# Nottingham City Council

## Local Air Quality Management

## Detailed Assessment for Nitrogen Dioxide

## November 2013



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| **Report Reference number** | NCCDA2013 |
| **Date** | 21 November 2013 |

## Executive Summary

Nottingham City Council's Detailed Assessment for Nitrogen Dioxide report 2013 fulfils the requirements of the Local Air Quality Management process as set out in Part IV of the Environment Act (1995), the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 and the relevant Policy and Technical Guidance documents.

The Detailed Assessment (DA) follows the Progress Report in 2011; the Updating and Screening Assessment Report 2012 and the Progress Report 2013 that identified 2 or 3 locations outside the existing Air Quality Management Areas (AQMAs) where diffusion tube monitoring results exceeded the nitrogen dioxide annual mean air quality objective (AQO) of 40µg/$m^3$.

The Detailed Assessment (DA), involved complex air quality modelling, verification, and comparison with monitoring data. This was carried out over a large area of the city and encompassed the locations where annual mean diffusion tube monitoring results exceeded 40µg/$m^3$. The work was undertaken following the Department for Environment, Food and Rural Affairs (Defra) recommended procedures.

The results show general agreement between modelled nitrogen dioxide concentrations and those measured at the automatic analysers and the diffusion tubes in the existing Air Quality Management Areas (AQMAs). However, outside the AQMAs, the findings were variable with both agreement and differences between monitored levels and model predictions, potentially caused by uncertainties inherent in the processes.

The Technical Guidance LAQM.TG (09) states that the DA process should 'identify with reasonable certainty whether or not a likely exceedance will occur' and inform the local authority to accordingly declare, revise or revoke any Air Quality Management Areas.

Nottingham City Council has therefore determined that it is not appropriate to amend the AQMAs at this time and; to carry out further, more widespread monitoring to better understand the extent of the areas of monitored or modelled AQO exceedence that lie outside the AQMAs.

Nottingham City Council's Local Transport Air Quality Action Plan is designed to reduce traffic related emissions of nitrogen dioxide across the City and the conurbation area, and the Plan's action measures encompass the locations currently outside the AQMAs where monitored levels of nitrogen dioxide exceed the AQO.

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# 1 Local Air Quality Management

## 1.1 Introduction

The Environment Act 1995 Part IV introduced the requirement for a National Air Quality Strategy (NAQS) 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 prescribed air quality objectives will be achieved by the specified attainment dates for each pollutant of concern. The objectives are stated in the NAQS and enacted through the Air Quality (England) Regulations 2000 (as amended).

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

## 1.2 Air Quality Management Areas

Nottingham City Council completed its first round of review and assessment (R & A) in September 2001 and subsequently declared three Air Quality Management Areas (AQMAs): AQMA No1 - Sulphur dioxide area around the City Hospital; AQMA No 2 - Nitrogen dioxide City Centre area and AQMA No 3 - Nitrogen dioxide Dunkirk area.

Following further rounds of R & A, AQMA No1 was revoked in April 2007. AQMAs No 2 and No 3 were amended by AQMA Variation Orders dated 22 June 2010. They are now referred to as ‘AQMA No.2 2010’ and ‘AQMA No.3 2010’; their geographical locations and extent are shown in Figure 1.

Currently the approximate population living within the current AQMAs is 5,416 people in AQMA No2 - City Centre and 140 people in AQMA No.3 – Dunkirk area. These figures have been estimated using the Council’s Geographic Information System (GIS) to obtain the number of residential households in the AQMAs multiplied by 2.5 people per household.

## 1.3 Air Quality Action Plans

Throughout the R & A process, local road traffic has been identified as the major source of the measured/predicted exceedences of the nitrogen dioxide annual mean AQO.

Consequently the Air Quality Action Plan (AQAP) has been incorporated into the Local Transport Plan (LTP). The aim of AQAP is to improve air quality and reduce areas of exceedence. It contains a description of measures to be taken and dates by which it is hoped they will be achieved.

The AQAP relating to the current AQMAs were produced in June 2010 and are part of the current LTP – '**Nottingham City Council's Local Transport Plan 3: 2011 – 2026 Strategy**' (LTP 3).

Nottingham's Local Transport Plan can be found at the following web address which also has links to associated documents and pages:

www.nottinghamcity.gov.uk/transportstrategies

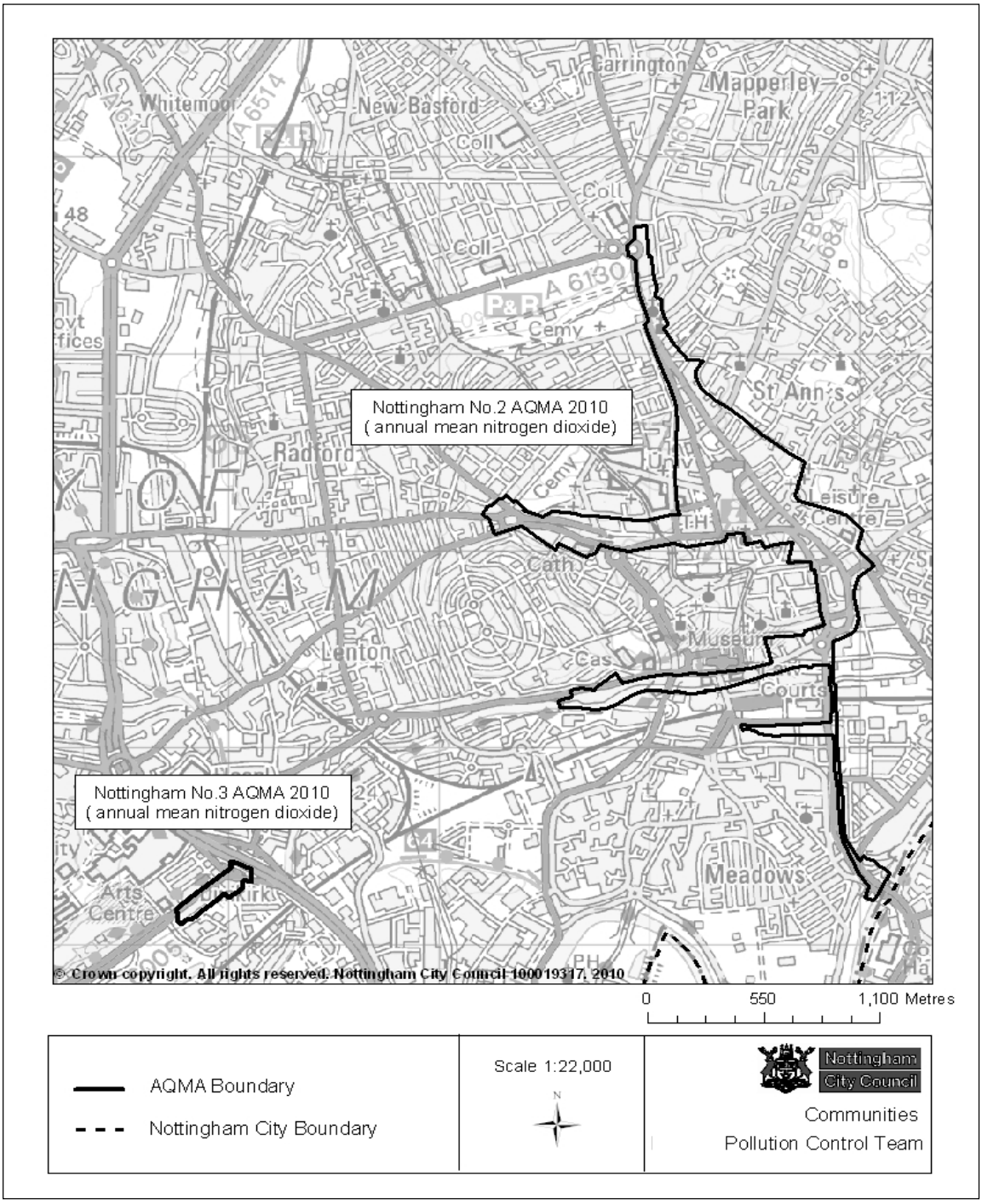
The action plan measures are updated annually and progress is reported via the LAQM reports – the most recent of which is the Progress Report August 2013.

### 1.4 Local Air Quality Management Reports

All of Nottingham City Council's LAQM reports are listed in Appendix A Table A-1 and are available on our website:

http://www.nottinghamcity.gov.uk/article/23015/Air-Quality

**Figure 1 Map showing Nottingham City Air Quality Management Areas**



# 2 Detailed Assessment for Nitrogen Dioxide

## 2.1 Purpose

Defra has issued guidance to which LAs are expected to have regard to when undertaking their LAQM duties: LAQM TG (09) Technical Guidance and LAQM PG (09) Policy Guidance. PG (09) states that where an authority identifies a risk that an air quality objective will be exceeded at a relevant location the local authority is required to proceed to a Detailed Assessment.

The review and assessment of Nottingham's air quality is an ongoing process and reports are prepared annually. Since 2010 diffusion tube (DT) monitoring results have identified two or three sites outside the AQMAs where exceedences of the annual mean $NO_2$ AQO have been measured. It is generally recognised that where an AQO exceedence is measured by diffusion tubes it is not appropriate to undertake a Detailed Assessment (DA) on the basis of a single year's data.

The conclusion of the 2011 Progress Report was that a Detailed Assessment with regard to annual mean nitrogen dioxide air quality objective ($NO_2$ AQO) was necessary. The subsequent USA 2012 and PR 2013 confirmed this. The need to undertake a DA has been acknowledged by the Department for the Environment and Rural Affairs (Defra).

TG (09) 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".

TG (09) makes it clear that likely exceedences of the AQOs 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. Exceedences of the objectives at any location where relevant public exposure would not be realistic should not be considered.

When assessing likely exposure the guidance 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'.

## 2.2 Scope

Following the amendment of the AQMAs in June 2010, under the Environment Act 1995 Section 84 (1) a further assessment of existing and likely future air quality in the AQMAs was required. This was undertaken and the findings reported in the '**Air Quality Management Areas 2010 Further Assessment Report**' January 2012 (FA2012). The FA2012 confirmed the finding of the PR 2011 of the need for a DA as a result of exceedence of the annual mean $NO_2$ AQO at 2 DT sites. The FA2012 also identified that there are under construction/future residential planning developments at various sites external but close to the boundary of the City Centre AQMA and; concluded that these factors suggested that it may be necessary to reconsider the geographical extent of the AQMA.

Consequently this DA report assesses those DT monitoring sites outside AQMAs where AQO exceedence has been measured and encompasses the decision stated in the FA2012 to broaden the scope of the future DA. It includes an assessment of whether the extent of the City Centre AQMA is sufficiently precautionary to avoid amending it in the future and; investigates whether an AQMA that covers a much larger area of the inner City should be considered.

The report is structured as follows:

Section 1 LAQM introduction, AQMAs, AQAP, LAQM reports
Section 2 Detailed assessment for nitrogen dioxide, purpose and scope
Section 3 Nitrogen dioxide monitoring information
Section 4 2011 Modelled and Monitored Nitrogen Dioxide Assessment
Section 5 Future Air Quality
Section 6 Detailed Assessment Conclusion

# 3 Nitrogen Dioxide Monitoring Information

## 3.1 Continuous Automatic Monitoring Sites

Nottingham City Council undertakes continuous nitrogen oxides monitoring adjacent to residential properties at three roadside sites – Carter Gate (CG NOx), Lace Street (LS NOx) and St Andrew's Road (SA NOx).

The Council also provides local site operators (LSOs), for Defra's Automatic Urban and Rural Network, (AURN) site on Clinton Street East. It is located on a pedestrianised street and is classified as an 'Urban background' site.

Detailed information about the sites, QA/QC etc is available in the previous LAQM reports, the most recent of which is the Progress Report 2013. Summaries of continuous monitoring data for 2010, 2011 and 2012 are given in Tables 1-4.

## 3.2 Nitrogen Dioxide ($NO_2$) Diffusion Tube Monitoring

Diffusion tubes (DT) are a simple and relatively cheap means of sampling $NO_2$ but they provide limited information. For several years Nottingham City Council has located DTs at a number of locations, mostly on the facades of residential buildings. The majority of sites are classified as 'Roadside' i.e. a site sampling typically within one to five metres of the kerb of a busy road (although the distance can be up to 15 m from the kerb in some cases). Tubes are exposed at site for a month before being sent for laboratory analysis.

Detailed information about the sites; their locations, QA/QC, raw monthly data and bias adjustment calculations is available in the previous LAQM reports, the most recent of which is the Progress Report 2013.

## 3.3 Co-location of Diffusion Tubes at Automatic Monitoring Sites

It is known that diffusion tube measurement may show under/over estimation of $NO_2$ concentrations compared to continuous measurement. Therefore, in accordance with the recommendation in TG (09), three $NO_2$ diffusion tubes were co-located at each of the roadside continuous monitoring sites i.e. CG NOx, LS NOx and SA NOx to enable 'bias correction' factors to be determined.

## 3.4 Nitrogen Dioxide Monitoring Data

The 2010, 2011 and 2012 nitrogen dioxide monitoring results measured at the automatic sites are shown in Tables 1 to 4 below. The results are ratified data for 12 months January to December each year (exceptions are noted).

The National Air Quality Objectives for nitrogen dioxide are:

| Pollutant | Concentration | Measured as | Date to be achieved by |
|---|---|---|---|
| **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 |

### 3.4.1 Automatic Monitoring Results

**Table 1**

**2010 to 2012 Annual Summary Statistics for Nitrogen Dioxide Measured at AURN, Clinton Street East, City Centre**

| Urban Background site outside AQMA No.2 | $NO_2$ µgm$^{-3}$ | | | Objective exceeded? |
|---|---|---|---|---|
| | 2010 | 2011 | 2012 | |
| Annual mean | 40 | 36 | 37 | No |
| Number of 1 hourly means > 200µgm$^{-3}$ | 2 | 0 | 0 | No |
| | | | | |
| Data Capture % | 98.6 | 96.1 | 97.7 | |

**Table 2**

**2010 to 2012 Annual Summary Statistics for Nitrogen Dioxide Measured at CG NOx, Carter Gate, City Centre**

| Roadside site within AQMA No.2 | $NO_2$ µgm$^{-3}$ | | | Objective exceeded? |
|---|---|---|---|---|
| | 2010 | 2011 | 2012 | |
| Annual mean | **43.3** | **42.3** | **42** | **Yes** |
| Number of 1 hourly means > 200µgm$^{-3}$ | 0 | 0 | 0 | No |
| | | | | |
| Data Capture % | 98.5 | 92.6 | 95.4 | |

**Table 3**

**2010 to 2012 Annual Summary Statistics for Nitrogen Dioxide Measured at SA NOx, St Andrew's Road**

| Roadside site within AQMA No.2 | $NO_2$ µgm$^{-3}$ | | | Objective exceeded? |
|---|---|---|---|---|
| | 2010 | 2011 | 2012 | |
| Annual mean | **46.8*** | **41.4** | **44** | **Yes** |
| Number of 1 hourly means > 200µgm$^{-3}$ | 0 | 0 | 0 | No |
| | | | | |
| Data Capture % | 41.9 | 98.8 | 93.4 | |

* SA NOx established 2010 – 5 months data annualised in accordance with TG (09) – see PR 2011 for details.

**Table 4**

**2010 to 2012 Annual Summary Statistics for Nitrogen Dioxide Measured at LS NOx, Lace Street, Dunkirk**

| Roadside site within AQMA No.3 | $NO_2$ µgm$^{-3}$ | | | Objective exceeded? |
|---|---|---|---|---|
| | 2010 | 2011 | 2012 | |
| Annual mean | **40.9** | 38.1 | 40 | Yes (in 2010) |
| Number of 1 hourly means > 200µgm$^{-3}$ | 2 | 0 | 0 | No |
| | | | | |
| Data Capture % | 99.7 | 92.3 | 95.1 | |

None of the continuous monitoring sites measured exceedence of the hourly nitrogen dioxide AQO of 200µgm$^{-3}$ no more than 18 times per annum.

### 3.4.2 Diffusion Tube Results

The 2010, 2011 and 2012 DT bias adjusted annual mean nitrogen dioxide monitoring data are shown in Table 5. Concentrations above the annual mean $NO_2$ AQO are highlighted in bold typeface. The shaded rows highlight sites that are not within AQMAs and where exceedences of the AQO were measured.

The bias adjustment factor was 0.95 for 2010, 0.91 for 2011 and 0.97 for 2012. The raw DT data and details of the bias adjustment factors applied are given in the USA 2011, PR 2012 and PR 2013 reports respectively.

**Table 5**

**2010 to 2012 Annual Mean Nitrogen Dioxide Concentrations - Diffusion Tube Measurement**

| Site Type | Tube Id | Site | Within AQMA 2010? | 2010 Bias Adjusted Annual Mean $NO_2$ $\mu gm^{-3}$ | 2011 Bias Adjusted Annual Mean $NO_2$ $\mu gm^{-3}$ | 2012 Bias Adjusted Annual Mean $NO_2$ $\mu gm^{-3}$ |
|---|---|---|---|---|---|---|
| R | G | Beeston Road | Y | **42** | 39 | **41** |
| Su | I | Derby Road | N | 34 | 31 | 32 |
| R | X | Western Boulevard | N | 34 | 34 | 33 |
| R | X2 | Wilkinson Street | N | 35 | 34 | 36 |
| R | X3 | Nottingham Road (1) | N | **42** | **41** | **42** |
| R | X3-2 | Nottingham Road (2) | N | - | 38 | 35 |
| R | X3-3 | Highland Court | N | - | 33 | 31 |
| R | X4 | Danethorpe Vale | N | 33 | 31 | 31 |
| R | AA | Ilkeston Road | N | - | **43** | **43** |
| R | AA-2 | Rayner Court | N | - | 31 | 33 |
| R | V | Bentinck Road | N | 37 | 36 | 39 |
| R | V2 | Gregory Boulevard | N | - | 34 | 33 |
| R | K3 | Grove PH Castle Blvd | N | **48** | **41** | Relocated to K4 |
| R | K4 | Castle Gardens | N | - | - | **51** |
| R | K3-2 | Castle Boulevard (2) | N | - | 29 | 30 |
| R | K3-3 | Sherwin Road | N | - | 30 | 29 |
| R | K | Castle Boulevard (1) | Y | **43** | **42** | **45** |
| R | M | Canning Terrace | Y | **55** | **51** | **57** |
| R | N | Upper Parliament St | Y | **52** | **51** | **53** |
| R | O | Shakespeare St | Y | **50** | **47** | **48** |
| R | P | Mansfield Road | Y | **51** | **46** | **48** |
| R | Y | Bloomsbury Court | Y | **50** | **45** | **48** |
| R | U (U2) | Trent Bridge PH | Y | 33 | **41** | **(42)** |
| R | T | Queens Rd | Y | **53** | **47** | **51** |

R = Roadside Su = Suburban

The automatic monitoring and diffusion tube results for the years 2010 to 2012 show that in the majority of instances, where exceedences of the nitrogen dioxide annual mean AQO have been measured the sites are within the AQMAs. The exceptions are DT sites X3, AA -2 and K4, where in 2012 average $NO_2$ concentrations of 42, 43 and 51µg/$m^3$ respectively were measured. These areas have been included in the current modelling exercise.

The results also show that, generally at any given site, the measured levels are similar year on year.

For the 3 years' data shown in Table 5 none of the $NO_2$ results were greater than 60µg$m^{-3}$ at roadside sites. Therefore, in accordance with advice given in TG (09), the 1 hourly $NO_2$ AQO of 200µg$m^{-3}$no more than18 times per annum was unlikely to have been exceeded.

# 4 2011 Modelled and Monitored Nitrogen Dioxide Assessment

## 4.1 Modelling Information

Atmospheric dispersion modelling can be used for predicting air quality concentrations for single point sources, line sources such as roads or for complex urban areas; outputs can be numerical or displayed as contour plots. Nottingham City Council carries out modelling using an advanced dispersion model - ADMS-Urban v 3.1 (developed by Cambridge Environmental Research Consultants, CERC). Previous modelling work undertaken by Nottingham City Council for the Review and Assessment process led to the declaration of the existing AQMAs.

Comprehensive validation of the model has been carried out by CERC and others (see the CERC website www.cerc.co.uk). However to have confidence in the model predictions for the Nottingham City area, verification work has been undertaken. Model verification involves comparison between modelled and monitored pollutant concentrations at relevant locations and consideration of the various uncertainties associated with differences between the results. Verification may lead to the conclusion that an adjustment factor should be applied to predicted pollutant concentrations so that they more accurately represent the monitoring information for the area.

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 quality assurance /quality control (QA/QC) of the monitoring equipment and data.

## 4.2 Model Verification and Adjustment

LAQM TG (09) Annex 3 gives guidance about modelling, model verification and adjustment. In undertaking the air quality modelling for this report the approach specified in TG (09) has been followed. The guidance states that where comparison between modelled/monitored nitrogen dioxide indicates a model adjustment is necessary, the adjustment should be based on NOx not on $NO_2$ concentrations. It also comments that when only road traffic sources have been modelled, the adjustment of NOx should be carried out on the component derived from local road traffic emissions – the 'road source contribution' NOx.

Initial comparison of 2011 monitored v modelled $NO_2$ concentrations at roadside automatic and DT monitoring sites indicated that an adjustment factor was required and therefore the modelling presented in this report has been verified using this methodology.

The verification approach and the calculations made to determine the NOx adjustment factor have been discussed and agreed with the Review and Assessment helpdesk.

## 4.3 Nitrogen Dioxide Modelling Methodology

Following verification, the model was used to predict concentrations of annual mean $NO_2$ across a large part of the Nottingham City area. The area chosen for the modelling was informed by previous R & A work and is delineated by the red outline in Figure 2.

In accordance with the TG (09) guidance the road source contribution NOx has been modelled. An adjustment factor (AF) = 0.6137 derived from the verification process was applied to the road source contribution NOx model output. The modelling was undertaken as 56 x 1$km^2$ areas, this allowed the corresponding background $NO_2$ concentrations to be used in subsequent calculations.

The corrected annual mean $NO_2$ concentrations were determined from the adjusted road source contribution NOx model output and the background $NO_2$ concentrations using the NOx-$NO_2$-Calculator-v3.2 spreadsheet. The spreadsheet is one of the tools available and can be found on the LAQM support pages provided by Defra – http://laqm.defra.gov.uk/review-and-assessment/tools/tools.html

Further information about the modelling process - model inputs and outputs; verification and the derived NOx adjustment factor and the LAQM tools used is given in Appendix B.

## 4.4 Modelling Results

Figure 2 shows the mapped contours for the estimated 2011 annual mean $NO_2$ concentrations greater than 39$\mu gm^{-3}$. The modelling predicts that in 2011 the annual mean

$NO_2$ AQO was not met at all locations and that some of these locations are outside the AQMAs. The results are shown at this scale so that the context of the modelled area in relation to the AQMAs and the whole city can be understood. At this map scale it is not possible to show whether there is relevant exposure of members of the public in the areas of exceedence, outside the AQMAs. However it is apparent that in the City Centre the majority of the modelled area of exceedence is within AQMA No.2.

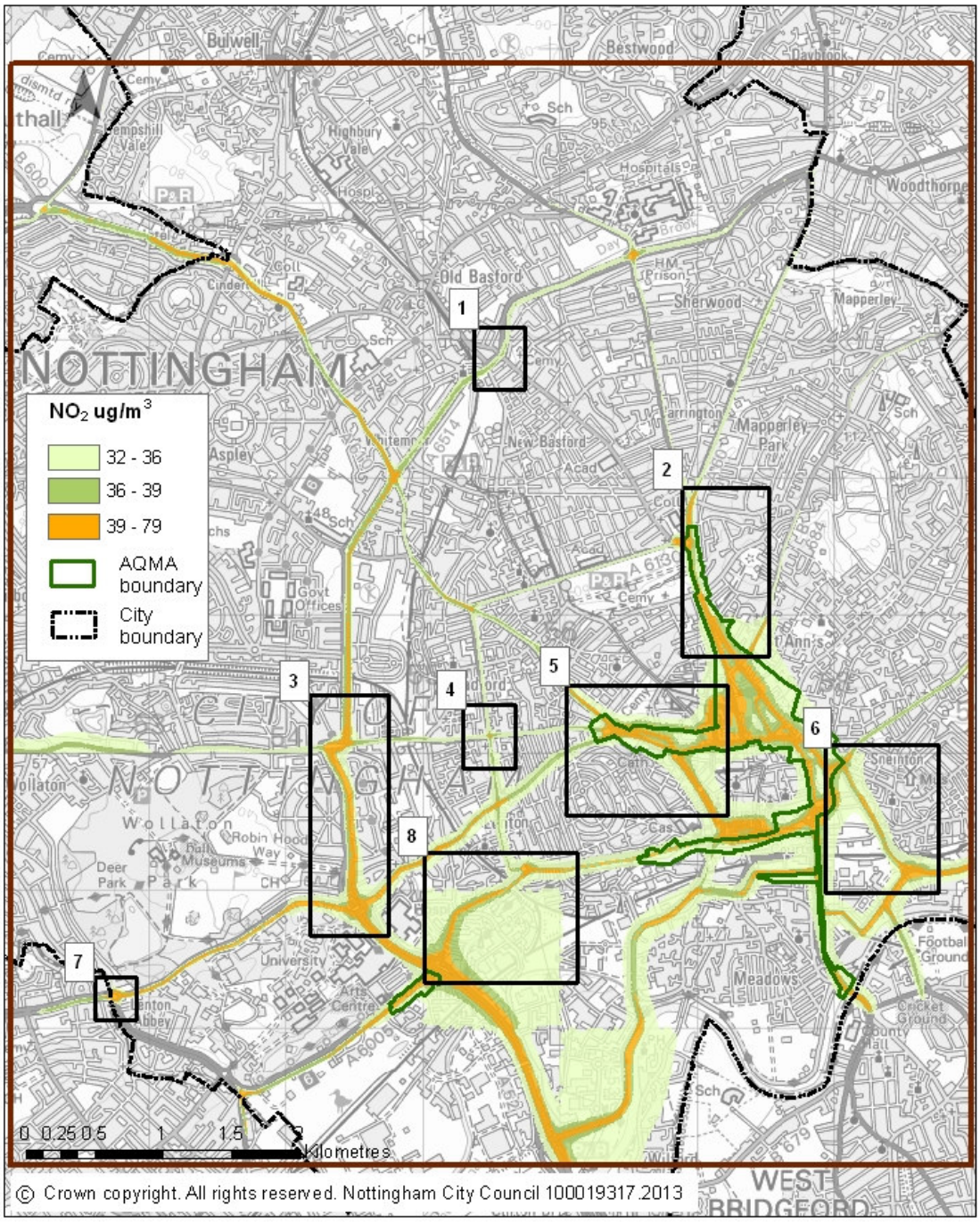
Therefore the areas of exceedence have been looked at more closely and for those areas; where there is relevant exposure and predicted AQO exceedence outside the AQMAs, larger scale maps are shown in Figures 2-1 to 2-8.

The larger scale allows more detailed contours and monitoring information to be displayed. With reference to Figure 2, Areas 1 to 8 are shown in the following Figures 2-1 to 2-8.

Figures 2-1 and 2-4 are included because even though the modelling did not predict exceedence, some 2011 DT $NO_2$ monitoring results were greater than 40µg/$m^3$ and the sites are outside the AQMAs.

**Figure 2**

**2011 Adjusted Modelled Annual Mean Nitrogen Dioxide Concentrations**



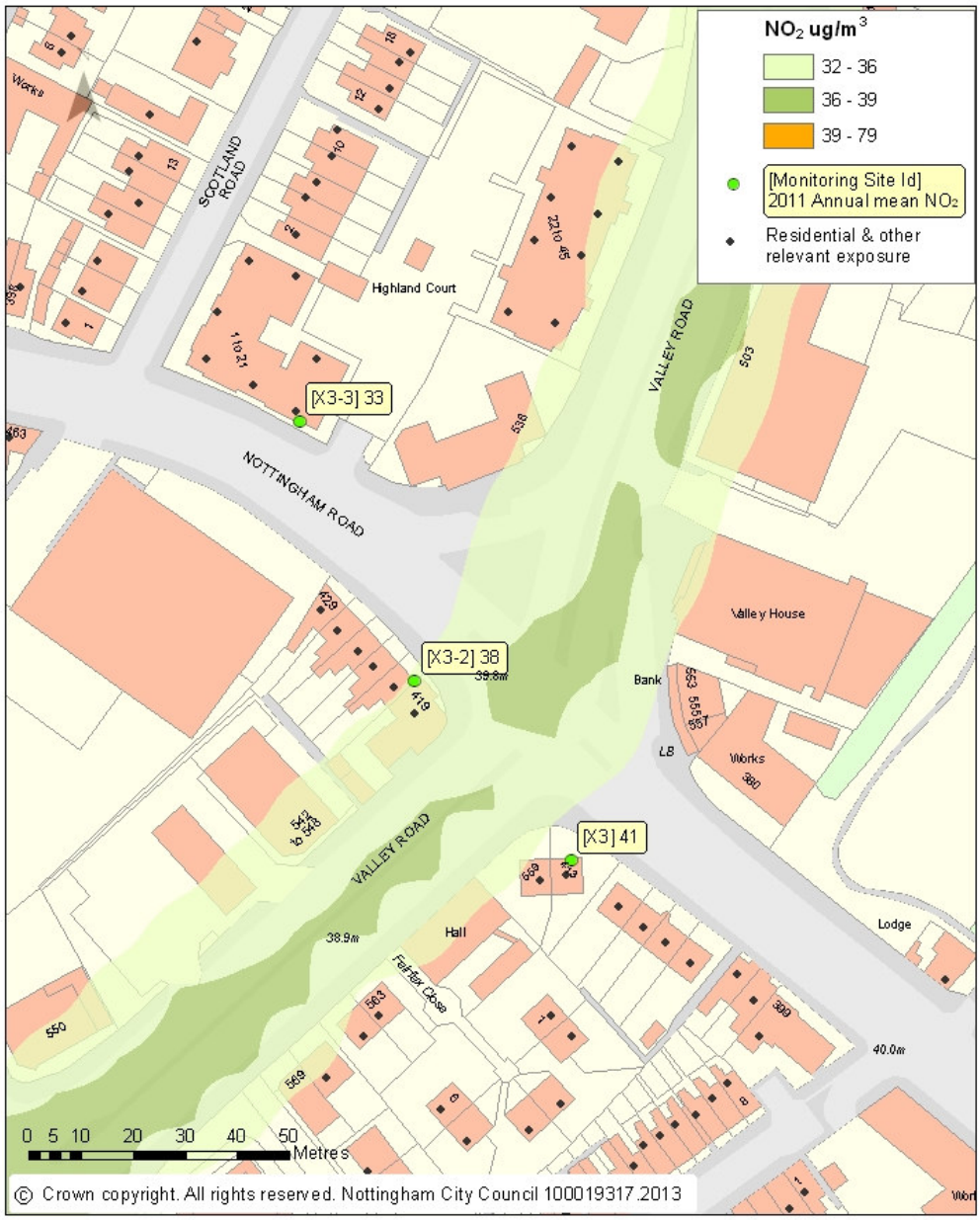

| | | |
|---|---|---|
| **1** | Valley Road/Nottingham Road Junction | **Figure 2-1** |
| **2** | Mansfield Road near the Forest Recreation Ground | **Figure 2-2** |
| **3** | Ring Road – Crown Island to Derby Road | **Figure 2-3** |
| **4** | Lenton Boulevard/ Ilkeston Road Junction | **Figure 2-4** |
| **5** | Canning Circus/Maid Marian Way | **Figure 2-5** |
| **6** | Manvers Street/ Meadow Lane | **Figure 2-6** |
| **7** | Derby Road/ Woodside Road Junction | **Figure 2-7** |
| **8** | Dunkirk Roundabout A52 to Abbey Bridge/ Castle Boulevard Junction | **Figure 2-8** |

The A453 (a major road leading from the ring road to the south western City boundary) was not modelled for this DA. However the A453 is the part of a major widening road scheme and as part of the planning submission an Environmental Impact Assessment (EIA) was carried out prior to its commencement. The EIA included a comprehensive AQ assessment undertaken by WYG Environment. One of the conclusions of the report was that with or without the widening scheme the annual mean $NO_2$ AQO was not exceeded in 2006/7 (measured by DT) and; from modelling predictions would not be exceeded in 2015.

Information about the A453 widening scheme can be found on the Highways Agency website http://www.highways.gov.uk/roads/road-projects/a453-widening-m1-junction-24-to-a52-nottingham/.

Figures 2-1 to 2-8 on the following pages show more detailed $NO_2$ contours for the selected modelled/monitored areas along with monitoring site locations and the 2011 annual mean $NO_2$ concentrations. Under each figure comment is made on the results.

**Figure 2-1 Area 1 Valley Road/Nottingham Road Junction**

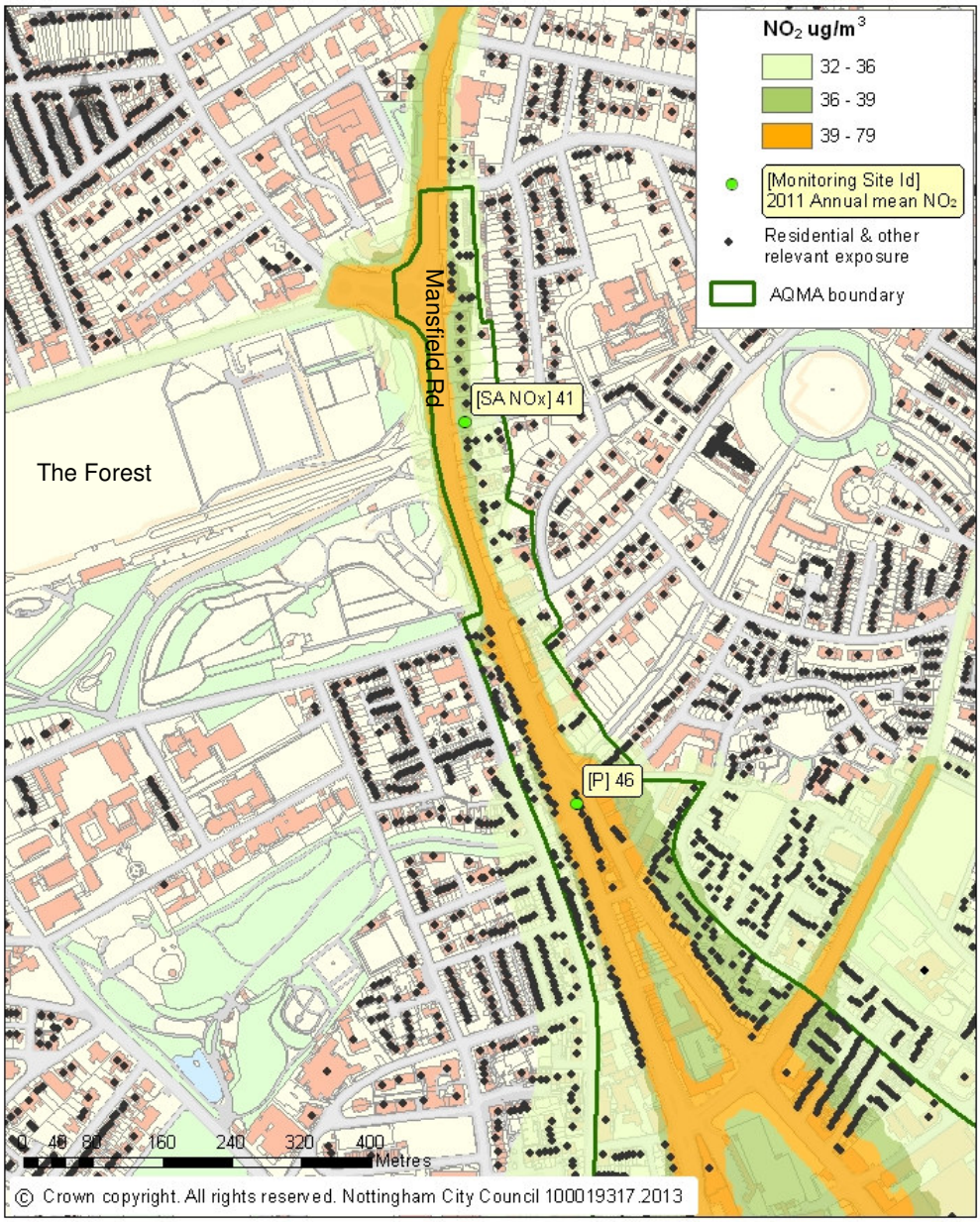



In 2010 following the modelling exercise that was undertaken for the DA 2009 , the X3 diffusion tube was sited at the Valley Road/ Nottingham Road junction. In 2010, 2011 and 2012 annual mean $NO_2$ concentrations were 42, 41 and 42µgm$^{-3}$ respectively.

In 2011 further tubes X3-2 and X3-3 were placed to help determine the extent of the AQO exceedence. In 2011 $NO_2$ levels were 38µgm$^{-3}$ at X3-2 and 33µgm$^{-3}$ at X3-3 whilst in 2012 the levels were 35µgm$^{-3}$ and 31µgm$^{-3}$ respectively.

As shown above the current modelling for this junction does not predict exceedence of the annual mean AQO however the model output does not reflect the measured $NO_2$ levels. When considering both the monitoring and the modelling data the results suggest that further monitoring needs to be undertaken in closer proximity to X3. Therefore it would not be appropriate to declare an AQMA at this location at this time.

**Figure 2-2 Area 2 Mansfield Road near the Forest Recreation Ground**




The 2010, 2011 and 2012 monitoring data for sites SA NOx and P shows that the annual mean $NO_2$ AQO has consistently been exceeded – measured concentrations have been between 41.4 and 51µgm$^{-3}$.

The modelling indicates that where exceedence of the AQO is predicted and there is relevant public exposure the locations are within AQMA No2. There are three residential properties at the northern most end of the AQMA that are very close to but not within the predicted exceedence area.

**Figure 2-3 Area 3 Ring Road – Crown Island to Derby Road**

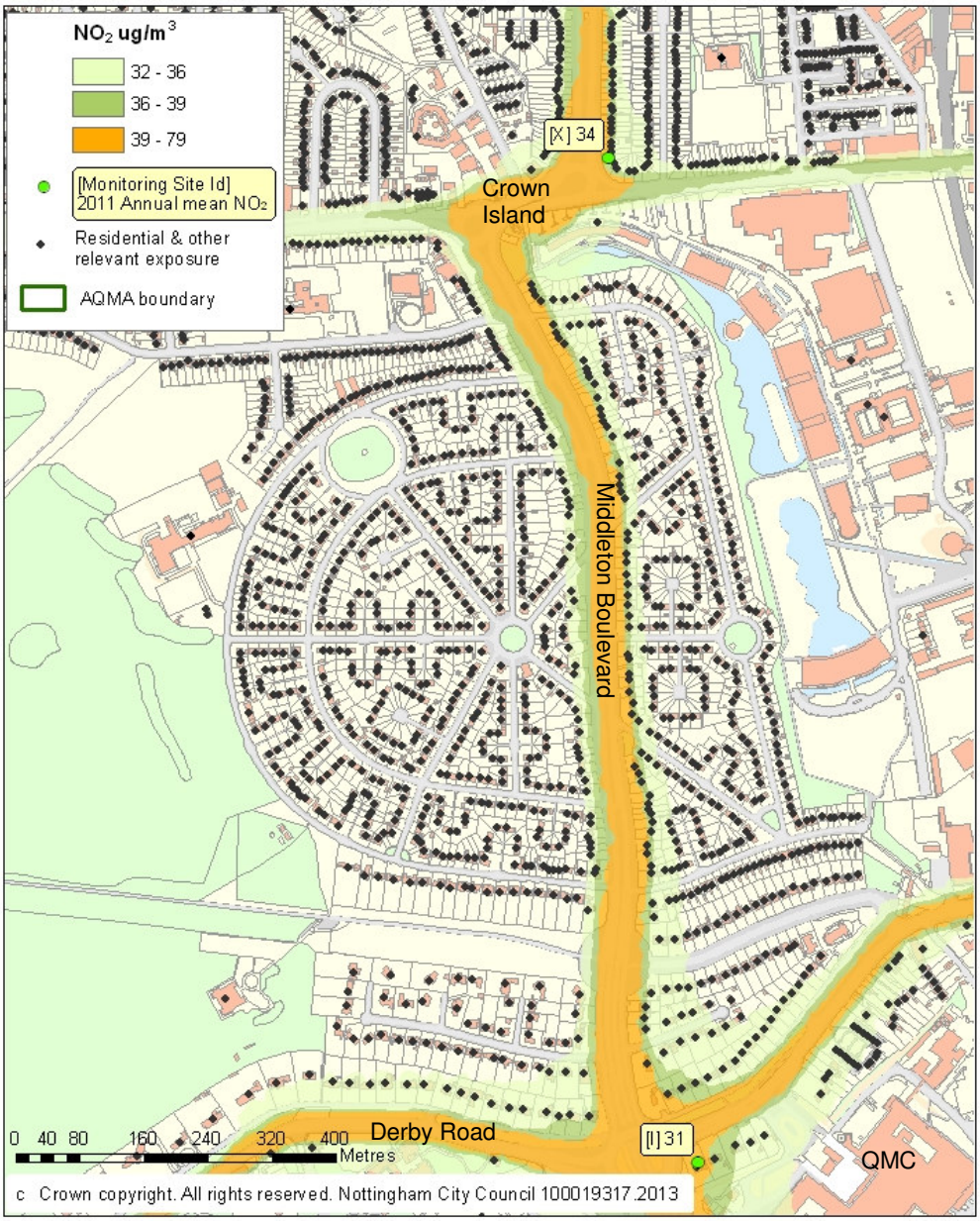
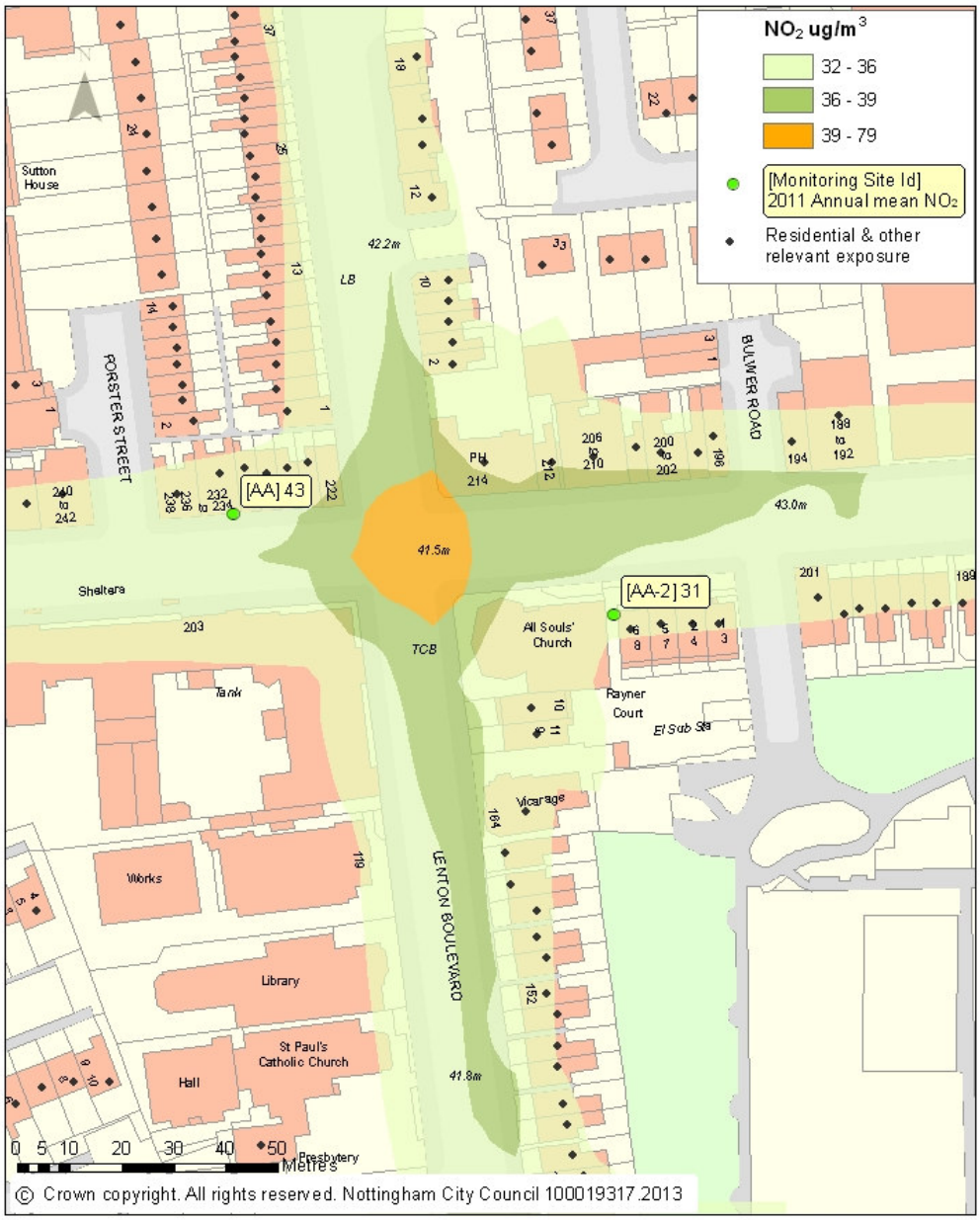



Figure 2-3 shows DT sites X and I; at X the 2010 to 2012 $NO_2$ levels were 33 to 34µgm$^{-3}$ while at I they were between 31 and 34 µgm$^{-3}$. Although both diffusion tubes are located at residential properties very close to heavily trafficked junctions the annual mean $NO_2$ AQO has not been exceeded.

In contrast the modelling suggests that in 2011 the AQO was exceeded at residential properties close to the junctions and along Middleton Boulevard.

The ring road is characterised by a wide carriage way with properties set back from it. Various changes to junctions and road layouts are taking place as part of the Ring Road Improvement scheme (see LTP 3). Given the monitoring results it is not necessary to declare an AQMA in the area at this time. Further monitoring will be carried out to inform any future LAQM decisions.

**Figure 2-4 Area 4 Lenton Boulevard/ Ilkeston Road Junction**

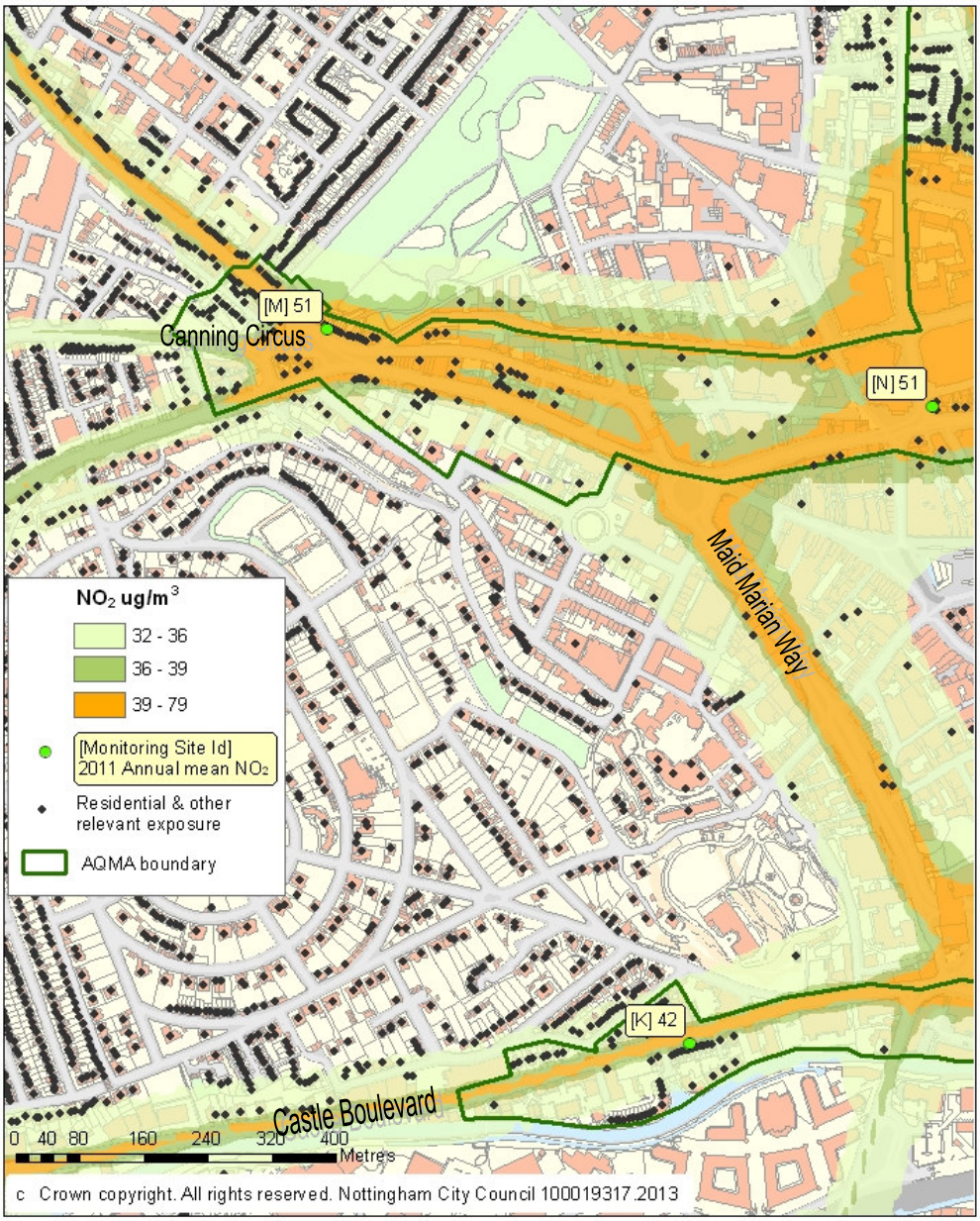



AT DT site AA, the 2011 and 2012 annual mean $NO_2$ was 43µgm$^{-3}$ whereas at AA-2 across the junction the concentrations were considerably lower, 31 and 33µgm$^{-3}$ respectively. Unfortunately it has become apparent that at AA the DT is located on a lamppost close to but not on the façade of a commercial premises with residential accommodation above. This is not consistent the DT siting requirements given in TG (09) and the tube will be re-located.

The above figure shows that the 2011 modelling for the junction does not predict exceedence of the AQO. The modelling compares well with AA-2 monitored results but not all with those at AA.

From comparison of the monitoring and the modelling data it is concluded that there is insufficient information to justify the declaration of an AQMA and; that further appropriately sited monitoring should be undertaken.

**Figure 2-5 Area 5 Canning Circus/Maid Marian Way**

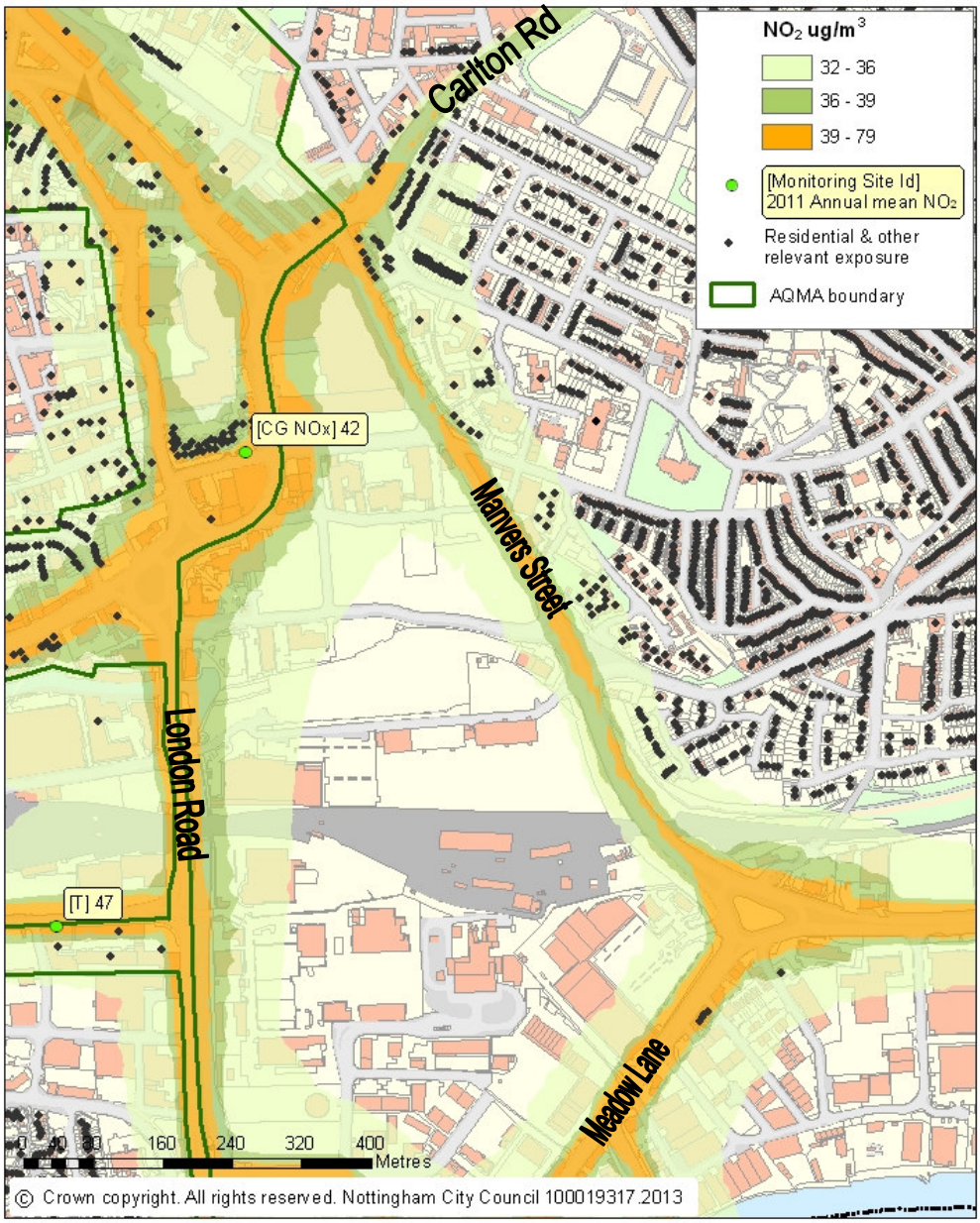



The 2010, 2011 and 2012 monitoring data shows that each year the annual mean $NO_2$ AQO was exceeded at sites K, M and N; all of these sites are within AQMA2.

The modelling indicates that where exceedence of the AQO is predicted and there is relevant public exposure most of the locations are within AQMA No2. There are residential properties on Alfreton Road (road north westerly from Canning Circus) and on Maid Marian Way where the modelling predicted exceedence. There are other properties near the northern boundary of the AQMA that are close to but not within the exceedence area.

The modelling results mean that further monitoring needs to be undertaken in the areas identified in the previous paragraph.

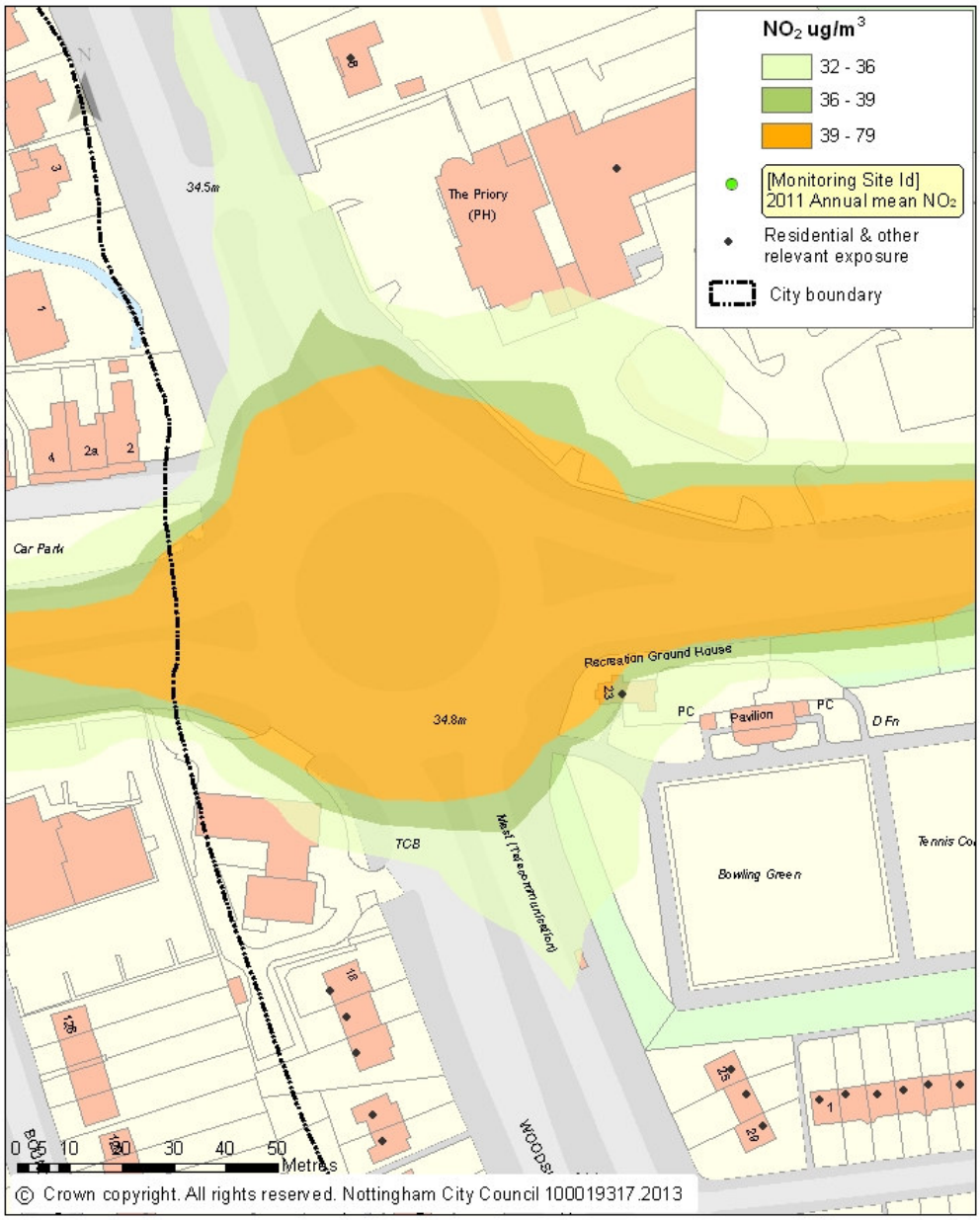
**Figure 2-6 Area 6 Manvers Street/ Meadow Lane**




Monitoring sites T and CG NOx are in AQMA No.2 and in 2010, 2011 and 2012 measured levels of $NO_2$ greater than the AQO.

The majority of properties where the modelling predicted exceedence of the AQO are within the AQMA but there are few premises around the Carlton Road/ Manvers Road junction and on Meadow Lane where exceedence was predicted, that are outside the AQMA. The modelling results mean that monitoring needs to be undertaken in these areas.

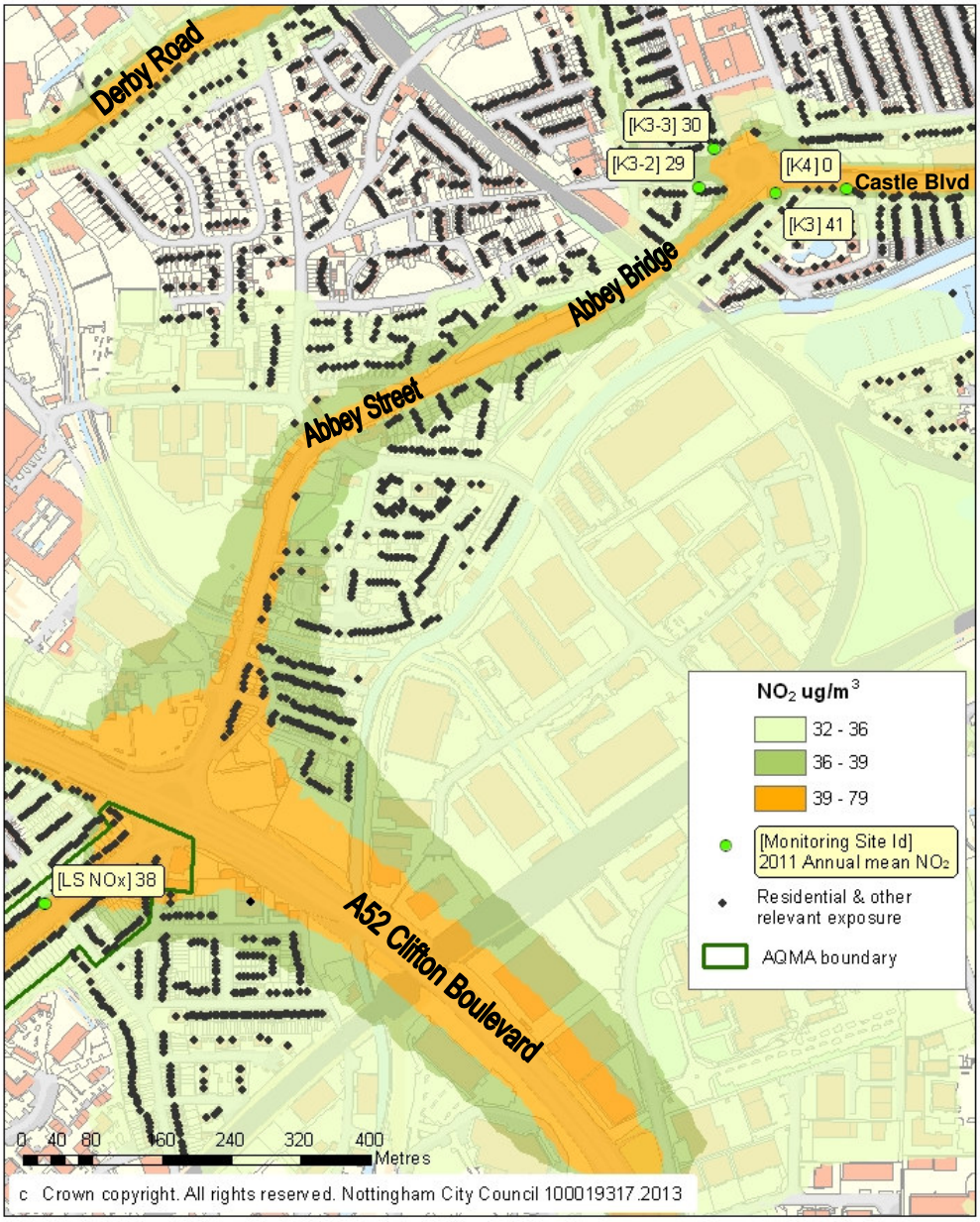
**Figure 2-7 Area 7 Derby Road/ Woodside Road Junction**




While the modelling predicts exceedence of the annual mean $NO_2$ AQO at a single residential site close to the junction, no monitoring has taken place in this area.

Monitoring will be carried out to inform any future LAQM decisions.

**Figure 2-8 Area 8 Dunkirk Roundabout A52 to Abbey Bridge/ Castle Boulevard Junction**




Dunkirk Roundabout /A52 – monitoring results show that at the LS NOx site (inside AQMA No.3) annual mean $NO_2$ levels were 41, 38 and 40 $\mu gm^{-3}$ in 2010, 2011 and 2012 respectively. This suggests borderline exceedence of the annual mean AQO has occurred.

The modelling for the Lace Street area shows AQO exceedence that is not borne out by the monitoring. The modelling indicates that there are properties close to the AQMA boundary; near the A52 and on Abbey Street that may be in an area of AQO exceedence.

Abbey Bridge /Castle Boulevard junction - the 2011 and 2012 monitoring at K3-2 and K3-3 measured $NO_2$ levels of 29 - 30$\mu gm^{-3}$ while at K3 $NO_2$ levels for 2010 and 2011 were 48 and 41$\mu gm^{-3}$. Following comment from R &A USA reviewers the K3 tube was relocated from the roundabout to site K4 on Castle Boulevard, in 2012 annual mean $NO_2$ was 51$\mu gm^{-3}$ at K4.

The modelling indicates that there are properties near the Abbey Bridge/ Castle Boulevard junction that may be in an area of AQO exceedence.

When considering both the monitoring and the modelling data shown in Figure 2-8 the results indicate that additional monitoring needs to be undertaken near A52 and Abbey Street and; near the Abbey Bridge and Castle Boulevard junction areas. This would give a more informed view of the extent of AQO exceedence.

### 4.5 Conclusions of 2011 Monitoring/Modelling Assessment

In this section the discussion is with reference to the monitoring data shown in Tables 1 to 5 and the 2011 modelled $NO_2$ concentrations contours - Figures 2 and 2-1 to 2-8.

Area 1 (Figure 2-1), Area 4 (Figure 2-4) and Area 8 (Figure 2-8 (Abbey Bridge)) all show monitoring locations where a single DT measured levels of $NO_2$ greater than 40$\mu gm^{-3}$ whilst at two nearby tubes the AQO was not exceeded. In some instances there was a considerable difference between them e.g. Area 8 - in 2011 the difference in $NO_2$ concentrations between K3 and K3-3 across the junction was 11$\mu gm^{-3}$.

For Area 8 (near Abbey Bridge) the modelling indicates exceedence on Castle Boulevard near K4 (a relocated DT where 2012 annual mean $NO_2$ = 51$\mu gm^{-3}$) but not at K3-2 and K3-3. This is consistent with the monitoring results.

In Area 8 (Dunkirk roundabout area) the nearest monitoring at the LS NOx station measured 2010 to 2012 $NO_2$ levels between 38 and 41$\mu gm^{-3}$. The modelling predicted AQO exceedence in the vicinity of the station on Beeston Road, across the A52 junction and extending on to Abbey Road. Given the distance from the monitoring station to the farthest extent of the predicted exceedence additional monitoring is required before any expansion of AQMA No 3 should be considered.

The modelling did not predict AQO exceedence in Areas 1 and 4.

Figure 2-3 Area 3 shows an area where for 2010 to 2012 the monitored $NO_2$ concentrations were 34$\mu gm^{-3}$ or less but modelling predicted AQO exceedence at the junctions and along the ring road.

Figures 2-2, 2-5 and 2-6 show Areas 2, 5 and 6 respectively that include parts of the City Centre AQMA and where the monitoring within the AQMA consistently measures $NO_2$ levels greater than 40$\mu gm^{-3}$.

In Area 6 and part of Area 5 the modelling predicted exceedence of the AQO outside the AQMA where there is relevant public exposure but there was no nearby monitoring.

In Area 2 and other parts of Area 5 it can be seen that there are residential properties near the AQMA boundary that are close to but not in the area of predicted exceedence.

Figure 3-7 Area 7 shows a single residential property where modelling predicts AQO exceedence - there is no monitoring in the area.

In summary there are 3 DT monitoring sites outside the AQMAs where 1 of 3 diffusion tubes measured $NO_2$ greater than 40$\mu gm^{-3}$. At other locations there are a small number of residential properties outside the existing AQMAs where the modelling predicted exceedence of the AQO.

A precautionary approach in respect of the possible AQO exceedences could be taken by expanding the AQMAs' boundaries where modelling predicts exceedence close to an existing AQMA. However whilst modelling allows estimation of nitrogen dioxide levels over a much greater area than that covered by monitoring, the methodology used and the influence of estimated background concentrations means the results are inherently more uncertain than measured data.

TG(09).says that since the dates that the AQOs have to be achieved by have passed there is inevitably an increasing reliance on monitoring data, as opposed to modelling predictions, to determine actual exceedences. It also 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.

Therefore Nottingham City Council has taken a pragmatic approach and determined that it is appropriate to carry out further, more widespread monitoring to better inform those areas of monitored or modelled AQO exceedences that lie outside the AQMAs. It should be noted that the Air Quality Action Plan already covers most of these areas so any measures to improve air quality in the AQMAs will already apply to them.

# 5 Future Air Quality

Nottingham's future nitrogen dioxide levels may be similar to the measured values outlined in this report mainly because as can be seen from the three years' monitoring results presented here, at any given site $NO_2$ levels are similar each year. This is consistent with the national trend at 8 long running traffic urban AURN sites - reported in Defra's '**Air Pollution in the UK 2012'** document.

In the FA2012 calculations were made using TG(09) methodology that predicted that the annual mean $NO_2$ AQO should be achieved at CG NOx and LS NOx continuous monitoring sites and some DT sites by 2015. However comment was made that it is difficult to predict how quickly the AQO will be met in the whole of Nottingham City's area.

There are a number of transport related schemes e.g. the Ring Road Improvement Scheme, A453 Widening and Phase 2 Tram extension that are likely to impact on Nottingham's air quality. These along with the uncertainty associated with modelling means that currently, it would not be meaningful to undertake further modelling to predict future annual mean $NO_2$ concentrations in the Nottingham City area.

It should be noted that in Defra's '**Air Quality Plan for the achievement of EU air quality limit values for nitrogen dioxide (NO2) in Nottingham Urban Area (UK0008) September 2011**' the modelling suggests that by 2015 the annual mean $NO_2$ concentration will be below 40$\mu gm^{-3}$ in the City area.

# 6 Detailed Assessment Conclusion

The information presented in this report has identified that, in keeping with previous rounds of R & A, the nitrogen dioxide annual mean AQO of 40μgm$^{-3}$ is likely to be met in the majority of the Nottingham City area outside of the AQMAs.

However within the AQMAs and at a small number of locations outside them, both modelling and/or monitoring results indicate that the objective has been exceeded at locations with relevant exposure of members of the public.

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

The monitoring data presented shows that none of the continuous monitoring sites measured one hour $NO_2$ concentrations over 200μgm$^{-3}$ more than 18 times per annum and; none of the diffusion tube results were greater than 60μgm$^{-3}$ therefore the 1 hourly $NO_2$ AQO was not exceeded in 2010, 2011 or 2012.

Generally future air quality in Nottingham City will be influenced by the Council's existing Air Quality Action Plans and the Government's Air Quality Plan. Some areas will be directly affected by current /future road schemes, by the tram extensions and other developments taking place.

The findings of this report show that there is a need to expand the diffusion tube monitoring programme to cover those areas where modelling suggests exceedence but there is a high degree of uncertainty and/or; where a single diffusion tube measures exceedence and others close by do not. Both of these circumstances are such that it is not appropriate to propose Air Quality Management Areas for these locations at the moment. Additional monitoring will assist in informing future rounds of Review and Assessment.

**Nottingham City Council has concluded that currently it is not necessary to modify the existing AQMAs or to declare new Air Quality Management Areas. However it is necessary to expand the nitrogen dioxide monitoring programme.**

## 6.1 What Happens Next

Following acceptance of the Detailed Assessment 2013 by Defra, in accordance with the Policy Guidance, LAQM PG (09) Nottingham City Council will consult with all relevant statutory consultees, local stakeholders, businesses and members of the public

According to the timetable shown in LAQM TG (09) Box 1.3 the next R & A requirement is for a Progress Report to be completed by the end of April 2014. All authorities are expected to complete this, "regardless of whether they are undertaking a Detailed Assessment or not". Currently the LAQM process is the subject of Government consultation so the future requirements may change.

# 7 References


AEA Energy & Environment (Feb 2008) **Diffusion Tubes for Ambient $NO_2$ Monitoring: Practical Guidance for Laboratories and Users Issue 1a**

**Air Quality (England) Regulations 2000 (SI 928)**

**The Air Quality (England) (Amendment) Regulations 2002 (SI 3043)**

Department for the Environment, Food and Rural Affairs (September 2013) **Air Pollution in the UK 2012**

Department for the Environment, Food and Rural Affairs (September 2011) **Air Quality Plan for the achievement of EU air quality limit values for nitrogen dioxide (NO2) in Nottingham Urban Area (UK0008) September 2011**

Department for the Environment, Food and Rural Affairs (February 2009) **Part IV of the Environment Act 1995 Local Air Quality Management: Policy Guidance (PG 09)**

Department for the Environment, Food and Rural Affairs (February 2009) **Part IV of the Environment Act 1995 Local Air Quality Management Technical Guidance LAQM.TG (09)**

Department for the Environment, Food and Rural Affairs (2007) **The Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007**

**Environment Act 1995**

Nottingham City Council (2000 – 2013) **Previous Review and Assessment Reports:**

**Air Quality Review & Assessment First & Second Stage** April 2000

**Air Quality Review & Assessment Second & Third Stage Report** 2001

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

**Local Air Quality Management: Updating and Screening Assessment** October 2003

**Local Air Quality Management: Detailed Assessment** August 2004

**Local Air Quality Management: Progress Report** April 2005

**Local Air Quality Management: Updating and Screening Assessment** June 2006

**Local Air Quality Management: Detailed Assessment Consultation Document** May 2008

**Local Air Quality Management: Progress Report** July 2008

**Local Air Quality Management: Progress Report** July 2008

**Local Air Quality Management: Updating and Screening Assessment Report** April 2009

**Local Air Quality Management: Detailed Assessment Report** January 2010

**Local Air Quality Management: Air Quality Progress Report** October 2010

**Local Air Quality Management: Progress Report** July 2011

**Local Air Quality Management: Air Quality Management Areas Further Assessment Report** January 2012

**2012 Air Quality Updating and Screening Assessment for Nottingham City Council** July 2012

**2013 Air Quality Progress Report for Nottingham City Council** August 2013

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

Nottingham City Council (April 2011)
**Local Transport Plan 3:2011- 2026 Strategy, LTP**

Nottingham City Council (June 2013)
**Local Transport Plan 3: Implementation Plan 2013 - 16**

**Web Addresses**

http://laqm.defra.gov.uk/laqm-faqs/faq136.html

http://laqm.defra.gov.uk/review-and-assessment/tools/tools.html

https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs

http://www.highways.gov.uk/roads/road-projects/a453-widening-m1-junction-24-to-a52-nottingham/.

http://www.nottinghamcity.gov.uk/article/23015/Air-Quality

http://www.nottinghamcity.gov.uk/transportstrategies

https://www.gov.uk/government/publications/local-air-quality-management-technical-guidance-laqm-tg-09

www.cerc.co.uk

# Appendix A

## Table 1.2 Previous Review and Assessment Reports

All reports are available on Nottingham City Council's internet site.

| Title | Date | Outcome | **AQMA Declared/ Revoked?** (Date of AQMA Order/s) |
|---|---|---|---|
| City of Nottingham Air Quality Review & Assessment First & Second Stage | April 2000 | Concluded a third stage assessment for sulphur dioxide, nitrogen dioxide and particles, PM10 was necessary.<br><br>No further assessment of 1, 3 Butadiene, benzene, carbon monoxide and lead required. | |
| City of Nottingham Air Quality Review & Assessment Second & Third Stage Report | Sept 2001 | Areas of the city where unlikely to meet air quality objectives for nitrogen dioxide or sulphur dioxide.<br><br>Proposed 1 AQMA for $SO_2$ and 2 AQMAs for $NO_2$ | **Declared**<br>AQMA No:1 (Sulphur dioxide) (2002)<br>AQMA No:2 (Nitrogen dioxide) (2002)<br>AQMA No:3 (Nitrogen dioxide) (2002) |
| City of Nottingham 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.<br><br>Concluded insufficient monitoring data available to allow revocation of any of the AQMAs. | |

| Title | Date | Outcome | **AQMA Declared/ Revoked?** (Date of AQMA Order/s) |
|---|---|---|---|
| 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).<br><br>Necessary to maintain AQMAs No 2 & 3 (nitrogen dioxide) | |
| Nottingham City 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.<br><br>AQMA No:1 (Sulphur dioxide) to be revoked - agreed by Defra | **Revoked**<br>AQMA No:1 2002 (Sulphur dioxide) (5 April 2007) |
| Nottingham City Local Air Quality Management Detailed Assessment Consultation Document | May 2008 | **Proposed amendments to existing AQMAs No.2 & No.3 for nitrogen dioxide.**<br><br>**Further work for nitrogen dioxide to be undertaken following comment and assessment by Defra.**<br><br>Conclusion that no further action required for $PM_{10}$ accepted by Defra. | |
| Nottingham City Local Air Quality Management Progress Report | July 2008 | Confirmed findings of Detailed Assessment 2008 and need to vary extent of the AQMAs. | |
| 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 2008 Annex 1 - | October 2009 | Confirmed the DA May 2008 findings - **need for amended AQMAs for annual mean $NO_2$.**<br><br>Accepted by Defra on 31 December 2009. | |

| Title | Date | Outcome | **AQMA Declared/ Revoked?** (Date of AQMA Order/s) |
|---|---|---|---|
| Supplementary Information for Nitrogen Dioxide | | | |
| Nottingham City Council Local Air Quality Management Detailed Assessment 2009 | January 2010 | For clarification this is a consolidated report of DA May 2008 $PM_{10}$ findings and DA 2008 Annex 1 $NO_2$ findings | **Declared**<br><br>AQMA No:2 2010 (nitrogen dioxide)<br><br>AQMA No:3 2010 (nitrogen dioxide)<br><br>BY AQMA Variation Orders dated 22 June 2010 |
| 2010 Air Quality Progress Report for Nottingham City Council | October 2010 | Concluded that there was no need to undertake a Detailed Assessment for any of the regulated pollutants - accepted by Defra | |
| 2011 Air Quality Progress Report for Nottingham City Council | July 2011 | Concluded that it was necessary to undertake a Detailed Assessment for annual mean nitrogen dioxide at two diffusion tube sites outside the existing AQMAs - accepted by Defra | |
| Air Quality Management Areas 2010 - Further Assessment Report | January 2012 | Confirmed decision to alter the AQMA boundaries was correct. Concluded that it was necessary to broaden the scope of the DA being undertaken as a result of the 2011 PR findings. Report accepted by Defra | |
| 2012 Air Quality Updating and Screening Assessment for Nottingham City Council | July 2012 | Confirmed PR 2011 findings that it is necessary to undertake a Detailed Assessment for annual mean nitrogen dioxide air quality objectives outside the existing AQMAs – accepted by Defra | |
| 2013 Air Quality Progress Report for Nottingham City Council | August 2013 | Confirmed PR 2011 and USA 2012 findings that it was necessary to undertake a Detailed Assessment for annual mean nitrogen dioxide at diffusion tube sites outside the existing AQMAs – awaiting Defra comments | |

# Appendix B

## Nitrogen Dioxide Modelling Information

ADMS-Urban v3.1 – an atmospheric dispersion model was used to predict pollutant concentrations within the Nottingham City area.

### Model Inputs

Traffic data

LGV and HGV traffic flows from 2011 AADT supplied by the Nottingham City Council's Transport Projects Section and the average speed for each link either supplied or previously determined for earlier modelling work. The emission factors used were the UK EFT v5.1 (2 VC).

Meteorological Data

2011 hourly sequential data meteorological data from the Watnall station approximately 8 miles north of Nottingham.

Background NOx and $NO_2$ Data

The background NOx and $NO_2$ data, LAQM Tools spreadsheets and calculations referred to can be found on the LAQM website. The 2010-based background maps for 2011 background NOx and $NO_2$ were used.

The following is from the website:
"The 2010-based background maps are calibrated against monitoring data for 2010 and it is now widely recognised that high $NO_2$ concentrations during 2010 meant that the resulting projected background concentrations for $NO_x/NO_2$ within these maps may be higher than is to be expected in a typical year. Updated maps with a 2011 base will be released in due course."

The maps with a 2011 base have not been released yet so as advised on the website and using the calculations given amendments were made to the 2011 NOx and $NO_2$ background data to remove the influence of the 2010 high $NO_2$ pollution year from the maps.

This was undertaken by scaling the map data and using the $NO_2$ Background Sector Removal Tool – see http://laqm.defra.gov.uk/laqm-faqs/faq136.html

**Model Outputs**

Long term modelling was used to predict annual mean road contribution $NO_x$ concentrations for 56 x 1km$^2$ areas of the City. This approach enabled the appropriate background to be applied to each 1km$^2$. Outputs for receptors at the monitoring sites and contours were produced.

**Model Verification**

TG (09) recognises that dispersion models may perform differently at kerbside, roadside and background sites and 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.”

From comparison between monitored and modelled calculated annual mean $NO_2$ concentrations it was apparent that the model over predicted concentrations at a number of 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.

Model Verification 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 2011 amended background NOx value from the total measured NOx for each roadside monitoring location.

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 = 0.6137x.

The modelled road source contribution NOx was multiplied by the adjustment factor (AF) = 0.6137 to give the adjusted modelled road source contribution NOx

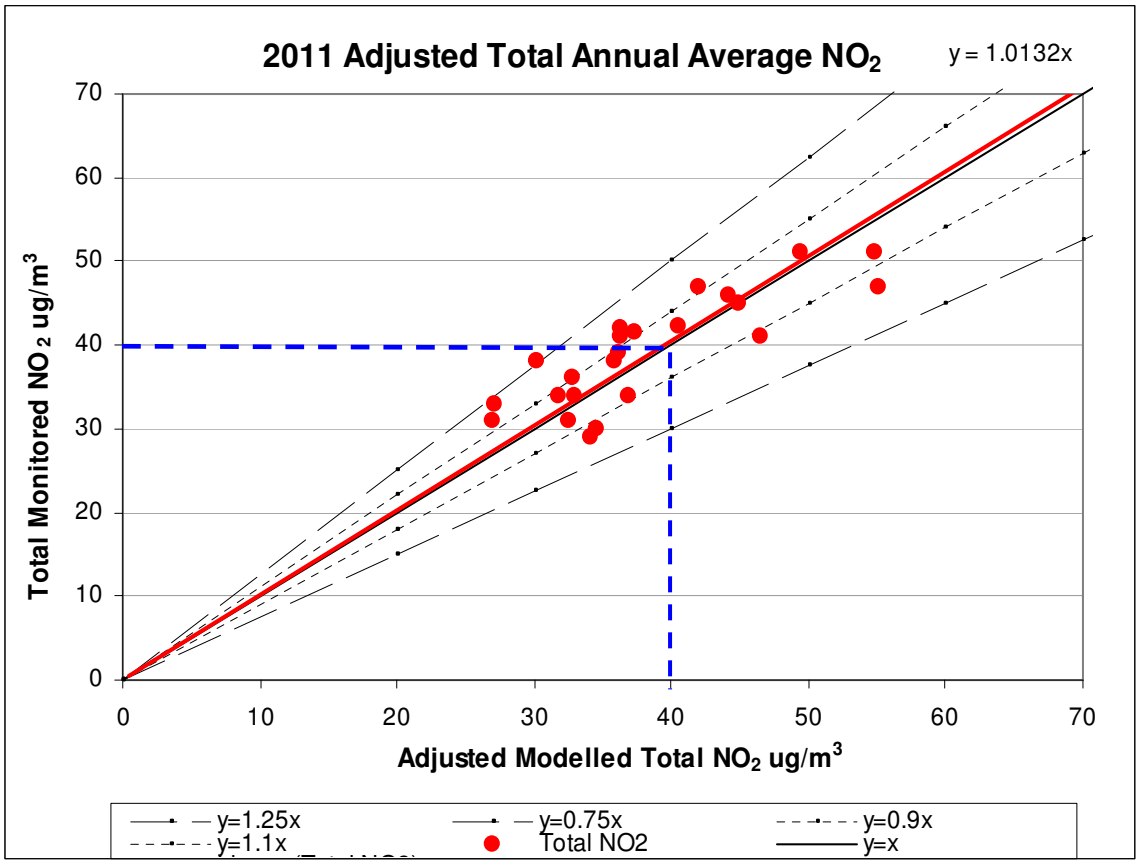
c) Determine the corrected total annual mean $NO_2$

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 amended background $NO_2$ concentrations to be input.

In Figure B1 below the graph shows the 2011 monitored total $NO_2$ v corrected modelled total $NO_2$ and the linear trend 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 modelled 2011 NOx outputs for the City area.

**Figure B-1**



**Predicted Annual Mean Nitrogen Dioxide Concentrations**

ADMS Urban was used to model 2011 annual mean road source contribution NOx for 56 x 1km$^2$ areas.

The $NO_2$ concentrations in the modelled areas were determined using the methodology outlined in LAQM TG (09) Annex 3 - the adjustment factor = 0.6137 was applied to the modelled annual mean road source contribution NOx and then the LAQM Tools - NOx to $NO_2$ spreadsheet used to calculate the adjusted total annual mean $NO_2$ concentrations.

The mapped adjusted predicted annual mean nitrogen dioxide concentrations are shown in Figure 2 and Figures 2-1 to 2-8.

Full details of the verification and modelling prediction methodology can be found in TG (09) Annex 3 Box A3.6. The guidance is available on the Gov website:

https://www.gov.uk/government/publications/local-air-quality-management-technical-guidance-laqm-tg-09