Traffic Signs Policy

Estimating the number of traffic signs in England: 2013

V2.0

In House Analytical Consultancy

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GORS

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Contents

Chapter 1: Management Summary

This study aimed to estimate the number of traffic signs in England, both in total and by various sign classifications or groups.

This provides an evidence base to underpin reviews of traffic sign policy, and Impact Assessments.

The last estimate of the number of traffic signs was in 1993, when it was estimated that there were 2.45m traffic signs in England, with a 95% confidence range of 2.33m to 2.56m. Not all sign groups estimated in 1993 were estimated in this study - around 0.29m signs were excluded – leaving 2.16m signs as a basis for comparison.

The 1993 study was based on a survey in which signs were physically counted and analysed using external consultants. It was therefore labour intensive and costly (approximately £3m in 1993). Due to resource constraints an alternative approach was needed for the 2013 study and it was decided to use existing local authority traffic sign inventories. All the work for this study was undertaken by analytical staff in DfT and the cost of the analysis has been estimated at £50,000.

Data was received from 30 local authorities, the Highways Agency and Transport for London. Of these, 19 local authority/highway authority datasets were used to develop a model that could be used for the estimation. A further 10 datasets were used to test the model. The data used in the model amounted to 807,544 sign records, covering around 25% of the area of England.

There was a lot of variation in the consistency, coverage and timeliness of the data provided by each local authority. As a result a significant amount of work was required to try to standardise the data as far as possible.

It has been assumed that the data used to build the model is representative – this is unlikely to be completely true, and therefore the true confidence intervals are likely to be wider than stated in this report. The results in this study should be treated as rough estimates.

We have estimated that there were likely to be around 4.57m traffic signs in England in 2013, with a 95% confidence range of 4.53m to 4.61m. For the sign groups being considered, this represents an overall increase of approximately 111.5% since 1993.

The top three signs, in terms of the number of signs were waiting/loading restrictions (554,296), speed limits (441,394), and parking regulations (337,880). These were all significantly higher than the 1993 estimates. Waiting/loading signs were 443,790 1993 – an increase of 24.9%, speed limits were 224,885 – 96.3% increase; and parking regulation signs increased by 841.8% from 35,875.

There were also disproportionally large increases in the number of signs for Speed humps (4,675 in 1993 to 98,351 in 2013), Pedestrian/Cycle regulations (5,690 to 90,692), Priority restriction (1,572 to 23,135), Cycle route (2,857 to 41,188), and Cycle information (1,018 to 36,418).

Two sign groups were estimated to have decreased – Stop (6,298 to 4,021) and Restrictive zones (12,012 to 3,004). While the estimate for Steep hill was exactly the same as in 1993 – 4,613.

Some of these changes may be in part due to sampling and modelling errors. Also, there were 34,406 signs that could not be identified.

Chapter 2: Introduction

The purpose of this report is to publish the results of a project to estimate the number of traffic signs in England, and to document the methodology employed, and highlight the limitations of the both the analytical approach and data used for the estimation.

2.1 Background

Traffic signs are essential for road safety and for the efficient use of the road network. A consistent traffic signs system, such as that used in Great Britain, helps to deliver this, and consistency is provided by legislation and guidance on traffic signing.

The Road Traffic Regulation Act (RTRA) 1984 provides the legislative framework for traffic signs, and specific regulations for signs are contained within the Traffic Signs Regulations and General Directions 2002 document, and the Traffic Signs (Amendment) (No. 2) Regulations and General Directions 2011 document (referred to together in this report as TSRGD)

The Traffic Signs Policy Review set out recommendations to reduce regulation and provide more flexibility for local authorities, so they can work more effectively with traffic signing, including:

- Removal of unnecessary signs
- Removing the requirement for signing
- Easier to understand parking signs
- Relaxation of parking bays
- Relaxation of lighting requirements
- Helping to promote safer cycling
- Make certain signs self enforceable with traffic orders

An estimate of the number of traffic signs in England was last made in 1993. It was thought likely (due to increases in the total length of road in England, population and traffic increases, as well as signing policy changes) that the number of traffic signs in England will have also increased since 1993, and therefore a new estimate was required.

The key outputs from this study are

- Information to feed into the impact assessment for the revised TSRGD.
- A baseline for assessing the effectiveness of current policy and developing the future changes to TSRGD.
- Information to help measure the costs and carbon emissions arising from lighting traffic signs.

2.2 Methodology

A scoping study was conducted in the Autumn of 2012, and this study follows on from this, using the methodology proposed during the scoping study.

The 1993 study involved counting traffic signs at the roadside in a sample of areas across England. Resource constraints in 2013 meant that it was not possible to use this approach. In addition, there is now more information on signs held by Local Authorities and Highway Authorities than there was 20 years ago. As a result, the methodology relied on a group of Local Authorities that had data which was then used to estimate the number of signs in those areas where data was not available.

A limited amount of data on the demography, geography and road network of each Middle Super Output Areas (MSOAs) in England was obtained. This was used to provide explanatory variables for a regression models that were used to predict the number of signs in those parts of the country with no signs data.

Annex D provides a description of the MSOAs.

The 1993 study had divided England into 5km x 5km squares – counting the signs in a sample than extrapolating to estimate the total. This study initially attempted to use a similar approach based on 5km x 5km squares. However, this led to difficulties in allocating the geographic data – particularly where squares were only partially covered by a Local Authority that had provided data.

Not all sign groups estimated in 1993 were estimated in this study. 286,579 signs were in groups not estimated this time – leaving 2,161,695 signs as a basis for comparison.

Full details of the methodology used are provided in Annex B.

2.3 Data limitations

The availability and quality of sign data varied between different Local Authorities: some Local Authorities had no electronic, consistently recorded records of signs and their locations; others had very high quality, up to date and comprehensive datasets. The sign group of 34,406 signs could not be identified from the data. The variation in recording approaches is likely to have had an impact on the accuracy and reliability of the estimates for national sign numbers, and this is discussed in further detail in Chapter 3.

The explanatory variables used were limited to population, some geographical data (on lakes, forests for example) and information based on the road network – e.g. length of M, A and B roads. Additional datasets that may have been useful (particularly for some sign groups) were identified e.g. railway lines/stations, schools, hospitals etc. However, resource constraints meant that these datasets were not used, but should be considered in any future work.

2.4 Results

The study has produced an estimate of the total number of traffic signs in England, and provides a 95% confidence interval around this estimate.

Sign types were grouped by category and estimated separately. Sign groups which include less common signs were, likely to have relatively wider confidence intervals i.e. the estimate are less reliable.

An estimate of the number of illuminated and non-illuminated signs was also produced, and for the number of signs in four different sign categories (Direction, Informatory, Regulatory, Warning)

Traffic signals and lights, and road markings are not included in the estimate: we were unable to collect sufficient data across England on these. Similarly, we were not able to collect consistent data on date of installation for signs, so we were not able to analyse how sign numbers have changed over time beyond the two point estimates in 1993 and 2013.

Chapter 3: Data considerations

A request for data on traffic signs was sent to all local authorities and highway authorities (Highways Agency and Transport for London) in January 2013. Responses to this request revealed that the level, timeliness and extent of recording of traffic signs on electronic inventories varied widely between different local authorities.

This chapter discusses the issues raised by the variation in data quality, timeliness and coverage.

3.1 Data quality

The quality of the data received from each Local Authority/Highway Authority varied. Some were very good in terms of being up-to-date, consistently coded and well constructed full datasets.

Others were full datasets, but contained a variety of descriptors (either free-text or diagram numbers) for the same sign, and with many sign records with no information about the type of sign. For these datasets, a large number of signs needed to be classified as “unknown” – over 40% of some datasets. These can be used to help estimate the total number of traffic signs in England, but do not provide information on the number of signs of different types.

One Local Authority provided data which was up-to-date, but covered only an estimated 85% of the signs in the Local Authority. Another Local Authority had data on all but directional signs, and a large number of unknowns – further investigation with the Local Authority lead to the classification of the unknown signs as directional signs.

Some Local Authority datasets were not completely up-to-date. We decided to discard the data from one Local Authority which was last updated in 1995. Another Local Authority provided data from 2005, and others were 3 or 4 years out of date. We used this data, but it must be borne in mind that these are not current inventories.

Some Local Authorities have been able to provide partial datasets. For example, some only keep an inventory of illuminated traffic signs and were able to provide these. Some had an inventory of signs, but no information on the location of these signs. Others provided a list of sign locations, but no information about the sign types.

A small number of Local Authorities did not hold an inventory of traffic signs, but provided their own estimate of the number of traffic signs in their Local Authority.

The partial datasets and Local Authority estimates were not used in the analysis.

A number of Local Authorities have provided details of particular concerns they have with the accuracy of specific areas of their data, largely due to the challenge of keeping these sign inventories up to date. These are recorded in Annex B.

3.2 Data coverage

The sampling framework for Local Authority data that we were seeking to match is described in Annex B: the aim was to collect data from as representative sample of Local Authorities as possible.

Annex C provides a list of the Local Authorities who provided data, and how it was used. Overall we were able to use data on 807,544 signs to develop the model, signs which fell into 1,121 MSOAs covering 25% of the area of England.

We received data from a range of different Local Authority types, and from all regions of England. See B.2.1 for more detail.

A small number of Local Authorities expected to have sign inventories within the next 12-18 months, and these could be used for re-estimating of traffic sign numbers.

3.3 Consistency of datasets

The variation on what signs were recorded by different Local Authorities, and how records were kept emerged during data cleaning (which is described in Annex B). Therefore we made adjustments to the raw data sent to us try and make the data as consistent as possible across Local Authorities.

In particular, the following issues had to be addressed:

1. Removing non traffic signs from data sets – such as “no dog fouling”, “no fly-tipping” and “no ball games” signs, street name plates, bus stop flags, and rights of way signs.
2. Assigning signs a TSRGD sign diagram number, based on a (sometimes abbreviated) text description provided by the Local Authority.
3. Signs with variations to TSRGD diagram numbers were grouped with signs with the base-level TSRGD diagram number, unless we were otherwise advised.
4. Removing supplementary plates where they were recorded as a separate sign.
5. Direction signs were recorded as Stack, Gantry, Flag or other, but the road type of the sign was not recorded (i.e. primary route stack signs were grouped with minor road stack signs).
6. Some Local Authorities did not recorded whether or not signs were illuminated.
7. Signs with diagram number 561 (Edge of carriageway) were removed from all datasets – some Local Authorities had recorded many of these, others none.
8. Some Local Authorities had obviously recorded where speed limit repeaters were two signs on one post (for example, two small 30 mph speed limit repeaters, each one facing one direction of travel, back-to-back on a post). For other datasets, it was less clear whether this had been done or not. This was not possible to resolve.

3.4 Impact on model and results

A number of data issues are likely to have had an impact on the accuracy of the final model and sign estimates. These include:

- The timeliness of the data – old data may lead to an over or under estimate of the total signs.
- The overall accuracy of the data. The inventories have been maintained by many different people over the years, using different approaches, and with different objectives and priorities. Therefore the data used for the estimation is not 100% accurate or consistent either within or across Local Authorities.
- The grouping of signs – groups containing infrequently recorded signs will be harder to estimate,

and have a much wider confidence interval.

- The large number of unknown signs in some Local Authorities is an issue. The overall estimate of signs nationally will not be affected, but we will be missing data for sign group estimates, therefore potentially underestimating these.

- The data we have used in the model is unlikely to be a truly representative sample of traffic signs across England, and therefore may introduce bias (and hence an over or under estimation) into the final results.

In addition, the particular issues described in section 3.3 will also lead to either under or over-estimation of the number of traffic signs.

The accuracy/timeliness of the explanatory variables is also likely to have had an impact. For example, population was derived from 2011 census data and we had to assign population estimates at LSOA level to the MSOAs.

Also the length of roads had to be estimates where road links crossed the boundary of one MSOA to another. If a stretch of road crossed a boundary, it would be counted in both MSOAs. However, since many to the road links were quite small, this was not considered to be a problem.

The key message here is that the estimate of the number of signs, and in particular by sign group should be used with respect for these caveats.

3.5 Validation of model

Using the 1,121 MSOAs where the number of signs were known, a subset of roughly half the MSOAs were randomly selected. The selected MSOAs were used to produce a regression model based on the principal components of the explanatory variables. The model was then used to make predictions of the number of signs in the MSOA that had not been used to generate the regression model and the errors examined.

Models for lit and unlit signs were generated and used to estimate the 8 Local Authorities that had partial data. While only 4 of these were within the predicted 95% confidence interval, the estimate for the total number of signs in all 8 was within the confidence 95% interval.

This analysis suggested that at MSOA and local Authority levels, predictions were likely to be unreliable but larger consolidations were more likely to provide reasonable estimates.

Chapter 4: Headline estimates of the number of traffic signs

This section provides and summary of the main results.

Annex A provides: estimates for the total number of signs nationally, and for signs by sign group and category.

Annex B describes the methodology.

Annex E the results from the 1993 study.

4.1 Results

Key findings – all signs

Total number of traffic signs in England, for the groups considered, increased from 2,161,695 in 1993 to 4,571,710 (with a 95% confidence interval of 4,528,516 to 4,614,904) in 2013 – an increase of 111.5%.

Results for different categories of signs and for illuminated/non-illuminated signs are shown below. There were no comparable 1993 figures.

Results by category in 000s

	Estimated number of signs	95% lower bound	95% upper bound
Direction	701	690	712
Informatory	396	390	401
Regulatory	2,346	2,318	2,375
Warning	922	912	932
All illuminated signs	582	573	590
All non-illuminated signs	4,004	3,965	4,044

Results for the estimated three largest sign groups are shown in the table below, rounded to the nearest thousand.

Results for three most common signs in 000

	Waiting/ Loading restriction	Speed limits	Parking regulations
2013 Estimate	**554**	**441**	**338**
Lower 95% range	**541**	**434**	**323**
Upper 95% range	**567**	**449**	**353**
1993 estimate	**444**	**225**	**36**
Difference	**112**	**216**	**302**
% change	**25**	**96**	**842**

Results for three groups with a high % increase are shown in the table below.

Signs with high % increases in 000

	Speed Humps	Pedestrian /Cycle regulations	Cycle Information
2013 Estimate	**98**	**91**	**31**
Lower 95% range	**96**	**88**	**30**
Upper 95% range	**101**	**94**	**32**
1993 estimate	**5**	**6**	**1**
Difference	**93**	**85**	**30**
% change	**2,004**	**1,494**	**2,960**

Annex A: Detailed results by Group, Category and Total

Table 1a										
Traffic sign group (some of these are mergers of two or more smaller groups)		Estimated number of signs 1993 - where applicable	Estimated number of signs 2013	95% Confidence interval	%	95% lower bound	95% upper bound	% Increase or Decrease	Number of MSOAs in the 1,121 MSOAs containing sign type	Number in the sample of 1,121 MSOAs
1	Distance to stop or Give Way line	11,655	30,127	954	3.2%	29,173	31,080	158.5%	670	6,080
2	Junction warning	62,427	76,232	2,092	2.7%	74,140	78,325	22.1%	825	15,166
3	Roundabout warning	12,779	23,858	595	2.5%	23,263	24,452	86.7%	761	3,811
4	Bend Warning and Sharp Deviation	102,215	229,051	3,789	1.70%	225,261	232,840	124.09%	1,041	43,146
5	Road narrows	22,557	34,131	881	2.6%	33,250	35,012	51.3%	822	6,539
6	Two way traffic	13,324	20,781	662	3.2%	20,119	21,443	56.0%	659	3,347
7	Steep hill	4,613	4,613	664	14.4%	3,948	5,277	0.0%	184	1,214
8	Bridge/Tunnel warning	2,833	3,200	224	7.0%	2,976	3,425	13.0%	198	632
9	Miscellaneous danger warning	12,007	108,842	2,871	2.6%	105,971	111,713	806.5%	1,003	20,830
10	Cycle warning	809	11,150	464	4.2%	10,686	11,615	1278.3%	475	1,881
11	Vehicle warning	488	4,846	377	7.8%	4,468	5,223	893.0%	209	999
12	Sharp deviation		Included in group 4						-	-
13	Roundabout deviation	22,961	No estimate possible as no signs of this type in sample data						-	-
14	Merge	1,743	2,720	202	7.4%	2,518	2,922	56.1%	121	402
15	Speed humps	4,675	98,351	2,552	2.6%	95,799	100,902	2003.8%	878	15,559

16	Slow lorries	103	No estimate possible as no signs of this type in sample data						-	-
17	Height warning	11,486	16,820	779	4.6%	16,041	17,599	46.4%	420	2,937
18	Train warning	3,143	22,048	1,623	7.4%	20,425	23,671	601.5%	305	4,186
19	Traffic signals ahead	5,836	15,780	532	3.4%	15,248	16,312	170.4%	603	2,431
20	Pedestrian warning	73,352	193,059	2,285	1.2%	190,774	195,344	163.2%	1,117	32,841
21	Animal warning	12,478	22,089	1,260	5.7%	20,829	23,350	77.0%	545	5,010
22	Water warning	1,568	3,470	502	14.5%	2,968	3,971	121.3%	146	848
23	Stop	6,298	4,021	216	5.4%	3,805	4,237	-36.2%	315	756
24	Give way	92,449	124,316	2,202	1.8%	122,114	126,518	34.5%	1,084	22,759
25	Turning regulation	40,739	148,042	2,777	1.9%	145,265	150,820	263.4%	1,056	23,622
26	Turning restriction	21,028	34,938	1,446	4.1%	33,493	36,384	66.2%	719	5,759
27	Vehicle prohibition	11,114	49,862	1,424	2.9%	48,438	51,286	348.6%	808	8,759
28	Restriction ends	4,541	15,694	704	4.5%	14,990	16,398	245.6%	393	2,835
29 & 31	Speed limits & Speed Limit Repeaters	224,885	441,394	7,784	1.8%	433,610	449,178	96.3%	1,057	83,144
30	Speed derestriction	67,626	147,154	2,828	1.9%	144,326	149,982	117.6%	885	29,060
32	Minimum speed limit	37	No estimate possible as too few signs of this type in sample data						26	42
33	Give priority to right (mini roundabout)	8,534	33,075	933	2.8%	32,143	34,008	287.6%	724	5,350
34	No entry	53,354	70,546	1,657	2.3%	68,889	72,203	32.2%	942	11,360
35	No entry with supplementary plate	978	No estimate possible as too few signs of this type in sample data						3	4

39 & 40	Waiting/Loading restriction	443,790	554,296	13,110	2.4%	541,187	567,406	24.9%	1,049	89,063
36, 37, 41 & 43	No stopping, No stopping repeater, Urban clearway & Clearway regulations	47,700	115,450	2,961	2.6%	112,489	118,411	142.0%	985	19,454
42 & 44	Vehicle regs & Vehicle weight limits	27,109	39,138	1,139	2.9%	37,999	40,278	44.4%	714	7,019
45	Pedestrian/Cycle regulations	5,690	90,692	2,898	3.2%	87,794	93,590	1493.9%	799	14,197
46	Vehicle size prohibition	12,654	9,388	533	5.7%	8,856	9,921	-25.8%	310	1,727
47	Priority restrictions	1,572	23,135	932	4.0%	22,204	24,067	1371.7%	459	3,721
48	Pedestrian/Cycle prohibitions	8,762	18,414	641	3.5%	17,773	19,055	110.2%	582	2,955
49	One way traffic	37,737	56,929	2,039	3.6%	54,890	58,968	50.9%	739	9,386
50	No overtaking	566	No estimate possible as too few signs of this type in sample data						18	116
51	Bus lane	2,742	20,471	1,268	6.2%	19,203	21,738	646.6%	406	3,254
52	Parking regulations	35,875	337,880	14,797	4.4%	323,083	352,677	841.8%	938	55,550
53	Motorway regulations	1,298	2,009	121	6.0%	1,888	2,130	54.7%	94	266
56	Restricted zones	12,012	3,044	313	10.3%	2,731	3,357	-74.7%	107	526
57, 62, 67 & 72	Direction-Gantry	3,854	2,542	207	8.1%	2,335	2,749	-34.0%	48	311
58, 63,	Advance	42,733	91,042	4,451	4.9%	86,592	95,493	113.0%	954	17,245

68 & 73										
59, 64, 69 & 74	Stack	27,989	19,849	640	3.2%	19,209	20,490	-29.1%	667	3,411
60, 65, 70 & 75	Flag	275,188	197,156	5,674	2.9%	191,482	202,831	-28.4%	979	38,393
61, 66, 71 & 76	Other (Direction)	8,299	55,330	2,918	5.3%	52,413	58,248	566.7%	770	10,731
77	Goods vehicle	3,079	7,357	402	5.5%	6,954	7,759	138.9%	323	1,213
78	Pedestrians	14,764	133,511	6,932	5.2%	126,579	140,443	804.3%	825	24,511
79	Cycle route	2,857	36,418	1,271	3.5%	35,147	37,689	1174.7%	634	6,136
80	Services	617	21,499	779	3.6%	20,720	22,279	3384.5%	660	3,813
82	MOD	2,363	3,802	453	11.9%	3,349	4,256	60.9%	137	686
83	Tourists (old type)	634	22,606	970	4.3%	21,636	23,576	3465.6%	487	3,617
81 & 84	Ancient Monument & Tourists (new type)	24,534	35,901	1,080	3.0%	34,820	36,981	46.3%	722	6,568
85	Place names	36,970	59,167	1,542	2.6%	57,625	60,708	60.0%	812	12,095
86	Station	3,149	4,652	256	5.5%	4,396	4,907	47.7%	272	763
87	Parking	11,630	20,593	824	4.0%	19,769	21,418	77.1%	580	3,463
88	Avoiding prohibited movement	47	1,109	83	7.5%	1,026	1,193	2260.3%	125	188
91	Traffic lane permitted	841	2,529	161	6.4%	2,368	2,690	200.7%	165	383

	movements									
92	Radio travel news	-	No estimate possible as no signs of this type in sample data						-	-
93	No through roads	103,481	103,483	1,908	1.8%	101,575	105,391	0.0%	1,067	17,266
94	AA/RAC Telephone/service	556	No estimate possible as too few signs of this type in sample data						6	17
95	Traffic merge	736	3,376	241	7.1%	3,135	3,617	358.7%	130	500
96	Pedestrian information	-	7,065	535	7.6%	6,530	7,600		293	1,177
97	Cycle information	1,018	31,154	1,054	3.4%	30,099	32,208	2960.3%	669	5,030
98	Information signs	278	2,487	282	11.3%	2,205	2,769	794.7%	95	391
99	Controlled parking zone	18,294	68,090	2,674	3.9%	65,416	70,763	272.2%	800	11,528
100	Lane control	-	No estimate possible as too few signs of this type in sample data						14	29
101	Narrow road	5,943	15,187	681	4.5%	14,506	15,868	155.5%	486	3,162
102	Countdown markers	2,891	15,237	758	5.0%	14,479	15,995	427.1%	296	2,531
103	Crossing information	4,210	7,639	780	10.2%	6,859	8,420	81.5%	152	1,514
104	Hard shoulder signs	457	No estimate possible as no signs of this type in sample data						-	-
105	Dual carriageway	2,691	19,546	823	4.2%	18,723	20,369	626.4%	472	3,032
106	Crawler lane	0	No estimate possible as no signs of this type in sample data						-	-
89, 90 & 107	Miscellaneous - Informatory	7,567	20,511	675	3.3%	19,836	21,186	171.1%	663	3,563
108	Miscellaneous - Miscellaneous	256	11,225	801	7.1%	10,424	12,026	4284.7%	148	1,817
109	Roadworks (diagram numbers 7000s)	1,627	12,349	515	4.2%	11,834	12,864	659.0%	499	2,013

110	Parking information		637	90	14.1%	548	727		43	107
111	Police and other officer signs		1,307	131	10.0%	1,176	1,437		93	216
112	Traffic cameras		23,086	853	3.7%	22,232	23,939		610	3,832
113	Bus information		67,995	2,519	3.7%	65,476	70,514		564	10,923
114	Queues ahead		1,833	153	8.4%	1,680	1,987		103	311
115	Rural direction signs (finger posts not footpath s		No estimate possible as too few signs of this type in sample data						15	50
116	Other Misc		No estimate possible as too few signs of this type in sample data						3	5
117	Unknown		200,927	6,851	3.4%	194,076	207,778		766	34,406
120	Red Route signs		11,331	1,278	0	10,053	12,609		64	1,860
121	Congestion Charge Zone signs		No estimate possible as too few signs of this type in sample data						21	138
	Total	2,161,695	4,600,584							807,544

Note – the estimate for the total number of signs (4,571,710) was generated using all signs within each MSOA, rather than summing the estimates for the individual sign groups.

Table 1b		
Traffic signs in 1993 not included in 1a		**Estimated number of signs in 1993**
38	Bollards	131,434
54	Perm stay lane signs	49
55	Vehicle regulatory	90
110	Blank grey VMS	569
112	Pelican	11,618
113	Signals with ped control	12,671
302	Signals-no ped control	10,723
304	Rural direction	119,425
	Total	286,579
	Total from table 1a and 1b	2,448,274

Table 2 - By Sign Category										
Traffic sign category		**Estimated number of signs in 1993**	**Estimated number of signs**	**Confidence interval**	**%**	**95% lower bound**	**95% upper bound**	**% Increase or Decrease**	**Number of sample MSOAs containing sign type**	**Number in sample 1,121 MSOAs**
200	All signs	2,161,695	4,571,710	43,194	0.9%	4,528,516	4,614,904	111.5%	1,121	807,544
300	Direction		701,299	11,086	1.6%	690,213	712,385		1,104	133,144
301	Informatory		395,951	5,530	1.4%	390,421	401,480		1,119	65,201
302	Regulatory		2,346,370	28,595	1.2%	2,317,775	2,374,965		1,120	400,740
304	Warning		922,006	9,702	1.1%	912,304	931,708		1,120	167,859
400	All illuminated signs		581,724	8,757	1.5%	572,967	590,481		1,039	91,777
401	All non-illuminated signs		4,004,332	39,739	1.0%	3,964,593	4,044,071		1,120	715,767

Table 3 - By Sign Category using the Population/MSOA only										
Traffic sign category		**Estimated number of signs in1993**	**Estimated number of signs**	**Confidence interval**	**%**	**95% lower bound**	**95% upper bound**	**% Increase or Decrease**	**Number of sample MSOAs containing sign type**	**Number in sample 1,121 MSOAs**
200	All signs	2,161,695	4,816,544	72,780	1.5%	4,743,764	4,889,324	122.8%	1,121	807,544
300	Direction		792,480	20,522	2.6%	771,958	813,002		1,104	133,144
301	Informatory		388,644	6,412	1.6%	382,232	395,057		1,119	65,201
302	Regulatory		2,386,459	37,373	1.6%	2,349,086	2,423,832		1,120	400,740
304	Warning		1,004,738	21,024	2.1%	983,714	1,025,762		1,120	167,859
400	All illuminated signs		547,649	10,338	1.9%	537,311	557,987		1,039	91,777
401	All non-illuminated signs		4,268,931	69,228	1.6%	4,199,704	4,338,159		1,120	715,767

Annex B: Methodology

B.1 Outline of methodology

A summary of the approach used to estimate the number of traffic signs in England is as follows:

1. GIS software was used to map geographical explanatory variables onto 1,121 MSOAs. For example Population, A road length and segments etc Data were stored in an Access database.

2. An initial analysis of the explanatory variables showed that they were highly correlated; therefore it was decided to generate the principal components for use in the regression model rather than use the original variables themselves.

3. Using the datasets from 17 Local Authorities, each sign was assigned to an MSOA.

4. To test the approach, roughly half the 1,121 were randomly selected in order to produce a regression model (based on the principal components) that was then used to estimate the signs in the other half. The results suggested the approach was applicable. We also used the model to predict 10 Local Authorities that had supplied part data sets.

5. A multivariate linear regression was then run to find the best fitting model for number of signs in 1,121 MSOAs.

6. This produced a set of regression coefficients that could be used to predict the number of signs in the unknown MSOAs.

7. The sign estimates for the unknown MSOAs were combined with the number of signs in the known MSOAs to give a national estimate.

8. Steps 5 to 7 were repeated for each sign group. To do this an automatic procedure was written in Excel/VBA to automatically cycle through the sign groups, calculate the principal components, run the regression algorithm and produce a national estimate.

More detail about each of these steps is provided below.

B.2 Collecting and preparing Local Authority/Highway Authority sign data

B.2.1 Sampling Local Authority data

It was established during the pilot study in 2012 that not all Local Authorities held up to date or comprehensive traffic sign inventories. Some Local Authorities held very good records, others had no records at all, and there was a range of coverage and quality and timeliness of records between these two extremes. For more details see Chapter 3 of the report, and Annex C.

A sampling strategy was devised for an ideal sample of Local Authority sign data. This set out to obtain a number of sign datasets in each region of England, and across different types of Local Authority, weighted by population. The target and actual number of datasets received are shown in the table below. Population proved to be one of the most significant factors in predicting the number of road signs.

	Total number of highway authorities (exc. TfL and HA)	**152**			**Target sample (exc TfL and HA)**	
Local Authority Type	**Number of…**		**Total population**	**% of population**	**From sample of 30**	**Datasets received**
	Non metropolitan counties	27	21,251,019	41.1%	12	10
	Unitary Authorities	56	12,112,835	23.4%	7	8
	Within metropolitan counties	36	10,170,395	19.7%	6	7
	Within Greater London	33	8,173,941	15.8%	5	5
Region	Number within…		**Total population**		**From sample of 30**	
	North East	12	2,596,886	5.0%	2	1
	North West	23	7,052,177	13.6%	4	2
	Yorkshire and the Humber	14	5,052,512	9.8%	3	7
	East	11	5,846,965	11.3%	3	3
	East Midlands	9	4,533,222	8.8%	3	2
	West Midlands	13	4,528,802	8.8%	3	3
	London	33	8,173,941	15.8%	5	5
	South West	16	5,288,935	10.2%	3	2
	South East	19	8,634,750	16.7%	5	5
				Total	**30**	**30**

Of the 30 Local Authority datasets collected, plus datasets from TfL and HA (32 in total), 19 were used to build the regression model. The other datasets were not suitable for either developing or testing the model.

B.2.2 Data cleaning and preparation

All datasets required the data to be cleaned to make them consistent. Geographical location codes (Eastings and Northings in the majority of cases) needed to be checked (e.g. did the sign fall into the Local Authority concerned?), multiple signs recorded in one record split out, and sign diagram numbers checked against the TRSGD list of signs, and then classified into one of approximately 100 sign groups, which were the same sign groups as used in the 1993 study. For some Local Authorities, this process was lengthy, as the quality of the sign diagram number data was poor, and there was a need to interpret text field descriptors of signs. Traffic Signs Policy provided guidance and advice

on how to classify some signs. If signs were located outside of the boundary of the Local Authority (usually due to data errors), they were discarded.

Once the data was cleaned, it was imported into ArcGIS and each sign allocated to an MSOA.

TfL and HA datasets for signs were overlaid on the Local Authority sign data, and where they intersected an MSOA, added to the sign data for that MSOA. In addition, BPRN (B and Primary Road Network) data were added to London Borough sign data where it was not included in the data provided by the Local Authorities.

A total of 807,544 signs were assigned across 1,121 MSOAs.

B.3 Preparing the explanatory variables

B.3.1 Explanatory variables

For each MSOA, the following data was collected using ArcGIS and map data on roads, population and geographical features, and attributed to the relevant MSOA:

- Total road length and number of road segments (as counted from the ArcGIS map data) for 6 different road categories: A roads, B roads, Minor roads, Local roads, Motorways and Pedestrianised streets.
- Total length of each of canals, main rivers, secondary rivers and minor rivers.
- Total area of each of woodland, lakes and foreshore
- Total population. This was calculated by locating the centroid of each LSOA (Lower layer Super Output Area) census data point, and attributing the population in that LSOA to the MSOA containing it. LSOAs have populations of around 1,200 – 1,400, and the area of an LSOA can vary depending on the population density of the area.
- Area of MSOA.

This set of explanatory variables was stored in an Access database.

B.4 Multivariate regression models

B.4.1 Total signs estimate

In estimating the total number of traffic signs across the sample Local Authorities, multivariate linear regression provided good fitting models. The Population variable tended to be most closely related to the number of signs in a MSOA. The other variables that were included were based on road length and number of segments. However, all these variables tended to highly correlated with each other – which might be expected - and suggested that there may be problems in using the variables in a regression model due to multicollinearity. It was therefore decided to use the principal components in all of the regression modelling.

A regression model using principal components, gave an estimate for all signs of 4,571,710 +/- 43,194 (95% confidence interval). We believe that the confidence interval is understated – partly because of the quality of the data and partly because we had no control over which MSOAs that were used – i.e. we were not able to take a random sample but were limited to data that were available.

In order to validate the approach, the 1,121 MSOAs where the number of signs was known, a subset of roughly half the MSOAs were randomly selected. The selected MSOAs were used to produce a regression model based on the principal components of the explanatory variables. The model was then used to make predictions of the number of signs in the MSOA that had not been used to generate the regression model. The errors were examined to see that they were normally distributed.

Models for lit and unlit signs were then generated and used to estimate 8 Local Authorities that had partial data. While only 4 of these were within the predicted 95% confidence interval, the estimate of the total number of signs for all 8 was within the confidence 95% interval.

This analysis suggested that at MSOA and local Authority levels, predictions were likely to be unreliable but larger consolidations were more likely to provide reasonable estimates.

As a comparative benchmark for the approach, we also ran a simple ordinary linear regression model based on Population (per MSOA). This gave an estimate of 4,816,544 signs – higher than the estimate using principal components; however, this may be due to some sign groups not exclusively driven by population.

B.4.2 Estimating sign groups

The same approach was taken to find a best fitting model for estimating the number of traffic signs in individual sign groups – although the models produced for sign groups were not as good as for all signs. It was decided to not to estimate a sign group unless there were at least 30 MSOAs that had at least one of that sign group.

In a number of cases, especially where the number of signs in a group was small, multivariate linear regression did not produce a satisfactory model, and so both Poisson, Negative Binomial regression was considered. In general, neither of these variations tended to improve the quality of the model. In general the more unusual/scarce the sign group the more difficult it was to find a good fitting model. If an attempt to use this approach is made in future, we suggest that a wider range of explanatory variables are collected.

Some sign groups only appear in parts of the country – e.g. Red Routes only appear in London and Birmingham. In those cases the analysis only included relevant MSOAs in both fitting the regression model and making the prediction.

Annex C: Data summary

The following table provides a summary of the data provided by each Local Authority or Highways Authority, and includes details of any data limitations specific to that data provider.

	Local Authority or Highway Authority	Notes on data quality/content	Total number of signs	% "unknown" sign type	Total area of Local Authority (sq kms)
Highway Authority	**Highways Agency**	Reasonable - some diagram numbers missing. "The data are maintained by the Service Providers, we cannot guarantee its accuracy or completeness".	172,194	11%	
	TfL	Good. Does not include bus stops nor wayfinding signs.	57,608	none	
	London BPRN	Good - all London primary route signs. Duplicated with some other London Local Authority data.	99,204	3%	
Data to use in Model (Local Authority data plus HA/TfL/LondonBPRN) - Full datasets	**Birmingham**	Good. TSRGD signs only and no street furniture i.e. way markers, way finders, street name plates or bus stops etc.	64,062	0.4%	376
	Blackpool	Good. “Hazard Illumination” signs classified as illuminated.	9,073	0.3%	40.39
	Cambridgeshire	Good	54,834	3%	3043.69
	Camden	Good	23,450	2%	21.78
	Derbyshire	Good	73,384	1%	2526.24
	Hammersmith and Fulham	Good	21,116	2%	17.15
	Hertfordshire	Good	121,870	7%	1642.09
	Lincolnshire	Good	85,518	0.6%	6008.9
	Medway	Reasonable - some diagram numbers missing, and not possible to classify these further. “Regarding the sign data for Medway. Sign number 0 or NA or * is what we know as a sign with no reference. This is due to our internal processes in Medway. If a sign cannot be fitted into a particular sign ref number then it is given a null value. We will then have a photograph attached to the sign which allows officers see what exactly is there. An example of this is non primary directional signs.	12,908	46%	250.86

	Local Authority or Highway Authority	Notes on data quality/content	Total number of signs	% "unknown" sign type	Total area of Local Authority (sq kms)
		Regarding bus stop flags. We do not managed these in Highways so they are not included in the register which was provided to you. Footpath signs will be in the list but they are not categorised as "Footpath Directional Signs". Within our asset management system I have started sub categorising Footpath signs as "PROW directional" however this is not complete so not all footpath signs are categorised in this way.			
	Newcastle	Good	22,876	5.4%	115.05
	Norfolk	Good, but no data on illumination	85,832	8%	5358.3
	North Yorkshire	Good	93,339	5%	7830.56
	Redbridge	85% of signs covered. Good data. No evidence received that the missing signs are biased to any one type of road or area. No adjustment was made for the missing data in the data feeding the model.	14,372	4%	56.43
	Surrey (East)	Good - although many text descriptions rather than diagram numbers, and coordinates difficult to place on map of Surrey. Data had to be transposed to sit on map of Surrey, so approximations introduced.	39,628	0.2%	764.69
	Westminster	Good, except no data on whether or not a sign was illuminated.	16,539	1.0%	22.04
	West Sussex	Good	55,071	6%	2441.68
	York	Old data, and may not be 100% complete coverage. Unknown signs were all direction signs - allocated proportionately across different direction sign groups	13,722	0%	264.13
	Staffordshire	Good data, but for illuminated signs only. Used for validation.			

	Local Authority or Highway Authority	Notes on data quality/content	Total number of signs	% "unknown" sign type	Total area of Local Authority (sq kms)
	Portsmouth	Good data for non-illuminated. It includes both illuminated and non-illuminated signs. No diagram numbers for illuminated signs. Used for validation.			
	IoW	No diagram numbers available - high level sign descriptions provided. Rights of Way signs were not included in the surveys (survey related to Highway Assets only) and bus stop signs are the responsibility of Southern Vectis. Used for validation.	14,250		
	Lancashire	Summary data only. Not used for model or validation.			
	Plymouth	Total number of signs by category. Only covers A and B roads. Not used for model or validation.			
	Sheffield	No diagram numbers (or descriptors). Used for validation.	34,274		
	Cornwall	Summary data only - not used for model or validation. Includes pedestrian direction signs but not Bus Stops			
	Portsmouth	No diagram numbers (or descriptors) for illuminated signs - used for validation.			
	Lambeth	Illuminated signs only. No Eastings and Northings. Inventory covers all but 30km of Lambeth's roads (they are still completing) – equates to missing 10% of Lambeth's roads. Not used for model or validation.			
	Coventry	Full list of illuminated signs, but only some diagram numbers. Validation only.			
	East Riding	Illuminated signs only. No Eastings and Northings. Seemingly low number of signs for size of Local Authority. Not used for model or validation.			
	Barnsley	Location info only, for illuminated signs only. No diagram numbers. Validation only.			

	Local Authority or Highway Authority	Notes on data quality/content	Total number of signs	% "unknown" sign type	Total area of Local Authority (sq kms)
	Calderdale	Reasonable data only (text descriptors of signs rather than diagram number), but for illuminated signs only, and not all had Eastings and Northings. Query over what has been included as total number is high – also whether it include non traffic signs. Not used for model or validation.			
	Bradford	Location info only, for illuminated signs only. No diagram numbers. Validation only.			

Annex D: Middle Super Output Areas

D.1.1 Introduction

Middle Super Output Areas (MSOAs) were chosen as they possessed several useful features:

- They are well defined in geographical terms with easting/northing, boundaries and a centre.
- They are supported by the Office for National Statistics (ONS) with population projections.
- They have similar populations – although this means they vary in shape and area.
- They respect local authority boundaries.
- They were small enough to define distinct areas without oversimplifying the problem.

The remainder of this section provides a more detailed description of MSOAs and how they relate to Super Output Areas (SOAs) and Lower Layer Super Output Areas (LSOAs).

D.1.2 Super Output Areas (SOAs)

Super Output Areas (SOAs) are a geography designed for the collection and publication of small area statistics. They are used on the Neighbourhood Statistics site and across National Statistics.

There are currently two layers of SOA, with areas intermediate in size between census Output Areas (OAs) and local authorities and each layer nesting inside the layer above. This offers a choice of scale for the collection and publication of data, and allows for the release of local data that could be disclosive if published for OAs.

SOAs give an improved basis for comparison across the country because the units are more similar in size of population than, for example, electoral wards. They are also intended to be stable, enabling the improved comparison and monitoring of policy over time. In addition, figures for user defined geographies are aggregated and best fitted from data held for OAs and SOAs.

The link below gives more information on the SOAs.[1]

D.1.3 Lower Layer Super Output Areas (LSOAs)

The 33,323 Lower Layer SOAs (LSOAs) in England were generated automatically and released to the public in February 2004.

[1]http://neighbourhood.statistics.gov.uk/dissemination/Info.do?page=/aboutneighbourhood/geography/geography.htm

The LSOAs were built using 2001 Census data from groups of Output Areas (typically four to six) and were constrained by the Standard Table wards used for 2001 Census outputs. They had a minimum size of 1,000 residents and 400 households, but average 1,500 residents. Measures of proximity (to give a reasonably compact shape) and social homogeneity (to encourage areas of similar social background) were also included.

(Note: the specific homogeneity criteria used related to type of dwelling - e.g., detached/semi-detached etc. - and nature of tenure - e.g., owner-occupied, private rented etc.).

D.1.4 Middle Super Output Areas (MSOAs)

The Middle Layer SOAs (MSOAs) were defined in a two-stage process: an initial set was generated automatically but the boundaries were then modified in consultation with local authorities and other local bodies. The final boundaries were released to the public in August 2004.

The MSOAs used in this analysis were formulated with the 2001 census. Since the 2011 census, certain boundaries have changed, resulting in eight new MSOAs. However, this data was unavailable when the analysis was performed.

As with the LSOAs, initial Middle Layer SOAs were generated automatically by zone-design software. They were built using 2001 Census data from groups of Lower Layer SOAs and had a minimum size of 5,000 residents and 2,000 households. They also fitted within the boundaries of local authorities as at the end of 2002 (corresponding with the geography of the Census).

A nationwide consultation exercise gave local authorities the opportunity to amend the initial Middle Layer SOAs to define areas more suited to local requirements. The consultation resulted in 6,781 MSOAs in England (and 413 in Wales) with an average population size of 7,200.

Annex E: 1993 results

ROAD SIGNS: ENGLAND-WIDE ESTIMATES

SIGN CATEGORY	SIGN TYPE	SIGNS ON ALL ROADS	SUPPLEMENTARY SIGN %	% VARIABLILTY
WARNING	S1 Dist. stop/give way	11655	88	3
	S2 Junction warning	62427	4	3
	S3 Roundabout warning	12779	29	7
	S4 Bend warning	65275	13	2
	S5 Road narrows	22557	16	4
	S6 Two-way traffic	13324	1	6
	S7 Steep hill	4613	24	7
	S8 Bridge/tunnel warn.	2833	12	8
	S9 Misc. danger warning	12007	42	10
	S10 Cycle warning	809	18	17
	S11 Vehicle warning	488	6	25
	S12 Sharp deviation	36940	2	4
	S13 Roundabt. deviation	22961	1	8
	S14 Road merge	1743	15	38
	S15 Speed humps	4675	91	9
	S16 Slow lorries	103	76	208
	S17 Height warning	11486	39	7
	S18 Train warning	3143	51	10
	S19 Traff. signals ahead	5836	19	11
	S20 Pedestrian warning	73352	81	2
	S21 Animal warning	12478	10	5
	S22 Water warning	1568	19	11
REGULATORY	S23 Stop	6298	2	4
	S24 Give way	92449	5	2
	S25 Turning regulation	40739	35	5
	S26 Turning restriction	21028	5	12
	S27 Vehicle prohibition	11114	66	5
	S28 Restriction ends	4541	1	7
	S29 Speed limit	120730	0	3
	S30 No speed restriction	67626	0	3
	S31 Speed limit repeaters	104155	0	5
	S32 Minimum speed limit	37	0	760
	S33 Mini roundabout	8534	2	13
	S34 No entry	53354	2	5
	S35 No entry/except buses etc	978	0	12
	S36 No stopping	34289	61	10
	S37 No stopping repeater	9112	0	19
	S38 Bollards	131434	0	5
	S39 Waiting/loading rest	421948	0	4
	S40 Waiting limit	21842	0	7
	S41 Urban clearway	855	0	20
	S42 Vehicle regulations	2026	0	13
	S43 Clearway regulation	3444	0	14
	S44 Veh. weight limits	25083	80	7
	S45 Pedests/cycle route	5690	3	17
	S46 Veh. size prohib.	12654	58	6
	S47 Vehicle priority	1572	21	10

TABLE D1

ROAD SIGNS: ENGLAND-WIDE ESTIMATES

SIGN CATEGORY	SIGN TYPE	SIGNS ON ALL ROADS	SUPPLEMENTARY SIGN %	% VARIABLILTY
REGULATORY	S48 Ped/cycle restriction	8762	1	6
	S49 One way traffic	37737	4	6
	S50 No overtaking	566	55	45
	S51 Bus lanes	2742	9	21
	S52 Parking regulations	35875	0	18
	S53 Motorway regulations	1298	0	42
	S54 Perm stay lane signs	49	0	54
	S55 Vehicle regulatory	90	0	104
	S56 Restricted zones	12012	0	7
DIRECTION	S57 Motorway Gantry	1272	0	153
	S58 Motorway Advance	2160	0	77
	S59 Motorway Stack	229	0	177
	S60 Motorway Flag	3503	0	29
	S61 Motorway Other	1233	0	45
	S62 Primary Route Gantry	481	0	73
	S63 Primary Rte.Advance	12238	0	10
	S64 Primary Rte. Stack	2343	0	17
	S65 Primary Rte. Flag	26225	0	7
	S66 Primary Rte. Other	3825	0	16
	S67 NPR Gantry	175	0	187
	S68 NPR Advance	22503	0	5
	S69 NPR Stack	10212	0	7
	S70 NPR Flag	72244	0	4
	S71 NPR Other	2844	0	15
	S72 Local Gantry	1926	0	23
	S73 Local Advance	5832	0	12
	S74 Local Stack	15205	0	8
	S75 Local Flag	173216	0	3
	S76 Local Other	397	0	27
	S77 Goods vehicles	3079	0	16
	S78 Pedestrians	14764	0	7
	S79 Cycle route	2857	0	15
	S80 Services	617	0	62
	S81 Ancient Monument	545	0	28
	S82 MOD	2363	0	20
	S83 Tourists (old type)	634	0	38
	S84 Tourists (new type)	23989	0	6
	S85 Place names	36970	0	3
	S86 Station direction	3149	0	11
	S87 Parking direction	11630	0	9
	S88 Dir. prohib. movemt.	47	0	43
	S89 Permanent diversion	1648	0	25
	S90 Cemetary sign	60	0	30
INFORMATION	S91 Lane permitted move	841	0	23
	S92 Radio travel news	0	.	.
	S93 No through roads	103481	0	3
	S94 AA/RAC Phone/Serv.	556	0	34
	S95 Traffic merge	736	0	72

TABLE D1 (Cont)

ROAD SIGNS: ENGLAND-WIDE ESTIMATES

SIGN CATEGORY	SIGN TYPE	SIGNS ON ALL ROADS	SUPPLEMENTARY SIGN %	% VARIABLILTY
INFORMATION	S96 Pedestrian info.	0	.	.
	S97 Cycle information	1018	0	23
	S98 Information /taxis	278	0	64
	S99 Parking place sign	18294	0	8
	S100 Lane control	0	.	.
	S101 Narrow road	5943	0	6
	S102 Countdown markers	2891	0	22
	S103 Crossing information	4210	0	22
	S104 Hard shoulder signs	457	0	125
	S105 Dual carriageway	2691	0	10
	S106 Crawler lane	0	.	.
	S107 Miscellaneous	5859	0	9
	S108 Various	256	0	23
	S109 Old design direction sign	1627	0	13
	S110 Blank grey VMS	569	0	27
	S112 Pelican	11618	0	8
	S113 Signals with ped control	12671	0	15
	S114 Signls-no ped control	10723	0	12
	S115 Rural direction signs	119425	0	3

TABLE D1 (Cont.)

Annex F: Analytical Assurance Statement

The level of assurance for the results of the analysis undertaken is low.

The In House Analytical Consultancy (IHAC) has undertaken an analysis of a subset of Local Authorities (Local Authorities), Transport for London TFL and Highways sign inventory data to estimate the number of traffic signs in England – both in total and for a number of specified groups. In areas where the number of signs were known (about 25% by area) these were related to explanatory variables such as population, road lengths/type etc within those specific areas. This enabled estimates to be made for those areas where sign data were not available.

The data had a number of limitations in terms of coverage and accuracy and these are fully identified in the report. Significant improvements in the quality and depth of coverage of the data would be needed, the responsibility of which lies with Local Authorities, TFL and Highways, in order to obtain more reliable estimates. A number of slightly different approaches were used and these gave similar answers. - that the total number of signs had roughly doubled from just under 2.2 million in 1993 to just over 4.5 million in 2013.

The work was undertaken by experienced and skilled staff with sufficient time and resources to analyse the data. Given the quality of the data however, the results should be treated as “ball park” figures.