Cambridge Environmental Research Consultants

Source Apportionment for the City of London Corporation

Final report

Prepared for
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CERC

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CONTENTS

1. Summary

Source apportionment modelling has been carried out for the City of London Corporation using ADMS-Urban (version 2.3.3.1) air quality modelling software. The study was carried out using projected emissions of NO_x, PM_{10} and $PM_{2.5}$ for the years 2011 and 2015 from the London Atmospheric Emissions Inventory (LAEI) 2008.

Emissions from sources within the City of London represent less than 1% of total emissions from the LAEI area for all three pollutants for both the years 2011 and 2015. The contribution of sources within the City of London to predicted NO_x concentrations at receptor locations ranges from 30% at urban background locations to 85% at roadside locations. Background concentrations, representing the contribution from outside of the LAEI area, are the largest contribution to predicted PM_{10} and $PM_{2.5}$ concentrations at all receptor locations, accounting for more than 50% of the total predicted concentrations at roadside locations and more than 80% of the total predicted concentration at urban background locations, for both years.

Major roads account for the majority of the emissions from within the City of London for all three pollutants and both years. Major roads contribute at least 59% of the total emissions within the City of London for all three pollutants.

The largest contributors to NO_x emissions from major roads within the City of London are buses and coaches, as well as taxis, for both 2011 and 2015. There are also significant contributions from cars, LGVs and rigid HGVs for both years. Predicted NO_x concentrations at receptor locations show significant contributions from all vehicle types except motorcycles and articulated HGVs. The percentage of NO_x emitted as NO_2, known as primary NO_2, is high for cars, taxis and LGVs, compared to other vehicle types for both years. The percentage contribution of these vehicles to NO_2 concentrations is therefore expected to be greater than the percentage contribution to NO_x concentrations.

Exhaust emissions account for 51% and 38% of PM_{10} emissions from road transport within the City of London for the years 2011 and 2015 respectively, with the remainder coming from brake & tyre wear emissions. Taxis are the largest contributor to exhaust PM_{10} emissions within the City of London, accounting for 38% and 50% of emissions for the years 2011 and 2015 respectively. Cars are the largest contributor to brake and tyre wear PM_{10} emissions within the City of London, accounting for 43% of emissions for both years.

Predicted PM_{10} concentrations at receptor locations include a contribution from road wear and resuspension. Exhaust emissions contribute approximately 35% and 25% of the predicted PM_{10} concentrations from major roads for the years 2011 and 2015 respectively; non-exhaust sources are therefore the largest contributor for both years. The percentage breakdown of predicted concentrations from exhaust and brake and tyre wear sources is similar to their respective emissions breakdown.

Exhaust emissions account for 65% and 53% of $PM_{2.5}$ emissions from major roads within the City of London for the years 2011 and 2015 respectively. Taxis are the largest contributor to exhaust $PM_{2.5}$ emissions within the City of London, accounting for 38% and 50% of emissions for the years 2011 and 2015 respectively. Cars are the largest contributor to brake and tyre wear $PM_{2.5}$ emissions within the City of London, accounting for 43% and 44% of emissions for the years 2011 and 2015 respectively.

Predicted $PM_{2.5}$ concentrations at receptor locations include a contribution from road wear. Exhaust emissions contribute approximately 60% and 45% of the predicted $PM_{2.5}$ concentrations from major roads for the years 2011 and 2015 respectively. The percentage breakdown of predicted concentrations from exhaust and brake and tyre wear sources is similar to their respective emissions breakdown.

2. Introduction

The concentration of a pollutant at a given point is made up of contributions from numerous sources of different types and, in the case of NO_2, is affected by chemical reactions in the atmosphere. The contribution of different sources will vary depending on the relative locations of the sources and receptor.

This report provides a breakdown of the emissions from different source groups and their contributions to the annual average concentrations at a set of receptors. The receptors which have been considered, which are the locations of monitoring sites, are shown in Figure 2.1.

Source apportionment for NO_x, PM_{10} and $PM_{2.5}$ was carried out using projected emissions for the years 2011 and 2015 in the London Atmospheric Emissions Inventory (LAEI) 2008. Contributions to pollutant concentrations at receptor locations were predicted using ADMS-Urban (version 2.3.3.1) air quality modelling software. Model inputs and assumptions used for the source apportionment are described in the main modelling report *Air Quality Modelling for the City of London Corporation: Model Verification & Air Quality Maps.*

Source apportionment breakdown for NO_x, PM_{10} and $PM_{2.5}$ is reported in sections 3, 4 and 5 respectively, with a discussion of the results in Section 6.

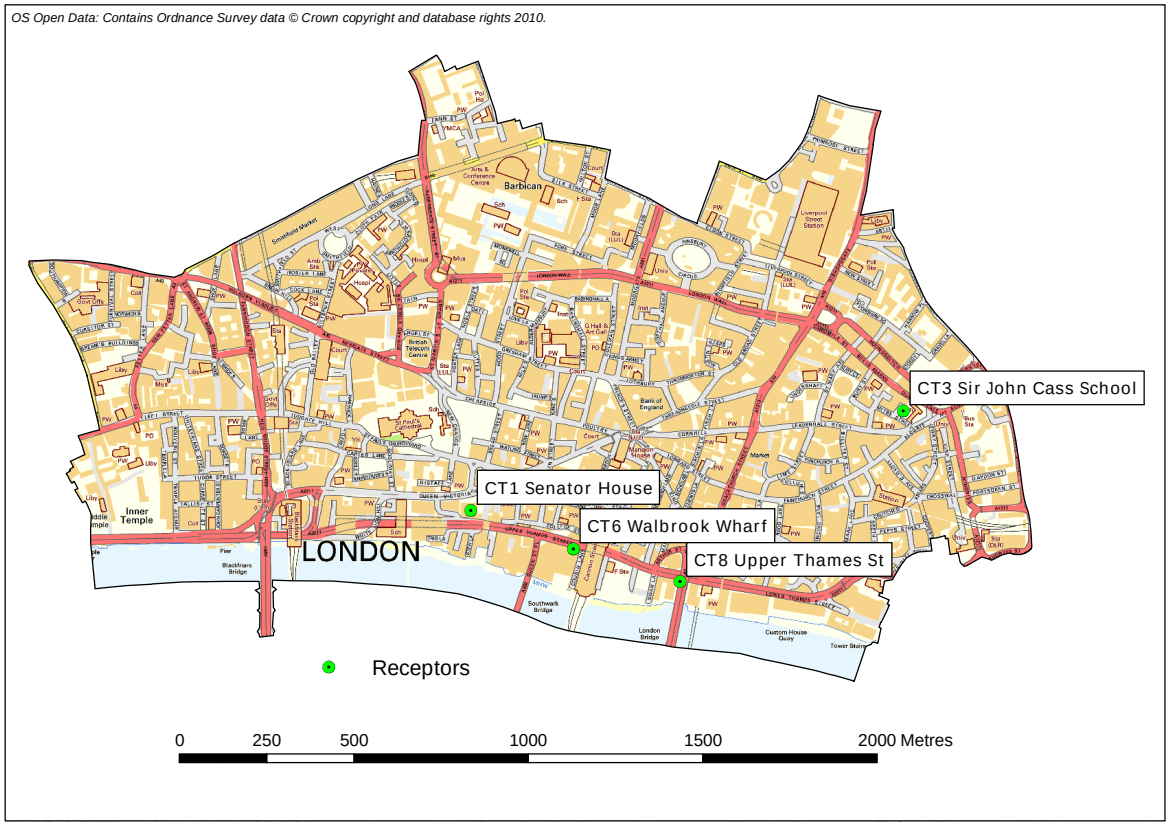

Figure 2.1: Source apportionment receptors

3. NO_x source apportionment

The contribution of different source groups to the total NO_2 concentration cannot be determined due to the non-linearity of the chemical reactions which take place in the atmosphere. However, the contribution to the total NO_x concentration can be calculated and these contributions are presented in this section.

The contribution of different source groups to total NO_2 concentrations will be related to the contribution of each group to total NO_x concentrations and the proportion of NO_x emissions emitted as NO_2, known as 'primary NO_2'. Therefore percentage primary NO_2 emissions for road traffic emissions are also included in this section.

3.1. NO_x source apportionment for the year 2011

Figure 3.1a shows the contribution of the NO_x emissions generated within the City of London, the rest of Central London, as defined in the LAEI (approximately the area covered by the 2003 Congestion Charging Zone), and the rest of the LAEI area, for the year 2011. Figure 3.1b shows the impact of these sources at the receptor locations in the City.

Figure 3.2a shows the contribution of each major source group to the total NO_x emissions from within the City of London, for the year 2011. The contribution of these sources to the total NO_x concentrations at the set of receptor locations is shown in Figure 3.2b.

Figure 3.3a shows the contribution of each vehicle type to the total road traffic NO_x emissions within the City of London, for the year 2011 and Table 3.1 shows percentage primary NO_2 emissions for each vehicle type. The contribution of these vehicle types to the total NO_x concentrations at the set of receptor locations is shown in Figure 3.3b.

Source apportionment of NO_x concentrations at the set of receptor locations, for the year 2011, is summarised in Table 3.2.

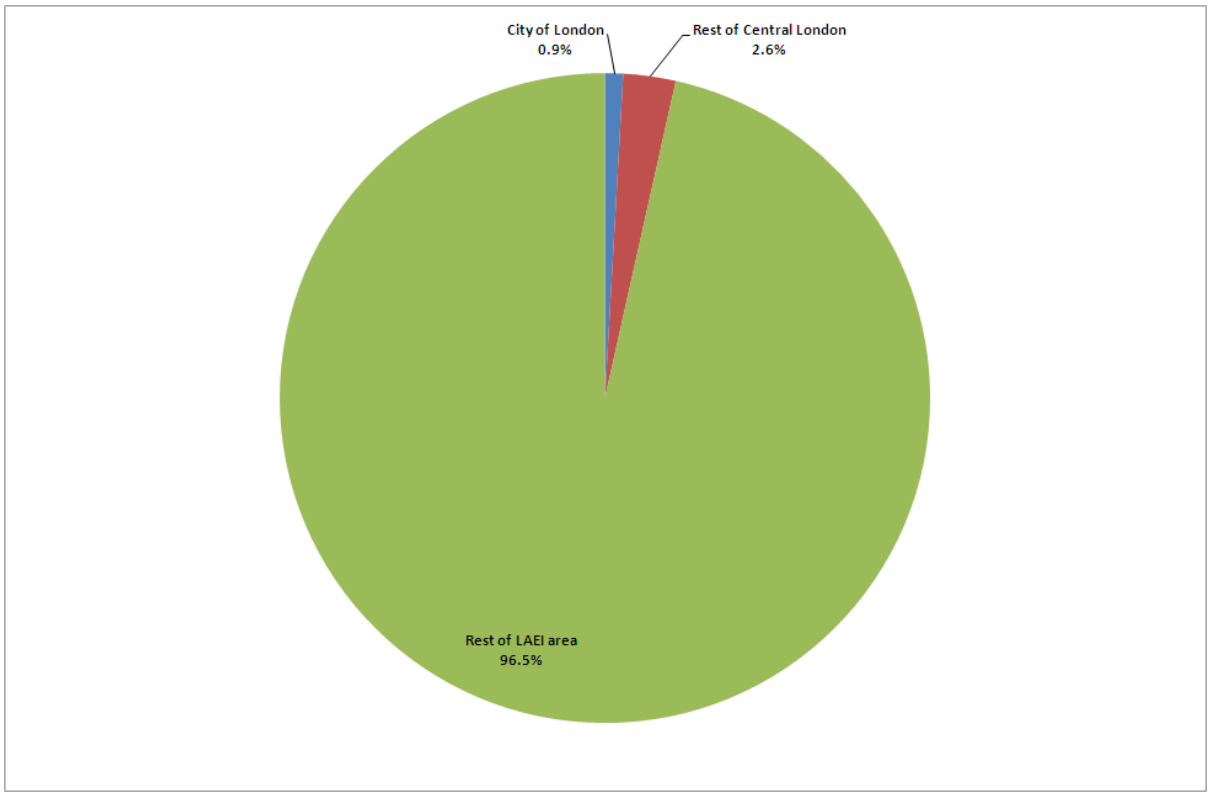

Figure 3.1a: NO_x emissions by location, 2011

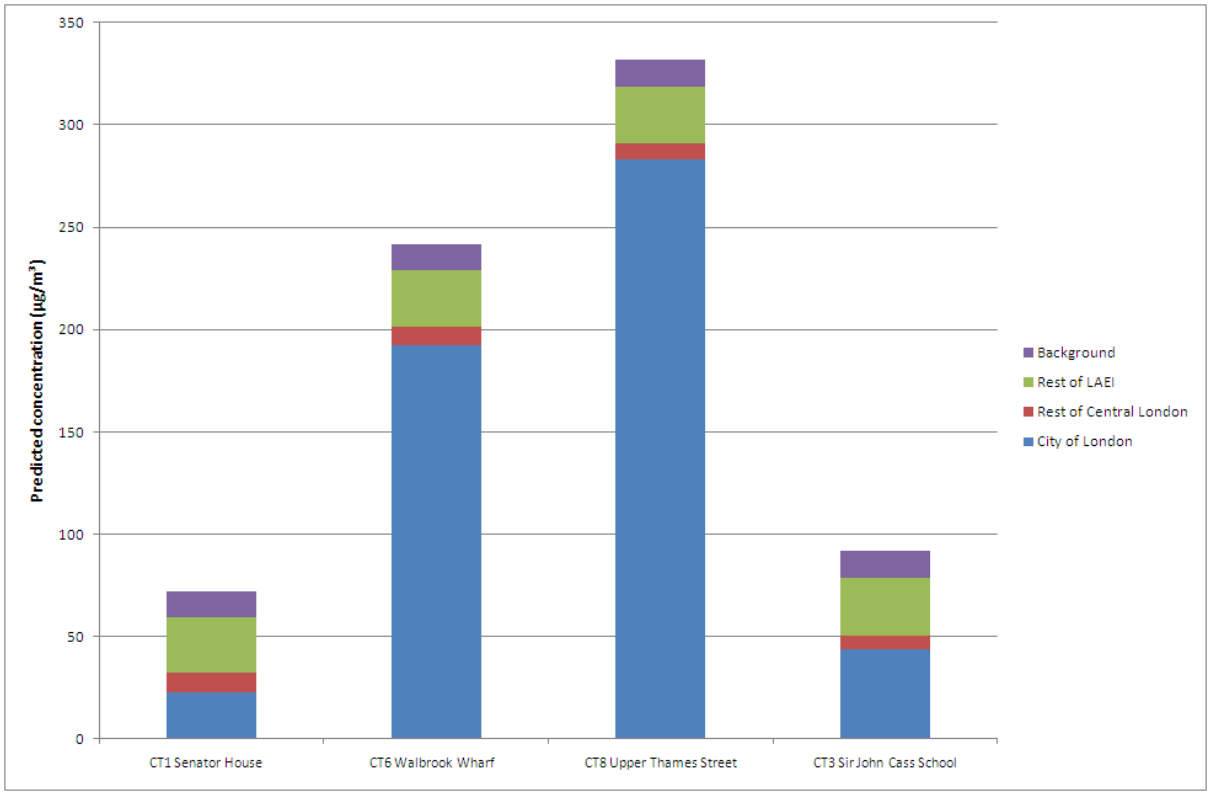

Figure 3.1b: NO_x source apportionment by location, 2011

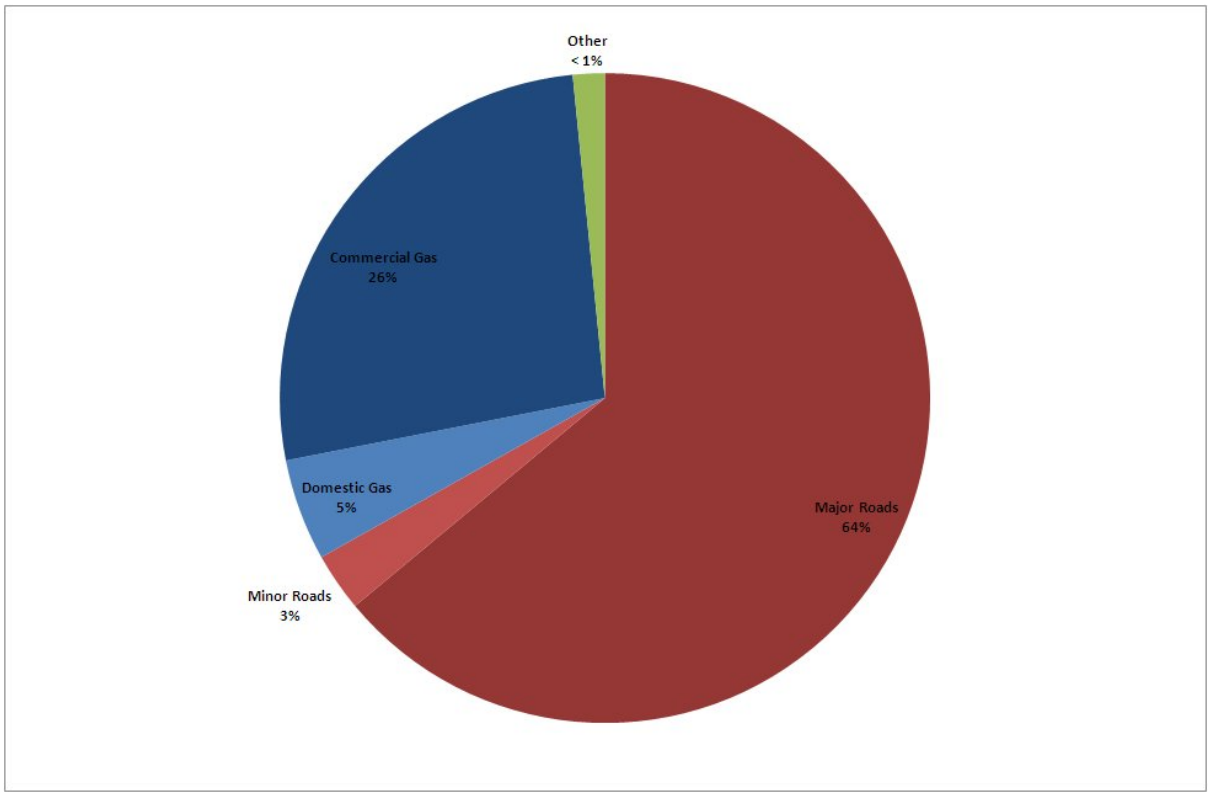

Figure 3.2a: City of London NO_x emissions by source type, 2011

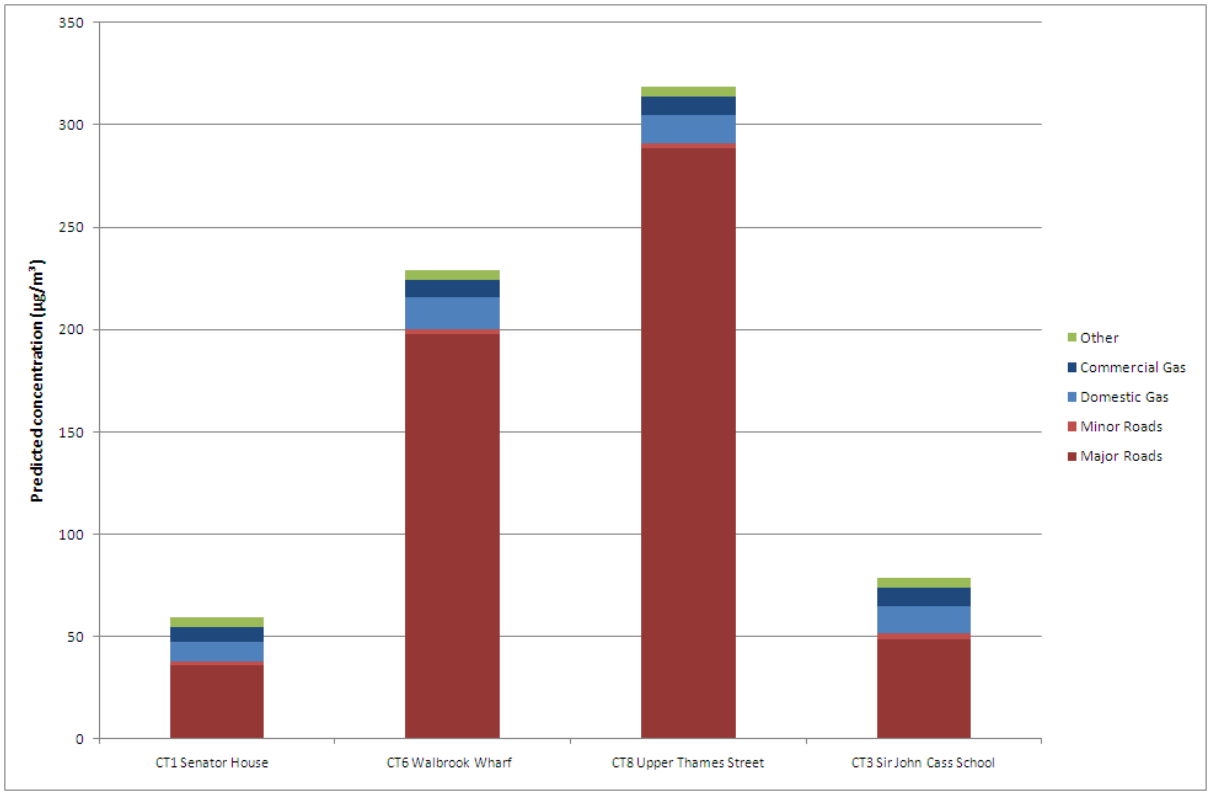

Figure 3.2b: NO_x source apportionment by source type, 2011

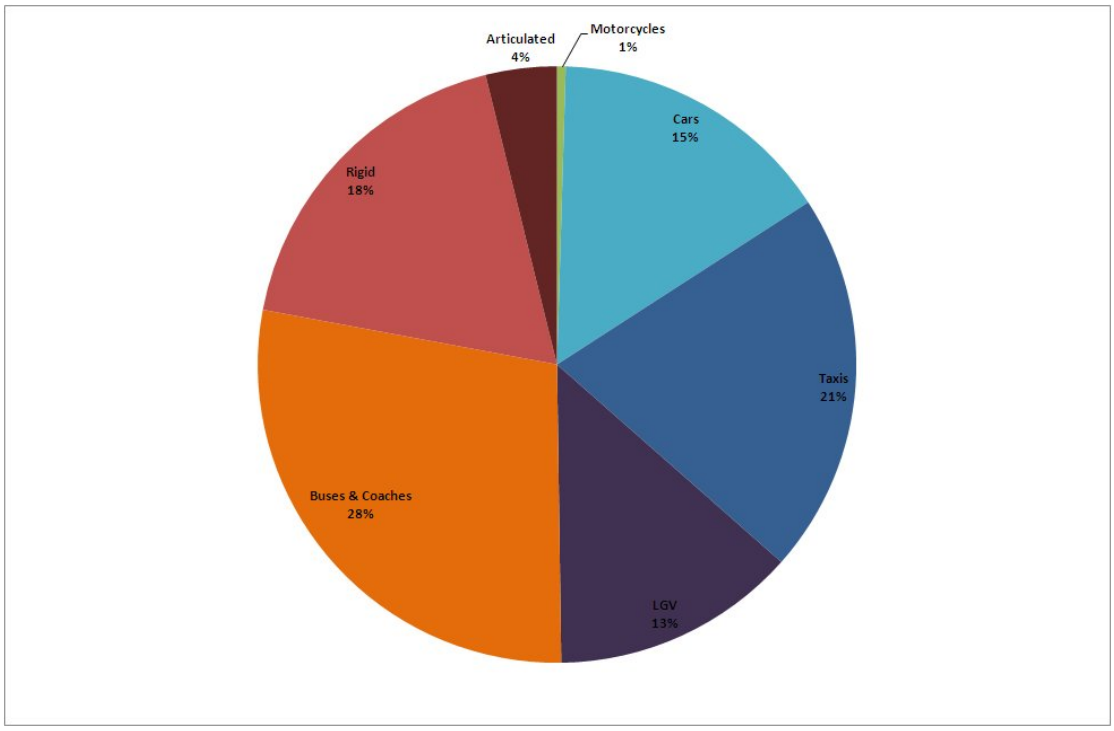

Figure 3.3a: City of London road traffic NO_x emissions by vehicle type, 2011

Motorcycles	Cars	Taxis	LGV	Buses & Coaches	Rigid	Articulated	All Vehicles
4.0	38.0	32.6	45.8	23.8	12.3	12.3	28.1

Table 3.1: Primary NO_2 percentage for City of London road traffic NO_x emissions by vehicle type, 2011

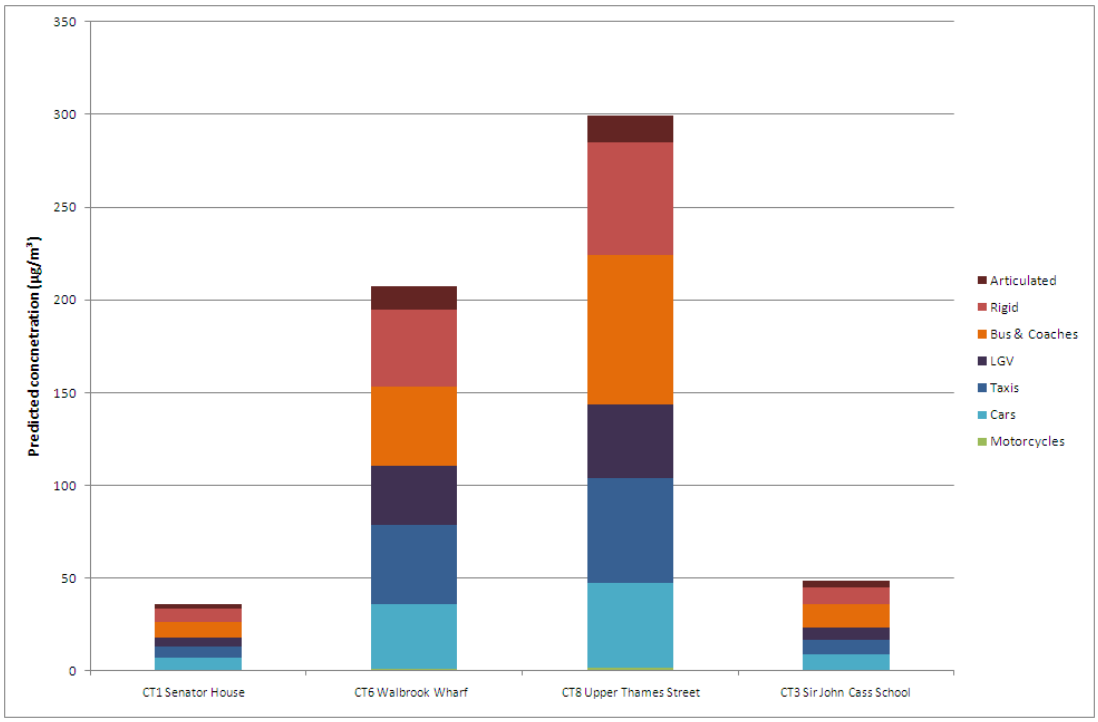

Figure 3.3b: NO_x source apportionment by vehicle type, 2011

Type of source apportionment	Source group	CT1 Senator House	CT6 Walbrook Wharf	CT8 Upper Thames Street	CT3 Sir John Cass School
Location	City of London	22.5	192.6	282.9	44.0
	Rest of Central London	9.9	9.0	8.3	6.2
	Rest of LAEI	26.8	27.1	27.5	28.6
	Background	13.0	13.0	13.0	13.0
Source type	Major Roads	36.1	197.9	288.6	48.9
	Minor Roads	1.8	2.4	2.3	2.5
	Domestic Gas	9.6	15.4	14.1	13.4
	Commercial Gas	7.2	8.3	8.5	9.1
	Other	4.5	4.8	5.2	4.9
Vehicle type	Motorcycles	0.1	1.3	1.8	0.2
	Cars	7.1	34.8	45.7	8.8
	Taxis	5.7	42.3	56.4	7.6
	LGV	5.1	31.8	40.0	6.7
	Bus & Coaches	8.6	42.9	80.6	12.7
	Rigid	6.8	41.7	60.4	9.3
	Articulated	2.8	12.7	14.6	3.2

Table 3.2: Summary of NO_x source apportionment, 2011

3.2. NO_x source apportionment for the year 2015

Figure 3.4a shows the contribution of the NO_x emissions generated within the City of London, the rest of Central London as defined in the LAEI and the rest of the LAEI area, for the year 2015. Figure 3.4b shows the impact of these sources at the receptor locations in the City.

Figure 3.5a shows the contribution of each major source group to the total NO_x emissions from within the City of London, for the year 2015. The contribution of these sources to the total NO_x concentrations at the set of receptor locations is shown in Figure 3.5b.

Figure 3.6a shows the contribution of each vehicle type to the total road traffic NO_x emissions within the City of London, for the year 2015 and Table 3.3 shows percentage primary NO_2 emissions for each vehicle type. The contribution of these vehicle types to the total NO_x concentrations at the set of receptor locations is shown in Figure 3.6b.

Source apportionment of NO_x concentrations at the set of receptor locations, for the year 2015, is summarised in Table 3.4.

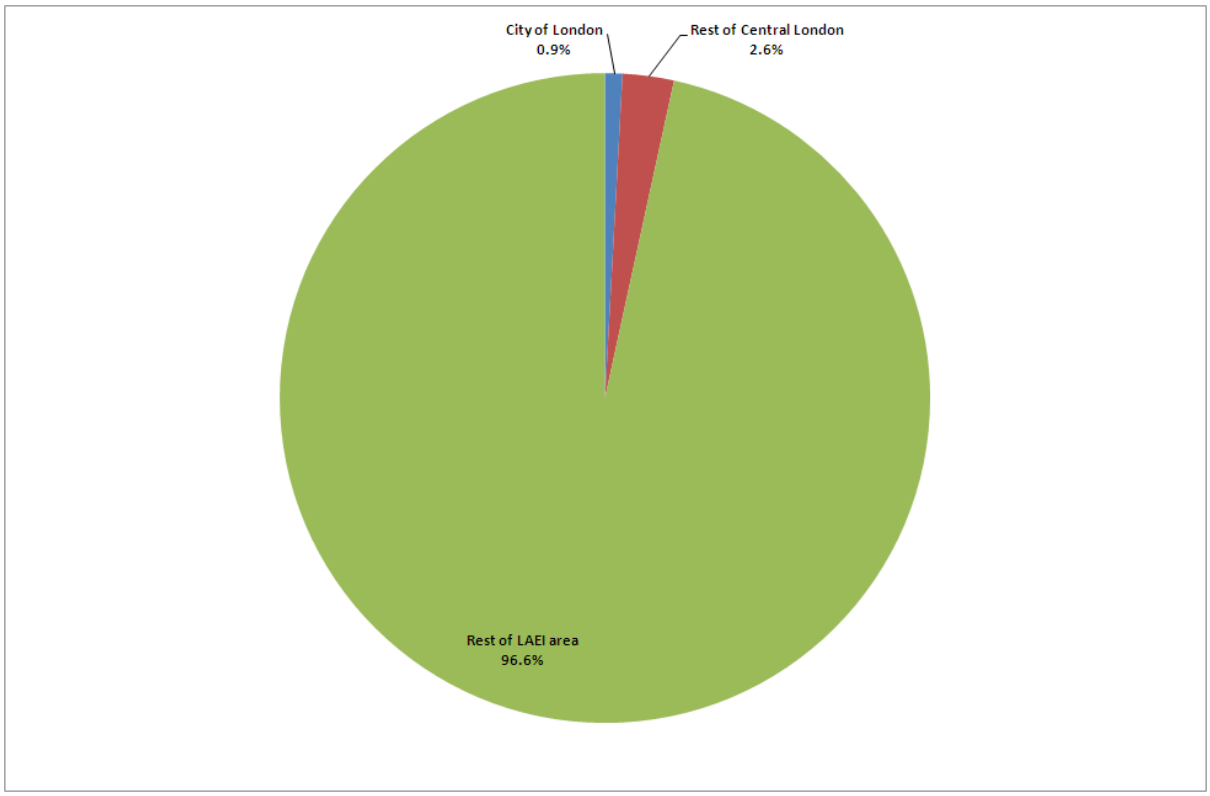

Figure 3.4a: NO_x emissions by location, 2015

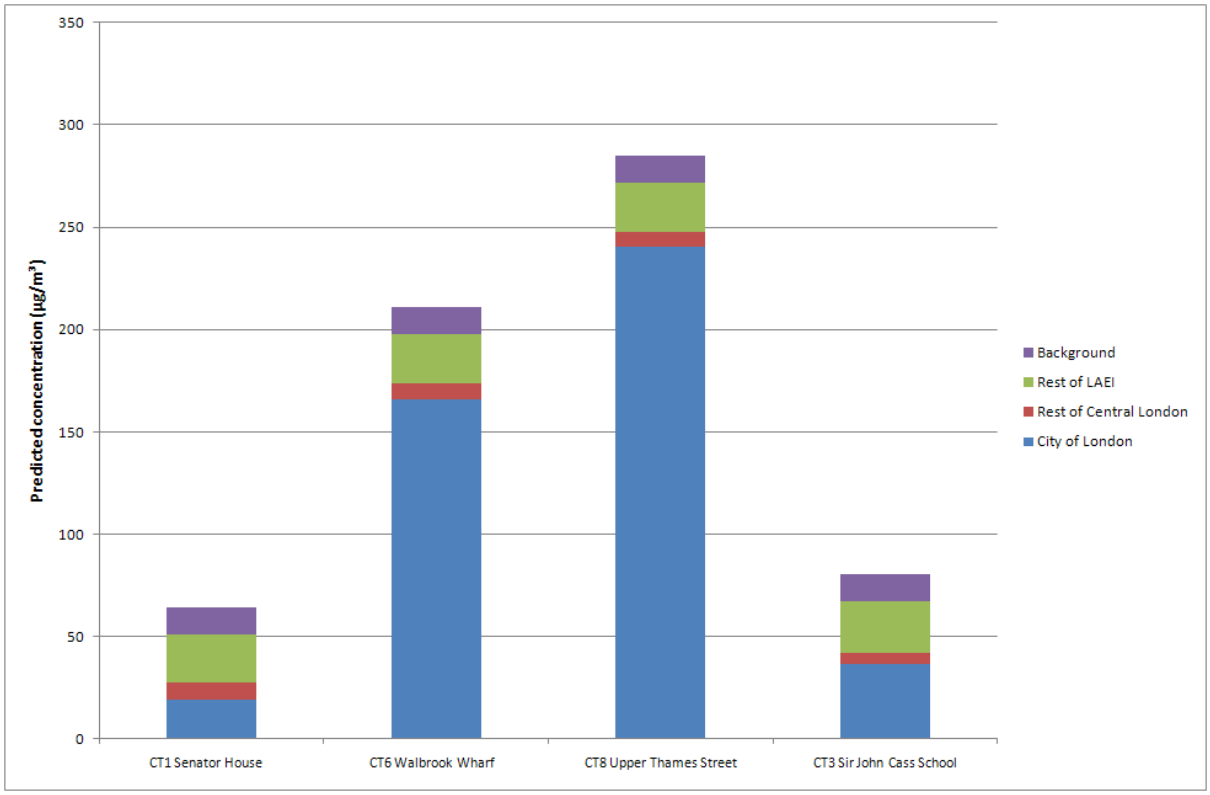

Figure 3.4b: NO_x source apportionment by location, 2015

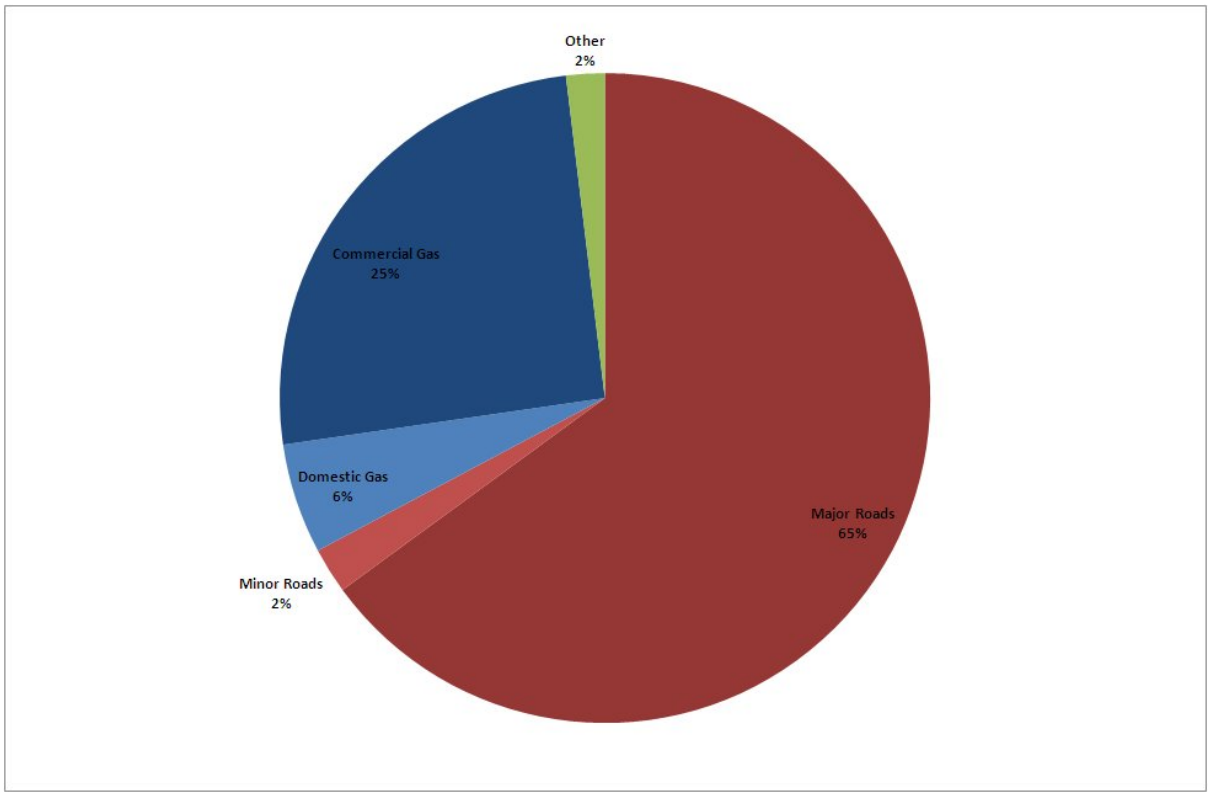

Figure 3.5a: City of London NO_x emissions by source type, 2015

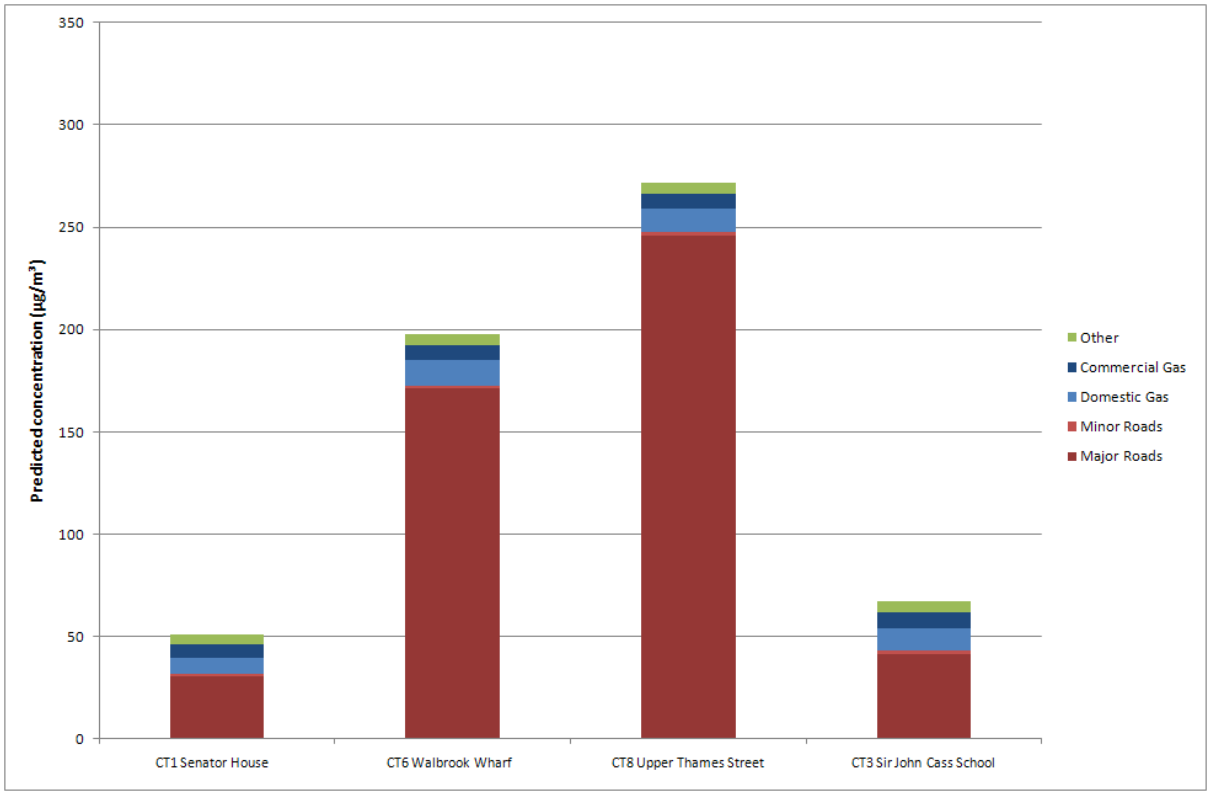

Figure 3.5b: NO_x source apportionment by source type, 2015

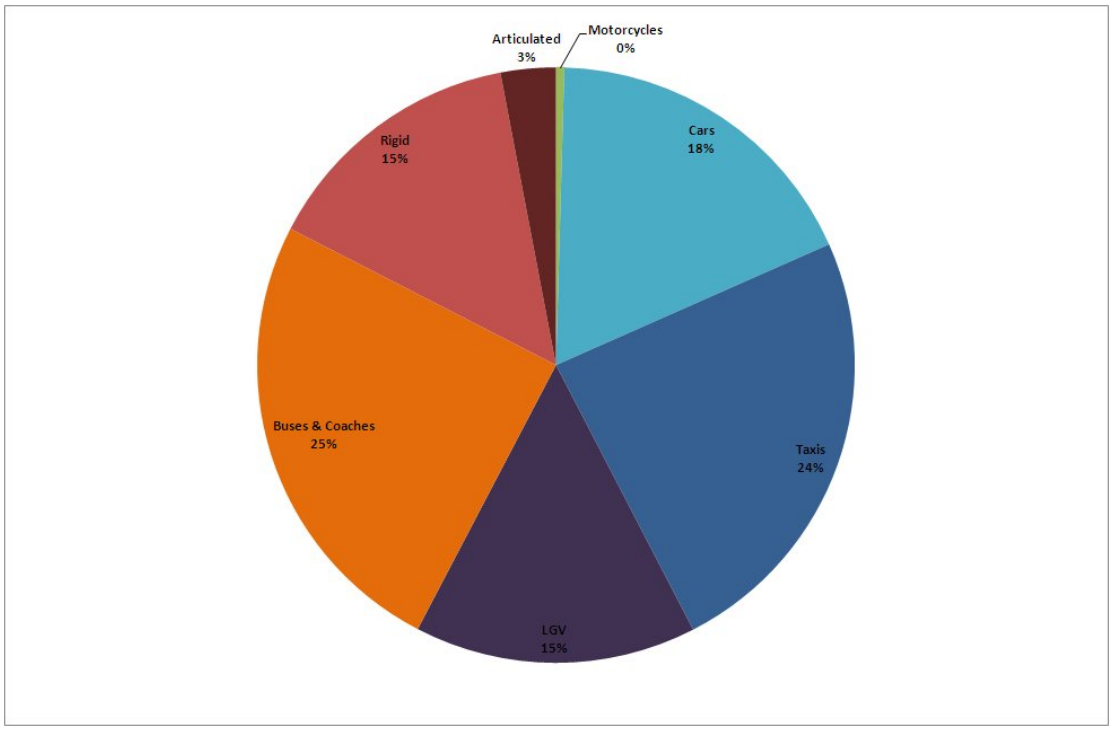

Figure 3.6a: City of London road traffic NO_x emissions by vehicle type, 2015

Motorcycles	Cars	Taxis	LGV	Buses & Coaches	Rigid	Articulated	All Vehicles
4.0	43.9	37.6	48.2	19.7	10.8	10.7	31.1

Table 3.3: Primary NO_2 percentage for City of London road traffic NO_x emissions by vehicle type, 2015

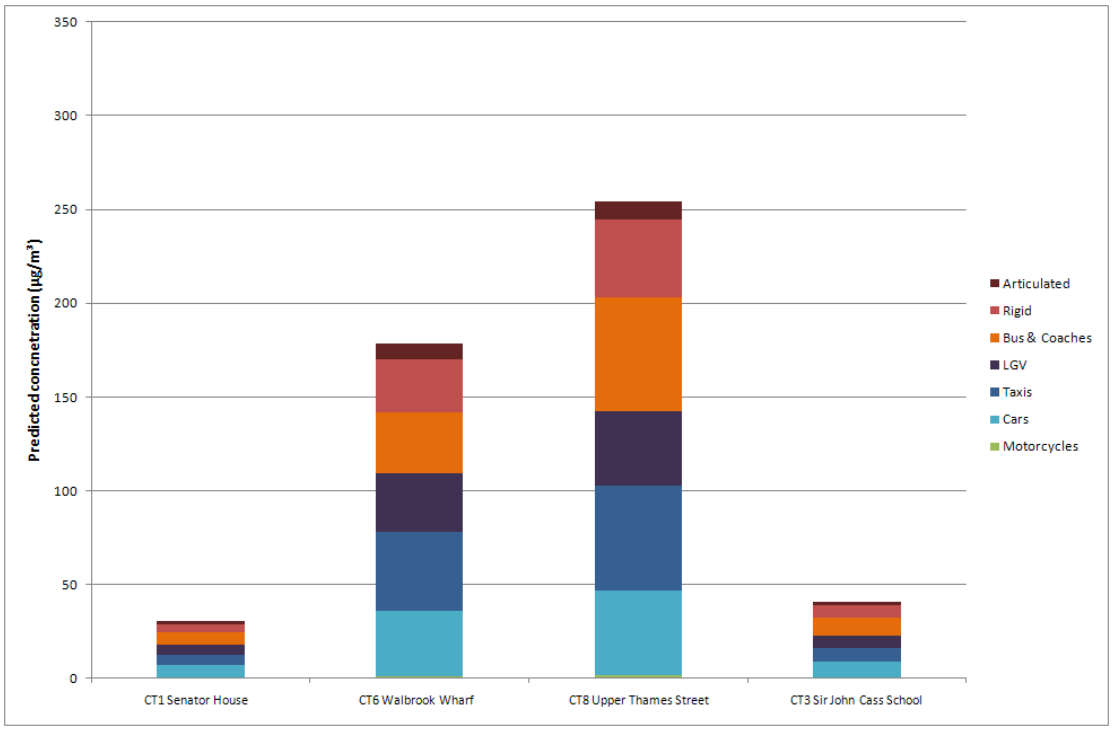

Figure 3.6b: NO_x source apportionment by vehicle type, 2015

Type of source apportionment	Source group	CT1 Senator House	CT6 Walbrook Wharf	CT8 Upper Thames Street	CT3 Sir John Cass School
Location	City of London	18.9	166.1	240.7	36.8
	Rest of Central London	8.4	7.7	7.1	5.3
	Rest of LAEI	23.7	23.9	24.2	25.2
	Background	13.0	13.0	13.0	13.0
Source type	Major Roads	30.7	171.1	245.9	41.3
	Minor Roads	1.2	1.6	1.5	1.6
	Domestic Gas	7.7	12.4	11.4	10.8
	Commercial Gas	6.6	7.5	7.7	8.3
	Other	4.8	5.1	5.4	5.2
Vehicle type	Motorcycles	0.1	1.1	1.4	0.1
	Cars	7.0	34.7	45.4	8.7
	Taxis	5.7	42.1	56.1	7.6
	LGV	5.0	31.3	39.4	6.6
	Bus & Coaches	6.5	32.5	61.0	9.6
	Rigid	4.6	28.4	41.1	6.3
	Articulated	1.8	8.5	9.7	2.1

Table 3.4: Summary of NO_x source apportionment, 2015

4. PM_{10} source apportionment

The total concentration of PM_{10} at a given location is made up of contributions from emissions from sources such as road traffic and industries as well as a significant contribution from outside London and from resuspension. This section presents the breakdown of the emissions from within London and the contribution of each component to the total annual average PM_{10} concentrations.

4.1. PM_{10} source apportionment for the year 2011

Figure 4.1a shows the contribution of the PM_{10} emissions generated within the City of London, the rest of Central London, as defined in the LAEI, and the rest of the LAEI area, for the year 2011. Figure 4.1b shows the impact of these sources at the receptor locations in the City of London.

Figure 4.2a shows the contribution of each major source group to the total PM_{10} emissions within the City of London, for the year 2011. The contribution of these sources to the total PM_{10} concentrations at the set of receptor locations is shown in Figure 4.2b. Note that the road traffic contribution is made up of exhaust, brake and tyre wear, road wear and resuspension components.

Figure 4.3a shows the contribution of exhaust and brake and tyre wear PM_{10} emissions within the City of London, for the year 2011. The contribution of these sources and of road wear and resuspension to the total PM_{10} concentrations at the set of receptor locations is shown in Figure 4.3b. Note that road wear and resuspension contribute to concentrations but have not been included in the emissions chart as they are not directly emitted by the vehicle.

Figure 4.4a shows the contribution of each vehicle type to the total road traffic exhaust PM_{10} emissions within the City of London, for the year 2011. The contribution of these vehicle types to the total PM_{10} concentrations at the set of receptor locations is shown in Figure 4.4b.

Figure 4.5a shows the contribution of each vehicle type to the total brake and tyre wear PM_{10} emissions within the City of London. The contribution of these vehicle types to the total PM_{10} concentrations at the set of receptor locations is shown in Figure 4.5b.

Source apportionment of PM_{10} concentrations at the set of receptor locations, for the year 2011, is summarised in Table 4.1.

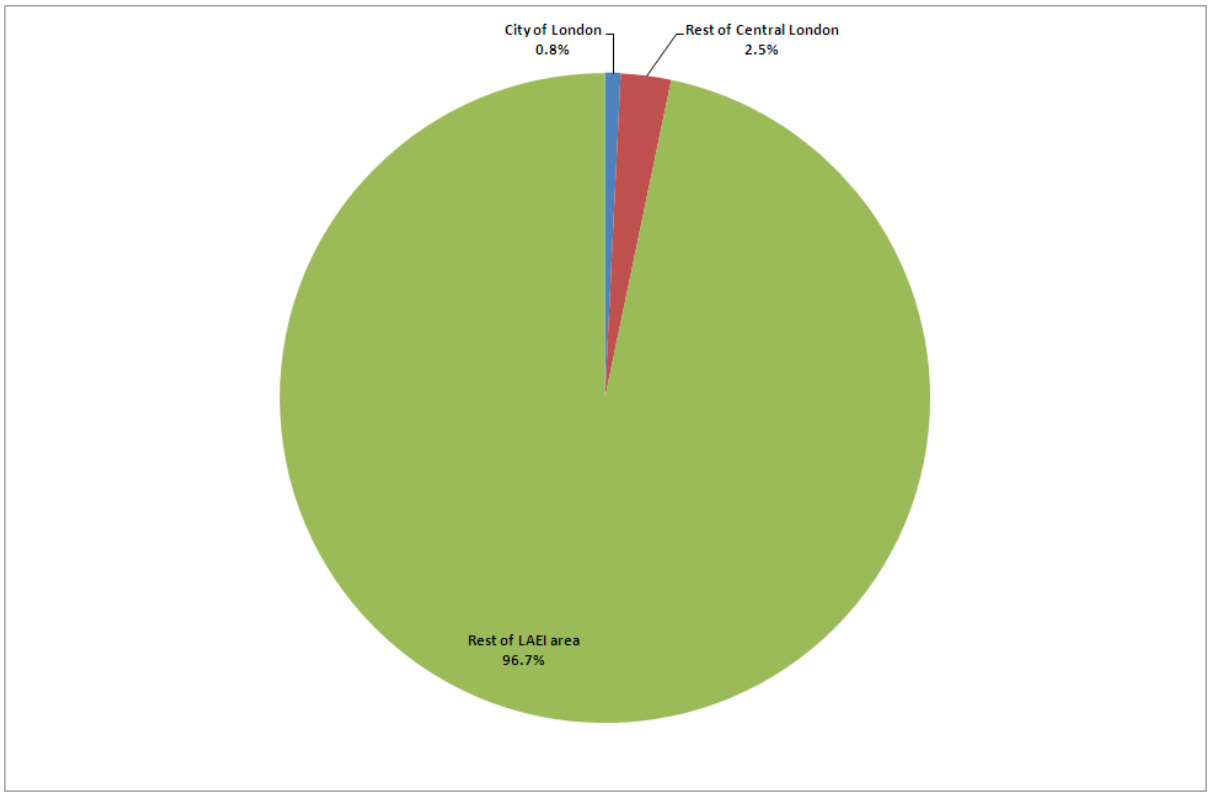

Figure 4.1a: PM_{10} emissions by location, 2011

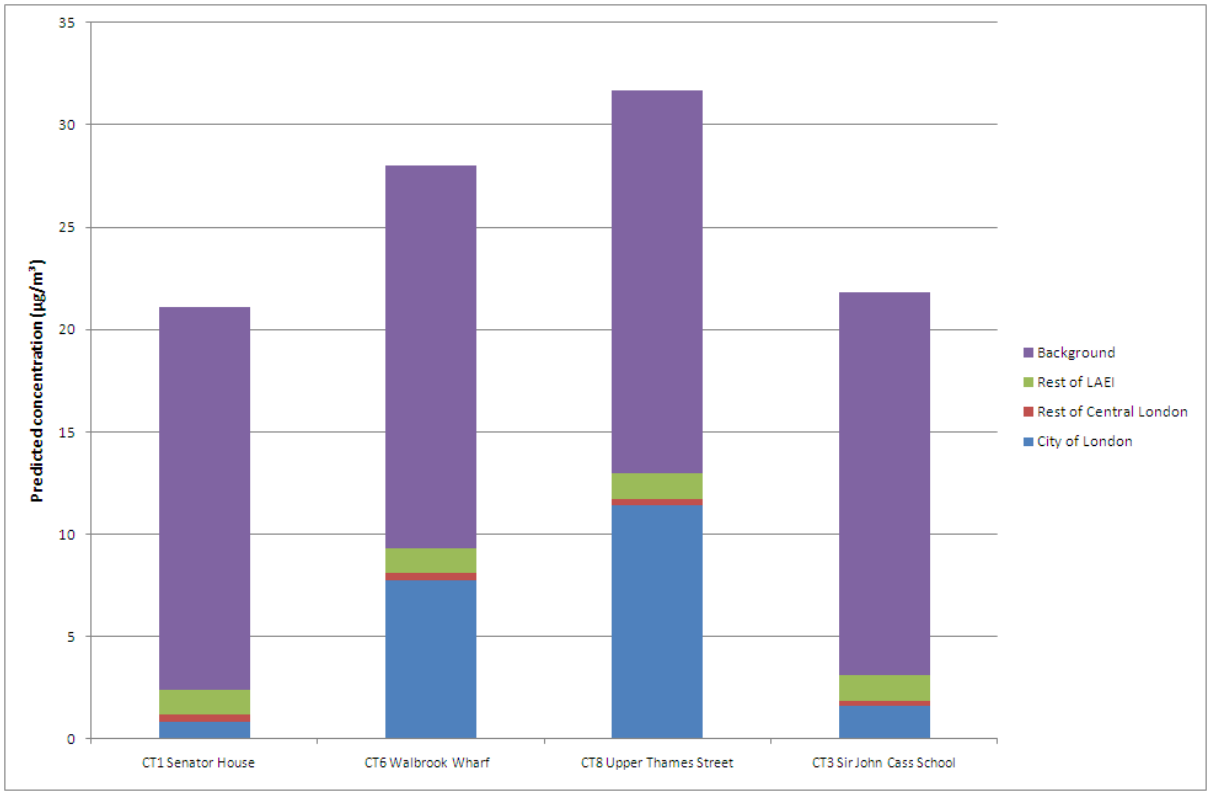

Figure 4.1b: PM_{10} source apportionment by location, 2011

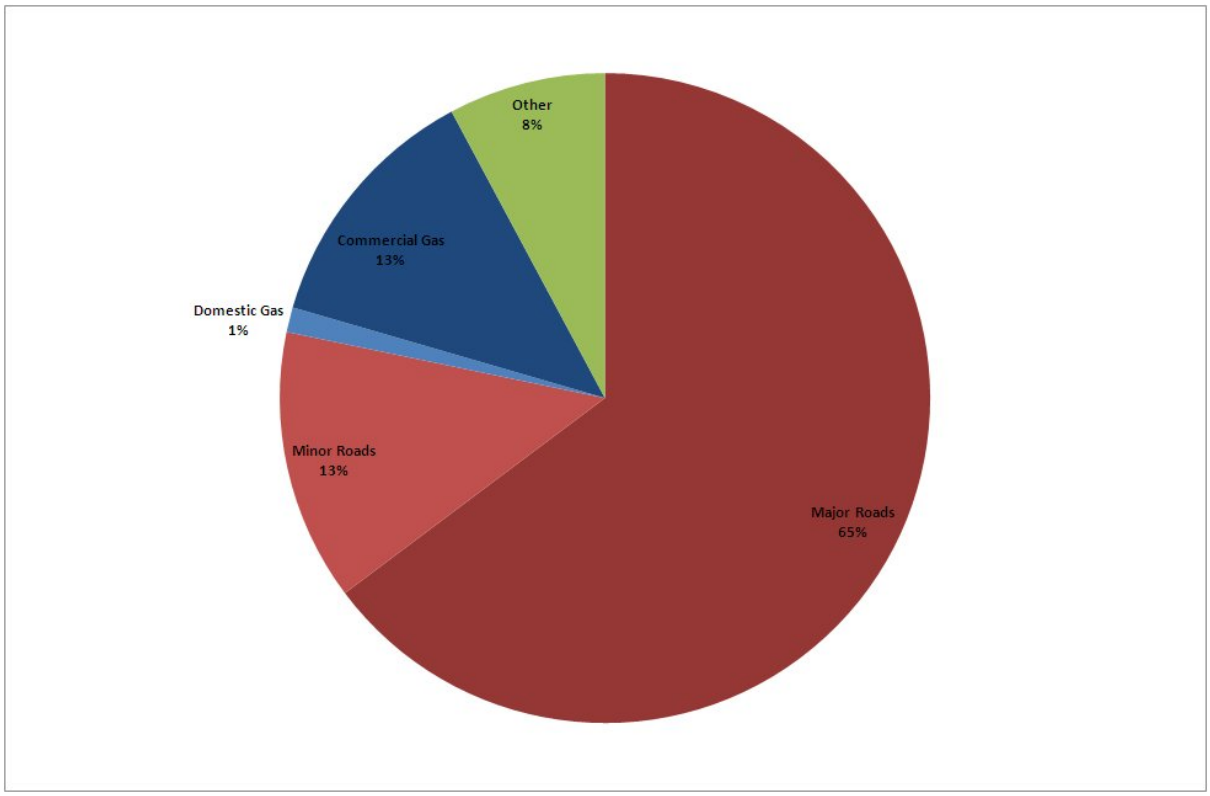

Figure 4.2a: City of London PM_{10} emissions by source type, 2011

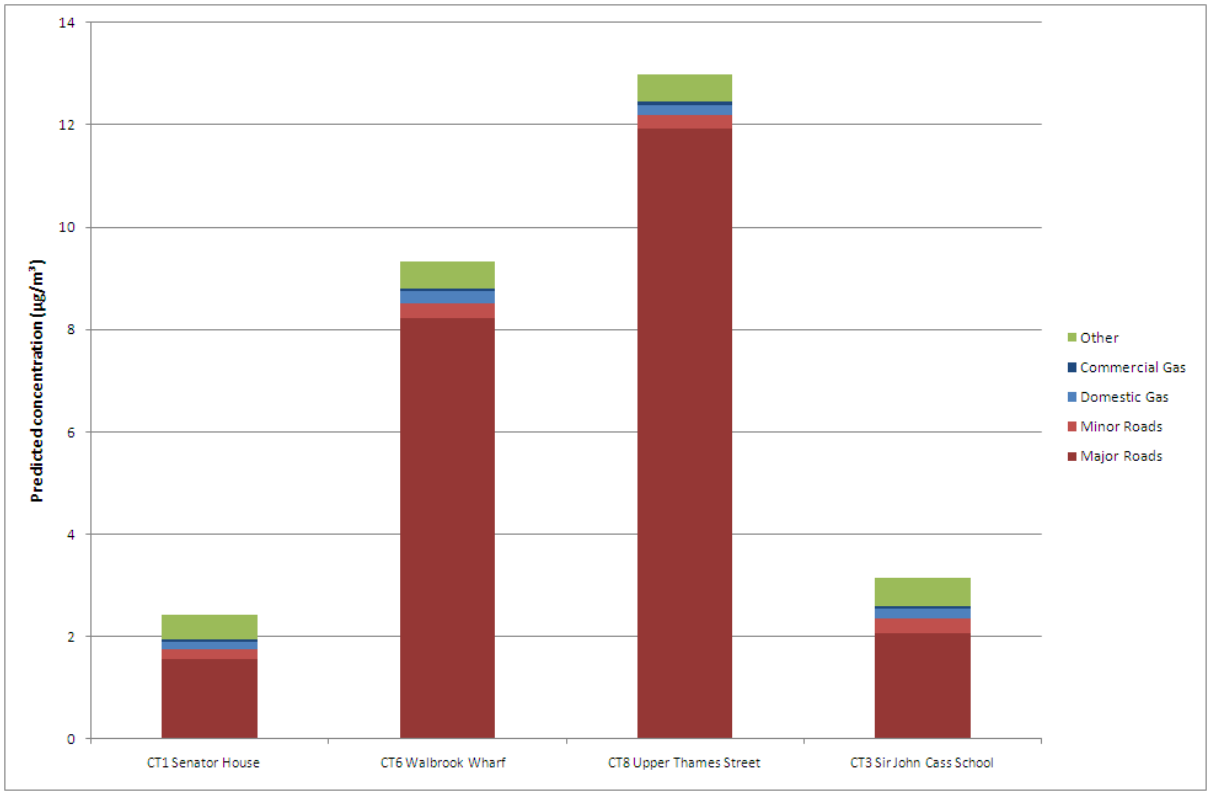

Figure 4.2b: PM_{10} source apportionment by source type, 2011

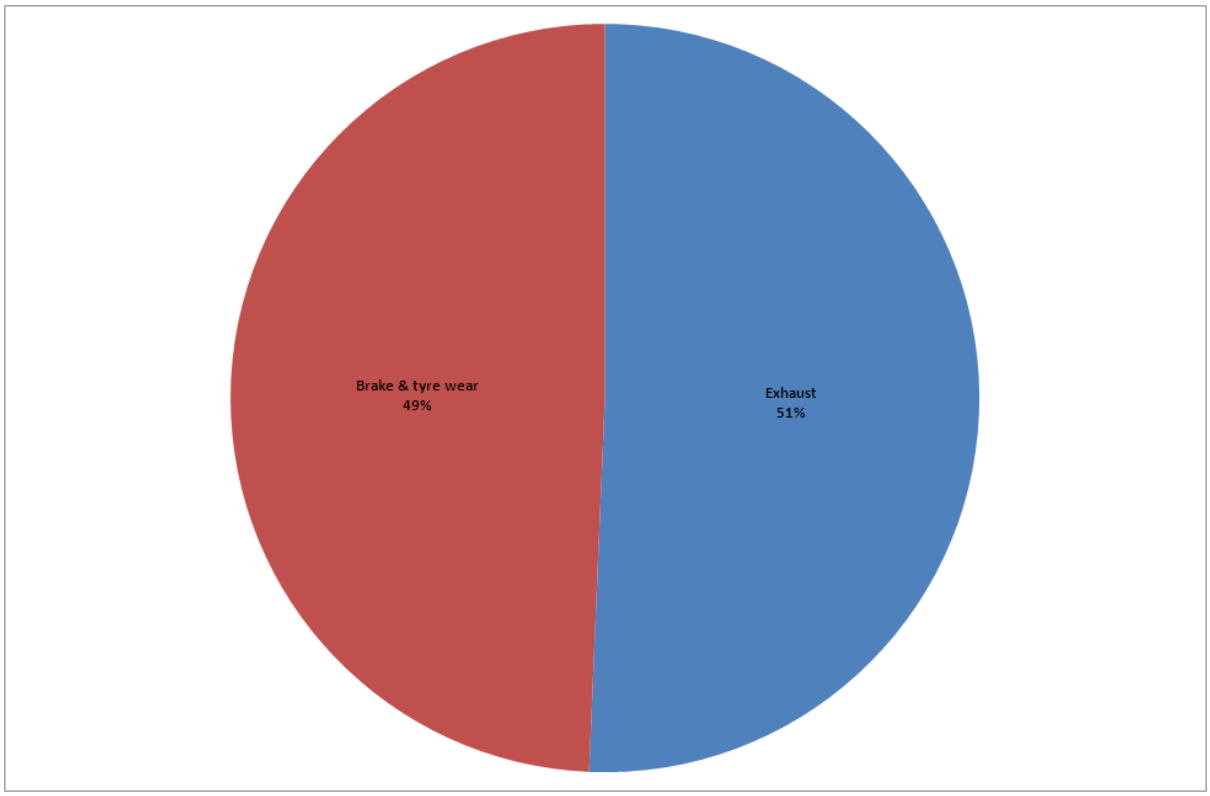

Figure 4.3a: City of London road traffic PM_{10} emissions by road source type, 2011

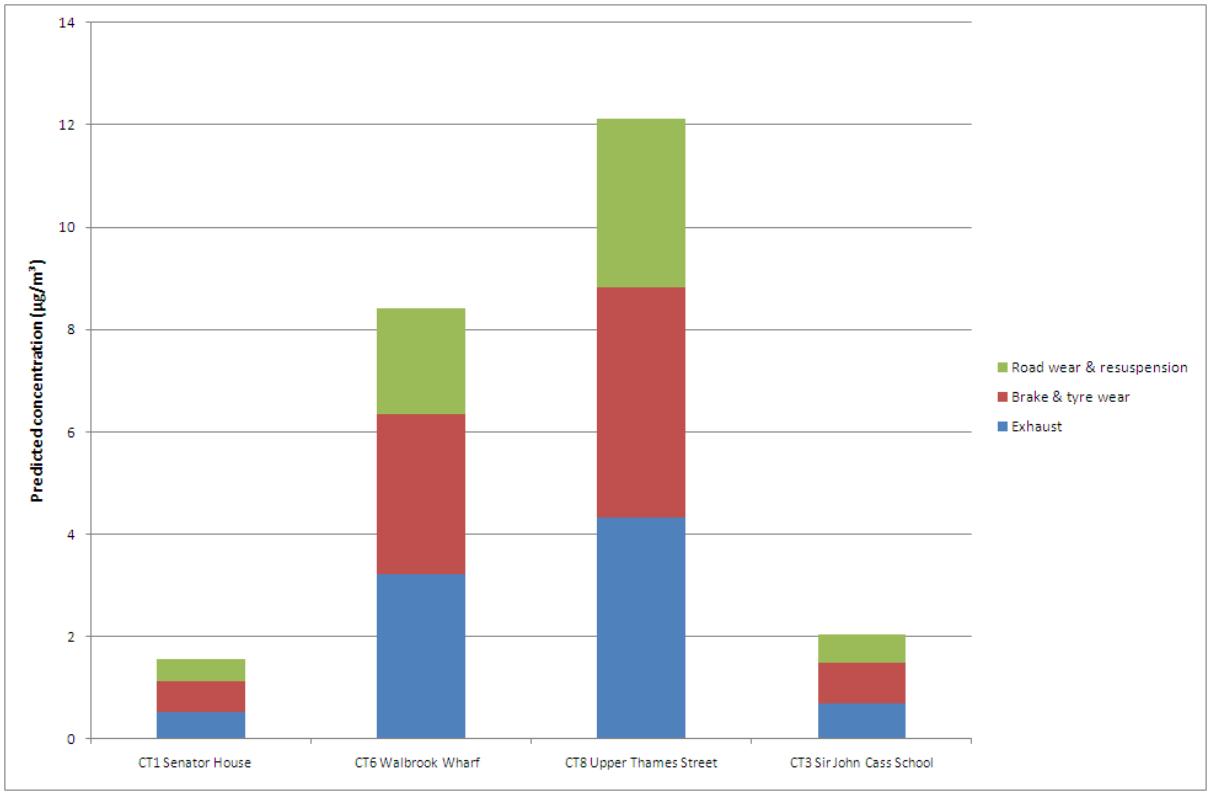

Figure 4.3b: PM_{10} source apportionment by road source type, 2011

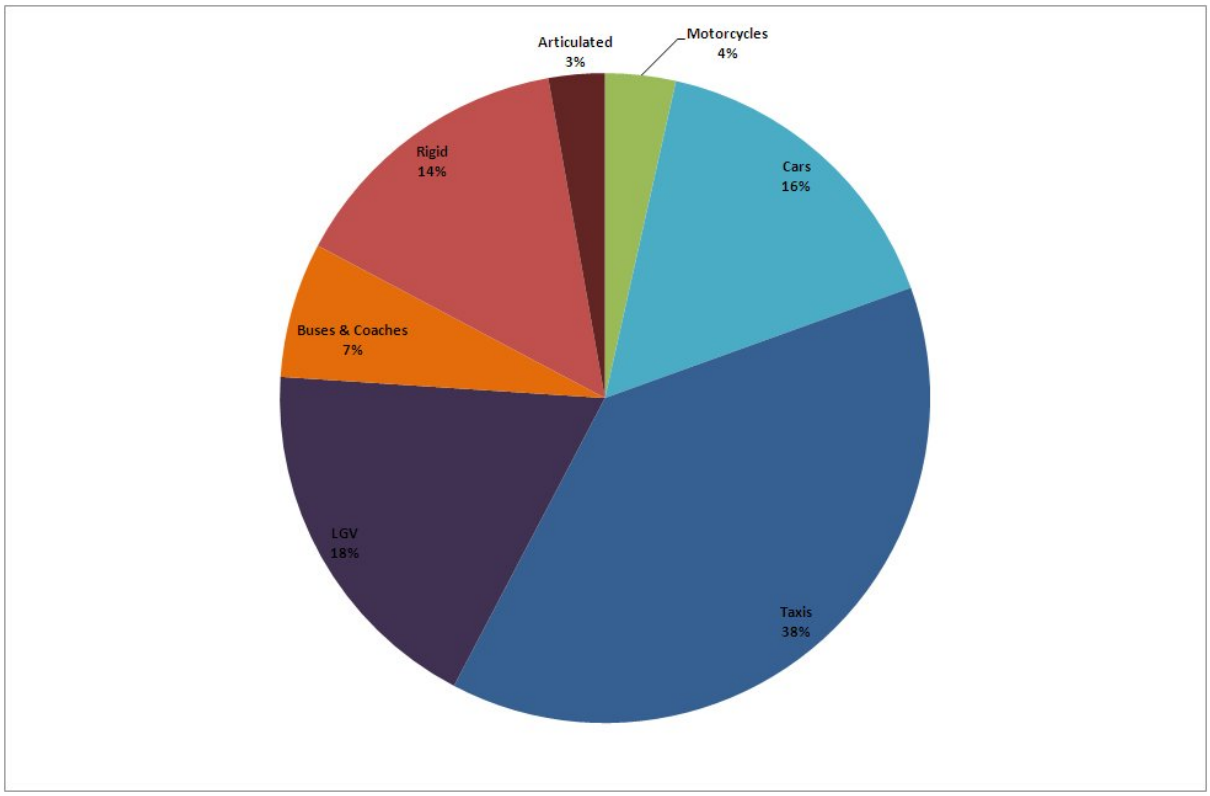

Figure 4.4a: City of London road traffic exhaust PM_{10} emissions by vehicle type, 2011

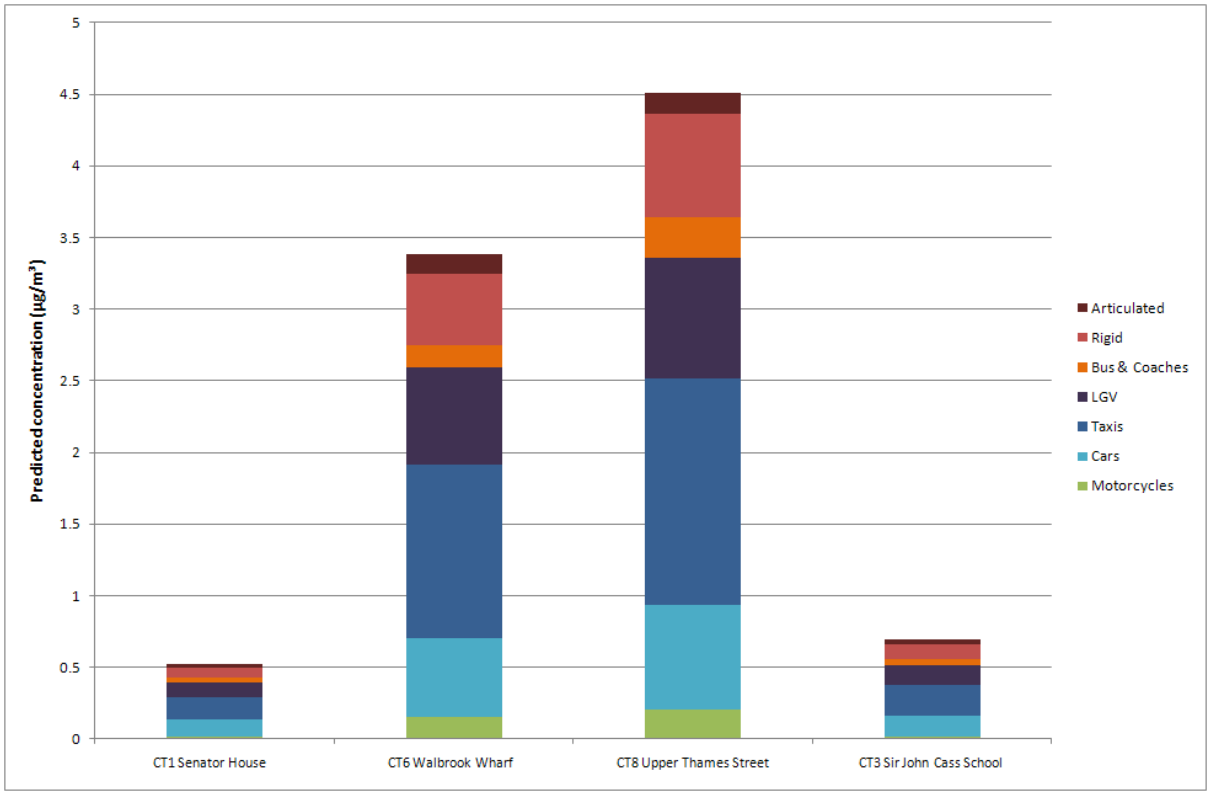

Figure 4.4b: PM_{10} source apportionment of vehicle exhaust emissions, 2011

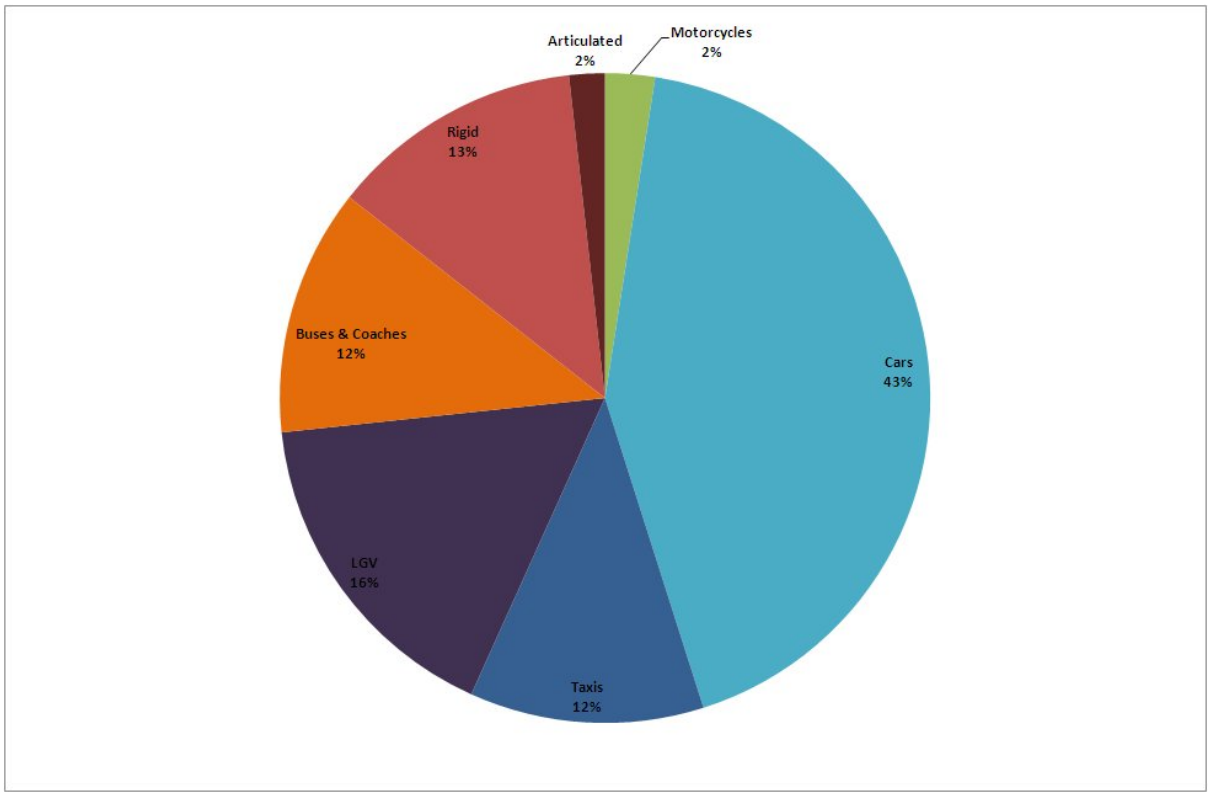

Figure 4.5a: City of London brake and tyre wear PM_{10} emissions by vehicle type, 2011

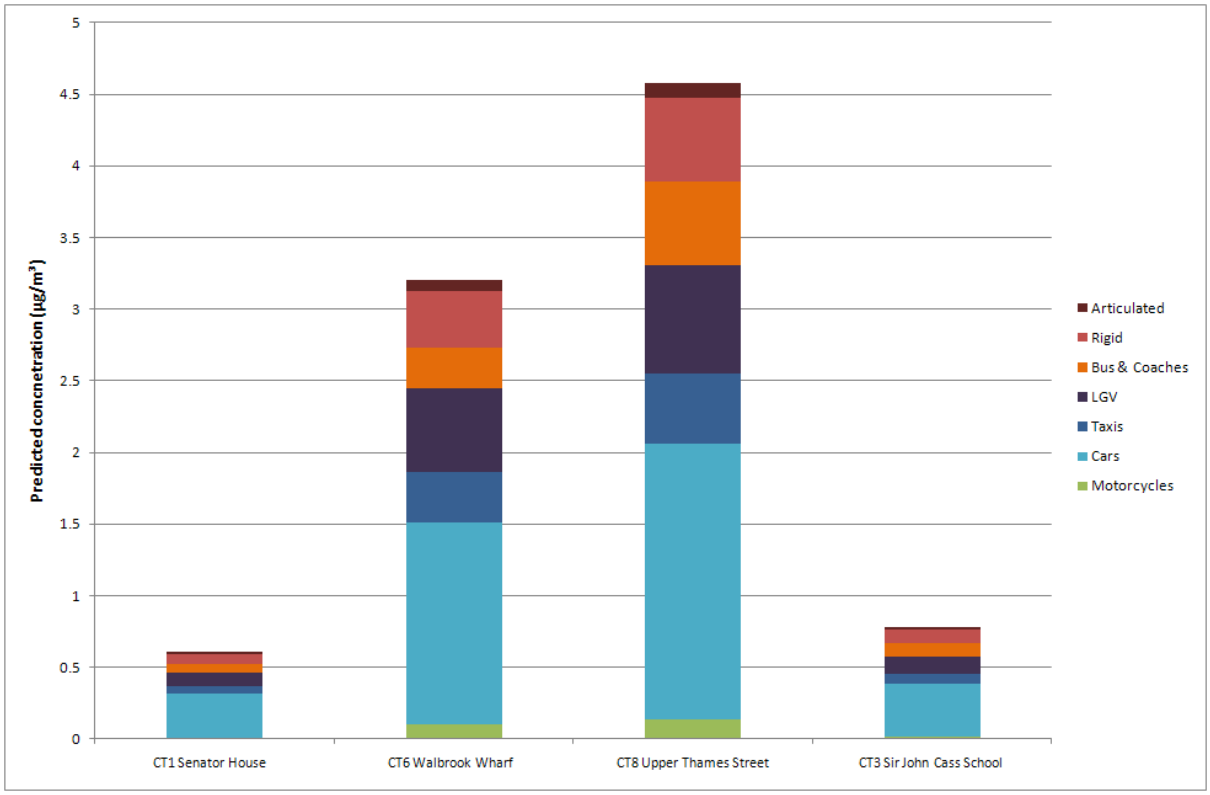

Figure 4.5b: PM_{10} source apportionment of brake and tyre wear emissions, 2011

Type of source apportionment	Source group	CT1 Senator House	CT6 Walbrook Wharf	CT8 Upper Thames Street	CT3 Sir John Cass School
Location	City of London	0.8	7.7	11.4	1.6
	Rest of Central London	0.4	0.4	0.3	0.3
	Rest of LAEI	1.2	1.2	1.2	1.3
	Background	18.7	18.7	18.7	18.7
Source type	Major Roads	1.6	8.2	11.9	2.1
	Minor Roads	0.2	0.3	0.3	0.3
	Domestic Gas	0.1	0.2	0.2	0.2
	Commercial Gas	0.1	0.1	0.1	0.1
	Other	0.5	0.5	0.5	0.5
Road source type	Exhaust	0.5	3.2	4.3	0.7
	Brake & tyre wear	0.6	3.1	4.5	0.8
	Road wear & resuspension	0.4	2.0	3.3	0.6
Exhaust emissions	Motorcycles	<0.1	0.2	0.2	<0.1
	Cars	0.1	0.6	0.7	0.1
	Taxis	0.2	1.2	1.6	0.2
	LGV	0.1	0.7	0.8	0.1
	Bus & Coaches	<0.1	0.2	0.3	<0.1
	Rigid	0.1	0.5	0.7	0.1
	Articulated	<0.1	0.1	0.2	<0.1
Brake & tyre wear emissions	Motorcycles	<0.1	0.1	0.1	<0.1
	Cars	0.3	1.4	1.9	0.4
	Taxis	<0.1	0.4	0.5	0.1
	LGV	0.1	0.6	0.8	0.1
	Bus & Coaches	0.1	0.3	0.6	0.1
	Rigid	0.1	0.4	0.6	0.1
	Articulated	<0.1	0.1	0.1	<0.1

Table 4.1: Summary of PM_{10} source apportionment, 2011

4.2. PM_{10} source apportionment for the year 2015

Figure 4.6a shows the contribution of the PM_{10} emissions generated within the City of London, the rest of Central London, as defined in the LAEI, and the rest of the LAEI area, for the year 2015. Figure 4.6b shows the impact of these sources at the receptor locations in the City of London.

Figure 4.7a shows the contribution of each major source group to the total PM_{10} emissions within the City of London, for the year 2015. The contribution of these sources to the total PM_{10} concentrations at the set of receptor locations is shown in Figure 4.7b. Note that the road traffic contribution is made up of exhaust, brake and tyre wear, road wear and resuspension components.

Figure 4.8a shows the contribution of exhaust and brake and tyre wear PM_{10} emissions within the City of London, for the year 2015. The contribution of these sources and of road wear and resuspension to the total PM_{10} concentrations at the set of receptor locations is shown in Figure 4.8b. Note that road wear and resuspension contribute to concentrations but have not been included in the emissions chart as they are not directly emitted by the vehicle.

Figure 4.9a shows the contribution of each vehicle type to the total road traffic exhaust PM_{10} emissions within the City of London, for the year 2015. The contribution of these vehicle types to the total PM_{10} concentrations at the set of receptor locations is shown in Figure 4.9b.

Figure 4.10a shows the contribution of each vehicle type to the total brake and tyre wear PM_{10} emissions within the City of London. The contribution of these vehicle types to the total PM_{10} concentrations at the set of receptor locations is shown in Figure 4.10b.

Source apportionment of PM_{10} concentrations at the set of receptor locations, for the year 2015, is summarised in Table 4.2.

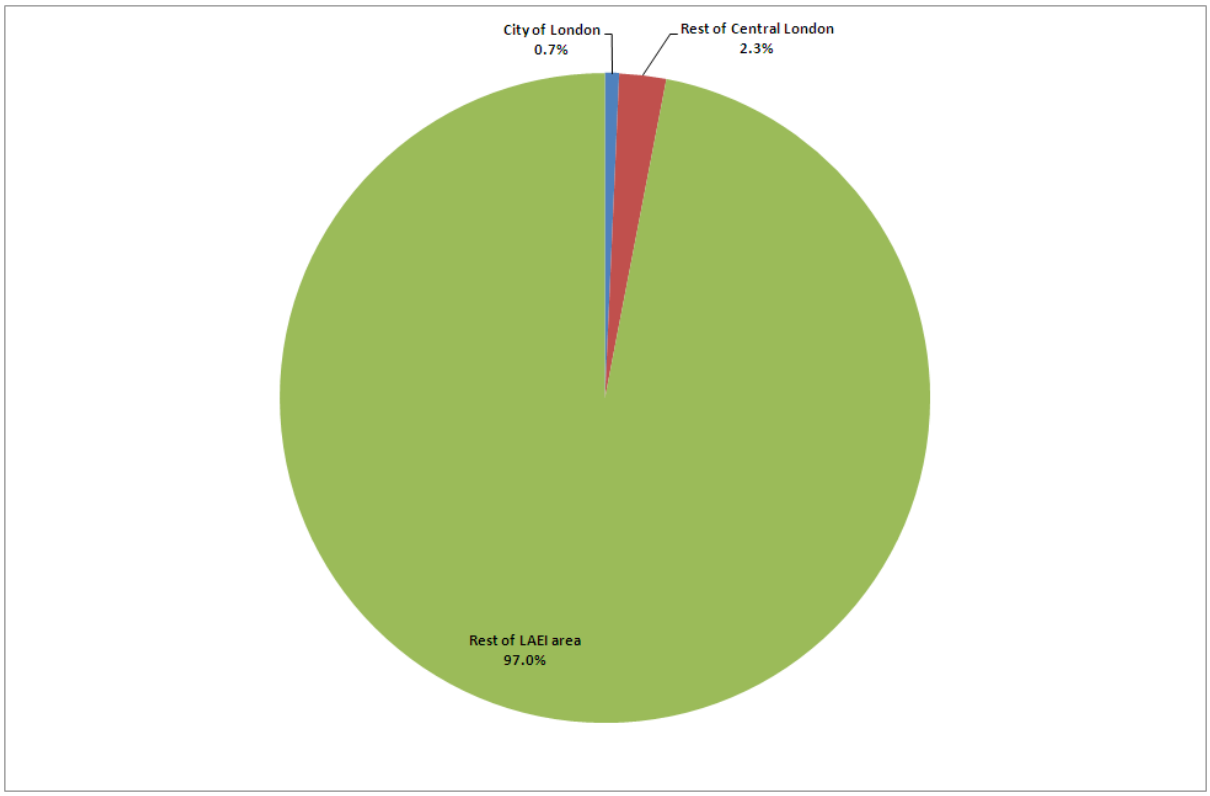

Figure 4.6a: PM_{10} emissions by location, 2015

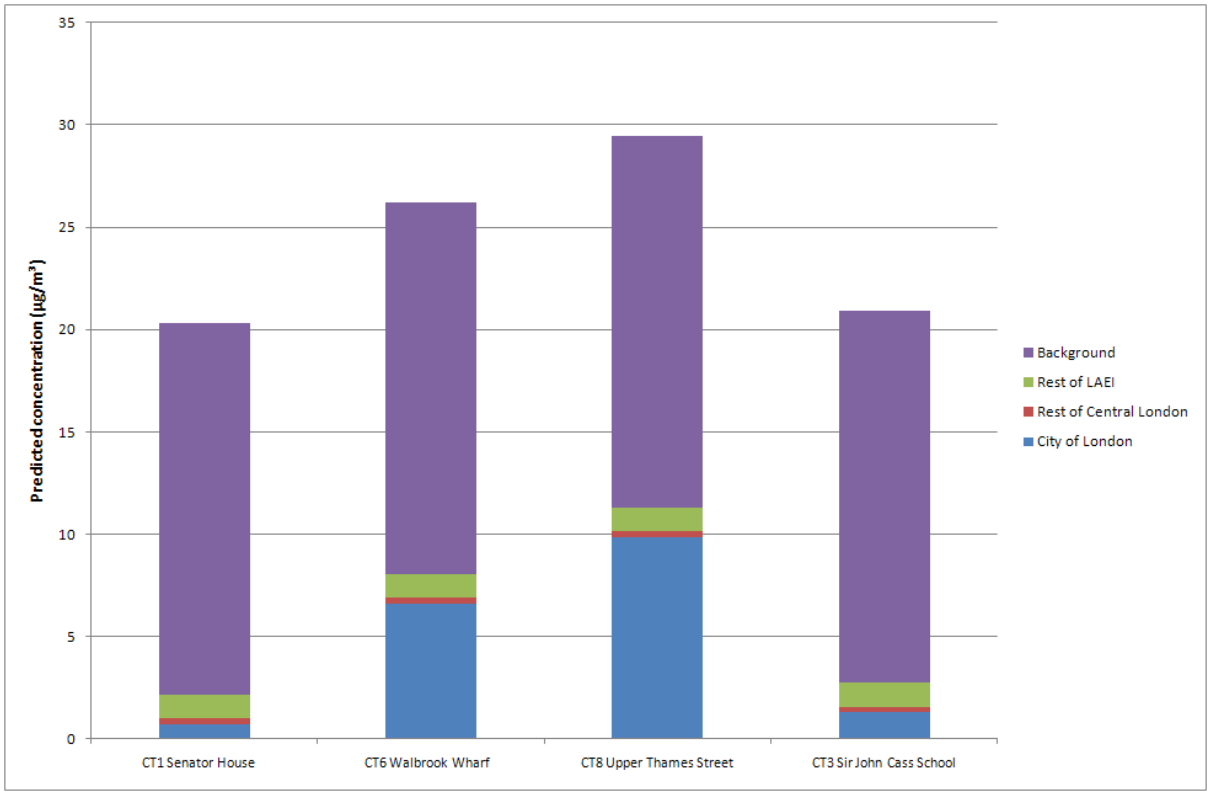

Figure 4.6b: PM_{10} source apportionment by location, 2015

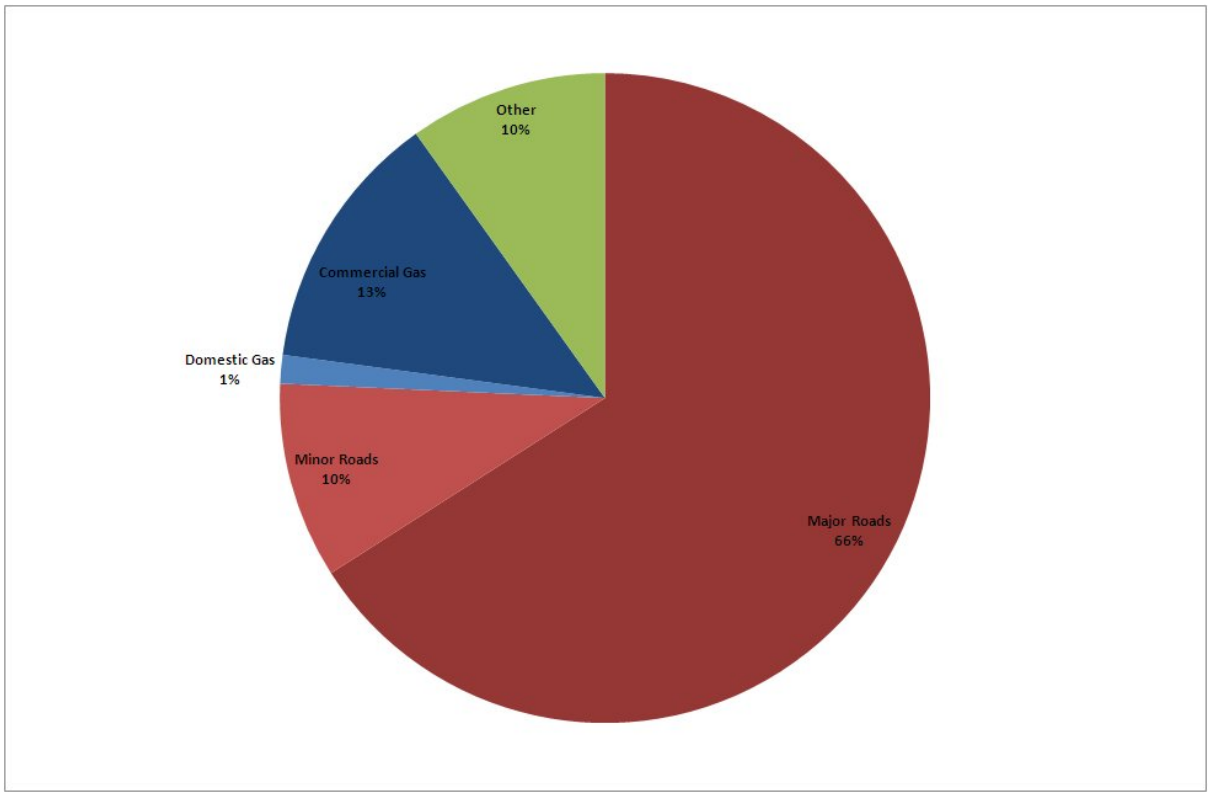

Figure 4.7a: City of London PM_{10} emissions by source type, 2015

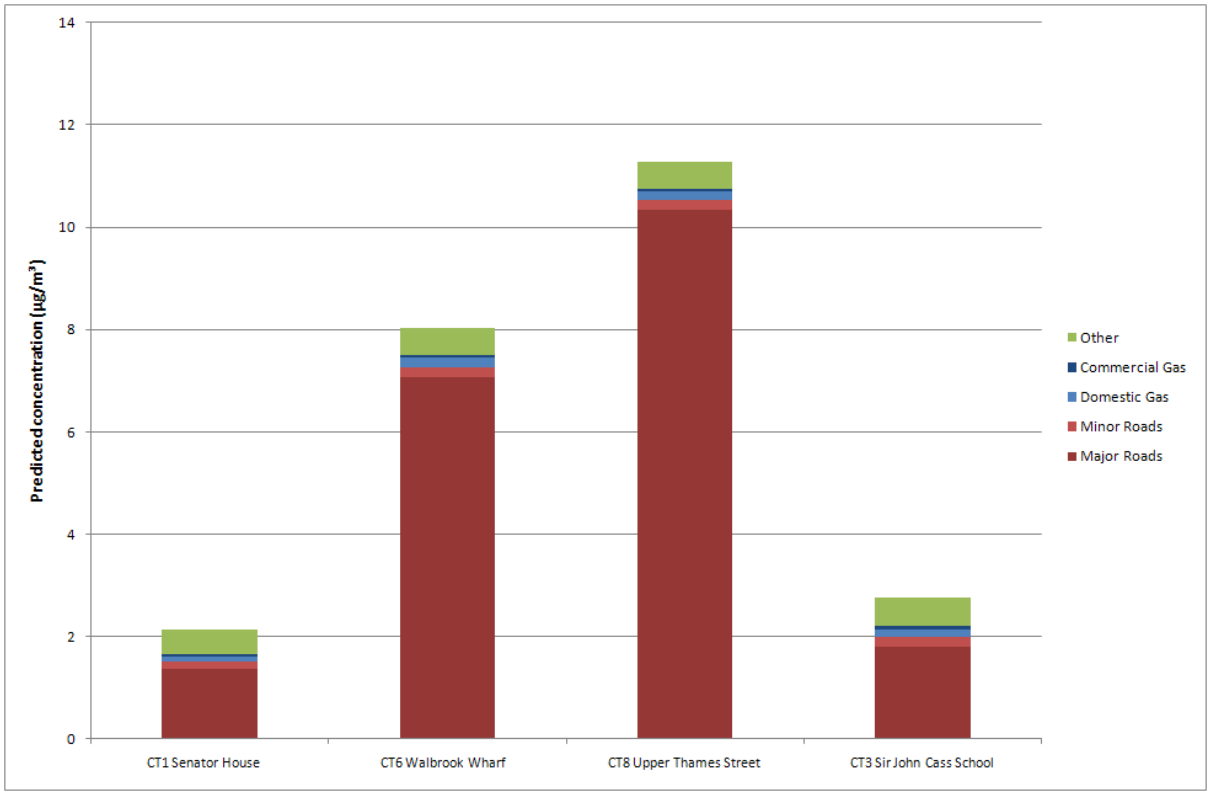

Figure 4.7b: PM_{10} source apportionment by source type, 2015

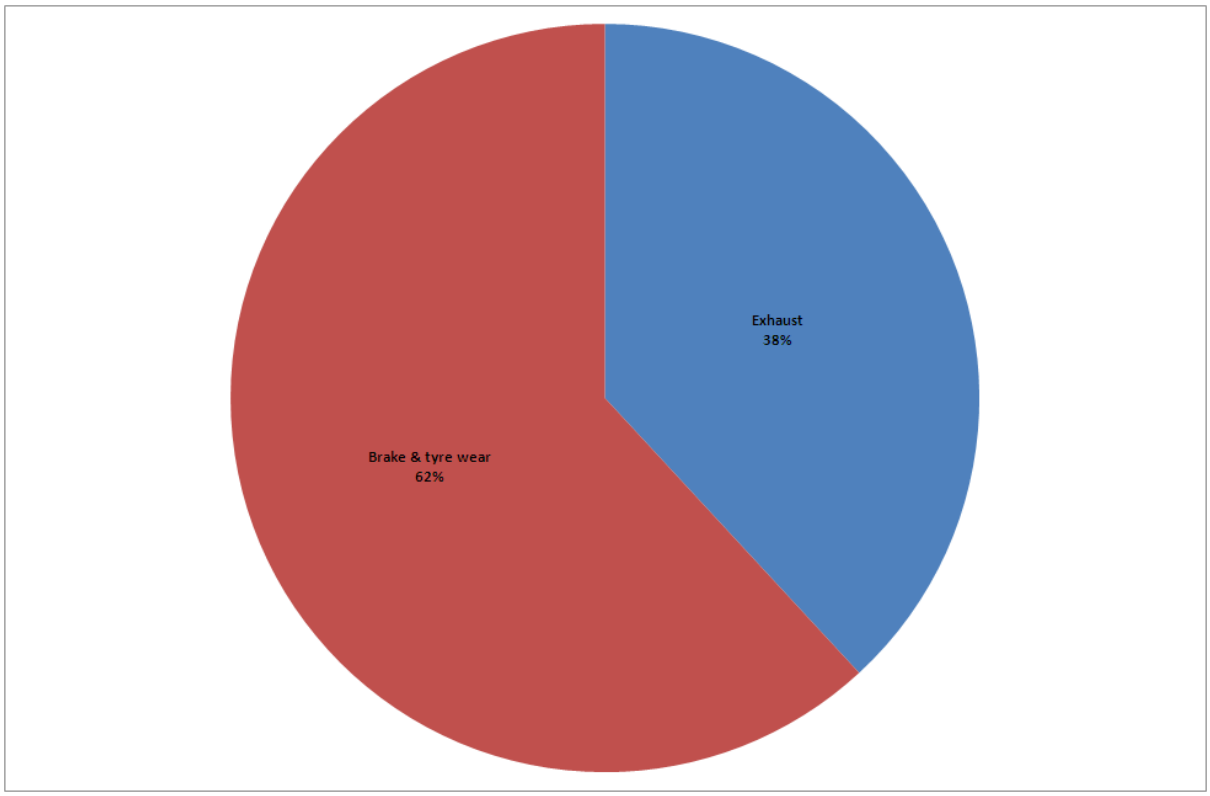

Figure 4.8a: City of London road traffic PM_{10} emissions by road source type, 2015

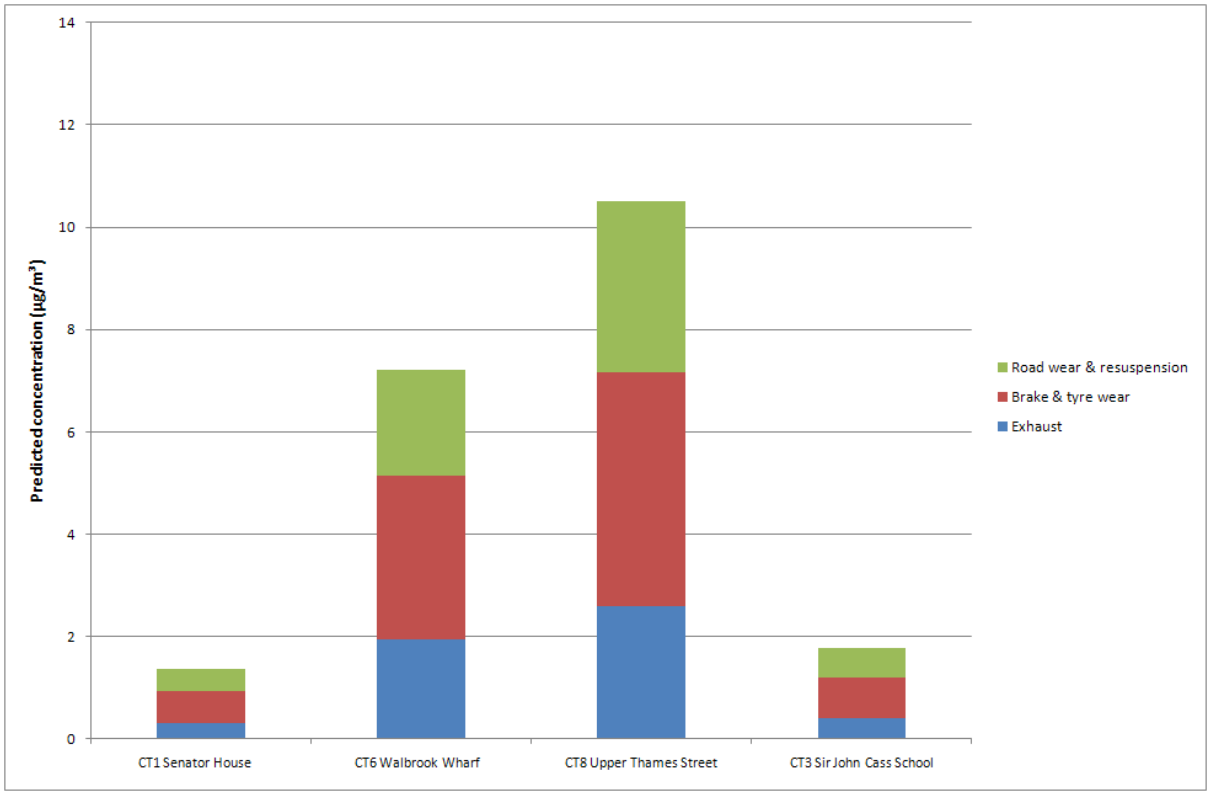

Figure 4.8b: PM_{10} source apportionment by road source type, 2015

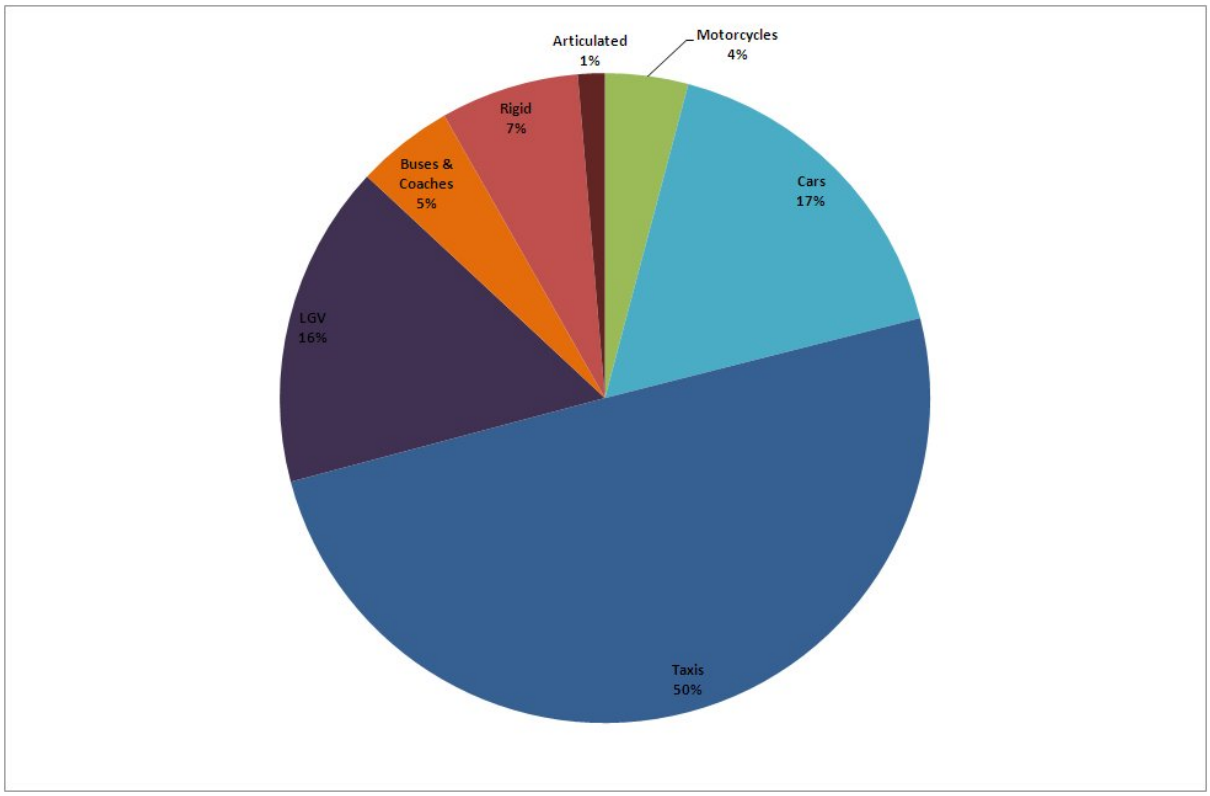

Figure 4.9a: City of London road traffic exhaust PM_{10} emissions by vehicle type, 2015

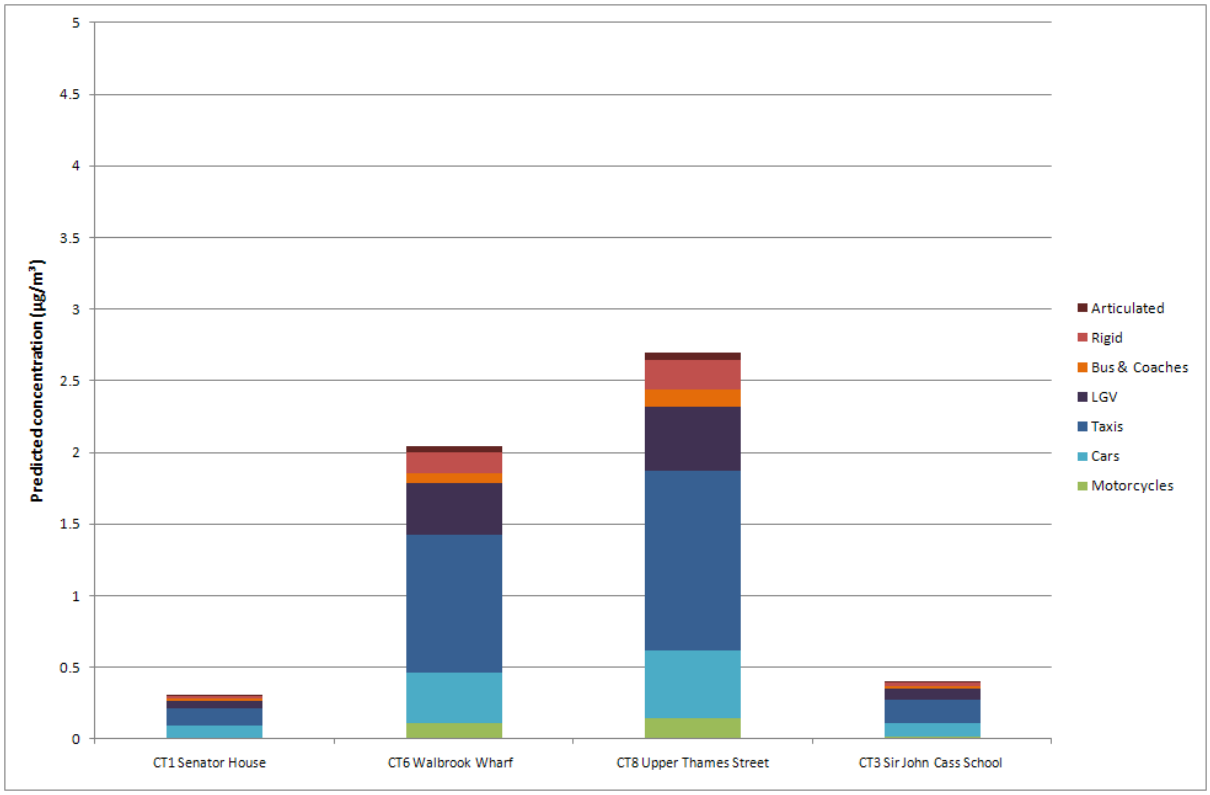

Figure 4.9b: PM_{10} source apportionment of vehicle exhaust emissions, 2015

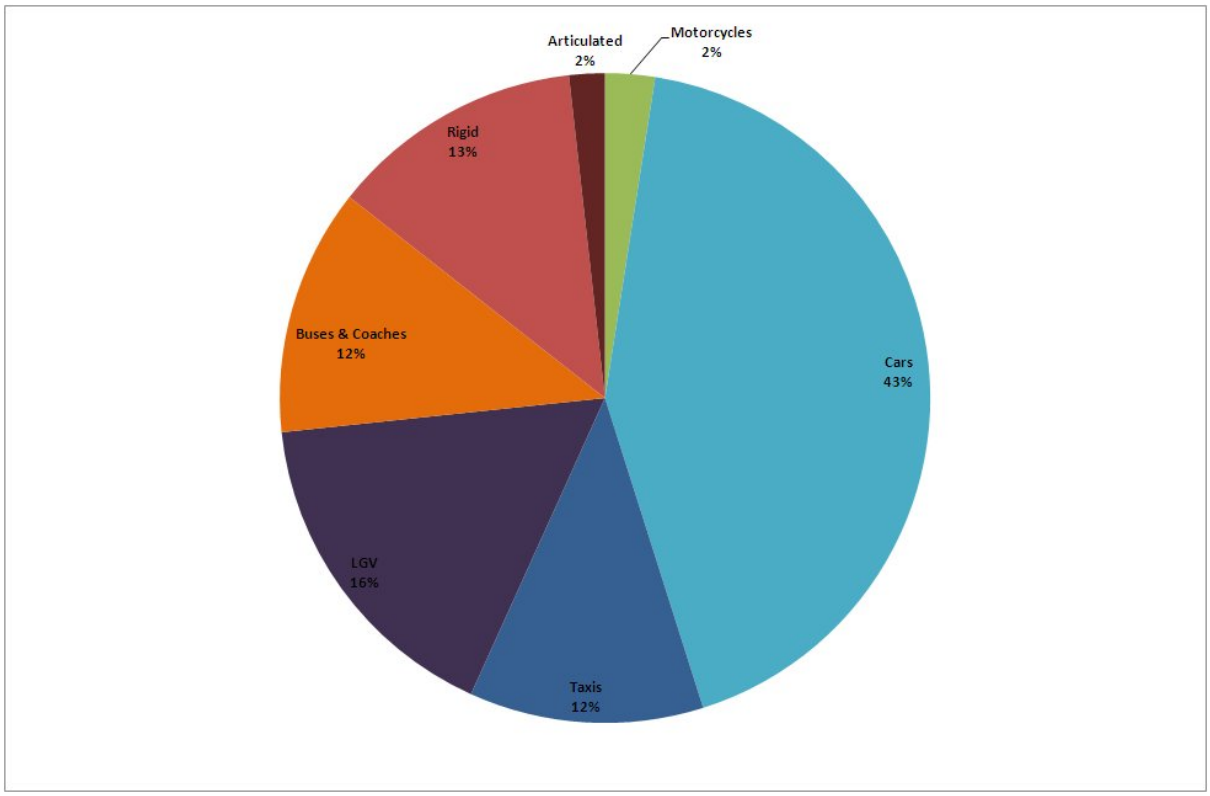

Figure 4.10a: City of London brake and tyre wear PM_{10} emissions by vehicle type, 2015

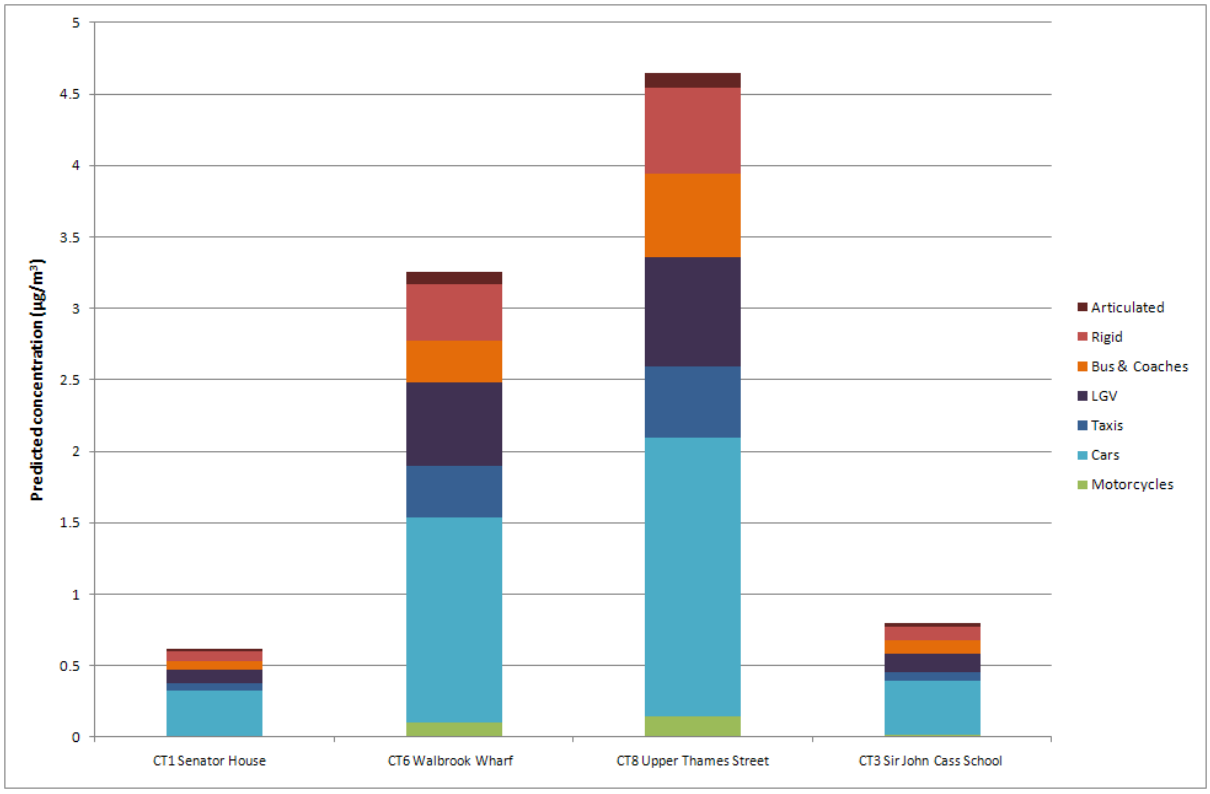

Figure 4.10b: PM_{10} source apportionment of brake and tyre wear emissions, 2015

Type of source apportionment	Source group	CT1 Senator House	CT6 Walbrook Wharf	CT8 Upper Thames Street	CT3 Sir John Cass School
Location	City of London	0.7	6.6	9.9	1.3
	Rest of Central London	0.3	0.3	0.3	0.2
	Rest of LAEI	1.1	1.1	1.1	1.2
	Background	18.2	18.2	18.2	18.2
Source type	Major Roads	1.4	7.1	10.3	1.8
	Minor Roads	0.1	0.2	0.2	0.2
	Domestic Gas	0.1	0.2	0.2	0.2
	Commercial Gas	<0.1	0.1	0.1	0.1
	Other	0.5	0.5	0.5	0.6
Road source type	Exhaust	0.3	2.0	2.6	0.4
	Brake & tyre wear	0.6	3.2	4.6	0.8
	Road wear & resuspension	0.4	2.1	3.3	0.6
Exhaust emissions	Motorcycles	<0.1	0.1	0.1	<0.1
	Cars	0.1	0.4	0.5	0.1
	Taxis	0.1	1.0	1.3	0.2
	LGV	0.1	0.4	0.4	0.1
	Bus & Coaches	<0.1	0.1	0.1	<0.1
	Rigid	<0.1	0.1	0.2	<0.1
	Articulated	<0.1	<0.1	<0.1	<0.1
Brake & tyre emissions	Motorcycles	<0.1	0.1	0.1	<0.1
	Cars	0.3	1.4	2.0	0.4
	Taxis	<0.1	0.4	0.5	0.1
	LGV	0.1	0.6	0.8	0.1
	Bus & Coaches	0.1	0.3	0.6	0.1
	Rigid	0.1	0.4	0.6	0.1
	Articulated	<0.1	0.1	0.1	<0.1

Table 4.2: Summary of PM_{10} source apportionment, 2015

5. $PM_{2.5}$ source apportionment

The total concentration of $PM_{2.5}$ at a given location is made up of contributions from emissions from sources such as road traffic and industries as well as a significant contribution from outside London. This section presents the breakdown of the emissions from within London and the contribution of each component to the total annual average $PM_{2.5}$ concentrations.

5.1. $PM_{2.5}$ source apportionment for the year 2011

Figure 5.1a shows the contribution of the $PM_{2.5}$ emissions generated within the City of London, the rest of Central London, as defined in the LAEI, and the rest of the LAEI area, for the year 2011. Figure 5.1b shows the impact of these sources at the receptor locations in the City of London.

Figure 5.2a shows the contribution of each major source group to the total $PM_{2.5}$ emissions within the City of London, for the year 2011. The contribution of these sources to the total $PM_{2.5}$ concentrations at the set of receptor locations is shown in Figure 5.2b. Note that the road traffic contribution is made up of exhaust and brake and tyre wear and road wear components.

Figure 5.3a shows the contribution of exhaust and brake and tyre wear $PM_{2.5}$ emissions within the City of London, for the year 2011. The contribution of these sources and of road wear to the total $PM_{2.5}$ concentrations at the set of receptor locations is shown in Figure 5.3b.

Figure 5.4a shows the contribution of each vehicle type to the total road traffic exhaust $PM_{2.5}$ emissions within the City of London, for the year 2011. The contribution of these vehicle types to the total $PM_{2.5}$ concentrations at the set of receptor locations is shown in Figure 5.4b.

Figure 5.5a shows the contribution of each vehicle type to the total brake and tyre wear $PM_{2.5}$ emissions within the City of London. The contribution of these vehicle types to the total $PM_{2.5}$ concentrations at the set of receptor locations is shown in Figure 5.5b.

Source apportionment of $PM_{2.5}$ concentrations at the set of receptor locations, for the year 2011, is summarised in Table 5.1.

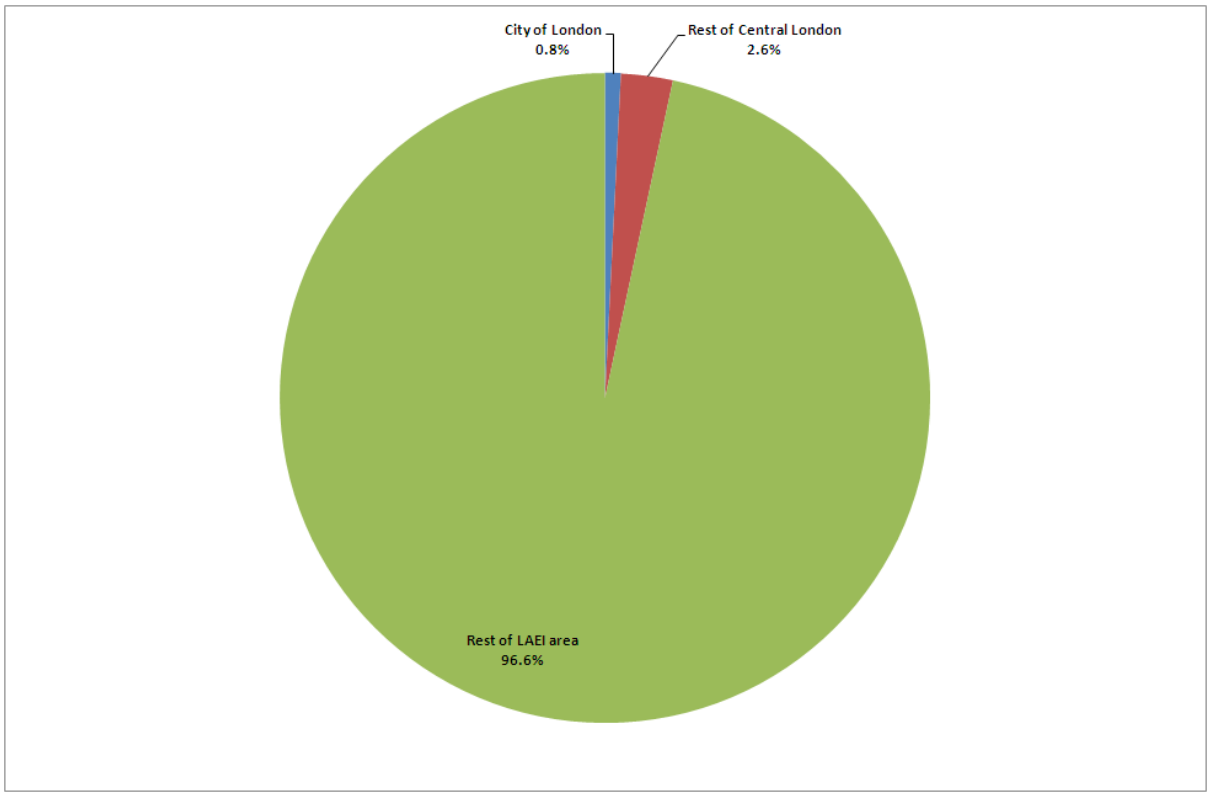

Figure 5.1a: $PM_{2.5}$ emissions by location, 2011

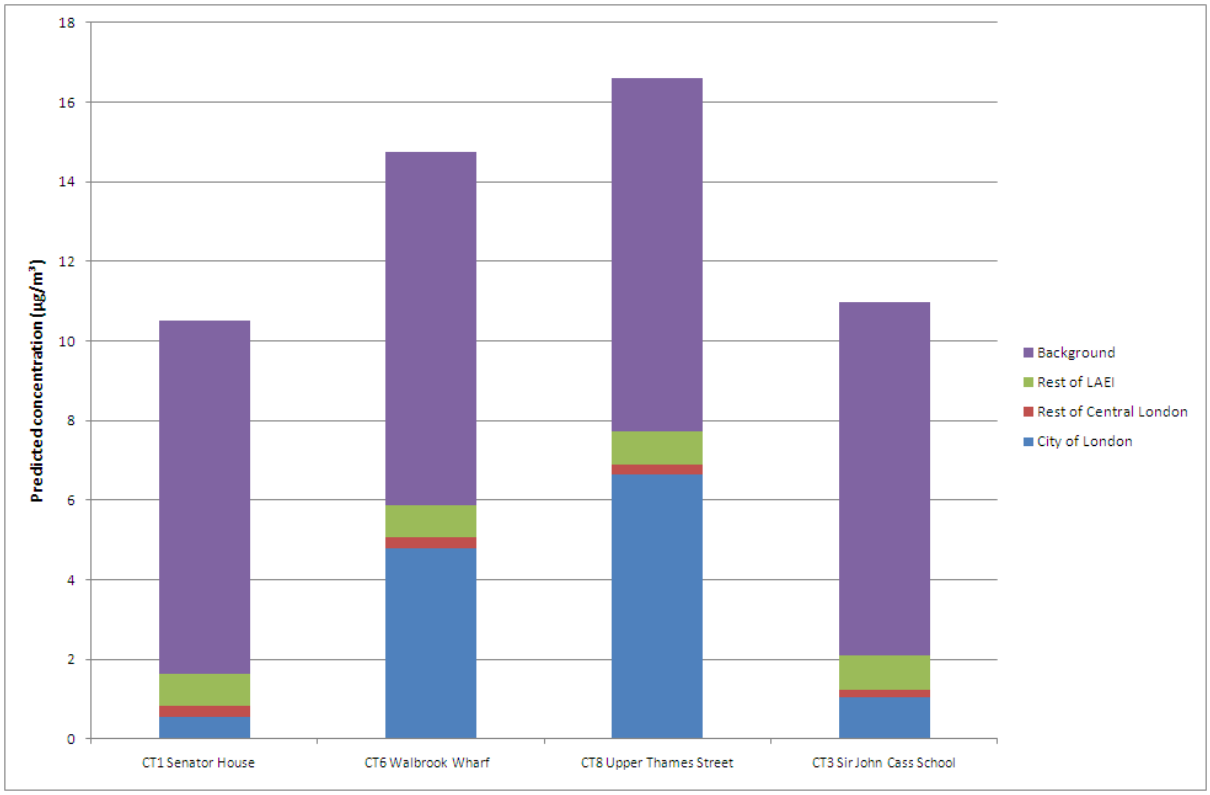

Figure 5.1b: $PM_{2.5}$ source apportionment by location, 2011

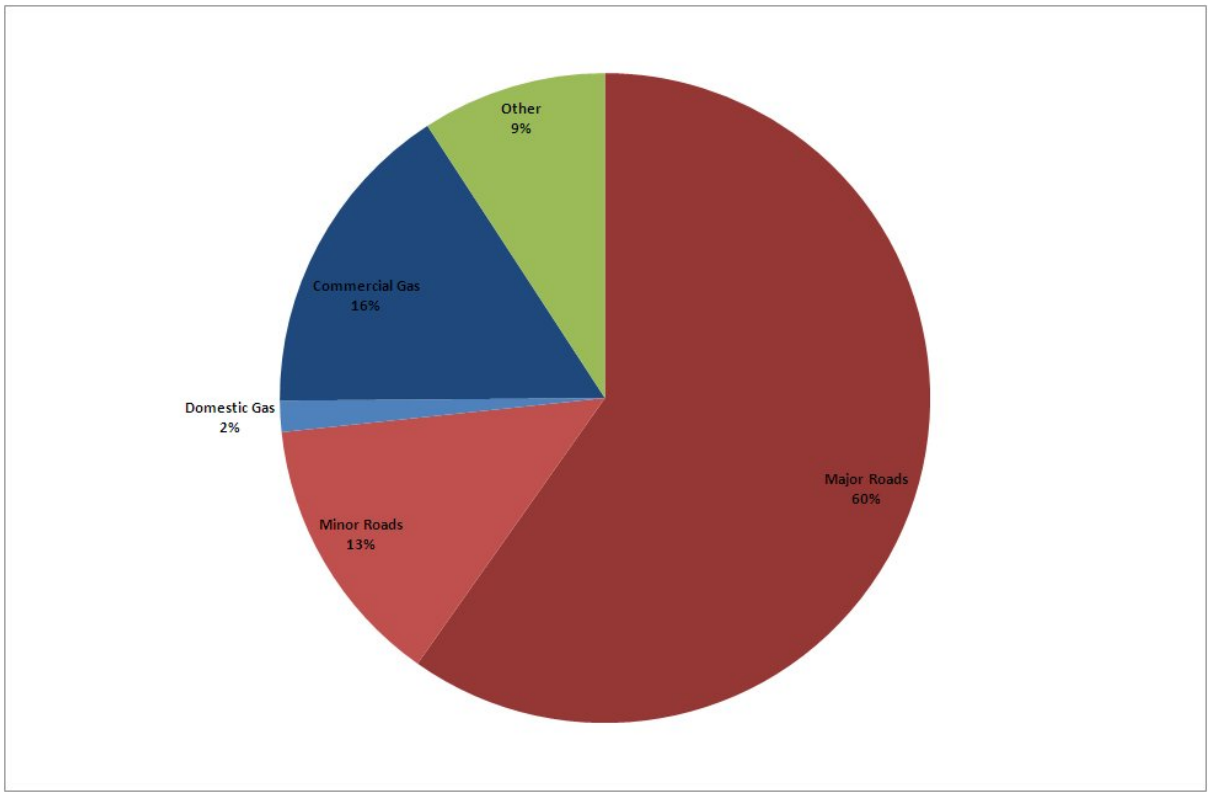

Figure 5.2a: City of London $PM_{2.5}$ emissions by source type, 2011

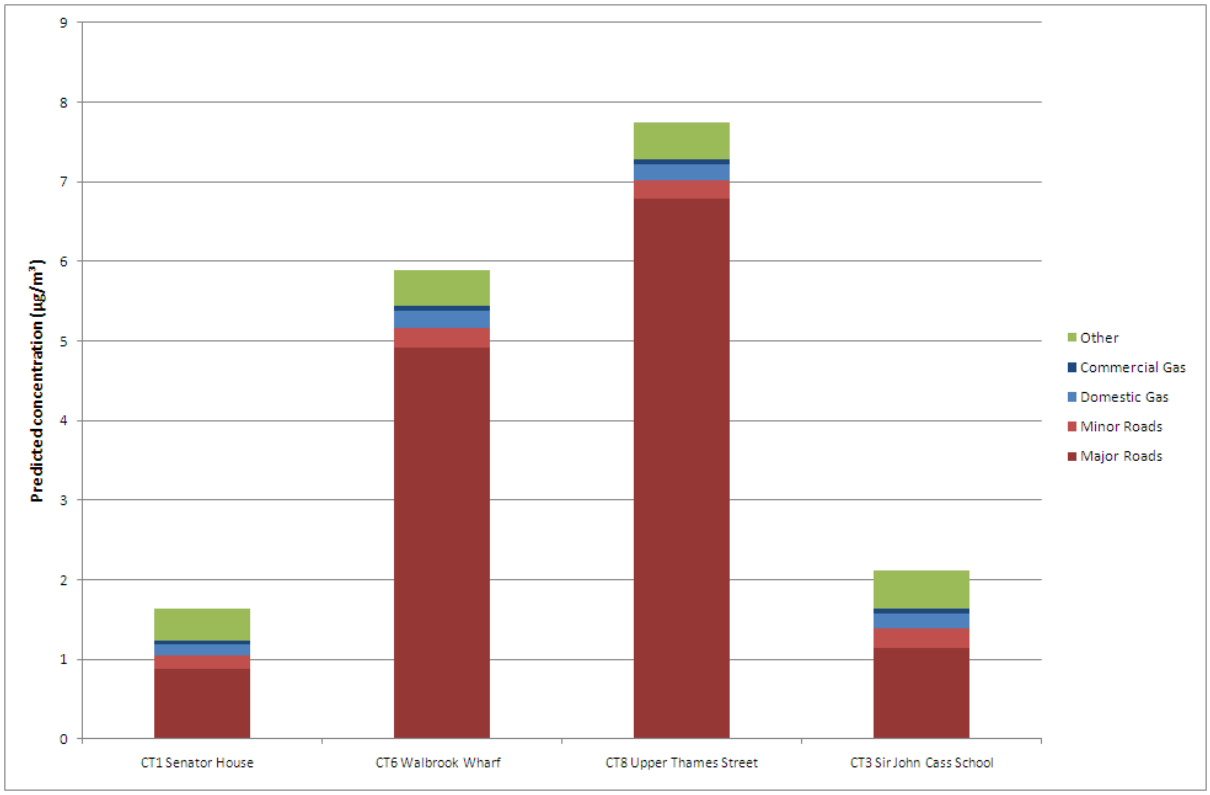

Figure 5.2b: $PM_{2.5}$ source apportionment by source type, 2011

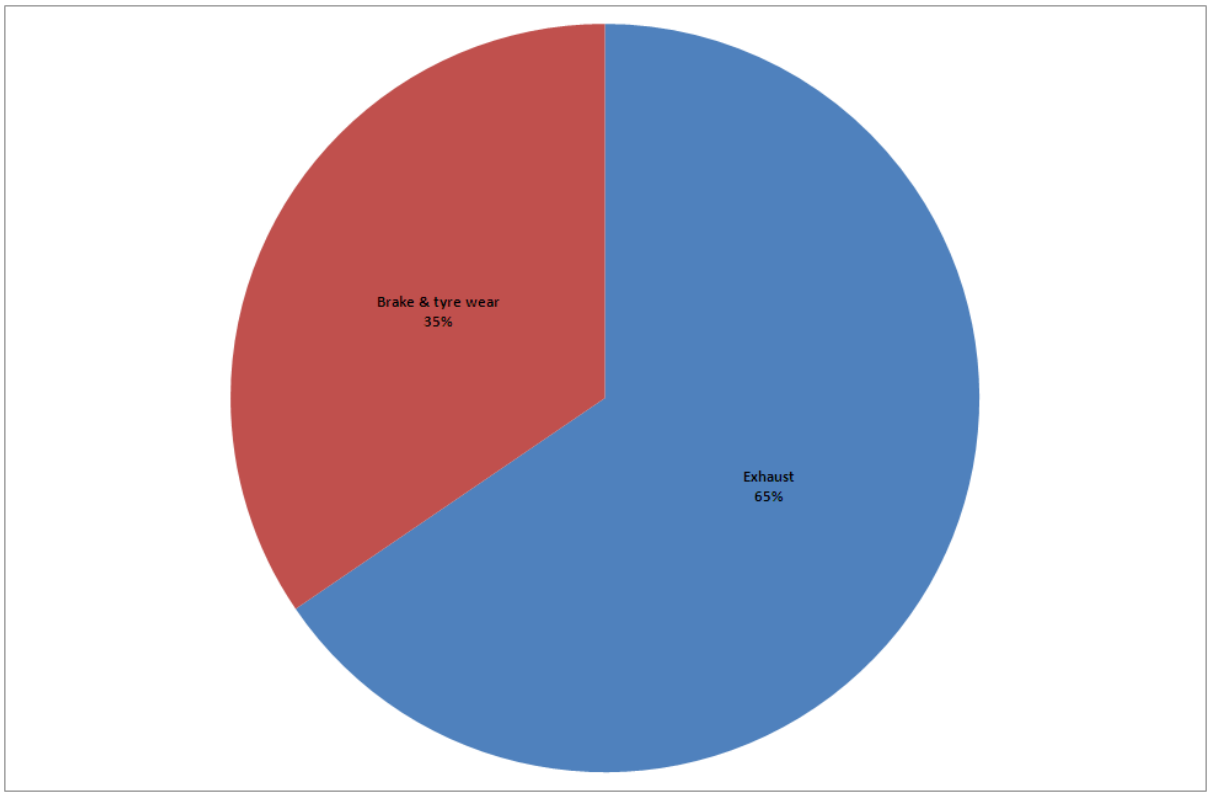

Figure 5.3a: City of London road traffic $PM_{2.5}$ emissions by road source type, 2011

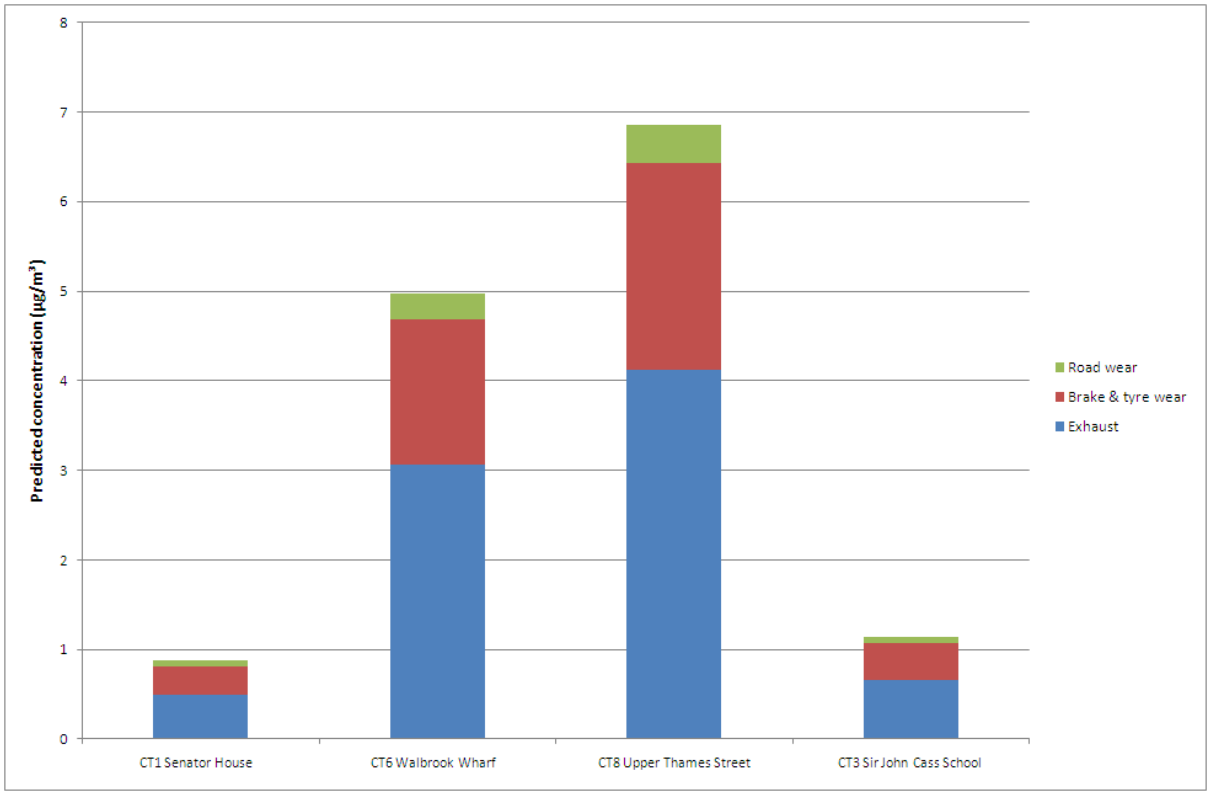

Figure 5.3b: $PM_{2.5}$ source apportionment by road source type, 2011

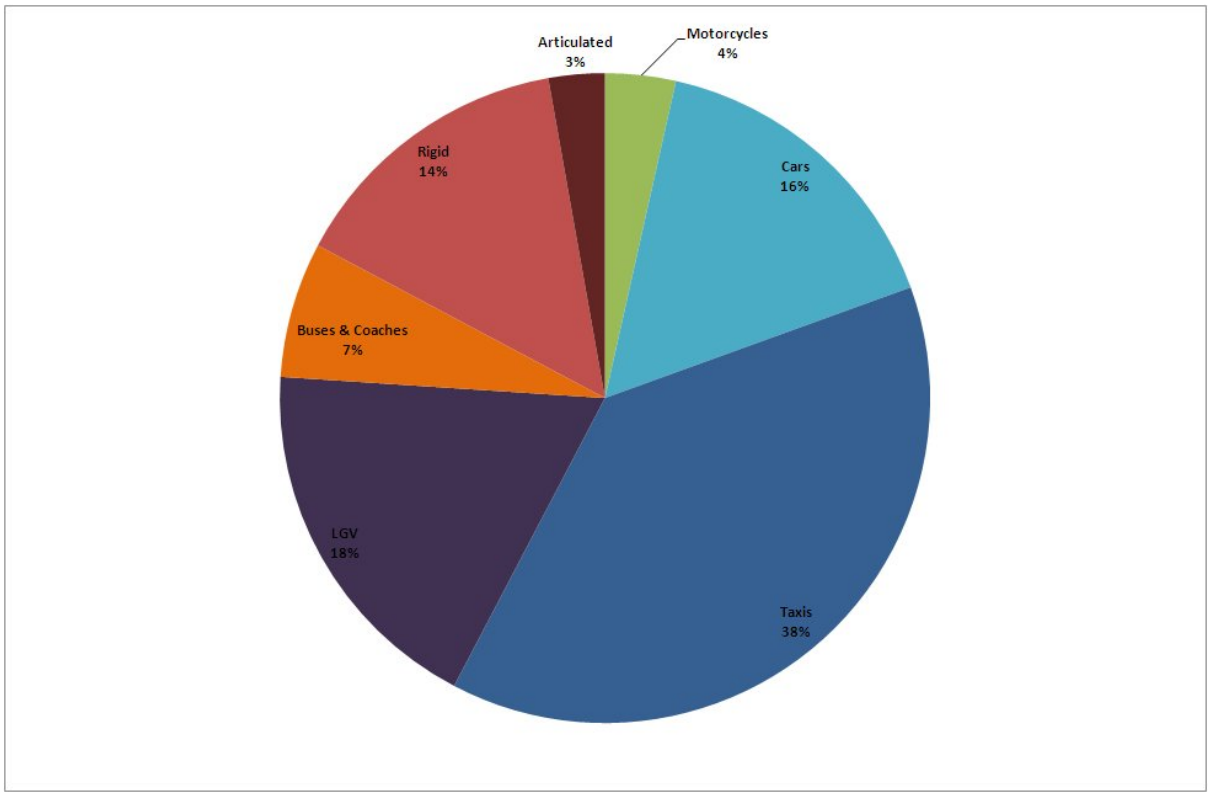

Figure 5.4a: City of London road traffic exhaust $PM_{2.5}$ emissions by vehicle type, 2011

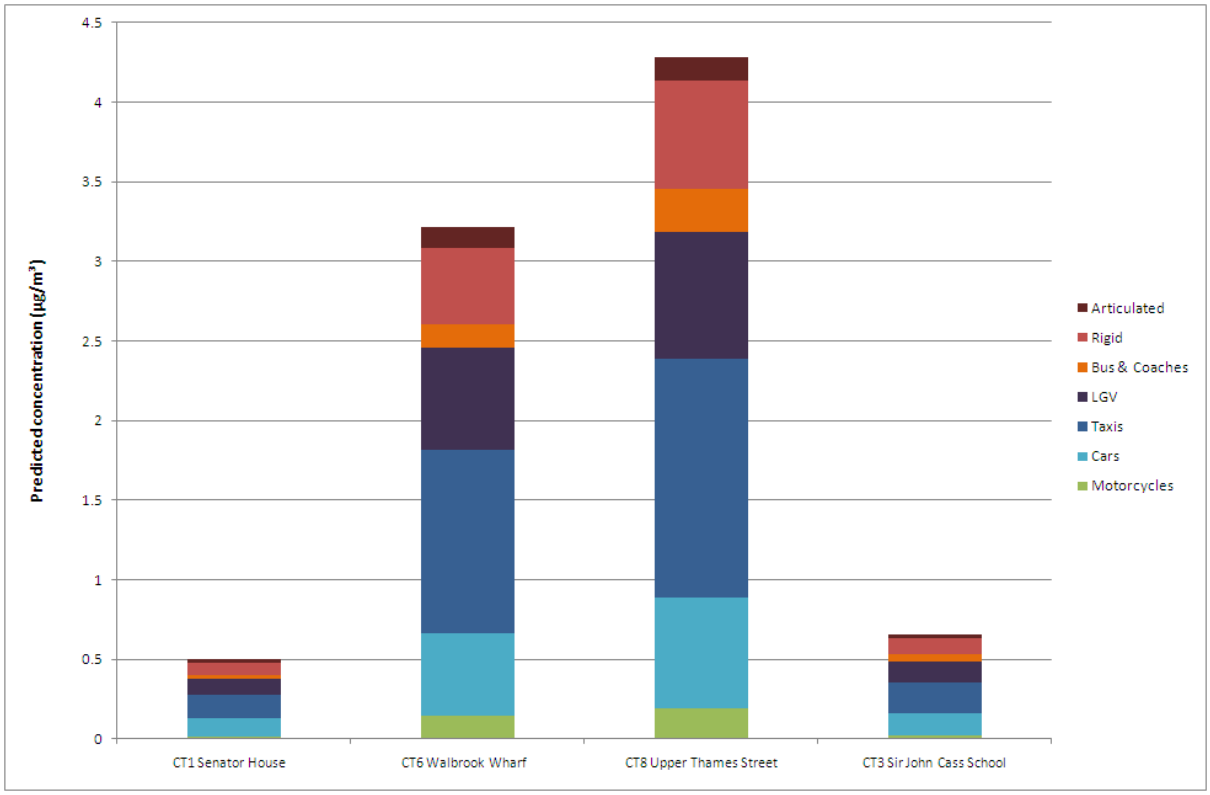

Figure 5.4b: $PM_{2.5}$ source apportionment of vehicle exhaust emissions, 2011

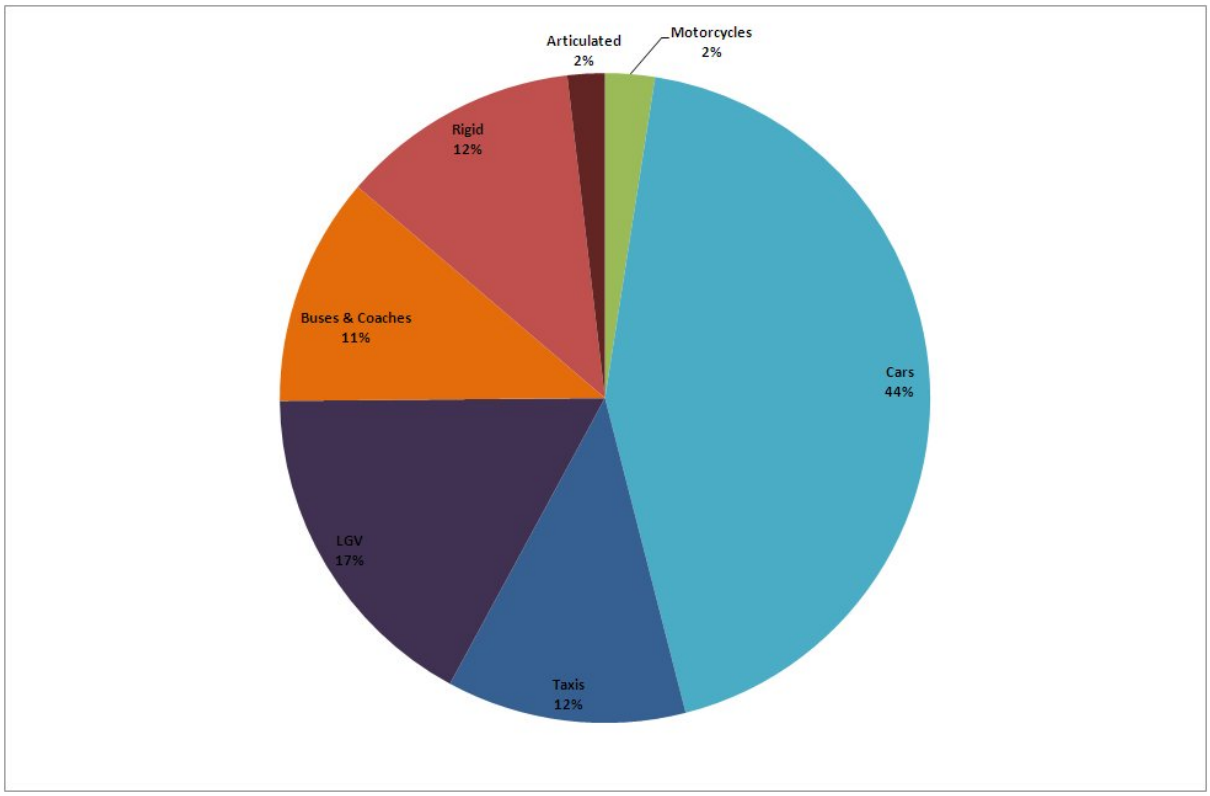

Figure 5.5a: City of London brake and tyre wear $PM_{2.5}$ emissions by vehicle type, 2011

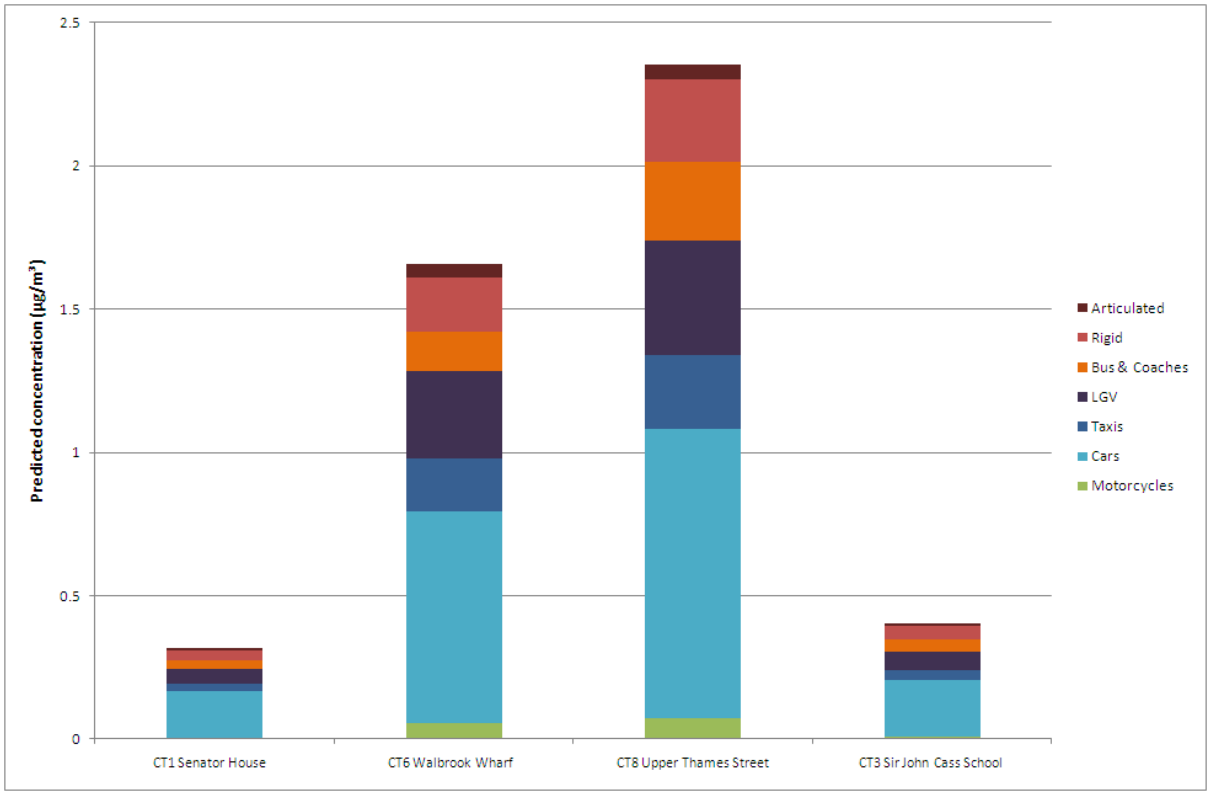

Figure 5.5b: $PM_{2.5}$ source apportionment of brake and tyre wear emissions, 2011

Type of source apportionment	Source group	CT1 Senator House	CT6 Walbrook Wharf	CT8 Upper Thames Street	CT3 Sir John Cass School
Location	City of London	0.5	4.8	6.7	1.1
	Rest of Central London	0.3	0.3	0.2	0.2
	Rest of LAEI	0.8	0.8	0.8	0.9
	Background	8.9	8.9	8.9	8.9
Source type	Major Roads	0.9	4.9	6.8	1.1
	Minor Roads	0.2	0.2	0.2	0.2
	Domestic Gas	0.1	0.2	0.2	0.2
	Commercial Gas	0.1	0.1	0.1	0.1
	Other	0.4	0.5	0.5	0.5
Road source type	Exhaust	0.5	3.1	4.1	0.7
	Brake & tyre wear	0.3	1.6	2.3	0.4
	Road wear	0.1	0.3	0.4	0.1
Exhaust emissions	Motorcycles	<0.1	0.1	0.2	<0.1
	Cars	0.1	0.5	0.7	0.1
	Taxis	0.1	1.2	1.5	0.2
	LGV	0.1	0.6	0.8	0.1
	Bus & Coaches	<0.1	0.1	0.3	<0.1
	Rigid	0.1	0.5	0.7	0.1
	Articulated	<0.1	0.1	0.1	<0.1
Brake & tyre emissions	Motorcycles	<0.1	0.1	0.1	<0.1
	Cars	0.2	0.7	1.0	0.2
	Taxis	<0.1	0.2	0.3	<0.1
	LGV	0.1	0.3	0.4	0.1
	Bus & Coaches	0.0	0.1	0.3	<0.1
	Rigid	<0.1	0.2	0.3	<0.1
	Articulated	<0.1	<0.1	0.1	<0.1

Table 5.1: Summary of $PM_{2.5}$ source apportionment, 2011

5.2. $PM_{2.5}$ source apportionment for the year 2015

Figure 5.6a shows the contribution of the $PM_{2.5}$ emissions generated within the City of London, the rest of Central London, as defined in the LAEI, and the rest of the LAEI area, for the year 2015. Figure 5.6b shows the impact of these sources at the receptor locations in the City of London.

Figure 5.7a shows the contribution of each major source group to the total $PM_{2.5}$ emissions within the City of London, for the year 2015. The contribution of these sources to the total $PM_{2.5}$ concentrations at the set of receptor locations is shown in Figure 5.7b. Note that the road traffic contribution is made up of exhaust and brake and tyre wear and road wear components.

Figure 5.8a shows the contribution of exhaust and brake and tyre wear $PM_{2.5}$ emissions within the City of London, for the year 2015. The contribution of these sources and of road wear to the total $PM_{2.5}$ concentrations at the set of receptor locations is shown in Figure 5.8b.

Figure 5.9a shows the contribution of each vehicle type to the total road traffic exhaust $PM_{2.5}$ emissions within the City of London, for the year 2015. The contribution of these vehicle types to the total $PM_{2.5}$ concentrations at the set of receptor locations is shown in Figure 5.9b.

Figure 5.10a shows the contribution of each vehicle type to the total brake and tyre wear $PM_{2.5}$ emissions within the City of London. The contribution of these vehicle types to the total $PM_{2.5}$ concentrations at the set of receptor locations is shown in Figure 5.10b.

Source apportionment of $PM_{2.5}$ concentrations at the set of receptor locations, for the year 2015, is summarised in Table 5.2.

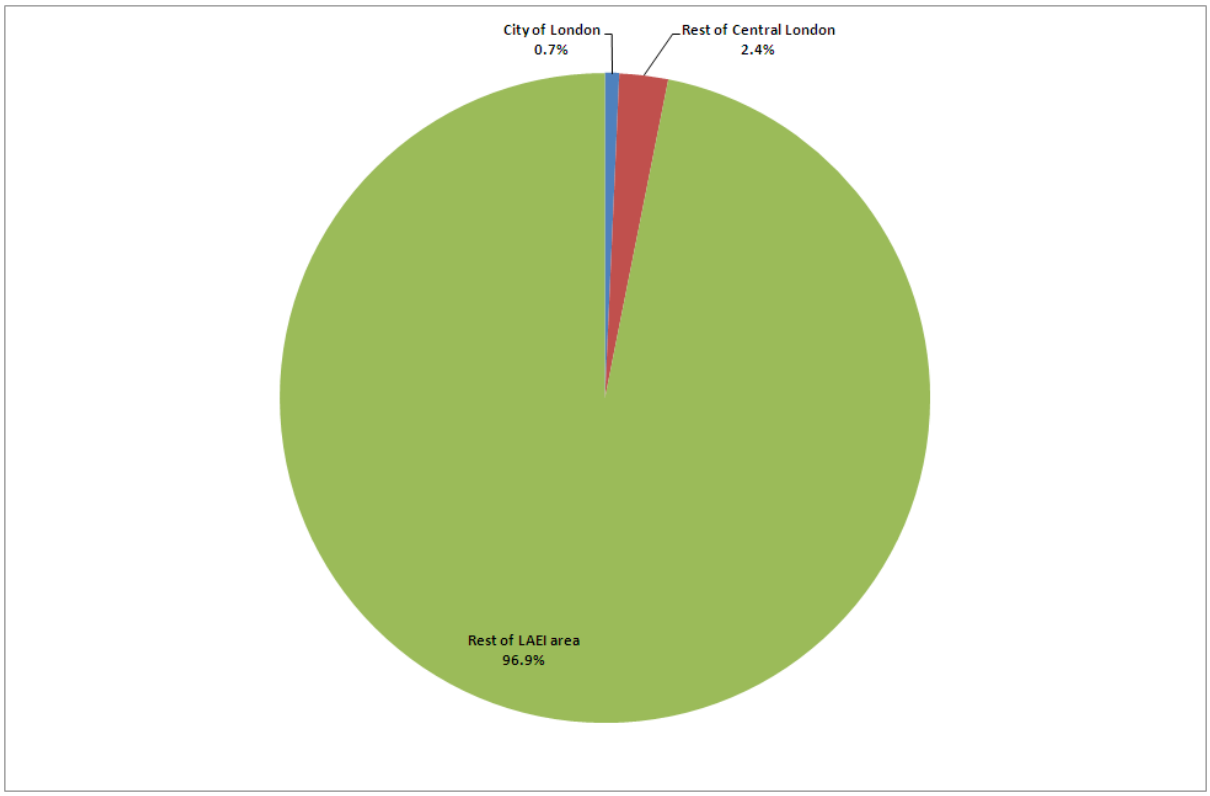

Figure 5.6a: $PM_{2.5}$ emissions by location, 2015

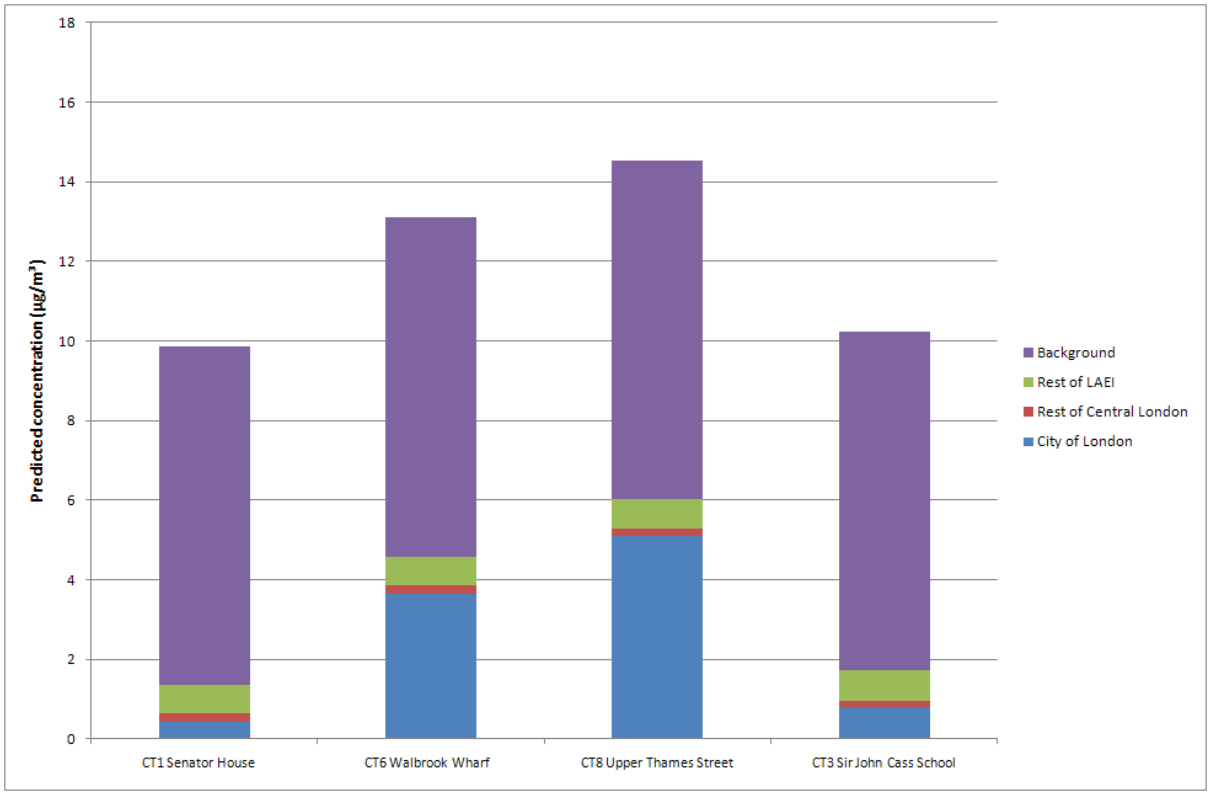

Figure 5.6b: $PM_{2.5}$ source apportionment by location, 2015

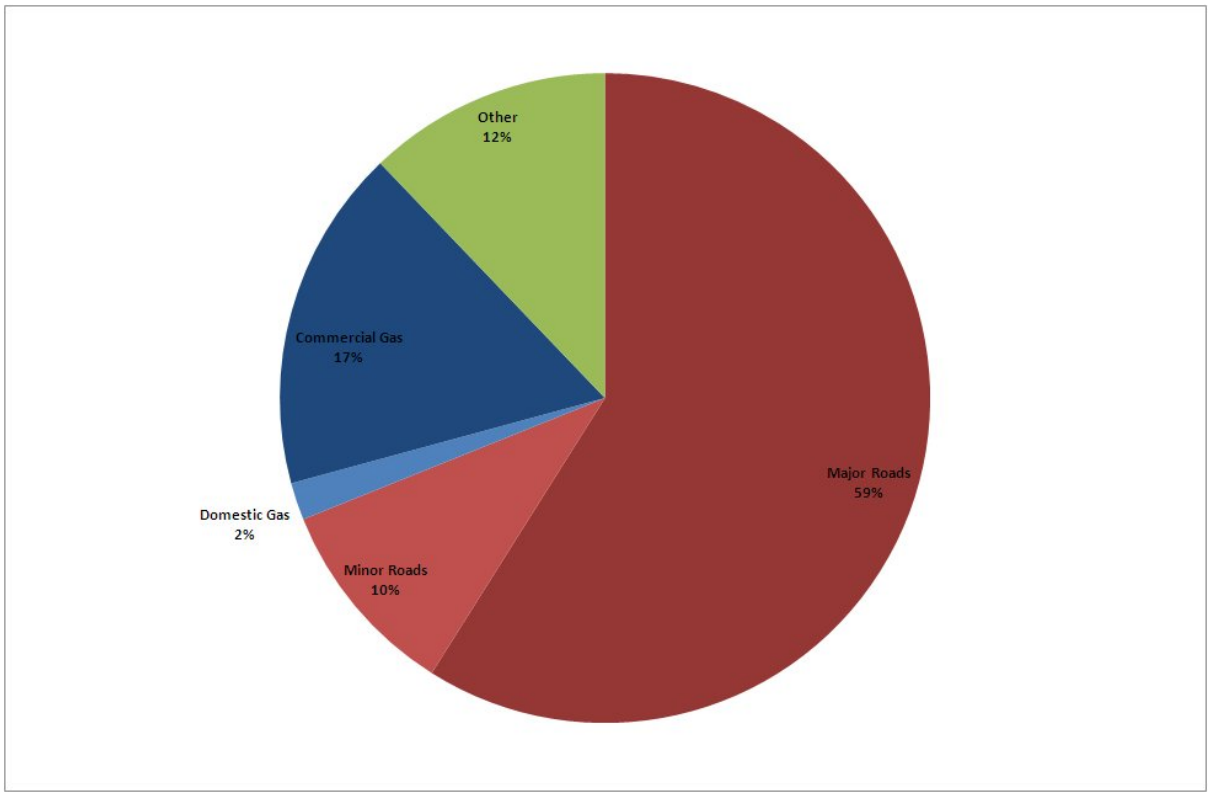

Figure 5.7a: City of London $PM_{2.5}$ emissions by source type, 2015

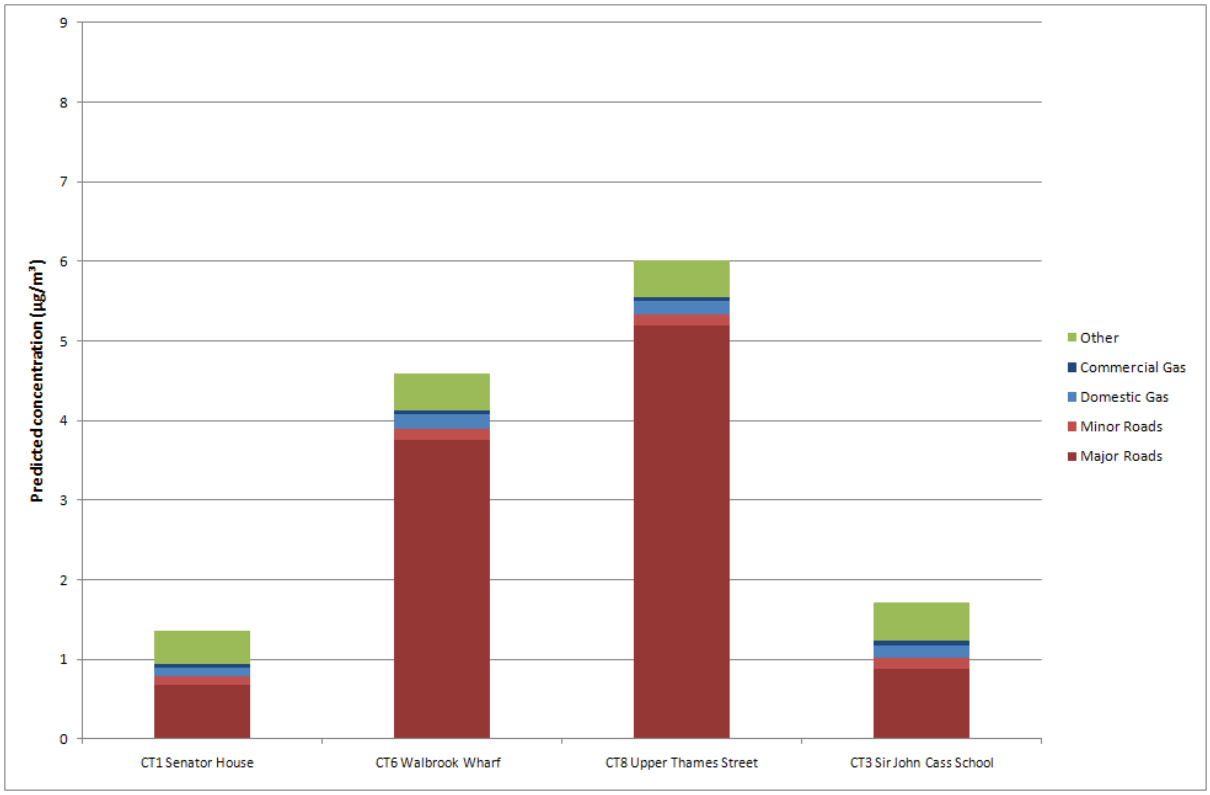

Figure 5.7b: $PM_{2.5}$ source apportionment by source type, 2015

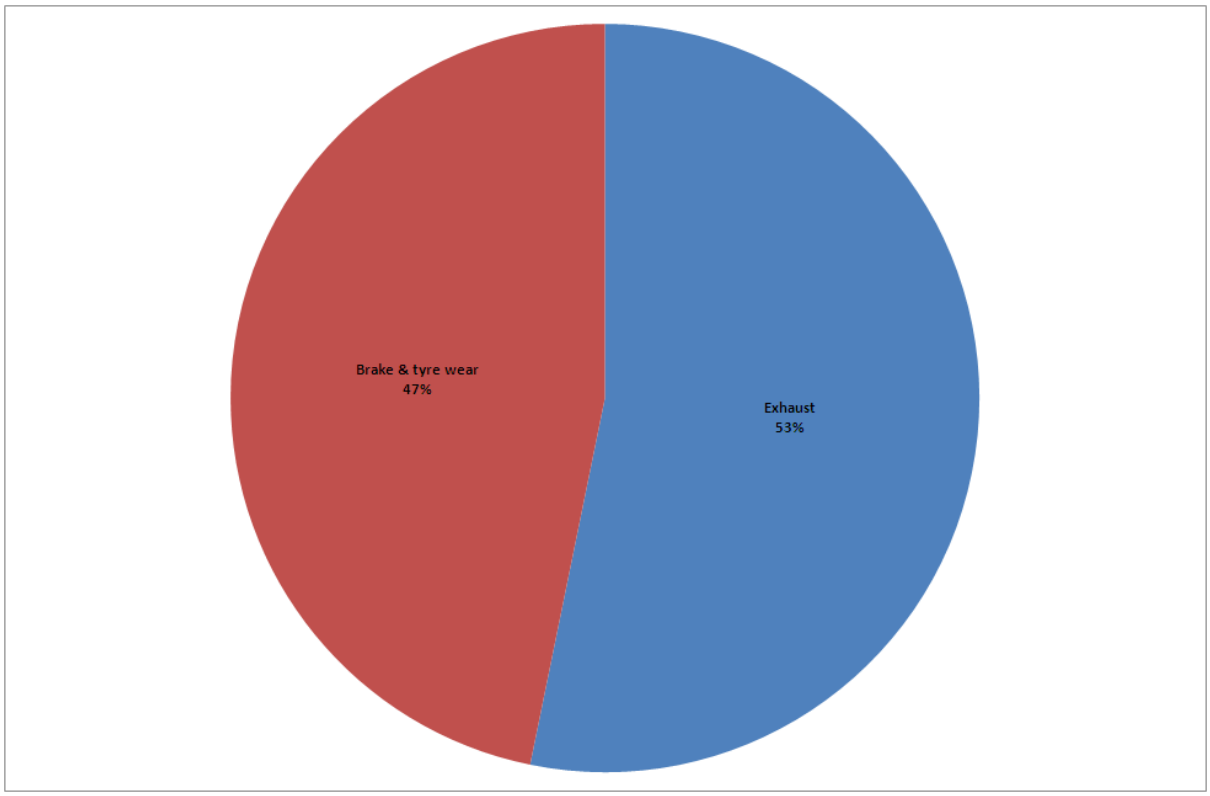

Figure 5.8a: City of London road traffic $PM_{2.5}$ emissions by road source type, 2015

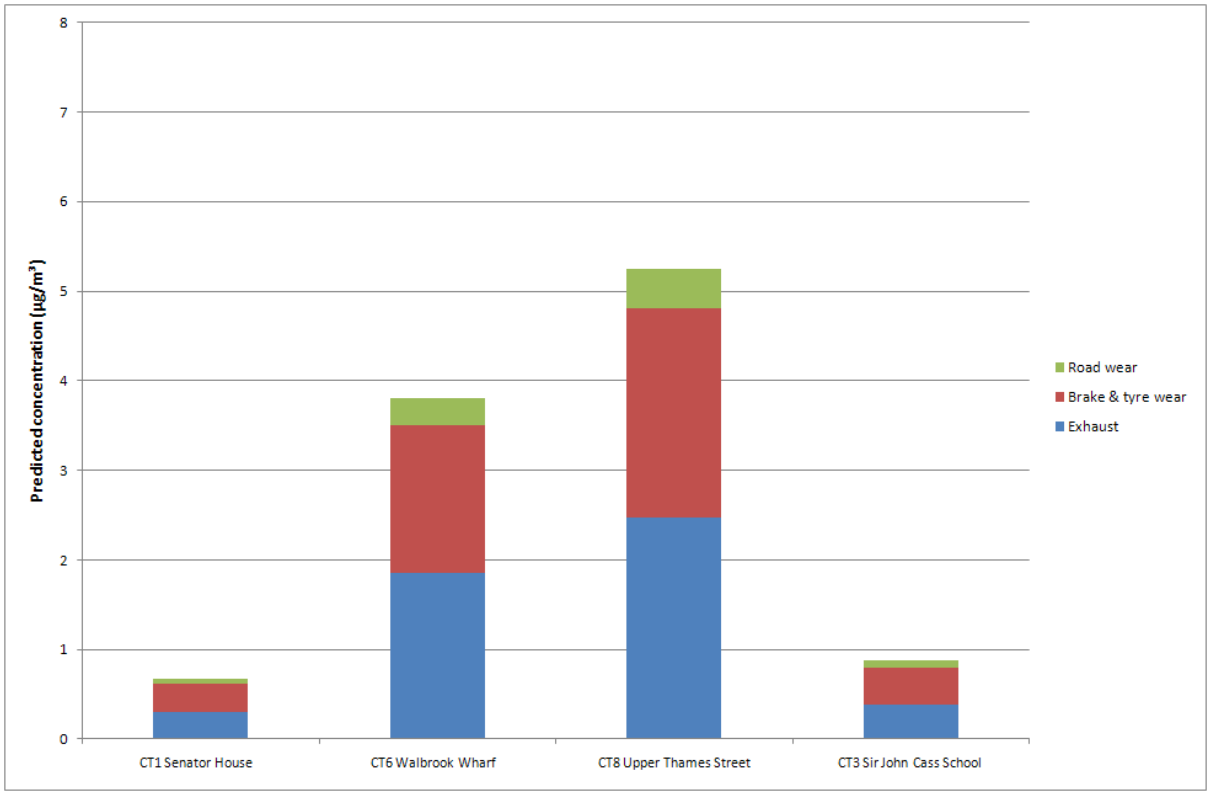

Figure 5.8b: $PM_{2.5}$ source apportionment by road source type, 2015

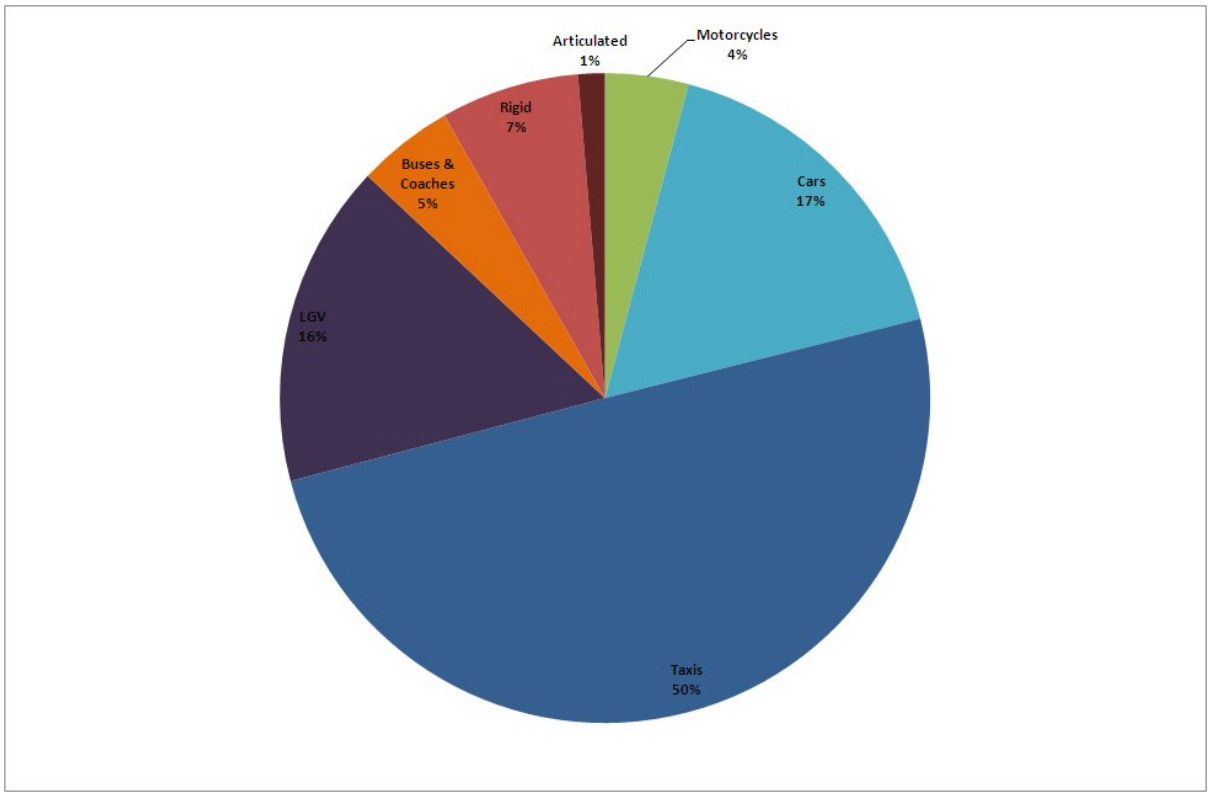

Figure 5.9a: City of London road traffic exhaust $PM_{2.5}$ emissions by vehicle type, 2015

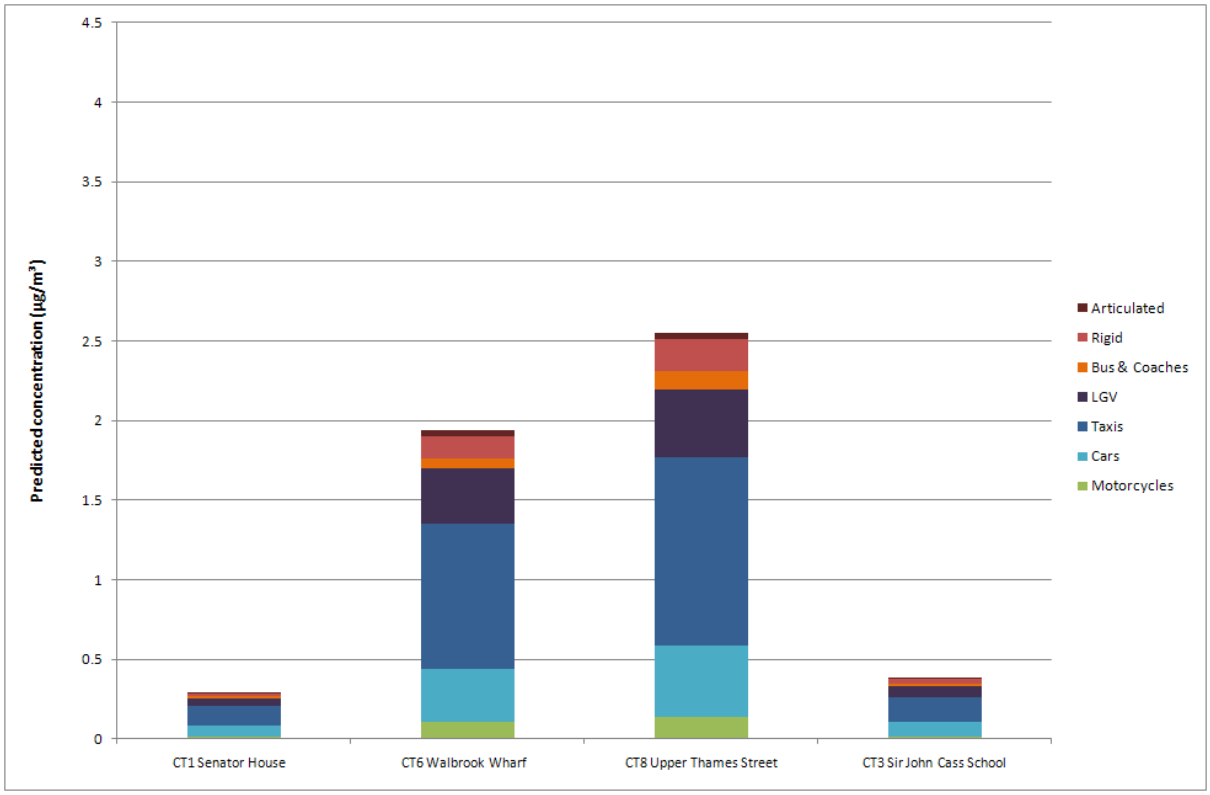

Figure 5.9b: $PM_{2.5}$ source apportionment of vehicle exhaust emissions. 2015

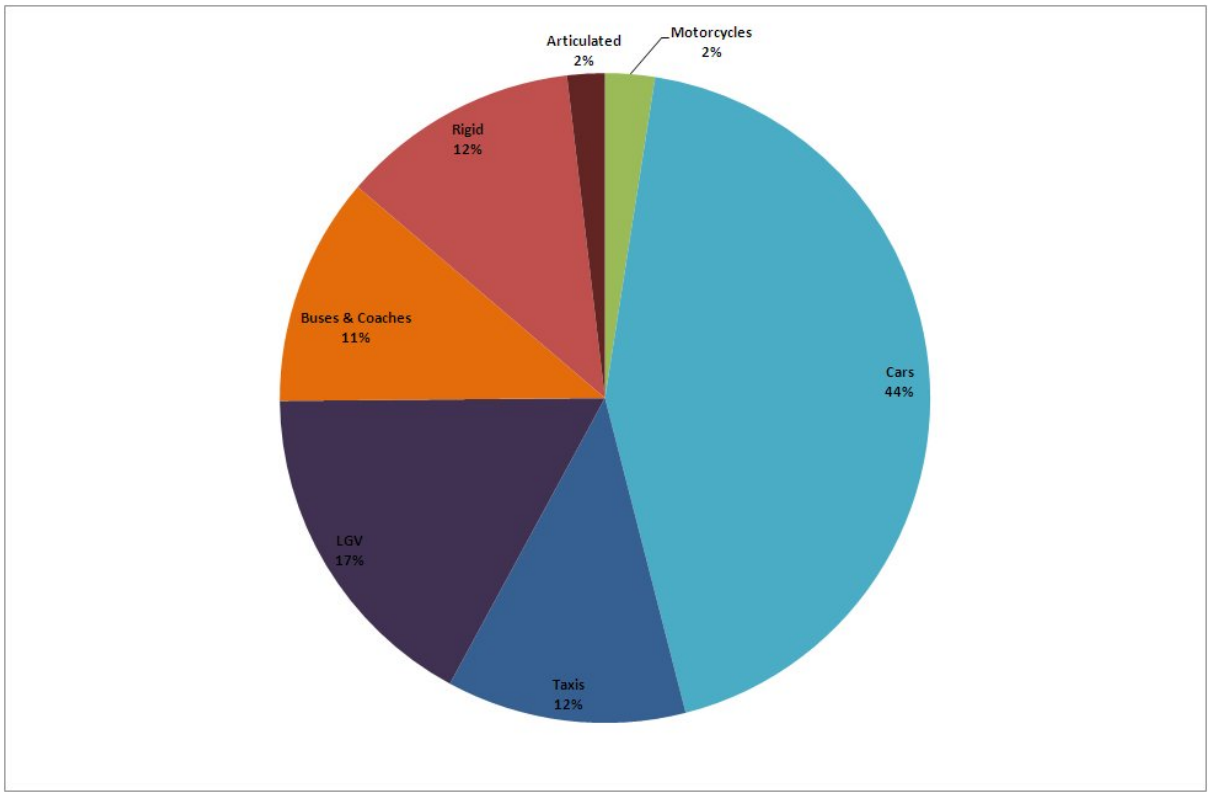

Figure 5.10a: City of London brake and tyre wear $PM_{2.5}$ emissions by vehicle type, 2015

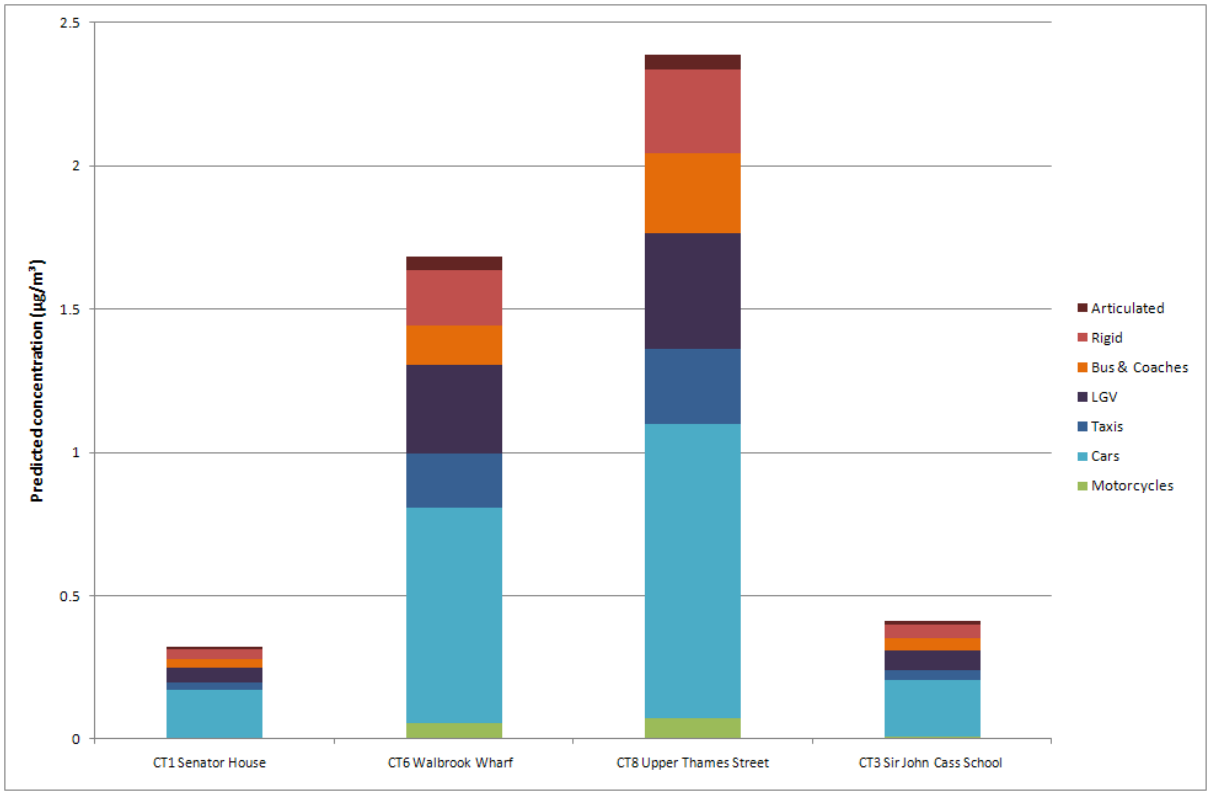

Figure 5.10b: $PM_{2.5}$ source apportionment of brake and tyre wear emissions, 2015

Type of source apportionment	Source group	CT1 Senator House	CT6 Walbrook Wharf	CT8 Upper Thames Street	CT3 Sir John Cass School
Location	City of London	0.4	3.7	5.1	0.8
	Rest of Central London	0.2	0.2	0.2	0.1
	Rest of LAEI	0.7	0.7	0.7	0.8
	Background	8.5	8.5	8.5	8.5
Source type	Major Roads	0.7	3.8	5.2	0.9
	Minor Roads	0.1	0.1	0.1	0.1
	Domestic Gas	0.1	0.2	0.2	0.2
	Commercial Gas	<0.1	0.1	0.1	0.1
	Other	0.4	0.5	0.5	0.5
Road source type	Exhaust	0.3	1.9	2.5	0.4
	Brake & tyre wear	0.3	1.6	2.3	0.4
	Road wear	0.1	0.3	0.4	0.1
Exhaust emissions	Motorcycles	<0.1	0.1	0.1	<0.1
	Cars	0.1	0.3	0.4	0.1
	Taxis	0.1	0.9	1.2	0.2
	LGV	0.1	0.3	0.4	0.1
	Bus & Coaches	<0.1	0.1	0.1	<0.1
	Rigid	<0.1	0.1	0.2	<0.1
	Articulated	<0.1	<0.1	<0.1	<0.1
Brake & tyre emissions	Motorcycles	<0.1	0.1	0.1	<0.1
	Cars	0.2	0.8	1.0	0.2
	Taxis	<0.1	0.2	0.3	<0.1
	LGV	0.1	0.3	0.4	0.1
	Bus & Coaches	<0.1	0.1	0.3	<0.1
	Rigid	<0.1	0.2	0.3	<0.1
	Articulated	<0.1	<0.1	0.1	<0.1

Table 5.2: Summary of $PM_{2.5}$ source apportionment, 2015

6. Discussion

Source apportionment modelling has been carried out for the City of London Corporation using ADMS-Urban (version 2.3.3.1) air quality modelling software. The study was carried out using projected emissions of NO_x, PM_{10} and $PM_{2.5}$ for the years 2011 and 2015 from the London Atmospheric Emissions Inventory (LAEI) 2008.

Emissions from sources within the City of London represent 0.9% of the total NO_x emissions in the LAEI area for both 2011 and 2015. The percentage contribution of sources within the City of London, to total NO_x concentrations at receptor locations, ranges from 30% at the urban background location, CT1 Senator House, to 85% at the roadside location, CT8 Upper Thames Street.

Major roads account for the majority of the NO_x emissions from within the City of London, accounting for 64% and 65% of emissions for the years 2011 and 2015 respectively. Major roads are also predicted to be the major contributor to NO_x concentrations at all receptor locations. At the roadside receptor location, CT8 Upper Thames Street, major roads account for 91% and 90% of the predicted NO_x concentrations for 2011 and 2015 respectively.

The largest contributors to NO_x emissions from major roads within the City of London are buses and coaches, as well as taxis, for both 2011 and 2015. Buses and coaches account for 28% and 25% of the NO_x emissions for the years 2011 and 2015 respectively. Taxis account for 21% and 24% of the NO_x emissions for the years 2011 and 2015 respectively. There are also significant contributions from cars, LGVs and rigid HGVs for both years. Predicted NO_x concentrations at receptor locations show significant contributions from all vehicle types except motorcycles and articulated HGVs. The percentage of NO_x emitted as NO_2, known as primary NO_2, is high for cars, taxis and LGVs, compared to other vehicle types for both years. The percentage contribution of these vehicles to NO_2 concentrations is therefore expected to be greater than the percentage contribution predicted for NO_x concentrations.

Emissions from sources within the City of London represent 0.8% and 0.7% of the total PM_{10} emissions in the LAEI area for the years 2011 and 2015, respectively. Background concentrations, which represent the contribution from outside the LAEI area, make up the greater proportion of the predicted PM_{10} concentrations at all receptor locations, accounting for approximately 60% of the total predicted concentrations at roadside locations and approximately 90% of the total predicted concentration at urban background locations, for both years.

Major roads account for the majority of the PM_{10} emissions from within the City of London, accounting for 65% and 66% of emissions for the years 2011 and 2015 respectively. Major roads are also the largest contributor to predicted PM_{10} concentrations at receptor locations from sources within the LAEI area, for both years. Major roads account for approximately 65% and 90% of the predicted PM_{10} concentrations at urban background and roadside locations respectively.

Exhaust emissions account for 51% and 38% of PM_{10} emissions from major roads within the City of London for the years 2011 and 2015 respectively. Predicted PM_{10} concentrations at receptor locations include the contribution from road wear and resuspension. Exhaust emissions contribute approximately 35% and 25% of the predicted PM_{10} concentrations from major roads for the years 2011 and 2015 respectively. Non-exhaust sources are therefore the largest contributor for both years.

Emissions from taxis are the largest contributor to exhaust PM_{10} emissions within the City of London, accounting for 38% and 50% of emissions for the years 2011 and 2015 respectively. Taxis are also the major contributor to predicted PM_{10} concentrations from exhaust emissions at receptor locations, accounting for up to 36% and up to 47% of the predicted concentrations for 2011 and 2015 respectively.

Emissions from cars are the largest contributor to brake and tyre wear PM_{10} emissions within the City of London, accounting for 43% of emissions for both years. Cars are also the major contributor to predicted PM_{10} concentrations from brake & tyre emissions at receptor locations, accounting for up to 50% of the predicted concentrations for both years.

Emissions from sources within the City of London represent 0.7% and 0.8% of the total $PM_{2.5}$ emissions in the LAEI area for the years 2011 and 2015 respectively. Background concentrations, which represent the contribution from outside the LAEI area, make up the greater proportion of the predicted $PM_{2.5}$ concentrations at all receptor locations, accounting for more than 50% of the total predicted concentrations at roadside locations and more than 80% of the total predicted concentration at urban background locations, for both years.

Major roads account for the majority of the $PM_{2.5}$ emissions from within the City of London, accounting for 60% and 59% of emissions for the years 2011 and 2015 respectively. Major roads are also the largest contributor to predicted $PM_{2.5}$ concentrations at receptor locations from sources within the LAEI area, for both years. Major roads account for more than 50% and more than 80% of the predicted $PM_{2.5}$ concentrations at urban background and roadside locations respectively.

Exhaust emissions account for 65% and 53% of $PM_{2.5}$ emissions from major roads within the City of London, for the years 2011 and 2015 respectively. Predicted $PM_{2.5}$ concentrations at receptor locations include the contribution from road wear. Exhaust emissions contribute approximately 60% and 45% of the predicted $PM_{2.5}$ concentrations from major roads for the years 2011 and 2015 respectively.

Taxis are the largest contributor to exhaust $PM_{2.5}$ emissions within the City of London, accounting for 38% and 50% of emissions for the years 2011 and 2015 respectively. Taxis are also the major contributor to predicted $PM_{2.5}$ concentrations from exhaust emissions at receptor locations, accounting for up to 36% and up to 47% of the predicted concentrations for 2011 and 2015 respectively.

Cars are the largest contributor to brake and tyre wear $PM_{2.5}$ emissions within the City of London, accounting for 43% and 44% of emissions for the years 2011 and 2015 respectively. Cars are also the major contributor to predicted $PM_{2.5}$ concentrations from brake & tyre emissions at receptor locations, accounting for up to 51% of the predicted concentrations for both years.