Cambridge Environmental Research Consultants

Detailed air quality modelling and source apportionment

Guildford Borough Council

Final report

Prepared for
Surrey Local Authorities

19th November 2019

CERC

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1	04/04/19	Draft report
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4	19/11/19	Final report with changes to Table 3.1

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1 Air quality contour plots

A detailed contour plot of annual mean NO_2 concentrations in Guildford for the year 2017 is presented in Figure 1.1.

Figure 1.2 presents a contour plot of the modelled annual mean PM_{10} concentrations across Guildford for 2017.

Figure 1.3 presents a contour plot of the modelled annual mean $PM_{2.5}$ concentrations across Guildford for 2017.

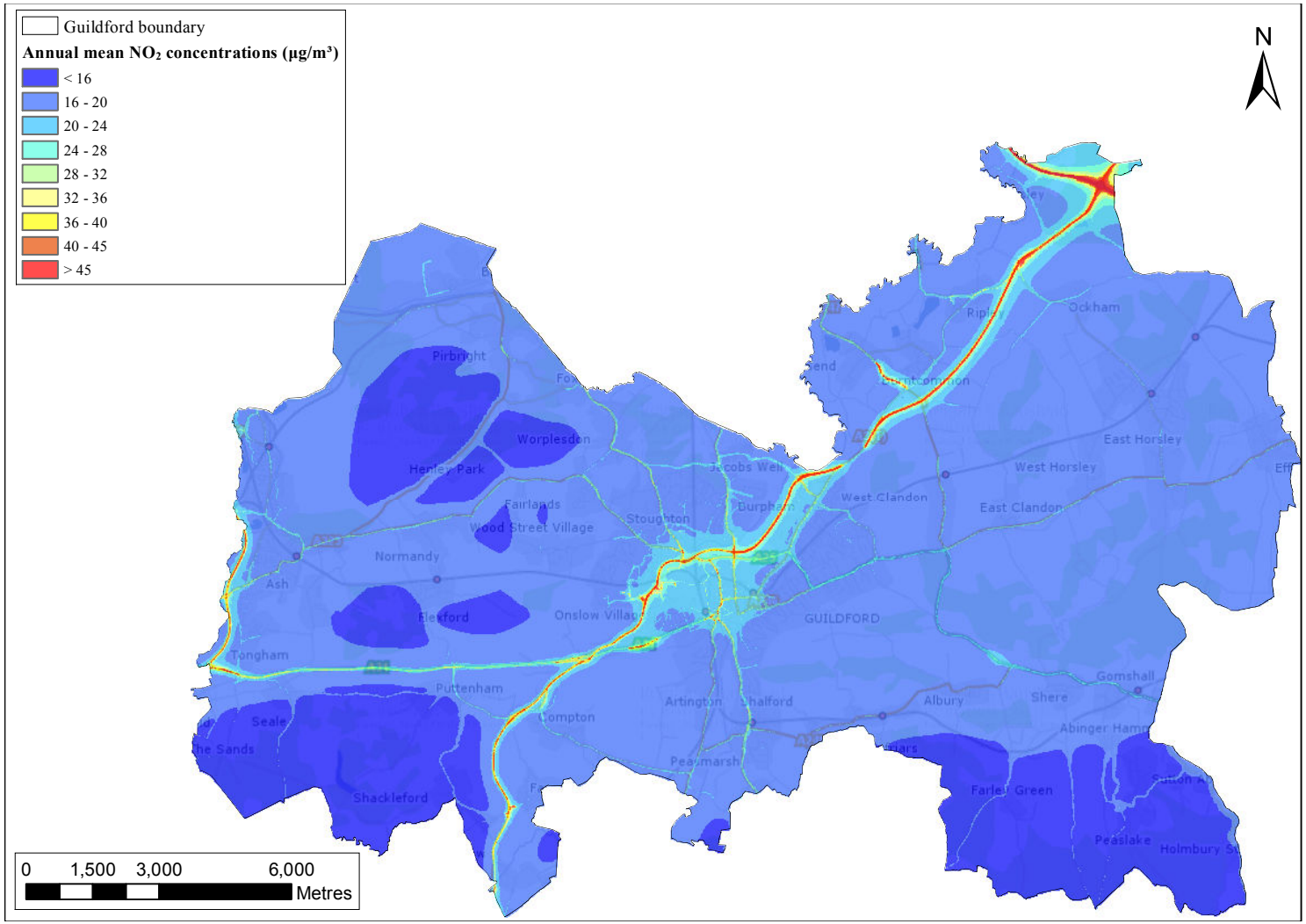

Figure 1.1: Annual mean NO_2 concentrations for Guildford, 2017 (µg/m³)

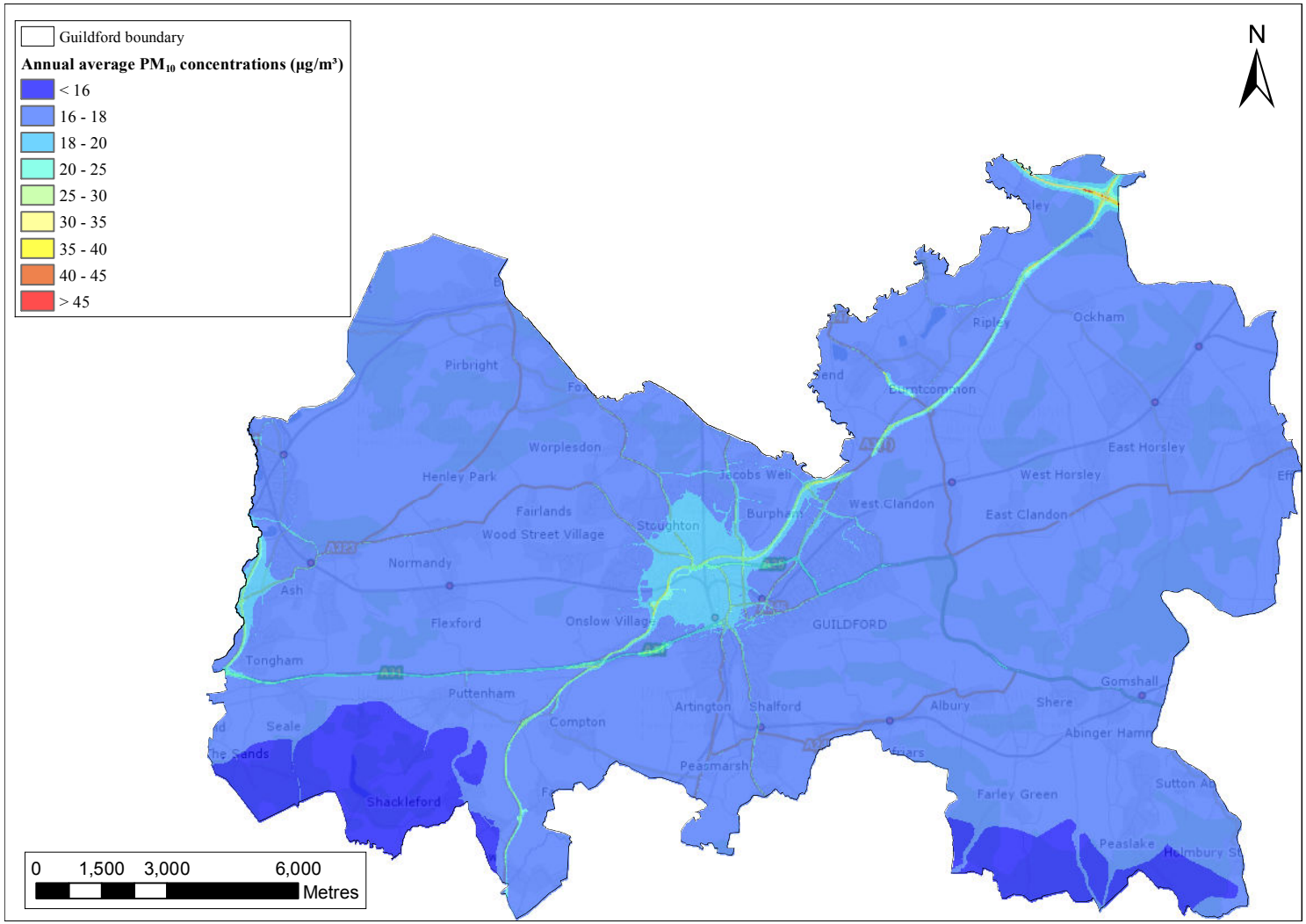

Figure 1.2: Annual mean PM_{10} concentrations for Guildford, 2017 (µg/m³)

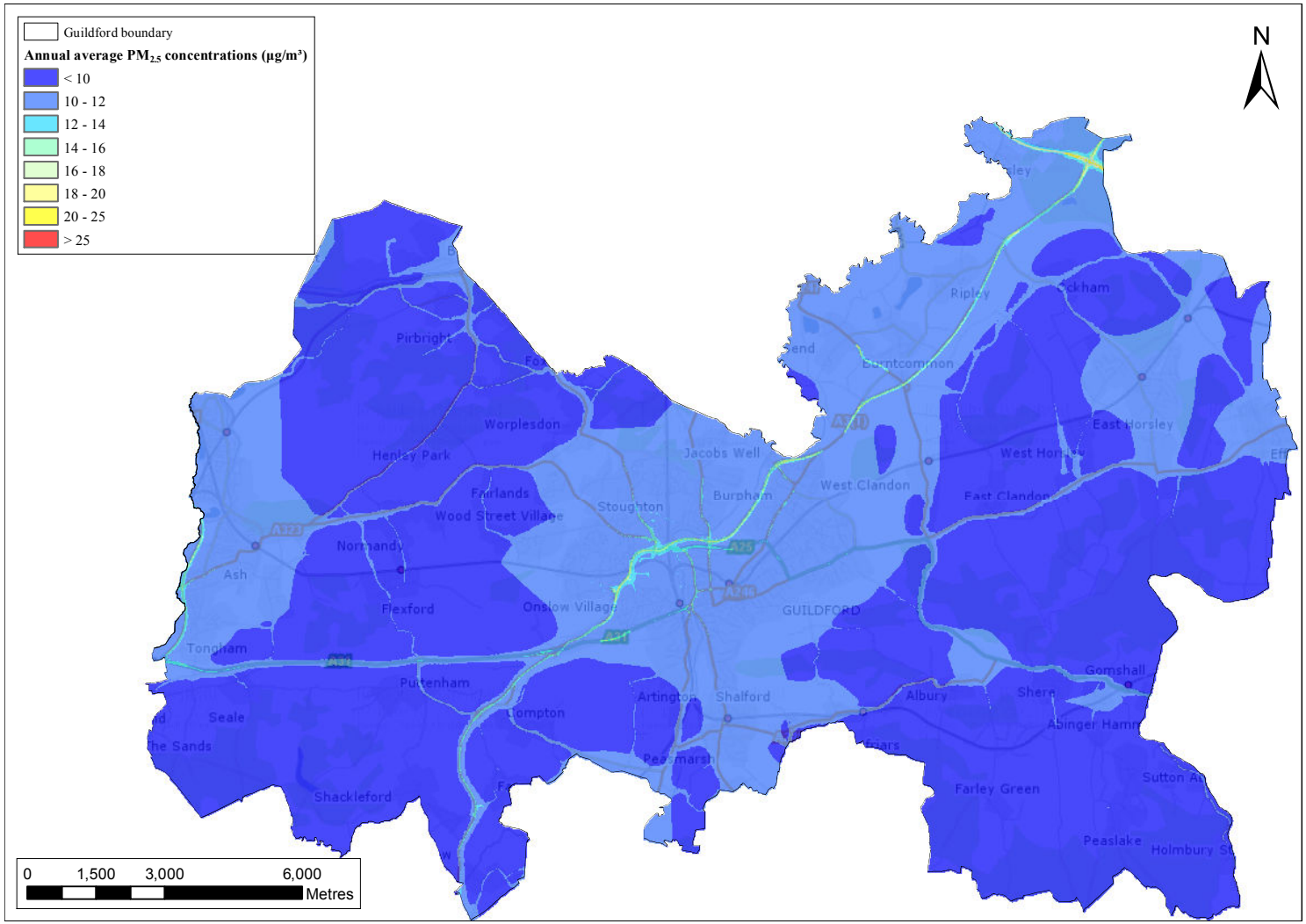

Figure 1.3: Annual mean $PM_{2.5}$ concentrations for Guildford, 2017 (µg/m³)

2 Source apportionment

An overview of NO_x, PM_{10} and $PM_{2.5}$ source apportionment for Guildford is presented in this section. The pollutants of interest are split into group type, vehicle category and non-exhaust concentrations for particulate matter. The source apportionment locations are detailed in Table 2.1

Figure 2.1 presents the average NO_x concentrations found within Guildford, for each group type. Road traffic sources are further split by vehicle category in Figure 2.2. Finally, a summary of NO_x source apportionment can be found in Table 2.2.

Figure 2.3 presents the average PM_{10} concentrations found within Guildford, for each group type. Road traffic sources are further split by vehicle category in Figure 2.4. The majority of road traffic PM_{10} concentrations consist of non-exhaust concentrations, which are illustrated in Figure 2.5. Finally, a summary of PM_{10} source apportionment can be found in Table 2.3.

Figure 2.6 presents the average $PM_{2.5}$ concentrations found within Guildford, for each group type. Road traffic sources are further split by vehicle category in Figure 2.7. The majority of road traffic $PM_{2.5}$ concentrations consist of non-exhaust concentrations, which are illustrated in Figure 2.8. Finally, a summary of $PM_{2.5}$ source apportionment can be found in Table 2.4.

Table 2.1: Source apportionment receptor locations throughout Guildford

Receptor	XY	Address
GBC 1	499313, 149521	YMCA
GBC 2	499761, 149914	Sandfield School
GBC 3	499806, 150792	Stoke road
GBC 4	499628, 152226	Woking Road
GBC 5	498654, 150786	Worplesdon Road/A3
GBC 6	498178, 150677	A3
GBC 7	498114, 151083	Aldershot Road
GBC 8	488350, 150078	A331
GBC 9	489920, 150781	Ash
GBC 10	495438, 147285	Compton
GBC 11	503771, 154642	West Clandon
GBC 12	507525, 158517	A3 Wisley (near conservation Area)
GBC 13	506680, 157812	near disused airfield Wisley
GBC 14	509241, 147642	Abinger Hammer
GBC 15	499968, 147721	Shalford
GBC 16	502375, 153017	Burpham
GBC 17	505194, 156744	Ripley
GBC 18	499106, 149443	Farnham Road
GBC 19	488639, 148864	Tongham
GBC 20	499300, 149201	Portsmouth Road, Guildford

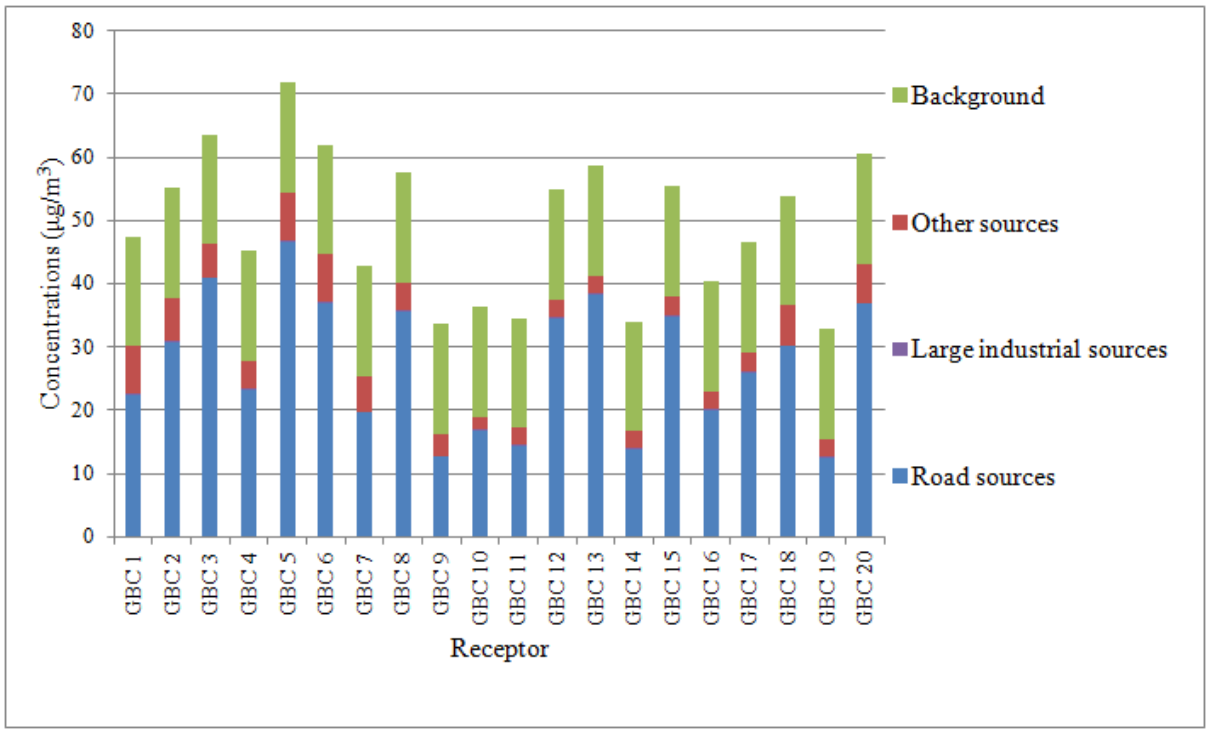

Figure 2.1:NO_x concentrations by major source group, Guildford [1]

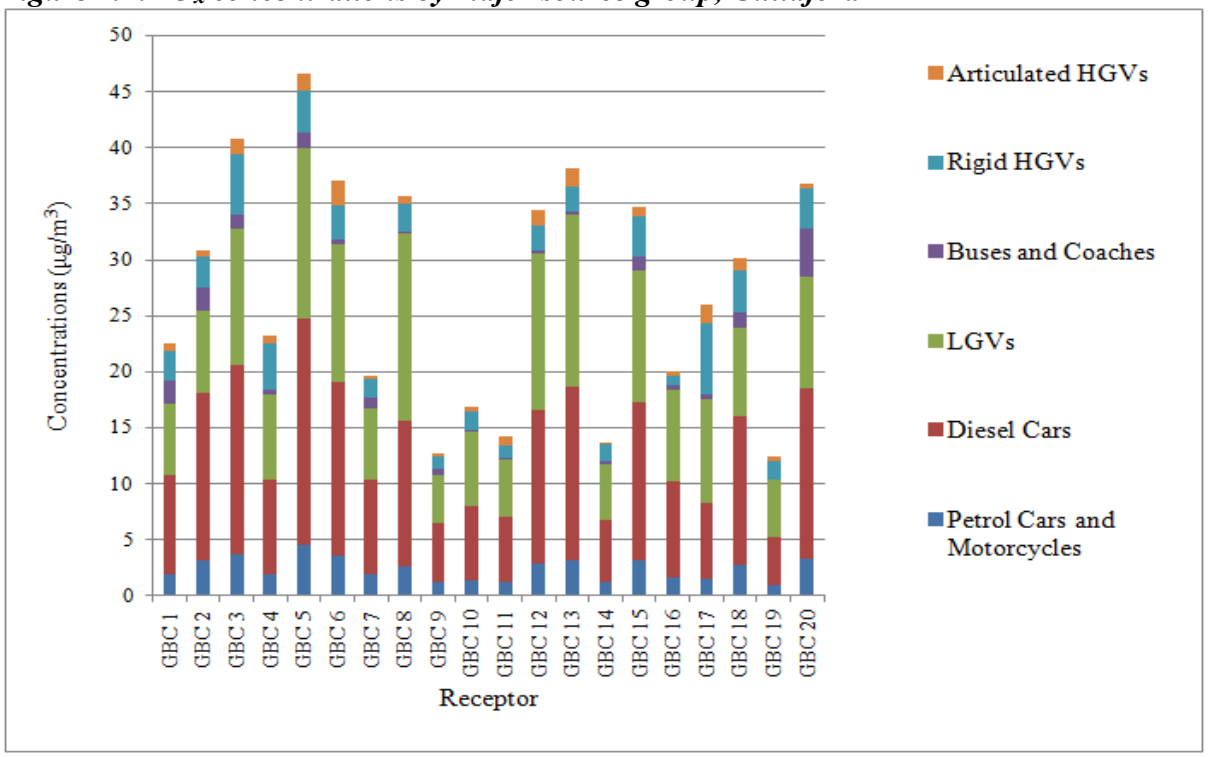

Figure 2.2: Road transport NO_x concentrations by vehicle category, Guildford

[1] Other sources include: (1) combustion in commercial, institution and agricultural sectors, (2) combustion in industry, (3) combustion in energy production and transfer, (4) production processes, (5) extraction and distribution of fossil fuels, (6) solvent use, (7) other transport and machinery, (8) waste treatment and disposal, (8) agricultural, forests and land use change, (10) other sources and sinks.

Table 2.2: Summary of NO_x concentration source apportionment, Guildford

NO_x (µg/m³)	Type of source apportionment									
	Source type				Vehicle type					
Receptor	Road sources	Other sources	Background	Large industrial sources	Petrol Cars & Motorcycles	Diesel Cars	LGVs	Buses & Coaches	Rigid HGVs	Articulated HGVs
GBC 1	22.5	7.4	17.4	0.2	1.9	8.9	6.4	2.1	2.6	0.7
GBC 2	30.8	6.8	17.4	0.2	3.2	15.0	7.3	2.2	2.8	0.5
GBC 3	40.8	5.2	17.4	0.2	3.7	16.9	12.2	1.2	5.4	1.4
GBC 4	23.3	4.3	17.4	0.2	1.9	8.5	7.6	0.4	4.1	0.8
GBC 5	46.6	7.6	17.4	0.2	4.6	20.2	15.2	1.4	3.7	1.6
GBC 6	37.0	7.5	17.4	0.2	3.5	15.6	12.3	0.5	3.0	2.2
GBC 7	19.6	5.5	17.4	0.2	1.9	8.5	6.3	1.0	1.6	0.3
GBC 8	35.6	4.4	17.4	0.2	2.6	13.1	16.7	0.2	2.5	0.6
GBC 9	12.7	3.4	17.4	0.2	1.2	5.3	4.3	0.6	1.1	0.3
GBC 10	16.9	2.0	17.4	0.2	1.4	6.6	6.6	0.2	1.5	0.5
GBC 11	14.2	2.7	17.4	0.2	1.3	5.8	5.0	0.2	1.1	0.8
GBC 12	34.4	2.8	17.4	0.3	2.9	13.7	14.0	0.3	2.2	1.3
GBC 13	38.2	2.7	17.4	0.3	3.2	15.5	15.3	0.3	2.2	1.7
GBC 14	13.7	2.5	17.4	0.4	1.2	5.6	4.9	0.3	1.5	0.2
GBC 15	34.8	3.1	17.4	0.2	3.1	14.2	11.7	1.3	3.6	0.9
GBC 16	20.0	2.8	17.4	0.2	1.7	8.5	8.2	0.4	0.9	0.4
GBC 17	26.0	2.8	17.4	0.2	1.5	6.8	9.3	0.4	6.3	1.6
GBC 18	30.1	6.3	17.4	0.2	2.8	13.2	7.8	1.4	3.7	1.0
GBC 19	12.4	2.7	17.4	0.3	0.9	4.3	5.2	0.1	1.6	0.4
GBC 20	36.8	6.1	17.4	0.2	3.2	15.3	10.0	4.3	3.5	0.5

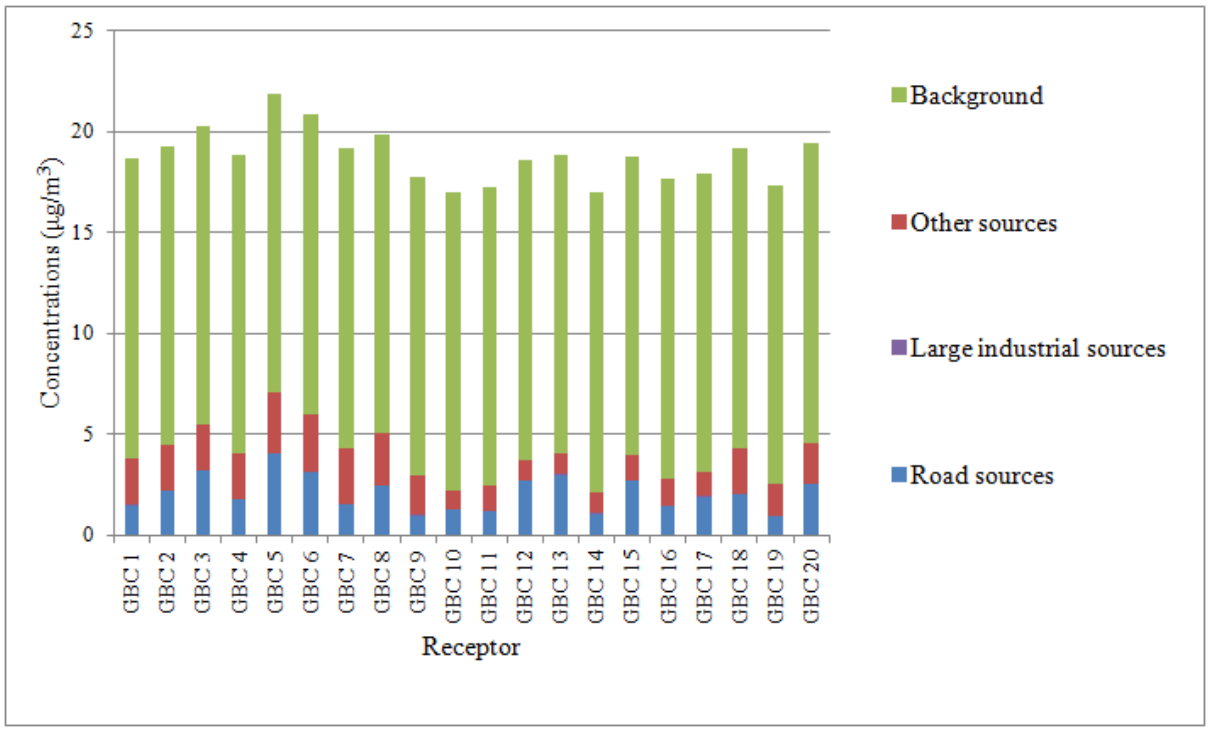

Figure 2.3: PM_{10} concentrations by major source group, Guildford

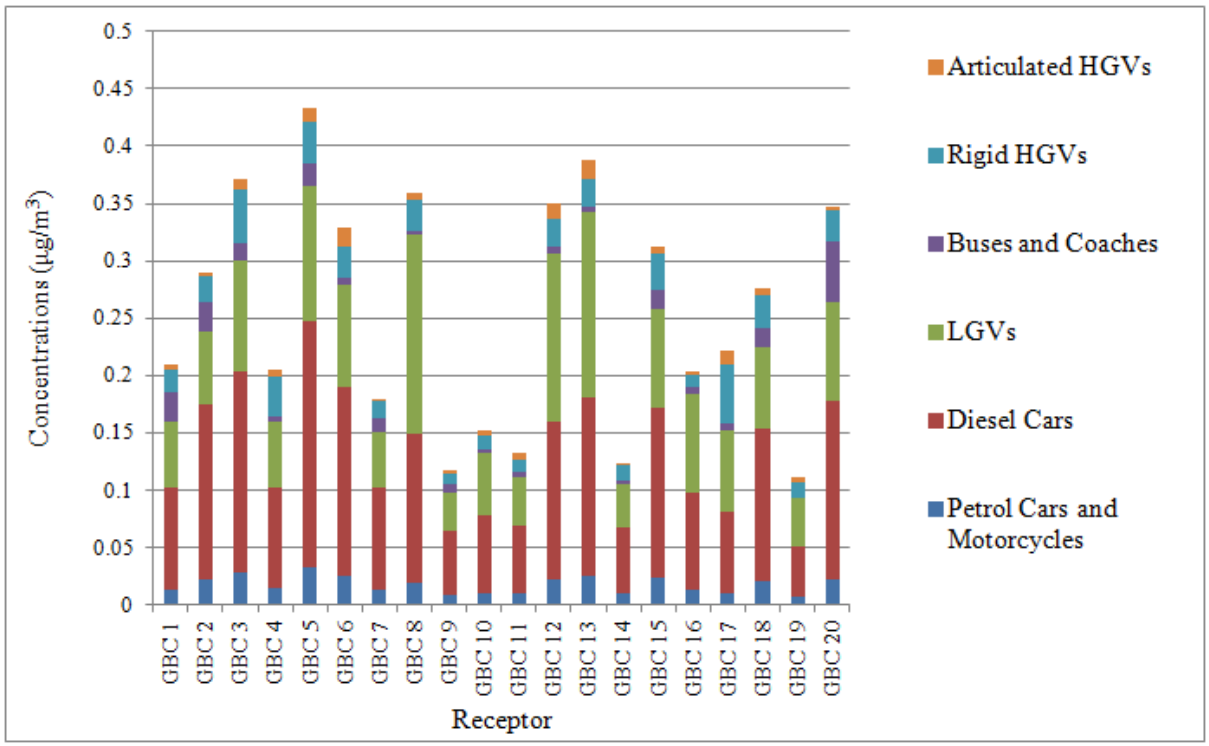

Figure 2.4: Road transport exhaust PM_{10} concentrations by vehicle category, Guildford

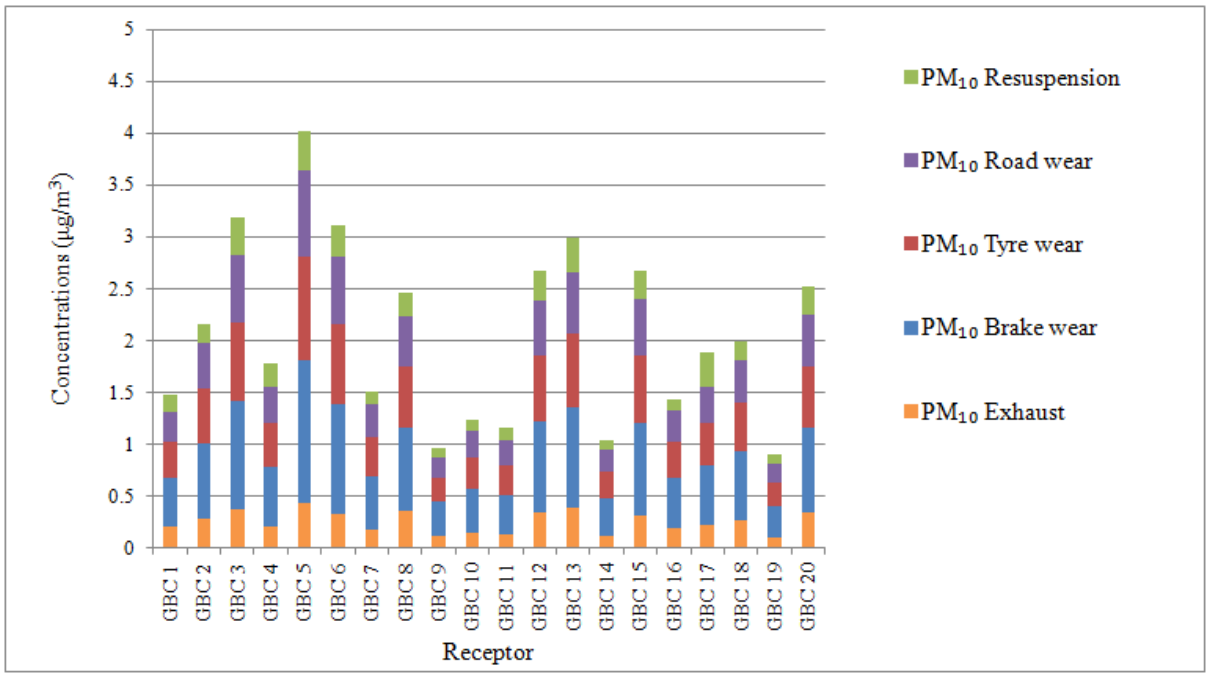

Figure 2.5: Road transport PM_{10} concentrations by exhaust and non-exhaust components, Guildford

Table 2.3: Summary of PM_{10} concentration source apportionment, Guildford

PM_{10} (µg/m³)	Type of source apportionment													
	Source type				Road transport - exhaust by vehicle type						Road transport - non-exhaust			
Receptor	Road sources	Other sources	Background	Large industrial sources	Petrol Cars & Motorcycles	Diesel Cars	LGVs	Buses & Coaches	Rigid HGVs	Articulated HGVs	PM_{10} Brake wear	PM_{10} Tyre wear	PM_{10} Resuspension	PM_{10} Road wear
GBC 1	1.5	2.3	14.8	<0.1	0.01	0.09	0.06	0.03	0.02	<0.01	0.5	0.3	0.2	0.3
GBC 2	2.2	2.3	14.8	<0.1	0.02	0.15	0.06	0.03	0.02	<0.01	0.7	0.5	0.2	0.4
GBC 3	3.2	2.3	14.8	<0.1	0.03	0.17	0.10	0.02	0.05	<0.01	1.1	0.8	0.4	0.6
GBC 4	1.8	2.2	14.8	<0.1	0.01	0.09	0.06	<0.01	0.03	<0.01	0.6	0.4	0.2	0.4
GBC 5	4.0	3.0	14.8	<0.1	0.03	0.21	0.12	0.02	0.03	0.01	1.4	1.0	0.4	0.8
GBC 6	3.1	2.9	14.8	<0.1	0.03	0.16	0.09	<0.01	0.03	0.02	1.1	0.8	0.3	0.6
GBC 7	1.5	2.8	14.8	<0.1	0.01	0.09	0.05	0.01	0.01	<0.01	0.5	0.4	0.1	0.3
GBC 8	2.5	2.6	14.8	<0.1	0.02	0.13	0.17	<0.01	0.03	<0.01	0.8	0.6	0.2	0.5
GBC 9	1.0	1.9	14.8	<0.1	<0.01	0.06	0.03	<0.01	<0.01	<0.01	0.3	0.2	<0.1	0.2
GBC 10	1.2	0.9	14.8	<0.1	<0.01	0.07	0.05	<0.01	0.01	<0.01	0.4	0.3	0.1	0.3
GBC 11	1.2	1.3	14.8	<0.1	<0.01	0.06	0.04	<0.01	0.01	<0.01	0.4	0.3	0.1	0.2
GBC 12	2.7	1.0	14.8	<0.1	0.02	0.14	0.15	<0.01	0.02	0.01	0.9	0.6	0.3	0.5
GBC 13	3.0	1.0	14.8	<0.1	0.02	0.16	0.16	<0.01	0.02	0.02	1.0	0.7	0.3	0.6
GBC 14	1.0	1.1	14.8	<0.1	0.01	0.06	0.04	<0.01	0.01	<0.01	0.4	0.3	<0.1	0.2
GBC 15	2.7	1.3	14.8	<0.1	0.02	0.15	0.09	0.02	0.03	<0.01	0.9	0.6	0.3	0.5
GBC 16	1.4	1.4	14.8	<0.1	0.01	0.08	0.09	<0.01	<0.01	<0.01	0.5	0.3	0.1	0.3
GBC 17	1.9	1.2	14.8	<0.1	0.01	0.07	0.07	<0.01	0.05	0.01	0.6	0.4	0.3	0.4
GBC 18	2.0	2.3	14.8	<0.1	0.02	0.13	0.07	0.02	0.03	<0.01	0.7	0.5	0.2	0.4
GBC 19	0.9	1.6	14.8	<0.1	<0.01	0.04	0.04	<0.01	0.01	<0.01	0.3	0.2	<0.1	0.2
GBC 20	2.5	2.1	14.8	<0.1	0.02	0.16	0.09	0.05	0.03	<0.01	0.8	0.6	0.3	0.5

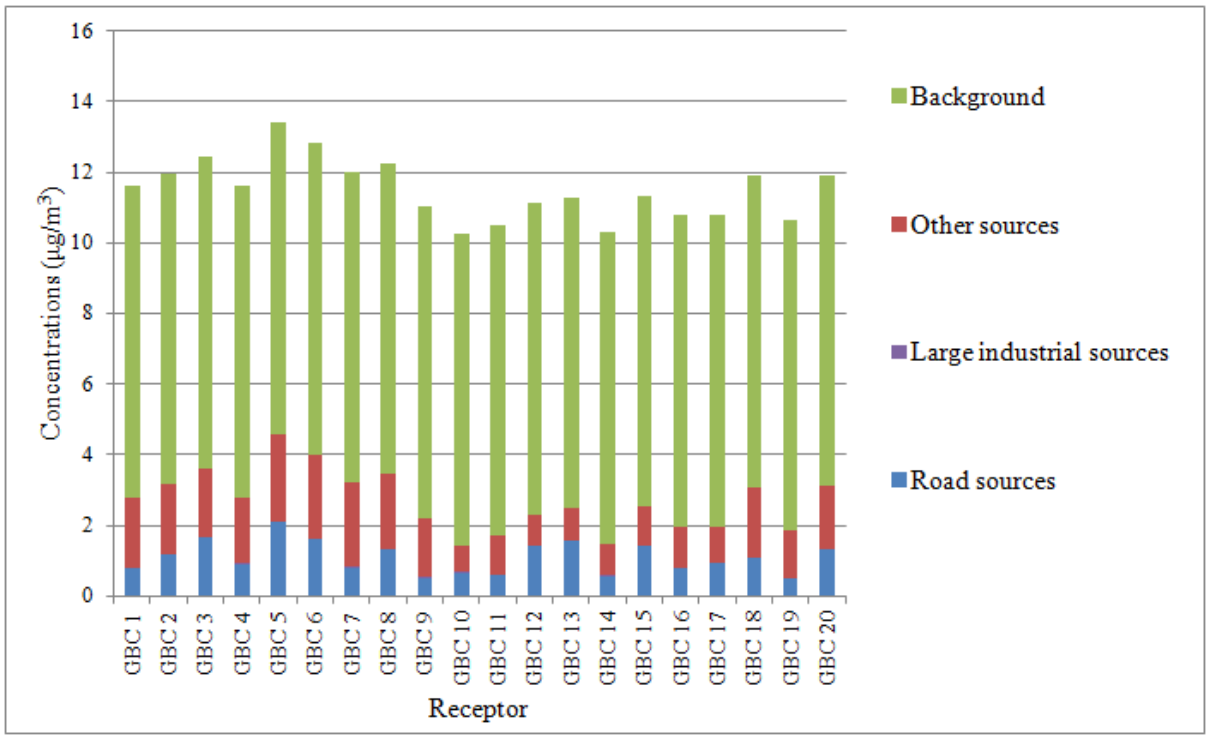

Figure 2.6: $PM_{2.5}$ concentrations by major source group, Guildford

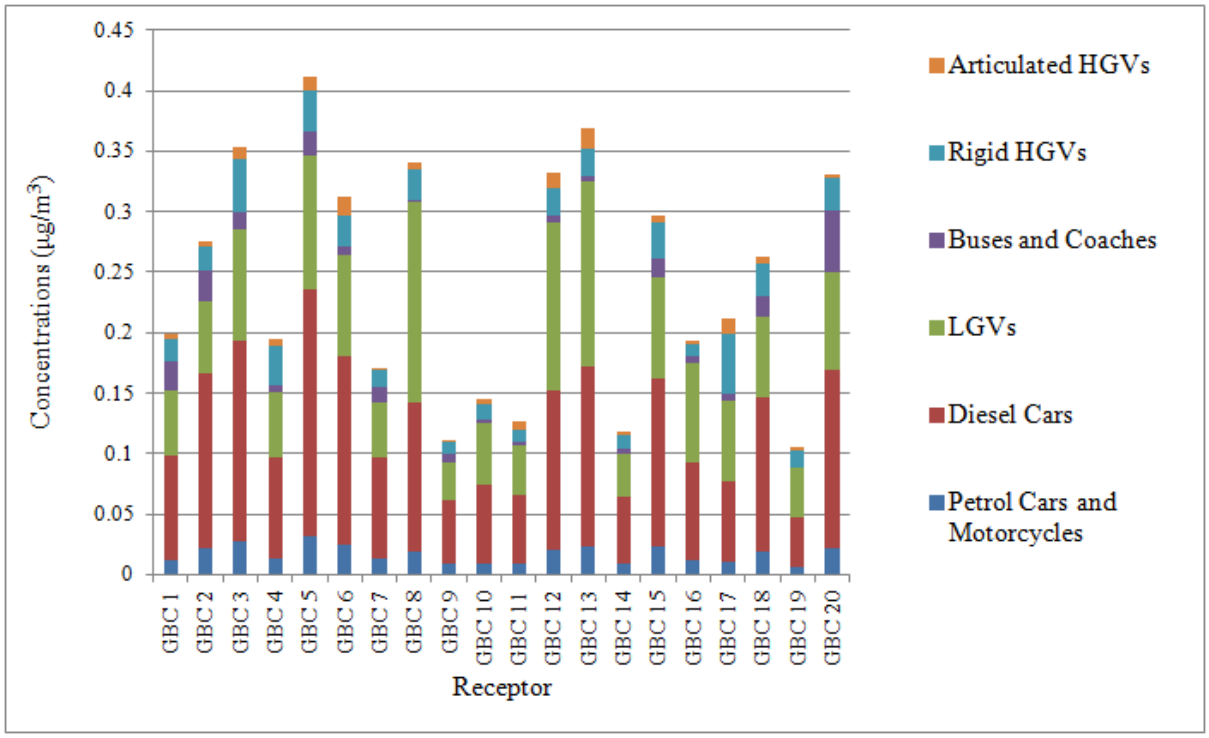

Figure 2.7: Road transport exhaust $PM_{2.5}$ concentrations by vehicle category, Guildford

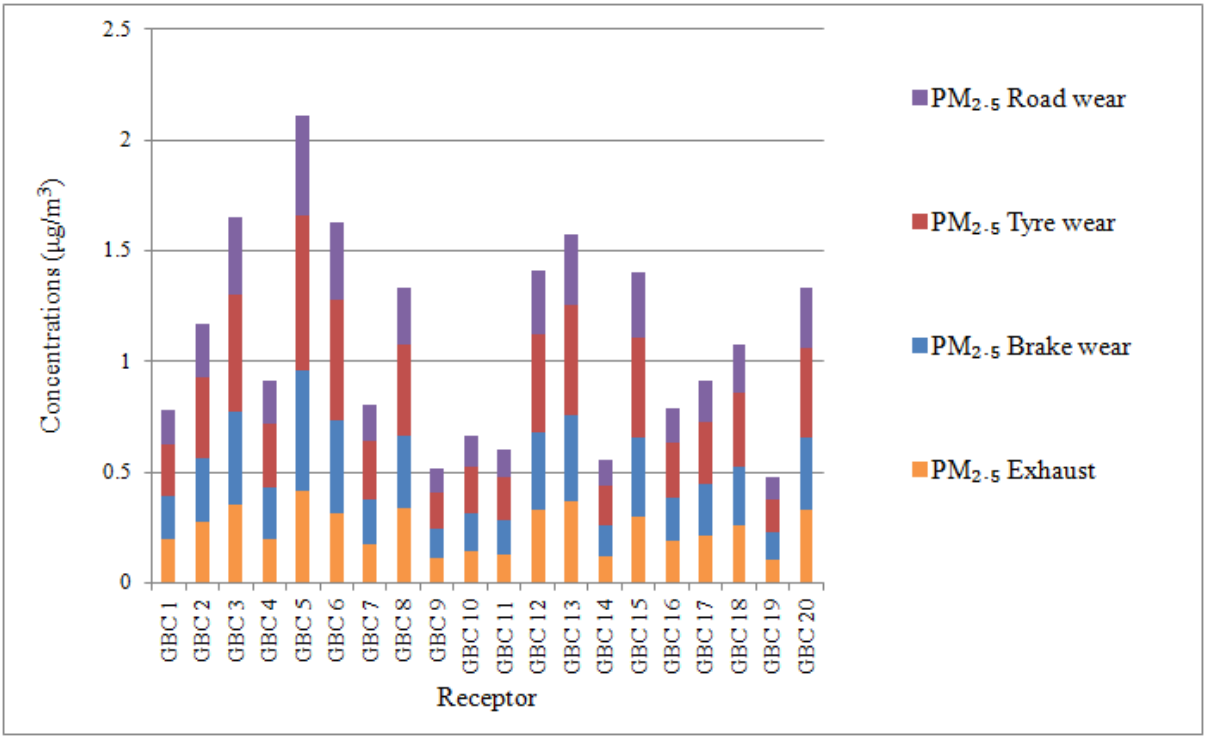

Figure 2.8: Road transport $PM_{2.5}$ concentrations by exhaust and non-exhaust components, Guildford

Table 2.4: Summary of $PM_{2.5}$ concentration source apportionment, Guildford

$PM_{2.5}$ ($\mu g/m^3$)	Type of source apportionment												
	Source type				Road transport - exhaust by vehicle type						Road transport - non-exhaust		
Receptor	Road sources	Other sources	Background	Large industrial sources	Petrol Cars & Motorcycles	Diesel Cars	LGVs	Buses & Coaches	Rigid HGVs	Articulated HGVs	$PM_{2.5}$ Brake wear	$PM_{2.5}$ Tyre wear	$PM_{2.5}$ Road wear
GBC 1	0.8	2.0	8.8	<0.1	0.01	0.09	0.05	0.02	0.02	<0.01	0.2	0.2	0.2
GBC 2	1.2	2.0	8.8	<0.1	0.02	0.14	0.06	0.02	0.02	<0.01	0.3	0.4	0.2
GBC 3	1.7	2.0	8.8	<0.1	0.03	0.17	0.09	0.01	0.04	<0.01	0.4	0.5	0.3
GBC 4	0.9	1.9	8.8	<0.1	0.01	0.08	0.05	<0.01	0.03	<0.01	0.2	0.3	0.2
GBC 5	2.1	2.5	8.8	<0.1	0.03	0.20	0.11	0.02	0.03	0.01	0.6	0.7	0.5
GBC 6	1.6	2.4	8.8	<0.1	0.02	0.16	0.08	<0.01	0.03	0.02	0.4	0.5	0.3
GBC 7	0.8	2.4	8.8	<0.1	0.01	0.08	0.05	0.01	0.01	<0.01	0.2	0.3	0.2
GBC 8	1.3	2.1	8.8	<0.1	0.02	0.12	0.17	<0.01	0.03	<0.01	0.3	0.4	0.3
GBC 9	0.5	1.7	8.8	<0.1	<0.01	0.05	0.03	<0.01	<0.01	<0.01	0.1	0.2	0.1
GBC 10	0.7	0.8	8.8	<0.1	<0.01	0.06	0.05	<0.01	0.01	<0.01	0.2	0.2	0.1
GBC 11	0.6	1.1	8.8	<0.1	<0.01	0.06	0.04	<0.01	0.01	<0.01	0.2	0.2	0.1
GBC 12	1.4	0.9	8.8	<0.1	0.02	0.13	0.14	<0.01	0.02	0.01	0.3	0.4	0.3
GBC 13	1.6	0.9	8.8	<0.1	0.02	0.15	0.15	<0.01	0.02	0.02	0.4	0.5	0.3
GBC 14	0.6	0.9	8.8	<0.1	<0.01	0.06	0.03	<0.01	0.01	<0.01	0.1	0.2	0.1
GBC 15	1.4	1.1	8.8	<0.1	0.02	0.14	0.08	0.02	0.03	<0.01	0.4	0.5	0.3
GBC 16	0.8	1.2	8.8	<0.1	0.01	0.08	0.08	<0.01	<0.01	<0.01	0.2	0.2	0.2
GBC 17	0.9	1.1	8.8	<0.1	<0.01	0.07	0.07	<0.01	0.05	0.01	0.2	0.3	0.2
GBC 18	1.1	2.0	8.8	<0.1	0.02	0.13	0.07	0.02	0.03	<0.01	0.3	0.3	0.2
GBC 19	0.5	1.3	8.8	<0.1	<0.01	0.04	0.04	<0.01	0.01	<0.01	0.1	0.2	<0.1
GBC 20	1.3	1.8	8.8	<0.1	0.02	0.15	0.08	0.05	0.03	<0.01	0.3	0.4	0.3

3 Mortality burden

Table 3.1 presents a mortality burden associated with NO_2 and $PM_{2.5}$ concentrations by Guildford ward.

The range of values given for attributable fraction, life years lost and economic cost for each pollutant were derived from the minimum and maximum values for each of the individual pollutants. These were calculated using pairs of concentration response functions (CRFs) for $PM_{2.5}$ and NO_2 taken from four different studies; see Section 9 of main report for more information.

Total life years lost and total economic cost were derived from the combination of pollutants within each study.

Table 3.1: Summary of life years lost and economic cost resulting from NO_2 and $PM_{2.5}$ concentrations by Guildford ward

Ward		NO_2				$PM_{2.5}$				Total life years lost	Total economic cost (£ Million)
Code	Name	Concentrations (µg/m³)	Attributable fraction	Life years lost	Economic cost (£ Million)	Concentrations (µg/m³)	Attributable fraction	Life years lost	Economic cost (£ Million)		
E05007286	Ash South and Tongham	19.9	0.022-0.039	21-38	0.90-1.62	10.9	0.017-0.047	17-45	0.71-1.92	54-66	2.33-2.82
E05007287	Ash Vale	18.5	0.020-0.036	10-18	0.43-0.78	10.7	0.017-0.046	9-23	0.37-0.99	27-33	1.14-1.42
E05007288	Ash Wharf	18.7	0.020-0.036	18-33	0.78-1.40	10.9	0.017-0.046	15-42	0.66-1.79	48-60	2.06-2.57
E05007289	Burpham	23.1	0.025-0.045	9-16	0.38-0.68	11.2	0.018-0.048	6-17	0.27-0.73	22-26	0.95-1.11
E05007290	Christchurch	20.8	0.022-0.040	10-18	0.42-0.76	11.0	0.017-0.047	8-21	0.33-0.89	25-31	1.09-1.31
E05007291	Clandon and Horsley	17.0	0.018-0.033	17-30	0.71-1.27	10.0	0.016-0.042	14-38	0.60-1.61	44-54	1.87-2.32
E05007292	Effingham	16.9	0.018-0.033	3-5	0.13-0.23	10.1	0.016-0.043	3-7	0.11-0.30	8-10	0.34-0.43
E05007293	Friary and St Nicolas	22.2	0.024-0.043	18-32	0.77-1.37	11.2	0.018-0.048	13-36	0.57-1.53	45-54	1.94-2.30
E05007294	Holy Trinity	19.7	0.021-0.038	12-21	0.50-0.89	10.8	0.017-0.046	9-25	0.40-1.07	30-37	1.29-1.57
E05007295	Lovelace	19.6	0.021-0.038	4-7	0.17-0.30	10.2	0.016-0.043	3-8	0.12-0.34	10-12	0.42-0.50
E05007296	Merrow	18.0	0.020-0.035	11-20	0.47-0.84	10.8	0.017-0.046	10-26	0.41-1.10	29-37	1.24-1.57
E05007297	Normandy	16.3	0.018-0.032	7-12	0.29-0.52	9.9	0.015-0.042	6-16	0.25-0.69	18-23	0.78-0.98
E05007298	Onslow	22.4	0.024-0.043	11-20	0.47-0.85	11.2	0.018-0.048	8-22	0.35-0.94	28-33	1.20-1.41
E05007299	Pilgrims	16.3	0.018-0.032	9-15	0.37-0.66	9.7	0.015-0.041	7-20	0.31-0.84	23-28	0.97-1.21
E05007300	Pirbright	16.5	0.018-0.032	3-5	0.11-0.20	9.9	0.015-0.042	2-6	0.10-0.26	7-9	0.30-0.38
E05007301	Send	18.6	0.020-0.036	10-19	0.44-0.79	10.3	0.016-0.044	8-22	0.35-0.96	27-33	1.15-1.40
E05007302	Shalford	17.3	0.019-0.034	20-35	0.84-1.51	10.1	0.016-0.042	16-44	0.70-1.89	52-64	2.21-2.73
E05007303	Stoke	20.0	0.022-0.039	15-26	0.63-1.13	11.2	0.018-0.048	12-33	0.52-1.39	38-47	1.64-2.02
E05007304	Stoughton	19.5	0.022-0.039	21-38	0.90-1.61	11.5	0.018-0.049	19-50	0.79-2.15	56-71	2.40-3.04
E05007305	Tillingbourne	16.1	0.020-0.036	9-17	0.40-0.72	9.8	0.015-0.041	8-22	0.35-0.94	25-31	1.06-1.34
E05007306	Westborough	19.9	0.020-0.036	18-32	0.75-1.35	11.3	0.018-0.049	15-40	0.63-1.70	46-57	1.98-2.45
E05007307	Worplesdon	17.2	0.025-0.045	18-32	0.76-1.36	10.2	0.016-0.043	15-41	0.65-1.76	47-59	2.01-2.51

*The pollutant concentrations presented are based on LSOA averaged concentrations and the attributable fractions and life years lost are calculated accordingly