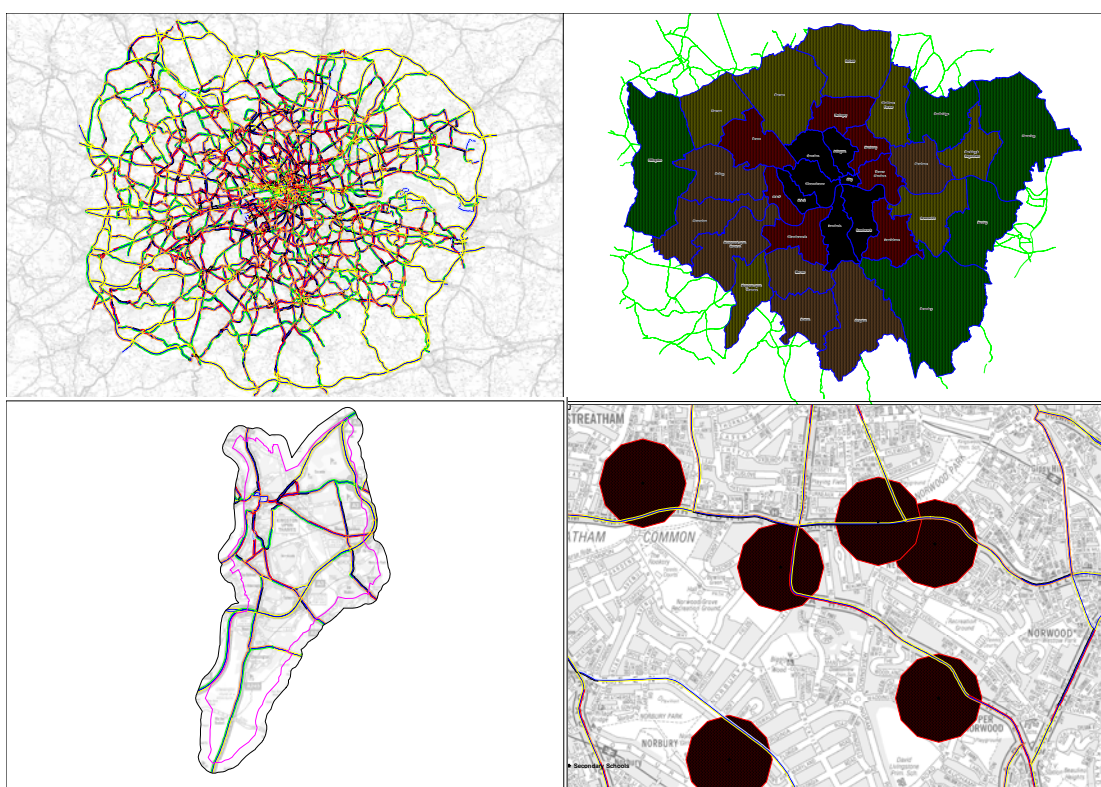


Road Network Performance & Research Team

RNPR Technical Note 3 April 2006

Total vehicle delay for London



Précis:

This technical note provides a summary and analysis of estimated total vehicle delay in London derived from the ITIS journey time data in conjunction with recorded traffic flows (from DfT traffic counts). It summarises total vehicle delay for London broken down by different networks, areas and times of day. It also provides an estimated cost of total annual vehicle delay in London.

Contents

Contents.....	1
1 Introduction.....	2
2 Delay on the Network of Interest.....	2
3 Delay on the TLRN and SRN.....	6
4 Delay on the BPRN.....	9
5 Estimated cost of vehicle delay.....	10
6 Methodology for calculating total vehicle delay.....	10
7 Assumptions made for calculating total vehicle delay.....	12
8 Contacts for further information.....	12
9 Library of technical notes.....	13
10 References.....	13

Tables

Table 1 – Estimated total daily vehicle delay within Greater London on the NOI by area, time period and day of the week.....	3
Table 2 – Estimated total annual vehicle delay within Greater London on the NOI by area and time period.....	3
Table 3 – Estimated total annual vehicle delay on the NOI by borough and time period.....	4
Table 4 – Estimated total daily vehicle delay within Greater London on the TLRN and SRN by area, time period and day of the week.....	7
Table 5 – Estimated total annual vehicle delay within Greater London on the TLRN and SRN by area and time period.....	8
Table 6 – Estimated total daily vehicle delay within Greater London on the BPRN by area, time period and day of the week.....	9
Table 7 – Estimated total annual vehicle delay within Greater London on the BPRN by area and time period.....	9
Table 8 – Estimated cost of annual vehicle delay on the NOI, TLRN, and SRN.....	10

Figures

Figure 1 – Thematic map of total annual vehicle delay on the NOI by borough (million minutes per km).....	5
-----------------------------------------------------------------------------------------------------------	---

1 Introduction

- 1.1 Traffic speed data (commonly referred to as 'ITIS data') is supplied by the company ITIS Holdings plc (Integrated Transport Information Services). The basic data results from a GPS-based tracking system that records the position every minute of vehicles that are signed up to the system. The Department for Transport have contracted the ITIS Holdings company to supply data for a three year period (2004-2006) as well as provide historic data (2001 – 2003) at a later date, to be used by highways authorities including TfL. This will enable detailed analysis of traffic speeds and cross-analysis of these with a variety of land use planning and cartographical features, across the whole of London.
- 1.2 This technical note, produced by the Road Network Performance and Research (RNPR) Team within TfL, provides a summary and analysis of estimated total vehicle delay in London derived from the ITIS journey time data in conjunction with recorded traffic flows (from DfT traffic counts). It summarises total vehicle delay for London broken down by different networks, areas and times of day. In Section 5, the total cost of vehicle delay for London is estimated.
- 1.3 Section 6 of this technical note provides a full methodology detailing how the delay figures reported have been estimated. For the purposes of this technical note delay on each network link has been interpreted as the actual speed compared to free flow speed. Free flow speeds have been approximated by using the actual nighttime speed (10pm to 6am). This takes into account that freeflow speeds will vary by area, for instance they are not expected to be as high in Central London compared to Outer London.
- 1.4 The aim of this technical note is to provide an estimation of the amount of time and cost vehicle delay causes in London. This note will be updated annually by the RNPR team so that year on year comparisons can also be made. This technical note is based on 2003 data.

2 Delay on the Network of Interest

- 2.1 The Network of Interest (NOI) is defined as all 'M' and 'A' numbered roads, plus busy minor roads, and busy bus routes. It comprises of around 2930 km of network in total, 2300 km within the Greater London area and is split into 9400 individual links.
- 2.2 Table 1 on the next page shows total vehicle delay within Greater London on the NOI by area, time period and day of the week. Both weekdays and weekend days show the greatest vehicle delay occurring in the PM Peak. However whereas the average AM Peak vehicle delay is significant on weekdays, it is much less so on weekend days.

Table 1 – Estimated total daily vehicle delay within Greater London on the NOI by area, time period and day of the week

		Total vehicle delay (000's minutes)			
		AM Peak per hour	Inter Peak per hour	PM Peak per hour	12 Hour (7am to 7pm) Total
Average weekday	Central	171	191	209	2,283
	Inner	722	616	876	8,491
	Outer	2,035	1,343	2,258	20,934
	Total	2,927	2,150	3,342	31,709
Average Saturday	Central	51	100	129	1,141
	Inner	197	505	606	5,441
	Outer	629	1,347	1,502	14,476
	Total	877	1,952	2,237	21,058
Average Sunday	Central	47	136	213	1,597
	Inner	107	425	630	4,760
	Outer	429	1,024	1,230	11,118
	Total	583	1,585	2,072	17,474

2.3 Table 2 below shows the estimated total annual vehicle delay on the NOI by area and time period. In total, annual vehicle delay on the NOI was 10,250 million minutes. As expected the highest proportion of annual vehicle delay occurred within Outer London which makes up the majority of the network. However when the length of network in each area is taken into account Inner London shows the highest annual vehicle delay per km with 5.67 million minutes.

Table 2 – Estimated total annual vehicle delay within Greater London on the NOI by area and time period

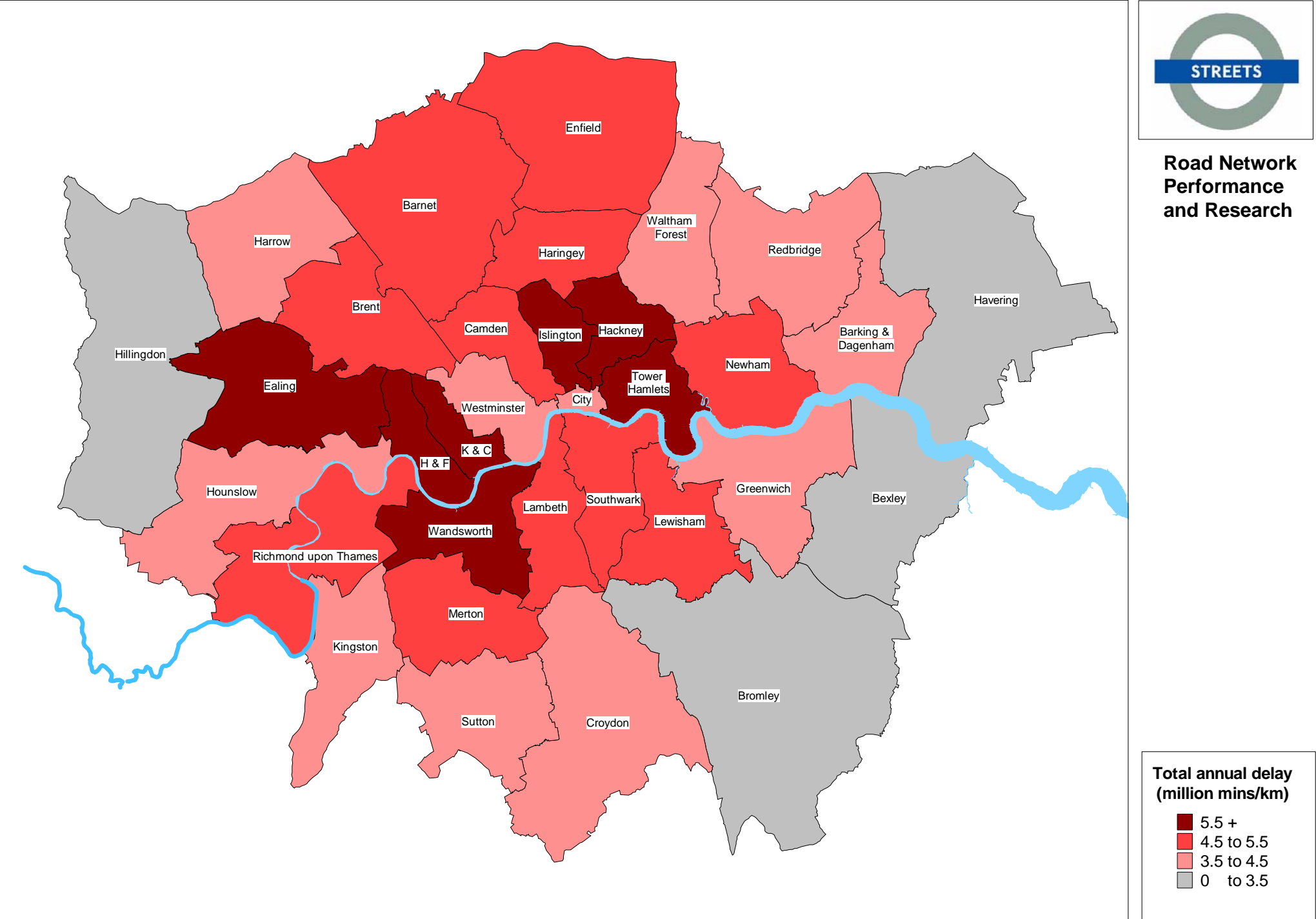
	Total annual vehicle delay (million minutes)					Length of Network (Km)
	AM Peak per hour	Inter Peak per hour	PM Peak per hour	12 Hour (7am to 7pm) Total	12 Hour Total (per Km)	
Central	49.5	61.9	72.0	736.1	4.62	159
Inner	203.4	208.6	292.0	2738.2	5.67	483
Outer	584.0	472.4	729.1	6773.7	4.08	1660
Total (Greater London)	837.0	742.9	1093.1	10248.0	4.45	2301

2.4 Table 3 on the next page shows the estimated total annual vehicle delay on the NOI by borough and time period. The borough of Hammersmith and Fulham shows the highest annual vehicle delay per km of network with 7.6 million minutes followed by Kensington & Chelsea with 6.9 million minutes. Bromley shows the lowest annual vehicle delay per km with 2.7 million minutes closely followed by Bexley and Hillingdon both 2.8 million minutes. The thematic map (Figure 1) on page 5 shows the total annual vehicle delay per km by borough.

Table 3 – Estimated total annual vehicle delay on the NOI by borough and time period

Borough	Total annual vehicle delay (million minutes)					
	AM Peak per hour	Inter Peak per hour	PM Peak per hour	12 Hour (7am to 7pm) Total	12 Hour Total (per Km)	Length of Network (Km)
Barking & Dagenham	15.2	11.2	16.5	162.3	3.62	45
Barnet	52.9	42.4	68.6	618.8	5.14	120
Bexley	20.0	16.4	20.3	219.5	2.77	79
Brent	28.2	28.5	40.2	376.4	5.22	72
Bromley	28.8	26.3	35.0	349.2	2.72	128
Camden	19.9	24.4	33.1	305.1	4.65	66
City of London	6.6	6.3	5.6	74.5	3.54	21
Croydon	30.8	29.7	40.5	392.3	3.94	100
Ealing	49.4	36.9	60.1	550.0	6.33	87
Enfield	39.0	31.4	49.1	452.6	4.52	100
Greenwich	35.3	21.8	35.4	342.8	3.80	90
Hackney	15.4	18.6	26.8	237.9	5.57	43
Hammersmith & Fulham	21.3	21.6	34.7	297.5	7.60	39
Haringey	21.5	19.8	28.6	268.9	4.83	56
Harrow	17.4	14.8	24.1	213.5	3.57	60
Havering	19.7	17.3	29.6	251.9	3.04	83
Hillingdon	34.1	18.0	37.1	321.5	2.79	115
Hounslow	39.5	23.4	41.4	383.6	4.26	90
Islington	20.2	20.7	24.8	259.1	6.12	42
Kensington & Chelsea	16.8	21.7	27.1	261.9	6.89	38
Kingston upon Thames	21.1	13.6	20.4	206.3	3.87	53
Lambeth	27.3	24.2	32.8	325.3	5.06	64
Lewisham	21.9	24.4	31.9	307.4	5.20	59
Merton	21.6	21.0	26.1	269.0	4.61	58
Newham	20.3	21.3	26.8	268.8	4.94	54
Redbridge	22.0	20.9	34.2	294.1	4.01	73
Richmond upon Thames	27.9	22.9	38.1	335.0	4.74	71
Southwark	23.7	23.1	31.9	305.2	4.57	67
Sutton	17.5	15.0	21.4	206.7	4.46	46
Tower Hamlets	21.0	20.8	35.0	292.9	6.38	46
Waltham Forest	18.5	17.9	31.8	258.1	4.24	61
Wandsworth	36.4	32.1	41.4	426.1	6.26	68
Westminster	26.6	34.7	40.3	408.7	4.20	97

Figure 1 – Thematic map of total annual vehicle delay on the NOI by borough (million minutes per km)



3 Delay on the TLRN and SRN

- 3.1 The Transport for London Road Network (TLRN) and Strategic Road Network (SRN) are subsets of the NOI. The TLRN is comprised around 585 km of network and makes up around 25% of the NOI within Greater London. It makes up 4% of all roads in Greater London but carries 29% of all the traffic.
- 3.2 A further 500km of main borough roads have been designated by the Secretary of State as London's Strategic Road Network (SRN). Boroughs will retain overall responsibility for their roads, but where an existing borough road forms part of the new SRN, they will have to notify TfL before using their traffic powers. In particular, they must notify TfL of schemes designed to alter the performance of roads that comprise the SRN.
- 3.3 Table 4 on the next page shows total vehicle delay on the TLRN and SRN by area, time period and day of the week. Figures are reported separately for the TLRN, the SRN and the TLRN & SRN combined. On the TLRN the total vehicle delay on an average weekday is almost twice as much as on an average Saturday or Sunday. However on the SRN the difference between total vehicle delay on an average weekday and an average Saturday or Sunday is not as great.

Table 4 – Estimated total daily vehicle delay within Greater London on the TLRN and SRN by area, time period and day of the week

		Total vehicle delay (000's minutes)				
		AM Peak per hour	Inter Peak per hour	PM Peak per hour	12 Hour (7am to 7pm) Total	
TLRN	Average weekday	Central	97	93	117	1,202
		Inner	366	302	446	4,248
		Outer	772	379	741	6,812
		Total	1,235	774	1,304	12,262
	Average Saturday	Central	22	48	65	548
		Inner	81	220	272	2,376
		Outer	155	358	445	3,945
		Total	258	625	781	6,869
	Average Sunday	Central	20	62	123	800
		Inner	42	201	320	2,292
		Outer	107	299	412	3,348
		Total	169	562	854	6,439
SRN	Average weekday	Central	39	55	54	609
		Inner	146	135	195	1,832
		Outer	429	374	526	5,105
		Total	614	564	774	7,546
	Average Saturday	Central	12	26	32	289
		Inner	40	120	143	1,269
		Outer	150	380	396	3,916
		Total	202	526	572	5,474
	Average Sunday	Central	13	43	55	461
		Inner	23	90	133	1,008
		Outer	89	259	277	2,653
		Total	126	392	465	4,123
TLRN & SRN	Average weekday	Central	136	149	171	1,811
		Inner	513	437	641	6,080
		Outer	1,201	752	1,267	11,917
		Total	1,849	1,338	2,078	19,808
	Average Saturday	Central	34	74	97	837
		Inner	120	340	415	3,645
		Outer	305	737	841	7,861
		Total	459	1,151	1,353	12,343
	Average Sunday	Central	33	105	177	1,261
		Inner	65	291	453	3,300
		Outer	196	558	689	6,001
		Total	294	954	1,319	10,562

3.4 Table 5 below shows the estimated total annual vehicle delay on the TLRN and SRN by area and time period. In total, annual vehicle delay on the TLRN was 3,880 million minutes and 2,461 million minutes on the SRN. As expected the highest proportion of annual vehicle delay for each of these networks occurred within the Outer London area which makes up the majority of the network. For both the TLRN and SRN the highest vehicle delay per km occurs within the Inner London area. However for the TLRN total annual vehicle delay per km in the Central area is also relatively high (7.57 million minutes per km) compared to the NOI and SRN. The total annual vehicle delay per km on the TLRN is more than on the SRN in all areas of London.

Table 5 – Estimated total annual vehicle delay within Greater London on the TLRN and SRN by area and time period

		Total annual vehicle delay (million minutes)					Length of Network (Km)
		AM Peak per hour	Inter Peak per hour	PM Peak per hour	12 Hour (7am to 7pm) Total	12 Hour Total (per Km)	
TLRN	Central	27.4	30.0	40.1	382.5	7.57	50.5
	Inner	101.6	100.4	146.7	1347.3	7.71	174.7
	Outer	214.3	132.6	237.2	2150.2	5.97	360.3
	Total (Greater London)	343.3	263.0	424.0	3880.1	6.63	585.4
SRN	Central	11.3	18.0	18.5	197.4	4.33	45.6
	Inner	41.3	46.0	65.0	594.7	6.53	91.0
	Outer	123.9	130.4	171.7	1669.0	4.97	336.0
	Total (Greater London)	176.6	194.3	255.2	2461.0	5.21	472.5
TLRN & SRN	Central	38.8	48.0	58.6	579.9	6.04	96.1
	Inner	142.9	146.3	211.7	1942.0	7.31	265.7
	Outer	338.2	263.0	408.9	3819.2	5.49	696.2
	Total (Greater London)	519.9	457.3	679.2	6341.1	5.99	1058.0

4 Delay on the BPRN

- 4.1 The Borough Principal Road Network (BPRN) is also a subset of the NOI. The BPRN is comprised of around 1120 km of strategic network which is managed by the boroughs.
- 4.2 Table 6 below shows total vehicle delay on the BPRN by area, time period and day of the week. Total vehicle delay on an average weekday is around twice as much as on an average Sunday and almost 40% more than on an average Saturday.

Table 6 – Estimated total daily vehicle delay within Greater London on the BPRN by area, time period and day of the week

		Total vehicle delay (000's minutes)			
		AM Peak per hour	Inter Peak per hour	PM Peak per hour	12 Hour (7am to 7pm) Total
Average weekday	Central	54	72	68	797
	Inner	260	232	318	3,128
	Outer	910	734	1,083	10,384
	Total	1,224	1,038	1,469	14,310
Average Saturday	Central	18	35	43	393
	Inner	79	204	235	2,163
	Outer	343	740	790	7,841
	Total	440	979	1,069	10,396
Average Sunday	Central	15	54	66	567
	Inner	45	160	222	1,763
	Outer	210	514	563	5,404
	Total	271	728	852	7,733

- 4.3 Table 7 below shows the estimated total annual vehicle delay on the BPRN by area and time period. In total, annual vehicle delay on the BPRN is 4,663 million minutes. The highest proportion of annual vehicle delay for the BPRN occurs within the Outer London area which makes up the majority of the network. The highest annual vehicle delay per km on the BPRN occurs within the Inner London area (5.22 million minutes per km).

Table 7 – Estimated total annual vehicle delay within Greater London on the BPRN by area and time period

	Total annual vehicle delay (million minutes)					
	AM Peak per hour	Inter Peak per hour	PM Peak per hour	12 Hour (7am to 7pm) Total	12 Hour Total (per Km)	Length of Network (Km)
Central	15.7	23.3	23.4	257.1	4.19	61.3
Inner	74.1	79.3	106.5	1017.5	5.22	195.1
Outer	265.3	256.2	351.9	3388.6	3.94	860.0
Total (Greater London)	355.2	358.7	481.8	4663.2	4.18	1116.4

5 Estimated cost of vehicle delay

- 5.1 The DfT uses COBA (COst Benefit Analysis) to compare road schemes costs against the derived benefits to road users, and presents the results as a monetary value. One benefit attributes a monetary value on time savings, and this can be used to produce an estimation of delay cost.
- 5.2 The COBA Manual identifies three main travel purposes;
- 1 - Work (travel in the course of work);
 - 2 - Commuting (travel to and from normal place of work);
 - 3 - Other (travel for non-working reasons).

These are based on various assumptions which can be found in more detail at: http://www.dft.gov.uk/stellent/groups/dft_econappr/documents/page/dft_econappr_504873.pdf

- 5.3 The cost of delay for an average vehicle is given as £9.30 per hour in (volume 13, section 1) chapter 1, part 2 of the COBA Manual. This is based on 2002 national average vehicle proportions, travel purpose proportions, resource prices and 2000 vehicle occupancies. This cost equates to 15.5 pence per minute for an average vehicle. By applying this to the figures for total delay in million minutes for each network the total annual cost of vehicle delay can be estimated:

Table 8 – Estimated cost of annual vehicle delay on the NOI, TLRN, and SRN

	Estimated cost of annual vehicle delay (£million)			
	NOI	TLRN	SRN	TLRN & SRN
Central	114.1	59.3	30.6	89.9
Inner	424.4	208.8	92.2	301.0
Outer	1049.9	333.3	258.7	592.0
Total	1588.4	601.4	381.5	982.9

- 5.4 Table 8 shows that the estimated total cost of annual vehicle delay on the NOI is £1.6 billion. The TLRN accounts for 38% of this (£601 million) and the SRN 24% (£382 million). These figures are likely to be conservative as the cost of delay for an average vehicle in London is expected to be higher than the national figure due to higher vales of time and higher vehicle occupancies. In addition, only busier roads, with recorded flows and speeds have been included in the assessment. These factors are balanced in part by the assumptions made in calculating total vehicle delay (see section 7.)

6 Methodology for calculating total vehicle delay

- 6.1 This section provides a step by step methodology describing how the tables and figures contained in this technical note are derived:
1. Summary ITIS data is extracted from the processed raw data using October 2003, a generally neutral month of the year. This shows for each link on the ITIS network the average journey time and frequency of observations split for (i) working days only (ii) Saturdays and (iii) Sundays for the AM Peak (7am to 10am), Inter Peak (10am to 4pm), PM Peak (4pm to 7pm) and Night time (10pm to 6am) periods. Note the following steps are repeated for weekdays, Saturdays and Sundays separately.

2. For each link the AM, Inter and PM Peak period delay measurements are calculated (measured in minutes per km). This is a measure comparing the actual average peak speed to the actual average night time speed (free flow). Where there are no night time observations the speed limit of the link is used as a proxy for the free flow speed.
3. Links with fewer than 2 observations in each of the daytime peak periods are set to missing. As a sensitivity test this process was repeated but with links with 4 or fewer observations set to missing instead. The overall results showed there is no significant difference between the criteria used in this step and therefore the analysis was completed with links with fewer than 2 observations set to missing.
4. Links which have a negative delay are set to zero delay (ie daytime speed is greater than free flow speed).
5. For each peak period multiply the average vehicle delay (mins per km) for each link by the average vehicle km travelled per hour recorded from DfT National Road Traffic Census Counts. Sum these for each time period, by area of London, and by road class to calculate the total vehicle delay per hour for each group. Additionally calculate the length of network which has valid observations for each group – The ratio of the network with valid observations to the full network is used to factor the estimated delay to reflect the entire network.

Note:

Areas of London used:

Central = TfL Central Cordon Boundary (an area within radius 2.5 – 3 kms from a centre at Aldwych);

Inner = Between Central Area and TfL Inner Cordon Boundary (an area roughly corresponding to the old London City Council, but excluding much of the boroughs of Greenwich and Lewisham);

Outer = Between Inner Area and current GLA Boundary;

Beyond Outer = Area outside GLA Boundary.

Road Classes used:

'M', 'A', 'B', 'C' and 'U'

6. From the extrapolated summary tables which now represent vehicle delay on the entire network for each group multiply the AM Peak total vehicle delay per hour by 3, Inter Peak by 6, and PM Peak by 3. The sum of these will represent the total vehicle delay for the 12 hour (7am to 7pm) period. Figures for Central, Inner and Outer London can then be calculated by summing the relevant groupings. Completing this for weekdays, Saturdays and Sundays gives an average figure for each of these days. An annual delay figure can be estimated by multiplying the average weekday delay by 260, average Saturday delay by 52, and average Sunday delay by 52.

7 Assumptions made for calculating total vehicle delay

7.1 The key assumptions made are:

- The traffic data used to calculate the vehicle kilometres figures are derived from DfT manual classified counts. These are undertaken on neutral months/weekdays (i.e. March, April, May, June, September, and October). There may be scope to apply factors to calculate total annual delay (i.e. not simply weekday average x 260 and each weekend day x 52). However it is anticipated this would not significantly change the summary figures reported in this technical note.
- October 2003 (base month for delay) is representative of annual delay.
- Currently the recorded traffic flows used to calculate the total weekend delay are the same as those used to calculate total weekday delay. There may be a need to apply factors to these to compensate for the drop in traffic at weekends, however it is anticipated this would not significantly change the summary figures reported in this technical note.
- There is no delay between 7pm and 7am.

7.2 The estimates of delay are likely to be maximum values given the assumptions above as they are likely to introduce positive error into the calculations.

8 Contacts for further information

8.1 If you require further information on this traffic note or have any other related queries please contact:

Mike Tarrier
0207 027 9039
miketarrier@streetmanagement.org.uk

Lee Abbott
0207 027 9339
leeabbott@streetmanagement.org.uk

Martin Obee
0207 027 9343
martinobee@streetmanagement.org.uk

9 Library of technical notes

Other technical notes in the RNPR series include:

ITIS

- ITIS – Validation Paper July 2005
- RNPR Technical Note 1 – ITIS Speed Survey Data
- RNPR Technical Note 2 – Traffic Delays in London on Weekdays, Saturdays and Sundays
- RNPR Technical Note 3 – Total vehicle delay for London

DfT NRTCC Counts

- Traffic Note 1 – Traffic levels on major roads in Greater London 1993-2004
- Traffic Note 2 - Expansion factors for road traffic counts in London

TfL Cordon and Screenline Counts

- Traffic Note 3 – TfL Cordon and Screenlines 1975 to 2005 (Draft – to be published Spring 2006)

Moving Observer Survey Data

- Traffic Note 4 – Traffic Speed in London 2001-2006 (Draft – to be published June 2006 at the end of cycle 12)

10 References

- Journey time information used in this technical note is derived from data provided by ITIS Holdings obtained from vehicles fitted with GPS devices
- Traffic data used in this technical note is derived from Department for Transport National Road Traffic Census Counts (NRTCC).