Detailed Assessment of Air Quality 2013

Main Street, Rutherglen, South Lanarkshire

Report for South Lanarkshire Council

Ricardo-AEA/R/ED56927001-RuthDA
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Executive summary

Ricardo-AEA were commissioned to undertake this Detailed Assessment of Air Quality for Main Street and the surrounding area in Rutherglen by South Lanarkshire Council. The assessment has been undertaken to investigate the potential scale and extent of exceedances of Air Quality Objectives in the study area. This Detailed Assessment will allow South Lanarkshire Council to decide whether or not an Air Quality Management Area is required at the study location.

This atmospheric dispersion modelling study, which has used the most recent traffic, monitoring and meteorological data for the area indicates that there are marginal exceedances of the PM_{10} annual mean objective at locations with relevant exposure.

The exceedance area encompasses the section of Main St up to 40m to the east of the junction with Farmeloan Road where there are residential properties at ground floor level. Due to the predicted exceedances of the PM_{10} objective being very marginal, the results should be considered in context with the model error and uncertainty described in the model verification section of the report.

In light of this Detailed Assessment of Air quality, South Lanarkshire Council should consider declaring an Air Quality Management encompassing all areas of exceedance of the PM_{10} annual mean objective predicted in this study.

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1 Introduction

Ricardo-AEA has been commissioned by South Lanarkshire Council to undertake a Detailed Assessment of Air Quality for Main Street and the surrounding area in Rutherglen. The assessment has been undertaken to investigate the scale and extent of potential exceedances of the Air Quality Objectives within the study area. The Detailed Assessment will allow South Lanarkshire Council to decide whether or not an Air Quality Management Area is required at this location.

1.1 Policy background

The Environment Act 1995 placed a responsibility on 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), carry out a Further Assessment of Air Quality, 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 and the devolved administrations' Technical Guidance- LAQM.TG(09).

Table 1 lists the objectives relevant to this assessment that are included in the Air Quality (Scotland) Regulations 2000 (Scottish SI 2000 No 97) and the Air Quality (Scotland) (Amendment) Regulations 2002 (Scottish SI 2002 No 297) for the purposes of Local Air Quality Management (LAQM).

Table 1: NO_2 and PM_{10} Objectives for the purpose of Local Air Quality Management

Pollutant	Air Quality Objective	
	Concentration	Measured as
Nitrogen dioxide	200 $\mu g.m^{-3}$ not to be exceeded more than 18 times a year	1 hour mean
	40 $\mu g.m^{-3}$	Annual mean
Particles (PM_{10}) (gravimetric) Authorities in Scotland only	50 $\mu g.m^{-3}$ not to be exceeded more than 7 times a year	24 hour mean
	18 $\mu g.m^{-3}$	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 be exposed over the averaging period of the objective. Table 2 summarises examples of where air quality objectives for NO_2 and PM_{10} should and should not apply.

Table 2: Examples of where the NO_2 Air Quality Objectives should and should not apply

Averaging Period	Pollutants	Objectives *should* apply at …	Objectives should *not* generally apply at …
Annual mean	NO_2, PM_{10}	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
24-hr mean	PM_{10}	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties (should represent areas of the garden where relevant public exposure is likely)	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean	NO_2	All locations where the annual mean and 24 and 8-hour mean objectives apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks and railway stations etc. which are not fully enclosed. Any outdoor locations to which the public might reasonably be expected to have access.	Kerbside sites where the public would not be expected to have regular access.

1.3 Purpose of this Detailed Assessment

This study is a Detailed Assessment, which aims to assess the magnitude and spatial extent of any exceedances of the NO_2 and PM_{10} objectives at locations where relevant human exposure may occur within selected locations in Rutherglen.

1.4 Overview of the Detailed 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 of NO_2 and PM_{10} concentrations;
- Recommend if South Lanarkshire Council should declare an AQMA at any location within Rutherglen and suggest its spatial extent.

The modelling methodologies provided for Detailed Assessments outlined in Defra Technical Guidance LAQM.TG(09)[1] were used throughout this study.

1.5 Previous Air Quality Review and Assessment work

2009 Updating and Screening assessment

South Lanarkshire Council's 2009 Updating and Screening assessment concluded a Detailed Assessment was required at Rutherglen; this recommendation was based on measured PM_{10} and NO_2 concentrations and screening of road traffic emissions within South Lanarkshire.

Detailed Assessment at Rutherglen 2010

Annual mean PM_{10} concentrations in excess of the 2010 objective were predicted at multiple locations of relevant human exposure across the study area. Based on the modelling predictions it was considered necessary to declare an Air Quality Management Area (AQMA) within this area of Rutherglen for PM_{10}.

The AQMA has not been formally declared. Since the original Detailed Assessment was conducted there have been changes to the traffic flows within Rutherglen; this is attributable to the M74 extension opening in 2011. This has displaced traffic that previously used Rutherglen as a route into Glasgow city from the south east; and observed daily traffic flows through Rutherglen have decreased significantly. It has also been recognised that areas out-with the original study area were affected by traffic congestion at locations where relevant exposure is present close to the road; and as a result an expansion in the NO_2 diffusion tube network was undertaken to further inform any future decisions regarding the AQMA boundary.

A meeting held between Scottish Government and South Lanarkshire Council on 17th December 2013 and subsequent email agreement concluded that it is now appropriate to produce a revised Detailed Assessment using the latest traffic and monitoring data, subject to the AQMA declaration process being taken forward early in 2014

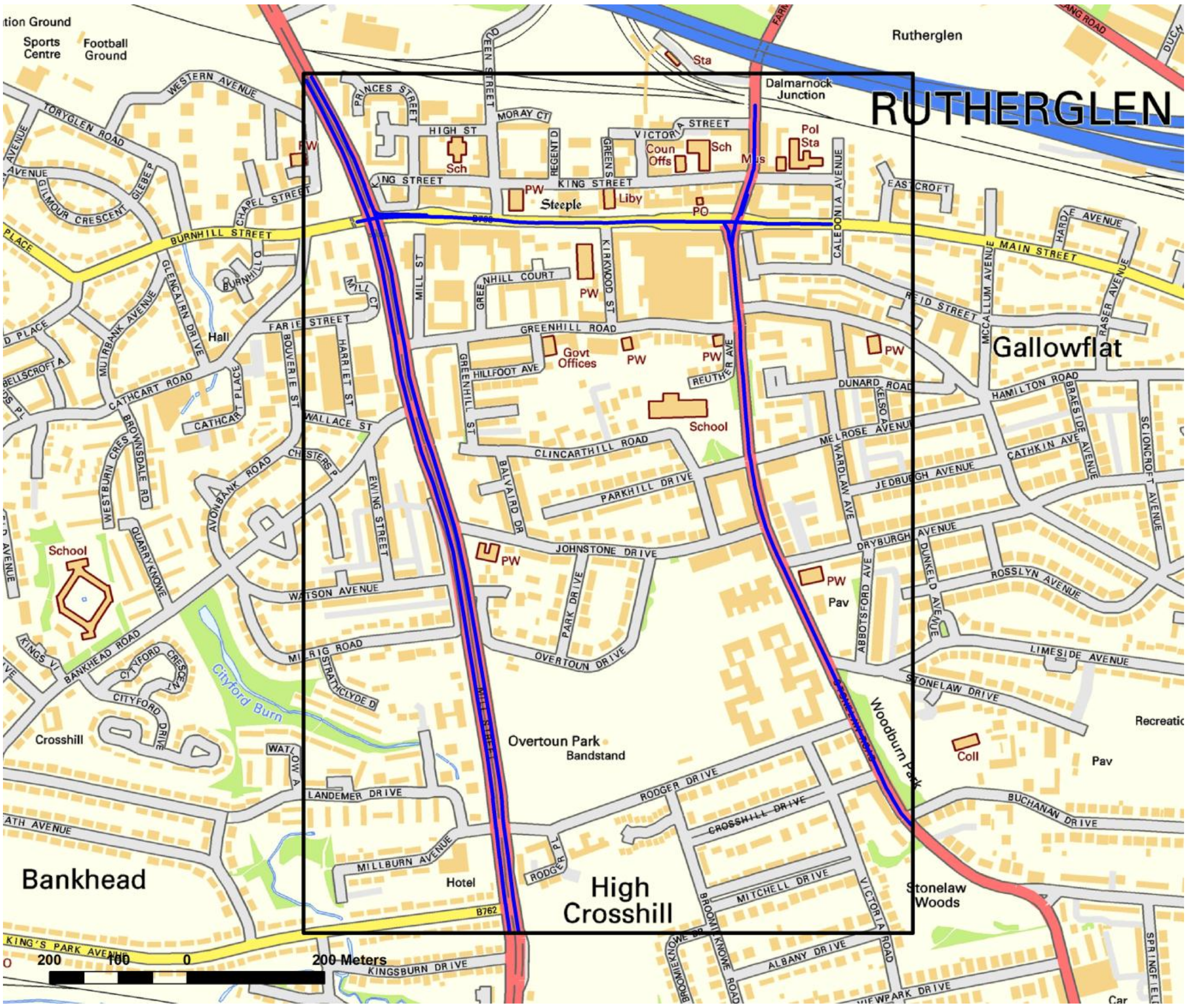
[1] Local Air Quality Management Technical Guidance LAQM.TG(09), Defra, 2009

2 Detailed Assessment study area

Rutherglen is situated at the north-western tip of South Lanarkshire, bordering the City of Glasgow. Formerly within the Glasgow City boundary, the town is commonly considered part of greater-Glasgow and is a densely populated area of large scale former industrial land use. The land use in Rutherglen predominantly comprises residential properties and local retail with some remaining industry.

The study area, including the roads modelled and the extent of the detailed assessment is presented in Figure 1 below. The size of the study area is approximately 1.2 km by 0.9 km.

Figure 1: Detailed Assessment study area



Legend:

Study area boundary

Road to be modelled

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3 Information used to support this assessment

3.1 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.

3.2 Road traffic data

3.2.1 Average flow, speed and fleet split

Traffic data for the assessment was available from South Lanarkshire Council's local automatic traffic count network. Annual average daily traffic (AADT) flows and vehicle fleet split data from four count locations in Rutherglen were used. Some assumptions have been made where traffic data was not available for specific roads sections included in the modelling. Appendix 1 summarises all of the traffic flow data used, data sources and any assumptions made.

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 inherent within the modelling.

3.2.2 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.

No queue observation data from traffic surveys was available for the assessment. As an alternative indicative method of observing local traffic patterns, real time traffic flows were observed a number of times using the traffic layer on Google maps. The observations indicated that traffic becomes regularly congested or slow moving during the morning/evening and late afternoon/evening peak periods along Main Street and at the junctions where the other roads modelled intersect with Main Street; and at other locations where junctions or traffic signals are present.

The TG(09) 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 speeds and traffic flows 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 available from the local traffic count data but no speed measurement data was available. Peak periods in traffic flow were therefore accounted for in the model by applying the diurnal traffic flow profile to the average hourly emission rate.

A method of modelling queuing traffic using ADMS-Roads proposed by model developers CERC has also been used at some locations close to junctions where traffic congestion was observed during peak periods. The method assumes that the vehicles are travelling at the lowest speed that can be modelled using ADMS-Roads (5 km/hr), with an average vehicle length of 4m, and are positioned close to each other during congested periods. The annual average hourly traffic (AAHT) flow is calculated by dividing the speed of the vehicles by the average vehicle length, which gives a representative AAHT of 1250 vehicles per hour during congested periods. A time–varying file is then used in the model to turn the congested road sections on for the relevant fraction of each hour of the day when congestion is known to occur.

3.2.3 Emission factors

The latest version of the Emissions Factors Toolkit[2] (EFT V5.2c Jan 2013) release) was used in this assessment to calculate pollutant emissions factors for each road link modelled. The calculated emission factors were then imported in to the ADMS-Roads model.

Parameters such as traffic volume, speed and fleet composition are entered into the EfT, and an emissions factor in grams of NOx/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 v8.1. These emissions factors were published in May 2011 through the European Environment Agency and are widely used for the purpose of calculating emissions from road traffic in Europe.

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.

Vehicle emission projections are based largely on the assumption that emissions from the fleet will reduce as newer vehicles are introduced. Any inaccuracy in the emissions factors contained in the EFT will be unavoidably carried forward into this modelling assessment.

3.3 Meteorological data

Hourly sequential meteorological data (wind speed, direction etc.) for 2012 from the Glasgow Bishopton meteorological measurement site was obtained from a third party supplier and used for the modelling assessment. The meteorological measurement site is located approximately 20 km to the north 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.

3.4 Background concentrations

Background NOx concentrations for a dispersion modelling study can be derived from either local monitoring data conducted at a background site or from the Scottish LAQM background maps[3].

The closest urban background NO_2 monitoring site is located at Cambuslang Road approximately 1.8km east of the study area. The NO_2 annual mean concentration measured at the Cambuslang

[2] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft
[3] SAQD (2013) http://www.scottishairquality.co.uk/maps

Road site during the study period was however greater that the annual mean measured at the Stonelaw Road diffusion tube site which is within the study area. This indicates that the background NO_2 concentration at Cambuslang Road is not representative of the background concentration within the study area. There are no urban background PM_{10} monitoring locations nearby.

The mapped background NOx and PM_{10} concentrations were therefore used in the study. A CSV file containing concentrations across the South Lanarkshire Council area was obtained and the background NOx and PM_{10} concentrations for the appropriate grid square extracted. The source contributions of background pollutant concentrations attributable to road traffic on the primary A roads within the study area have been subtracted from the total background to avoid double counting emissions from the roads.

The mapped annual mean NOx background concentration for the relevant grid square during 2013 was 32.5 $\mu g.m^{-3}$ and for annual mean PM_{10} was 12.6 $\mu g.m^{-3}$. It should be noted that the 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.

4 Ambient monitoring

South Lanarkshire Council currently measures NO_2 and PM_{10} concentrations at one continuous analyser in Rutherglen; and also measure NO_2 concentrations at four diffusion tube sites within the study area. A map showing the location of the monitoring sites is presented in Table 3.

Details of the monitoring sites and the annual mean concentrations measured during the period September 2012 to August 2013 are presented for NO_2 in Table 3 and PM_{10} in Table 4. All diffusion tube results have been bias adjusted using factor of 0.74 calculated from the co-location study conducted at the Rutherglen automatic site during 2012. Full details of bias adjustment factors applied to the diffusion tube results and QA/QC procedures are presented in South Lanarkshire Council's 2013 LAQM Progress Report and are reproduced in Appendix 4.

No annual mean NO_2 concentrations in excess of the 40 $\mu g.m^{-3}$ objective were measured at the diffusion tubes site within the study area during the non-calendar year study period. The annual mean measured at the automatic analyser on Main Street was 40 $\mu g.m^{-3}$ during the study period.

The annual mean PM_{10} concentration of 19$\mu g.m^{-3}$ measured at the automatic analyser was in excess of the 18 $\mu g.m^{-3}$ annual mean objective during the non-calendar year study period. The monitoring site is however at a roadside location with the nearest relevant exposure approximately 10 metres away.

Table 3: NO_2 measurements - comparison with annual mean objective

Site	Type	OS Grid Ref.		Relevant exposure Y/N with distance (m)	Data Capture Sep 2012 – Aug 2013 (%)	NO_2 Annual mean Sep 2012 – Aug 2013 ($\mu g.m^{-3}$)
		Easting	Northing			
Main Street Automatic analyser	R	261117	661690	Y (10m)	97.7%	**40**
Farmeloan Rd DT	R	261642	661689	Y (25m)	100%	39.2
263 Main Street DT	R	261688	661682	Y (0m)	100%	35.4
Stonelaw Rd DT	R	261687	661174	Y (21m)	100%	24.0
Mill St DT	R	261302	660734	Y (4m)	100%	30.9
Exceedances of the annual mean objective are highlighted in **bold** R – Roadside monitoring location, 1-5m from the kerb of a busy road						

Table 4: PM_{10} measurements – comparison with annual mean objective

Site	Type	OS Grid Ref.		Relevant exposure Y/N with distance (m)	Data Capture Sep 2012 – Aug 2013 (%)	NO_2 Annual mean Sep 2012 – Aug 2013 ($\mu g.m^{-3}$)
		Easting	Northing			
Main Street Automatic analyser	R	261117	661690	Y (10m)	92.1 %	**19**
Exceedances of the annual mean objective are highlighted in **bold**						
R – Roadside monitoring location, 1-5m from the kerb of a busy road						

Figure 2: Rutherglen air quality monitoring locations

Legend:

Diffusion tube site

Automatic analyser

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5 Modelling

5.1 Modelling methodology

Annual mean concentrations of NO_2 and PM_{10} have been modelled within the study area using the atmospheric dispersion model ADMS Roads (version 3.2).

The model was verified by comparing the modelled predictions of road NOx and PM_{10} with local monitoring results. The available measurements (described in Section 4 above) were used to verify the annual mean road NOx model predictions. Following initial comparison of the modelled concentrations with the available monitoring data, refinements were made to the model input to achieve the best possible agreement with the monitoring results. Further information on model verification is provided in Section 5.1.3 and Appendix 3

A surface roughness of 1 m was used in the modelling to represent the urban conditions in the model domain. A limit for the Monin-Obukhov length of 10 m was applied to represent a small town.

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 spaced at approximately 4 m being used to represent concentrations further away from the road. The grid height was set at 1.5m to represent human exposure at head height. The predicted concentrations were 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.

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.

Queuing traffic was treated in the model using the methodology described in Section 3.2.2 above as provided by the model developers. Queuing was assigned to specific road sections based on local knowledge and observations of typical congestion patterns. A time varying emissions file was used in the model to account for the daily variations in queuing traffic.

5.1.1 Treatment of modelled NOx road contribution

It is necessary to convert the modelled NOx concentrations to NO_2 for comparison with the relevant objectives. The Defra NOx/NO_2 model[4] 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 South Lanarkshire Council area in 2012 with the “All UK Traffic” option specified in the model, the NOx/NO_2 model estimates that 22.9% of NOx is released as primary NO_2.

5.1.2 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.

[4] Defra (2010) NOx to NO_2 conversion spreadsheet; Available at http://laqm1.defra.gov.uk/review/tools/monitoring/calculator.php

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.

5.1.3 Verification of the baseline model

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. Dispersion models of this nature carry a degree of uncertainty for the reasons explained in previous sections so it is important to check their performance against measurements and adjust their outputs accordingly. A full description of the model verification procedure for the baseline models is presented in Appendix 2.

A primary NOx adjustment factor (PAdj) of 1.5226 based on model verification using monitoring results covering the non-calendar year study period was applied to all modelled Road NOx data prior to calculating an NO_2 annual mean. After the NOx/NO_2 model was run no further adjustments were made to the data. Model agreement for the NO_2 monitoring data after adjustment is presented in Table 5and Figure 3.

To evaluate the model performance and uncertainty, the Root Mean Square Error (RMSE) for the observed vs predicted NO_2 annual mean concentrations was calculated, as detailed in Technical Guidance LAQM.TG(09), Box A3.7, Appendix 3. Details of the RMSE calculation are presented in Appendix 2. It is not possible in this instance to calculate the RMSE of the PM_{10} model as there is only one measurement site available.

It is recommended that the RMSE is below 25% of the objective that the model is being compared against, but ideally under 10% of the objective i.e. 4 µg.m^{-3} (NO_2 annual mean objective of 40 µg.m^{-3}). In this case the RMSE for the NO_2 annual mean was calculated at 0.36 µg.m^{-3}; the model uncertainty is therefore well within the recommended value and the model has performed very well for use within this assessment.

Based on a comparison of the monitored road contribution of PM_{10}, and the modelled road contribution of PM_{10} at the automatic monitor site; the model was found to be under-predicting PM_{10} concentrations and was corrected using a factor of 2.79.

It is not possible to estimate the RMSE in the PM_{10} model as only one monitoring site is available for comparison. However, the low RMSE based on NO_2 agreement indicates that the predicted PM_{10} values are reasonable given the common source of both pollutants.

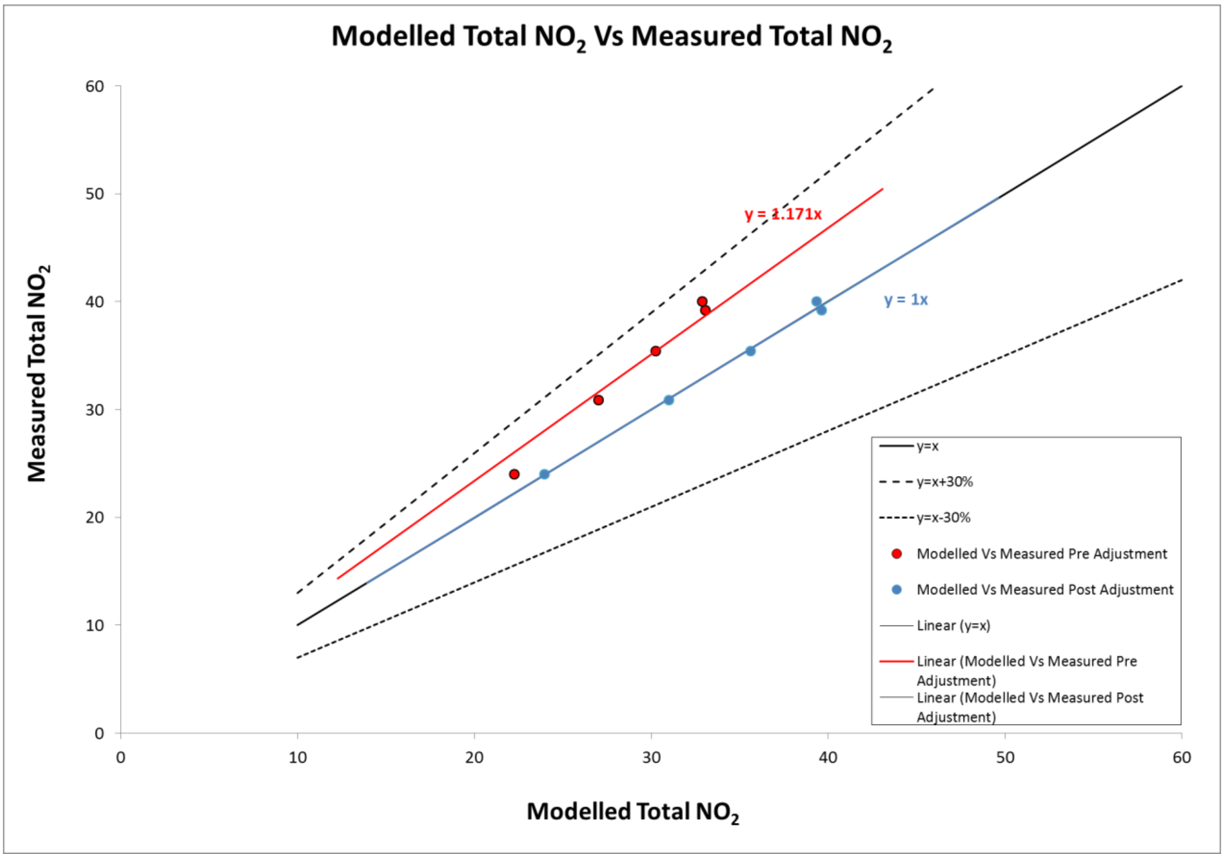
Verifying modelling data with diffusion tube monitoring data will always be subject to uncertainty due to the inherent limitations in such monitoring data (even data from continuous analysers has notable uncertainty). The model results should be considered in this context.

Further information on the verification process, including linear regression plots, is provided in Appendix 3.

Table 5: Modelled vs. measured annual mean NO_2 concentrations (Sep 2012 – Aug 2013)

Site	NO_2 annual mean concentration ($\mu g.m^{-3}$)	
	Measured	Modelled
Farmeloan Rd DT	39.2	39.6
263 Main Street DT	35.4	35.6
Stonelaw Rd DT	24.0	24.0
Mill St DT	30.9	31.0
Auto analyser	40.0	39.4
RMSE =		**0.36**

Figure 3: Linear regression analysis of modelled vs. monitored NO_2 annual mean



5.2 Modelling results

Annual mean NO_2 and PM_{10} concentrations have been predicted at a selection of receptor locations within the study area where relevant exposure is present at ground level. The receptors are located at the facade of residential buildings in the model domain where relevant exposure is present next to the roads sources being modelled. The receptors have been modelled at 1.5m height to represent ground level exposure. Pollutant concentrations have also been predicted across a grid of points at ground level (1.5m) to allow contour plots showing the spatial variation in pollutant concentrations to be created.

5.2.1 NO_2 Annual mean concentrations

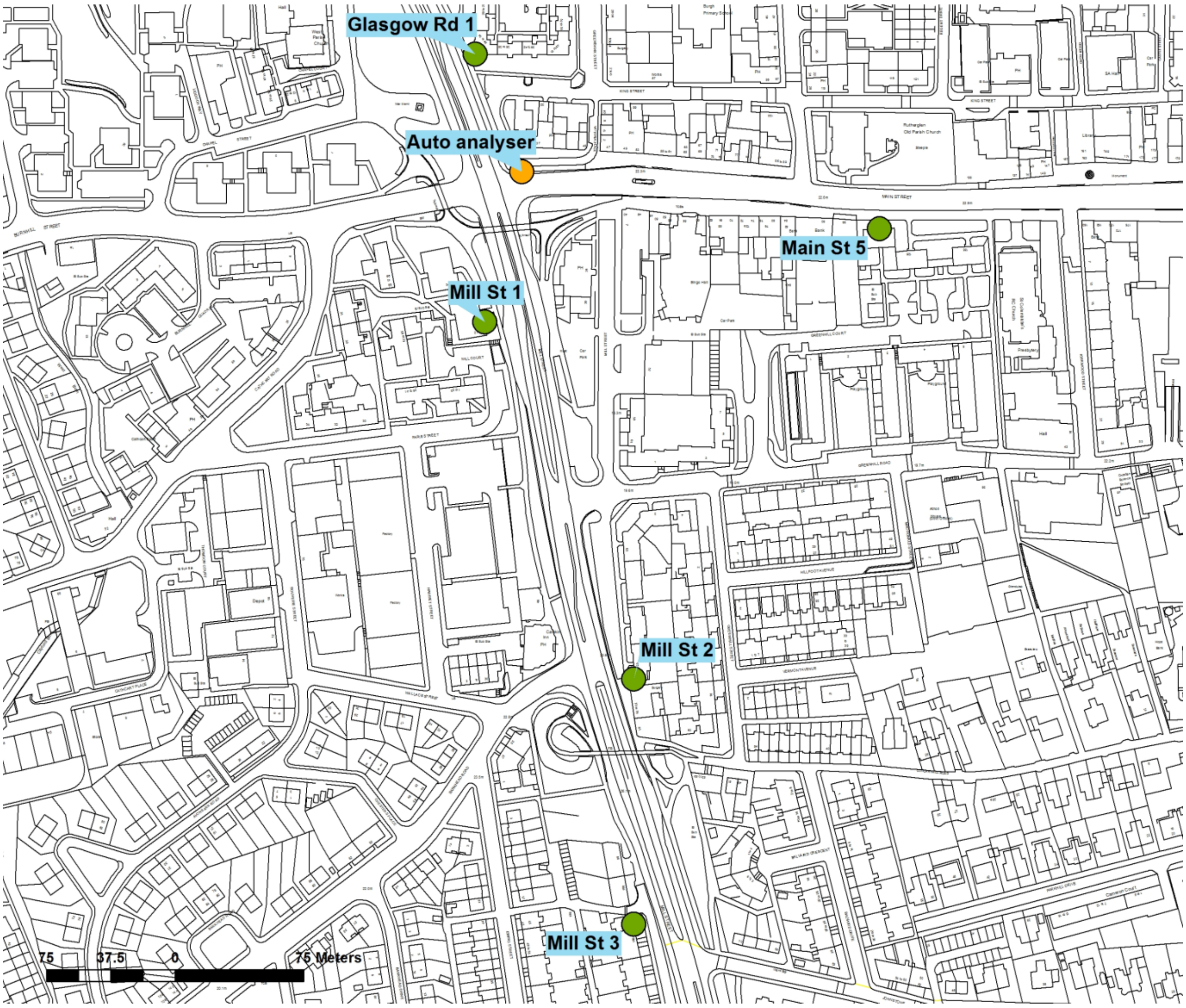
The predicted annual mean NO_2 concentrations at each of the specified receptors during the September 2012 to August 2013 study period are presented in Table 6. Maps representing the predicted annual mean NO_2 concentrations at the specified receptors using graduated colours are presented in Figure 4 to Figure 7. No annual mean NO_2 concentrations in excess of the 40 $\mu g.m^{-3}$ objective were predicted at any of the specified receptor locations over the non-calendar year study period.

Contours showing the predicted spatial variation in annual mean NO_2 concentrations are presented in Figure 8 to Figure 10. The contour in Figure 9 indicates that there may be very marginal annual mean concentrations in excess of the 40 $\mu g.m^{-3}$ objective occurring at ground level on the west side of Farmeloan road just north of the junction with King Street; at this location however there are only commercial properties present at ground level which are not considered locations of relevant exposure. Based on the model predicting very marginal exceedances of the 40 $\mu g.m^{-3}$ objective at ground level, it is considered unlikely that there will be exceedances at first floor height where residential properties are present.

Table 6: Predicted annual mean NO_2 concentrations at specified receptors (Sep 2012 – Aug 2013)

Receptor location	Height (m)	OS Grid reference		Annual mean NO_2 concentration ($\mu g.m^{-3}$)
		X	Y	
Farmeloan Rd DT	2.5	261642	661689	39.6
263 Main Street DT	2.5	261688	661682	35.6
Stonelaw Rd DT	2.5	261687	661174	23.9
Mill St DT	2.5	261302	660734	31.8
Auto analyser	1.8	261117	661690	39.4
Main St 1	1.5	261700	661664	35.1
Main St 2	1.5	261683	661664	36.0
Main St 3	1.5	261678	661682	37.2
Main St 4	1.5	261697	661682	35.3
Farmeloan Rd 1	1.5	261662	661798	27.3
Farmeloan Rd 2	1.5	261661	661773	28.1
Farmeloan Rd 3	1.5	261647	661789	34.7
Farmeloan Rd 4	1.5	261646	661767	36.4
Main St 5	1.5	261325	661656	22.3
Glasgow Rd 1	1.5	261089	661758	24.5
Mill St 1	1.5	261095	661602	23.3
Mill St 2	1.5	261182	661393	22.6
Mill St 3	1.5	261182	661251	21.6
Mill St 4	1.5	261304	660753	27.0
Mill St 5	1.5	261309	660725	27.1
Mill St 6	1.5	261311	660711	26.7
Mill St 7	1.5	261283	660653	21.5
Stonelaw Rd 1	1.5	261641	661500	25.9
Stonelaw Rd 2	1.5	261643	661295	23.5
Stonelaw Rd 3	1.5	261666	661290	24.3
Stonelaw Rd 4	1.5	261650	661266	23.5
Stonelaw Rd 5	1.5	261797	660927	22.4
Stonelaw Rd 6	1.5	261841	660840	22.8
Stonelaw Rd 7	1.5	261859	660811	22.3

Figure 4: Predicted NO_2 annual mean at specified receptor locations – NW of study area



Legend:

NO_2 annual mean concentration ($\mu g.m^{-3}$)

- < 25
- 25 - 30
- 30 - 36
- 36 - 39.6

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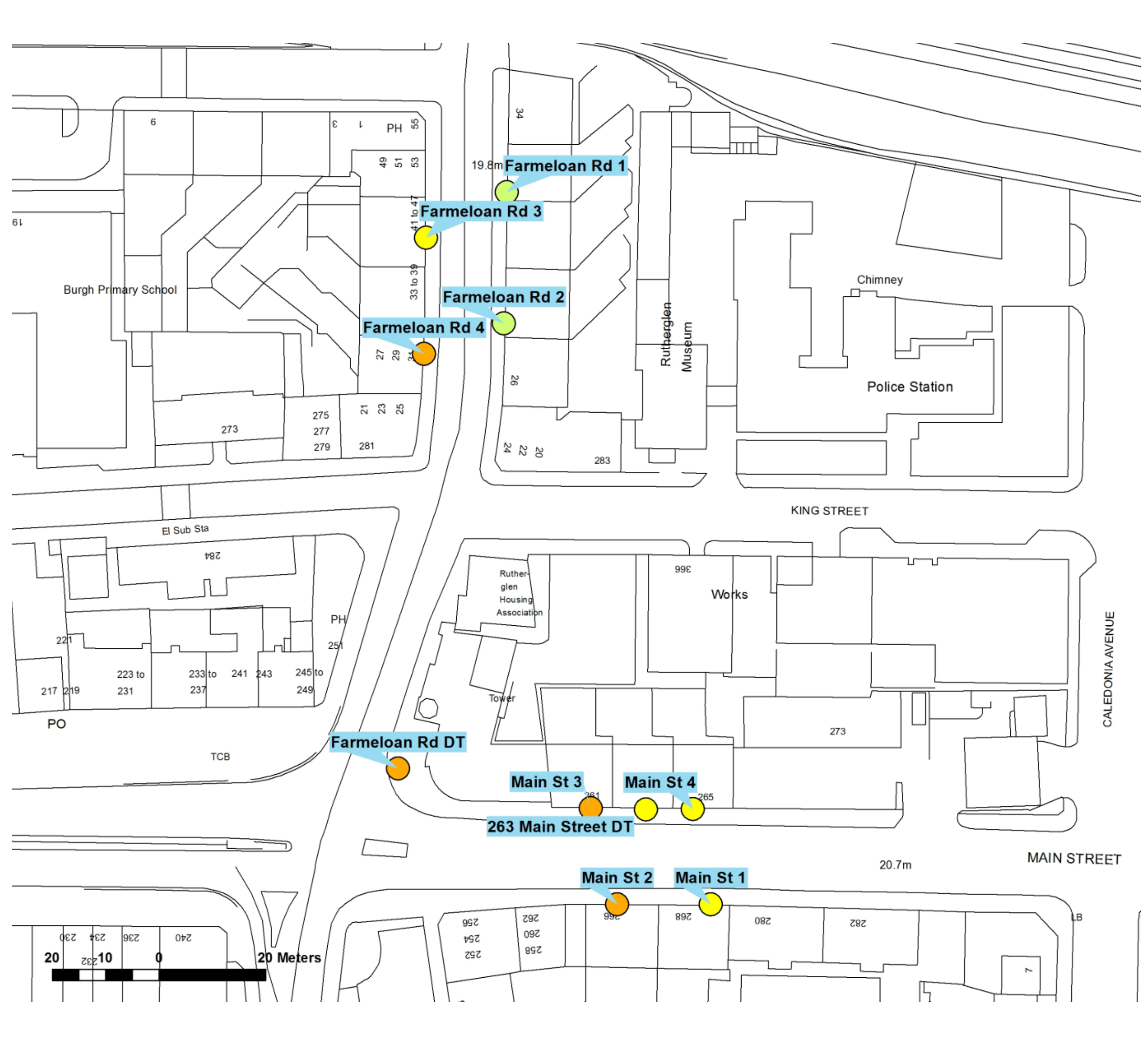
Figure 5: Predicted NO_2 annual mean at specified receptor locations – NE of study area



Legend:

NO_2 annual mean concentration ($\mu g.m^{-3}$)

- < 25
- 25 - 30
- 30 - 36
- 36 - 39.6

Figure 6: Predicted NO_2 annual mean at specified receptor locations – SE of study area

Legend:

NO_2 annual mean concentration ($\mu g.m^{-3}$)

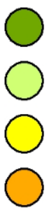


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Figure 7: Predicted NO_2 annual mean at specified receptor locations – SW of study area

N

Legend:

NO_2 annual mean concentration ($\mu g.m^{-3}$)

- < 25
- 25 - 30
- 30 - 36
- 36 - 39.6

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Figure 8: Predicted NO_2 annual mean concentration contour – NW of study area

Legend:

NO_2 annual mean concentration ($\mu g.m^{-3}$)

- < 30
- 30 - 36
- 36 - 40
- 40 - 44
- 44 - 50
- 50 - 55

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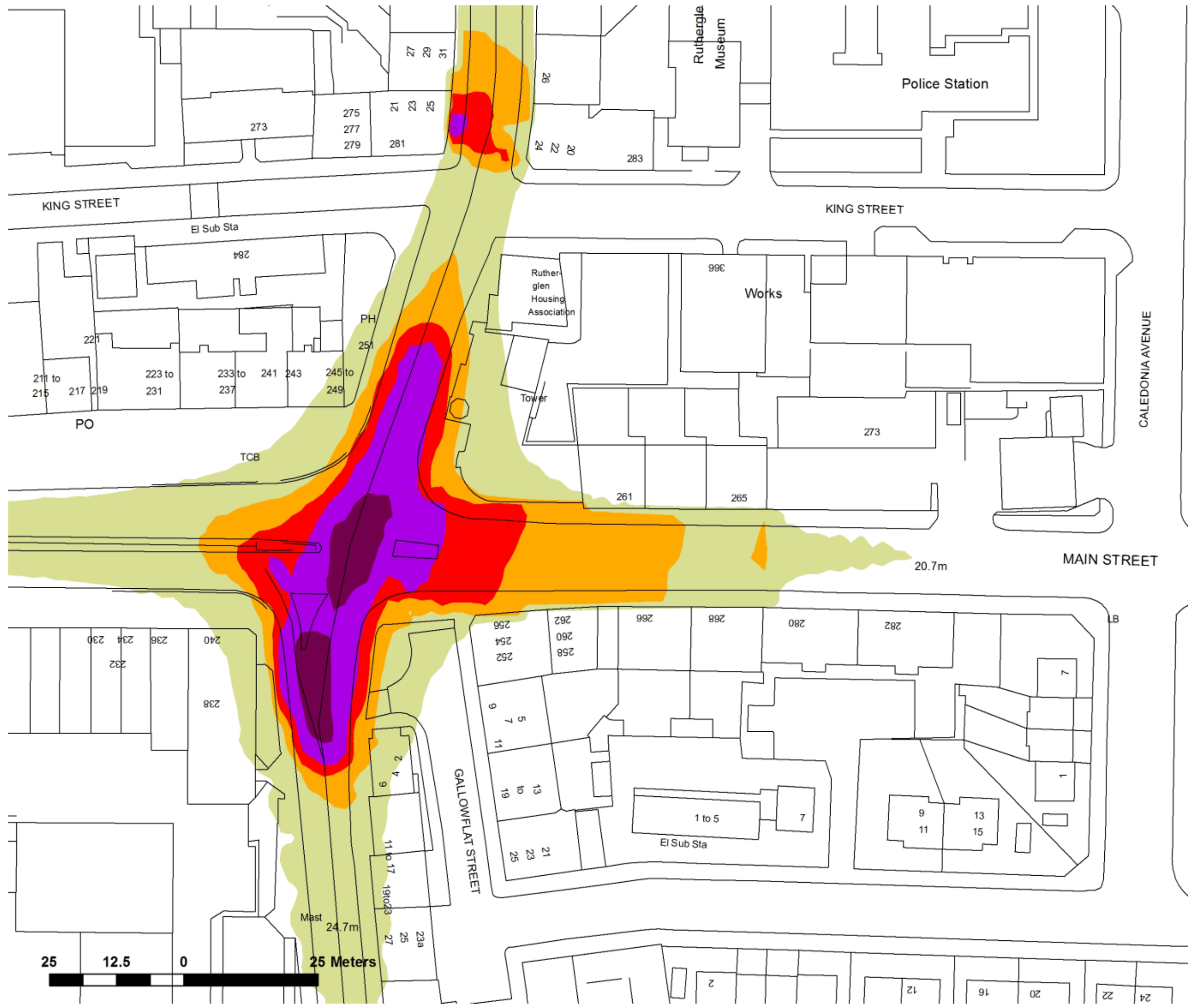
Figure 9: Predicted NO_2 annual mean concentration contour – NE of study area



N

Legend:

NO_2 annual mean concentration ($\mu g.m^{-3}$)

- < 30
- 30 - 36
- 36 - 40
- 40 - 44
- 44 - 50
- 50 - 55

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Figure 10: Predicted NO_2 annual mean concentration contour – SW of study area

Legend:

NO_2 annual mean concentration ($\mu g.m^{-3}$)

- < 30
- 30 - 36
- 36 - 40
- 40 - 44
- 44 - 50
- 50 - 55

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5.2.2 PM_{10} annual mean concentrations

The predicted annual mean PM_{10} concentrations at each of the specified receptors during the September 2012 to August 2013 study period are presented in Table 7. Maps representing the predicted annual mean PM_{10} concentrations at the specified receptors using graduated colours are presented in Figure 11 to Figure 14.

Annual mean PM_{10} concentrations in excess of the 18 $\mu g.m^{-3}$ Scottish objective were predicted at three of the specified receptor locations, two of which were the automatic analyser on Main Street and the Farmeloan Road diffusion tube site, both these sites are at a roadside locations where relevant exposure is not present. The other receptor location was at the Main Street 3 receptor which is located approximately 40m east of the junction with Main Street and Farmeloan Road where residential properties are present at ground level. The predicted annual mean concentration of 18.1 $\mu g.m^{-3}$ at this location is however considered marginal in comparison with the 18 $\mu g.m^{-3}$ objective, and the exceedance of 0.1 $\mu g.m^{-3}$ could be accounted for by the calculated error/uncertainty of the model (as described in Section 5.1.3 above)

Contours showing the predicted spatial variation in annual mean PM_{10} concentrations are presented in Figure 15 to Figure 17. The contour in Figure 16 indicates that annual mean PM_{10} concentrations just in excess of the 18 $\mu g.m^{-3}$ Scottish objective may be occurring at the facades of the ground level properties at the section of Main St up to 40m to the east of the junction with Farmeloan Road. At this location there are mainly commercial properties on the south side of the road and some commercial and residential properties at the north side. The results should be considered in context with the model error and uncertainty described in the model verification section of the report. It should be noted that the PM_{10} model predictions are likely to be more uncertain than for NO_2 as there was only one monitoring site available for model verification which is approximately 500m west of this location; uncertainty in the PM_{10} model predictions is likely to be greater at locations further away from the monitoring site.

Table 7: Predicted annual mean PM_{10} concentrations at specified receptors (Sep 2012 – Aug 2013)

Receptor location	Height (m)	OS Grid reference		Annual mean PM_{10} concentration ($\mu g.m^{-3}$)
		X	Y	
Farmeloan Rd DT	2.5	261642	661689	**18.2**
263 Main Street DT	2.5	261688	661682	17.6
Stonelaw Rd DT	2.5	261687	661174	14.3
Mill St DT	2.5	261302	660734	16.8
Auto analyser	1.8	261117	661690	**19.0**
Main St 1	1.5	261700	661664	17.5
Main St 2	1.5	261683	661664	17.7
Main St 3	1.5	261678	661682	**18.1**
Main St 4	1.5	261697	661682	17.6
Farmeloan Rd 1	1.5	261662	661798	15.0
Farmeloan Rd 2	1.5	261661	661773	15.2
Farmeloan Rd 3	1.5	261647	661789	17.4
Farmeloan Rd 4	1.5	261646	661767	17.9
Main St 5	1.5	261325	661656	13.7
Glasgow Rd 1	1.5	261089	661758	14.2
Mill St 1	1.5	261095	661602	14.1
Mill St 2	1.5	261182	661393	14.0
Mill St 3	1.5	261182	661251	13.6
Mill St 4	1.5	261304	660753	15.2
Mill St 5	1.5	261309	660725	15.2
Mill St 6	1.5	261311	660711	15.1
Mill St 7	1.5	261283	660653	13.4
Stonelaw Rd 1	1.5	261641	661500	14.8
Stonelaw Rd 2	1.5	261643	661295	14.0
Stonelaw Rd 3	1.5	261666	661290	14.3
Stonelaw Rd 4	1.5	261650	661266	14.1
Stonelaw Rd 5	1.5	261797	660927	13.8
Stonelaw Rd 6	1.5	261841	660840	13.9
Stonelaw Rd 7	1.5	261859	660811	13.8

Figure 11: Predicted PM_{10} annual mean at specified receptor locations – NW of study area

Legend:

PM_{10} annual mean concentration ($\mu g.m^{-3}$)

- < 15
- 15 - 16
- 16 - 17
- 17 - 18
- 18 - 19

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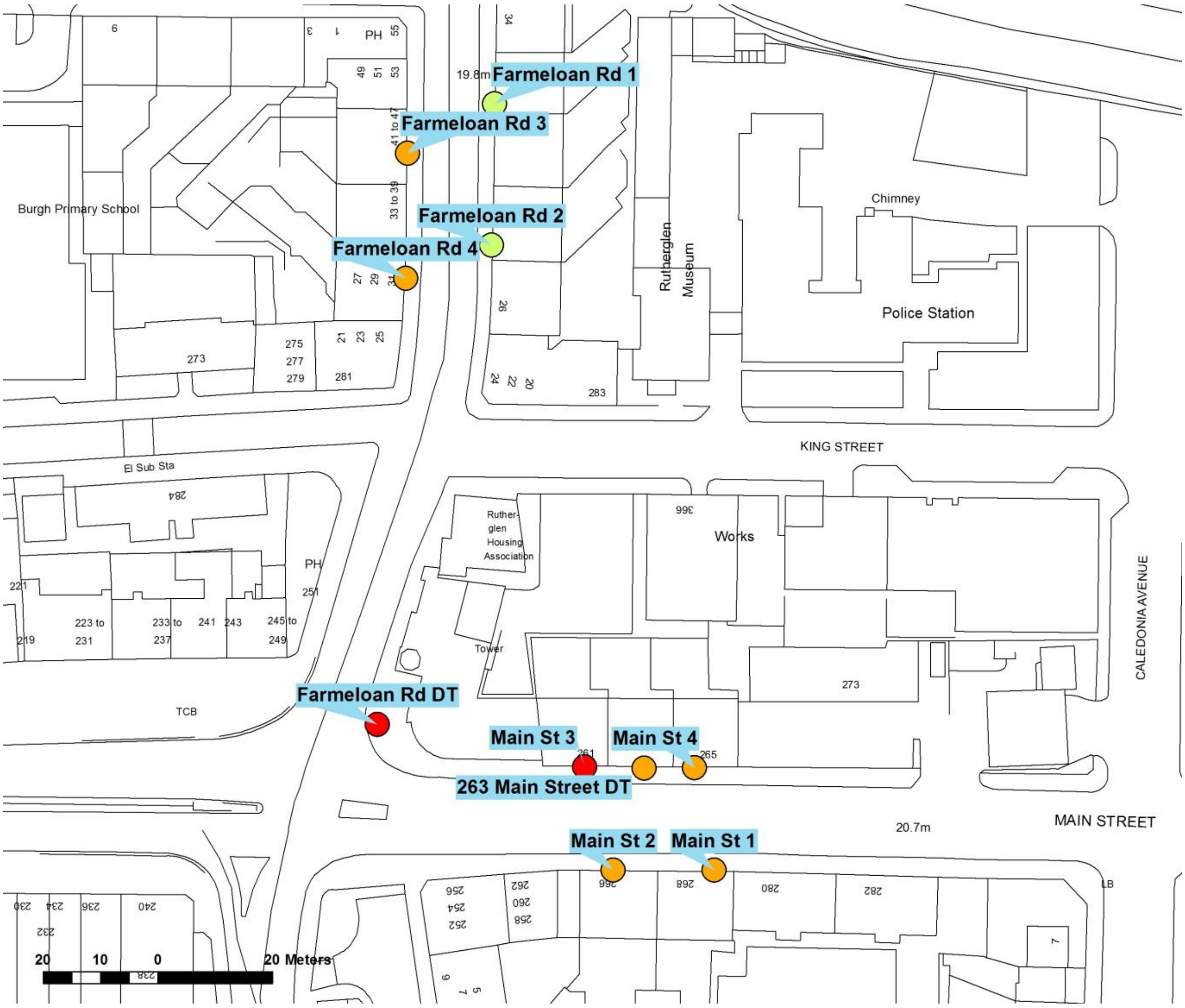
Figure 12: Predicted PM_{10} annual mean at specified receptor locations – NE of study area



Legend:

PM_{10} annual mean concentration (µg.m^{-3})

- < 15
- 15 - 16
- 16 - 17
- 17 - 18
- 18 - 19

Figure 13: Predicted PM_{10} annual mean at specified receptor locations – SE of study area

Legend:

PM_{10} annual mean concentration ($\mu g.m^{-3}$)

- < 15
- 15 - 16
- 16 - 17
- 17 - 18
- 18 - 19

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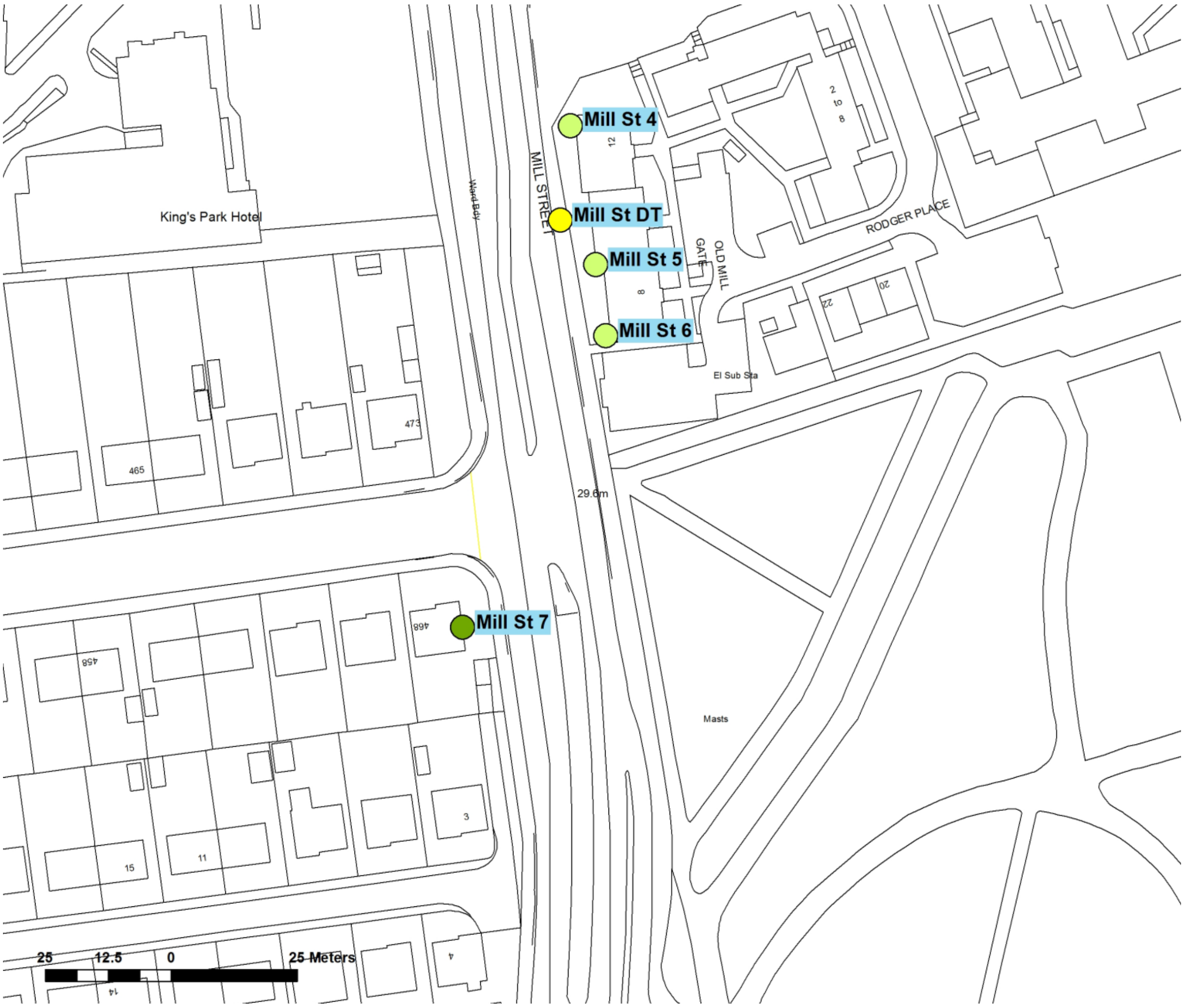
Figure 14: Predicted PM_{10} annual mean at specified receptor locations – SW of study area



Legend:

PM_{10} annual mean concentration (µg.m^{-3})

- < 15
- 15 - 16
- 16 - 17
- 17 - 18
- 18 - 19

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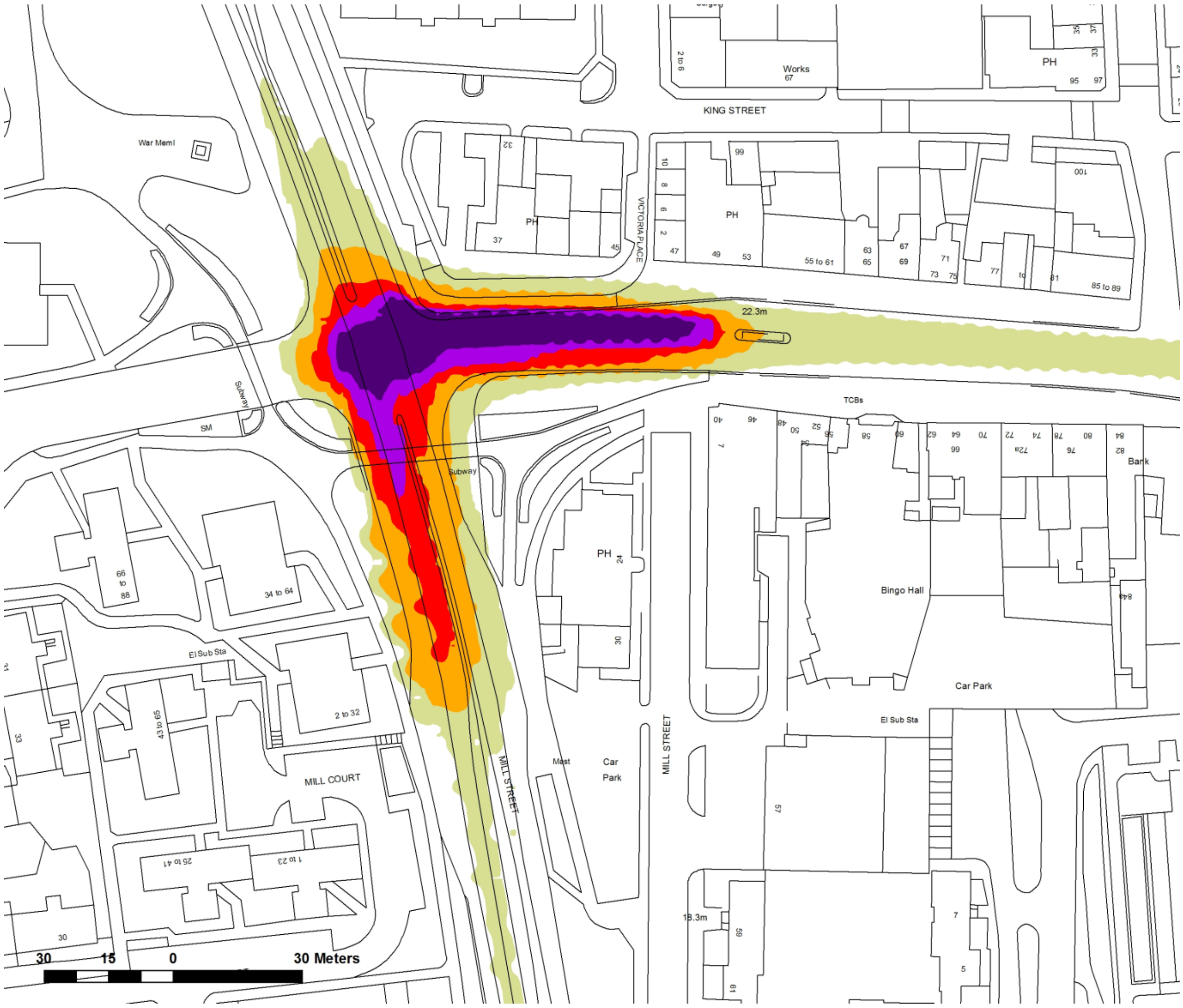
Figure 15: Predicted PM_{10} annual mean concentration contour – NW of study area



Legend:

PM_{10} annual mean concentration ($\mu g.m^{-3}$)

- < 16
- 16 - 17
- 17 - 18
- 18 - 19
- 19 - 20
- 20 - 25

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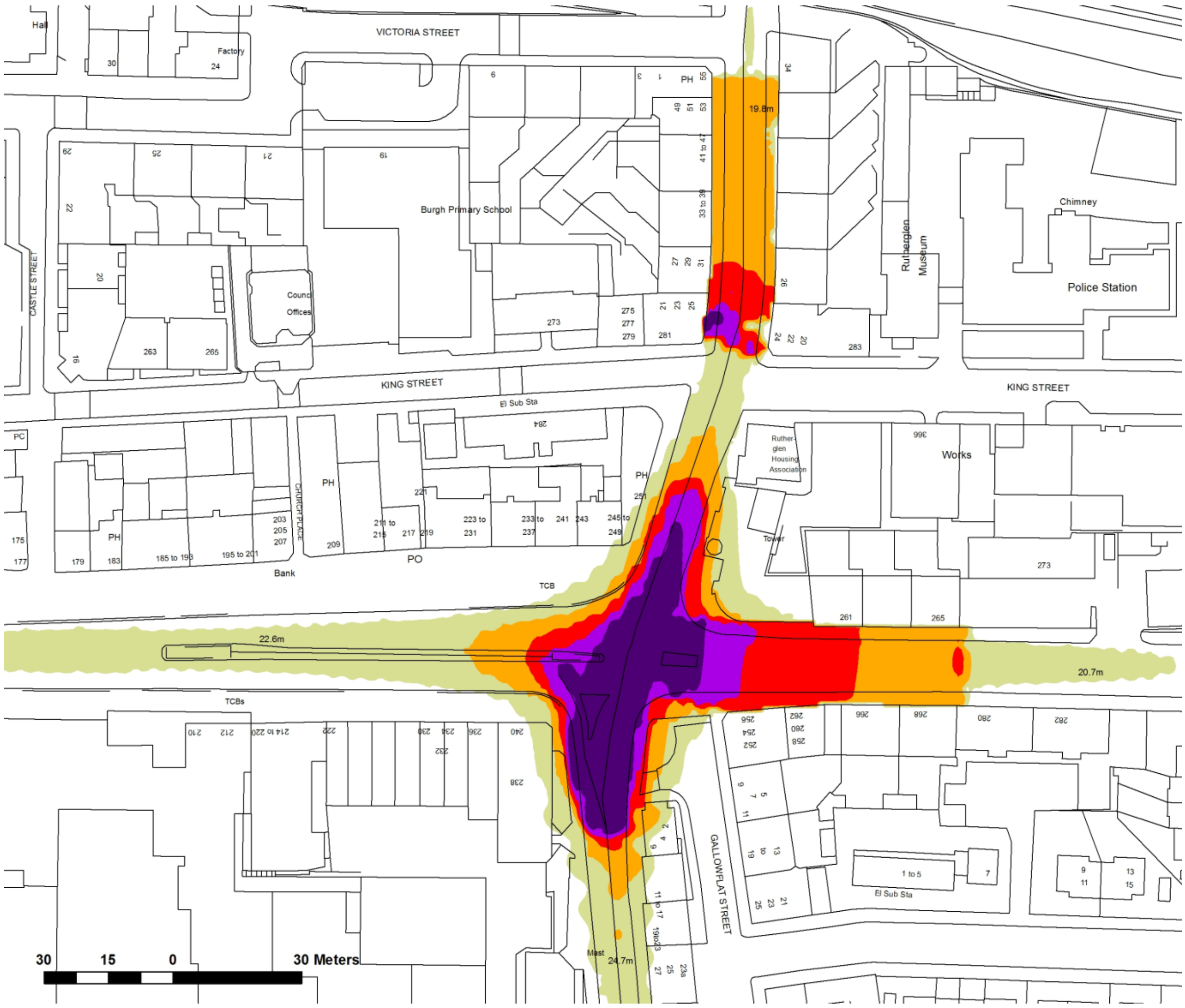
Figure 16: Predicted PM_{10} annual mean concentration contour – NE of study area



N

Legend:

PM_{10} annual mean concentration ($\mu g.m^{-3}$)

- < 16
- 16 - 17
- 17 - 18
- 18 - 19
- 19 - 20
- 20 - 25

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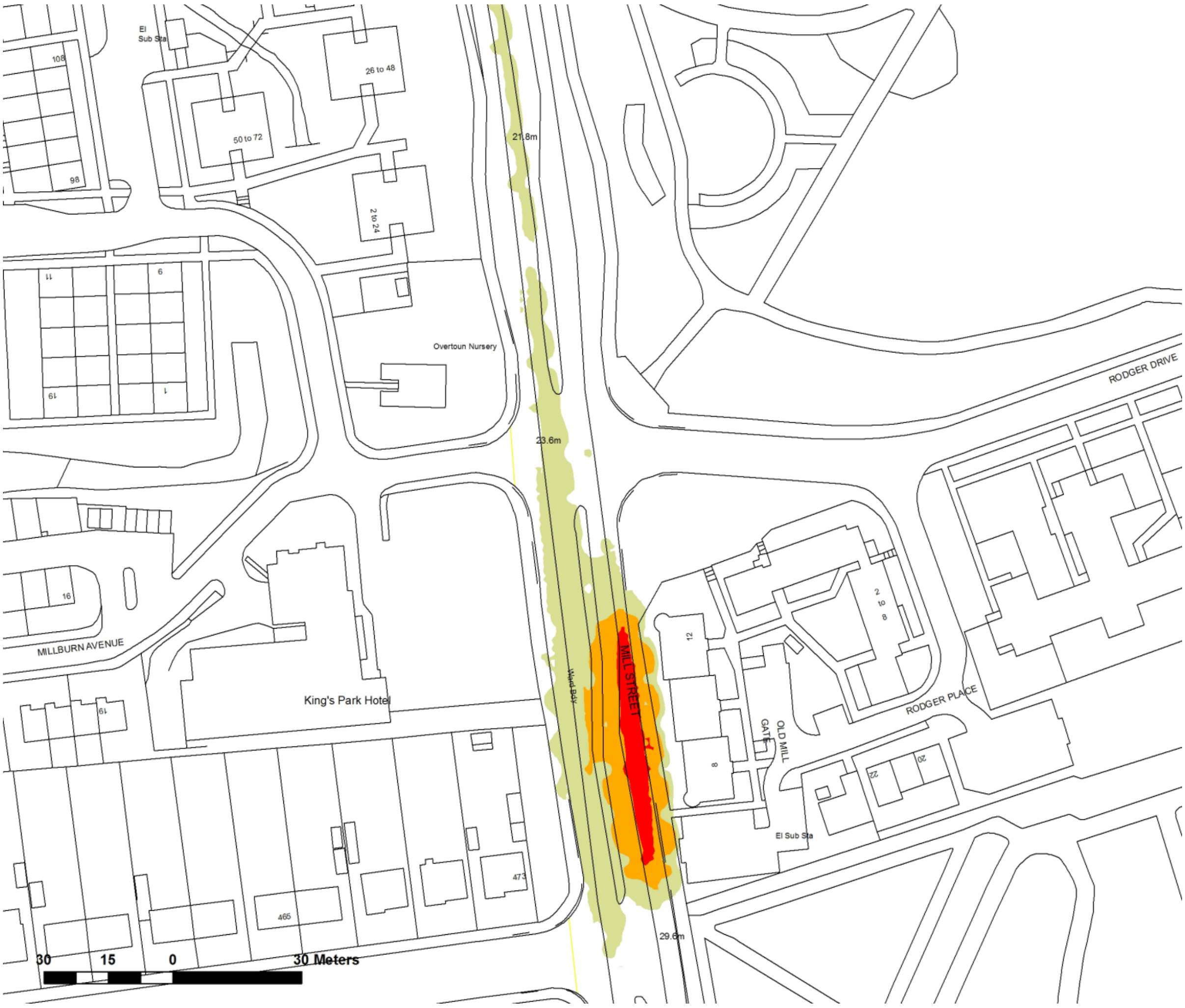
Figure 17: Predicted PM_{10} annual mean concentration contour – SW of study area



Legend:

PM_{10} annual mean concentration ($\mu g.m^{-3}$)

- < 16
- 16 - 17
- 17 - 18
- 18 - 19
- 19 - 20
- 20 - 25

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6 Conclusion

A dispersion modelling study of road traffic emission in Rutherglen has been conducted to allow a detailed assessment of both NO_2 and PM_{10} concentrations at this location.

The modelling study, which has used the most recent traffic, monitoring and meteorological data for Rutherglen indicates that there are no exceedances of the NO_2 annual mean objective occurring at locations where there is relevant exposure. The NO_2 model has a low RMSE value so the results can be considered to be robust.

The modelling study does however indicate that there are marginal exceedances of the Scottish PM_{10} annual mean objective occurring at locations where relevant exposure exists. The exceedance area encompasses the section of Main St up to 40m to the east of the junction with Farmeloan Road where there are residential properties at ground floor level. Due to the predicted exceedances of the PM_{10} objective being very marginal, the results should be considered in context with the model error and uncertainty described in the model verification section of the report.

In light of this Detailed Assessment of Air quality, should a precautionary approach be considered appropriate; South Lanarkshire Council should declare an Air Quality Management encompassing all areas of exceedance of the PM_{10} annual mean objective predicted.

7 Acknowledgements

Ricardo-AEA gratefully acknowledges the support received from Bronah Byrne, Anne Crossar and Andrew Smith of South Lanarkshire Council when completing this assessment.

Appendices

Appendix 1: Traffic data

Appendix 2: Meteorological data – Windrose

Appendix 3: Model Verification

Appendix 4: Monitoring data QA/QC

Appendix 1: Traffic data

Table A2.1 summarises the Annual Average Daily Traffic (AADT) counts and fleet compositions used within the model. Traffic data were not growth adjusted forward to 2012.

Table A2.1: Lanark Annual Average Daily Flows - 2011

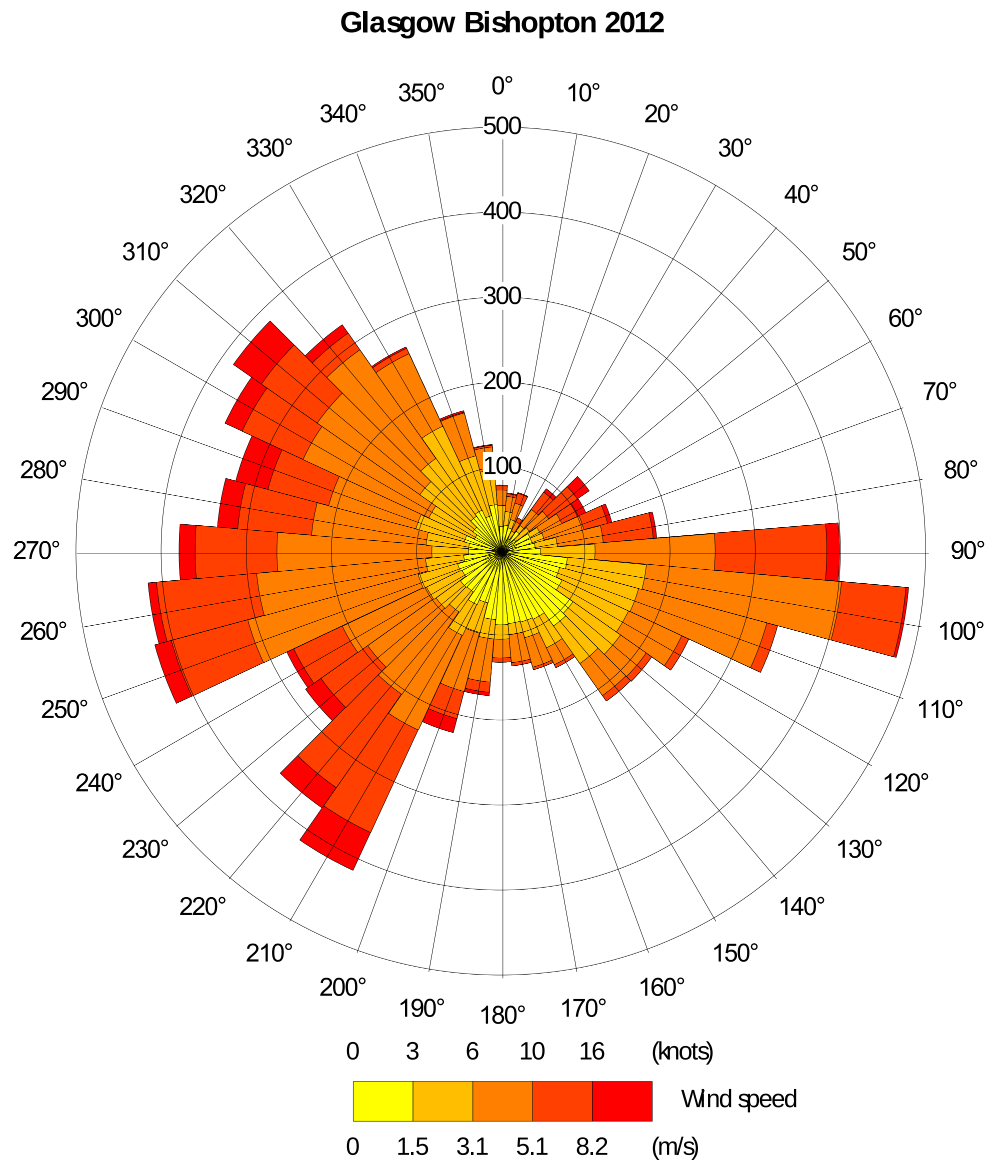
Street	%Cars	%LGV	%HGV	%Bus	%2WM	AADF
Main Street	85.8	12.7	0.5	0.3	0.8	12622
Mill Street northbound	92.4	12.7	0.5	0.3	0.8	10354
Mill Street Southbound	92.4	6.6	0.1	0.3	0.5	6935
Farmeloan Road	89.9	6.6	0.1	0.3	0.5	12100
Glasgow Road northbound	90.4	6.7	0.2	2.9	0.3	8466
Glasgow Road southbound	90.4	5.9	0.2	2.0	1.5	5670
Stonelaw Rd	91.2	5.9	0.2	2.0	1.5	13916

LGV – Light Goods Vehicles
HGV – Heavy Goods Vehicles (Articulate and Rigid)
2WM - Motorcycles

Appendix 2: Meteorological data – Windrose

The Wind Rose for the 2012 Glasgow Bishopton meteorological dataset is presented in Figure A2.1

Figure A2.1 Meteorological dataset windrose



Appendix 3: 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. This can be followed by adjustment of the modelled results if required. LAQM.TG(09) recommends making the adjustment to the road contribution only and not the background concentration these are combined with.

NO_2

The approach outlined in Example 2 of LAQM.TG(09) has been used in this case.

It is appropriate to verify the performance of the ADMS Roads model in terms of primary pollutant emissions of nitrogen oxides ($NOx = NO + NO_2$). To verify the model the predicted annual mean Road NOx concentrations were compared with concentrations measured at the monitoring sites during the study period.

The model output of Road NOx (the total NOx originating from road traffic) has 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 2012 version of the Defra NOx/NO_2 calculator.

The initial comparison of the modelled vs measured Road NOx identified that the model was under-predicting the Road NOx contribution. Some refinements were subsequently made to the model input to improve the overall model performance.

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. This factor was then applied to the modelled Road NOx concentration for each modelled point to provide adjusted modelled Road NOx concentrations. A linear regression plot comparing modelled and monitored Road NOx concentrations before and after adjustment is presented in Figure A3.1.

The background NOx concentration was then added to determine the adjusted total modelled NOx concentrations. The total annual mean NO_2 concentrations were then determined using the NOx/NO_2 calculator.

A primary NOx adjustment factor (PAdj) of **1.5226** based on model verification using the monitoring results during the study period was applied to all modelled Road NOx data prior to calculating an NO_2 annual mean. A plot comparing modelled and monitored NO_2 concentrations before and after adjustment during 2011 is presented in Figure A3.2.

PM_{10}

In the case of PM_{10}, as there is only a single monitoring location a simple arithmetic correction was derived. The model adjustment factor required for Road PM_{10} at this location was **2.79**. This value was applied to all modelled Road PM_{10} predictions before the annual mean background concentration as added. There is considerable uncertainty in the PM_{10} model predictions at locations away from the monitoring site.

Figure A3.1 Comparison of modelled Road NO_x Vs Measured Road NO_x before and after adjustment

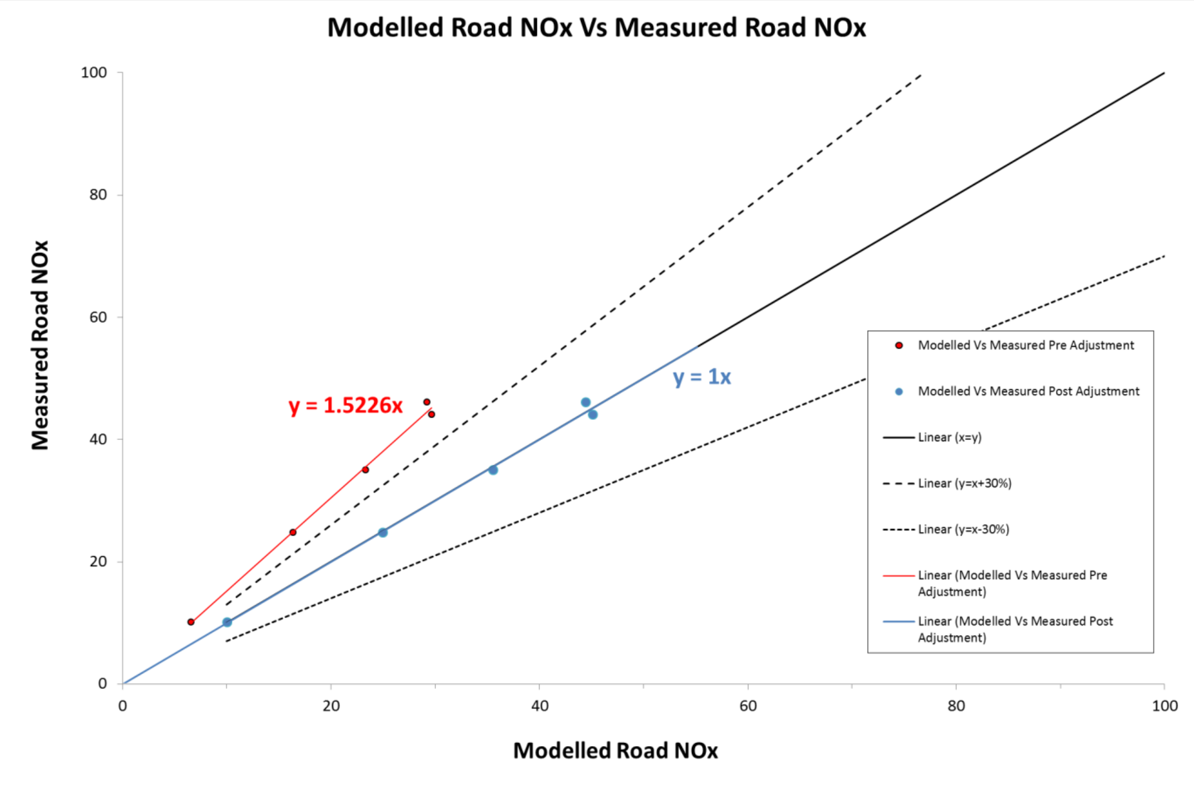
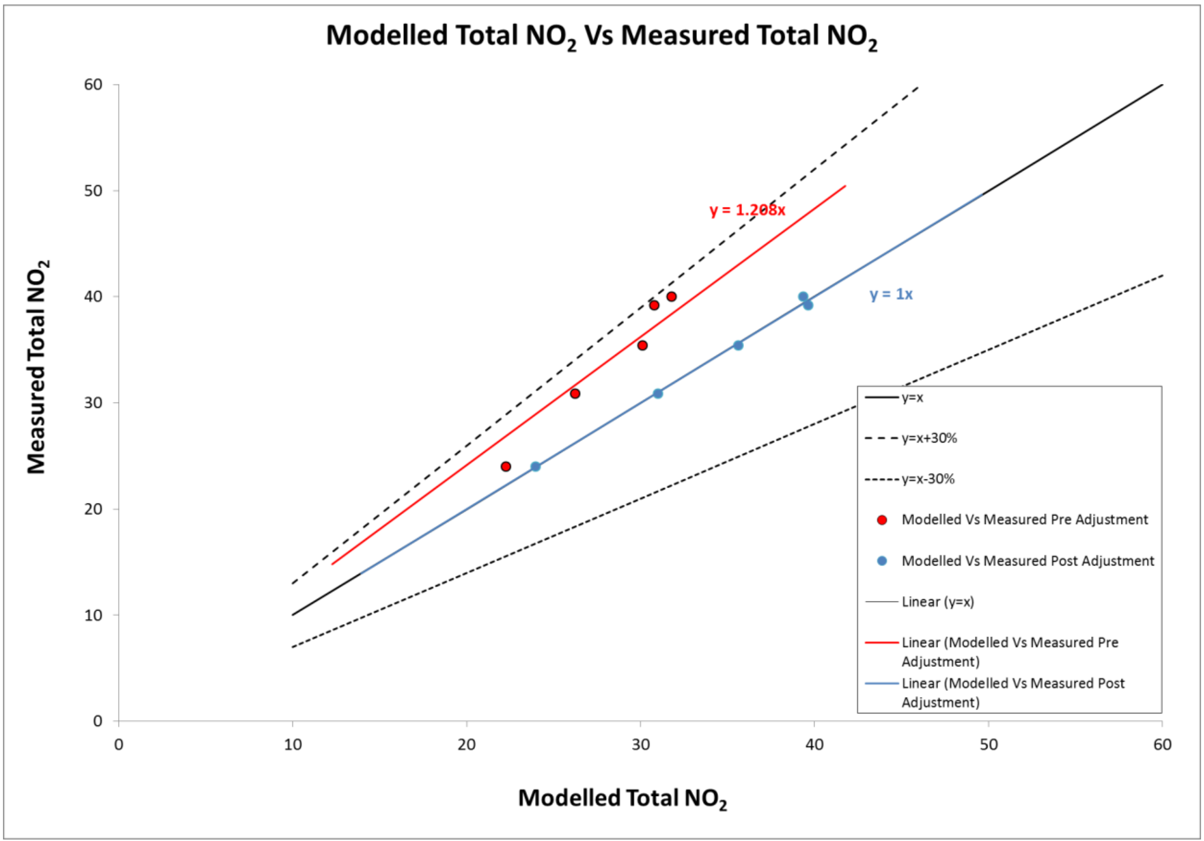


Figure A3.2: Linear regression analysis of modelled vs. monitored NO_2 annual mean 2011



To evaluate the model performance and uncertainty, the Root Mean Square Error (RMSE) for the observed vs predicted NO_2 annual mean concentrations was calculated, as detailed in Technical Guidance LAQM.TG(09), Box A3.7, Appendix 3. The calculated RMSE is presented in Table A3.1.

It is recommended that the RMSE is below 25% of the objective that the model is being compared against, but ideally under 10% of the objective i.e. 4 $\mu g.m^{-3}$ (NO_2 annual mean objective of 40 $\mu g.m^{-3}$). In this case the RMSE is calculated at 0.4 $\mu g.m^{-3}$; the model uncertainty is therefore considered acceptable and the model has performed sufficiently well for use within this assessment.

Table A3.1: Root mean square error

NO_2 Monitoring Site	NO_2 annual mean concentration ($\mu g.m^{-3}$)	
	Measured	Modelled
Farmeloan Rd DT	39.2	39.6
263 Main Street DT	35.4	35.6
Stonelaw Rd DT	24.0	24.0
Mill St DT	30.9	31.0
Auto analyser	40.0	39.4
	RMSE =	**0.36**

Appendix 4: Monitoring data QA/QC

QA/QC of automatic monitoring

All of South Lanarkshire Council's automatic monitoring sites are calibrated and audited by Ricardo-AEA Ltd whereby monitoring data are managed to the same procedures and standards as AURN sites.

PM Monitoring Adjustment

All PM_{10} measurements were made using TEOM analysers fitted with FDMS units. The measurements are therefore considered gravimetric equivalent and no adjustments have been applied to the data.

All TEOM FDMS data were fully ratified by Ricardo-AEA to AURN standards.

QA/QC of diffusion tube monitoring

All passive diffusion tubes (PDT) for NO_2 measurement were prepared and analysed by Edinburgh Scientific Services. The PDTs were prepared using the 50% triethanolamine (TEA) in water method.

Edinburgh Scientific Services is a UKAS accredited laboratory with documented Quality Assurance/Quality Control (QA/QC) procedures for diffusion tube analysis.

Edinburgh Scientific Services participates in the HSL WASP NO_2 PT rounds and the percentage (%) of results submitted which were subsequently determined to be satisfactory during the previous five rounds in 2011 and 2012 based upon a z-score of < ± 2 were as follows:

- Jan - Mar 2012:100%
- Apr - Jun 2012: 100%
- July - Sep 2012: 100%
- Oct - Dec 2012: 100%
- Jan - Mar 2012: 100%

Over a rolling five round WASP window, it is expected that 95 % of laboratory results should be ≤ ± 2. If this percentage is substantially lower than 95 % for a particular laboratory, within this five round window, then one can conclude that the laboratory in question may have significant systematic sources of bias in their assay. In this case the average percentage over the last five rounds is 100%.

Diffusion Tube Bias Adjustment Factors

Two co-location studies were conducted during 2012 at the Whirlies Roundabout and Rutherglen monitoring sites where NO_2 concentrations are measured using automatic analysers. Bias factors have been calculated for each site. Details of the co-location factor calculations, including the precision checks are presented in Figures A.1 to A.2.. The bias factor from the national database is presented in Fig A.4.

Figure A.1: Co-location study – Whirlies Roundabout East Kilbride

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Automatic Method: Period Mean	Automatic Method: Data Capture (% DC)	Data Quality Check: Tubes Precision Check	Data Quality Check: Automatic Monitor Data Capture Check
1	04/01/2012	01/02/2012	48.0	46.0	47.0	47	1.0	2	2.5	48.6	100.0	Good	Good
2	01/02/2012	29/02/2012	59.0	50.0	47.0	52	6.2	12	15.5	74.4	29.0	Good	Poor Data Capture
3	29/02/2012	28/03/2012	33.0	42.0	45.0	40	6.2	16	15.5		0.0	Good	Poor Data Capture
4	28/03/2012	25/04/2012	56.0	55.0	57.0	56	1.0	2	2.5		0.0	Good	Poor Data Capture
5	25/04/2012	30/05/2012	62.0	60.0	62.0	61	1.2	2	2.9	19.9	20.0	Good	Poor Data Capture
6	30/05/2012	27/06/2012	45.0	48.0	46.0	46	1.5	3	3.8	28.8	100.0	Good	Good
7	27/06/2012	01/08/2012	53.8	26.2		40	19.5	49	175.3	24.2	100.0	Poor Precision	Good
8	01/08/2012	29/08/2012	43.8	44.3	46.7	45	1.6	3	3.9	29.2	100.0	Good	Good
9	29/08/2012	26/09/2012	46.9	43.8	46.3	46	1.6	4	4.1	26.8	100.0	Good	Good
10	26/09/2012	31/10/2012	55.9	55.9	62.1	58	3.6	6	8.9	47.5	83.0	Good	Good
11	31/10/2012	28/11/2012	53.1	55.6	53.5	54	1.3	2	3.3	28.1	68.0	Good	Poor Data Capture
12	28/11/2012	02/01/2013	53.1	55.6	53.5	54	1.3	2	3.3	46.2	87.0	Good	Good
13													

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> Good precision | Poor Overall DC

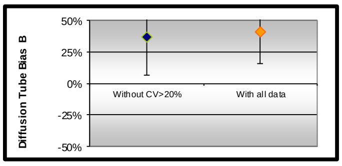
Site Name/ ID: Whirlies Roundabout, East Kilbride

Precision 11 out of 12 periods have a CV smaller than 20%

(Check average CV & DC from Accuracy calculations)

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 6 periods of data
Bias factor A 0.77 (0.62 - 1)
Bias B 30% (0% - 61%)
Diffusion Tubes Mean: 49 μgm^{-3}
Mean CV (Precision): 4
Automatic Mean: 38 μgm^{-3}
Data Capture for periods used: 95%
Adjusted Tubes Mean: 38 (31 - 49) μgm^{-3}

Accuracy (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 7 periods of data
Bias factor A 0.75 (0.63 - 0.92)
Bias B 34% (9% - 59%)
Diffusion Tubes Mean: 48 μgm^{-3}
Mean CV (Precision): 10
Automatic Mean: 36 μgm^{-3}
Data Capture for periods used: 96%
Adjusted Tubes Mean: 36 (30 - 44) μgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

Figure A.2: Co-location study – Rutherglen

Checking Precision and Accuracy of Triplicate Tubes

AEA Energy & Environment
From the AEA group

Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Automatic Method: Period Mean	Automatic Method: Data Capture (% DC)	Data Quality Check: Tubes Precision Check	Data Quality Check: Automatic Monitor Data
1	04/01/2012	01/02/2012	50.0	50.0	55.0	52	2.9	6	7.2	44.9	99.0	Good	Good
2	01/02/2012	29/02/2012	57.0	58.0	66.0	60	4.9	8	12.3	39.9	100.0	Good	Good
3	29/02/2012	28/03/2012	59.0	52.0	49.0	53	5.1	10	12.7	38.4	100.0	Good	Good
4	28/03/2012	25/04/2012	57.0	54.0	56.0	56	1.5	3	3.8	39.3	100.0	Good	Good
5	25/04/2012	30/05/2012	55.0	49.0	56.0	53	3.8	7	9.4	35.6	100.0	Good	Good
6	30/05/2012	27/06/2012	34.0	34.0	30.0	33	2.3	7	5.7	33.4	100.0	Good	Good
7	27/06/2012	01/08/2012	44.4	44.1	44.0	44	0.2	0	0.5	30.3	100.0	Good	Good
8	01/08/2012	29/08/2012								33.2	100.0		Good
9	29/08/2012	26/09/2012	44.1	47.6	45.5	46	1.8	4	4.4	28.5	100.0	Good	Good
10	26/09/2012	31/10/2012	61.0	64.4		63	2.4	4	21.6	44.7	100.0	Good	Good
11	31/10/2012	28/11/2012	84.7							45.6	100.0		Good
12	28/11/2012	02/01/2013	84.7							58.8	100.0		Good
13													

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> Good precision | Good Overall DC

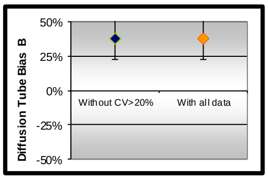
Site Name/ ID: Main Street, Rutherglen

Precision 9 out of 9 periods have a CV smaller than 20%

(Check average CV & DC from Accuracy calculations)

Accuracy (with 95% confidence interval)
without periods with CV larger than 20%
Bias calculated using 9 periods of data
Bias factor A 0.73 (0.66 - 0.82)
Bias B 37% (22% - 52%)
Diffusion Tubes Mean: 51 μgm^{-3}
Mean CV (Precision): 5
Automatic Mean: 37 μgm^{-3}
Data Capture for periods used: 100%
Adjusted Tubes Mean: 37 (34 - 42) μgm^{-3}

Accuracy (with 95% confidence interval)
WITH ALL DATA
Bias calculated using 9 periods of data
Bias factor A 0.73 (0.66 - 0.82)
Bias B 37% (22% - 52%)
Diffusion Tubes Mean: 51 μgm^{-3}
Mean CV (Precision): 5
Automatic Mean: 37 μgm^{-3}
Data Capture for periods used: 100%
Adjusted Tubes Mean: 37 (34 - 42) μgm^{-3}



Jaume Targa, for AEA
Version 04 - February 2011

Figure A.3: Edinburgh ***Scientific Services – National average bias adjustment factor***

National Diffusion Tube Bias Adjustment Factor Spreadsheet — **Spreadsheet Version Number: 06/13**

Follow the steps below in the correct order to show the results of relevant co-location studies
Data only apply to tubes exposed monthly and are not suitable for correcting individual short-term monitoring periods
Whenever presenting adjusted data, you should state the adjustment factor used and the version of the spreadsheet
This spreadsheet will be updated every few months: the factors may therefore be subject to change. This should not discourage their immediate use.

This spreadsheet will be updated at the end of September 2013
LAQM Helpdesk Website

The LAQM Helpdesk is operated on behalf of Defra and the Devolved Administrations by Bureau Veritas, in conjunction with contract partners AECOM and the National Physical Laboratory.

Spreadsheet maintained by the National Physical Laboratory. Original compiled by Air Quality Consultants Ltd.

Step 1: Select the Laboratory that Analyses Your Tubes from the Drop-Down List. If a laboratory is not shown, we have no data for this laboratory.

Step 2: Select a Preparation Method from the Drop-Down List. If a preparation method is not shown, we have no data for this method at this laboratory.

Step 3: Select a Year from the Drop-Down List. If a year is not shown, we have no data[2]

Step 4: Where there is only one study for a chosen combination, you should use the adjustment factor shown with caution. Where there is more than one study, use the overall factor[3] shown in blue at the foot of the final column.

If you have your own co-location study then see footnote[4]. If uncertain what to do then contact the Local Air Quality Management Helpdesk at LAQMHelpdesk@uk.bureauveritas.com or 0800 0327953

Analysed By[1]	Method (To undo your selection, choose (All) from the pop-up list)	Year[5] (To undo your selection, choose (All))	Site Type	Local Authority	Length of Study (months)	Diffusion Tube Mean Conc. (Dm) ($\mu g/m^3$)	Automatic Monitor Mean Conc. (Cm) ($\mu g/m^3$)	Bias (B)	Tube Precision[6]	Bias Adjustment Factor (A) (Cm/Dm)
Edinburgh Scientific Services	50% TEA in acetone	2012	KS	Marylebone Road Intercomparison	12	110	95	16.0%	G	0.86
Edinburgh Scientific Services	50% TEA in acetone	2012	R	Stirling Council	11	30	29	4.5%	G	0.96
Edinburgh Scientific Services	50% TEA in acetone	2012	R	City Of Edinburgh Council	11	46	39	16.7%	G	0.86
Edinburgh Scientific Services	50% TEA in acetone	2012	R	City Of Edinburgh Council	10	73	52	41.3%	G	0.71
Edinburgh Scientific Services	50% TEA in acetone	2012	R	City Of Edinburgh Council	12	43	28	52.8%	G	0.65
Edinburgh Scientific Services	50% TEA in acetone	2012	R	City Of Edinburgh Council	12	38	30	24.9%	G	0.80
Edinburgh Scientific Services	50% TEA in acetone	2012	KS	City Of Edinburgh Council	11	76	56	34.5%	G	0.74
Edinburgh Scientific Services	50% TEA in acetone	2012		Overall Factor[3] (7 studies)					Use	0.78

Discussion of Choice of Factor to Use

The bias adjustment factor of 0.74 from the co-location study conducted at Rutherglen in 2012 was used to adjust to adjust the diffusion tube results. This adjustment factor was considered most appropriate because:

- There was poor data capture at the Whirlies Roundabout, East Kilbride automatic monitoring site during 2012
- Although there has been an increase in measured NO_2 annual mean concentrations across many of the diffusion tube sites since 2011; the locally derived adjustment factor of 0.74 provides results reasonably consistent with recent years across the South Lanarkshire Council diffusion tube network. Using the national average factor of 0.78 would result in a large increase in measured concentration across all sites, which does not seem realistic when compared with the change in automatic monitoring results.

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