Transport for London
Congestion Charging

Central London Congestion Charging Scheme:
ex-post evaluation of the quantified impacts of the original scheme

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1 Introduction

1.1 This paper provides an outturn or *ex post facto* monetised evaluation of the quantified impacts of the original Central London congestion charge introduced in 2003. It brings together various previous estimates by Transport for London from a number of sources and takes account of the latest guidance from the Department for Transport on economic evaluation. It also responds to the preliminary evaluations of the congestion charging scheme prepared and published by others.

1.2 A summary version of the main evaluation presented here is included in section 7 of Transport for London's *Congestion Charging Impacts Monitoring Fifth Annual Report.*

1.3 This note is structured around the estimation of the principal benefit items and costs of the central area congestion charging scheme with its initial £5 charge, with an estimate made of the changes resulting from the increase to an £8 charge in July 2005. It does not consider the effects of the western extension of charging or the earlier finish to charging hours, introduced in February 2007.

1.3 Transport for London has estimated the impacts arising from the congestion charge from a number of sources. There has been a comprehensive programme of monitoring of traffic conditions since the charge was introduced in February 2003 and comparison with pre-charge conditions.

1.4 These observed changes in flows and speeds have been replicated in different traffic models to assist the derivation of estimates of the principal benefit items. In particular the LTS model – the London Transportation Studies four stage model – has been used as a traffic assignment model, with aggregate traffic flows and speeds constrained to observed values, to estimate total changes in travel times.

1.5 The principal evaluations of the congestion charge from outside Transport for London of which we are aware are those prepared by:

- *Prud'homme and Bocarejo: The London congestion charge: a tentative economic appraisal. Transport Policy 12 (2005),*
- *Mackie: The London congestion charge: a tentative economic appraisal. A comment on the paper by Prud'homme and Bocarejo Transport Policy 12 (2005), and*
- *Santos and Shaffer: Preliminary results of the London congestion charging scheme. Public Works Management and Policy 9 (2004)*

1.6 In Section 2 of this note, Transport for London's current economic evaluation of the congestion charge is summarised. This is based on LTS model output and follows the Department for Transport's *WebTAG* principles set out in *WebTAG note 3.5.3 - Transport User Benefit Calculation.* The possibility of wider benefits outside the evaluation is considered.

1.7 Section 3 summarises the findings of the non-Transport for London estimates and in Section 4 some of the issues raised in the evaluations from outside Transport for London are discussed. For example:

- What effect does the congestion charge have outside the charged area?
- What values of time savings have been and should be used?
- What is the effect of the change in the daily charge from £5 to £8?
- What contribution do small time savings make to the overall evaluation?

1.8 Section 5 summarises the findings to date.

1.9 This paper seeks to provide an economic evaluation of the 'pure' effects of charging – separating the effects of charging from other changes that have occurred since charging was first introduced in 2003, including changes facilitated by charging. The evaluation of charging has been undertaken in two steps:

- the effects of the initial £5 charge have been evaluated essentially by comparing post-charging conditions in 2003 with those prevailing pre-charging in 2002, and

- the incremental effects of the change from a £5 charge to an £8 charge, together with adjustments to monthly, annual, fleet and resident charges, have been evaluated by comparing conditions in 2005 with an £8 charge with 2005 conditions with a £5 charge.

1.10 The two main changes that the evaluation has aimed to set to one side are: an apparent long-term decline in traffic levels within Central and Inner London, probably largely attributable to the consequences of parking policies; and increased congestion inside the charging zone, attributed by Transport for London to traffic management and other interventions that have the effect of redistributing effective highway capacity.

1.11 In 2006, observed traffic flows in the charged area were lower than in any recent year, in part no doubt because of the change to an £8 charge in July 2005. But network traffic speeds in the charged area were also lower than in any recent year. The observed average travel rate in the charged area, measured from different sources, has decreased from 3.5 min/km (around 17 km/hour) in 2003 to around 3.7 min/km (around 16 km/hour) in 2005, and to around 4.0 min/km (around 15 km/hour) in the latter months of 2006.

1.12 The declining average speed over the period 2003 to 2006 mirrors a long-term trend in Central London. Data from the past thirty years show traffic speeds in the charging zone declining from around 18 km/hour in the late 1970s to around 14 km/hour in 2000 to 2002. Over this period traffic flows in Central London initially increased but then declined. In the late 1970s around 1.6 million vehicles per day crossed the Central London cordon. This total reached a peak of around 1.8 million in the late 1980s but by 2002 the total had fallen to around 1.5 million – see Figure 3.9 of Transport for London's *Congestion Charging Fourth Annual Impacts Monitoring Report, June 2006.*

1.13 Among the factors contributing to this long-term decline in speeds are a variety of interventions aimed at bringing about a better balance between all users of the road network, which fall into four broad categories:

- widespread use of traffic control and safety-related measures on major and minor roads, having impacts on traffic levels and speeds

- continuing allocation of the road carriageway to bus services, including bus lanes and bus priorities at traffic signals, perhaps offset by improved ticketing arrangements

- enhanced provision for cyclists and pedestrians at junctions

- enhancements of the 'public realm' with increased space for pedestrians.

1.14 Road capacity can also be affected by street works in support of traffic and highway measures and in connection with water, gas, electricity and telecommunications utilities; this appears to be an important factor in the latter part of 2006 when the intensity of congestion increased significantly.

1.15 The implementation of capacity re-allocation measures may have accelerated in the post-charging environment and will have contributed to the continuing decline in speeds. It is probable that some of these measures have been enabled by charging and would not have happened had charging not reduced traffic levels in the centre of London.

1.16 Thus the benefit estimates presented here are based on the assumption that the highway network is left unaltered after charging, so that the main benefit of charging is that traffic remaining on the network has a faster journey. In broad terms, it is considered that the changes in travel rates as a consequence of charging are largely unaffected by these interventions. Thus an improvement of, say, 0.5 minutes per kilometre in 2003 as a result of charging is still assumed to apply in 2006 even if absolute travel rates have increased.

1.17 This analysis therefore ignores the effects these subsequent interventions have had in reducing effective highway capacity. It also ignores the consequences of changes in traffic levels across London more generally. The assessment of these effects is outside the scope of this paper.

1.18 This is in contrast with TfL's *Fifth Annual Monitoring Report*, which reports on observed, real changes from year to year from 2002 onwards. While all of the changes reported there will have been influenced by the congestion charge, some will also have been influenced by other changes which are eliminated from this analysis. This means that some of the recent impacts of congestion charging, including the change from a £5 to an £8 charge, presented more definitively here, are much less distinct in the data presented in the *Fifth Annual Monitoring Report.*

2 Transport for London's evaluation

2.1 This evaluation combines the Department for Transport's methodologies set out in *WebTAG 3.5.1 (Public Accounts Sub-Objective)* and *3.5.2 (Transport Economic Efficiency Sub-Objective)* and incorporates other impacts – eg, safety, CO2, pollutants – from other parts of the *WebTAG* appraisal process. The values expressed are annual values, not net present values, in 2005 values and prices. The evaluations are expressed in the market price unit of account rather than the factor cost unit of account.

Public Accounts

2.2 The three impacts of charging on the public accounts are on

- 'Government' costs
- 'Government' revenues
- changes in indirect tax revenues

2.3 'Government' revenues equal all congestion charging revenues: charge payments of £120 million and penalty payments of £70 million at 2005 prices and values with a charge at £5 ie £190 million in total. See also Table 9.2 of Transport for London's *Fourth Annual Impacts Monitoring Report, June 2006.*

2.4 Consideration needs to be given to the unit of account in which payments are made. The factor cost unit of account expresses prices in resource costs. The market price unit of account expresses prices in market prices, the price paid by consumers for goods and services in the market place, including all indirect taxation. Prices that do not include taxation (eg: public transport fares, congestion charge payments) are still perceived by consumers in the market price unit of account. The factor to convert between factor costs and market prices is 1.209 from *WebTAG 3.5.6,* the average rate of indirect taxation in the economy.

2.5 Payments by non-business users, referred to later as 'individuals', are assumed to be in the market price unit of account. Payments by business users are assumed to be in the factor price unit of account, since businesses can reclaim VAT.

2.6 Around 62% of charge payments with a £5 charge are estimated from various indicators to be made by business users, who are assumed to account for about 40% of car trips and all commercial vehicle trips; and around 38% by individuals. So 38% of the charging revenues of £190m (ie £72 million) are from individuals and 62% (ie £118 million) from business users. In the market price unit of account, total revenue would be £72 million from individuals and £118 million multiplied by 1.209, ie £143 million, from business users, making around £215 million in total.

2.7 With the charge increased to £8, annual revenues have increased from about £190 million to around £210 million, with the increase in revenues affected by a reduction in the number of charge payers and smaller increases in fleet payments, which increased only from £5.50 to £7. There were also lower numbers of, and revenues from, Penalty Charge Notices as a result of various initiatives such as the subsequent variation that allows the payment of the charge on the day following the trip in the charging zone. In the market price unit of account, revenues can be estimated at £79 million from individuals and £130 million multiplied by 1.209, ie £157 million, from business users, making around £236 million in total.

2.8 'Government operating costs' equal Transport for London's congestion charging direct operating costs of around £5 million, plus the payments to the service providers that operate the congestion charge on behalf of Transport for London of around £85 million (2005 prices and values, charge at £5 – Table 9.2 of *the Fourth Annual Monitoring Report*) and various other costs. This equals £90 million in the factor cost unit of account or £90 million multiplied by 1.209, ie about £109 million in the market price unit of account.

2.9 The congestion charge affects indirect tax revenues. Reduced fuel consumption means a loss of fuel duty. Charge payments by individuals and increased bus and underground use mean a loss of tax revenue because these are zero-rated for VAT. The changes in indirect tax revenues amount to lost fuel taxation and lost VAT on additional fares and on charges paid by individuals.

2.10 Lost fuel duty is estimated at £25 million with a £5 charge and £27 million with an £8 charge, based on savings in fuel consumption of around 44 million litres in a year with a £5 charge and 48 million with an £8 charge – see paragraph 2.49 *et seq* on vehicle operating costs. Lost VAT on expenditure diverted to public transport fares is estimated at 0.175/1.175 * £16m which equals £2.4 million; and lost VAT on charges paid by individuals at 0.175/1.175 * £72 million which equals £10.7 million with a £5 charge or 0.175/1.175 * £79 million which equals £11.8 million with an £8 charge. In total, this gives around £13 -14 million in lost VAT and some £38 - 41 million in lost VAT and fuel duty. An allowance has also been made for the net loss in parking revenues to those boroughs inside the charging zone. In the absence of detailed data, this has been set at £15 million per year after consideration of the available information.

Infrastructure Costs

2.11 Costs of around £162 million were incurred in implementing congestion charging, equivalent to £196 million in the market price unit of account. The major items of expenditure were for traffic management measures, communications and public information on the scheme, systems set-up and management. These are converted here to an annual cost by depreciating over 10 years and adding in an opportunity cost of 5%, to give an equivalent annual cost of £25 million.

Public Accounts analysis

2.12 The impacts on the public accounts of £5 and £8 charges are summarised in Table 1.

Table 1: WebTAG Public Accounts with £5 and £8 charges, £M per year, 2005 values and prices

	£5 charge		£8 charge	
	Vehicles / occupants	**Buses / passengers**	**Vehicles / occupants**	**Buses / passengers**
Transport for London charge revenues				
- Charges paid by individuals	72		79	
- Charges paid by business	143		157	
Operating costs	-109		-109	
Infrastructure costs	-25		-25	
Sub-total	**81**		**102**	
Central government tax losses				
Fuel duty	-25		-27	
VAT on bus fares		-2		-2
VAT on charges	-11		-12	
Sub-total	**-36**	**-2**	**-39**	**-2**
Borough revenues				
Net parking revenue	-15		-15	
Sub-total	**-15**		**-15**	
Public Accounts Net annual change	**+28**		**+46**	

Notes Based on £5 and £8 charges, applied from 07.00 to 18.30 hours. In market prices.
Lost fuel duty shown here means that VAT on fuel duty is also lost, but this is assumed to be offset by equal VAT on the replacement expenditure.

2.13 Revenues are presented as positive numbers: costs and lost revenues as negative numbers. There are net surpluses to the public accounts of £28 million per year with a £5 charge and £46 million with an £8 charge.

2.14 The *WebTAG* Public Accounts Table for £5 and £8 charges is presented as Table 1 and the Transport Economic Efficiency Table as Table 2. The information in these tables is later brought together to give a complete evaluation of the £5 charge in Table 18 and of the £8 charge in Table 19.

Transport Economic Efficiency

2.15 The *WebTAG* Transport Economic Efficiency table, Table 2, shows efficiency savings to individuals and business. Travel time and travel time reliability savings, vehicle operating cost savings and user charges are shown separately for individuals – used to refer to all non-business trips, trips made by individuals for their own personal reasons, including commuting – and business users. The effects on private sector revenues and operating costs are also shown to give a full effect on the business community. The table is completed for both £5 and £8 charges.

2.16 With a £5 charge, there is a small loss to road users as a whole since their savings – time, reliability, vehicle operating costs – fall just short of their charge payments and compliance costs. Business users, with their higher values of time, enjoy a net benefit of around £14 million: individuals suffer a net disbenefit of £22 million. Bus passengers enjoy benefits from time and reliability savings of around £40 million, giving an overall net benefit to transport users of £36 million.

2.17 With an £8 charge, the numbers are slightly higher. Road users as a whole enjoy a small net benefit. Business users enjoy a benefit of £27 million; individuals suffer a net disbenefit of £23 million. The benefit to bus passengers has not been re-estimated for the higher charge.

2.18 Around 25% of the estimated benefits to road users are estimated to accrue to charge-payers, with 75% accruing to non-charge-payers who gain most of the benefits in Inner and Outer London and a surprisingly large proportion of benefits in the charged area.

2.19 From traffic and payments data it is estimated that about 40% of the vehicle movements into the charged area in a charging day are made by vehicles for which a full charge has been paid. This is referred to later in the section on benefits to chargepayers and non-chargepayers.

Table 2: WebTAG Transport Economic Efficiency, £M per year, 2005 values and prices

	£5 charge			£8 charge		
	Vehicles / occupants	**Buses / passen-gers**	**Total**	**Vehicles / occupants**	**Buses / passen-gers**	**Total**
Individual travellers (non-business travel)						
Travel time	54	35	89	65	35	100
Travel time reliability	5	8	13	5	8	13
Vehicle operating costs – fuel	5		5	6		6
Vehicle operating costs – non fuel	4		4	4		4
Chargepayer compliance costs	-6		-6	-5		-5
Chargepayer payments	-72		-72	-79		-79
Disbenefit to deterred trips	-12		-12	-19		-19
Sub total - individual benefits	**-22**	**43**	**21**	**-23**	**43**	**20**
Business travellers						
Travel time	142	0	142	163	0	163
Travel time reliability	22	0	22	27	0	27
Vehicle operating costs – fuel	10		10	11		11
Vehicle operating costs – non fuel	7		7	9		9
Chargepayer compliance costs	-16		-16	-14		-14
Chargepayer payments	-143		-143	-157		-157
Disbenefit to deterred trips	-8		-8	-12		-12
Sub total - business travellers	**14**	**0**	**14**	**27**	**0**	**27**
Business – private sector providers: additional bus services, car park operators						
Bus revenues	19		19	19		19
Bus operating costs	-18		-18	-18		-18
Net car park revenues	-10		-10	-10		-10
Sub total - business providers	**-9**		**-9**	**-9**		**-9**
Society impacts						
Accidents			14			14
CO_2			2			2
NOx and PM_{10}			1			1
Sub total - society			**17**			**17**
Transport Economic Efficiency Net Annual Benefits			**+43**			**+55**

Explanations

Travel time savings – cars, taxis, goods vehicles

2.20 Travel time savings are estimated from modelled post-charging scenarios based on observed flows and a pre-charging scenario obtained by applying observed flow changes to the post-charging scenario. The comparisons give the following changes in traffic flow (excluding buses).

Table 3: Percentage reductions in traffic flows with £5 and £8 charges

	£5 charge			£8 charge		
	am peak	inter peak	pm peak	am peak	inter peak	pm peak
Central Zone	18	15	19	21	17	22
Inner Ring Road and Inner London	3	4	4	3	4	4
On North and South Circular Roads	1	1	1	1	1	1
Rest of London / inside M25 (Outer Area)	1	1	1	1	1	1
Average, across London	2.1	2.4	2.4	2.4	2.7	2.7

2.21 LTS modelled changes in traffic flows generally accord well with observed changes in flows. With a £5 charge, traffic flows excluding buses are reduced in the central zone by around 17%. Observed traffic circulating within the zone fell by 17% between 2002 and 2003 and by an unexpected further 5% in 2004. Note that these are changes in vehicle kilometres by four or more-wheeled vehicles excluding buses and coaches. TfL's monitoring report makes the point that the indication of a 5% decline in vehicle kilometres between 2003 and 2004 is not borne out by other data which suggests relatively stable traffic volumes in and around the charging zone.

2.22 On the Inner Ring Road modelled flows increased by 4 to 5%, while observed flows were more or less unchanged in 2003 from 2002 (four or more-wheeled vehicles excluding buses and coaches – Figure 20 of the *Third Annual Monitoring Report*). At the extended Central London cordon, observed two-way traffic levels reduced by 5 to 6% (four or more-wheeled vehicles, including a 20+% increase in buses and coaches – Figure 23 of the *Third Annual Monitoring Report*). Modelled flows at a cordon just outside the Inner Ring Road, closer to the charging zone where a greater reduction might be expected, are reduced by 8%.

Induced Trips

2.23 The estimated hours saved per charging day by continuing car, taxi and goods vehicle trips, by area and by time period with a £5 charge are set out in Table 4. In the Central area, time savings are based on the model outputs that give the flow changes. In the Inner and Outer areas, an adjustment is made to model output to allow for induced traffic. The imposition of charges in the Central area leads to a reduction in vehicle kilometres in the Inner and Outer areas, which in turn leads to higher road speeds in these areas. The higher speeds and absence of charges can be expected to induce additional traffic in these areas.

2.24 Based on observed speed elasticities (the percentage change in speed for a 1% change in traffic levels) for traffic on main roads of -0.9 in the Inner area and -0.7 in the Outer area and assumed, but less certain, elasticities of demand with respect to generalised cost of -1.0 in both areas, it is estimated that induced traffic could offset around 33% of the modelled reduction in traffic in these areas. Modelled time savings in the Inner and Outer areas have been reduced by 33%.

2.25 Given the scale of the time savings outside the charged area, the treatment of induced traffic is important and is returned to below.

2.26 A second adjustment allows for reductions in traffic levels outside the modelled (charged) hours. The reduction in traffic from charging leads to a reduction in traffic levels outside charged hours. From examination of traffic data, the time savings estimated in the charged hours are increased by 7.5% to allow for time savings outside the charged period. The time savings to remaining trips with a £5 charge are summarised in Table 4.

Table 4: Vehicle hours saved per day, allowing for induced traffic; LTS model estimates

	Am peak period	Inter peak period	Pm peak period	Out of hours	Total
Central	2,900	5,400	2,900	800	12,000
Inner	3,600	5,600	4,000	1,000	14,200
Outer	1,800	2,000	1,600	400	5,800
Total	**8,300**	**13,000**	**8,500**	**2,200**	**32,000**

Notes Hours saved per charging day by cars, taxis and goods vehicles, £5 charge, 07.00-18.30.
Hours saved in Inner London and Outer area factored down to allow for induced traffic

2.27 Of the estimated total daily saving of around 32,000 hours, the two peak periods (3 hours in the am peak and 2.5 hours in the pm peak) account for 53%, while the inter-peak 6 hours account for 40% and the non-charged hours 7%. Only 37% of the time savings arise in the central, charged area, 45% arise in Inner London and 18% in Outer London.

2.28 With an £8 charge the total savings in travel time increase by up to 15% compared with a £5 charge, despite the relatively modest changes in traffic activity. Table 5 summarises total time savings by area at the two charge levels.

Table 5: Vehicle Hours Saved per day with £5 and £8 Charges

	£5 charge	£8 charge
Central	12,000	14,300
Inner	14,200	16,100
Outer	5,800	6,400
Total	**32,000**	**36,800**

Reliability savings

2.29 Reliability savings have been taken to be 30% of travel time savings in the charging zone, where reliability gains are most significant, but zero elsewhere. This estimate goes back to the Government Office for London's 1995 *London Congestion Charging Research Programme.* The modelling process applied in that study calculated link speeds and hence in-vehicle times but also estimated the reliability of total journey time by highway modes.

2.30 It did this by first estimating the standard deviation of travel time, based on a relationship between current time and free-flow time obtained from commissioned research. The reliability benefit on each link was estimated as 0.79 times the reduction in the standard deviation of the link time, multiplied by the value of time on the link, based on the results of more commissioned research. For all of the charging options appraised in LCCRP, the value of the reliability benefits to car trips was between 29% and 31% of the value of time savings.

2.31 The Department for Transport's *Feasibility Study of Road Pricing in the UK, July 2004*, suggests (paragraph B.85) that reliability savings could equal 20% of the estimated time savings from road pricing in urban areas. The impact in central London, with its high intensity of congestion can be expected to be higher than urban areas more generally.

Value of Time and Reliability Savings

Values of Time

2.32 Values of time have been based on *WebTAG 3.5.6* values, factored up to 2005 values and prices and given a London weighting. *WebTAG 3.5.6* values of time per person per hour are summarised in Table 6 below.

2.33 The London weighting applied is 1.385. This is based on Transport for London's *Business Case Development Manual* which cites the *New Earnings Survey 2000* Table A21 with London earnings being 1.34 times the national average. In 2003, the *New Earnings Survey* London factor was 1.43. The average of 1.385 is taken here. Only a small minority of those affected by the scheme live or work outside Greater London.

Table 6: WebTAG Values of Time, £ per person per minute, 2002 values and prices

Vehicle type	Occupant	Resource costs	Market prices	Market prices
		2002 values and prices	2002 values and prices	2005 values and prices
Car	Employers business driver	36.5	44.0	51.2
	Employers business passenger	26.2	31.5	36.7
	Commuter	7.0	8.3	9.7
	Other	6.2	7.5	8.5
Taxi	Driver	13.5	16.3	18.8
	Work passenger	61.7	74.5	86.5
	Non work passenger [1]	6.5	8.0	9.0
Light goods vehicle	Occupant	14.0	17.0	19.7
Other goods vehicle	Occupant	14.0	17.0	19.7
Bus	Passenger	9.2	11.2	12.4

Note 1 Non-work taxi passengers are assumed to be 50% commuters, 50% others

2.34 These allocated values convert to 2005 values per vehicle per minute, allowing for variations in vehicle occupancies, vehicle types and journey purposes by area, as indicated in Table 7. The average value of time per person in the central, charged area is around 40 pence per minute. Without any London weighting it would be around 29 pence per minute. Without any London weighting in resource costs rather than market prices it would be around 24 pence per minute.

Table 7: Allocated Values of Time by Area, pence per vehicle/person minute 2005 values and prices, market price unit of account

		Central			Inner			Outer		
		Vehicle occup-ants	pence per min	*Vehicle share %*	Vehicle occup-ants	pence per min	*Vehicle share %*	Vehicle occup-ants	pence per min	*Vehicle share %*
Car	Employer's business	1.16	79	*19*	1.19	72	*19*	1.21	82	*12*
	Commuter	1.43	19	*28*	1.47	20	*51*	1.49	20	*68*
	Other	1.43	17		1.47	17		1.49	18	
Taxi		0.86 pass	83	*26*	0.67 pass	56	*9*	1.00 pass	55	*3*
Van		1.22	33	*21*	1.23	33	*16*	1.23	33	*11*
Lorry		1.34	37	*7*	1.17	32	*4*	1.00	27	*6*
Average vehicle			**51**			**37**			**29**	
Average person			**42**			**28**			**21**	

Note 1 2002 values and prices are factored by 1.09 to reflect retail price index and by 1.052 or 1.065 to allow for real growth in values of time

Note 2 Non work taxi passengers are assumed to be 50% commuters, 50% others

Note 3 Vehicle occupancies and vehicle mix data are taken from traffic counts in London, principally in 2003. Purpose data are from National Travel Survey and LTS model data.

2.35 Tables 8 and 9 indicate the breakdown of travel time and reliability savings by area with £5 and £8 charges respectively. The effects of induced traffic in reducing benefits by 33% in Inner and Outer London have been allowed for. With a £5 charge, some 46% of the time savings by value and all of the reliability savings arise in the central area, 41% of time savings by value in Inner London and 14% in Outer London. The central area accounts for 52% of all time and reliability savings.

Table 8: Value of Estimated Time and Reliability Savings by Area with £5 charge, £M per year, 2005 values and prices

	Time	Reliability	Time and reliability
Central London	90	27	117
Inner London	80	0	80
Outer London	27	0	27
Total	**197**	**27**	**224**

2.36 With an £8 charge, the total value of time and reliability savings is £260 million, some 16% higher than with a £5 charge, with the central area accounting for 53% of all time and reliability savings.

Table 9: Value of Estimated Time and Reliability Savings by Area with £8 charge, £M per year, 2005 values and prices

	Time	Reliability	Time and reliability
Central London	107	32	139
Inner London	91	0	91
Outer London	29	0	29
Total	**228**	**32**	**260**

2.37 Alternative assumptions about the generation of induced trips could substantially affect the estimate of time savings. With a £5 charge, if 50% rather than 33% of benefits in the Inner and Outer areas were lost to induced traffic, total time savings would fall from £197 million to £158 million (that is by one fifth), while if induced traffic meant that 67% of these time savings were effectively lost, total time savings would fall to £133 million (that is by around one third).

2.38 With an £8 charge, the loss of 50% of time savings in Inner and Outer areas would reduce total time savings from £228 million to £184 million and the loss of 67% would reduce total time savings to £157 million.

Benefits to Chargepayers and Non-Chargepayers

2.39 Analysis of vehicle movements (four or more wheels) into charged area within a charging day indicates that about 40% are made by vehicles for which a full charge has been paid. A further 4% or so of incoming movements are made by residents' vehicles; 7% by buses; 23% by taxis; 10% by London licensed private hire vehicles; 5% carrying a notified blue badge holder; 2% exempt emergency service vehicles; around 4% potentially liable to a penalty charge; and 5% by other exempt or 100% discounted vehicles.

2.40 Because of repeat movements this translates into about 55% of unique vehicles inside the charging zone during charging hours paying the full charge and another 5% paying the residents' discounted charge.

2.41 It can be deduced from this data that about 44% of central (charged) area benefits therefore accrue to charge-paying vehicles and assume that, 'on average' every movement into or out of the charged area by charge-paying vehicles entails 5 kilometres of travel in Inner London and a further 5 kilometres in Outer London, as indicated in recent surveys. This would mean charge-payers receiving around 8% of the savings in Inner London and 3% in Outer London. The time and reliability savings to chargepayers would be as indicated in Tables 10 and 11. Chargepayers would receive around 26% of total time and reliability savings: non charge-payers around 74**%**.

Table 10: Value of Estimated Time and Reliability Savings to Charge-Paying Vehicles with £5 charge, £M per year, 2005 values and prices

	Time	Reliability	Time and reliability
Central	40	10	50
Inner	6	0	6
Outer	1	0	1
Total	**47**	**10**	**57**

Table 11: Value of Estimated Time and Reliability Savings to Charge-Paying Vehicles with £8 charge, £M per year, 2005 values and prices

	Time	Reliability	Time and reliability
Central	47	12	59
Inner	7	0	7
Outer	1	0	1
Total	**55**	**12**	**67**

Compliance Costs

2.42 Scheme users bear transaction costs in using the scheme, in the form of the time they spend registering their vehicles on the scheme database, in the cost of phone calls, text messages or internet access, and in the time taken to deal with Penalty Charge Notices - PCNs. These are referred to as compliance costs. Separate calculations have been made for the costs incurred by people making their own payment arrangements – a cost of 50p per charge payment has been assumed. For businesses arranging for payment associated with business travel, whether by car, van or heavy goods vehicle, a cost of £1.00 per charge payment has been assumed. These assumed costs are being investigated; early results indicate they are of the correct order.

2.43 Total compliance costs are estimated at £6 million per year for non-business travel and £16 million per year for business travel with a £5 charge; somewhat less with an £8 charge, reflecting the reduction in the number of charge payments.

Disbenefits to Deterred Road Users

2.44 Deterred road users suffer a loss of individual surplus which is estimated from the additional costs that cause them to stop making trips by road. There are assumed to be three components: the congestion charge; a transaction cost associated with paying the charge, estimated at 50p per transaction; and, partly offsetting these costs, the value of the time they would have saved had they continued to travel by car.

2.45 The 'rule of a half' is used to estimate the average cost to a deterred trip. On the basis that the number of movements into the charged area by charge-paying vehicles fell by 34% with the £5 charge and by a further 6% with the increase to £8, half of the charge is taken to be £2.50 for the £5 charge and £3.10 (the weighted sum of 34% at £2.50 and 6% at £6.50) for the £8 charge.

2.46 Taking recorded numbers of deterred trips and making assumptions on the numbers of charged area entries per vehicle per day and the time savings that deterred trip makers would have enjoyed, the disbenefit to deterred trips is estimated at £20 million with a £5 charge and £31 million with an £8 charge.

Vehicle Operating Costs

2.47 Vehicle operating cost savings have been estimated using the Department for Transport's standard, speed-based vehicle operating cost formulae, so savings arise from two sources: the reduction in vehicle kilometres and the small reduction in cost of every continuing vehicle kilometre. The estimates presented here relate to the charging day or year only. They do not allow for costs incurred in the evenings or at weekends. Operating costs cover fuel costs and items such as engine and tyre wear and other distance-related vehicle costs.

2.48 Estimated annual fuel consumption throughout the charging day in London is shown in Table 12. Savings in fuel consumption, London-wide, are estimated from reduced distance travelled and improved average vehicle speeds. They are estimated at around 44 million litres per year with a £5 charge and 48 million with an £8 charge. These amount to around 3% of London's 'without charge' fuel consumption during charging hours, estimated at around 1,570 million litres in the charging year.

Table 12: Estimated London-wide Fuel Consumption, million litres per charging year

	No charge	£5 charge	£8 charge
Fuel consumption	1,567	1,523	1,519
Total saving		44	48
Saving from reduced vehicle kilometres		27	30
Saving from lower fuel consumption per continuing km travelled		17	18

2.49 The fuel savings arising from reduced vehicle kilometres across London are 27 million litres (1.7%) with a £5 charge and 30 million litres (1.9%) with an £8 charge, resulting from vehicle kilometre reductions of 210 million per year and 240 million respectively. The average distance travelled per litre of fuel by continuing road users is estimated to increase from 7.8 kilometres without charging to 7.9 kilometres with charging, ie, by just over 1%, giving further reductions in fuel consumption of 17 million litres with a £5 charge and 18 million with an £8 charge.

2.50 Total fuel cost savings are given in Table 13 and the savings to continuing road users in Table 14. The fuel cost saving to continuing road users – their fuel consumption without the charge minus their fuel consumption with the charge – shown in Table 14 is just over a third of the total fuel saving.

Table 13: Total Fuel Cost Savings, £M per year

	£5 charge	£8 charge
Resource costs	9.6	10.6
Fuel duty	24.9	27.5
VAT	6.0	6.7
Total	**40.5**	**44.8**

Note 1: The fuel duty row supplies Table 1

Table 14: Fuel Cost Savings to Continuing Road Users, £M per year

	£5 charge	£8 charge
Resource costs	3.6	3.9
Fuel duty	9.5	10.2
VAT	2.3	2.5
Total	**15.4**	**16.6**

Note 1: The total row, split by individuals and business trips, supplies Table 2

2.51 Other vehicle operating costs – oil, tyres, maintenance, and vehicle depreciation – are similarly saved as a result of the reduced vehicle kilometres and higher average speeds with charging. The total resource saving amounts to £26 million with a £5 charge and £29 million with an £8 charge. Further details are in Table 15.

Table 15: Total Other Vehicle Operating Cost Savings

	No charge	£5 charge	£8 charge
Resource costs, £ million per year	847	821	818
Saving, £ million per year		26	29
Pence per vehicle kilometre	6.9	6.8	6.8

2.52 Other vehicle operating cost savings to continuing road users – their operating costs with and without charging – are estimated at around £11 million with a £5 charge and around £12 million

with an £8 charge. Around two thirds of these cost savings accrue to work cars and taxis, light and heavy goods vehicles, ie to business; and around one third to non-work cars and taxis.

User Charges

2.53 The principal user charges are fares and the congestion charge. Changes in parking charges are also addressed. Individual user charges are bus fares of £16 million, which assumes all additional bus passengers are non-business, and a share of charge payments. Individuals are estimated to pay around 38% of all charge payments, business users around 62%. Individuals therefore pay 38% of £190 million, £72 million, plus bus fares of £16 million.

2.54 Business users pay 62% of the £190 million, which equals £118 million. This is assumed to be in the factor cost unit of account so needs to be multiplied by 1.209 to give £143 million in the market price unit of account.

2.55 Congestion charging appears to have caused a reduction in parking activity and parking revenues in Central London but almost no change in other parts of London. Transport for London surveyed rail-heading at nine national rail and underground stations in Outer London and found no discernible difference in the number of parking acts, pre- and post-charging. The Association of London Government, a body serving London Boroughs, in its *Study to produce an independent assessment of the Central London congestion charging scheme* of 2004, surveyed six areas around stations in Outer London and the weighted results showed an increase in the occupancy of spaces on streets closest to the stations, which 'may indicate a slight increase in train-based commuting.'

2.56 In that report the Association of London Government analysed parking information from boroughs within and just outside the charging zone and found that: between 2002 and 2003 parking charges generally increased; there was a 28% reduction in on-street paid parking events inside the charging zone, compared with a 3% reduction outside the charging zone; and revenues from on-street parking within the charging zone fell by 18%.

2.57 The report gives no indication of the absolute level of the change but the following estimate may provide an illustration. The number of cars and vans entering the charged area has fallen by around 70,000 movements per day (Figure 2.1 of Transport for London's Fourth Annual Monitoring Report) from around 250,000 prior to the introduction of charging. Not all of these would require to park for any significant length of time. Some would be through trips, others stopping only to pick up or drop off people or goods. Some would have private parking spaces. However, we can expect there to have been a reduction in the use of public and private off-street parking places as well as on-street spaces.

2.58 Recent surveys – January 2007 - undertaken by Transport for London indicate that 48% of respondents who have recently accessed the charging zone by car have paid an average charge of £11.80 to park. If these same characteristics were applied also to those no longer using their cars and parking, the lost parking revenue would be around £70 million per year (48% * 50,000 terminating car movements * £11.80 * 250 days per year). However, it is unclear whether this level of average parking cost applied to the vehicles 'priced off' by the £5 charge and the exact level of lost revenue may be considerably lower.

2.59 Less intensive use of parking spaces may mean that some parking spaces are unused and redundant; some may have been put to alternative uses, and less intensive use of on-street parking may have made it easier for continuing road users to find a parking space. Nevertheless, even if the exact figure cannot be derived, it is likely that there has been a significant financial impact on public and private car park operators inside the charging zone.

2.60 A notional value of £15 million has been taken as the 'lost' net parking revenues to boroughs inside the charging zone. A corresponding figure of £10 million has been assumed for private sector car park operators. Together these allowances assume a loss of net parking revenue of £25 million; ie, the lost parking revenue exceeds the associated saving in parking-related costs by £25 million. These notional lost revenues are assumed to be in the market price unit of account, with the majority assumed to be paid by individuals or non-business users.

Bus operators

2.61 Bus services are included here because, in some cases, bus operators bear the revenue risk of their operation. The costs to private sector providers include operating costs of about £20 million for extra bus services minus £4.5 million savings from gains in the efficiency of bus operations, say £15.5 million in total. Private sector revenues – public transport fare revenues of £16 million – and the net operating costs of £15 million need to be converted to the market price unit of account (ie multiplied by 1.209) giving revenues of £19 million and costs of £18 million.

Other operators

2.62 The costs (including service provider costs) of operating the congestion charging scheme have been included in the public accounts estimates as a cost to Transport for London. Charging revenues are also shown in the public accounts estimates. The net loss in revenue to private car park operators referred to above, the loss in revenues that cannot be offset by cost savings, is included to complete the financial impacts of congestion charging on business.

Public Transport Benefits

2.63 Benefits to public transport (bus) users have been estimated as follows:

- Reduced waiting times, given higher bus frequencies, estimated at £20 million,
- Reduced travel times estimated at £9 million, and
- Improved bus travel time reliability, measured as the reduction in excess waiting time, estimated at £7 million.

2.64 In each case these estimates were made for the central, charged area only and only half of observed changes in speeds or waiting times have been counted as the effect of charging. Over time, other policies have been having the effect of increasing bus speeds and reliability.

Other Factors

Accidents

2.65 Reported Personal injury accident statistics for weekdays during charging hours (0700 to 1900 hours) in different areas of London in recent years from Transport for London's Fourth Annual Monitoring Report, June 2006, are summarised below.

Table 16: Reported Personal Injury Accidents by Area

	Charging zone	Inner Ring Road	Rest of London	Total
2001	1,644	528	18,410	20,582
2002	1,418	450	16,964	18,832
2003	1,270	428	16,226	17,924
2004	1,131	374	14,694	16,199

2.66 Between 2002 and 2003, when charging was introduced, reported personal injury accidents in the charging zone fell by 148 accidents in total (around 10%); on the Inner Ring Road by 22 accidents (5%); and in the rest of London by 738 accidents (4%). From this data alone it might be inferred that the charge had played a part in the higher rate of reduction in the charging zone and might be responsible for around half of the charging zone reduction, say around 75 Personal Injury Accidents.

2.67 But charging has reduced vehicle kilometres in areas outside the charging zone so might reasonably be credited with some of the accident reduction outside the charging zone. On the other hand, in each area of London in each of the three years shown there has been a reduction in the number of personal injury accidents, which suggests strongly that factors other than the congestion charge are contributing to the reduction in reported accidents.

2.68 An accident prediction model has been developed that relates accidents by type (involving motor vehicles, pedestrians, powered two-wheelers and pedal cycles, in different combinations) and by area (central zone, Inner Ring Road, inner London and outer London) to changes in flows of relevant vehicle/person types. Alternative (low and high) assumptions on the sensitivity of accidents by type to changes in relevant flows are made. Inputting observed and estimated changes in flows attributable to congestion charging gives an estimated reduction of personal injury accidents in the charging zone and on the Inner Ring Road of 29 to 81 personal injury accidents (around 2% to 5% of personal injury accidents) attributable to congestion charging and 254 (low) and 307 (high) across London, or around a quarter to one third of the observed reduction in that year's reported personal injury accidents.

2.69 The estimates of 254 and 307 personal injury accidents saved would give annual benefits of around £22 million to £26 million applying the standard cost of around £85,000 per personal injury accident, allowing also for the cost of damage-only accidents too. A more cautious estimate of the benefit generated by congestion charging which nevertheless attributes some of the accident reduction beyond the Inner Ring Road to congestion charging would suggest a benefit of around £14 million in accident savings to congestion charging with a £5 charge.

Carbon Dioxide

2.70 Vehicle kilometres across London reduce by some 211 million per year with a £5 charge and 237 million with an £8 charge. Fuel consumption falls by 44 million litres and 48 million litres per year with £5 and £8 charges.

2.71 The average CO_2 emission rate is assumed to be around 2.5 kg per litre of fuel, based on standard emission rates of 2.4 kg per litre of petrol and 2.7 kg per litre of diesel. A tonne of carbon is valued at around £75 (based on the values derived for the Department of Food, Environment and Rural Affairs in the Government Economic Service working paper *Estimating the Social Cost of Carbon Emissions,* 2002 - and re-confirmed by the Department in 2006 in the light of research feeding the *Stern Review on the Economics of Climate Change*) and a tonne of CO_2 therefore at around £20.45, with carbon representing 6/22 of CO_2 by weight. These assumptions imply total CO_2 emissions of around 110,000 to 120,000 tonnes with £5 and £8 charges and a value of the CO_2 emissions saved of around £2.3 million to £2.5 million with £5 and £8 charges.

Table 17: Estimated CO_2 savings per year

	£5 charge	£8 charge
Vehicle km saved	211 million	237 million
Fuel savings, litres	44 million	48 million
CO_2 savings, tonnes	110,000	120,000
CO_2 savings, £	£2.3 million	£2.5 million

Pollution

2.72 The major pollutants affected by congestion charging are believed to be nitrogen oxides, NO_x; and particulate matter, PM_{10}. Total primary emissions of NO_x on major and minor roads (including cold starts) in the charging area fell by 13.4% (from 1405 to 1216 tonnes) between 2002 and 2003. On the Inner Ring Road they fell by 7%, from 427 to 398 tonnes. These reductions are attributable in part to the flow and speed changes brought about by the congestion charge, but also to changes in the vehicle stock between these two years. Using observed traffic volumes and speeds and emissions relationships for different vehicle types, it is estimated that the congestion charge was responsible for an 8% reduction in the charging area and a 0.2% reduction on the Inner Ring Road.

2.73 This suggests that the congestion charge is responsible for an overall reduction in NO_x emissions of 112 tonnes per year. There will also have been some reduction in emissions in Inner and Outer London which has not been estimated. At a value of NO_x emissions of £1,800 per tonne, this reduction is valued at £202,000. The reduction in PM_{10} emissions between 2002 and 2003 has been estimated at 16% (from 125 to 106 tonnes) in the charging area and 7% (from 35 to 33 tonnes) on the Inner Ring Road. Again these reductions are attributable to changes in the vehicle stock as well as the effects of the congestion charge. The charge is estimated to be responsible for a reduction of 6% in emissions in the charged area but an increase of 3% in emissions on the Inner Ring Road

2.74 This suggests the charge has been responsible for an overall reduction in PM10 emissions of around eight tonnes per year, again without including changes in Inner and Outer London. At a value of PM10 emissions of £154,000 per tonne in London (the value falls to £24,000 per tonne outside London, where concentrations are lower) the eight tonnes saved have a value of around £1.2 million. The pollution savings in NOx and PM10 emissions in the charged area and on the Inner Ring Road generated by the congestion charge are estimated at between £1 and £1.5 million per year.

Overall Evaluation

2.75 Tables 18 and 19 aim to bring all relevant impacts together in market prices for £5 and £8 charges, combining the information in Tables 1 and 2. Savings and revenues to Transport for London are treated as positive; costs and payments to other organisations are treated as negative.

Table 18: Impacts of £5 Central Area Charge, 2005 market prices and values, £M per year

		Travel time and reliability	Operating costs	Other resources and surpluses	Financial impacts	Total
Car, van and goods vehicle users	Business	164	17	- 16 compliance cost	-143 user charges	**22**
	Individuals	59	9	- 6 compliance cost	-72 user charges	**-10**
Bus passengers	Individuals	43				**43**
Deterred trips	Business			-8		**-8**
	Individuals			-12		**-12**
Society	Accidents			14		**14**
	CO_2			2		**2**
	NO_x and PM_{10}			1		**1**
Transport for London / Government / Boroughs	Fuel duty				-25	**-25**
	VAT				-13	**-13**
	Charging		-109		215 [1]	**106**
	Additional buses		-18		19	**1**
	Infrastructure			-25		**-25**
	Parking revenues				-15	**-15**
Private parking	Net revenues				-10	**-10**
Total		**+266**	**-101**	**-50**	**-44**	**+71**

[1] Note 1 Charge payments and penalty payments at market prices

Table 19: Impacts of £8 Central Area Charge, 2005 market prices and values, £M per year

		Travel time and reliability	Operating costs	Other resources and surpluses	Financial impacts	Total
Car, van and goods vehicle users	Business	190	18	- 14 compliance cost	-157 user charges	**37**
	Individuals	70	10	- 5 compliance cost	-79 user charges	**-4**
Bus passengers	Individuals	43				**43**
Deterred trips	Business			-12		**-12**
	Individuals			-19		**-19**
Society	Accidents			14		**14**
	CO_2			2		**2**
	NO_x and PM_{10}			1		**1**
Transport for London / Government / Boroughs Private sector parking	Fuel duty				-27	**-27**
	VAT				-14	**-14**
	Charging		-109		236[1]	**127**
	Additional buses		-18		19	**1**
	Infrastructure			-25		**-25**
	Parking revenues				-15	**-15**
Private parking	Net revenues				-10	**-10**
Total		**+303**	**-99**	**-58**	**-47**	**+99**

Note 1 Charge payments and penalty payments at market prices

2.76 By type of impact – by column – the principal impacts are**:**

- Time and reliability savings to road and bus users are estimated at about £266 million per year with a £5 charge and around £303 million with an £8 charge and the related adjustments to monthly, annual and fleet charges. The actual traffic impacts of the charge increase to £8 are much less distinct than the original application of the £5 charge

- The principal changes in operating costs are the operating costs of the charging scheme, savings in vehicle operating costs, fuel and non-fuel, to road users and the additional operating costs of bus services.

- There are other costs - time, text or phone charges - incurred by users in registering their vehicles. These are shown as compliance costs. Deterred trips suffer a loss of surplus. There are savings in accidents and in the quantity of CO_2 and pollutants generated, but infrastructure and other costs were incurred prior to the introduction of charging to facilitate charging.

- The principal financial impacts are user charges – charge payments and penalty payments by road users, a loss of tax revenues – fuel duty and VAT on charge payments and bus fares – to government, a loss in net parking revenues to local authorities and private sector operators and additional revenues to Transport for London from the charging scheme and to bus operators from the additional bus passengers.

- With a £5 charge there is an overall surplus of £71 million, based on the column totals in Table 18. The annual 'benefits' of time and reliability savings of £266 million minus the other resource costs and lost surpluses of £50 million, or £216 million net, exceed scheme operating costs of £101 million by £115 million, or by a ratio of 2.1. The net 'benefits' exceed operating costs and other financial impacts (£101 million + £44 million ie £145 million) by £71 million, or by a ratio of 1.5:1. Full discounting is complicated because of the introduction of the western extension after four years operation; however it would result in a somewhat lower ratio.

- With an £8 charge there is an overall surplus of £99 million, based on the column totals in Table 19. The net 'benefits' (time and reliability savings minus other resource costs and lost surpluses of £303 million - £58 million ie £245 million) exceed scheme operating costs of £99 million by £146 million, or by a ratio of 2.5:1. The net 'benefits' exceed operating costs and other financial impacts of (£99 million + £47 million ie £146 million) by £99 million, or by a ratio of 1.7:1. Again full discounting would result in a somewhat lower ratio.

- *WebTAG 3.5.4* indicates that the cost to be included in a cost benefit analysis is the cost to Public Accounts as defined in *WebTAG 3.5.1* – incorporating 'government' costs and revenues and the change in indirect tax revenues. But this is not a useful measure in the context of congestion charging since the congestion charge has a negative cost to the public accounts: the revenues from the charge and associated penalty payments exceed the sum of the scheme operating costs and the changes in indirect tax revenues.

- Thus the more traditional resource-based estimates of benefits and costs give undiscounted benefit:cost ratios of around 2.1:1 and 2.5:1 with £5 and £8 charges. The *WebTAG* approach, which also includes the net effects on public accounts, reduces these ratios to around 1.5:1 and 1.7:1 respectively.

Summary

2.77 This evaluation is based on speeds observed in the charged area after the respective charges were introduced and elsewhere on speeds derived in part from models. As with all transport scheme evaluations there are uncertainties attached to these estimates, but the estimates used here have the advantage of being derived *ex post facto*.

2.78 The congestion charge has been extensively monitored, at least in the charged area of Central London, so we can be more confident of the estimated impacts there. The estimated impact of charging on the reliability of travel times in Central London is uncertain, but it is generally believed there would be such an impact and our estimate of its likely scale is compatible with estimates made by other practitioners.

2.79 The benefit:cost ratio derived from this evaluation for the £8 charge is higher than that shown for the £5 charge, at 1.7:1 as opposed to 1.5:1. As explained the additional benefits of the £8 charge over the £5 charge have been estimated from models of two scenarios in 2005 – one before the change from £5 to £8, and one after. This represents a fairly simple comparison between two scenarios close in time, a comparison that has become less distinct with the passage of time as road space has been increasingly affected by utility works and roadworks or as road space and priority on the road network has been re-allocated to other beneficiaries.

2.80 There is greater uncertainty attached to the estimated impacts in Inner and Outer London, where the changes are too small to be observed reliably and they have been estimated from a combination of transport model outputs and what are believed to be reasonable transport planning assumptions. These include an allowance for new trips being induced by the improved travel conditions in these areas, which acts to reduce scheme benefits.

2.81 Travel time savings dominate the benefits, raising questions about the value to be applied to time savings in London and the perennial question of the value to be attached to small time savings. These questions are addressed in Section 4 below. The other quantified impacts – savings in vehicle operating costs, reductions in accidents, CO_2 and air pollution reductions – are relatively small by comparison, and we believe the estimates presented here have the right orders of magnitude.

Other transport impacts

2.82 There are other transport impacts from the scheme that have not been included in this evaluation. The principal ones are the impacts on pedestrians; pedal and motor cyclists; coach passengers; underground and rail passengers; and waiting time for taxi passengers.

2.83 The reduced traffic inside and outside the zone will mean very slightly less delay to pedestrians waiting the cross the road and very slightly easier conditions for pedal and motorcyclists. However, despite the numbers involved, the net aggregate gains to pedestrians in monetary terms will be relatively very small given the scale of individual time savings involved in crossing streets as a consequence of traffic reductions.

2.84 Pedal and motorcyclists' journey times are much less affected by traffic levels than those of the occupants of four wheeled vehicles. Consequently their individual aggregate time savings will relatively small, albeit positive. However, the numbers involved limit the significance of this impact.

2.85 Coach passengers will benefit directly from reduced congestion but the aggregate scale of this impact is likely to be relatively insignificant.

2.86 Some car users have transferred to underground and rail services; and some underground and rail passengers have been attracted to the increased bus capacity and more reliable bus services. The net impact on underground and rail passengers is small. It is complicated by other factors but earlier studies have indicated that the potential monetary value would be marginal.

2.87 Taxi passengers gain from the charging scheme in two direct ways: their journeys are quicker and consequently their fares are, on average, slightly cheaper. But they will also gain from having to wait less as the overall taxi frequency has increased. Given the high value taxi passengers place on time savings, this may be a more significant impact, but has not been assessed due to inadequate data.

2.88 Overall, these other transport impacts that have not been quantified are judged to have a relatively small positive net impact – but are unlikely to affect significantly the overall evaluation.

Wider impacts

2.89 It is also possible that the scheme has had wider impacts, such as an improvement in the 'amenity' of central London or in the overall economic performance of the central London economy.

2.90 Amenity impacts are difficult to measure or evaluate. One such impact that can be measured is ambient noise levels; but there is no measurable reduction in ambient noise levels, for example, that can be attributed to the reduced traffic levels caused by congestion charging. On the other hand it is likely that some traffic management measures for pedestrians may have been made easier to introduce as a consequence of reduced traffic, though there is a risk that such benefits may be at least partially double-counted alongside the value of reduced road accidents or savings in pedestrian delay discussed above. For this evaluation, no wider amenity impacts have been included.

2.91 Wider economic benefits are another possible impact. In connection with major public transport improvements serving central London, various wider impacts have been evaluated such as a move to more productive jobs, agglomeration benefits, increased labour force participation and improved competition.

2.92 However, as far as can be assessed from the various data sources, the congestion charging scheme has not resulted in more people travelling to central London. Nor has it resulted in a net increase in physical transport capacity. Moreover, many of those who gain time savings in travelling to central London will have to pay the charge, which in many cases more than offsets the value of their time savings.

2.93 For those who experience time savings and do not pay the congestion charge the key groups are: bus passengers; taxi passengers; coach passengers; residents; and users of exempt and discounted vehicles. Within these groups the category 'taxi passengers' covers a significant number of individuals in employment; and 'bus passengers' and 'residents' groups include significant numbers of commuters. But as far as the data permits, any increase in these categories of road user appears to be as a result of transfers from other transport modes.

2.94 Transport for London has no evidence that there are significant wider economic impacts arising from the scheme. The business and economic monitoring studies have so far concluded, insofar as the data permits, that the net macroeconomic impact of the scheme is broadly neutral with no clearly attributable impacts, positive or negative.

2.95 However, the scheme has created an ability to influence traffic conditions in and around central London, thus enabling a wider range of policies and objectives to be pursued. Moreover, by delivering greater efficiency to the transport network serving the central area, the scheme may assist the continuing growth of the highly productive central London economy. This, in turn, would generate benefits for the national economy. However, any such increased flexibility and potential longer term economic impacts have not been taken into account in the analysis.

2.96 The issue of potential wider benefits is one that TfL intends to pursue as more data becomes available.

3 Other Evaluations

Prud'homme and Bocarejo

3.1 Prud'homme and Bocarejo produced T*he London congestion charge: a tentative economic appraisal,* Transport Policy 12 (2005) pages 279-287. The abstract summarises the paper:

'Pre-charge and post-charge data (particularly on speed and road usage) in the London congestion charge zone is used to estimate demand and cost curves for road usage. Pre-charge congestion costs are estimated, and shown to be small (0.1% of the area GDP). They are largely (90%) eliminated by the charge, which produces an economic benefit. Charge proceeds are about three times larger than the value of the congestion. Unfortunately, the yearly amortisation and operation costs of the charge system appear to be significantly higher than the economic benefit produced by the system. The London congestion charge, which is a great technical and political success, seems to be an economic failure. It could be defined as mini Concorde.'

3.2 Prud'homme and Bocarejo produced the following estimates in relation to the £5 charge:

- Benefits (reduced congestion costs but excluding benefits for bus users, for increased reliability and for environmental improvement) of €272,000 per day (ie £47 million per year, at €1.44 = £1; and 247 charged days per year),
- Charge proceeds of €650,000 per day (£111 million per year),
- Collection costs of €689,000 per day (£118 million per year),
- Benefits net of costs of -€417,000 per day (-£72 million per year).

3.3 They made further estimates of benefits resulting from the increased speed for bus users (€124,000 per day or £21 million per year) and environmental benefits (€20,000 per day or £3 million per year) and allowed for the cost of the additional subsidy to buses (€18,000 per day or £3 million per year). They concluded that costs of €707,000 per day substantially exceeded benefits of €414,000 per day.

3.4 Prud'homme and Bocarejo acknowledged that these findings are preliminary and are based on:

- Changes in the charged zone only. They did not know whether congestion in the rest of London increased or decreased.
- The *ROCOL (Road Charging Options for London, Government Office for London, 2000)* values of time, which Prud'homme and Bocarejo describe as 'generous'.
- Ignoring '*a likely gain in transportation reliability experienced by both car and bus users, which is hard to measure and harder to value'.*

Mackie

3.6 Mackie, in *The London congestion charge: a tentative economic appraisal. A comment on the paper by Prud'homme and Bocarejo,* Transport Policy 12 (2005) pages 288-290, commented on the following:

- Scheme costs: Mackie's understanding was that scheme operating costs contained an accelerated depreciation element so could fall appreciably over the scheme life, but the public sector investment costs identified by Prud'homme and Bocarejo and charge-payer compliance costs must be included.

- Time savings: Transport for London had always claimed that time savings would occur outside the charged zone, but the robustness of the evidence for these benefits could be questioned. They would depend on small changes in very large numbers over a wide area. Given the relatively high proportions of trips, and particularly time savings to trips, on employers' business, Prud'homme and Bocarejo's suggestion that the ROCOL value of time was generous indicates peculiar relativities in French values of time.

- Buses: Bus quality of service and reliability benefits could be considerable and should not be excluded from the cost: benefit table.

- Safety and environment. Prud'homme and Bocarejo did not consider safety benefits but Transport for London's estimate seems too high.

- Transport for London make no allowance for Central London becoming a more pleasant local environment in which to walk, shop, visit, work and live. It would be interesting to know what this is worth.

- Policy implications: The normal expectation about road user charging in congested conditions is that it would be economically desirable but socially unacceptable. Prud'homme and Bocarejo's proposition, ironically, is that a scheme that has gained a fair degree of social acceptance is economically unsatisfactory, having a benefit: cost ratio well below unity. The resource cost of running the scheme is very high, with scheme operating costs taking around two-thirds of the benefits and capital replacement costs also to be considered. Could the costs be reduced? The revenue:cost ratio is also worrying, being dependent on the penalty regime for revenues to equal costs.

- The win-win situation of road user charging providing both a net economic benefit and a financial gain to the city authority seems elusive.

3.7 Key remaining questions were:

- What are the impacts of the scheme outside the zone?

- What are the impacts on uncharged traffic categories inside the zone – taxis, motorcycles?

- Can the scheme operating costs be reduced?

- If Central London is a more pleasant place, what will the long term effects be?

Santos and Shaffer

3.8 Santos and Shaffer in *Preliminary Results of the London Congestion Charging Scheme,* Public Works Management & Policy, Volume 9, No 2, October 2004, pages 164-181 reported on the charging scheme's first year. They calculated a point elasticity of demand for car trips (31% reduction) with respect to generalised cost (23.5% increase, consisting of £5 charge minus time and reliability savings of £1.75 over two trips totalling 23.4 km per day) of -1.3.

3.9 Transport for London's equivalent calculation gives an elasticity value of around -1.6, ignoring any change in use of vehicles outside charging hours or outside the charging zone. This is based on a lower change in demand than Santos and Shaffer assumed – since their 31% reduction includes trips which re-routed around the charged area – and an even lower change in cost – since Santos and Shaffer assumed low values of time and a relatively low vehicle distance travelled per day of 23 kilometres, so the £5 charge represented a relatively large increase in generalised cost. However, an arc-elasticity is probably more appropriate given the scale of change involved. Elasticity estimates of driver responses to charging are outside the scope of this evaluation.

4 Some reactions

4.1 This section addresses some of the major issues raised by Prud'homme and Bocarejo and by Mackie as they sought further understanding of the effects of and success of congestion charging in London. It is intended to provide information on the following:

- What effect does the congestion charge have outside the charged area?
- What values of time savings have been and should be used?
- What is the effect of the change from £5 to £8 in the daily charge?
- What contribution do small time savings make to the overall evaluation?

Effects Inside and Outside the Charged Area

4.2 Prud'homme and Bocarejo's estimate of time savings takes into account only the savings within the charged area. They had no knowledge of what happened outside that area. Annex 1 contains a series of statistics for Central, Inner and Outer London to illustrate the effects of charging. The traffic statistics for Inner and Outer London are based on LTS model outputs.

4.3 The principal modelled changes in three areas of London – the charged central area; the inner area within the North and South Circular Roads; and the outer area – are summarised below. Pre-charging there were around 10 times as many vehicle kilometres in the inner area as in the charged area and just over 20 times as many in the outer area.

4.4 Post-charging there is a reduction in vehicle kilometres in all areas, greatest in percentage terms in the charged area but greater in volume terms in each of the other areas. The charged area accounts for 37% of all time savings, the inner area for 45% and the outer area for 18%.

Table 26: Vehicle Kilometres and Time Saved by Area, with £5 charge, allowing for Induced Trips in the Inner and Outer Areas

	Pre-charge veh km	Post-charge veh km	Reduction in veh km	Veh hours saved per day	Post-charge per veh km
	000 per day	000 per day	000 per day	Hours per day	Mins saved
Charged area	1,531	1,276	255 (17%)	11,953	0.59
Inner area	15,100	14,722	378 (2.5%)	14,245	0.06
Outer area	32,929	32,708	221 (1%)	5,812	0.01

Notes
1. Charged area flow and speed changes are observed.
2. Observed elasticity of speed with respect to traffic -1.0.
3. Inner and Outer area speed changes are estimated on the basis of LTS version 11.2 flow changes and elasticities of speed with respect to traffic of between -0.7 and -1.0.
4. Minutes saved per vehicle km are total time savings by area with a £5 charge from 07.00 to 18.30 divided by the post-charging vehicle kilometres

Values of Time

4.5 This section of the note shows how the values of time were derived in order to address Prud'homme and Bocarejo's point that the values of time are high and Mackie's query about the London weighting. It repeats information given earlier, for example in Table 6, to bring all the relevant value of time information into one section. The values of time used have been based on *WebTAG 3.5.6* values, as updated in October 2006, factored up to 2005 values and prices and given a London weighting. They are in the market price unit of account. The *WebTAG* values of time per person per minute are summarised in Table 27 which reproduces Table 6.

Table 27: *WebTAG* Values of Time, pence per person per minute

Vehicle type	Occupant	Resource costs	Market prices	Market prices
		2002 values and prices	2002 values and prices	2005 values and prices
Car	Business driver	36.5	44.0	51.2
	Business passenger	26.2	31.5	36.7
	Commuter	7.0	8.3	9.7
	Other	6.2	7.5	8.5
Taxi	Driver	13.5	16.3	18.8
	Work passenger	61.7	74.5	86.5
	Non work passenger	6.5	8.0	9.0
Van	Occupant	14.0	17.0	19.7
Lorry	Occupant	14.0	17.0	19.7

4.6 The London weighting applied is 1.385. This is based on Transport for London's *Business Case Development Manual* which cites *the New Earnings Survey 2000 Table A21* with London earnings being 1.34 times the national average. In 2003, the *New Earnings Survey* London factor was 1.43. The average of 1.385 is taken here.

4.7 These values convert to 2005 values per vehicle minute, allowing for variations in occupancies, vehicle types and journey purposes, by area as follows, all in the market price unit of account. Table 28 repeats for ease of reference Table 7 above

Table 28: Allocated Values of Time by Area, pence per vehicle/person minute 2005 values and prices, market price unit of account

		Central			Inner			Outer		
		Vehicle occup-ants	pence per min	*Vehicle share %*	Vehicle occup-ants	pence per min	*Vehicle share %*	Vehicle occup-ants	pence per min	*Vehicle share %*
Car	Employer business	1.16	79	*19*	1.19	72	*19*	1.21	82	*12*
	Commuter	1.43	19	*28*	1.47	20	*51*	1.49	20	*68*
	Other	1.43	17		1.47	17		1.49	18	
Taxi		0.86 pass	83	*26*	0.67 pass	56	*9*	1.00 pass	55	*3*
Van		1.22	33	*21*	1.23	33	*16*	1.23	33	*11*
Lorry		1.34	37	*7*	1.17	32	*4*	1.00	27	*6*
Average vehicle			**51**			**37**			**29**	
Average person			**42**			**28**			**21**	

4.8 The average value of time per person in the central, charged area is around 40 pence per minute or £25 per hour. Without any London weighting it would be around £18 per hour. Without any London weighting and in resource costs rather than market prices it would be around £15 per hour.

4.9 Prud'homme and Bocarejo used the ROCOL value of time which they quote at €15.6 per person hour or £10.8 per hour, and which they believe to be high. This value is around 28% below the current *WebTAG* national resource cost value of time, in 2005 values and prices, without any London weighting. It should be noted that the *ROCOL* study was undertaken in 1999 and used 2001 values of time, so there are a few years of inflation and real growth in values of time to allow for. The *ROCOL* value is just over 40% of the London-weighted, market price value of time used here.

The increase from £5 to £8

4.10 On 4 July 2005 the standard central area daily charge was increased from £5 to £8. There was no substantial public reaction and relatively little traffic response.

4.11 The initial observations made by Transport for London indicate that the volumes of traffic entering the charging zone have declined by up to 6%, comparing movements by vehicles with four or more wheels and charge payments in equivalent weeks in 2005 and 2006. Taking background trends into account, this suggests that the change in the charge has been responsible for a reduction of around 4% in traffic entering the charged area. This is towards the lower end of Transport for London's prior expectations.

4.12 There are similar indications that the volume of traffic circulating within the charged area is 3 to 4% down in early 2006 on a year previously. The available data suggests there are larger reductions in the volume of potentially chargeable vehicles (cars, vans and lorries), being partly offset by increases in non-chargeable vehicles (buses, taxis and two-wheeled vehicles).

4.13 The time savings from the imposition of the £5 charge are estimated at around £197 million, with charged area reliability savings estimated at £27 million. Increasing the charge from £5 to £8 for individual charge-payers and from £5.50 to £7 for fleet vehicles generates additional time savings of around £31 million and reliability savings of about £5 million. Thus, the increase in the charge of up to 60% adds only 16% to time and reliability savings. The increased charge also increases the cost to the extra deterred trips by around £11 million, from £20 million to £31 million, through a combination of more deterred trips and a higher cost to each deterred trip.

Small Time Savings

4.14 Mackie raised the perennial issue that time savings arising outside the charged area might fall into the category of small time savings and may consequently be less robust and of lesser value. This is a view often debated in the profession and never resolved.

4.15 The position of Transport for London and the Department for Transport is that small time savings should be included in an evaluation.

4.16 Time savings by vehicle kilometre by area have been shown above in Table 26. They vary from around 0.6 minutes per kilometre in the central, charged area, to 0.06 minutes per kilometre in the inner area and 0.01 minutes per kilometre in the outer area.

4.17 While the saving in the central area would not be questioned, the savings in the inner area of around 4 seconds per kilometre might be regarded as falling into the category of small time savings. A 10-kilometre east-west journey across the inner area would save on average just over half a minute on a journey taking almost 30 minutes. In the outer area there is less doubt. Saving only one minute on a 100 kilometre journey must be regarded as a small time saving

4.18 Therefore perhaps around half the total time savings from the scheme might be regarded as derived from 'small' time savings.

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5 Conclusions

5.1 This paper presents an *ex post facto* evaluation of the quantifiable costs and benefits of the Central London congestion charge. It also summarises other published economic evaluations of the London congestion charge and addresses some of the issues raised in those evaluations.

5.2 The principal benefits are time and reliability savings to continuing road users including bus users. These are estimated at around £220 million to road users per year with a £5 charge and up to £260 million with an £8 charge and an additional £40 million or so to bus users. There are other impacts on road users aside from paying the charge: continuing road users have to bear transaction costs and deterred road users suffer a loss of surplus. Society benefits from reduced accident costs and CO_2 and pollution costs but has incurred additional infrastructure costs to pave the way for the congestion charging scheme. These impacts are estimated at a net cost of around £50-60 million per year.

5.3 The principal on-going costs are those of operating the scheme and of operating additional bus services to accommodate deterred trips. Continuing road users enjoy reduced vehicle operating costs. On-going costs are estimated at a net cost of £101 million per year with a £5 charge and £99 million per year with an £8 charge.

5.4 The principal financial impacts are the payments of (and receipts of) congestion charges and associated penalty payments, additional bus fares and lost fuel duty and VAT to government – since fuel consumption is reduced and there is more individual expenditure on the congestion charge and on bus fares both of which are zero-rated for VAT. There is also a loss in net parking revenues to boroughs and private car parks in the charging zone. There is a net surplus to the public purse of £28 million with a £5 charge and £46 million with an £8 charge.

5.5 Overall, using a typical year's operation, the identified benefits of the congestion charge exceed the identified costs, by a ratio of around 1.5:1 with a £5 charge and by up to 1.7:1 with an £8 charge.

5.6 The benefits are dominated by time savings in Central, Inner and Outer London and reliability savings in Central London. The time savings in Central London are based on observed flow and speed data before and soon after charging was introduced so are more certain. Time savings in Inner and Outer London are based on model outputs so are less certain and are subject to the scale of the effects of induced traffic consuming the gains in network performance. There is uncertainty attached to travel time reliability savings also, but the scale of the reliability savings estimated here is broadly consistent with previous estimates produced elsewhere.

5.7 In 2006 observed speeds in the charged area had fallen below those used in this evaluation, which were observed in 2003 and 2005 after the £5 and £8 charges had been introduced. There is a long experience in Central London in particular of traffic speeds falling even during periods when traffic flows have remained largely unchanged. This is in part due to measures to restrict traffic speeds, largely for safety reasons, and to reallocate road space and priority on the road network in favour of buses, pedestrians and cyclists. These activities have continued and appear to have been compounded in 2006 by a significant increase in road works.

5.8 This does not invalidate the benefits estimates quoted above, which have been derived from a comparison of post-charging observed and modelled conditions, with observed and modelled conditions in 2002 serving as a proxy for the without-charging conditions in 2003 and 2005. Insofar as conditions in 2002 would have deteriorated by 2003 or 2005 without charging, the estimated benefits may be an underestimate. On the other hand, insofar as the analysis does not take account of declining levels of traffic in Central and Inner London and potential second order consequences of reduced effective road capacity, it may overestimate the true benefits. Any wider amenity or economic benefits are not assessed in this evaluation.

5.9 Transport for London's monitoring and investigations continue. Studies of the impacts of the western extension, introduced in February 2007, will contribute new evidence.

Annex

A1 This annex contains relevant statistical data showing the key impacts in the charging area and in Inner and Outer London of charges at £5 and £8 per day.

	units	charge	Central	Inner	Outer	
Vehicle km per charging day	000	£0	1532	15100	32929	
including induced trips		£5	1276	14722	32708	
		£8	1237	14678	32684	
Vehicle km reduction per charging day	000	£5	256	378	221	
including induced trips		£8	295	422	245	
	%	£5	16.7%	2.5%	0.7%	
	%	£8	19.3%	2.8%	0.7%	
Vehicle km reduction per year	million	£5	63.232	93.366	54.587	
including induced trips		£8	72.865	104.234	60.515	
Vehicle hours per charging day	000	£0	109	691	1018	
		£5	78	657	1004	
		£8	73	653	1003	
Vehicle speeds, km per hour		£0	14.1	21.9	32.2	
		£5	16.4	22.4	32.4	
		£8	16.9	22.5	32.4	
Hours saved per charging day		£5	11953	14245	5812	
by remaining traffic		%	37%	45%	18%	
allowing for induced traffic and out of hours savings		£8	14312	16059	6409	
		%	39%	44%	17%	
Values of time, 2005 values and prices						
per person hour	£ per hour		25.06	16.79	12.81	
per vehicle hour	£ per hour		30.33	22	17.64	
Value of time saved	£ million	£5	89.5	80.4	26.6	
		%	46%	41%	14%	
		£8	107.2	91.3	29.2	
		%	47%	40%	13%	
including induced traffic						
Fuel consumption	million litres	£0	65.0	513.1	989.2	
	per year	£5	51.9	493.5	978	
		£8	50.1	491.6	977.2	
Litres saved	million litres	£5	13.1	19.6	11.2	
	per year	£8	14.9	21.5	12	
Value of fuel saved - resource cost	£ million	£5	2.9	4.3	2.4	
		£8	3.3	4.7	2.6	
Value of fuel saved - fuel duty	£ million	£5	7.4	11.1	6.4	
		£8	8.5	12.2	6.8	
Value of fuel saved - VAT	£ million	£5	1.8	2.7	1.5	
		£8	2.1	3.0	1.6	
	£ million	£0	45.7	292.5	509.1	
		£5	35.1	281.6	504.6	
		£8	33.6	280.5	504.2	
Value of non-fuel costs saved - resource costs		£5	10.6	10.9	4.5	
	£ million	£8	12.1	12	4.9	
Value of time saved						
chargepayers	%	£5	44.3	7.7	3.4	
	£ million		39.6	6.2	0.9	46.7
	%	£8	44.3	7.7	3.4	
	£ million		47.5	7.0	1.0	55.5
non-chargepayers	%	£5	55.7	92.3	96.6	
	£ million		49.9	74.2	25.7	149.8
	%	£8	55.7	92.3	96.6	
	£ million		59.7	84.3	28.2	172.2