road	**47.0**	**49**
R	Q	Woodborough Road	**51.7**	**48**
R	S	Carter Gate	**40.6**	**44**
R	T	Queens Road	**45.8**	**52**
R	U	Trent Bridge	30.5	****51**
R	V	Alfreton Rd./Bentinck Rd.	38.2	35

All 11 - 12 months averages except * 7 mths and ** 9 mths

R = Roadside UB =Urban background Su = Suburban NS = national survey

Concentrations above the annual mean NO_2 AQO are highlighted in bold typeface.

2007 and 2008 Monitoring Data Analysis

The above results show that neither of the AQOs for nitrogen dioxide (annual mean=40μg/m^3 and I hour mean = 200μg/m^3 not to be exceeded more than 18 times per year) were exceeded at the AURN and the AQMS which are non-roadside continuous monitoring sites.

This contrasts with the results for the roadside continuous monitoring sites CG NOx and LS NOx. The 2007 and 2008 NO_2 concentrations were between 41 and 44μg/m^3 therefore the annual mean AQO was exceeded both years at both sites. The 1 hour mean AQO was not exceeded at either site.

The 2007 and 2008 diffusion tube NO_2 levels are broadly consistent with the 2006 results and show exceedences of the annual mean AQO at some sites within or nearby existing AQMAs or where traffic flows have significantly altered as a result of traffic schemes such as Turning Point.

The proposed amended AQMAs outlined in the DA 2008 encompassed most of the additional diffusion tube sites where exceedences of the annual mean AQO were identified.

The R & A Appraisal comments about exceedences outside the proposed amended AQMAs relate to the three diffusion tube monitoring sites, K, T and U. Table 10 shows that in 2007 and 2008 at sites K and T the annual mean NO_2 AQO was exceeded which is consistent with the 2006 data. NO_2 levels at site U have varied between exceeding and not exceeding 40μg/m^3 between 2006 and 2008 - given this and its location near a busy 6 lane, main traffic route it is reasonable to consider it as a site of likely exceedence of the annual mean NO_2 AQO.

In respect of the 1 hour AQO the guidance advises Local Authorities that it can be assumed that exceedences of this objective are only likely to occur where annual mean nitrogen dioxide concentrations are equal to or greater than 60μg/m^3. No continuous monitoring or diffusion tube annual mean nitrogen dioxide concentrations for 2007 and 2008 were greater than 55μg/m^3.

Generally, it is reasonable to assume from the last three years' monitoring results that nitrogen dioxide levels won't significantly reduce for the next few years and therefore the annual mean AQO is likely to continue to be exceeded in parts of the Nottingham city area.

Nitrogen Dioxide, NO_2 Modelling Information

Previous nitrogen dioxide modelling work undertaken by Nottingham City Council for the Review and Assessment process led to the declaration of the existing AQMAs No 2 and 3 and to the proposed amendments outlined in the DA 2008. The modelling approach used then was to compile an emission inventory of road traffic information, area and industrial sources and use meteorological data from a nearby weather station as well as monitored background pollutant concentrations from an AURN rural site.

Following verification work a model adjustment factor was derived by comparison between monitoring and modelled data at the continuous monitoring sites. Modelling was used to predict nitrogen dioxide levels and the model adjustment factor applied to give the final concentrations.

The most recent guidance, LAQM TG (09) Annex 3 states that where the modelled/monitored NO_2 comparison indicates a model adjustment is required then the NOx concentrations should be verified and adjusted (if necessary) before they are used within empirical equations or models. It also comments that "The adjustment of NOx is often carried out on the component derived from local Road Traffic Emissions – the Road Contribution" therefore the 2007 modelling presented in this report has been carried out using this methodology .

2008 has not been modelled for a number of reasons: 2008 meteorological data has not been obtained; 2008 is not considered a typical year; modelling 2008 would lead to further delay in completing the DA and the amendment of the AQMAs; there are differences in the findings between 2006 and 2007 and to add a further year could potentially add complications that don't alter the outcomes. Also the recently published, new traffic emission factors need to be incorporated into the modelling undertaken for future rounds of R & A but are not currently available for the model.

Model Verification and Adjustment

The model verification and adjustment approach specified in LAQM TG (09) Annex 3 has been followed with advice and guidance from the R & A helpdesk.

In respect of verification the guidance says that where modelling underestimates total nitrogen dioxide concentrations then adjusted modelled predictions of road source contribution NOx should be used to predict total annual mean nitrogen dioxide concentrations.

The following is a précis of the adjusted road contribution NOx methodology for which only roads are modelled:

a) Determine an estimate of the monitored road source contribution NOx.

b) Compare monitored road NOx with modelled road NOx and derive an adjustment factor to apply to the modelled road source contribution NOx.

c) Determine the corrected total annual mean NO_2 from the adjusted modelled road source contribution NOx.

Full details of the methodology can be found in LAQM TG (09) Annex 3 Box A3.6. The guidance is available on Defra's website:
http://www.defra.gov.uk/environment/airquality/local/guidance/index.htm

Modelling information about model inputs and outputs; verification and the derived adjustment factor is given in Appendix C.

Uncertainties associated with monitoring and modelling processes arise for a number of reasons including:-

- Measured data uncertainty – partly reflected by the precision and accuracy of the monitoring systems.
- Model uncertainty - the model algorithms are mathematical approximations to the way the atmosphere behaves (e.g. chemistry, dispersion).The parameters used in the model set-up (e.g. surface roughness) are mathematical constants used to represent a physical characteristic.
- Input data uncertainty - emissions are either monitored with their inherent error or derived; estimated background concentrations; meteorological data; source geometry. All of these carry a degree of error.

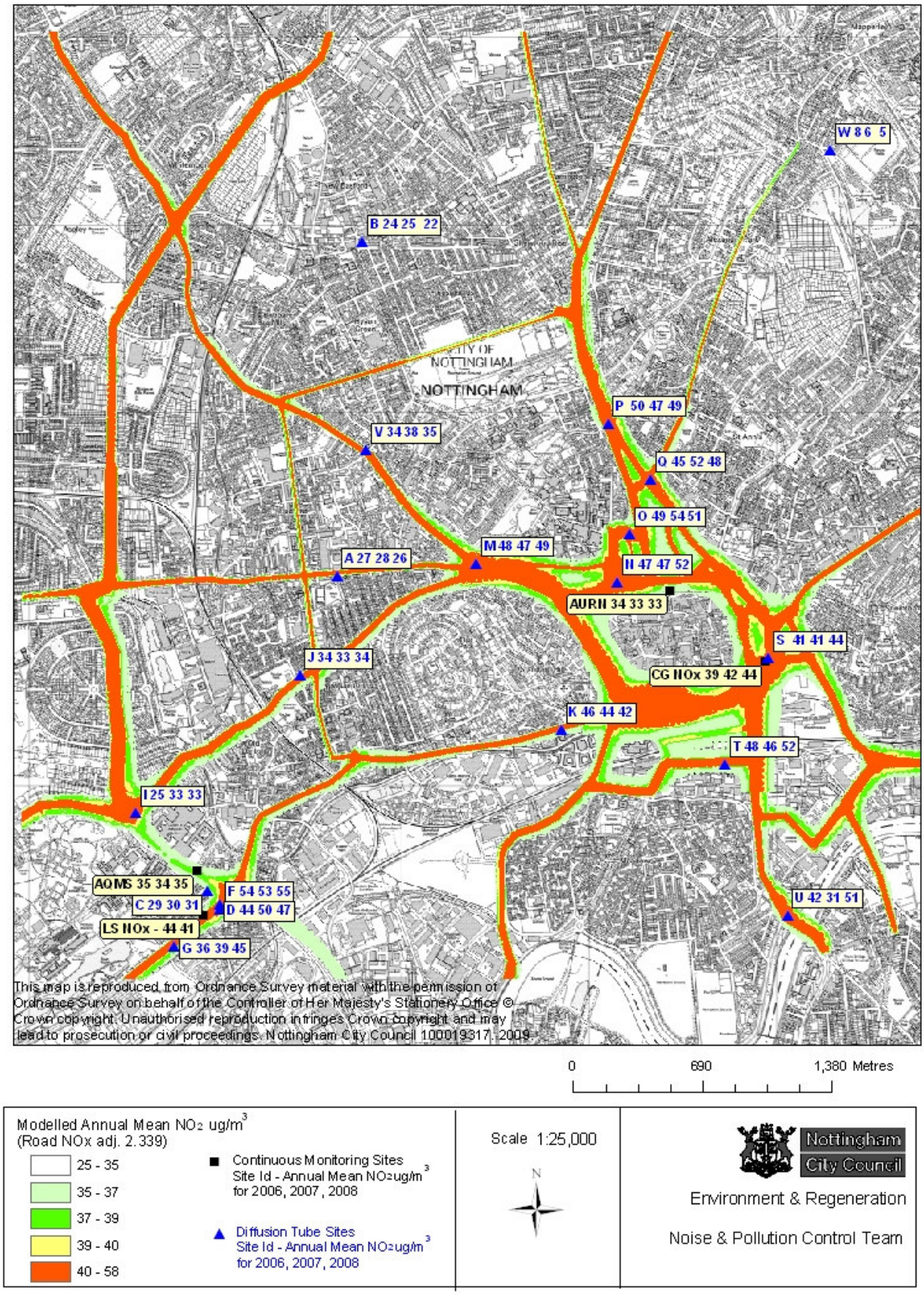
It is generally recognised that differences between monitored and modelled results are likely to be due to a combination of the above. While such uncertainties cannot be eliminated where possible they have been minimised by verification of the modelling; checking model inputs and ensuring a good standard of QA/QC of the monitoring equipment and data.

Following verification, road source contribution NOx was modelled for 25 x 1 km^2 areas (this allowed the appropriate background to be added) in the city. The adjustment factor was applied to the road source contribution NOx model output and the corrected annual mean NO_2 concentrations determined.

Figure 2 shows mapped contours for the corrected predicted 2007 annual mean NO_2 concentrations. The monitored annual mean NO_2 concentrations for 2006, 2007 and 2008 at continuous and diffusion tube sites are also shown.

Figure 2

2007 Adjusted Modelled Total Annual Mean Nitrogen Dioxide Concentrations



Modelling Data Analysis

The modelling predicts that the annual mean nitrogen dioxide Air Quality Objective may not have been met in all locations with relevant exposure during 2007. Generally outside the AQMAs the areas of predicted exceedence are along the modelled roads which, in some instances, extend to properties either side. Currently no monitoring takes place near some of these roads, so the diffusion tube monitoring programme will be need to be expanded to cover these areas to better inform future rounds of R & A.

Considering sites where exceedences of the annual mean AQO were measured there is good agreement between the modelled and monitored nitrogen dioxide levels. This applies to most of the sites - LS NOx, F, G, H, S, N and CG NOx within the existing AQMAs.

Tubes such as P, Q, M, F, D and G were placed as result of previous rounds of R & A; the modelling is in agreement with monitoring results and confirms exceedence of the annual mean AQO. These areas of exceedence are consistent with the 2006 modelling presented in the DA 2008.

At T, K & U the sites referred to the R & A DA 2008 appraisal, the road source contribution NOx modelling methodology predicts exceedence of the AQO and this is consistent with the diffusion tube monitoring results.

Figure 2 also shows that NO_2 levels were over estimated at roadside DT sites such A, C, J, and V which are on heavily trafficked routes into and out of the city. The information below shows tube distances from the kerb and the 2007 monitored and modelled annual mean NO_2 concentrations.

Site Id	Distance from Kerb (m)	2007 Monitored Annual Mean NO_2 μgm^{-3}	2007 Modelled Annual Mean NO_2 μgm^{-3}
A	6	27.7	34.8
C	13	29.2	35.5
J	12	32.7	35.7
V	6	35.7	38.2

At site I, the monitored and modelled concentrations were 33.1$\mu g/m^3$ and 42.7$\mu g/m^3$ respectively. The tube is located on the façade of a residential property 25m from the kerb of a major traffic junction which, because it is not within 15m of the kerb is not considered a

roadside site. It is classified as a ‘Suburban’ site - the most suitable of the monitoring descriptions options given in LAQM TG (09).

The tubes at these five sites A, C, J, V and I are all located on the facades of residential properties or sensitive receptors. The sites are typical of much of the Nottingham City inner area encompassed by the ring road in that; the main traffic routes are characterised by relatively wide roads with residential properties either side, quite often set back from the roadside.

The monitored 2006, 2007 and 2008 nitrogen dioxide concentrations have been similar year on year at each of these sites and the annual mean AQO has not been exceeded.

The over estimation of concentrations is probably mainly due to the use of the national background estimated data since this contribution to total nitrogen dioxide levels is much greater than the road contribution.

Nottingham City has two urban background diffusion tube sites, B and W that are part of the National Nitrogen Dioxide Survey. For 2007 at site B the national background map NO_2 unmodified concentration was 27.2μg/m^3 compared with the diffusion tube annual mean NO_2 of 25.1μg/m^3. Site W is more distant from the City centre and the comparison is poor, the respective values being 22.4μg/m^3 and 6.1μg/m^3. The area around site W was not part of the 25 x 1 km^2 areas that were modelled for this report.

Nitrogen Dioxide - Detailed Assessment Conclusions

The information presented in this report indicates that, in keeping with previous rounds of R & A, the nitrogen dioxide annual mean AQO of 40µg/m^3 is likely to be met in the majority of the Nottingham City area. However there are parts of the City, mostly near and within existing AQMAs, where both modelling and monitoring results demonstrate that the objective has been exceeded at locations with relevant exposure of members of the public. This is consistent with the 2006 modelling exercise undertaken for the DA 2008.

At other locations, the modelling suggested exceedence occurred however some of these were monitoring sites and their results showed that the annual mean AQO was not exceeded.

None of the continuous monitoring sites measured exceedence of the hourly nitrogen dioxide AQO of 200µg/m^3 no more than 18 times per annum.

Nottingham City Council needs to expand its diffusion tube monitoring programme to cover those areas where modelling suggests exceedence but the degree of uncertainty is such that it is not appropriate to include them in Air Quality Management Areas at the moment. Additional monitoring information will assist in informing future rounds of Review and Assessment.

Nottingham City Council has identified with reasonable certainty that the nitrogen dioxide annual mean Air Quality Objective has been exceeded and is likely to continue to be exceeded in parts of its area. Therefore it is necessary to modify both of the existing Air Quality Management Areas to reflect the findings of the modelling and monitoring.

Progressing Local Air Quality Management.

Amendments to the Existing Air Quality Management Areas

The Environment Act 1995 Section 83 (2) states 'An order under this section may, as a result of a subsequent air quality review,-

(a) be varied by a subsequent Order; or

(b) be revoked by such an Order,

if it appears on that subsequent Air Quality Review that the Air Quality Standards and Objectives are being achieved, and are likely throughout the relevant period to be achieved, within the designated area.

Proposed Air Quality Management Areas Amendments

In determining the boundaries of the amended AQMAs - the 2007/8 monitoring data; the predicted modelled contours; the advice given in the guidance LAQM TG (09), PG (09) and by the R & A help desk have been taken into account. The geographical extent of the amended AQMAs has been defined where predicted annual mean nitrogen concentrations are 39µg/m^3 or greater and there is relevant exposure of members of the public. A concentration of 39µg/m^3 was chosen to account, in part, for the numerous uncertainties associated with the modelled inputs and outputs.

The boundary lines of the AQMAs have been drawn by aligning to them to defined features such as roads and therefore the perimeters of the AQMAs tend to cover a slightly greater area than the modelled exceedence contours.

As shown in Figure 2 page 29 there are a number of locations, outside the existing AQMAs, where both modelled and monitored annual mean nitrogen dioxide concentrations show exceedence of the AQO. Where there is relevant exposure of members of the public these areas have been incorporated into the amended AQMAs.

LAQM TG (09) says that "Provided that the data are "fit for purpose", then precedence should always be given to measured concentrations over those that have been predicted using a model". Consequently the sites where 2007 and 2008 measured annual mean nitrogen dioxide levels were less than 40µg/m^3 but the modelling predicts exceedence of the AQO have not been included.

Also where the modelling predicts exceedence but there is no monitoring data these locations have not been included because it is evident that the modelling over predicts concentrations at some similar sites that are monitored and in the absence of measurements the level of uncertainty is relatively high.

Nottingham No:2 Air Quality Management Area – Nitrogen Dioxide

The current AQMA No:2 is located in the City centre. It is proposed to amend the area as shown in Figure 3 page 35. The amendment extends the AQMA to the north, north-west and to the south along roads where there are residential properties nearby and removes a bus station and a bus depot.

The southernmost perimeter of the amendment ends at north side of Trent Bridge. The neighbouring authority is Rushcliffe Borough Council and the boundary of their AQMA for nitrogen dioxide is at the south side of Trent Bridge.

Nottingham No:3 Air Quality Management Area – Nitrogen Dioxide

This AQMA is located in the Dunkirk area of the City. It is proposed to amend the area as shown in Figure 4 page 36. The amendment extends the AQMA along a road to incorporate the residential properties that border it. It removes an area around a major junction where three years of diffusion tube monitoring have shown that the annual mean AQO has not been exceeded although the modelling predicts exceedence. The junction is a large multi-lane roundabout with the ring road passing underneath it which means it is complex to model and while the model output for this area could be considered the worst case scenario it has to be interpreted with caution.

The amendment also removes the QMC Hospital campus from the AQMA - three years of continuous monitoring at the site have shown that neither of the nitrogen dioxide AQOs have been exceeded.

Figure 3 Proposed Variation of AQMA No:2 Nitrogen Dioxide – City Centre Area

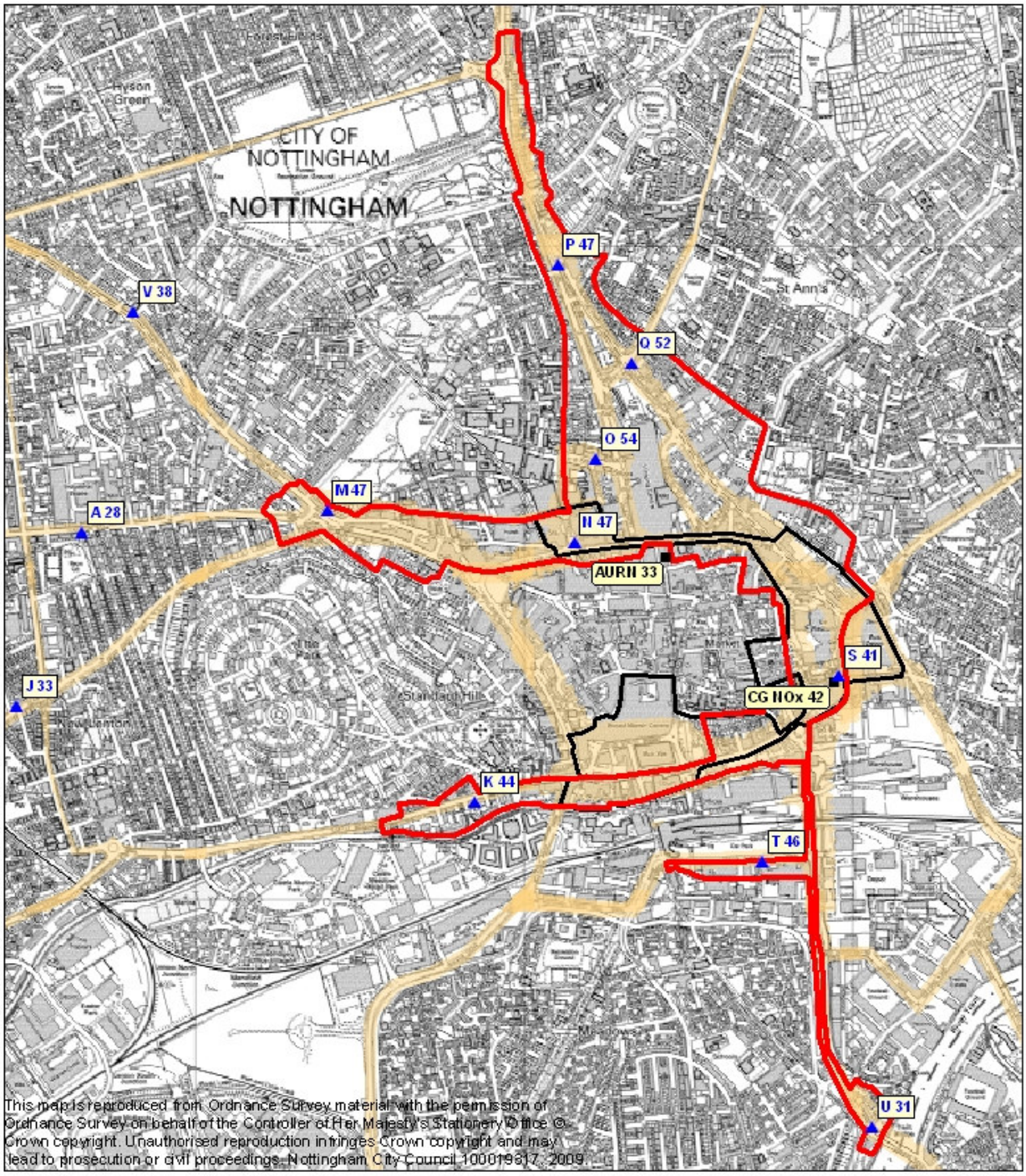
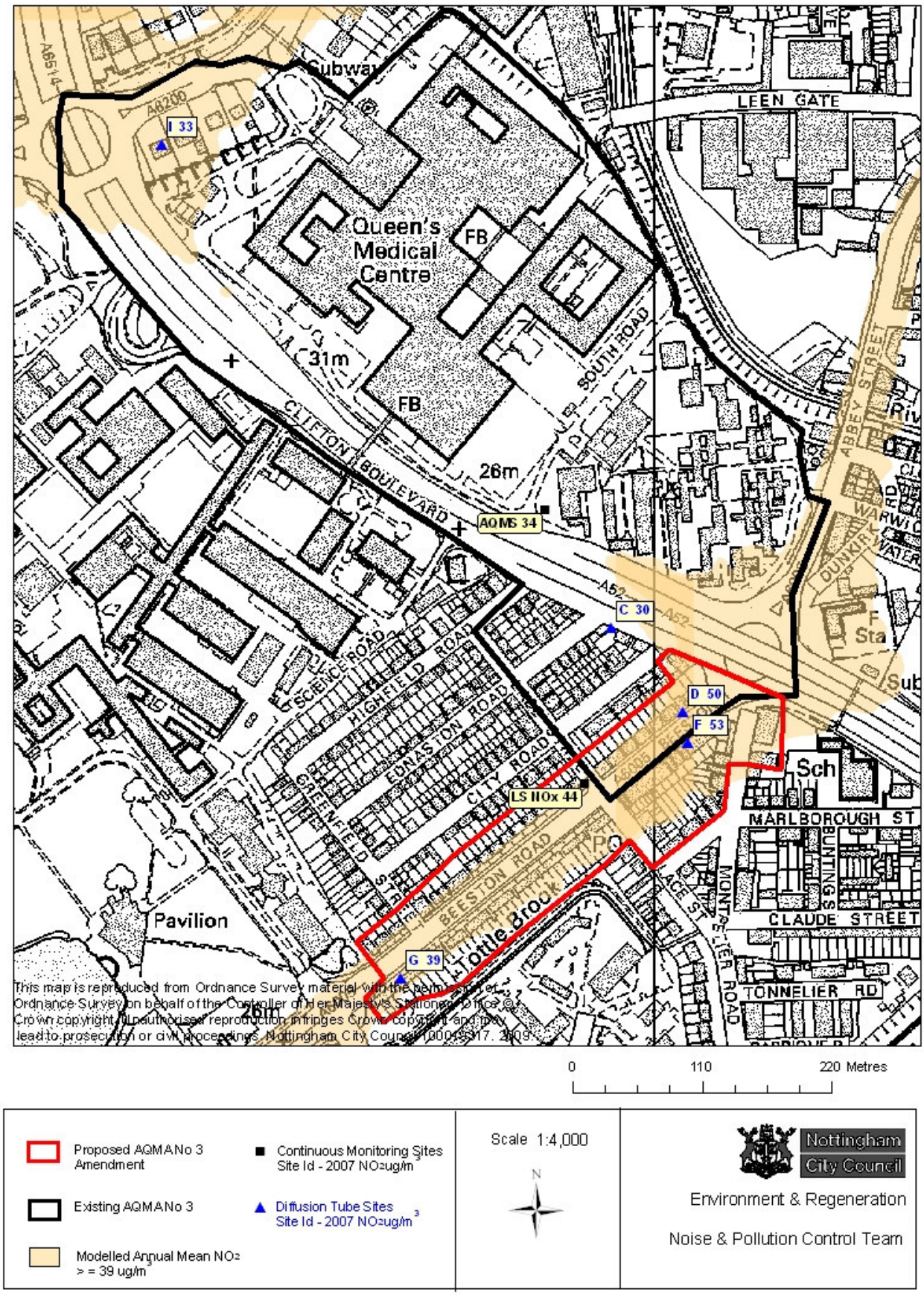


Figure 4 Proposed Variation of AQMA No:3 Nitrogen Dioxide – Dunkirk Area



What Happens Next

As required by the Policy Guidance, LAQM PG (09), Nottingham City Council will consult all relevant statutory consultees, local stakeholders, businesses and members of the public on the Detailed Assessment 2009 and the proposed amendments to the AQMAs.

Following acceptance by Defra of the reports and varied AQMAs proposals and consultation, in order to comply with the LAQM.PG (09), Nottingham City Council is expected to finalise the boundaries for the amended AQMAs and to make the Orders for the amended Air Quality Management Areas within four months of receipt of Defra's comments – by the end of April 2010.

Air Quality Actions Plans

For the existing AQMAs, road traffic is the major contributor to exceedences of the annual mean NO_2 AQO and consequently Nottingham City Council has integrated the required AQAP into its Local Transport Plan (LTP) which is available on the Council's website. This approach will be continued for the amended AQMAs. The integration of Action Plans with Local Transport Plans or Local Implementation Plans is advocated in the PG (09) as a systematic way to join up air quality management and transport planning.

Further Assessment of Air Quality within an AQMA

Section 84 (1) of the Environment Act 1995 requires Local Authorities to undertake a further assessment of existing and likely future air quality in an AQMA. Section 84 (2) requires the further assessment to be made within twelve months of designating (or varying) the AQMA. There is also a requirement to consult on the further assessment and make it available to the public.

For the variation of an AQMA, the guidance states that "If there is only to be a minor extension to an existing AQMA order, such as the encompassing of a few further buildings or inclusion of a road junction, as long as the authority has access to substantial information about the area of extension or can reliably extrapolate from information it has about the area originally designated, Defra, ….. would not expect that authority to have to undertake an extensive further assessment." A more comprehensive assessment is expected if the order is varied by a more substantial change, for example going from a few streets to a whole borough designation.

The Next Annual Air Quality Report

Local authorities are required to prepare annual air quality reports between subsequent rounds of reviews and assessments to ensure continuity in the LAQM process. According to the timetable shown in LAQM TG (09) Box 1.3 and in Table 2 the next step is for a Progress Report to be completed by the end of April 2010. All authorities are expected to complete this, **"regardless of whether they are undertaking a Detailed Assessment or not".**

References

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Nottingham City Council (2000 - 2009) **Previous Review and Assessment Reports:**

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City of Nottingham
Air Quality Review & Assessment Second & Third Stage Report 2001

City of Nottingham
Local Air Quality Management: Stage Four Review & Assessment of Nottingham's Air Quality Management Areas July 2003

City of Nottingham
Local Air Quality Management: Updating and Screening Assessment October 2003

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Nottingham City Council
Local Air Quality Management: Progress Report July 2008

Local Air Quality Management: Updating and Screening Assessment for Nottingham City Council April 2009

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Local Air Quality Management: Detailed Assessment 2008 Annex 1 – Supplementary Information for Nitrogen Dioxide October 2009

Nottingham City Council (March 2006) **Local Transport Plan, LTP 2005/7-2010/11**

Websites

www.cerc.co.uk

http://www.defra.gov.uk/environment/airquality/local/guidance/index.htm

Nottingham City Council Website http://www.nottinghamcity.gov.uk

http://www.nottinghamcity.gov.uk/sitemap/services/environment/pollution/air_pollution/air_quality.htm

http://www.nottinghamcity.gov.uk/sitemap/services/transport_and_streets/transport_planning/cdt_local_transport_plan.htm

Appendix A

Previous Review and Assessment Reports

Table A1 Previous Review and Assessment Reports

Title	Date	Outcome	AQMA Declared/ Revoked? (Date)
City of Nottingham Air Quality Review & Assessment First & Second Stage	April 2000	Third stage assessment for sulphur dioxide, nitrogen dioxide and particulates, PM10 necessary. No further assessment of 1, 3 Butadiene, benzene, carbon monoxide and lead required.	-
City of Nottingham Air Quality Review & Assessment Second & Third Stage Report	September 2001	Areas of the city where unlikely to meet air quality objectives for nitrogen dioxide or sulphur dioxide. Proposed 1 AQMA for SO_2 and 2 AQMAs for NO_2	**Declared** AQMA No:1 (Sulphur dioxide) (2002) AQMA No:2 (Nitrogen dioxide) (2002) AQMA No:3 (Nitrogen dioxide) (2002)
City of Nottingham Local Air Quality Management Stage Four Review & Assessment of Nottingham's Air Quality Management Areas	July 2003	Determined that AQOs for sulphur dioxide – hospital chimney and nitrogen dioxide – traffic sources, unlikely to be exceeded by 'due dates' therefore no Air Quality Action Plans needed	-
City of Nottingham Local Air Quality Management Updating and Screening Assessment	October 2003	Necessary to proceed to a Detailed Review and Assessment for nitrogen dioxide with respect to a number of roads and for sulphur dioxide in the vicinity of the Nottingham Main-line Station.	-
City of Nottingham Local Air Quality Management Detailed Assessment	August 2004	Sulphur dioxide 15-minute mean AQO likely to be met at locations of 'relevant exposure' at Nottingham Mainline Station. Nitrogen dioxide annual mean AQO likely to be met. Concluded insufficient monitoring data available to allow revocation of any of the AQMAs.	-

Title	Date	Outcome	AQMA Declared/ Revoked? (Date)
City of Nottingham Local Air Quality Management Progress Report	April 2005	Concluded that SO_2 monitoring data sufficient to propose revocation of AQMA No:1 (Sulphur dioxide). Necessary to maintain AQMAs No 2 & 3 (nitrogen dioxide)	
Nottingham City Council Local Air Quality Management Updating and Screening Assessment:	June 2006	Necessary to proceed to a Detailed Assessment for PM_{10} for 2 roads in the city centre and for nitrogen dioxide for a number of roads and junctions based on guidance criteria and some diffusion tube data. AQMA No:1 (Sulphur dioxide) to be revoked – agreed by Defra	**Revoked** AQMA No:1 2002 (Sulphur dioxide) (5 April 2007)
** Nottingham City Council Local Air Quality Management Detailed Assessment Consultation Document	May 2008	Conclusion that no further action required for PM_{10} - accepted by Defra **Proposed amendments to existing AQMAs No.2 & No.3 for nitrogen dioxide.** **Further work for nitrogen dioxide undertaken following comment and assessment by Defra - see DA-Annex 1 October 2009**	-
Nottingham City Council Local Air Quality Management Progress Report	July 2008	Concluded that there was no need to undertake a further detailed assessment - accepted by Defra	-
2009 Air Quality Updating and Screening Assessment for Nottingham City Council	April 2009	Concluded that there was no need to undertake an additional detailed assessment because all areas of potential exceedence are being considered in the revised DA May 2008 - accepted by Defra	
Nottingham City Council Local Air Quality Management Detailed Assessment Annex 1-Supplementary Information for Nitrogen Dioxide	October 2009	Accepted by Defra – 31 December 2009. Consultation and declaration of amended AQMAs to be completed by 30 April 2010	

Appendix B

Model Description, Methodology and Verification for Particles, PM_{10}

Model Description

Dispersion models enable the user to predict the concentration of a substance at distances remote from the point of emission. Nottingham City used ADMS Urban 2 by CERC to model emissions from a variety of sources and to calculate pollutant concentrations over a geographical area.

In order to model an emission, its dispersion, dilution and consequent concentration at a given location, specific information is required - the input to the model. It performs complex calculations using this information to predict a concentration - the output of the model.

Model Input

Meteorology

A number of factors have a direct bearing on the concentration of an emitted substance at any given point:-

i. The initial height of discharge/release
ii. The temperature and velocity of the release
iii. The wind speed and direction
iv. Atmospheric stability

The release height, velocity and temperature of an emission may be readily determined.

Wind direction, wind speed and the degree of turbulence determine where an emission is directed, how quickly it travels and how much mixing with the ambient air occurs, i.e. its dispersion and dilution. The degree of turbulence is indirectly derived from cloud cover, the height of the mixing layer, the time of day, and the time of year.
Weather varies from season to season, day to day and hour to hour. A dispersion model requires this time varying information and meteorological data specific for the geographical area being modelled so that pollutant concentrations can be more accurately predicted.
Meteorological data may be provided as: -

i. Hourly sequential - wind speed, direction, cloud cover, date, time of day, temperature and possibly precipitation or

ii. Statistical data comprising wind speed, direction, surface sensible heat flux, boundary layer depth and precipitation.

Meteorological data

Watnall weather station located approximately 8 miles north of the City measures all the required parameters for ADMS-Urban. Therefore 2006 meteorological data from this station was used.

Topographical Information - Surface roughness

Buildings, hills and undulations cause friction and turbulence as the wind moves over land. Turbulence effects the dispersion of an emission. The amount of friction that topographical features cause is described by the parameter 'surface roughness'. Values for surface roughness vary from 1.0 for Cities and woodlands, to 0.5 for parkland and open suburbia, to 0.02 for open grassland. In ADMS Urban only one value may be chosen for the modelled area.

Nottingham City is characterised by low rise suburban housing, parks, fields and a relatively small 'high rise' core. A value of 1.0 was therefore used.

Emission sources

ADMS Urban can deal with four different types of emission sources, point, line, area and volume. The first three adequately describe emission sources that occur in Nottingham City.

Point Sources (metres)

The emission occurs from a specific point. A point source is usually a chimney, which for non-combustion processes may also be called a 'stack'.

Stack height i.e. the height of the point of emission above ground level and stack diameter i.e. the internal diameter of chimney are required. In a chimney with multiple flues the aggregated diameter is used.

Area Sources (square kilometres)

An area source is usually a large building or process with emissions occurring in a number of locations over the area. It may also be a large geographical area such as a housing estate where small emissions occur from a large number of point sources which are thus

impracticable to model discreetly but collectively emit a significant quantity of a substance and can be included when defined as an area source.

Line Sources (metres or kilometres)

A line source is usually a road, where a large number of discrete moving point sources can be modelled as a continuous emission along the length of a road. The following information is required:

Physical parameters - road width and road/segment length.

Traffic volume and average speed - traffic speed affects the emission rate and composition of exhaust gases. Annual average daily traffic flows, percentage vehicle split and some average speed data was obtained from Nottingham City Council's Transport Projects Section. Other average speeds were found by timed journeys or estimated. The model allows one speed to be specified per line source. Therefore where it is known that vehicle speeds vary along a given road the road was divided into segments. The average speed was determined for each segment.

Traffic type/mix - emissions vary between classes of vehicle e.g. Heavy goods vehicles, (HGVs) and cars and light goods vehicles, (LGVs). The model requires the vehicle split between LGV and HGV classes.

Emission factor (grammes per kilometre) - the model has the capacity for either the 1999 and 2003 DMRB emission factors to be used. These factors are derived from the UK emissions factors database http://www.rsk.co.uk/ukefd/.

Pollutant Characteristics

The model is pre-programmed with the characteristics of a number of common pollutants including sulphur dioxide, nitric oxide, nitrogen dioxide and particles PM_{10}. If the emission is not gaseous the model allows the user to specify the size of the particle emitted.

Background Pollutant Concentrations

ADMS Urban models a pollutant source discreetly. To predict the pollutant's concentration it is necessary to add the pollutants background concentration to the modelled concentration. Background concentrations from the rural AURN station sited at Rochester were used in model predictions.

Rate of pollutant emission

Each process emits pollutants at a given rate which can vary. In the case of sulphur dioxide from a coal-fired combustion plant it depends upon the sulphur content of the coal and the rate at which the fuel is burned. For point sources this rate was obtained from data supplied by the plant operator. In the case of line sources and area sources, from data derived from the statistical analysis of national data sets.

Emission temperature

The temperature of an emission affects its thermal buoyancy. If an emission is 'hot' it acts like an extension to a chimney or stack increasing the effective height of discharge.

For point sources the emission temperature was obtained from data supplied by process operators. For area sources it was considered to be the same as the ambient air temperature. It is not a required input parameter for line sources.

Model Outputs

The model calculates pollutant concentrations in a defined study area. ADMS Urban was used in conjunction with ArcGIS 9.2 for defining output grids for contour plots and specifying receptor points.

ArcGIS 9.2 is a Geographical Information System, GIS and can be used to overlay the predicted concentration data produced by ADMS Urban on a map.

Pollutant concentrations are determined as the amount of a substance in a given volume, usually one cubic metre of air.

Long term averaging gives one output value at each location averaged over the whole of the input meteorological data set. Percentiles of pollutant concentrations can be calculated using long term averaging.

ADMS allows several percentiles to be calculated during a single model run. The percentiles chosen were appropriate for the Air Quality Objective being modelled, for example, for PM_{10} the 24 hour mean of no more than 35 exceedances of a concentration of 50µg/m^3 equates to the 90.1th percentile.

Modelling Methodology

Long term modelling was used to predict:
i) annual mean PM_{10} concentrations and
ii) the 90.1th percentile of the 24 hour daily PM_{10} (i.e. equivalent to 18 exceedances)

The following parameters and data were used to model PM_{10} concentrations.
Surface Roughness = 1m
Minimum Monin-Obukov length = 30m
GRS chemistry
Meteorology = Watnall 2006 - (hourly sequential data)
Background pollutant concentrations - hourly averaged data from the Rochester AURN for the year 2006 was used and included NO_2, NOx, O_3, SO_2, PM_{10}.

Emissions data
Roads – LGV and HGV traffic flows for 2006 calculated from 2006 AADT supplied by the Nottingham City Council's Transport Projects Section and the average speed for each link either supplied or determined previously for earlier modelling work. 2003 DMRB emission factors for 'urban' roads.

Point – the parameters and emissions supplied by the operators or reasonable assumed values.

Model Verification – ADMS Urban V2.2
In order to have confidence in the model predictions verification work was undertaken. Verification involves comparison between modelled and monitored pollutant concentrations.

Model verification studies were undertaken as part of the Stage 2 and 3 Review and Assessment 2001 and the Detailed Assessment October 2004 and are detailed in that report. However since then an updated version of ADMS Urban has been developed so further model verification has been undertaken.

The parameters described in the modelling methodology above were used for the PM_{10} verification work.

Model verification was carried out in a similar way to that used for the Stage 2 and 3 Review and Assessment 2001 and the Detailed Assessment 2004. This entailed modelling

the year 2006, good quality monitoring data was available and comparison between model predictions with monitored concentrations at the three continuous monitoring sites was possible. An adjustment factor for the difference between monitored and modelled concentrations was then derived.

Table B1 below shows the monitored and modelled values for the 2006 PM_{10} annual mean.

Model Adjustment Factor

Table B1 Monitored and Modelled Particles, PM_{10} Annual Mean 2006

Monitoring Station - Site type	Annual Mean Monitored NO_2 µg/m^3	Annual Mean Modelled NO_2 µg/m^3	Monitored/modelled ratio
AURN 2006 – urban centre	24	23.1	1.04

Monitored data capture rates were greater than 90%

Although the model under-predicted PM_{10} levels by approx 4% no adjustment was made to the modelled PM_{10} predicted concentrations shown in Figure 1 because the predicted levels were considerably below the annual mean AQO of 40µg/m^3.

Appendix C

Nitrogen Dioxide Diffusion Tube Information

Table C1 2007 and 2008 Diffusion Tube Unbiased Annual Mean Nitrogen Dioxide Concentrations

Tube Id	Site	2007		2008	
		Annual Mean NO_2 μgm^{-3}	Data Capture %	Annual Mean NO_2 μgm^{-3}	Data Capture %
A	Ilkeston Road (NS)	30.2	100	30.0	92
B	Noel Street Baths (NS)	29.0	100	24.3	100
W	Ransom Drive (NS)	7.0	100	5.8	92
C	Clifton Boulevard	34.2	100	35.5	100
D	Beeston Road (1)	58.3	92	52.3	100
F	Beeston Road (2)	60.7	92	62.3	100
G	Beeston Road (4)	45.6	100	51.5	100
H	Beeston Road (3)	52.9	100	42.3	100
I	Derby Road (1)	38.3	100	37.0	100
J	Derby Road (2)	37.8	100	38.5	100
K	Castle Boulevard	51.1	100	47.3	100
M	Canning Terrace	53.8	100	55.3	100
N	Upper Parliament St.	54.5	92	58.3	100
O	Shakespeare St.	62.4	58	56.8	100
P	Mansfield Road	54.3	100	54.3	100
Q	Woodborough Road	59.8	100	54.0	100
S	Carter Gate	46.9	92	49.8	100
T	Queens Road	52.9	100	58.5	100
U	Trent Bridge	35.3	100	51.0	75
V	Alfreton Rd./Bentinck Rd.	44.2	100	39.0	100

NS = national survey

Nitrogen Dioxide Diffusion Tube, Bias Adjustment and QA/QC Information

2007

During 2007 Nottingham City Council's diffusion tubes were supplied and analysed by Bureau Veritas Laboratories. The tubes were prepared using a 10% solution of TEA (triethanolamine) in de-ionised water. The tubes were exposed on site for one month before being returned for laboratory analysis.

Diffusion Tube Bias Adjustment Factor

A co-location study of triplicate diffusion tubes at three of the sites that monitor nitrogen dioxide continuously i.e. AURN, CG NOx and LS NOx between January 2007 and December 2007 was undertaken.

A bias adjustment factor was derived for AURN and CG NOx sites both of which had 12 months of data and data capture greater than 90%. These values were then averaged to give a single value. The averaged bias adjustment factor A = 0.865 was applied to the raw diffusion tube nitrogen dioxide concentrations. The bias adjusted annual means are shown in Table 10.

This approach was used because the two sites used represent urban background and roadside locations respectively. They are consistent with the majority of Nottingham City's diffusion tube sites and for some sites it would be difficult to determine which of the bias adjustment factors to use.

QA/QC

The laboratory is UKAS accredited and is required to take part in other proficiency schemes. Bureau Veritas Laboratories participate in a number of QA/QC monitoring systems to demonstrate satisfactory performance.

More detailed information regarding 2007 bias adjustment and diffusion tube QA/QC can be found in the Progress Report July 2008.

2008

Since April 2008 Nottingham City Council's diffusion tubes have been supplied and analysed by Gradko International, Hampshire. The tubes are prepared using a 20%

solution of triethanolamine (TEA) in de-ionised water. The tubes are exposed on site for one month before being returned for laboratory analysis.

Diffusion Tube Bias Adjustment Factor

The R&A Helpdesk Database 2008 bias adjustment factor for Gradko 20% TEA in water tubes = 0.92.

The R&A Helpdesk Database 2008 bias adjustment factor for Casella/../Bureau Veritas 10% TEA in water tubes = 0.81.

The bias adjusted annual means shown in Table 10 are based on 12 months' data, January to December 2008 using the following calculation:

Ave Jan to Mar 10% TEA NO_2 x 0.81 = Y
Ave Apr to Dec 20% TEA NO_2 x 0.92 = Z

Annual mean NO_2 = (Y x 0.25) + (Z x 0.75) i.e. 25% of 10% TEA value + 75% of 20% TEA value.

Example

Y = 37 x 0.81 = 29.97
Z = 35 x 0.92 = 32.20

Annual mean NO_2 = (29.97 x 0.25) + (32.2 x 0.75) = 31.6 $\mu g/m^3$

QA/QC

Gradko International (diffusion tube supplier and analyst) is UKAS accredited; is assessed annually for compliance to ISO 17025 and participates in other proficiency schemes.

Gradko have confirmed that:

- their procedures have been amended to follow the guidance issued on behalf of Defra (AEA Energy & Environment, Feb 2008) relating to the preparation, extraction, analysis and calculation procedures for passive NO_2 diffusion tubes

- that most of these procedures were in force before the guidance was introduced and any amendments necessary in achieving compliance were minimal.

Gradko also participate in a number of QA/QC monitoring systems to demonstrate satisfactory performance:

- The Workplace Analysis Scheme for Proficiency (WASP) programme to ensure uniformity in data throughout the year. Only laboratories that are in the WASP scheme are used for analysing tubes from the National Nitrogen Dioxide Diffusion Tube Network.

- The monthly field inter-comparison exercise with other laboratories to enable assessment of bias and precision undertaken by AEA Energy & Environment.

- An external QC scheme to check solutions run by AEA Energy & Environment.

More detailed information regarding 2008 bias adjustment and diffusion tube QA/QC can be found in the Updating and Screening Assessment Report April 2009.

Appendix D

Nitrogen Dioxide Modelling Information

ADMS-Urban v2.3 – an atmospheric dispersion model was used to predict pollutant concentrations within the Nottingham City area.

Model Verification and Adjustment

The LAQM TG (09) guidance identifies that dispersion models may perform differently at kerbside, roadside and background sites. It also says “In most cases, local authorities are concerned with the predictions closer to roadside sites as these are more at risk of exceeding the air quality objectives and model verification is generally based on these locations.”

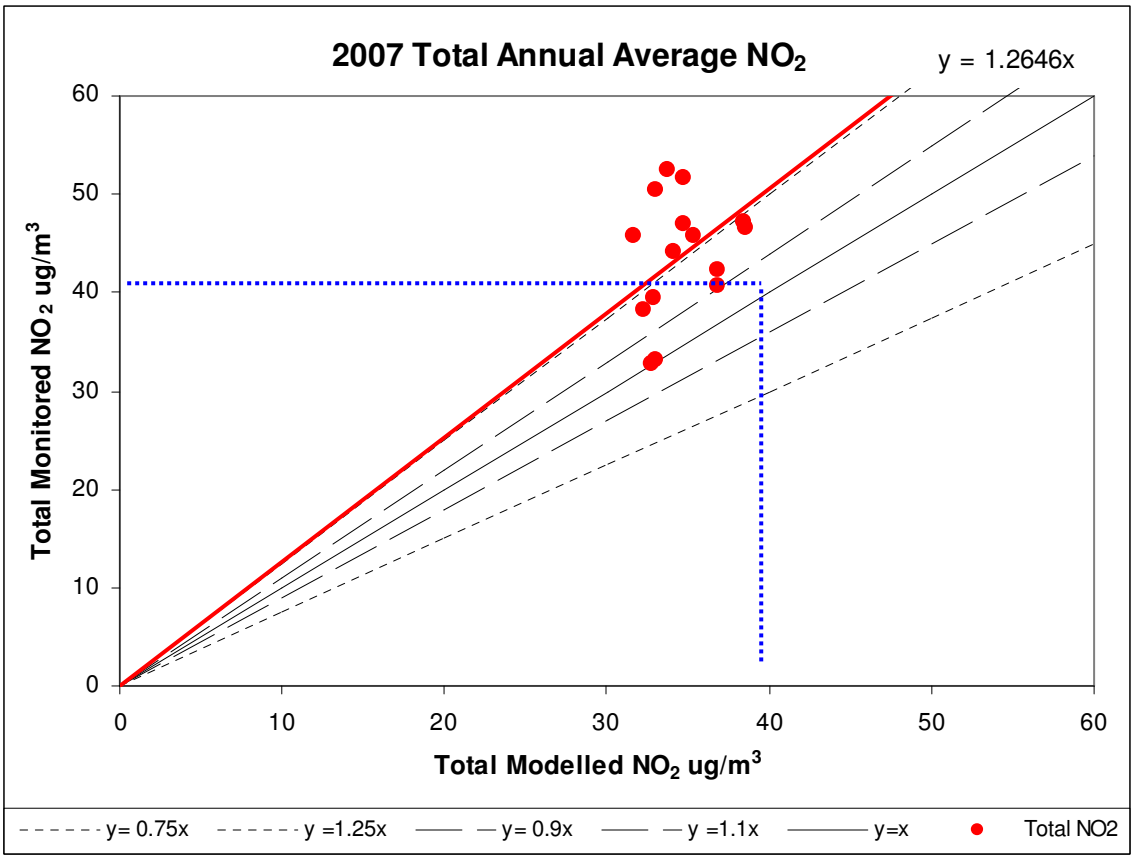
Initially the 2007 verification was carried out using the methodology outlined in the DA 2008 i.e. information was input on road traffic, traffic composition, flows and speeds; industrial and domestic sources, background pollutant data and meteorology.

Long term modelling was used to predict annual mean NO_2 concentrations and 99.8 percentile for NO_2 (i.e.1 hour mean equivalent to 18 exceedences) across the area and at specific locations.

However from comparison between monitored and modelled annual mean NO_2 concentrations it was apparent that the model under predicted NO_2 concentrations at a number of sites as shown in Graph D1 below. The graph shows the monitored v modelled NO_2 levels and it shows that a number of points are not within +/- 25% of the 1:1 regression line. The monitored data is for continuous and diffusion tube roadside sites.

In situations such as this, LAQM TG (09) advises that where adjustment needs to be undertaken it should be based on NOx (not NO_2) also that it should be applied to the ‘road source contribution’ NOx and not to total NOx concentrations.

Graph D1



Therefore following the methodology outlined in LAQM TG (09) Annex 3 ADMS Urban was used to model 2007 annual mean road source contribution NOx for the verification and modelling exercises.

Model Inputs

Traffic data

LGV and HGV traffic flows from 2007 AADT supplied by the Nottingham City Council's Transport Projects Section and the average speed for each link either supplied or determined previously for earlier modelling work. DMRB 2003 emission factors for 'urban' roads were used.

Meteorological Data

The 2007 hourly sequential data meteorological data from the Watnall station approximately 8 miles north of Nottingham.

Model Outputs

Long term modelling was used to predict annual mean road contribution NO_x concentrations for 25 x 1km^2 areas of the City. This approach enabled the appropriate background to be applied to each 1km^2. Both points and contour outputs were produced.

Background NOx and NO_2 Data

Nottingham City has two urban background diffusion tube sites, B and W that are part of the National Nitrogen Dioxide Survey. For 2007 at site B the national background map NO_2 unmodified concentration was 27.2µg/m^3 and this compares reasonably well with the diffusion tube annual mean NO_2 of 25.1µg/m^3. Site W is more distant from the City centre and the comparison is poor, the respective values being 22.4µg/m^3 and 6.1µg/m^3. The area around site W was not part of the 25 km^2 that were modelled for this report. The mapped locations of these sites can be seen in Figure 2 page 29.

The total background 1 x1 km NOx levels given in the national background maps are disaggregated into various source contributions. This allowed the trunk road and A road NOx - which were explicitly modelled - to be removed from the total NOx (where appropriate) before using the data in calculations thus avoiding double counting.

Where the total NOx was modified in this way the national background NO_2 data was adjusted using the LAQM Tools – 'NO_2 Adjustment for NO_x Sector Removal' calculator.

The background NOx and NO_2 data, LAQM Tools spreadsheets and calculator referred to in this appendix can be found on the website www.airquality.co.uk/laqm/tools.php

Model Adjustment Methodology

A number of steps were followed to determine an adjustment factor that could be applied to model predictions:

a) Estimate the monitored road source contribution NOx

For continuous data this involved taking the local estimated background NOx from the total measured NOx.

The local estimated background NOx for each location was found from the national background maps.

For diffusion tube data, the LAQM Tools - NOx to NO_2 spreadsheet was used to calculate road source contribution NOx since no direct measurement of NOx is possible with diffusion tubes.

b) Compare monitored road source contribution NOx with modelled road source contribution NOx

From a graph of monitored road source contribution NOx versus modelled road source contribution NOx, linear regression was used to determine an adjustment factor, the equation for the line was y=2.339x.

The modelled road source contribution NOx was multiplied by 2.339 to give the adjusted modelled road source contribution NOx

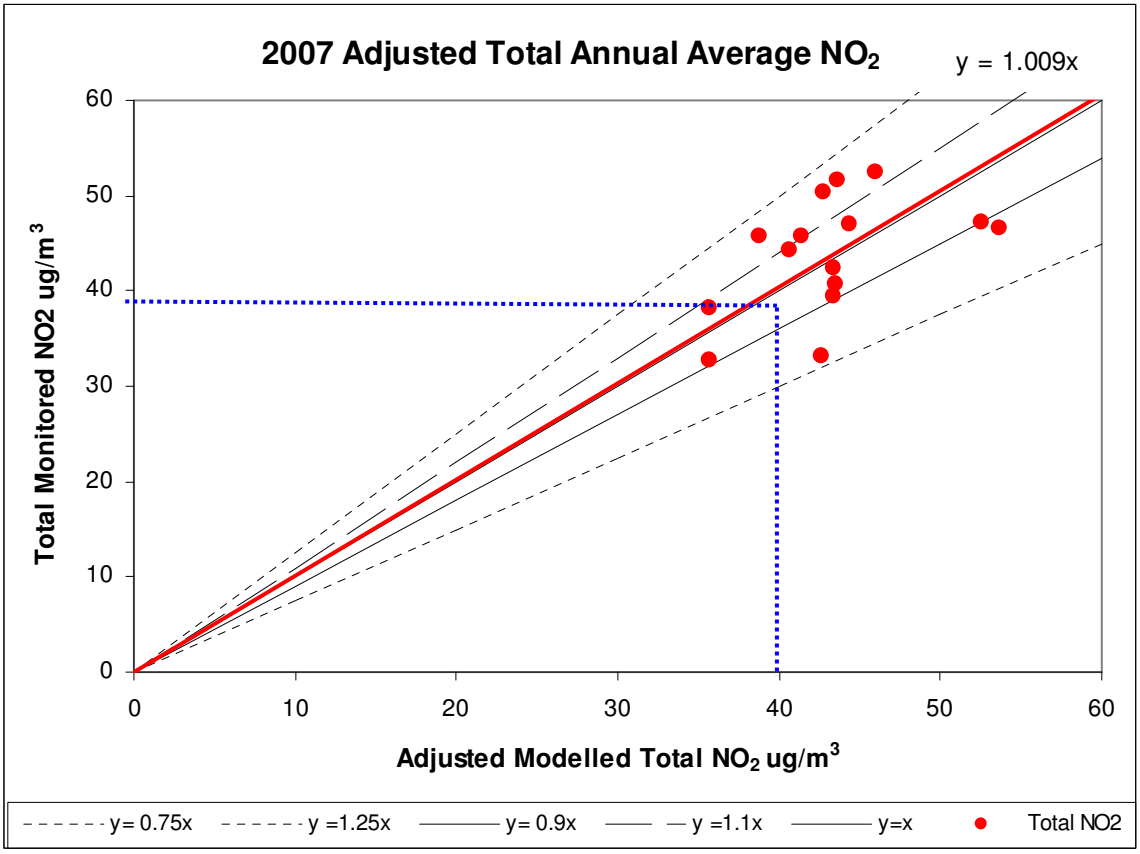
c) Determine the corrected total annual mean NO_2

The LAQM Tools - NOx to NO_2 spreadsheet was used to calculate the adjusted total annual mean NO_2 concentrations. The spreadsheet calculation required both the adjusted modelled road source contribution NOx and the adjusted background NO_2 concentrations to be input.

Graph D2 below shows the monitored total NO_2 v corrected modelled total NO_2 and the linear regression line through zero which is very close to the 1:1 line of regression.

All points are within +/- 25% of the 1:1 regression line and this indicates that it is reasonable to apply the derived adjustment factor to the modelling output.

Graph D2



Predicted Annual Mean Nitrogen Dioxide Concentrations

Annual mean nitrogen dioxide concentrations in the modelled areas were determined by applying the model adjustment factor to the modelled annual mean NOx for roads (i.e. road source contribution NOx) and then using the LAQM Tools - NOx to NO_2 spreadsheet to calculate the adjusted total annual mean NO_2 concentrations. The mapped adjusted predicted annual mean nitrogen dioxide concentrations are shown in Figure 2 page 29.