Birmingham Clean Air Zone

A38 Junction Amendment

Birmingham City Council

Air Quality Assessment Report

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Executive Summary

Birmingham City Council (BCC) plan to undertake highway works to deliver a segregated cycle route along the A38 between Selly Oak and Birmingham City Centre. This will involve the introduction of a number of Traffic Regulations Orders (TROs), which will result in the restricting of some vehicle movements along the Bristol Road (A38) corridor and the removal of other turning manoeuvre restrictions. These alterations to turning movements and the TROs are necessary to install the proposed segregated cycle route.

This report details the assessment of air quality effects associated with the implementation of the TROs for the Bristol Road A38 Cycle Scheme (the Proposed Scheme), which has the potential to affect air quality concentrations as a result of changes to vehicle movements (and therefore emissions).

In consideration of, Road Traffic Regulation Act 1984, Section 122, Subsection (2), with regard to air quality, this assessment was carried out in accordance with the Design Manual for Roads and Bridges (DMRB) HA207/07 Air Quality, associated Highways England (HE) Interim Advice Notes (IANs) and Defra's Local Air Quality Management Technical Guidance (LAQM.TG16), where appropriate.

Two traffic datasets (one factored from AM and Inter-Peak (IP) traffic model [AMIP], and one factored from AM, IP and PM traffic models [AMIPPM]) were modelled using Atmospheric Dispersion Modelling Software ADMS-Roads 4.1 to evaluate the potential impact of the Proposed Scheme upon local air quality.

Roads included within the assessment were those identified by qualifying criteria published in HA207/07 based on changes between Do Minimum (DM) and Do Something (DS) scenarios, as follows:

- Horizontal road alignment will change by 5m or more;
- Daily traffic flows will change by >=1,000 Annual Average Daily Traffic (AADT);
- Heavy Duty Vehicle (HDV) flows will change by >=200 AADT;
- Daily average speed will change by >=10kph; or
- Peak hour speed will change by >=20kph.

The assessment showed that between 30 and 35 properties that were predicted to exceed the annual mean air quality objective (AQO) for nitrogen dioxide (NO_2) were also predicted to receive small increases in pollutant concentrations, while between 2 and 4 properties that were predicted to exceed the annual mean AQO for NO_2 were also predicted to receive small decreases in pollutant concentrations.

Overall, changes in air pollutions concentrations at modelled receptors did not satisfy criteria to classify overall scheme effects as significant. The Proposed Scheme therefore was not predicted to result in significant air quality effects.

1. Introduction

Birmingham City Council (BCC) plan to undertake highway works to deliver a segregated cycle route along the A38 between Selly Oak and Birmingham City Centre. This will involve the introduction of a number of Traffic Regulations Orders (TROs), which will result in the restricting of some vehicle movements along the Bristol Road (A38) corridor and the removal of other turning manoeuvre restrictions. These alterations to turning movements and the TROs are necessary to install the proposed segregated cycle route.

This report details the assessment of air quality effects associated with the implementation of the TROs for the Bristol Road A38 Cycle Scheme (the Proposed Scheme), which has the potential to affect air quality concentrations as a result of changes to vehicle movements (and therefore emissions) on the local road network. The Proposed Scheme has the potential to increase emissions from vehicle traffic, and change ambient air quality concentrations at nearby receptors.

A detailed air quality assessment has been undertaken to establish the potential air quality effects of the Proposed Scheme on local air quality at identified selected receptors. This report describes the assessment, and the operational effects arising from the Proposed Scheme.

Air quality is a term used to describe concentrations of specific pollutants in ambient air, taking into account their effects on sensitive receptors, which are made up of human-health receptors and vegetation / ecosystem receptors. As specified in DMRB HA207/07, the main pollutant of concern in the local air quality assessment is associated with vehicle exhaust emissions, primarily nitrogen dioxide (NO_2) for human-exposure.

2. Legislation and Guidance

International, national and local legislation and guidance exist that are relevant to air quality. Those relevant to the air quality assessment are provided as follows.

2.1 Legislation

This assessment considers the relevant air quality legislation and the process of Local Air Quality Management (LAQM). Key air quality legislation is detailed in Table 1.

Table 1 Summary of Key Legislation

Legislation	Description
European Legislation	
The European Union Directive 2008/50/EC Ambient Air Quality and Cleaner Air for Europe	This Directive was published to consolidate previous European Directives on ambient air quality. These European Directives form the basis for UK air quality legislation. Although published in 2007, the Air Quality Strategy is consistent with The Air Quality Standards Regulations (England) 2010.
National Legislation	
The Environment Act 1995, Part IV	Introduced a system of LAQM in the UK. This requires local authorities to review and assess air quality within their boundaries regularly and systematically against Air Quality Objectives (AQOs), appraise development and transport plans against these assessments and make plans to meet the AQOs where these are exceeded. Where relevant, the air quality assessment would demonstrate the potential interaction with the LAQM process being undertaken by local authorities.
The Air Quality (Wales) Regulations 2000; Air Quality (Amendment) (Wales) Regulations 2002	Legislates for the AQOs for pollutants set out in the 2000 Air Quality Strategy, which was revised in 2007. (Department for Environment, Food and Rural Affairs (Defra, 2007). AQOs exist for a variety of pollutants including nitrogen oxides (NO_x) and NO_2. These are established for both the protection of human-health and the protection of vegetation and ecosystems (see Table 2) for AQOs relevant to this assessment). The air quality assessment makes a comparison between the predicted concentrations of these pollutants resulting from the proposed works against their relevant AQOs, taking existing levels into account.
Air Quality Standards Regulations 2010	Transposes the air quality Limit Values set out in the European Union (EU) ambient air quality directive 2008/50/EC (European Commission, 2008) to UK law. The UK Government is responsible to the European Commission (EC) for ensuring that it complies with the provisions of EU Directives. On the UK Government's behalf, the Department for Transport and Defra have Public Service Agreements relating to EU Limit Values.

The UK government is responsible to the EC for ensuring that it complies with the provisions of the EU Directives. The UK government and governments of other member states are currently in negotiations with the EC over breaching Limit Values for NO_2.

The responsibilities of Local Authorities with respect to meeting air quality standards are not the same as the responsibilities of the UK Government to the EC. Local Authorities do have statutory duties for LAQM, but are not obliged to ensure AQOs are met but are worked towards in the shortest practical time.

It is important to recognise the difference between the EU Limit Values (for which compliance is determined at a national level by Government) and the AQOs (for which compliance is determined at a local level by local authorities under the LAQM regime). Whilst the Limit Values and AQOs for the relevant pollutant (NO_2) are set at the same concentration value (e.g. 40 µg/m^3, as an annual mean) the means of determining compliance are fundamentally different, and they must be considered separately.

Article 3 of the EU Directive requires Member States to nominate the competent authority for the assessment of air quality (which in the UK is the Secretary of State for the Environment) and it may be interpreted that only the competent authority can determine compliance with the Limit Values. Compliance is determined via the national monitoring network and national model (the Pollution Climate Mapping (PCM) model), and there are a number of important differences between this and the monitoring / modelling carried out by local authorities to determine compliance with the AQOs.

Because of these differences, there are many locations across the UK where the national compliance with the Limit Values, and local compliance with the AQOs, is not in agreement. For the purpose of this assessment, they are treated separately.

The AQOs for NO_x and NO_2 in the latest National Air Quality Strategy are detailed in Table 2.

Table 2 Relevant National Air Quality Objectives

Pollutant	Air quality objective		To be achieved by and maintained thereafter
	Concentration	Measured as*	
Nitrogen dioxide (NO_2)	200 µg/m^3	1-hour mean not to be exceeded more than 18 times per year	31/12/2005
	40 µg/m^3	Annual Mean	31/12/2005
Nitrogen oxides applies to sensitive habitats only (NO_x)	30 µg/m^3	Annual mean	19/07/2001

For sensitive habitats, critical loads are used to assess the level of nitrogen deposition that would have harmful effects on the particular ecosystem / habitat being considered. Critical Loads are therefore site, ecosystem and habitat specific. Where necessary, the Air Pollution Information System (APIS) website (APIS, 2017) was used to determine relevant critical loads.

2.2 Guidance

The air quality assessment was undertaken in line with the key guidance summarised in Table 3.

Table 3 Summary of Key Guidance

Document	Description
Land-Use Planning and Development Control: Planning For Air Quality (Environmental Protection UK and Institute of Air Quality Management (EPUK and IAQM), 2017).	This document contains advice on the need for an air quality assessment with regard to traffic emissions and combustion plant, selection of modelling methodologies, how to describe air quality effects, and advice on determining the significance of air quality effects.
DMRB, Volume 11 Environmental Assessment, Section 3 Environmental Assessment Techniques, Part 1 HA207/07 Air Quality (Highways Agency, 2007).	This document provides guidance on the assessment of the impact that road projects may have on local and regional air quality.
Interim Advice Note (IAN) 174/13 Evaluation of Significant Local Air Quality Effects (Highways Agency, June 2013).	Updated advice for evaluating significant local air quality effects for users of DMRB Volume 11, Section 3, Part 1 Air Quality (HA207/07)
IAN 170/12v3 Updated air quality advice on the assessment of future NOx and NO_2 projections (Highways Agency, October 2013)	Updated air quality advice on the assessment of future NO_x and NO_2 projections for users of DMRB Volume 11, Section 3, Part 1 'Air Quality
LAQM.TG(16) Defra and the devolved administrations (Defra, 2016).	This is designed to guide local authorities through the LAQM process and includes detailed technical guidance on air quality screening, modelling and assessment. It also provides guidance on where the AQOs apply.

3. Methodology

This assessment has been undertaken in accordance with DMRB HA207/07, associated Highways England (HE – *formerly Highways Agency*) IANs and LAQM.TG16, where appropriate. This assessment has been carried out using the latest Defra Emissions Factor Toolkit (EFT) [Version 7.0] and Advanced Dispersion Modelling Software ADMS-Roads [Version 4.1], developed by Cambridge Environmental Research Centre (CERC).

The key elements of the assessment are as follows:

- Consideration of relevant local authorities' Local Air Quality Review and Assessment documents
- Baseline assessment of existing local air quality conditions through a review of available air quality monitoring data for the study area
- Local air quality assessment for NO_2 at human-exposure receptors within 200m of affected roads using dispersion modelling

The assessment identifies potential air quality effects by predicting changes in air quality pollutant concentrations resulting from the combination of background concentrations with the contributions from the roads in the study area, including the Proposed Scheme.

This assessment conforms to the standard practice of EIA, whereby the baseline is established, and then the situation with the development in place (Do Something - DS) is compared to the situation without it (Do Minimum - DM).

3.1 Assessment Scenarios

The assessment of local air quality included the following scenarios:

- Baseline - without the Proposed Scheme (DM) 2016 (AMIP and AMIPPM)
- Do Something – with the Proposed Scheme (DS) 2016 (AMIP and AMIPPM)

In order to assess the performance of the air quality model, the results of the base year modelling were compared with appropriate local authority monitoring data collected between January-December 2016, in a process known as model verification and adjustment. This process identified that adjustment of the model was required, and this was undertaken following guidance in LAQM.TG (16). The model adjustment has been applied to the assessment results presented in this report. For a more detailed methodology behind the model verification refer to Appendix A.

3.2 Traffic Data

The traffic data utilised for the modelling scenarios has been provided by Saturn traffic models produced by Jacobs. The base year air quality modelling uses traffic data, pollution measurements and meteorological measurements from 2016.

Two traffic datasets were used in the assessment, as follows, and considered for sensitivity-testing purposes:

- AMIP (traffic data factored from AM and IP time period traffic model data)
- AMIPPM (traffic data factored from AM, IP and PM time period traffic model data)

Traffic data that represent the average conditions occurring in specific time periods were provided for the periods specified in Table 4.

Table 4 Annual Average Weekday Time Periods Used In The Assessment

Traffic Period	Time Period
Annual Average Daily Traffic (AADT)	00:00 – 23:00
Annual Average Weekday Traffic (AAWT) AM peak (AM)	07:00 – 09:00
AAWT inter-peak (IP)	10:00 – 15:00
AAWT PM peak (PM)	16:00 – 18:00
AAWT off peak (OP)	19:00 – 06:00

For each time period, the following traffic data parameters were provided:

- Total traffic flow, defined as vehicles/hour
- Percentage Heavy Duty Vehicles (HDV)
- Vehicle speed, in kilometres per hour (kph)

3.3 Meteorological Data

The effect of meteorological conditions on dispersion is given a complex treatment within the model. The most significant factors in the dispersion of emitted pollutants are wind speed and direction. The meteorological data site considered to be most representative of conditions across the study area was Birmingham Airport. A 2016 meteorological dataset was used in the assessment.

3.4 Vehicle Emissions

The ADMS-Roads takes into account the emissions produced by Light Duty Vehicles (LDV), less than 3.5 tonnes; and HDV, greater than 3.5 tonnes, travelling at speed along a section of road over an average hour. Vehicle emissions are calculated using the Defra EFT. Emissions for the road links HDV and LDV component are then inputted into the dispersion model.

3.5 Human Exposure Receptors

Within the study area, residential properties and where present other sensitive receptors (such as schools and nursing homes) have been considered. Building usage has been determined using the Ordnance Survey Address Base Plus dataset, and calculations made at the nearest façade to the busiest road.

A total of 1,408 receptors (for the AMIP scenario), and 1,422 receptors (for the AMIPPM scenario) were identified within the study area and were selected using professional judgement for being:

- Close to the affected roads
- Representative of the maximum effects of the Proposed Scheme in that region
- Risk of exceeding AQOs

The receptors were used in the assessment at 'ground-floor' level (i.e. not accounting for first floor properties where air quality concentrations have the potential to be lower).

3.6 Designated Sites

Within the study area, nature conservation sites designated at an International, European or National level have been considered. A desktop assessment identified the Edgbaston Pool Site of Special Scientific Interest (SSSI) as the only identified designated site in the vicinity of the Proposed Scheme. However, the site is not within 200m of the affected road network and is therefore not considered further in this assessment.

3.7 Background Concentrations

'Background' air quality is a concept used to enable assessments of the effects of particular emissions sources, without the need for all sources in the area to be considered explicitly. For the purposes of this assessment, the background air quality is the boundary condition of the road emissions pollution model. The road derived pollution is added to the background pollution concentration.

Defra provides empirically-derived national background maps, providing estimates of background pollutant concentrations on a 1km x 1km grid square resolution. Background mapping data have been obtained from Defra (http://www.laqm.Defra.gov.uk) for NO_x and NO_2 and is derived from a base year of 2013 (dataset available at time of the assessment) from which future years are projected.

The 'in-grid square' contribution trunk 'A' road and primary 'A' road sectors have been removed from the background annual mean NO_x concentration estimates, and background annual mean NO_2 estimates have been corrected using the Defra's Background NO_2 Calculator. This process has been undertaken to avoid double counting of road traffic emissions included in the dispersion model. Where predicted concentrations for specific receptors are presented, the sector-removed background concentrations used are also presented. The predicted background concentrations across the study area are within the relevant AQOs.

3.8 Assessment of Impact Magnitude and Overall Significance of Effects

The dispersion model results were used to assess the likelihood of significant effects as a result of the Proposed Scheme. Highways England's approach to air quality assessment identifies and assesses sensitive receptors near roads where air quality might be affected, and is set out in IAN 174/13 (Highways Agency, 2013b). Consequently, areas where national AQOs might be expected to be exceeded are considered, which includes Air Quality Management Areas (AQMAs).

The dispersion model results were interpreted to identify if receptors were in exceedance of AQOs in either the DM or DS scenario. These are the only receptors which were considered in the judgement of significance. The change in predicted concentration was then calculated as the difference between DS and DM model results at these receptors.

Where the difference in concentrations was less than 1% of the AQO e.g. less than 0.4 μg/m³ for annual mean NO_2, then the change at these receptors was considered to be imperceptible, and they were scoped out of the judgement of overall scheme significance.

Highways England has developed a framework to provide guidance on the number of receptors for each of the magnitude of change categories that might result in a significant environmental effect. However, they are guideline values only, and are to be used to inform professional judgement on significant effects of the Proposed Scheme. The significance categories and guideline property numbers are summarised in Table 5.

Table 5 Significance Categories and Guideline Property Numbers for Air Quality

Magnitude of Change in Annual Mean NO_2 or PM_{10} Concentration (μg/m³)	Number of Receptors with:	
	Worsening of AQO already above objective or creation of a new exceedance	Improvement of an AQO already above objective or the removal of an existing exceedance
Large (>4)	1 to 10	1 to 10
Medium (>2)	10 to 30	10 to 30
Small (>0.4)	30 to 60	30 to 60

3.9 Assumptions and Limitations

The air quality impact assessment is based on a series of computer models containing forecasted future conditions. The process relies on the modelling of future traffic flows, which is subject to limitations and uncertainties. This traffic data is used to compare future air quality conditions both with and without the Proposed Scheme. The air quality model draws on a number of other trends and parameters that must be projected into the future.

As with any computer model that seeks to predict future conditions, there is uncertainty in the predictions made. Whilst being the best predictions available, elements of impact prediction such as the specific concentration of a given pollutant at a given property, or whether an exceedance of the Air Quality Objectives (AQOs) would or would not occur at a specific location, are not precise and are always subject to a margin for error. Some margins of error have been estimated by undertaking model verification and is detailed in Appendix A.

4. Baseline Environment

The baseline conditions have considered information and data from the following sources:

- Defra background mapping for projected background concentrations in the assessment years (Defra, 2016)
- Birmingham City Councils' Local Air Quality Management (LAQM) reports
- Scheme specific monitoring data
- Human-exposure receptors were identified using Ordnance Survey (OS) Address base Plus dataset

4.1 Study Area

The study area for the assessment of local air quality has been defined in line with the guidance contained in the DMRB Volume 11, Section 3, Part 1 HA207/07. This provides criteria by which certain changes in traffic information on the road network are then classed as 'Affected Roads', based on the changes between Base / DM and DS scenarios that would occur as a result of the Proposed Scheme being implemented, as follows:

- Horizontal road alignment will change by 5m or more
- Daily traffic flows will change by >=1,000 Annual Average Daily Traffic (AADT)
- Heavy Duty Vehicle (HDV) flows will change by >=200 AADT
- Daily average speed will change by >=10kph
- Peak hour speed will change by >=20kph

Road links that meet any of the criteria above are therefore deemed an 'affected road', which forms the air quality study area (or Affected Road Network (ARN)). Sensitive receptors within 200m of the ARN are then identified. Beyond 200m, the contribution of vehicle emissions to local pollution levels is considered to be not significant. The study area is presented in Figure 1.

4.2 Air Quality Management Areas

Under Local Air Quality Management responsibilities, local authorities continually monitor and review air quality concentrations within their areas. Where concentrations identify an exceedance of AQS objectives, an AQMA is declared, and an action plan put in place for improvement. Birmingham City Council has declared one city wide AQMA for annual mean NO_2 and 24-hour mean PM_{10}. The AQMA includes the Proposed Scheme location.

4.3 Background Concentrations

Background annual mean pollutant concentration estimates for 2016 across the study area are presented in Table 6.

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Table 6 Background Annual Mean NO_2 Pollutant Concentrations (AQO = 40 µg/m^3)

OS Grid Squares (X_Y)	2016 Annual Average NO_2 (µg/m^3)
403500_280500	18.8
403500_282500	20.1
404500_282500	23.1
404500_283500	30.2
404500_285500	22.2
404500_286500	22.9
405500_280500	21.5
405500_281500	20.8
405500_282500	21.4
405500_283500	22.4
405500_284500	22.7
405500_285500	26.0
405500_286500	26.3
406500_283500	20.5
406500_284500	22.2
406500_285500	24.4
406500_286500	32.2
407500_283500	22.3
407500_284500	23.8
407500_285500	26.7
407500_286500	32.3

4.4 Monitoring Data

Air quality monitoring data within the study area have been collated and reviewed for use in the assessment. BCC manages a network of NO_2 diffusion tubes, including locations in the vicinity of the study area.

Sites with suitable data capture (≥75%), and where the exact monitoring location could be confirmed have been used to inform the air quality assessment, and verify dispersion modelling results (see Appendix A). These are provided in Table 7.

Table 7 Birmingham City Council NO_2 Monitoring Data In The Vicinity Of the Proposed Scheme

Site	Address	Coordinates		Type	Data Capture	2016 Annual mean* (µg/m^3)
		X	Y			
BHM8	Broad Street - O'Neills	406036	286490	UT	92%	48.4
BHM20	641 Bristol Road	404445	282885	UT	83%	38.8
BHM29	Suffolk Street Queensway	406583	286729	UT	83%	55.4
BHM31	Holiday Street	406564	286685	UT	75%	52.4
BHM33	Severn Street	406703	286514	UT	83%	52.0

UT – Urban Traffic

* 2016 annual mean NO_2 concentrations bias adjusted

5. Impact Assessment and Significant Effects

While Base / Do Minimum dispersion modelling has indicated a reasonable overall agreement between predicted concentrations and measured concentrations at the monitoring locations, they also show a slight over-estimate of total pollutant concentrations. Details of the model verification exercise are provided in Appendix A.

To support a conservative evaluation of the Proposed Scheme's impacts, interpretation has been undertaken using the worst-case (i.e. non-adjusted results). Results that have been adjusted for model over-estimation of total pollutant concentrations are provided in Appendix B.

The potential effects of the operation of the Proposed Scheme on local air quality along affected roads in the study area are presented below.

5.1 AMIP Model Scenario

Of the 1,408 local air quality receptors assessed for the local air quality assessment, 171 were predicted to exceed the NO_2 annual mean AQO in the Do Something scenario. Thirty-four (34) of these were predicted to receive changes in pollutant concentrations >0.4 µg/m^3 and are presented in Table 8 and illustrated in Figure 2.

Table 8 Do Something Air Quality Assessment Results (Annual NO_2) : AMIP Scenario

Receptor ID	Coordinates		NO_2 Annual mean* (µg/m³)		Change in Concentration (µg/m³)
	X	Y	Base / Do Minimum	Do Something	
NEWR1267	406752	286516	64.1	64.6	0.5
NEWR1294	406780	286480	63.9	64.5	0.6
NEWR1302	406854	286395	61.1	61.6	0.5
NEWR1264	406802	286460	57.6	58.0	0.4
NEWR1259	406926	286250	54.8	55.7	0.9
NEWR778	406916	286272	54.4	55.1	0.7
NEWR1277	406914	286277	54.3	55.1	0.8
NEWR739	406919	286266	54.1	54.9	0.8
NEWR1307	406928	286002	52.8	53.7	0.9
NEWR155	406928	286000	52.6	53.5	0.9
NEWR1314	407076	285407	51.3	51.9	0.6
NEWR1312	406896	286154	49.3	49.7	0.4
NEWR305	406927	285993	45.9	46.9	1.0
NEWR559	406923	285936	45.9	46.8	0.9
NEWR341	406924	285951	45.7	46.7	1.0
NEWR126	406926	285978	45.6	46.6	1.0
NEWR308	406927	285989	45.5	46.5	1.0
NEWR560	406924	285946	45.4	46.4	1.0
NEWR340	406925	285961	45.4	46.3	0.9
NEWR1320	406926	285973	45.3	46.2	0.9
NEWR154	406927	285984	45.1	46.1	1.0
NEWR1288	406924	285940	45.2	46.0	0.8
NEWR306	406925	285956	45.1	46.0	0.9
NEWR307	406926	285968	44.9	45.8	0.9
NEWR752	405492	286261	44.7	44.2	-0.5
NEWR397	407019	286349	43.1	43.5	0.4
NEWR1309	405497	286258	43.9	43.4	-0.5
NEWR632	405474	286274	43.3	42.8	-0.5

Receptor ID	Coordinates		NO_2 Annual mean* (µg/m³)		Change in Concentration (µg/m³)
	X	Y	Base / Do Minimum	Do Something	
NEWR1298	405481	286270	43.1	42.7	-0.4
RR715	406888	285092	40.0	41.6	1.6
NEWR1006	405510	280462	40.4	40.8	0.4
NEWR503	405501	280448	40.4	40.8	0.4
NEWR150	407005	285303	39.9	40.4	0.5
NEWR151	407002	285297	39.7	40.2	0.5

The highest DS concentration was predicted to be 64.6 µg/m³ and occur at NEWR1267. The greatest increase in pollutant concentration was predicted to be 1.6 µg/m³ and occur at RR715; whereas the greatest reduction in pollutant concentration was predicted to be 0.5 µg/m³ and occur at NEWR1309, NEWR632 and NEWR752.

Four new exceedances of AQOs were predicted to occur as a result of the Proposed Scheme and no exceedances were predicted to be removed in this model scenario.

5.2 AMIPPM Model Scenario

Of the 1,422 local air quality receptors assessed for the local air quality assessment, 154 were predicted to exceed the NO_2 annual mean AQO in the Do Something scenario. Thirty-seven (37) of these were predicted to receive changes in pollutant concentrations >0.4 µg/m³ and are presented in Table 9 and illustrated in Figure 3.

Table 9 Do Something Air Quality Assessment Results (Annual NO_2) : AMIPPM Scenario

Receptor ID	Coordinates		NO_2 Annual mean* (µg/m³)		Change in Concentration (µg/m³)
	X	Y	Base / Do Minimum	Do Something	
NEWR1006	405510	280462	40.6	41.2	0.6
NEWR1314	407076	285407	49.5	50.1	0.6
NEWR1259	406926	286250	54.2	55.1	0.9
NEWR559	406923	285936	45.5	46.7	1.2
NEWR305	406927	285993	45.4	46.7	1.3
NEWR341	406924	285951	45.3	46.5	1.2
NEWR126	406926	285978	45.2	46.5	1.3
NEWR1307	406928	286002	52.2	53.4	1.2
NEWR778	406916	286272	53.8	54.3	0.5
NEWR308	406927	285989	45.0	46.3	1.3
NEWR155	406928	286000	52.0	53.3	1.3
NEWR560	406924	285946	45.0	46.2	1.2
NEWR739	406919	286266	53.6	54.1	0.5
NEWR340	406925	285961	44.9	46.2	1.3
NEWR1277	406914	286277	53.8	54.3	0.5
NEWR1320	406926	285973	44.8	46.0	1.2
NEWR1288	406924	285940	44.7	45.9	1.2
NEWR154	406927	285984	44.6	45.9	1.3
NEWR306	406925	285956	44.6	45.8	1.2
NEWR307	406926	285968	44.5	45.7	1.2
NEWR1303	406122	285907	43.2	42.8	-0.4
NEWR1257	406118	285911	42.7	42.3	-0.4

Receptor ID	Coordinates		NO_2 Annual mean* (µg/m³)		Change in Concentration (µg/m³)
	X	Y	Base / Do Minimum	Do Something	
NEWR1194	405493	280436	41.2	41.8	0.6
NEWR122	404843	286009	40.2	40.6	0.4
NEWR1263	405495	280439	41.0	41.6	0.6
NEWR1310	404956	286011	43.2	43.7	0.5
NEWR397	407019	286349	42.8	43.5	0.7
NEWR1319	407334	286074	42.4	42.0	-0.4
NEWR250	405507	280457	40.4	40.9	0.5
NEWR1291	407061	286341	40.7	41.2	0.5
NEWR411	405498	280444	41.1	41.6	0.5
NEWR433	405413	280237	52.3	52.7	0.4
NEWR441	405491	280432	40.9	41.4	0.5
NEWR503	405501	280448	40.6	41.2	0.6
NEWR890	405488	280429	42.1	42.6	0.5
NEWR923	405504	280453	40.8	41.4	0.6
RR715	406888	285092	39.1	40.2	1.1

The highest DS concentration was predicted to be 55.1 µg/m^3 and occur at NEWR1259. The greatest increase in pollutant concentration was predicted to be 1.4 µg/m^3 and occur at NEWR305, NEWR126, NEWR308, NEWR155, NEWR340, NEWR154; whereas the greatest reduction in pollutant concentration was predicted to be 0.4 µg/m^3 and occur at NEWR1303, NEWR1257 and NEWR1319.

Two new exceedances of AQOs were predicted to occur as a result of the Proposed Scheme and no exceedances were predicted to be removed in this model scenario.

6. Significance of Effects

Tables 10 and 11 allocate the number of properties predicted to exceed AQOs and receive changes in pollutant concentrations >0.4 µg/m^3 according to HE Impact Magnitude classes for assessment of overall scheme significance.

Table 10 Summary of Significance of Effects : AMIP Scenario

Impact Magnitude		No. Receptors Exceeding Annual Mean Air Quality Objective for NO_2 (40 µg/m^3)			
		Worsening	Improving	Net (Worsening minus Improvement)	Guideline
≥4 µg/m^3	Large Impacts	0	0	0	1-10
≥2 µg/m^3	Large and Medium Impacts	0	0	0	10-30
≥0.4 µg/m^3	Large, Medium and Small Impacts	30	4	26	30-60

Table 11 Summary of Significance of Effects : AMIPPM Scenario

Impact Magnitude		No. Receptors Exceeding Annual Mean Air Quality Objective for NO_2 (40 µg/m^3)			
		Worsening	Improving	Net (Worsening minus Improvement)	Guideline
≥4 µg/m^3	Large Impacts	0	0	0	1-10
≥2 µg/m^3	Large and Medium Impacts	0	0	0	10-30
≥0.4 µg/m^3	Large, Medium and Small Impacts	35	2	33	30-60

The significance of effects interpretation shows that the Proposed Scheme is unlikely to have a significant effect on air quality in either traffic data scenario.

7. Mitigation

The significance of effects interpretation shows that the Proposed Scheme is unlikely to have a significant effect on air quality in either traffic data scenario. As such, there is no requirement to implement impact mitigation.

8. Residual Effects

As there is no requirement to implement impact mitigation, it is concluded that Residual Effects are also likely to be Not Significant.

9. Summary and Conclusions

A detailed air quality assessment has been undertaken to assess the potential for air quality impacts at sensitive receptors as a result of the Bristol Road A38 Cycle Scheme, using ADMS-Roads dispersion modelling software. The assessment has shown the changes in air quality concentration at receptors that were included in the judgement of significance do not meet the criteria to classify the effects as significant.

Therefore, the Proposed Scheme was not predicted to result in significant air quality effects, nor require impact mitigation to be implemented. Consequently, it is concluded that Residual Effects are also likely to be Not Significant.

Appendix A. Model Verification and Adjustment

The comparison of modelled concentrations with local monitored concentrations is a process termed 'verification'. Model verification investigates the discrepancies between modelled and measured concentrations, which can arise due to the presence of inaccuracies and/or uncertainties in model input data, modelling and monitoring data assumptions. The following are examples of potential causes of such discrepancy:

- Estimates of background pollutant concentrations
- Meteorological data uncertainties
- Traffic data uncertainties
- Model input parameters such as 'roughness length'
- Overall limitations of the dispersion model

Model Precision

Residual uncertainty may remain after systematic error or 'model accuracy' has been accounted for in the final predictions. Residual uncertainty may be considered synonymous with the 'precision' of the model predictions (i.e. how wide the scatter or residual variability of the predicted values compare with the monitored true value once systematic error has been allowed for). The quantification of model precision provides an estimate of how the final predictions may deviate from true (monitored) values at the same location over the same period.

Suitable local monitoring data for the purpose of verification is available for concentrations of NO_2 at the locations shown in Figure 1. This monitoring data have been used to validate the dispersion model prediction and obtain adjustment factors, which can be applied to predictions of pollutant concentrations in the base and future years.

Model Performance

An evaluation of model performance has been undertaken to establish confidence in model results. LAQM.TG(16) identifies a number of statistical procedures that are appropriate to evaluate model performance and assess the uncertainty. The statistical parameters used in this assessment are:

- Root mean square error (RMSE)
- Fractional bias (FB)
- Correlation coefficient (CC)

A brief for explanation of each statistic is provided in Table 12.

Table 12 Model Performance Statistics

Statistical parameter	Comments	Ideal value
RMSE	RMSE is used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared. If the RMSE values are higher than 25% of the objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements. For example, if the model predictions are for the annual mean NO_2 objective of 40µg/m^3, if an RMSE of 10µg/m^3 or above is determined for a model it is advised to revisit the model parameters and model verification. Ideally an RMSE within 10% of the air quality objective would be derived, which equates to 4µg/m^3 for the annual mean NO_2 objective.	0.00

Statistical parameter	Comments	Ideal value
FB	It is used to identify if the model shows a systematic tendency to over or under predict. FB values vary between +2 and -2 and has an ideal value of zero. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.	0.00
CC	It is used to measure the linear relationship between predicted and observed data. A value of zero means no relationship and a value of 1 means absolute relationship. This statistic can be particularly useful when comparing a large number of model and observed data points.	1.00

These parameters estimate how the model results agree or diverge from the observations.

These calculations have been carried out prior to, and after, adjustment and provide information on the improvement of the model predictions as a result of the application of the verification adjustment factors.

A.1 Assessment Verification

The verification process involves a review of the modelled pollutant concentrations against corresponding monitoring data to determine how well the air quality model has performed. Depending on the outcome it may be considered that the model has performed adequately and that there is no need to adjust any of the modelled results (LAQM.TG(16)).

Alternatively, the model may perform poorly against the monitoring data. There is then a need to check all the input data to ensure that it is reasonable and accurately represented in the air quality modelling process.

Where all input data, such as traffic data, emissions rates and background concentrations, have been checked and considered as reasonable, then the modelled results require adjustment to best align with the monitoring data. This may either be a single verification adjustment factor to be applied to the modelled concentrations across the study area, or a range of different adjustment factors to account for different zones in the study area (e.g. motorways, local roads).

A summary of the verification results, and adjustment factors for both traffic scenarios is provided in Table 13.

Table 13 Summary of Verification and Adjustment Model Performance

	AMIP Scenario		AMIPPM Scenario	
	No Adjustment	With Nox Roads Adjustment	No Adjustment	With Nox Roads Adjustment
RMSE	3.686	2.276	3.279	2.515
Correlation	0.969	0.974	0.974	0.977
Fractional Bias	-0.045	0.014	-0.028	0.017
Adjustment Factor	0.815		0.854	

The model verification review identified a NO_x adjustment factors of 0.815 (AMIP) and 0.854 (AMIPPM) should to be applied to the modelled concentrations to achieve a realistic representation of monitored NO_2 concentrations.

Appendix B. Air Quality Modelling Results

Table 14 Modelled Receptors Air Quality Modelling Results (With NOx Adjustment) : AMIP Scenario

Modelled Receptor ID	X	Y	Annual Mean NO2 concentration (µg/m^3)		
			Base	DS	Change (DS-DM)
NEWR1267	406752	286516	58.9	59.3	0.4
NEWR1294	406780	286480	58.8	59.2	0.4
NEWR52	406761	286507	56.7	57.1	0.4
NEWR1302	406854	286395	56.4	56.8	0.4
NEWR1264	406802	286460	53.4	53.8	0.4
NEWR1314	407076	285407	47.2	47.7	0.5
NEWR1259	406926	286250	51.0	51.8	0.8
NEWR559	406923	285936	42.3	43.1	0.8
NEWR305	406927	285993	42.3	43.1	0.8
NEWR341	406924	285951	42.1	43.0	0.9
NEWR126	406926	285978	42.1	42.9	0.8
NEWR1307	406928	286002	49.3	50.1	0.8
NEWR778	406916	286272	50.6	51.3	0.7
NEWR308	406927	285989	42.0	42.8	0.8
NEWR155	406928	286000	49.1	49.9	0.8
NEWR560	406924	285946	41.9	42.7	0.8
NEWR739	406919	286266	50.5	51.1	0.6
NEWR340	406925	285961	41.8	42.7	0.9
NEWR1277	406914	286277	50.6	51.2	0.6
NEWR1320	406926	285973	41.7	42.6	0.9
NEWR1288	406924	285940	41.7	42.4	0.7
NEWR154	406927	285984	41.6	42.4	0.8
NEWR306	406925	285956	41.6	42.4	0.8
NEWR307	406926	285968	41.4	42.2	0.8
NEWR1309	405497	286258	40.9	40.5	-0.4
NEWR397	407019	286349	41.2	41.6	0.4
NEWR752	405492	286261	41.6	41.2	-0.4

The highest DS concentration was predicted to be 59.3 µg/m^3 and occur at NEWR1267. The greatest increase in pollutant concentration was predicted to be 0.9 µg/m^3 and occur at NEWR341, NEWR340 and NEWR1320; whereas the greatest reduction in pollutant concentration was predicted to be 0.4 µg/m^3 and occur at NEWR1309, and NEWR752.

Table 15 Modelled Receptors Air Quality Modelling Results (with NOx Adjustment) : AMIPPM Scenario

Modelled Receptor ID	X	Y	Annual mean NO2 concentration (µg/m³)		
			2016 Base	20X DS	Change (DS-DM)
NEWR1314	407076	285407	46.5	47.1	0.6
NEWR1259	406926	286250	51.3	52.1	0.8
NEWR559	406923	285936	42.7	43.7	1.0
NEWR305	406927	285993	42.6	43.8	1.2
NEWR341	406924	285951	42.5	43.6	1.1
NEWR126	406926	285978	42.4	43.6	1.2
NEWR1307	406928	286002	49.6	50.6	1.0
NEWR778	406916	286272	51.0	51.4	0.4
NEWR308	406927	285989	42.3	43.4	1.1
NEWR155	406928	286000	49.4	50.5	1.1
NEWR560	406924	285946	42.3	43.3	1.0
NEWR739	406919	286266	50.8	51.2	0.4
NEWR340	406925	285961	42.2	43.3	1.1
NEWR1277	406914	286277	50.9	51.4	0.5
NEWR1320	406926	285973	42.1	43.2	1.1
NEWR1288	406924	285940	42.0	43.0	1.0
NEWR154	406927	285984	42.0	43.1	1.1
NEWR306	406925	285956	41.9	43.0	1.1
NEWR307	406926	285968	41.8	42.9	1.1
NEWR1275	406766	286258	44.3	44.7	0.4
NEWR1310	404956	286011	40.5	40.9	0.4
NEWR397	407019	286349	41.4	41.9	0.5
NEWR1319	407334	286074	41.0	40.6	-0.4

The highest DS concentration was predicted to be 52.1 µg/m^3 and occur at NEWR1259. The greatest increase in pollutant concentration was predicted to be 1.2 µg/m^3 and occur at NEWR305 and NEWR126; whereas the greatest reduction in pollutant concentration was predicted to be 0.4 µg/m^3 and occur at NEWR1319.