Highways Forecasting and Analytical Services

The Greater Manchester Emissions Inventory
2014 Update

HFAS Report 1894 April 2016

Summary

This report describes the 2014 update of the atmospheric **em**issions **i**nventory for **G**reater **Ma**nchester, EMIGMA. The 2014 database continues with the revised methods and procedures for collecting and calculating the emissions introduced for the 2005 update for most sources. As part of the continuous improvement of the EMIGMA inventory a web-based system has been developed to collect the Part A and B processes data.

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1. Introduction

The original EMIGMA database was compiled by the London Research Centre (LRC) and RSK Radian on behalf of the Department of the Environment, Transport and the Regions (DETR) Air and Environment Quality Research Programme. Released in June 1997, it represents the second of a series of atmospheric emissions inventories covering many of the UK's major urban and industrial zones (Buckingham et al, 1997).

The emissions inventory contains information on the emissions of pollutants identified in the UK's Air Quality Strategy from all identifiable sources in the area. The emissions sources are grouped into three broad categories:

- stationary point sources - predominantly industrial processes
- mobile line sources - road, rail and air transportation
- area sources - other influential sources, such as domestic emissions, which it is not practical to resolve to point or line representations but which are nevertheless collectively significant. These sources are essentially population based and include, for example, combustion and solvent usage related emissions from domestic houses. They also include hot soaks vehicle emissions, which are based on estimates of vehicle destinations in each of 864 transport model zones making up Greater Manchester.

The emissions are then aggregated to a 1km^2 grid covering Greater Manchester. Highways Forecasting and Analytical Services (HFAS)[1] was commissioned on behalf of the Greater Manchester Local Authorities to undertake an update of the EMIGMA emissions inventory for a base year of 2014. The updates prior to 2004 were undertaken by the Centre for Air Transport and the Environment (CATE), formerly called ARIC.

The 2014 EMIGMA database covers an area of 1272 km^2 encompassing the ten administrative districts of Greater Manchester.

The database allows the magnitude and spatial distribution of emissions across Greater Manchester to be investigated and enables the relative importance of different sources of air pollution to be examined. The emissions data has a further role in providing the basis for dispersion modelling exercises and air quality management planning. In conjunction with transport models it also provides the basis for forecasting air quality and determining the effects of changes in land use planning and transportation policies on mass emissions.

Accompanying this report is a set of data and Geographical Information System (GIS) files showing emissions broken down by individual 1km grid squares. See Appendix 7 for details.

[1] On 1st April 2011 the Greater Manchester Transportation Unit (GMTU) became part of Transport for Greater Manchester (TfGM) and was renamed Highways Forecasting and Analytical Services (HFAS).

2. The 2014 Update

Following the handover of responsibility for updating EMIGMA from CATE to HFAS the methodology employed in creating the emissions inventory was reviewed. The industrial Part A and Part B processes[2] form a major component of the EMIGMA database. As the documentation from the previous EMIGMA updates was limited and HFAS lacked expertise in this area the update of the Part A and the Part B processes was contracted to Royal Haskoning. Royal Haskoning categorised the processes using a similar system to the Source Categorisation Codes used by the EMEP/Corinair atmospheric emission inventories. Royal Haskoning produced a series of Microsoft Excel templates for the 2005 update. Since the 2006 update HFAS has used these templates as the basis for a series of web-based forms which can be used by Districts to enter the point source data.

A number of tasks have been carried out by HFAS for the 2014 update in relation to the maintenance, improvement and update of the Greater Manchester emissions inventory :

- update of the part A and part B emission factors from the NAEI data warehouse (NAEI, Reference 13)
- update and recalculation of domestic emissions
- update and recalculation of commercial combustion emissions
- update of airport related emissions
- update and recalculation of point sources emissions
- update and recalculation of major roads emissions
- update and recalculation of minor roads emissions
- update and recalculation of hot soaks emissions
- update and recalculation of cold starts emissions
- update and recalculation of rail emissions
- update of CO_2 from electricity generation at the point of use
- an update of the inventory for 2014

The enhancements to the inventory associated with CO_2 emissions have been implemented to ensure that EMIGMA is capable of satisfying AGMA's requirements for monitoring carbon emissions within GM or attributable to GM in the case of electricity consumption.

This report gives details of the maintenance and update activities that have been undertaken by HFAS and presents the results of the 2014 EMIGMA update.

[2] These are the main polluting industries in the UK, prescribed under the Pollution Prevention and Control (PPC) regime as either A1, A2 or B activities.

3. Methodology for the 2014 Update

3.1 Road Sources

Road traffic emissions have been estimated using emission factors from the National Atmospheric Emissions Inventory website, in association with traffic speed and flow data from the Greater Manchester Saturn model.

Separate estimates of vehicle emissions were calculated for:

- Major Roads – representing warm running emissions from vehicles traveling on major roads represented in the Saturn model
- Minor Roads – representing warm running emissions from vehicles traveling on local roads that are not represented in the Saturn model
- Cold Starts – representing extra emissions caused by cold-running engines at the start of each journey
- Hot soaks (evaporative emissions) – representing extra emissions emanating from a hot engine after switching off at the end of each journey.

The calculation of the road traffic emissions is described in the remainder of this section. The section is organised as follows. Section 3.1.1 describes the major roads update. The calculation of the minor road emissions is described in Section 3.1.2. The calculation of the hot soak emissions is described in Section 3.1.3. Section 3.1.4 describes how cold start emissions were estimated. The emission factors and road traffic expansion factors are shown in Appendix 2.

3.1.1 The Major Roads Update

3.1.1.1 Description of the Traffic Model

The major roads update made use of traffic speed and flow data from the 2014 Greater Manchester SATURN Model, (GMSM, Reference 1), which covers all of Greater Manchester and the surrounding area.

The model has two main components comprising:

- The highway networks, which represent the roads and junctions used by traffic and bus services
- The trip matrices, which represent the demand for travel and the flow of vehicles between the zones in the model.

The highway networks that are used with the model represent all roads of traffic significance within the Greater Manchester, including all motorways, A roads and B roads. The networks also include all of the yellow coloured roads on the Ordnance Survey's Landranger maps of the area, and all roads carrying known bus services. The network outside the county is represented in much less detail, and becomes increasingly less dense with increasing distance from the county boundary.

The highway network within Greater Manchester is coded in full Saturn 'simulation' format, and includes detailed junction data including, for example, information about permitted turning movements, lane usage (including the locations of bus lanes) and details of traffic signal settings. This allows the interaction of traffic at junctions and the resulting delays and queues to be accurately modelled. Outside the county, the network is coded in Saturn ‘buffer’ format. The roads in this part of the model are represented in less detail than in the simulation network, and only include information about link attributes as opposed to the detailed junction information required for the simulation network.

The modelled area is split into 993 zones, comprising 864 zones within Greater Manchester and 129 zones outside the county. The zones inside the county are the most detailed, formed by splitting local authority wards into areas with similar trip making characteristics. (The outputs from the model can, therefore, be aggregated to wards and then districts if necessary). The zones outside the county are generally larger, and become increasingly large with increasing distance from the county boundary.

The GMSM trip matrices contain representations of all vehicle trips with an origin or destination inside Greater Manchester, and all external-to-external trips that cross the county boundary. The matrices also include partial representations of other external-to-external trips that do not enter Greater Manchester, but which are required to model the routing of trips into and out of the county.

Separate matrices are maintained for car, Light Goods Vehicle (LGV- goods vehicles up to 3.5 tonnes gross vehicle weight) and Other Goods Vehicle (OGV- goods vehicles over 3.5 tonnes gross vehicle weight) trips, for the morning peak hour (0800-0900), the evening peak hour (1700-1800) and an average inter-peak hour for the period 1000-1530.

For modelling purposes, the separate vehicle matrices are combined to form Passenger Car Unit (PCU) matrices for assignment to the highway networks. Assignment is the name given to the process by which the vehicles travelling between each pair of zones in the model are loaded onto the routes between the zones as determined by the model's routeing algorithm. Buses are not assigned, as they follow fixed routes, but are included in the networks as fixed link loads.

3.1.1.2 Traffic Assignments

The loaded network files for input to the EMIGMA database were created by assigning the separate 2014 PCU vehicle matrices to the highway networks, which were then converged. This is an iterative process, that includes a looped sequence of steps, in which the routes between the zones in the traffic model are determined, the movements between these zones in the trip matrices are loaded onto the network, the network link speeds are re-calculated using the flow-delay relationships within the model, new routes are determined etc. until the traffic flows and link speeds do not change significantly from one iteration to the next.

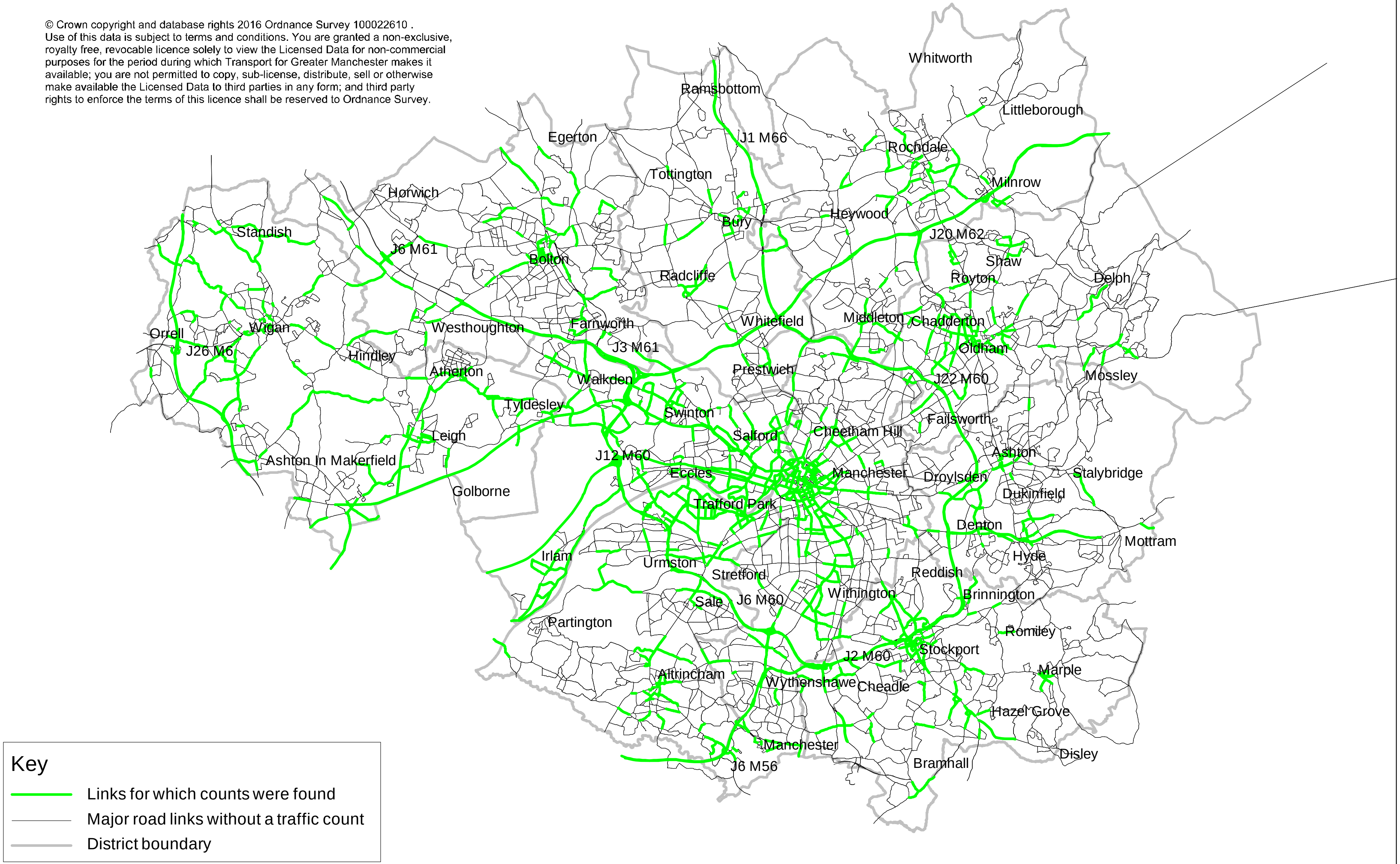
Once the networks had been converged, the assigned PCU flows for the separate car, LGV and OGV matrices were converted back to vehicles and saved in a format suitable for input to the EMIGMA database using software written by HFAS.

3.1.1.3 Updating the Assigned Flows with Counts

To improve the accuracy of the road traffic emission estimates, the modelled flows from the converged highway networks were replaced with traffic counts from HFAS's COUNTS database (Reference 2), for all roads where counts were available. This involved checking the count data and identifying all car, LGV, OGV and bus counts undertaken on the roads represented in the Saturn model between 1 January 2012 and the present day.

The 1st January 2012 was chosen for the earliest count date to exclude older counts that might be unreliable due to changes in travel patterns and traffic flows over time. In total, counts were found for approximately 25 per cent of the links in the simulation network. Most of these were on the busier links, which produce the largest volumes of emissions, as shown in Figure 3.1.

The GMSM models traffic flows on a typical weekday, assumed to be an October average weekday. When more than one count was available for a link, therefore, the count undertaken closest in time to 1st October 2014 was chosen. The selected counts were then factored to the 2014 October average weekday using local count conversion factors developed by HFAS, (Reference 4), and were then copied onto the modelling networks. Finally, the network link speeds were made compatible with the counted link flows using the flow-delay relationships from the traffic model, prior to copying the networks into the EMIGMA database.



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2014 EMIGMA Road Traffic Update Counted Links

Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : 3.1

3.1.1.4 Bus Speed Factors

The EMIGMA database includes a procedure for applying bus-speed adjustment factors to allow link speeds for buses to be reduced, to take into account the fact that buses stop more frequently and travel more slowly than other road vehicles.

The bus-speed factors were estimated by comparing observed bus and car journey times on equivalent routes in HFAS's road traffic journey time databases GMTimes and GMBusTimes (Reference 5). The calculated factors are shown below in Table 3.1.

3.1.1.5 Emission Estimates

Separate estimates of road traffic emissions were derived for the following six pollutants:

- VOCs
- CO
- CO_2 as C
- NO_X
- SO_2
- PM_{10}

Forecasts were produced by vehicle type and time period for each link in the highway network using:

- the link length
- the link flow by vehicle type (cars, LGVs, OGVs, buses, motorcycles)
- the link speed
- a table describing the composition of the vehicle fleet in terms of vehicle type, emission standard and method of propulsion
- a table giving emission factors by 5 kph speed band.

Information about the fleet composition was obtained from two sources:

- the National Atmospheric Emissions Inventory (NAEI) fleet composition projections, (Reference 7), which provide details of the percentage of vehicles complying with different emission standards as well as the petrol/diesel car/LGV split
- details of rigid and articulated heavy goods vehicle flows by road type for 2014 from HFAS's traffic counts database (GMCOUNTS, Reference 2)

The emission factors were calculated by combining the fleet composition projections with speed emission coefficients from the NAEI website (Reference 13). The calculated factors are shown in Table A2.1-Table A2.16 of Appendix 2. The fleet composition data are shown in Table A2.17.

The emission totals for the modelled hours were expanded to annual totals using the hour-to-period and period-to-day factors shown in Table A2.18. The calculated totals for all road sources are shown in Table 4.1 and for major roads only in Table 4.2, broken down by road type.

Table 4.3 and Table 4.4 present motorway emissions and Table 4.5 presents all major roads emissions broken down by vehicle type. Table 4.6 presents the results broken down by District. Modelled annual vehicle kilometre totals on motorways and other roads are shown in Table 3.2 and Table 3.3. HFAS Report 1840 (Reference 8) contains more detailed information on traffic flows and traffic growth.

Table 3.1

2014 Bus Speed Adjustment Factors	
Time Period	**Factor**
AM Peak Period	0.707
Off-Peak Period	0.667
PM Peak Period	0.765

Notes

These factors are used to adjust bus speeds, to take into account that buses stop more frequently and travel more slowly than other road vehicles. For example, if a link has a modelled link speed of 20 kph and the bus speed factor is set equal to 0.75, it is assumed that cars, LGVs and OGVs travel at 20 kph along the link, whilst buses travel at 20*0.75 = 15 kph.

Table 3.2

Modelled 2014 Vehicle Kilometres on Motorways by District					
District	Annual Vehicle Kilometres (Millions)				
	Car	LGV	OGV	Bus	All Motors
Bolton	427	90	48	1	567
Bury	544	126	83	2	758
Manchester	529	93	43	2	668
Oldham	146	34	15	0	197
Rochdale	590	140	119	2	853
Salford	802	183	129	2	1,119
Stockport	374	78	35	1	489
Tameside	278	63	29	1	372
Trafford	314	59	27	0	402
Wigan	420	91	67	2	581
Total	4,424	958	595	13	6,007

Notes

The all motors figures include motorcycles.

Table 3.3

Modelled 2014 Vehicle Kilometres on Other Major Roads by District					
District	Annual Vehicle Kilometres (Millions)				
	Car	LGV	OGV	Bus	All Motors
Bolton	840	138	30	12	1,027
Bury	504	72	18	8	605
Manchester	1,263	176	43	35	1,526
Oldham	591	97	23	10	725
Rochdale	546	84	29	8	672
Salford	669	112	38	12	837
Stockport	885	123	35	11	1,060
Tameside	514	83	25	8	634
Trafford	680	93	30	9	817
Wigan	927	158	45	13	1,150
Total	7,419	1,138	316	125	9,052

Notes

The all motors figures include motorcycles.

3.1.2 Minor Roads Emissions

Minor roads emissions are calculated separately from emissions on major roads, as minor road traffic flows are not available from the GMSM. Instead, emissions on minor roads are calculated using a traffic modelling procedure that makes use of SATURN buffer networks built from information held in the Integrated Transport Network layer (ITN) of the Ordnance Survey's MasterMap system, and isolated trip matrices formed using trip end totals from the trip matrices used with the GMSM (Reference 10).

Full details of the procedure are given in Reference 10. Briefly, however, the process involves building separate SATURN buffer networks from data held in the ITN for each of the 864 zones within Greater Manchester that are represented in the Saturn model. Any roads in the ITN that are also represented in the GMSM network are then discarded, to leave networks that only contain 'minor' roads that are not represented in the countywide traffic model.

Next, centroid connector links, (themselves attached to zones), are coded into each of the ITN minor road networks, so that trips that end in the associated GMSM zone can be loaded onto the network at the points representing junctions of major roads with minor roads, and can be taken off the network at points representing junctions of minor roads with other minor roads, or the terminal points of minor roads. The trips that begin in the GMSM zone are loaded onto the minor road network at the minor road junctions and are taken off the network at the major road junctions, where the minor road network provides access to the major road links represented in the Saturn model. This procedure is reversed for trips that end in the GMSM zone.

The assignment matrices that are used with the procedure are formed using trip end totals from the GMSM trip matrices, giving the total number vehicle trips that begin and end in each of the zones represented in the Saturn model.

For each GMSM zone and minor road network in turn, the trips that end in the zone are split equally between the coded internal zones representing the minor road junctions, so that an equal number of trips are taken off the network at each of these points. The origins of these external to internal trips are coded to a single (external) zone representing the major road junctions, (which are coded into the network using multiple centroid connector links), so that the assignment model determines the precise number of trips that are loaded onto the minor road network at each point providing access from the major road system.

A similar approach is adopted for distributing the internal to external trips that begin in the GMSM zones, although in this case the trips that begin in the zones are split equally between the internal minor road zones, so that equal numbers of trips join the minor road network at each of the minor road junctions. All of the trip destinations are coded to the external zone representing the major road junctions, so that the assignment model determines the number trips that leave the minor road network at each of the junctions that provide access to the major road system.

Separate matrices are formed for car, LGV and OGV trips, for each of the three time periods represented by the GMSM. The matrices are assigned to the highway network and the network converged, to provide estimates of traffic speeds and flows on each of the roads represented in the network. The assigned flows are then processed in a similar way to that described for major roads, using the fleet composition, road traffic expansion and speed related emission factors shown in Appendix 2 to calculate annual emission totals for each link.

The calculated minor road emissions are shown in Table 4.7, broken down by vehicle type. Emission totals by District are shown in Table 4.8.

3.1.3 Hot Soaks

Hot soak (or evaporative) emissions are the emissions that result when a hot engine is turned off. Heat from the engine and exhaust system increases the temperature of the fuel in the system that is no longer flowing. Carburettor float bowls are particularly significant source of hot soak emissions.

Hot soak emissions were estimated for cars and LGVs by applying vehicle specific emission factors to trip end totals calculated from the GMSM.

Hourly trip end estimates for petrol and diesel powered vehicles were then estimated using the fleet composition data shown in Table A2.17 of Appendix 2.

Fleet-weighted 2012 hot soak emission factors were obtained from the NAEI in April

2016. These were used to estimate rates for 2014 by applying the percentage change between 2012 and 2014 of equivalent warm-running emission factors for a speed of 40 kph. The 2014 factors are shown in Table A2.20.

The factors were used to calculate emission totals by hour, which were then expanded to give annual totals using the expansion factors shown in Table A2.18. The calculated totals are shown in Table 4.9, broken down by vehicle type.

3.1.4 Cold Starts

Cold start emissions represent the additional emissions produced by vehicles until they reach their normal operating temperature.

These emissions have been estimated using cold start emission factors (per trip values) from the NAEI website for petrol and diesel cars and LGVS, as shown in Table A2.19. The lack of emission factors for other vehicle types, including OGVs and buses, implies that these vehicles never or rarely experience cold starts. For the majority of such vehicles this is likely to be true, however, since engines cool slowly and commercial vehicles are used more intensively than cars and light vans. Furthermore, these vehicle types form only a small part of the total vehicle fleet and the relatively small numbers of journeys they make are considerably longer than those made by cars and LGVs.

In earlier versions of the EMIGMA database, all cold start emissions were assumed to arise at the trip's origin zone centroid, which were then allocated to 1km^2 grid squares along with the link based major and minor roads emissions described earlier. In practice, however, for most vehicles, their cold start emissions will be spread over the links they traverse until the engine is warm and, in many cases, the majority of these emissions will occur outside the origin zone.

The development of GMSM presented an opportunity to improve the modelling of cold start emissions by making use of a traffic assignment procedure to allow emissions to be allocated to links in the major road network. The procedure uses a traffic assignment option within Saturn that allows trips to be assigned for only part of their routes, defined in terms of distance from their origins. It is possible, therefore, to model the first n metres of a vehicle's journey, when the engine is still cold. (Our current best estimate of the distance travelled with a cold engine is 1,932m, as described in Reference 11). The modelling procedure correctly accounts for the situation where the nth metre is reached mid-link by loading only a proportion of the trip on the link. For example, if the nth metre point occurs halfway along a link then only half a trip is loaded on to the link. Full details of the procedure are given in Reference 12.

The cold start emissions were estimated for each of the modelled hours and vehicle types represented by the Saturn model, and were then expanded to give annual totals using the expansion factors shown in Table A2.18. The calculated cold start emissions are shown in Table 4.9, broken down by vehicle type. Cold start emissions by District are shown in Table 4.10.

3.1.5 Road Transport Other

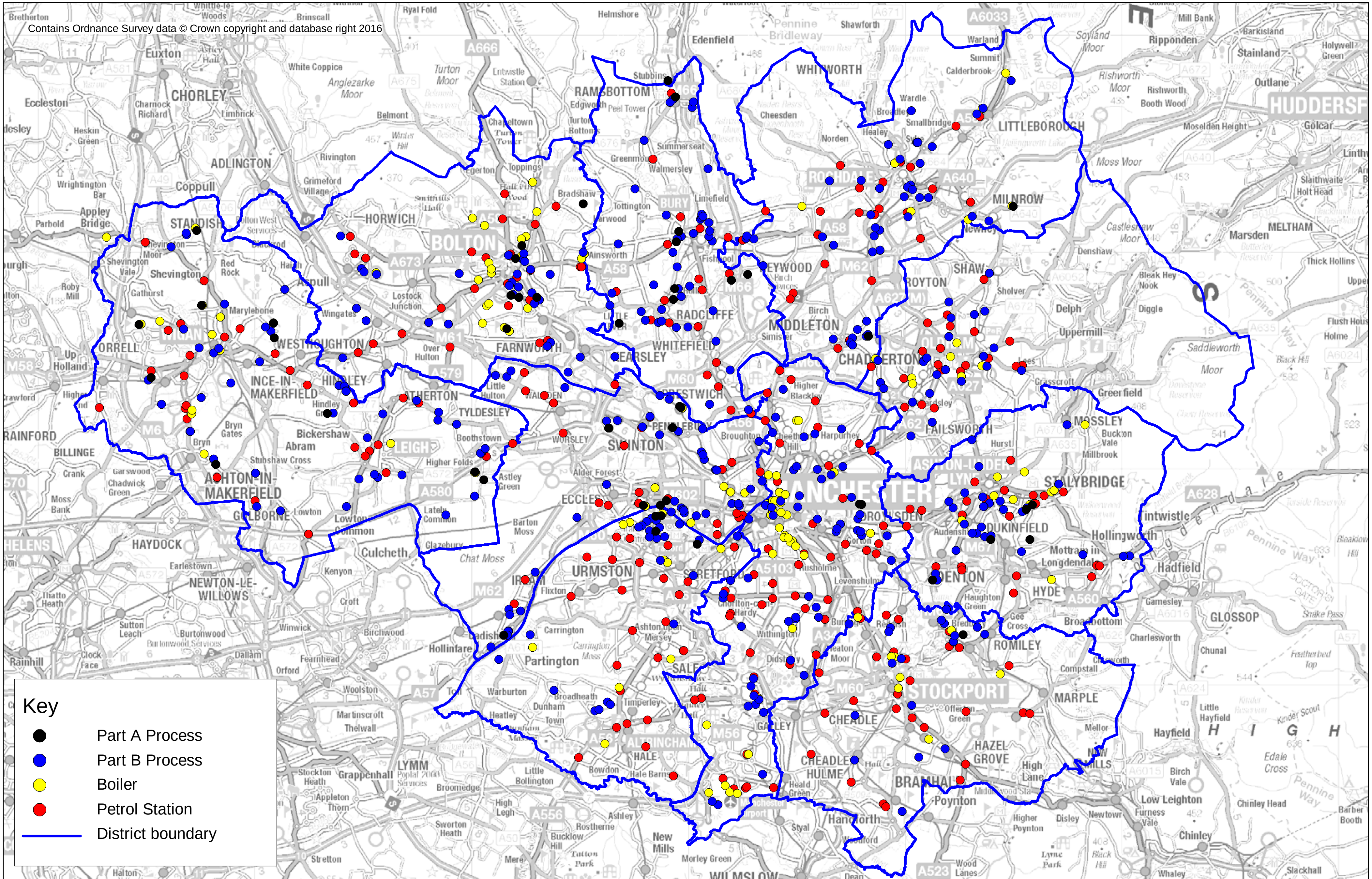
There are two other small sources of emissions from road traffic included in the inventory. These are combustion of waste lubricants and emissions from LPG vehicles. Both of these sources are distributed across LAs using estimates of total vehicle kilometres calculated from the NAEI maps of traffic flows. Data from DECC was obtained for the local emissions of CO_2 from these two sources at a district level (Reference 23). The results are shown in Table 4.1

3.2 Point Sources

The method for collecting, storing and calculating emissions from point source data was completely revised for the 2005 EMIGMA update. Royal Haskoning were commissioned to review the current procedures for calculating industrial emissions and to develop a new system based on traceable and verifiable emission factors. They produced a series of Excel templates, one for each process, and an accompanying handbook (Reference 18). The handbook describes the activities, emissions, emission factors and source of the emission factors for each process. The templates prompt the user to enter the relevant activity data e.g. the amount of output produced as opposed to the amount of input material. The factors are embedded in the templates so the calculated emissions are displayed and can be checked when the activity data is entered. A system for rating the data quality and reliability of both the generic emission factors and the specific industry activity information was introduced, in order to derive a qualitative system for scaling the overall uncertainty. This in turn can be used in future updates to prioritise efforts and resources towards improving the data with the greatest uncertainties. More details can be found in Royal Haskonings final report (Reference 19) and a sample from the handbook can be found in Appendix 8.

Building on the work done by Royal Haskoning, these templates were used as a basis for a web-based data entry system. The new system allows the user to enter and check new sites and processes online from any location. The system has a mapping element that enables the user to locate the site on a map and automatically generate an accurate grid reference. The system administrator can see the current progress of data entry for each district and can add and amend factors and processes, which become immediately available to the user. Appendix 8 contains a sample EMIGMA website data entry screen.

Figure 3.2 shows the locations of all of the point source data.



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Part A and B processes, boiler and petrol station locations

Drawn By : I Hull	Scale : Not applicable	Date : 29/04/2016	Figure 3.2

3.3 Rail Sources

The rail data has been updated. Train movement data was obtained from Network Rail from the ACTRAFF database for the period 20th September 2015 to 17th October 2015. ACTRAFF is a database recording the actual traffic movement across the rail network. The data contains the number of movements on each section of track broken down by traction class - locomotives and diesel multiple units (DMU's). Electric multiple units were also included but were not included in the calculations as the electricity data has already been included in section 3.6. The data also included a comprehensive breakdown on the number of wagons, but this data was not used in the emissions calculations as the emissions factors assume an 'average' load.

The first step was to draw the rail network in our geographic information system (GIS) broken down by the each of the 398 sections listed in the ACTRAFF data. Factors were obtained from the Rail Emission Model report on the DfT website (Reference 21). The factors are shown in Table A6.1. The 52 train classes from the ACTRAFF data were then allocated the most appropriate factor. The number of movements were factored to 52 weeks and then had the emission factors applied. The emissions were then allocated to the GIS network.

As the emissions factors incorporate an assumed station spacing the calculated emissions on the rail track now contain the emissions at stations, so the station emissions are no longer required.

3.4 Bus Stations

An updated bus station usage file was obtained from the TfGM. The file was based on bus station data for September 2012 and had weekdays, Saturdays and Sundays listed separately. This was more accurate than previous estimates where a typical weekday was factored by 365. It was assumed that bank holidays would be equivalent to Sunday services and that each bus would idle for 5 minutes at the bus station (this is the maximum time that is theoretically allowed). Updated emission factors were then applied for the lowest speed band (i.e. 5km/hr) and emissions calculated. The emission factors from the road update were used, which were obtained from the NAEI website (Reference 13) and are shown in Table A2.16.

3.5 Domestic and Commercial Combustion

The domestic and commercial combustion emissions were both updated and recalculated. Files of 2014 domestic and commercial gas usage were obtained from the Department for Energy and Climate Change (DECC), Reference 16. The domestic gas usage was broken down by Lower Layer Super Output Area (LLSOA) and the commercial gas usage broken down by Middle Layer Super Output Area (MLSOA). This section describes how the combustion figures were updated.

3.5.1 Domestic Combustion

3.5.1.1 Gas Combustion

The Lower Layer Super Output Area (LLSOA) level gas consumption data was disaggregated proportionally across the $1km^2$ grid.

The emission factors were obtained from the NAEI website (Reference 13) and are shown in Table A3.1.

3.5.1.2 Non-Gas Combustion

Non-gas fuel use was obtained at local authority level from the DECC website (Reference 14). The data is given in tonnes of oil equivalent (toe) which was then converted to kWh using the factor 1 toe=11630 kWh, from the Digest of United Kingdom Energy Statistics 2013 (DUKES 2013) (Reference 17). The kWh values were then converted to Megatonnes using a calorific value for coke from DUKES 2013. The appropriate emissions factors, shown in Table A3.2, were obtained from the NAEI website (Reference 13) and applied. The emissions were spread between the LLSOA's weighted by 2014 mid-year population figures.

The domestic emissions for oil combustion were calculated in an identical method to the solid fuel. The emission factors used are given in Table A3.3.

3.5.2 Commercial Combustion

3.5.2.1 Gas Combustion

The method for distributing the MLSOA commercial gas figures between the 1km grid squares has been revised.

Part A, Part B and boiler gas consumption estimates from the point source data input to the website by the Districts was removed from the relevant DECC MLSOA commercial gas delivery figures to avoid double counting. However, in 17 MLSOAs the total gas use by the point sources (Part A processes etc.) was more than that given in the data from DECC. There could be a number of reasons for this, for example, the gas data returned by the District officers could be incorrect or there could be differences in location between where the gas is metered and where it is used. Where the process data is greater than the DECC data the gas usage in that MLSOA was reset to 0. This is the method used in previous EMIGMA updates. In some cases upto 36% of the gas consumption in the DECC data was unallocated at the local authority level. This gas was allocated between the MLSOAs for that district pro rata to the gas usage in each MLSOA. However, the gas could have been consumed in just one or two of the MLSOAs within that district. The adjusted data was then allocated to the 1km^2 grid by using the proportion of commercial building area. The Ordnance Survey (OS) AddressPoint product was used to identify commercial addresses and using these addresses the building extents were selected from the OS MasterMap Topography building layer. The area of the commercial building extents was calculated and proportioned into the 1km grid. The gas was allocated according to these proportions.

The emission factors were obtained from the NAEI website (Reference 13) and are shown in Table A3.4.

3.5.2.2 Non-Gas Combustion

As in previous updates the oil and solid fuel emissions were not estimated for commercial/industrial usage as it was thought (jointly by the Greater Manchester Authorities) that these would be covered, in the majority, by the boiler emissions.

3.6 Electricity Generation

The CO_2 emissions from electricity generation have been calculated as if they arose at the point of use rather than at the power station. Note that there are no power stations within Greater Manchester. Electricity consumption data for 2014 was obtained from the Department for Energy and Climate Change (DECC), Reference 16. The domestic data was at Lower Layer Super Output Area (LSOA) and the commercial data at Middle Layer Super Output Area (MSOA). The commercial and industrial electricity consumption figures were disaggregated by the commercial building area (see section 3.5.2.1). The CO_2 produced during generation was calculated using the value of 394 tonnes of CO_2 per GWh of electricity supplied. This factor was obtained from DUKES 2015 (Reference 25) and is a composite factor for all sources of electricity generation including nuclear and renewables.

3.7 Aviation

Data for 2014 was supplied by Manchester Airport plc. The data includes ground based aircraft movements and movements up to an altitude of 200m. The data also contains vehicle movements off the public highway including airside traffic. This data has been aggregated to the 1km grid. The emissions, broken down by activity, are available in the accompanying data in the file “Manchester Airport 2014 Data.xls”. Table 3.4 gives the passenger numbers and annual traffic movements for comparison with previous years.

Table 3.4

Passenger Numbers and Annual Traffic Movements (ATMs)		
Year	**Passengers**	**ATMs**
2003	19,901,403	207,037
2004	21,555,600	205,700
2005	22,106,335	234,794
2006	22,776,337	229,717
2007	22,362,106	222,670
2008	21,087,944	204,608
2010	17,672,241	159,070
2011	18,814,045	167,351
2014	19,009,988	197,450

Data for 2014 has also been supplied by City Airport Manchester Ltd (Manchester Barton). City airport is business and general aviation airfield for light aircraft and helicopters. The data contains the number of movements and circuits broken down by aircraft weight categories. This is available in the accompanying data in the file “City Airport 2014 Data.xls”. Factors were obtained from Federal Office of Civil Aviation, FOCA, the Swiss aviation authority website (Reference 20) and are shown in Table A4.1. The factors used are the recommended factors for emission inventories and try to take a representative mixture between LTO (Landing and Take-Off), circuit flying and the variation in performance between different aircraft. The factors give the emissions from the aircraft until they reach cruise altitude, which is assumed for light aircraft, to be 3000ft or 1500ft for circuit flying.

Aviation emissions are shown in Table 4.17.

3.8 Area Sources

Data from DEFRA was obtained on the numbers of livestock by a 5km grid for 2010. The emissions for each 5km square were calculated using emission factors from the EMEP/CORINAIR Emission Inventory Guide book – 2006 (Reference 15), which are shown in Table A5.1. The emissions were disaggregated to the 1km grid inversely proportional to the number of addresses from the Ordnance Survey AddressPoint data. This was used as a proxy for the amount of developed land.

3.9 Agricultural Combustion

Data for 2009 was obtained from NAEI for the local emissions of CO_2 mapped to a 1kmx1km grid. The following is an extract from the Local Authority CO2 emissions estimates 2009: Methodology summary (Reference 24).

“The use of oil and solid fuel by agriculture is estimated using IDBR employment data. Other agricultural emissions estimated at the national level are those associated with off-road machinery use and breakdowns of pesticides.

Emissions from off-road machinery use are distributed using arable, pasture and forestry land use data combined with information on the number of hours of use of tractors and other machinery on the different types of land.

Emissions from pesticides applied to crops are distributed using maps of arable land cover.”

The results are shown in Table 4.19

3.10 Land use, land-use change and forestry

Land use, land-use change and forestry (LULUCF) is defined by the United Nations Climate Change Secretariat as "A greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities." (Reference 22)

Data from DECC was obtained for the local emissions of CO_2 at a district level (Reference 23). The results are shown in Table 4.20

4. Results of the 2014 Update

A summary of some of the results of the 2014 update are shown in this section. More information can be obtained from the data held in the GIS tables in the accompanying data.

4.1 Road Transport

Table 4.1 shows a summary of the emissions by all road sources. Table 4.2 to Table 4.6 show the results of the major road emissions broken down road type, vehicle type and District. Table 4.7 and Table 4.8 show the minor road emissions broken down by vehicle type and District. Table 4.9 shows the emissions from cold starts and hot soaks.

Table 4.1

2014 Road Transport Sources (Tonnes/Year)							
Pollutant	**Motorways**	**Other Major Roads**	**Minor Roads**	**Hot Soaks**	**Cold Starts**	**Other**	**Total**
VOCs	200	625	38	48	281		1191
CO	2672	5242	309		7569		15793
CO_2 as C	356372	514034	33016			4934	908355
NO_X	3162	5155	289		393		9000
SO_2	6.7	8.2	0.6				15.5
PM_{10}	490	689	51		52		1282

Notes

The sum of the columns may not equal the total due to rounding.

Table 4.2

2014 Major Road Emission Totals by Road Type (Tonnes/Year)			
Pollutant	**Motorways**	**Other Major Roads**	**Total**
VOCs	200	625	826
CO	2672	5242	7914
CO_2 as C	356372	514034	870406
NO_X	3162	5155	8317
SO_2	6.7	8	14.9
PM_{10}	490	689	1179

Notes

The sum of the columns may not equal the total due to rounding.

Table 4.3

2014 Motorway Emission Totals by Vehicle Type (Tonnes/Year)						
Pollutant	**Vehicle Type**					
	Motor Cycles	**Cars**	**LGVs**	**OGVs**	**Buses**	**Total**
VOCs	8	125	39	28	1	200
CO	113	2134	255	166	5	2672
CO_2 as C	581	163247	60496	129942	2106	356372
NO_X	4	1335	624	1157	42	3162
SO_2	0.0	2.8	1.2	2.6	0.1	6.7
PM_{10}	0	309	83	95	2	490

Notes

The sum of the columns may not equal the total due to rounding.

Table 4.4

2014 Motorway Emission Totals by District (Tonnes/Year)						
District	**Pollutant**					
	VOCs	**CO**	**CO_2 as C**	**NO_X**	**SO_2**	**PM_{10}**
Bolton	18	269	32462	285	0.6	46
Bury	25	337	46790	412	0.9	63
Manchester	22	307	35125	310	0.6	52
Oldham	7	95	11264	100	0.2	16
Rochdale	29	355	56274	504	1.1	72
Salford	38	469	68939	617	1.3	93
Stockport	16	211	26261	234	0.5	39
Tameside	13	178	21294	193	0.4	30
Trafford	13	192	21668	190	0.4	32
Wigan	19	260	36296	316	0.7	48
Total	200	2672	356372	3162	6.7	490

Notes

The sum of the rows may not equal the total due to rounding.

Table 4.5

2014 Major Road Emission Totals by Vehicle Type (Tonnes/Year)						
Pollutant	**Vehicle Type**					
	Motor Cycles	**Cars**	**LGVs**	**OGVs**	**Buses**	**Total**
VOCs	59	552	132	54	28	826
CO	500	6189	788	313	125	7914
CO_2 as C	2151	502314	129755	198657	37530	870406
NO_X	11	3538	1431	2392	945	8317
SO_2	0.0	7.8	2.3	4.1	0.6	14.9
PM_{10}	2	815	182	149	31	1179

Notes

The sum of the columns may not equal the total due to rounding.

Table 4.6

2014 Major Road Emission Totals by District (Tonnes/Year)						
District	**Pollutant**					
	VOCs	**CO**	**CO_2 as C**	**NOx**	**SO_2**	**PM_{10}**
Bolton	83	836	87388	811	1.5	123
Bury	66	671	79833	736	1.4	108
Manchester	138	1250	126959	1286	2.0	170
Oldham	57	517	52289	511	0.9	71
Rochdale	73	723	93939	883	1.7	124
Salford	100	988	119730	1142	2.1	158
Stockport	90	842	85768	808	1.4	118
Tameside	57	540	57735	565	1.0	78
Trafford	67	654	66735	628	1.1	93
Wigan	94	893	100029	947	1.7	136
Total	826	7914	870406	8317	14.9	1179

Notes

The sum of the rows may not equal the total due to rounding.

Table 4.7

2014 Minor Road Emission Totals by Vehicle Type (Tonnes/Year)						
Pollutant	**Motor Cycles**	**Cars**	**LGVs**	**OGVs**	**Buses**	**Total**
VOCs	4	27	5	1	0	38
CO	29	242	31	8	0	309
CO_2 as C	115	24617	4427	3857	0	33016
NO_X	1	166	57	67	0	289
SO_2	0.00	0.42	0.08	0.09	0	0.59
PM_{10}	0.1	41.1	7.1	3.1	0	51.4

Notes

The sum of the columns may not equal the total due to rounding.

Table 4.8

2014 Minor Road Emission Totals by District (Tonnes/Year)						
District	**Pollutant**					
	VOCs	**CO**	**CO_2 as C**	**NO_X**	**SO_2**	**PM_{10}**
Bolton	3.6	29	3097	27	0.06	4.8
Bury	3.1	25	2658	23	0.05	4.2
Manchester	5.7	47	4946	43	0.09	7.7
Oldham	2.8	23	2410	21	0.04	3.8
Rochdale	3.2	26	2905	27	0.05	4.4
Salford	3.7	30	3233	29	0.06	5.0
Stockport	5.0	41	4365	38	0.08	6.8
Tameside	2.6	21	2273	20	0.04	3.5
Trafford	3.9	32	3400	30	0.06	5.3
Wigan	4.3	35	3729	32	0.07	5.8
Total	37.7	309	33016	289	0.59	51.4

Notes

The sum of the rows may not equal the total due to rounding.

Table 4.9

2014 Cold Start and Hot Soak Emission Totals (Tonnes/Year)						
Pollutant	**Cold Starts**			**Hot Soaks**		
	Cars	**LGVs**	**Total**	**Cars**	**LGVs**	**Total**
VOCs	253	28	281	46	1	48
CO	7324	245	7569	n/a	n/a	n/a
NO_X	339	54	393	n/a	n/a	n/a
PM_{10}	36	16	52	n/a	n/a	n/a

Notes

n/a – not applicable
The sum of the columns may not equal the total due to rounding.

Table 4.10

2014 Cold Start Emission Totals by District (Tonnes/Year)				
District	Pollutant			
	VOCs	CO	NO_X	PM_{10}
Bolton	29	770	40	5.3
Bury	21	568	29	3.8
Manchester	46	1234	65	8.6
Oldham	22	593	31	4.1
Rochdale	23	625	33	4.3
Salford	27	718	38	5.1
Stockport	33	899	46	5.9
Tameside	22	581	30	4.0
Trafford	28	763	39	5.1
Wigan	30	819	42	5.6
Total	281	7569	393	51.8

Notes

The sum of the rows may not equal the total due to rounding.

4.2 Point Sources

Table 4.11 shows a summary of the emissions by the various point sources.

Table 4.11

2014 Point Source Emission Totals (Tonnes/Year)					
Pollutant	**Part A's**	**Part B's**	**Boilers**	**Petrol Stations**	**Total**
Non-Methane VOCs	276	5863	23	722	6884
CO	340	38	309		688
CO_2 as C	660824	4580	197279		862683
NO_X	395	184	557		1136
SO_2	60	102	49		211
Benzene	0.3	0.1	1.9	1.1	3.4
PM_{10}					0
Hg	17	134	16		167
Pb	0	0	0		0
CH_4	0	0	0		0

Notes

The sum of the columns may not equal the total due to rounding.

4.3 Rail Sources

Table 4.12 shows a summary of the emissions by rail stations and rail tracks.

Table 4.12

2014 Rail Source Emission Totals (Tonnes/Year)	
Pollutant	**Rail Track Total**
Non-Methane VOCs	107
CO	135
CO_2 as C	114403
NO_X	1099
SO_2	143
PM_{10}	34

4.4 Bus Stations

Table 4.13 shows a summary of the emissions at bus stations.

Table 4.13

2014 Bus Station Emission Totals (Tonnes/Year)	
Pollutant	**Total**
VOCs	1.6
CO	6.4
CO_2 as C	2058
NO_X	50
SO_2	0.01
PM_{10}	1.03

4.5 Domestic and Commercial Combustion

4.5.1 Domestic Combustion

Table 4.14 shows a summary of the emissions by all forms of domestic combustion (gas, oil and solid fuel).

Table 4.14

2014 Domestic Combustion Emission Totals (Tonnes/Year)	
Pollutant	**Total**
Non-Methane VOCs	295
CO	6898
CO_2 as C	747434
NO_X	1225
SO_2	696
Benzene	18
PM_{10}	88
CH_4	446

4.5.2 Commercial Combustion

Table 4.15 shows a summary of the emissions by all commercial gas combustion.

Table 4.15

2014 Commercial Gas Combustion Emission Totals (Tonnes/Year)	
Pollutant	**Total**
Non-Methane VOCs	43
CO	192
CO_2 as C	269736
NO_X	976
Benzene	4
PM_{10}	15
CH_4	87

4.6 Electricity Generation

Table 4.16 shows the amount of CO_2 (as carbon) emissions for electricity generation at point of use broken down by District.

Table 4.16

2014 Electricity CO_2 Emission Totals (Tonnes/Year)	
District	**Total**
Bolton	115404
Bury	71804
Manchester	277618
Oldham	79051
Rochdale	100526
Salford	109833
Stockport	116521
Tameside	90341
Trafford	162763
Wigan	136706
Total	1260566

Notes

The sum of the rows may not equal the total due to rounding.
CO_2 refers to carbon dioxide as C.

4.7 Aviation

Table 4.17 shows a summary of the emissions by aviation.

Table 4.17

2014 Aviation Emission Totals (Tonnes/Year)	
Pollutant	**Total**
VOCs	120
CO	885
NO_X	415
SO_2	19
PM_{10}	5
CO_2 as C	27886

4.8 Area Sources

Table 4.18 shows a summary of the emissions by other area sources.

Table 4.18

2014 Other Emission Totals (Tonnes/Year)	
Pollutant	**Total**
VOCs	22194
CO	9
NO_X	36
SO_2	438
Benzene	17
1,3 butadiene	0
PM_{10}	26

4.9 Agricultural Combustion

Table 4.20 shows the amount of CO_2 (as carbon) emissions for agricultural combustion broken down by District.

Table 4.19

2014 Agricultural Combustion CO2 Totals (Tonnes/Year)	
District	**Total**
Bolton	391
Bury	305
Manchester	92
Oldham	237
Rochdale	389
Salford	102
Stockport	391
Tameside	202
Trafford	168
Wigan	414
Total	2691

Notes

The sum of the rows may not equal the total due to rounding.
CO_2 refers to carbon dioxide as C.

4.10 Land use, land-use change and forestry

Table 4.20 shows the amount of CO_2 (as carbon) emissions for land use, land-use change and forestry broken down by District.

Table 4.20

2014 Land use, land-use change and forestry CO_2 Totals (Tonnes/Year)	
District	**Total**
Bolton	1664
Bury	682
Manchester	627
Oldham	1282
Rochdale	1445
Salford	9927
Stockport	464
Tameside	873
Trafford	2155
Wigan	3491
Total	22609

Notes

Positive figures indicate net emissions from these sources.
The sum of the rows may not equal the total due to rounding.
CO_2 refers to carbon dioxide as C.

4.11 Total Emissions

The following tables and figures give the total emissions, in Greater Manchester and each District separately, from all sources and the relative proportions.

Table 4.21

2014 Total Emissions in Greater Manchester from all sources																					
Pollutant	**Roads[2]**		**Rail**		**Air**		**Other[1]**		**Part A's**		**Part B's**		**Boilers**		**Petrol Stations**		**Combustion**		**Bus Stations**		**Total**
	t/yr	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**
VOCs	1191	3.9	107	0.3	120	0.4	22194	72.0	276	0.9	5863	19.0	23	0.1	722	2.3	338	1.1	2	0.0	30836
CO	15793	64.2	135	0.5	885	3.6	9	0.0	340	1.4	38	0.2	309	1.3			7090	28.8	6	0.0	24606
CO_2 as C	908355	30.7	114403	3.9	27886	0.9	25300	0.9	660824	22.3	4580	0.2	197279	6.7			1017170	34.4	2058	0.1	2957856
NO_X	9000	64.6	1099	7.9	415	3.0	36	0.3	395	2.8	184	1.3	557	4.0			2201	15.8	50	0.4	13938
SO_2	15	1.0	143	9.3	19	1.2	438	28.5	60	3.9	102	6.6	49	3.2			710	46.2	0	0.0	1537
Benzene	0.2	0.4					17	40.4	0	0.8	0.1	0.2	2	4.4	1	2.5	22	51.4	0	0.0	43
PM_{10}	1282	79.3	34	2.1	5	0.3	26	1.6	17	1.0	134	8.3	16	1.0			103	6.4	1	0.1	1618
HG									0.002	1.1	0	98.5	0.00	0.4							0
PB									0.03	22.1	0.1	69.0	0.0	8.9							0
Methane									348	37.6	1	0.1	44	4.8			533	57.5			925

Notes

[1]Other includes LULUCF and agricultural combustion
[2]The emissions factors no longer have values for benzene under warm running conditions.
The emissions are given in tonnes per year (t/yr)
The sum of the rows may not equal the total due to rounding.

Figure 4.1 SO_2 Emissions in Greater Manchester

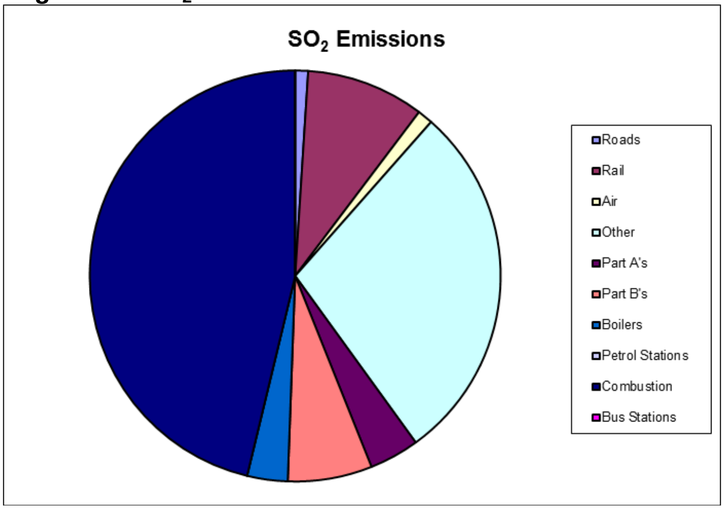


Figure 4.2 NO_X Emissions in Greater Manchester

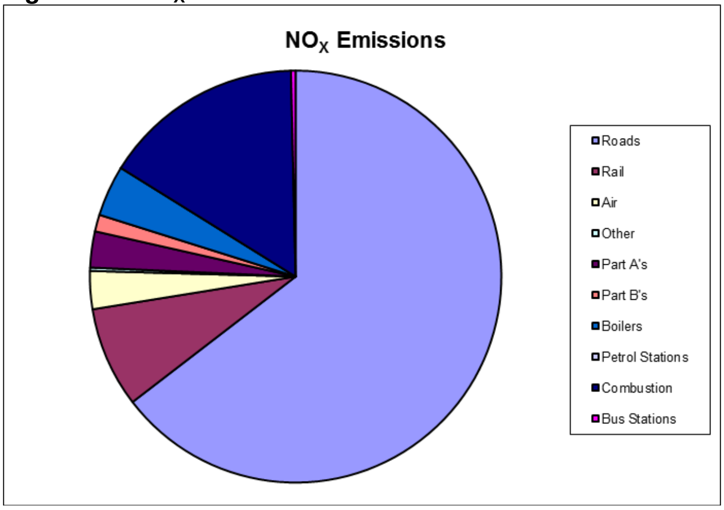


Figure 4.3 CO Emissions in Greater Manchester

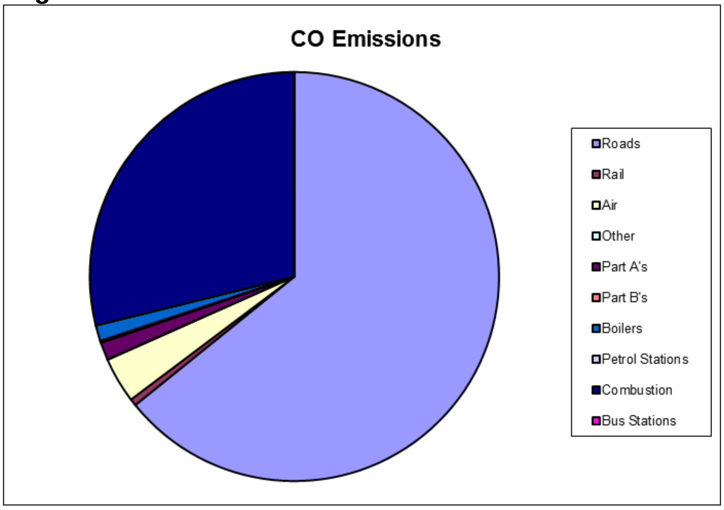


Figure 4.4 VOCs Emissions in Greater Manchester

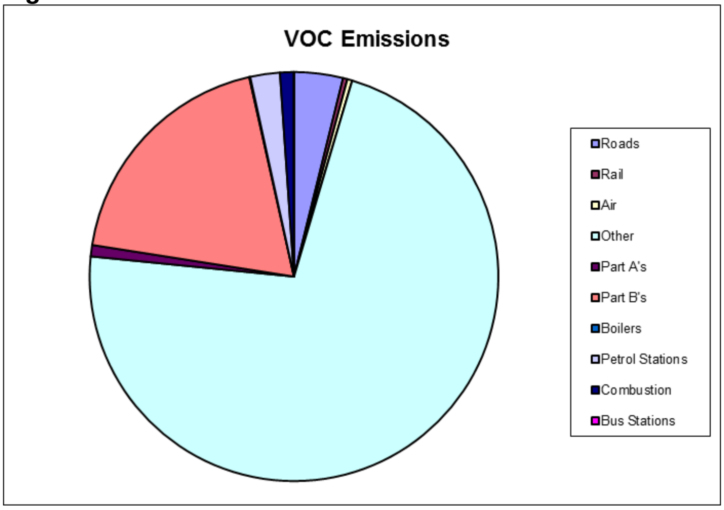


Figure 4.5 CO_2 Emissions in Greater Manchester

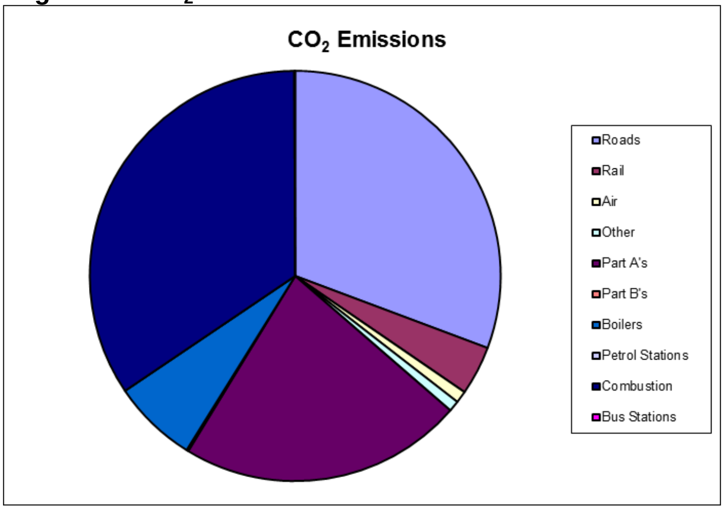


Figure 4.6 PM_{10} Emissions in Greater Manchester

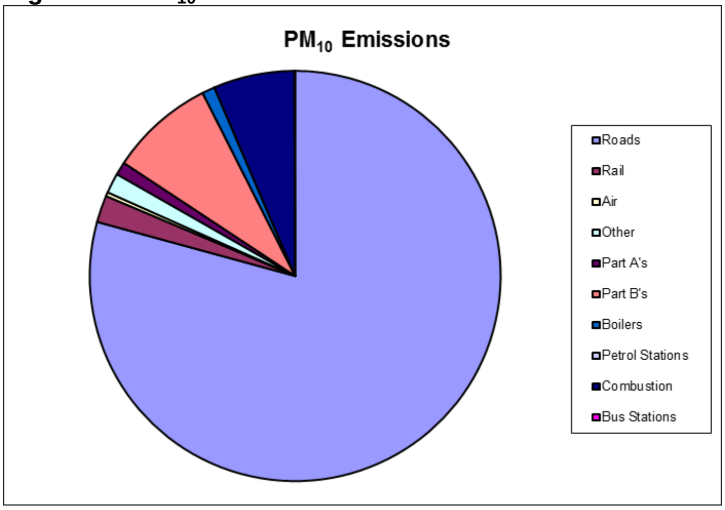


Table 4.22

2014 Total Emissions in Bolton from all sources

Pollutant	Roads[2]		Rail		Air		Other[1]		Part A's		Part B's		Boilers		Petrol Stations		Combustion		Bus Stations		Total
	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr
VOCs	120	4.3	6	0.2	0	0.0	2297	82.6	1	0.0	239	8.6	2	0.1	85	3.0	33	1.2	0	0.0	2782
CO	1636	68.7	6	0.2	0	0.0	1	0.0	12	0.5	1	0.0	21	0.9			706	29.6	1	0.0	2383
CO_2 as C	91055	41.1	6209	2.8			2054	0.9	8406	3.8	510	0.2	12897	5.8			99970	45.2	179	0.1	221280
NO_X	879	67.6	62	4.8	0	0.0	4	0.3	91	7.0	4	0.3	53	4.1			203	15.6	4	0.3	1300
SO_2	2	1.1	8	5.6	0	0.0	48	35.6	3	2.4	0	0.2	4	3.0			71	52.0	0	0.0	136
Benzene	0.02	0.4	0	0.0	0	0.0	2	36.2	0	7.0	0	0.2	0.2	3.9	0	2.8	2	49.4	0	0.0	4
PM_{10}	133	80.8	2	1.1	0	0.0	3	1.6	1	0.5	12	7.0	5	2.9			10	6.1	0	0.1	164
HG			0	0.0					0.002	27.5	0	59.7	0.00	12.8							0
PB			0	0.0					0.01	46.8	0	26.3	0.0	27.0							0.0
Methane									184	76.5	0.17	0.1	4	1.6			52	21.8			240

Notes

[1]Other includes LULUCF and agricultural combustion.
[2]The emissions factors no longer have values for benzene under warm running conditions.
The emissions are given in tonnes per year (t/yr)
The sum of the rows may not equal the total due to rounding.

Figure 4.7 SO_2 Emissions in Bolton

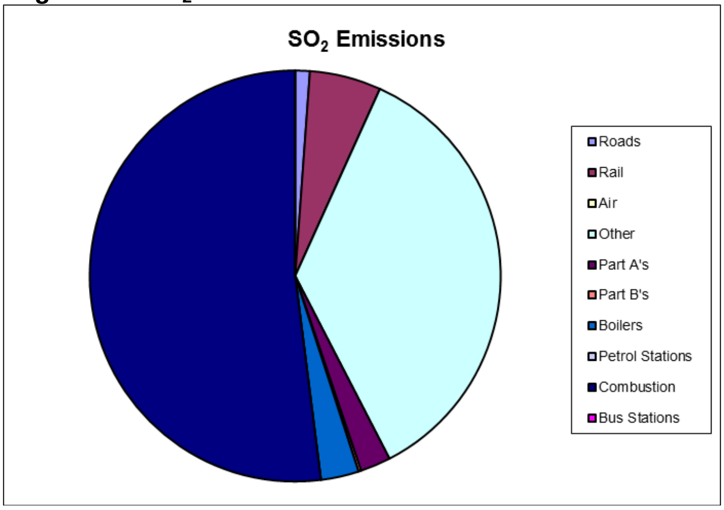


Figure 4.8 NO_X Emissions in Bolton

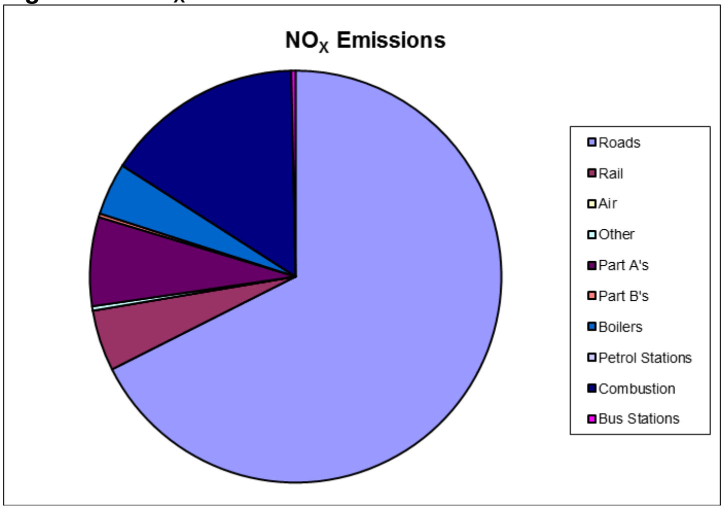


Figure 4.9 CO Emissions in Bolton

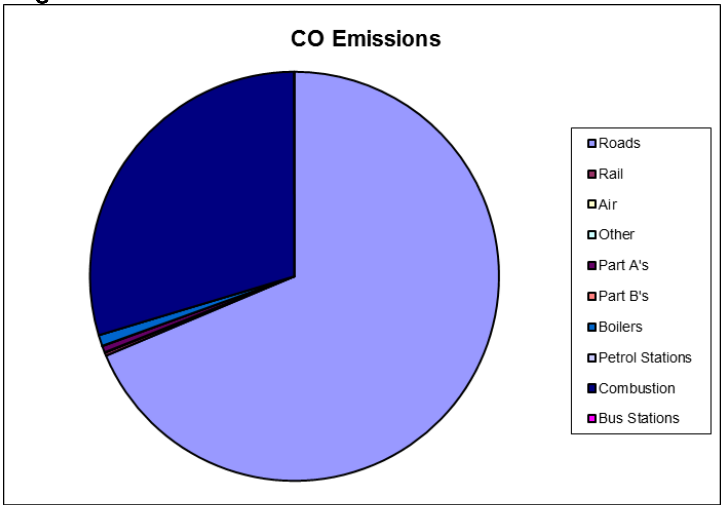


Figure 4.10 VOCs Emissions in Bolton

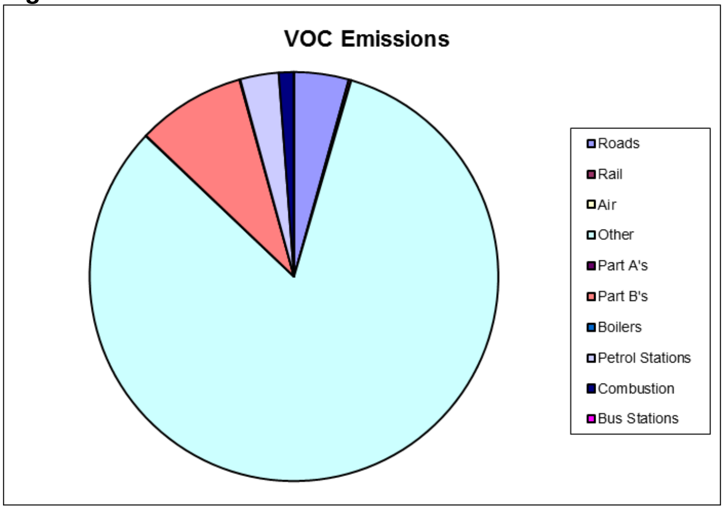


Figure 4.11 CO_2 Emissions in Bolton

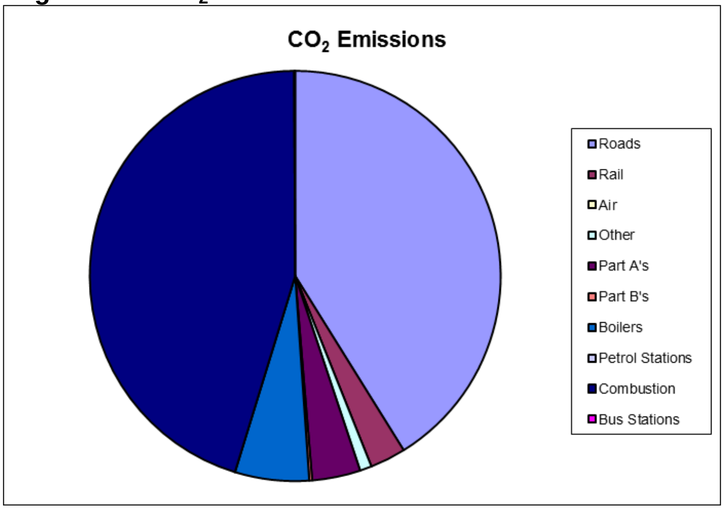


Figure 4.12 PM_{10} Emissions in Bolton

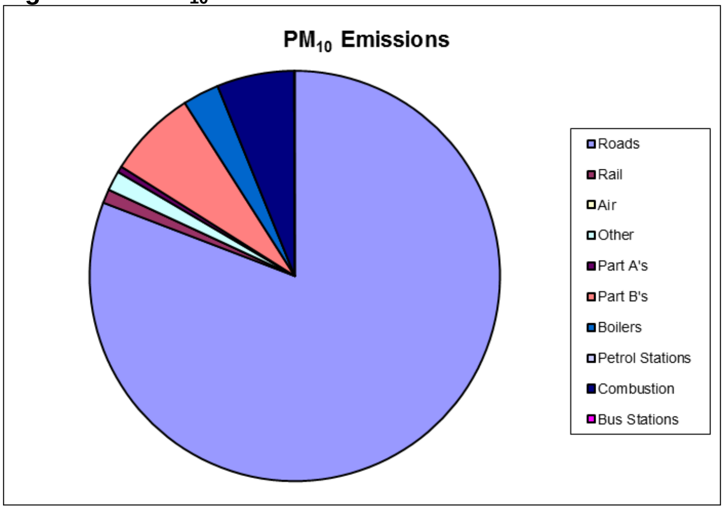


Table 4.23

2014 Total Emissions in Bury from all sources																					
Pollutant	**Roads[2]**		**Rail**		**Air**		**Other[1]**		**Part A's**		**Part B's**		**Boilers**		**Petrol Stations**		**Combustion**		**Bus Stations**		**Total**
	t/yr	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**
VOCs	93	4.7	0	0.0	0	0.0	1552	77.5	2	0.1	287	14.3	0	0.0	47	2.3	20	1.0	0	0.0	2001
CO	1264	70.0	0	0.0	0	0.0	1	0.0	136	7.5	13	0.7	0	0.0			390	21.6	0	0.0	1805
CO_2 as C	82925	36.5	0	0.0			987	0.4	68602	30.2	0	0.0	0	0.0			74404	32.8	152	0.1	227071
NO_X	788	75.9	0	0.0	0	0.0	4	0.4	12	1.1	77	7.4	0	0.0			154	14.8	4	0.4	1038
SO_2	1	1.6	0	0.0	0	0.0	34	37.7	5	5.0	11	11.6	0	0.0			40	44.1	0	0.0	91
Benzene	0.01	0.5	0	0.0	0	0.0	1	46.4	0.0	0.0	0.0	0.0	0	0.0	0.1	2.4	1	50.7	0	0.0	3
PM_{10}	116	69.5	0	0.0			2	1.0	0	0.0	43	25.9	0	0.0			6	3.6	0.1	0.0	167
HG			0	0.0					0	0.0	0	100.0	0.000	0.0							0.12
PB			0	0.0					0	0.0	0.00	100.0	0.000	0.0							0.00
Methane									0	0.0	0.00	0.0	0	0.0			34	100.0			34

Notes

[1]Other includes LULUCF and agricultural combustion.
[2]The emissions factors no longer have values for benzene under warm running conditions.
The emissions are given in tonnes per year (t/yr)
The sum of the rows may not equal the total due to rounding.

Figure 4.13 SO_2 Emissions in Bury

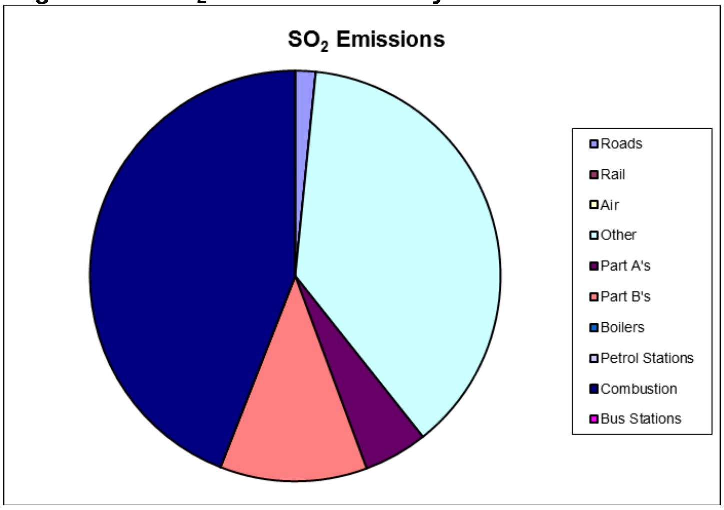


Figure 4.14 NO_X Emissions in Bury

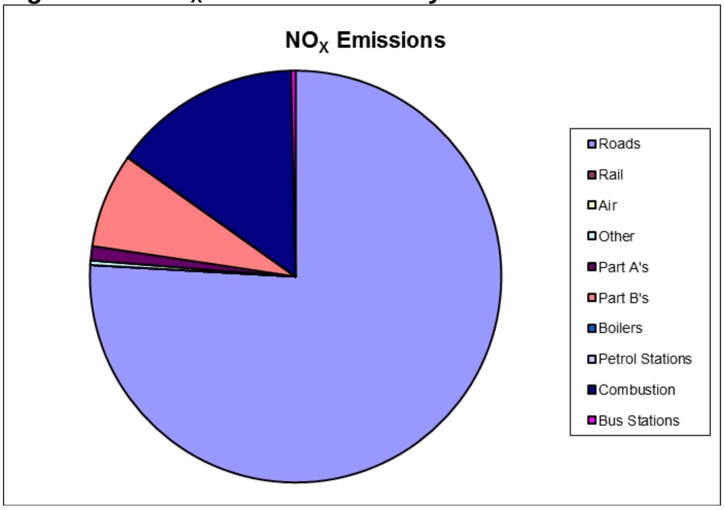


Figure 4.15 CO Emissions in Bury

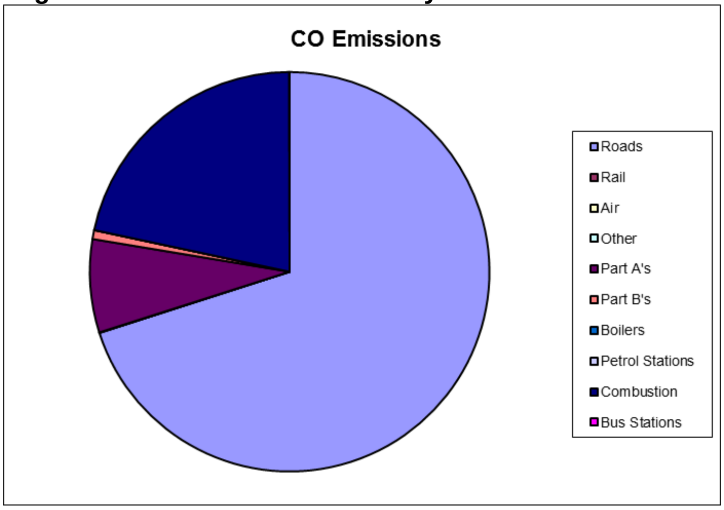


Figure 4.16 VOCs Emissions in Bury

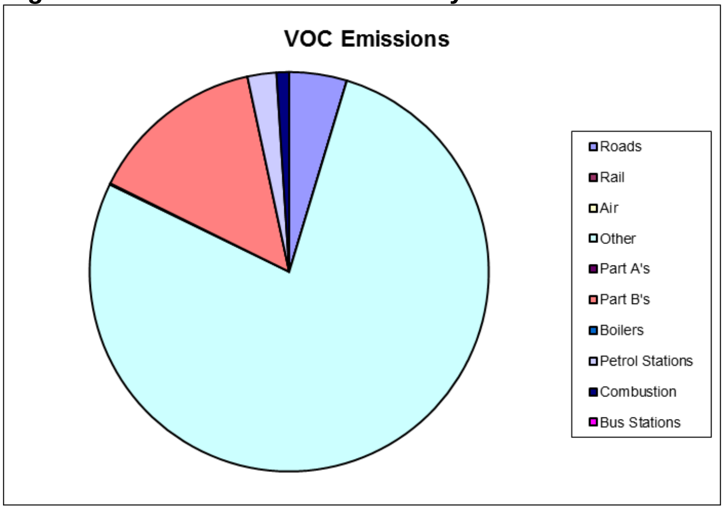


Figure 4.17 CO_2 Emissions in Bury

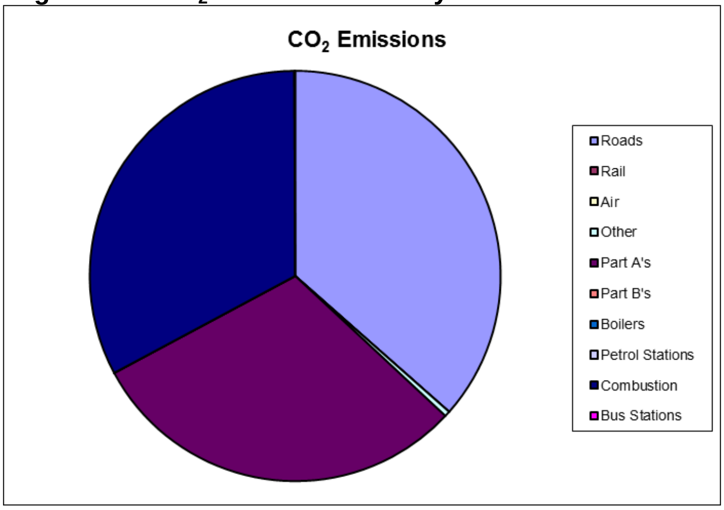


Figure 4.18 PM_{10} Emissions in Bury

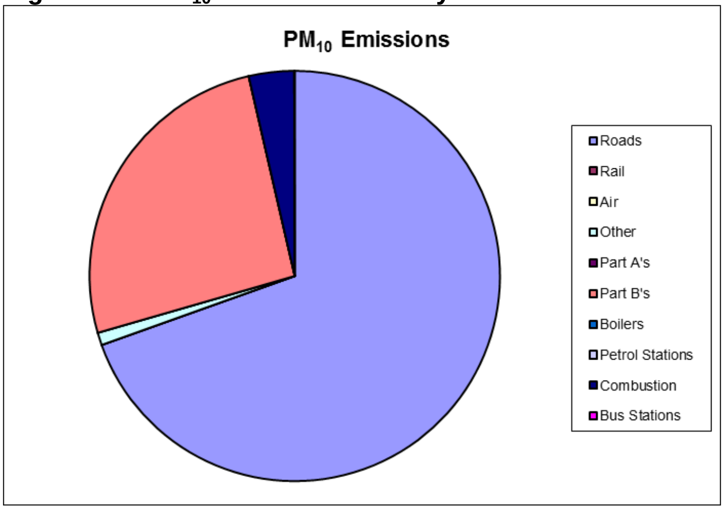


Table 4.24

2014 Total Emissions in Manchester from all sources																					
Pollutant	**Roads**[2]		**Rail**		**Air**		**Other**[1]		**Part A's**		**Part B's**		**Boilers**		**Petrol Stations**		**Combustion**		**Bus Stations**		**Total**
	t/yr	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**
VOCs	198	3.9	23	0.4	117	2.3	4190	82.4	0	0.0	412	8.1	5	0.1	106	2.1	36	0.7	0	0.0	5086
CO	2530	64.0	25	0.6	798	20.2	1	0.0	0	0.0	4	0.1	23	0.6			567	14.4	2	0.0	3951
CO_2 as C	132693	35.0	23845	6.3	27886	7.3	720	0.2	0	0.0	1279	0.3	29638	7.8			162835	42.9	552	0.1	379448
NO_X	1394	54.8	235	9.2	414	16.3	1	0.0	0	0.0	5	0.2	113	4.4			368	14.5	13	0.5	2544
SO_2	2	1.3	30	18.6	19	11.5	40	24.8	0.0	0.0	19	11.8	0	0.0			52	32.0	0	0.0	161
Benzene	0.03	0.6	0	0.0	0	0.0	2	38.5	0	0.0	0	0.2	0	7.8	0.2	2.8	3	50.1	0	0.0	5
PM_{10}	186	81.3	7	3.1	5	2.3	5	2.1	0	0.0	13	5.8	2	0.8			10	4.5	0.3	0.1	229
HG			0	0.0					0	0.0	0.00	100.0	0.000	0.0							0.00
PB			0	0.0					0	0.0	0.0	100.0	0.00	0.0							0.0
Methane									0	0.0	0.2	0.3	10	13.0			64	86.7			74

Notes

[1]Other includes LULUCF and agricultural combustion.
[2]The emissions factors no longer have values for benzene under warm running conditions.
The emissions are given in tonnes per year (t/yr)
The sum of the rows may not equal the total due to rounding.

Figure 4.19 SO_2 Emissions in Manchester

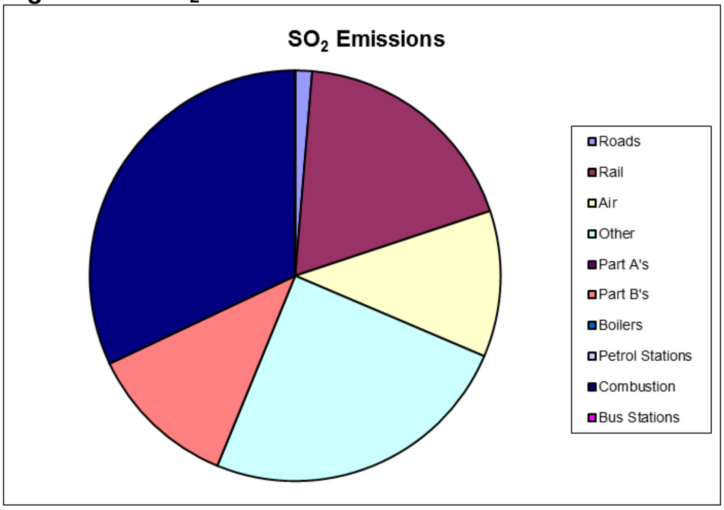


Figure 4.20 NO_X Emissions in Manchester

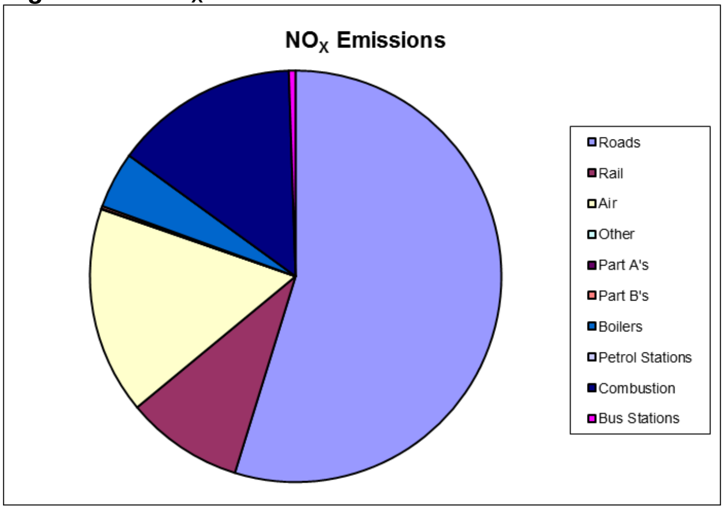


Figure 4.21 CO Emissions in Manchester

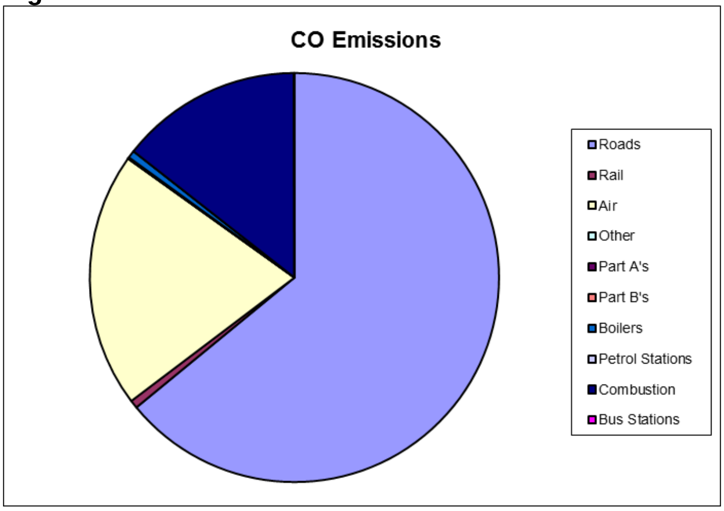


Figure 4.22 VOCs Emissions in Manchester

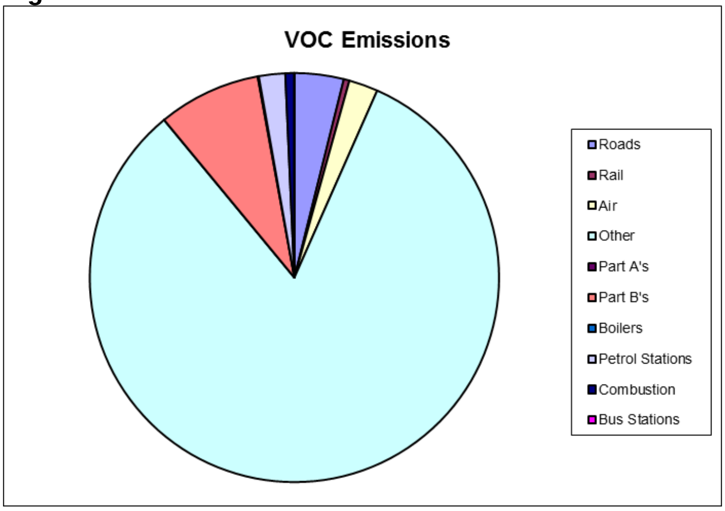


Figure 4.23 CO_2 Emissions in Manchester

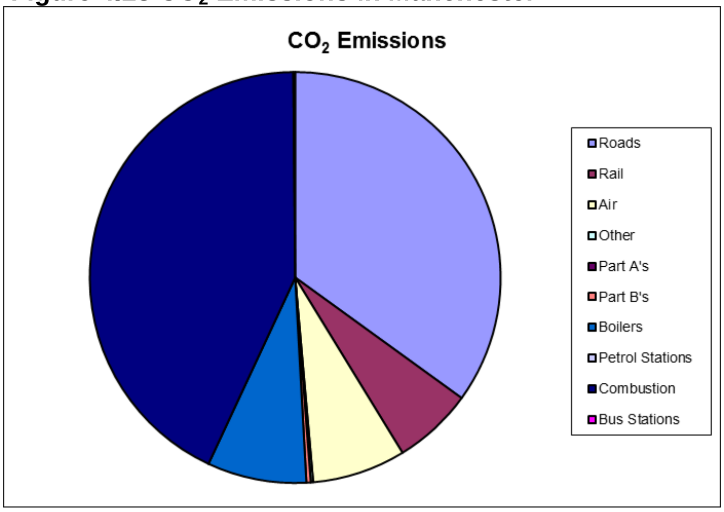


Figure 4.24 PM_{10} Emissions in Manchester

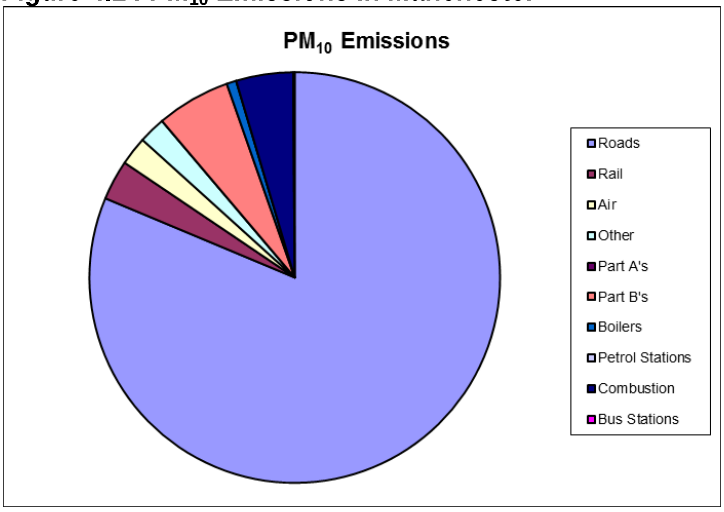


Table 4.25

2014 Total Emissions in Oldham from all sources																					
Pollutant	**Roads[2]**		**Rail**		**Air**		**Other[1]**		**Part A's**		**Part B's**		**Boilers**		**Petrol Stations**		**Combustion**		**Bus Stations**		**Total**
	t/yr	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**
VOCs	86	4.1	6	0.3	0	0.0	1897	89.7	0	0.0	44	2.1	1	0.0	59	2.8	22	1.0	0	0.0	2114
CO	1133	71.0	6	0.4	0	0.0	1	0.1	0	0.0	9	0.6	5	0.3			442	27.7	0	0.0	1596
CO_2 as C	54994	37.5	5991	4.1			1519	1.0	0	0.0	1369	0.9	6671	4.5			76020	51.8	154	0.1	146718
NO_X	563	69.1	60	7.4	0	0.0	3	0.4	0	0.0	12	1.5	24	3.0			148	18.1	4	0.5	815
SO_2	1	0.8	8	6.5	0	0.0	48	41.6	0.0	0.0	7	6.0	5	4.1			48	41.0	0	0.0	116
Benzene	0.01	0.5	0	0.0	0	0.0	1	44.1	0.00	0.0	0	0.4	0.1	2.1	0.1	2.9	2	50.1	0	0.0	3
PM_{10}	79	85.9	1.9	2.1	0	0.0	2	2.4	0	0.0	2	1.6	1	0.9			6	7.0	0.1	0.1	92
HG			0	0.0					0	0.0	0.00	98.9	0.000	1.1							0.00
PB			0	0.0					0	0.0	0.1	98.5	0.00	1.5							0.1
Methane									0	0.0	0.12	0.3	3	6.5			36	93.2			39

Notes

[1]Other includes LULUCF and agricultural combustion.
[2]The emissions factors no longer have values for benzene under warm running conditions.
The emissions are given in tonnes per year (t/yr)
The sum of the rows may not equal the total due to rounding.

Figure 4.25 SO_2 Emissions in Oldham

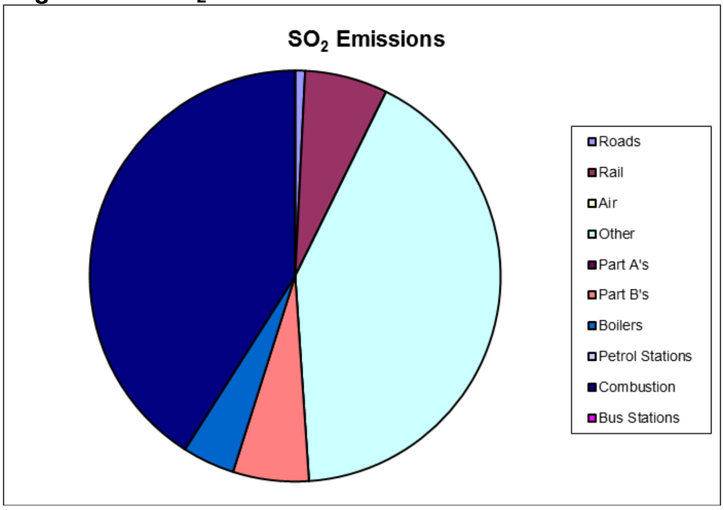


Figure 4.26 NO_X Emissions in Oldham

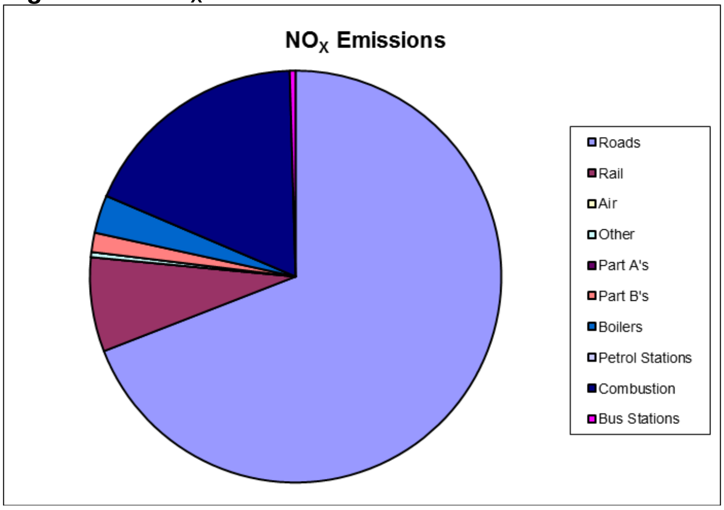


Figure 4.27 CO Emissions in Oldham

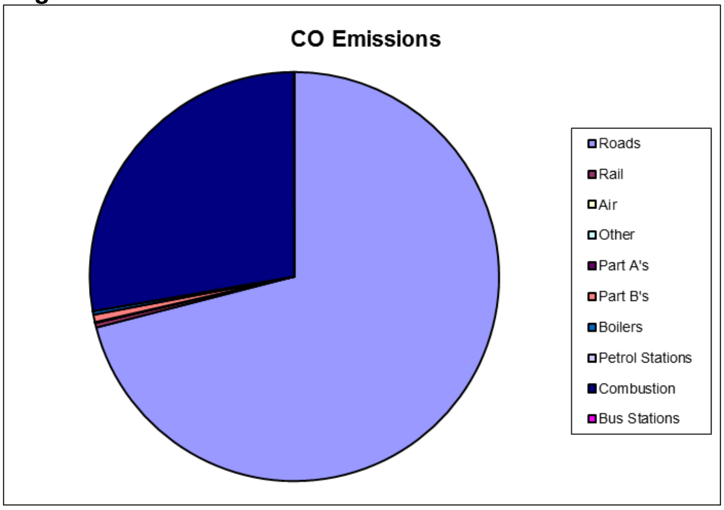


Figure 4.28 VOCs Emissions in Oldham

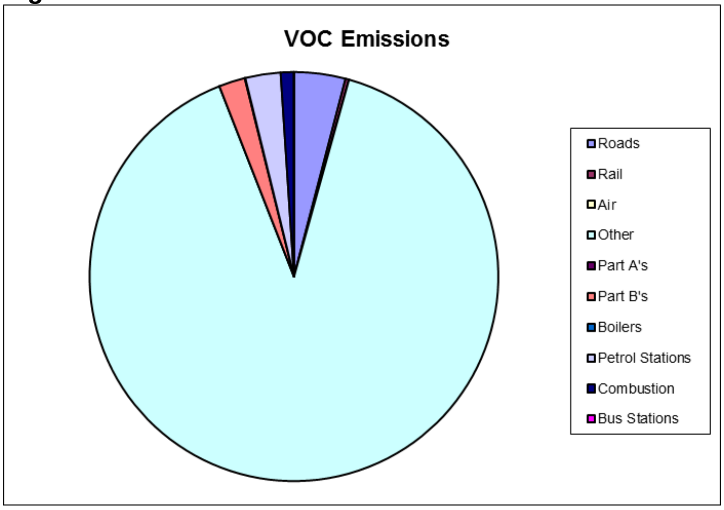


Figure 4.29 CO_2 Emissions in Oldham

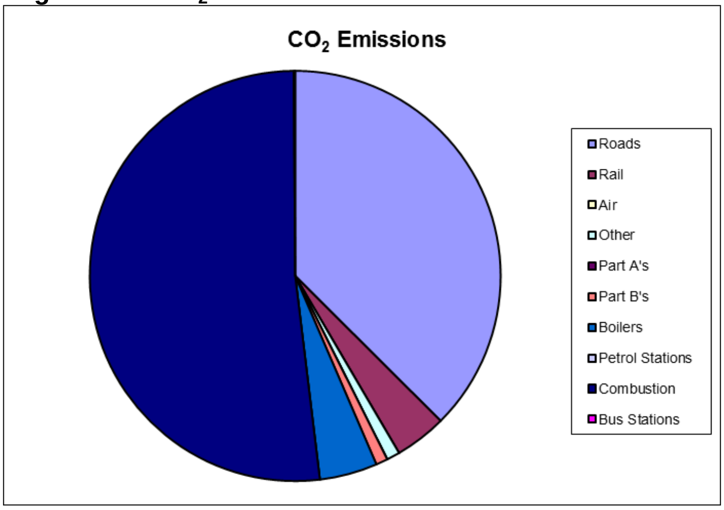


Figure 4.30 PM_{10} Emissions in Oldham

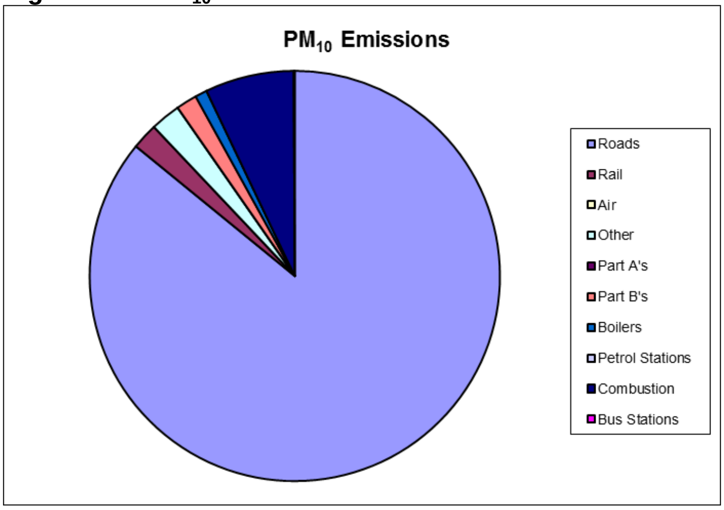


Table 4.26

2014 Total Emissions in Rochdale from all sources

Pollutant	Roads[2]		Rail		Air		Other[1]		Part A's		Part B's		Boilers		Petrol Stations		Combustion		Bus Stations		Total
	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr
VOCs	104	3.8	5	0.2	0	0.0	1944	70.6	10	0.4	608	22.1	0	0.0	55	2.0	27	1.0	0	0.0	2753
CO	1374	70.4	5	0.3	0	0.0	1	0.1	0	0.0	9	0.5	2	0.1			558	28.6	1	0.0	1950
CO_2 as C	97275	51.2	5685	3.0			1835	1.0	1000	0.5	758	0.4	2115	1.1			80959	42.6	203	0.1	189830
NO_X	943	76.3	57	4.6	0	0.0	2	0.1	0	0.0	47	3.8	8	0.7			174	14.1	5	0.4	1235
SO_2	2	1.4	7	5.5	0	0.0	55	42.2	0	0.2	6	4.6	0	0.0			60	46.1	0	0.0	130
Benzene	0.02	0.4	0	0.0	0	0.0	2	49.8	0.0	0.0	0	0.3	0.0	0.8	0.1	2.1	2	46.5	0	0.0	4
PM_{10}	132	88.4	2	1.1	0	0.0	2	1.4	0	0.0	5	3.5	0	0.1			8	5.4	0.1	0.1	150
HG			0	0.0					0	0.0	0.07	100.0	0.000	0.0							0.07
PB			0	0.0					0.00	0.0	0.0	97.1	0.00	2.9							0.0
Methane									0	0.0	0.24	0.6	1	1.6			42	97.9			43

Notes

[1]Other includes LULUCF and agricultural combustion.
[2]The emissions factors no longer have values for benzene under warm running conditions.
The emissions are given in tonnes per year (t/yr)
The sum of the rows may not equal the total due to rounding.

Figure 4.31 SO_2 Emissions in Rochdale

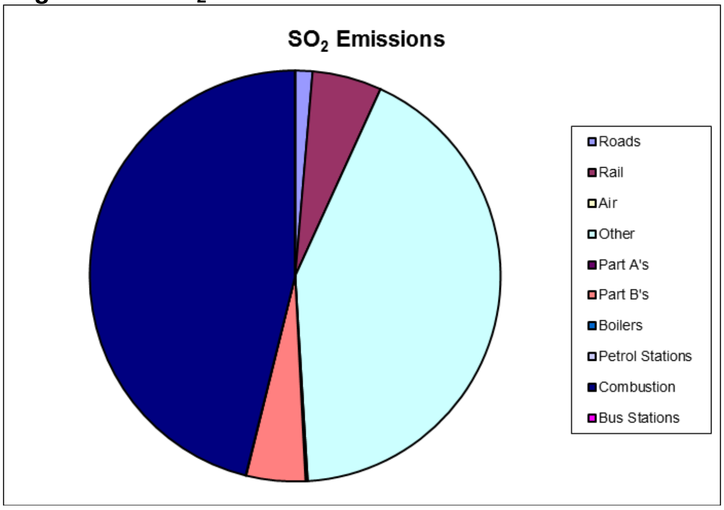


Figure 4.32 NO_X Emissions in Rochdale

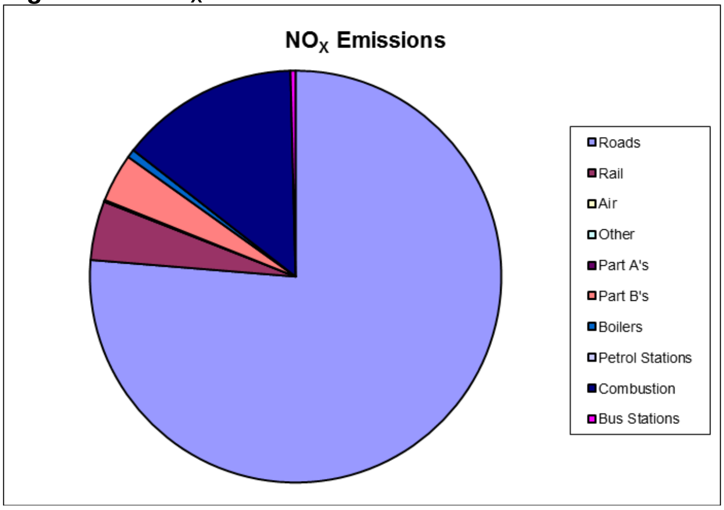


Figure 4.33 CO Emissions in Rochdale

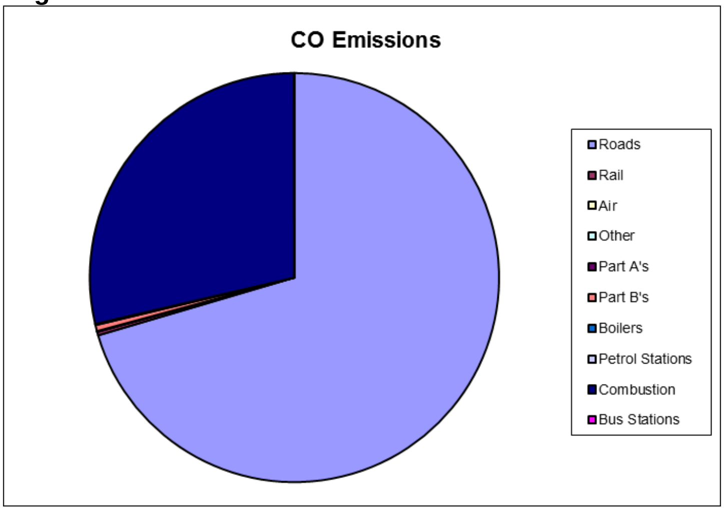


Figure 4.34 VOCs Emissions in Rochdale

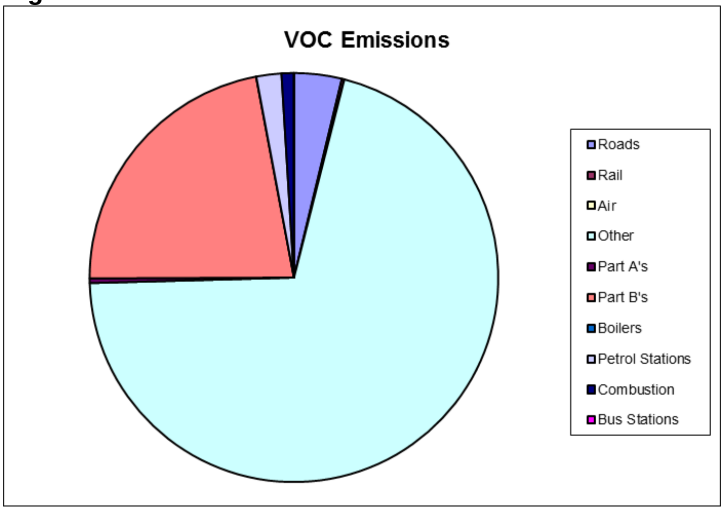


Figure 4.35 CO_2 Emissions in Rochdale

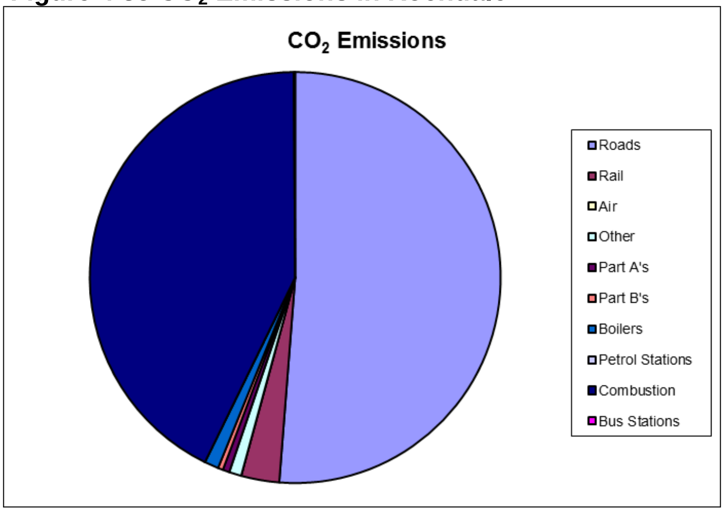


Figure 4.36 PM_{10} Emissions in Rochdale

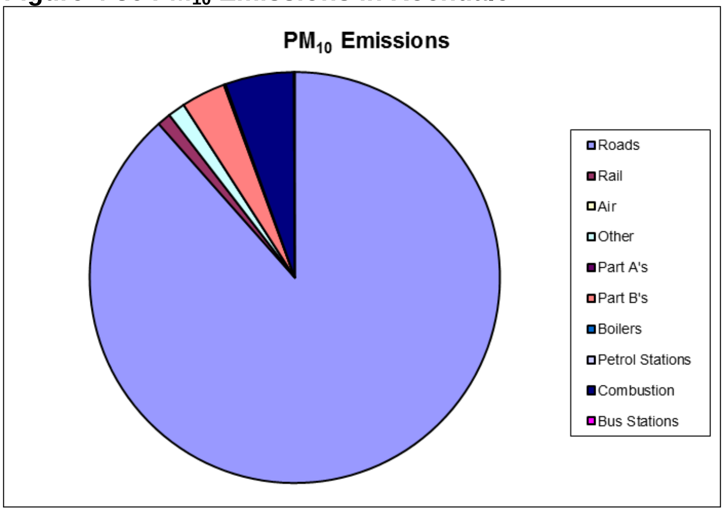


Table 4.27

2014 Total Emissions in Salford from all sources

Pollutant	Roads[2]		Rail		Air		Other[1]		Part A's		Part B's		Boilers		Petrol Stations		Combustion		Bus Stations		Total
	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr
VOCs	135	3.9	15	0.4	2	0.1	1905	54.5	61	1.7	1289	36.9	1	0.0	58	1.6	28	0.8	0	0.0	3494
CO	1736	71.4	21	0.8	71	2.9	1	0.0	1	0.0	0	0.0	5	0.2			597	24.5	1	0.0	2432
CO_2 as C	123612	51.8	15354	6.4			10029	4.2	797	0.3	195	0.1	6803	2.9			81636	34.2	192	0.1	238618
NO_X	1209	76.7	155	9.8	1	0.0	2	0.2	1	0.1	2	0.1	26	1.7			176	11.2	5	0.3	1577
SO_2	2	1.9	19	16.9	0	0.0	34	29.6	0	0.0	0	0.2	0	0.0			59	51.5	0	0.0	114
Benzene	0.02	0.4	0	0.0	0	0.0	2	51.6	0.0	0.3	0.00	0.1	0	2.4	0.1	2.0	2	43.3	0	0.0	4
PM_{10}	168	89.4	5	2.5	0	0.0	2	1.2	3	1.4	1	0.6	0	0.2			9	4.6	0	0.1	188
HG			0	0.0					0.000	0.0	0.00	100.0	0	0.0							0.00
PB			0	0.0					0.00	0.0	0.0003	98.6	0.00000	1.4							0.00
Methane									4	7.7	0	0.1	2	4.4			44	87.8			50

Notes

[1]Other includes LULUCF and agricultural combustion.

[2]The emissions factors no longer have values for benzene under warm running conditions.

The emissions are given in tonnes per year (t/yr)

The sum of the rows may not equal the total due to rounding.

Figure 4.37 SO_2 Emissions in Salford

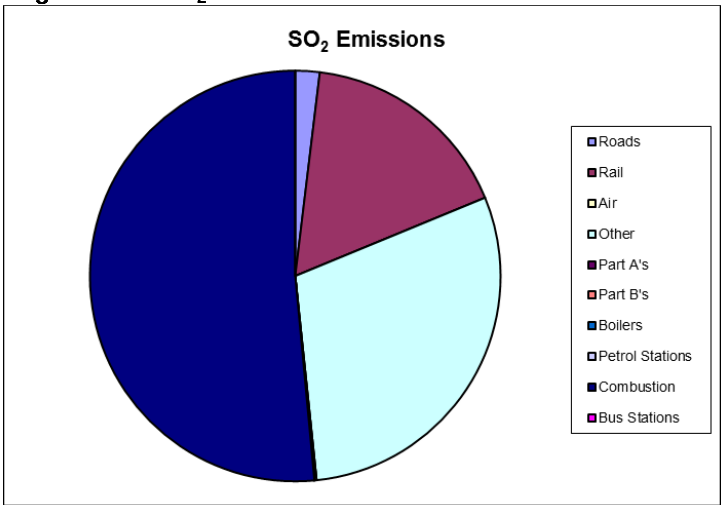


Figure 4.38 NO_X Emissions in Salford

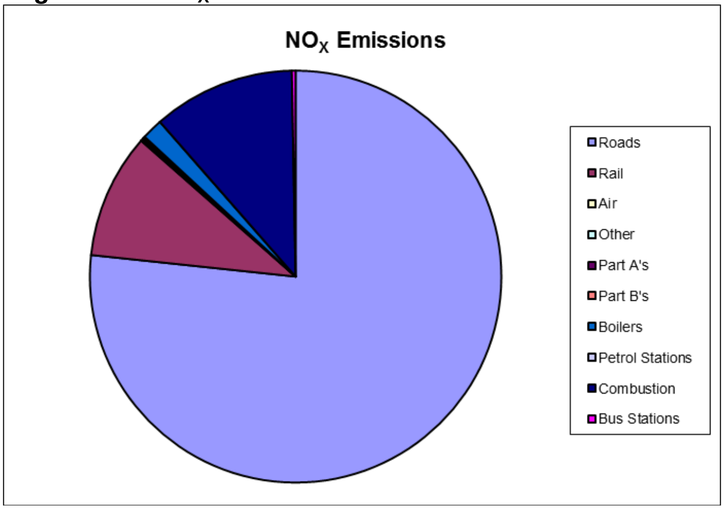


Figure 4.39 CO Emissions in Salford

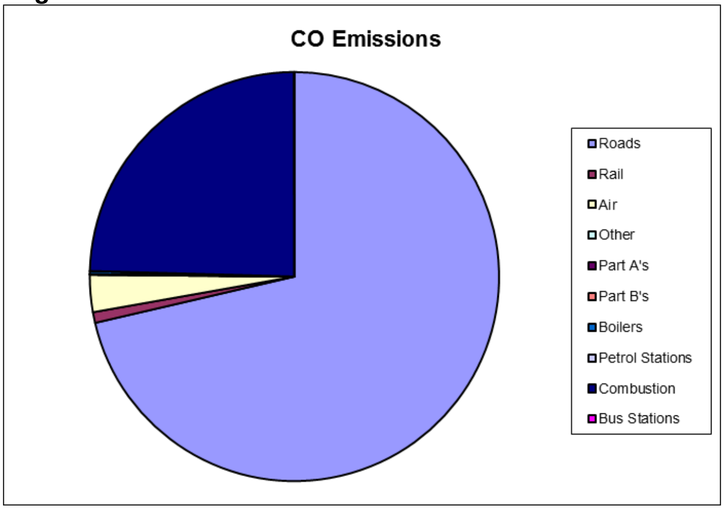


Figure 4.40 VOCs Emissions in Salford

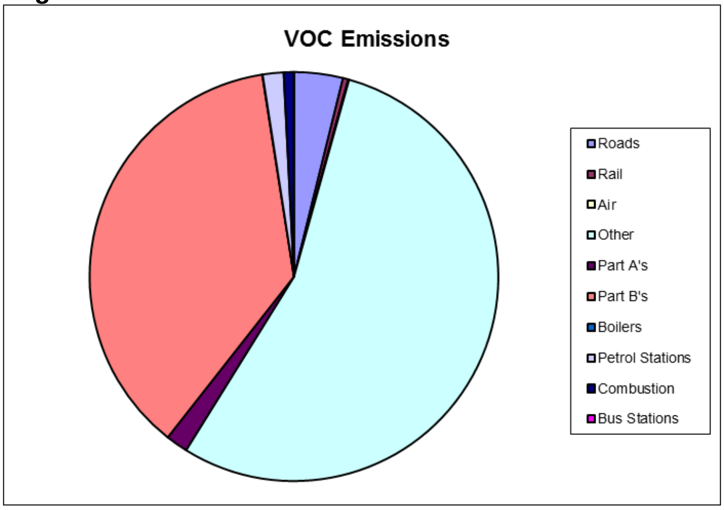


Figure 4.41 CO_2 Emissions in Salford

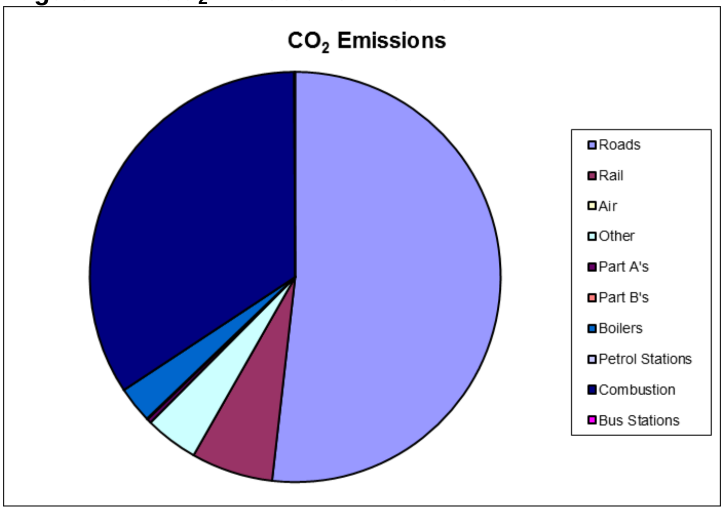


Figure 4.42 PM_{10} Emissions in Salford

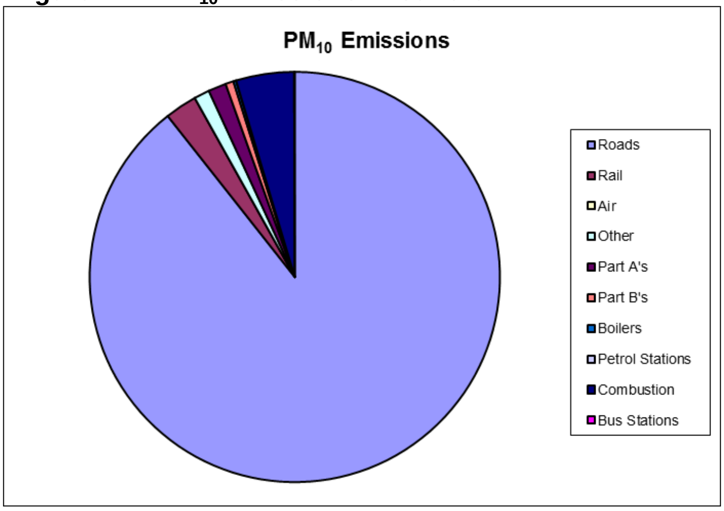


Table 4.28

2014 Total Emissions in Stockport from all sources

Pollutant	Roads[2]		Rail		Air		Other[1]		Part A's		Part B's		Boilers		Petrol Stations		Combustion		Bus Stations		Total
	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr
VOCs	134	3.1	17	0.4	0	0.0	2318	54.4	0	0.0	1689	39.7	1	0.0	72	1.7	27	0.6	0	0.0	4258
CO	1782	76.9	23	1.0	0	0.0	1	0.0	0	0.0	0	0.0	7	0.3			503	21.7	0	0.0	2318
CO_2 as C	90626	39.5	18749	8.2			854	0.4	0	0.0	0	0.0	9209	4.0			109587	47.8	156	0.1	229182
NO_X	891	67.2	180	13.6	0	0.0	3	0.2	0	0.0	2	0.1	35	2.7			211	15.9	4	0.3	1326
SO_2	2	1.3	23	19.2	0	0.0	44	36.1	0	0.0	0	0.2	0	0.0			52	43.2	0	0.0	121
Benzene	0.02	0.5	0	0.0	0	0.0	2	42.0	0	0.0	0	0.8	0.1	3.4	0.1	2.7	2	50.6	0	0.0	4
PM_{10}	131	65.5	5	2.6	0	0.0	3	1.4	0	0.0	53	26.4	1	0.3			8	3.8	0.1	0.0	200
HG			0	0.0					0	0.0	0.00	100.0	0	0.0							0.00
PB			0	0.0					0	0.0	0.0001	100.0	0	0.0							0.0001
Methane									0	0.0	0.00	0.0	3	6.0			47	94.0			50

Notes

[1]Other includes LULUCF and agricultural combustion.
[2]The emissions factors no longer have values for benzene under warm running conditions.
The emissions are given in tonnes per year (t/yr)
The sum of the rows may not equal the total due to rounding.

Figure 4.43 SO_2 Emissions in Stockport

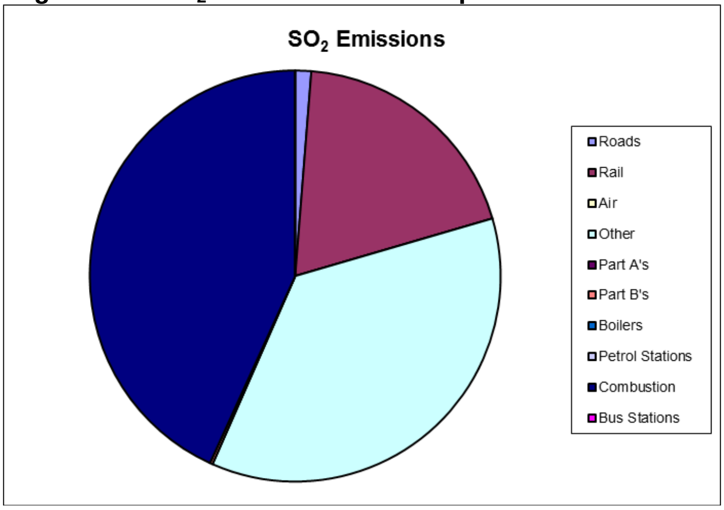


Figure 4.44 NO_X Emissions in Stockport

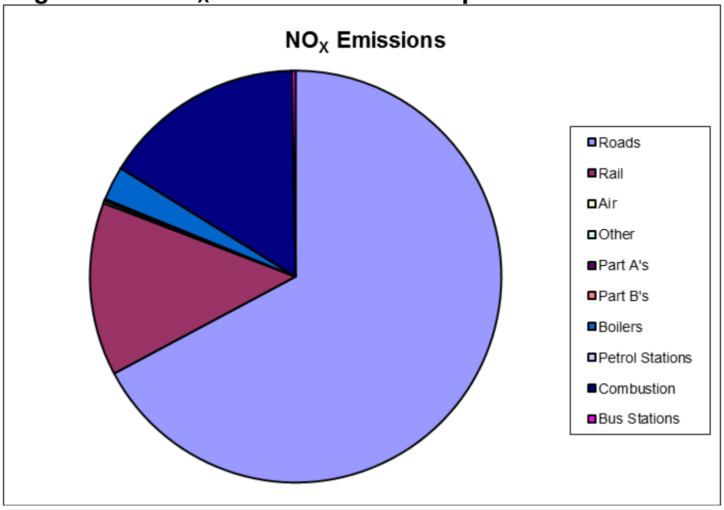


Figure 4.45 CO Emissions in Stockport

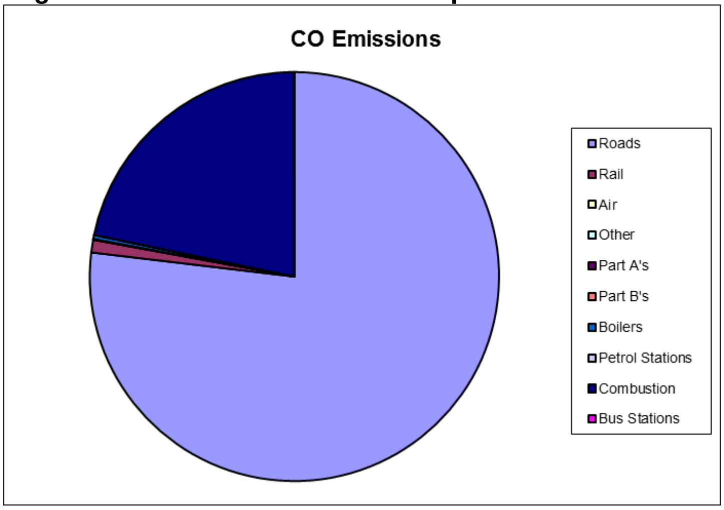


Figure 4.46 VOCs Emissions in Stockport

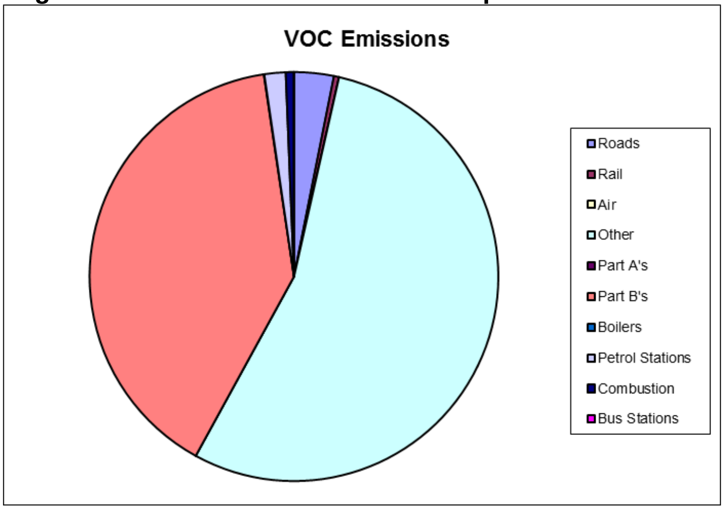


Figure 4.47 CO_2 Emissions in Stockport

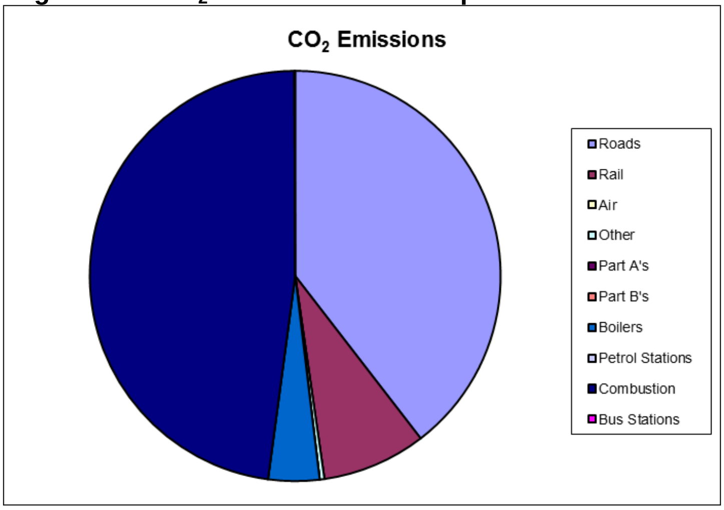


Figure 4.48 PM_{10} Emissions in Stockport

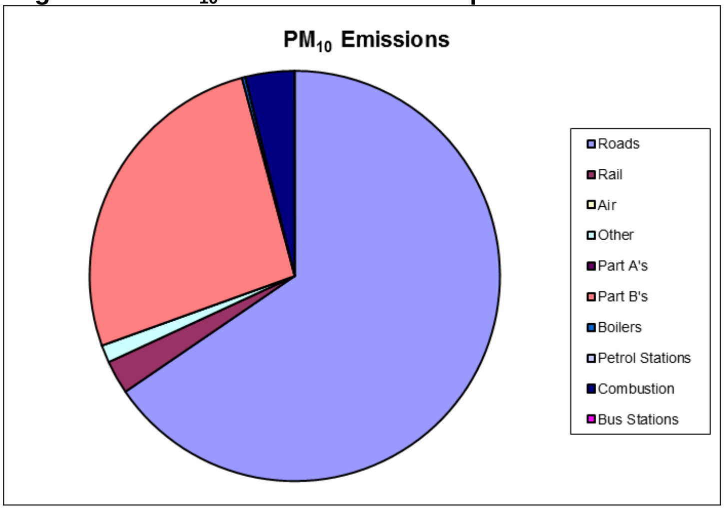


Table 4.29

2014 Total Emissions in Tameside from all sources																							
Pollutant	**Roads[2]**		**Rail**		**Air**		**Other[1]**		**Part A's**		**Part B's**		**Boilers**		**Petrol Stations**		**Combustion**		**Bus Stations**		**Total**
	t/yr	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**	**%**	**t/yr**
VOCs	85	4.2	10	0.5	0	0.0	1778	88.9	5	0.3	32	1.6	1	0.0	64	3.2	24	1.2	0	0.0	2000
CO	1142	69.2	10	0.6	0	0.0	1	0.0	0	0.0	0	0.0	5	0.3			491	29.8	1	0.0	1649
CO_2 as C	60322	37.9	10809	6.8			1074	0.7	0	0.0	0	0.0	5784	3.6			81080	50.9	221	0.1	159291
NO_X	616	64.6	105	11.0	0	0.0	3	0.3	0	0.0	31	3.2	26	2.7			168	17.6	5	0.6	953
SO_2	1	0.6	13	7.9	0	0.0	36	21.0	0	0.0	58	34.5	14	8.2			47	27.7	0	0.0	170
Benzene	0.01	0.4	0	0.0	0	0.0	2	48.8	0	0.0	0	0.0	0.1	2.0	0.1	2.6	2	46.2	0	0.0	4
PM_{10}	86	86.2	3	3.1	0	0.0	2	2.1	0	0.0	0.5	0.5	1	0.8			7	7.3	0.1	0.1	100
HG			0	0.0					0	0.0	0.00	99.4	0.00001	0.6							0.00
PB			0	0.0					0	0.0	0.00005	9.9	0.0005	90.1							0.0006
Methane									0	0.0	0	0.0	2	4.8			39	95.2			41

Notes

[1]Other includes LULUCF and agricultural combustion.
[2]The emissions factors no longer have values for benzene under warm running conditions.
The emissions are given in tonnes per year (t/yr)
The sum of the rows may not equal the total due to rounding.

Figure 4.49 SO_2 Emissions in Tameside

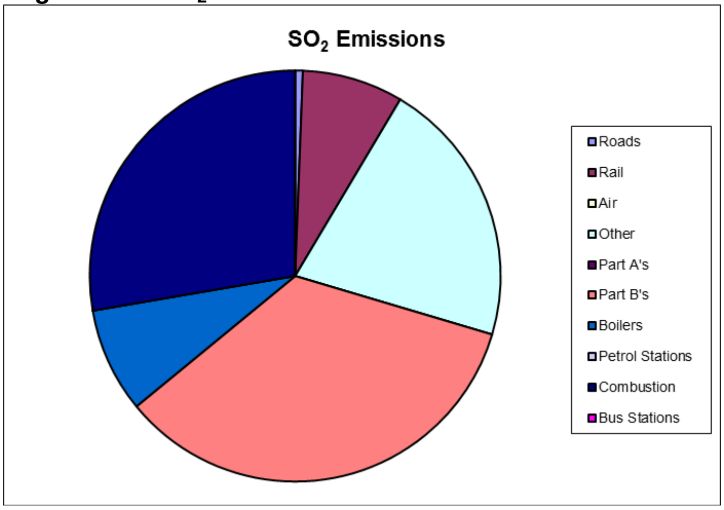


Figure 4.50 NO_X Emissions in Tameside

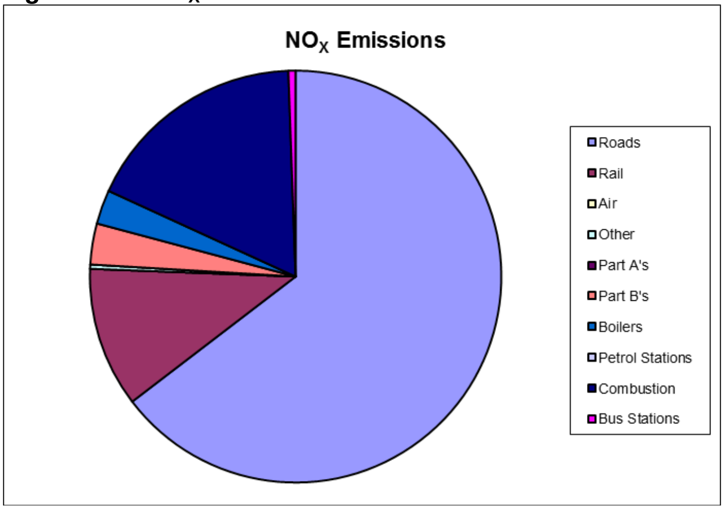


Figure 4.51 CO Emissions in Tameside

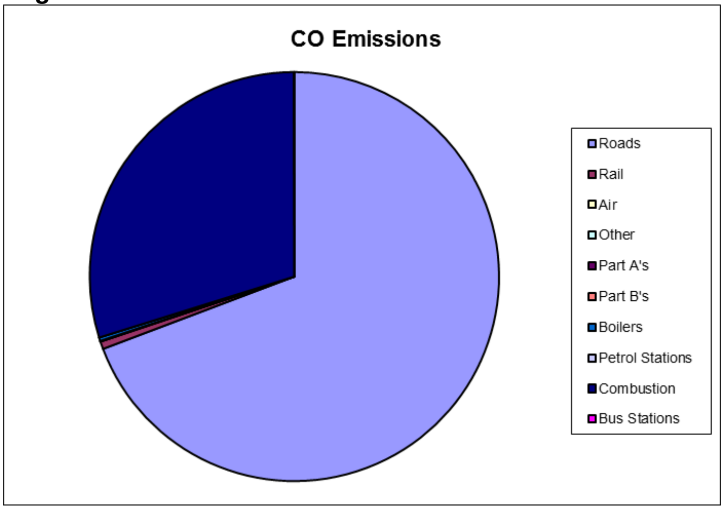


Figure 4.52 VOCs Emissions in Tameside

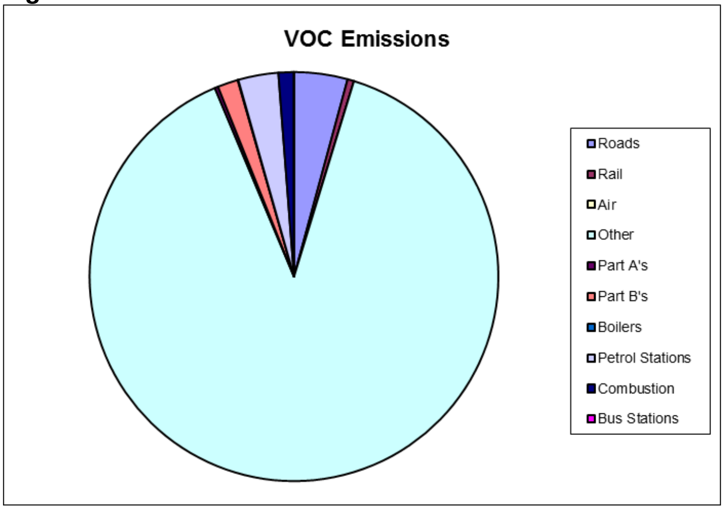


Figure 4.53 CO_2 Emissions in Tameside

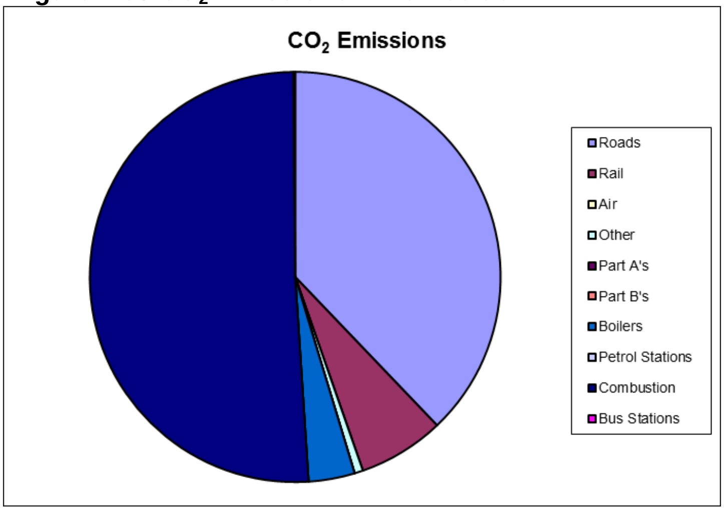


Figure 4.54 PM_{10} Emissions in Tameside

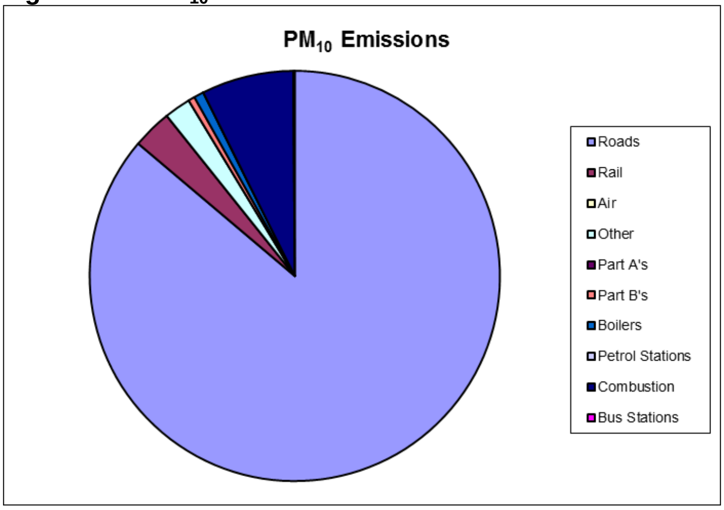


Table 4.30

2014 Total Emissions in Trafford from all sources

Pollutant	Roads[2]		Rail		Air		Other[1]		Part A's		Part B's		Boilers		Petrol Stations		Combustion		Bus Stations		Total
	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr
VOCs	103	4.1	5	0.2	1	0.0	2059	81.7	185	7.3	62	2.4	9	0.4	69	2.7	27	1.1	0	0.0	2520
CO	1448	69.3	5	0.2	16	0.8	1	0.0	1	0.0	0	0.0	226	10.8			394	18.8	0	0.0	2091
CO_2 as C	70575	8.0	5269	0.6			2322	0.3	569089	64.4	13	0.0	105713	12.0			130866	14.8	63	0.0	883909
NO_X	697	49.1	51	3.6	0	0.0	11	0.8	139	9.8	0	0.0	194	13.7			327	23.0	2	0.1	1421
SO_2	1	1.4	7	7.8	0	0.0	37	43.4	3	3.1	0	0.0	0	0.2			37	44.0	0	0.0	84
Benzene	0.02	0.4	0	0.0	0	0.0	2	39.2	0.0	0.0	0	0.0	0.6	13.4	0	2.1	2	44.9	0	0.0	5
PM_{10}	104	83.3	1.4	1.1	0	0.0	2	1.9	0	0.0	4	3.0	5	4.1			8	6.5	0	0.0	124
HG			0	0.0					0	100.0	0.00	0.0	0.00	0.0							0.00
PB			0	0.0					0	0.0	0	100.0	0.0	0.0							0.0
Methane									0	0.0	0	0.0	14	22.4			50	77.6			64

Notes

[1]Other includes LULUCF and agricultural combustion.
[2]The emissions factors no longer have values for benzene under warm running conditions.
The emissions are given in tonnes per year (t/yr)
The sum of the rows may not equal the total due to rounding.

Figure 4.55 SO_2 Emissions in Trafford

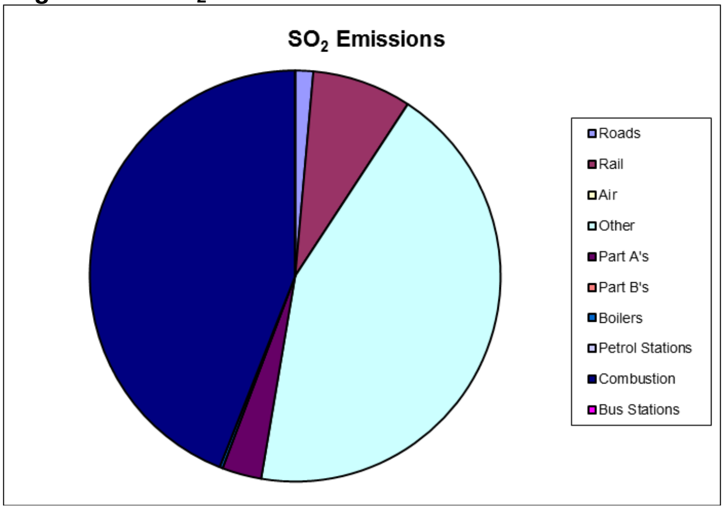


Figure 4.56 NO_X Emissions in Trafford

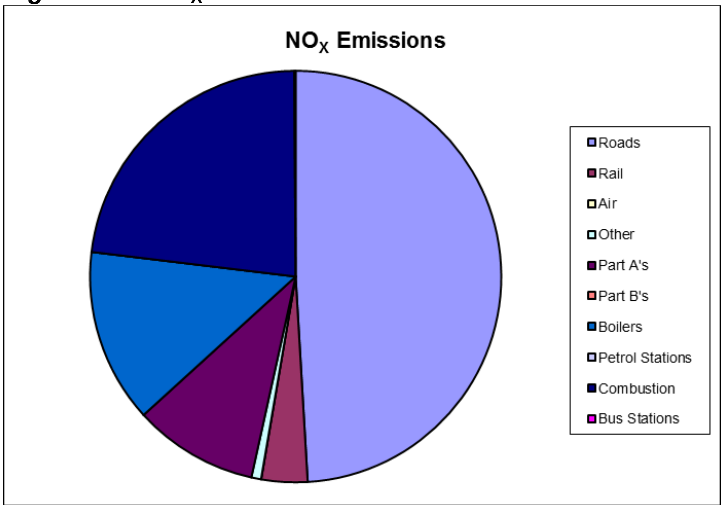


Figure 4.57 CO Emissions in Trafford

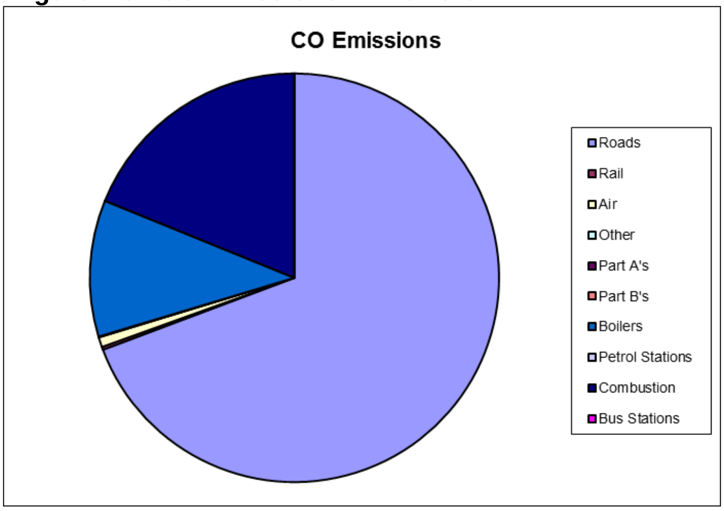


Figure 4.58 VOCs Emissions in Trafford

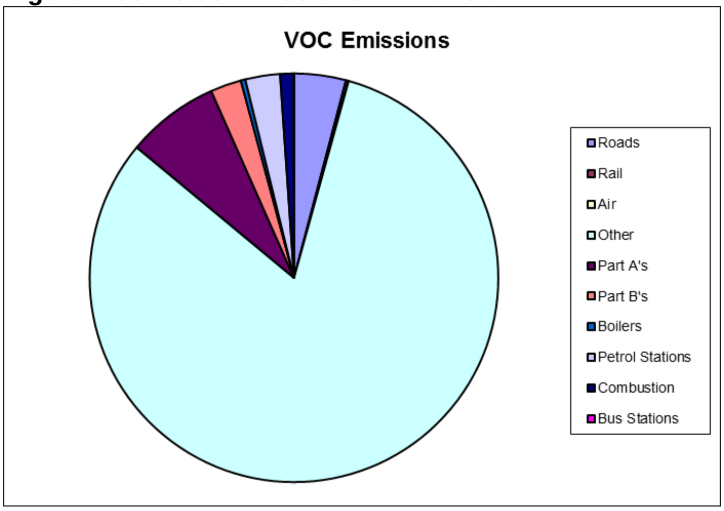


Figure 4.59 CO_2 Emissions in Trafford

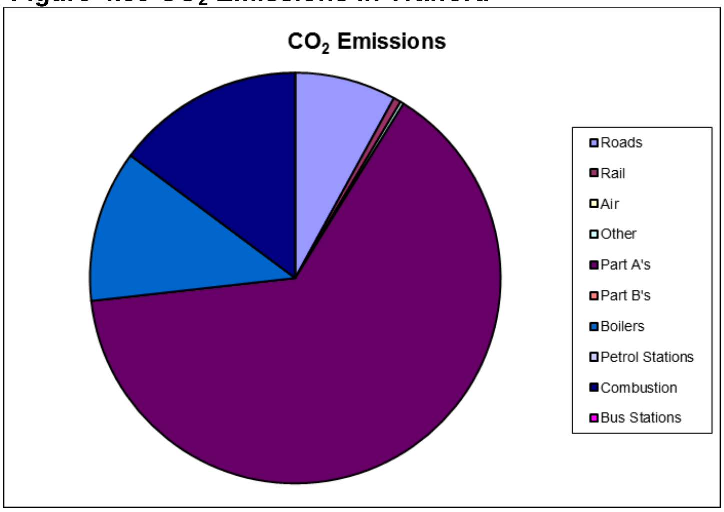


Figure 4.60 PM_{10} Emissions in Trafford

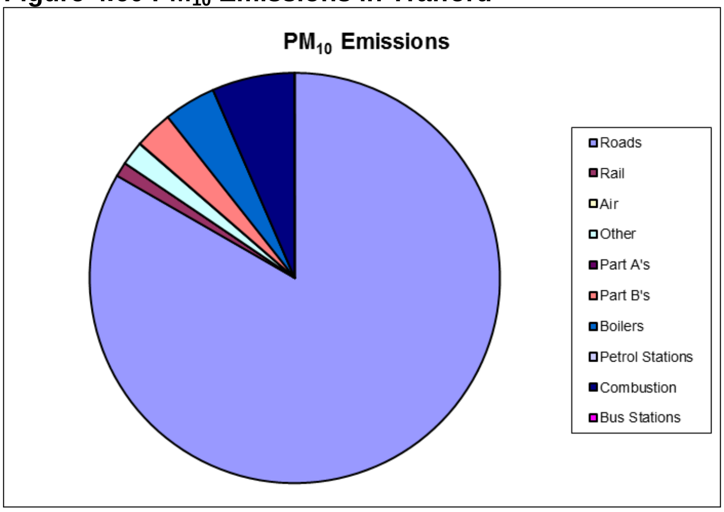


Table 4.31

2014 Total Emissions in Wigan from all sources

Pollutant	Roads[2]		Rail		Air		Other[1]		Part A's		Part B's		Boilers		Petrol Stations		Combustion		Bus Stations		Total
	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr
VOCs	134	3.5	21	0.5	0	0.0	2254	58.9	12	0.3	1201	31.4	3	0.1	109	2.9	93	2.4	0	0.0	3827
CO	1748	39.4	34	0.8	0	0.0	1	0.0	191	4.3	1	0.0	15	0.3			2442	55.1	1	0.0	4431
CO_2 as C	104279	36.9	22493	8.0			3905	1.4	12929	4.6	456	0.2	18449	6.5			119812	42.4	185	0.1	282508
NO_X	1021	59.1	193	11.2	0	0.0	2	0.1	153	8.8	4	0.2	77	4.5			273	15.8	5	0.3	1728
SO_2	2	0.4	28	6.8	0	0.0	63	15.2	50	12.0	0	0.1	26	6.2			246	59.4	0	0.0	414
Benzene	0.02	0.3	0	0.0	0	0.0	2	24.4	0.0	0.4	0.01	0.1	0	3.5	0.2	2.3	5	69.2	0	0.0	7
PM_{10}	147	72.3	7	3.6	0	0.0	3	1.3	13	6.5	1	0.3	2	0.9			31	15.1	0.1	0.0	204
HG			0	0.0					0	0.0	0.00	99.0	0.000	1.0							0.00
PB			0	0.0					0.01	90.0	0.00	3.0	0.00	7.0							0.0
Methane									160	55.0	0.1	0.1	6	2.1			124	42.8			291

Notes

[1]Other includes LULUCF and agricultural combustion.
[2]The emissions factors no longer have values for benzene under warm running conditions.
The emissions are given in tonnes per year (t/yr)
The sum of the rows may not equal the total due to rounding.

Figure 4.61 SO_2 Emissions in Wigan

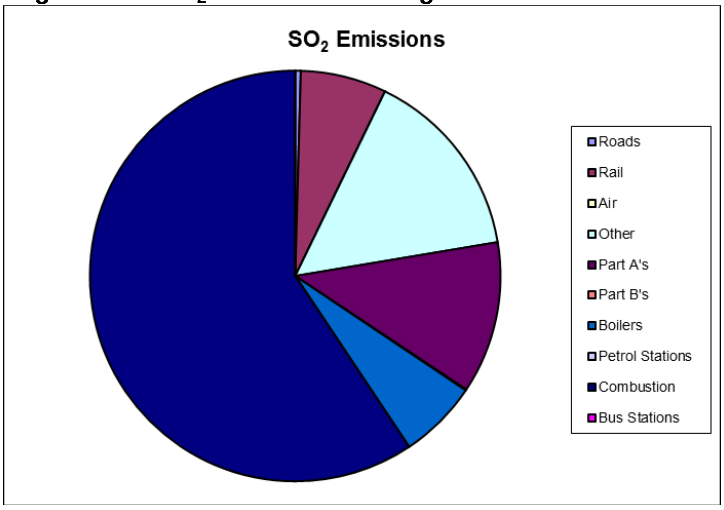


Figure 4.62 NO_X Emissions in Wigan

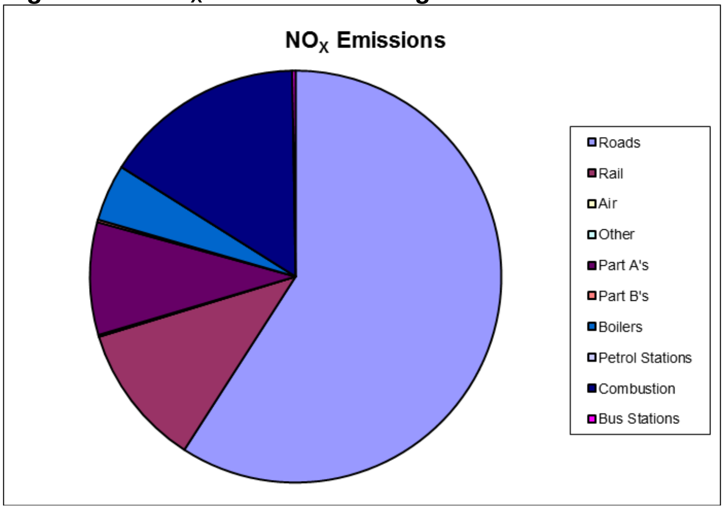


Figure 4.63 CO Emissions in Wigan

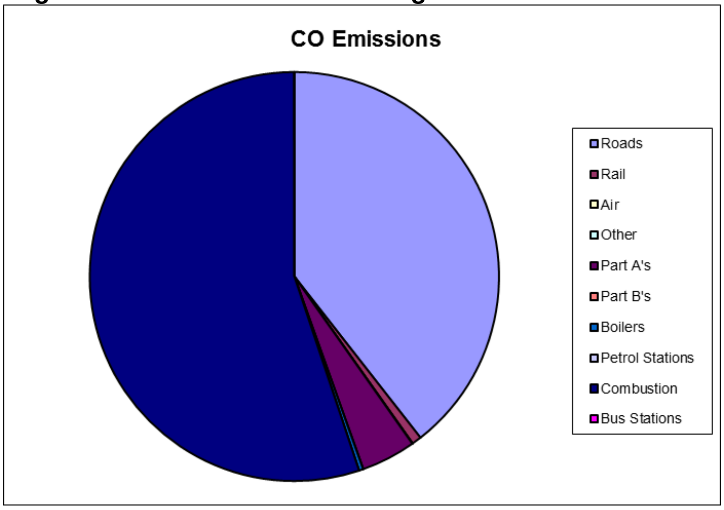


Figure 4.64 VOCs Emissions in Wigan

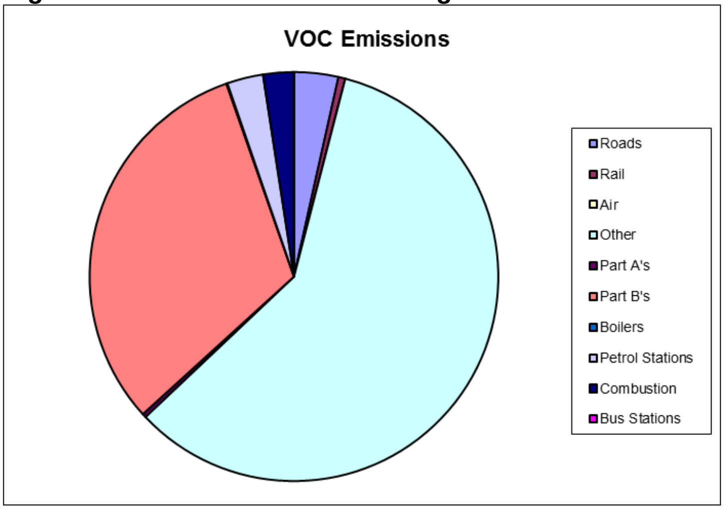


Figure 4.65 CO_2 Emissions in Wigan

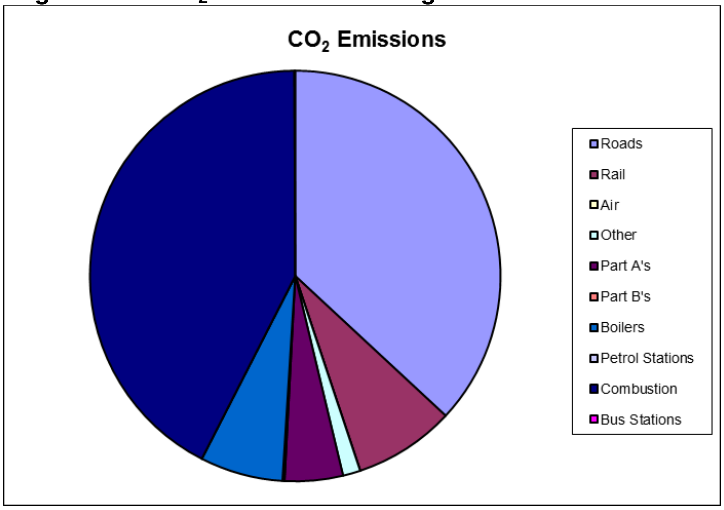
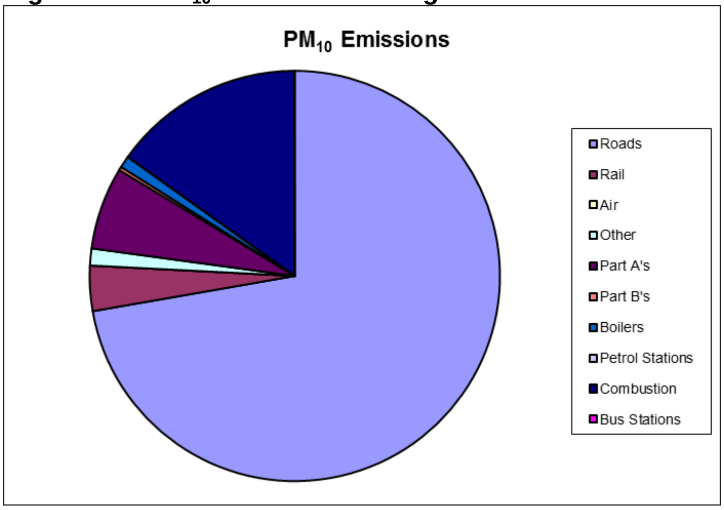


Figure 4.66 PM_{10} Emissions in Wigan



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Appendices

Appendix 1 Maps of emissions from all sources

The following figures show maps of emissions from all sources, road transport and electricity generation at point of use.

Figure A1.1 Total emissions of NO_X in 2014

Figure A1.2 Total emissions of CO_2 in 2014

Figure A1.3 Total emissions of SO_2 in 2014

Figure A1.4 Total emissions of VOCs in 2014

Figure A1.5 Total emissions of PM_{10} in 2014

Figure A1.6 Total emissions of CO in 2014

Figure A1.7 Total emissions of Benzene in 2014

Figure A1.8 Emissions of NO_X in 2014 from road transport

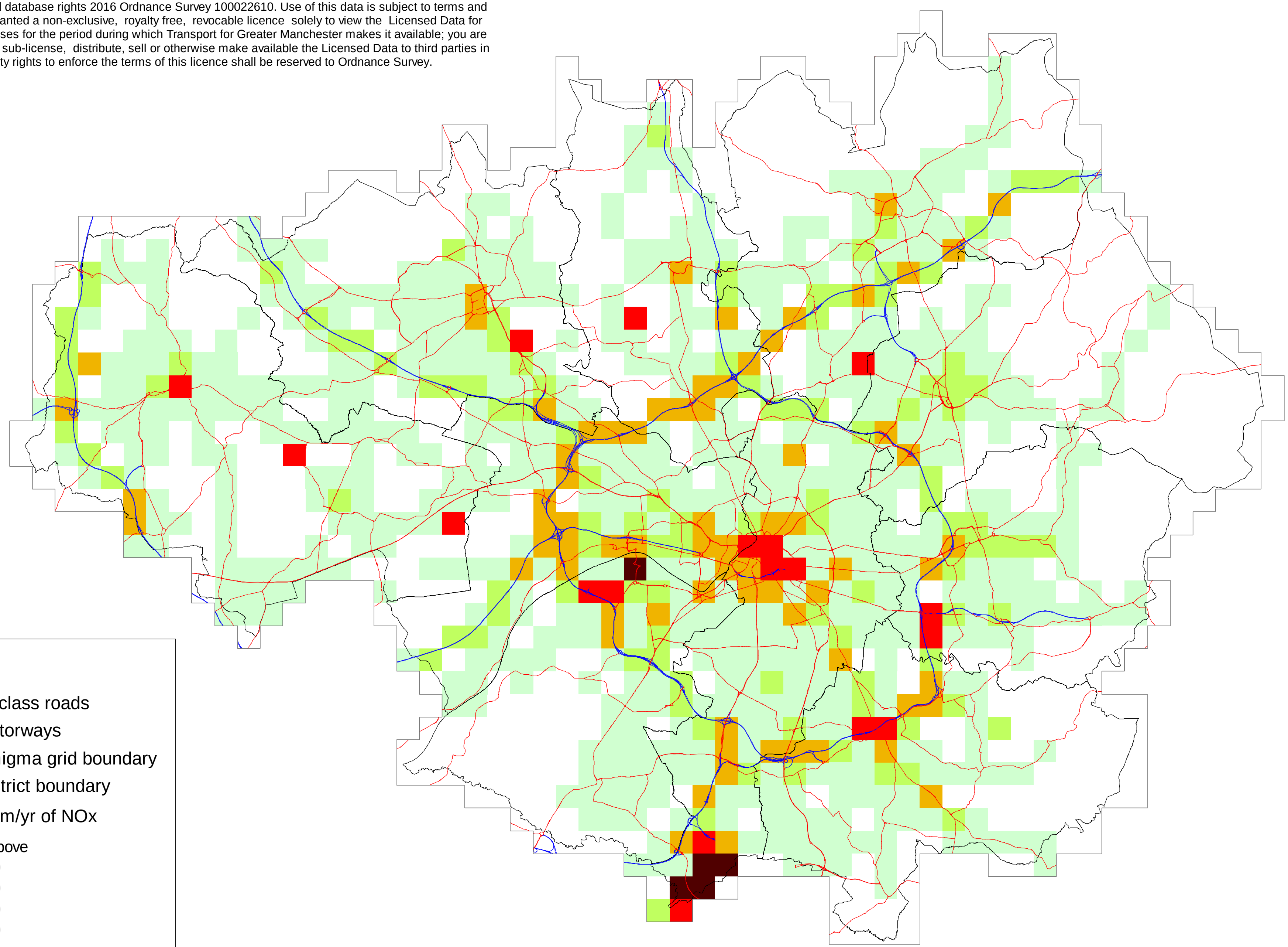
Figure A1.9 Emissions of CO_2 in 2014 from road transport

Figure A1.10 Emissions of VOCs in 2014 from road transport

Figure A1.11 Emissions of PM_{10} in 2014 from road transport

Figure A1.12 Emissions of CO in 2014 from road transport

Figure A1.13 Emissions of CO_2 in 2014 from electricity generation at point of use



Key

'A' class roads

Motorways

Emigma grid boundary

District boundary

Tonnes/sq km/yr of NOx

100 and above

50 to 100

30 to 50

20 to 30

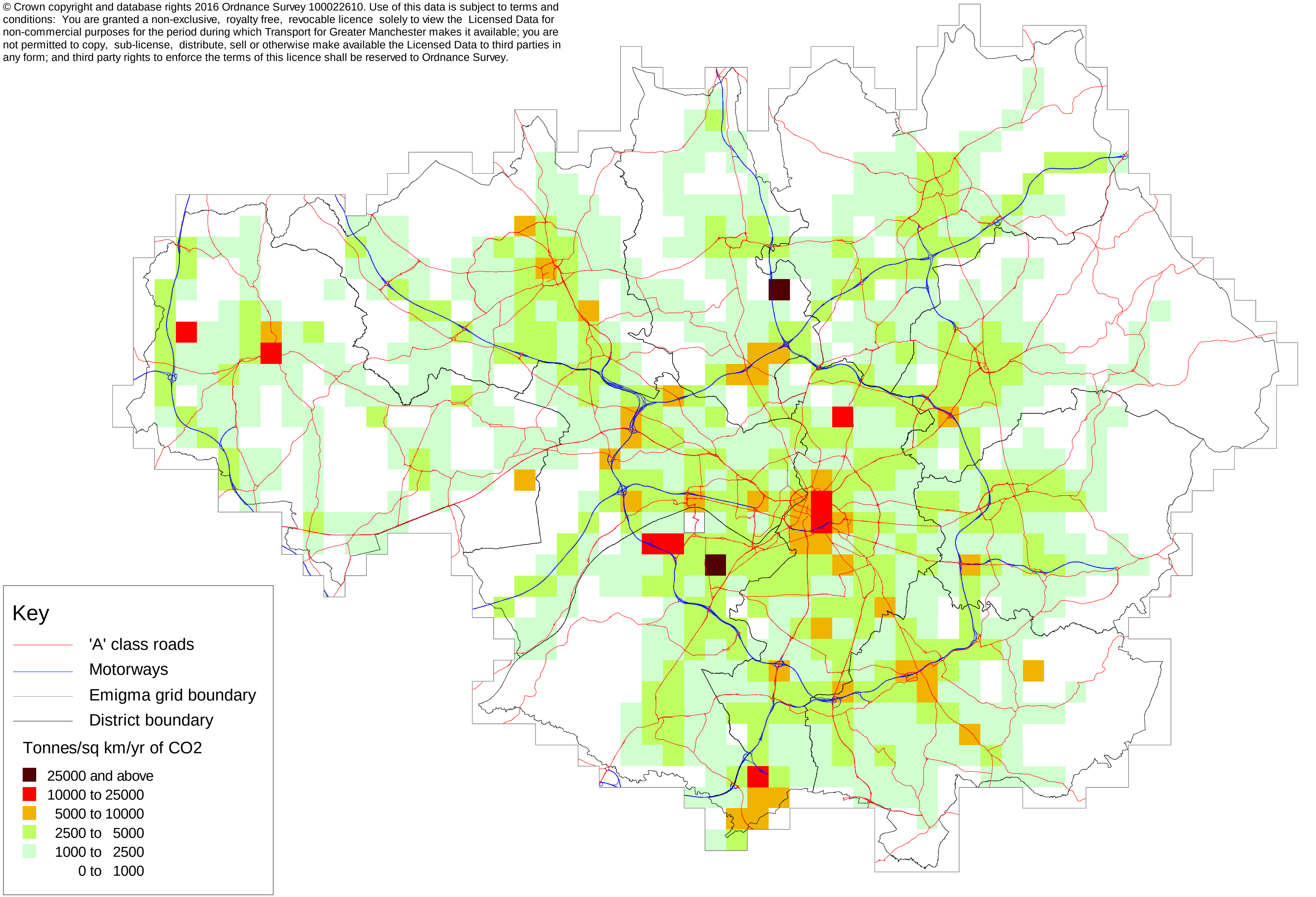
5 to 20

0 to 5

Transport for Greater Manchester

2 Piccadilly Place,
Manchester,
M1 3BG

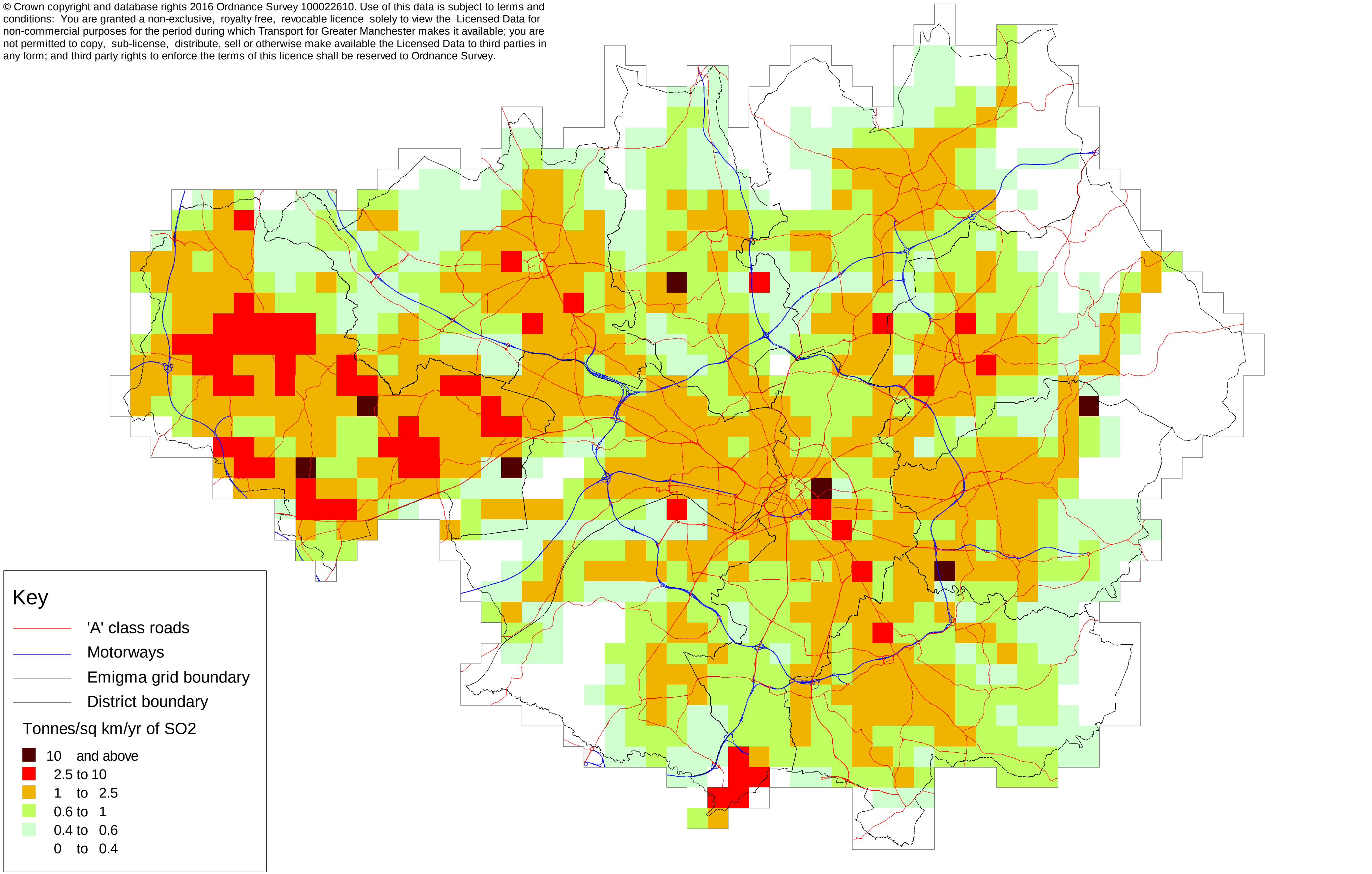
Total emissions of NOx in 2014			
Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.1



Transport for Greater Manchester
2 Piccadilly Place,
Manchester,
M1 3BG

Total emissions of CO2 in 2014

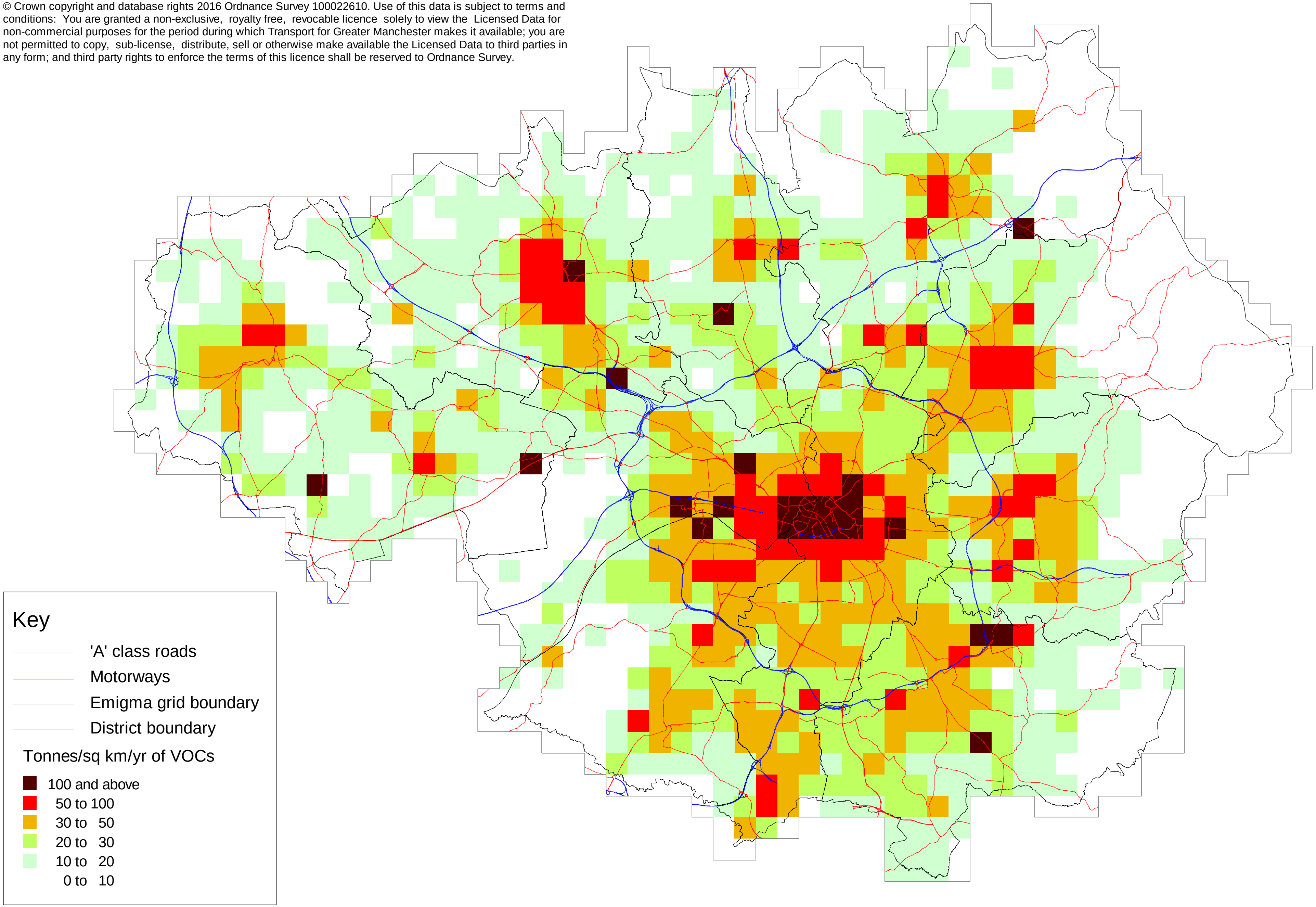
Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.2



Transport for Greater Manchester
2 Piccadilly Place,
Manchester,
M1 3BG

Total emissions of SO2 in 2014

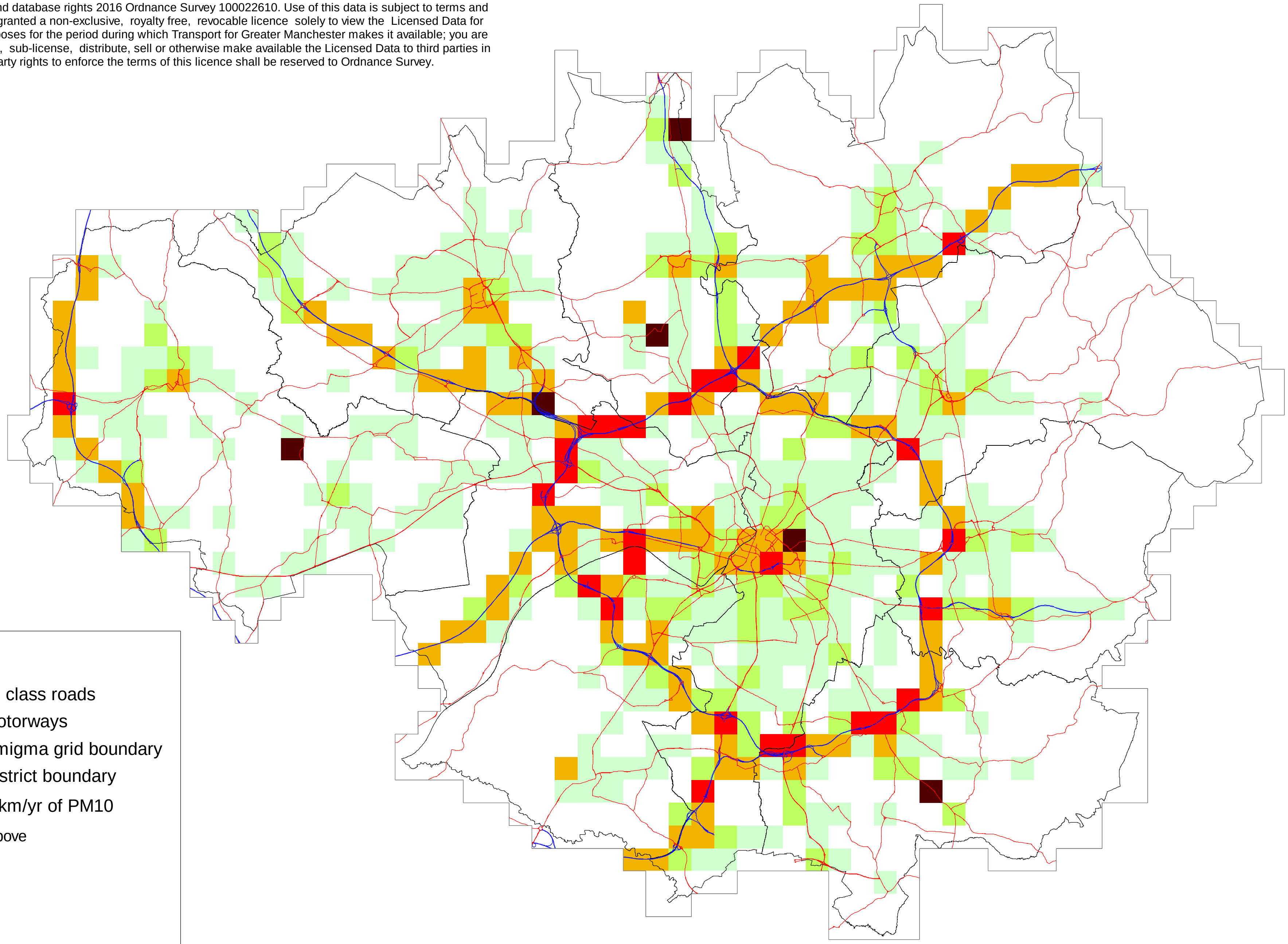
Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.3



Transport for Greater Manchester

2 Piccadilly Place,
Manchester,
M1 3BG

Total emissions of VOCs in 2014			
Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.4



Key

'A' class roads

Motorways

Emigma grid boundary

District boundary

Tonnes/sq km/yr of PM10

10 and above

5 to 10

3 to 5

2 to 3

1 to 2

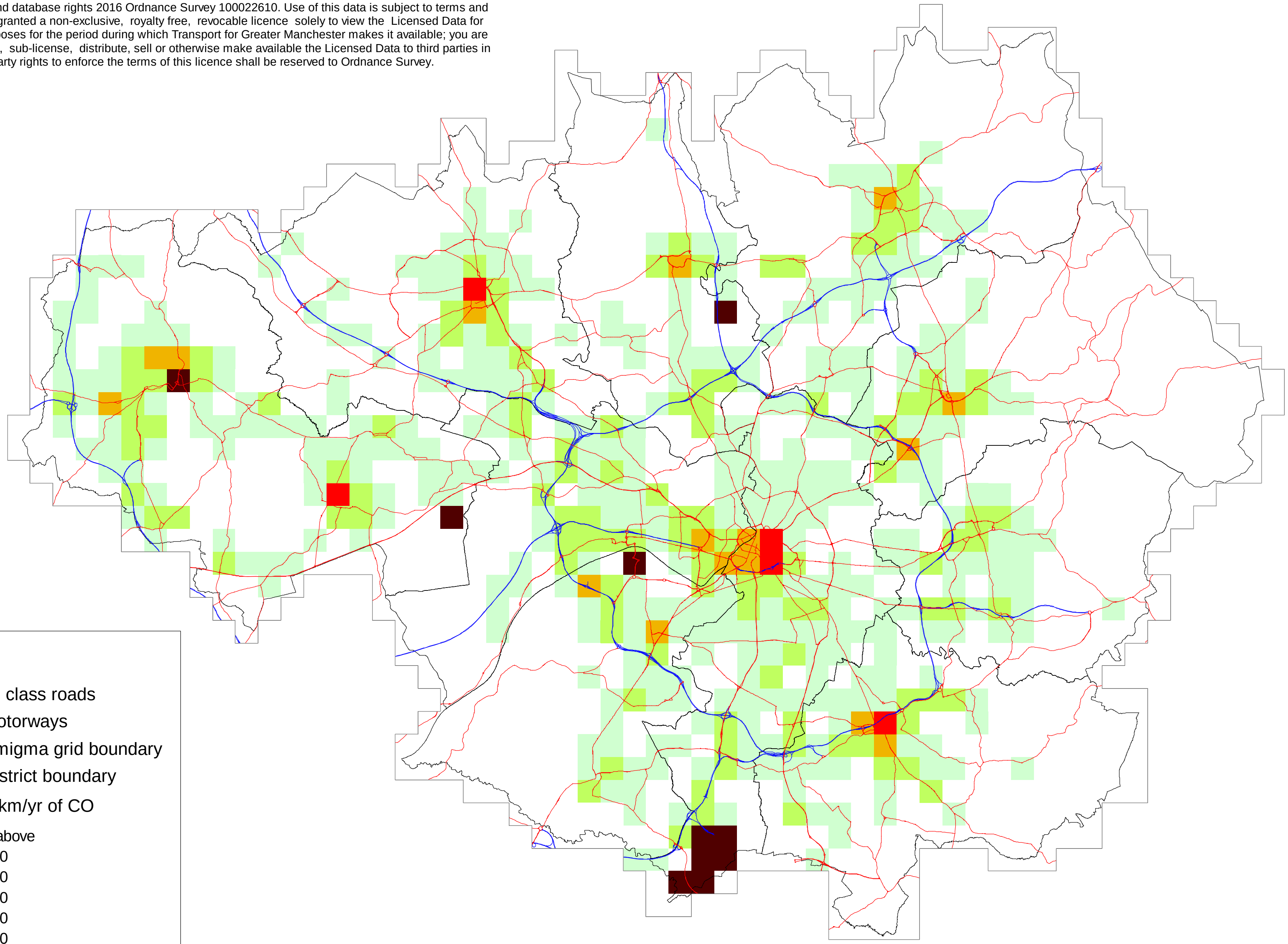
0 to 1

Transport for Greater Manchester

2 Piccadilly Place,
Manchester,
M1 3BG

Total emissions of PM10 in 2014

Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.5



Key

'A' class roads
Motorways
Emigma grid boundary
District boundary

Tonnes/sq km/yr of CO

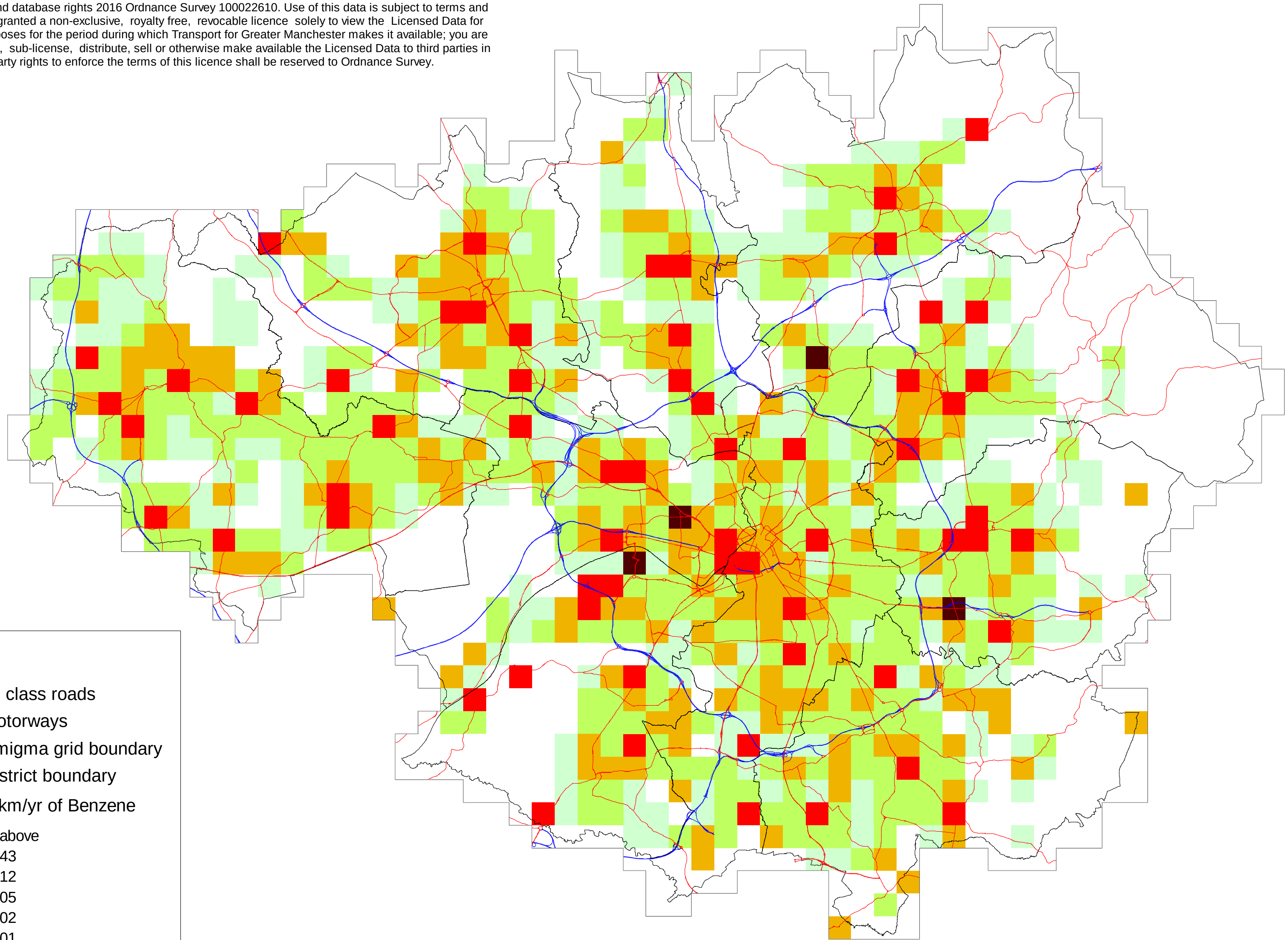
100 and above
80 to 100
60 to 80
40 to 60
20 to 40
0 to 20

Transport for Greater Manchester

2 Piccadilly Place,
Manchester,
M1 3BG

Total emissions of CO in 2014

Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.6



Key

'A' class roads
Motorways
Emigma grid boundary
District boundary

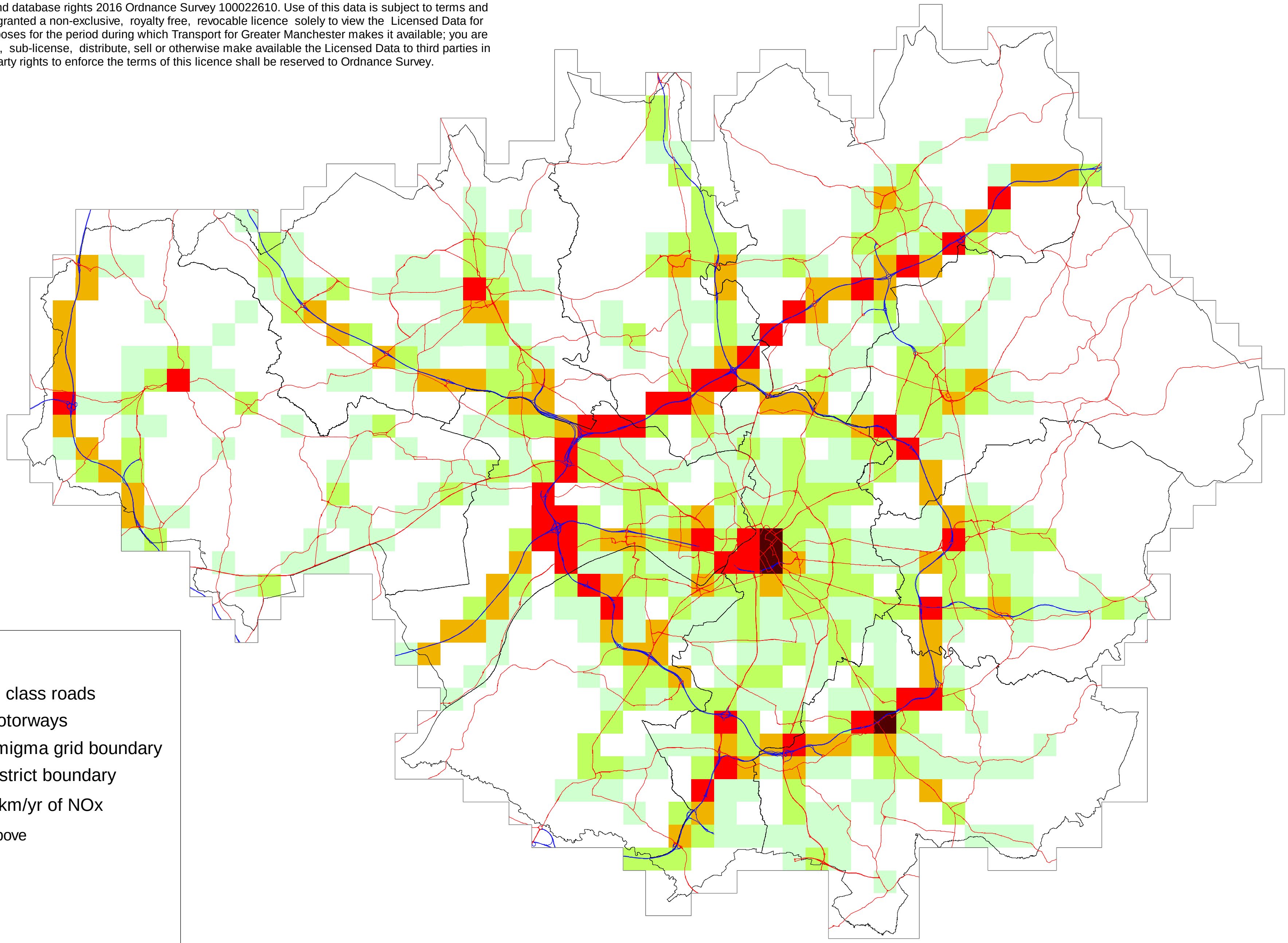
Tonnes/sq km/yr of Benzene

0.5 and above
0.12 to 0.43
0.05 to 0.12
0.02 to 0.05
0.01 to 0.02
0 to 0.01

Transport for Greater Manchester
2 Piccadilly Place,
Manchester,
M1 3BG

Total emissions of Benzene in 2014

Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.7



Key

'A' class roads

Motorways

Emigma grid boundary

District boundary

Tonnes/sq km/yr of NOx

50 and above

30 to 50

20 to 30

10 to 20

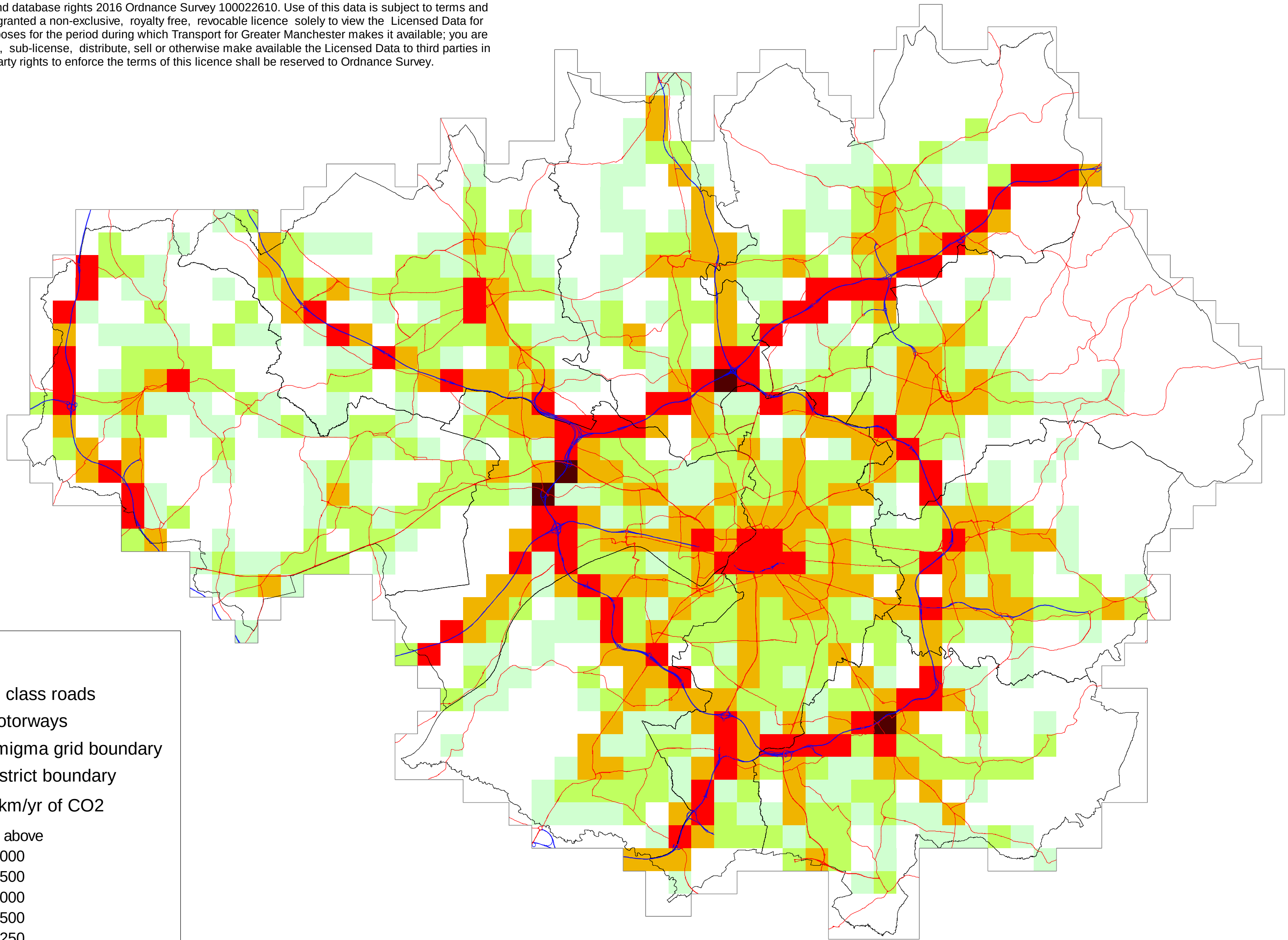
5 to 10

0 to 5

Transport for Greater Manchester
2 Piccadilly Place,
Manchester,
M1 3BG

Emissions of NOx in 2014 from road transport

Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.8



Key

- 'A' class roads
- Motorways
- Emigma grid boundary
- District boundary

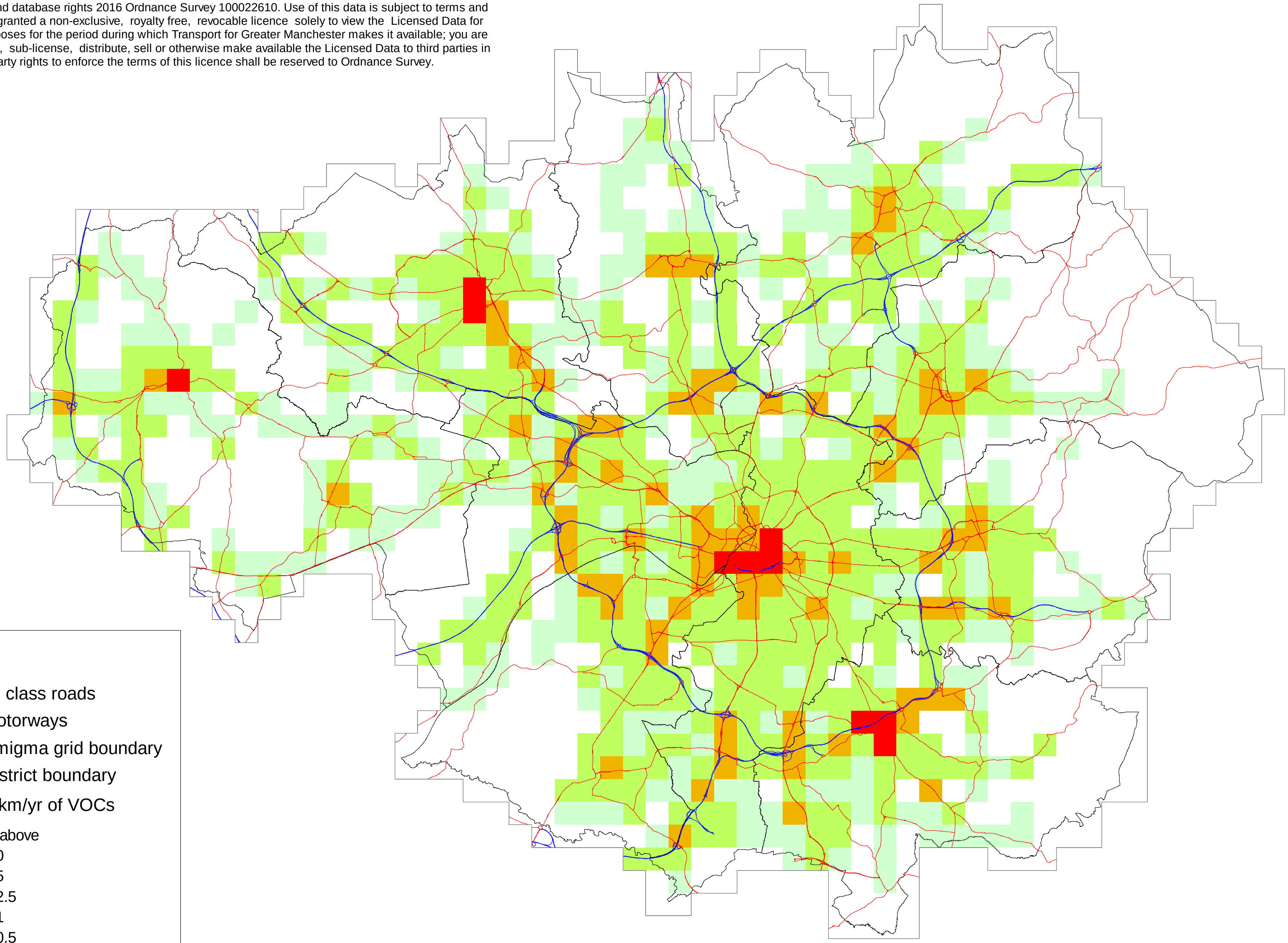
Tonnes/sq km/yr of CO2

- 5000 and above
- 2500 to 5000
- 1000 to 2500
- 500 to 1000
- 250 to 500
- 0 to 250

Transport for Greater Manchester
2 Piccadilly Place,
Manchester,
M1 3BG

Emissions of CO2 in 2014 from road transport

Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.9



Key

'A' class roads
Motorways
Emigma grid boundary
District boundary

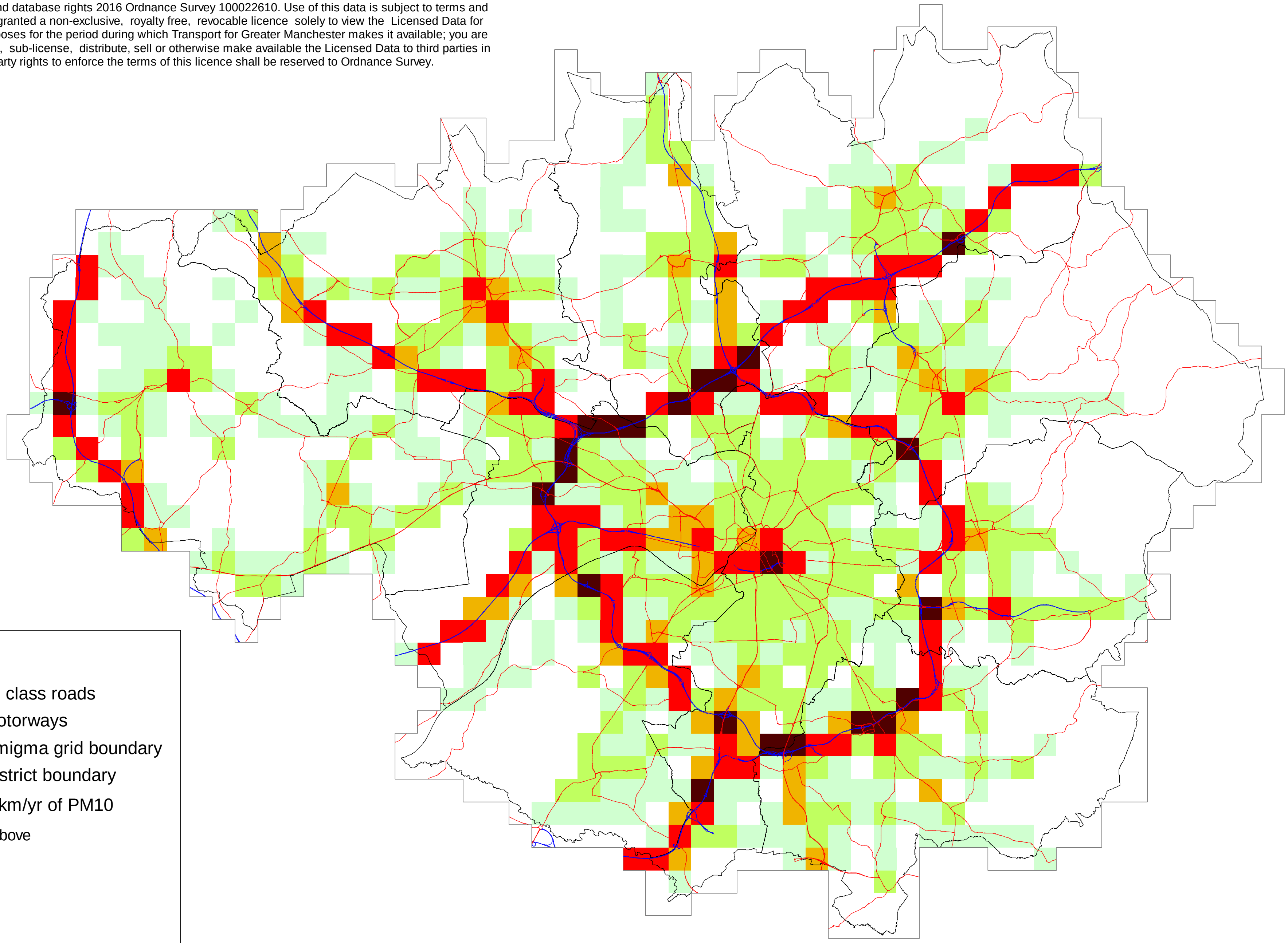
Tonnes/sq km/yr of VOCs

10 and above
5 to 10
2.5 to 5
1 to 2.5
0.5 to 1
0 to 0.5

Transport for Greater Manchester
2 Piccadilly Place,
Manchester,
M1 3BG

Emissions of VOCs in 2014 from road transport

Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.10



Key

'A' class roads
Motorways
Emigma grid boundary
District boundary

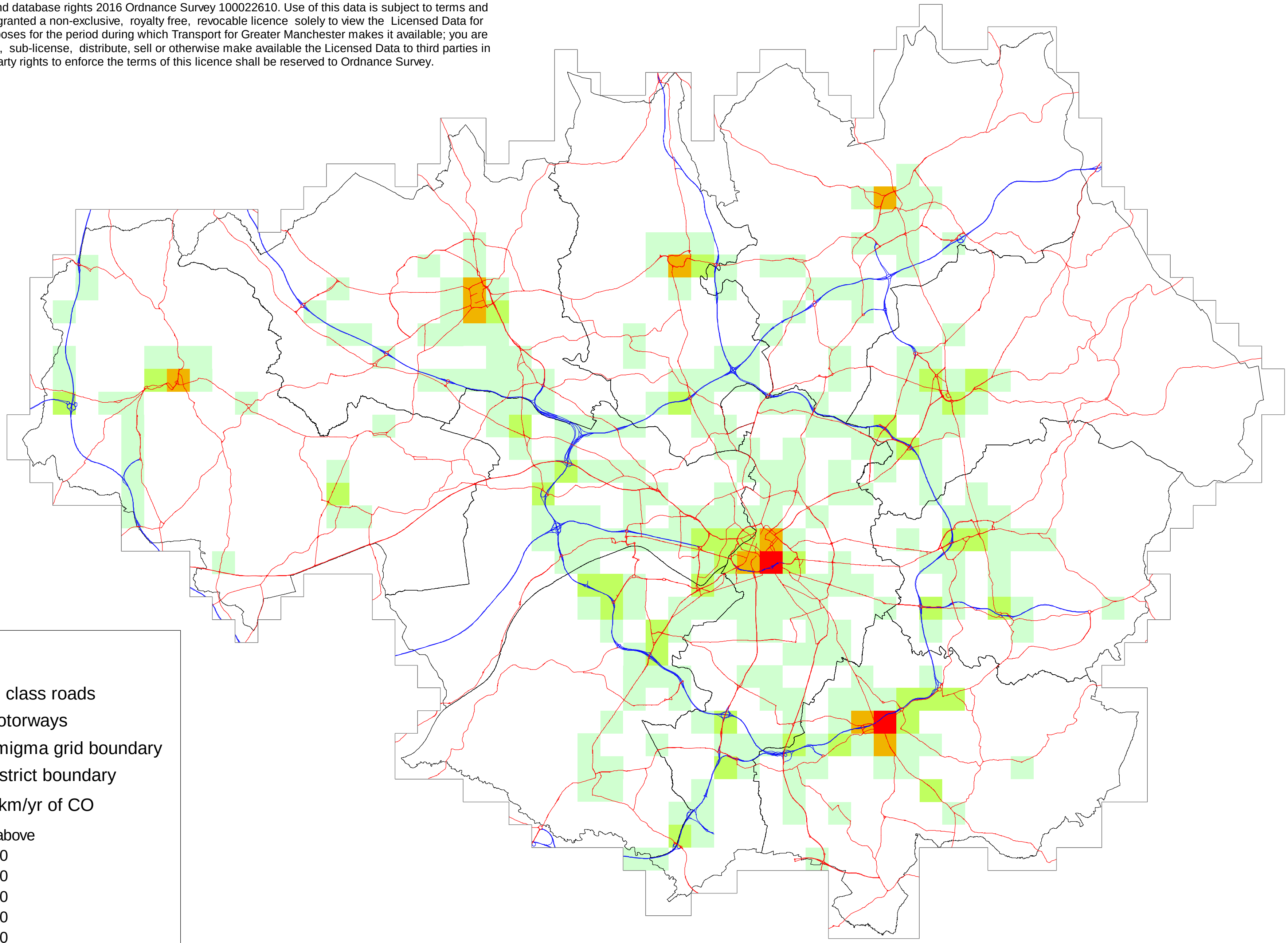
Tonnes/sq km/yr of PM10

5 and above
3 to 5
2 to 3
1 to 2
0.5 to 1
0 to 0.5

Transport for Greater Manchester
2 Piccadilly Place,
Manchester,
M1 3BG

Emissions of PM10 in 2014 from road transport

Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.11



Key

'A' class roads

Motorways

Emigma grid boundary

District boundary

Tonnes/sq km/yr of CO

100 and above

80 to 100

60 to 80

40 to 60

20 to 40

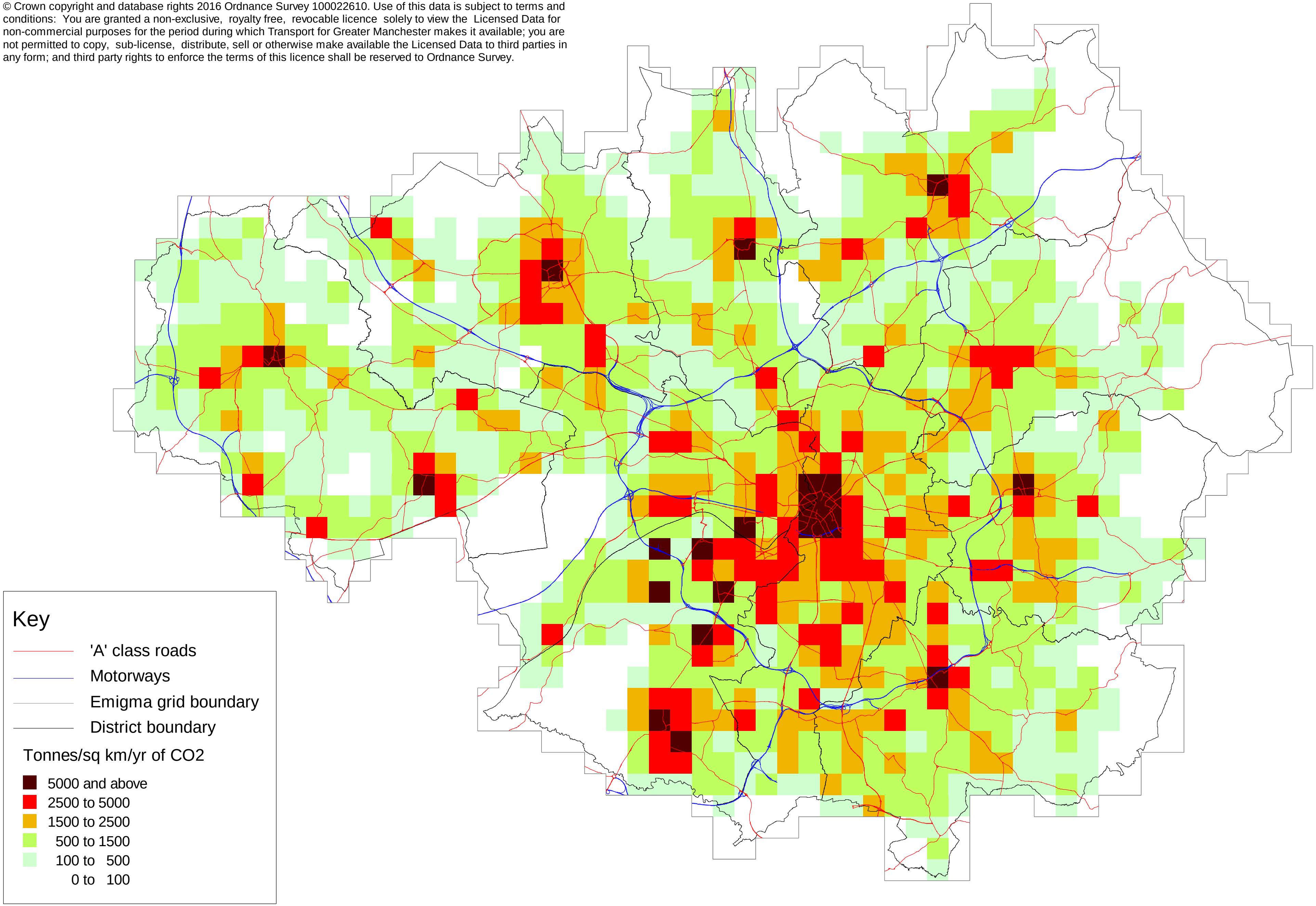
0 to 20

Transport for Greater Manchester

2 Piccadilly Place,
Manchester,
M1 3BG

Emissions of CO in 2014 from road transport

Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.12



Transport for Greater Manchester
2 Piccadilly Place,
Manchester,
M1 3BG

Emissions of CO2 in 2014 from electricity generation at point of use

Drawn By : I Hull	Scale : NTS	Date : 29/04/2016	Figure : A1.13

Appendix 2 Emission Factors and Road Traffic Expansion factors

The following tables show the emission factors and road traffic expansion factors used during the update of the road source data [1,2]

Table A2.1 Motorway Speed Emission Factors for Motor Cycles
Table A2.2 Motorway Speed Emission Factors for Petrol Cars
Table A2.3 Motorway Speed Emission Factors for Diesel Cars
Table A2.4 Motorway Speed Emission Factors for Petrol LGVS
Table A2.5 Motorway Speed Emission Factors for Diesel LGVS
Table A2.6 Motorway Speed Emission Factors for Rigid HGVS
Table A2.7 Motorway Speed Emission Factors for Articulated HGVS
Table A2.8 Motorway Speed Emission Factors for Buses

Lowest emission factor

Figure A5.1 NO_X Motorway Road Traffic Emission Profiles
Figure A5.2 PM_{10} Motorway Road Traffic Emission Profiles
Figure A5.3 CO Motorway Road Traffic Emission Profiles
Figure A5.4 VOC Motorway Road Traffic Emission Profiles
Figure A5.5 NO_2 Motorway Road Traffic Emission Profiles
Figure A5.6 Motorway Road Traffic Fuel Consumption Profiles
Figure A5.7 CO_2 Motorway Road Traffic Emission Profiles
Table A2.9 Non-Motorway Speed Emission Factors for Motor Cycles
Table A2.10 Non-Motorway Speed Emission Factors for Petrol Cars
Table A2.11 Non-Motorway Speed Emission Factors for Diesel Cars
Table A2.12 Non-Motorway Speed Emission Factors for Petrol LGVS
Table A2.13 Non-Motorway Speed Emission Factors for Diesel LGVS
Table A2.14 Non-Motorway Speed Emission Factors for Rigid HGVS
Table A2.15 Non-Motorway Speed Emission Factors for Articulated HGVS
Table A2.16 Non-Motorway Speed Emission Factors for Buses

Lowest emission factor

Figure A5.8 NO_X Motorway Road Traffic Emission Profiles
Figure A5.9 PM_{10} Motorway Road Traffic Emission Profiles
Figure A5.10 CO Motorway Road Traffic Emission Profiles
Figure A5.11 VOC Motorway Road Traffic Emission Profiles
Figure A5.12 NO_2 Motorway Road Traffic Emission Profiles
Figure A5.13 Motorway Road Traffic Fuel Consumption Profiles
Figure A5.14 CO_2 Motorway Road Traffic Emission Profiles
Table A2.17 Fleet Composition Data
Table A2.18 Road Traffic Expansion Factors
Table A2.19 Fleet-Weighted Cold Start Emission Factors
Table A2.20 Fleet-Weighted Hot Soak Emission Factors

1 The VOCs speed emission factors for cars, LGVs, OGVs and buses include methane.

2 The NAEI website does not provide speed emission factor coefficients for SO_2, although road transport represents only a minor source of UK sulphur emissions. Speed emission factors for SO_2 have therefore been estimated using 2010 drive-cycle factors from Reference 10, applying the urban driving factors for speeds up to 60 kph and the motorway factors for speeds greater than 60 kph

Table A2.1

2014 Motorway Speed Emission Factors for Motorcycles (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	0.178955	0.020210	14.050296	2.231144	86.692224	0.000406
10	0.153795	0.020210	10.342196	1.813607	71.884444	0.000406
15	0.131171	0.020210	8.456208	1.485041	60.513431	0.000406
20	0.113278	0.020210	7.228618	1.229316	51.938367	0.000406
25	0.100188	0.020210	6.386643	1.032415	45.604775	0.000406
30	0.091667	0.020210	5.811935	0.882299	41.038592	0.000406
35	0.087433	0.020210	5.434999	0.768774	37.840240	0.000406
40	0.087213	0.020210	5.208490	0.683354	35.678704	0.000406
45	0.090770	0.020210	5.098026	0.619128	34.285598	0.000406
50	0.097897	0.020210	5.078269	0.570622	33.449243	0.000406
55	0.108424	0.020210	5.130906	0.533667	33.008740	0.000406
60	0.122211	0.020210	5.243436	0.505265	32.848038	0.000406
65	0.139149	0.020210	5.408322	0.483451	32.890015	0.000561
70	0.159155	0.020210	5.622324	0.467159	33.090547	0.000561
75	0.182165	0.020210	5.885935	0.456091	33.432577	0.000561
80	0.208137	0.020210	6.202867	0.450575	33.920197	0.000561
85	0.237040	0.020210	6.579574	0.451437	34.572713	0.000561
90	0.268853	0.020210	7.024792	0.459862	35.418724	0.000561
95	0.303562	0.020210	7.549090	0.477261	36.490190	0.000561
100	0.341154	0.020210	8.164436	0.505135	37.816511	0.000561
105	0.381613	0.020210	8.883762	0.544943	39.418593	0.000561
110	0.424916	0.020210	9.720530	0.597961	41.302928	0.000561
115	0.471032	0.020210	10.688314	0.665154	43.455661	0.000561
	Lowest emission factor					

Table A2.2

2014 Motorway Speed Emission Factors for Petrol Cars (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	0.163297	0.068409	4.938316	0.434640	162.158740	0.000656
10	0.140622	0.065615	2.324971	0.213567	92.841877	0.000656
15	0.134580	0.064716	1.492392	0.140661	69.728086	0.000656
20	0.128417	0.064297	1.101128	0.104801	58.221404	0.000656
25	0.121426	0.064076	0.885340	0.083745	51.402641	0.000656
30	0.115055	0.063958	0.757725	0.070073	46.965398	0.000656
35	0.109412	0.063902	0.681705	0.060602	43.921219	0.000656
40	0.104551	0.063889	0.639524	0.053742	41.775878	0.000656
45	0.100460	0.063907	0.621659	0.048610	40.254801	0.000656
50	0.097088	0.063951	0.622622	0.044683	39.193248	0.000656
55	0.094360	0.064016	0.639089	0.041632	38.486381	0.000656
60	0.092206	0.064102	0.668998	0.039241	38.064310	0.000656
65	0.090959	0.064207	0.711095	0.037369	37.878648	0.000613
70	0.090724	0.064332	0.764697	0.035916	37.894835	0.000613
75	0.090882	0.064476	0.829585	0.034815	38.087525	0.000613
80	0.091436	0.064641	0.905957	0.034019	38.437710	0.000613
85	0.092408	0.064829	0.994420	0.033493	38.930853	0.000613
90	0.093834	0.065042	1.096008	0.033213	39.555649	0.000613
95	0.095771	0.065281	1.212219	0.033158	40.303172	0.000613
100	0.098299	0.065549	1.345054	0.033312	41.166281	0.000613
105	0.101530	0.065848	1.497069	0.033660	42.139196	0.000613
110	0.105609	0.066183	1.671426	0.034185	43.217187	0.000613
115	0.110726	0.066555	1.871956	0.034867	44.396348	0.000613
	Lowest emission factor					

Table A2.3

2014 Motorway Speed Emission Factors for Diesel Cars (g/km)						
Speed km/hour	**NO_X**	**PM_{10}**	**CO**	**VOCs[1]**	**CO_2 as C**	**SO_2[2]**
5	1.539571	0.092836	0.714232	0.157284	110.399656	0.000722
10	0.835316	0.080327	0.357755	0.086527	73.153397	0.000722
15	0.746241	0.076352	0.238750	0.062889	59.656074	0.000722
20	0.675434	0.074488	0.179101	0.051031	52.221235	0.000722
25	0.616402	0.073461	0.143183	0.043885	47.311586	0.000722
30	0.566350	0.072850	0.119122	0.039095	43.748032	0.000722
35	0.523874	0.072480	0.101831	0.035651	41.025245	0.000722
40	0.488200	0.072266	0.088764	0.033049	38.890561	0.000722
45	0.458863	0.072160	0.078509	0.031008	37.203612	0.000722
50	0.435578	0.072137	0.070218	0.029359	35.880176	0.000722
55	0.418161	0.072178	0.063352	0.027996	34.866659	0.000722
60	0.406496	0.072273	0.057550	0.026848	34.127330	0.000722
65	0.400513	0.072414	0.052564	0.025863	33.637453	0.000645
70	0.400177	0.072596	0.048217	0.025009	33.379358	0.000645
75	0.405485	0.072814	0.044379	0.024258	33.340090	0.000645
80	0.416458	0.073068	0.040952	0.023591	33.509929	0.000645
85	0.433155	0.073355	0.037862	0.022993	33.881445	0.000645
90	0.455669	0.073675	0.035050	0.022453	34.448857	0.000645
95	0.484152	0.074031	0.032472	0.021962	35.207604	0.000645
100	0.518835	0.074425	0.030091	0.021512	36.154034	0.000645
105	0.560080	0.074861	0.027878	0.021098	37.285192	0.000645
110	0.608472	0.075347	0.025808	0.020714	38.598660	0.000645
115	0.665010	0.075890	0.023862	0.020356	40.092441	0.000645
	Lowest emission factor					

Table A2.4

2014 Motorway Speed Emission Factors for Petrol LGVs (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	0.777339	0.076206	41.138640	1.733264	266.253004	0.000878
10	0.438363	0.073436	19.840459	0.919698	143.885511	0.000878
15	0.440595	0.072539	12.870714	0.649544	103.743568	0.000878
20	0.443118	0.072116	9.482513	0.515073	84.179961	0.000878
25	0.444099	0.071887	7.526993	0.434837	72.871058	0.000878
30	0.446395	0.071759	6.288221	0.381747	65.713856	0.000878
35	0.449942	0.071691	5.459619	0.344230	60.954123	0.000878
40	0.454668	0.071664	4.888078	0.316523	57.718440	0.000878
45	0.460503	0.071667	4.488674	0.295439	55.524881	0.000878
50	0.467370	0.071694	4.210558	0.279076	54.087279	0.000878
55	0.475194	0.071740	4.021463	0.266233	53.226264	0.000878
60	0.483897	0.071805	3.899959	0.256118	52.824777	0.000878
65	0.494459	0.071887	3.831294	0.248198	52.804117	0.000905
70	0.507377	0.071987	3.805014	0.242105	53.110254	0.000905
75	0.521076	0.072104	3.813554	0.237594	53.705618	0.000905
80	0.535554	0.072239	3.851346	0.234508	54.563963	0.000905
85	0.550814	0.072395	3.914258	0.232759	55.667051	0.000905
90	0.566857	0.072572	3.999220	0.232322	57.002431	0.000905
95	0.583688	0.072773	4.103971	0.233226	58.561930	0.000905
100	0.601310	0.072999	4.226889	0.235551	60.340591	0.000905
105	0.619731	0.073169	4.320145	0.239821	61.956213	0.000905
110	0.638961	0.073359	4.425766	0.245707	63.742504	0.000905
115	0.647290	0.073571	4.543369	0.253424	65.700646	0.000905
	Lowest emission factor					

Table A2.5

2014 Motorway Speed Emission Factors for Diesel LGVs (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	1.854781	0.148007	1.788395	0.468920	225.100667	0.000928
10	1.023064	0.110377	0.894996	0.230291	122.323899	0.000928
15	0.945100	0.098033	0.599081	0.151400	88.632935	0.000928
20	0.875034	0.091996	0.452538	0.112444	72.325873	0.000928
25	0.812465	0.088488	0.365744	0.089462	63.059455	0.000928
30	0.757221	0.086259	0.308824	0.074468	57.385887	0.000928
35	0.709216	0.084783	0.268974	0.064039	53.829518	0.000928
40	0.668400	0.083799	0.239794	0.056462	51.656017	0.000928
45	0.634746	0.083167	0.217728	0.050789	50.462095	0.000928
50	0.608237	0.082809	0.200640	0.046447	50.011395	0.000928
55	0.588859	0.082675	0.187173	0.043075	50.159898	0.000928
60	0.576608	0.082739	0.176422	0.040430	50.818621	0.000928
65	0.571477	0.082988	0.167760	0.038345	51.933537	0.001291
70	0.573466	0.083419	0.160740	0.036700	53.474099	0.001291
75	0.582573	0.084036	0.155033	0.035407	55.426352	0.001291
80	0.598800	0.084852	0.150392	0.034402	57.788630	0.001291
85	0.622151	0.085889	0.146631	0.033633	60.568773	0.001291
90	0.652631	0.087175	0.143601	0.033061	63.782270	0.001291
95	0.690251	0.088746	0.141188	0.032656	67.450985	0.001291
100	0.735023	0.090648	0.139300	0.032393	71.602275	0.001291
105	0.786971	0.092935	0.137860	0.032252	76.268348	0.001291
110	0.846131	0.095672	0.136809	0.032217	81.485806	0.001291
115	0.849622	0.098934	0.136095	0.032274	87.295300	0.001291
	Lowest emission factor					

Table A2.6

2014 Motorway Speed Emission Factors for Rigid HGVs (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	12.948223	0.296657	1.772085	0.357915	432.649243	0.004416
10	8.139042	0.248790	1.300521	0.262834	328.704201	0.004416
15	7.008168	0.218018	0.997464	0.197104	274.215186	0.004416
20	5.725279	0.198973	0.807634	0.155082	242.392967	0.004416
25	4.856808	0.185875	0.674825	0.126074	218.979409	0.004416
30	4.227189	0.176468	0.577870	0.105456	200.141175	0.004416
35	3.751241	0.169586	0.506090	0.090603	184.736588	0.004416
40	3.381383	0.164525	0.453094	0.079838	172.420523	0.004416
45	3.088305	0.160832	0.414639	0.072040	163.046638	0.004416
50	2.852571	0.158203	0.387723	0.066463	156.458811	0.004416
55	2.660529	0.156431	0.370117	0.062616	152.424107	0.004416
60	2.502127	0.155369	0.360082	0.060185	150.624709	0.004416
65	2.369677	0.154909	0.356176	0.058956	150.677069	0.003743
70	2.257096	0.154954	0.357099	0.058760	152.164668	0.003743
75	2.159439	0.155402	0.361561	0.059409	154.678036	0.003743
80	2.072586	0.156126	0.368168	0.060643	157.858847	0.003743
85	1.993026	0.156955	0.375312	0.062071	161.446424	0.003743
90	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
95	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
100	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
105	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
110	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
115	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
	Lowest emission factor					

Table A2.7

2014 Motorway Speed Emission Factors for Articulated LGVs (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	18.194562	0.301965	0.977297	0.221163	717.436548	0.005967
10	11.713468	0.249919	0.722468	0.157856	536.642390	0.005967
15	9.808130	0.218728	0.552138	0.114875	458.203611	0.005967
20	7.692811	0.200282	0.444013	0.088091	415.720881	0.005967
25	6.277918	0.187852	0.368714	0.070148	381.698055	0.005967
30	5.260465	0.178976	0.314403	0.057812	350.513268	0.005967
35	4.498342	0.172465	0.274730	0.049230	321.842252	0.005967
40	3.912728	0.167645	0.245744	0.043212	296.628237	0.005967
45	3.454745	0.164100	0.224803	0.038970	275.839982	0.005967
50	3.091503	0.161556	0.210087	0.035985	260.066242	0.005967
55	2.799433	0.159825	0.200318	0.033932	249.414400	0.005967
60	2.560753	0.158771	0.194576	0.032618	243.535824	0.005967
65	2.361470	0.158288	0.192162	0.031930	241.709723	0.004682
70	2.190164	0.158275	0.192472	0.031794	242.956246	0.004682
75	2.037225	0.158626	0.194887	0.032129	246.165182	0.004682
80	1.894352	0.159211	0.198674	0.032808	250.233429	0.004682
85	1.754204	0.159865	0.202880	0.033614	254.207627	0.004682
90	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
95	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
100	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
105	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
110	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
115	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
	Lowest emission factor					

Table A2.8

2014 Motorway Speed Emission Factors for Buses (g/km)						
Speed km/hour	**NO_X**	**PM_{10}**	**CO**	**VOCs**[1]	**CO_2 as C**	**SO_2**[2]
5	17.804558	0.364005	2.279490	0.559532	729.166011	0.004652
10	11.369334	0.292586	1.706648	0.352285	470.623171	0.004652
15	9.103103	0.254238	1.277572	0.260647	340.715212	0.004652
20	7.381288	0.232422	1.000317	0.214508	275.590159	0.004652
25	6.223693	0.217424	0.813076	0.182698	236.686306	0.004652
30	5.379883	0.206297	0.683418	0.157685	211.149748	0.004652
35	4.740844	0.197867	0.590862	0.137583	193.471672	0.004652
40	4.248202	0.191520	0.521922	0.121864	180.897669	0.004652
45	3.865789	0.186827	0.467942	0.110115	171.897513	0.004652
50	3.568618	0.183419	0.423747	0.101704	165.553068	0.004652
55	3.337927	0.180959	0.386605	0.095789	161.280066	0.004652
60	3.158698	0.179145	0.355319	0.091454	158.688994	0.004652
65	3.018287	0.177738	0.329364	0.087913	157.510191	0.003503
70	2.905628	0.176594	0.308067	0.084750	157.551040	0.003503
75	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
80	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
85	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
90	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
95	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
100	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
105	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
110	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
115	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
(green)	Lowest emission factor					

Figure A5.1 NO_X Motorway Road Traffic Emission Profiles

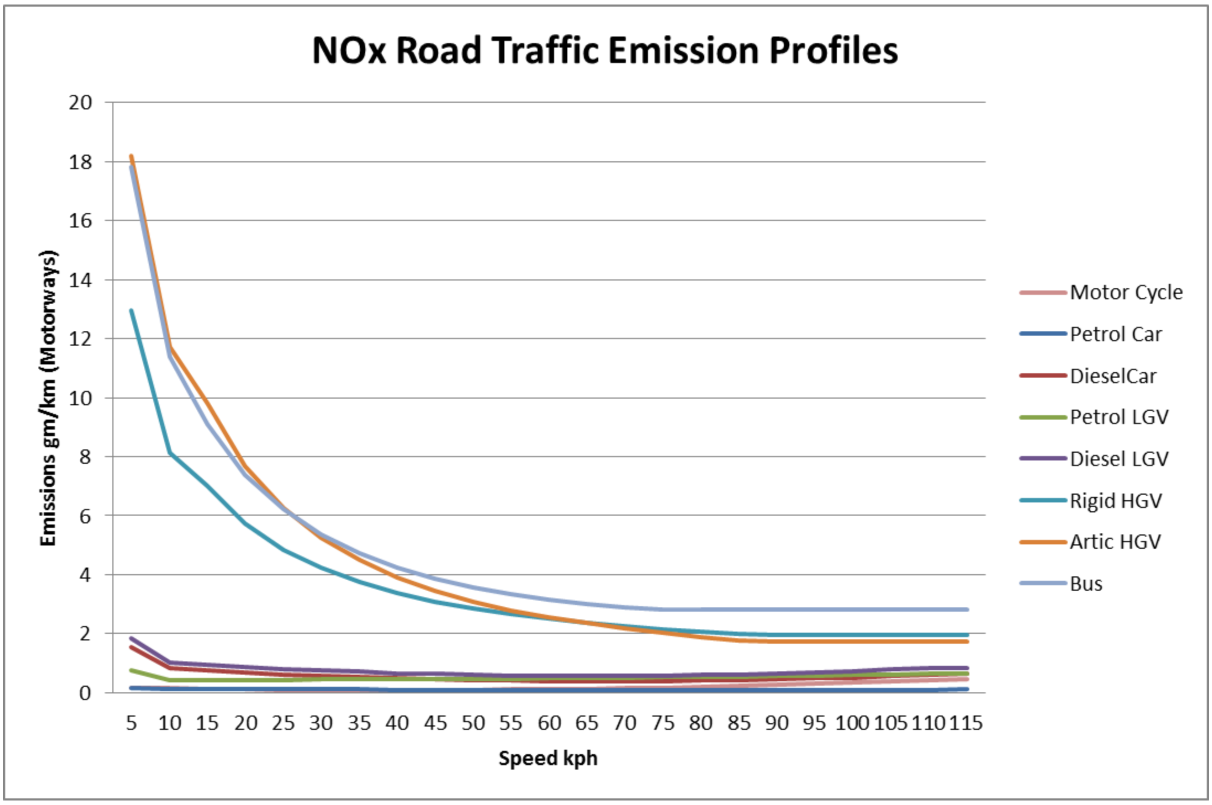


Figure A5.2 PM_{10} Motorway Road Traffic Emission Profiles

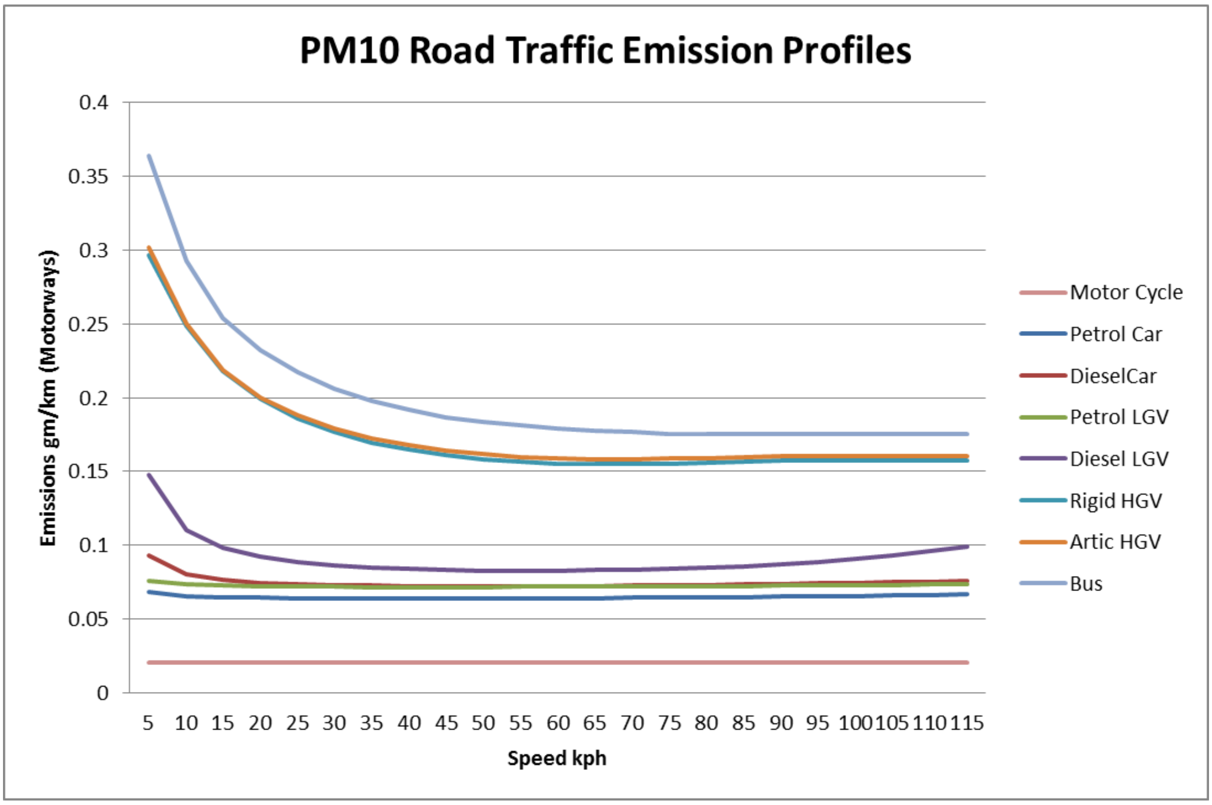


Figure A5.3 CO Motorway Road Traffic Emission Profiles

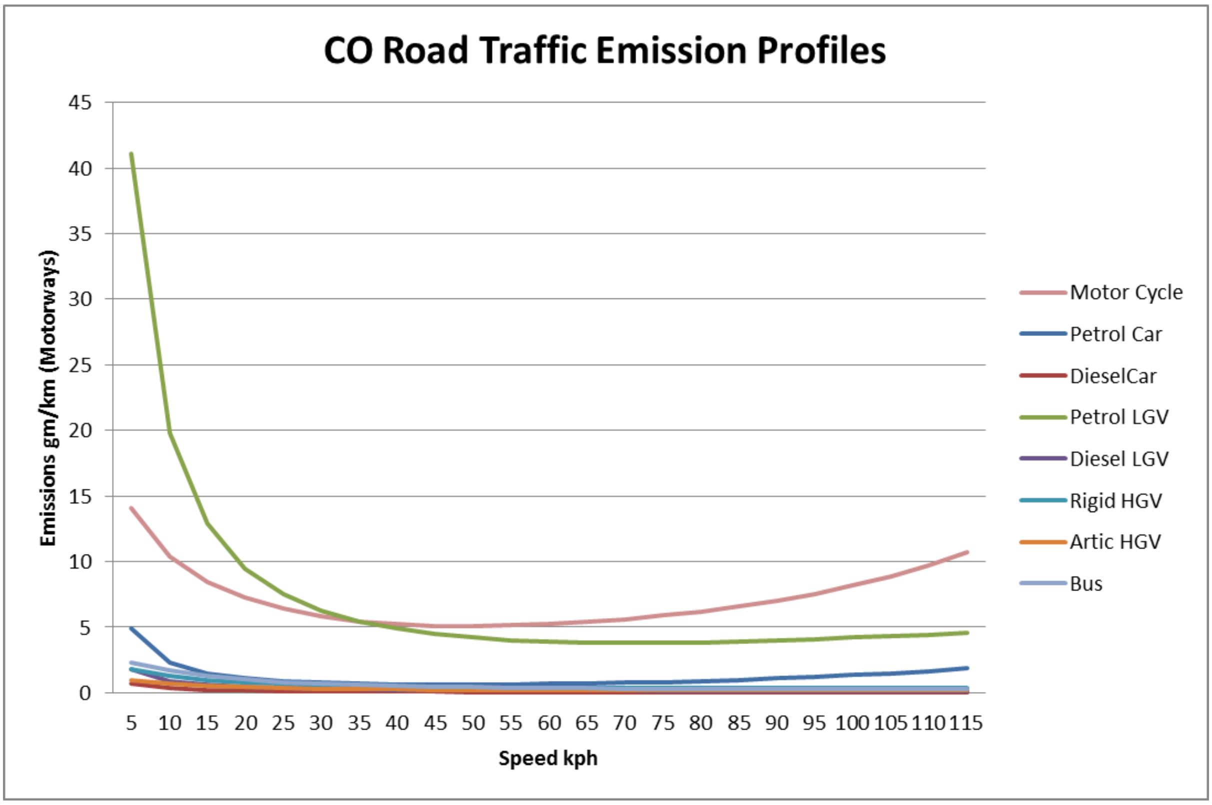


Figure A5.4 VOC Motorway Road Traffic Emission Profiles

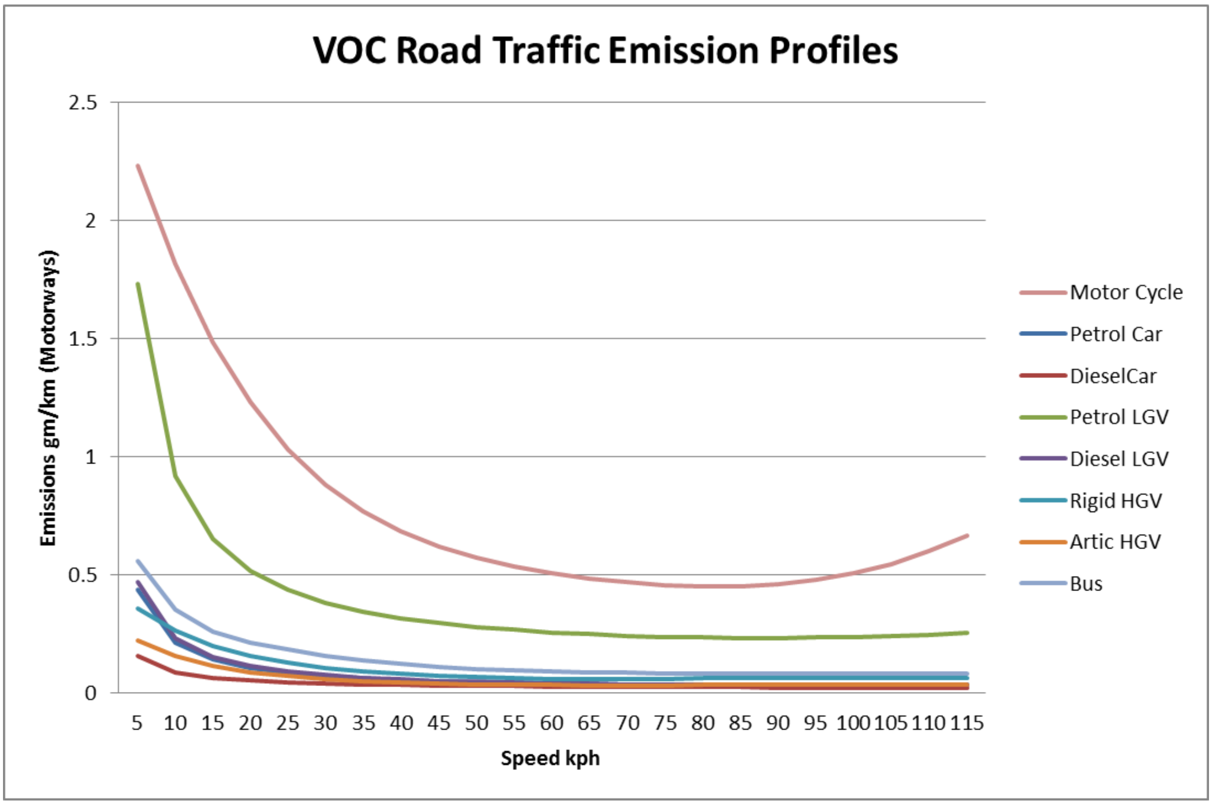


Figure A5.5 NO_2 Motorway Road Traffic Emission Profiles

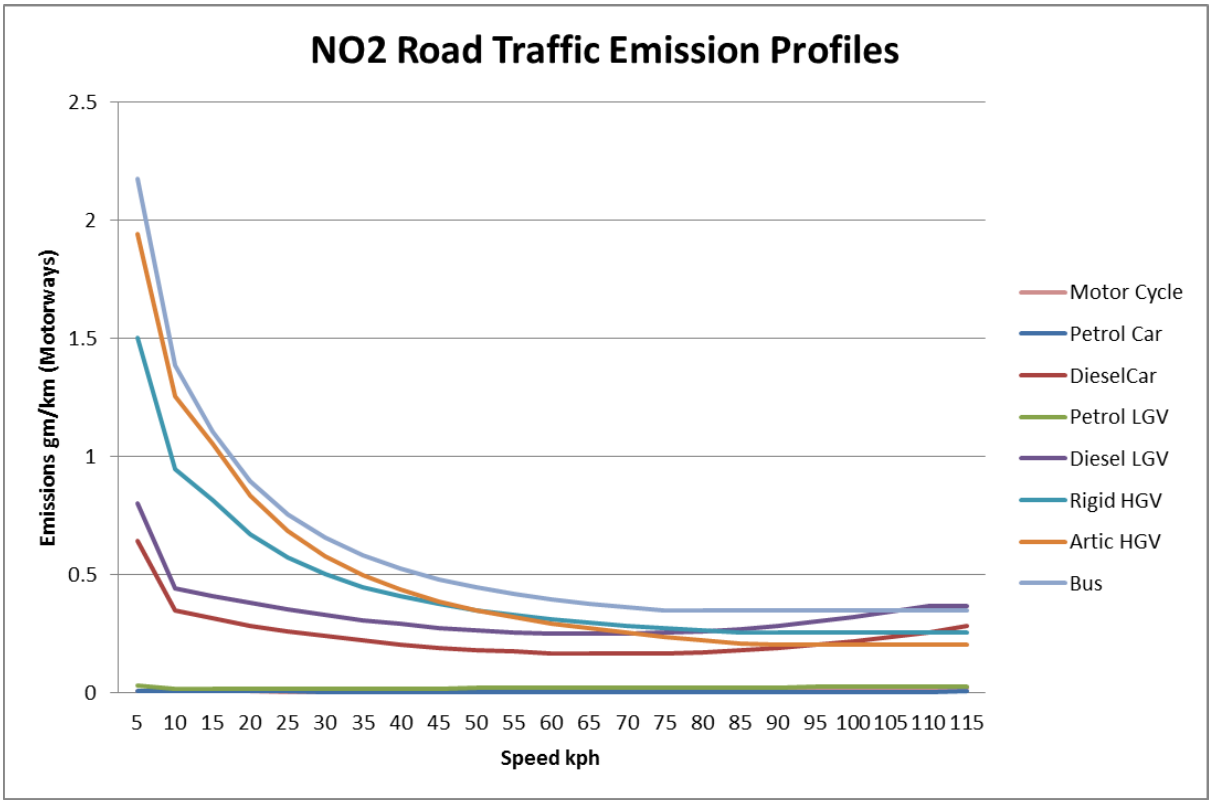


Figure A5.6 Motorway Road Traffic Fuel Consumption Profiles

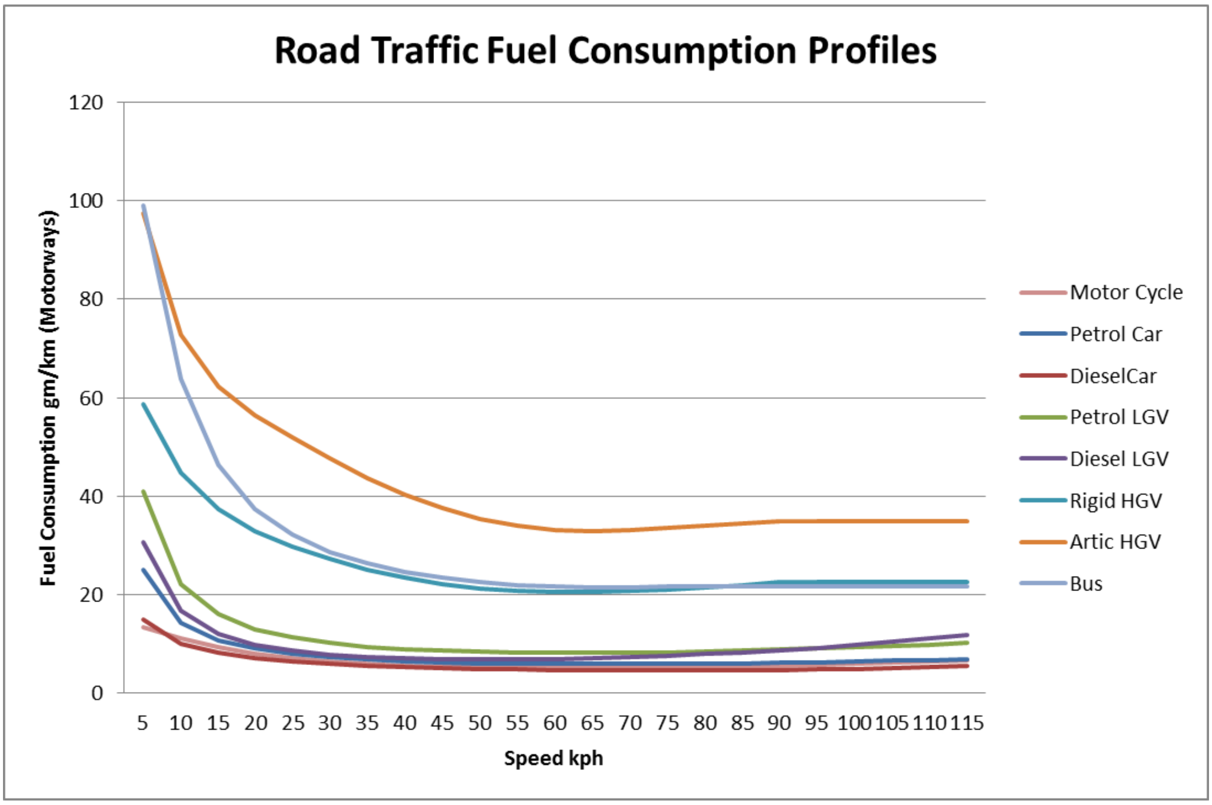


Figure A5.7 CO_2 Motorway Road Traffic Emission Profiles

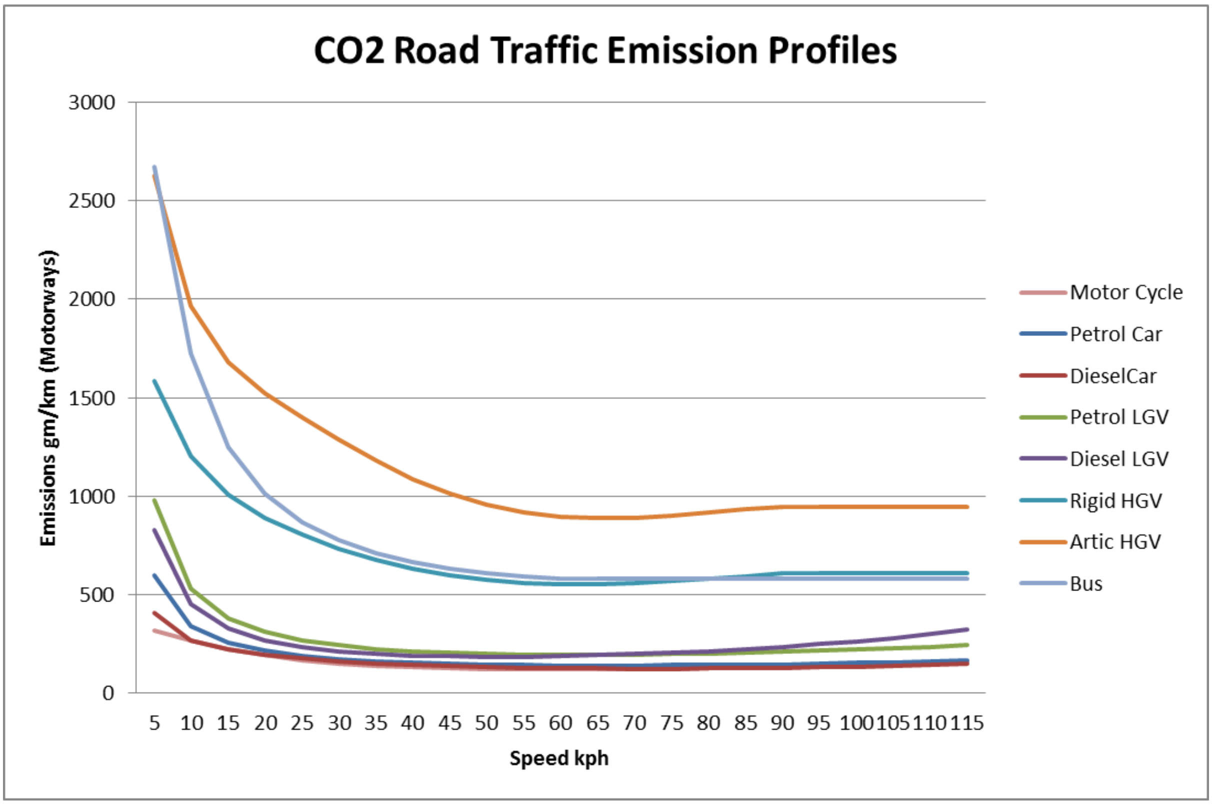


Table A2.9

2014 Non-Motorway Speed Emission Factors for Motorcycles (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	0.164626	0.022612	12.146996	2.082041	59.819470	0.000406
10	0.144023	0.022612	9.988683	1.748035	49.606181	0.000406
15	0.129010	0.022612	8.666180	1.486286	41.890135	0.000406
20	0.119024	0.022612	7.768426	1.283184	36.174255	0.000406
25	0.113342	0.022612	7.165050	1.127035	32.035576	0.000406
30	0.111332	0.022612	6.781212	1.007922	29.119362	0.000406
35	0.112474	0.022612	6.564676	0.917566	27.133225	0.000406
40	0.116350	0.022612	6.476919	0.849181	25.841243	0.000406
45	0.122639	0.022612	6.489573	0.797334	25.058085	0.000406
50	0.131101	0.022612	6.582479	0.757808	24.643123	0.000406
55	0.141562	0.022612	6.742310	0.727456	24.494558	0.000406
60	0.153901	0.022612	6.961451	0.704062	24.543535	0.000406
65	0.168036	0.022612	7.236978	0.686202	24.748264	0.000561
70	0.183907	0.022612	7.569704	0.673098	25.088141	0.000561
75	0.201465	0.022612	7.963245	0.664485	25.557865	0.000561
80	0.220657	0.022612	8.423112	0.660461	26.161559	0.000561
85	0.241407	0.022612	8.955807	0.661353	26.906888	0.000561
90	0.263608	0.022612	9.567927	0.667573	27.799180	0.000561
95	0.287103	0.022612	10.265270	0.679478	28.835546	0.000561
100	0.311671	0.022612	11.051947	0.697227	29.998995	0.000561
105	0.333568	0.022612	11.822404	0.715531	31.159074	0.000561
110	0.357648	0.022612	12.720900	0.741207	32.502935	0.000561
115	0.384375	0.022612	13.761872	0.774669	34.023763	0.000561
	Lowest emission factor					

Table A2.10

2014 Non-Motorway Speed Emission Factors for Petrol Cars (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	0.163297	0.068409	4.938316	0.434640	162.158740	0.000656
10	0.140622	0.065615	2.324971	0.213567	92.841877	0.000656
15	0.134580	0.064716	1.492392	0.140661	69.728086	0.000656
20	0.128417	0.064297	1.101128	0.104801	58.221404	0.000656
25	0.121426	0.064076	0.885340	0.083745	51.402641	0.000656
30	0.115055	0.063958	0.757725	0.070073	46.965398	0.000656
35	0.109412	0.063902	0.681705	0.060602	43.921219	0.000656
40	0.104551	0.063889	0.639524	0.053742	41.775878	0.000656
45	0.100460	0.063907	0.621659	0.048610	40.254801	0.000656
50	0.097088	0.063951	0.622622	0.044683	39.193248	0.000656
55	0.094360	0.064016	0.639089	0.041632	38.486381	0.000656
60	0.092206	0.064102	0.668998	0.039241	38.064310	0.000656
65	0.090959	0.064207	0.711095	0.037369	37.878648	0.000613
70	0.090724	0.064332	0.764697	0.035916	37.894835	0.000613
75	0.090882	0.064476	0.829585	0.034815	38.087525	0.000613
80	0.091436	0.064641	0.905957	0.034019	38.437710	0.000613
85	0.092408	0.064829	0.994420	0.033493	38.930853	0.000613
90	0.093834	0.065042	1.096008	0.033213	39.555649	0.000613
95	0.095771	0.065281	1.212219	0.033158	40.303172	0.000613
100	0.098299	0.065549	1.345054	0.033312	41.166281	0.000613
105	0.101530	0.065848	1.497069	0.033660	42.139196	0.000613
110	0.105609	0.066183	1.671426	0.034185	43.217187	0.000613
115	0.110726	0.066555	1.871956	0.034867	44.396348	0.000613
	Lowest emission factor					

Table A2.11

2014 Non-Motorway Speed Emission Factors for Diesel Cars (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	1.539571	0.092836	0.714232	0.157284	110.399656	0.000722
10	0.835316	0.080327	0.357755	0.086527	73.153397	0.000722
15	0.746241	0.076352	0.238750	0.062889	59.656074	0.000722
20	0.675434	0.074488	0.179101	0.051031	52.221235	0.000722
25	0.616402	0.073461	0.143183	0.043885	47.311586	0.000722
30	0.566350	0.072850	0.119122	0.039095	43.748032	0.000722
35	0.523874	0.072480	0.101831	0.035651	41.025245	0.000722
40	0.488200	0.072266	0.088764	0.033049	38.890561	0.000722
45	0.458863	0.072160	0.078509	0.031008	37.203612	0.000722
50	0.435578	0.072137	0.070218	0.029359	35.880176	0.000722
55	0.418161	0.072178	0.063352	0.027996	34.866659	0.000722
60	0.406496	0.072273	0.057550	0.026848	34.127330	0.000722
65	0.400513	0.072414	0.052564	0.025863	33.637453	0.000645
70	0.400177	0.072596	0.048217	0.025009	33.379358	0.000645
75	0.405485	0.072814	0.044379	0.024258	33.340090	0.000645
80	0.416458	0.073068	0.040952	0.023591	33.509929	0.000645
85	0.433155	0.073355	0.037862	0.022993	33.881445	0.000645
90	0.455669	0.073675	0.035050	0.022453	34.448857	0.000645
95	0.484152	0.074031	0.032472	0.021962	35.207604	0.000645
100	0.518835	0.074425	0.030091	0.021512	36.154034	0.000645
105	0.560080	0.074861	0.027878	0.021098	37.285192	0.000645
110	0.608472	0.075347	0.025808	0.020714	38.598660	0.000645
115	0.665010	0.075890	0.023862	0.020356	40.092441	0.000645
	Lowest emission factor					

Table A2.12

2014 Non-Motorway Speed Emission Factors for Petrol LGVs (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	0.777339	0.076206	41.138640	1.733264	266.253004	0.000878
10	0.438363	0.073436	19.840459	0.919698	143.885511	0.000878
15	0.440595	0.072539	12.870714	0.649544	103.743568	0.000878
20	0.443118	0.072116	9.482513	0.515073	84.179961	0.000878
25	0.444099	0.071887	7.526993	0.434837	72.871058	0.000878
30	0.446395	0.071759	6.288221	0.381747	65.713856	0.000878
35	0.449942	0.071691	5.459619	0.344230	60.954123	0.000878
40	0.454668	0.071664	4.888078	0.316523	57.718440	0.000878
45	0.460503	0.071667	4.488674	0.295439	55.524881	0.000878
50	0.467370	0.071694	4.210558	0.279076	54.087279	0.000878
55	0.475194	0.071740	4.021463	0.266233	53.226264	0.000878
60	0.483897	0.071805	3.899959	0.256118	52.824777	0.000878
65	0.494459	0.071887	3.831294	0.248198	52.804117	0.000905
70	0.507377	0.071987	3.805014	0.242105	53.110254	0.000905
75	0.521076	0.072104	3.813554	0.237594	53.705618	0.000905
80	0.535554	0.072239	3.851346	0.234508	54.563963	0.000905
85	0.550814	0.072395	3.914258	0.232759	55.667051	0.000905
90	0.566857	0.072572	3.999220	0.232322	57.002431	0.000905
95	0.583688	0.072773	4.103971	0.233226	58.561930	0.000905
100	0.601310	0.072999	4.226889	0.235551	60.340591	0.000905
105	0.619731	0.073169	4.320145	0.239821	61.956213	0.000905
110	0.638961	0.073359	4.425766	0.245707	63.742504	0.000905
115	0.647290	0.073571	4.543369	0.253424	65.700646	0.000905
	Lowest emission factor					

Table A2.13

2014 Non-Motorway Speed Emission Factors for Diesel LGVs (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	1.854781	0.148007	1.788395	0.468920	225.100667	0.000928
10	1.023064	0.110377	0.894996	0.230291	122.323899	0.000928
15	0.945100	0.098033	0.599081	0.151400	88.632935	0.000928
20	0.875034	0.091996	0.452538	0.112444	72.325873	0.000928
25	0.812465	0.088488	0.365744	0.089462	63.059455	0.000928
30	0.757221	0.086259	0.308824	0.074468	57.385887	0.000928
35	0.709216	0.084783	0.268974	0.064039	53.829518	0.000928
40	0.668400	0.083799	0.239794	0.056462	51.656017	0.000928
45	0.634746	0.083167	0.217728	0.050789	50.462095	0.000928
50	0.608237	0.082809	0.200640	0.046447	50.011395	0.000928
55	0.588859	0.082675	0.187173	0.043075	50.159898	0.000928
60	0.576608	0.082739	0.176422	0.040430	50.818621	0.000928
65	0.571477	0.082988	0.167760	0.038345	51.933537	0.001291
70	0.573466	0.083419	0.160740	0.036700	53.474099	0.001291
75	0.582573	0.084036	0.155033	0.035407	55.426352	0.001291
80	0.598800	0.084852	0.150392	0.034402	57.788630	0.001291
85	0.622151	0.085889	0.146631	0.033633	60.568773	0.001291
90	0.652631	0.087175	0.143601	0.033061	63.782270	0.001291
95	0.690251	0.088746	0.141188	0.032656	67.450985	0.001291
100	0.735023	0.090648	0.139300	0.032393	71.602275	0.001291
105	0.786971	0.092935	0.137860	0.032252	76.268348	0.001291
110	0.846131	0.095672	0.136809	0.032217	81.485806	0.001291
115	0.849622	0.098934	0.136095	0.032274	87.295300	0.001291
	Lowest emission factor					

Table A2.14

2014 Non-Motorway Speed Emission Factors for Rigid HGVs (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	12.948223	0.296657	1.772085	0.357915	432.649243	0.004416
10	8.139042	0.248790	1.300521	0.262834	328.704201	0.004416
15	7.008168	0.218018	0.997464	0.197104	274.215186	0.004416
20	5.725279	0.198973	0.807634	0.155082	242.392967	0.004416
25	4.856808	0.185875	0.674825	0.126074	218.979409	0.004416
30	4.227189	0.176468	0.577870	0.105456	200.141175	0.004416
35	3.751241	0.169586	0.506090	0.090603	184.736588	0.004416
40	3.381383	0.164525	0.453094	0.079838	172.420523	0.004416
45	3.088305	0.160832	0.414639	0.072040	163.046638	0.004416
50	2.852571	0.158203	0.387723	0.066463	156.458811	0.004416
55	2.660529	0.156431	0.370117	0.062616	152.424107	0.004416
60	2.502127	0.155369	0.360082	0.060185	150.624709	0.004416
65	2.369677	0.154909	0.356176	0.058956	150.677069	0.003743
70	2.257096	0.154954	0.357099	0.058760	152.164668	0.003743
75	2.159439	0.155402	0.361561	0.059409	154.678036	0.003743
80	2.072586	0.156126	0.368168	0.060643	157.858847	0.003743
85	1.993026	0.156955	0.375312	0.062071	161.446424	0.003743
90	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
95	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
100	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
105	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
110	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
115	1.977715	0.157659	0.381059	0.063117	165.325706	0.003743
	Lowest emission factor					

Table A2.15

2014 Non-Motorway Speed Emission Factors for Articulated HGVs (g/km)						
Speed km/hour	**NO_X**	**PM_{10}**	**CO**	**VOCs[1]**	**CO_2 as C**	**SO_2[2]**
5	18.194562	0.301965	0.977297	0.221163	717.436548	0.005967
10	11.713468	0.249919	0.722468	0.157856	536.642390	0.005967
15	9.808130	0.218728	0.552138	0.114875	458.203611	0.005967
20	7.692811	0.200282	0.444013	0.088091	415.720881	0.005967
25	6.277918	0.187852	0.368714	0.070148	381.698055	0.005967
30	5.260465	0.178976	0.314403	0.057812	350.513268	0.005967
35	4.498342	0.172465	0.274730	0.049230	321.842252	0.005967
40	3.912728	0.167645	0.245744	0.043212	296.628237	0.005967
45	3.454745	0.164100	0.224803	0.038970	275.839982	0.005967
50	3.091503	0.161556	0.210087	0.035985	260.066242	0.005967
55	2.799433	0.159825	0.200318	0.033932	249.414400	0.005967
60	2.560753	0.158771	0.194576	0.032618	243.535824	0.005967
65	2.361470	0.158288	0.192162	0.031930	241.709723	0.004682
70	2.190164	0.158275	0.192472	0.031794	242.956246	0.004682
75	2.037225	0.158626	0.194887	0.032129	246.165182	0.004682
80	1.894352	0.159211	0.198674	0.032808	250.233429	0.004682
85	1.754204	0.159865	0.202880	0.033614	254.207627	0.004682
90	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
95	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
100	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
105	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
110	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
115	1.725909	0.160373	0.206239	0.034205	257.429948	0.004682
	Lowest emission factor					

Table A2.16

2014 Non-Motorway Speed Emission Factors for Buses (g/km)						
Speed km/hour	NO_X	PM_{10}	CO	VOCs[1]	CO_2 as C	SO_2[2]
5	17.804558	0.364005	2.279490	0.559532	729.166011	0.004652
10	11.369334	0.292586	1.706648	0.352285	470.623171	0.004652
15	9.103103	0.254238	1.277572	0.260647	340.715212	0.004652
20	7.381288	0.232422	1.000317	0.214508	275.590159	0.004652
25	6.223693	0.217424	0.813076	0.182698	236.686306	0.004652
30	5.379883	0.206297	0.683418	0.157685	211.149748	0.004652
35	4.740844	0.197867	0.590862	0.137583	193.471672	0.004652
40	4.248202	0.191520	0.521922	0.121864	180.897669	0.004652
45	3.865789	0.186827	0.467942	0.110115	171.897513	0.004652
50	3.568618	0.183419	0.423747	0.101704	165.553068	0.004652
55	3.337927	0.180959	0.386605	0.095789	161.280066	0.004652
60	3.158698	0.179145	0.355319	0.091454	158.688994	0.004652
65	3.018287	0.177738	0.329364	0.087913	157.510191	0.003503
70	2.905628	0.176594	0.308067	0.084750	157.551040	0.003503
75	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
80	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
85	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
90	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
95	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
100	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
105	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
110	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
115	2.810743	0.175701	0.289795	0.082170	158.670289	0.003503
	Lowest emission factor					

Figure A5.8 NO_X Other Road Traffic Emission Profiles

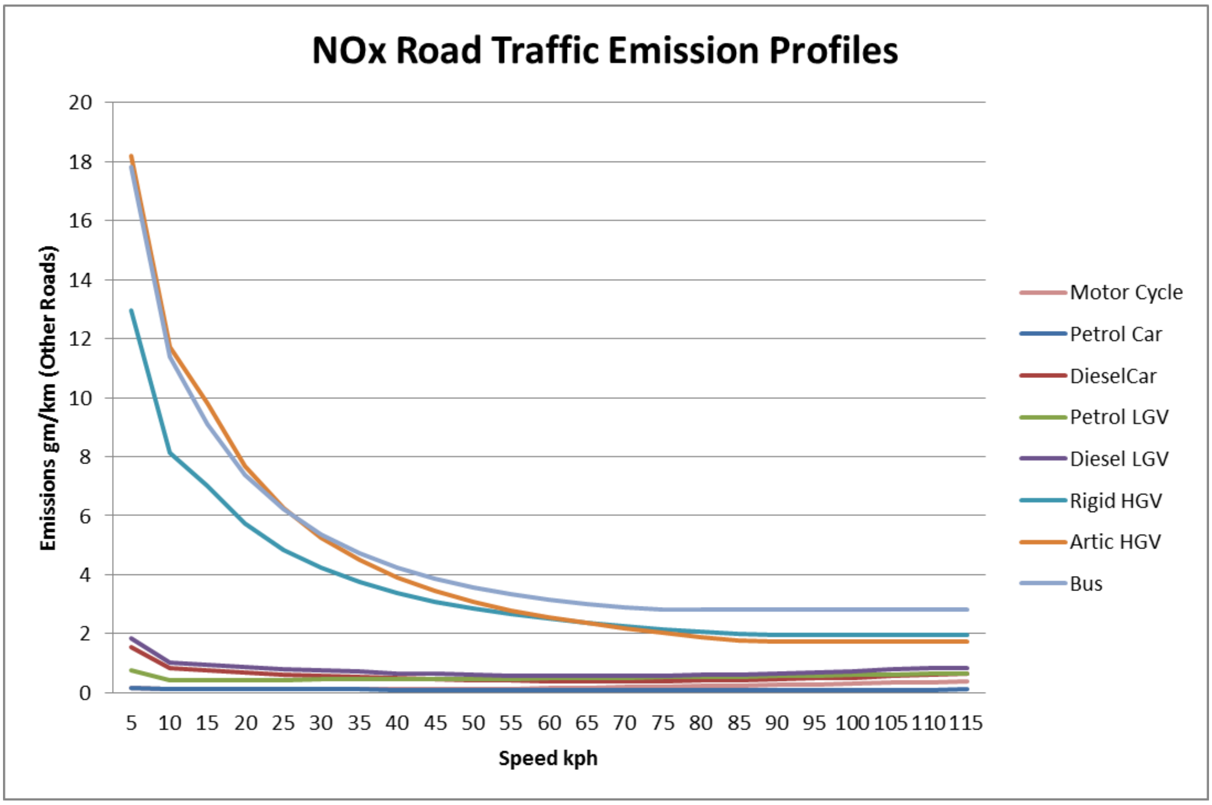


Figure A5.9 PM_{10} Other Road Traffic Emission Profiles

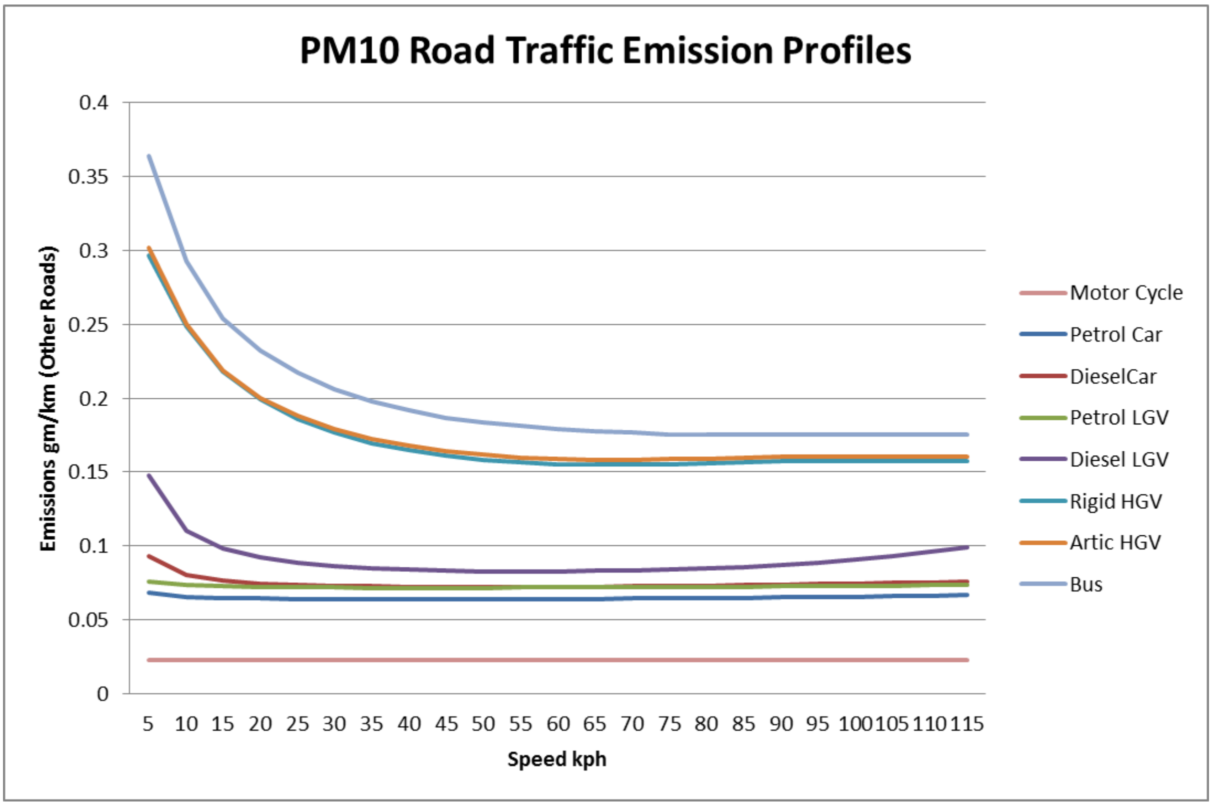


Figure A5.10 CO Other Road Traffic Emission Profiles

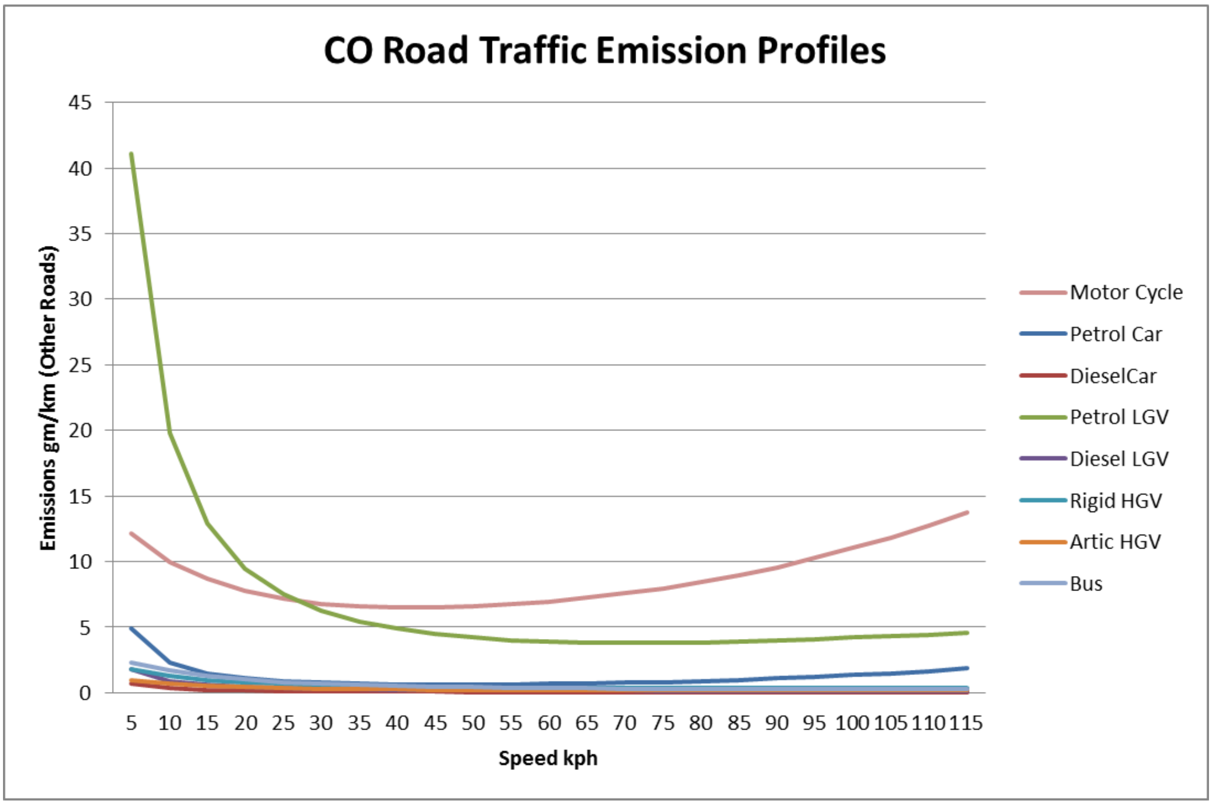


Figure A5.11 VOC Other Road Traffic Emission Profiles

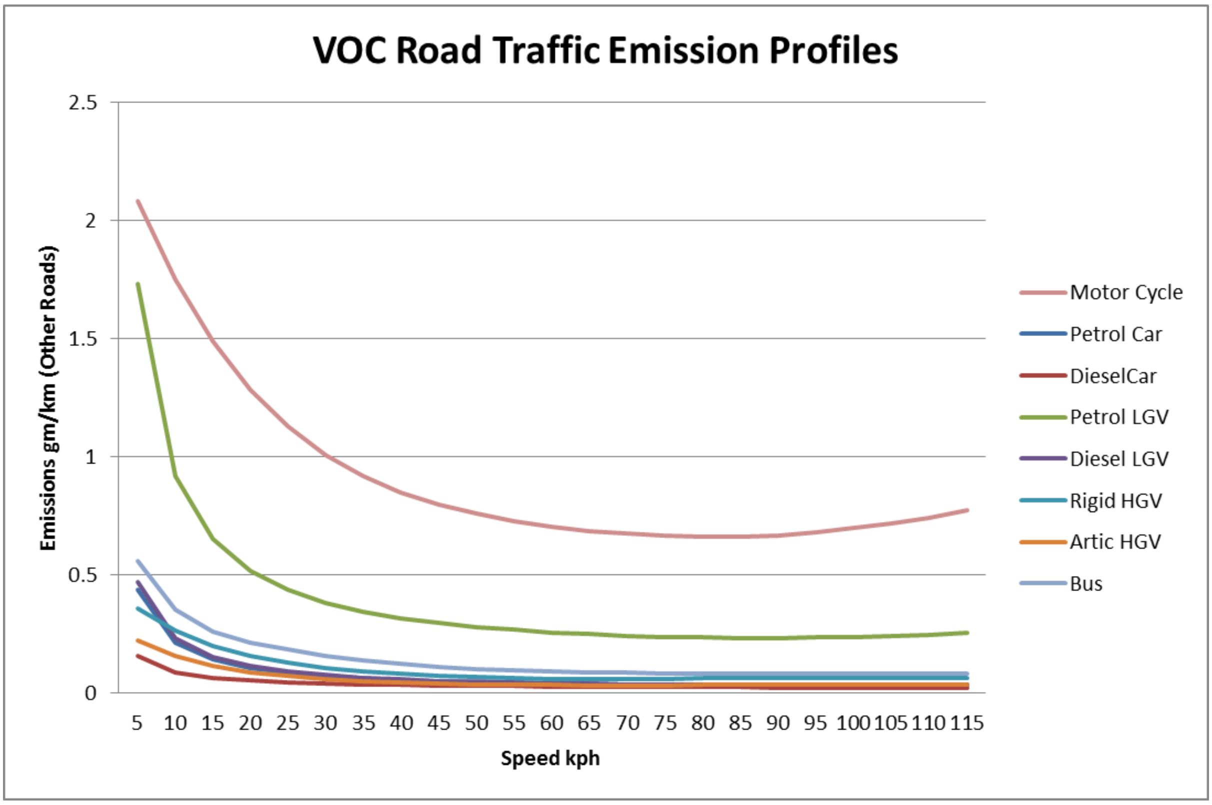


Figure A5.12 NO_2 Other Road Traffic Emission Profiles

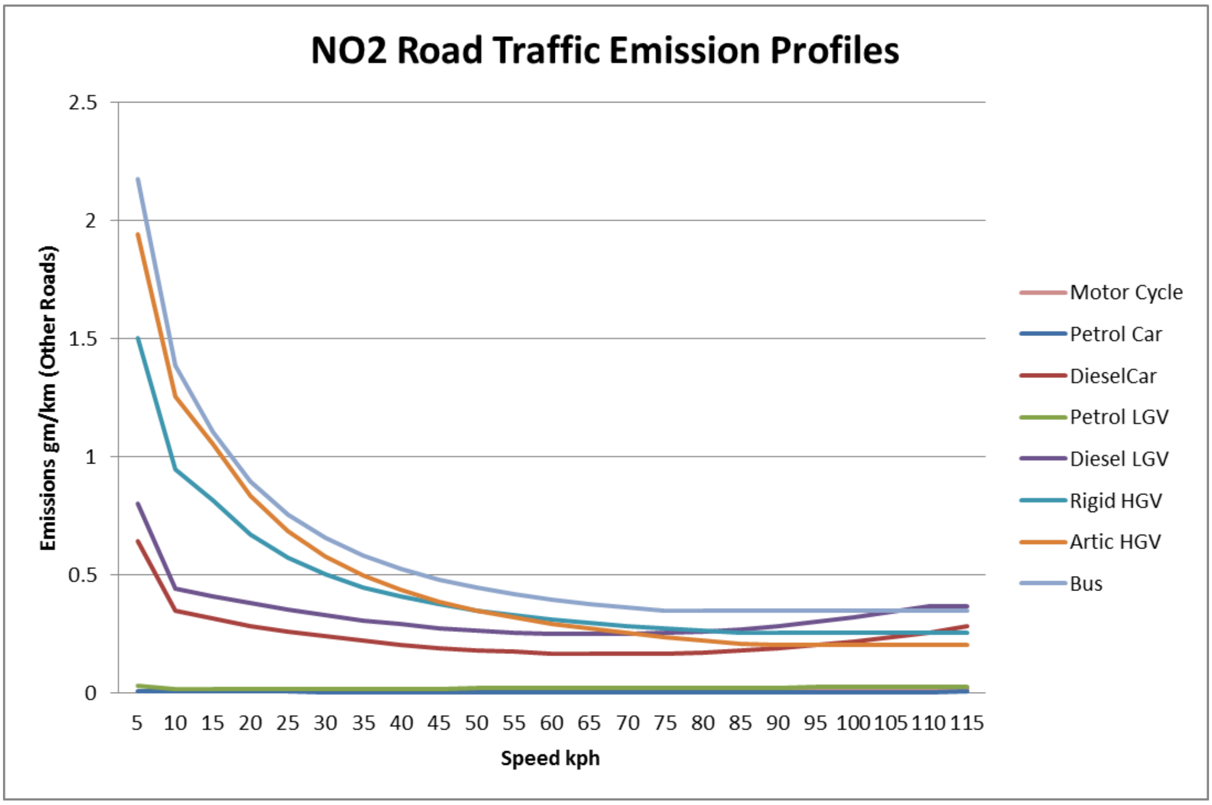


Figure A5.13 Other Road Traffic Fuel Consumption Profiles

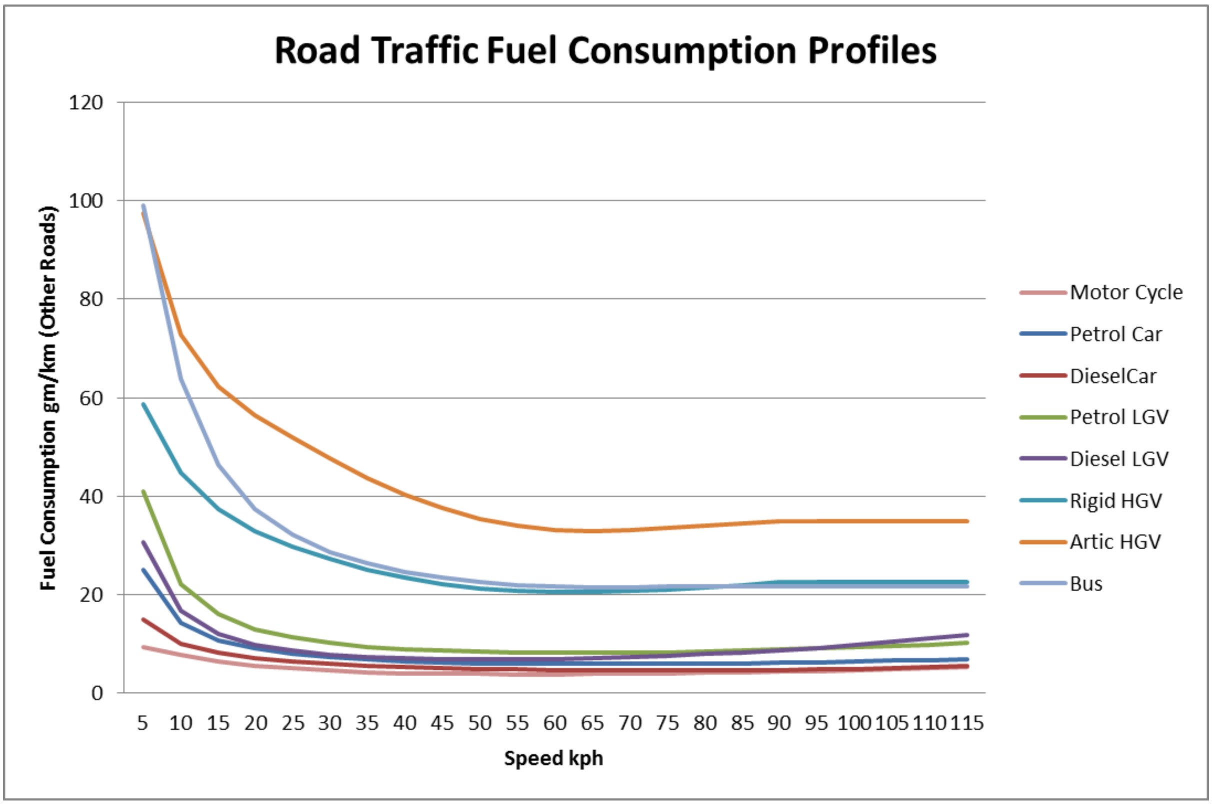


Figure A5.14 CO_2 Other Road Traffic Emission Profiles

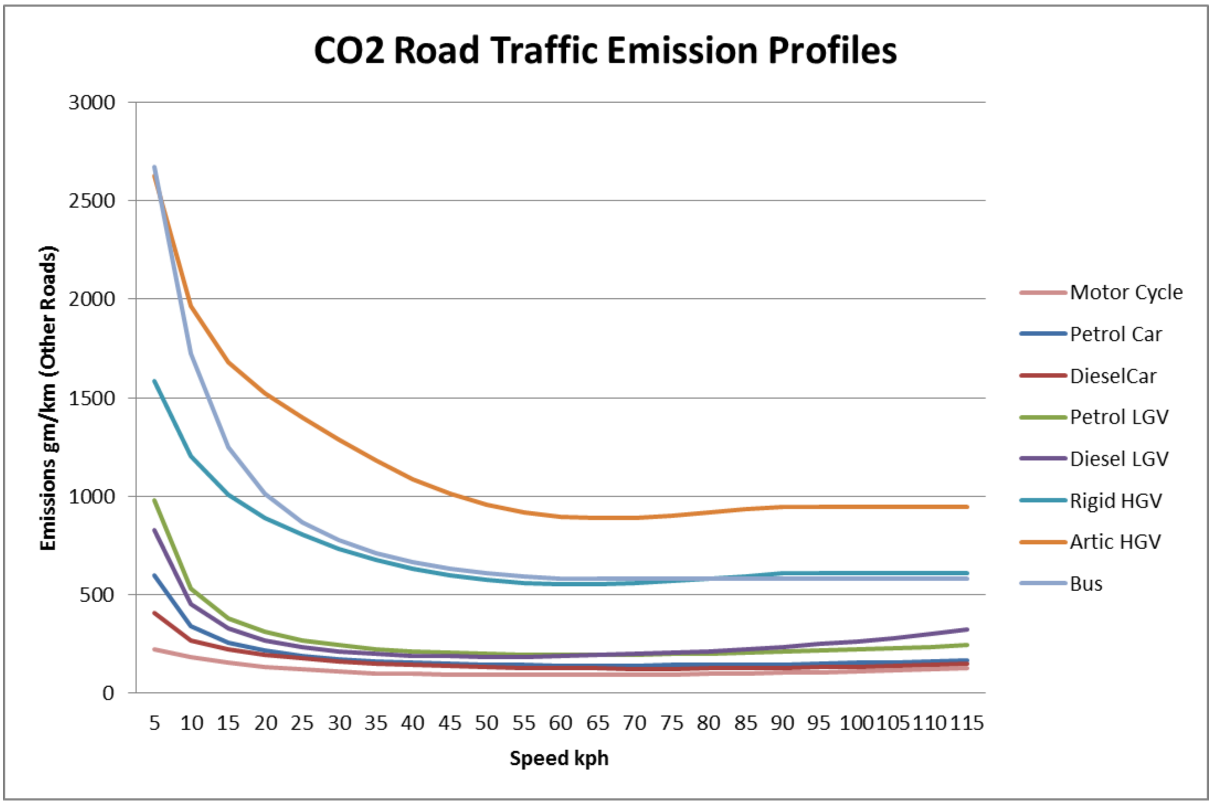


Table A2.17

2014 Fleet Composition Data		
Vehicle Type	**Emission Standard**	**Percentage**
Petrol Cars	Pre-Euro I	0.00
	Euro I (Cat OK)	0.38
	Euro I (Failed Cat)	0.08
	Euro II (Cat OK)	3.54
	Euro II (Failed Cat)	0.75
	Euro III (Cat OK)	25.46
	Euro III (Failed Cat)	0.32
	Euro IV (Cat OK)	31.29
	Euro IV (Failed Cat)	0.39
	Euro V (Cat OK)	37.34
	Euro V (Failed Cat)	0.40
	Euro VI (Cat OK)	0.00
	Euro VI (Failed Cat)	0.00
% by engine size	< 1.4	42.51
	1.4 - 2.0	44.99
	> 2.0	12.50
% Petrol Cars	Motorways	42.89
	Other Roads	56.18
Diesel Cars	Pre-Euro I	0.00
	Euro I	0.16
	Euro II	1.02
	Euro III	12.70
	Euro III + particulate trap	2.55
	Euro IV	25.02
	Euro IV + particulate trap	6.26
	Euro V Combined	52.30
	Euro VI Combined	0.00
% by engine size	< 1.4	8.08
	1.4 - 2.0	62.17
	> 2.0	29.75
% Diesel Cars	Motorways	57.11
	Other Roads	43.82
Petrol LGV	Pre-Euro I	0.19
	Euro I (Cat OK)	1.74
	Euro I (Failed Cat)	0.37
	Euro II (Cat OK)	15.14
	Euro II (Failed Cat)	3.19
	Euro III (Cat OK)	24.92
	Euro III (Failed Cat)	4.96
	Euro IV (Cat OK)	28.15
	Euro IV (Failed Cat)	4.68
	Euro V (Cat OK)	15.64
	Euro V (Failed Cat)	1.02
	Euro VI (Cat OK)	0.00
	Euro VI (Failed Cat)	0.00
% Petrol LGVs		2.94

Diesel LGV	Pre-Euro I	0.05
	Euro I	0.18
	Euro II	1.26
	Euro III	9.16
	Euro IV	35.50
	Euro V (Cat OK)	53.85
	Euro V (Failed Cat)	0.00
	Euro VI (Cat OK)	0.00
	Euro VI (Failed Cat)	0.00
% Diesel LGVs		97.35
Rigid HGVs	Pre-Euro I	0.00
	Euro I	0.00
	Euro II	2.09
	Euro III	19.46
	Euro IV	16.89
	Euro V	42.65
	Euro VI	18.91
Euro V SCR vs EGR	SCR	75.00
	EGR	25.00
% Rigid HGVs (of total HGV)	Motorways	41.33
	Other Roads	74.98
Artic HGVs	Pre-Euro I	0.00
	Euro I	0.00
	Euro II	0.23
	Euro III	5.46
	Euro IV	9.40
	Euro V	54.01
	Euro VI	30.90
% Artic HGV(of total HGV)	Motorways	58.67
	Other Roads	25.02
Buses	Pre-Euro I	0.00
	Euro I	0.76
	Euro II	6.38
	Euro III	25.58
	Euro IV	16.48
	Euro V	37.15
	Euro VI	13.65
Euro V SCR vs EGR	SCR	75.00
	EGR	25.00
Motorcycles (as % of cars)	Motorways	0.37
	Other Roads	0.73

Notes

The traffic flows that are input to EMIGMA do not include motorcycles. Motorcycle flows are treated as additional volumes, expressed as a percentage of the input car flows.

The Petrol/Diesel splits for cars and LGVs have been obtained from NAEI Reference 7).

The Rigid/Articulated HGV percentages are used to convert from assigned OGV flows to Rigid/Artic HGV volumes, by road type. These figures have been calculated from traffic count data from Reference 8.

Table A2.18

2014 EMIGMA Road Traffic Expansion Factors						
Hour to Period Factors						
	Motorways			**Other Roads**		
	AM Peak	**Off-Peak**	**PM Peak**	**AM Peak**	**Off-Peak**	**PM Peak**
Cars/Motorcycles	2.877	9.822	2.813	2.643	9.465	2.764
LGVS	3.220	9.822	3.133	3.095	9.465	3.027
OGVS	3.165	9.822	3.221	3.030	9.465	3.216
Buses	3.505	9.822	3.234	2.866	9.465	3.079

Weekday to Saturday/Sunday/Bank Holiday Factors		
	Motorways	**Other Roads**
Weekday Off-Peak Period - Saturday	1.322	1.439
Weekday Off-Peak Period - Sunday	1.209	1.188
Weekday Off-Peak Period – Bank Holiday	1.209	1.188

Day Factors	
Average Weekday – Annual Weekdays	253
Saturday – Annual Saturdays	52
Sunday – Annual Sundays	52
Bank Holiday – Annual Bank Holidays	8

Notes:

AM peak period = 0700-1000
PM peak period = 1600-1900
Off-peak period = 0000-0700 + 1000-1600 + 1900-2400

Table A2.19

2014 Fleet-Weighted Cold Start Emission Factors (g/trip)		
Vehicle Type	**Pollutant**	**Factor**
Petrol Car	NMVOCs CO NO_X PM_{10}	0.301435 9.743505 0.179850 -
Diesel Car	NMVOCs CO NO_X PM_{10}	0.049037 0.149001 0.349793 0.060782
Petrol LGV	NMVOCs CO NO_X PM_{10}	0.901966 32.707231 0.410902 -
Diesel LGV	NMVOCs CO NO_X PM_{10}	0.133447 0.497962 0.295732 0.090765

Notes:

2014 cold start emission factors were not available at the time the 2014 EMIGMA update was carried out. 2014 factors were therefore estimated by applying the percentage change in warm running emission factors (at a speed of 40 kph) to 2012 cold start factors from the NAEI April 2016.

Table A2.20

2014 Fleet-Weighted Hot Soak Emission Factors (g/trip)		
Vehicle Type	**Pollutant**	**Factor**
Petrol Car	NMVOCs	0.059372
Petrol LGV	NMVOCs	0.222997

Notes:

2014 hot soak factors were not available at the time the 2014 EMIGMA update was carried out. 2014 factors were therefore estimated by applying the percentage change in warm running emission factors (at a speed of 40 kph) to 2012 hot soak factors from the NAEI April 2016.

Appendix 3 Emission Factors for Domestic and Commercial Combustion

The following tables show the comparison of the 2007 to 2008 emission factors used for the calculation of the domestic and commercial combustion

Table A3.1 Domestic Gas Combustion Emission Factors

Table A3.2 Domestic Coke Combustion Emission Factors

Table A3.3 Domestic Oil Combustion Emission Factors

Table A3.4 Commercial Gas Combustion Emission Factors

Table A3.1

Domestic Gas Combustion Emission Factors						
Pollutant	Factor (kilotonne per Megatherm fuel consumed)			Factor (kilotonne per kWh fuel consumed)		
	2010	2011	2013	2010	2011	2013
CO_2	1.5	1.5	1.5	5.12E-08	5.01E-08	5.03E-08
CH_4	5.30E-04	5.28E-04	4.75E-04	1.81E-11	1.8E-11	1.62E-11
CO	3.20E-03	3.25E-03	3.25E-03	1.09E-10	1.11E-10	1.11E-10
NO	1.10E-05	1.06E-05	9.50E-06	3.75E-13	3.60E-13	3.24E-13
NO_X as NO_2	2.30E-03	2.31E-03	2.24E-03	7.85E-11	7.87E-11	7.66E-11
NMVOCs	2.40E-04	2.35E-04	2.35E-04	8.19E-12	8.02E-12	8.02E-12
C_6H_6	2.10E-05	2.12E-05	2.12E-05	7.17E-13	7.22E-13	7.22E-13
PM_{10}	5.30E-05	5.28E-05	5.28E-05	1.81E-12	1.80E-12	1.80E-12

Notes

Using 1 therm = 105.506MJ = 29.307kWh, 1 megatherm = 29.307e6 kWh

Table A3.2

Domestic Coke Combustion Emission Factors			
Pollutant	**Emission factor (kilotonne per Megatonne fuel consumed)**		
	2010	**2011**	**2013**
CO_2	850	847	859
CH_4	5.8	5.8	5.8
CO	120	100	145
NO	0.12	0.12	0.12
NO_X as NO_2	3	3	3.99
NMVOCs	4.9	4.9	4.9
C_6H_6	0.22	0.22	0.22
PM_{10}	3	3	1.7
SO_2	15	13	14

Table A3.3

Domestic Oil Combustion Emission Factors			
Pollutant	**Emission factor (kilotonne per Megatonne fuel consumed)**		
	2010	**2011**	**2013**
CO_2	880	879	879
CH_4	0.43	0.43	0.41
CO	0	0	0
NO	0.026	0.026	0.24
NO_X as NO_2	0	0	0
NMVOCs	0.14	0.14	0.14
C_6H_6	0.0069	0.0069	0
PM_{10}	0	0	0
SO_2	15	15	15

Table A3.4

Commercial Gas Combustion Emission Factors						
Pollutant	**Factor (kilotonne per Megatherm fuel consumed)**			**Factor (kilotonne per kWh fuel consumed)**		
	2010	**2011**	**2013**	**2010**	**2011**	**2013**
CO_2	1.50	1.50	1.5	5.12E-08	5.12E-08	5.03E-08
CH_4	5.30E-04	5.30E-04	4.75E-04	1.81E-11	1.81E-11	1.62E-11
CO	1.50E-03	1.50E-03	1.05E-03	5.12E-11	5.12E-11	3.58E-11
NO	1.10E-05	1.10E-05	9.50E-06	3.75E-13	3.75E-13	3.24E-13
NO_X as NO_2	6.10E-03	6.10E-03	5.33E-03	2.08E-10	2.08E-10	1.82E-10
NMVOCs	2.40E-04	2.40E-04	2.35E-04	8.19E-12	8.19E-12	8.02E-12
C_6H_6	2.10E-05	2.10E-05	2.14E-05	7.17E-13	7.17E-13	7.29E-13
PM_{10}	9.60E-05	9.60E-05	8.06E-05	3.28E-12	3.28E-12	2.75E-12

Notes

Using 1 therm = 105.506MJ = 29.307kWh, 1 megatherm = 29.307e6 kWh

Appendix 4 Emission Factors for Light Aircraft and Helicopters

Table A5.1 shows the emission factors used for the calculation of the emissions from light aircraft and helicopters from City Airport Manchester

Table A4.1

Light Aircraft Emission Factors					
Aircraft Weight categories	**Aircraft assumed**	**Engine Assumed**	**Combined Emission Factor g/LTO**		
			HC	**CO**	**NO_X**
Aircraft upto 450kg (Microlights)	-	Rotax 912	46.8	940	33
Aircraft 451kg - 1200kg	-	Lycoming IO-360-A1B6	102	4922	5
Helicopters < 1200kg (Piston)	Enstrom 280c	HIO-360	102	6591	14
Helicopters > 1200kg (Turbine)	Eurocopter AS 350 Ecureuil	Arriel 1B	294	375	129

Notes

LTO refers to Landing and Take Off

Appendix 5 Emission Factors for Agriculture

Table A5.1 shows the emission factors used for the calculation of the methane emissions from livestock

Table A5.1

Methane Emission Factors			
Description	**Enteric Fermentation**	**Manure Management**	**Combined Emission Factor**
Dairy cows	100	14	114
Other cattle	48	6	54
Pigs	1.5	3	4.5
Sheep	8	0.19	8.19
Goats	5	0.12	5.12
Poultry	Not relevant	0.078	0.078

Notes

Emission factors in kilograms of CH_4 per animal

Appendix 6 Emission Factors for Rail

Table A6.1 shows the emission factors for each train class. These were obtained from the Rail Emission Model report on the DfT website (Reference 21)

Table A6.1

Rail Emission Factors						
Train type (class)	**CO_2**	**SO_2**	**VOCs**	**CO**	**PM_{10}**	**NO_X**
Class 37	11270	14.3	12.1	24.5	5.1	51.8
Class 47	16723	21.3	30.8	26.1	5.1	80.1
Class 56	21441	27.3	21.6	43.2	5.1	129.6
Class 58	21441	27.3	11.6	22.5	5.1	103.5
Class 60	20154	25.7	10.4	21.6	4.7	129.6
Class 66	19147	24.4	17.3	6.8	2.9	120
Class 67	9277	11.8	10.6	3.8	1.6	66.7
Class 47+7 passenger coaches	9764	12.4	11.1	39.9	5.1	127.6
Class 101 (1PC + 1TC)	2606	3.3	2.5	2.6	0.9	26.5
Class 116 (2PC + 0TC)	2420	3.1	2.3	2.4	0.8	24.6
Class 117 (2PC + 1TC)	3351	4.3	3.2	3.4	1.1	34.1
Class 121 (1PC + 0TC)	1564	2	1.5	1.6	0.5	15.9
Class 122 (1PC + 0TC)	1713	2.2	1.7	1.7	0.6	17.4
IC125 (2PC)	12170	31	29.1	56.2	17	194.8
Class 141/1 (2PC + 0TC)	2085	2.7	2	2.1	0.7	21.2
Class 143/6 (2PC + 0TC)	2011	2.6	1.9	2	0.7	20.5
Class 144 (2PC + 0TC)	1862	2.4	1.8	1.9	0.6	18.9
Class 144 (3PC + 0TC)	2606	3.3	2.5	2.6	0.9	26.5
Class 150 (3PC + 0TC)	3202	4.1	3.1	3.2	1.1	32.6
Class 153/0 (1PC + 0TC)	1415	1.8	1.4	1.4	0.5	14.4
Class 156 (2PC + 0TC)	2234	2.8	2.2	2.2	0.7	22.7
Class 156 (3PC + 0TC)	2904	3.7	2.8	2.9	1	29.5
Class 158/0 (2PC + 0TC)	2793	3.6	2.7	2.8	0.9	28.4
Class 158/0 (3PC + 0TC)	3723	4.7	3.6	3.7	1.2	37.9
Class 159/0 (3PC + 0TC)	3723	4.7	3.6	3.7	1.2	37.9
Class 165 (2PC + 0TC)	1824	2.3	1.8	1.8	0.6	18.6
Class 165 (3PC + 0TC)	2979	3.8	2.9	3	1	30.3
Class 166/0 (3PC + 0TC)	2979	3.8	2.9	3	1	30.3
Class 221 (1PC + 3TC)	2594	3.3	2.5	8.2	0.9	26.8
Siemens future diesel 3 car unit	5570	7.1	5.4	5.6	1.8	56.7

Notes

Emission factors in g/km

Appendix 7 Associated Files

Table A7.1 shows the associated files that are available for Local Authority use only.

Table A7.1

Associated Files
ESRI\Rail\RailLinks2015_polyline.shp
ESRI\Rail\RailLinks2015_polyline.shx
ESRI\Rail\RailLinks2015_polyline.dbf
ESRI\Rail\RailLinks2015_polyline.prj
ESRI\area\other14_rectangle.shp
ESRI\area\other14_rectangle.shx
ESRI\area\other14_rectangle.dbf
ESRI\area\other14_rectangle.prj
ESRI\Airport\Manchester Airport 2014 Data.xlsx
ESRI\Airport\City Airport 2014 Data.xls
ESRI\Roads\RoadTotal_rectangle.shp
ESRI\Roads\RoadTotal_rectangle.shx
ESRI\Roads\RoadTotal_rectangle.dbf
ESRI\Roads\RoadTotal_rectangle.prj
ESRI\Roads\RoadTotal_region.shp
ESRI\Roads\RoadTotal_region.shx
ESRI\Roads\RoadTotal_region.dbf
ESRI\Roads\RoadTotal_region.prj
ESRI\Roads\ColdStartEmissions2014ByGrid_polyline.shp
ESRI\Roads\ColdStartEmissions2014ByGrid_polyline.shx
ESRI\Roads\ColdStartEmissions2014ByGrid_polyline.dbf
ESRI\Roads\ColdStartEmissions2014ByGrid_polyline.prj
ESRI\Roads\MinorRoadEmissions2014ByGrid_rectangle.shp
ESRI\Roads\MinorRoadEmissions2014ByGrid_rectangle.shx
ESRI\Roads\MinorRoadEmissions2014ByGrid_rectangle.dbf
ESRI\Roads\MinorRoadEmissions2014ByGrid_rectangle.prj
ESRI\Roads\MinorRoadEmissions2014ByGrid_region.shp
ESRI\Roads\MinorRoadEmissions2014ByGrid_region.shx
ESRI\Roads\MinorRoadEmissions2014ByGrid_region.dbf
ESRI\Roads\MinorRoadEmissions2014ByGrid_region.prj
ESRI\Roads\MajorRoadEmissions2014ByGrid_rectangle.shp
ESRI\Roads\MajorRoadEmissions2014ByGrid_rectangle.shx
ESRI\Roads\MajorRoadEmissions2014ByGrid_rectangle.dbf
ESRI\Roads\MajorRoadEmissions2014ByGrid_rectangle.prj
ESRI\Roads\MajorRoadEmissions2014ByGrid_region.shp
ESRI\Roads\MajorRoadEmissions2014ByGrid_region.shx
ESRI\Roads\MajorRoadEmissions2014ByGrid_region.dbf
ESRI\Roads\MajorRoadEmissions2014ByGrid_region.prj
ESRI\Roads\MajorRoadEmissions2014_polyline.shp
ESRI\Roads\MajorRoadEmissions2014_polyline.shx
ESRI\Roads\MajorRoadEmissions2014_polyline.dbf
ESRI\Roads\MajorRoadEmissions2014_polyline.prj
ESRI\Roads\HotSoakEmissions2014ByGrid_region.shp
ESRI\Roads\HotSoakEmissions2014ByGrid_region.shx
ESRI\Roads\HotSoakEmissions2014ByGrid_region.dbf
ESRI\Roads\HotSoakEmissions2014ByGrid_region.prj
ESRI\Roads\ShapedMajorAWT2014_polyline.shp
ESRI\Roads\ShapedMajorAWT2014_polyline.shx
ESRI\Roads\ShapedMajorAWT2014_polyline.dbf
ESRI\Roads\ShapedMajorAWT2014_polyline.prj
ESRI\Totals\totalff_rectangle.shp
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MapInfo\area\other14.ID
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MapInfo\Bus stations\Bus Station Departures (Period 9 2012_13).xls
MapInfo\Bus stations\BusStationData2014.DAT
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Appendix 8 Sample from the EMIGMA website and Emission Factor Handbook

The following pages give a sample screenshot from the EMIGMA data entry website and sample pages from the EMIGMA Industrial Air Pollutant Emissions Sources Emission Factor Handbook (Reference 18).

Sample EMIGMA website data entry screen

Emigma point sources : 2010 update

Submissions for All authorities

Edit submission

Basics

site My Factory (My factory House, Factory Lane, Anyshire)

process Combustion: Combustion

location X-coordinate 384636.000 Y-coordinate 397984.000 find on map

last updated 12/11/2012 by Emigma Administration

comments (optional)

submission complete

Emission factor calculations

Emission rates, measured in kt/Mt are taken from NAEI. Emissions, E, are calculated using the formula E=EF*M, where EF is the emission factor and M is the amount of fuel consumed.

Emission factor rating **B**

Natural Gas 100 kilotherm Enter the amount of fuel consumed annually.

A enter the rating of the input data used above help

Monitoring and stack details

Enter emissions in grammes per second

add stack

Annual Emissions from Environment Agency Pollution Inventory

Emission Rate (tonnes per annum)

pollutant	Black Smoke	CO_2 as C	CH_4	CO	NO	NO_2	SO_2	NMVOC	Hg	Pb	Benzene	PM10	B[a]P
emissions													

Emission Results (t)

Method for calculating results

use Emission factor calculations refresh

pollutant	Black Smoke	CO_2 as C	CH_4	CO	NO	NO_2	SO_2	NMVOC	Hg	Pb	Benzene	PM10	B[a]P
values used	0.00E+00	1.50E+02	5.30E-02	1.50E-01	1.10E-03	0.00E+00	0.00E+00	2.40E-02	0.00E+00	0.00E+00	2.10E-03	9.60E-03	0.00E+00

Overall rating **A**

cancel save save and close delete submission

Debugging information

submissionID
siteID 0

6 PG 2/03 ELECTRICAL, CRUCIBLE AND REVERBERATORY FURNACES

PG /NOTE:	PG2/03 Electrical, Crucible and Reverberatory Furnaces
PPC SECTOR:	2.2
SNAP CODE:	030302

6.1 Activities included

This chapter refers to emissions from electric arc (under 7 tonnes), induction, crucible, resistance and reverberatory furnaces in which iron, steel or ferrous alloys are melted, refined, held or poured. This chapter also covers the melting of nickel and cobalt alloys, except for nickel alloy processes with a furnace, bath or vessel with a designed holding capacity of 5 tonnes or more.

This chapter also covers emissions from the pouring of metal into a ladle and metal treatments undertaken in the furnace or ladle. These treatments include nodularisation with magnesium to produce ductile iron and carburisation using a carbon source.

Refining ladles are refractory lined containers specially designed for treating the molten metal outside the melting furnace. They can be equipped with a heating system (electric arc or induction).

Nodularisation is the addition to the melt of an alloy containing magnesium. It produces a ductile iron by promoting the formation of graphite in the nodular or spheroidal form. White magnesium oxide fume is produced. There is a choice of techniques which should meet the emission requirements depending upon the process specific circumstances; they include:

i) a Tundish cover for the ladle.
ii) use of totally enclosed flow through treatment boxes.
iii) magnesium addition in the mould.
iv) use of magnesium - containing wire feed process.
v) collection of the emission followed by arrestment in a bag filtration system.

6.2 Emissions

The key emissions from these processes that constitute pollution for the purposes of the Pollution Prevention and Control Regulations 2000 are those consisting of particulate matter, metallurgical fume and products of combustion.

Particulate Matter

The following parts of the process may give rise to particulate matter in the form of dust:

- Transfer of potentially dusty materials including charge material.
- Handling of dross and ash in non ferrous processes.
- Furnace charging and tapping operations.

Other pollutants

The following parts of the process may give rise to other pollutants:

- Charging, melting, metal treatment and pouring may give rise to metallurgical fume emissions.
- Smoke arises in the event of poor (or incomplete) combustion.
- Smoke may arise from contaminants such as oil or paint burning off the scrap.

6.3 Emission Factor

Source of Emission Factor: UK National Atmospheric Emissions Inventory

Emission Factor Used: "Iron and Steel (Electric Arc Furnaces)"

Description: This emission factor covers emissions of by-products of combustion due to oxidation of organic matter in scrap material fed to electric arc furnaces.

Units: Kilotonne of pollutant / Mt material produced

Note: There are separate PG notes which cover hot and cold blast cupolas and rotary furnaces (PG2/5), and zinc and zinc alloy processes (PG2/7). There are separate chapters which cover casting, grinding and fettling, finishing and other foundry operations. See Table 6.2**Error! Reference source not found.**. IF THE PROCESS IS COVERED BY 2 OR MORE PG NOTES ENSURE AN EMIGMA SPREADSHEET IS COMPLETED FOR EACH NOTE.

Table 6.1 Emission Factors Electrical, crucible and reverberatory furnaces Emission factors are expressed as kilotonne of pollutant/Mt material produced)

Pollutant	CO_2 as C	CH_4	CO	NO	NO_2	SO_2	NMVOC	Hg	Pb	Benzene
Factor	3.6	0.01	1.25	0.005	0.2	0.09	0.0000553	0.00587	0.16	0.01

Table 6.2 Chapter References

PG Note	Title	Refer to Chapter
PG2/4	Iron, Steel and Non-Ferrous Metal Foundry Processes	7
PG2/6a	Processes Melting and Producing Aluminium and its Alloys	8
PG2/6b	Processes Melting and Producing Magnesium and its Alloys	9
PG2/8	Copper and Copper Alloy Processes	10

6.4 Emission Factor Rating

The emission factor rating for PG2/3 Electrical, crucible and reverberatory furnaces is C.

6.5 Weakest Aspects/Priority Areas For Improvement In Current Methodology

Emission Factor/s

The NAEI has not provided information on how the emission factors for Iron and Steel (Electric Arc Furnaces) have been derived.

EMIGMA

Historically data entered in EMIGMA did not differentiate between raw material and material produced. Data entered must relate to the amount of metal melted per annum.

6.6 Checklist

The checklist in Appendix 1 should be used in conjunction with the information in this chapter to ensure that data is entered correctly into EMIGMA.

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Ian Hull	ian.hull@tfgm.com	0161 244 1454

Version	Change	Reason for Change	Date
0.1	Draft		April 2016
0.2	Draft	Road traffic sections reviewed Tony Morris	04/05/2016
0.3	Draft	Inclusion of emission factor profile charts	13/05/2016
0.4	Draft	Add associated files data	24/05/2016