Brent Air Quality Action Plan – Report 2: Brent AQ assessment and AQMA review

London Borough of Brent AQAP – Report 2

Report for Brent Council

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Executive Summary

This Air Quality Action Plan (AQAP) has been produced as part of our duty to London Local Air Quality Management. It outlines the actions that the Council will take to improve air quality in the London Borough of Brent between 2016 and 2021.

There are 3 action plan reports which set out the main elements of the action plan development, these are:

- Report 1: LLAQM, policy review and AQAP themes
- Report 2: Brent AQ assessment and AQMA review
- Report 3: Brent AQAP (2016-21)

This is Report 2: Brent AQ assessment and AQMA review.

This report describes an atmospheric dispersion modelling assessment of Nitrogen Dioxide (NO_2) and particulate matter (PM_{10}) concentrations within the London Borough of Brent. It also describes the review of the current Air Quality Management Area boundary and an assessment of key air quality action measures that may be implemented under the Air Quality Action Plan for Brent.

The modelling assessment has been undertaken to assist Brent Council with identifying and prioritising air quality action plan measures; and to identify and confirm the areas where exceedances of the national air quality objectives are occurring within the borough boundaries.

The assessment aims to:

- Identify the areas where exceedances of the air quality objectives may be occurring within the borough boundaries. The aim is to provide Brent Council with sufficient evidence to allow them to confirm or revise the boundary of the existing AQMA.
- Conduct a source apportionment analysis of NO_2 pollutant sources; whereby the contribution of different sources of pollutants to overall concentrations are quantified so that air quality action plan measures may be appropriately targeted.
- Model future baseline pollutant concentration and assess the impact of various potential emission reduction measures. For this purpose, the assessment includes a source apportionment analysis at a selection of locations where the highest pollutant concentrations have been measured in the Borough.

The assessment has concluded:

- The modelling of NO_2 and PM_{10} indicates that there are several hotspots in the borough that correspond with the focus areas and the known congestion areas already integrated into the AQMA. Some marginal areas where there may be an exceedance have been identified however as these are on the fringes of the current AQMA boundary, such as the A4006/Roe Green junction, adjusting the boundary to include them may not be necessary. This is because Brent's action plan measures coupled with London wide actions and focus area measures will combine to benefit air quality across the borough in the future any marginal changes to the boundary may not be required.
- As no new areas of exceedance of the air quality objectives have been identified, there is no new evidence to suggest that there is a requirement to change the current AQMA boundary.
- No exceedances of the annual mean PM_{10} objective are predicted at locations of relevant exposure across the Borough.
- The baseline model result indicates that out-with the existing AQMA boundary the greatest roadside annual mean NO_2 concentrations modelled are on the stretch of Preston Road south of the roundabout with Woodcock Hill and Shaftesbury Avenue. Based on the findings of the baseline modelling, it may be advisable to deploy an NO_2 diffusion tube at this location on Preston Road to gather more monitoring data before proceeding with any other assessment.

The source apportionment analysis can be summarised as:

- Background NOx concentration range from approximately 19% to 48.2% of total NOx concentrations at the receptors included; whereas background PM_{10} accounts for up to a more significant 89.4% of the total concentration at each receptor. Actions aimed at local sources are therefore likely to have a greater impact on NOx/NO_2 concentrations.
- The greatest background contribution at all receptors is from other background roads sources i.e. sources not included in the dispersion model, this includes minor roads and roads out-with each background square.
- Emissions from buses contribute approximately 15% of overall NOx concentrations at most of the receptor locations with the exception of site 23 (Junction North Circular Rd / Chartley Avenue) and site 52 (IKEA, Hut, North Circular Road) where the bus contribution is relatively low at around 5%.
- Emissions from buses are a dominant source of NOx at site BRT53 (High Road Wembley) accounting for 53% of total Road NOx; and to a slightly lesser extent at site BRT55 (High Street, Harlesden) where 22% of Road NOx is attributable to bus emissions.
- Emissions from taxis are relatively high at site 23 (Junction North Circular Rd / Chartley Avenue) and at site 52 (IKEA, Hut, North Circular Road) accounting for 8% of overall Road NOx concentrations. The HGV contribution to Road NOx of 18-20% and LGV contribution of approximately 15% are also high at each of these locations when compared with the other receptors included.

London Borough of Brent have identified a series of Air Quality Action Areas (AQAA) which are key areas of concern for the Council. The AQAAs encompass most of the GLA “Focus areas” but also include areas of planned development, areas of concern for communities and regeneration zones.

The Brent Air Quality Action Plan (AQAP) consider a number of potential measures that may help reduce vehicle emission and NO_2 concentrations. Scenarios simulating either single emission reduction measures or a mix of measures have been modelled within each AQAA.

The emission reduction scenarios modelled are:

A. Impact on emissions from the (proposed) extension of the London ULEZ [ULEZ extension]
B. Restricted access to controlled routes for HGVs [HGV routes]
C. Clean-air routes for Buses [Bus Clean-air routes]
D. Clean-air taxi ranks and routes for Taxis [Taxi Clean-air routes]
E. T-charge (proposal) restricting diesel LGVs and taxi in addition to HGV and Bus restrictions. [T-charge impact]
F. 5% of diesel cars convert to Euro 6 petrol due to local measures (£25 fee diesel parking charge, eV parking, car free developments etc.)

The scenario modelling indicates that Scenario A, which considers the impact of the proposed extension of the London Ultra Low Emission Zone (ULEZ) is likely to have the greatest impact on NO_2 concentrations within each AQAA. Even if effective in transforming a large amount of the vehicle fleet to the emission standards compliant with the ULEZ requirements; the impact of the ULEZ extension is not likely to achieve compliance with the NO_2 annual mean objective at all locations, particularly within AQAA1 where residential properties are located on the North Circular Road. Further analysis of the likely impact of the ULEZ extension on the future vehicle fleet mix in Brent is required to get a better idea of the air quality benefits that could be achieved.

The scenario modelling has also indicated that electrification of the bus fleet could reduce NO_2 concentrations significantly at some locations within AAQ3 (Kilburn) and AQAA4 (Wembley).

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Appendices

1 Introduction

Ricardo Energy & Environment has been commissioned by Brent Council to undertake an atmospheric dispersion modelling assessment of Nitrogen Dioxide (NO_2) and particulate matter (PM_{10}) concentrations within the London Borough of Brent.

The assessment has been undertaken for three main reasons:

1. To identify the areas where exceedances of the air quality objectives may be occurring within the borough boundaries. The aim is to provide Brent Council with sufficient evidence to allow them to confirm or revise the boundary of the existing AQMA.
2. To conduct a source apportionment analysis of NO_2 pollutant sources; whereby the contribution of different sources of pollutants to overall concentrations are quantified so that air quality action plan measures may be appropriately targeted.
3. Model future baseline pollutant concentration and assess the impact of various potential emission reduction measures. For this purpose, the assessment includes a source apportionment analysis at a selection of locations where the highest pollutant concentrations have been measured in the Borough.

1.1 Policy Background

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

The 1995 Act also requires that Local Authorities "Review and Assess" air quality in their areas following a prescribed timetable. The Review and Assessment process is intended to locate and spatially define areas where the AQS objectives are not being met. In such instances the Local Authority is required to declare an Air Quality Management Area (AQMA) and develop an Air Quality Action Plan (AQAP) which should include measures to improve air quality so that the objectives may be achieved in the future. The timetables and methodologies for carrying out Review and Assessment studies are prescribed in Defra's Technical Guidance – LAQM.TG(16) and the LLAQM guidance (LLAQM.TG(16)).

Table 1 NO_2 and PM_{10} Objectives included in the Air Quality Regulations and subsequent Amendments for the purpose of Local Air Quality Management

Pollutant	Air Quality Objective Concentration	Measured as
Nitrogen dioxide	200 µg.m^{-3} not to be exceeded more than 18 times a year	1 hour mean
	40 µg.m^{-3}	Annual mean
Particles (PM_{10}) (gravimetric)	50 µg.m^{-3} not to be exceeded more than 35 times a year	24 hour mean
	40 µg.m^{-3}	Annual mean

1.2 Locations where the objectives apply

When carrying out the review and assessment of air quality it is only necessary to focus on areas where the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective.

Table 2: Examples of where the NO_2 and PM_{10} annual mean Air Quality Objectives should and should not apply

Averaging period	Pollutant	Objectives should apply at…	Objectives should not apply at…
Annual mean	NO_2, PM_{10}	Al locations where members of the public might be regularly exposed. Building facades of residential properties, schools, hospitals, care homes etc…	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

1.3 Overview of the Assessment

The general approach taken to this Detailed Assessment was:

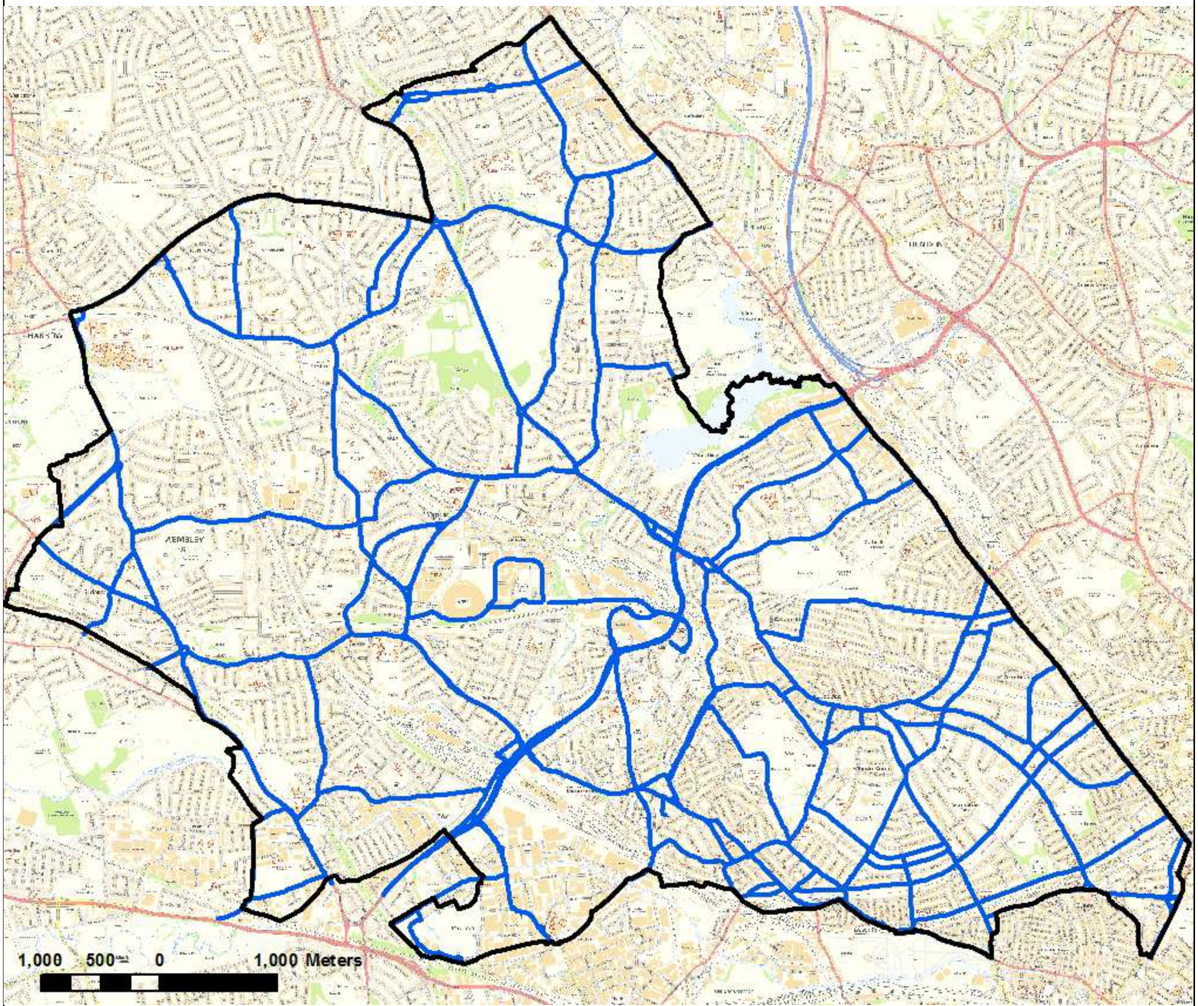
- Collect and interpret data from previous Review and Assessment reports.
- Collect and analyse recent traffic, monitoring, meteorological and background concentration data for use in a dispersion modelling study.
- Use dispersion modelling to produce numerical predictions of NO_2 and PM_{10} concentrations at points of relevant exposure.
- Use dispersion modelling to produce contour plots showing the expected spatial variation in annual mean NO_2 and PM_{10} concentrations.
- Apportion the main sources of NO_2 and PM_{10} at the locations where annual mean concentrations in excess of the objective are occurring.
- Recommend if Brent Council should update the AQMA boundaries.
- Use dispersion modelling to assess the potential impact of road traffic emission reduction measures in the future year 2021.

The modelling methodologies provided for Local Air Quality Management purposed as outlined in the Defra Technical Guidance LAQM.TG(16) were used throughout this study.

For this assessment, two modelling approaches have been used, one at regional scale to model the entire Borough of Brent and also at local scale to model the council's Air Quality Action Areas (AQAA). More details on these two approaches are provided in Section 5 (Modelling Methodology) below.

The borough wide study area, including the roads modelled and the extent of the detailed assessment are presented in Figure 1. Details of the local scale AQAAs are presented in Section 6.

Figure 1: Borough wide study area



Legend:

London Borough of Brent boundary

Roads to be modelled

Ricardo Energy & Environment

2 Information used for this assessment

2.1 Maps

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

2.2 Road traffic data

2.2.1 Average flow, fleet split and speeds.

Traffic data from the London Atmospheric Emissions Inventory (LAEI)[1] were used for the assessment. A growth factor derived using TEMPRO of 1.0156 has been used to project the 2013 LAEI base year forward to the assessment year of 2015. That data includes annual average daily traffic (AADT) flows for the main roads in London split into five vehicle classifications. The dataset also provides average link speeds based on averaged speed data from GPS enabled vehicles. All future emission scenarios have used the 2020 LAEI traffic dataset growth factored to 2021.

TrafficMaster GPS average speed measurement data provided by the Transport for London (TfL) consisting of 2014-2015 average speed, delay and journey time statistics for the AM, Inter and PM peaks, and overnight period, provided for the links within the London Borough of Brent. For each link, the 2014-15 Traffic Master daily average speed has been calculated and used in priority to the 2013 speed data provided in the LAEI data. No assumptions have therefore been made with respect to assigning average traffic speeds to road links within the model.

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

2.2.1 Congestion

During congested periods average vehicle speeds reduce when compared to the daily average; the combination of slower average vehicle speeds and more vehicles lead to higher pollutant emissions during peak hours; it's therefore important to account for this when modelling vehicle emissions to estimate pollutant concentrations.

The LAQM.TG(16) guidance states that the preferred approach to representing the resulting increase in vehicle emissions during these peak periods is to calculate the emission rate for the affected roads for each hour of the day or week, on the basis of the average speed and traffic flow for each hour of the day. The hourly specific emission rates can then be used to calculate a 24-hr diurnal emission profile which can be applied to that section of road. In this case an annual average diurnal profile of traffic flow across the study area was estimated from the latest DfT national statistics for traffic distribution by time of day[2], but no hourly resolution speed measurement data were available. Peak periods in traffic flow were therefore accounted for in the model by applying the typical diurnal traffic flow profile to the average hourly emission rate, assuming an average daily vehicle speed as available in the LAEI data and TrafficMaster GPS data.

[1] http://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory-2010
[2] TRA0308 Traffic distribution on all roads by the time of day in Great Britain, https://www.gov.uk/government/statistical-data-sets/tra03-motor-vehicle-flow

2.2.2 Vehicle emission factors

The latest version of the Emissions Factors Toolkit[3] (EFT V6.0.2 November 2014 release) was used in this assessment to calculate pollutant emission factors for each road link modelled. The calculated emission factors were then imported into the model.

Parameters such as traffic volume, speed and fleet composition are entered into the EFT, and an emissions factor in grams of pollutant/kilometre/second is generated for input into the dispersion model. In the latest version of the EFT, NOx emissions factors previously based on DFT/TRL functions have been replaced by factors from COPERT 4 v10. These emissions factors are widely used for the purpose of calculating emissions from road traffic in Europe. Defra recognise these as the current official emission factors for road traffic sources when conducting local, regional and national scale dispersion modelling assessments.

The latest version of the EFT also includes addition of road abrasion emission factors for particulate matter; and changes to composition of the vehicle fleet in terms of the proportion of vehicle km travelled by each Euro standard, technology mix, vehicle size and vehicle category. Much of the supporting data in the EfT is provided by the Department for Transport (DfT), Highways Agency and Transport Scotland.

Vehicle emission projections are based largely on the assumption that emissions from the fleet will fall as newer vehicles are introduced at a renewal rate forecast by the DfT. Any inaccuracy in the projections or the COPERT IV emissions factors contained in the EFT will be unavoidably carried forward into this modelling assessment.

2.3 Ambient monitoring

During 2015 Brent Council measured NO_2 concentration at twenty-five diffusion tube sites within the borough boundaries. Further details of these monitoring locations and recent measured concentrations are provided in Section 4.

2.4 Meteorological data

Hourly sequential meteorological data (wind speed, direction etc.) for 2015 measured at the Heathrow Airport site was used for the modelling assessment. The meteorological measurement site is located approximately 14.5 km south-west of the study area and has good data quality for the period of interest.

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

2.5 Background concentrations

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

In this case the mapped background NOx and PM_{10} concentrations for the relevant 1 km x 1km grid square were used. The mapped annual mean background NOx and PM_{10} concentrations for 2015 are represented using graduated colours in Figure 2 and Figure 3.

[3] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft
[4] Defra (2012) http://laqm1.defra.gov.uk/review/tools/background.php (accessed September 2012)

Figure 2: NOx mapped background concentrations

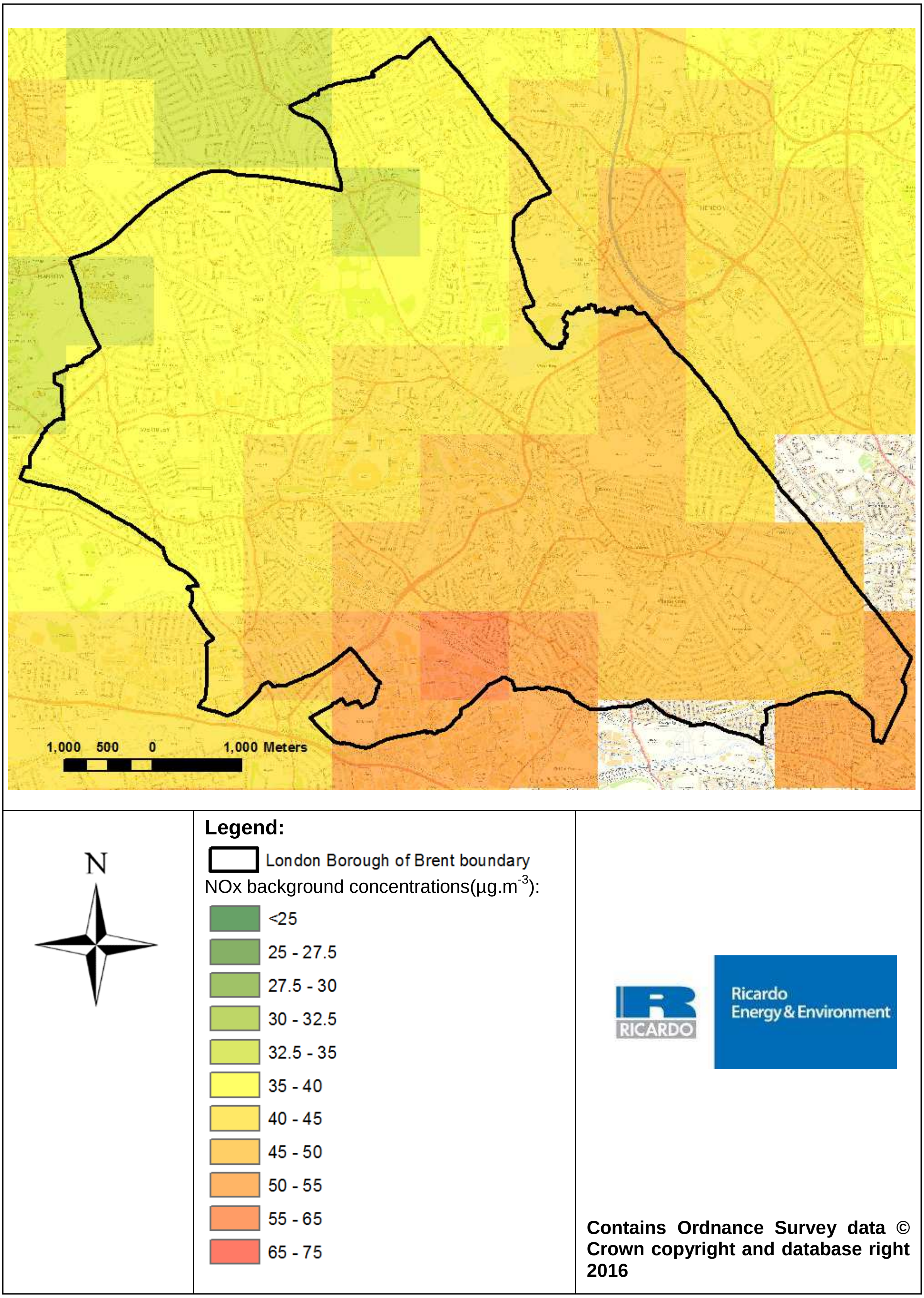
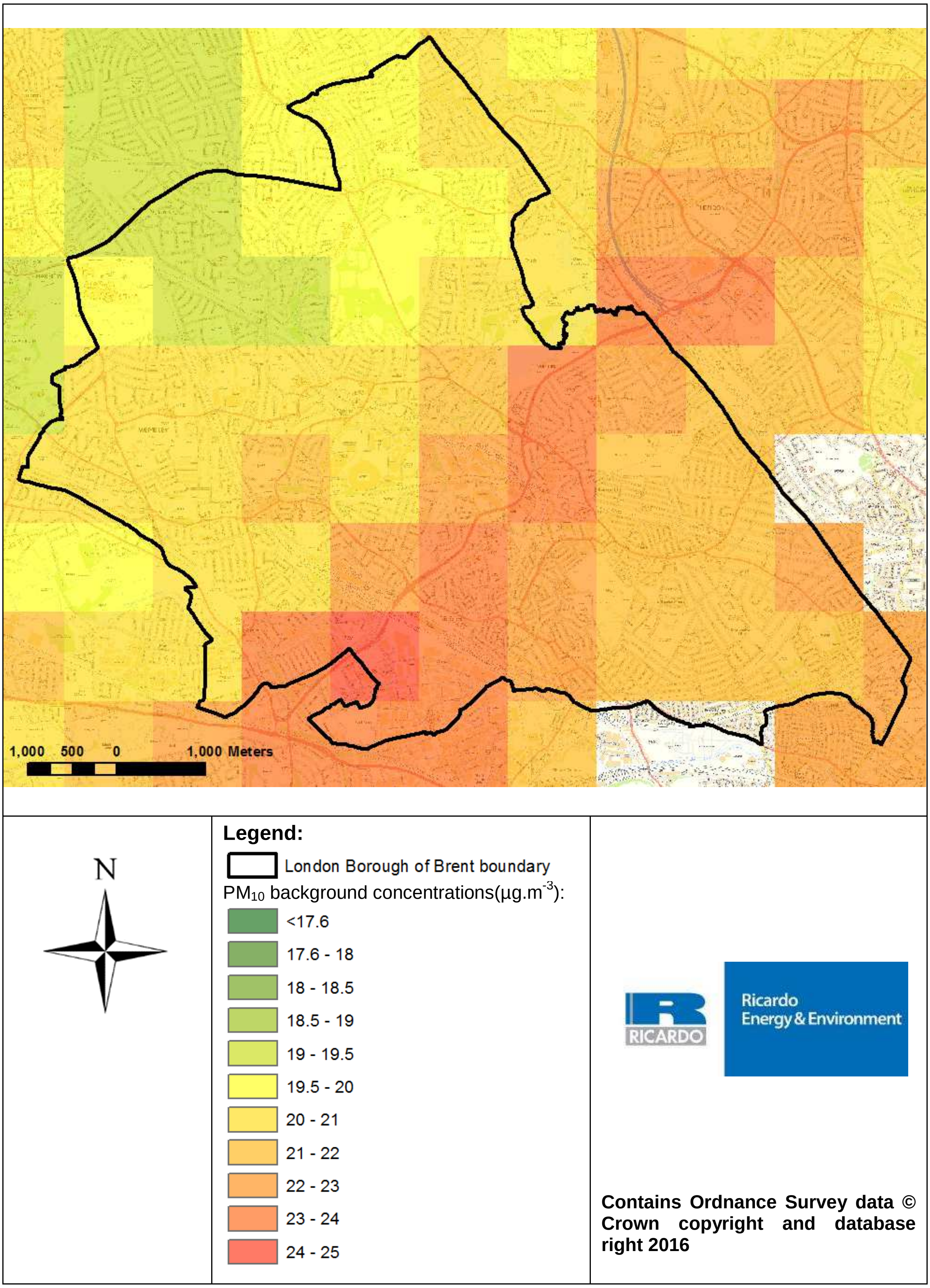


Figure 3: PM_{10} mapped background concentrations



3 Monitoring data

Brent Council currently measures NO_2 concentrations at 25 NO_2 diffusion tube sites and three automatic NO_2 and PM_{10} monitoring sites. Due to operational problems, NO_2 monitoring data for all the automatic monitoring sites are not available for 2015. Measured PM_{10} concentrations for BT5 (Nearsden Lane) are not yet ratified for 2015, the data has not been used in this study.

Details of the NO_2 diffusion tube monitoring sites and the annual mean NO_2 concentrations measured during 2015 are presented in Table 3. Details of the PM_{10} monitoring sites and the annual mean PM_{10} concentrations measured during 2015 are presented in Table 4. Concentrations in excess of each respective annual mean air quality objective are highlighted in bold.

Annual mean NO_2 concentrations in excess of the 40 $\mu g.m^{-3}$ objective were measured during 2015 at all of the roadside sites. Over recent years, NO_2 concentrations measured at many of these diffusion tube locations have been significantly greater than the annual mean objective.

The national bias adjustment factor[5] of 0.91 has been used to adjust the raw 2015 NO_2 measured concentrations at the diffusion tube locations. Further information on QA/QC of the measurements is provided in the 2015 LAQM Updating & Screening Assessment[6].

No exceedances of the PM_{10} annual mean objective have been measured in Brent during the last five years.

[5] AQC(2015) Database_Diffusion_Tube_Bias_Factors_v03_16_Finla_v2; Gradko 20% TEA In water 2015
[6] Brent Council (2015) LAQM Updating and Screening Assessment for Brent Council.

Table 3: NO_2 diffusion tube measurements 2015

Site ID	Description	Type	Within AQMA	Easting	Northing	Bias corrected (0.91) annual mean 2015 $\mu g.m^{-3}$)
1	Junction of Kenton Rd / Upton Gardens	Roadside	Y	516929	188560	**40.1**
2	Harrow Rd, Sudbury Court Drive	Roadside	Y	515793	186042	**41.7**
4	Junction of Shaftesbury Avenue / Woodcock Hill	Roadside	Y	518254	187771	**40.3**
7	Bridgewater Rd / Ealing Road	Roadside	Y	517921	183716	**62.3**
9	Junction of East Lane / Wembley Hill Road	Roadside	Y	518499	186168	**47.3**
17	Old Church Lane junction with Neasden Lane	Roadside	Y	520480	186537	**55.4**
21A	Central Middlesex Hospital, Central Way	Roadside	Y	520078	182857	**48.7**
22	Junction of Kingsbury Road / Edgware Road	Roadside	Y	521447	188730	**56.7**
23	Junction North Circular Rd / Chartley Avenue	Roadside	Y	521213	186125	**93.2**
26	Dudden Hill Lane junction with High Road	Roadside	Y	522191	184821	**63.9**
29	Junction Dollis Hill Lane / Cricklewood	Roadside	Y	523191	186571	**74.1**
30	Chichele Road near Melrose Ave	Roadside	Y	523663	185353	**52.6**
41	R/O 246 Neasden Lane	Roadside	Y	521455	185920	**60.7**
48	Kilburn Park Rd near junction with Shirland Rd	Roadside	Y	525196	182517	**56.5**
53	Junction Ealing Road / High Road	Roadside	Y	518020	185043	**66.6**
54	Ealing Road / Riverside Gardens	Roadside	Y	518221	183206	**47.1**
33A	Fryent Park Car Park area	Background	N	519572	187691	22.9
52**	IKEA, Hut, North Circular Road	Roadside	Y	520874	185173	**87.9**

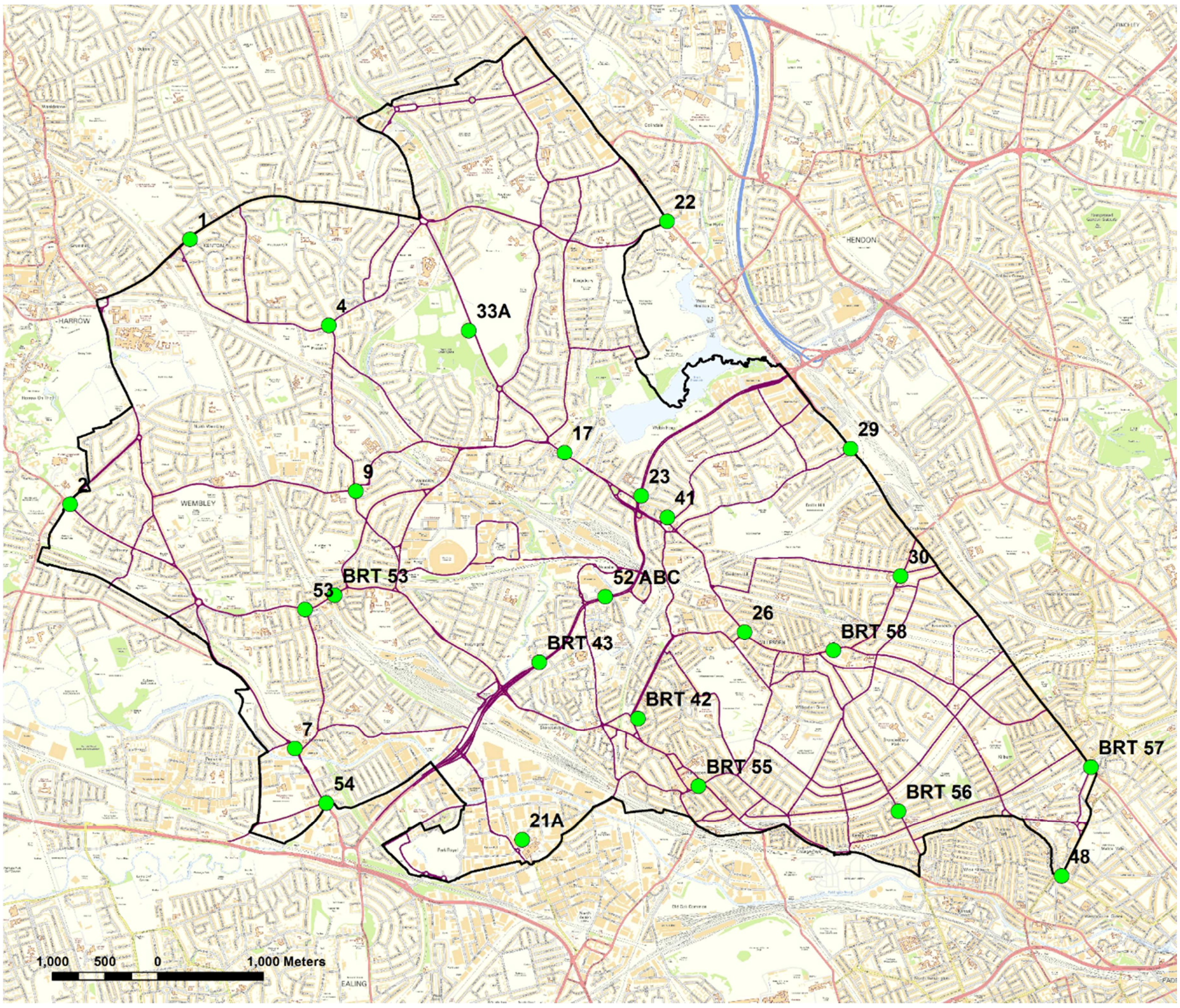
Site ID	Description	Type	Within AQMA	Easting	Northing	Bias corrected (0.91) annual mean 2015 µg.m^{-3})
BRT 42	Police Station, Craven Park	Roadside	Y	521155	184002	**41.8**
BRT 43	Pitfield Way	Roadside	Y	520242	184541	**80.3**
BRT 53	High Road Wembley	Roadside	Y	518303	185181	**75.7**
BRT 55	High Street, Harlesden	Roadside	Y	521743	183361	**73.5**
BRT 56	Chamberlayne Road	Roadside	Y	523635	183153	**56.8**
BRT 57	Kilburn Bridge	Roadside	Y	525461	183558	**85.3**
BRT 58	51 High Road, Willesden	Roadside	Y	412031	184655	**58.1**

*** Concentrations have not been distance corrected to nearest relevant exposure**
****Triplicate tubes**

Table 4: PM_{10} measurements 2015

Site	Description	Type	Within AQMA	Easting	Northing	PM_{10} annual mean 2015 (µg.m^{-3})
BT4	Ikea	Roadside	Y	520866	185169	29.1
BT6	John Keeble Primary School	Roadside	Y	521619	183554	20.4

Figure 4: NO_2 diffusion tube locations



Legend:

London Borough of Brent boundary

Diffusion tube site

4 Modelling methodology

Annual mean pollutant concentrations have been modelled using both a regional/borough scale model, and a local scale model; each method is described in turn below. It should be noted that any dispersion modelling study has a degree of uncertainty associated with it; all reasonable steps have been taken to reduce this where possible.

4.1 Borough scale modelling

The RapidAir model was used for the regional/borough scale dispersion. RapidAir is an urban air quality dispersion model developed by Ricardo Energy & Environment which focuses on dispersion of road traffic emissions over a wide area. It is based on a GIS platform that can be adapted to any urban environment in order to evaluate in a very short period of time, the effects of pollution reduction policy measures applied to road traffic across a city scale or regional model domain. RapidAir uses dispersion kernels created with the US Environmental Protection Agency's AERMOD model. RapidAir has been developed to provide graphical and numerical outputs which are comparable with other models used widely in the United Kingdom. In recent years, RapidAir has been extensively used in informing policy decisions on road traffic management in United Kingdom cities (e.g. Southampton, Slough, Fife) and internationally for Riyadh, Saudi Arabia and Jinan, China.

The benefits of this modelling method are:

- Very fast run times when compared to complex dispersion models.
- Ability to model a large area quickly – minutes compared to days.
- Uses the same underlying emissions data and dispersion maths.
- Provides a regional picture of pollutant concentrations and identifies pollutant hotspots

Some uncertainty is however introduced by verifying the regional model outputs over such a large area. This may be influenced by varying estimates of background concentrations across a wide area so it's not always possible to get good model agreement with measurements across the entire domain.

Model agreement and average error are generally better when modelling at a local scale; the regional approach is therefore very useful for identifying hotspots which can then be looked at in more detail using ADMS. Alternatively, a different, locally specific adjustment factor can be applied at the local scale to achieve better model agreement.

4.2 Local scale modelling

Pollutant concentrations during 2015 have been modelled within each AQAA study area using the atmospheric dispersion model ADMS Roads (version 4).

4.2.1 Validation of ADMS-Roads

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

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

4.2.2 Model Input parameters

A surface roughness of 1 m was used in ADMS Roads to represent the city conditions within each model domain. A limit for the Monin-Obukhov length of 30 m was applied to represent a city.

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

Queuing traffic was considered using the methodology described in Section 2.2.1 above; whereby a time varying emissions file was used in the model to account for daily variations in traffic.

4.3 Treatment of modelled NOx road contribution

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

The Defra NOx/NO_2 model[7] was used to calculate NO_2 concentrations from the NOx concentrations predicted by ADMS-Roads. The model requires input of the background NOx, the modelled road contribution and accounts for the proportion of NOx released as primary NO_2. For the London Borough of Brent area in 2015 with the “All other UK urban Traffic” option in the model, the NOx/NO_2 model estimates that 22.7% of NOx is released as primary NO_2.

4.4 Model verification

Each model has been verified by comparison of the modelled predictions of road NOx and, where relevant, Road PM_{10} with local monitoring results. The available roadside measurements within each study area were used to verify the annual mean road NOx and PM_{10} model predictions.

Following initial comparison of the modelled concentrations with the available monitoring data, refinements are typically made to the model input to achieve the best possible agreement with the measured concentrations.

More information regarding model verification for both the borough wide and local scale modelling is presented in Appendix 1.

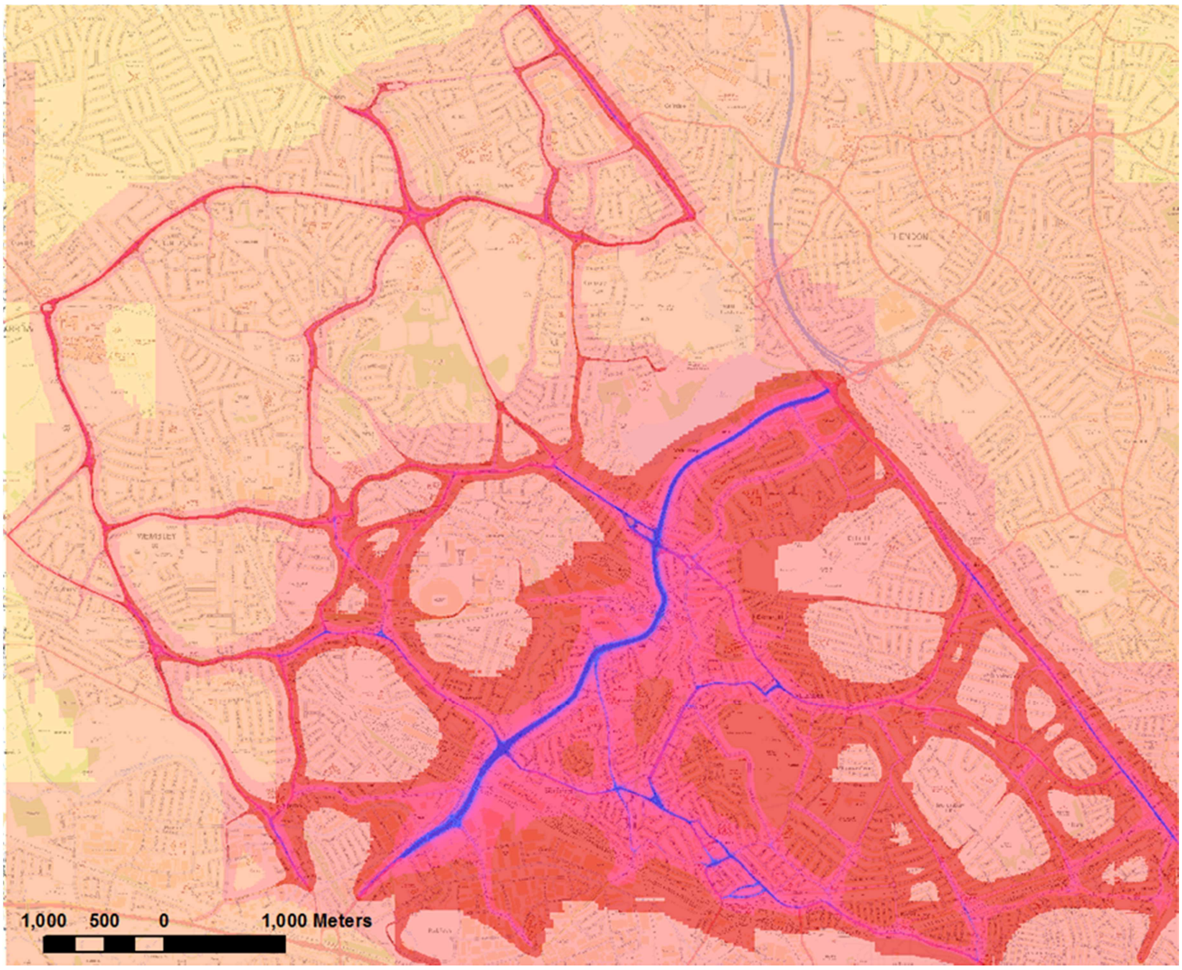
5 Borough scale modelling results

5.1 Pollutant concentrations across the borough

To provide an overview of annual mean NO_2 and PM_{10} concentrations across the entire borough the RapidAir regional modelling approach has been used as described in Section 4.1 . Contour plots showing the modelled spatial variation of NO_2 and PM_{10} annual mean concentrations across the borough are presented in Figure 5 and Figure 6.

[7] Defra (2014) NOx NO_2 Calculator v4.1 released June 2014; Available at http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

Figure 5: Borough scale model - NO_2 annual mean concentrations 2015 at 1.5m height



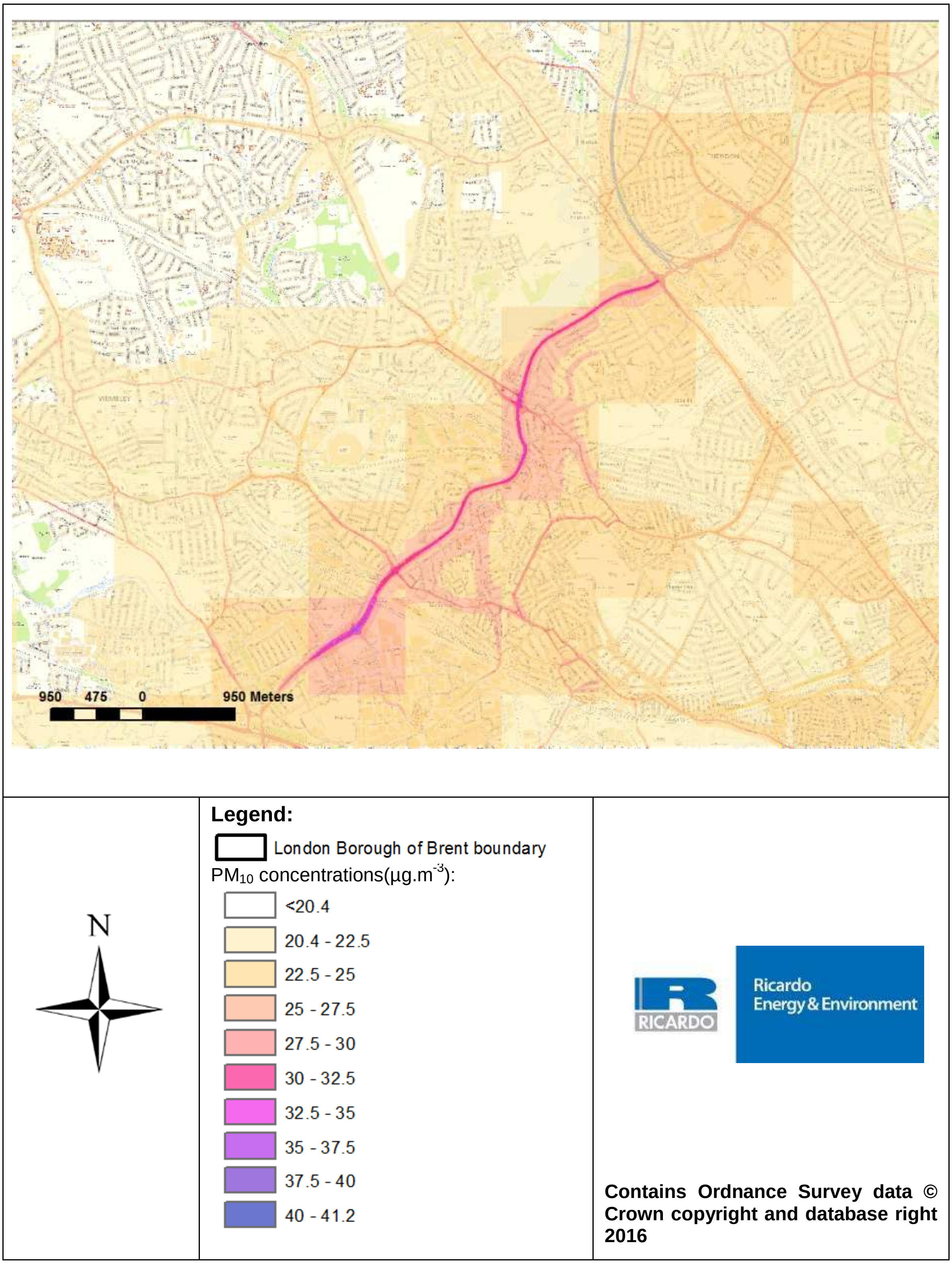
Legend:

London Borough of Brent boundary

NO_2 concentrations($\mu g.m^{-3}$):

- <27
- 27 - 30
- 30 - 35
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 110.9

Figure 6: Borough scale model - PM_{10} annual mean concentrations 2015 at 1.5m height



5.2 North-west area model

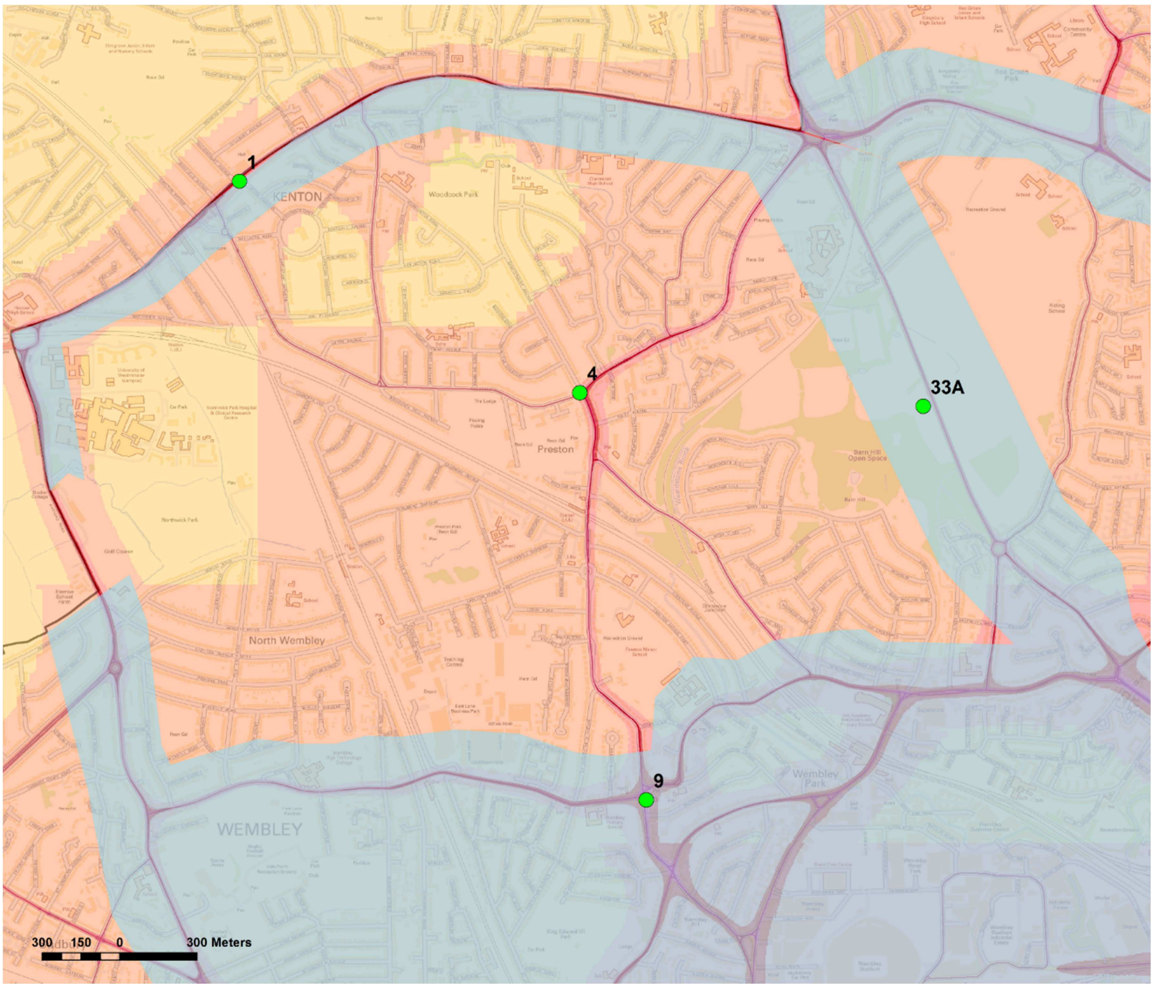
NO_2 annual mean concentrations measured in 2014 at diffusion tube sites within the north-west area of the borough were either very close to, or slightly over the 40 $\mu g.m^{-3}$ annual mean objective. To establish if the current AQMA boundary is appropriate in this part of the borough, this area has been modelled in closer detail. This aims to provide a better understanding of NO_2 and PM_{10} concentrations at locations where relevant exposure is present.

To reduce model uncertainty, a NOx adjustment factor specific to this section of the model domain has been applied; further information on model verification for this model scenario is presented in Appendix 1.

Modelled NO_2 annual mean concentrations for the North-west area are presented in Figure 7. An enlarged graphic is also presented in Figure 7 showing the modelled NO_2 annual mean concentrations in the Preston Rd/Preston Hill area.

Modelled PM_{10} annual mean concentrations for the North-west area are presented in Figure 10.

Figure 7: North-west of Brent modelled NO_2 annual mean concentrations 2015 at 1.5m height



N

Legend:

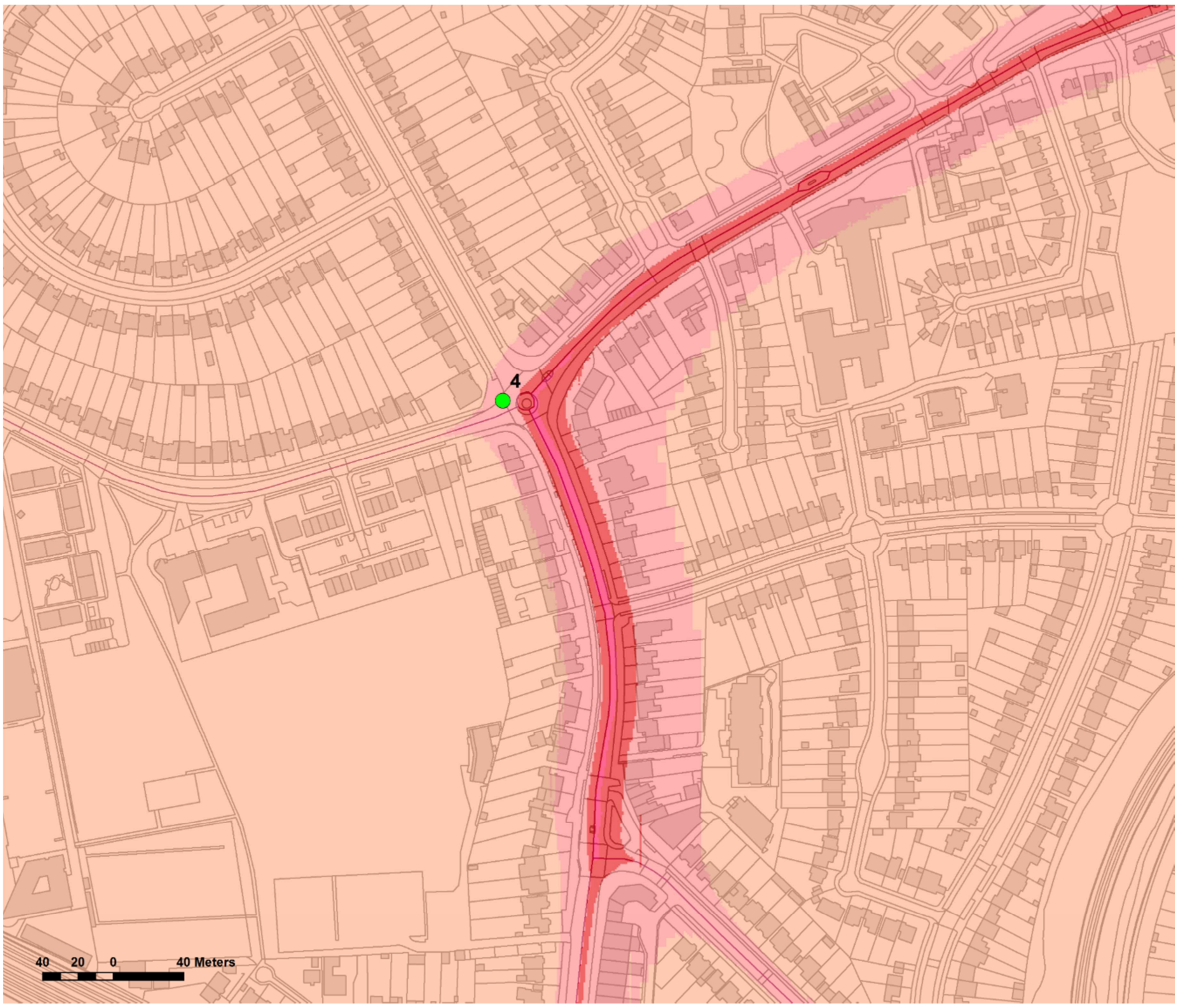
AQMA

NO_2 concentrations($\mu g.m^{-3}$):

<27	50 - 55
27 - 30	55 - 60
30 - 35	60 - 65
35 - 40	65 - 70
40 - 45	70 - 75
45 - 50	75 - 110.9

Ricardo Energy & Environment

Figure 8: NO_2 annual mean concentrations 2015 – Preston Road



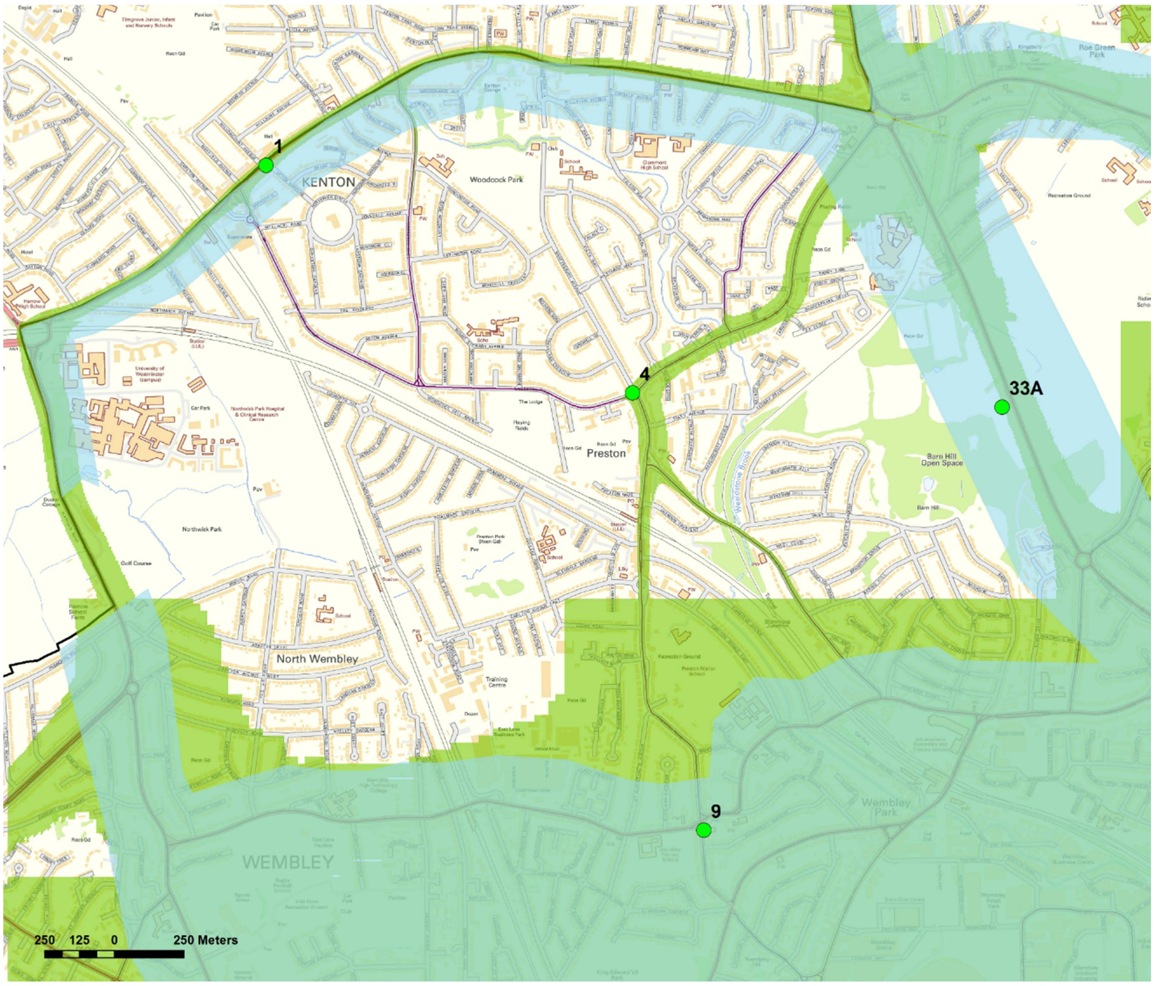
Legend:

AQMA

NO_2 concentrations($\mu g.m^{-3}$):

<27	50 - 55
27 - 30	55 - 60
30 - 35	60 - 65
35 - 40	65 - 70
40 - 45	70 - 75
45 - 50	75 - 110.9

Figure 9: Modelled PM_{10} annual mean concentrations 2015 at 1.5m height



Legend:

AQMA

NO_2 concentrations($\mu g.m^{-3}$):

- < 20.4
- 20.4 - 25
- 25 - 30
- 30 - 35
- 35 - 40
- 40 - 41.2

5.3 Review of existing AQMA boundary

The borough scale air quality modelling and resultant annual mean NO_2 concentration contour plots show the spatial variation of the predicted 2015 annual mean NO_2 concentrations across the study area at ground level (1.5m height). The contour plots indicate that the 40 $\mu g.m^{-3}$ annual mean objective is being exceeded at many locations within the existing AQMA boundary.

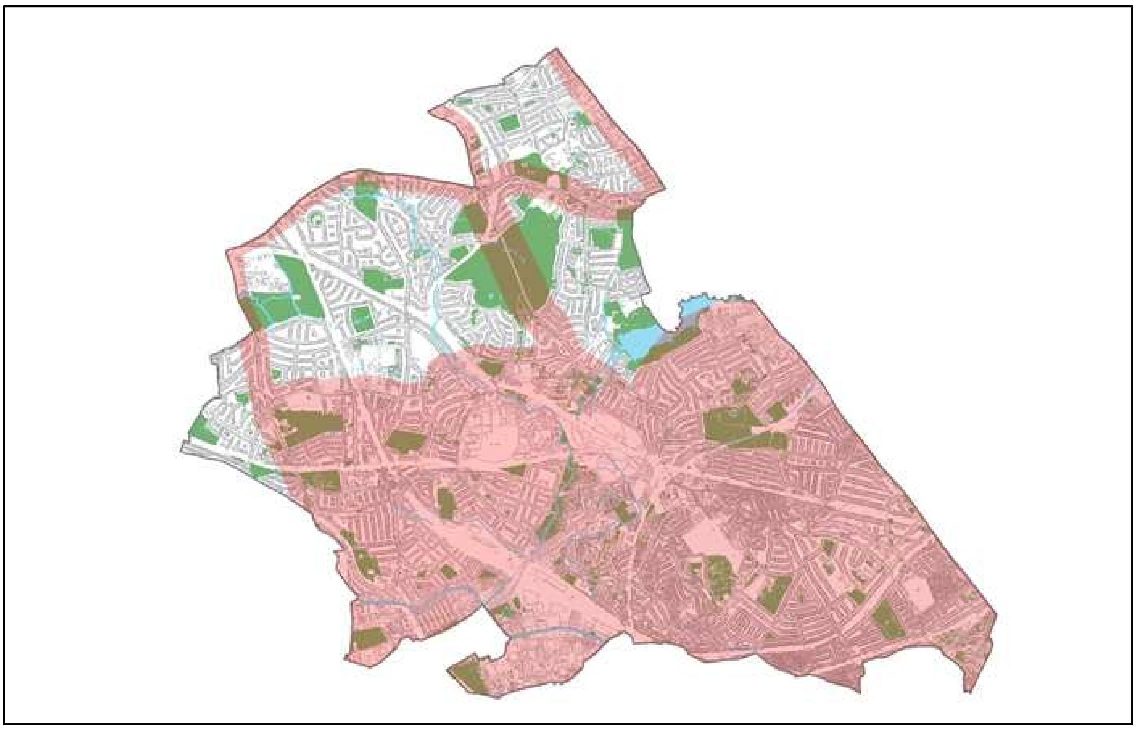
Examination of Figure 7 indicates that out-with the existing AQMA boundary the greatest roadside annual mean NO_2 concentrations modelled are on the stretch of Preston Road approximately 150m south of the roundabout with Woodcock Hill and Shaftesbury Avenue. A close up of the modelled concentrations at this location are presented in Figure 8. The contours indicate that there may be exceedances of the 40 $\mu g.m^{-3}$ objective occurring at residential properties on the east side of Preston Road. The modelling has however been verified at this location using diffusion tube measurements which are located away from where exceedances may be occurring; and where screening using the 'NO_2 with distance from Road' method has indicated there is no need to proceed to a Detailed Assessment. It may be advisable to deploy an NO_2 diffusion tube at this location on Preston Road to gather more monitoring data before proceeding with any other assessment. Using more local measurements will provide a much more robust modelling assessment should it be required at this location.

The contour plots showing the spatial variation of modelled 2015 annual mean PM_{10} concentrations indicate that there are no exceedances of the 40 $\mu g.m^{-3}$ PM_{10} annual mean objective at any ground level locations where relevant exposure is present within the borough.

The modelling of NO_2 and PM_{10} indicates that there are several hotspots in the borough that correspond to the focus areas and the known congestion areas already integrated into the AQMA. Some marginal areas where there may be an exceedance have been identified however as these are on the fringes of the current AQMA boundary, such as the A4006/Roe Green junction, adjusting the boundary to include them may not be necessary. This is because Brent's action plan measures coupled with London wide actions and focus area measures will combine to benefit air quality across the borough in the future any marginal changes to the boundary may not be required.

As no new areas of exceedance of the air quality objectives have been identified, there is no new evidence to suggest that there is a requirement to change the current AQMA boundary.

Figure 10: London Borough of Brent Air Quality Management Area



5.4 Source apportionment

Source apportionment is the process whereby the contribution of different pollutant sources to overall concentrations are quantified. This aims to allow the Local Authority's Action plan to target and prioritise specific sources when attempting to reduce pollutant concentrations in the AQMA.

The TG16 guidance recommends that the source apportionment for the assessment should initially separate the sources into:

- Regional background, which the authority is unable to influence;
- Local background, which the authority should have some influence over; and
- Local sources, which will add to the background to give rise to the hotspot area of exceedances. These will be the principal sources for the local authority to control within the Action Plan.

As the main source of NOx at roadside locations in Brent is likely to be road traffic emissions, the source apportionment should also:

- Confirm that exceedances of the NO_2 annual mean are due to road traffic.
- Determine the extent to which different vehicle types are responsible for the emission contributions to NOx/NO_2 concentrations.
- Quantify what proportion of each pollutant is due to background emissions from busy roads in the local area. This will help determine whether local traffic management measures could have a significant impact on reducing emissions in the area of exceedance, or, whether national measures are likely to be more effective in achieving the air quality objectives.

In this case, the contributions from each of the following sources have been quantified:

- Background – a separate breakdown of background concentrations has also been included.
- Cars
- Taxis
- Light Goods Vehicles
- Heavy Goods Vehicles
- Buses

The respective Road NOx contributions from the above sources have been modelled at a selection of receptor locations across the borough of Brent. The receptors included comprise of the diffusion tube locations where the highest NO_2 annual mean concentrations were measured during 2015. The locations of the monitoring sites included are presented in Figure 11.

To calculate the proportion of total pollutant concentrations attributable to each different vehicles type, the 'breakdown by vehicle type' output option in the Emission Factor Toolkit (EFT) was used. This allowed emission rates for each vehicle type to be modelled independently in RapidAir.

Table 5 and Table 6 summarise the relevant NOx contributions from the above sources at the worst-case receptor locations. The PM_{10} source apportionment breakdown by vehicle type are presented in Table 7 and Table 8. No annual mean concentrations in excess of the 40 $\mu g.m^{-3}$ objective are predicted at any of the receptor locations.

The source apportionment of different vehicle types and a breakdown of background sources contributions to overall NOx concentrations are presented visually using pie charts in Figure 12.

Examination of the source apportionment results indicate that:

- Background NOx concentration range from approximately 19% to 48.2% of total NOx concentrations at the receptors included; whereas background PM_{10} accounts for up to a more significant 89.4% of the total concentration at each receptor. Actions aimed at local sources are therefore likely to have a greater impact on NOx/NO_2 concentrations.

- The greatest background contribution at all receptors is from other background roads sources i.e. sources not included in the dispersion model, this includes minor roads and roads out-with each background square. These background contributions may have been overestimated within background grid squares closer to the centre of the borough where emissions from out-with the borough wide modelling domain have less influence on overall concentrations.
- Emissions from buses contribute approximately 15% of overall NOx concentrations at most of the receptor locations with the exception of site 23 (Junction North Circular Rd / Chartley Avenue) and site 52 (IKEA, Hut, North Circular Road) where the bus contribution is relatively low at around 5%.
- Emissions from buses are a dominant source of NOx at site BRT53 (High Road Wembley) accounting for 53% of total Road NOx; and to a slightly lesser extent at site BRT55 (High Street, Harlesden) where 22% of Road NOx is attributable to bus emissions.
- Emissions from taxis are relatively high at site 23 (Junction North Circular Rd / Chartley Avenue) and at site 52 (IKEA, Hut, North Circular Road) accounting for 8% of overall Road NOx concentrations. The HGV contribution to Road NOx of 18-20% and LGV contribution of approximately 15% are also high at each of these locations when compared with the other receptors included.

Figure 11: Diffusion tube locations used for source apportionment analysis

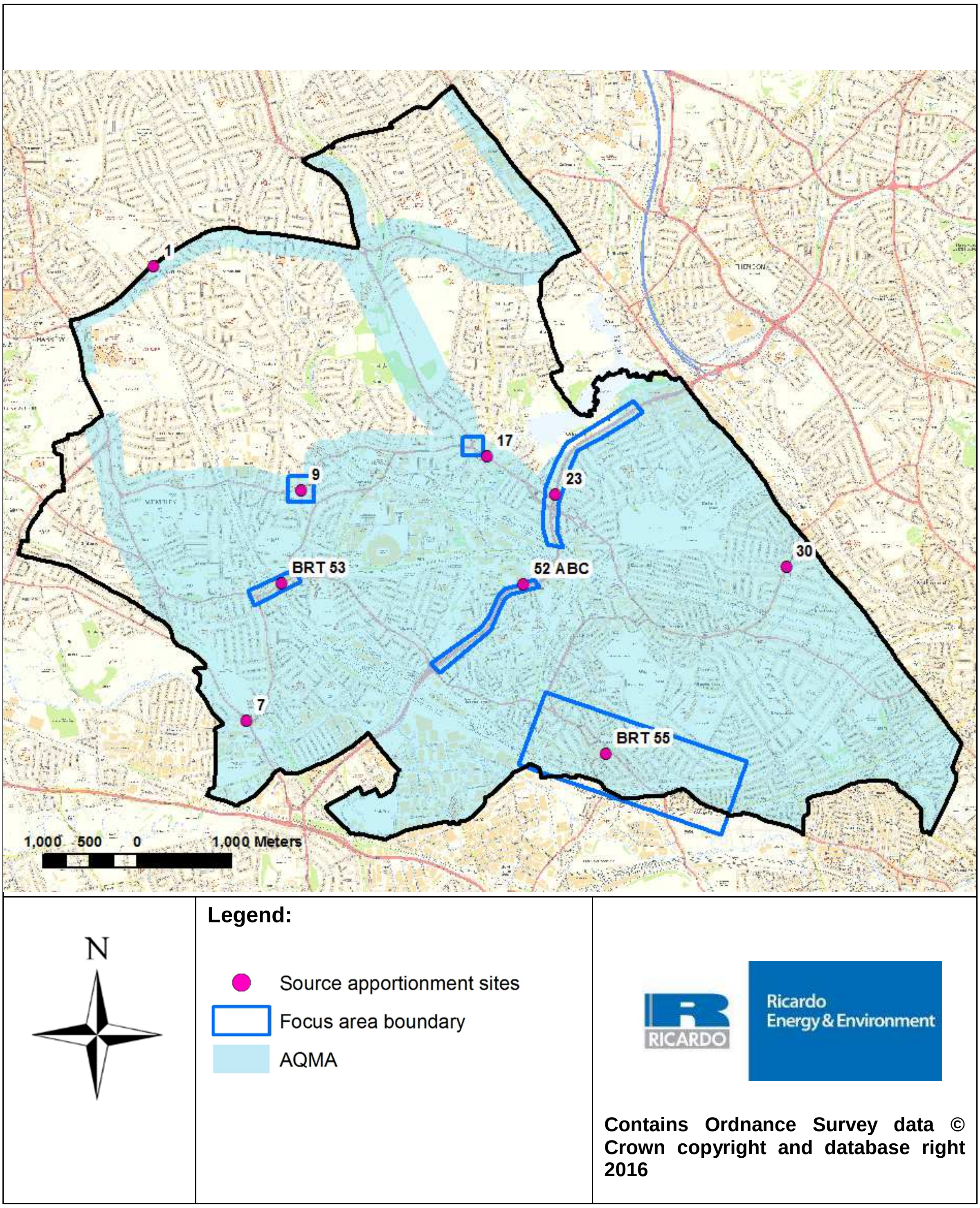


Table 5: NOx source apportionment – Contribution by vehicle type (μg.m^{-3}) (excludes motorcycles)

Site ID	Description	Total NOx	Background	Road NOx	Cars	HGV	Buses	LGV	Taxi
1	Junction of Kenton Rd / Upton Gardens	81.5	36.5	45.1	20.1	5.9	12.1	6.1	0.8
7	Bridgewater Rd / Ealing Road	105.0	43.6	61.4	22.7	14.6	13.1	10.1	1.0
9	Junction of East Lane/Wembley Hill Rd	104.9	38.7	66.2	47.3	8.8	5.2	4.1	0.8
17	Old Church Lane junction with Neasden Lane	141.4	41.2	100.2	46.4	17.4	19.7	14.5	2.3
23	Junction North Circular Rd / Chartley Avenue	227.1	42.4	184.7	65.7	54.3	10.1	34.9	19.6
30	Chichele Road near Melrose Ave	91.6	44.1	47.5	14.6	10.7	12.0	6.4	3.8
52	IKEA, Hut, North Circular Road	194.3	47.3	147.0	50.7	45.4	7.3	27.3	16.2
BRT53	High Road Wembley	152.6	42.5	110.2	22.9	12.7	65.0	8.5	1.0
BRT55	High Street, Harlesden	156.3	51.2	105.1	22.9	34.9	31.3	9.4	6.7

Table 6: NOx source apportionment – Contribution by vehicle type (% of total NOx)

Receptor location	Description	Total NOx	Background	Road NOx	Cars	HGV	Buses	LGV	Taxi
1	Junction of Kenton Rd / Upton Gardens	100%	44.7%	55.3%	24.7%	7.3%	14.8%	7.5%	0.9%
7	Bridgewater Rd / Ealing Road	100%	41.5%	58.5%	21.6%	13.9%	12.5%	9.6%	1.0%
9	Junction of East Lane/Wembley Hill Rd	100%	37.0%	36%	45.0%	8.0%	5.0%	4.0%	1.0%
17	Old Church Lane junction with Neasden Lane	100%	29.1%	70.9%	32.8%	12.3%	13.9%	10.2%	1.6%
23	Junction North Circular Rd / Chartley Avenue	100%	18.7%	81.3%	29.0%	23.9%	4.5%	15.4%	8.6%
30	Chichele Road near Melrose Ave	100%	48.2%	51.8%	15.9%	11.7%	13.1%	7.0%	4.2%
52	IKEA, Hut, North Circular Road	100%	24.3%	75.7%	26.1%	23.4%	3.8%	14.1%	8.4%
BRT53	High Road Wembley	100%	27.8%	72.2%	15.0%	8.4%	42.6%	5.6%	0.7%
BRT55	High Street, Harlesden	100%	32.8%	67.2%	14.6%	22.3%	20.0%	6.0%	4.3%

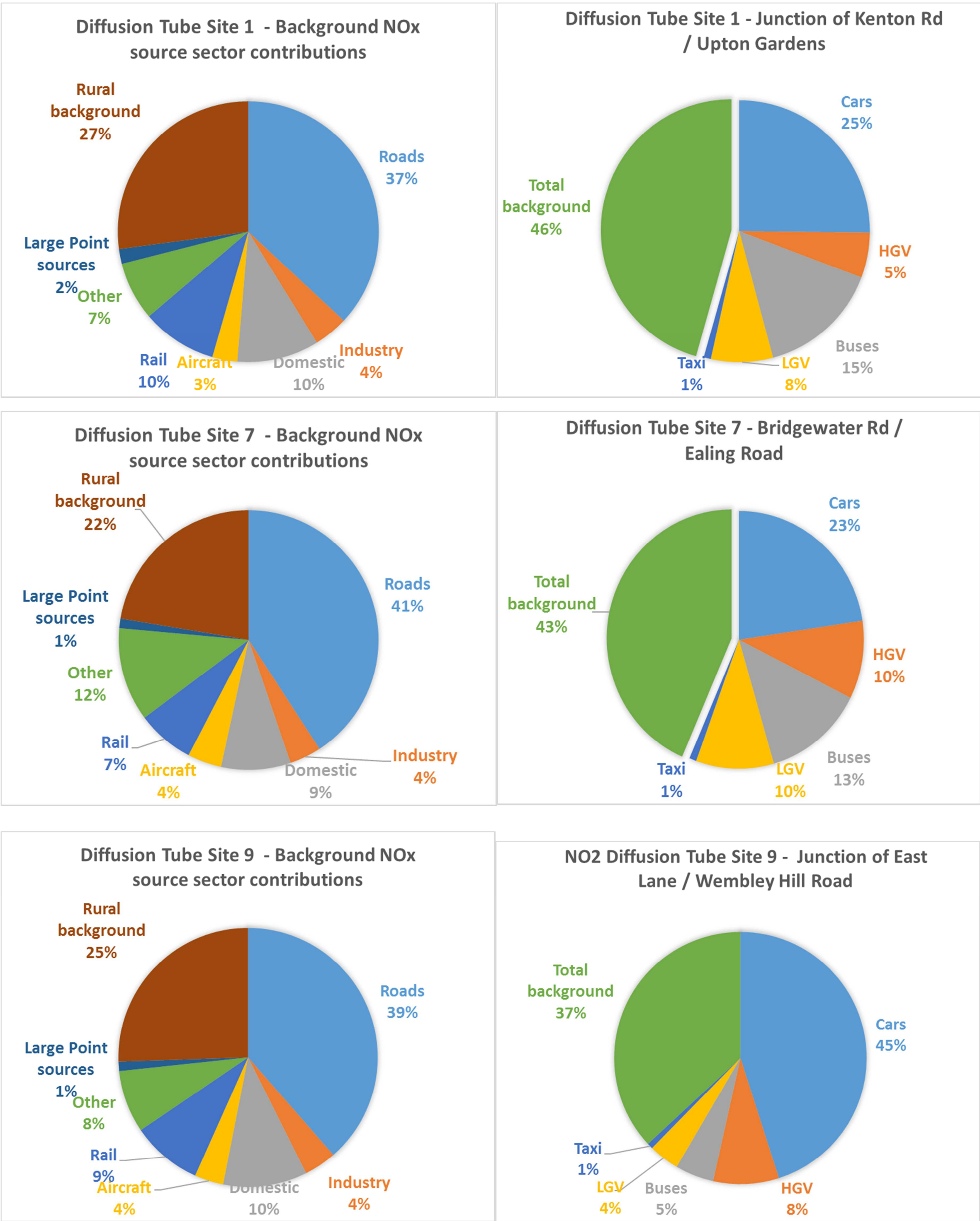
Table 7: PM_{10} source apportionment – Contribution by vehicle type ($\mu g.m^{-3}$) (excludes motorcycles)

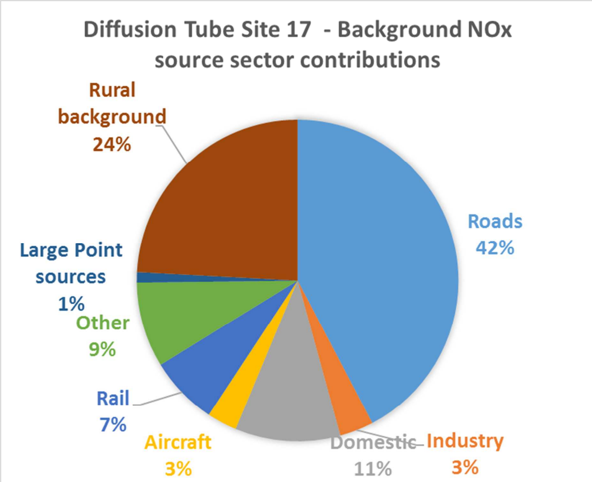
Site ID		Total PM_{10}	Background	Road PM_{10}	Cars	HGV	Buses	LGV	Taxi
1	Junction of Kenton Rd / Upton Gardens	22.3	19.5	2.8	1.9	0.2	0.3	0.3	0.0
7	Bridgewater Rd / Ealing Road	24.0	20.7	3.3	2.0	0.4	0.3	0.5	0.1
17	Old Church Lane junction with Neasden Lane	27.8	21.2	6.6	4.5	0.6	0.5	0.8	0.1
23	Junction North Circular Rd / Chartley Avenue	38.5	23.4	15.1	8.2	2.9	0.4	2.3	1.3
30	Chichele Road near Melrose Ave	24.3	21.7	2.6	1.4	0.3	0.3	0.4	0.2
52	IKEA, Hut, North Circular Road	33.2	22.2	11.0	5.9	2.0	0.2	1.7	1.1
BRT53	High Road Wembley	24.9	21.1	3.8	1.8	0.3	1.2	0.4	0.1
BRT55	High Street, Harlesden	27.2	22.8	4.4	1.9	0.9	0.6	0.5	0.5

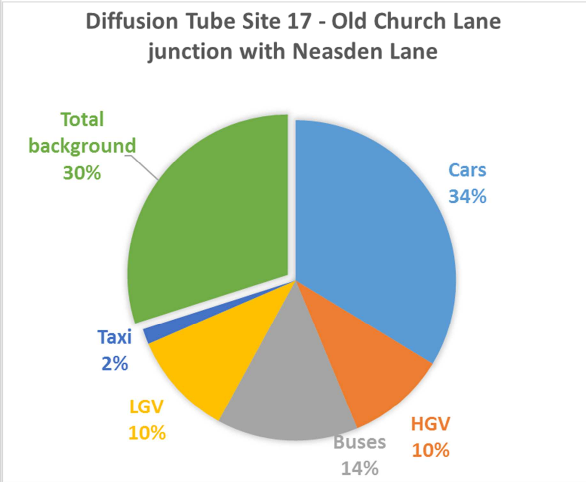
Table 8: PM_{10} source apportionment – Contribution by vehicle type (% of total PM_{10})

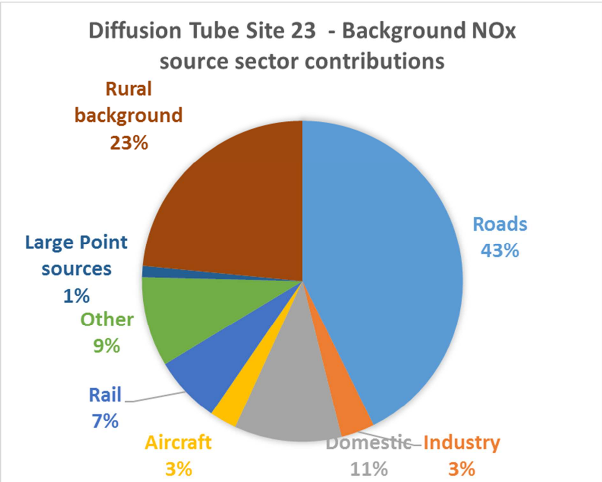
Site ID		Total PM_{10}	Background	Road PM_{10}	Cars	HGV	Buses	LGV	Taxi
1	Junction of Kenton Rd / Upton Gardens	100%	87.3%	12.7%	8.6%	0.8%	1.4%	1.5%	0.2%
7	Bridgewater Rd / Ealing Road	100%	86.4%	13.6%	8.2%	1.6%	1.2%	2.2%	0.3%
17	Old Church Lane junction with Neasden Lane	100%	76.4%	23.6%	16.2%	2.1%	1.9%	2.9%	0.5%
23	Junction North Circular Rd / Chartley Avenue	100%	60.8%	39.2%	21.3%	7.4%	1.0%	6.1%	3.4%
30	Chichele Road near Melrose Ave	100%	89.4%	10.6%	5.6%	1.3%	1.2%	1.4%	1.0%
52	IKEA, Hut, North Circular Road	100%	66.9%	33.1%	17.9%	6.1%	0.7%	5.2%	3.2%
BRT53	High Road Wembley	100%	84.6%	15.4%	7.4%	1.2%	4.7%	1.7%	0.3%
BRT55	High Street, Harlesden	100%	83.8%	16.2%	7.1%	3.1%	2.3%	1.8%	1.9%

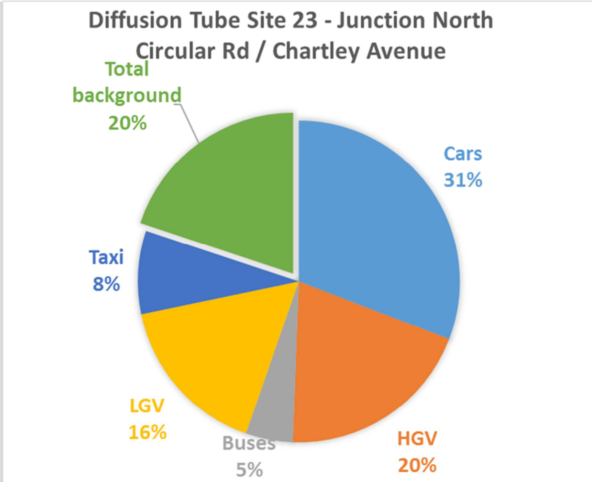
Figure 12: NOx source apportionment at each receptor location

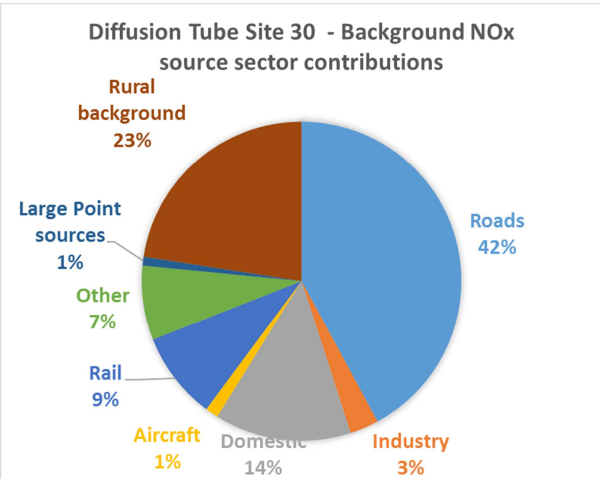


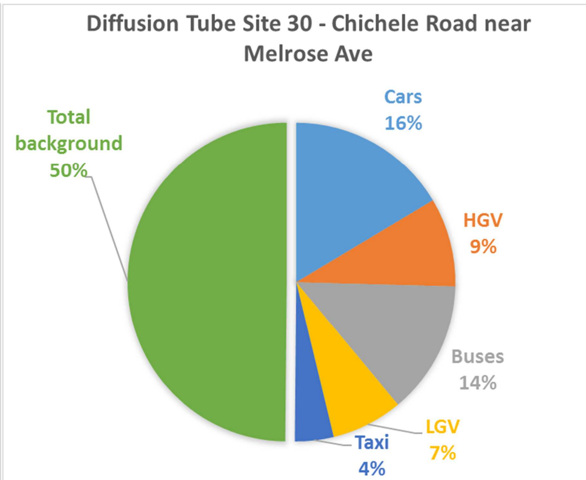

Diffusion Tube Site 17 - Background NOx source sector contributions
Rural background 24%
Roads 42%
Large Point sources 1%
Other 9%
Rail 7%
Aircraft 3%
Domestic 11%
Industry 3%

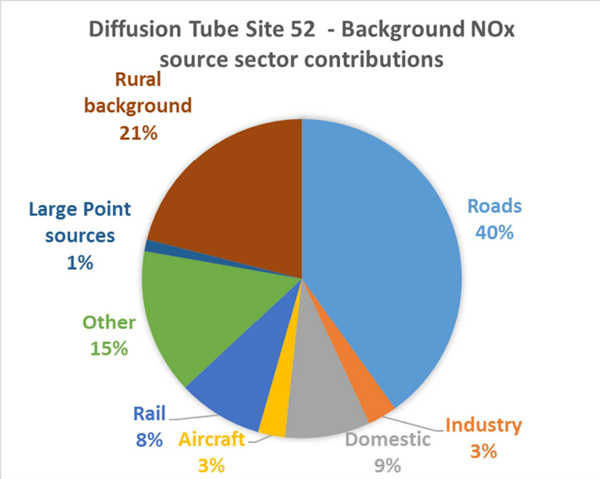

Diffusion Tube Site 17 - Old Church Lane junction with Neasden Lane
Total background 30%
Cars 34%
Taxi 2%
LGV 10%
Buses 14%
HGV 10%

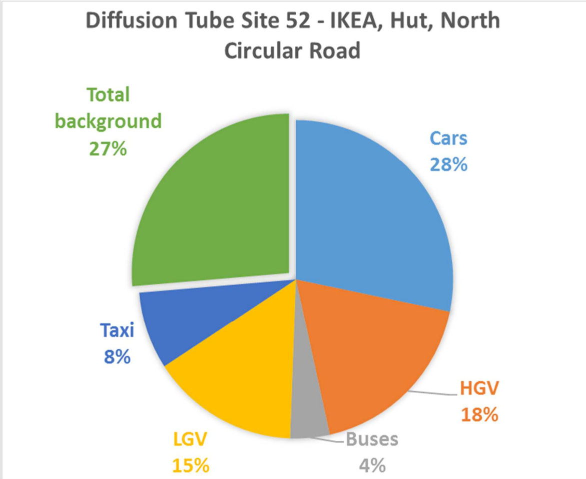

Diffusion Tube Site 23 - Background NOx source sector contributions
Rural background 23%
Roads 43%
Large Point sources 1%
Other 9%
Rail 7%
Aircraft 3%
Domestic 11%
Industry 3%

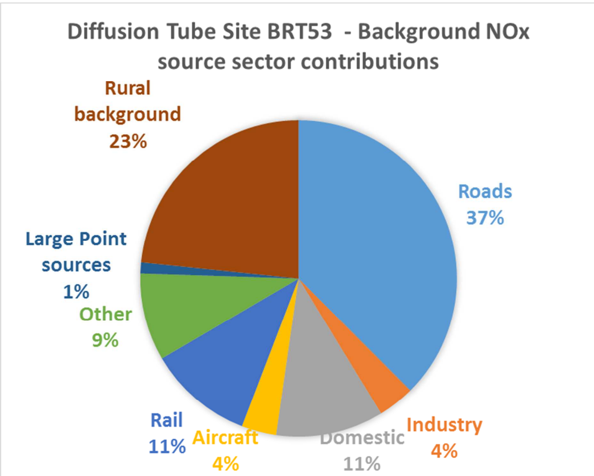

Diffusion Tube Site 23 - Junction North Circular Rd / Chartley Avenue
Total background 20%
Cars 31%
Taxi 8%
LGV 16%
Buses 5%
HGV 20%

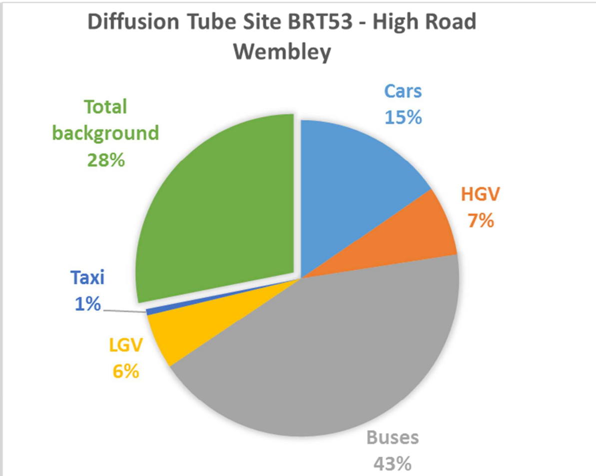

Diffusion Tube Site 30 - Background NOx source sector contributions
Rural background 23%
Roads 42%
Large Point sources 1%
Other 7%
Rail 9%
Aircraft 1%
Domestic 14%
Industry 3%

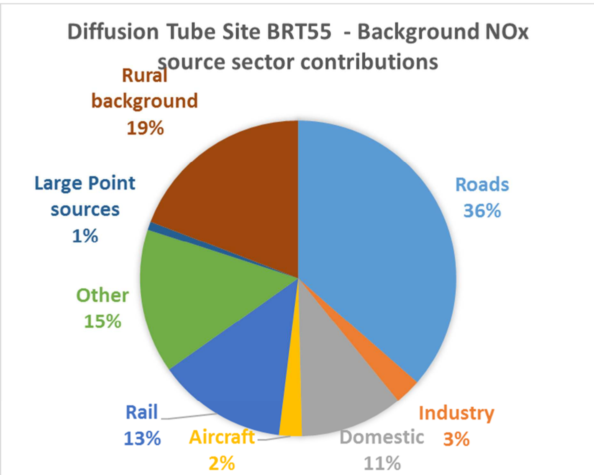

Diffusion Tube Site 30 - Chichele Road near Melrose Ave
Cars 16%
Total background 50%
HGV 9%
Buses 14%
LGV 7%
Taxi 4%

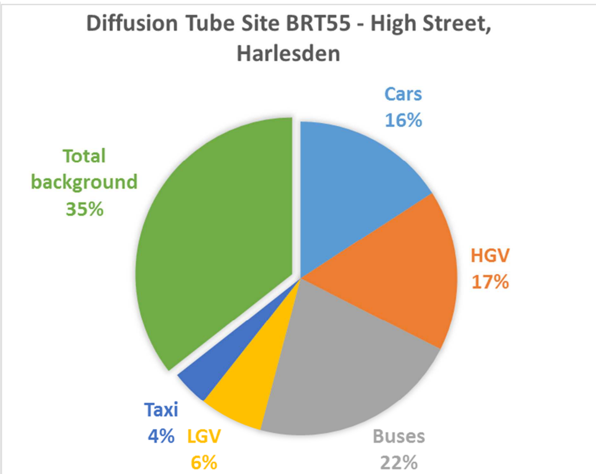

Diffusion Tube Site 52 - Background NOx source sector contributions
Rural background 21%
Large Point sources 1%
Other 15%
Rail 8%
Aircraft 3%
Domestic 9%
Industry 3%
Roads 40%


Diffusion Tube Site 52 - IKEA, Hut, North Circular Road
Total background 27%
Cars 28%
Taxi 8%
HGV 18%
LGV 15%
Buses 4%


Diffusion Tube Site BRT53 - Background NOx source sector contributions
Rural background 23%
Roads 37%
Large Point sources 1%
Other 9%
Rail 11%
Aircraft 4%
Domestic 11%
Industry 4%


Diffusion Tube Site BRT53 - High Road Wembley
Cars 15%
Total background 28%
HGV 7%
Taxi 1%
LGV 6%
Buses 43%


Diffusion Tube Site BRT55 - Background NOx source sector contributions
Rural background 19%
Large Point sources 1%
Roads 36%
Other 15%
Rail 13%
Aircraft 2%
Domestic 11%
Industry 3%


Diffusion Tube Site BRT55 - High Street, Harlesden
Cars 16%
Total background 35%
HGV 17%
Taxi 4%
LGV 6%
Buses 22%

6 Local Scale modelling of Air Quality Action Areas (AQAA)

6.1 Air Quality Action Areas

London Borough of Brent have identified a series of Air Quality Action Areas (AQAA) which are key areas of concern for the Council. The AQAAs encompass most of the GLA “Focus areas” but also include areas of planned development, areas of concern for communities and regeneration zones. The Brent Air Quality Action Plan (AQAP) will develop strategic policies and locally focussed measures in these areas.

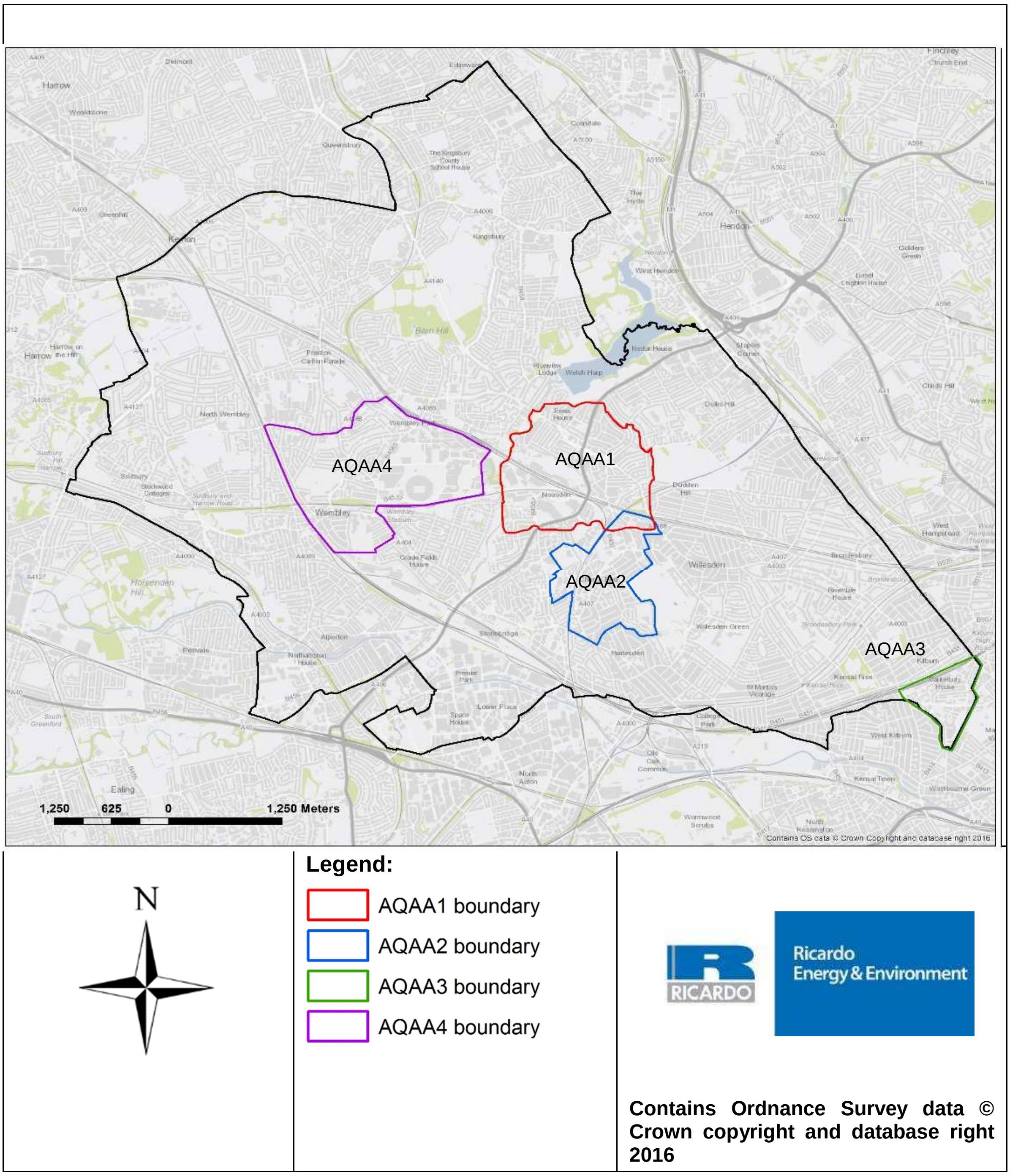
The AQAAs are:

- AQAA 1: Neasden town centre
- AQAA 2: Church End
- AQAA 3: Kilburn Regeneration Area
- AQAA 4: Wembley and Tokyngton

For this part of the assessment, pollutant concentrations have been modelled at a local scale within each AQAA using the atmospheric dispersion model ADMS Roads (version 4). Each locally focused AQAA model was initially modelled using 2015 traffic data verified using the 2015 diffusion tube measurements and a Road NOx adjustment factor derived. Further information on model verification for each AQAA model is presented in Appendix A.

A map showing the location of each AQAA relative to the Borough Boundary is presented in Figure 13.

Figure 13: London Borough of Brent Air Quality Action Area (AQAA) locations



6.2 Emission Reduction Scenarios

The Brent AQAP action plan consider a number of potential measures that may help reduce vehicle emission and NO_2 concentrations. Scenarios simulating either single emission reduction measures or a mix of measures have been modelled within each AQAA.

The emission reduction scenarios modelled are:

A. Impact on emissions from the (proposed) extension of the London ULEZ [ULEZ extension]
B. Restricted access to controlled routes for HGVs [HGV routes]
C. Clean-air routes for Buses [Bus Clean-air routes]
D. Additional -5% diesel convert to Euro 6 petrol due to local measures (£25 fee diesel parking charge, eV parking, car free developments.)
E. T-charge (proposal) restricting diesel LGVs and taxi in addition to HGV and Bus restrictions. [T-charge impact]

Further detail on each emission reduction scenario is provided in Section 6.2.1 and Section 6.2.2 below.

All future scenarios, including the future baseline, have been modelled during the year 2021. Future traffic flows data from the 2020 LAEI traffic dataset growth factored to 2021 have been used. All future modelled NO_2 concentrations account for the predicted reduction in background NOx/NO_2 concentrations, projected decreases in vehicle NOx emissions, and projected changes to the fraction of NOx emitted as primary NO_2 from road vehicles over time as the vehicle fleet changes.

Additional community based and/or local focussed actions are also planned within the AQAP, however measures such as walking, cycling, electric vehicle hubs and low emission neighbourhoods have not been modelled. This is because although these measures are valued and essential for delivering an effective Action Plan they are also difficult to quantify with definitive emissions reductions.

6.2.1 Borough wide scenarios

Scenario A and E are borough wide scenarios which aim to simulate the impact of potential GLA plans that are currently proposed (yet to be consulted) by the new London Mayor.

6.2.1.1 Scenario A - Ultra Low Emission Zone (ULEZ)

Scenario A considers the impact of the proposed extension of the London Ultra Low Emission Zone (ULEZ). On the 5th July 2016, The Mayor of London launched a consultation proposing an extended ULEZ along with other measures. The proposals relevant to the ULEZ were to:

- Introduce the central London Ultra-Low Emission Zone one year earlier in 2019;
- Extend the ULEZ beyond central London from 2020: for motorcycles, cars and vans, to the North and South Circular; and for lorries, buses and coaches London-wide.

The current ULEZ vehicle requirements are presented in **Error! Not a valid bookmark self-reference.**. To model the impact of the latest ULEZ proposal on air quality within Brent we have assumed that take up of the vehicle criteria will be 100% effective within the Borough. This is an optimistic estimate of the emission reductions possible.

To provide a better estimate of the potential effectiveness of enforcing the ULEZ vehicle requirements within Brent, further analysis of the impact on the local traffic fleet is required. The predicted emission and concentration reductions are therefore likely to be an overestimate of the actual impact of this measure. The change in emissions from motorcycles, cars and vans has only been applied to road links located north of the north circular road.

Vehicle type (includes hybrid vehicles)	Minimum emission standards*	Date from which manufacturers must register new vehicles meeting the new emission standards (usually a year earlier for earlier adopters)	Maximum age of vehicle by 2020**	Charge if vehicle is not compliant with ULEZ standards***
Motorcycle, moped etc. - Category L	Euro 3	From 1 July 2007	13 years	£12.50
Car and small van - Category M1 and N1 (I)	Euro 4 (petrol) Euro 6 (diesel)	From 1 January 2006 From 1 September 2015	14 years 5 years	£12.50
Large van and minibus - Category N1 (II and III) and M2	Euro 4 (petrol) Euro 6 (diesel)	From 1 January 2007 From 1 September 2016	13 years 4 years	£12.50
HGV - Category N2 and N3	Euro VI	From 1 January 2014	6 years	£100
Bus/coach - Category M3	Euro VI	From 1 January 2014	6 years	£100

Table 9: London ULEZ vehicle requirements

* Euro standards for heavy-duty diesel engines use Roman numerals and light-duty vehicle standards use Arabic numerals
** Vehicles this age or younger in 2020 will comply the ULEZ standards and not incur a charge
*** This is payable in addition to any applicable LEZ and/or CC charges

6.2.1.2 Scenario E - T-Charge Proposals

Scenario E considers the impact of the proposal to implement an emissions Surcharge (The 'T-charge') on the most polluting vehicles entering central London from 2017. If implemented, the charge will apply to all vehicles with pre-Euro 4 emission standards (broadly speaking those registered before 2005) and will cost an extra £10 per day on top of the existing Congestion Charge.

To model the potential effect of this measure on air quality, two sub-scenarios estimating how implementation of the T-Charge may affect the vehicle fleet mix within Brent have been modelled. It should be noted that these are arbitrary estimates of the impact of the T-Charge. Detailed analysis of the likely traffic impacts of this measure will be required to provide a more realistic estimate of the actual likely change in the vehicle fleet mix, should it be required.

The sub-scenarios modelled were:

- Scenario E1 – simulates a 20% reduction in Euro 4 (all vehicles) – assumes all Euro 4 are replaced with Euro 6
- Scenario E2 – simulates a 50% reduction in Euro 4 (all vehicles) – assumes all Euro 4 are replaced with Euro 6

6.2.2 Locally focused scenarios

Scenarios B, C, D and F locally focused emission reduction measure options in the AQAAs.

6.2.2.1 Scenario B - Restricted access to controlled routes for HGVs

Scenario B assesses the impact of restricting HGV traffic and has been modelled in the Kilburn AQAA3 only. Two sub-scenarios estimating how implementation of the HGV restrictions may affect NO_2 concentrations within the Kilburn area have been modelled.

The sub-scenarios modelled were:

- B1 - 20% reduction in HGV traffic on main routes
- B2 - 50% reduction in HGV traffic on main routes

6.2.2.2 Scenario C - Clean-air routes for Buses

Scenario C assesses the impact of implementing clean air routes for buses whereby either fully electric buses or hybrid buses are adopted. Two sub scenarios have been modelled as follows:

- C1 – 100% buses are electric, effectively removing NOx emissions from buses completely.
- C2 – 50% of buses are hybrid/electric and 50% are electric bus.

6.2.2.3 Scenario D – Local measures to discourage diesel vehicle uptake and use.

Scenario D represents an estimated reduction of 5% in diesel car use that could be achieved by implementing local measures e.g. a £25 fee diesel parking charge, free parking for electric vehicles and car free development zones.

6.3 Emission reduction scenario modelling results

The following sections of this chapter present the local scale dispersion modelling results for each of the four AQAAs identified. For each AQAA we have included a summary of information regarding its selection as an area of concern, the modelled 2015 baseline NO_2 concentrations and the relevant source apportionment analysis. This then leads on to which emission reduction measure scenarios have been modelled in each locality followed by the modelled future year (2021) NO_2 concentrations for each scenario tested.

Annual mean NO_2 concentrations have been predicted at a selection of worst case receptor locations within each AQAA. The predicted magnitude of change in annual mean NO_2 concentrations when compared with the future baseline i.e. business as usual in 2021 is presented for each scenario.

6.3.1 AQAA 1: Neasden town centre

AQAA1 is the area around Neasdon town centre. A map showing the location of the receptors included in the scenario analysis is presented in Figure 11.

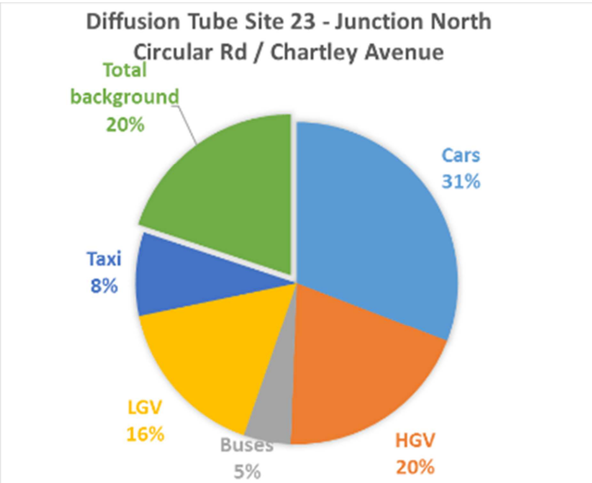
This area has been identified as an area of concern for the following reasons:

- It incorporates some of the North circular which is a critical route through the Borough and a significant source of pollution.
- It is in very close proximity to the air quality focus area which incorporates Dudden Hill Lane.
- Includes Neasden Goods Yard – a significant source of PM_{10}, and other sources of industrial PM in this location also
- Includes the automatic air quality monitoring station (IKEA)
- Includes Neasden Town Centre – location earmarked for Public Realm Improvement so may offer the opportunity for future joint work and funding

6.3.1.1 Baseline modelling and source apportionment results

The source apportionment pie charts for the diffusion tube sites within AQAA1 are reproduced in Figure 14; these are based on the modelled emissions and background concentrations in 2015. A contour plot showing the modelled spatial variation in annual mean NO_2 concentrations in 2015 is presented in Figure 16.

Figure 14: Source apportionment analysis at diffusion tube sites in AQAA1



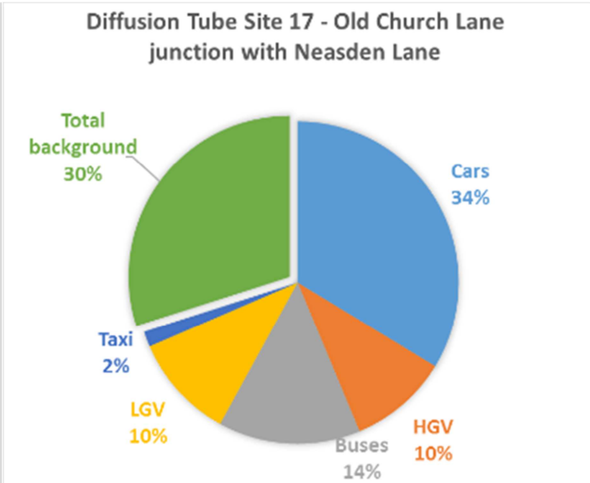
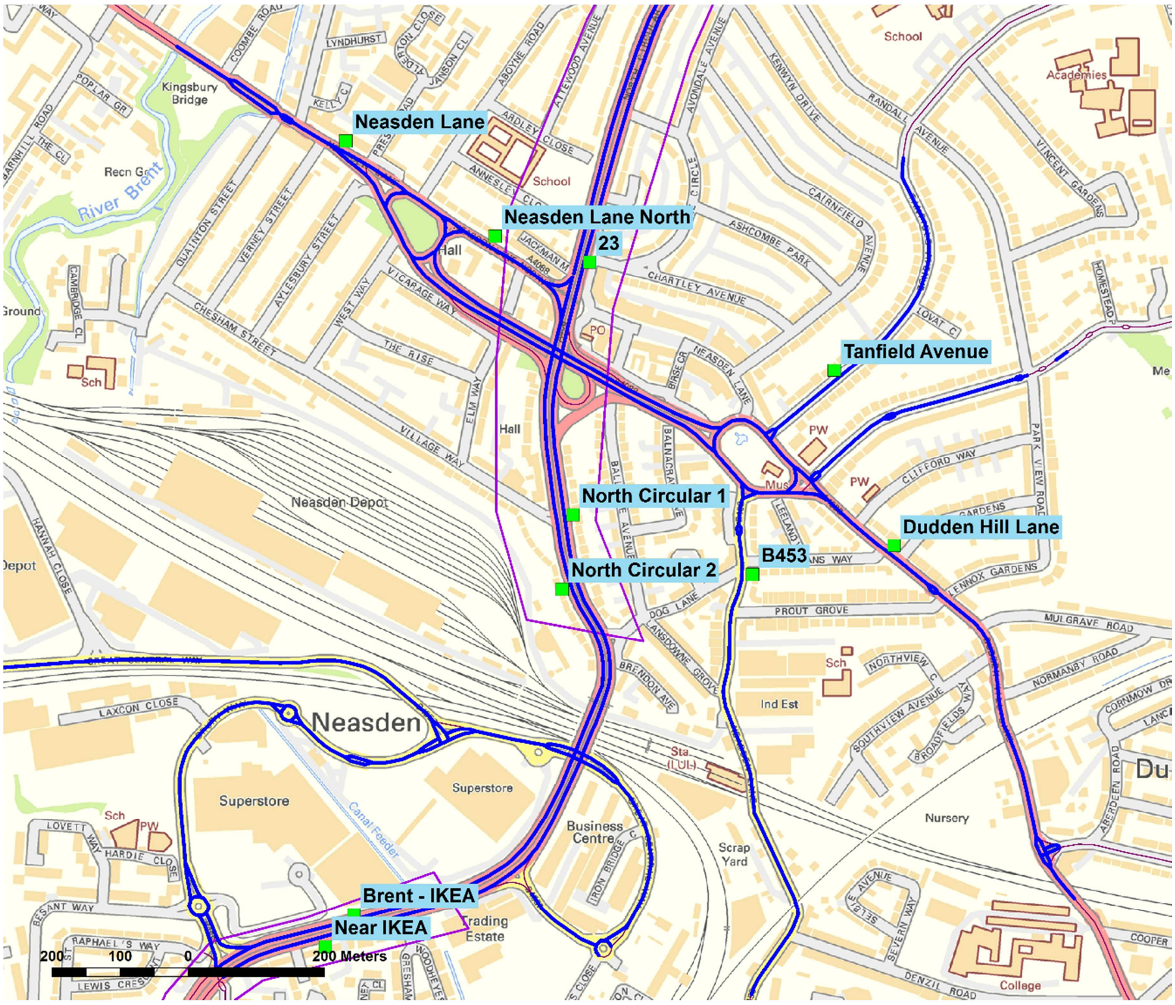


Figure 15: AQAA1 – Neasdon Lane – Model receptor locations

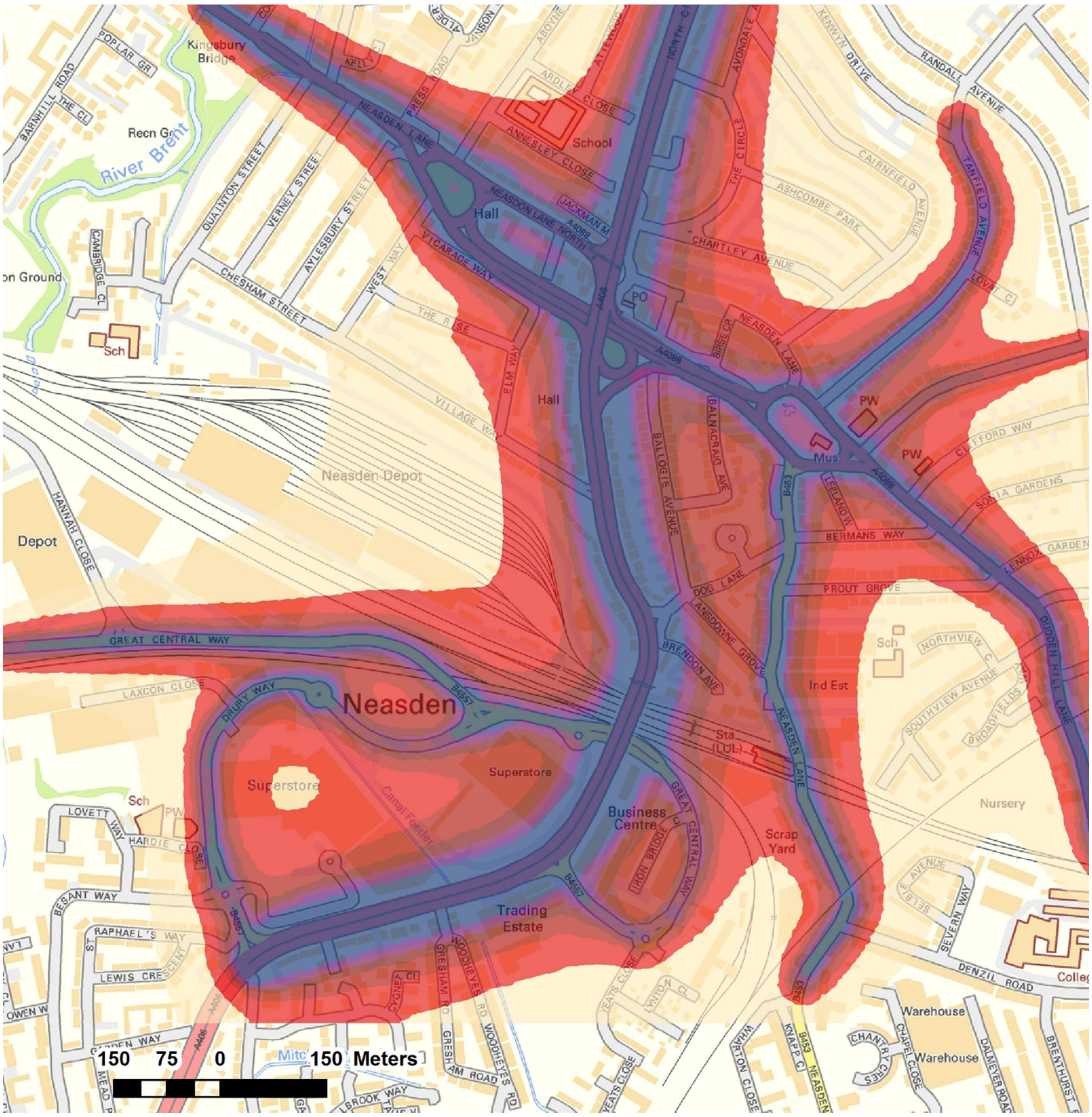


Legend:

- ADMS Receptor
- ADMS Road Source
- Focus area boundary

Contains Ordnance Survey data © Crown copyright and database right 2016

Figure 16: AQAA1 – Neasdon Lane – NO_2 annual mean concentrations 2015 at 1.5m height



N

Legend

NO_2 Annual Mean ($\mu g.m^{-3}$)

- <36
- 36 - 40
- 40 - 44
- 44 - 48
- 48 - 52
- 52 - 56
- 56 - 60
- 60 - 145.5

6.3.1.2 AQAA1 - Emission reduction scenarios

The scenarios modelled within AQAA1 were as follows:

A. ULEZ extension
B. -
C. Bus Clean-air routes (Euro standards 2021 (baseline) scenario)
   - C1 - electric (100 %)
   - C2 - hybrid/elec. (50%) /electric bus routes (50%)
D. -
E. T-charge impacts
   - E1 – 20% reduction in Euro 4 (all vehicles) replace AADT with Euro 6
   - E2 – 50% reduction in Euro 4 (all vehicles) as above

A comparison of the predicted annual mean NO_2 concentrations for each scenario at the modelled receptor locations are presented in Table 10 to Table 14.

The predicted magnitude of change in annual mean NO_2 concentrations when compared with the future baseline i.e. business as usual in 2021 is presented as both a concentration and percentage change for each scenario modelled.

The 2021 baseline results are in excess of the 40 $\mu g.m^{-3}$ NO_2 annual mean objective at all of the receptor locations modelled. Scenario A (ULEZ extension) provides the greatest reductions in emission concentrations. The predicted impact of the ULEZ scenario, which is likely to be optimistic (as discussed in Section 6.2.1) is still insufficient to achieve compliance with the NO_2 annual mean objective at the majority of the receptor locations modelled.

Table 10: AQAA1 – Scenario A ULEZ extension – predicted NO_2 annual mean concentrations

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
Brent - IKEA	2.5	62.9	51.9	11.0	17%
23	2.5	68.0	55.5	12.5	18%
Neasden Lane	1.5	49.6	43.4	6.2	13%
Neasden Lane North	1.5	46.5	41.6	5.0	11%
North Circular 1	1.5	62.4	51.5	11.0	18%
North Circular 2	1.5	51.1	43.4	7.7	15%
Dudden Hill Lane	1.5	43.5	38.0	5.4	13%
Near IKEA	1.5	56.8	47.7	9.1	16%
B453	1.5	44.1	38.4	5.7	13%
Tanfield Avenue	1.5	41.0	35.5	5.5	13%

Table 11: AQAA1 – Scenario C1 Bus Clean Air Routes (100% electric) – predicted NO_2 annual mean conc.

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
Brent - IKEA	2.5	62.9	62.1	0.8	1%
23	2.5	68.0	66.8	1.2	2%
Neasden Lane	1.5	49.6	45.8	3.8	8%

Neasden Lane North	1.5	46.5	44.5	2.0	4%
North Circular 1	1.5	62.4	61.5	0.9	1%
North Circular 2	1.5	51.1	50.4	0.7	1%
Dudden Hill Lane	1.5	43.5	42.4	1.0	2%
Near IKEA	1.5	56.8	56.0	0.8	1%
B453	1.5	44.1	43.1	1.0	2%
Tanfield Avenue	1.5	41.0	38.7	2.3	6%

Table 12: AQAA1 – Scenario C2 Bus Clean Air Routes (50% Hybrid/50% electric) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
Brent - IKEA	2.5	62.9	62.7	0.2	0.3%
23	2.5	68.0	67.7	0.3	0.5%
Neasden Lane	1.5	49.6	48.6	1.0	2%
Neasden Lane North	1.5	46.5	46.0	0.5	1%
North Circular 1	1.5	62.4	62.2	0.3	0.4%
North Circular 2	1.5	51.1	50.9	0.2	0.4%
Dudden Hill Lane	1.5	43.5	43.2	0.3	1%
Near IKEA	1.5	56.8	56.6	0.2	0.4%
B453	1.5	44.1	43.9	0.3	1%
Tanfield Avenue	1.5	41.0	40.4	0.6	2%

Table 13: AQAA1 – Scenario E1 T-Charge (20% reduction in Euro 4) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
Brent - IKEA	2.5	62.9	62.4	0.5	1%
23	2.5	68.0	67.3	0.6	1%
Neasden Lane	1.5	49.6	49.1	0.5	1%
Neasden Lane North	1.5	46.5	46.2	0.4	1%
North Circular 1	1.5	62.4	61.9	0.5	1%
North Circular 2	1.5	51.1	50.7	0.4	1%
Dudden Hill Lane	1.5	43.5	43.2	0.3	1%
Near IKEA	1.5	56.8	56.4	0.4	1%
B453	1.5	44.1	43.9	0.3	1%
Tanfield Avenue	1.5	41.0	40.7	0.3	1%

Table 14: AQAA1 – Scenario E2 T-Charge (50% reduction in Euro 4) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline (µg.m^{-3})	2021 with emission measure (µg.m^{-3})	Magnitude of change (µg.m^{-3})	Magnitude of change (%)
Brent - IKEA	2.5	62.9	61.7	1.2	2%
23	2.5	68.0	66.5	1.5	2%
Neasden Lane	1.5	49.6	48.6	1.0	2%
Neasden Lane North	1.5	46.5	45.7	0.8	2%
North Circular 1	1.5	62.4	61.2	1.2	2%
North Circular 2	1.5	51.1	50.2	0.9	2%
Dudden Hill Lane	1.5	43.5	42.9	0.5	1%
Near IKEA	1.5	56.8	55.9	0.9	2%
B453	1.5	44.1	43.5	0.6	1%
Tanfield Avenue	1.5	41.0	40.5	0.5	1%

6.3.2 AQAA 2: Church End

AQAA2 encompasses the area around Church end. A map showing the location of the AQAA and the receptors included in the scenario analysis is presented in Figure 18.

This area has been identified as an area of concern for the following reasons:

- Church End is one of the priority areas in the borough.
- Promoted for mixed use regeneration, around eight hectares of brownfield land will provide space for approximately 800 new homes by 2026 supported by additional infrastructure such as education facilities, affordable housing, new health provision and space for recreation and play
- Close proximity to Air Quality Focus Area
- Includes/very close to Harlesden Town Centre, another location for AQ monitoring station
- Includes a range of uses power station, industrial areas, residential, green space and canal
- On borough boundary so consider potential for cross-borough work and partnership.

6.3.2.1 Baseline modelling and source apportionment results

The source apportionment pie charts for the diffusion tube sites within AQAA2 are reproduced in Figure 17; these are based on the modelled emissions and background concentrations in 2015. A contour plot showing the modelled spatial variation in annual mean NO_2 concentrations in 2015 is presented in Figure 19

Figure 17: Source apportionment analysis at diffusion tube sites in AQAA2

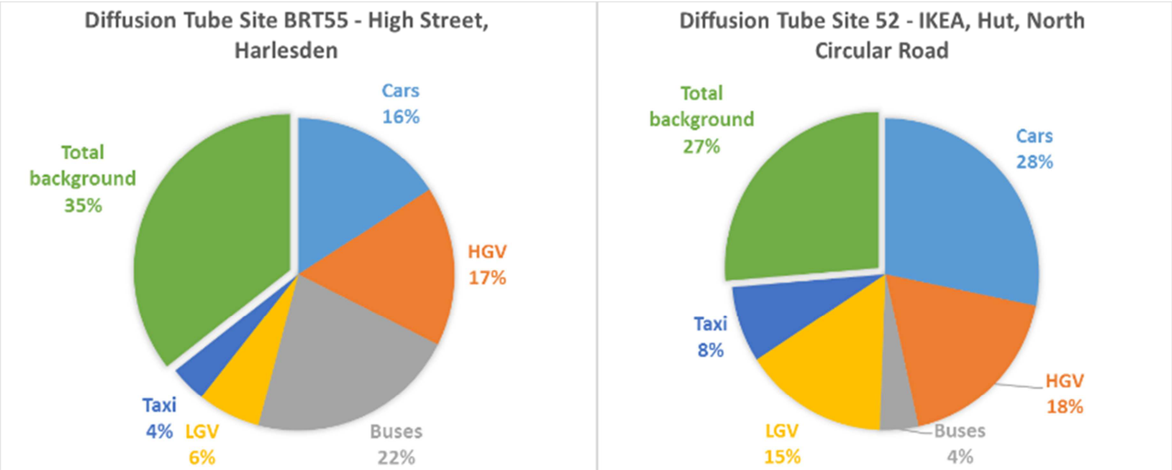
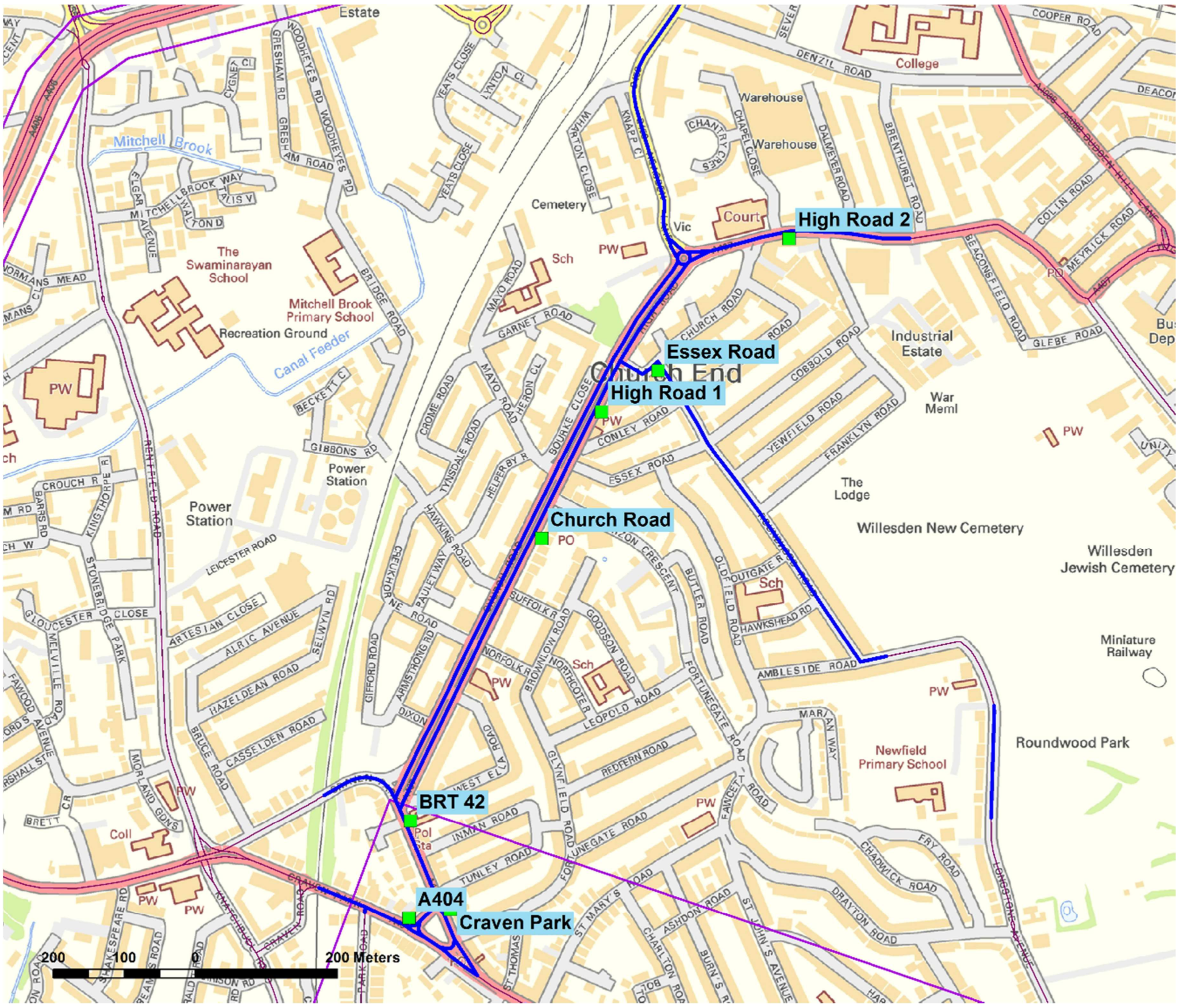


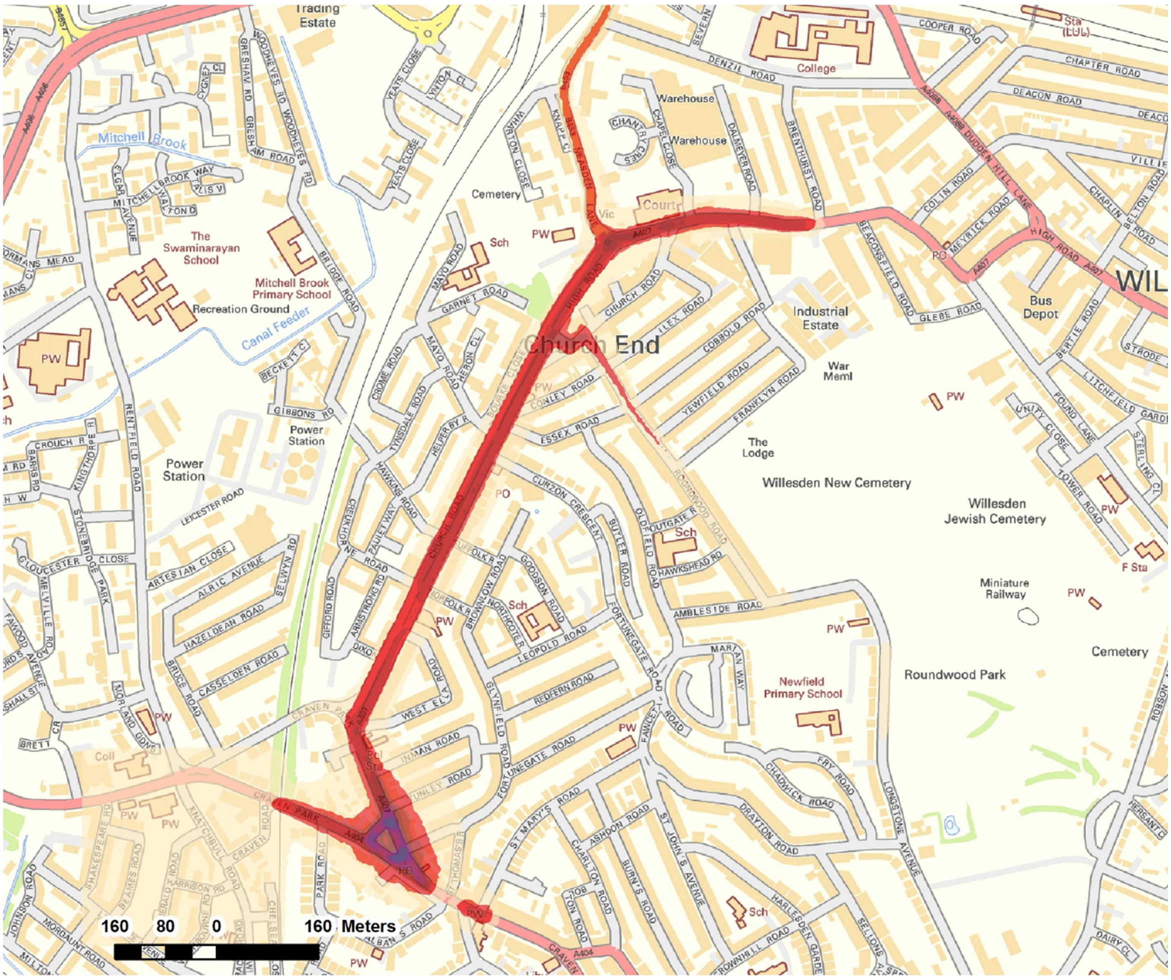
Figure 18: AQAA2 – Church End



Legend:

- ADMS Receptor
- ADMS Road Source
- Focus area boundary

Figure 19: AQAA2 – Church End – NO_2 annual mean concentrations 2015 at 1.5m height



N

Legend:

NO_2 Annual Mean ($\mu g.m^{-3}$)

- <36
- 36 - 40
- 40 - 44
- 44 - 48
- 48 - 52
- 52 - 56
- 56 - 60
- 60 - 67.6

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6.3.2.2 AQAA2 - Emission reduction scenarios

The scenarios modelled within AQAA2 were as follows:

A. ULEZ extension
B. -
C. Bus Clean-air routes (Euro standards 2021 (baseline) scenario)
   - C1 - electric (100 %)
   - C2 - hybrid/elec. (50%) /electric bus routes (50%)
D. –
E. T-charge impacts (Borough wide)
   - E1 – 20% reduction in Euro 4 (all vehicles) replace AADT with Euro 6
   - E2 – 50% reduction in Euro 4 (all vehicles) as above

A comparison of the predicted annual mean NO_2 concentrations for each scenario are presented in Table 15 to Table 19. The predicted magnitude of change in annual mean NO_2 concentrations when compared with the future baseline i.e. business as usual in 2021 is presented as both a concentration and percentage change for each scenario modelled.

The 2021 baseline results indicate that NO_2 annual mean concentrations will be compliant with the 40 $\mu g.m^{-3}$ objective at all except one of the receptor locations modelled (Craven Park). Scenario A (ULEZ extension) provides the greatest reductions in emission concentrations. The results for Scenario C1 (Bus Clean Air Routes (100% electric)) also indicate that compliance with the annual mean objective could be achieved at all of the modelled receptor locations with this measure in place.

Table 15: AQAA2 – Scenario A ULEZ extension – predicted NO_2 annual mean concentrations

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
BRT 42	2.5	37.8	35.4	2.4	6%
Craven Park	1.5	41.5	37.5	4.0	10%
A404	1.5	38.4	35.9	2.5	7%
Church Road	1.5	34.9	33.0	2.0	6%
High Road 1	4	33.8	32.3	1.5	4%
Essex Road	1.5	35.4	33.3	2.1	6%
High Road 2	1.5	35.4	33.2	2.2	6%

Table 16: AQAA2 – Scenario C1 Bus Clean Air Routes (100% electric) – predicted NO_2 annual mean conc.

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
BRT 42	2.5	37.8	36.6	1.2	3%
Craven Park	1.5	41.5	39.1	2.5	6%
A404	1.5	38.4	37.2	1.2	3%
Church Road	1.5	34.9	33.8	1.1	3%
High Road 1	4	33.8	33.0	0.7	2%
Essex Road	1.5	35.4	34.6	0.8	2%
High Road 2	1.5	35.4	34.3	1.1	3%

Table 17: AQAA2 – Scenario C2 Bus Clean Air Routes (50% Hybrid/50% electric) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline (µg.m^{-3})	2021 with emission measure (µg.m^{-3})	Magnitude of change (µg.m^{-3})	Magnitude of change (%)
BRT 42	2.5	37.8	37.5	0.3	1%
Craven Park	1.5	41.5	40.9	0.7	2%
A404	1.5	38.4	38.1	0.3	1%
Church Road	1.5	34.9	34.6	0.3	1%
High Road 1	4	33.8	33.6	0.2	1%
Essex Road	1.5	35.4	35.2	0.2	1%
High Road 2	1.5	35.4	35.1	0.3	1%

Table 18: AQAA2 – Scenario E1 T-Charge (20% reduction in Euro 4) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline (µg.m^{-3})	2021 with emission measure (µg.m^{-3})	Magnitude of change (µg.m^{-3})	Magnitude of change (%)
BRT 42	2.5	37.8	37.7	0.1	0.4%
Craven Park	1.5	41.5	41.3	0.3	0.6%
A404	1.5	38.4	38.2	0.1	0.4%
Church Road	1.5	34.9	34.8	0.1	0.4%
High Road 1	4	33.8	33.7	0.1	0.3%
Essex Road	1.5	35.4	35.3	0.1	0.3%
High Road 2	1.5	35.4	35.3	0.1	0.4%

Table 19: AQAA2 – Scenario E2 T-Charge (50% reduction in Euro 4) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline (µg.m^{-3})	2021 with emission measure (µg.m^{-3})	Magnitude of change (µg.m^{-3})	Magnitude of change (%)
BRT 42	2.5	37.8	37.5	0.3	1%
Craven Park	1.5	41.5	41.1	0.4	1%
A404	1.5	38.4	38.1	0.3	1%
Church Road	1.5	34.9	34.7	0.2	1%
High Road 1	4	33.8	33.6	0.2	0.5%
Essex Road	1.5	35.4	35.2	0.2	1%
High Road 2	1.5	35.4	35.2	0.2	1%

6.3.3 AQAA 3: Kilburn Regeneration Area

AQAA3 covers the Kilburn area in Brent. A map showing the location of the AQAA and the receptors included in the scenario analysis is presented in Figure 21: AQAA3 – KilburnFigure 21.

This area has been identified as an area of concern for the following reasons:

- Area prioritised for development of 2600 homes to 2026
- Some work being undertaken in this area Cambridge Gardens, Brondesbury road with TfL to improve/ escalate the provision of cleaner buses (hybrid)
- Brent Council is in the process of assisting local residents to undertake their own monitoring
- Location for HS2 at borough edge – including the vent shaft for HS2, high local HGV traffic from vehicles is expected in the future
- Major regeneration area, close location to Kilburn High Road – key town centre
- Opportunity for joint work or initiatives with Camden and / or Westminster
- The is a proposal for local energy centre

The source apportionment pie chart for the diffusion tube sites within AQAA3 is reproduced in Figure 20. A contour plot showing the modelled spatial variation in annual mean NO_2 concentrations in 2015 is presented in Figure 16.

6.3.3.1 Baseline modelling and source apportionment results

Figure 20: NOx Source apportionment analysis in AQAA3

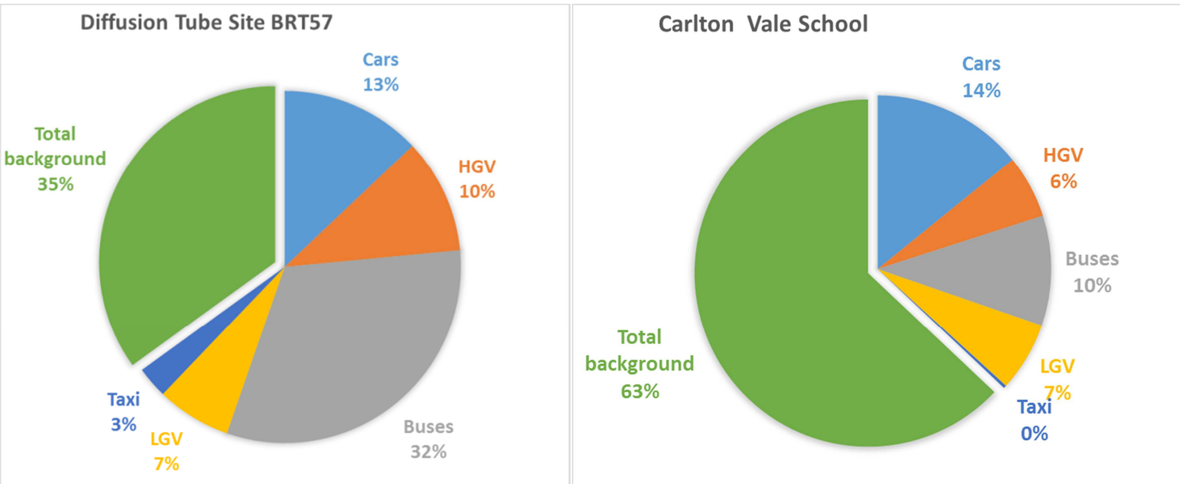
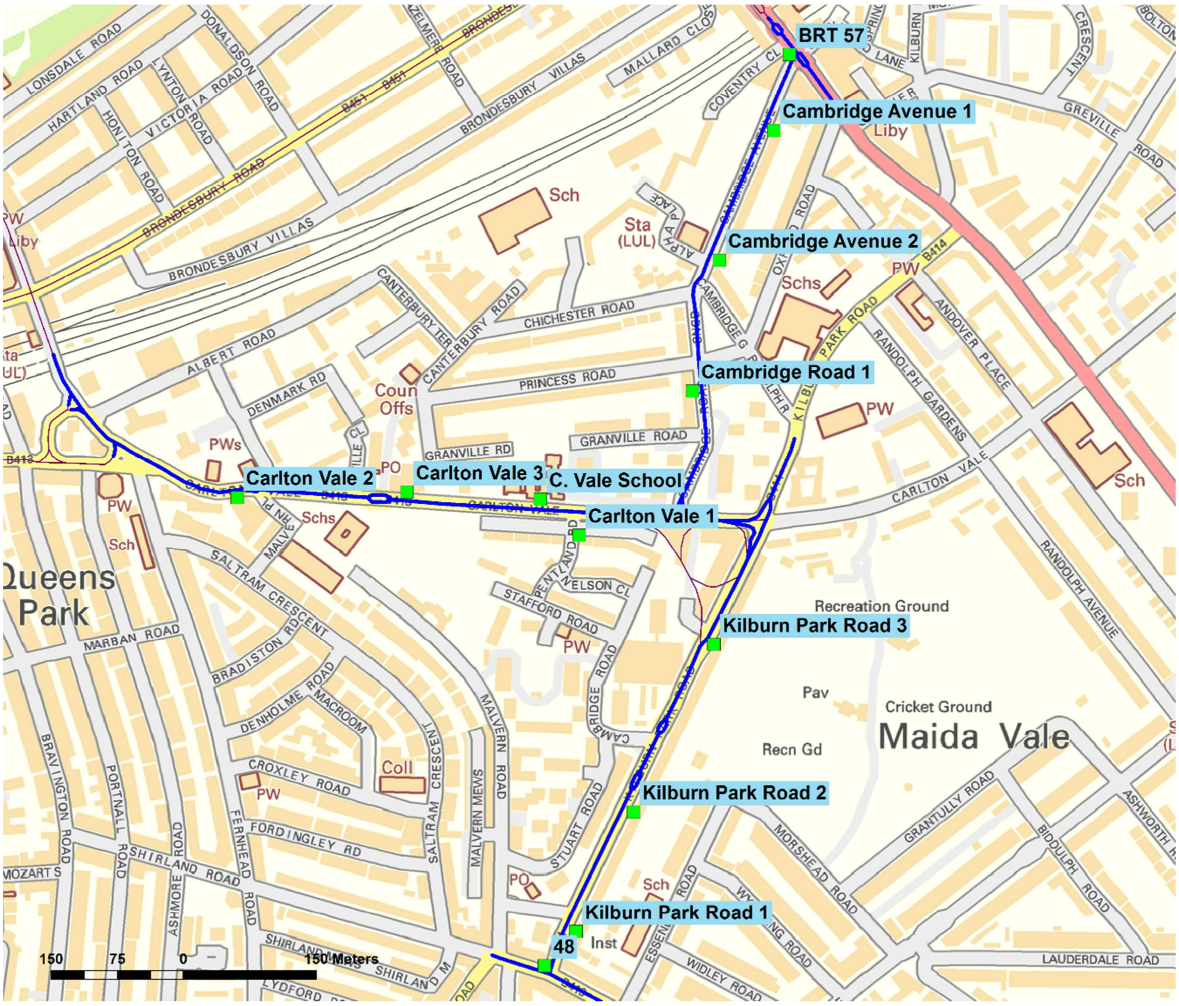


Figure 21: AQAA3 – Kilburn



Legend:

- ADMS Receptor
- ADMS Road Source
- Focus area boundary

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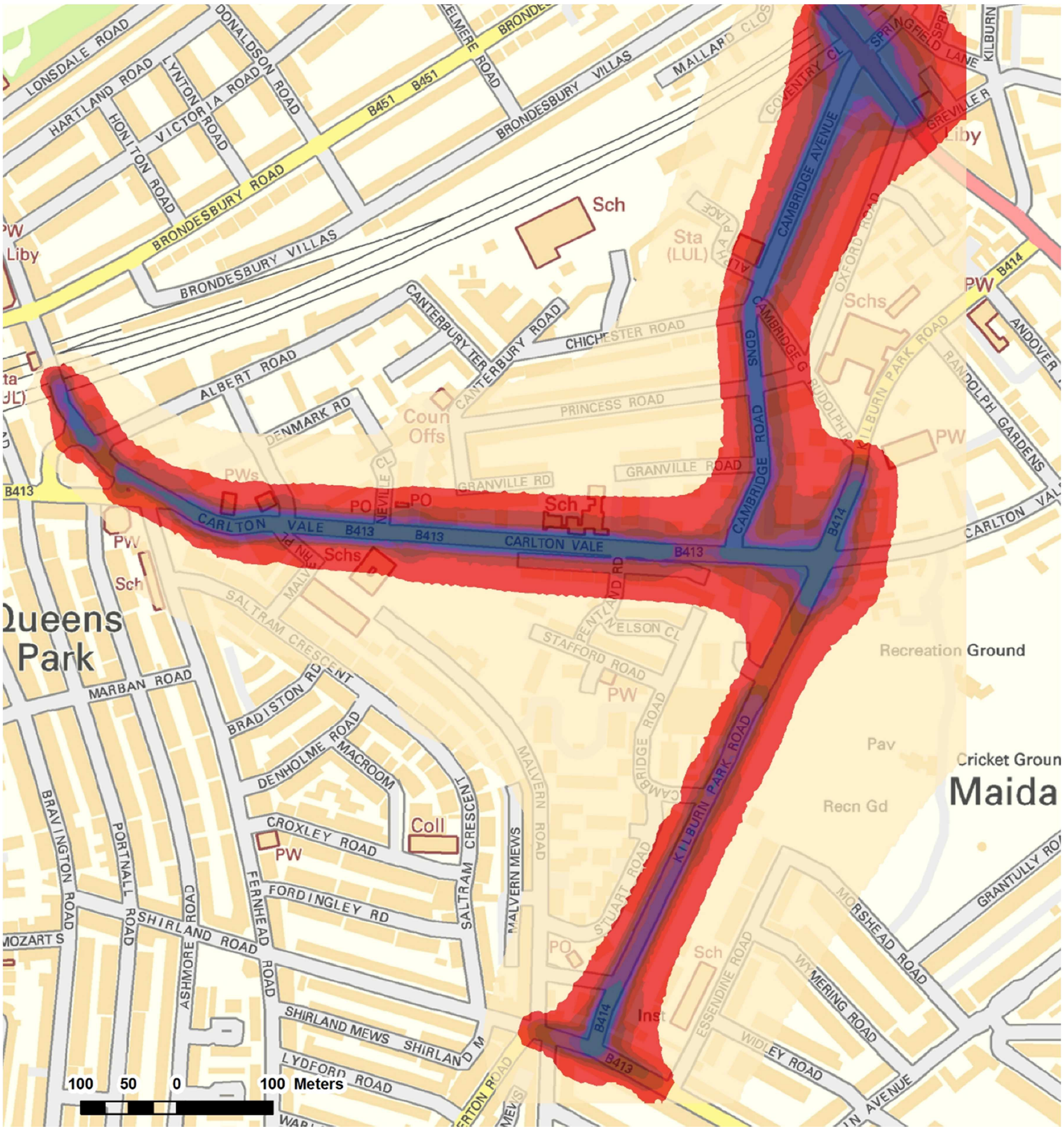
Figure 22: AQAA3 – Kilburn – NO_2 annual mean concentrations 2015 at 1.5m height



Legend

NO_2 Annual Mean ($\mu g.m^{-3}$)

- <36
- 36 - 40
- 40 - 44
- 44 - 48
- 48 - 52
- 52 - 56
- 56 - 60
- 60 - 137.7

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6.3.3.2 AQAA3 - Emission reduction scenarios

The scenarios modelled within AQAA3 were as follows:

A. ULEZ extension
B. HGV –
   - o B1 - 20% reduction on main routes
   - o B2 – 50% reduction on main routes
C. Bus Clean-air routes (Euro standards 2021 (baseline) scenario)
   - o C1 - electric (100 %)
   - o C2 - hybrid/elec. (50%) /electric bus routes (50%)
D. -
E. T-charge impacts
   - E1 – 20% reduction in Euro 4 (all vehicles) replace AADT with Euro 6
   - E2 – 50% reduction in Euro 4 (all vehicles) as above

A comparison of the predicted annual mean NO_2 concentrations for each scenario are presented in Table 20 to Table 26. Exceedances of the 40 µg.m^{-3} annual mean objective are predicted at most of the receptor locations in the future baseline year 2021.

As with the other AQAA's, the model results for Scenario A (ULEZ extension) indicate that this measure will provide the greatest reductions in NO_2 concentrations. The Scenario A results indicate that compliance could be achieved at most receptor locations, although the predicted concentration with this measure in place are still close to the 40 µg.m^{-3} objective. These results should therefore be considered in context with the limitations of the assumptions in the ULEZ extension scenario, i.e. its' impact is likely to be optimistic as based on 100% effectiveness. The modelled reduction in concentration can be adjusted to reflect any future evidence that becomes available on the likely impact of the ULEZ extension on the vehicle fleet mix in Brent.

The results for Scenario C1 (Bus Clean Air Routes (100% electric)) indicate that this measure will have a reasonably significant impact on annual mean NO_2 concentrations, with reductions of up to 21% predicted. This corresponds with the source apportionment analysis at diffusion tube site BRT57 at Kilburn Bridge where buses account for a large proportion of total NOx.

Table 20: AQAA3 – Scenario A ULEZ extension – predicted NO_2 annual mean concentrations

Receptor	Height	2021 Future Baseline (µg.m^{-3})	2021 with emission measure (µg.m^{-3})	Magnitude of change (µg.m^{-3})	Magnitude of change (%)
48	2.5	44.2	38.0	6.2	14%
BRT 57	2.5	62.5	48.0	14.5	23%
Kilburn Park Road 1	1.5	40.1	36.5	3.7	9%
Kilburn Park Road 2	1.5	39.4	35.2	4.2	11%
Kilburn Park Road 3	1.5	41.5	36.2	5.3	13%
Carlton Vale 1	1.5	37.5	34.9	2.6	7%
Cambridge Road 1	1.5	39.1	35.3	3.9	10%
Cambridge Avenue 1	1.5	47.1	38.4	8.7	19%
C. Vale School	1.5	43.5	39.0	4.5	10%
Carlton Vale 2	1.5	45.0	39.8	5.2	12%
Cambridge Avenue 2	1.5	44.8	37.3	7.5	17%
Carlton Vale 3	4	40.9	37.1	3.8	9%

Table 21: AQAA3 – Scenario B1 20% HGV reduction – predicted NO_2 annual mean concentrations

Receptor	Height	2021 Future Baseline (µg.m^{-3})	2021 with emission measure (µg.m^{-3})	Magnitude of change (µg.m^{-3})	Magnitude of change (%)
48	2.5	44.2	43.9	0.3	1%
BRT 57	2.5	62.5	61.8	0.6	1%
Kilburn Park Road 1	1.5	40.1	40.0	0.1	0.3%
Kilburn Park Road 2	1.5	39.4	39.3	0.2	0.4%
Kilburn Park Road 3	1.5	41.5	41.3	0.2	0.5%
Carlton Vale 1	1.5	37.5	37.4	0.1	0.3%
Cambridge Road 1	1.5	39.1	38.9	0.2	1%
Cambridge Avenue 1	1.5	47.1	46.8	0.4	1%
C. Vale School	1.5	43.5	43.3	0.2	0.4%
Carlton Vale 2	1.5	45.0	44.8	0.2	0.4%
Cambridge Avenue 2	1.5	44.8	44.5	0.3	1%
Carlton Vale 3	4	40.9	40.8	0.1	0.3%

Table 22: AQAA3 – Scenario B2 50% HGV reduction – predicted NO_2 annual mean concentrations

Receptor	Height	2021 Future Baseline (µg.m^{-3})	2021 with emission measure (µg.m^{-3})	Magnitude of change (µg.m^{-3})	Magnitude of change (%)
48	2.5	44.2	43.5	0.7	2%
BRT 57	2.5	62.5	60.8	1.6	3%
Kilburn Park Road 1	1.5	40.1	39.7	0.4	1%
Kilburn Park Road 2	1.5	39.4	39.0	0.4	1%
Kilburn Park Road 3	1.5	41.5	41.0	0.5	1%
Carlton Vale 1	1.5	37.5	37.2	0.2	1%
Cambridge Road 1	1.5	39.1	38.7	0.5	1%
Cambridge Avenue 1	1.5	47.1	46.2	0.9	2%
C. Vale School	1.5	43.5	43.1	0.4	1%
Carlton Vale 2	1.5	45.0	44.6	0.4	1%
Cambridge Avenue 2	1.5	44.8	44.0	0.8	2%
Carlton Vale 3	4	40.9	40.5	0.3	1%

Table 23: AQAA3 – Scenario C1 Bus Clean Air Routes (100% electric) – predicted NO_2 annual mean conc.

Receptor	Height	2021 Future Baseline (µg.m^{-3})	2021 with emission measure (µg.m^{-3})	Magnitude of change (µg.m^{-3})	Magnitude of change (%)
48	2.5	44.2	39.4	4.8	11%
BRT 57	2.5	62.5	49.2	13.3	21%
Kilburn Park Road 1	1.5	40.1	37.5	2.6	6%
Kilburn Park Road 2	1.5	39.4	35.7	3.7	9%
Kilburn Park Road 3	1.5	41.5	36.8	4.6	11%
Carlton Vale 1	1.5	37.5	35.6	1.9	5%

Cambridge Road 1	1.5	39.1	36.2	2.9	7%
Cambridge Avenue 1	1.5	47.1	39.1	8.0	17%
C. Vale School	1.5	43.5	41.1	2.4	6%
Carlton Vale 2	1.5	45.0	42.4	2.6	6%
Cambridge Avenue 2	1.5	44.8	38.0	6.8	15%
Carlton Vale 3	4	40.9	38.6	2.3	6%

Table 24: AQAA3 – Scenario C2 Bus Clean Air Routes (50% Hybrid/50% electric) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
48	2.5	44.2	42.9	1.3	3%
BRT 57	2.5	62.5	59.2	3.3	5%
Kilburn Park Road 1	1.5	40.1	39.4	0.7	2%
Kilburn Park Road 2	1.5	39.4	38.4	1.0	3%
Kilburn Park Road 3	1.5	41.5	40.2	1.2	3%
Carlton Vale 1	1.5	37.5	37.0	0.5	1%
Cambridge Road 1	1.5	39.1	38.4	0.8	2%
Cambridge Avenue 1	1.5	47.1	45.1	2.1	4%
C. Vale School	1.5	43.5	42.8	0.7	2%
Carlton Vale 2	1.5	45.0	44.3	0.7	2%
Cambridge Avenue 2	1.5	44.8	43.0	1.8	4%
Carlton Vale 3	4	40.9	40.3	0.6	1%

Table 25: AQAA3 – Scenario E1 T-Charge (20% reduction in Euro 4) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
48	2.5	44.2	43.7	0.5	1%
BRT 57	2.5	62.5	61.5	1.0	2%
Kilburn Park Road 1	1.5	40.1	39.8	0.3	1%
Kilburn Park Road 2	1.5	39.4	39.1	0.4	1%
Kilburn Park Road 3	1.5	41.5	41.0	0.4	1%
Carlton Vale 1	1.5	37.5	37.3	0.2	1%
Cambridge Road 1	1.5	39.1	38.9	0.3	1%
Cambridge Avenue 1	1.5	47.1	46.5	0.6	1%
C. Vale School	1.5	43.5	43.2	0.3	1%
Carlton Vale 2	1.5	45.0	44.6	0.4	1%
Cambridge Avenue 2	1.5	44.8	44.3	0.5	1%
Carlton Vale 3	4	40.9	40.6	0.3	1%

Table 26: AQAA3 – Scenario E2 T-Charge (50% reduction in Euro 4) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
48	2.5	44.2	43.5	0.7	2%
BRT 57	2.5	62.5	61.1	1.4	2%
Kilburn Park Road 1	1.5	40.1	39.7	0.4	1%
Kilburn Park Road 2	1.5	39.4	38.9	0.5	1%
Kilburn Park Road 3	1.5	41.5	40.9	0.6	1%
Carlton Vale 1	1.5	37.5	37.2	0.3	1%
Cambridge Road 1	1.5	39.1	38.7	0.4	1%
Cambridge Avenue 1	1.5	47.1	46.3	0.9	2%
C. Vale School	1.5	43.5	42.9	0.6	1%
Carlton Vale 2	1.5	45.0	44.4	0.6	1%
Cambridge Avenue 2	1.5	44.8	44.0	0.8	2%
Carlton Vale 3	4	40.9	40.4	0.4	1%

6.3.4 AQAA 4: Wembley and Tokyngton

AQAA4 includes the Wembley and Tokyngton areas in Brent. Maps showing the location of the receptors included in the scenario analysis are presented in Figure 24 and Figure 25. This area has been identified as an area of concern for the following reasons:

- This area incorporates Wembley High Road
- 3 stations – Wembley Park, Wembley Stadium and Wembley Central
- 2 key regeneration areas – Wembley Regeneration area around the stadium and Wembley Triangle
- Close proximity to Copland School Development and other residential development along the High Road.

6.3.4.1 Baseline modelling and source apportionment results

The source apportionment pie charts for the diffusion tube sites within AQAA4 are reproduced in Figure 23; as for the other AQAAs these are based on the modelled emissions and background concentrations in 2015. A contour plot showing the modelled spatial variation in annual mean NO_2 concentrations in 2015 is presented in Figure 26.

Figure 23: Source apportionment analysis at diffusion tube sites in AQAA4

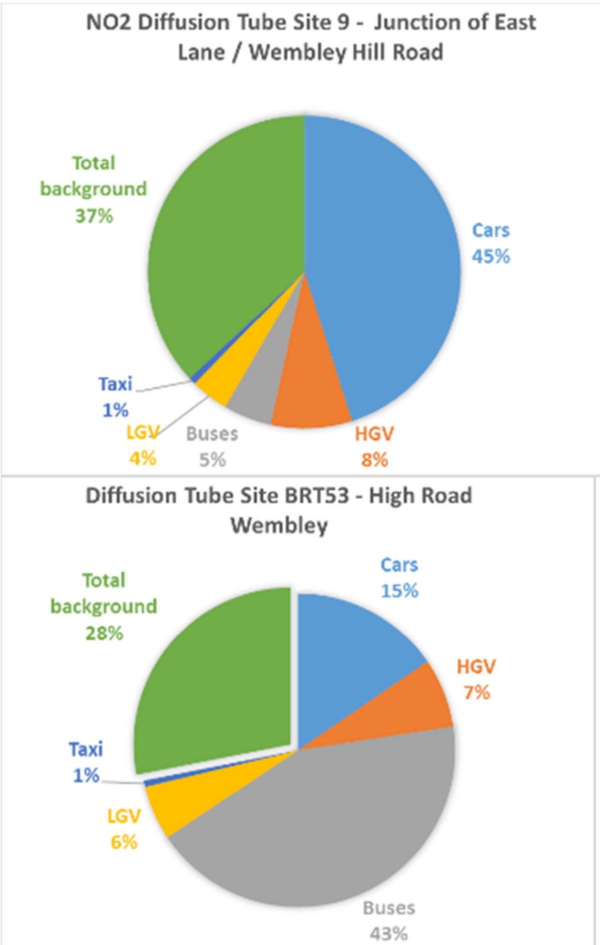
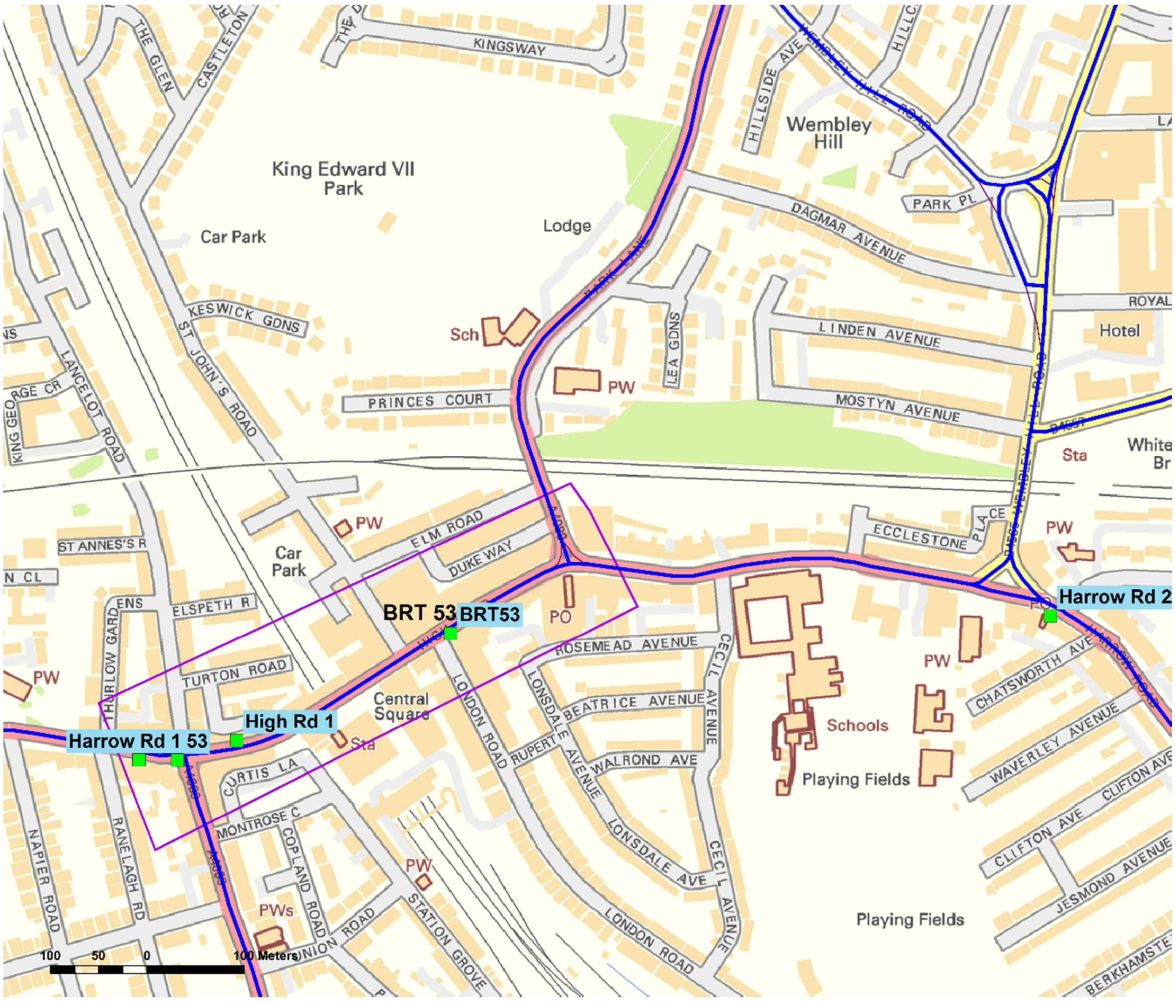


Figure 24: AQAA4 – Wembley and Tokyngton – Harrow Road



Legend:

- ADMS Receptor
- ADMS Road Source
- Focus area boundary

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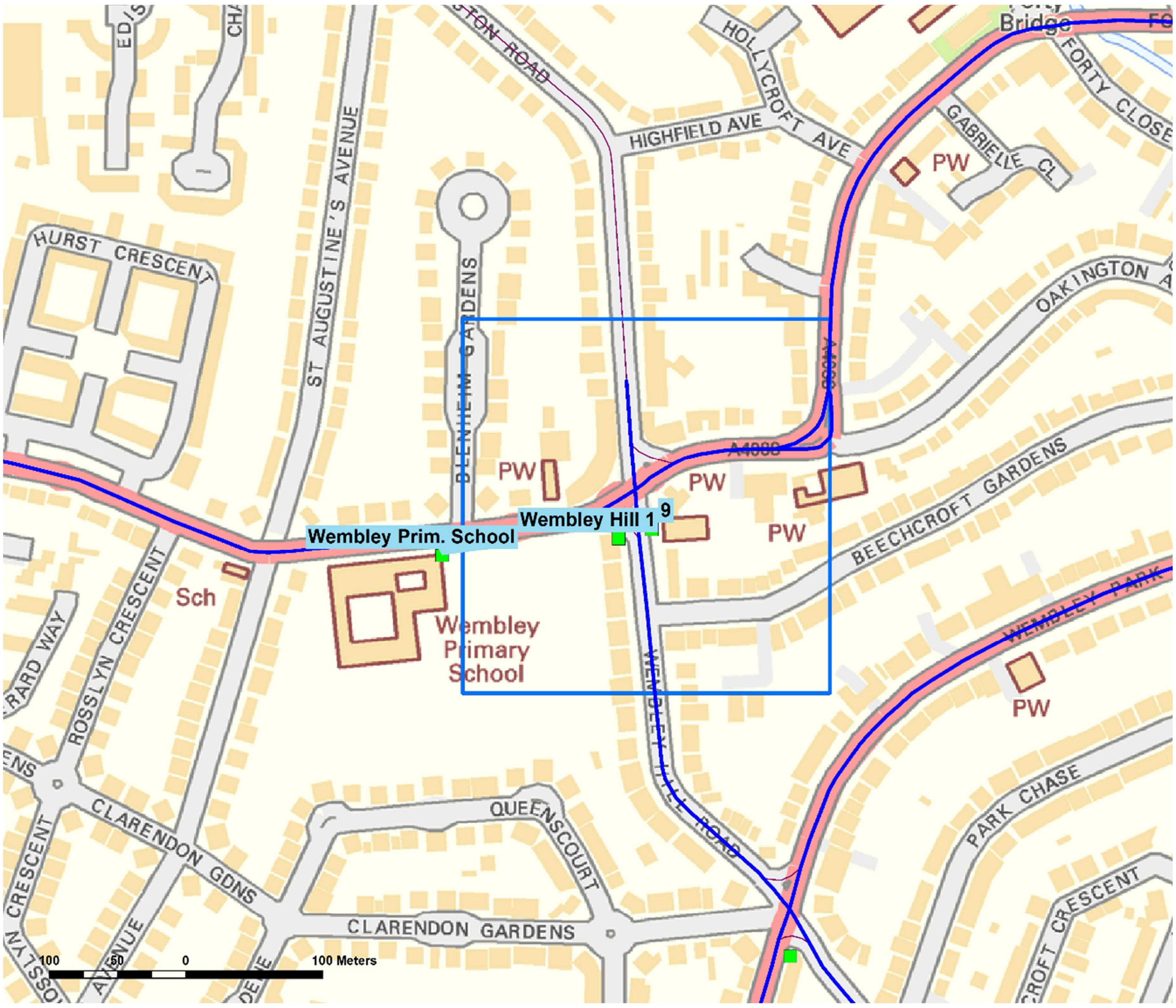
Figure 25: AQAA4 – Wembley and Tokyngton – Harrow Road

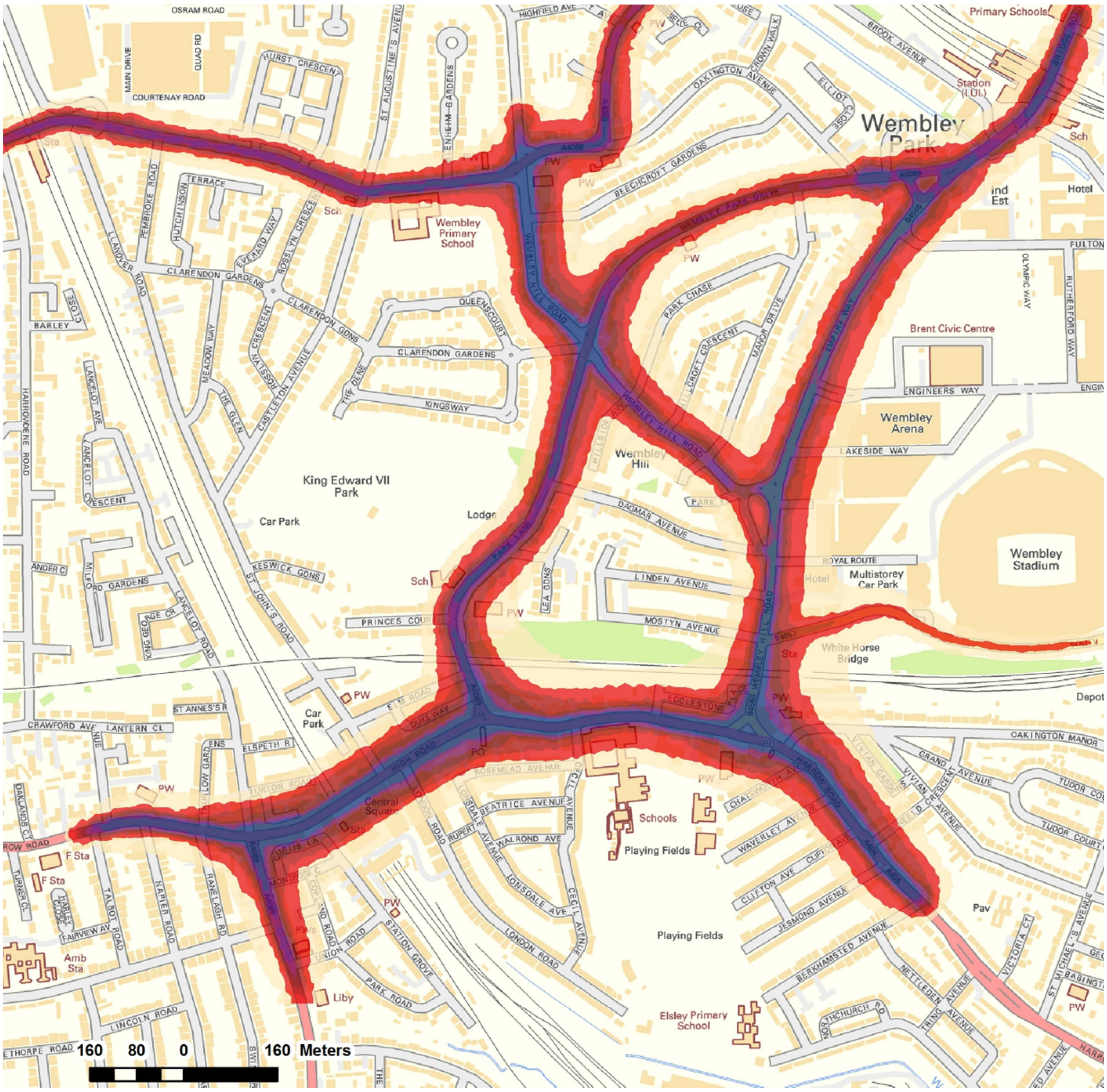


Legend:

- ADMS Receptor
- ADMS Road Source
- Focus area boundary

Contains Ordnance Survey data © Crown copyright and database right 2016

Figure 26: AQAA1 – AQAA4 – Wembley and Tokyngton – NO_2 annual mean concentrations 2015 at 1.5m height



N

Legend

NO_2 Annual Mean ($\mu g.m^{-3}$)

- <36
- 36 - 40
- 40 - 44
- 44 - 48
- 48 - 52
- 52 - 56
- 56 - 60
- 60 - 125.0

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6.3.4.2 AQAA4 - Emission reduction scenarios

The scenarios modelled within AQAA4 were as follows:

A. ULEZ extension (ULEZ feasibility study = % reductions (assumptions) x 1 – (No change to LGV north of the N Circular, ULEZ extended all areas south of the N Circular – ULEZ HGV and Bus standards apply everywhere
B.
C. Bus Clean-air routes (Euro standards 2021 (baseline) scenario)
    - C1 - electric (100%)
    - C2 - hybrid/elec. (50%) /electric bus routes (50%)
D. Additional -5% diesel convert to Euro 6 petrol due to local measures (£25 fee diesel parking charge, eV parking, car free developments.)
E. T-charge impacts (Borough wide)
    - E1 – 20% reduction in Euro 4 (all vehicles) replace AADT with Euro 6
    - E2 – 50% reduction in Euro 4 (all vehicles) as above

A comparison of the predicted annual mean NO_2 concentrations for each scenario are presented in Table 27 to Table 32. Exceedances of the 40 µg.m^{-3} annual mean objective are predicted at all except one of the receptor locations in the future baseline year 2021.

As with the other AQAA's, the model results for Scenario A (ULEZ extension) indicate that this measure will provide the greatest reductions in NO_2 concentrations. The predicted reductions are not however significant enough to achieve compliance with the 40 µg.m^{-3} objective at most of the modelled receptors.

The results for Scenario C1 (Bus Clean Air Routes (100% electric)) indicate that this measure will have a significant impact on annual mean NO_2 concentrations at some receptors, with reductions of up to 28% predicted. This corresponds with the source apportionment analysis at diffusion tube site BRT53 at High Road Wembley where buses account for a large proportion of total NOx.

Table 27: AQAA4 – Scenario A ULEZ extension – predicted NO_2 annual mean concentrations

Receptor	Height	2021 Future Baseline (µg.m^{-3})	2021 with emission measure (µg.m^{-3})	Magnitude of change (µg.m^{-3})	Magnitude of change (%)
Diffusion tube 9	2.5	52.6	48.3	4.3	8%
Diffusion tube 53	2.5	56.2	47.5	8.8	16%
BRT53	2.5	61.9	48.5	13.3	22%
Harrow Rd 1	4	40.5	36.4	4.0	10%
High Rd 1	4	46.9	39.5	7.4	16%
Harrow Rd 2	4	45.5	42.1	3.5	8%
Wembley Hill 1	1.5	44.2	41.1	3.1	7%
Wembley Prim. School	1.5	38.2	36.0	2.2	6%
Park Lane 1	1.5	47.5	44.3	3.2	7%

Table 28: AQAA3 – Scenario C1 Bus Clean Air Routes (100% electric) – predicted NO_2 annual mean conc.

Receptor	Height	2021 Future Baseline (µg.m^{-3})	2021 with emission measure (µg.m^{-3})	Magnitude of change (µg.m^{-3})	Magnitude of change (%)
Diffusion tube 9	2.5	52.6	49.9	2.7	5%
Diffusion tube 53	2.5	56.2	45.5	10.7	19%
BRT53	2.5	61.9	44.7	17.2	28%
Harrow Rd 1	4	40.5	35.7	4.8	12%

High Rd 1	4	46.9	37.8	9.1	19%
Harrow Rd 2	4	45.5	42.5	3.1	7%
Wembley Hill 1	1.5	44.2	41.9	2.3	5%
Wembley Prim. School	1.5	38.2	36.3	1.9	5%
Park Lane 1	1.5	47.5	44.8	2.8	6%

Table 29: AQAA3 – Scenario C2 Bus Clean Air Routes (50% Hybrid/50% electric) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
Diffusion tube 9	2.5	52.6	51.9	0.7	1%
Diffusion tube 53	2.5	56.2	53.5	2.7	5%
BRT53	2.5	61.9	57.6	4.2	7%
Harrow Rd 1	4	40.5	39.2	1.3	3%
High Rd 1	4	46.9	44.5	2.3	5%
Harrow Rd 2	4	45.5	44.7	0.8	2%
Wembley Hill 1	1.5	44.2	43.6	0.6	1%
Wembley Prim. School	1.5	38.2	37.7	0.5	1%
Park Lane 1	1.5	47.5	46.8	0.7	2%

Table 30: AQAA3 – Scenario D Local Measures (5% diesel cars convert to Euro 6 petrol) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
Diffusion tube 9	2.5	52.6	52.2	0.4	1%
Diffusion tube 53	2.5	56.2	55.9	0.3	1%
BRT53	2.5	61.9	61.6	0.3	0.4%
Harrow Rd 1	4	40.5	40.3	0.2	0.5%
High Rd 1	4	46.9	46.7	0.2	0.4%
Harrow Rd 2	4	45.5	45.2	0.3	1%
Wembley Hill 1	1.5	44.2	43.9	0.3	1%
Wembley Prim. School	1.5	38.2	38.0	0.2	1%
Park Lane 1	1.5	47.5	47.1	0.4	1%

Table 31: AQAA3 – Scenario E1 T-Charge (20% reduction in Euro 4) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
Diffusion tube 9	2.5	52.6	52.1	0.5	1%
Diffusion tube 53	2.5	56.2	55.3	0.9	2%
BRT53	2.5	61.9	60.6	1.3	2%

Harrow Rd 1	4	40.5	40.0	0.4	1%
High Rd 1	4	46.9	46.2	0.7	1%
Harrow Rd 2	4	45.5	45.1	0.4	1%
Wembley Hill 1	1.5	44.2	43.8	0.3	1%
Wembley Prim. School	1.5	38.2	37.92	0.3	1%
Park Lane 1	1.5	47.5	47.1	0.4	1%

Table 32: AQAA3 – Scenario E2 T-Charge (50% reduction in Euro 4) – predicted NO_2 annual mean concentrations.

Receptor	Height	2021 Future Baseline ($\mu g.m^{-3}$)	2021 with emission measure ($\mu g.m^{-3}$)	Magnitude of change ($\mu g.m^{-3}$)	Magnitude of change (%)
Diffusion tube 9	2.5	52.6	51.7	0.9	2%
Diffusion tube 53	2.5	56.2	54.9	1.3	2%
BRT53	2.5	61.9	60.1	1.7	3%
Harrow Rd 1	4	40.5	39.8	0.7	2%
High Rd 1	4	46.9	45.9	1.0	2%
Harrow Rd 2	4	45.5	44.8	0.7	2%
Wembley Hill 1	1.5	44.2	43.5	0.7	1%
Wembley Prim. School	1.5	38.2	37.7	0.5	1%
Park Lane 1	1.5	47.5	46.7	0.8	2%

7 Summary and conclusions

This report describes an atmospheric dispersion modelling assessment of Nitrogen Dioxide (NO_2) and particulate matter (PM_{10}) concentrations within the London Borough of Brent.

The assessment has been undertaken to assist Brent Council with identifying and prioritising air quality action plan measures; and to identify and confirm the areas where exceedances of the national air quality objectives are occurring within the borough boundaries.

The assessment aims to:

- Identify the areas where exceedances of the air quality objectives may be occurring within the borough boundaries. The aim is to provide Brent Council with sufficient evidence to allow them to confirm or revise the boundary of the existing AQMA.
- Conduct a source apportionment analysis of NO_2 pollutant sources; whereby the contribution of different sources of pollutants to overall concentrations are quantified so that air quality action plan measures may be appropriately targeted.
- Model future baseline pollutant concentration and assess the impact of various potential emission reduction measures. For this purpose, the assessment includes a source apportionment analysis at a selection of locations where the highest pollutant concentrations have been measured in the Borough.

The assessment has concluded:

- The modelling of NO_2 and PM_{10} indicates that there are several hotspots in the borough that correspond with the focus areas and the known congestion areas already integrated into the AQMA. Some marginal areas where there may be an exceedance have been identified however as these are on the fringes of the current AQMA boundary, such as the A4006/Roe Green junction, adjusting the boundary to include them may not be necessary. This is because Brent's action plan measures coupled with London wide actions and focus area measures will combine to benefit air quality across the borough in the future any marginal changes to the boundary may not be required.

- As no new areas of exceedance of the air quality objectives have been identified, there is no new evidence to suggest that there is a requirement to change the current AQMA boundary.
- No exceedances of the annual mean PM_{10} objective are predicted at locations of relevant exposure across the Borough.
- The baseline model result indicates that out-with the existing AQMA boundary the greatest roadside annual mean NO_2 concentrations modelled are on the stretch of Preston Road south of the roundabout with Woodcock Hill and Shaftesbury Avenue. Based on the findings of the baseline modelling, it may be advisable to deploy an NO_2 diffusion tube at this location on Preston Road to gather more monitoring data before proceeding with any other assessment.

The source apportionment analysis can be summarised as:

- Background NOx concentration range from approximately 19% to 48.2% of total NOx concentrations at the receptors included; whereas background PM_{10} accounts for up to a more significant 89.4% of the total concentration at each receptor. Actions aimed at local sources are therefore likely to have a greater impact on NOx/NO_2 concentrations.
- The greatest background contribution at all receptors is from other background roads sources i.e. sources not included in the dispersion model, this includes minor roads and roads out-with each background square.
- Emissions from buses contribute approximately 15% of overall NOx concentrations at most of the receptor locations with the exception of site 23 (Junction North Circular Rd / Chartley Avenue) and site 52 (IKEA, Hut, North Circular Road) where the bus contribution is relatively low at around 5%.
- Emissions from buses are a dominant source of NOx at site BRT53 (High Road Wembley) accounting for 53% of total Road NOx; and to a slightly lesser extent at site BRT55 (High Street, Harlesden) where 22% of Road NOx is attributable to bus emissions.
- Emissions from taxis are relatively high at site 23 (Junction North Circular Rd / Chartley Avenue) and at site 52 (IKEA, Hut, North Circular Road) accounting for 8% of overall Road NOx concentrations. The HGV contribution to Road NOx of 18-20% and LGV contribution of approximately 15% are also high at each of these locations when compared with the other receptors included.

London Borough of Brent have identified a series of Air Quality Action Areas (AQAA) which are key areas of concern for the Council. The AQAAs encompass most of the GLA “Focus areas” but also include areas of planned development, areas of concern for communities and regeneration zones.

The Brent Air Quality Action Plan (AQAP) consider a number of potential measures that may help reduce vehicle emission and NO_2 concentrations. Scenarios simulating either single emission reduction measures or a mix of measures have been modelled within each AQAA.

The emission reduction scenarios modelled are:

A. Impact on emissions from the (proposed) extension of the London ULEZ [ULEZ extension]
B. Restricted access to controlled routes for HGVs [HGV routes]
C. Clean-air routes for Buses [Bus Clean-air routes]
D. 5% of diesel cars convert to Euro 6 petrol due to local measures (£25 fee diesel parking charge, eV parking, car free developments etc.)
E. T-charge (proposal) restricting diesel LGVs and taxi in addition to HGV and Bus restrictions. [T-charge impact]

The scenario modelling indicates that Scenario A, which considers the impact of the proposed extension of the London Ultra Low Emission Zone (ULEZ) is likely to have the greatest impact on NO_2 concentrations within each AQAA. Even if effective in transforming a large amount of the vehicle fleet to the emission standards compliant with the ULEZ requirements; the impact of the ULEZ extension is not likely to achieve compliance with the NO_2 annual mean objective at all locations, particularly within AQAA1 where residential properties are located on the North Circular Road. Further analysis of the likely impact of the ULEZ extension on the future vehicle fleet mix in Brent is required to get a better idea of the air quality benefits that could be achieved.

The scenario modelling has also indicated that electrification of the bus fleet could reduce NO_2 concentrations significantly at some locations within AAQ3 (Kilburn) and AQAA4 (Wembley).

Appendix 1 – Model Verification

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. This helps to identify how the model is performing at the various monitoring locations. The verification process involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in better agreement with the monitoring results. LAQM.TG(16) recommends making the adjustment to the road contribution of the pollutant only and not the background concentration these are combined with.

The approach outlined in LAQM.TG(16) section 7.508 – 7.534 (also in Box 7.14 and 7.15) has been used in this case.

As stated in Section **Error! Reference source not found.** above, the models were verified using annual mean NO_2 measurements from the various NO_2 diffusion tube sites within the study areas. Of the available roadside and kerbside diffusion tube sites, three sites were excluded from model verification because no traffic data was available on the adjacent roads.

It is appropriate to verify the ADMS Roads models in terms of primary pollutant emissions of nitrogen oxides (NOx = NO + NO_2). The models have been run to predict annual mean Road NOx concentrations during the 2015 calendar year at the diffusion tube sites. The models output of Road NOx (the total NOx originating from road traffic) have been compared with the measured Road NOx, where the measured Road NOx contribution is calculated as the difference between the total NOx and the background NOx value. Total measured NOx for each diffusion tube was calculated from the measured NO_2 concentration using the latest version of the Defra NOx/NO_2 calculator.

The initial comparison of the modelled vs measured Road NOx identified that in most cases, the models were under-predicting the Road NOx contribution.

For each study area, the gradient of the best fit line for the modelled Road NOx contribution vs. measured Road NOx contribution was then determined using linear regression and used as the adjustment factor for the respective model. This factor was then applied to the modelled Road NOx concentration for each modelled point to provide adjusted modelled Road NOx concentrations within each study area. A linear regression plot comparing modelled and monitored Road NOx concentrations before and after adjustment are presented in Figure A2.1 to Figure A2.11.

The primary adjustment factor for each model are presented in Table A2.1 and are based on model verification using 2015 monitoring results. The relevant primary Road NOx adjustment factor for each study are was then applied to all modelled Road NOx data prior to calculating an NO_2 annual mean. Plots comparing modelled and monitored NO_2 concentrations before and after adjustment are presented in Figure A2.2 to Figure A2.12.

Following adjustment, the modelled NO_2 concentrations are in reasonable agreement with the local NO_2 measurements so we are confident that the predicted spatial variation in NO_2 concentrations is reasonably representative of local conditions.

Table A2.1: Adjustment factors for each study area

Study area	Adjustment factor
Whole Borough	2.8329
North west area	1.6441
AQAA 1	3.3787
AQAA 2	0.6934
AQAA 3	4.3660
AQAA 4	2.9654

Model uncertainty can be estimated by calculating the root mean square error (RMSE). The RMSE after adjustment are presented in Table A2.2 for each study area. For all except the Borough wide model, the calculated RMSE are all within value suggested in in LAQM.TG(16) (10% of the objective being assessed). The local scale models have therefore performed sufficiently well for use in this assessment.

Some uncertainty is introduced by verifying the regional model outputs over such a large area. This may be influenced by varying estimates of background concentrations across a wide area so it's not always possible to get good model agreement with measurements across such a large model domain.

Model agreement and average error are generally better when modelling at a local scale; the regional approach is therefore very useful for identifying hotspots which can then be looked at in more detail using ADMS. In this case locally specific adjustment factor have been be applied to achieve better model agreement for the local scale modelling.

Table A2.2: RMSE for each study area

Study area	RMSE ($\mu g.m^{-3}$)
Whole Borough	9.54
North west area	3.55
AQAA 1	3.12
AQAA 3	0.89
AQAA 4	0.51

Figure A2.1: Comparison of modelled Road NOx Vs Measured Road NOx – Whole Borough

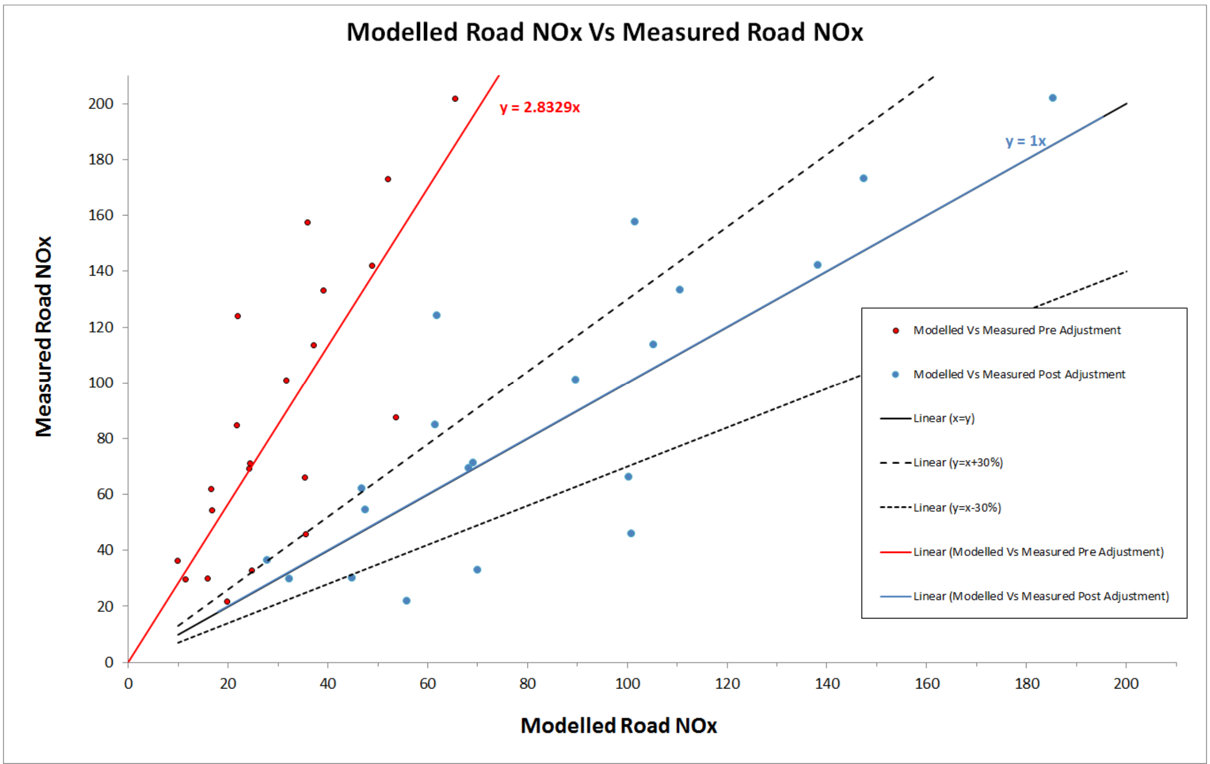


Figure A2.2: Comparison of modelled Road NOx Vs Measured Road NOx – Whole Borough

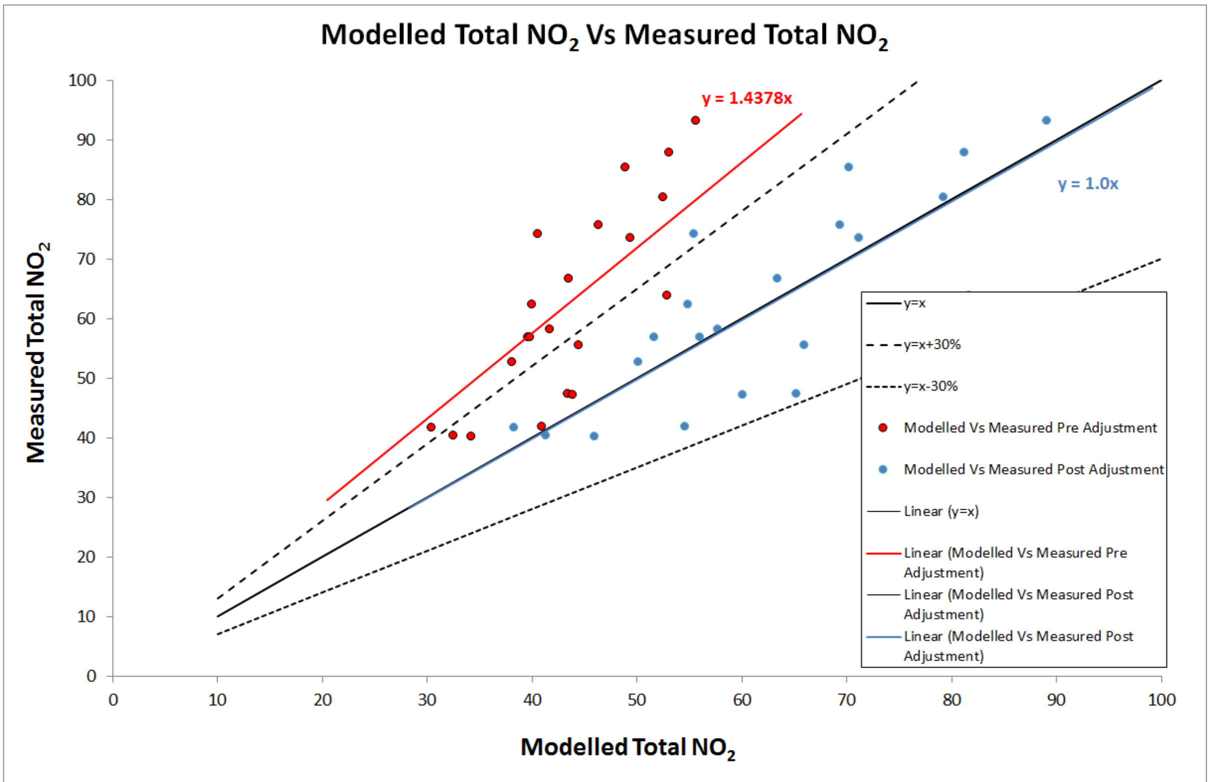


Figure A2.3: Comparison of modelled Road NOx Vs Measured Road NOx – North west area

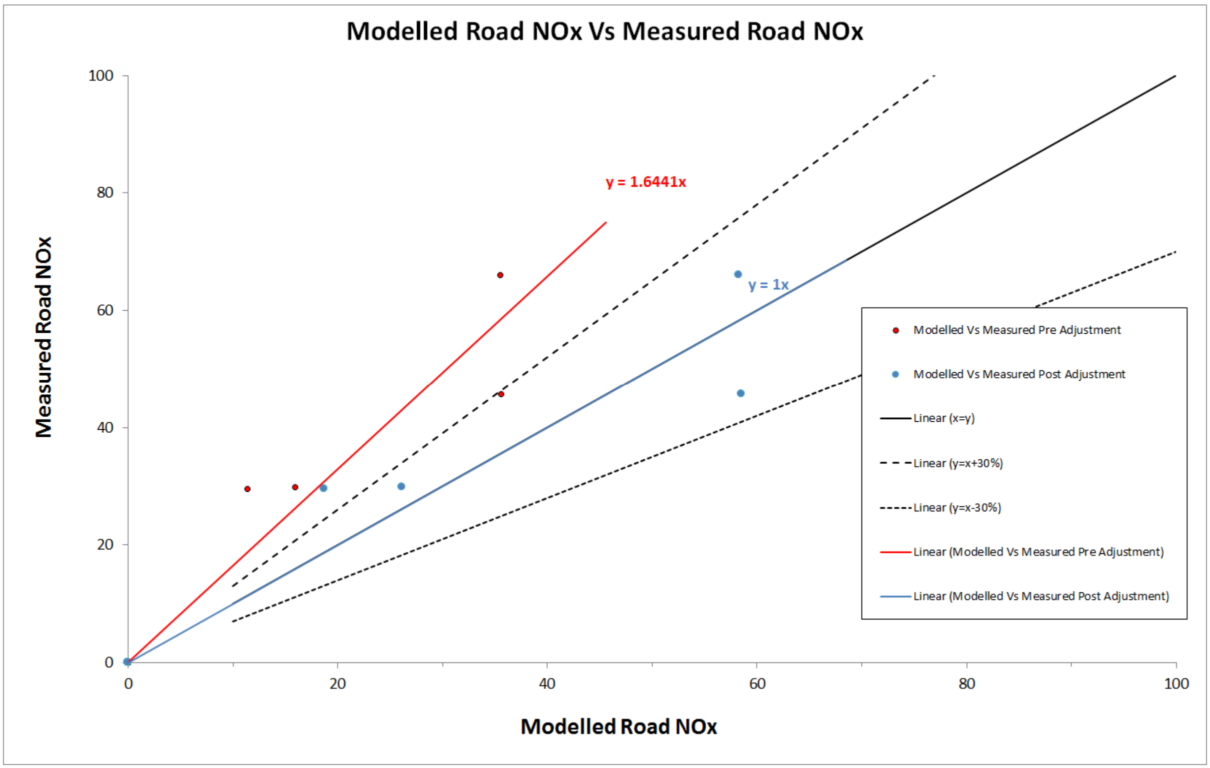


Figure A2.4 Comparison of modelled Road NOx Vs Measured Road NOx – North west area

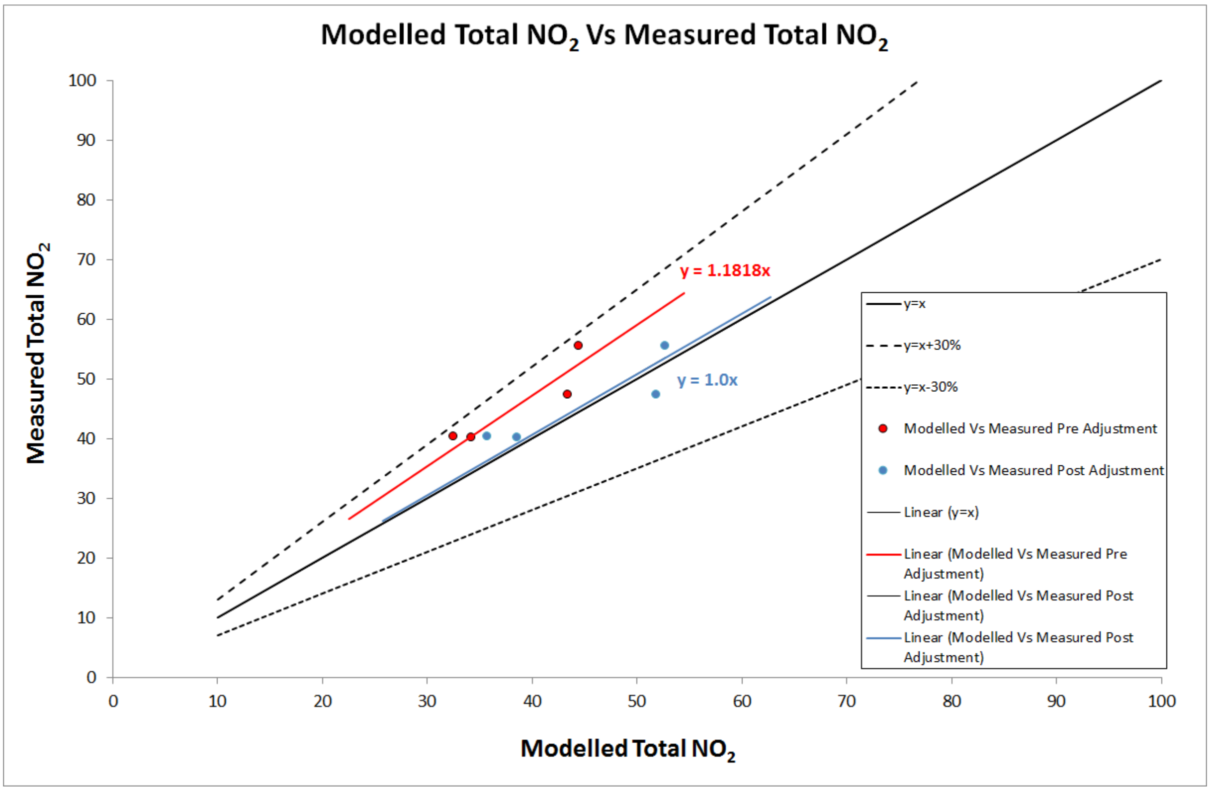


Figure A2.5: Comparison of modelled Vs Monitored NO_2 annual mean 2015 – AQAA 1

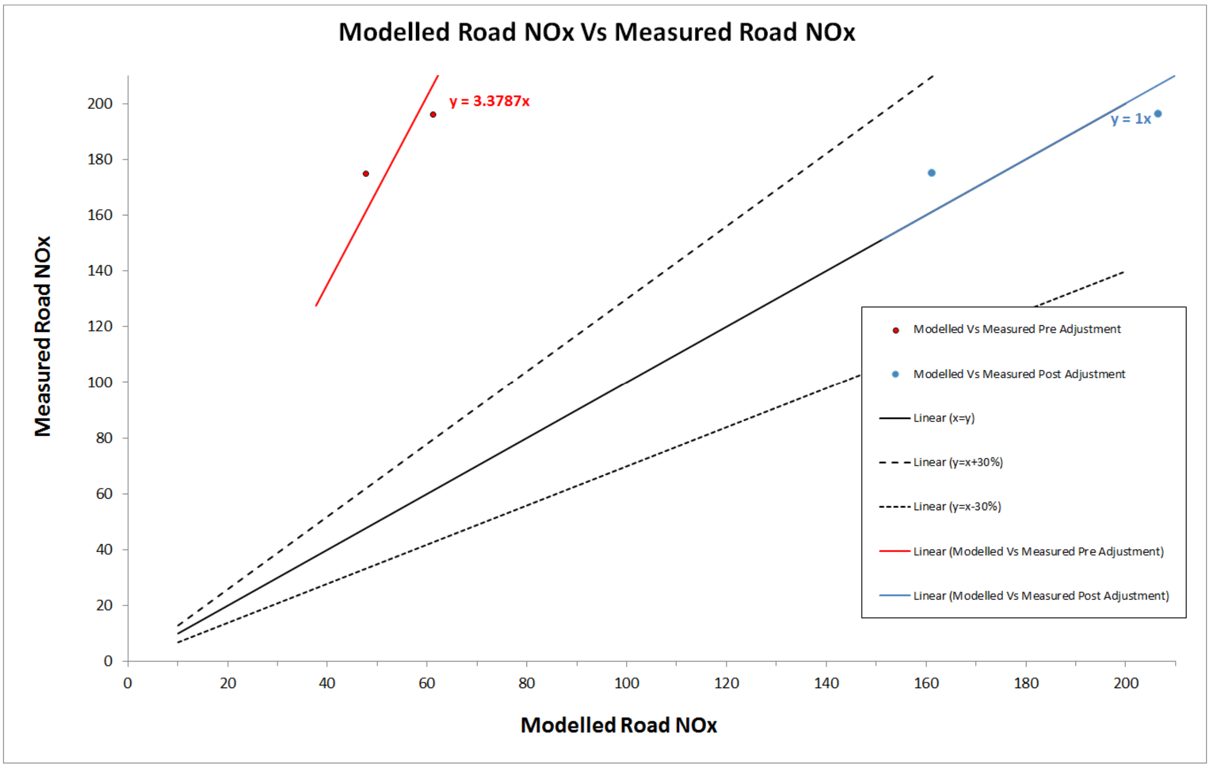


Figure A2.6: Comparison of modelled Vs Monitored NO_2 annual mean 2015 – AQAA 1

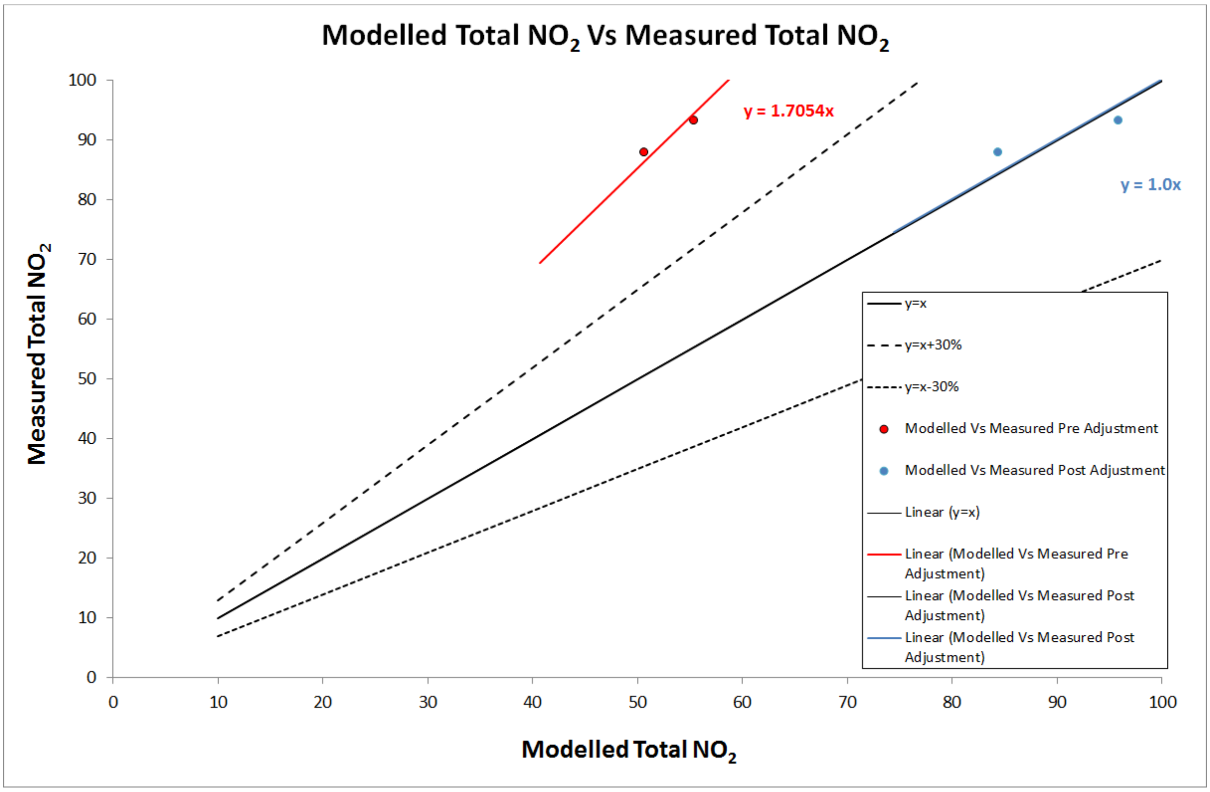


Figure A2.7: Comparison of modelled Vs Monitored NO_2 annual mean 2015 – AQAA 2

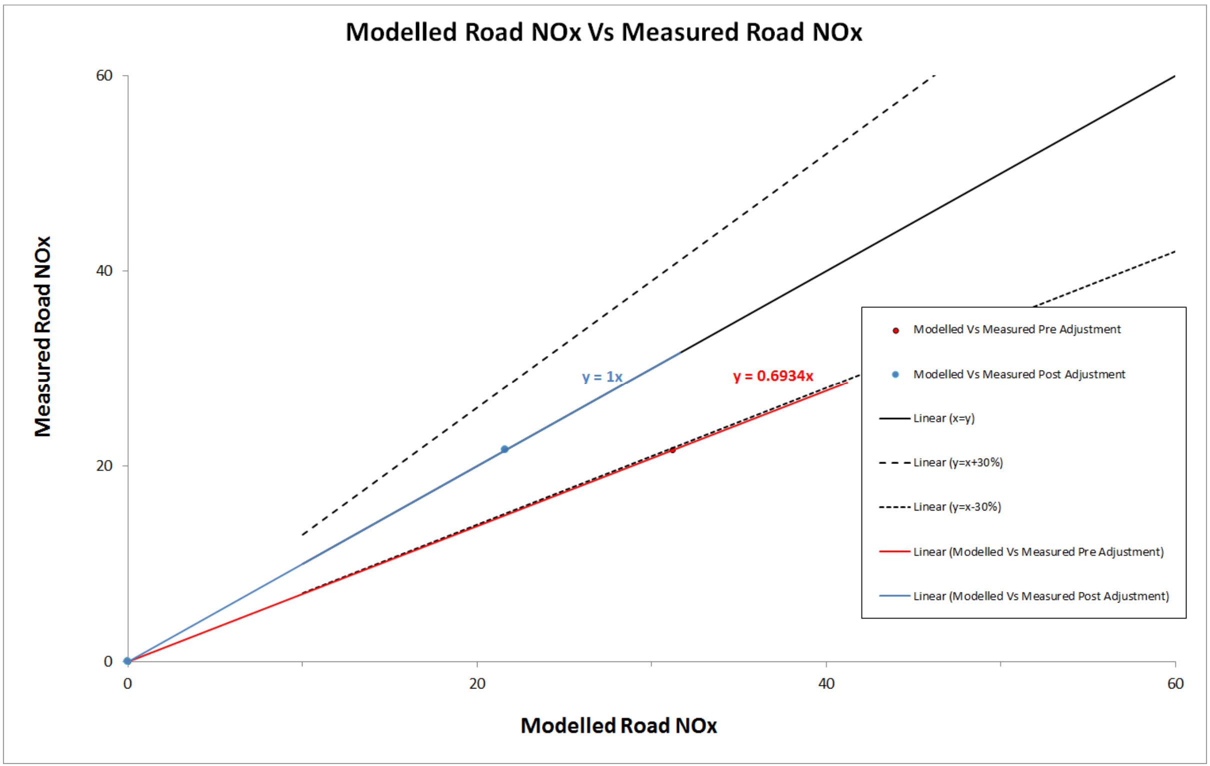


Figure A2.8: Comparison of modelled Vs Monitored NO_2 annual mean 2015 – AQAA 2

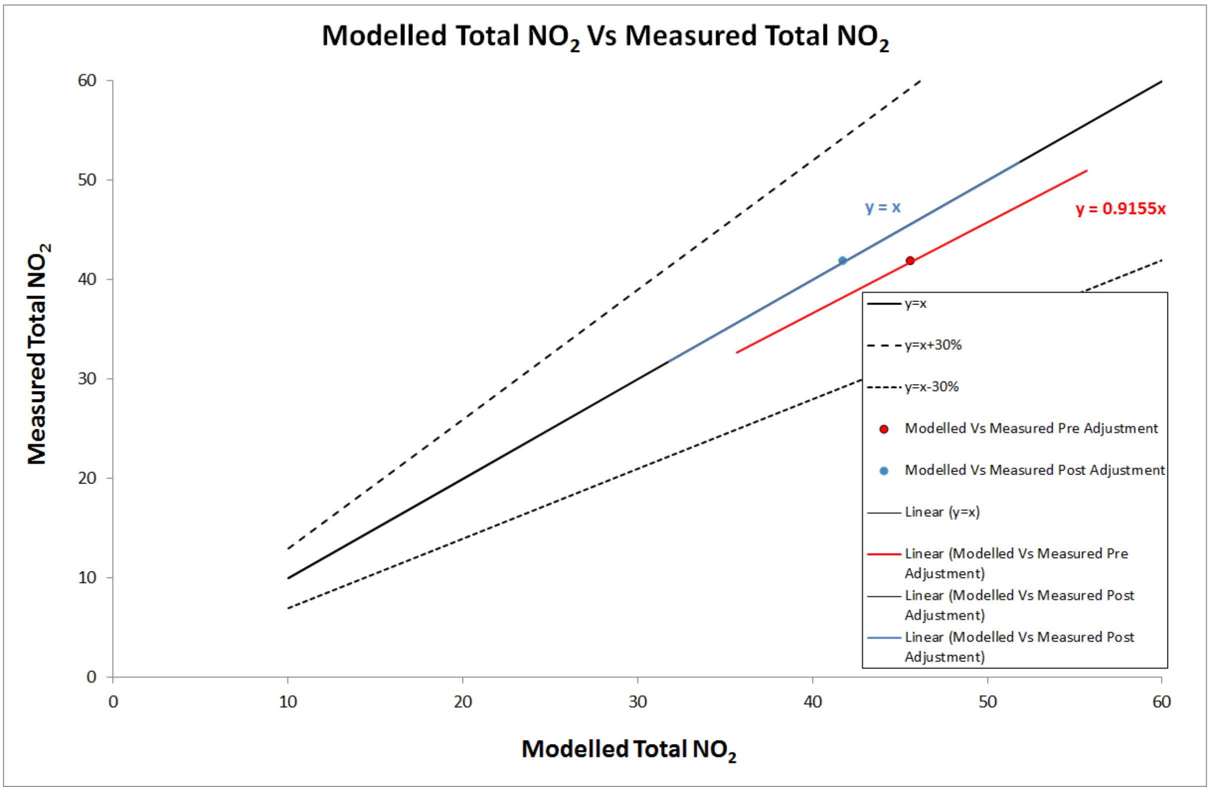


Figure A2.9: Comparison of modelled Vs Monitored NO_2 annual mean 2015 – AQAA 3

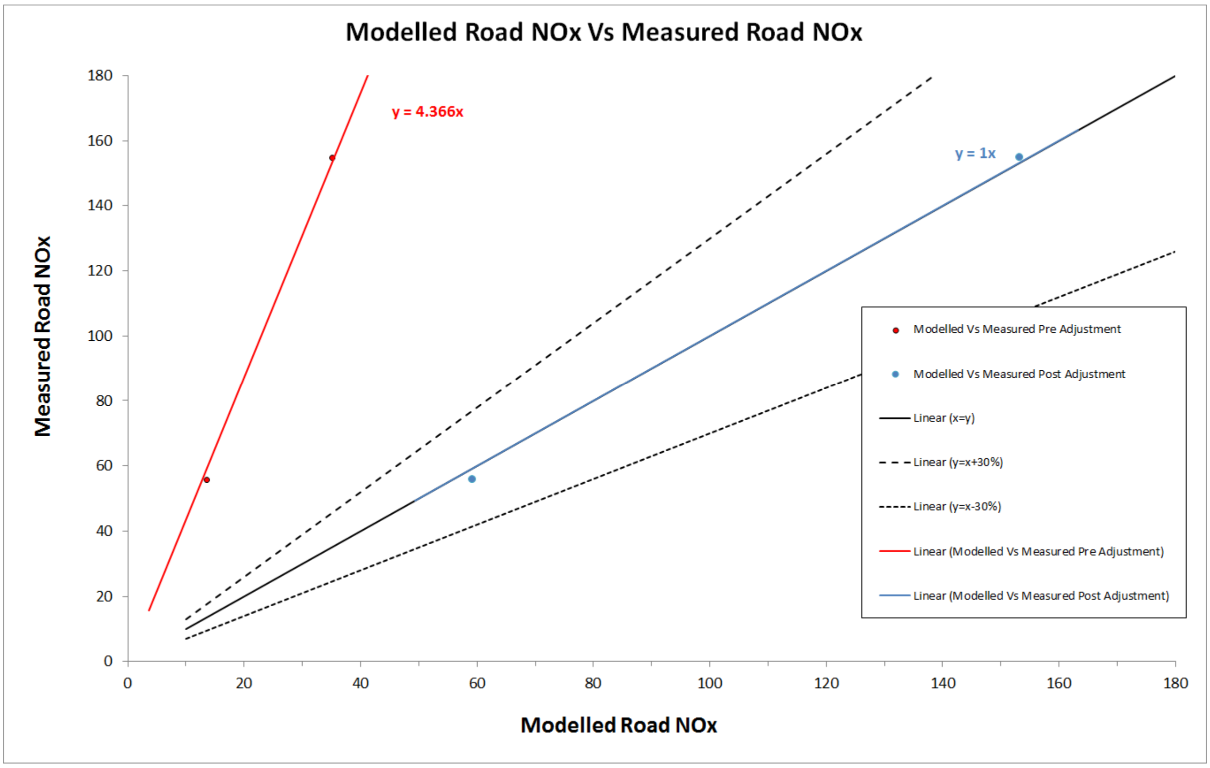


Figure A2.10: Comparison of modelled Vs Monitored NO_2 annual mean 2015 – AQAA 3

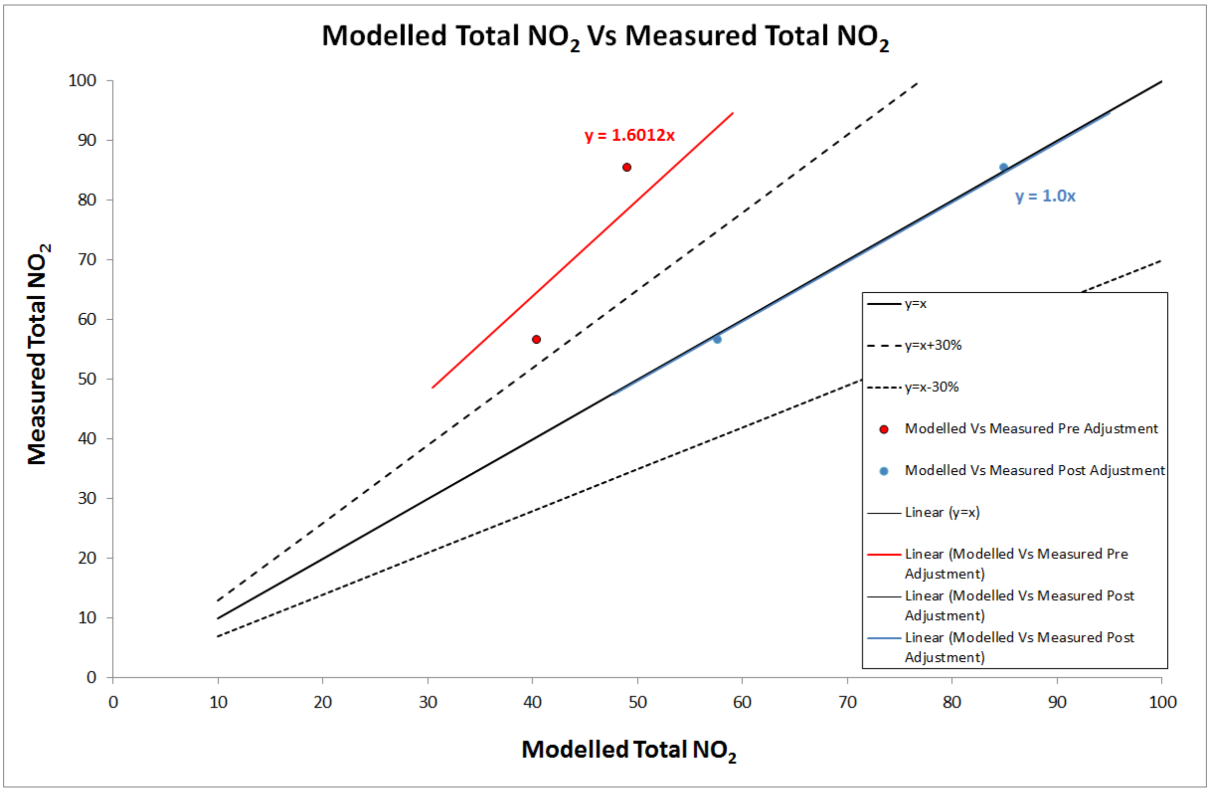


Figure A2.11: Comparison of modelled Vs Monitored NO_2 annual mean 2015 – AQAA 4

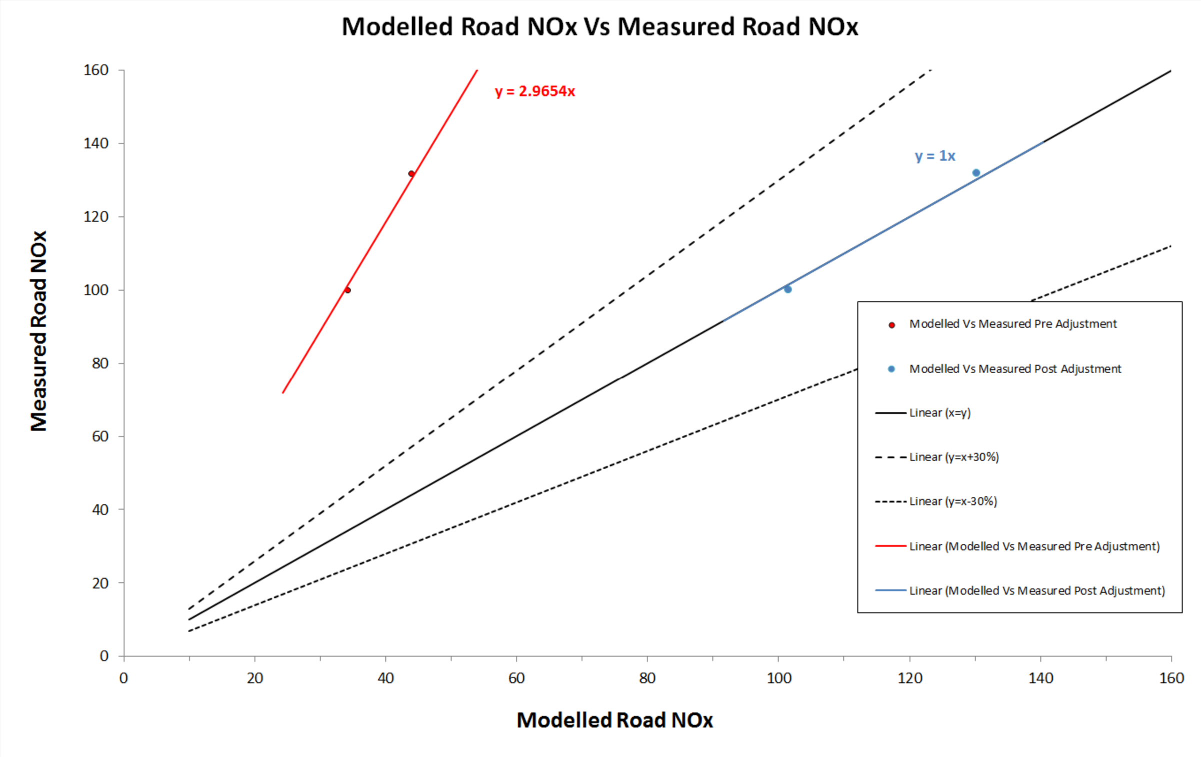
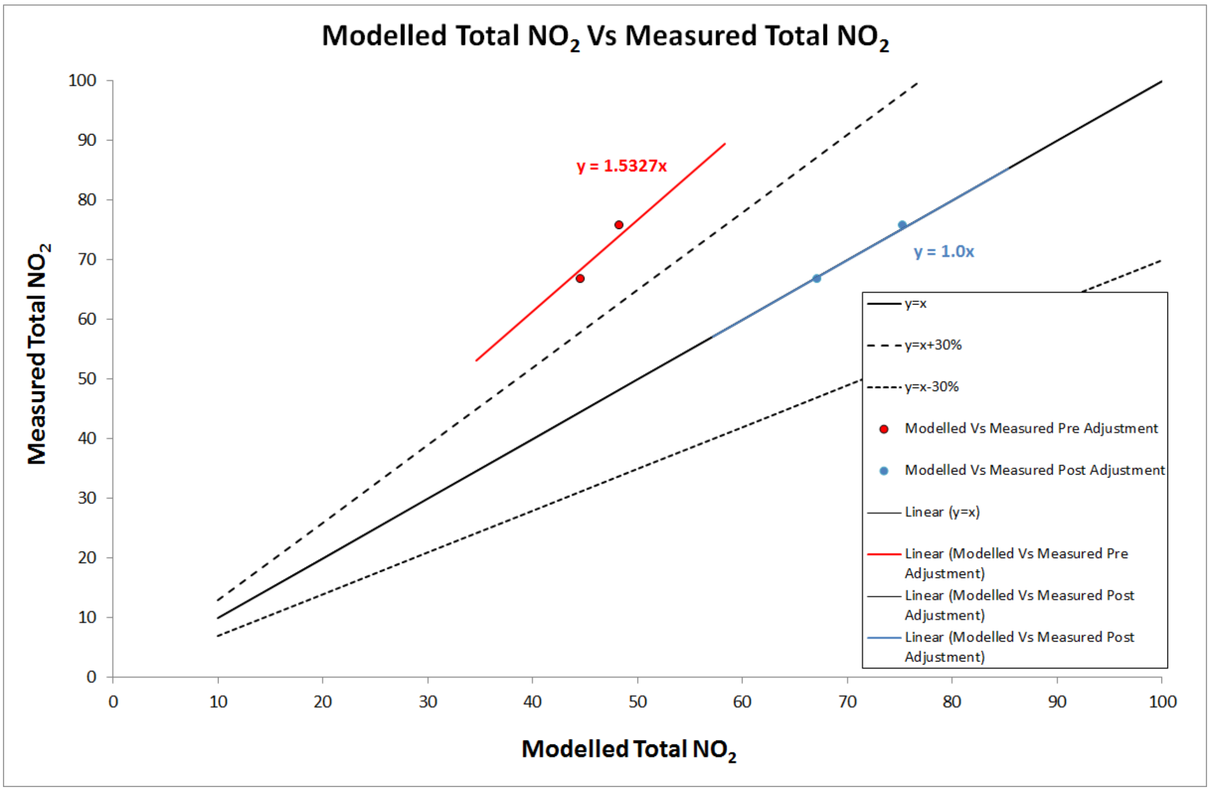


Figure A2.12: Comparison of modelled Vs Monitored NO_2 annual mean 2015 – AQAA 4



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