Transport for Greater Manchester

Highways Forecasting and Analytical Services

The Greater Manchester Emissions Inventory 2007 Update

HFAS Report 1679 October 2011

Summary

This report describes the 2007 update of the atmospheric **em**issions **i**nventory for **G**reater **Ma**nchester, EMIGMA. The 2007 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 2007. This is the eleventh year of updates. The updates prior to 2004 were undertaken by the Centre for Air Transport and the Environment (CATE), formerly called ARIC.

The 2007 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

2. The 2007 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 do not have much 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. For the 2006 update HFAS have 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 2007 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 14)
- update and recalculation of domestic and commercial combustion emissions;
- update and recalculation of bus stations emissions
- update and recalculation of rail 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 of CO_2 from electricity generation at the point of use
- the inclusion of emissions from City Airport Manchester (formerly Barton Aerodrome)
- an update of the inventory for 2007

This report gives details of the maintenance and update activities that have been undertaken by HFAS and presents the results of the 2007 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 2007 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 references are contained in Section 5. 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 2007 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 the roads as opposed to the junctions.

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

Loaded network files for input to the EMIGMA database were created by assigning the separate 2007 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.

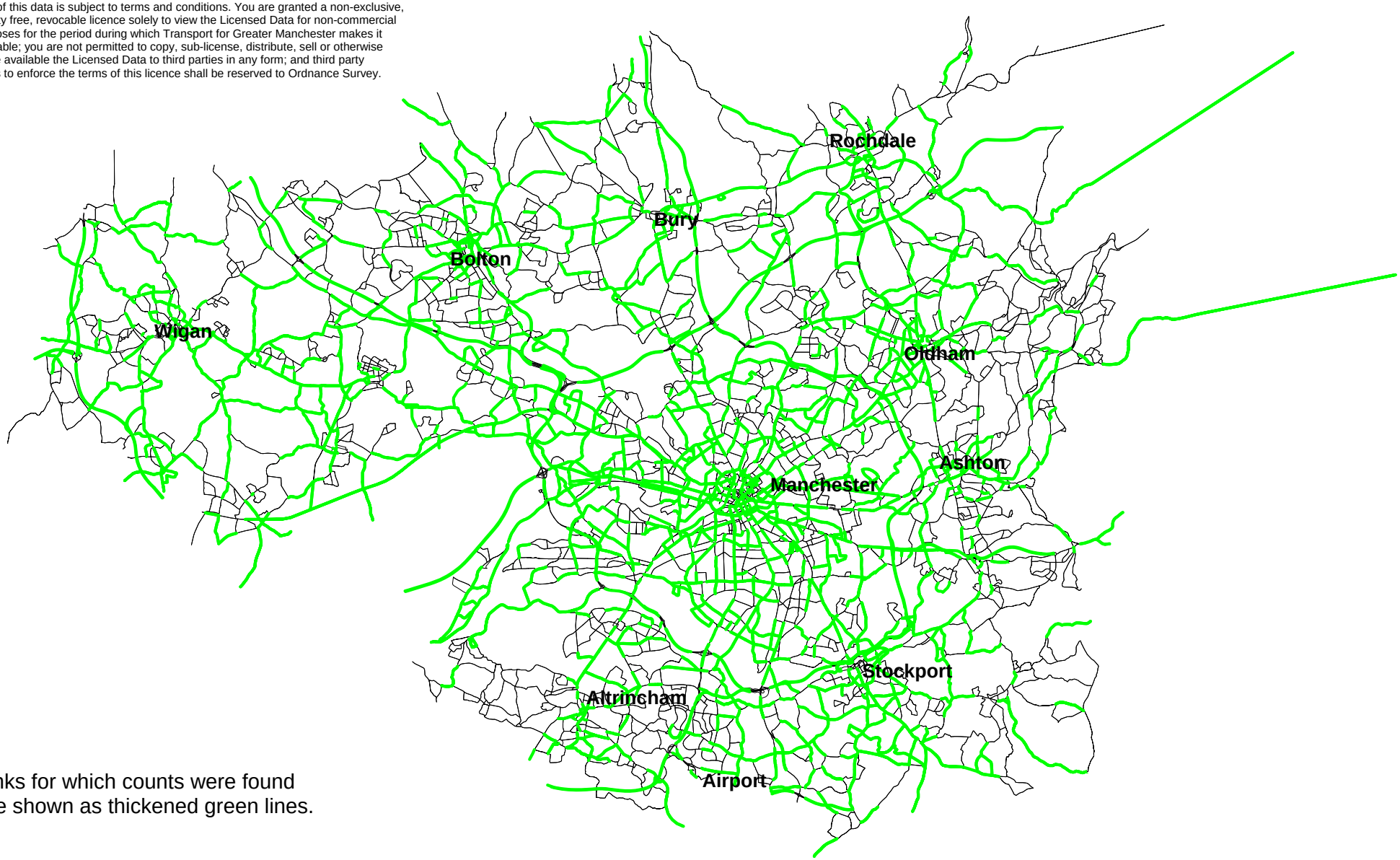
Once the networks had been converged, the assigned PCU flows for the separate car, LGV and OGV matrices were converted back to vehicles and saved in a format suitable for input to the EMIGMA database using software written by HFAS.

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 2004 and the present day.

The 1st January 2004 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 41 percent of the links in the network, representing 43 percent of the network mileage. 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 2007 was chosen. The selected counts were then factored to the 2007 October average weekday using 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.



Links for which counts were found are shown as thickened green lines.

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2007 EMIGMA Road Traffic Update Counted Links

Drawn By : I Hagyard	Scale : Not Applicable	Date : November 2011	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 2007 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 in Table 3.1.

3.1.1.5 Emission Estimates

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

- VOCs
- CO
- CO_2
- NO_X
- SO_2
- Benzene
- 1,3 Butadiene
- 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 three 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
- the DTLR's publication, Transport Statistics Great Britain 2007 Edition, (Reference 8), which provides details of the petrol/diesel car/LGV split
- GMTU Report 1387, Transport Statistics Greater Manchester 2007, (Reference 9), which provides details of the percentage of rigid/articulated HGVs by road type

The emission factors were calculated by combining the fleet composition projections with speed emission coefficients from the NAEI website (Reference 14). The

calculated factors are shown in Table A2.1-Table A2.8 of Appendix 2. The fleet composition data are shown in Table A2.9.

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 A2.10. 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. GMTU Report 1387 (Reference 9) contains more detailed information on traffic flows and traffic growth.

Table 3.1

2007 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 2007 Vehicle Kilometres on Motorways by District					
District	**Annual Vehicle Kilometres (Millions)**				
	Car	**LGV**	**OGV**	**Bus**	**All Motors**
Bolton	426	87	55	1	571
Bury	537	130	101	2	771
Manchester	506	87	52	1	649
Oldham	131	33	18	0	183
Rochdale	567	131	132	2	834
Salford	768	156	143	1	1,071
Stockport	349	70	42	1	463
Tameside	283	60	36	1	380
Trafford	323	59	36	0	421
Wigan	396	73	74	2	547
Total	4,286	885	689	12	5,889

Notes

The all motors figures include motorcycles.

Table 3.3

Modelled 2007 Vehicle Kilometres on Other Major Roads by District					
District	**Annual Vehicle Kilometres (Millions)**				
	Car	**LGV**	**OGV**	**Bus**	**All Motors**
Bolton	883	147	39	16	1,091
Bury	511	76	19	9	618
Manchester	1,337	193	51	41	1,632
Oldham	590	96	29	12	731
Rochdale	562	91	26	10	693
Salford	701	124	40	13	883
Stockport	921	134	37	13	1,112
Tameside	527	93	30	10	664
Trafford	670	98	28	9	811
Wigan	941	164	55	18	1,186
Total	7,643	1,216	355	151	9,421

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 11).

Full details of the procedure are given in Reference 11. 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 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 destinate 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 A2.9 of Appendix 2.

The fleet-weighted 2007 hot soak emission factors were obtained from the NAEI

website (Reference 14), as shown in Table A2.12.

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 A2.10. 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 A2.11. 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, 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 12). 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 13.

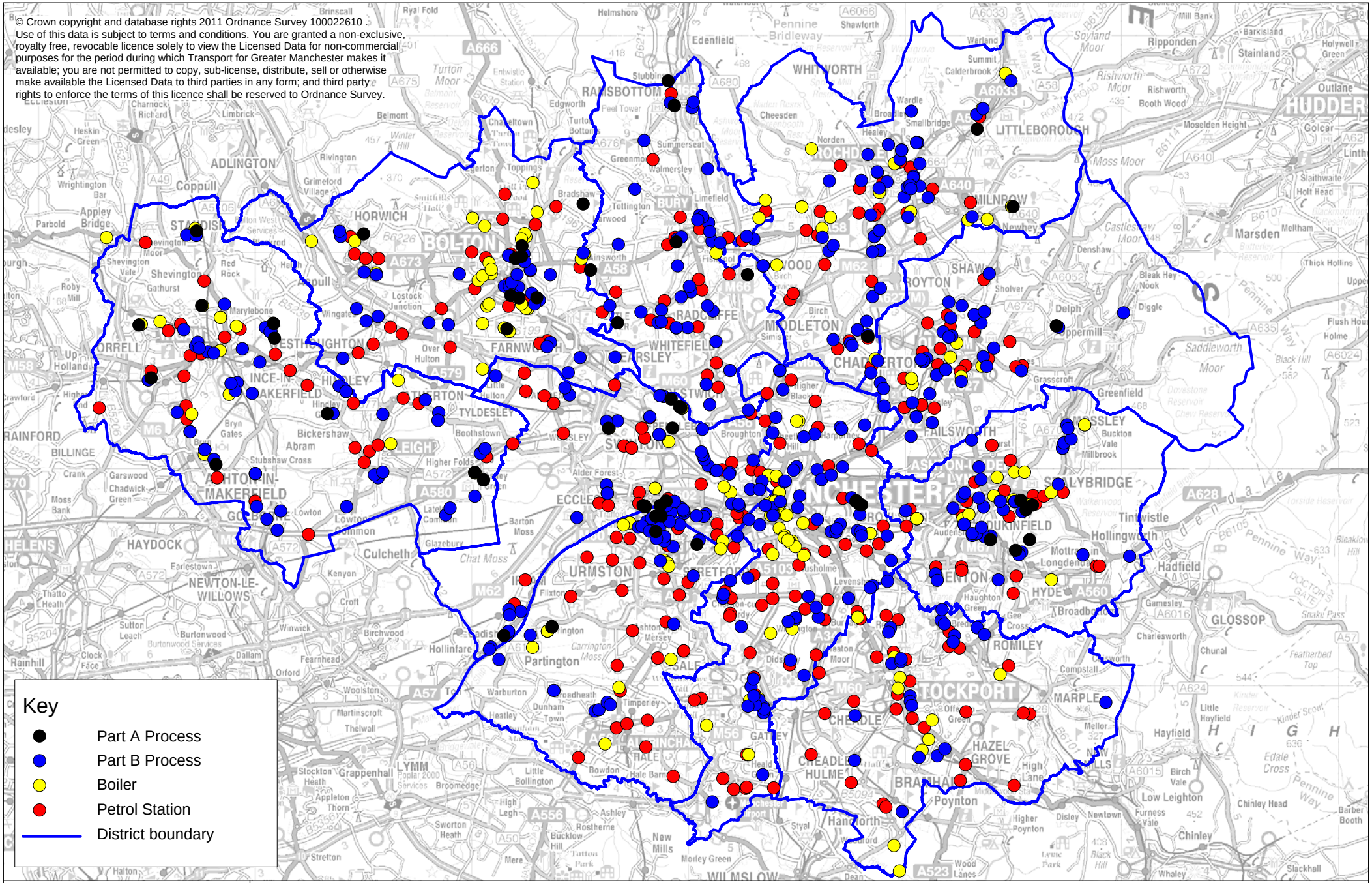
The cold start emissions were estimated for each of the modelled hours and vehicle types represented by the Saturn model, and were then expanded to give annual totals using the expansion factors shown in Table A2.10. The calculated cold start emissions are shown in Table 4.9, broken down by vehicle type. Cold start emissions by District are shown in Table 4.10.

3.2 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 19). 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 20) and a sample from the handbook and corresponding template 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.

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 : 12/10/2011	Figure 3.2

3.3 Rail Sources

The rail data for 2007 has been updated for the first time since 2003. Train movement data was obtained from Network Rail from the ACTRAFF database for the ACTRAFF period 177 (14th October 2007 to 10th November 2007). 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 586 sections listed in the ACTRAFF data. Factors were obtained from the Rail Emission Model report on the DfT website (Reference 22). 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 2008 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 14) and are shown in Table A2.8.

3.5 Domestic and Commercial Combustion

The domestic and commercial combustion emissions were both updated and recalculated. A file of 2007 domestic and commercial gas usage broken down by Middle Layer Super Output Area (MSOA) was obtained from the Department for Energy and Climate Change (DECC), Reference 17 (previously from the Department for Business Innovation and Skills, BIS, and prior to that Department for Business Enterprise and Regulatory Reform, BERR). This section describes how the combustion figures were updated.

3.5.1 Domestic Combustion

3.5.1.1 Gas Combustion

Mid-Year Population Estimates for 2007 were obtained from the Office for National Statistics (ONS) at Lower Layer Super Output Area (LSOA) level. The gas consumption data at MSOA was then weighted by the (varying) population densities at LSOA level. The gas consumption data, now at LSOA level, was then disaggregated across the $1km^2$ grid.

The emission factors were obtained from the NAEI website (Reference 14) 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 15). 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 2008 (DUKES 2008) (Reference 18). The kWh values were then converted to Megatonnes using a calorific value for coke from DUKES 2008. The appropriate emissions factors, shown in Table A3.2, were obtained from the NAEI website (Reference 14) and applied. The emissions were spread equally between the MSOA's rather than weighted by population because it was thought that solid fuel use does not directly correlate to population density.

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 2001 Census Origin-Destination Statistics data give the home to workplace trips for the entire of the UK. Using this we were able to estimate the number of people working in each MSOA.

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 MSOA commercial gas delivery figures to avoid double counting. However, in 17 MSOAs 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. In some cases upto 1.24% of the gas consumption was unallocated at the local authority level. This gas was allocated between the MSOAs for that district pro rata to the gas usage in each MSOA. However, the gas could have been consumed in just one or two of the MSOAs within that district. Also 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 MSOA was reset to 0. This is the method used in previous EMIGMA updates. The adjusted data was then processed in the same way as the domestic gas consumption but using people working, rather than the population, in output areas to estimate commercial consumption for the 1km^2 grid.

The emission factors were obtained from the NAEI website (Reference 14) 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 2007 at Middle Layer Super Output Area (MSOA) was obtained from the Department for Energy and Climate Change (DECC), Reference 17. The domestic electricity consumption figures were disaggregated by the census population figures used for the domestic gas use (see section 3.5.1.1). The commercial and industrial electricity consumption figures were disaggregated by the workplace population (see section 3.5.2.1). The CO_2 produced during generation was calculated using the value of 137 tonnes of carbon per GWh of electricity supplied. This factor was obtained from DUKES 2008 (Reference 18) and is a composite factor for all sources of electricity generation including nuclear and renewables.

3.7 Aviation

Data for 2007 was supplied by Chris Paling, 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 2007 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

Data for 2007 has also been supplied by Nick Duriez, 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 2007 Data.xls”. Factors were obtained from Federal Office of Civil Aviation, FOCA, the Swiss aviation authority website (Reference 21) 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 to be 3000ft or 1500ft for circuit flying.

Aviation emissions are shown in Table 4.17.

3.8 Area Sources

The area source data has not been updated from the 2006 update. The rest of this section is a summary of how the livestock data was updated previously.

Data from DEFRA was obtained on the numbers of livestock by a 5km grid for 2004. The Ordnance Survey's (Meridian 2) developed land use area boundary file was used to exclude built up areas from the 1km squares within Greater Manchester. The emissions for each 5km square were calculated using emission factors from the EMEP/CORINAIR Emission Inventory Guide book – 2006 (Reference 16), which are shown in Table A5.1. The emissions for each 5km square were then divided equally between the non-developed areas.

4. Results of the 2007 Update

A summary of some of the results of the 2007 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

2007 Road Transport Sources (Tonnes/Year)

Pollutant	Motorways	Other Major Roads	Minor Roads	Hot Soaks	Cold Starts	Total
VOCs	798	1627	99	755	1583	4862
CO	5163	12228	722		19293	37406
CO_2 as C	483233	578682	35316			1097231
NO_X	7226	6437	349		1366	15378
SO_2	42	56	4			102
Benzene	9	31	2	2	65	109
1,3 Butadiene	17	26	1		11	55
PM_{10}	544	718	48		83	1393

Notes

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

Table 4.2

2007 Major Road Emission Totals by Road Type (Tonnes/Year)			
Pollutant	**Motorways**	**Other Major Roads**	**Total**
VOCs	798	1627	2425
CO	5163	12228	17391
CO_2 as C	483233	578682	1061915
NO_X	7226	6437	13663
SO_2	42	56	98
Benzene	9	31	40
1,3 Butadiene	17	26	43
PM_{10}	544	718	1262

Notes

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

Table 4.3

2007 Motorway Emission Totals by Vehicle Type (Tonnes/Year)						
Pollutant	**Vehicle Type**					
	Motor Cycles	**Cars**	**LGVs**	**OGVs**	**Buses**	**Total**
VOCs	15	314	66	400	3	798
CO	350	3372	528	903	10	5163
CO_2 as C	746	188189	60833	231509	1957	483233
NO_X	6	1587	652	4924	57	7226
SO_2	0	24	7	11	0	42
Benzene	0	7	1	0	0	9
1,3 Butadiene	0	4	1	12	0	17
PM_{10}	3	253	132	155	2	544

Notes

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

Table 4.4

2007 Motorway Emission Totals by District (Tonnes/Year)								
District	**Pollutant**							
	VOCs	**CO**	**CO_2**	**NO_X**	**SO_2**	**Ben-zene**	**1,3 Buta-diene**	**PM_{10}**
Bolton	67	490	45519	651	4	1	1	53
Bury	110	667	64581	994	6	1	2	73
Manchester	76	552	45507	624	4	1	1	54
Oldham	24	172	15116	215	1	0	0	18
Rochdale	129	716	75940	1224	6	1	3	80
Salford	154	928	91286	1410	8	2	3	100
Stockport	58	382	32147	454	3	1	1	38
Tameside	47	348	30852	436	3	1	1	36
Trafford	56	392	31062	435	3	1	1	36
Wigan	78	516	51224	783	4	1	2	55
Total	798	5163	483233	7226	42	9	17	544

Notes

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

Table 4.5

2007 Major Road Emission Totals by Vehicle Type (Tonnes/Year)						
Pollutant	**Vehicle Type**					
	Motor Cycles	**Cars**	**LGVs**	**OGVs**	**Buses**	**Total**
VOCs	157	1358	204	619	87	2425
CO	1096	13400	1231	1404	261	17391
CO_2 as C	2720	556503	145283	321541	35867	1061915
NO_X	16	3809	1526	7182	1131	13663
SO_2	0	62	16	15	5	98
Benzene	5	31	4	0	0	40
1,3 Butadiene	3	16	2	19	3	43
PM_{10}	10	708	277	234	32	1262

Notes

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

Table 4.6

2007 Major Road Emission Totals by District (Tonnes/Year)								
District	**Pollutant**							
	VOCs	**CO**	**CO_2**	**NOx**	**SO_2**	**Ben-zene**	**1,3 Buta-diene**	**PM_{10}**
Bolton	243	1833	110340	1363	11	4	4	135
Bury	214	1456	100919	1377	9	3	4	118
Manchester	388	2910	150810	1808	14	7	6	180
Oldham	146	1078	59649	725	6	3	2	74
Rochdale	240	1535	116376	1675	10	3	5	132
Salford	313	2116	147987	2054	13	5	6	169
Stockport	252	1887	100173	1168	10	4	4	122
Tameside	165	1209	72734	920	7	3	3	88
Trafford	191	1420	78778	938	8	3	3	96
Wigan	274	1948	124150	1636	11	4	5	146
Total	2425	17391	1061915	13663	98	40	43	1262

Notes

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

Table 4.7

2007 Minor Road Emission Totals by Vehicle Type (Tonnes/Year)						
Pollutant	**Motor Cycles**	**Cars**	**LGVs**	**OGVs**	**Buses**	**Total**
VOCs	11	67	9	12	0	99
CO	50	610	35	27	0	722
CO_2 as C	139	24197	5600	5380	0	35316
NO_X	1	154	61	133	0	349
SO_2	0	3	1	0	0	4
Benzene	0	1	0	0	0	2
1,3 Butadiene	0	1	0	0	0	1
PM_{10}	1	33	10	5	0	48

Notes

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

Table 4.8

2007 Minor Road Emission Totals by District (Tonnes/Year)								
District	**Pollutant**							
	VOCs	**CO**	**CO_2**	**NO_X**	**SO_2**	**Ben-zene**	**1,3 Buta-diene**	**PM_{10}**
Bolton	10	73	3543	34	0	0	0	5
Bury	7	55	2587	24	0	0	0	4
Manchester	15	107	5237	52	1	0	0	7
Oldham	7	54	2619	26	0	0	0	4
Rochdale	9	61	3060	31	0	0	0	4
Salford	10	71	3535	36	0	0	0	5
Stockport	14	101	4803	46	1	0	0	7
Tameside	7	52	2579	26	0	0	0	4
Trafford	10	73	3538	35	0	0	0	5
Wigan	11	76	3815	39	0	0	0	5
Total	99	722	35316	349	4	2	1	48

Notes

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

Table 4.9

2007 Cold Start and Hot Soak Emission Totals (Tonnes/Year)						
Pollutant	**Cold Starts**			**Hot Soaks**		
	Cars	**LGVs**	**Total**	**Cars**	**LGVs**	**Total**
Non-Methane VOCs	1533	50	1583	745	10	755
CO	18934	358	19293	n/a	n/a	n/a
NO_X	1306	60	1366	n/a	n/a	n/a
Benzene	64	1	65	2	0	2
1,3 Butadiene	10	0	11	n/a	n/a	n/a
PM_{10}	31	51	83	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

2007 Cold Start Emission Totals by District (Tonnes/Year)						
District	**Pollutant**					
	VOCs	**CO**	**NO_X**	**Benzene**	**1,3 Buta-diene**	**PM_{10}**
Bolton	169	2062	146	7	1.2	9
Bury	111	1357	96	5	0.8	6
Manchester	261	3176	225	11	1.8	14
Oldham	124	1515	107	5	0.9	6
Rochdale	132	1611	114	5	0.9	7
Salford	147	1786	127	6	1.0	8
Stockport	195	2373	168	8	1.3	10
Tameside	128	1555	110	5	0.9	7
Trafford	154	1883	133	6	1.1	8
Wigan	162	1976	140	7	1.1	8
total	1583	19293	1366	65	10.8	83

Notes

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

4.2 Point Sources

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

Table 4.11

2007 Point Source Emission Totals (Tonnes/Year)					
Pollutant	**Part A's**	**Part B's**	**Boilers**	**Petrol Stations**	**Total**
Non-Methane VOCs	1134	7806	99	2695	11735
CO	640	771	441		1852
CO_2 as C	651740	16245	181262		849246
NO_X	526	682	746		1954
SO_2	107	606	354		1066
Benzene	1	0	2	4	8
PM_{10}					0
HG	85	517	100		702
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

2007 Rail Source Emission Totals (Tonnes/Year)	
Pollutant	**Rail Track Total**
Non-Methane VOCs	96
CO	117
CO_2 as C	102258
NO_X	978
SO_2	130
PM_{10}	32

4.4 Bus Stations

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

Table 4.13

2007 Bus Station Emission Totals (Tonnes/Year)	
Pollutant	**Total**
VOCs	6.8
CO	20
CO_2 as C	1544
NO_X	52
SO_2	0.1
Benzene	0
1,3 Butadiene	0.2
PM_{10}	1.7

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

2007 Domestic Combustion Emission Totals (Tonnes/Year)	
Pollutant	**Total**
Non-Methane VOCs	196
CO	3154
CO_2 as C	984837
NO_X	4726
SO_2	377
Benzene	16
PM_{10}	61
CH_4	398

4.5.2 Commercial Combustion

Table 4.17 shows a summary of the emissions by all commercial gas combustion.

Table 4.15

2007 Commercial Gas Combustion Emission Totals (Tonnes/Year)	
Pollutant	**Total**
Non-Methane VOCs	64
CO	374
CO_2 as C	413034
NO_X	1627
Benzene	0
PM_{10}	6
CH_4	22

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

2007 Electricity CO_2 Emission Totals (Tonnes/Year)	
Pollutant	**Total**
Bolton	150668
Bury	102181
Manchester	366571
Oldham	119650
Rochdale	123228
Salford	151583
Stockport	168356
Tameside	125672
Trafford	228434
Wigan	166420
Total	1702762

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

2007 Aviation Emission Totals (Tonnes/Year)	
Pollutant	**Total**
VOCs	149
CO	1098
NO_X	532
SO_2	24
PM_{10}	6

4.8 Area Sources

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

Table 4.18

2007 Other Emission Totals (Tonnes/Year)	
Pollutant	**Total**
VOCs	45708
CO	18
NO_X	72
SO_2	876
Benzene	35
1,3 butadiene	0
PM_{10}	51

4.9 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 4.19

2007 Total Emissions in Greater Manchester from all sources

Pollutant	Roads		Rail		Air		Other		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	4862	7.7	96	0.2	152	0.2	45708	72.8	1134	1.8	7806	12.4	99	0.2	2695	4.3	261	0.4	7	0.0	62821
CO	37406	84.9	117	0.3	1098	2.5	18	0.0	640	1.5	771	1.8	441	1.0			3528	8.0	20	0.0	44039
CO_2 as C	1097231	31.8	102258	3.0					651740	18.9	16245	0.5	181262	5.3			1397870	40.5	1545	0.0	3448150
NO_X	15378	60.7	978	3.9	532	2.1	72	0.3	526	2.1	682	2.7	746	2.9			6353	25.1	52	0.2	25320
SO_2	102	4.0	130	5.1	24	0.9	876	34.0	107	4.2	606	23.5	354	13.7			377	14.6	0	0.0	2576
Benzene	109	63.1	0	0.0			35	20.1	1	0.7	0.4	0.2	2	1.0	4	2.5	21	12.4	0	0.0	173
1,3 butadiene	55	99.6	0	0.0			0	0.0											0.2	0.4	55
PM_{10}	1393	61.4	32	1.4	6	0.3	51	2.2	85	3.8	517	22.8	100	4.4			83	3.7	2	0.1	2269
HG			0	0.0					0.003	5.3	0	86.0	0.01	8.7							0
PB			0.000	0.0					0.03	17.7	0.1	46.2	0.1	36.1							0
Methane									977	89.5	5	0.5	110	10.0							1092

Notes

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

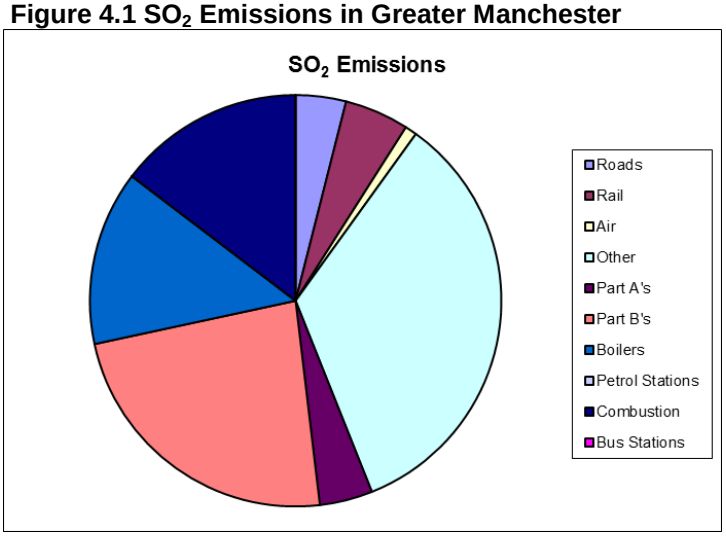


Figure 4.2 NO_X Emissions in Greater Manchester

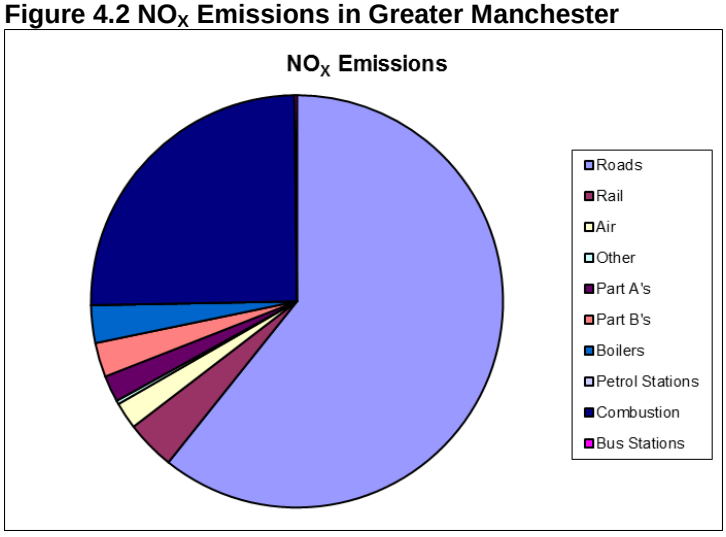


Figure 4.3 CO Emissions in Greater Manchester

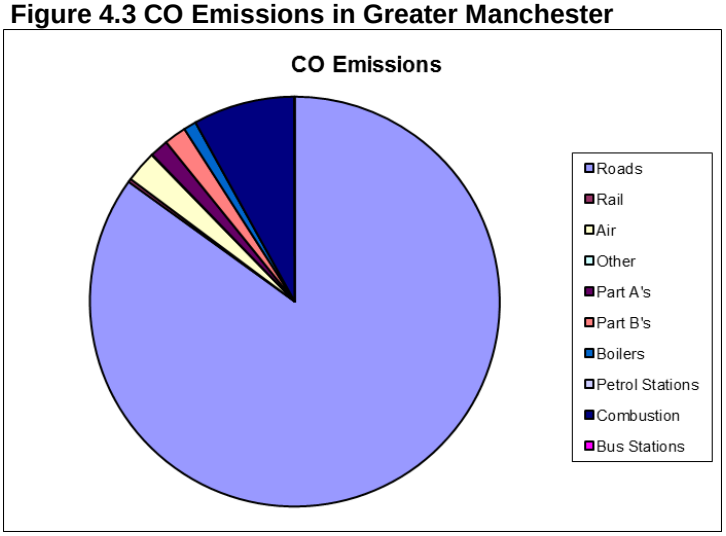


Figure 4.4 VOCs Emissions in Greater Manchester

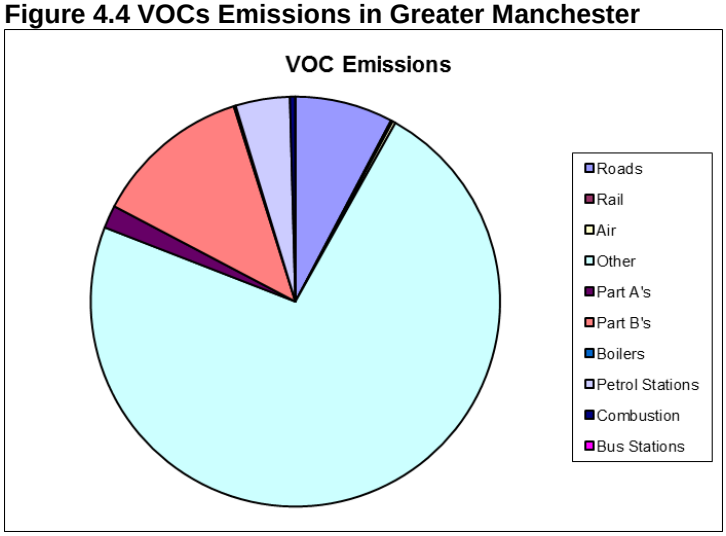


Figure 4.5 CO_2 Emissions in Greater Manchester

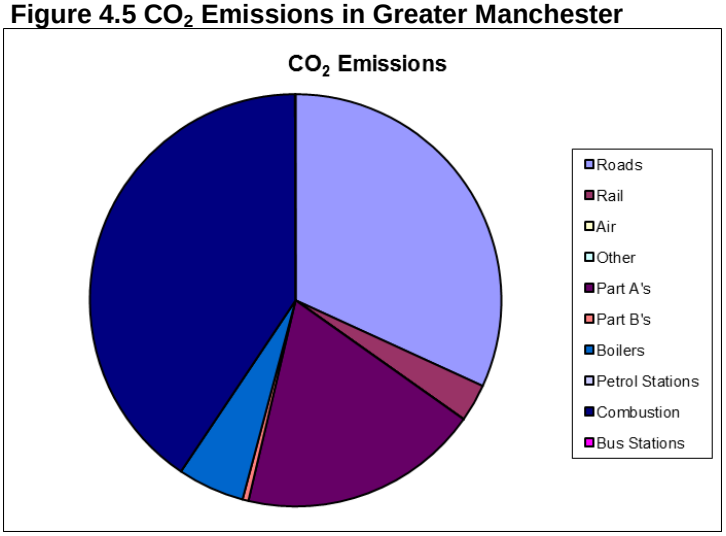


Figure 4.6 PM_{10} Emissions in Greater Manchester

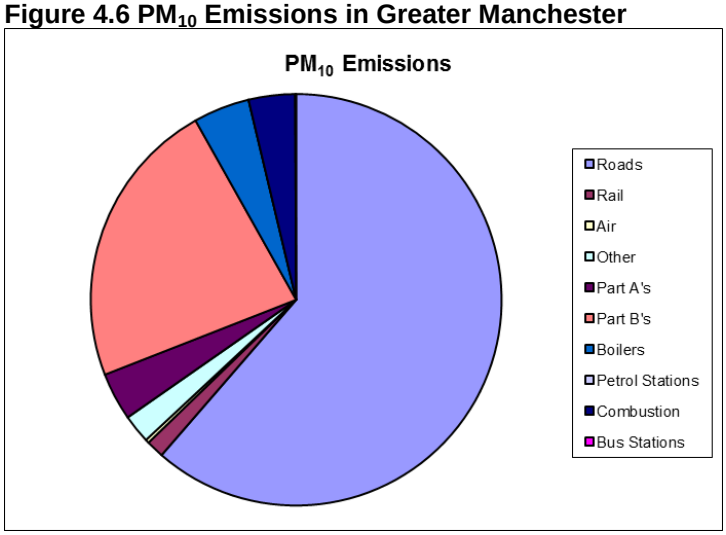


Table 4.20

2007 Total Emissions in Bolton from all sources

Pollutant	Roads		Rail		Air		Other		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	503	9.2	12	0.2			4656	85.5	1	0.0	153	2.8	3	0.1	94	1.7	23	0.4	1	0.0	5446
CO	3967	91.2	14	0.3			2	0.0	14	0.3	1	0.0	52	1.2			300	6.9	1	0.0	4352
CO_2 as C	113883	38.9	12177	4.2					10510	3.6	240	0.1	22949	7.8			132722	45.4	117	0.0	292599
NO_X	1543	60.9	121	4.8			9	0.4	121	4.8	2	0.1	121	4.8			613	24.2	4	0.2	2534
SO_2	11	3.3	16	4.7			97	29.1	4	1.3	0	0.1	174	52.2			31	9.4	0	0.0	332
Benzene	12	66.8	0	0.0			3	18.3	0	1.5	0	0.0	0.2	1.3	0	0.9	2	11.2	0	0.0	17
1,3 butadiene	5	99.7	0	0.0			0	0.0											0.02	0.3	5
PM_{10}	149	79.7	4	2.1			5	2.7	1	0.7	4	2.2	17	9.0			6	3.5	0	0.1	187
HG			0	0.0					0.003	26.0	0	52.1	0.00	21.8							0
PB			0	0.0					0.02	32.9	0	11.2	0.0	55.9							0.1
Methane									371	86.7	0.09	0.0	7	1.7			49	11.5			427

Notes

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

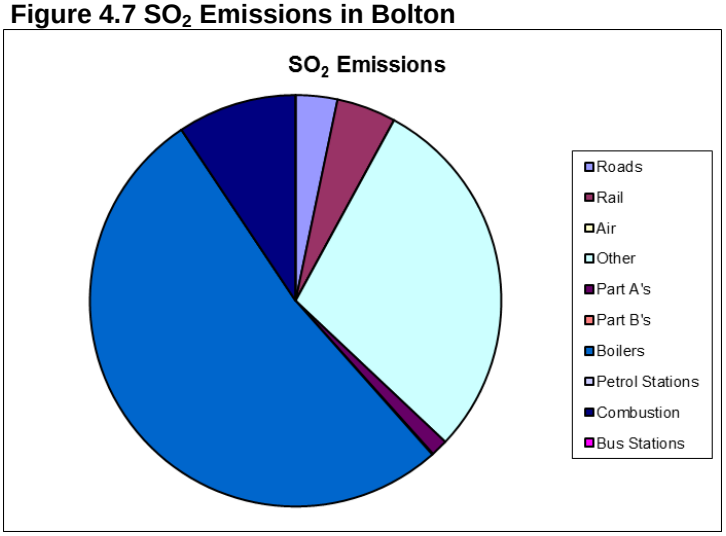


Figure 4.8 NO_X Emissions in Bolton

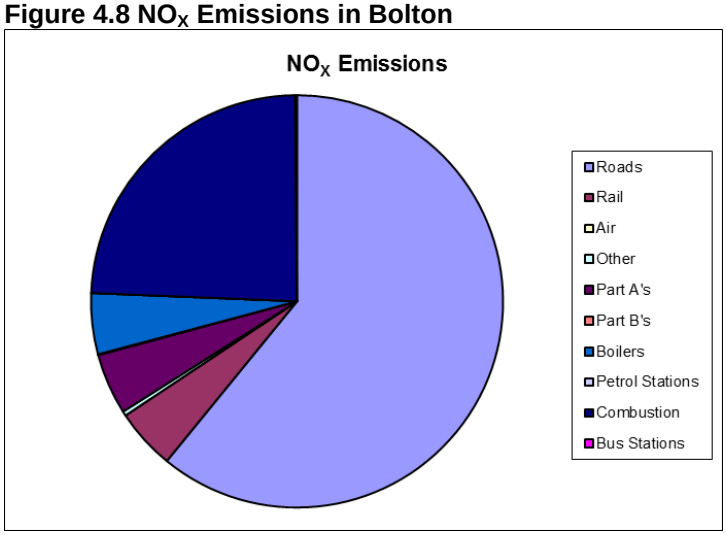


Figure 4.9 CO Emissions in Bolton

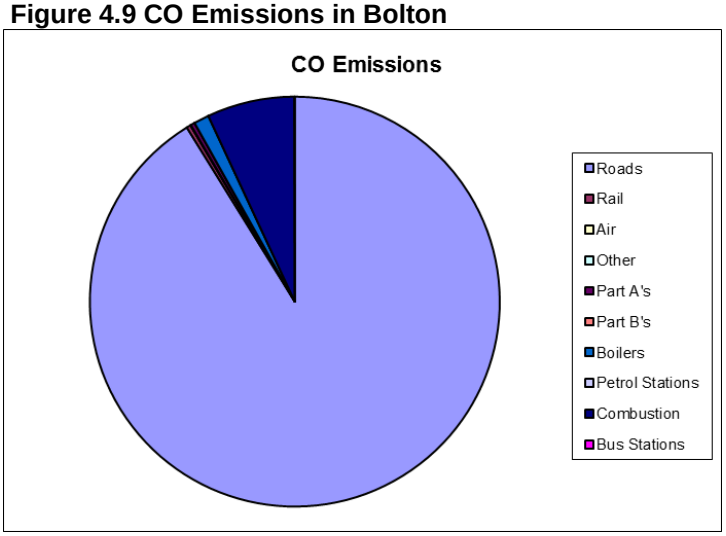


Figure 4.10 VOCs Emissions in Bolton

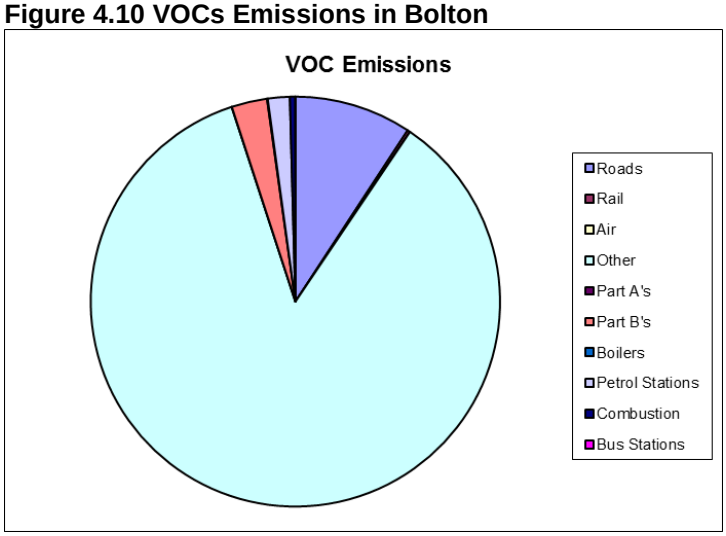


Figure 4.11 CO_2 Emissions in Bolton

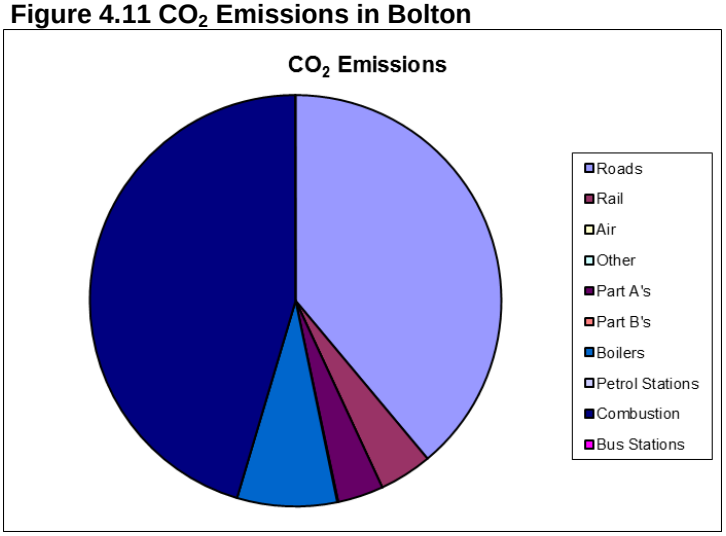


Figure 4.12 PM_{10} Emissions in Bolton

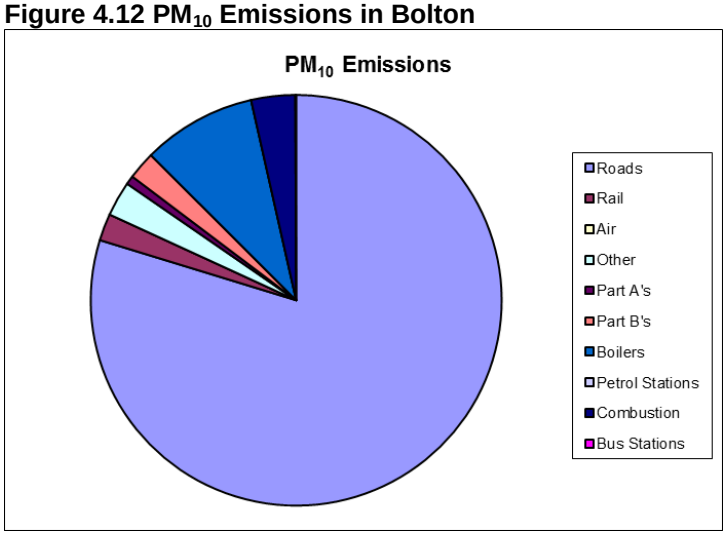


Table 4.21

2007 Total Emissions in Bury from all sources

Pollutant	Roads		Rail		Air		Other		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	385	6.9					3071	55.3	585	10.5	1397	25.2	0	0.0	95	1.7	19	0.3	0	0.0	5553
CO	2868	87.1					1	0.0	166	5.0	4	0.1	14	0.4			238	7.2	1	0.0	3293
CO_2 as C	103506	35.4							76135	26.1	4594	1.6	1660	0.6			106043	36.3	103	0.0	292041
NO_X	1497	71.4					7	0.3	80	3.8	18	0.9	11	0.5			480	22.9	3	0.2	2098
SO_2	10	5.3					69	38.3	32	17.6	0	0.0	40	22.1			30	16.7	0	0.0	180
Benzene	8	64.9					3	20.8	0.0	0.0	0.1	0.5	0	0.0	0.2	1.2	2	12.6	0	0.0	13
1,3 butadiene	5	99.7					0	0.0											0.01	0.3	5
PM_{10}	128	43.9					3	1.1	7	2.3	142	49.0	5	1.6			6	1.9	0.1	0.0	290
HG									0	0.0	0	0.0	0.00101	100.0							0.0010
PB									0	0.0	0.0000	0.0	0.011	100.0							0.011
Methane									0	0.0	1.65	4.0	0	0.1			40	95.9			42

Notes

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

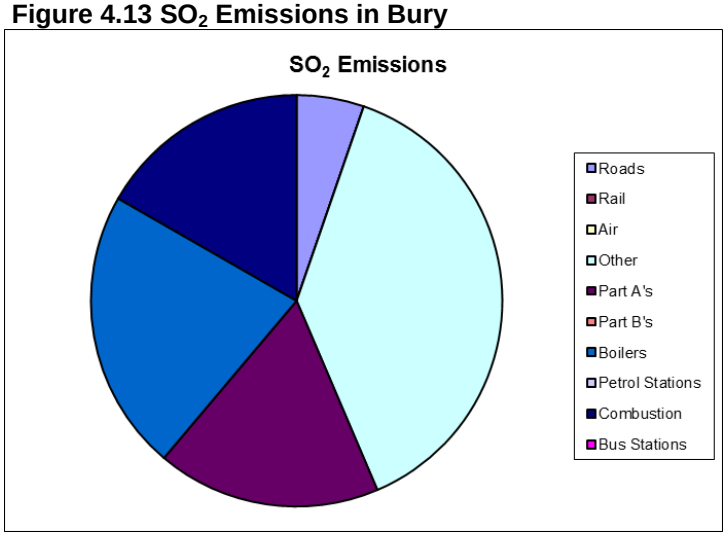


Figure 4.14 NO_X Emissions in Bury

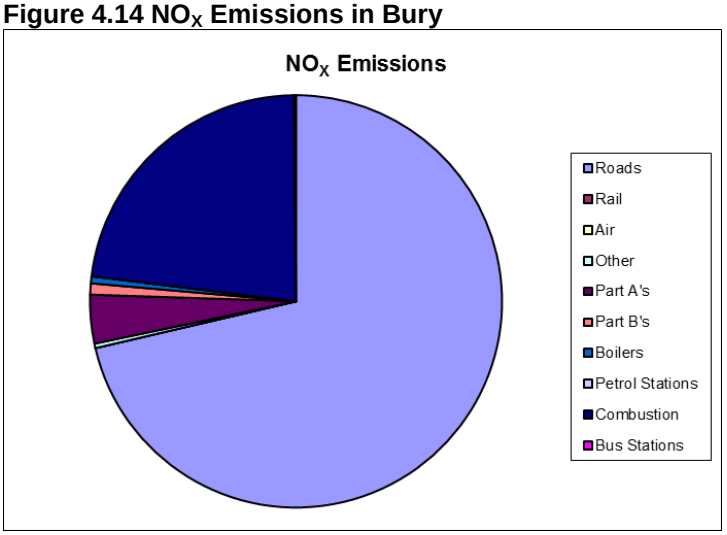


Figure 4.15 CO Emissions in Bury

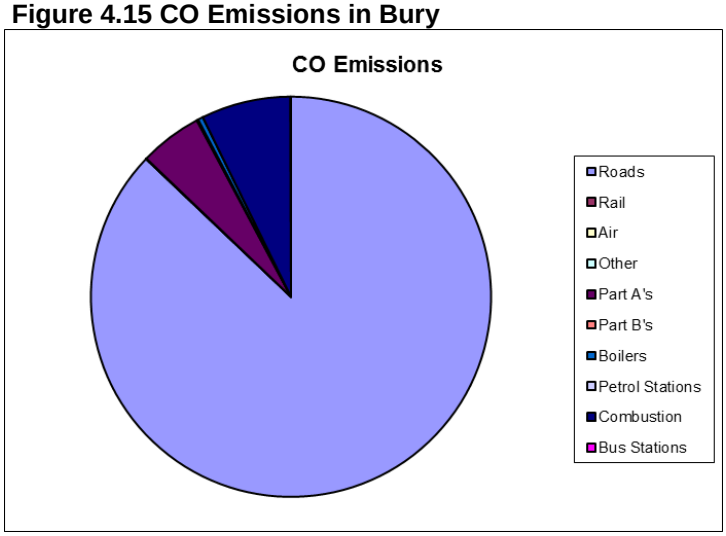


Figure 4.16 VOCs Emissions in Bury

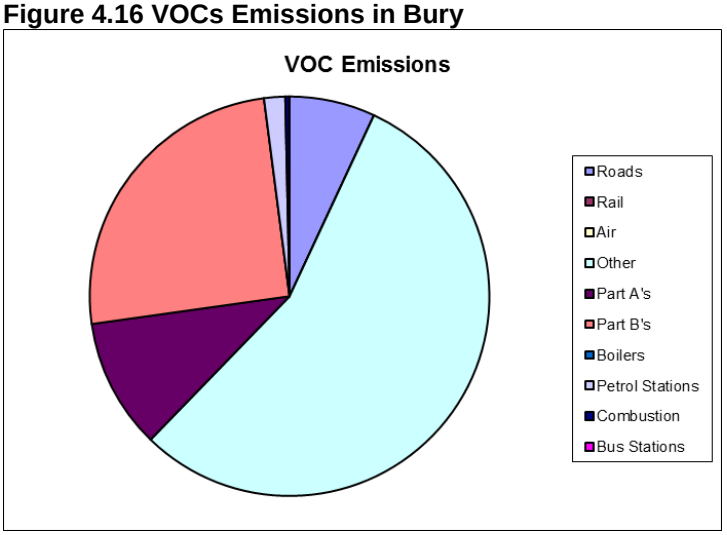


Figure 4.17 CO_2 Emissions in Bury

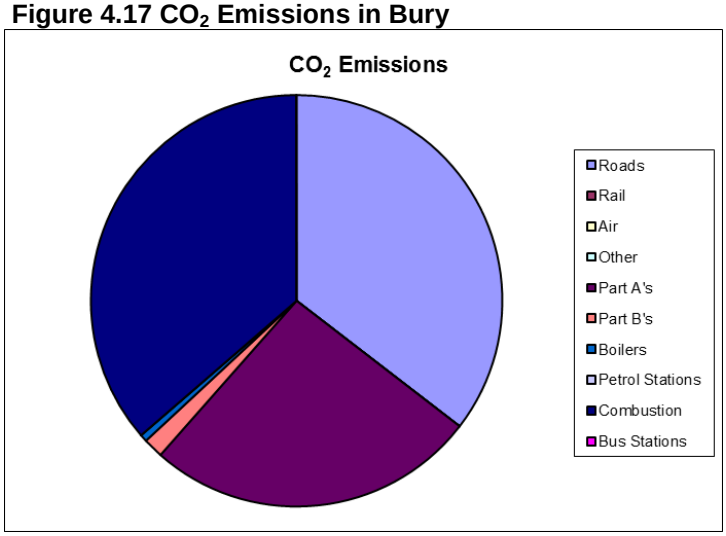


Figure 4.18 PM_{10} Emissions in Bury

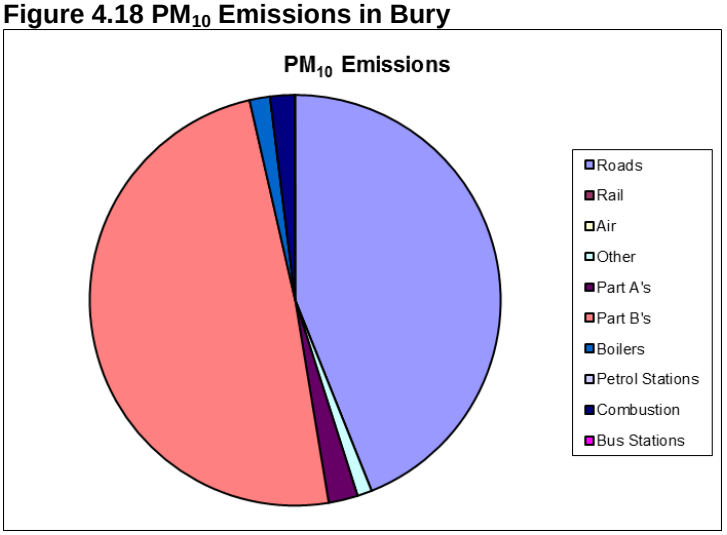


Table 4.22

2007 Total Emissions in Manchester from all sources

Pollutant	Roads		Rail		Air		Other		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	788	8.0	23	0.2	149	1.5	8589	86.7	5	0.0	118	1.2	3	0.0	191	1.9	37	0.4	3	0.0	9904
CO	6193	79.0	26	0.3	976	12.4	2	0.0	4	0.0	190	2.4	17	0.2			424	5.4	7	0.1	7839
CO_2 as C	156047	35.8	23836	5.5					2093	0.5	1384	0.3	19040	4.4			232762	53.4	578	0.1	435741
NO_X	2084	52.0	230	5.7	532	13.3	3	0.1	8	0.2	5	0.1	76	1.9			1053	26.2	20	0.5	4011
SO_2	15	7.5	30	15.5	24	12.2	80	40.7	0.1	0.1	26	13.4	0	0.0			21	10.6	0	0.0	196
Benzene	18	69.2	0	0.0	0	0.0	4	16.1	0	0.0	0	0.0	0	1.0	0.3	1.2	3	12.6	0	0.0	26
1,3 butadiene	8	99.1	0	0.0	0	0.0	0	0.0											0.07	0.9	9
PM_{10}	202	78.4	7	2.9	6	2.5	10	3.8	0	0.0	20	7.7	1	0.4			10	4.0	0.6	0.2	257
HG			0	0.0					0	0.0	0.01	100.0	0.000	0.0							0.01
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	7	7.6			83	92.2			90

Notes

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

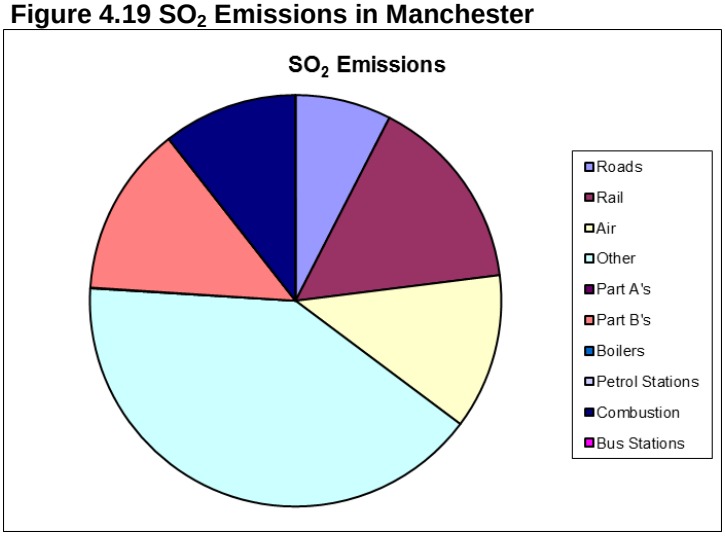


Figure 4.20 NO_X Emissions in Manchester

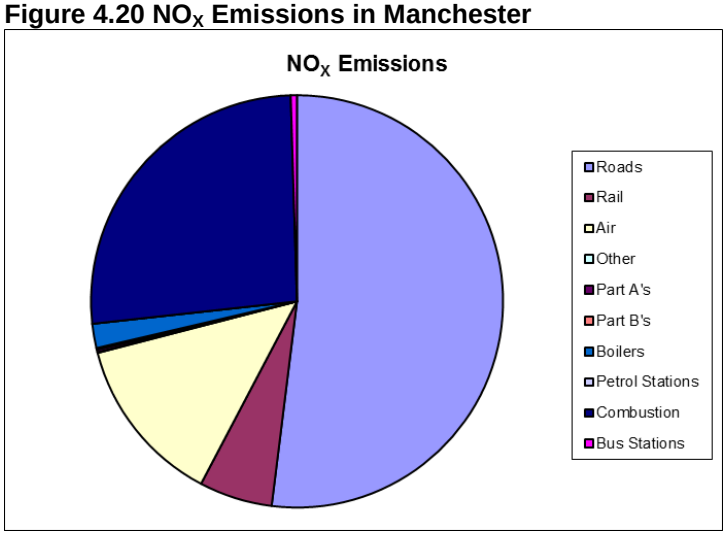


Figure 4.21 CO Emissions in Manchester

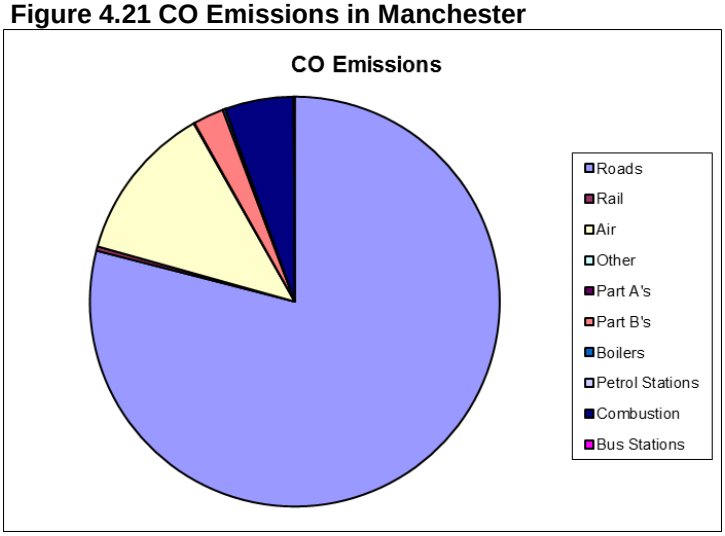


Figure 4.22 VOCs Emissions in Manchester

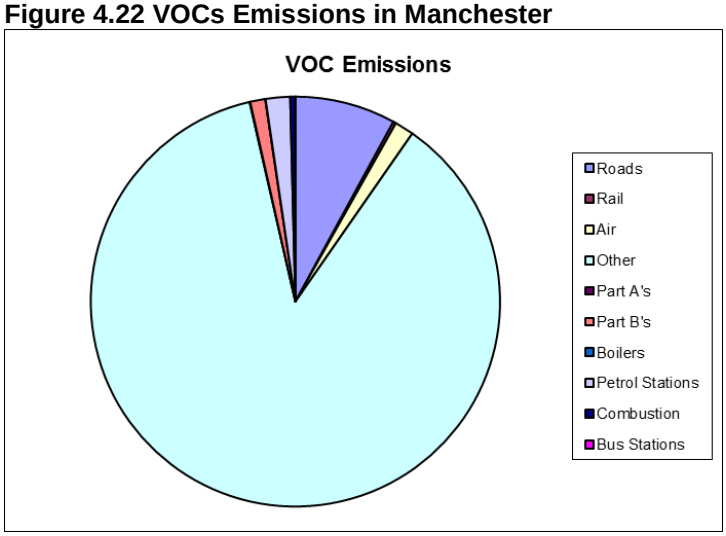


Figure 4.23 CO_2 Emissions in Manchester

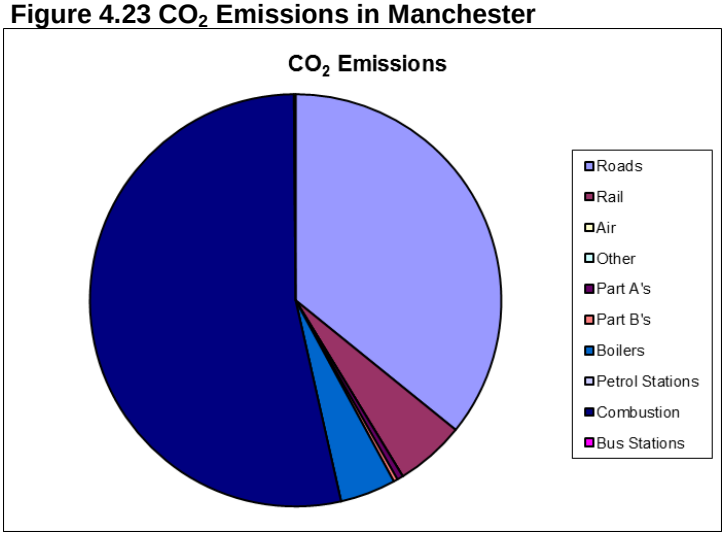


Figure 4.24 PM_{10} Emissions in Manchester

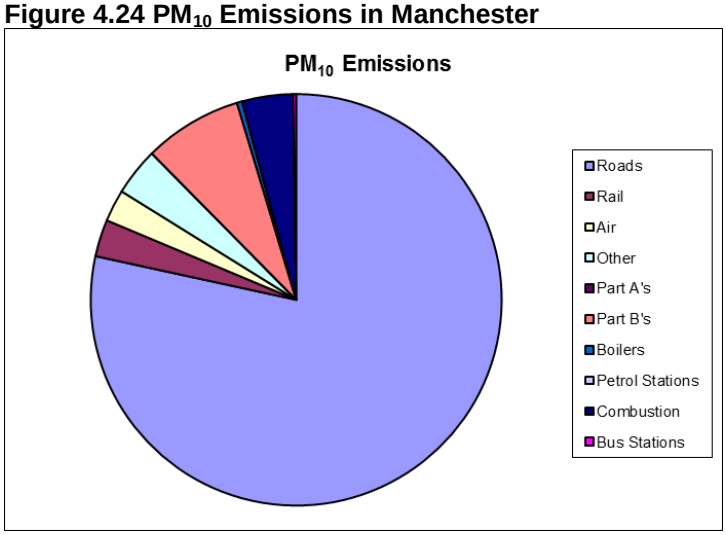


Table 4.23

2007 Total Emissions in Oldham from all sources

Pollutant	Roads		Rail		Air		Other		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	338	7.6	6	0.1			3944	88.5	0	0.0	60	1.3	1	0.0	87	1.9	21	0.5	0	0.0	4457
CO	2646	89.2	6	0.2			2	0.1	7	0.2	10	0.3	5	0.2			291	9.8	1	0.0	2967
CO_2 as C	62268	31.4	5923	3.0					11400	5.7	1369	0.7	6681	3.4			110632	55.8	97	0.0	198371
NO_X	858	58.2	58	3.9			7	0.4	2	0.1	11	0.8	25	1.7			510	34.6	3	0.2	1474
SO_2	6	3.7	8	4.7			97	59.7	1.4	0.9	7	4.2	10	6.3			33	20.6	0	0.0	162
Benzene	8	63.7	0	0.0			3	21.1	0.00	0.0	0	0.0	0.1	0.5	0.1	1.1	2	13.5	0	0.0	13
1,3 butadiene	3	99.6	0	0.0			0	0.0											0.01	0.4	3
PM_{10}	84	77.5	1.9	1.7			4	4.0	0	0.0	11	9.8	1	0.9			6	5.9	0.1	0.1	108
HG			0	0.0					0	0.0	0.01	99.7	0.000	0.3							0.01
PB			0	0.0					0	0.0	0.1	98.5	0.00	1.5							0.1
Methane									0	0.0	0.01	0.0	3	6.0			43	93.9			46

Notes

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

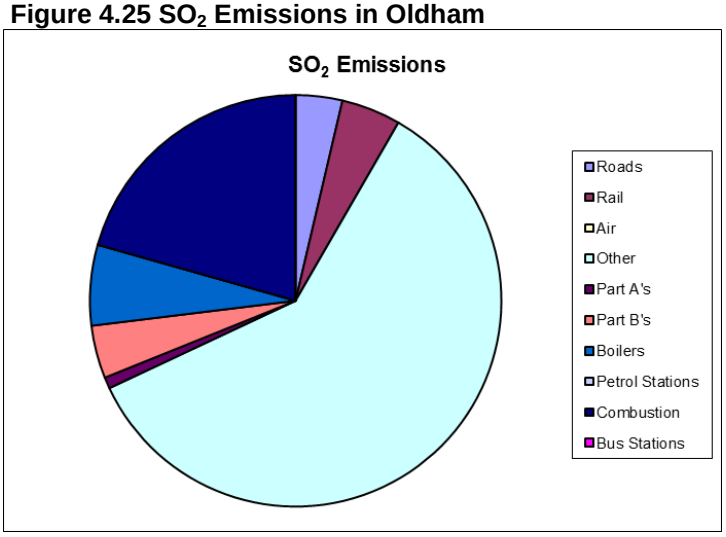


Figure 4.26 NO_X Emissions in Oldham

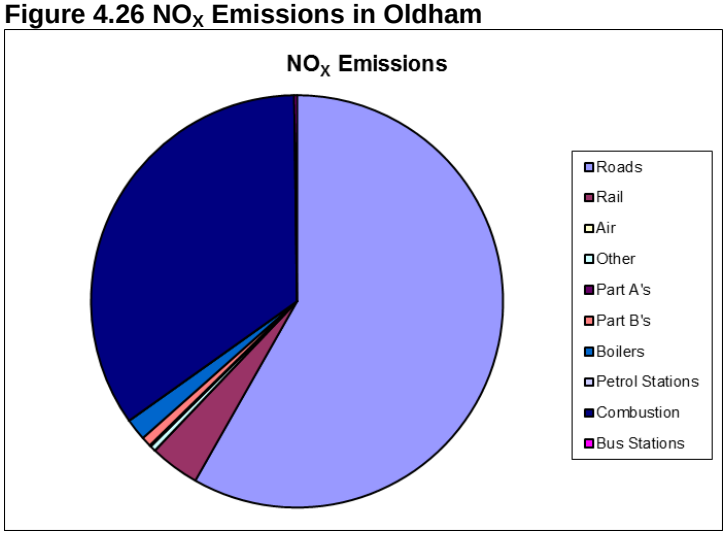


Figure 4.27 CO Emissions in Oldham

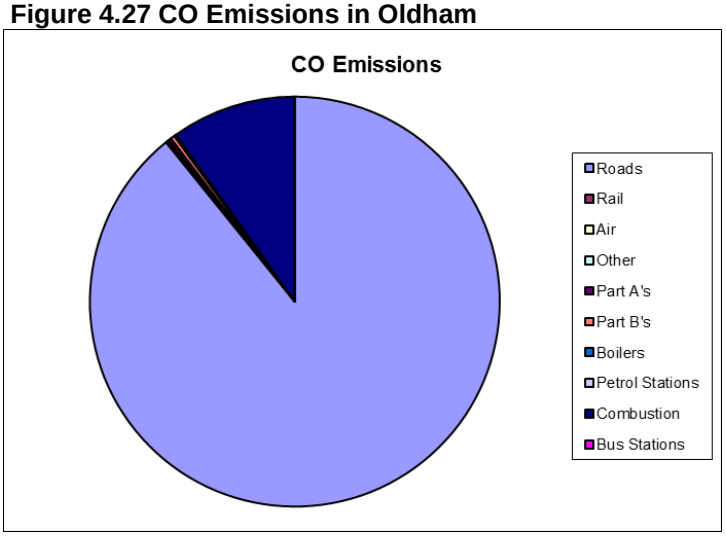


Figure 4.28 VOCs Emissions in Oldham

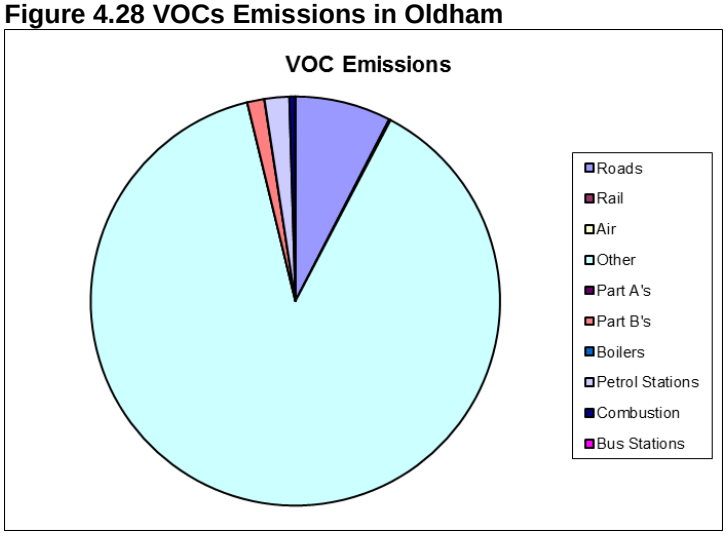


Figure 4.29 CO_2 Emissions in Oldham

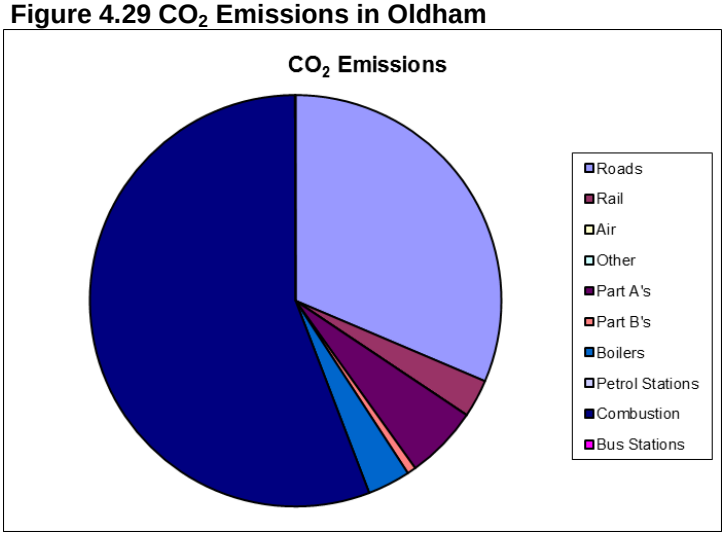


Figure 4.30 PM_{10} Emissions in Oldham

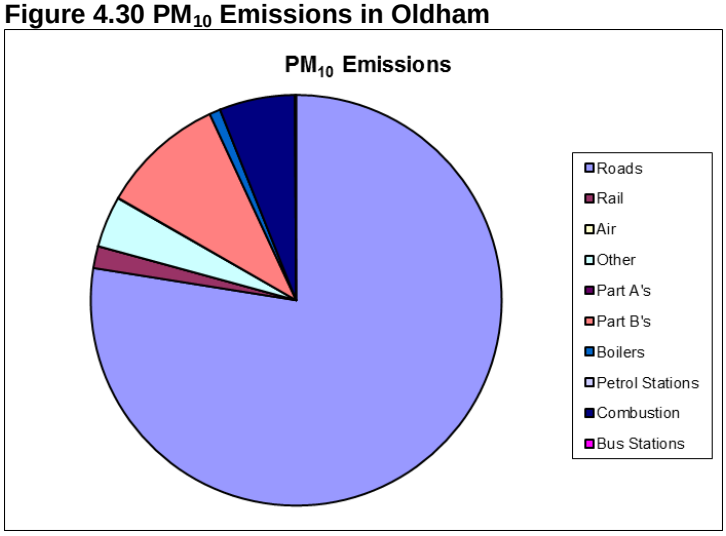


Table 4.24

2007 Total Emissions in Rochdale from all sources

Pollutant	Roads		Rail		Air		Other		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	445	4.9	5	0.1			4031	44.8	10	0.1	4364	48.5	3	0.0	115	1.3	23	0.3	1	0.0	8997
CO	3207	89.5	5	0.1			2	0.1	0	0.0	1	0.0	17	0.5			349	9.7	2	0.0	3582
CO_2 as C	119436	46.9	4948	1.9					1000	0.4	268	0.1	18759	7.4			110262	43.3	129	0.1	254803
NO_X	1820	74.1	48	1.9			3	0.1	0	0.0	2	0.1	75	3.1			502	20.5	4	0.2	2455
SO_2	11	6.2	6	3.6			109	63.3	0	0.1	0	0.1	0	0.2			46	26.4	0	0.0	173
Benzene	9	60.4	0	0.0			4	24.7	0.0	0.0	0	0.0	0.3	1.8	0.2	1.2	2	11.9	0	0.0	15
1,3 butadiene	6	99.7	0	0.0			0	0.0											0.02	0.3	6
PM_{10}	143	41.2	2	0.4			4	1.2	0	0.0	189	54.5	1	0.3			8	2.3	0.1	0.0	348
HG			0.00000	0.0					0	0.0	0.00	99.8	0.000	0.2							0.00
PB			0.000	0.0					0.00	0.0	0.0	94.5	0.00	5.5							0.0
Methane									0	0.0	0.10	0.2	7	12.7			46	87.1			53

Notes

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

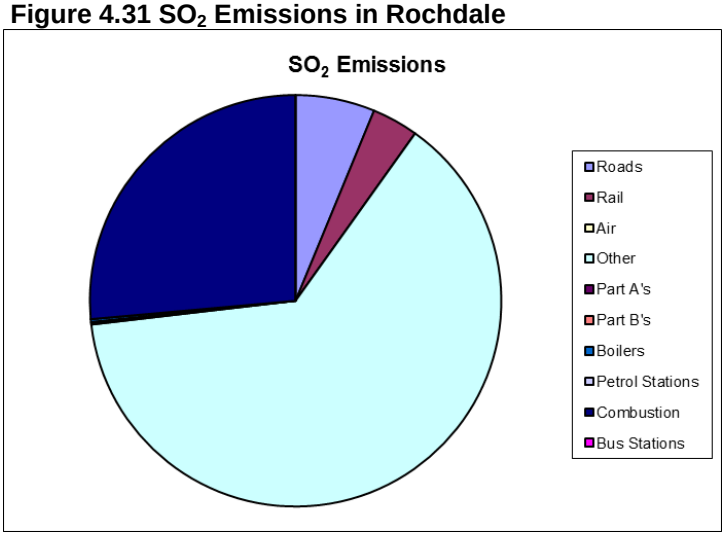


Figure 4.32 NO_X Emissions in Rochdale

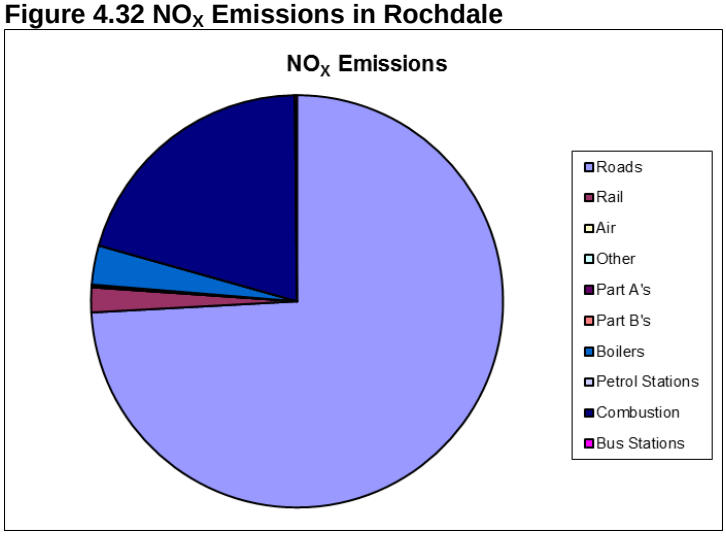


Figure 4.33 CO Emissions in Rochdale

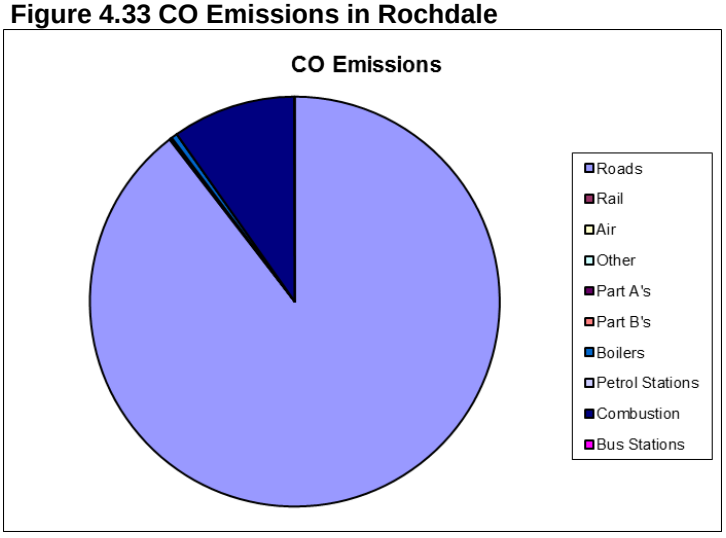


Figure 4.34 VOCs Emissions in Rochdale

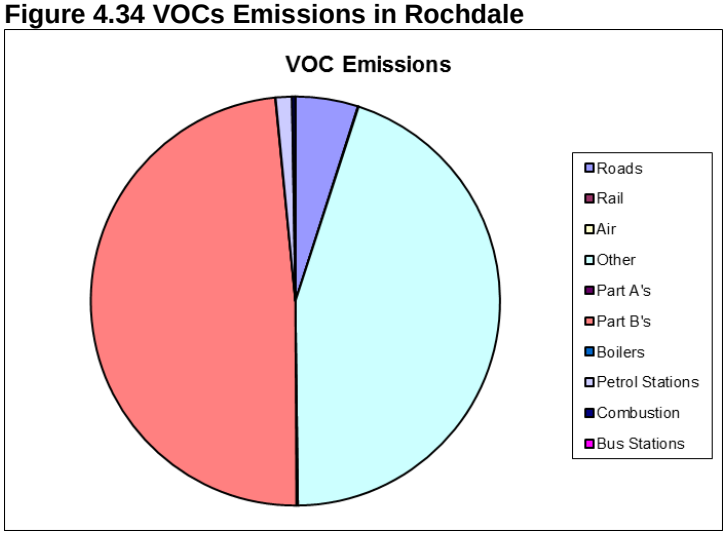


Figure 4.35 CO_2 Emissions in Rochdale

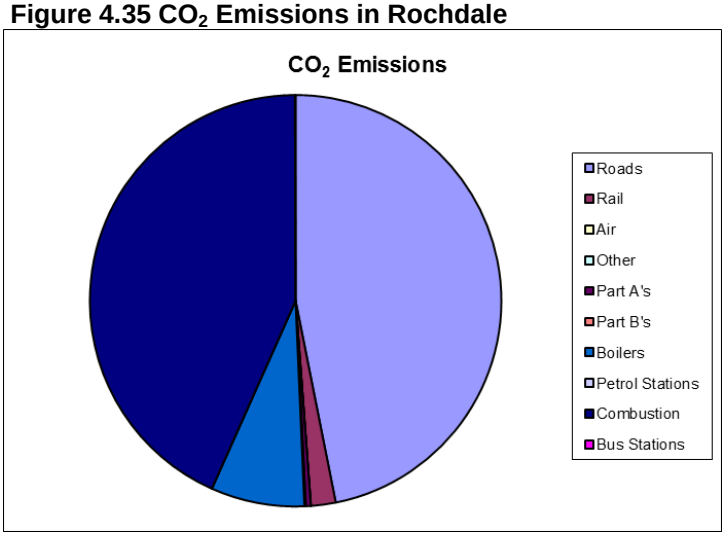


Figure 4.36 PM_{10} Emissions in Rochdale

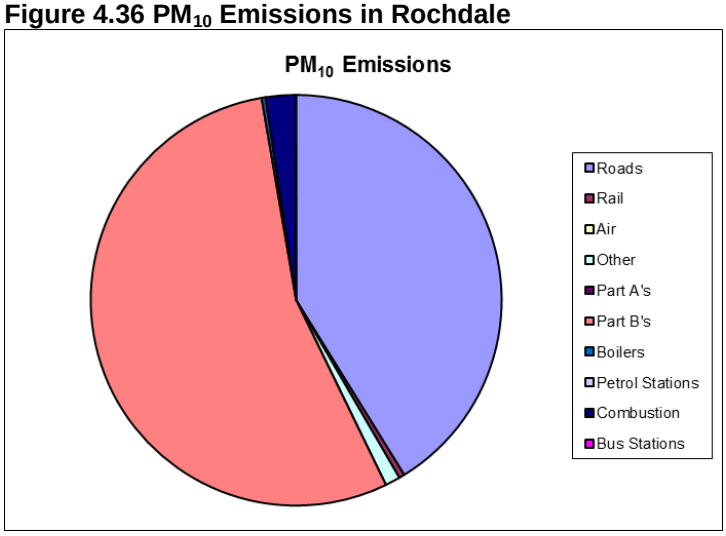


Table 4.25

2007 Total Emissions in Salford from all sources

Pollutant	Roads		Rail		Air		Other		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	537	11.1	14	0.3	3	0.1	3976	82.3	0	0.0	159	3.3	3	0.1	114	2.4	24	0.5	0	0.0	4829
CO	3973	88.3	16	0.3	100	2.2	1	0.0	40	0.9	1	0.0	17	0.4			349	7.8	1	0.0	4497
CO_2 as C	151523	48.2	14370	4.6					13062	4.2	470	0.1	18655	5.9			116436	37.0	103	0.0	314618
NO_X	2216	74.2	139	4.7	1	0.0	5	0.2	17	0.6	2	0.1	75	2.5			527	17.6	3	0.1	2986
SO_2	13	9.7	18	13.3	0	0.0	67	48.8	3	2.3	0	0.1	0	0.0			36	25.8	0	0.0	138
Benzene	11	59.2	0	0.0	0	0.0	4	23.1	0.9	5.1	0.01	0.0	0	1.4	0.2	1.0	2	10.1	0	0.0	19
1,3 butadiene	7	99.8	0	0.0	0	0.0	0	0.0											0.01	0.2	7
PM_{10}	182	82.6	5	2.1	0	0.0	5	2.1	3	1.5	16	7.5	1	0.5			8	3.8	0	0.1	221
HG									0.00	0.0	0.0038	100.0	0	0.0							0.00
PB									0.00	0.0	0.0001	98.5	0.00	1.5							0.00
Methane									446	89.1	0	0.0	7	1.3			48	9.6			501

Notes

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 SO2 Emissions in Salford

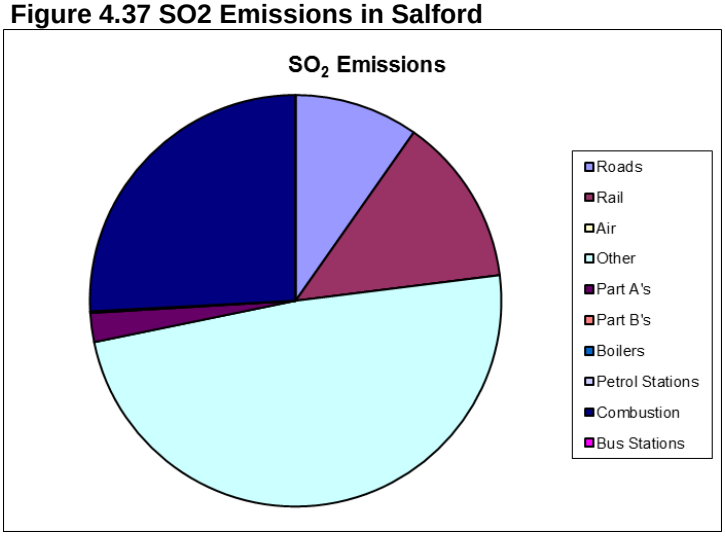


Figure 4.38 NOX Emissions in Salford

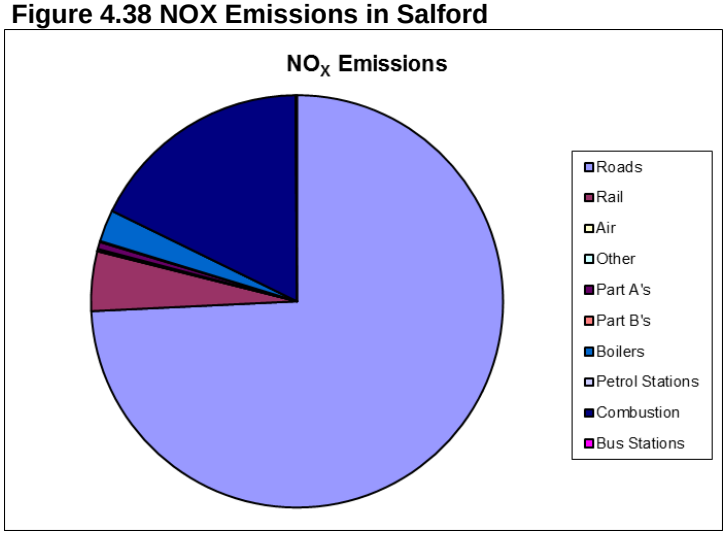


Figure 4.39 CO Emissions in Salford

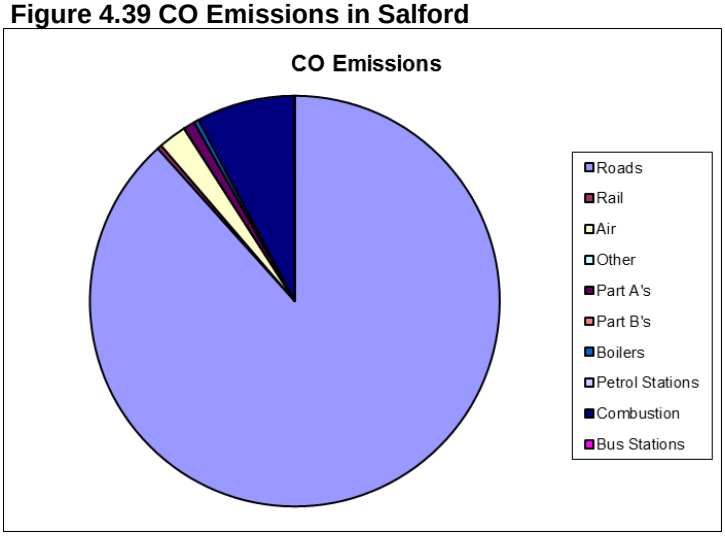


Figure 4.40 VOCs Emissions in Salford

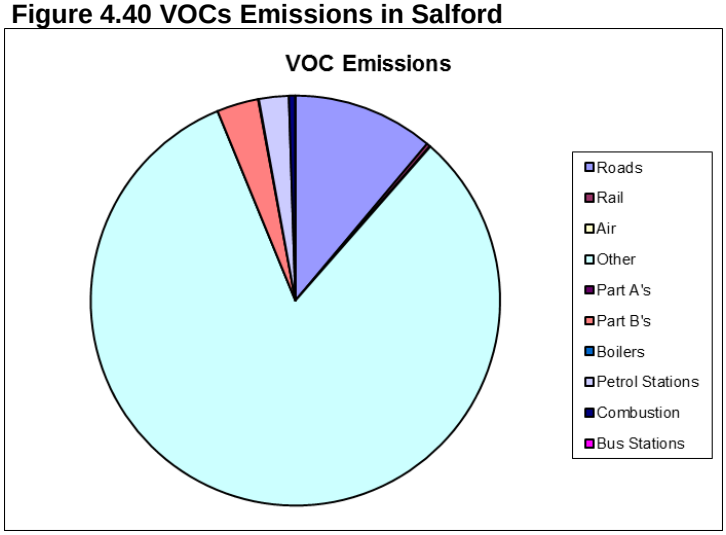


Figure 4.41 CO2 Emissions in Salford

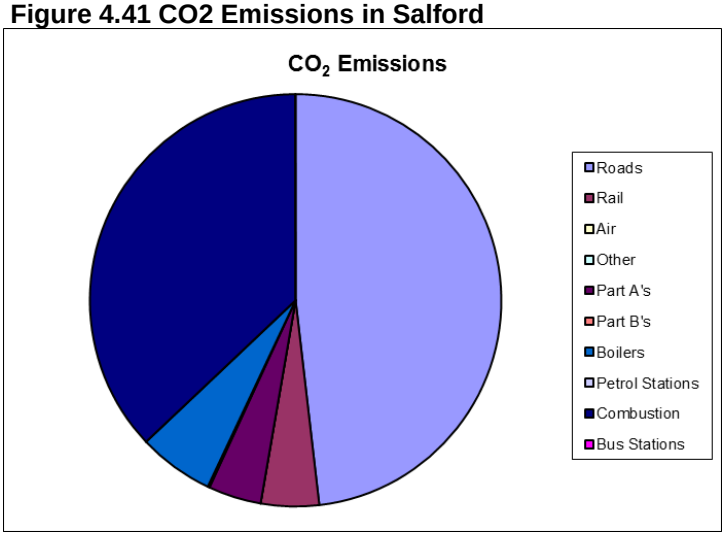


Figure 4.42 PM10 Emissions in Salford

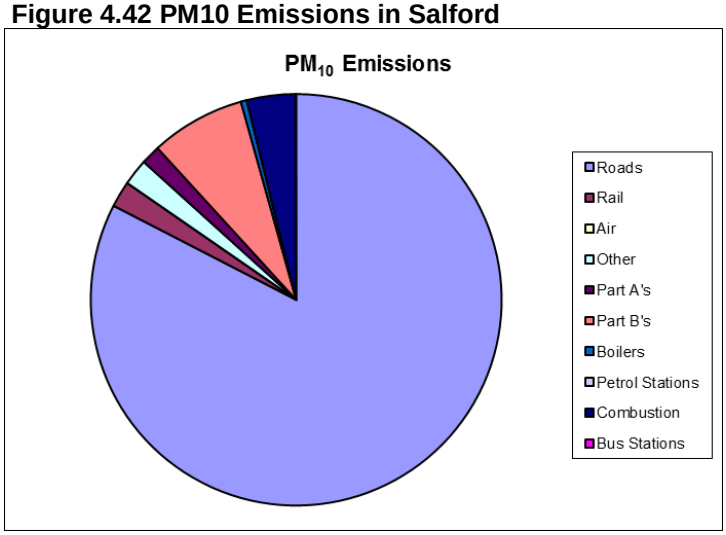


Table 4.26

2007 Total Emissions in Stockport from all sources

Pollutant	Roads		Rail		Air		Other		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	551	8.2	16	0.2			4797	71.3	0	0.0	1214	18.0	1	0.0	124	1.8	25	0.4	0	0.0	6729
CO	4361	92.3	22	0.5			2	0.0	0	0.0	0	0.0	8	0.2			330	7.0	1	0.0	4724
CO_2 as C	104976	37.4	17259	6.2					0	0.0	165	0.1	8439	3.0			149387	53.3	91	0.0	280317
NO_X	1381	60.6	161	7.1			5	0.2	0	0.0	2	0.1	34	1.5			691	30.3	3	0.1	2278
SO_2	10	6.6	22	14.3			87	56.5	0	0.0	3	2.1	0	0.0			32	20.5	0	0.0	154
Benzene	13	69.2	0	0.0			3	17.4	0	0.0	0	0.2	0.1	0.6	0.2	1.1	2	11.5	0	0.0	19
1,3 butadiene	6	99.8	0	0.0			0	0.0											0.01	0.2	6
PM_{10}	138	63.8	5	2.4			6	2.6	0	0.0	60	27.7	0	0.2			7	3.3	0.1	0.0	217
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	0.0000000	0.0							0.0001
Methane									0	0.0	0.08	0.1	3	5.2			55	94.7			58

Notes

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 SO2 Emissions in Stockport

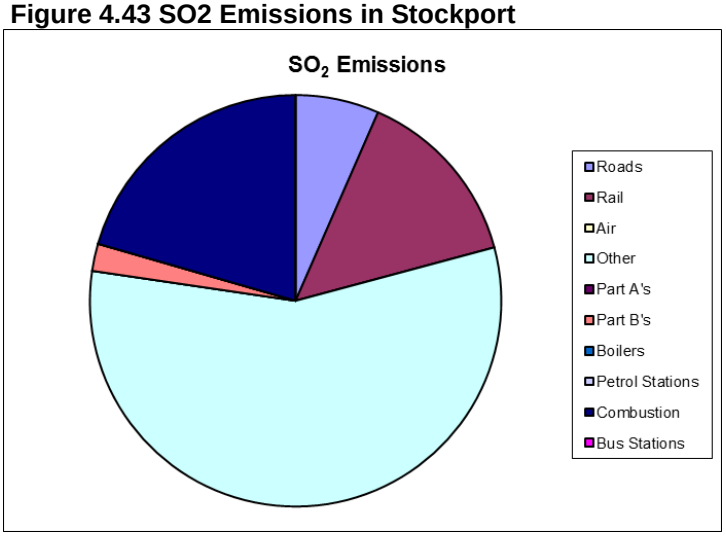


Figure 4.44 NOX Emissions in Stockport

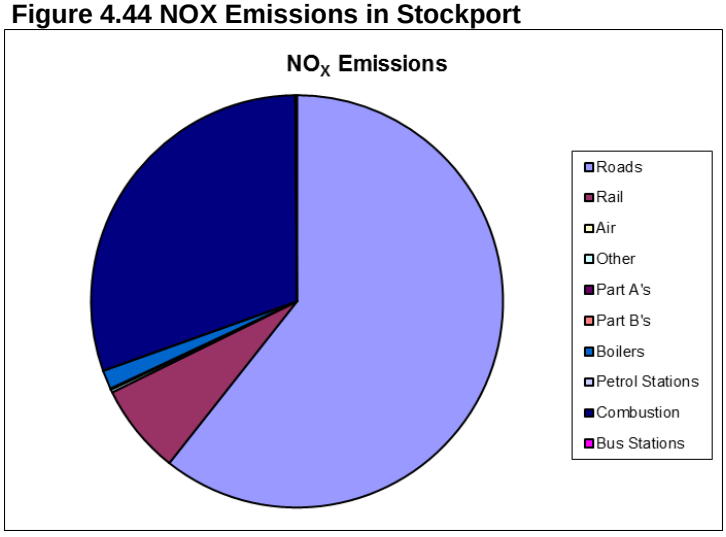


Figure 4.45 CO Emissions in Stockport

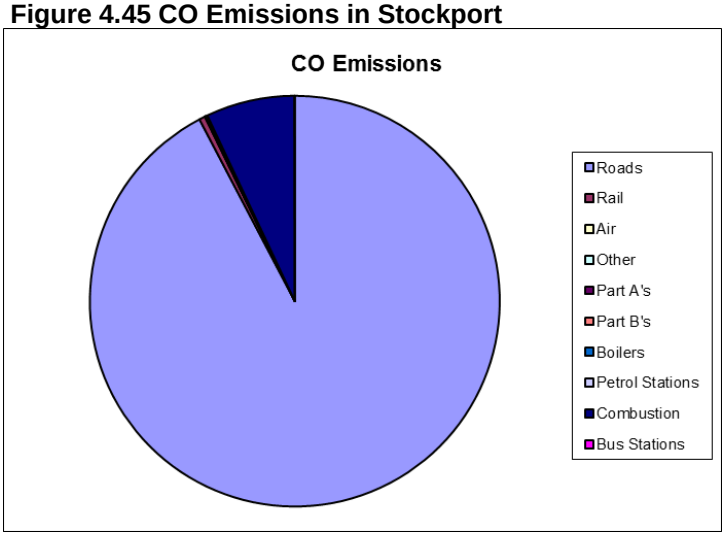


Figure 4.46 VOCs Emissions in Stockport

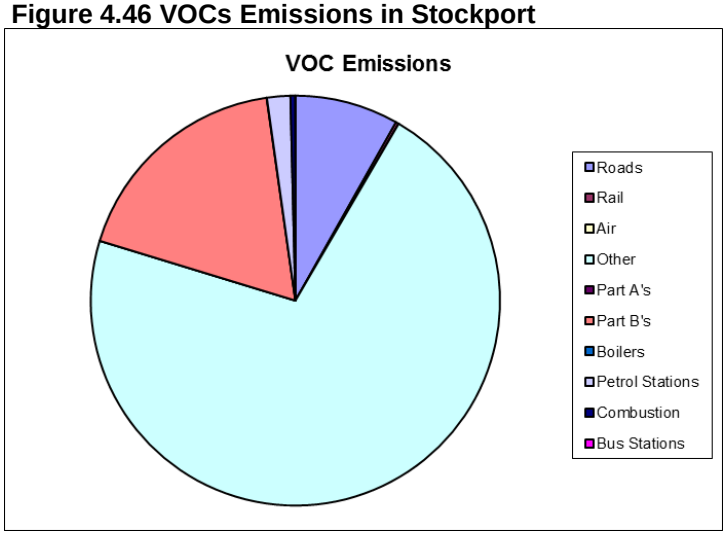


Figure 4.47 CO2 Emissions in Stockport

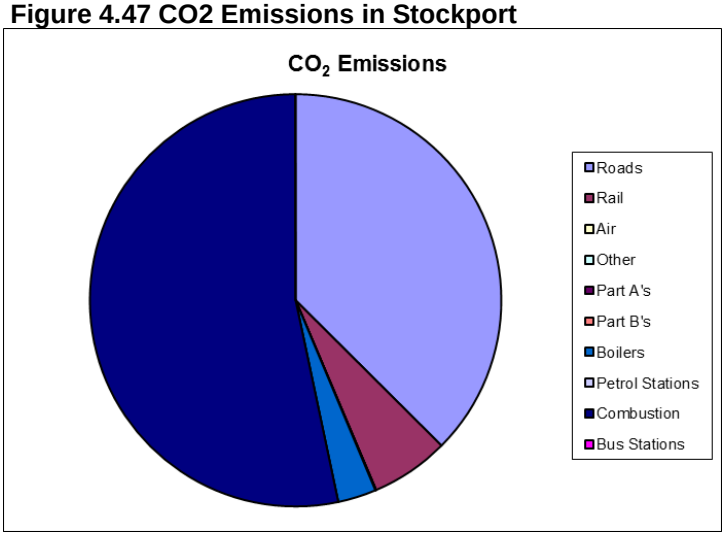


Figure 4.48 PM10 Emissions in Stockport

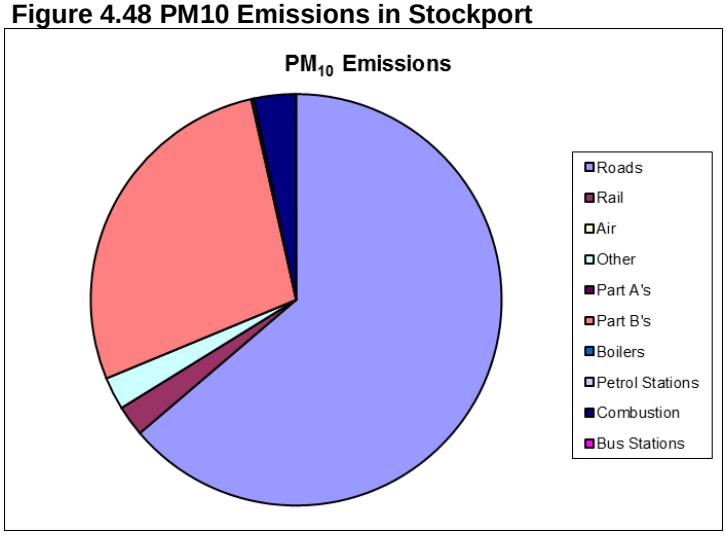


Table 4.27

2007 Total Emissions in Tameside from all sources

Pollutant	Roads		Rail		Air		Other		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	360	8.5	7	0.2	0	0.0	3646	86.2	13	0.3	74	1.7	1	0.0	106	2.5	20	0.5	1	0.0	4228
CO	2815	90.5	7	0.2	0	0.0	1	0.0	0	0.0	20	0.6	5	0.1			263	8.4	2	0.1	3112
CO_2 as C	75313	36.8	7352	3.6					2080	1.0	0	0.0	4990	2.4			114817	56.1	145	0.1	204696
NO_X	1056	62.0	68	4.0	0	0.0	6	0.4	1	0.0	17	1.0	26	1.5			524	30.8	5	0.3	1704
SO_2	7	1.0	9	1.3	0	0.0	71	10.2	0	0.0	568	81.4	15	2.1			27	3.9	0	0.0	698
Benzene	8	60.6	0	0.0	0	0.0	3	25.3	0	0.0	0	0.0	0.1	0.4	0.2	1.2	2	12.4	0	0.0	14
1,3 butadiene	4	99.5	0	0.0	0	0.0	0	0.0											0.02	0.5	4
PM_{10}	99	80.0	2	1.8	0	0.0	4	3.4	0	0.0	11.1	9.0	1	0.8			6	4.9	0.2	0.1	123
HG			0	0.0					0	0.0	0.00	99.6	0.00001	0.4							0.00
PB			0	0.0					0	0.0	0.00058	54.6	0.0005	45.4							0.0011
Methane									0	0.0	0	0.0	2	4.2			43	95.8			45

Notes

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

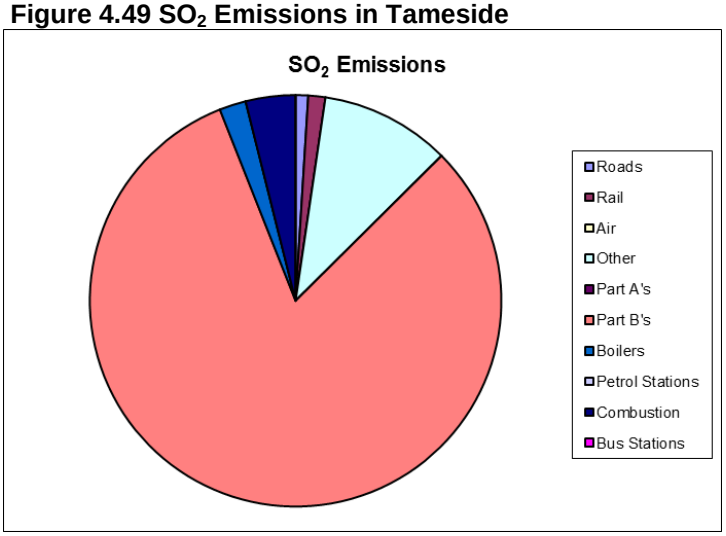


Figure 4.50 NO_X Emissions in Tameside

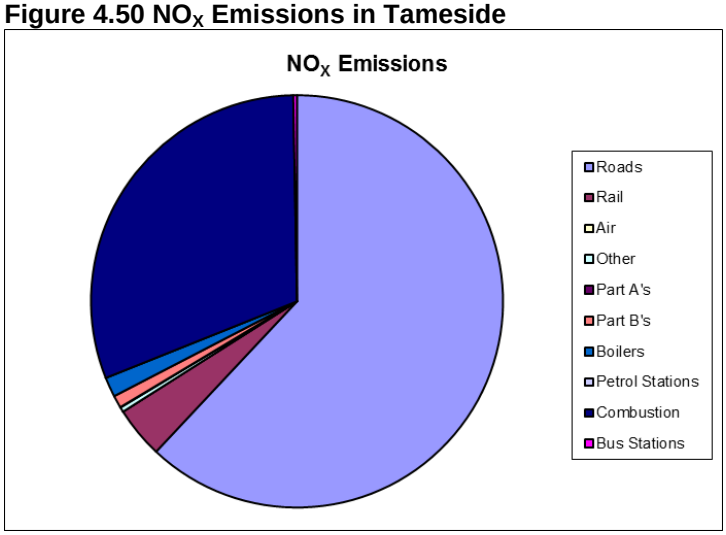


Figure 4.51 CO Emissions in Tameside

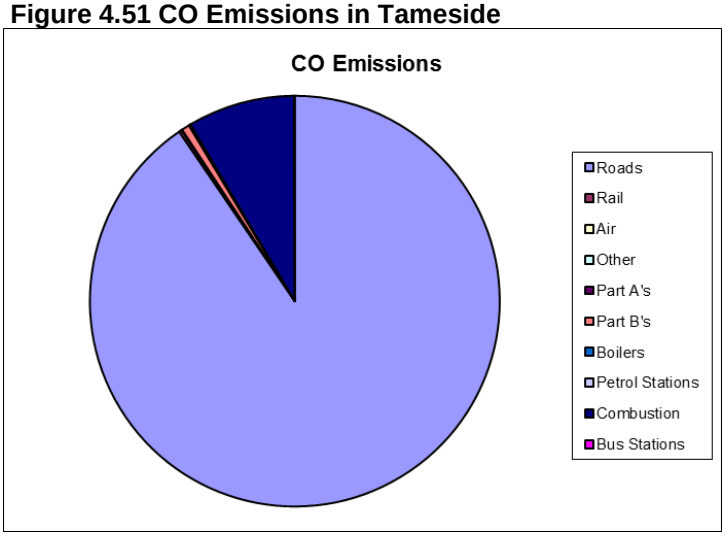


Figure 4.52 VOCs Emissions in Tameside

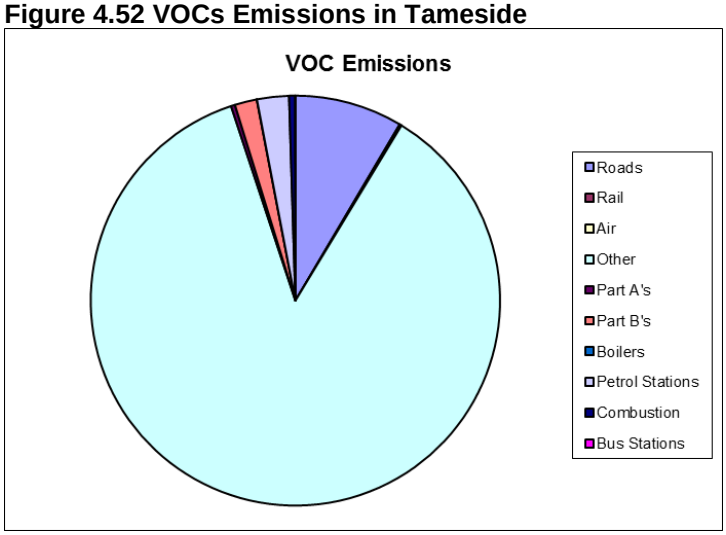


Figure 4.53 CO_2 Emissions in Tameside

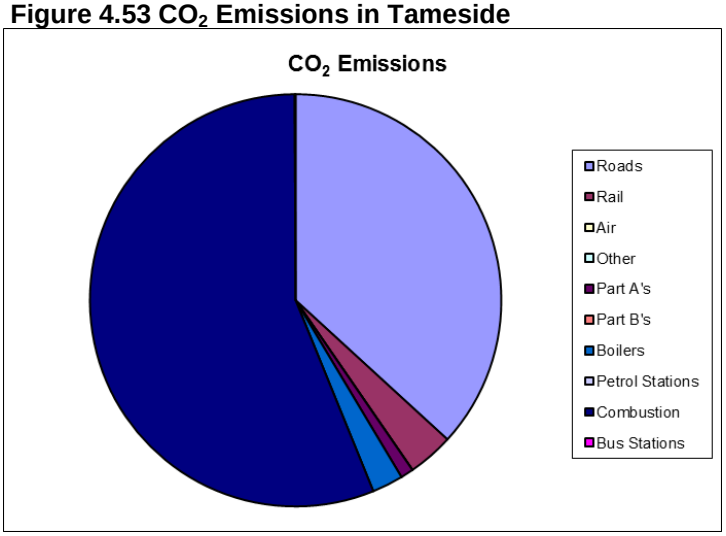


Figure 4.54 PM_{10} Emissions in Tameside

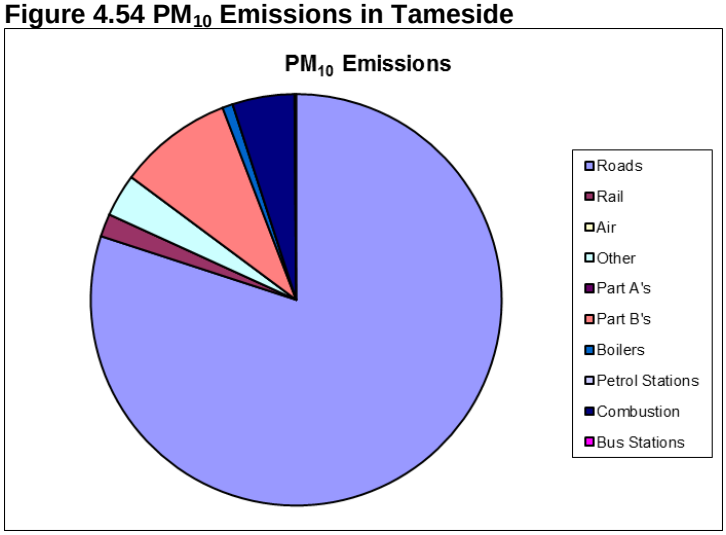


Table 4.28

2007 Total Emissions in Trafford from all sources

Pollutant	Roads		Rail		Air		Other		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	430	6.0	4	0.1	1	0.0	4289	60.3	505	7.1	169	2.4	81	1.1	1609	22.6	30	0.4	0	0.0	7118
CO	3376	69.4	4	0.1	23	0.5	1	0.0	286	5.9	537	11.0	276	5.7			362	7.4	1	0.0	4866
CO_2 as C	82316	9.8	4327	0.5					520110	62.1	0	0.0	60093	7.2			170699	20.4	61	0.0	837605
NO_X	1106	39.0	41	1.5	0	0.0	22	0.8	113	4.0	590	20.8	210	7.4			753	26.5	2	0.1	2838
SO_2	8	4.9	6	3.4	0	0.0	73	45.4	0	0.2	0	0.1	44	27.5			30	18.6	0	0.0	162
Benzene	10	52.3	0	0.0	0	0.0	4	19.5	0.0	0.0	0	0.6	0.2	0.9	3	13.4	3	13.3	0	0.0	19
1,3 butadiene	4	99.8	0.0	0.0	0	0.0	0	0.0											0.01	0.2	4
PM_{10}	109	35.8	1.3	0.4	0	0.0	5	1.5	60	19.7	53	17.5	66	21.7			10	3.2	0	0.0	304
HG			0	0.0					0	0.0	0.00	88.3	0.00	11.7							0.00
PB			0	0.0					0	0.0	0	0.0	0.0	100.0							0.0
Methane									0	0.0	0	0.0	67	51.0			65	49.0			132

Notes

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

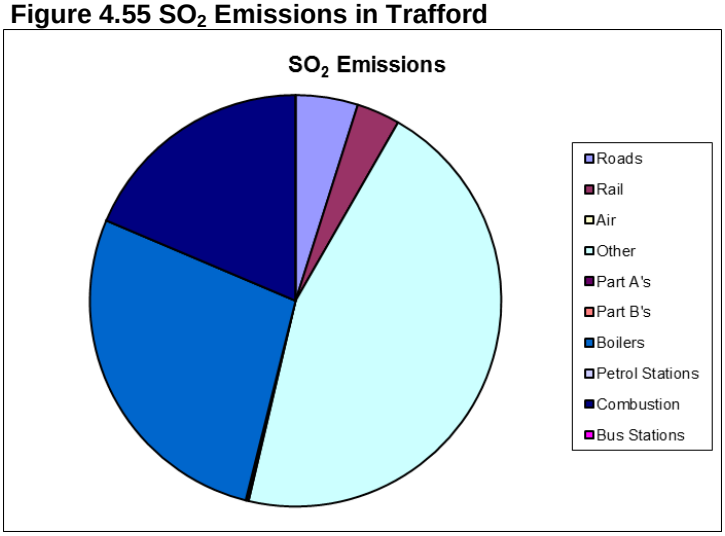


Figure 4.56 NO_X Emissions in Trafford

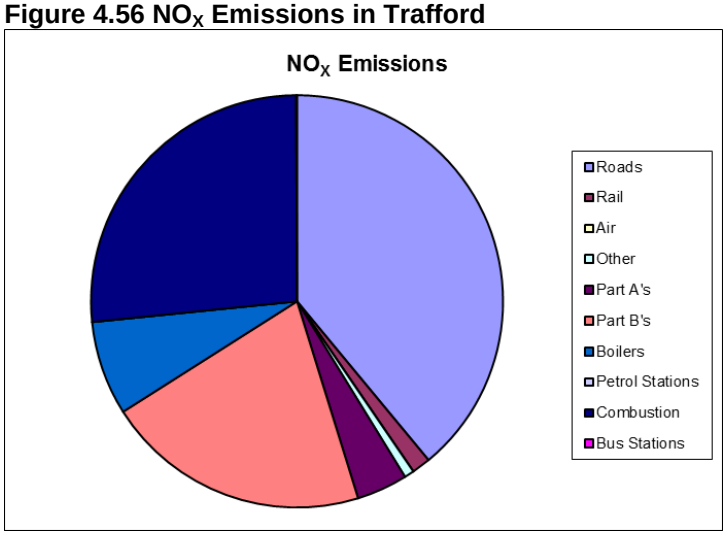


Figure 4.57 CO Emissions in Trafford

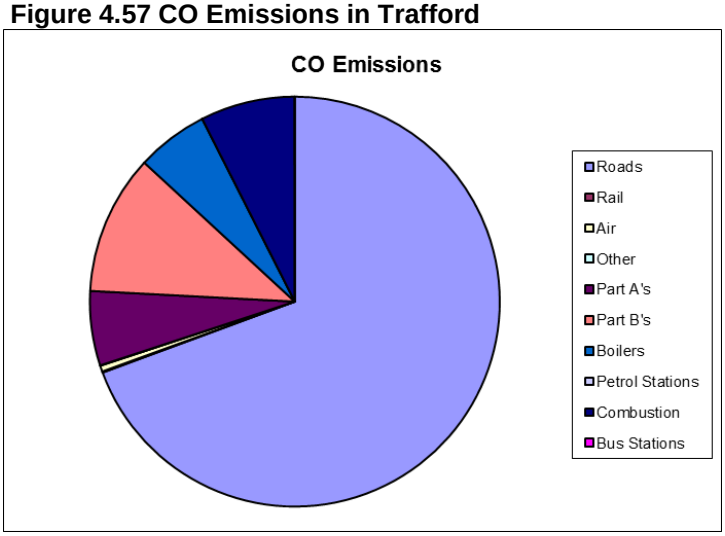


Figure 4.58 VOCs Emissions in Trafford

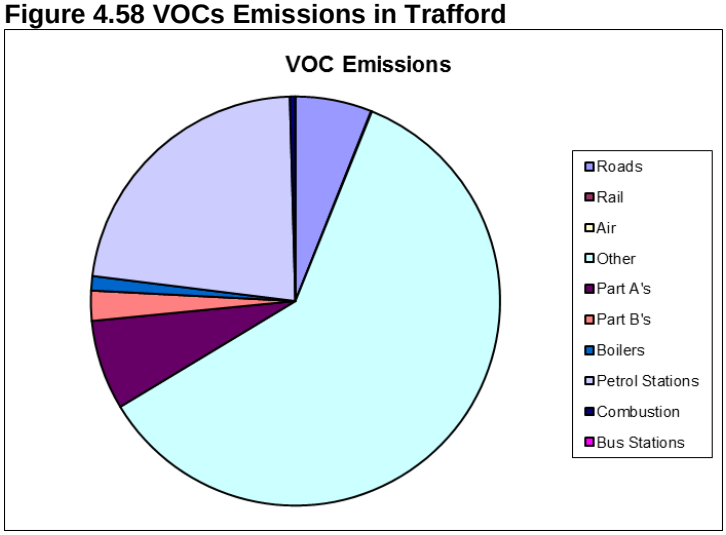


Figure 4.59 CO_2 Emissions in Trafford

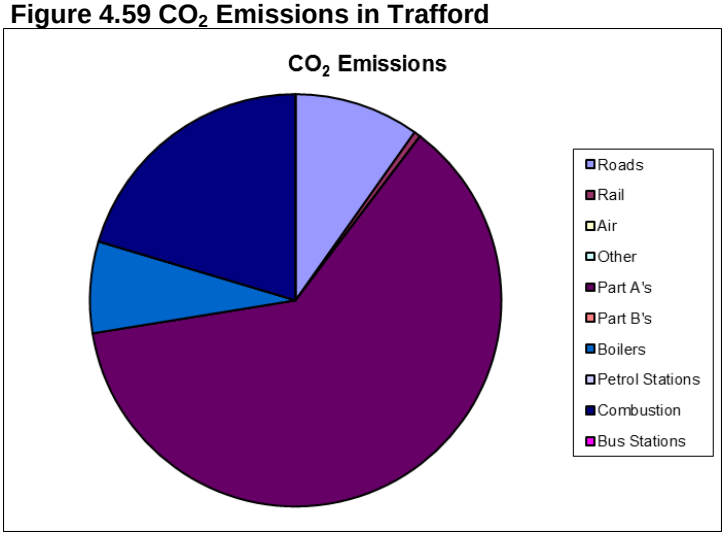


Figure 4.60 PM_{10} Emissions in Trafford

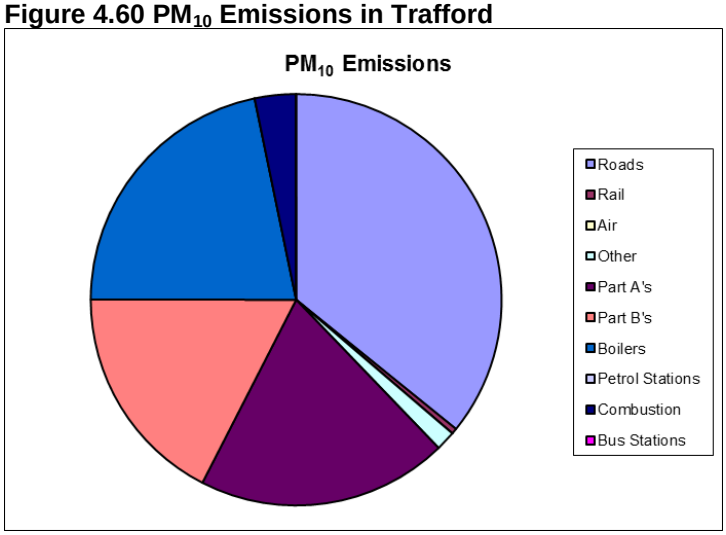


Table 4.29

2007 Total Emissions in Wigan from all sources

Pollutant	Roads		Rail		Air		Other		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	525	9.4	11	0.2	0	0.0	4710	84.7	15	0.3	99	1.8	3	0.1	159	2.9	38	0.7	1	0.0	5561
CO	4000	83.2	17	0.3	0	0.0	3	0.1	124	2.6	8	0.2	30	0.6			622	12.9	2	0.0	4805
CO_2 as C	127965	37.9	12067	3.6					15351	4.6	7752	2.3	19996	5.9			154109	45.7	122	0.0	337361
NO_X	1815	61.7	111	3.8	0	0.0	5	0.2	185	6.3	32	1.1	92	3.1			700	23.8	4	0.1	2944
SO_2	12	3.0	15	4.0	0	0.0	126	32.9	66	17.3	0	0.0	71	18.5			92	24.1	0	0.0	381
Benzene	12	62.8	0	0.0	0	0.0	3	18.7	0.0	0.1	0.11	0.6	0	1.3	0.3	1.4	3	15.0	0	0.0	18
1,3 butadiene	6	99.7	0	0.0	0	0.0	0	0.0											0.02	0.3	6
PM_{10}	160	74.5	4	1.7	0	0.0	5	2.5	14	6.5	10	4.5	7	3.4			15	6.9	0.1	0.1	215
HG			0	0.0					0	0.0	0.01	84.7	0.001	15.3							0.01
PB			0	0.0					0.01	49.9	0.00	1.7	0.01	48.4							0.0
Methane									160	66.6	2.8	1.2	7	2.9			71	29.4			240

Notes

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

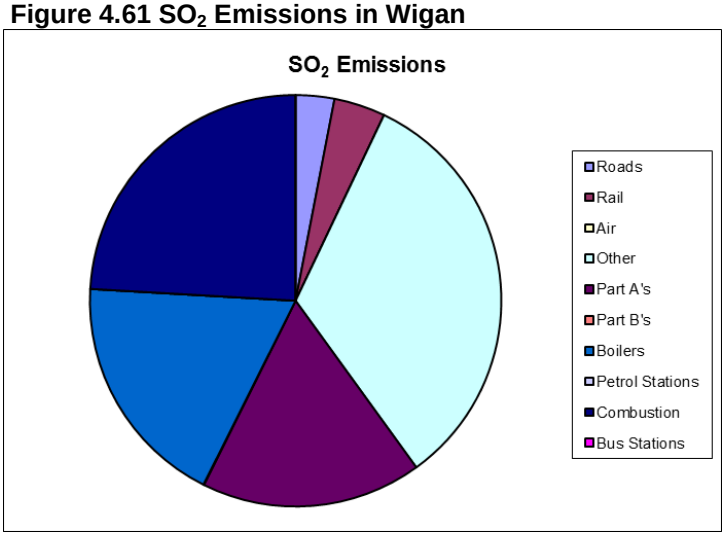


Figure 4.62 NO_X Emissions in Wigan

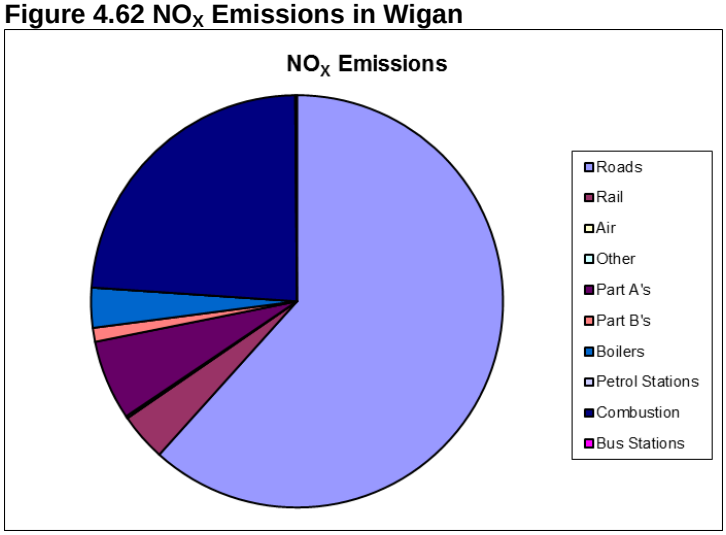


Figure 4.63 CO Emissions in Wigan

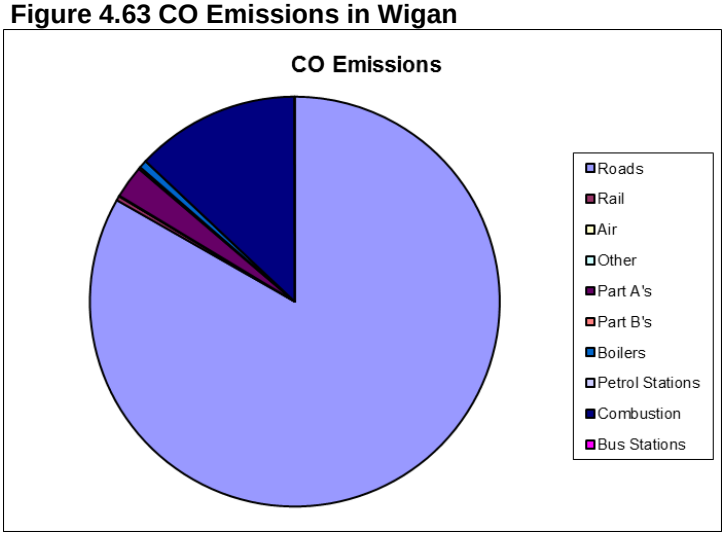


Figure 4.64 VOCs Emissions in Wigan

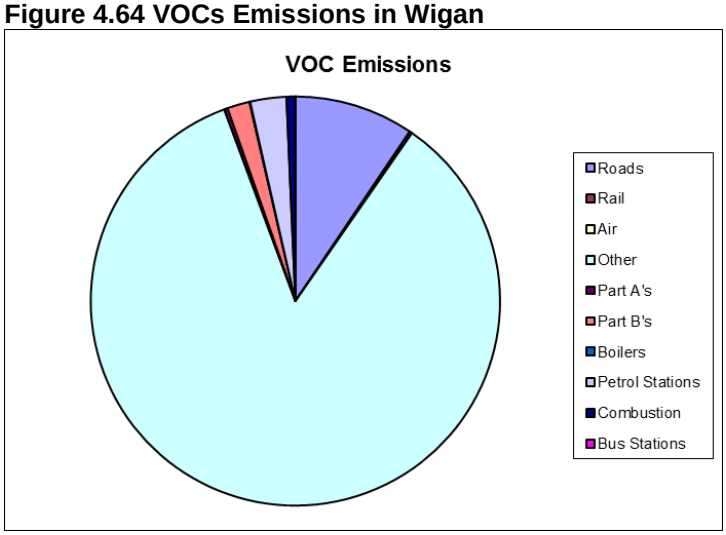


Figure 4.65 CO_2 Emissions in Wigan

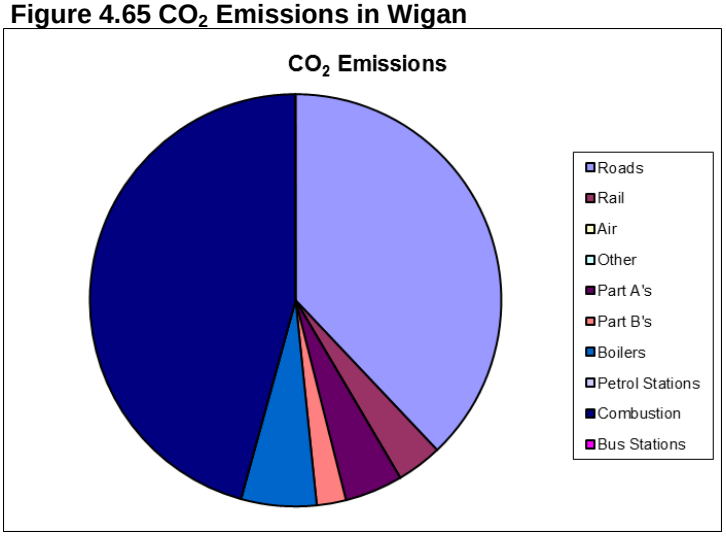
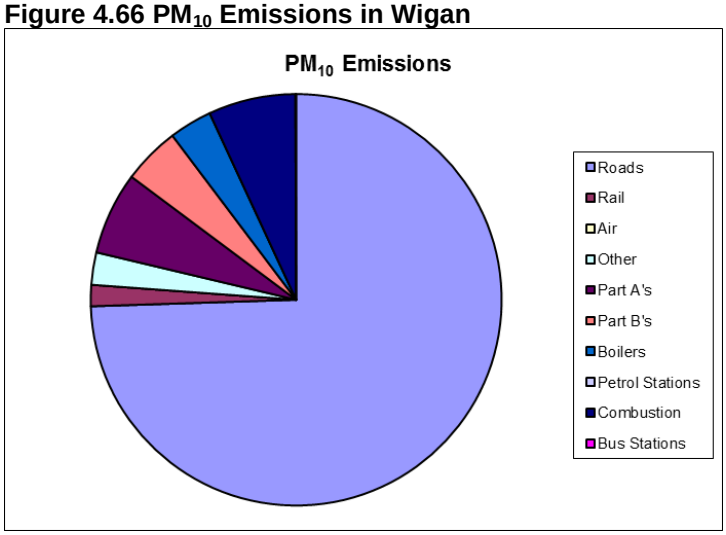


Figure 4.66 PM_{10} Emissions in Wigan



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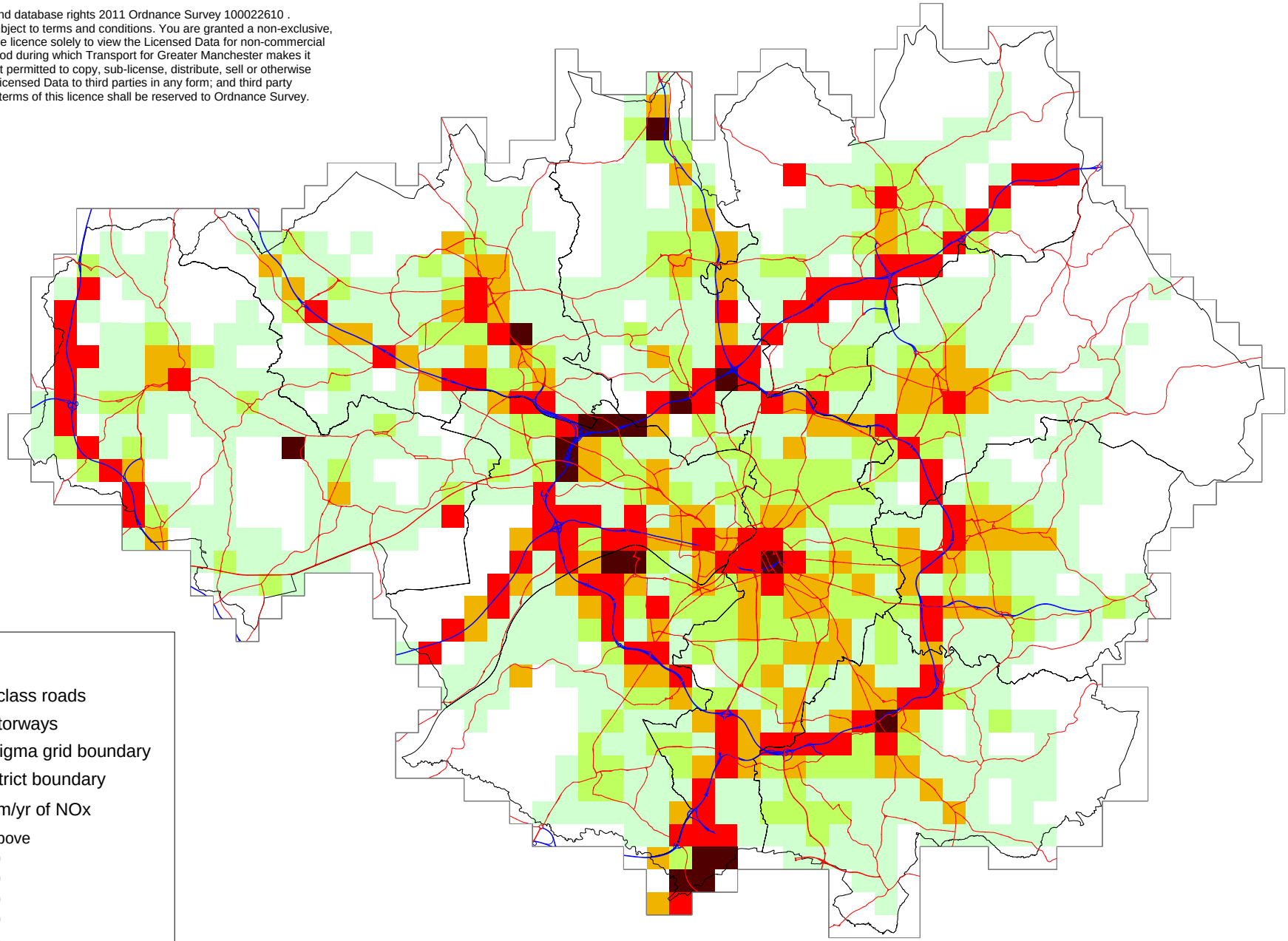
Appendices

Appendix 1 Maps of emissions from all sources

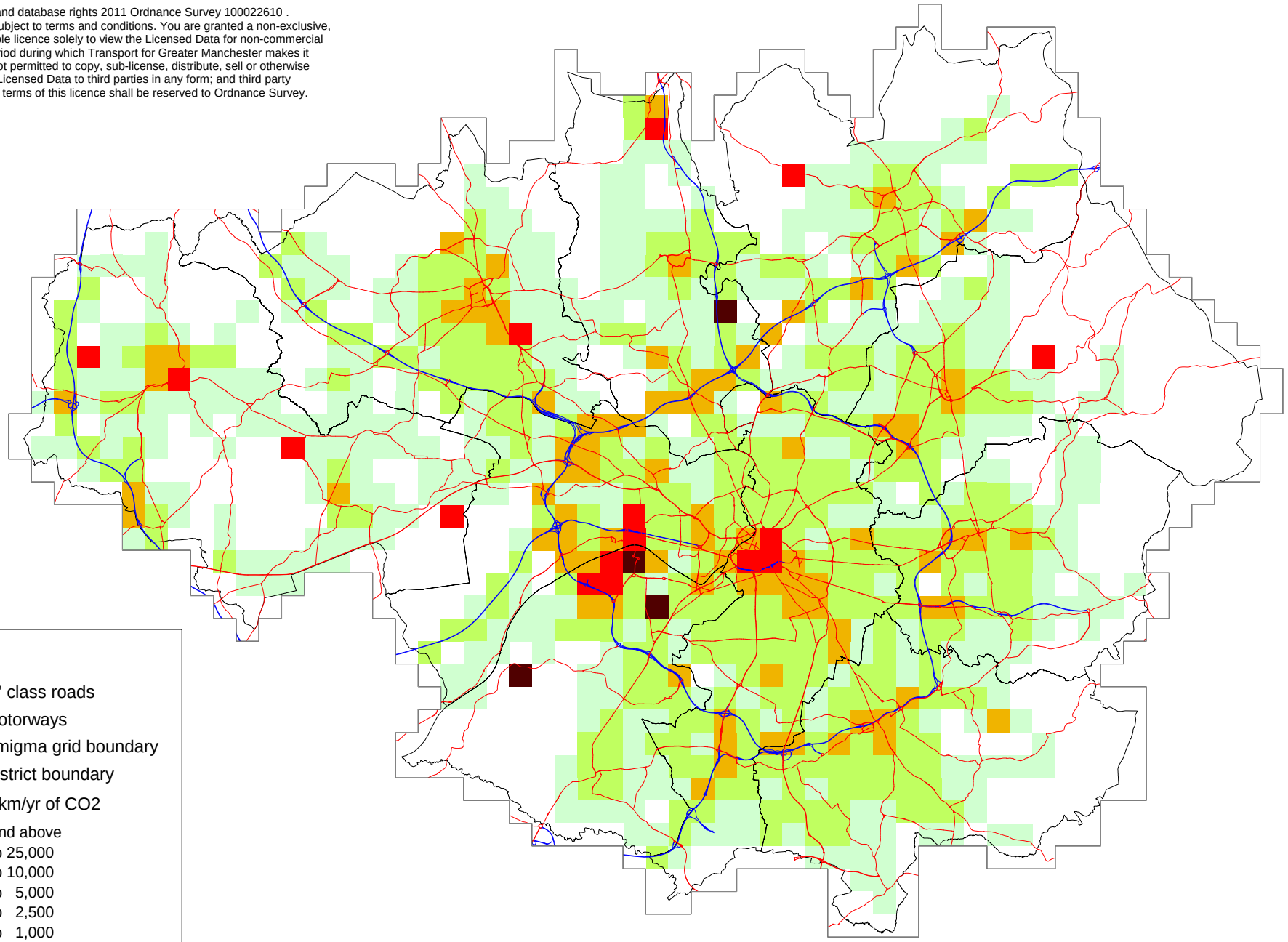
The following figures show maps of emissions from all sources, road transport and electricity generation at point of use.



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

Total emissions of NOx in 2007

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.1



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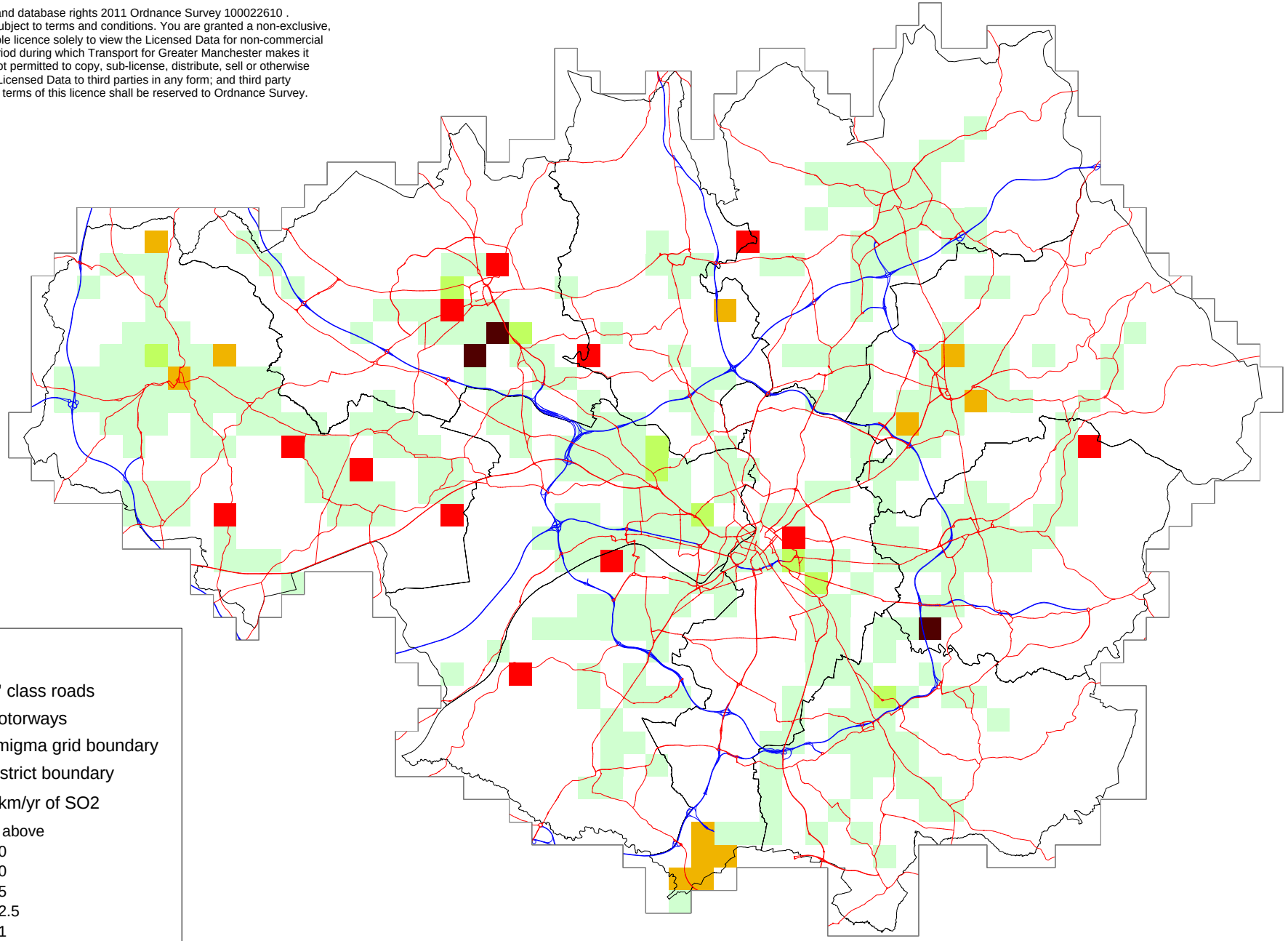
Total emissions of CO2 in 2007

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.2



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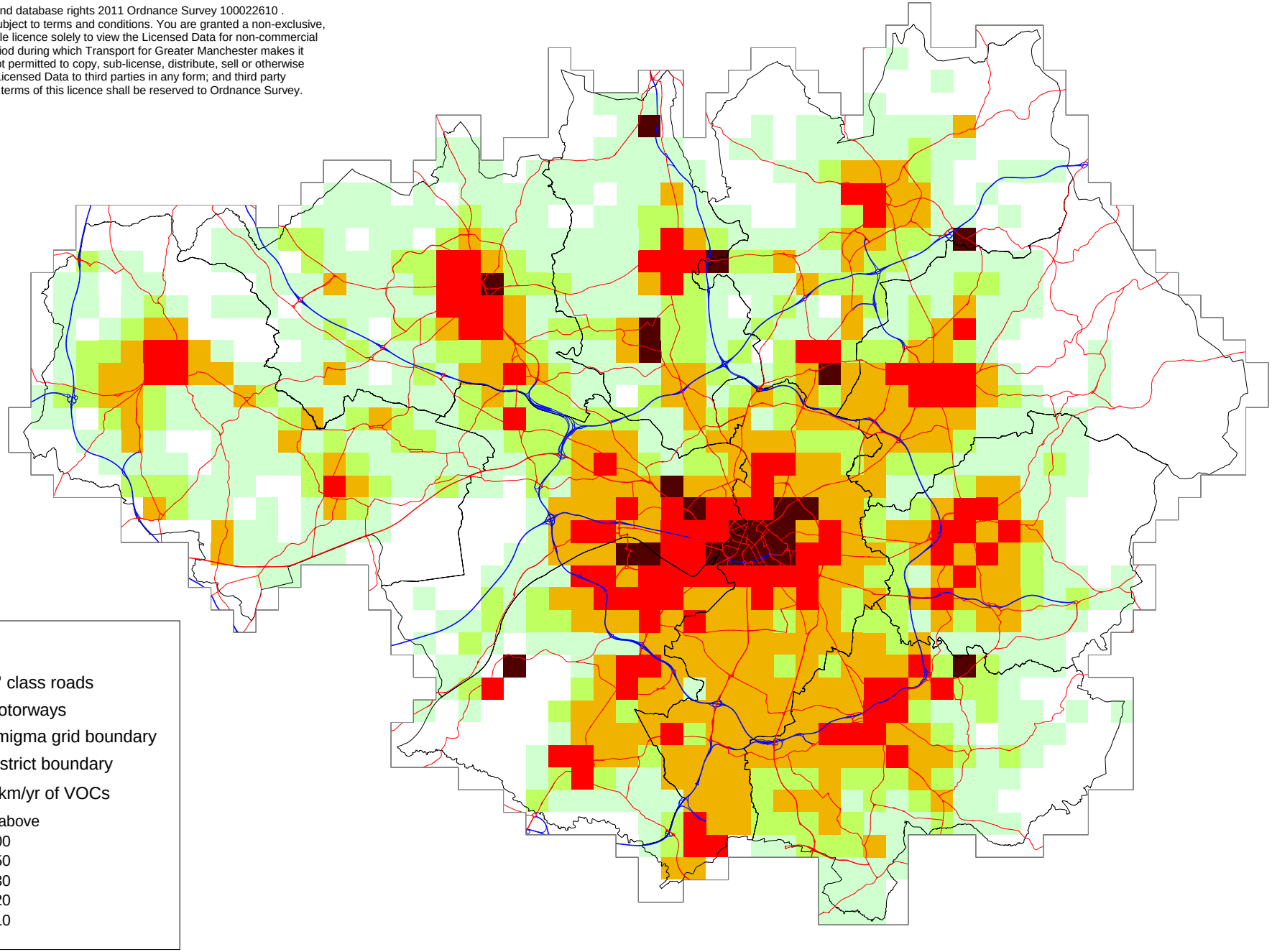
Total emissions of SO2 in 2007

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.3



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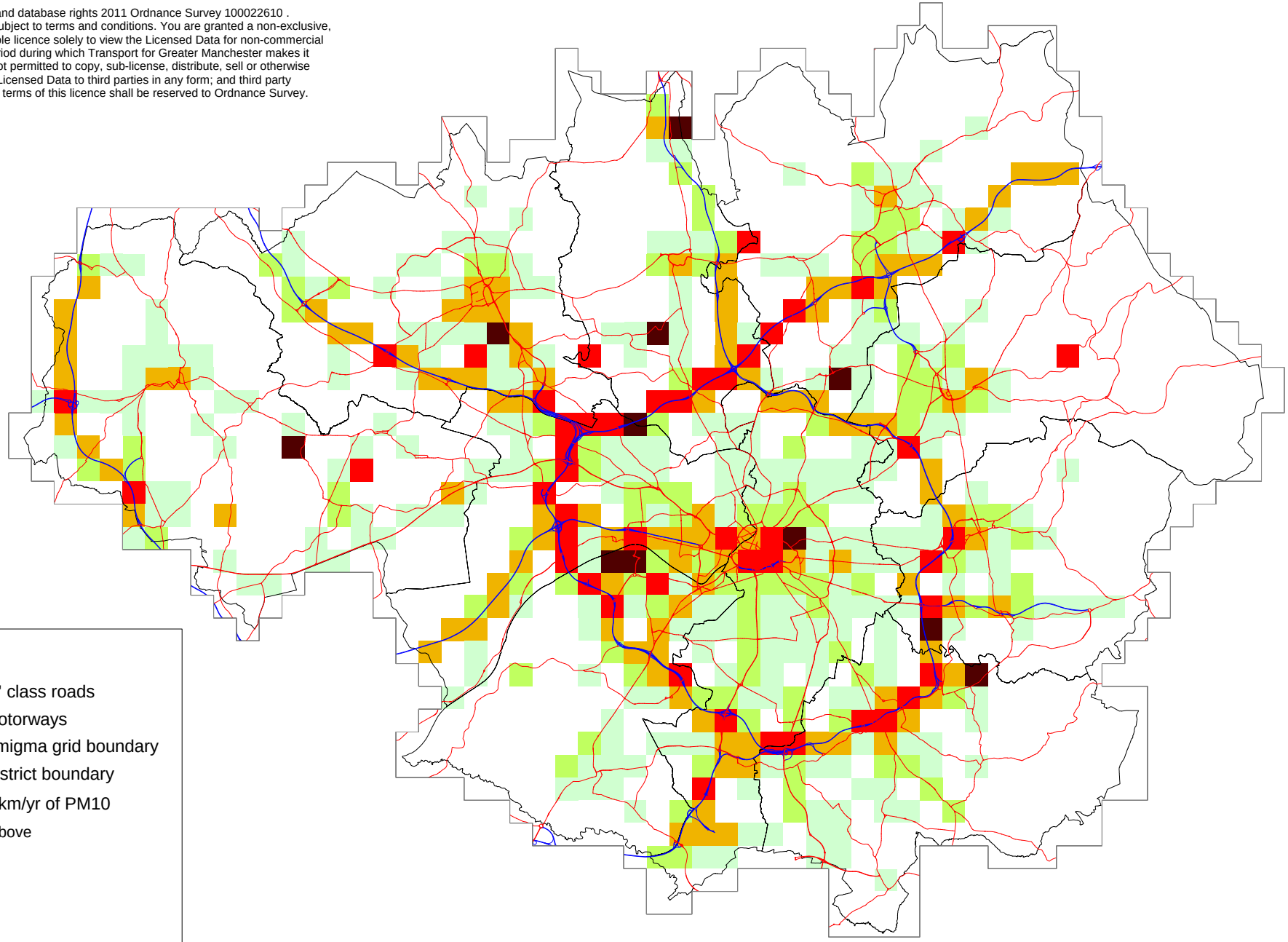
Total emissions of VOCs in 2007

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.4



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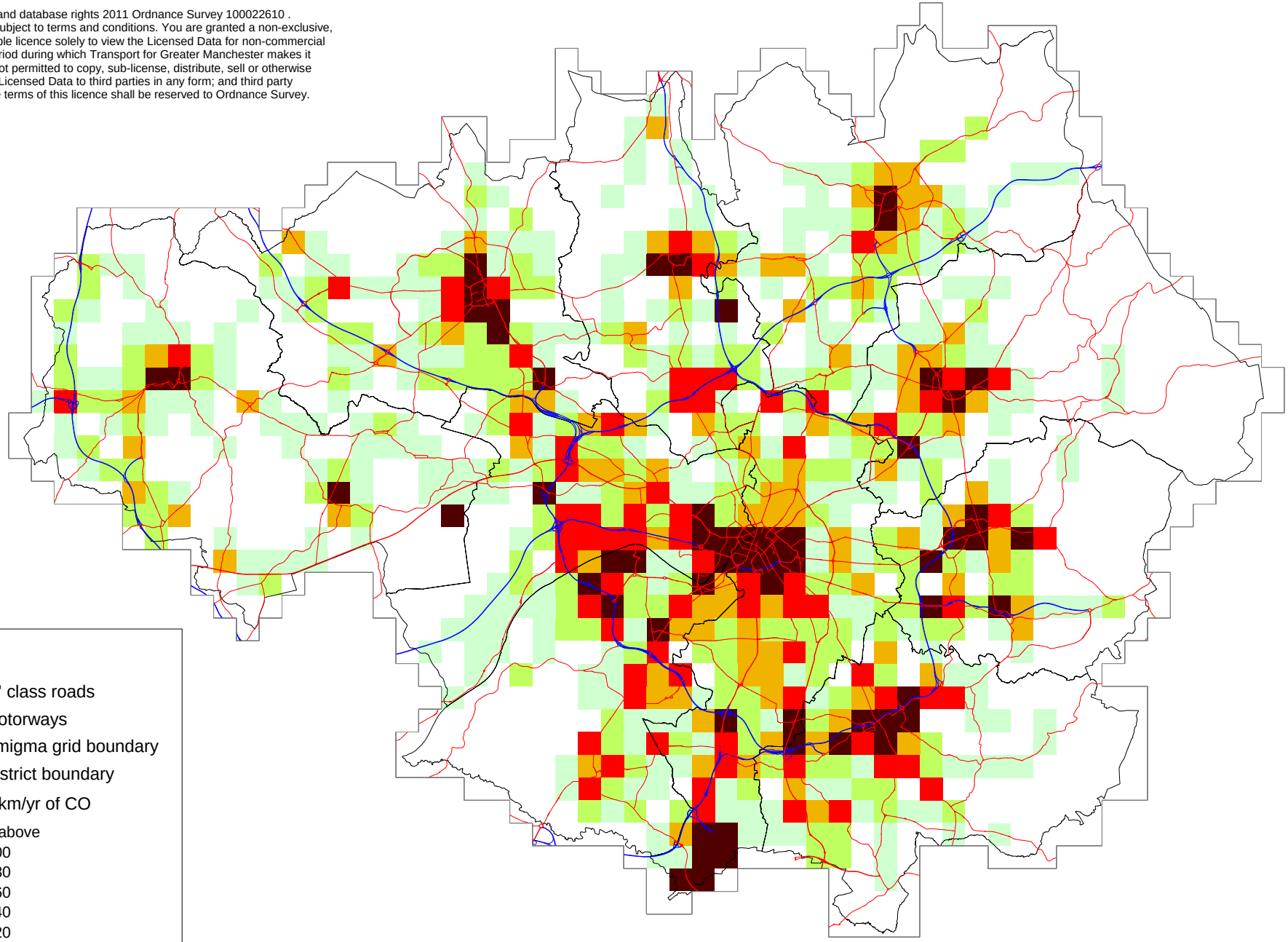
Total emissions of PM10 in 2007

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.5



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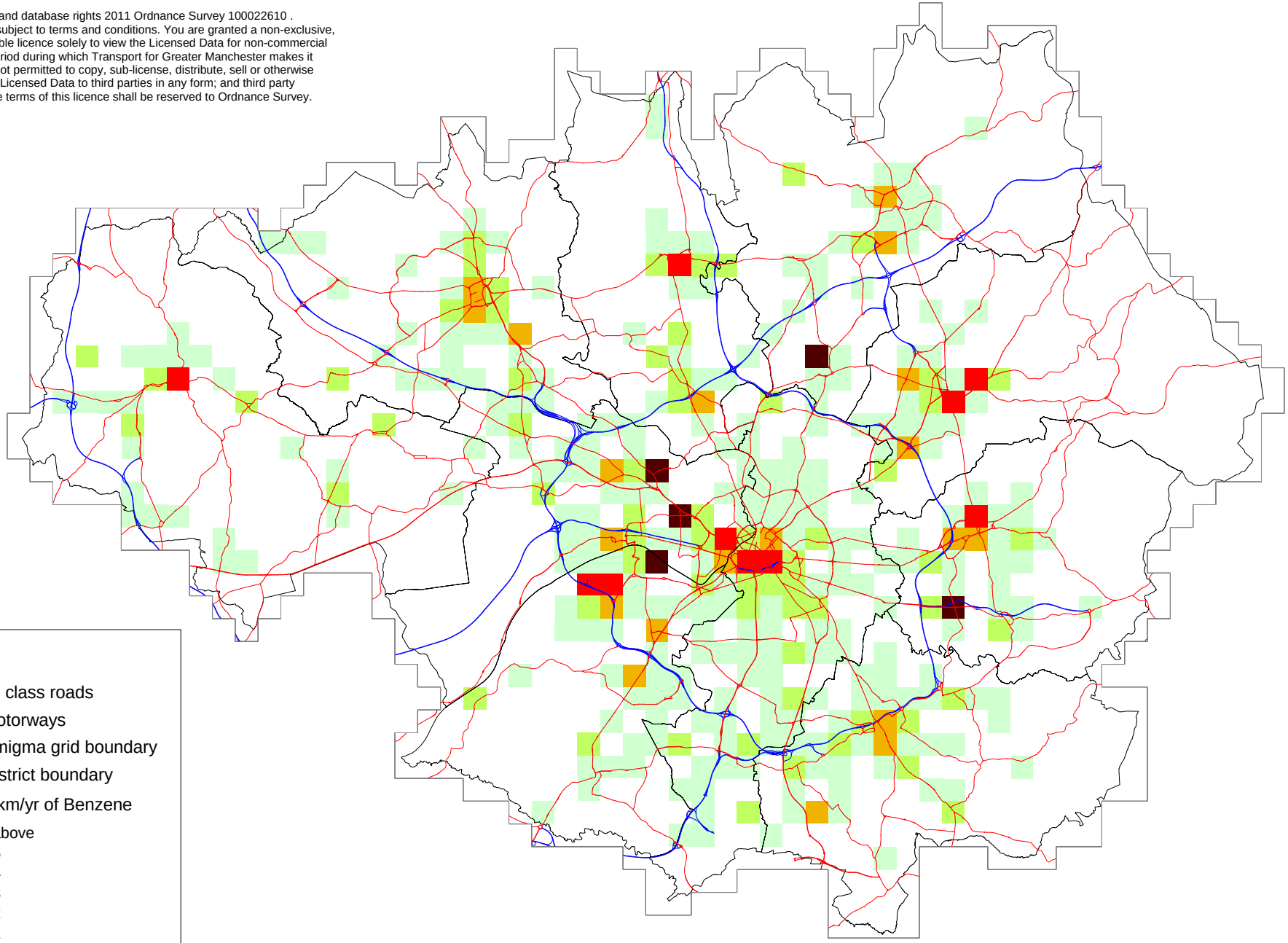
Manchester,
M1 3BG

Total emissions of CO in 2007

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.6



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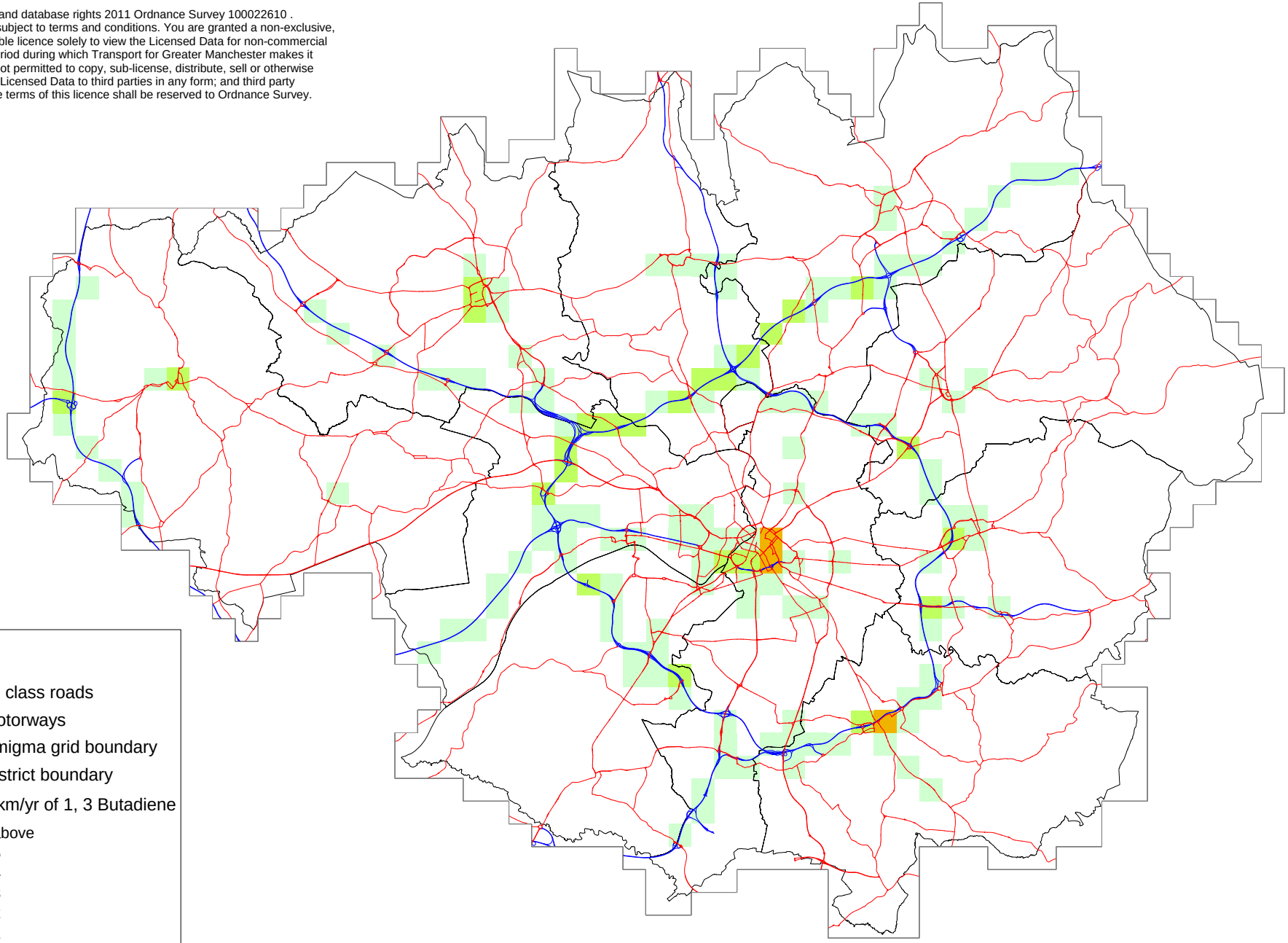
2 Piccadilly Place,
Manchester,
M1 3BG

Total emissions of Benzene in 2007

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.7



Transport for Greater Manchester
2 Piccadilly Place,
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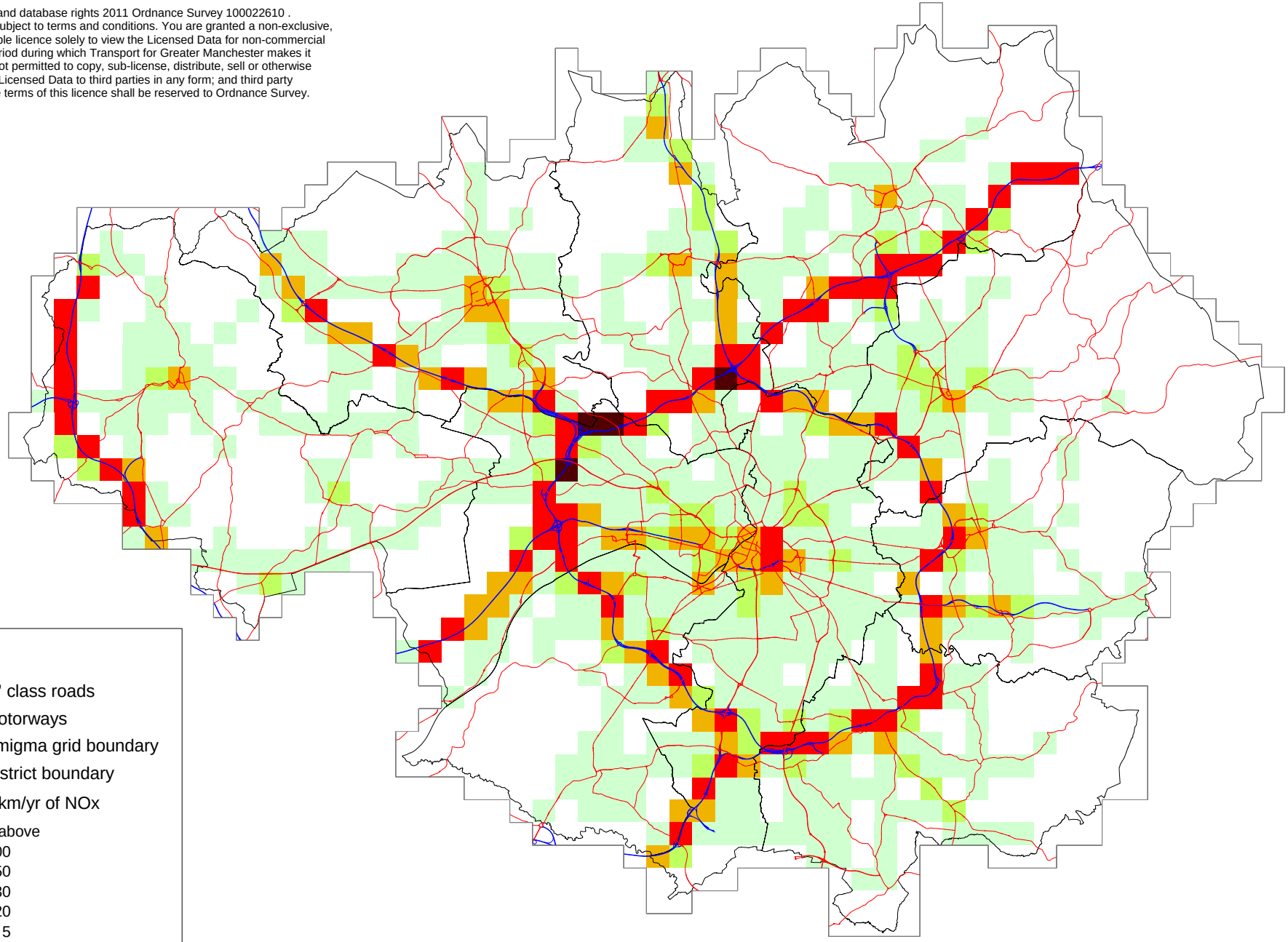
Total emissions of 1, 3 Butadiene in 2007

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.8



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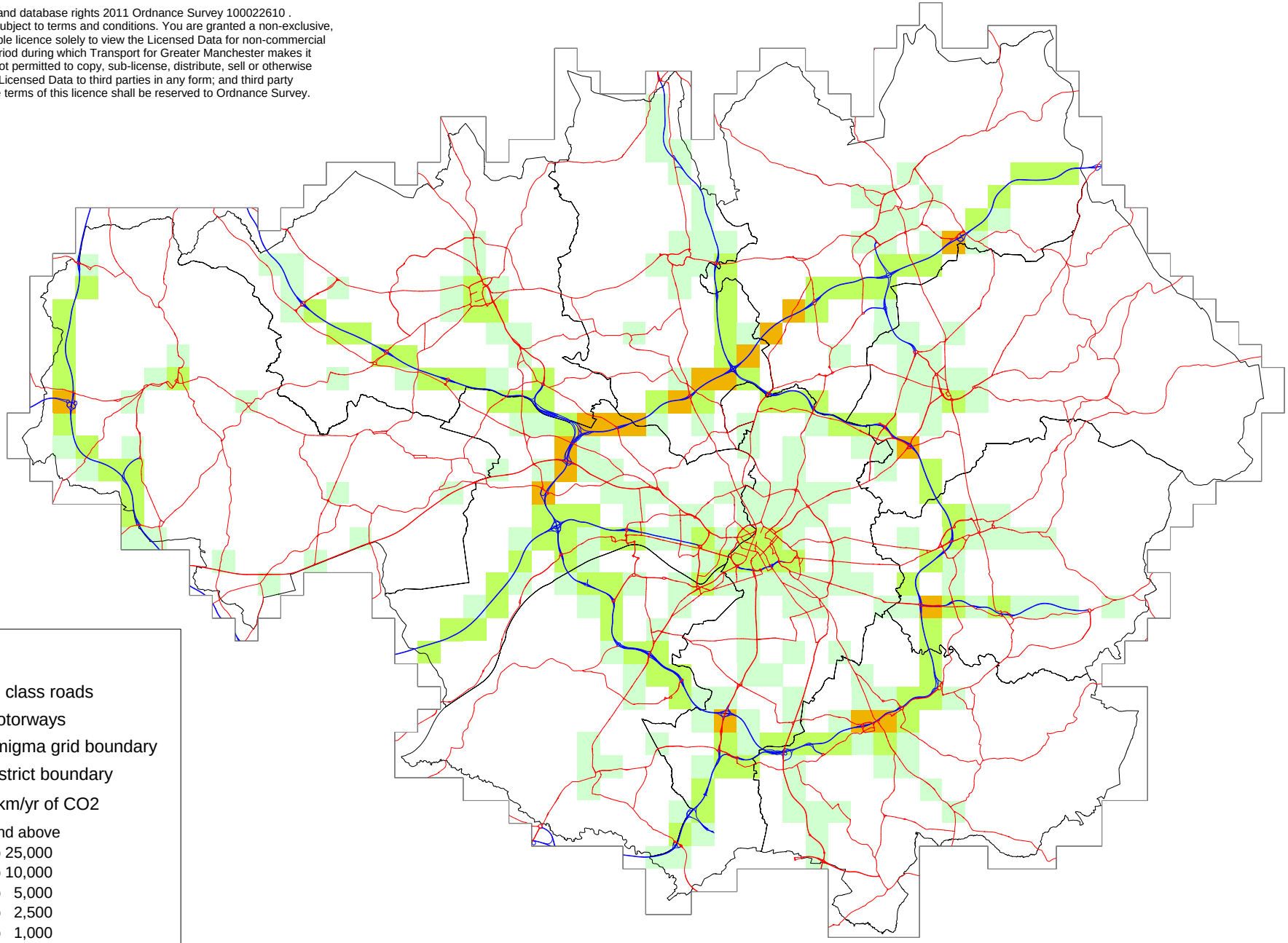
Emissions of NOx in 2007 from road transport

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.9



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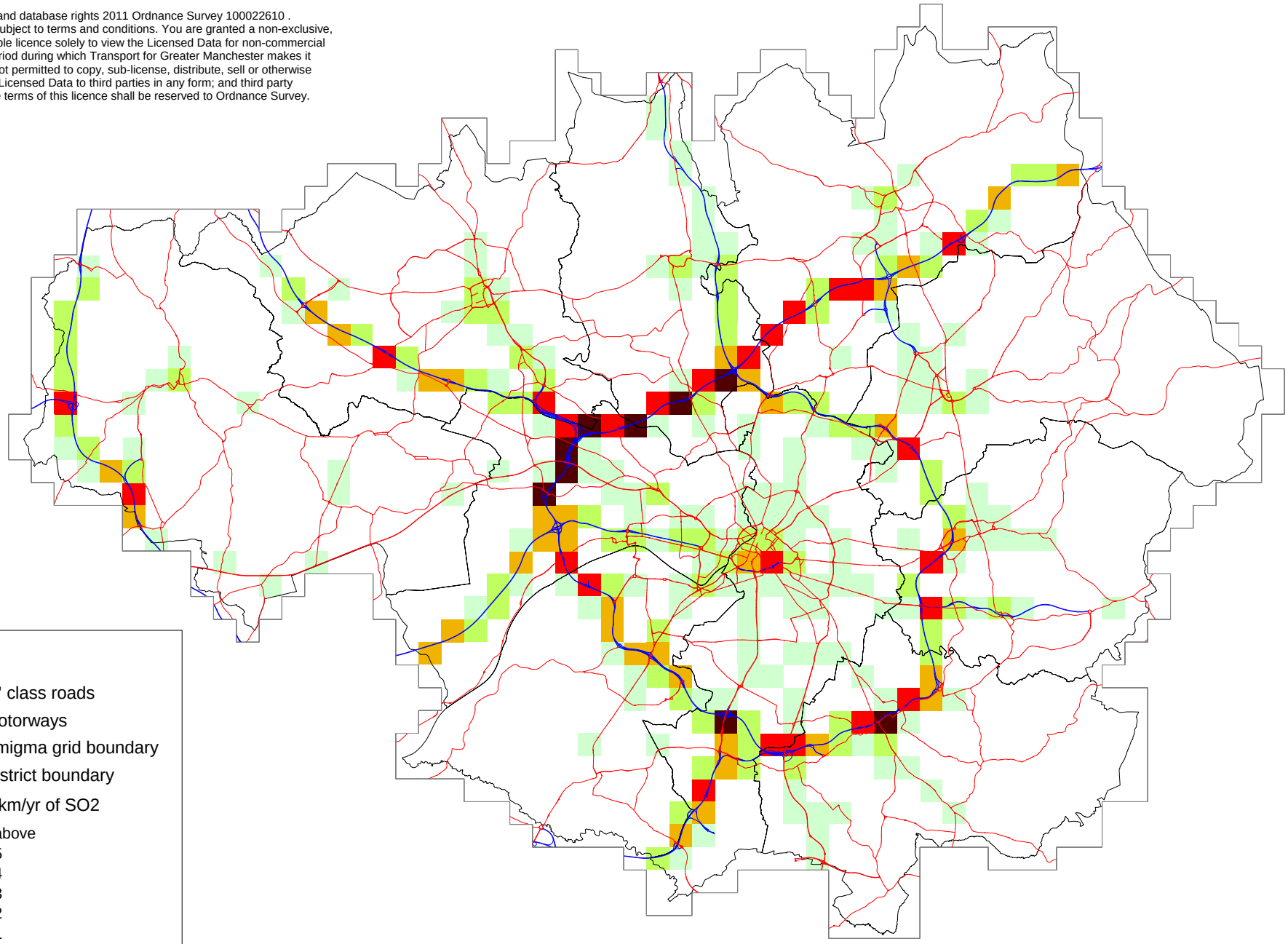
Emissions of CO2 in 2007 from road transport

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.10



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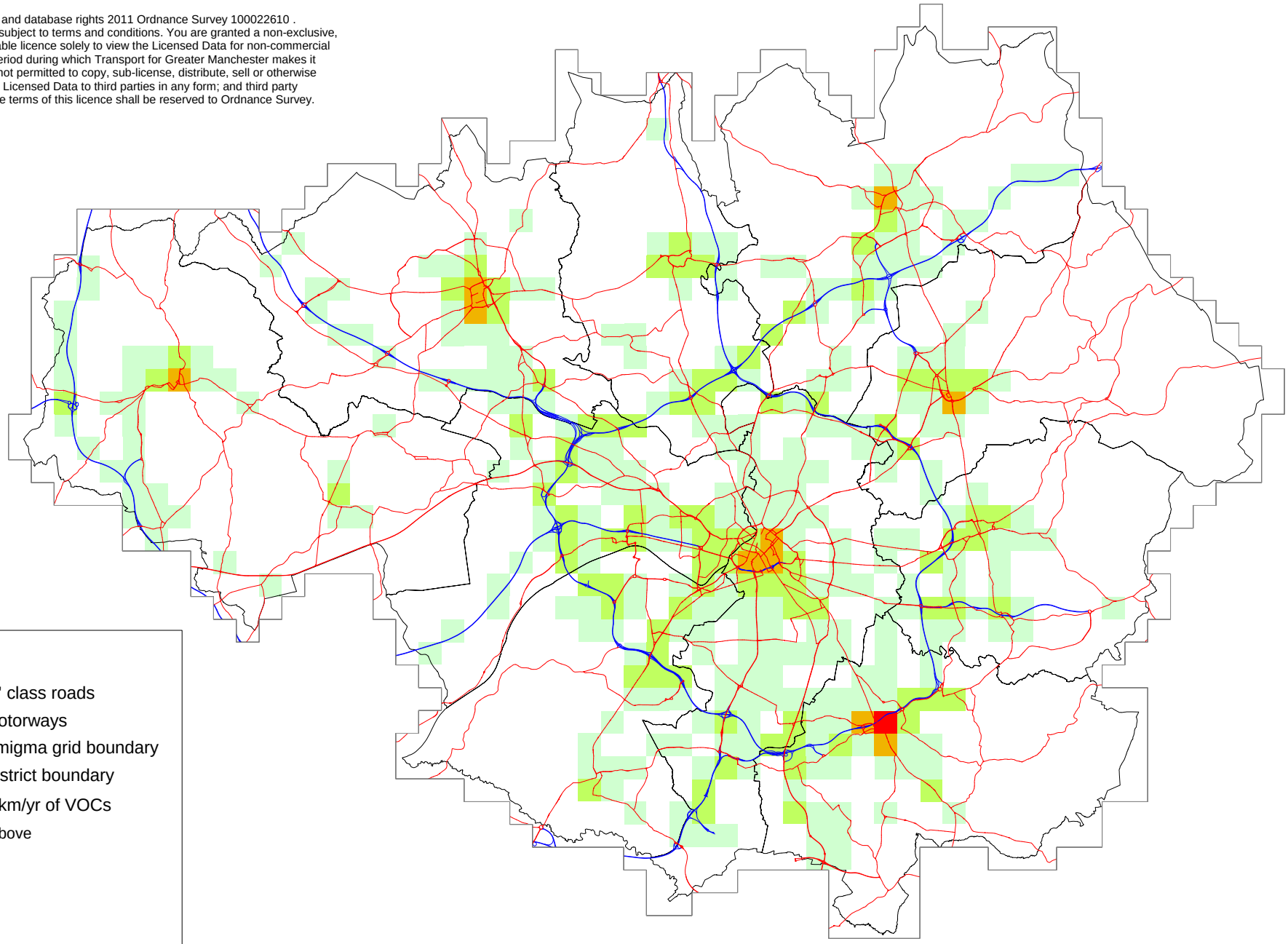
Emissions of SO2 in 2007 from road transport

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.11



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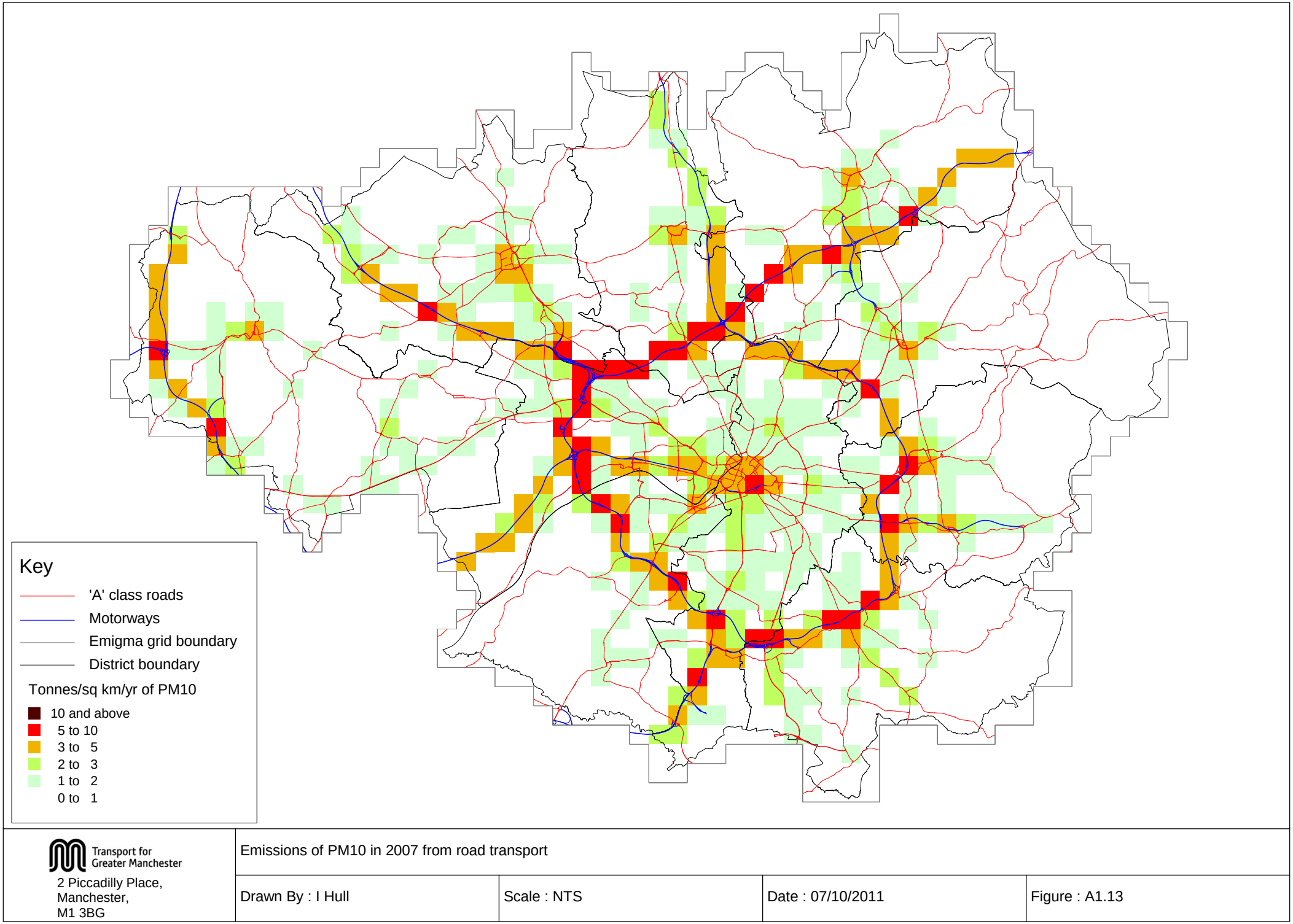
Emissions of VOCs in 2007 from road transport

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.12



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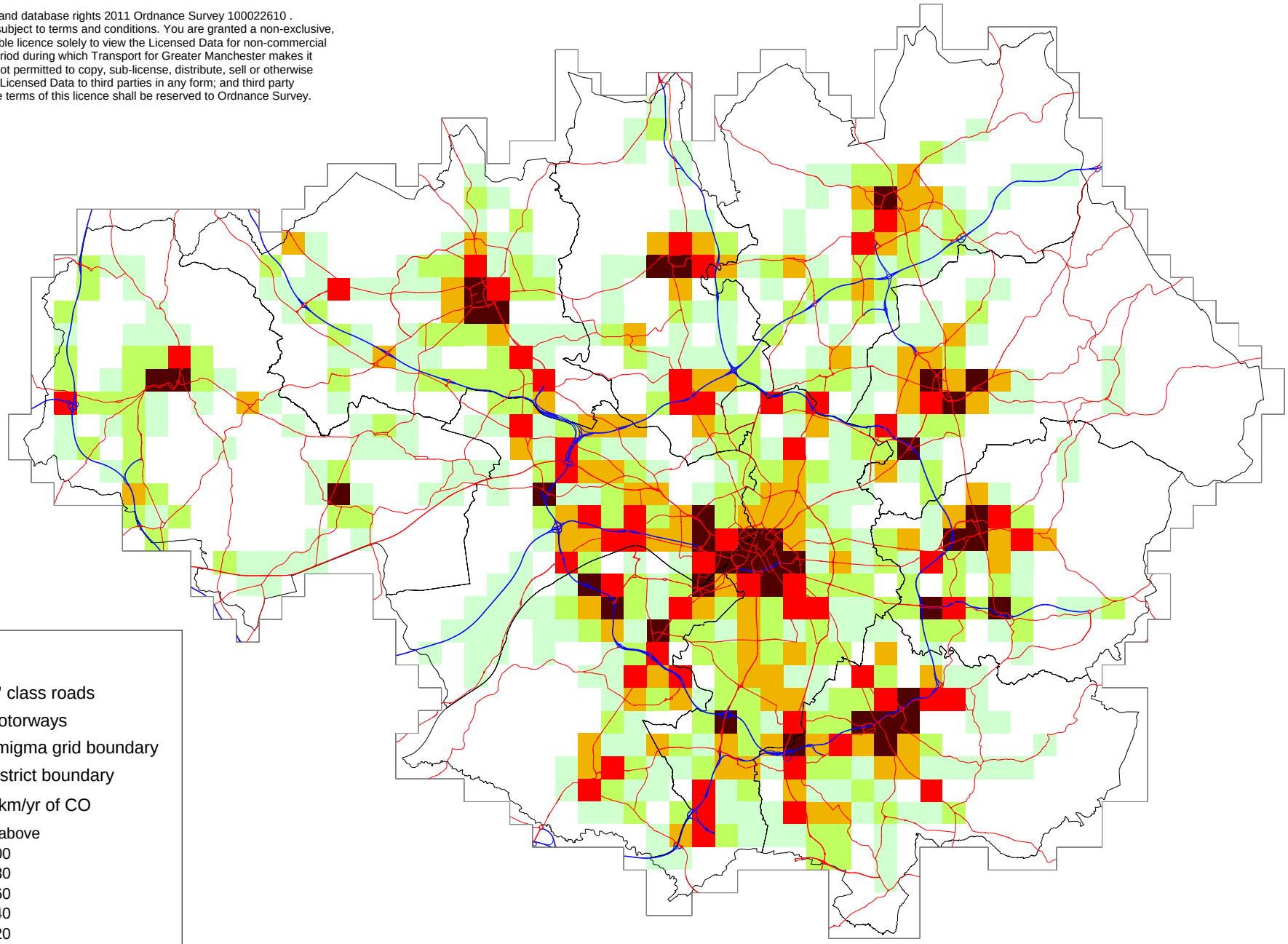
Emissions of PM10 in 2007 from road transport

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.13



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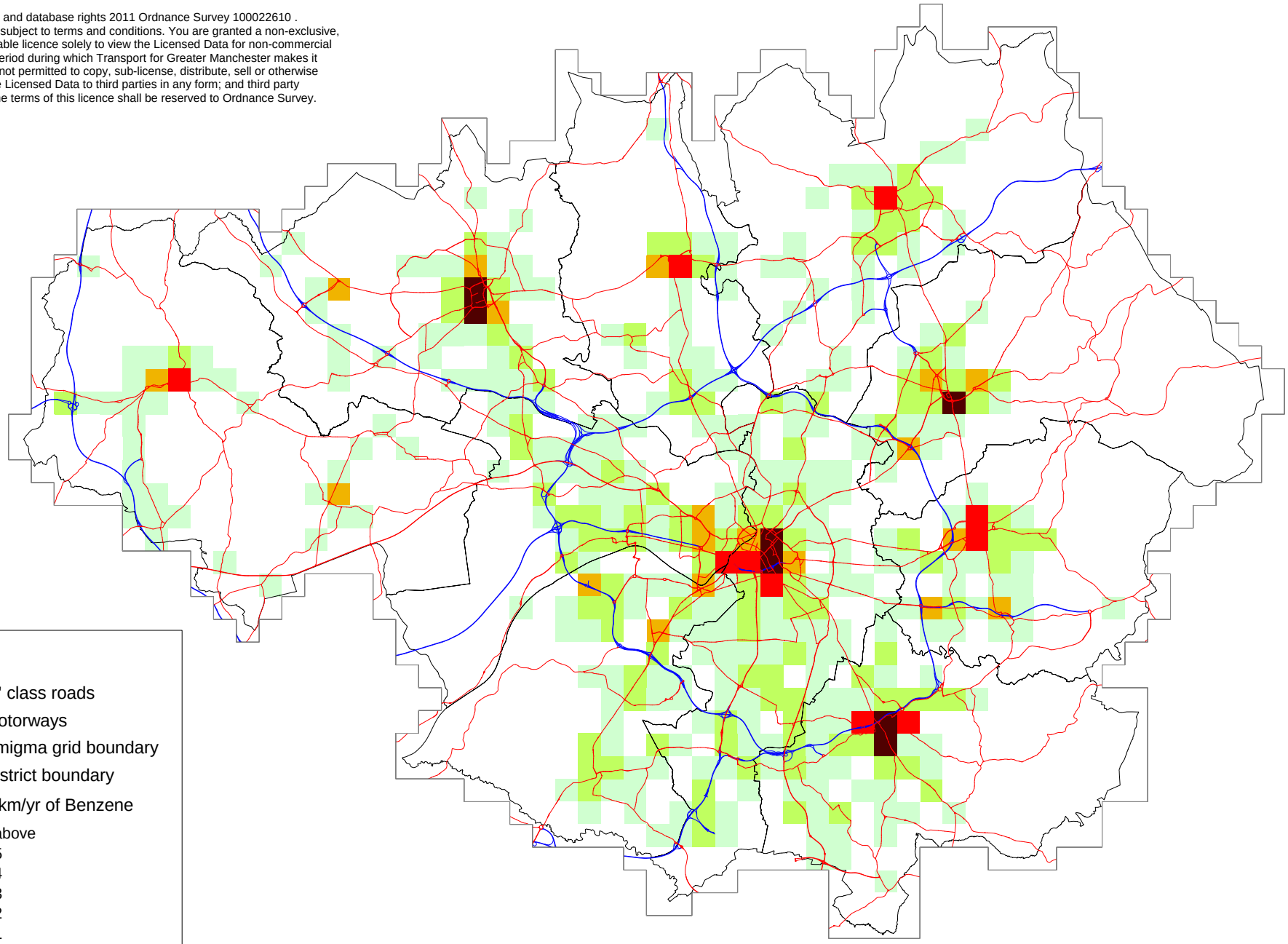
Emissions of CO in 2007 from road transport

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.14



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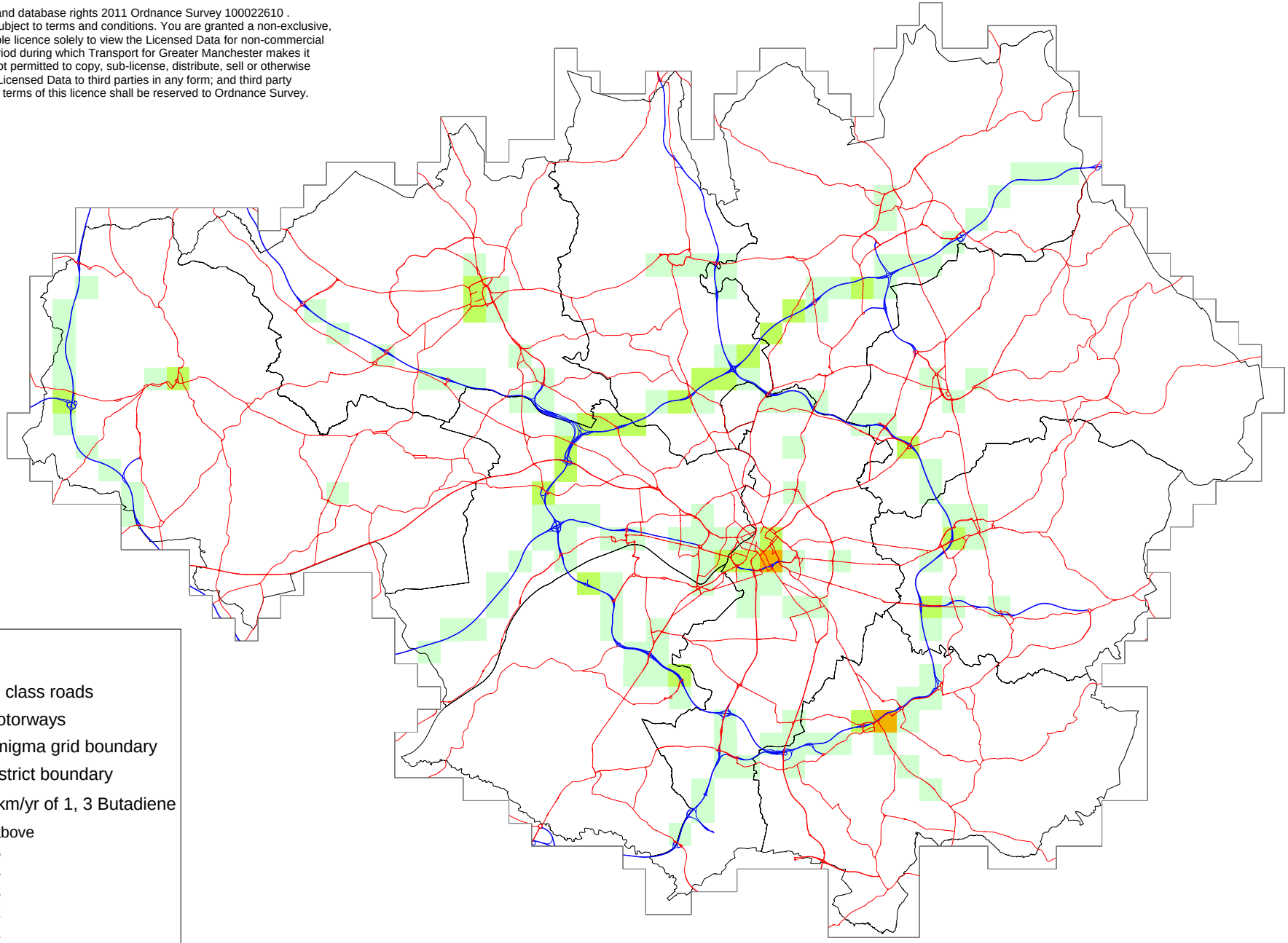
Emissions of Benzene in 2007 from road transport

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.15



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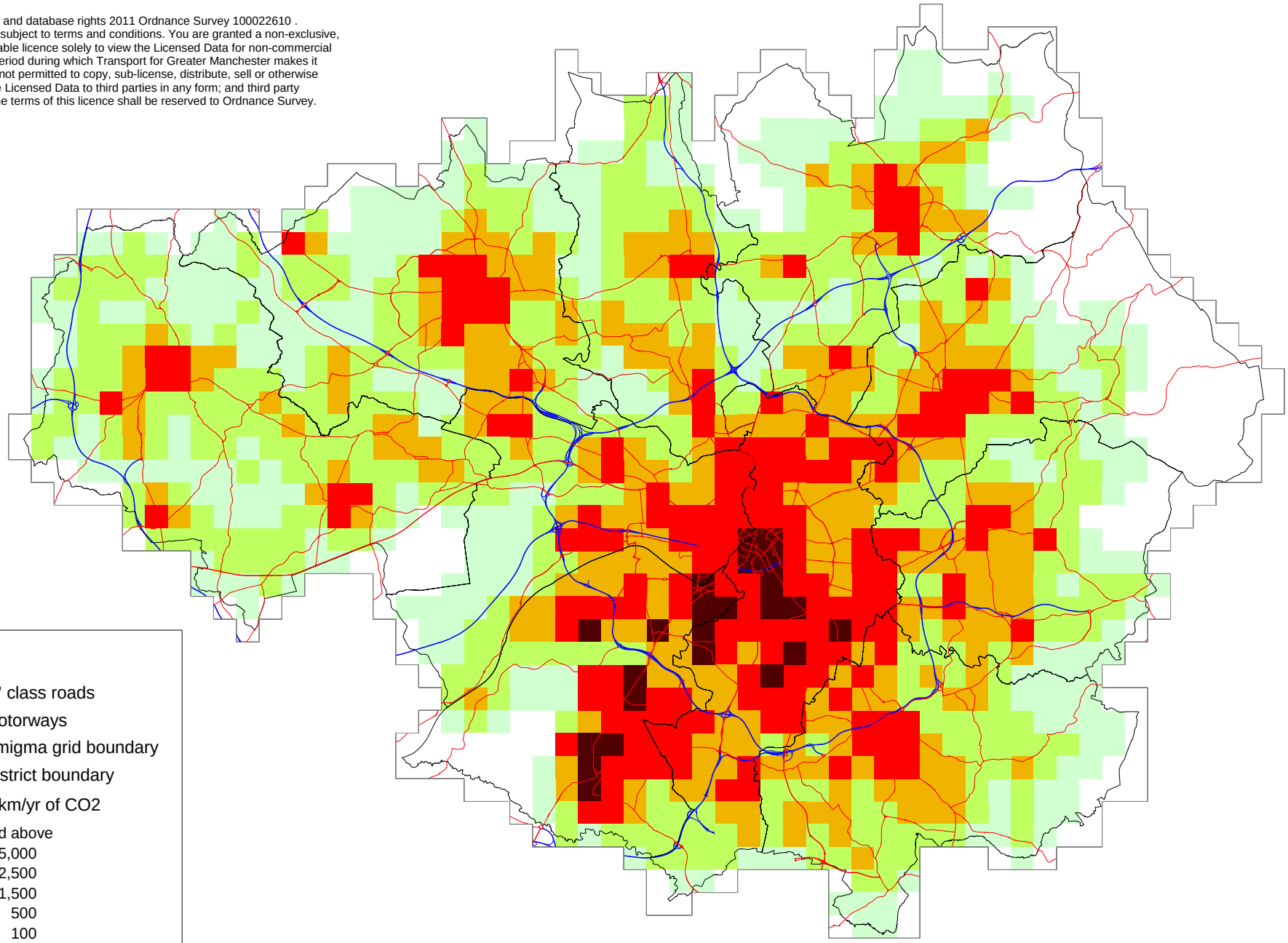
Emissions of 1, 3 Butadiene in 2007 from road transport

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.16



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Emissions of CO2 in 2007 from electricity generation at point of use

Drawn By : I Hull	Scale : NTS	Date : 07/10/2011	Figure : A1.17

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 [3,4]

Table A2.1 Speed Emission Factors for Motor Cycles

Table A2.2 Speed Emission Factors for Petrol Cars

Table A2.3 Speed Emission Factors for Diesel Cars

Table A2.4 Speed Emission Factors for Petrol LGVS

Table A2.5 Speed Emission Factors for Diesel LGVS

Table A2.6 Speed Emission Factors for Rigid HGVS

Table A2.7 Speed Emission Factors for Articulated HGVS

Table A2.8 Speed Emission Factors for Buses

Table A2.9 Fleet Composition Data

Table A2.10 Road Traffic Expansion Factors

Table A2.11 Fleet-Weighted Cold Start Emission Factors

Table A2.12 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 fleet composition data for motorcycles, or speed emission factor coefficients for SO_2, although road transport represents only a minor source of UK sulphur emissions. As an alternative, the speed emission factors for motorcycles and SO_2 have been estimated using the drive-cycle factors from Reference 11, applying the urban driving factors for speeds up to 60 kph and the motorway factors for speeds greater than 60 kph

Table A2.1

2007 Speed Emission Factors for Motor Cycles (g/km)[2]				
Speed km/hour	**NO_X**	**PM_{10}**	**CO**	**VOCs**
5	0.134000	0.134570	12.292000	2.762000
10	0.134000	0.134570	12.292000	2.762000
15	0.134000	0.134570	12.292000	2.762000
20	0.134000	0.134570	12.292000	2.762000
25	0.134000	0.134570	12.292000	2.762000
30	0.134000	0.134570	12.292000	2.762000
35	0.134000	0.134570	12.292000	2.762000
40	0.134000	0.134570	12.292000	2.762000
45	0.134000	0.134570	12.292000	2.762000
50	0.134000	0.134570	12.292000	2.762000
55	0.134000	0.134570	12.292000	2.762000
60	0.134000	0.134570	12.292000	2.762000
65	0.418000	0.164570	22.400000	0.718000
70	0.418000	0.164570	22.400000	0.718000
75	0.418000	0.164570	22.400000	0.718000
80	0.418000	0.164570	22.400000	0.718000
85	0.418000	0.164570	22.400000	0.718000
90	0.418000	0.164570	22.400000	0.718000
95	0.418000	0.164570	22.400000	0.718000
100	0.418000	0.164570	22.400000	0.718000
105	0.418000	0.164570	22.400000	0.718000
110	0.418000	0.164570	22.400000	0.718000
115	0.418000	0.164570	22.400000	0.718000
Speed km/hour	**Benzene**	**1,3 Butadiene**	**CO_2 as C**	**SO_2[2]**
5	0.080000	0.060000	34.000000	0.004000
10	0.080000	0.060000	34.000000	0.004000
15	0.080000	0.060000	34.000000	0.004000
20	0.080000	0.060000	34.000000	0.004000
25	0.080000	0.060000	34.000000	0.004000
30	0.080000	0.060000	34.000000	0.004000
35	0.080000	0.060000	34.000000	0.004000
40	0.080000	0.060000	34.000000	0.004000
45	0.080000	0.060000	34.000000	0.004000
50	0.080000	0.060000	34.000000	0.004000
55	0.080000	0.060000	34.000000	0.004000
60	0.080000	0.060000	34.000000	0.004000
65	0.020000	0.010000	47.000000	0.005540
70	0.020000	0.010000	47.000000	0.005540
75	0.020000	0.010000	47.000000	0.005540
80	0.020000	0.010000	47.000000	0.005540
85	0.020000	0.010000	47.000000	0.005540
90	0.020000	0.010000	47.000000	0.005540
95	0.020000	0.010000	47.000000	0.005540
100	0.020000	0.010000	47.000000	0.005540
105	0.020000	0.010000	47.000000	0.005540
110	0.020000	0.010000	47.000000	0.005540
115	0.020000	0.010000	47.000000	0.005540

Table A2.2

2007 Speed Emission Factors for Petrol Cars (g/km)				
Speed km/hour	**NO_X**	**PM_{10}**	**CO**	**VOCs[1]**
5	0.251495	0.058828	7.088015	0.565978
10	0.228632	0.055611	3.854812	0.334305
15	0.218948	0.054278	2.788777	0.259386
20	0.214075	0.053442	2.245025	0.218450
25	0.211924	0.052829	1.904948	0.190811
30	0.211680	0.052350	1.666177	0.169978
35	0.212983	0.051969	1.486218	0.153261
40	0.215669	0.051669	1.344487	0.139345
45	0.219671	0.051444	1.229957	0.127518
50	0.224972	0.051291	1.136304	0.117361
55	0.231586	0.051209	1.059743	0.108618
60	0.239547	0.051199	0.997951	0.101123
65	0.248896	0.051263	0.949498	0.094766
70	0.259684	0.051404	0.913528	0.089477
75	0.271968	0.051624	0.889559	0.085206
80	0.285807	0.051926	0.877370	0.081921
85	0.301263	0.052314	0.876919	0.079603
90	0.318401	0.052790	0.888298	0.078238
95	0.337285	0.053358	0.911691	0.077822
100	0.357982	0.054022	0.947356	0.078354
105	0.380560	0.054785	0.995606	0.079835
110	0.405087	0.055650	1.056793	0.082270
115	0.431631	0.056622	1.131305	0.085668
Speed km/hour	**Benzene**	**1,3 Butadiene**	**CO_2 as C**	**SO_2[2]**
5	0.013960	0.006664	141.010210	0.005432
10	0.007834	0.004046	85.267540	0.005432
15	0.005994	0.003157	66.730332	0.005432
20	0.005017	0.002664	57.413445	0.005432
25	0.004366	0.002328	51.787793	0.005432
30	0.003881	0.002074	48.036334	0.005432
35	0.003495	0.001870	45.391072	0.005432
40	0.003176	0.001700	43.474139	0.005432
45	0.002908	0.001554	42.079955	0.005432
50	0.002680	0.001429	41.088661	0.005432
55	0.002486	0.001321	40.426964	0.005432
60	0.002322	0.001228	40.048649	0.005432
65	0.002185	0.001149	39.924118	0.006312
70	0.002075	0.001082	40.034431	0.006312
75	0.001988	0.001028	40.367738	0.006312
80	0.001926	0.000985	40.917057	0.006312
85	0.001886	0.000954	41.678835	0.006312
90	0.001869	0.000935	42.651994	0.006312
95	0.001875	0.000927	43.837277	0.006312
100	0.001903	0.000930	45.236791	0.006312
105	0.001953	0.000945	46.853681	0.006312
110	0.002026	0.000971	48.691894	0.006312
115	0.002120	0.001010	50.756003	0.006312

Table A2.3

2007 Speed Emission Factors for Diesel Cars (g/km)				
Speed km/hour	**NO_X**	**PM_{10}**	**CO**	**VOCs[1]**
5	1.018148	0.129699	0.775888	0.249524
10	0.793596	0.104966	0.557348	0.145599
15	0.688315	0.096550	0.434884	0.108581
20	0.622702	0.092686	0.358961	0.088392
25	0.574233	0.090031	0.303116	0.074999
30	0.535394	0.087727	0.258157	0.065069
35	0.503204	0.085536	0.220253	0.057182
40	0.476394	0.083405	0.187567	0.050639
45	0.454448	0.081350	0.159118	0.045061
50	0.437229	0.079415	0.134341	0.040227
55	0.424801	0.077655	0.112887	0.036007
60	0.417345	0.076130	0.094533	0.032317
65	0.415115	0.074901	0.079130	0.029109
70	0.418408	0.074034	0.066573	0.026352
75	0.427554	0.073593	0.056789	0.024030
80	0.442903	0.073641	0.049725	0.022135
85	0.464819	0.074243	0.045340	0.020666
90	0.493675	0.075465	0.043607	0.019629
95	0.529855	0.077370	0.044502	0.019029
100	0.573747	0.080022	0.048009	0.018878
105	0.625742	0.083487	0.054114	0.019187
110	0.686236	0.087828	0.062808	0.019969
115	0.755628	0.093109	0.074083	0.021240
Speed km/hour	**Benzene**	**1,3 Butadiene**	**CO_2 as C**	**SO_2[2]**
5	0.004255	0.002085	115.477887	0.003326
10	0.002483	0.001216	76.313342	0.003326
15	0.001852	0.000907	62.037651	0.003326
20	0.001507	0.000738	54.488693	0.003326
25	0.001279	0.000627	49.660499	0.003326
30	0.001110	0.000544	46.225295	0.003326
35	0.000975	0.000478	43.629442	0.003326
40	0.000864	0.000423	41.608678	0.003326
45	0.000768	0.000376	40.026575	0.003326
50	0.000686	0.000336	38.810215	0.003326
55	0.000614	0.000301	37.921121	0.003326
60	0.000551	0.000270	37.340799	0.003326
65	0.000496	0.000243	37.062993	0.002868
70	0.000449	0.000220	37.089285	0.002868
75	0.000410	0.000201	37.426459	0.002868
80	0.000377	0.000185	38.084866	0.002868
85	0.000352	0.000173	39.077365	0.002868
90	0.000335	0.000164	40.418625	0.002868
95	0.000325	0.000159	42.124641	0.002868
100	0.000322	0.000158	44.212406	0.002868
105	0.000327	0.000160	46.699664	0.002868
110	0.000341	0.000167	49.604747	0.002868
115	0.000362	0.000177	52.946439	0.002868

Table A2.4

2007 Speed Emission Factors for Petrol LGVS (g/km)				
Speed km/hour	**NO_X**	**PM_{10}**	**CO**	**VOCs[1]**
5	0.228500	0.056518	4.807910	0.573714
10	0.227268	0.054448	2.925526	0.281941
15	0.226363	0.053579	2.274094	0.206718
20	0.225873	0.053010	1.918087	0.170153
25	0.225887	0.052566	1.678044	0.146863
30	0.226493	0.052197	1.496524	0.129810
35	0.227781	0.051886	1.350461	0.116331
40	0.229838	0.051629	1.229574	0.105214
45	0.232754	0.051430	1.129229	0.095835
50	0.236618	0.051293	1.047608	0.087846
55	0.241517	0.051224	0.984423	0.081039
60	0.247541	0.051232	0.940275	0.075285
65	0.254778	0.051326	0.916312	0.070502
70	0.263318	0.051512	0.914034	0.066635
75	0.273248	0.051801	0.935174	0.063649
80	0.284657	0.052202	0.981626	0.061521
85	0.297635	0.052723	1.055395	0.060238
90	0.312269	0.053374	1.158571	0.059792
95	0.328649	0.054165	1.293302	0.060179
100	0.346863	0.055104	1.461781	0.061398
105	0.367000	0.056201	1.666236	0.063452
110	0.389149	0.057465	1.908921	0.066345
115	0.413398	0.058906	2.192111	0.070082
Speed km/hour	**Benzene**	**1,3 Butadiene**	**CO_2 as C**	**SO_2[2]**
5	0.015190	0.006177	233.574745	0.007522
10	0.006607	0.003273	117.225121	0.007522
15	0.004641	0.002455	92.935789	0.007522
20	0.003773	0.002034	82.444399	0.007522
25	0.003260	0.001755	76.078839	0.007522
30	0.002904	0.001545	71.465056	0.007522
35	0.002634	0.001376	67.807999	0.007522
40	0.002417	0.001235	64.794018	0.007522
45	0.002238	0.001115	62.290613	0.007522
50	0.002088	0.001013	60.244048	0.007522
55	0.001961	0.000925	58.638672	0.007522
60	0.001855	0.000850	57.478807	0.007522
65	0.001767	0.000788	56.779962	0.008512
70	0.001695	0.000738	56.564242	0.008512
75	0.001640	0.000699	56.857821	0.008512
80	0.001600	0.000672	57.689476	0.008512
85	0.001576	0.000655	59.089706	0.008512
90	0.001566	0.000650	61.090177	0.008512
95	0.001571	0.000656	63.723367	0.008512
100	0.001590	0.000672	67.022331	0.008512
105	0.001624	0.000700	71.020545	0.008512
110	0.001673	0.000739	75.751789	0.008512
115	0.001736	0.000789	81.250077	0.008512

Table A2.5

2007 Speed Emission Factors for Diesel LGVS (g/km)				
Speed km/hour	**NO_X**	**PM_{10}**	**CO**	**VOCs[1]**
5	0.962485	0.153838	2.494609	0.406092
10	0.928735	0.146639	1.812876	0.232408
15	0.902813	0.142685	1.190156	0.173973
20	0.875841	0.138616	0.827993	0.144508
25	0.846687	0.134248	0.609415	0.126633
30	0.815749	0.129712	0.473596	0.114561
35	0.783886	0.125206	0.389124	0.105815
40	0.752127	0.120945	0.338546	0.099159
45	0.721583	0.117153	0.311478	0.093908
50	0.693401	0.114053	0.301382	0.089655
55	0.668754	0.111873	0.303948	0.086138
60	0.648824	0.110840	0.316226	0.083186
65	0.634801	0.111181	0.336130	0.080680
70	0.627883	0.113124	0.362144	0.078538
75	0.629268	0.116895	0.393145	0.076697
80	0.640157	0.122724	0.428282	0.075114
85	0.661755	0.130836	0.466900	0.073754
90	0.695266	0.141461	0.508487	0.072592
95	0.741894	0.154826	0.552639	0.071608
100	0.802846	0.171159	0.599033	0.070788
105	0.879328	0.190687	0.647406	0.070118
110	0.972547	0.213639	0.697548	0.069590
115	1.083711	0.240241	0.749283	0.069196
Speed km/hour	**Benzene**	**1,3 Butadiene**	**CO_2 as C**	**SO_2[2]**
5	0.007829	0.003835	152.470125	0.006744
10	0.004480	0.002195	109.162112	0.006744
15	0.003354	0.001643	93.403472	0.006744
20	0.002786	0.001365	84.448316	0.006744
25	0.002441	0.001196	78.127245	0.006744
30	0.002208	0.001082	73.101911	0.006744
35	0.002040	0.000999	68.851914	0.006744
40	0.001912	0.000936	65.165639	0.006744
45	0.001810	0.000887	61.969331	0.006744
50	0.001728	0.000847	59.258387	0.006744
55	0.001661	0.000814	57.066023	0.006744
60	0.001604	0.000786	55.447555	0.006744
65	0.001555	0.000762	54.471924	0.008518
70	0.001514	0.000742	54.216840	0.008518
75	0.001479	0.000724	54.765865	0.008518
80	0.001448	0.000709	56.206591	0.008518
85	0.001422	0.000697	58.629452	0.008518
90	0.001399	0.000686	62.126942	0.008518
95	0.001380	0.000676	66.793069	0.008518
100	0.001365	0.000669	72.722979	0.008518
105	0.001352	0.000662	80.012687	0.008518
110	0.001342	0.000657	88.758877	0.008518
115	0.001334	0.000654	99.058758	0.008518

Table A2.6

2007 Speed Emission Factors for Rigid HGVS (g/km)				
Speed km/hour	**NO_X**	**PM_{10}**	**CO**	**VOCs[1]**
5	13.627929	0.516762	4.805052	1.910237
10	9.659871	0.354370	2.895324	1.234582
15	7.700703	0.279845	1.916359	0.870563
20	6.590723	0.237825	1.464892	0.678901
25	5.879470	0.210682	1.219331	0.564216
30	5.387863	0.191632	1.069276	0.489432
35	5.032246	0.177544	0.969800	0.437799
40	4.768576	0.166780	0.899833	0.400738
45	4.571541	0.158403	0.848380	0.373428
50	4.425589	0.151838	0.809216	0.352955
55	4.320658	0.146713	0.778581	0.337459
60	4.249963	0.142778	0.754087	0.325698
65	4.208774	0.139858	0.734152	0.316810
70	4.193698	0.137826	0.717687	0.310181
75	4.202250	0.136591	0.703924	0.305358
80	4.232570	0.136083	0.692305	0.302003
85	4.283246	0.136250	0.682416	0.299857
90	4.353192	0.137049	0.673944	0.298720
95	4.441563	0.138451	0.666647	0.298432
100	4.547696	0.140427	0.660339	0.298867
105	4.547696	0.140427	0.660339	0.298867
110	4.547696	0.140427	0.660339	0.298867
115	4.547696	0.140427	0.660339	0.298867
Speed km/hour	**Benzene**	**1,3 Butadiene**	**CO_2 as C**	**SO_2[2]**
5	0.001284	0.060551	434.452233	0.010000
10	0.000830	0.039134	345.813019	0.010000
15	0.000585	0.027595	267.739879	0.010000
20	0.000456	0.021520	231.202673	0.010000
25	0.000379	0.017885	211.115453	0.010000
30	0.000329	0.015514	198.505551	0.010000
35	0.000294	0.013877	189.810018	0.010000
40	0.000269	0.012703	183.449665	0.010000
45	0.000251	0.011837	178.674841	0.010000
50	0.000237	0.011188	175.122454	0.010000
55	0.000227	0.010697	172.625774	0.010000
60	0.000219	0.010324	171.124981	0.010000
65	0.000213	0.010042	170.621858	0.010000
70	0.000209	0.009832	171.155404	0.010000
75	0.000205	0.009679	172.788009	0.010000
80	0.000203	0.009573	175.597278	0.010000
85	0.000202	0.009505	179.671008	0.010000
90	0.000201	0.009469	185.103998	0.010000
95	0.000201	0.009460	191.995969	0.010000
100	0.000201	0.009474	200.450174	0.010000
105	0.000201	0.009474	200.450174	0.010000
110	0.000201	0.009474	200.450174	0.010000
115	0.000201	0.009474	200.450174	0.010000

Table A2.7

2007 Speed Emission Factors for Articulated HGVS (g/km)				
Speed km/hour	**NO_X**	**PM_{10}**	**CO**	**VOCs[1]**
5	27.905619	1.156765	12.086546	4.690861
10	19.812957	0.789458	7.294748	3.058458
15	15.813500	0.615499	4.823450	2.167119
20	13.542903	0.516498	3.685238	1.693673
25	12.085887	0.452211	3.067053	1.408919
30	11.077812	0.406926	2.689763	1.222676
35	10.348047	0.373345	2.439873	1.093875
40	9.806635	0.347637	2.264206	1.001367
45	9.401795	0.327600	2.135035	0.933211
50	9.101668	0.311881	2.036678	0.882170
55	8.885604	0.299604	1.959674	0.843607
60	8.739649	0.290178	1.898019	0.814421
65	8.654045	0.283186	1.847733	0.792454
70	8.621774	0.278332	1.806086	0.776166
75	8.637669	0.275395	1.771150	0.764423
80	8.697846	0.274210	1.741526	0.756374
85	8.799336	0.274648	1.716175	0.751367
90	8.939837	0.276613	1.694315	0.748896
95	9.117542	0.280024	1.675341	0.748561
100	9.331014	0.284821	1.658784	0.750041
105	9.331014	0.284821	1.658784	0.750041
110	9.331014	0.284821	1.658784	0.750041
115	9.331014	0.284821	1.658784	0.750041
Speed km/hour	**Benzene**	**1,3 Butadiene**	**CO_2 as C**	**SO_2[2]**
5	0.003007	0.141780	1008.770540	0.020000
10	0.001961	0.092441	806.355701	0.020000
15	0.001389	0.065501	624.876110	0.020000
20	0.001086	0.051191	540.085930	0.020000
25	0.000903	0.042584	493.532767	0.020000
30	0.000784	0.036955	464.318875	0.020000
35	0.000701	0.033062	444.161578	0.020000
40	0.000642	0.030266	429.399434	0.020000
45	0.000598	0.028206	418.300839	0.020000
50	0.000566	0.026663	410.032195	0.020000
55	0.000541	0.025498	404.215380	0.020000
60	0.000522	0.024616	400.719884	0.020000
65	0.000508	0.023952	399.557666	0.020000
70	0.000498	0.023459	400.826614	0.020000
75	0.000490	0.023105	404.678553	0.020000
80	0.000485	0.022861	411.300336	0.020000
85	0.000482	0.022710	420.902237	0.020000
90	0.000480	0.022635	433.710610	0.020000
95	0.000480	0.022625	449.963086	0.020000
100	0.000481	0.022670	469.905381	0.020000
105	0.000481	0.022670	469.905381	0.020000
110	0.000481	0.022670	469.905381	0.020000
115	0.000481	0.022670	469.905381	0.020000

Table A2.8

2007 Speed Emission Factors for Buses (g/km)				
Speed km/hour	**NO_X**	**PM_{10}**	**CO**	**VOCs[1]**
5	14.718350	0.480291	5.505493	1.923758
10	10.426959	0.308941	3.114539	1.064554
15	8.384098	0.240266	2.077513	0.704074
20	7.219552	0.203235	1.585770	0.531755
25	6.462226	0.179927	1.309310	0.434457
30	5.929435	0.163853	1.135887	0.373399
35	5.536789	0.152108	1.019123	0.332330
40	5.240142	0.143196	0.936869	0.303366
45	5.014219	0.136272	0.877384	0.282257
50	4.843538	0.130823	0.833946	0.266517
55	4.718098	0.126517	0.802479	0.254605
60	4.631169	0.123132	0.780402	0.245513
65	4.631169	0.123132	0.780402	0.245513
70	4.631169	0.123132	0.780402	0.245513
75	4.631169	0.123132	0.780402	0.245513
80	4.631169	0.123132	0.780402	0.245513
85	4.631169	0.123132	0.780402	0.245513
90	4.631169	0.123132	0.780402	0.245513
95	4.631169	0.123132	0.780402	0.245513
100	4.631169	0.123132	0.780402	0.245513
105	4.631169	0.123132	0.780402	0.245513
110	4.631169	0.123132	0.780402	0.245513
115	4.631169	0.123132	0.780402	0.245513
Speed km/hour	**Benzene**	**1,3 Butadiene**	**CO_2 as C**	**SO_2[2]**
5	0.001195	0.056335	435.206798	0.030000
10	0.000661	0.031174	339.109406	0.030000
15	0.000437	0.020618	260.971656	0.030000
20	0.000330	0.015572	223.650007	0.030000
25	0.000270	0.012723	202.787389	0.030000
30	0.000232	0.010935	189.580468	0.030000
35	0.000206	0.009732	180.476238	0.030000
40	0.000188	0.008884	173.869655	0.030000
45	0.000175	0.008266	168.980602	0.030000
50	0.000166	0.007805	165.418302	0.030000
55	0.000158	0.007456	162.992259	0.030000
60	0.000153	0.007190	161.622388	0.030000
65	0.000153	0.007190	161.622388	0.010000
70	0.000153	0.007190	161.622388	0.010000
75	0.000153	0.007190	161.622388	0.010000
80	0.000153	0.007190	161.622388	0.010000
85	0.000153	0.007190	161.622388	0.010000
90	0.000153	0.007190	161.622388	0.010000
95	0.000153	0.007190	161.622388	0.010000
100	0.000153	0.007190	161.622388	0.010000
105	0.000153	0.007190	161.622388	0.010000
110	0.000153	0.007190	161.622388	0.010000
115	0.000153	0.007190	161.622388	0.010000

Table A2.9

2007 Fleet Composition Data		
Vehicle Type	**Emission Standard**	**Percentage**
Petrol Cars	ECE 15.01	0.00
	ECE 15.02	0.00
	ECE 15.03	0.00
	ECE 15.04 + FAILED CATS	6.66
	Euro I	7.62
	Euro II	21.19
	Euro III	16.65
	Euro IV	47.88
% by engine size	< 1.4	47.3
	1.4 - 2.0	46.0
	> 2.0	6.7
% Petrol Cars		77.62
Diesel Cars	Pre-Euro I	0.46
	Euro I	8.40
	Euro II	17.10
	Euro III	38.36
	Euro III + particulate trap	7.49
	Euro IV	21.14
	Euro IV + particulate trap	7.05
% by engine size	< 2.0	84.3
	> 2.0	15.7
% Diesel Cars		22.38
Petrol LGV	Pre-Euro I	4.64
	Euro I (93/59/EEC)	5.97
	Euro II	18.73
	Euro III	45.10
	Euro IV	25.56
% Petrol LGVs		7.17
Diesel LGV	Pre-Euro I	1.61
	Euro I (93/59/EEC)	6.16
	Euro II	26.45
	Euro III	39.40
	Euro IV	26.38
% Diesel LGVs		92.83
Rigid HGVs	Pre-1988	0.00
	Pre-Euro I (88/77EEC)	0.41
	Euro I (91/542/EEC)	4.91
	Euro II	26.59
	Euro III	53.29
	Euro IV	14.80
	Euro IV+	0.00
% Rigid HGVs	Motorways	42.24
(of total HGV)	Other Roads	78.65

Artic HGVs	Pre-1988	0.00
	Pre-Euro I (88/77EEC)	0.17
	Euro I (91/542/EEC)	2.53
	Euro II	19.73
	Euro III	59.78
	Euro IV	17.78
	Euro IV+	0.00
% Artic HGV(of total HGV)	Motorways	57.76
	Other Roads	21.35
Buses	Pre-1988	1.72
	Pre-Euro I (88/77EEC)	4.45
	Euro I (91/542/EEC)	6.58
	Euro II	28.72
	Euro III	46.05
	Euro IV	12.49
	Euro IV+	0.00
Motorcycles (as % of cars)	Motorways	0.38
	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 Transport Statistics Great Britain 2007 (Reference 8).

The Rigid/Articulated HGV percentages are used to convert from assigned OGV flows to Rigid/Artic HGV volumes, by road type.

Table A2.10

2007 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	2.833	9.624	2.739	2.582	9.311	2.745
LGVS	3.113	9.624	2.999	3.087	9.311	3.006
OGVS	3.156	9.624	3.262	3.041	9.311	3.383
Buses	3.214	9.624	3.162	2.903	9.311	3.098
Weekday to Saturday/Sunday/Bank Holiday Factors						
	Motorways	**Other Roads**				
Weekday Off-Peak Period - Saturday	1.282	1.428				
Weekday Off-Peak Period - Sunday	1.190	1.179				
Weekday Off-Peak Period – Bank Holiday	1.190	1.179				
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 A2.11

2007 Fleet-Weighted Cold Start Emission Factors (g/trip)		
Vehicle Type	**Pollutant**	**Factor**
Petrol Car	NMVOCs	1.482000
	CO	18.400000
	NO_X	1.228000
	Benzene	0.062000
	1,3 Butadiene	0.010000
	PM_{10}	-
Diesel Car	NMVOCs	0.042000
	CO	0.182000
	NO_X	0.156000
	Benzene	0.000880
	1,3 Butadiene	0.000432
	PM_{10}	0.105000
Petrol LGV	NMVOCs	1.256000
	CO	20.200000
	NO_X	1.283000
	Benzene	0.052000
	1,3 Butadiene	0.009180
	PM_{10}	-
Diesel LGV	NMVOCs	0.182000
	CO	0.430000
	NO_X	0.232000
	Benzene	0.003738
	1,3 Butadiene	0.001830
	PM_{10}	0.286000

Table A2.12

2007 Fleet-Weighted Hot Soak Emission Factors (g/trip)		
Vehicle Type	**Pollutant**	**Factor**
Petrol Car	NMVOCs	0.722000
	Benzene	0.001988
Petrol LGV	NMVOCs	0.724000
	Benzene	0.001978

Appendix 3 Emission Factors for Domestic and Commercial Combustion

The following tables show the comparison of the 2006 and 2007 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)**	
	2006	**2007**	**2006**	**2007**
CO_2	1.50	1.5	5.12e-08	5.12E-08
CH_4	5.28e-04	5.28E-04	1.80e-11	1.80E-11
CO	3.25e-03	3.25E-03	1.11e-10	1.11E-10
NO	1.06e-05	1.06E-05	3.62e-13	3.62E-13
NO_X as NO_2	7.3e-03	7.30E-03	2.49e-10	2.49E-10
NMVOCs	2.33e-04	2.34E-04	7.95e-12	7.98E-12
C_6H_6	2.1e-05	2.10E-05	7.17e-13	7.17E-13
PM_{10}	5.28e-05	5.28E-05	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)**	
	2006	**2007**
CO_2	761	800
CH_4	5.8	5.8
CO	119	119
NO	0.117	0.117
NO_X as NO_2	3	3
NMVOCs	4.9	4.9
C_6H_6	0.217	0.217
PM_{10}	3	3
SO_2	16	16

Table A3.3

Domestic Oil Combustion Emission Factors		
Pollutant	**Emission factor (kilotonne per Megatonne fuel consumed)**	
	2006	**2007**
CO_2	879	879
CH_4	0.433	0.433
CO	0	0
NO	0.026	0.0262
NO_X as NO_2	0	0
NMVOCs	0.14	0.142
C_6H_6	6.99-e03	0.0071
PM_{10}	0	0
SO_2	17	17

Table A3.4

Commercial Gas Combustion Emission Factors				
Pollutant	**Factor (kilotonne per Megatherm fuel consumed)**		**Factor (kilotonne per kWh fuel consumed)**	
	2006	**2007**	**2006**	**2007**
CO_2	1.5	1.5	5.12e-08	5.12E-08
CH_4	5.28e-04	5.28E-04	1.80e-11	1.80E-11
CO	1.41e-03	1.36E-03	4.81e-11	4.64E-11
NO	1.06e-05	1.06E-05	3.62e-13	3.62E-13
NO_X as NO_2	6.62e-03	5.91E-03	2.26e-10	2.02E-10
NMVOCs	2.33e-04	2.34E-04	7.95e-12	7.98E-12
C_6H_6	2.12e-05	2.13E-05	7.23e-13	7.27E-13
PM_{10}	9.90e-05	8.06E-05	3.38e-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 22)

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\Airport\airport_rectangle.dbf
ESRI\Airport\airport_rectangle.prj
ESRI\Airport\airport_rectangle.shp
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Appendix 8 Sample from the Emission Factor Handbook and Workbook

The following pages give a sample Excel Template workbook and the corresponding pages from the EMIGMA Industrial Air Pollutant Emissions Sources Emission Factor Handbook (Reference 19).

SECTION A - OPERATOR DETAILS AND RESULTS

Please refer to Chapter 6 of the Emigma Emission Factor Handbook and use the checklist provide

PG Note	PG2/3
SNAP	30302
Process	Electrical, Crucible and Reverberatory Furnaces

EMIGMA ID	
Date Updated	01/01/2007
Name	I Hull
Operator Name	A N Other
Authority	Manchester
Address	A N Other, 1 Any Street, Manchester
Postcode	M1 1AA
x-coordinate	123456
y-coordinate	123456

Results - Annual Emissions (t

	Black Smoke	CO2 as C	CH4	CO	NO	NO2	SO2	NMVOC	Hg	Pb	Benzene	PM10	B[a]P
Emissions Estimate from Section B	0.E+00	4.E+00	1.E-02	2.E+00	6.E-03	2.E-01	1.E-01	7.E-05	7.E-03	2.E-01	1.E-02	0.E+00	0.E+00
OR													
Monitoring Results from Section C	0.E+00	0.E+00	0.E+00	0.E+00	0.E+00	0.E+00	0.E+00	0.E+00	0.E+00	0.E+00	0.E+00	0.E+00	0.E+00
Values Used	**0.E+00**	**4.E+00**	**1.E-02**	**2.E+00**	**6.E-03**	**2.E-01**	**1.E-01**	**7.E-05**	**7.E-03**	**2.E-01**	**1.E-02**	**0.E+00**	**0.E+00**

The data are rated as follows:

Emission Factor Ratin	**C**	3.00
Data Quality Rating:	**D**	4.00
Overall Rating:	**D**	7.00

SECTION B - EMISSION FACTOR CALCULTIONS

THIS SECTION MUST BE COMPLETED. Please ensure you have selected the correct units

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

Emission Factor Rating: **C**

1210 t — Enter the annual amount of material produced.

D — Enter the rating of the input data used above (see Guidebook for further details)

SECTION C - MONITORING AND STACK DETAILS

Stack monitoring data may be used to overide the emission rates calculated using the Guidebook methodology. This should only be used if robust monitoring results are available.
The emission rates must be entered in grams per second and hours of operation per year must be known to calculate annual emissions from monitoring results.

Do you wish to use monitoring results as the annual emissions estimate? If in doubt, select "No". No

Stack ID	Emission Rate (g/s)													Hour of Operation per Year	Height (m)	Diameter (m)	Volumetric Flow (m3/s)	Temperature (K)	Data OK?
	Black Smoke	CO2 as C	CH4	CO	NO	NO2	SO2	NMVOC	Hg	Pb	Benzene	PM10	B[a]P						
																			NO
																			NO
																			NO
																			NO
																			NO
																			NO
																			NO
																			NO
																			NO
																			NO
Total	**0.E+00**	**0.E+00**	**0.E+00**	**0.E+00**	**0.E+00**	**0.E+00**	**0.E+00**	**0.E+00**	**0.E+00**	**0.E+00**	**0.E+00**	**0.E+00**	**0.E+00**						

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.

Authors	Ian Hull, Tony Morris, Kate Fraser, Ian Hagyard	
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Ian Hull	ian.hull@tfgm.com	0161 244 1454

Version	Change	Reason for Change	Date
0.1	Draft		October 2011
0.2		Proof reading amendments and formatting changes	10/11/2011
0.3		Further proof reading changes	11/11/2011
0.4		Amendments to SATURN model section	21/11/2011
0.5		Correction of network mileage covered by counts	24/11/2011
1.0	Version 1	Table 4.4 inserted	21/12/2011