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EAST AYRSHIRE COUNCIL

Detailed Assessment of John Finnie Street

Submitted to:
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REPORT

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1.0 INTRODUCTION

Golder Associates (UK) Limited (Golder) has been commissioned by East Ayrshire Council to conduct their Local Air Quality Management (LAQM) Detailed Assessment of NO_2 and PM_{10} concentrations from road traffic emissions in John Finnie Street, Kilmarnock. The Detailed Assessment forms part of the LAQM framework which requires local authorities to review and assess air quality within their area on a regular basis.

The study area consists of a busy network of roads in and around the centre of Kilmarnock, East Ayrshire, including:

- John Finnie Street;
- Portland Road;
- St Marnock Street;
- West George Street;
- Green Street;
- Langlands Brae;
- Portland Street;
- High Street; and
- Sturrock Street.

The main air quality issues are considered to arise from the volume of traffic travelling on this road network and slow moving through the town centre one way traffic light system.

The assessment comprises dispersion modelling using the most recent transport and other relevant emission data combined with current monitoring data to identify if there is potential for exceedence of the both the annual mean NO_2 and PM_{10} air quality objectives contained within the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 (NAQS)[1].

2.0 BACKGROUND

The Environment Act 1995 and subsequent regulations require local authorities to assess compliance of air quality in their area with the standards and objectives set out in NAQS. For local authorities within Scotland further regulations are set out in the Air Quality (Scotland) Regulations 2010.

The LAQM framework requires that local authorities carry out regular reviews of air quality. The first round of Review and Assessment commenced in 1998 and comprised a four stage approach to the assessment of air quality.

The Review and Assessment process was revised in 2009 and comprises a phased approach. The first phase of the Review and Assessment is an Updating and Screening Assessment (U&SA). The U&SA considers any changes that have occurred in pollutant emissions and sources since the last round of Review and Assessment that may affect air quality. The second phase is the completion of a Progress Report which is required to be completed annually, apart from the years when a U&SA is being completed.

[1] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1), Defra et al, July 2007.

The LAQM guidance requires that where the U&SA or Progress Report has identified a risk of exceedence of an air quality objective at a location with relevant public exposure, a Detailed Assessment be undertaken. A Detailed Assessment will consider any risk of exceedence of an objective in greater depth in order to determine whether it is necessary to declare an Air Quality Management Area (AQMA).

East Ayrshire Council has monitored ambient NO_2 concentrations in John Finnie Street since 1996, with subsequent extensions in the monitoring network in 2008 and 2009. Since 2008, measured concentrations have varied between meeting and marginal exceedence of the NAQS annual mean objective for NO_2. As a result, the Council undertook a Detailed Assessment in 2008 which concluded that there was a need for additional monitoring. The Council therefore installed an automatic monitoring station to measure both NO_2 and PM_{10} concentrations in 2010.

The principal pollutants of concern in the study area are NO_2 and $PM_{10.}$ The air quality objectives for both NO_2 and PM_{10} in Scotland are set in the NAQS and are presented in Table 1.

Table 1: Air Quality Objectives for NO_2 and PM_{10} in Scotland

Pollutant	Concentration	Measured as	Permitted Exceedences / Equivalent Percentile	Compliance Date
NO_2	40 µg/m3	Annual mean	--	31/12/2005
	200 µg/m3	1-hour mean	18 Exceedences	
PM_{10}	40 µg/m^3	Annual mean	--	31/12/2004
	18 µg/m^3	Annual mean	--	31/12/2010
	50 µg/m^3	24-hour mean	35 Exceedences 90.4th Percentile	31/12/2004
	50 µg/m^3	24-hour mean	7 Exceedences 98th Percentile	31/12/2010

The air quality objectives apply at areas of relevant public exposure as defined in LAQM Technical Guidance.[2] Long term objectives, such as the annual mean objectives, should be applied at all locations where members of the public might be regularly exposed, for example, residential properties and institutional buildings. Relevant public exposure for short term objectives includes all locations for which the annual mean objectives are relevant as well as all other outdoor locations where the public might reasonably be expected to spend the applicable exposure period for the objective.

3.0 AMBIENT MONITORING

The Council monitors PM_{10} and NO_2 at several locations throughout the Council area using both automatic and passive sampling methods. The monitoring locations within the study area are presented in Drawing 1.

All automatic monitoring data have been provided to Golder fully ratified. Diffusion tube data have been provided both bias corrected and annualised where necessary. Full details of the monitoring undertaken by the Council and their relevant QA procedures can be found in their Updating and Screening Assessment 2012[3].

The Council have experienced several issues with PM_{10} monitoring data capture at both automatic monitoring stations during 2012 with data capture as low as 25% at the John Finnie Street monitoring site. This is discussed in more detail in section 3.2. As 2011 has better data capture for PM_{10} of 85%, the modelling study considers 2011 as its base year. Measured concentrations from 2011 have also been used for model verification purposes.

[2] http://laqm.defra.gov.uk/supporting-guidance.html

[3] http://www.east-ayrshire.gov.uk/BusinessAndTrade/CommercialWastePollutionAndRecycling/AirPollution/AirPollution.aspx

3.1 NO_2

The Council currently operates two automatic monitoring sites and eight diffusion tubes within the study area. The details of the NO_2 monitoring sites are presented in Table 2 and Drawing 1.

Table 2: NO_2 Monitoring Site Details

Site Name	Site Type	Classification	Location	OS Grid Reference	
John Finnie Street Auto	Automatic	Roadside (R)	John Finnie St	242691	638095
St Marnock St Auto	Automatic	Roadside (R)	St Marnock Street	242742	637705
1	Passive Diffusion Tube	Kerbside (K)	Fowlds Street	242805	637620
11	Passive Diffusion Tube	Roadside (R)	96 John Finnie St	242657	637883
12	Passive Diffusion Tube	Roadside (R)	62 John Finnie St	242673	637955
14	Passive Diffusion Tube	Roadside (R)	95 / 97 John Finnie St	242619	637773
15	Passive Diffusion Tube	Roadside (R)	16 West George St	242766	638160
2	Passive Diffusion Tube	Roadside (R)	28 John Finnie St	242701	638083
25	Passive Diffusion Tube	Roadside (R)	Collocated John Finnie St	242691	638095
27	Passive Diffusion Tube	Kerbside (K)	King St / St Marnock Street	242771	637711

Presented in Table 3 are the measured annual mean concentrations of NO_2 from 2008 to 2011. The annual mean NO_2 concentrations were highest in 2010 when most monitoring sites within John Finnie Street were above the annual mean objective for NO_2. However, since 2011 measured concentrations have fallen well below the NAQS objective level for NO_2 at all monitoring sites.

Table 3: Measured Annual Mean NO_2 Concentrations

Site Name	Annual mean concentrations ($\mu g/m^3$)				
	2008	2009	2010	2011	2012
John Finnie Street Auto	N/A	N/A	**43**	35 (85%)	30 (85%)
St Marnock St Auto	N/A	N/A	N/A	N/A	36* (45%)
1	35	32.3	39.1	25.0	27
2	39	32.8	**40.2**	32.1	26
11	31	33.3	34.8	27.9	28
12	38	38.3	**40.0**	33.3	31
14	N/A	**43.7**	**43.8**	34.2	34
15	N/A	39.9	**43.2**	35.8	35
25	N/A	N/A	37.6	28.9	29
27	N/A	N/A	N/A	30.8	30

*annualised data

3.2 PM_{10}

The Council began monitoring PM_{10} in 2010 at John Finnie Street in Kilmarnock using a Beta Attenuation Monitor (BAM). In 2012, the Council installed a second automatic monitoring station in St Marnock Street. This station included the original BAM, which was moved from the John Finnie Street monitoring station to this new location and a TEOM FDMS was installed at the John Finnie Street monitoring station. The details of the current PM_{10} monitoring sites are presented in Table 4 and Drawing 1.

Table 4: PM_{10} Monitoring Site Details

Site Name	Site Type	Analyser	Location	OS Grid Reference	
John Finnie Street	Automatic	TEOM/FDMS	John Finnie St	242691	638095
St Marnock Street	Automatic	BAM (unheated inlet)	St Marnock Street	242742	637705

The annual mean PM_{10} monitoring data for 2010 to 2012 are presented in Table 5, with data capture (where available) presented in brackets.

Table 5: Comparison with PM_{10} Annual Mean Objective

Site Name.	Annual mean concentrations ($\mu g/m^3$)		
	2010	**2011**	**2012**
John Finnie Street	21	20 (87%)	12* (25%)
St Marnock Street	**N/A**	**N/A**	17* (37.1%)

*annualised data

The Council have experienced issues with data capture at both automatic monitoring sites during operation in 2012. The data ratification process excluded a large proportion of the data due to operational issues with the John Finnie Street instrument, whilst the St Marnock Street site was affected by on-street construction works.

There has been a considerable decrease in measured PM_{10} concentrations between 2011 and 2012, 8 $\mu g/m^3$. However due to the operational difficulties with both instruments and the low data capture it is unknown how representative the 2012 data are. It is thought that the reduction in measured concentrations in John Finnie Street may be due a reduction in traffic volume as a result of the closure of the Johnnie Walker factory. Unfortunately, however, there are no traffic count data available to verify this.

Due to the poor data capture in 2012 this dispersion modelling study considers 2011 as its base year. Measured concentrations from 2011 have also been used for model verification purposes.

4.0 ATMOSPHERIC DISPERSION MODELLING

Pollutant emissions were modelled using the advanced atmospheric dispersion modelling software ADMS Roads. ADMS Roads is an advanced dispersion model which allows up to 150 road sources and 35 industrial sources (including point, line, area and volume sources) to be modelled simultaneously. The model uses a number of input parameters to simulate the dispersion of pollutant emissions, predicting ambient pollutant concentrations. The input parameters include information on pollutant emissions, local meteorological conditions and background pollutant concentrations.

4.1 Modelled Domain and Receptors

Modelling predictions were undertaken over a modelled domain consisting of a 1 km by 1 km Cartesian grid pattern which encompasses the study area. The number of calculation points was set at 101 by 101 which provides predicted concentrations at an approximate maximum resolution of 10 x 10 m. The option of "intelligent gridding" was selected whereby the model predicts pollutant concentrations at a higher spatial density (finer resolution) close to the emission sources and at a lower spatial density at background locations.

The model can also predict pollutant concentrations at specific locations where relevant public exposure may occur and at monitoring locations which are used to verify the model predictions. Fourteen locations within the assessment area were specified as receptors. The receptor locations are presented Table 6 and annotated on Drawing 2.

Table 6: Specified Receptors

Receptor Name	Description	Grid Reference	
		Easting	Northing
John Finnie Street	Automatic Monitor / Collocated Tubes	242691	638095
St Marnock Street	Automatic Monitor	242742	637705
Fowlds Street	Passive Diffusion Tube	242805	637620
28 John Finnie St	Passive Diffusion Tube	242701	638083
96 John Finnie St	Passive Diffusion Tube	242657	637883
62 John Finnie St	Passive Diffusion Tube	242673	637955
95/97 John Finnie St	Passive Diffusion Tube	242619	637773
West George St	Passive Diffusion Tube	242766	638160
King St / St Marnock	Passive Diffusion Tube	242771	637711
Sturrock St receptor	Residential Receptor	242948	637690
Portland St receptor	Residential Receptor	242868	638268
Council Offices	Residential Receptor	242689	637999
School	Residential Receptor	242998	637743
Braehead Court	Residential Receptor	243156	637980

4.2 Meteorological Data

ADMS-Roads uses hourly sequential meteorological data to calculate atmospheric dispersion. The data file contains a number of parameters including wind speed and direction, cloud cover and solar heat flux. The nearest site that records all required parameters is located at Prestwick Airport. However due to the coastal influences of this site it was felt that the next closest site located at Bishopton, close to Glasgow Airport (approximately 30 km N of the study area), was more appropriate. Meteorological data for 2011 were used in this study, in order to allow a direct comparison with measured NO_2 and PM_{10} data. The wind rose for this year at this location presented below in Figure 1.

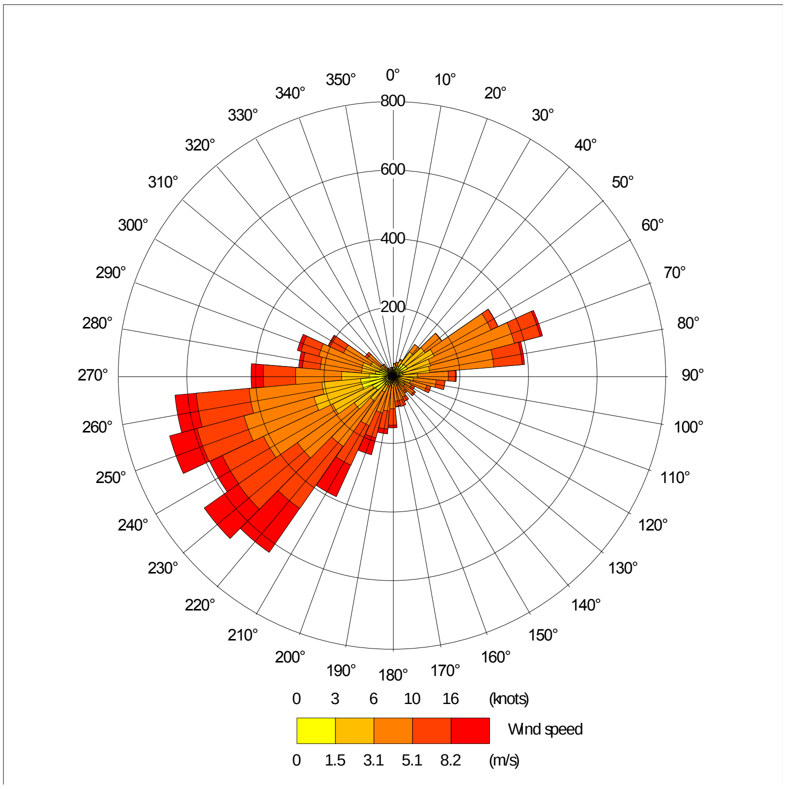


Figure 1: 2011 Glasgow Wind Rose

4.3 Surface Characteristics

The surface characteristics of an area have an influence on the dispersion of atmospheric pollutants through the generation of turbulence. The surface roughness factor used in the model is a measure of this turbulence. The surface roughness value of 0.5 m has been used in this assessment which is representative of the turbulence generated by urban areas.

4.4 Building Effects and Street Layout

The geometry of each road was determined through a combination of GIS mapping data and a site visit by a Golder Air Quality Specialist. The geometry of each road was defined in terms of the kerb-to-kerb road width and, where appropriate, the height of any street canyons.

The ADMS-Roads model does not allow buildings to be included explicitly but allows various street parameters to be input to simulate the local flow around buildings and other obstacles in the vicinity of the road. The street parameters included in the model are road width, street canyon height and road elevation.

Street canyons can be included in the model for roads where there are high rise buildings on either side which act as barriers to the air flow and can channel wind along the road or cause localised air circulations that trap pollutants at street level. Canyon effects are significant for streets where the height of the buildings is at least equivalent or greater than the width of the street. There were no street canyons identified in the roads being considered within the study area.

4.5 Road Traffic Emissions

Atmospheric emissions from road traffic were calculated by the model based on information of traffic flows and an in-built database of vehicle emission factors, (EFT v5.1, 7VC). Information on traffic flows on roads were obtained from road traffic counts survey carried out in Feb 2013 by Count on Us on behalf of Golder at fifteen locations. It was assumed, for the purposes of this study, that these counts would be representative of traffic counts for the baseline year 2011. It should be noted that volume of traffic flow on John Finnie Street may be lower in 2013 than 2011 when Johnnie Walker's bottling plant was in operation, however traffic data from this monitoring study are the best available data. Traffic count data for the remaining road network included in the study were obtained from the Department of Transport[4].

Traffic count data were manipulated into ADMS Roads format, which requires the data to be input as vehicle category, vehicle counts per hour, vehicle speed, and road type. ADMS Roads then uses information from the in-built emissions factors database to calculate an overall pollutant emission for each road in grams/second/km. The emission factors depend in part on assumptions made of vehicle types of different types of road i.e. Urban, Rural or Motorway. All specified roads are presented in Drawing 3.

4.5.1 Diurnal Traffic Profiles

The ADMS Roads model requires traffic data to be input as an average vehicle flow per hour. The accuracy of the traffic flow information can be improved by use of time varying emissions factors which details the diurnal profile of the road. The time varying factors allow the average hourly traffic flow to be multiplied by a factor representative of the expected traffic flow at each hour of the day. The traffic flow factors are calculated as a ratio between the hourly flow and the average flow.

Detailed hourly traffic flow data were available for some of the roads modelled and a diurnal profile was calculated where available for each road. Each diurnal profile was applied to each respective road.

4.5.2 Non-exhaust Traffic Emissions

Previously ADMS-Roads calculated pollutant emission rates from vehicles based on exhaust emissions only and additional road traffic sources were included to represent PM_{10} emissions from non-exhaust emissions. Road traffic processes other than fuel combustion include tyre wear, brake wear, clutch wear, road surface wear, corrosion of chassis, body and other vehicle components, all contributing collectively to road dust. However the latest version of ADMS ROADS has built into its emission factor database the non-exhaust emission component of PM_{10} and so this no longer requires to be added manually to the modelling study.

4.6 Other Emission Sources

Emissions from other sources in the study area were included in the modelling as volume sources. Data for the volume sources were obtained from the NAEI, which provides information on pollutant emissions in tonnes per year on 1 km^2 grid squares. Emissions are categorised into sectors including energy production; commercial; institutional and residential combustion; industrial combustion; industrial processes; fossil fuel production; road transport; other transport (non-road); waste treatment and disposal; agriculture; and nature.

The volume sources were modelled as 1 km square grids with a depth of 10 m. To avoid double counting of road traffic emissions, no road traffic emission were included in each grid square as the model included explicitly modelled roads. The volume sources included in the modelling study are presented in Table 7 and in Drawing 4.

Table 7: Volume Sources

Volume Source	Grid Reference	Grid Reference	NO_2 g/m^3/s	PM_{10} g/m^3/s
Volume Source 1	242500	638500	7.211E-08	4.253E-09
Volume Source 2	243500	638500	1.698E-08	9.439E-10
Volume Source 3	242500	637500	4.522E-08	4.073E-09
Volume Source 4	243500	637500	3.899E-08	2.148E-09

[4] http://www.dft.gov.uk/traffic-counts/

4.7 Chemistry Scheme and Background Concentrations

ADMS-Roads has the facility to model the photochemical reactions that occur between oxides of nitrogen (NOx), ozone and hydrocarbons. The chemistry scheme also models the conversion of sulphur dioxide (SO_2) to sulphate particles, which influence PM_{10} concentrations.

It is important to include chemical reactions since NO_2 emissions generally account for only around 10-20% of total NO_x emissions from motor vehicles. While there are numerous reactions that occur between these compounds, the facility in ADMS-Roads, the Chemical Reaction Scheme, simplifies this to eight reactions known as the Generic Reaction Set. ADMS roads uses a default 10% of total NO_x to NO_2 relationship from motor vehicles; however it is now known that the primary fraction of NO_2 can be up to 25% in some areas of London. For this study a primary fraction of 22% was used, based on the NO_x to NO_2 calculator v3.2.[5] Additional NO_2 emission rates from motor vehicles were included within ADMS-Roads for these studies.

The chemistry module of ADMS-Roads requires hourly averaged background concentrations of NO, NO_2, O_3, PM_{10} and SO_2. Since all local emission sources have been included in the modelling through the explicitly modelled roads and the emission inventory volume source emissions, the only remaining contribution to ambient pollutant concentrations will come from sources outside the study area.

Background concentrations for 2011 of NO_x, NO_2, O_3 and PM_{10} were taken from the rural background automatic monitoring site at Waulkmillglen Reservoir in Glasgow (approximately 20 km NNW of the study area). As this site does not monitor SO_2, background concentrations of SO_2 were taken from the urban background automatic monitoring site at Glasgow Centre (approximately 30 km NNW of the study area).

Waulkmillglen is the only AURN rural monitoring site located within the Central Belt of Scotland which monitors the pollutants required to be used as a background data within the model.

The annual mean background concentrations used in the study from Waulkmillglen and Glasgow Centre are presented in Table 8

Table 8: Background Concentrations

Year	NO_x (µg/m^3)	NO_2 (µg/m^3)	O_3 (µg/m^3)	PM_{10} (µg/m^3)	SO_2 (µg/m^3)
2011	16.5	10.5	54	12.0	2

4.8 Terrain

The terrain of an area can act to either increase or decrease ground level concentrations through altering the plume dispersion pattern. The effects of terrain upon pollutant dispersal are generally insignificant if the gradients within the study area are less than 1 in 10.

Terrain was not considered as part of this assessment given that the gradients within the study area are less than 1 in 10.

[5] http://laqm.defra.gov.uk/tools-monitoring-data/no-calculator.html

5.0 MODELLING RESULTS

5.1 Model Verification NO_2

In order to assess the model performance, predicted NO_2 concentrations from the model were compared with measured NO_2 concentrations. Comparisons of the measured and predicted NO_2 concentrations are presented in Table 9.

Table 9: Comparison of Modelled with Monitored

Monitoring Site	Site type	Regional Background NO_2 (µg/m^3)	Monitored total NO_2 (µg/m^3)	Modelled total NO_2 (µg/m^3)	% difference
John Finnie Street Auto	R	10.5	35	38.4	10%
1	K	10.5	25	43.8	75%
2	R	10.5	32.1	40.3	25%
11	R	10.5	27.9	39.2	40%
12	R	10.5	33.3	39.2	18%
14	R	10.5	27.9	37.7	35%
15	R	10.5	35.8	40.8	14%
27	K	10.5	30.8	45.4	47%
				Average	33%

The comparison of modelled NO_2 concentrations with monitored NO_2 showed an over prediction of 33%. This is out with +/-25% which LAQM guidance TG (09) recommends as the limits before model adjustment is required. The position of passive diffusion tube 1 and 27 were assessed as being in a kerbside position and therefore unsuitable for inclusion in the model verification.

Model adjustment has therefore been carried out following the suggested methodology in TG (09). Full details of the adjustment are presented in the Appendix A.

5.2 Model Verification PM_{10}

In order to assess the model performance, predicted PM_{10} concentrations from the model are compared with measured PM_{10} concentrations. The PM_{10} monitoring station is located within John Finnie Street and is the only PM_{10} analyser within the study area. Comparisons of the measured and predicted PM_{10} concentrations are presented in Table 10.

Table 10: Comparison of Modelled with Monitored.

Receptor Name	Site type	Background PM_{10} (µg/m^3)	Monitored total PM_{10} (µg/m^3)	Modelled total PM_{10} (µg/m^3)	% difference
John Finnie Street Automatic Station	Roadside	12.0	**20**	13.6	-32%

TG (09) paragraph A3.240 also advises that multiple sites should be used to verify the modelling results and the use of one continuous monitor alone is not recommended. However, this is the only monitoring site within the study area. The comparison of modelled PM_{10} concentrations with monitored PM_{10} at this location is an under prediction of 32%, also out with the $^{+/-}$25% which TG (09) recommends as the limit before model adjustment is required.

Before undertaking adjustment of the model the input data were reviewed to determine if improvements could be made. It was concluded that the best available data had been input into the model; therefore model adjustment was undertaken. Full details of the adjustment are presented in Appendix A.

5.3 Modelling Results

The modelling results for both NO_2 and PM_{10} for 2011 are presented in Table 11 and the adjusted annual mean contour plots are presented in Drawings 5 and 6, respectively.

Table 11: Modelling Results

Receptor	Modelled 2011 Annual Mean			Modelled 2011 Adjusted Annual Mean		
	NO_2 (µg/m^3)	NO_x (µg/m^3)	PM_{10} (µg/m^3)	NO_2 (µg/m^3)	NO_x (µg/m^3)	PM_{10} (µg/m^3)
John Finnie Street	38.4	56.4	13.6	30.8	59.8	**20.0**
St Marnock Street	**40.5**	60.4	13.9	32.6	64.2	**21.2**
Fowlds Street	**43.8**	74.1	14.8	38.3	79.0	**25.9**
28 John Finnie St	**40.2**	62.4	14.0	33.5	66.3	**22.0**
96 John Finnie St	39.2	61.0	14.1	32.8	64.7	**22.2**
62 John Finnie St	39.2	60.9	14.1	32.8	64.7	**22.1**
95/97 John Finnie St	37.7	54.7	13.7	30.0	58.0	**20.2**
West George St pdt	**40.8**	59.4	13.8	32.1	63.0	**20.7**
King St / St Marnock	**45.4**	79.2	14.9	**40.3**	84.5	**26.4**
Sturrock St receptor	38.4	51.6	13.4	28.6	54.6	**19.1**
Portland St receptor	37.9	50.3	13.2	28.0	53.2	**18.0**
Council Offices	38.3	56.3	13.7	30.8	59.7	**20.4**
School	35.7	44.7	13.0	25.4	47.1	16.7
Braehead Court	34.0	41.5	12.7	23.8	43.6	15.3

5.4 Analysis of Modelling Results

5.4.1 NO_2

Predicted annual mean NO_2 concentrations indicate that the annual mean objective is being exceeded at the diffusion tube 27, King Street - St Marnock Street junction. Further analysis of the associated contour plot indicates that the annual mean NO_2 objective is being exceeded at on-road locations only. There are no exceedences of the NAQS objective for NO_2 at any of the modelled sensitive receptors and therefore no requirement for an AQMA for the annual mean NO_2 objective.

5.4.2 PM_{10}

Following adjustment of the modelling results using the 2011 adjustment factor based on a single location, analysis of both the predicted concentrations at specified receptors and the contour plot indicates the annual mean is predicted to exceed the annual mean objective at locations adjacent to all roads considered within the study area.

Due to the considerable reduction in measured concentrations between 2011 and 2012 further analysis was undertaken in order to assist the Council to determine whether an AQMA for the PM_{10} annual mean objective is required. Therefore, a model comparison was undertaken based of the unadjusted 2011 modelled results with the 2012 measured results at both automatic monitoring sites. The comparison is presented in Table 12.

Table 12: Comparison of modelled 2011 PM_{10} annual mean with measured 2012 PM_{10} annual mean.

Receptor Name	Site type	Background PM_{10} ($\mu g/m^3$)	Monitored total PM_{10} ($\mu g/m^3$)	Modelled total PM_{10} ($\mu g/m^3$)	% difference
John Finnie Street	Roadside	12.0	**12**	13.6	+13%
St Marnock Street	Roadside	12.0	**17**	13.9	-18%
				Average	-2.5%

The results of this comparison indicates that the model is comparing within the +/-25% recommend by TG(09) with measured concentrations in 2012. This indicates that in 2012 the PM_{10} annual mean objective is currently being met at all specified receptors.

6.0 SOURCE APPORTIONMENT

A source apportionment study has been undertaken in order to investigate which emission sources make the highest contribution to predicted pollutant concentrations in the study area. Separate model runs have been conducted in the same manner as described in Section 4 using the "Groups" feature of ADMS-Roads. Different groups were set up to include different sources and the model then predicted pollutant concentrations as a result of emissions from each group. The groups which were included were:

- All sources (road traffic emissions and volume sources);
- All road traffic emissions; and
- Volume sources (i.e. non road traffic emissions).

Background concentrations were not included in the source apportionment model runs, as the purpose is to calculate the contribution from each local emission source. As such, chemistry is not included, as the chemical reactions within the chemistry scheme act on the total concentration, and cannot act on each individual group's contribution. For this reason, the model was not able to predict NO_2 and has predicted NO_x contributions only. Both PM_{10} and NO_x concentrations are calculated at specified points only.

Further source apportionment was carried out to look at the road contribution in more detail with the following groups included:

- LGV (motorcycle, cars and LGV) emissions; and
- HGV (bus, rigid HGV and articulated HGV) emissions.

The results of the source apportionment are presented in Table 13 to 15 and Figures 2 to 5.

Table 13: Source Apportionment NOx ($\mu g/m^3$)

Specified Receptor	Background	Roads Traffic Emissions	Volume Source Emissions
John Finnie Street Auto	16.5	15.9	8.6
St Marnock Street Auto	16.5	21.7	6.9
Fowlds Street	16.5	39.6	6.7
28 John Finnie Street St	16.5	22.1	8.5
96 John Finnie Street St	16.5	22.7	6.8

Specified Receptor	Background	Roads Traffic Emissions	Volume Source Emissions
62 John Finnie Street St	16.5	22.3	7.1
95/97 John Finnie Street St	16.5	16.4	6.8
West George St	16.5	18.6	9.0
King St / St Marnock St	16.5	40.4	6.9

Table 14: Source Apportionment PM_{10} ($\mu g/m^3$)

Specified Receptor	Background PM_{10}	Roads Traffic Emissions	Volume Source Emissions
John Finnie Street Auto	12	1.0	0.6
St Marnock Street Auto	12	1.3	0.6
Fowlds Street	12	2.4	0.6
28 John Finnie Street St	12	1.5	0.6
96 John Finnie Street St	12	1.5	0.6
62 John Finnie Street St	12	1.5	0.5
95/97 John Finnie Street St	12	1.1	0.6
West George St	12	1.2	0.6
King St / St Marnock St	12	2.3	0.6

Table 15: Source Apportionment Road Source for both NOx and PM_{10}

Specified Receptor	NOx ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)	
	HGV	LGV	HGV	LGV
John Finnie Street Auto	7.1	7.7	0.2	0.7
St Marnock Street Auto	12.8	7.5	0.4	0.7
Fowlds Street	18.7	19.3	0.6	1.8
28 John Finnie Street St	10.4	10.6	0.4	1.0
96 John Finnie Street St	10.9	10.9	0.4	1.1
62 John Finnie Street St	10.7	10.6	0.4	1.1
95/97 John Finnie Street St	8.0	7.7	0.3	0.8
West George St	9.1	7.6	0.3	0.7
King St / St Marnock St	24.6	14.2	0.8	1.4

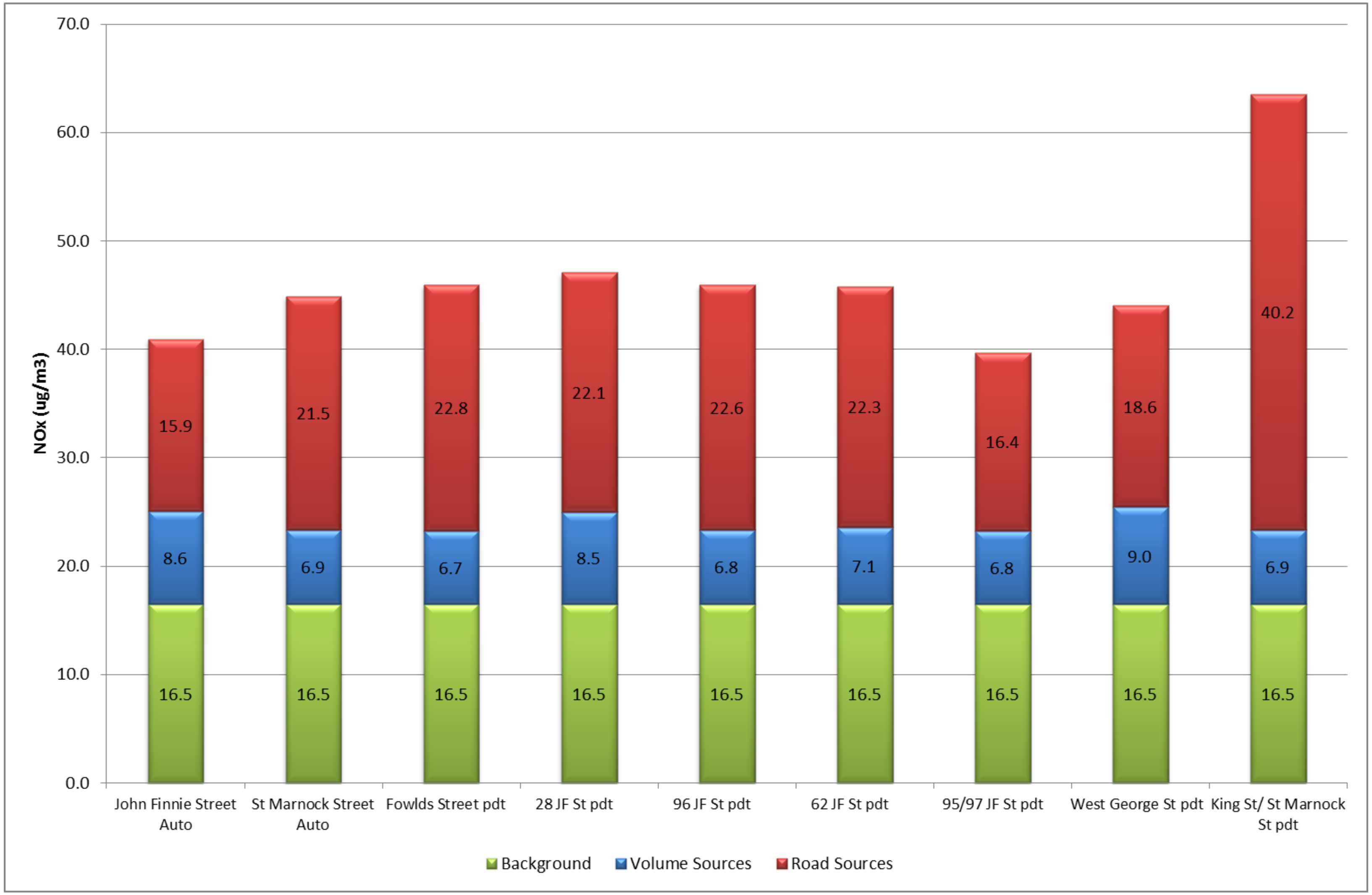


Figure 2: Source Apportionment NOx Emissions

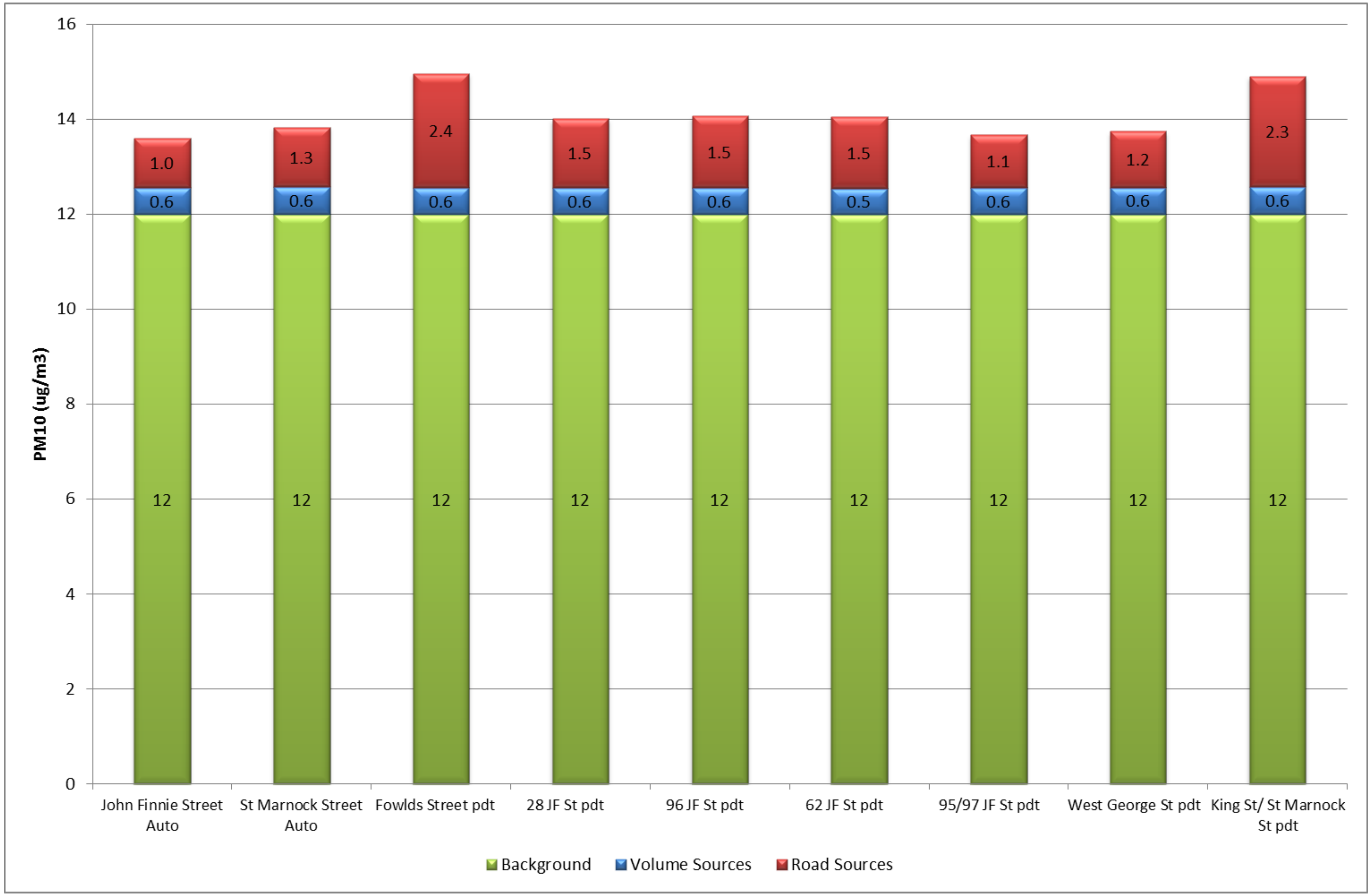


Figure 3: Source Apportionment PM_{10} Emissions

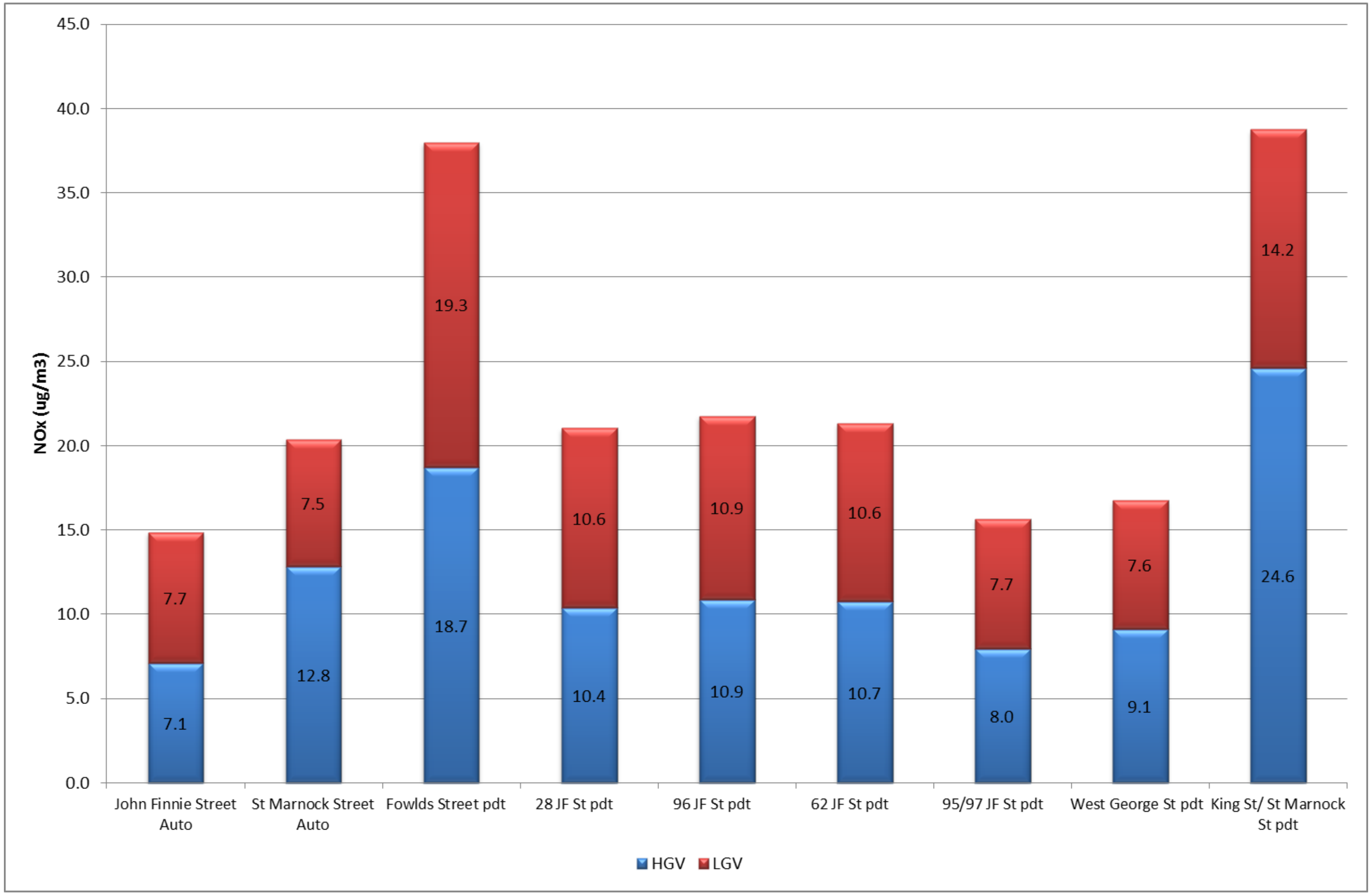


Figure 4: Source Apportionment NOx Road Traffic Emissions

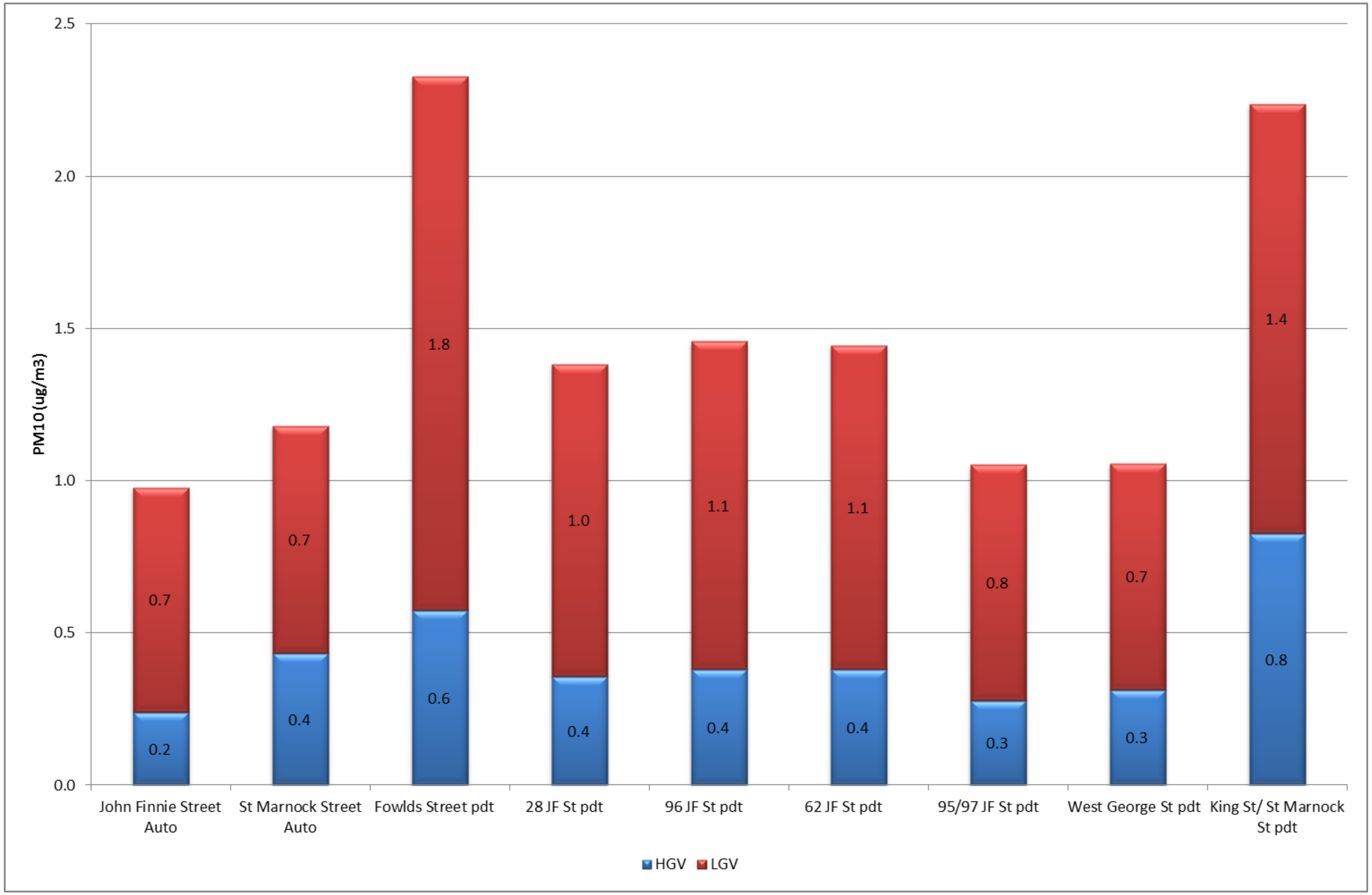


Figure 5: Source Apportionment PM_{10} Road Traffic Emissions

6.1 NO_x Source Apportionment

The source apportionment analysis indicates that road traffic emissions appear to be the main contributor to NO_x concentrations at all of the specified receptors.

Further analysis of the road traffic component of NO_x indicates that emissions from HGV and LGV contribute equally on John Finnie Street. However the results indicated that emissions from HGVs contribute the largest proportions of NO_x at the specified receptors close to St Marnock Street.

6.2 PM_{10} Source Apportionment

The source apportionment analysis indicates that the greatest contribution of PM_{10} emissions is from background sources. Road traffic emissions are responsible for the next highest contribution.

Further analysis of the road traffic component of PM_{10} emissions indicates that LGV contribute the largest proportions at all specified receptors.

7.0 CONCLUSIONS

Detailed dispersion modelling of emissions from road traffic has been conducted around Kilmarnock Town Centre focused on John Finnie Street to investigate the potential for exceeding the NO2 and PM10 annual mean objectives at relevant receptor locations.

Predicted NO2 concentrations were compared against the 2011 measured concentrations from the Council's passive and automatic monitoring network. The modelling predictions were shown to significantly over predict and following the guidance provided in Technical Guidance TG (09) an appropriate adjustment factor was calculated and applied.

Following adjustment the modelling predictions indicated that the NO2 annual mean objective was being met at all specified receptors in 2011 and therefore no requirement for an AQMA.

Predicted PM10 concentrations were also compared against the 2011 measured concentrations from the Council's monitoring site. The modelling predictions were shown to significantly under predict and following the guidance provided in Technical Guidance TG (09) an appropriate adjustment factor was calculated and applied.

After adjustment the modelling predictions indicated that the PM10 annual mean objective is being exceeded at all locations adjacent to all modelled roads in 2011.

However, the 2012 PM10 monitoring undertaken by the Council indicates that there has been a substantial reduction in PM10 concentrations in John Finnie Street. Measured PM10 concentrations reduced by 8 µg/m3 between 2011 and 2012. The monitoring results also indicate a 5 µg/m3 difference in measured concentrations at John Finnie Street and at St Marnock Street. This seems to be an unusually high difference given the proximity of these two sites. The modelling predictions based on the current traffic flows would indicate a difference of approximately 0.3 µg/m3 between the two monitoring sites where unadjusted concentrations are considered.

If the modelling predictions for 2011 are verified against 2012 monitoring data the results indicate that in 2012 the PM10 annual mean objective is currently being met at all specified receptors.

On the basis of both the results of the modelling study and the 2012 measured annual mean concentrations of PM10 it is the Council's intention to delay consideration of the declaration an AQMA in respect of the PM10 annual mean until 12 months of ratified data with the recommended >90% data capture is obtained. If a successful funding bid is obtained from the Scottish Government and following completion of a full twelve months of representative monitoring data, an Addendum to this report will be undertaken which will update the modelling study with the additional monitoring data and, if required, population exposure calculations will also be undertaken at that time..

Report Signature Page

GOLDER ASSOCIATES (UK) LTD

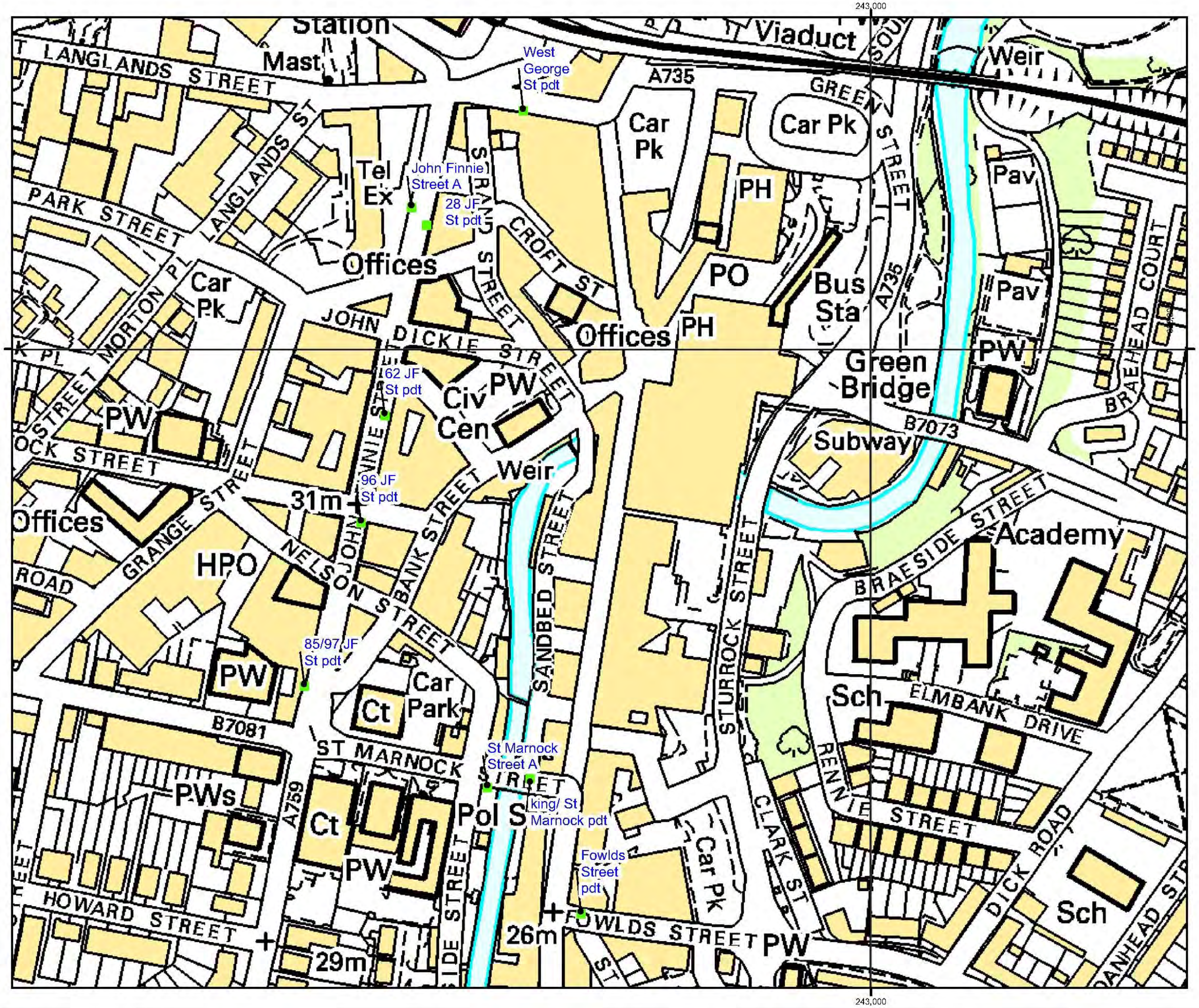
Stuart McGowan
Air Quality Specialist

SMcG/RF/te

Date: 6 December 2013

DRAWINGS

Drawing 1: Air quality monitoring locations
Drawing 2: Receptor locations
Drawing 3: Specified roads within study area
Drawing 4: Volume sources within the study area
Drawing 5: Adjusted annual mean contour plots for NO2
Drawing 6: Adjusted annual mean contour plots for PM10



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Legend

ADMS Receptor

REFERENCES

Coordinate System: WGS 1984 UTM Zone 38N.

75 37.5 0 75 METERS

N

SCALE 1:2,702 1 CENTIMETER = 0.03 KILOMETERS
WHEN PRODUCED AT SIZE A3

PROJECT

EAST AYRSHIRE COUNCIL
DETAILED ASSESSMENT OF JOHN FINNIE STREET

TITLE

MODELLED ROADS AND MONITORING LOCATIONS

Golder Associates
Edinburgh, UK

PROJECT No.	12514820689		FILE No.	
DESIGN	XX	xx/xx/xxxx	SCALE AS SHOWN	REV 0
GIS	XX	05/07/2013	DRAWING 1	
CHECK	XX	05/07/2013		
REVIEW	XX	05/07/2013		

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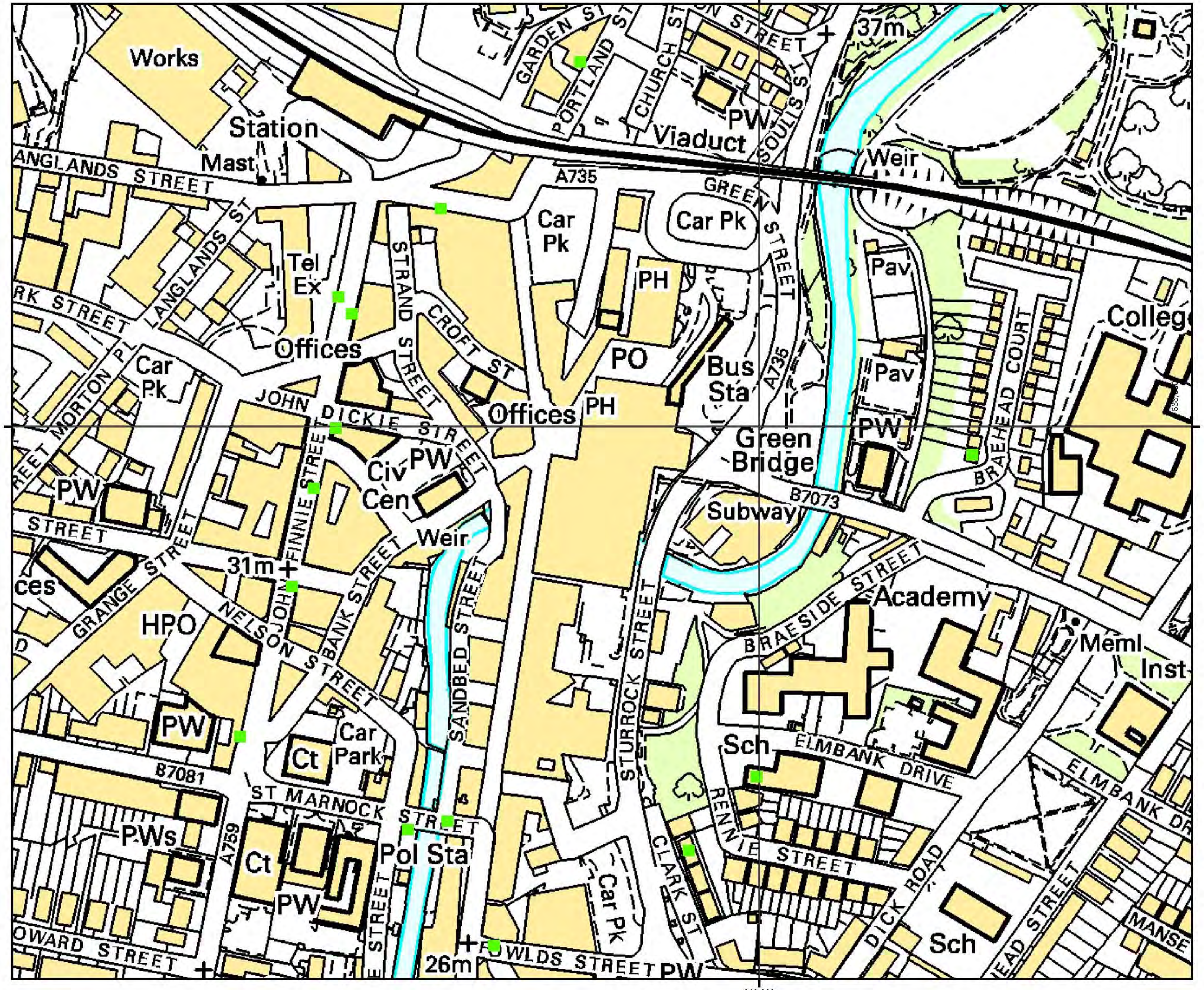
243,000



638,000

243,000

LEGEND

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ADMS Receptor

REFERENCES

Coordinate System: WGS 1984 UTM Zone 38N.

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WHEN PRODUCED AT SIZE A3

PROJECT

EAST AYRSHIRE COUNCIL
DETAILED ASSESSMENT OF JOHN FINNIE STREET

TITLE

SPECIFIED RECEPTORS

Golder Associates
Edinburgh, UK

PROJECT No.	12514820689		FILE No.	
DESIGN	XX	xx/xx/xxxx	SCALE AS SHOWN	REV 0
GIS	XX	05/07/2013	DRAWING 2	
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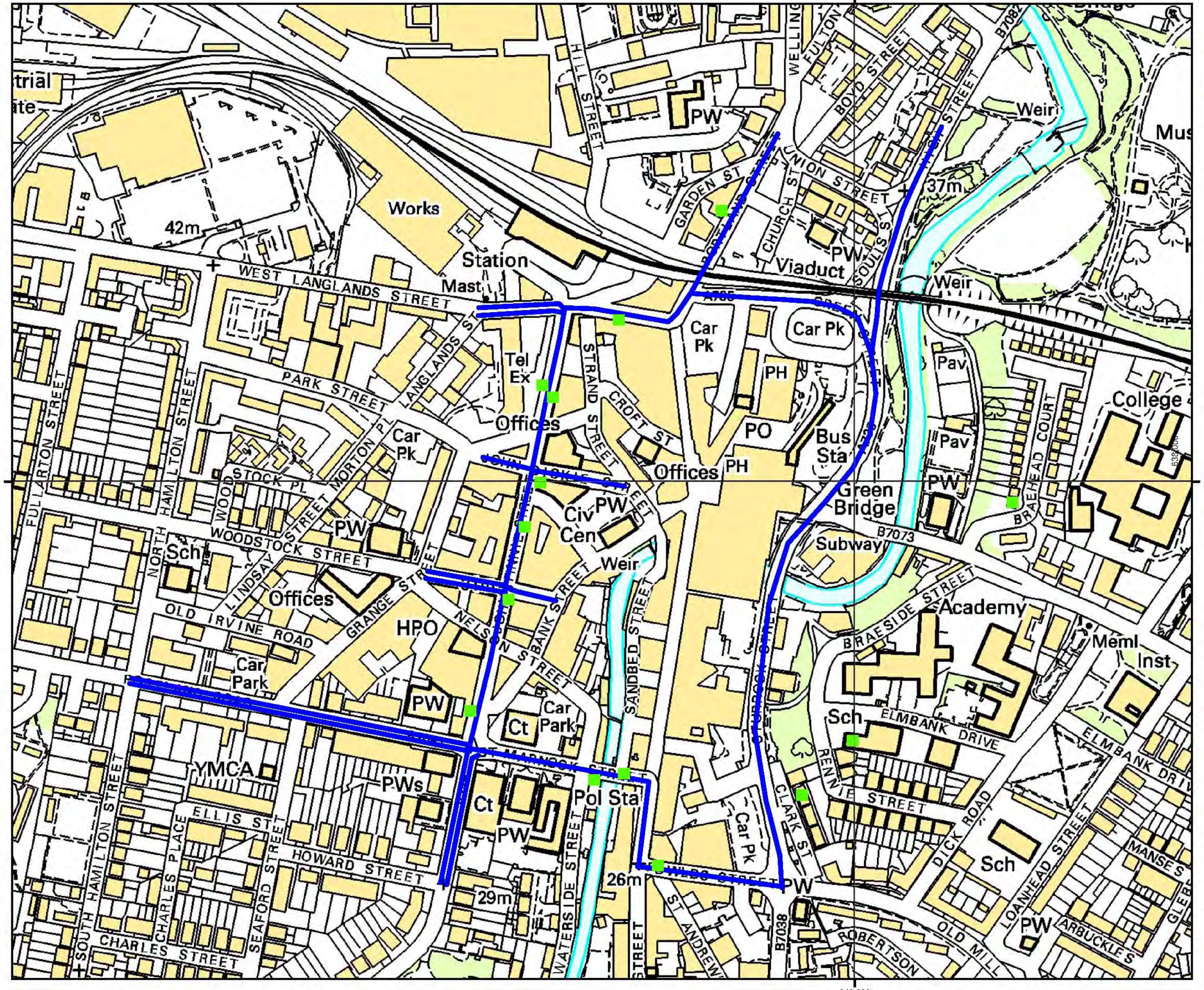

LEGEND

Legend

- ADMS Receptor
- ADMS Road Source

REFERENCES

Coordinate System: WGS 1984 UTM Zone 38N.

100 50 0 100 METERS

SCALE 1:4,000 1 CENTIMETER = 0.04 KILOMETERS

WHEN PRODUCED AT SIZE A3

N

PROJECT

EAST AYRSHIRE COUNCIL
DETAILED ASSESSMENT OF JOHN FINNIE STREET

TITLE

SPECIFIED RECEPTORS AND MODELLED ROADS

PROJECT No.	12514820689		FILE No.	
DESIGN	XX	xx/xx/xxxx	SCALE AS SHOWN	REV 0
GIS	XX	05/07/2013		
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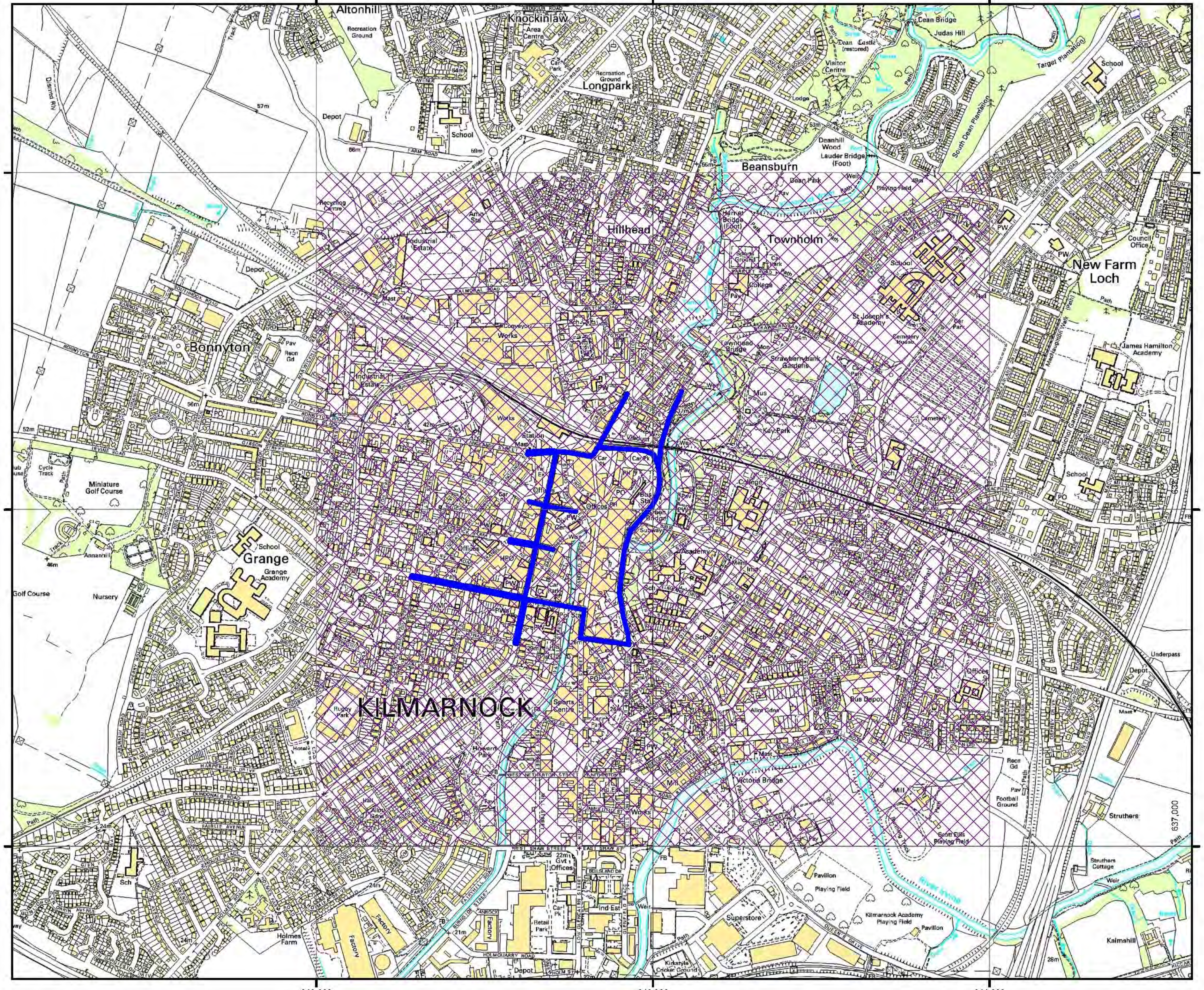

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ADMS Road Source

ADMS Volume Source

REFERENCES

Coordinate System: WGS 1984 UTM Zone 38N.

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SCALE 1:12,000 1 CENTIMETER = 0.12 KILOMETERS

WHEN PRODUCED AT SIZE A3

PROJECT

EAST AYRSHIRE COUNCIL
DETAILED ASSESSMENT OF JOHN FINNIE STREET

TITLE

MODELLED ROADS AND VOLUME SOURCES

Golder Associates
Edinburgh, UK

PROJECT No.	12514820689		FILE No.	
DESIGN	XX	xx/xx/xxxx	SCALE AS SHOWN	REV 0
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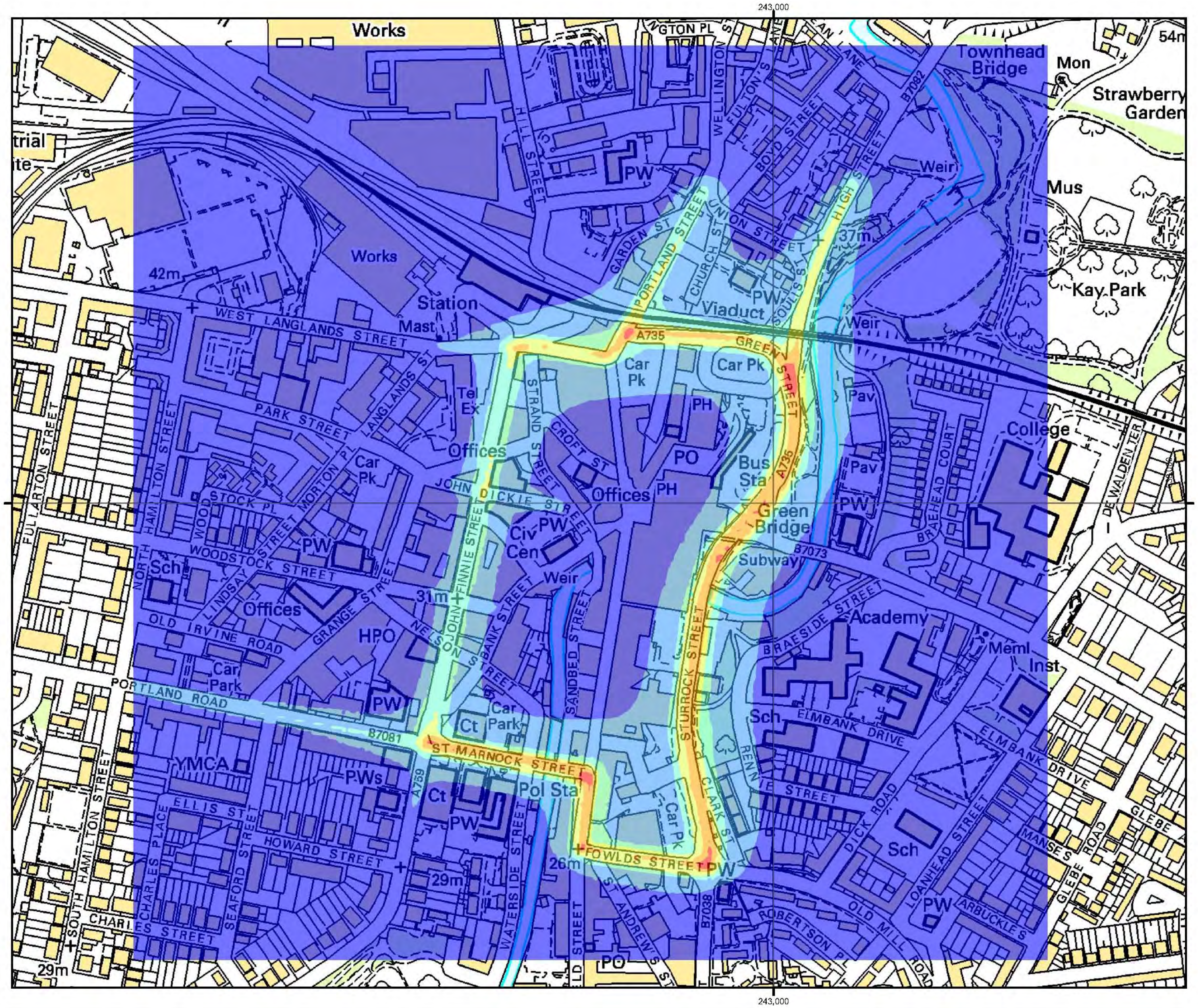

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- 26.1 - 29.8
- 29.9 - 33.5
- 33.6 - 37.3
- 37.4 - 40
- 40.1 - 44.9

REFERENCES

Coordinate System: WGS 1984 UTM Zone 38N.

150 75 0 150 METERS

N

SCALE 1:4,388 1 CENTIMETER = 0.04 KILOMETERS
WHEN PRODUCED AT SIZE A3

PROJECT

EAST AYRSHIRE COUNCIL
DETAILED ASSESSMENT OF JOHN FINNIE STREET

TITLE

ADJUSTED NO2 ANNUAL MEAN 2011

PROJECT No.	12514820689	FILE No.		
DESIGN	XX	xx/xx/xxxx	SCALE AS SHOWN	REV 0
GIS	XX	05/07/2013		
CHECK	XX	05/07/2013	DRAWING 5	
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Golder Associates
Edinburgh, UK

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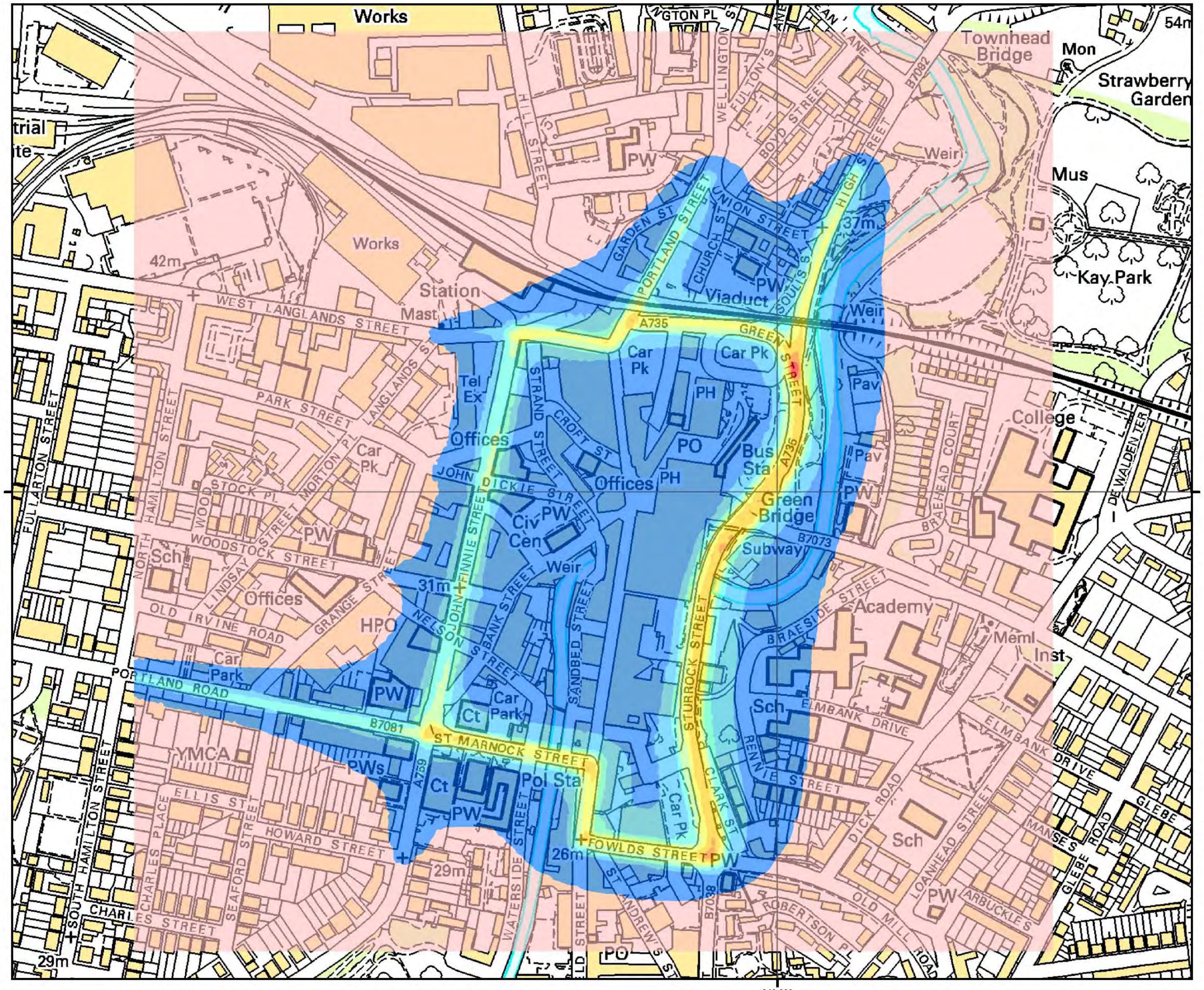

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adj_PM10_2011

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- 16.1 - 18
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- 20 - 21.8
- 21.9 - 23.8
- 23.9 - 25.7
- 25.8 - 27.7
- 27.8 - 29.6
- 29.7 - 31.6

REFERENCES

Coordinate System: WGS 1984 UTM Zone 38N.

N

150 75 0 150 METERS

SCALE 1:4,388 1 CENTIMETER = 0.04 KILOMETERS
WHEN PRODUCED AT SIZE A3

PROJECT

EAST AYRSHIRE COUNCIL
DETAILED ASSESSMENT OF JOHN FINNIE STREET

TITLE

ADJUSTED PM10 ANNUAL MEAN 2011

PROJECT No.	12514820689		FILE No.	
DESIGN	XX	xx/xx/xxxx	SCALE AS SHOWN	REV 0
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REVIEW	XX	05/07/2013		

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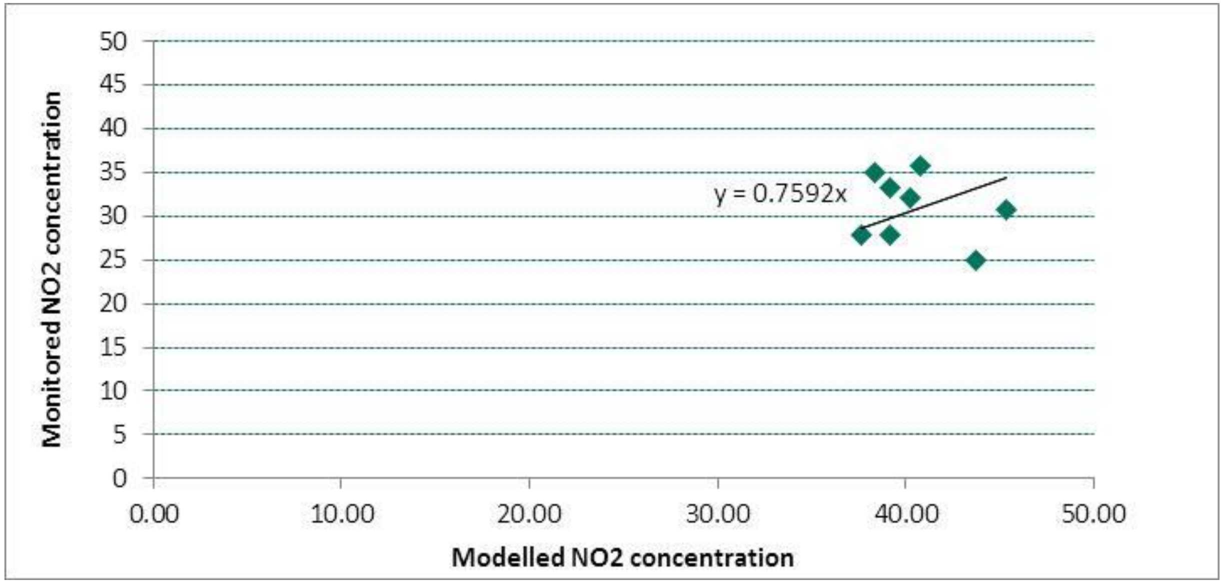
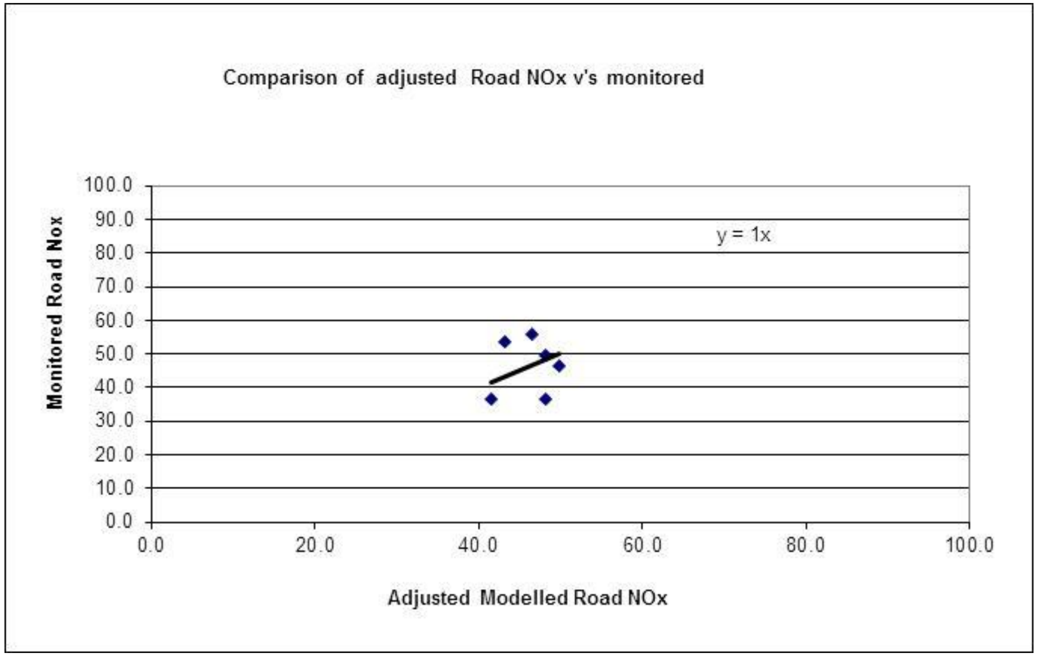
APPENDIX A

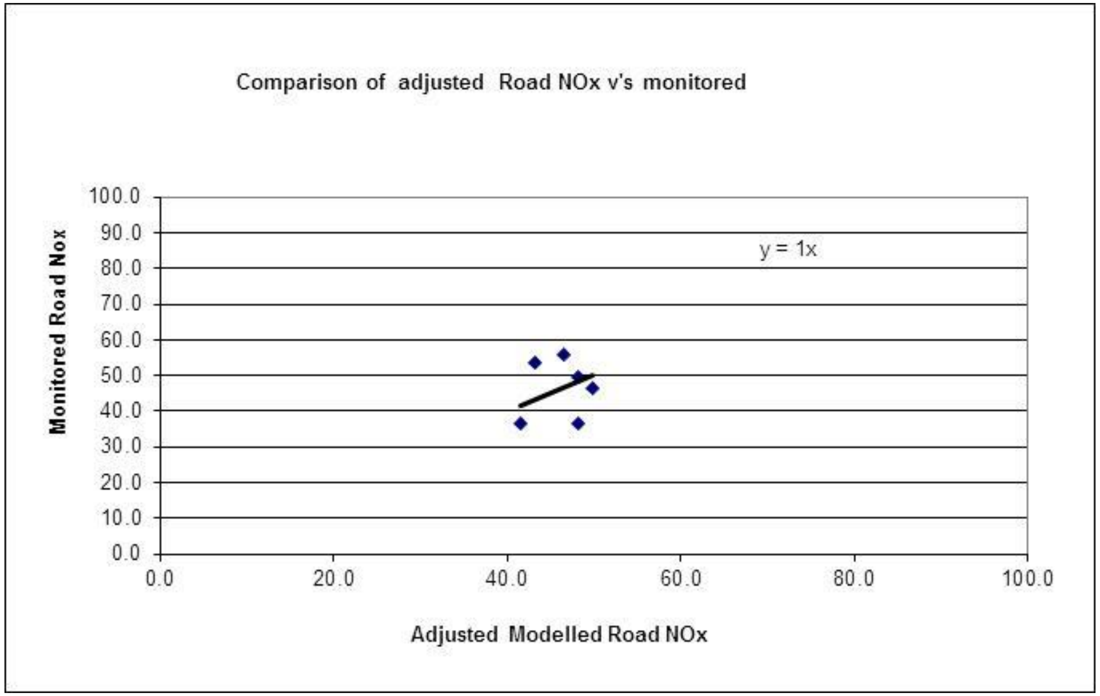
Model Adjustment

Site ID	Monitor type	Site Type	Background NO2	Monitored Total NO2	Modelled Total NO2	% Difference (modelled-monitored) / monitored NO2
John Finnie Street A		R	10.5	35	38.40	10%
Fowlds Street pdt		R	10.5	25	43.75	75%
28 JF St pdt			10.5	32.1	40.25	25%
96 JF St pdt			10.5	27.9	39.20	40%
62 JF St pdt			10.5	33.3	39.19	18%
85/97 JF St pdt			10.5	27.9	37.66	35%
West George St pdt			10.5	35.8	40.75	14%
King / St Marnock pdt			10.5	30.8	45.36	47%
						33%



Site Id	Monitored NO2	Monitored total Nox	Background NO2	Background Nox	Monitored road NO2 (total - background)	Modelled Total Nox	Monitored road contribution Nox (total-background)	Modelled road contribution Nox (excludes background)
John Finnie Street A	35.0	70.27	10.5	16.5	24.5	56.40	53.77	39.9
28 JF St pdt	32.1	62.97	10.5	16.5	21.6	62.42	46.47	45.9
96 JF St pdt	27.9	52.92	10.5	16.5	17.4	60.97	36.42	44.5
62 JF St pdt	33.3	65.90	10.5	16.5	22.8	60.88	49.4	44.4
85/97 JF St pdt	27.9	52.92	10.5	16.5	17.4	54.71	36.42	38.2
West George St pdt	35.8	72.34	10.5	16.5	25.3	59.39	55.84	42.9




Comparison of adjusted Road NOx v's monitored
Monitored Road Nox
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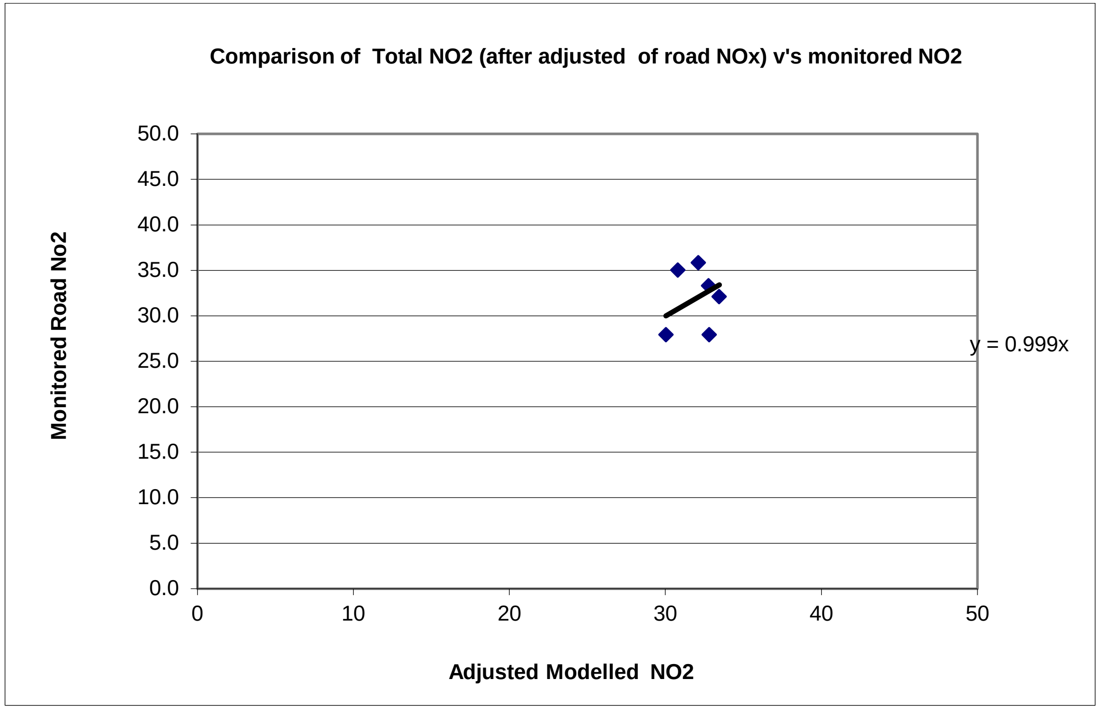
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
y = 1x
0.0
20.0
40.0
60.0
80.0
100.0
Adjusted Modelled Road NOx


Comparison of Total NO2 (after adjusted of road NOx) v's monitored NO2
Monitored Road No2
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40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
10
20
30
40
50
y = 0.999x
Adjusted Modelled NO2

Site Id	Ratio of monitored road Nox / modelled NOx	Adjustment factor	Adjusted modelled road contribution	Monitored road contribution Nox (total-background)	Adjusted modelled total Nox (inc background Nox)	Modelled total NO2(based on emperical NOX/NO2 relationship)	Monitored total NO2	% Difference [(modelled-monitored)/monitored]*100
John Finnie Street A	1.348	1.085	43.3	53.8	59.8	30.8	35.0	-12.0%
28 JF St pdt	1.012		49.8	46.5	66.3	33.45	32.1	4.2%
96 JF St pdt	0.819		48.2	36.4	64.7	32.82	27.9	17.6%
62 JF St pdt	1.113		48.2	49.4	64.7	32.78	33.3	-1.6%
85/97 JF St pdt	0.953		41.5	36.4	58.0	30.04	27.9	7.7%
West George St pdt	1.302		46.5	55.8	63.0	32.12	35.8	-10.3%

PM_{10} Verification

Site ID	Monitor type	Site Type	Background PM10	Monitored PM10	Modelled PM10	% Difference (modelled-monitored)/monitored PM10
JF Auto		R	12	13	13.63	5%
St marnock Street			12	17	13.88	-18%
Site Id	Monitored Pm10	Background PM10	Monitored road PM10 (total - background)	Modelled Total PM10	Monitored road contribution PM10(total-background)	Modelled road contribution Pm10 (excludes background)
JF Auto	13.0	12	1	13.63	1.00	1.6
St marnock Street	17.0	12	5	13.88	5.00	1.9
Site Id	Ratio of monitored road Nox / modelled NOx	Adjustment factor	Adjusted modelled road contribution	Adjusted Modelled total PM10	Monitored total PM10	% Difference [(modelled-monitored)/monitored]*100
JF Auto	0.614	1.7823	2.9	14.9	13.0	14.6%
St marnock Street	2.660	1.7823	3.4	15.4	17.0	-9.7%

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