Transport for London

River Crossings Package: Silvertown Tunnel Economic Assessment Report

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EXECUTIVE SUMMARY

Purpose of this report

1. Transport for London (TfL) is proposing to construct a new road tunnel under the River Thames between the Greenwich Peninsula and Silvertown ("the Silvertown Tunnel"). This document is a report of the initial work on the Economic Assessment and forms one of several documents for public consultation starting in October 2014. The non-statutory consultation provides a preliminary opportunity for stakeholders to comment on the scope and methodology of the assessment. There will be a further opportunity to comment on the Economic Assessment when TfL undertakes the statutory pre-application consultation on the proposed application for a Development Consent Order (DCO) for the Silvertown Tunnel in 2015.
2. This Economic Assessment Report (EAR) details the processes and calculations performed during the assembly of evidence for the economic case for the construction of the Silvertown Tunnel. This report deals only with the technical economic assessment of the user benefits and disbenefits – other topics such as wider economic benefits (job and housing support, agglomeration) are covered in the Outline Business Case[1].
3. Evidence has been assembled from two key sources. The impact upon users of the transport system has been derived from traffic modelling work. The cost estimates of construction and operation of the Silvertown Tunnel have been sourced from TfL's commercial finance model.
4. The impact and cost data have been provided as inputs to the Department for Transport's TUBA (Transport User Benefit Analysis) computer system outputs which provide monetised values of the scheme's costs and benefits. The appraisal period used in TUBA has been the standard assumed in WebTAG for major highway infrastructure projects of 60 years.

Options considered

5. A variety of options were considered in the Silvertown Needs and Options Report[2], and only the economic evaluation of the preferred option – for a bored tube tunnel at Silvertown – is described in detail in this report. The option has been appraised compared to an assumption that the existing tunnel configuration and mode of operation (Blackwall Tunnel only without road user charging) continues unchanged.

Economic results and conclusions

6. TUBA outputs four key economic results:

[1] Silvertown Crossing Outline Business Case
[2] Silvertown Crossing Assessment of Needs and Options, TfL, September 2014

- Present Value of Benefits (PVB) giving the monetised value of all user benefits arising from the scheme;
- Present Value of Costs (PVC) giving the cost to the public sector of constructing, maintaining and operating the new infrastructure. Revenue from user charges collected by public sector are included in this output;
- Net Present Value (NPV) for the scheme, being the difference between the PVB and PVC values. A positive NPV indicates that a scheme will have overall benefits to the economy after costs are deducted; and
- Benefit to Cost Ratio, being the PVB divided by the PVC, which indicates the value for money a scheme will provide. We note in the main report that (and as advised by the DfT) this particular measure has limited usefulness to the evaluation of a scheme such as this, which is almost totally financed by user charges.

7. The four key economic results for the Silvertown Tunnel scheme are given in Table 1. The £m values shown are in 2010 prices. The scheme is largely self-funded by user charges and the economic case is very positive, with the scheme being clearly very good value for money.

Table 1: Economic results for Silvertown Tunnel £m

Economic Measure	Bored Tunnel
Present Value of Benefits	£1,526.3m
Present Value of Costs	£905.6m
Net Present Value	£620.6m
Benefit Cost Ratio	1.7

8. Figure 6 and Table 17 in the main text shows the geographic distribution of user benefits. These show that the main beneficiaries of the additional capacity provided by the Silvertown Tunnel are the areas to the south of the river, where currently northbound capacity is severely constrained and delays are extensive.

1. Study overview

Purpose of this report

1.1. Economic appraisal of transport schemes is required in order to assist decision-makers:

- prioritise between schemes;
- prioritise between options; and
- ensure that value for public money is achieved.

1.2. In this report the economic appraisal process for the Silvertown Tunnel project is discussed. Many of the effects of the new scheme have been monetised according to DfT WebTAG guidance[3] and combined with construction and maintenance costs to give an indication of the economic value of the scheme over a 60 year appraisal period. The choice of appraisal period is informed by WebTAG which stipulates a 60 year appraisal for projects that are deemed to have an "indefinite life"[4], including some major infrastructure schemes such as tunnels and bridges. The monetised benefit and cost streams 'with scheme' (Do Something) are compared to those 'without scheme' (Do Minimum) to give an indication of both the absolute and relative of value of schemes.

1.3. This Economic Assessment Report (EAR):

- summarises the transport modelling process used;
- details the data and justify assumptions used in economic appraisal;
- reports the monetised costs and benefits in both geographical and temporal terms as appropriate; and
- combines the monetised costs and benefits for each assessed option in standard economic appraisal tables to produce economic performance indicators.

1.4. In the report sub-headings specifically required by Highways Agency best practice are shown in ***bold italics***, other sub-headings are underlined.

Study overview

1.5. There are currently four locations at which vehicles may cross the River Thames downstream of Tower Bridge. These are the Rotherhithe Tunnel, the twin bore Blackwall Tunnel, the Woolwich Ferry and the Dartford Tunnels and Bridge. The first three crossings are owned and maintained by TfL while the Dartford Crossing is the responsibility of the Secretary of State for Transport.

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[3] WebTAG Unit A1.1 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275125/webtag-tag-unit-a1-1-cost-benefit-analysis.pdf
[4] WebTAG Unit A1.1 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275125/webtag-tag-unit-a1-1-cost-benefit-analysis.pdf

1.6. The Mayor's Transport Strategy has identified the need for additional river crossings between east and southeast London. The plan is to relieve congestion at the existing crossings and to allow for the replacement of the present Woolwich Ferry and riverside infrastructure both of which will be life expired by 2024. A package of measures is being prepared comprising several options, one of which is for a new tunnel linking the Greenwich Peninsula with Silvertown.

1.7. A range of options for an additional crossing of the River Thames from the Greenwich Peninsula were considered prepared and assessed against the goals set out in the Mayor's Transport Strategy. The results of this assessment were reported in the ''Silvertown Crossing and Assessment of Needs and Options' report[5]. - this assessment has been summarised in the Silvertown Needs and Options report, TfL, 2014.

1.8. The following eight options and a 'do-nothing' option were assessed against the project objectives:

- Do Nothing (Option A)
- Manage demand and maximise public transport use (Option B)
- Congestion charging at Blackwall Tunnel (Option B1)
- DLR extension to Falconwood (Option B2)
- Lower cost road crossings (Option C)
  - Silvertown Ferry (Option C1)
- Fixed links road crossings (Option D)
  - Blackwall Tunnel third bore (Option D1)
  - Silvertown lifting bridge (Option D2)
  - Silvertown bored tunnel (Option D3)
  - Silvertown immersed tunnel (Option D4)

1.9. Of the eight options considered, a fixed link in the form of a tunnel (either bored or immersed) is the only river crossing option that would address the congestion and resilience problems experienced at the Blackwall Tunnel and support the growth planned for the area and accordingly, performs strongly against all of the project objectives. The bored/ immersed tunnel would:

- Reduce congestion at the Blackwall Tunnel
- Provide a highly resilient river crossing (based on its size)
- Reduce the number of incidents occurring at the Blackwall Tunnel
- Eliminate the (up to 20 minutes) delays at the Blackwall Tunnel
- Provide additional river crossing capacity in east London
- Enable opportunities for new cross-river bus services
- Provide improved connectivity to Opportunity Areas including Canary Wharf and Royal Docks

1.10. A detailed examination of eight tunnel sub-options has been undertaken, analysing the impacts of the bored and immersed tunnel options, as well as short and long

[5] Silvertown Crossing Assessment of Needs and Options, TfL, September 2014

tunnel options, Investigation of these tunnel variants, concluded that a bored tunnel best met project objectives and requirements. (Appendix A of the Outline Business Case describes the appraisal of bored and immersed tube tunnel variants, and Appendix H of this report describes the economic assessment between these variants).

1.11. Consequently the conclusion reached in the Silvertown Crossings Assessments of Needs and Options was that a bored tunnel from North Greenwich to Silvertown should be pursued along with the introduction of road user charging for the new tunnel and at the Blackwall Tunnel.

1.12. This report sets out the economic assessment of the preferred option, in comparison to the continuation of the present situation (the reference case). The reference case assumes a replacement of the Woolwich Ferry with 30% additional capacity (uncharged) . This removes from the economic assessment any of the effects if the existing Woolwich Ferry was to be replaced with a new ferry.

1.13. The economic assessment documented in this report consists only of Transport Economic Efficiency (TEE) assessments based upon results from TUBA. A full appraisal (to be submitted with any future Development Consent Order (DCO) process) will also include other elements as described in section 1.23.

(a) Statement of the scheme objectives

1.14. The River Crossing programme objectives and the project objectives and requirements for the Silvertown scheme are described in full in the Silvertown Needs and Options Report[6]. The Silvertown Tunnel scheme objectives are:

- **PO1**: to improve the resilience of the river crossings in the highway network in east and southeast London to cope with planned and unplanned events and incidents.
- **PO2**: to improve the road network performance of the Blackwall Tunnel and its approach roads.
- **PO3**: to support growth in east and southeast London by providing improved cross-river transport links for business and services (including public transport).
- **PO4**: to integrate with local and strategic land use policies.
- **PO5**: to minimise any adverse impacts of any proposals on health, safety and the environment.
- **PO6**: to ensure where possible that any proposals are acceptable in principle to key stakeholders, including affected boroughs.
- **PO7**: to achieve value for money.

1.15. In order to meet these objectives, a successful crossing option needs to meet a number of other core project requirements. The requirements are used in a detailed

[6] Silvertown Crossings Assessments of Needs and Options Report, TfL, 2014

assessment of shortlisted options for the Silvertown crossing (as set out in the accompanying Outline Business Case[7])

1.16. The project requirements for Silvertown are:

PR1: To provide a fixed link river crossing at Silvertown to relieve congestion and improve resilience at Blackwall Tunnel.

PR2: Design for future cross-river traffic demand associated with planned economic growth in the East London sub-region, giving specific consideration for: a) commercial traffic and the movement of goods; and b) bus and coach services.

PR3: To provide safe links with the local highway networks for all road users (including pedestrians and cyclists) and ensure adverse traffic impacts are mitigated.

PR4: To provide effective travel demand management by a combination of road user charging and strategic road space management (including Blackwall Tunnel).

PR5: Project should be fundable from user charging revenue.

PR6: To integrate known land-use and transport development proposals and minimise impacts on developable land and the environment.

(b) Description of the scheme including plan of the scheme

1.17. The scheme involves the construction of a tunnel at Silvertown in east London, following a safeguarded alignment between Silvertown and North Greenwich, as shown in Figure 1 and Figure 2. The new tunnel will be close to the existing heavily congested Blackwall Tunnels, and serve to relieve these tunnels. The Silvertown Tunnel scheme forms part of the East London River Crossings package described in the Mayor's Transport Strategy. The scheme also includes the introduction of a user charge to manage demand for the use of both the proposed Silvertown Tunnel and the Blackwall Tunnel.

1.18. The tunnel would provide two lanes in each direction and be built to full highway gauge of just over five metres headroom and full standard lane widths of 3.65 metres, which would accommodate all UK standard height vehicles including double-decker buses.

[7] Silvertown Tunnel Outline Business Case, TfL, 2014

Figure 1: Location plan of Silvertown Tunnel

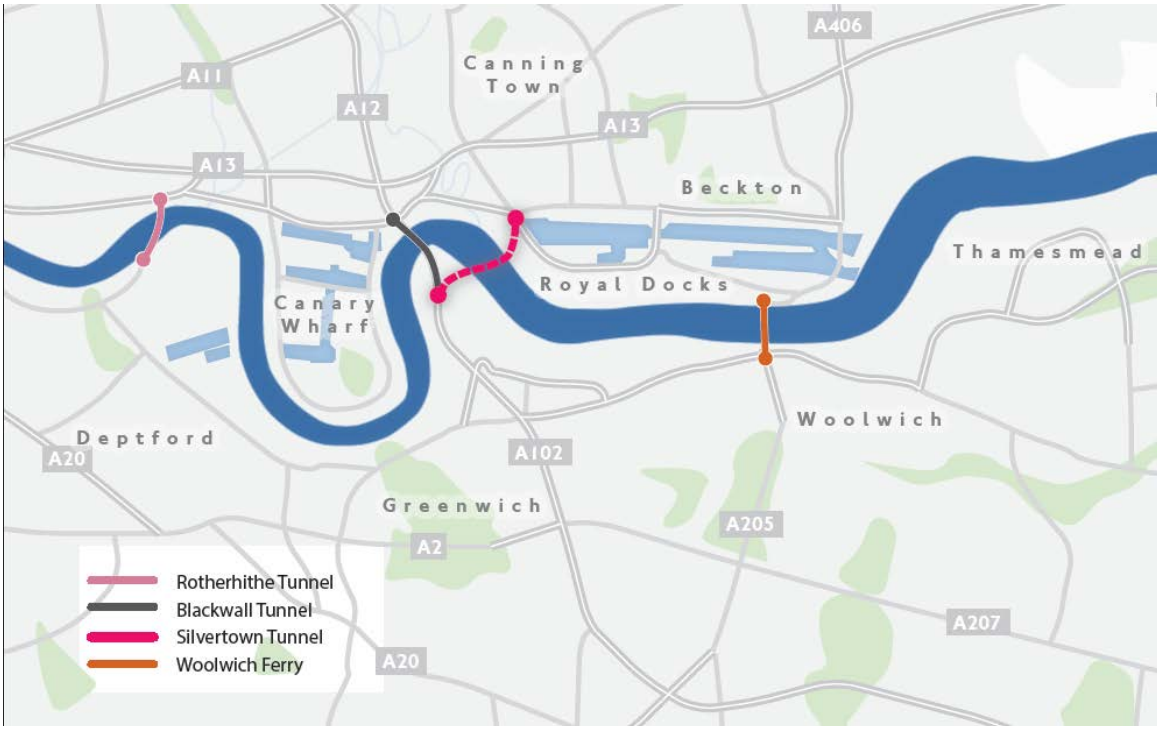
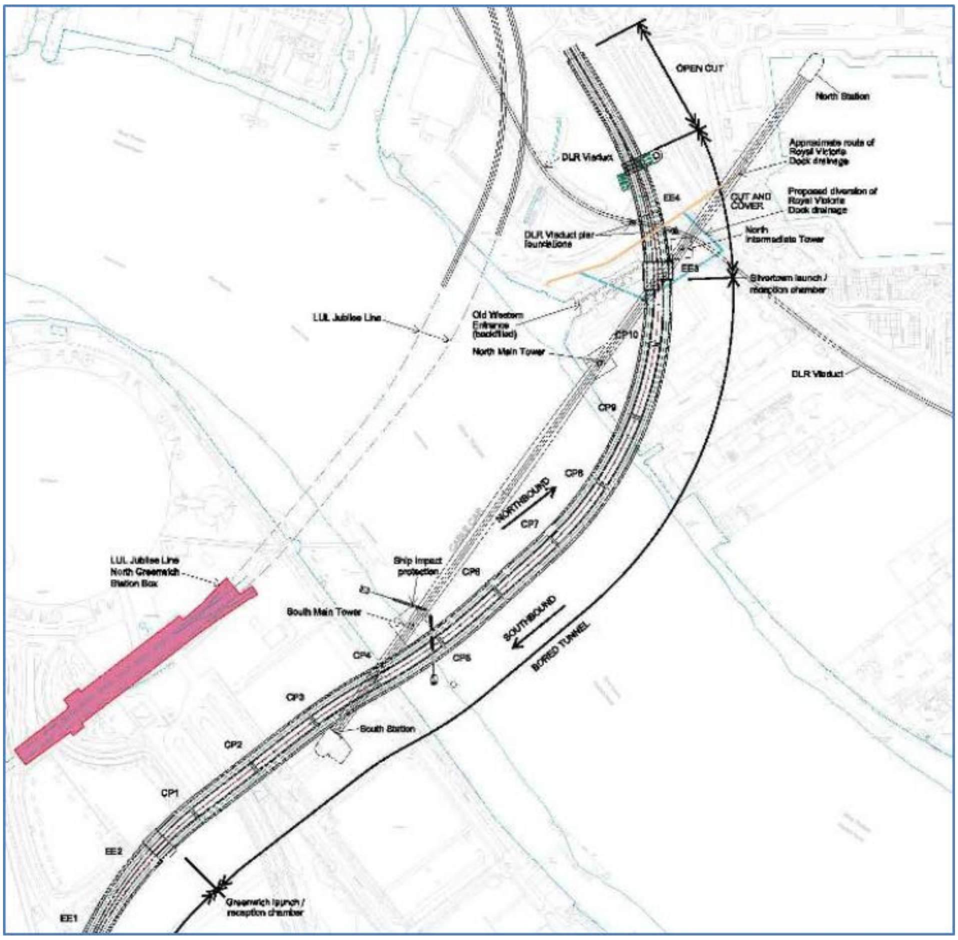


Figure 2: Detailed location of Silvertown Tunnel preferred option



1.19. The tunnel is expected to make a very significant contribution to a reduction in the number of incidents occurring at the existing Blackwall Tunnel. Journey times in the peak direction would be greatly reduced and the delays for current Blackwall Tunnel users (of around 20 minutes during peak periods) are likely to be effectively eliminated.

1.20. A tunnel would also offer a relatively fast and direct route into the Isle of Dogs and Royal Docks areas from the south, offering connectivity benefits to these Opportunity Areas. If the levels of local congestion at the Blackwall Tunnel are reduced, and resilience greatly improved, there would be general benefits for a large area of east and southeast London. In addition, a full gauge road tunnel between the Greenwich Peninsula and the Royal Docks enables opportunities for new cross-river bus services, further improving connectivity.

Costed options

1.21. The Silvertown Tunnel 'Tunnel Engineering Report – Addendum A' prepared for TfL by Mott MacDonald sets out the construction costs for the preferred option. The cost assumed for this assessment is the more expensive of the Bored Tunnel options (B2). The construction costs (2010 prices) are £625.7m, these costs are Present Value in 2010 market prices, discounted to 2010. They include a risk allowance and optimism bias.[8]

(c) Details of previous economic assessments carried out for the scheme

1.22. This Economic Assessment Report (and the associated Outline Business Case) is the first such economic report produced for the Silvertown Crossing project. No Outline Strategic Case preceded it, as other documents prepared by TfL provided the required depth of analysis. In addition to an assessment of need[9], an Economic Assessment Report was prepared for TfL's internal Gate process, which was subject to an external technical Gate B review by AECOM.

Future work for the Full Business Case

1.23. This report is prepared in support of an Outline Business Case. There will be more detailed studies and analysis undertaken for any future Full Business Case, which is the next stage in the economic appraisal process. The main areas of work which will be enhanced/covered in the future Full Business Case are:

- a detailed report on the regeneration and wider economic benefits;
- further sensitivity tests;
- further work on the reliability and safety impacts of the proposed scheme;

[8] The total construction cost in outturn prices is £926m, which is equivalent to the £625.7m figure shown when discounted and converted to 2010 market prices for the economic assessment

[9] East London River Crossings: Assessment of Need, TfL, 2013 and East London River Crossings: Assessment of Options, TfL, 2013

- analysis of delays at roadworks during construction; and
- further work on the distributional and social impacts of the scheme.

Structure of this report

1.24. The remainder of the report is as follows:

- Chapter 2 – the economic assessment approach;
- Chapter 3 – information on the estimation of costs;
- Chapter 4 – how benefits were estimated;
- Chapter 5 – the economic assessment results; and
- Chapter 6 – summarises the report and its conclusions.

2. Economic assessment approach

(a) Transport model used

2.1. The traffic data used in the economic assessment of the Silvertown Tunnel scheme was derived from the TfL River Crossings version (RXHAM) of the sub-regional ELHAM traffic model. This model is a highway-only based model and uses the SATURN modelling suite. Details of the traffic modelling and forecasts may be found in the Traffic Forecasting Report[10].

2.2. The ELHAM traffic model for the Silvertown Tunnel scheme was developed for the following time periods:

- morning (AM) peak hour (08:00-09:00);
- average inter-peak hour between 10:00 to 16:00 (IP); and
- evening (PM) peak hour (17:00-18:00).

2.3. The traffic assignment was carried out with seven different classes of vehicle and user as follows:

1. car, non-work time, <£20k income
2. car, non-work time, £20k-£50k income
3. car, non-work time, >£50k income
4. car, in-work time (i.e. business use)
5. taxi
6. light goods vehicles
7. heavy goods vehicles[11]

2.4. The model forecast years were 2021 (assumed Silvertown Tunnel opening year) and 2031 which is the standard TfL future horizon year.

Modelled scenarios

2.5. The options modelled for the Silvertown Tunnel are shown in Table 2. These comprise a ‘without scheme’ scenario and a ‘with scheme’ scenario for two assessment years. Further work for the Full Business Case will include sensitivity tests.

[10] Silvertown Tunnel Traffic Forecasting Report, TfL, 2014
[11] Buses are not part of the standard assignment process but their impact on road capacity is taken account of in the highway assignment model.

Table 2: Silvertown Tunnel options modelled

Scheme scenario	Traffic model network
Without scheme	For both 2021 and 2031, the Woolwich Ferry had a capacity increase of 30% but no charge
With scheme	For both 2021 and 2031 the Woolwich Ferry had a capacity increase of 30% and a user charge.[12]

2.6. For the full business case, it is envisaged that a further forecast year (2041) will be modelled, in addition to 2021 and 2031.

Variable demand model used (and form of responses)

2.7. TfL has used the London Regional Demand Model (LoRDM) to forecast the demand and traffic impacts of several options to provide new river crossings in east and southeast London. LoRDM uses population and employment figures (as contained in the Mayor's 2009 London Plan) as well as assumptions from Government on economic growth to predict overall travel demand on both public transport and the highway network. LoRDM also estimates highway and public transport network conditions. On the highway side, LoRDM includes TfL's River Crossings Highway Assignment Model (RXHAM) which represents the highway network in detail to determine the strategic routeing of trips between their origins and destinations.

2.8. LoRDM is strategic in nature and is used to identify broad changes in traffic patterns across the highway network, as well as the magnitude of this change. The results should not be taken as a definitive forecast of future flows, especially on minor roads or at individual junctions. Also the models do not yet assume any mitigation measures that might be introduced such as changes to junction capacities or new traffic calming measures.

2.9. The model results do not include any land use changes that could occur as a result of changes in travel accessibility. The model does, however, take into account how trips might redistribute between the locations of future population and job changes, and how mode share might be impacted. It will estimate variable demand for individual modes but the overall trip ends are fixed.

(b) Economic assessment process

2.10. The expected economic impacts of the scheme have been established through various transport studies, following methods set out in the Department's modelling and appraisal guidance (WebTAG). The assessment of Transport Economic Efficiency

12 For the purpose of traffic modelling, the reason for this assumption is that by 2031 the Woolwich Ferry would need to either be upgraded at its existing location or replaced with a new crossing. Other crossings east of Silvertown Tunnel are subject to a separate decision-making process. If the Woolwich Ferry were to be upgraded at its existing location, the modelling assumes that it would be charged to ensure consistency with the Blackwall, Silvertown and Dartford Crossings. The assumption about the existing and potential future capacity of the Woolwich Ferry has little material impact on the forecasts for Silvertown Tunnel.

benefits and costs was carried out using TUBA. The standard TUBA 1.9.4 economics file (see Appendix A) was used, and the inputs are described in more detail in section 4.

2.11. The Economic Assessment has been carried out using standard procedures and economic parameters as defined by WebTAG Unit A1. The following potential elements of the economic assessment have been considered:

- road user benefits - due to change in travel time and vehicle operating cost;
- safety benefits - due to a change in the number and/or severity of accidents;
- journey time reliability benefits - due to changes in the journey time reliability in the network. this is described but not monetised in this report, further detail with be provided in any full business case;
- construction and maintenance benefits - due to impacts to road user travel time and vehicle operating cost during scheme construction and maintenance (not included in this outline report, for future full business case);
- indirect tax revenue - due to change in the amount of fuel purchased and the associated impact to revenue from fuel duty;
- greenhouse gas benefits; and
- user charges.

2.12. The economic assessment assumes that the opening year for the scheme will be 2021 -the appraisal period is 60 years. The choice of appraisal period is informed by WebTAG which stipulates a 60 year appraisal for projects that are deemed to have an “indefinite life”, including some major infrastructure schemes such as tunnels and bridges.

2.13. The results of the assessment are presented in the following tables in section 5:

- Transport Economic Efficiency (TEE) Table;
- Public Accounts (PA) Table; and
- Analysis of Monetised Costs and Benefits (AMCB) Table.

(c) Non-standard procedures and economic parameters

2.14. The treatment of charge revenues in Public Accounts and AMCB tables is not ‘standard’ but is as advised by WebTAG Unit A1 and the DfT for this type of scheme, where funding is primarily by user charges. The DfT advice is reproduced in Appendix B.

3. Estimation of costs

(a) Do-something and Do-minimum costs and profile

3.1. The preparation of scheme costs for the Silvertown Tunnel has been carried out following the principles set out in WebTAG Unit A1.2 'Scheme Costs'. The costs have been estimated under three broad headings – investment, operating and maintenance costs.

3.2. Unless otherwise stated, all costs have been derived from The Silvertown Tunnel 'Tunnel Engineering Report – Addendum A' prepared for TfL by Mott MacDonald for option B2 (bored tunnel, cross passages at 100 metre centres).[13]

3.3. Investment costs are those that will be incurred in the preparation and construction of the scheme and, in addition, the cost of the land required for the scheme.

3.4. Operating costs comprise the costs of charge collection, the operation of the enforcement system and maintenance/operation of the ANPR cameras recording the vehicles passing through the tunnels. These costs cover the charging regime that will apply to both the Blackwall and Silvertown Tunnels which is planned to come into force on the opening of the latter.

3.5. Maintenance costs comprise the costs for the maintenance of the scheme, including periodic renewal and refurbishment of the tunnel and equipment.

3.6. All costs have been estimated in 2012 (Quarter 1) factor prices (without allowance for the effect of indirect taxation) and are stated by the financial year in which the expenditure will be incurred. They have been adjusted to 2010 prices when input into TUBA.

Investment costs

3.7. Investment costs for the Silvertown Tunnel have been estimated under three headings: preparation, land and construction costs.

3.8. Included in the preparation costs are planning/powers at £8.1m, and procurement at £10.0m, a total of £18.1m.

3.9. Land costs have been estimated at a value of £13m for the bored tunnel.

3.10. TfL project management is estimated at £6.3m.

3.11. Itemised construction cost estimates for the Silvertown Tunnel are listed in Table 3. These are shown for the selected Bored Tunnel option B2 (cross passages at 100 metre centres).

[13] Silvertown Tunnel Engineering Report – Addendum A '. prepared, for TfL by Mott MacDonald, 2013

Table 3: Construction cost estimates Q1 2012 prices

Cost Item	Bored Tunnel B2
Insurances	£18.4m
Contractor preliminaries	£53.1m
Drain diversion	£10.0m
TBM supply, erect and dismantle	£30.6m
TBM driving costs and tunnel lining segments	£51.6m
Launch chamber and portal construction	£8.3m
Cross passages	£17.2m
TBM reception chamber	£7.3m
Sump	£0.2m
Tunnel fill and cladding	£11.5m
Tunnel mechanical and electrical works	£49.2m
Silvertown cut and cover	£20.6m
Silvertown open cutting	£11.3m
Greenwich cut and cover	£28.0m
Greenwich open cutting	£10.0m
Substations and vent buildings	£19.4m
Link roads in Greenwich and Silvertown	£38.7m
Detailed design by contractor's consultant	£15.4m
Contractor overhead and profit	£40.1m
Total construction cost	**£440.9m**

3.12. Cost adjustments in respect of inflation to bring the sums to outturn prices are shown in Table 4.

Table 4: Inflation cost adjustments

Cost category	Q1, 2012 prices	Inflation adjustment	Outturn prices
Planning	£8.1m	£0.7m	£8.8m
Procurement	£10.0m	£2.2m	£12.2m
Land	£13.0m	£1.9m	£14.9m
Construction	£440.9m	£159.6m	£600.5m

TfL Project Management	£6.3m	£2.2m	£8.5m
Total			£644.9m

3.13. The total outturn prices for the costs amount to £644.9m.

(b) Risk and optimism bias assumptions

3.14. Allowances for risk in each cost category have been set and added to the post-inflation adjustment costs. The risk allowances are shown in Table 5.

Table 5: Risk allowances

Cost category	Risk allowance	Price before risk addition	Risk addition	Price after risk addition
Planning	40%	£8.8m	£3.6m	£12.4m
Procurement	40%	£12.2m	£4.9m	£17.1m
Land	40%	£14.9m	£5.9m	£20.8m
Construction	15%	£600.5m	£90.1m	£690.6m
TfL Proj Managem't	40%	£8.5m	£3.4m	£11.9m
Total				£752.8m

3.15. An uplift to mitigate against Optimism Bias applicable to each investment cost category has been determined and applied at the values shown in Table 6.

Table 6: Investment cost optimism bias

Cost category	Optimism bias uplift	Price before opt. bias	Optimism bias addition	Price after opt. bias
Planning	23%	£12.4m	£2.8m	£15.2m
Procurement	23%	£17.1m	£3.9m	£21.0m
Land	23%	£20.8m	£4.8m	£25.6m
Construction:	23%	£690.6m	£158.8m	£849.4m
TfL Proj Managem't	23%	£11.9m	£2.8m	£14.7m
Total				£925.9m

3.16. The distribution of the costs (after adjustment for inflation, risk and optimism bias) by year of anticipated expenditure, is shown in Table 7. Planning and procurement costs are listed together as preparation costs and the Silvertown Tunnel and Link Road costs have been combined as construction costs. The percentage splits of costs between years, is also shown as these are used in the input file for TUBA along with the total cost in each category. Project preparation costs for the years up to and including 2013 are excluded from the economic appraisal, as these are 'sunk' costs which will not influence the appraisal. These total £2.8m.

Table 7: Scheme costs for the preferred tunnel option, up to the completion of construction in 2024, in outturn prices

Year	Preparation	Supervision	Land	Construction	Total cost
2014	£6.3m (18.9%)				
2015	£5.1m (15.2%)				
2016	£4.1m (12.3%)		£4.6m (18.1%)		
2017	£11.3m (33.7%)		£16.1m (62.9%)		
2018	£5.9m (17.5%)	£0.8m (5.7%)	£4.9m (19.0%)	£48.6m (5.7%)	
2019	£0.8m (2.4%)	£2.4m (16.4%)		£139.2m (16.4%)	
2020		£2.9m (20.0%)		£169.7m (20.0%)	
2021		£3.1m (20.9%)		£177.7m (20.9%)	
2022		£3.2m (21.9%)		£186.1m (21.9%)	
2023		£1.9m (12.7%)		£107.9m (12.7%)	
2024		£0.4m (2.4%)		£20.3m (2.4%)	
Total	**£33.5m (100%)**	**£14.7m (100%)**	**£25.6m (100%)**	**£849.4m (100%)**	
Sunk cost					£2.8m
Total cost					**£926.0m**

3.17. The value of the construction costs (2010 prices discounted to 2010) is £625.7m.

Operational costs

3.18. The Silvertown Tunnel scheme comprises not only the planning and construction of the tunnel but also the introduction of a road user charge for both the new Silvertown Tunnel and the existing Blackwall Tunnel. It is anticipated that the charge will be collected from drivers using a similar method employed for collecting the Central London Congestion Charge. There will not be any plaza at which vehicles will have to stop and pay to use the tunnels.

3.19. Operating costs for the collection of the road user charge have been estimated for the 60 year appraisal period. They are comprised of several elements: charge collection costs, charge enforcement costs and charge operation and maintenance costs.

3.20. Charge collection costs per vehicle have been estimated at £1.11 if a user pays via a call centre, £0.21 if payment is made through a website and £0.20 for payment by direct debit. The proportions using each payment method are estimated at 10%, 10% and 80% respectively. This results in an average collection cost per vehicle of £0.29. Total collection costs for the charge for each appraisal year have been calculated by multiplying the estimated traffic volume for the year by the average charge, allowing for a 5% non-payment rate.

3.21. Charge enforcement is proposed to be through a Penalty Charge Notice (PCN) system, the purpose of which is to achieve 100% compliance in the payment of the due road user charge. Costs have been included at a rate of £1.85 per evading vehicle, derived from a cost of £0.85 to issue a PCN, £7.50 to re-present a PCN, and £50.00 to deal with an appeal. Total enforcement costs are calculated by multiplying annual traffic volumes by the evasion rate (5%) and by the cost per evading vehicle.

3.22. Charge operation and maintenance costs are estimated at a fixed £0.48m a year, comprising the cost of operating and maintaining 32 Automatic Number Plate Recognition (ANPR) cameras at £15,000 each a year.

3.23. The Silvertown Tunnel charge collection operating costs are shown in Table 8. Traffic flows for intermediate years between 2021 and 2031 have been interpolated on a straight-line basis, between the values for the two forecast years (2021 and 2031). Charge collection costs beyond 2031 up to 2080 have been assumed at the 2031 value as traffic volumes are assumed constant beyond this year. The percentage of the total operating cost that will be incurred in each year is also shown.

Table 8: Silvertown Tunnel operating costs

Year	Traffic flow	Charge collection*	Charge enforcement⁺	Operation / maintenance	Total
2021	23.145m	£6.42m	£2.14m	£0.48m	£9.04m (1.52%)
2022	23.402m	£6.49m	£2.16m	£0.48m	£9.13m (1.54%)
2023	23.659m	£6.56m	£2.19m	£0.48m	£9.23m (1.55%)
2024	23.916m	£6.63m	£2.21m	£0.48m	£9.32m (1.57%)
2025	24.172m	£6.71m	£2.24m	£0.48m	£9.43m (1.59%)
2026	24.429m	£6.78m	£2.26m	£0.48m	£9.52m (1.60%)
2027	24.686m	£6.85m	£2.28m	£0.48m	£9.61m (1.62%)
2028	24.943m	£6.92m	£2.31m	£0.48m	£9.71m (1.63%)
2029	25.200m	£6.99m	£2.33m	£0.48m	£9.80m (1.65%)
2030	25.456m	£7.06m	£2.35m	£0.48m	£9.89m (1.66%)
2031	25.713m	£7.13m	£2.38m	£0.48m	£9.99m (1.68%)
*£0.29 per vehicle, 5% evasion. ⁺£1.85 per evading vehicle.					

Maintenance costs

3.24. Maintenance costs for the proposed Silvertown Tunnel have been estimated under four separate headings: routine tunnel maintenance, reactive tunnel maintenance, lifecycle maintenance and tunnel services (electricity and water). Both the routine and reactive tunnel maintenance comprise elements for maintenance of the road infrastructure and for the traffic control equipment.

3.25. The routine tunnel maintenance cost totals £2.22m a year, with £1.94m attributable to the road infrastructure and £0.28m to the traffic control equipment.

3.26. Reactive tunnel maintenance has been estimated at £0.39m a year. This comprises elements of £0.30m for road infrastructure and £0.09 for traffic control equipment.

3.27. Life cycle costs comprise an allowance of £17.86m split over two years every ten years. Tunnel services costs comprise an annual charge of £0.16m for electricity and £0.01m for the supply of water, a total of £0.17m a year. Maintenance costs a year are recorded in Table 9 along with the percentage of the total represented by the total costs for each year.

Table 9: Silvertown Tunnel annual maintenance costs

Year	Routine maintenance	Reactive maintenance	Life cycle costs	Tunnel services	Total maintenance
2021	£1.51m	£0.26m	£0.00m	£0.11m	£1.88m (0.74%)
2031, 2032, 2041, 2042, 2051, 2052, 2061, 2062, 2071, 2072	£2.22m	£0.39m	£8.93m	£0.17m	£11.71m (4.59%)
All other years	£2.22m	£0.39m	£0.00m	£0.17m	£2.78m (1.09%)
Total	£132.49m	£23.27m	£89.30m	£10.14m	£255.20m (100.00%)
2021	£1.51m	£0.26m	£0.00m	£0.11m	£1.88m (0.74%)
2031, 2032, 2041, 2042, 2051, 2052, 2061, 2062, 2071, 2072	£2.22m	£0.39m	£8.93m	£0.17m	£11.71m (4.59%)

(c) Grants and subsidies

3.28. At this stage no grants and subsidies are applicable to this project.

4. Estimation of benefits

(a) Appraisal methodology

4.1. The appraisal was carried out using the TUBA v1.9.4. Adjustments were made post-TUBA for (1) a small reduction in weekend user benefits (2) bus and coach user benefits.

(b) Time savings calculations

Economic parameters

4.2. TUBA provides a complete set of default economic parameters in its 'Standard Economics File'. This contains values of time, vehicle operating cost data, tax rates, economic growth rates and many other economic parameter values.

4.3. TUBA version 1.9.4 reports economic values in 2010 prices, discounted to a present value of 2010. (There will therefore be some difference between the results reported at the earlier Phase 2a appraisal, which used on older version of TUBA (v1.8) based on 2002 prices).

4.4. The economic parameter file used in the appraisal is shown in Appendix A.

Scheme parameters

4.5. The scheme parameters were largely determined by the parameters used in the forecasting model, namely:

- first year – 2021 (assumed scheme opening year);
- horizon year – 2080 (60 years from opening year);
- modelled years – 2021, 2031; and
- current year – 2014.

4.6. For the purposes of the economic appraisal no traffic growth was assumed after 2031, the last modelled year.

Time slices and annualisation factors

4.7. TUBA works on the basis of five standard-definition time periods as follows:

- AM peak (weekday 07:00 to 10:00);
- PM peak (weekday 16:00 to 19:00);
- inter-peak (weekday 10:00 to 16:00);
- off-peak (weekday 19:00 to 07:00); and
- weekend.

4.8. The ELHAM-based Silvertown Tunnel model comprised three weekday time periods; an AM peak hour, an average inter-peak hour and a PM peak hour. The modelled period benefits calculated by TUBA were converted into an estimate of annual benefits using the following annualisation factors (see description of analysis in Appendix C):

- weekday AM peak period (7am to 10am): 704 x AM peak model hour;
- weekday interpeak and off-peak period (6am to 7am, 10am to 4pm, 7pm to 10pm): 2244 x interpeak model hour;
- weekday PM peak period (4pm to 7pm) : 724 x PM model hour; and
- weekend and bank holiday period (6am to 10pm): 1275 x interpeak model hour.

4.9. These factors cover the proposed charging period of 6am to 10pm, 7 days a week. They are for a standard year with 253 weekdays, 104 weekend days and 8 bank holidays.

4.10. An adjustment was applied (post-TUBA) to the weekend and bank holiday period results, by reducing the time and VOC benefits as from 6am to 8am the flows on these days are below 50% of the interpeak average hour and thus there is unlikely to be any benefit to users at these times as traffic is likely to be free-flowing. The reduction factor used was 6%, which was the proportion of the daily flow in these two hours. However, users will still need to pay the charges, and therefore no deduction has been made for user charge disbenefits, or operator revenue.

4.11. Note that no benefits have been taken into account outside the charging period. This is regarded as a conservative assumption as outside the charging period there are expected to be benefits from:

- a lower time and distance route for some users (e.g. those heading to the Royal Docks from south of the river);
- the benefits for travellers during maintenance of having two sets of tunnels available; and
- general reliability benefits.

User classes

4.12. The seven traffic model user classes were split into eleven user classes within TUBA to take account of varying values of time for different travel purposes and vehicle operating costs by vehicle type. The TUBA user classes are shown in Table 10along with the proportions of trips from each model user class – see details of analysis in Appendix D.

Table 10: TUBA user classes

TUBA user class	Description	Model user class	Proportion of model user class			
			AM	IP	PM	Off Peak and Weekend
1	Car <£20k commuting	1	0.61	0.20	0.43	0.116
2	Car <£20k other	1	0.39	0.80	0.57	1.141
3	Car £20k-£50k commuting	2	0.61	0.20	0.43	0.116
4	Car £20k-£50k other	2	0.39	0.80	0.57	1.141
5	Car >£50k commuting	3	0.61	0.20	0.43	0.116
6	Car >50k other	3	0.39	0.80	0.57	1.141
7	Car business	4	1.00	1.00	1.00	0.078
8	Taxis	5	1.00	1.00	1.00	1.000
9	Light Goods Vehicles	6	1.00	1.00	1.00	1.000
10	Heavy Goods Vehicles 2/3 axle	7	0.29*	0.271*	0.355*	0.271*
11	Heavy Goods Vehicles 4 axles	7	0.21*	0.229*	0.145*	0.229*
* Makes allowance for modelling of HGVs as 2 PCUs, factor converts to vehicles						

Scenarios

4.13. Within TUBA each modelled option is termed a scenario and these were classified as either 'Do Minimum' or 'Do Something' scenarios. For the Silvertown Tunnel scheme, the 'Do Minimum' scenario comprised the existing road network with any committed improvements, with no charge at Blackwall and the Woolwich Ferry renewed in 2024.

4.14. The 'Do Something' scenario comprised the Do Minimum scenario with the addition of the Silvertown Tunnel and user charging applied at both the Blackwall and proposed Silvertown Tunnels. The exact charges have not been decided yet, but those modelled in the 'central' case were the same as those to be introduced at the Dartford Crossing in October 2014 (see section 5.9 of the TfL's Draft outline strategy for user charging at Blackwall and Silvertown Tunnels report), with the exception that only half the user charge was assumed to apply in the counter-tidal direction in the weekday peak, in the interpeak and on weekends and public holidays. The modelled charge values by vehicle class are shown in Table 11.

Table 11: Modelled peak charges for use of Blackwall and Silvertown Tunnels

User class	2021 and 2031 Toll (in 2009 prices[14])
Car out of work <£20k	£1.64
Car out of work £20k - £50k	£1.64
Car out of work >£50k	£1.64
Car in work time	£1.64
LGV	£2.36
HGV	£4.07

Input matrices

4.15. Data input to TUBA comprised trip, flow weighted average travel time, and travel distance and charge skim matrices. These matrices were prepared for each scenario separately for combinations of three time periods (AM, IP, PM), seven user classes and two forecast years (2021 and 2031) for both Do Minimum (Without Scheme) and Do Something (With Scheme) scenarios. A total of 336 matrices were prepared (3 x 7 x 2 x 2 scenarios x 4 matrix types).

4.16. Within the TUBA input file, the total number of matrix lines specified rises to 704 because of the increase to 4 time periods and 11 user classes (4 x 11 x 2 x 2 x 4). Many vehicle matrices were included on several lines with the application of the factors listed in Table 10 to proportion them between different uses and/or vehicle types. This included an adjustment to convert PCU's to vehicles per hour where relevant.

Distance and time matrix factors

4.17. The SATURN software, which was used for the ELHAM model, uses metres and seconds as units. However, WebTAG unit A1.1 and the WebTAG Databook (and therefore TUBA) use kilometres and hours as units. Hence a factor of 0.001 was used in the TUBA input file where relevant to convert the SATURN calculated distances between zones into kilometres, and a factor of 0.00028 (=1/3600) to convert travel time between zones into hours.

[14] These values are lower than the cash prices at the Dartford Crossing as they are the average price paid which is lower because of TAG use as well as being adjusted to 2009 prices,

TUBA warning and logic checking

4.18. The top 50 warnings of each TUBA type were output and a sample of these was reviewed. Many warnings related to areas well outside the core study area (for example Scotland) others were not regarded as material for the assessment.

4.19. Other 'sense' checks were carried out:

- revenue figure was compared to a manual calculation direct from the SATURN crossing volumes and was found to be within a close range of the TUBA output;
- VOC benefits are approximately 7% of user benefits, which is broadly within the range expected; and
- different benefits were mapped to sectors, and the pattern appeared plausible, with no inconsistent results.

Bus and coach benefits

4.20. The benefits accruing to the large number of commuter coach users of the Blackwall Tunnel and users of the existing bus route 108 are not captured within the SATURN model. A separate estimate of these benefits has been made using WebTAG principles, as described in Appendix E. Only the benefits accruing to the morning (northbound) and afternoon (southbound) peak periods have been considered, and conservative assumptions have been made regarding time savings. In addition a saving of a bus Peak Vehicle Requirement (PVR) is expected and has been quantified. Further work on these issues will be undertaken for any Full Business Case, and the estimated benefits (£102.7m over 60 years in 2010 prices - £97.3m passenger benefits and £5.4m bus operating cost benefits) have been added to the TUBA outputs in the relevant output tables. It has been assumed that no user charges will apply to these passengers[15].

(c) Vehicle operating cost savings

4.21. Vehicle operating cost savings have been derived directly from TUBA, which is based on the appropriate WebTAG requirements, with the exception of saving in bus peak vehicle requirements as noted above.

(d) Accident cost savings

4.22. Accident cost savings have been calculated according to WebTAG unit A4.1 using COBA-LT software. The details of the analysis are described in Appendix F.

4.23. The basic principles of the analysis were as follows:

- road network of interest was identified (5% or greater change in modelled traffic flows);

[15] User charges may apply to the commuter coaches but not local bus services but for the purpose of this analysis no such charges have been included.

- geocoded database of road accidents for the area (2009-2013) was developed;
- Cobalt road types were allocated to all relevant SATURN links;
- 50 metre buffer was drawn around Saturn links with manual adjustment for where did not match road network to link accidents to the network;
- SATURN flows by link were based on AADT 24 hour flows for the relevant model year;
- annual vehicle kilometres were estimated (flow x link length x 365);
- average number of accidents in the study area by link type was estimated; and
- local accident rates were estimated by road type and were applied to a combined link and junction COBA-LT analysis.

(e) Incident delay and travel time variability

4.24. TfL Surface supplied extensive data for 2013 from traffic monitoring cameras on journey times in the vicinity of the Blackwall Tunnels and on the type, duration and location of incidents. Work is ongoing on the analysis of incident delay and travel time variability, but initial results are presented in this report. Details of the analysis are provided in Appendix G.

(f) Delays during construction

4.25. Work on the estimation of delays during construction is ongoing, using the methodology set out in WebTAG and the DfT's QUADRO software. This will be reported on in the Full Business Case.

(g) Cost of greenhouse gases

4.26. The cost of greenhouse gases has been derived directly from TUBA, which uses relevant WebTAG factors. A small adjustment to account for the 6% adjustment in weekend benefits was made post-TUBA.

5. Economic assessment results

Introduction

5.1. The following section describes the transport economic efficiency results for the principal comparative scenario – the situation with the new Silvertown Tunnel in place and both this and the adjacent Blackwall Tunnel operating under a road user charging regime.

5.2. A summary of the results is provided at the end of this chapter. All the benefits and costs mentioned in this section are in 2010 prices, discounted to 2010.

Headline scheme benefits

5.3. Table 12 shows a summary of the scheme benefits. Over the 60 year appraisal period the scheme will generate a total user benefit of about £717m. The user benefits are net of user charges, showing that the scheme provides additional benefits to the charge incurred by users.

Table 12: User benefit summary

Description	Value
Travel time	£1,446m
Vehicle operating costs	£95m
User charges	-£823m
Total user benefits	£718m

(a) User benefits by journey purpose

5.4. Table 13 shows the user benefits and charges by class of transport system user. This shows that some 35% of the travel time and vehicle operating cost benefits accrue to car users, with another 24% accruing to freight vehicles. Some 12% of benefits accrue to car commuters, 24% to cars with other journey purposes and 6% to bus and coach users. Only some 6% of all user benefits relate to a reduction in operating costs. The distribution of user charges which will be introduced at Blackwall and Silvertown Tunnels upon the opening of the latter follows a different pattern. Goods vehicles pay the highest proportion of the total charges (43%).

Table 13: User benefits and charges

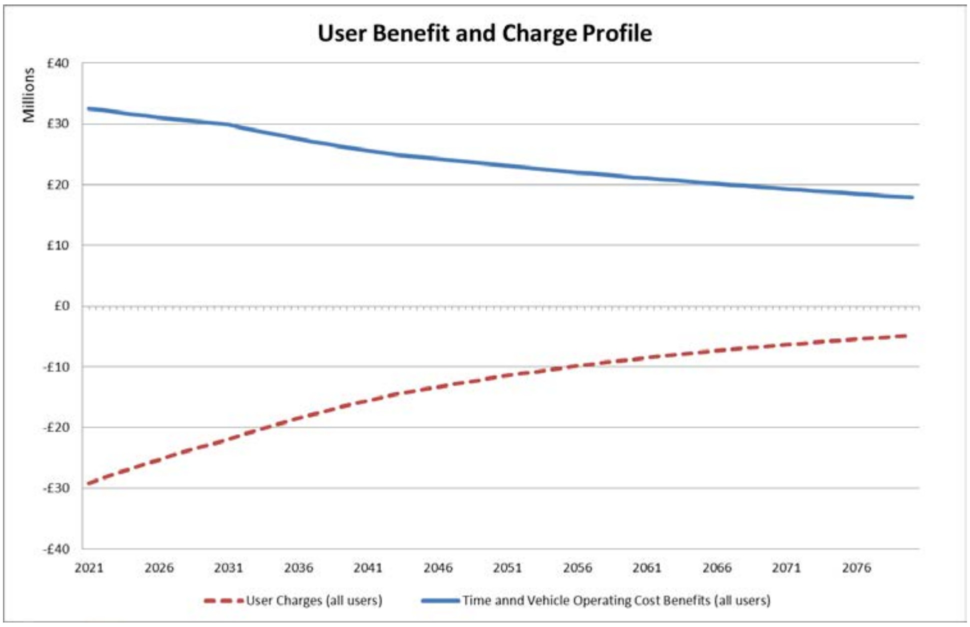
	Other users			Business users			Total
	Car commuting	Car other	Bus & coach	Car & taxi	LGV & HGV	Bus & coach	
Travel time	£172.8m	£337.4m	£97.1m	£515.7m	£322.9m	£0.2m	£1,4446.1m
Vehicle operating costs	£11.3m	£15.8m		£21.3m	£46.2m		£94.6m
Total user benefits	£184.1m	£353.2m	£97.1m	£537.0m	£369.1m	£0.2m	£1540.7m
% benefits	11.9%	22.9%	6.3%	34.9%	24.0%	0%	100%
User charges	-£117.8m	-£252.1m			-£96.7m	-£356.8m	-£823.4m
% user charges	14.3%	30.6%			11.7%	43.3%	100%

(b) Benefits by year

5.5. Figure 3 shows the user benefit and charge profile for the appraisal period. Benefits were plotted on a yearly, non-cumulative, basis. The profiles showed that both business and consumer benefits decreased year-by-year up to 2031, the final modelled year. Thereafter, the shape of the benefits curve, for both business and consumer users, is affected by:

- an assumption of zero traffic growth after the final modelled year (in this case 2031);
- growth in value of time; and
- discounting to the present value year of 2010.

Figure 3: User benefit and charge distribution by year (excluding bus & coach)



(c) Benefits by time period

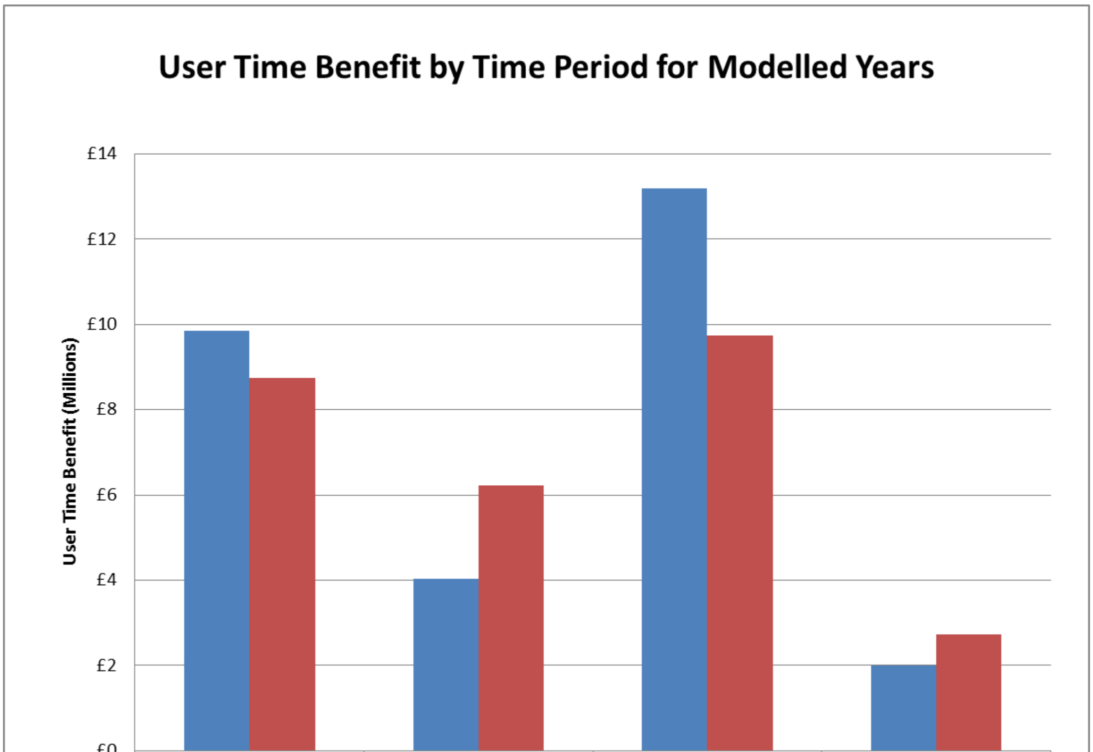
5.6. Table 14 shows the user benefits and charges by time period. The evening and morning peaks account for the largest proportion of benefits (37% and 34% respectively), which is to be expected given the congestion relief expected in the peak periods. Benefits at weekend are lowest, as with lower traffic flows, the relief to congestion provided by the Silvertown Tunnel is lower.

Table 14: User benefits and charges by time period

	AM peak	Inter-peak	PM peak	Off-peak & weekend	Total
Travel time	£484.8m	£292.2m	£539.5m	£129.7m	£,446.1m
VOC	£32.0m	£21.5m	£30.6m	£10.4m	£94.6m
Total	£516.8m	£313.7m	£570.1m	£140.1m	£1,540.7m
% benefit	33%	20%	37%	9%	100%
Hours per week	15 (3 x 5)	30 (6 x 5)	15 (3 x 5)	108 (12 x 5) +(24 x 2)	
Benefits per hour/week*	£34.2m	£10.5m	£38.2m	£1.3m	
User charges	-£171.2m	-£301.0m	-£184.7m	-£166.5m	-£823.4m
% charges	21%	37%	22%	20%	100%
Hours per week	15	30	15	108	
Charge per hour/week*	-£11.4m	-£10.0m	-£12.3m	-£1.5m	
* summed over the 60 year appraisal period.					

5.7. Figure 4 shows the user time benefits for each modelled year. The travel time benefits in the morning and evening peaks decline after opening of the Silvertown Tunnel and by 2031 are lower, particularly for the evening peak. This suggests that the impact of the additional capacity provided by the Silvertown Tunnel is eroded during this time period as traffic growth starts to erode some early benefits. During the inter-peak period and at weekends, when traffic volumes are lower, benefits rise slightly over the ten year period, indicating that the additional capacity is still sufficient for forecast growth.

Figure 4: User time benefits by time period and modelled year[16]



	AM peak	Inter-peak	PM peak	Weekend
2021	£9,848,000.00	£4,025,000.00	£13,197,000.00	£2,007,840.00
2031	£8,742,000.00	£6,216,000.00	£9,731,000.00	£2,738,220.00

Analysis of user benefit and charge totals by vehicle type and journey purpose is shown in

5.8. Table 15 and Table 16 The distribution of the benefit and charge totals by time period is also shown.

[16] Excludes bus and coach benefits

Table 15: User benefits by user type and time period

User type	Benefit total	AM	IP	PM	Weekend[17]
Car commute	£172.8m	49%	9%	38%	3%
Car other	£337.4m	20%	24%	35%	21%
Car business	£515.7m	33%	24%	39%	3%
LGV	£233.7m	32%	19%	37%	11%
HGV	£89.2m	36%	27%	23%	14%
Bus & coach	£97.3m	53%	0%	47%	0%
Total	£1,446.1.m	-	-	-	-

Table 16: User charges by user type and time period

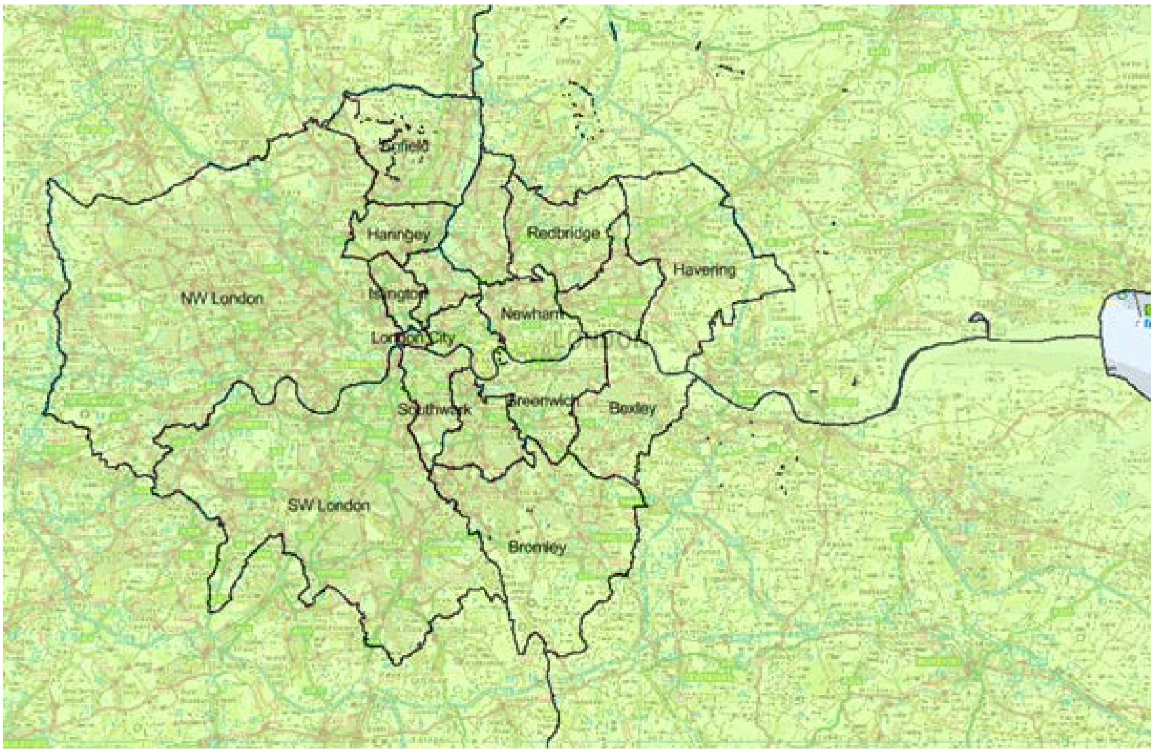
User type	Charge total	AM	IP	PM	Weekend
Car commute	-£117.8m	39%	20%	35%	7%
Car other	-£252.1m	12%	37%	22%	30%
Car business	-£96.7m	26%	42%	30%	2%
LGV	-£207.2m	19%	37%	22%	21%
HGV	-£149.6m	21%	45%	9%	25%
Total	£-823.4m	-	-	-	-

(d) Geographical distribution of time benefits

5.9. An analysis has been carried out of benefits on a geographical basis- TUBA was run with a sector file, which enables user benefits between each model zone origin-destination pair to be aggregated into larger geographical areas. In TUBA terminology, the larger geographical areas are known as sectors and the relationship between model zones and sectors is defined in the TUBA sector file. There were 21 sectors defined for the appraisal of the Silvertown Tunnel. The sectors are shown in full list of sectors is shown in Figure 5.

[17] 6% adjustment applied to TUBA results

Figure 5 TUBA sectors



5.10. As each sector covers both a different land area and has a different population, it is necessary to apply a standardising factor to enable benefits accruing to one sector to be compared meaningfully to those in another sector. As transport economic activity is broadly related to population size, the measure used for this report is population 18-74. The population in each sector has been determined from the 2011 Census results, which were obtained from Office of National Statistics. The user time benefits from each sector and to each sector were extracted from the detailed TUBA output file. By averaging these two values, an estimation of the time benefits accruing to each sector is derived. These time benefits per sector are then divided by the resident population to derive a benefit per person, Table 17. This is the (discounted) total benefit summed over the 60 year appraisal period and is in 2014 prices, discounted to 2010.

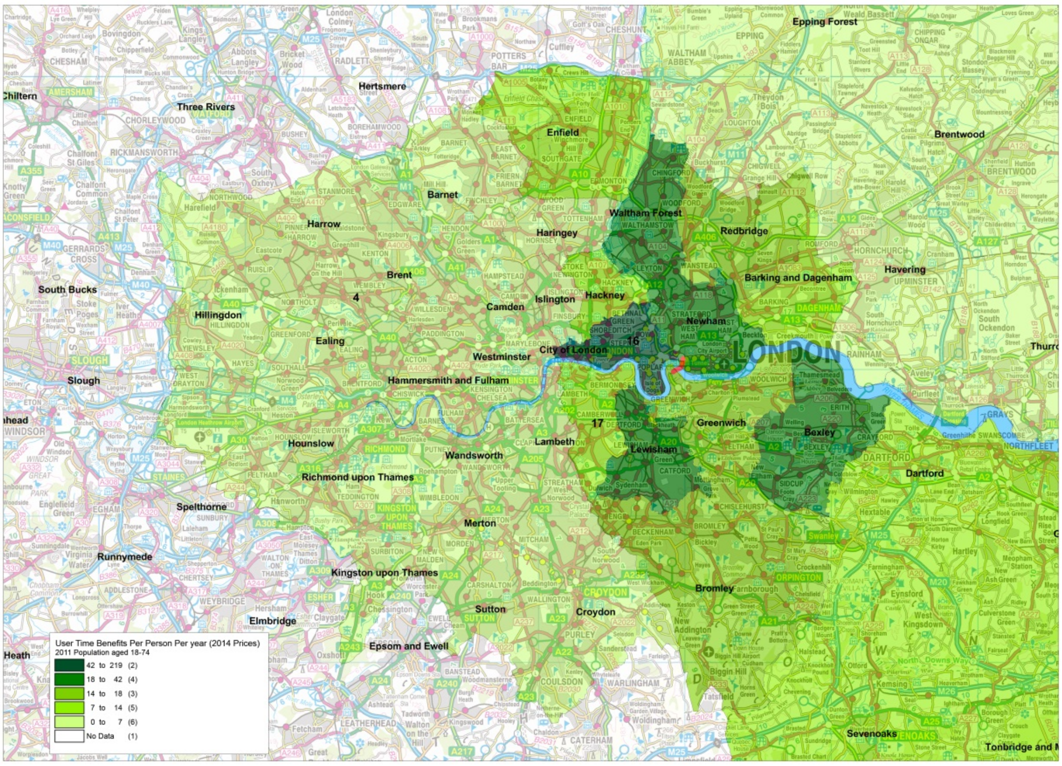
Table 17: User time benefits per sector per head of population 18-74

Sector no	Sector name	Origin time benefit (million)	Destination time benefit (million)	Average time benefit (million)	Population (16+)	Benefit per person per year (pounds)
1	Rest of world	£55.69	£34.90	£45.30	No Data	-
2	Essex	£39.12	£13.29	£26.21	1,206,392.00	£1.19
3	Kent	£170.63	£176.40	£173.52	1,202,833.00	£7.93
4	NW London	£20.86	£24.83	£22.85	1,870,272.55	£0.67
5	SW London	£20.52	£15.65	£18.09	1,252,257.59	£0.79
6	Enfield	£43.25	£36.34	£39.80	209,140.75	£10.46
7	Haringey	-£2.39	£13.30	£5.46	185,774.27	£1.61

Sector no	Sector name	Origin time benefit (million)	Destination time benefit (million)	Average time benefit (million)	Population (16+)	Benefit per person per year (pounds)
8	Waltham Forest	£70.09	£48.87	£59.48	180,587.98	£18.10
9	Redbridge	£59.86	£38.14	£49.00	189,457.00	£14.21
10	Havering	£7.64	£4.72	£6.18	160,443.99	£2.12
11	Islington	£4.43	£8.44	£6.44	161,595.86	£2.19
12	Hackney	£29.13	£32.72	£30.93	182,153.97	£9.33
13	Newham	£159.23	£167.49	£163.36	215,031.95	£41.75
14	Barking and Dagenham	£1.26	£43.14	£22.20	116,274.19	£10.49
15	London City	£30.27	£15.24	£22.76	5,725.71	£218.42
16	Tower Hamlets	£229.54	£325.34	£277.44	191,602.30	£79.58
17	Southwark	£33.44	£36.79	£35.12	203,459.90	£9.49
18	Lewisham	£122.38	£48.30	£85.34	196,656.06	£23.85
19	Greenwich	£59.86	£38.14	£49.00	178,460.60	£15.09
20	Bexley	£86.94	£72.65	£79.79	147,991.40	£29.63
21	Bromley	£66.12	£40.93	£53.52	198,967.99	£14.78
1	Rest of world	£55.69	£34.90	£45.30	No Data	-

5.11. Figure 6 shows the user benefits plotted geographically according to the value of the total benefit per person.

Figure 6: User benefit distribution



5.12. Displayed geographically, it can be seen that the main beneficiaries of the additional capacity provided by the Silvertown Tunnel are the areas to the south of the river, where currently northbound capacity is severely constrained and delays are extensive. There are some benefits indicated in the Enfield area which primarily relate to interpeak benefits and may be model 'noise' given the scale of the strategic model.

(e) Safety benefit assessment

5.13. Initial work on the COBA-LT analysis indicates that the overall study area shows an increase in accident costs of £6,556,000 for the defined area of 11,321 links over 60 years - this is a 0.04% change from the 'without scheme' total, well within the margin of error of the model used. However this initial estimate does not yet take into account the fact that much of the change in traffic volumes is due to the reduction in existing queueing rather than additional traffic volumes, and that there are significant numbers of accidents related to the existing queuing/merging points at Blackwall Tunnel, which will be reduced by the scheme. Future work will clarify these changes and identify any mitigation necessary, but for the initial estimate the conservative assumption of an increase in cost has been applied.

(f) Incident delay and travel time variability

5.14. All three of the present TfL east London river crossings suffer from high levels of traffic saturation, with congestion on a daily basis, and poor levels of reliability and resilience.

5.15. Traffic volumes at the Blackwall Tunnel vary by direction and by time of day. On weekdays, over 3,000 vehicles per hour travel northbound between 6am and 10am.

The traffic volume then reduces to between 2,500 and 3,000 vehicles every hour until 8pm, with some 4pm to 7pm evening peak flows rising just above 3,000 vehicles per hour. In the southbound direction, hourly traffic volumes are between 2,500 and 3,500 in the morning peak period from 6am to 9am. After 9am the southbound tunnel carries between 2,000 and 2,500 vehicles up to 12noon. Volumes then increase every hour until they are at their maximum between 5pm and 6pm with a recorded hourly flow of between 3,700 and 3,900 vehicles. After the evening peak, flows reduce hour by hour, though remaining above the 2,000 level until 9pm.

5.16. As previously highlighted because of the higher southbound capacity there are on average, 44,250 vehicles passing through the tunnel heading south between 6am and 10pm and 41,000 vehicles heading northwards during the same period. It is quite likely that these vehicle volumes would be similar if more capacity was available northbound with traffic transferring from other routes.

5.17. Traffic composition is the same in both directions, 68% cars, 18% vans and small lorries, 8% heavy lorries, motorbikes 3%, taxis and private hire cars 2% and buses/coaches 1%.

5.18. TfL has undertaken analysis of journey times in the vicinity of the tunnels and the types and length of incidents occurring in the Blackwall tunnel – a note describing this analysis is provided in Appendix G.

5.19. The work confirmed that the approaches to the Blackwall Tunnel are heavily congested northbound in the morning peak period and southbound during the evening peak period. Congestion in both directions, though lesser in extent, also occurs on Saturdays.

5.20. Delays are caused not only by an excess of demand, but also by the need to close the Blackwall Tunnel at short notice for a variety of reasons. A detailed log records the time, duration and type of every incident in the tunnels and on the immediate approaches, and the summary for 2013 is shown in Figure 7 and Figure 8.

5.21. During 2013 there were only 10 days with no recorded incidents northbound and only 35 days with no recorded incidents southbound.

5.22. . In the northbound direction, by far the predominant incident type is overheight vehicles, followed by a combined proportion of around 21% for breakdowns.

Figure 7: Incidents by type (Northbound)

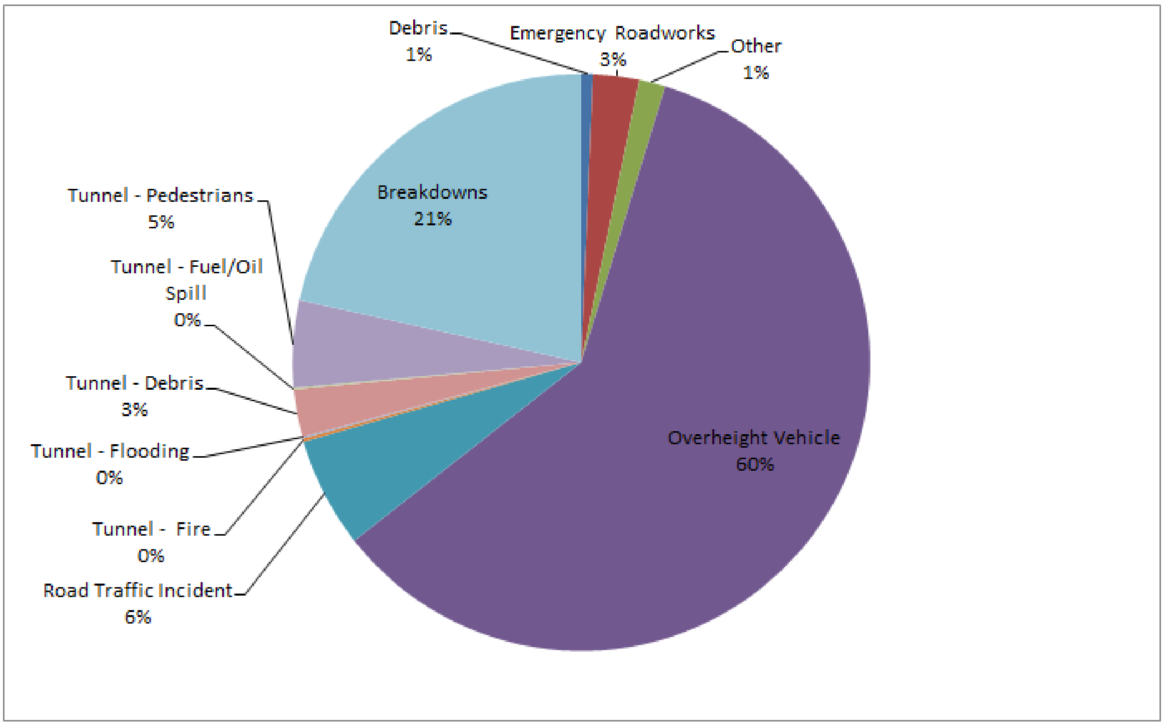
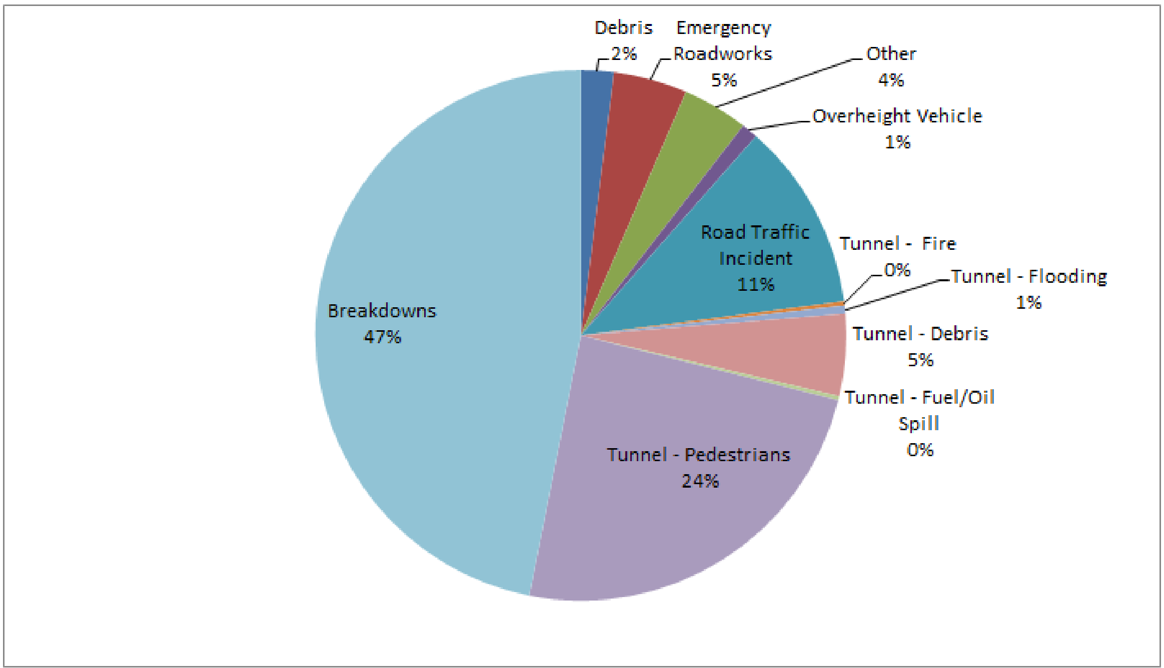
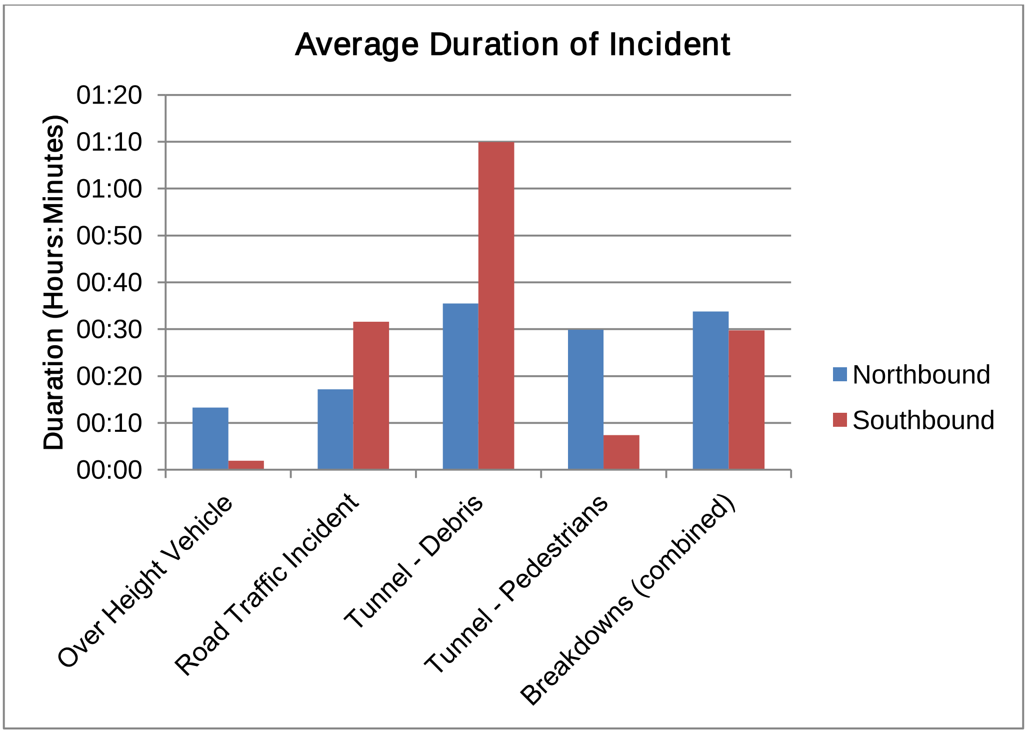


Figure 8: Incidents by type (Southbound)



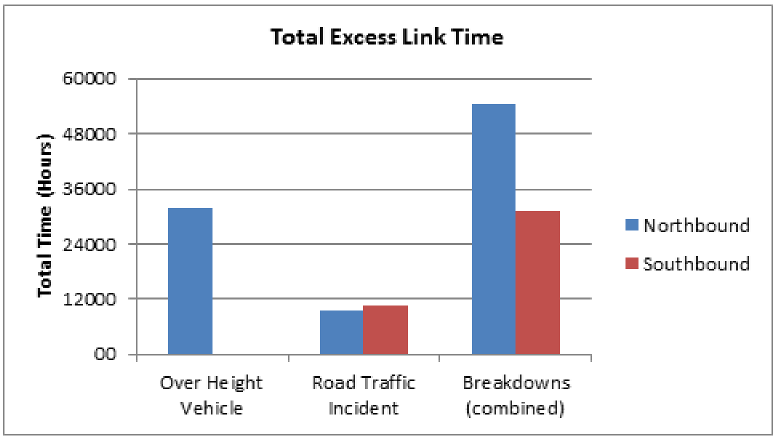
5.23. For certain types of incident, it is also useful to compare the average duration of each type of incident between the northbound and southbound bores as in Figure 9. Analysis indicates that the difference in duration between the bores is not due to response unit location and must be due to the much better geometric design features of the southbound bore compared to the northbound bore.

Figure 9: Comparison of duration of incidents (selected types only)



5.24. For each time period during each day of the week, the average link time has been calculated for all matching time periods during the year when no incidents (other than "congestion") were recorded as active. This gives a "clean week" profile to be used as a comparator. For each incident type, the total excess link time across the full year 2013, is calculated by comparing the actual link time while the incident was active with the corresponding "clean week" link time. The resulting excess link times per incident type are shown in Figure 10.

Figure 10: Excess link time per incident type (selected types only)



5.25. These selected incident types account for the following total excess link times:

- Northbound 96,100 hours (89% of total)
- Southbound 41,700 hours (82% of total)

5.26. It is assumed that the number of incidents is directly related to the number of vehicles passing through the tunnels, therefore for each of these time periods, the number of incidents forecast for 2021 has been pro-rated by the difference between 2013 and 2021 flow values. This method has also been used to split forecast incident numbers between existing and new tunnels. Incidents have been analysed for both peak and interpeak conditions on an annualised basis.

5.27. Reduction and mitigation effects are calculated by a combination of

- Adjustment to the overall number of incidents; and
- Adjustment to the average excess link time for each incident.

5.28. It is anticipated that the main scope for reduction and mitigation of the impact of incidents through the opening of new tunnels will only apply to the existing northern bore, as the southern bore is constructed to more recent standards.

5.29. The following assumptions have therefore been made in calculating the extent of reduction. There is an overall reduction of overheight vehicle incidents currently occurring in the northbound bore by 95% and there are no overheight vehicle incidents southbound.

5.30. Mitigation has two main components, as follows;

- of the overall impact of the incident on other traffic which continues to use the same bore.
- of the overall impact of the incident because traffic is able to divert through an alternative bore.

5.31. For mitigation within the same bore, it has been assumed that the average excess link times for northbound flows will be reduced to levels closer to those which currently apply to southbound flows.

5.32. The current calculations do not yet take into account the impact of being able to divert traffic into the second tunnel in case of incidents. Under the central case scenario the effect of user charging means that, outside of the peak periods, traffic flows through both tunnels are below the capacity of a single tunnel. This means that in the case of an incident, all traffic should be able to be diverted into the second tunnel. As a result the excess link times of diverted vehicles should be even lower.

5.33. During the peak periods, the ability to divert traffic away from an incident is more constrained since the combined peak direction flows exceeds the capacity of a single tunnel and the surrounding road network. There are no additional constraints on the A102 approach on the south side of the tunnels since this operates as a combined facility. However, diversions in the event of an incident will have a greater impact on the surrounding network on the north side. VISSIM micro-simulation modelling is currently being undertaken to estimate how the surrounding junctions could be optimised to accommodate increased flows through either of the tunnels in the event of an incident.

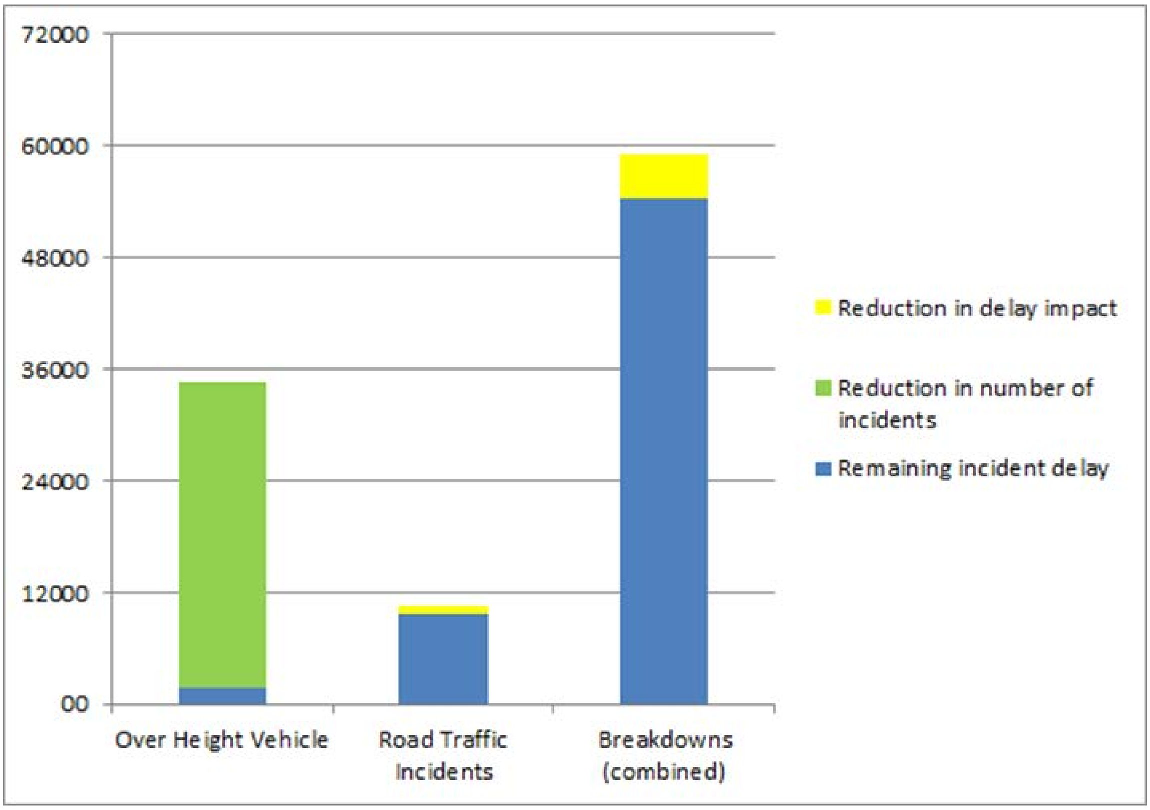
5.34. The combined effect of reduction and mitigation based on forecast 2021 data with both tunnels compared with forecast 2021 data for Blackwall Tunnel only, is as shown in Table 18– this indicates an overall saving of 37%; given that this is for incidents accounting for some 85% of all delays, it follows that the overall reduction in incident-related delay is of the order of 31%. The total change in annual excess link times associated with incidents is forecast as a reduction of 38,300 hours (37%).

Table 18: Potential reduction of incident impacts with Silvertown Tunnel (2021)

Incident type	Blackwall Tunnel only excess link time (hours)	With Silvertown Tunnel excess link time (hours)	Reduction
Overheight vehicle	34,600	1,700	95%
Road traffic incidents	10,500	9,700	7%
Breakdowns (combined)	59,100	54,400	8%
Total	104,200	65,900	37%

5.35. Figure 11 shows the current estimate of incident delay reduction – a very significant reduction in delays due to overheight vehicles, and a smaller reduction in delay due to breakdowns.

Figure 11 Estimated reduction of incidents with Silvertown (2021 annual hours of delay)



5.36. Pending the calculation of any potential for mitigation by diversion through the Silvertown Tunnel , it is considered that there is there is no scope for further mitigation of the effects of incidents southbound, as the existing southbound bore of the Blackwall Tunnel is already of a higher standard than the northbound bore..

5.37. In further analysis for the Full Business Case, these impacts will be monetised.

(g) Assessment of traffic delays during construction and maintenance

5.38. An assessment of traffic delays during construction and maintenance will be prepared as part of the preparatory work for the DCO application, probably using the DfT's QUADRO software.

(h) Monetised environmental assessment

5.39. An assessment of the monetised environmental implications of the scheme will be prepared as part of the preparatory work for the DCO application, applying WebTAG guidance.

(i) Transport Economic Efficiency (TEE)

5.40. The transport economic efficiency result for the preferred option is shown in Table 19. Total user benefits are estimated at £723m, with some £458m of this being attributable to business users. These benefits are after taking into account the charges paid by users.

Table 19: Transport Economic Efficiency

Non-business: Commuting	**ALL MODES**		**ROAD**		**BUS and COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Private Cars and LGVs**		**Passengers**	**Passengers**		
Travel time	£265,878		£172,833		£93,045	-		-
Vehicle operating costs	£11,281		£11,281					-
User charges	-£117,814		-£117,814		-	-		-
During Construction & Maintenance	-		-		-	-		-
NET NON-BUSINESS BENEFITS: COMMUTING	£159,345	*(1a)*	£66,299		£93,045	-		-
Non-business: Other	**ALL MODES**		**ROAD**		**BUS and COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Private Cars and LGVs**		**Passengers**	**Passengers**		
Travel time	£341,415		£337,386		£4,030	-		-
Vehicle operating costs	£15,794		£15,794					-
User charges	-£252,137		-£252,137		-	-		-
During Construction & Maintenance	£0		-		-	-		-
NET NON-BUSINESS BENEFITS: OTHER	£105,073	*(1b)*	£101,043		£4,030	-		-
Business								
User benefits			**Goods Vehicles**	**Business Cars & LGVs**	**Passengers**	**Freight**	**Passengers**	
Travel time	£838,822		£322,899	£515,714	£209	-	-	-
Vehicle operating costs	£67,504		£46,193	£21,311		-		-
User charges	-£453,520		-£356,809	-£96,711	-	-	-	-
During Construction & Maintenance	-		-	-	-	-	-	-
Subtotal	£452,806	*(2)*	£12,283	£440,314	£209	-	-	-
Private sector provider impacts						**Freight**	**Passengers**	
Revenue	-				-	-	-	-
Operating costs	£5,449				£5,449	-	-	-
Investment costs	-				-	-	-	-
Grant/subsidy	-				-	-	-	-
Subtotal	£5,449	*(3)*			£5,449	-	-	-
Other business impacts								
Developer contributions	-	*(4)*	-		-	-		-
NET BUSINESS IMPACT	£458,255	*(5) = (2) + (3) + (4)*						
TOTAL								
Efficiency Benefits (TEE)	£722,672	*(6) = (1a) + (1b) + (5)*						

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

(j) Public accounts (PA)

5.41. The Silvertown Tunnel project proposes user charging for 2 reasons:

- Traffic management - charging would manage demand and therefore levels of traffic passing through Blackwall and Silvertown Tunnels.
- Financial - revenue generated by the user charging scheme would help pay for the new tunnel.

5.42. Consequently:

- It is expected to be funded and maintained largely from user charges;
- The consequent net cost to the public purse will be very small over the 60 year appraisal period; and
- There will be residual (post charges) net benefits to users.

5.43. WebTAG guidance on the Public Accounts assessment is that the Present Value Costs "should only comprise Public Accounts impacts (i.e. costs borne by public bodies) that directly affect the budget available for transport". The guidance notes further that "Where a scheme leads to changes in public sector revenues (for example tolling options) careful consideration should be given to whether they will accrue to the Broad Transport Budget and all assumptions, and their justifications, should be clearly reported."

5.44. Clearly in this case, the cost borne by TfL in implementing the project would not directly affect the broad budget available for transport, as the scheme is largely self-funding. In these circumstances, DfT advice (reproduced in Appendix B) is that the revenue would have to be accounted for on the Present Value Benefit side of the BCR calculation. This means that the revenue is treated as public revenue and the costs accrue to the Present Value Costs.

5.45. The overall effect of this treatment as shown in the Public Accounts and AMCB included in Table 20 and Table 21, is a PV benefit of some £1,521 m, a PV cost of some £895m and consequently a Benefit/Cost Ratio of 1.7. This means the scheme does not use public funding, and that the charges pay for the investment and operating costs and result in a residual user benefit (after charges) – clearly a positive outcome.

Table 20: Public accounts – preferred option wider public finances

	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS and COACH	RAIL	OTHER
Local Government Funding						
Revenue	-£898,534	*(7a)*	-£898,534	-	-	-
Operating Costs	£279,943	*(7b)*	£279,943	-	-	-
Investment Costs	£625,662	*(7c)*	£625,662	-	-	-
Developer and Other Contributions	-		-	-	-	-
Grant/Subsidy Payments	-		-	-	-	-
NET IMPACT	£7,071		£7,071	-	-	-
Central Government Funding: Transport						
Revenue	-		-	-	-	-
Operating costs	-		-	-	-	-
Investment Costs	-		-	-	-	-
Developer and Other Contributions	-		-	-	-	-
Grant/Subsidy Payments	-		-	-	-	-
NET IMPACT	-	*(8)*	-	-	-	-
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£100,366	*(9)*	£100,366	-	-	-
TOTALS						
Broad Transport Budget	£905,605	*(10) = (7b) + (7c) + (8)*				
Wider Public Finances	-£798,168	*(11) = (9) + (7a)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.

All entries are discounted present values in 2010 prices and values.

Table 21: Analysis of monetised costs and benefits (including user charges)

Noise	-	(12)
Local Air Quality	-	(13)
Greenhouse Gases	£11,976	(14)
Journey Quality	-	(15)
Physical Activity	-	(16)
Accidents	-£6,556	(17)
Economic Efficiency: Consumer Users (Commuting)	£159,345	(1)
Economic Efficiency: Consumer Users (Other)	£105,073	
Economic Efficiency: Business Users and Providers	£458,255	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£100,366	- (11a) - sign changed from PA table, as PA table represents costs, not benefits
Wider Public Finances (Public sector operator revenue)	£898,534	(11b)
Present Value of Benefits (see notes) (PVB)	£1,526,260	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1) + (5) - (11)
Broad Transport Budget	£905,643	(10)
Present Value of Costs (see notes) (PVC)	£905,643	(PVC) = (10)
OVERALL IMPACTS		
Net Present Value (NPV)	£620,617	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	1.69	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

5.46. The alternative method of assessing the impact of the scheme in the accounts tables is to 'net' off the revenue against the costs, resulting in a small net change to public sector finances.. The revenue would fall under the Broad Transport Budget and is included in the PV Costs as revenue, but this would lead to a negative Benefit Cost Ratio – the NPV would be identical. DfT advice is that in terms of "Value for Money" assessment- negative BCRs of "revenue positive" schemes are not informative. It is advisable in such cases to look as well at the Net Present Values of transport options to compare them. In the present case, the NPV of the two approaches is identical.

5.47. A summary of the key economic values is given in Table 22.

Table 22: Key transport economic values £m

Economic measure	Bored tunnel
Present value of benefits	£1,526.3
Present value of costs	£905.6
Net present value	£620.6
Benefit cost ratio	1.7

(k) Sensitivity tests

5.48. As part of the preparatory work for the DCO application, a number of transport economic sensitivity tests will be undertaken and reported on. Tests are likely to include:

- High and Low economic growth;
- A range of different user charges and potentially discounts; and
- A range of different capital and operating/maintenance costs.

6. Summary and conclusions

(a) Summary of economic assessment process and results

6.1. The economic assessment process has followed WebTAG guidance and has used model results and the DfT's TUBA software package to assess the economic implications of the options.

6.2. The four key economic results for the Silvertown Tunnel scheme are given in Table 23. The £m values shown are in 2010 prices.

Table 23 - Summary economic analysis

Economic measure	Bored tunnel
Present value of benefits	£1,526.3
Present value of costs	£905.6
Net present value	£620.6
Benefit cost ratio	1.7

6.3. The preferred option has a positive Net Present Value of more than £600m over the appraisal period – in the context of a scheme that is almost fully funded by user charges, this represents ***very high value for money*** as a transport scheme. The BCR, while not recommended as an assessment indicator for this type of user-funded scheme, is 1.7.

(b) Summary of assumptions or caveats affecting the results

6.4. The results are highly dependent on the traffic model results, and these relate to the behaviour of motorists faced with a user charge, around which there is inevitably uncertainty. However work is ongoing in relation to this aspect and further sensitivity tests will be run.

6.5. The investment and operating costs have been estimated according to WebTAG guidance, but there is the potential for these to change as economic conditions change, and these will also be reviewed.

(c) Confirmation of the results presented in the AST for the scheme

6.6. The information from the TEE tables has been included in the Appraisal Summary Table (AST), which are contained within the Outline Business Case.

Appendix A – TUBA Economics File

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*******************************************************************************************************************************************

Economics v1.9.4 file details (WebTAG May 2014 & Data Book Spring 2014)

TUBA ECONOMIC PARAMETERS FILE (31/05/2014) Version 1.9.4 Final Release

*******************************************************************************************************************************************

PARAMETERS
TUBA_version   1.9.4      the current version of TUBA
base_year    2010      defines base year for 'economic parameters
pres_val_year  2010      present value year for discounting
GDP_base     100.00     value of GDP in base year

* TAG1 reference: Unit 3.5.6, para 1.1.9
* TAG2 reference: Unit A 1.3
av_ind_tax    19.0      %average final indirect tax rate

* TAG reference: TAG Data Book, Table A3.4 (for non-traded), 'webtag-databook.xlsm'(for traded, unpublished)
nt_carbdxvalues  26.77 80.32 53.55 base year non-traded carbon dioxide values in £/tonne(low high central)
t_carbdxvalues  11.76 11.76 11.76 base year traded carbon dioxide values in £/tonne(low high central)

*******************************************************************************************************************************************


MODES
*No.   Description
 1   Road
 2   Bus
 3   Rail

VEHICLE_TYPE/SUBMODE
*No.   Mode New_mode P&R  Type Description
 1    1   N     N  per  Car
 2    1   N     N  per  LGV Personal
 3    1   N     N  fre  LGV Freight
 4    1   N     N  fre  OGV1
 5    1   N     N  fre  OGV2
 6    2   N     N  per  Bus
 7    3   N     N  per  Light Rail
 8    3   N     N  per  Heavy rail

PERSON_TYPE
*No.  Type(D/P)  Description
 1    D     Driver
 2    P     Passenger
```

```
PURPOSE
*No.  Type(B/C/O) Description
 1    B     Business
 2    C     Commuting
 3    O     Other

FUEL_TYPE
*No.  Sector  Name   (sector: 1=untraded, sector 2=traded sector)
 1     1  Petrol
 2     1  Diesel
 3     2  Electric

TIME_PERIODS
*No.  Description   Comments
 1   AM peak     (7-10 weekdays)
 2   PM peak     (4-7 weekdays)
 3   Inter-peak    (10-4 weekdays)
 4   Off-peak     (7-7 weekdays)
 5   Weekend     (weekend)

BREAKPOINTS
*Description Breakpoint1  Breakpoint2  Breakpoint3...
Distance       1.0      5.0      10.0      15.0      20.0      50.0     100.0
TimeSaving      -5.0      -2.0      0.0      2.0      5.0

CHARGES
*No.  Sector      Description
 1   pri       PT fares (private operators)
 2   loc       PT fares (LA operated)
 3   loc       LA tolls
 4   cen       National tolls
 5   pri       Private tolls
 6   loc       LA on-street parking
 7   loc       LA off-street parking
 8   pri       Private parking

DISCOUNT_RATE

* TAG2 reference: Unit A 1.1, Table A 1.1.1
* TAG1 reference: Unit 3.5.4, Table 1
* %change p.a.
*Start_yr   End_yr   Rate
  1       30   3.50
 31       75   3.00
 76       80   2.50

VALUE_OF_TIME
* TAG1 reference: Unit 3.5.6, Table 1 (Work) & Table 2 (Commute, Other)
```

```
* TAG2 reference: Unit A 1.3, Table A 1.3.1
* pence per hour (in 2010 base year values and prices)
*Vtype/submode Person_type VOT_purpose1 VOT_purpose2 VOT_purpose3 ..
  1        1       2274     681     604
  1        2       1725     681     604
  2        1       1024     681     604
  2        2       1024     681     604
  3        1       1024      0      0
  3        2       1024      0      0
  4        1       1206      0      0
  4        2       1206      0      0
  5        1       1206      0      0
  5        2       1206      0      0
  6        1       1232      0      0
  6        2       1397     681     604
  7        1        0      0      0
  7        2       2208     681     604
  8        1        0      0      0
  8        2       2686     681     604

VALUE_OF_TIME_GROWTH
* TAG2 reference: Unit 1.3, Table 1.3.2
* TAG1 reference: Unit 3.5.6, Table 3b
* %change a year from 2010 base year
*Start_yr  End_yr   VOT_Gr_purpose1  VOT_Gr_purpose2  VOT_Gr_purpose3 ..
2011      2011       0.278       0.278       0.278
2012      2012      -0.383      -0.383      -0.383
2013      2013       1.068       1.068       1.068
2014      2014       2.051       2.051       2.051
2015      2015       1.668       1.668       1.668
2016      2016       1.951       1.951       1.951
2017      2017       1.987       1.987       1.987
2018      2018       1.901       1.901       1.901
2019      2019       2.235       2.235       2.235
2020      2020       2.245       2.245       2.245
2021      2021       1.859       1.859       1.859
2022      2022       1.872       1.872       1.872
2023      2023       1.887       1.887       1.887
2024      2024       1.902       1.902       1.902
2025      2025       2.018       2.018       2.018
2026      2026       2.035       2.035       2.035
2027      2027       2.053       2.053       2.053
2028      2028       2.070       2.070       2.070
2029      2029       2.088       2.088       2.088
2030      2030       2.105       2.105       2.105
2031      2031       2.021       2.021       2.021
2032      2032       2.036       2.036       2.036
2033      2033       2.051       2.051       2.051
2034      2034       1.963       1.963       1.963
```

2035	2035	2.074	2.074	2.074
2036	2036	2.083	2.083	2.083
2037	2037	2.091	2.091	2.091
2038	2038	2.104	2.104	2.104
2039	2039	2.104	2.104	2.104
2040	2040	2.203	2.203	2.203
2041	2041	2.203	2.203	2.203
2042	2042	2.222	2.222	2.222
2043	2043	2.222	2.222	2.222
2044	2044	2.222	2.222	2.222
2045	2045	2.222	2.222	2.222
2046	2046	2.222	2.222	2.222
2047	2047	2.150	2.150	2.150
2048	2048	2.150	2.150	2.150
2049	2049	2.150	2.150	2.150
2050	2050	2.150	2.150	2.150
2051	2051	2.150	2.150	2.150
2052	2052	2.086	2.086	2.086
2053	2053	2.086	2.086	2.086
2054	2054	2.086	2.086	2.086
2055	2055	2.086	2.086	2.086
2056	2056	2.086	2.086	2.086
2057	2057	2.112	2.112	2.112
2058	2058	2.112	2.112	2.112
2059	2059	2.112	2.112	2.112
2060	2060	2.212	2.212	2.212
2061	2061	2.212	2.212	2.212
2062	2062	2.218	2.218	2.218
2063	2063	2.214	2.214	2.214
2064	2064	2.214	2.214	2.214
2065	2065	2.214	2.214	2.214
2066	2066	2.214	2.214	2.214
2067	2067	2.196	2.196	2.196
2068	2068	2.196	2.196	2.196
2069	2069	2.196	2.196	2.196
2070	2070	2.196	2.196	2.196
2071	2071	2.196	2.196	2.196
2072	2072	2.175	2.175	2.175
2073	2073	2.175	2.175	2.175
2074	2074	2.175	2.175	2.175
2075	2075	2.175	2.175	2.175
2076	2076	2.175	2.175	2.175
2077	2077	2.166	2.166	2.166
2078	2078	2.166	2.166	2.166
2079	2079	2.166	2.166	2.166
2080	2080	2.166	2.166	2.166
2081	2081	2.166	2.166	2.166
2082	2082	2.171	2.171	2.171
2083	2083	2.171	2.171	2.171

```
2084      2084       2.171       2.171       2.171
2085      2085       2.171       2.171       2.171
2086      2086       2.171       2.171       2.171
2087      2087       2.174       2.174       2.174
2088      2088       2.176       2.176       2.176
2089      2089       2.176       2.176       2.176
2090      2090       2.150       2.150       2.150
2091      2091       2.150       2.150       2.150
2092      2092       2.150       2.150       2.150
2093      2093       2.150       2.150       2.150
2094      2094       2.150       2.150       2.150
2095      2095       2.150       2.150       2.150
2096      2096       2.150       2.150       2.150
2097      2097       2.150       2.150       2.150
2098      2098       2.150       2.150       2.150
2099      2099       2.150       2.150       2.150
2100      2100       2.150       2.150       2.150

AV_IND_TAX_CHANGES
* %change a year from 2010 base year
*Start_yr   End_yr   Growth
2011      2050    0.00

CHARGE_TAX_RATES
* %base year tax rates
*Charge   Final   Intermediate
 1      0.0      0.0
 2      0.0      0.0
 3      0.0      0.0
 4      0.0      0.0
 5      17.5      0.0
 6      0.0      0.0
 7      17.5      0.0
 8      17.5      0.0

CHARGE_TAX_RATES_CHANGES
* %change a year from 2010 base year
*Start_yr   End_yr   Charge    Final   Intermediate
2011      2011    1     0.000      0.000
2011      2011    2     0.000      0.000
2011      2011    3     0.000      0.000
2011      2011    4     0.000      0.000
2011      2011    5     14.286      0.000
2011      2011    6     0.000      0.000
2011      2011    7     14.286      0.000
2011      2011    8     14.286      0.000
2012      2100    1     0.000      0.000
2012      2100    2     0.000      0.000
2012      2100    3     0.000      0.000
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2012      2100    4     0.000      0.000
2012      2100    5     0.000      0.000
2012      2100    6     0.000      0.000
2012      2100    7     0.000      0.000
2012      2100    8     0.000      0.000

FUEL_COST
* TAG2 reference: Unit A 1.3, Table 1.3.7
* TAG2 reference: Unit A 3.3, Table 3.3 (CO2e values)
* TAG1 reference: Unit 3.5.6, Table 11a
* TAG1 reference: Unit 3.3.5, Table 1 (CO2e values)
* (In 2010 base year values and prices)
*Type  Resource(p/unit) Duty(p/unit)   VAT(%) CO2_grammes/unit (unit=litre for fuel types 1 & 2; unit=KWH for electric)
 1     42.57     57.19     17.50    2244.00
 2     44.31     57.19     17.50    2569.00
 3     12.23      0.00      5.00     379.00

FUEL_COST_CHANGES
* TAG1 reference: Unit 3.5.6, Table 11a/b (Derived) & Unit 3.3.5, Table 1 (Derived)
* TAG2 reference: Unit A 1.3, Table 1.3 (Derived) & Unit A 3.3, Table A 3.3 (Derived)
* %change a year from 2010 base year
*Start_yr   End_yr   Fuel_type  Resource    Duty      VAT CO2_Den_Change
2011      2011    1     21.936    -0.533     14.286     -0.844
2012      2012    1     1.980    -2.105      0.000     -0.518
2013      2013    1     -3.267    -1.575      0.000     -0.521
2014      2014    1     -0.467    -2.248      0.000     -1.038
2015      2015    1     1.048    -0.722      0.000     -1.049
2016      2016    1     0.963     1.375      0.000     -1.060
2017      2017    1     1.027     1.668      0.000     -1.071
2018      2018    1     1.017     1.765      0.000     -1.083
2019      2019    1     1.007     1.863      0.000     -1.095
2020      2020    1     1.068     1.469      0.000     -1.107
2021      2021    1     0.986     1.272      0.000     0.000
2022      2022    1     1.046     1.076      0.000     0.000
2023      2023    1     1.035     1.076      0.000     0.000
2024      2024    1     1.025     1.076      0.000     0.000
2025      2025    1     1.014     1.076      0.000     0.000
2026      2026    1     1.004     1.076      0.000     0.000
2027      2027    1     1.061     1.076      0.000     0.000
2028      2028    1     1.049     1.076      0.000     0.000
2029      2029    1     1.039     1.076      0.000     0.000
2030      2030    1     1.028     1.076      0.000     0.000
2031      2100    1     0.000     1.076      0.000     0.000
2011      2011    2     26.618    -0.533     14.286      0.188
2012      2012    2     3.190    -2.105      0.000     -0.516
2013      2013    2     -3.508    -1.575      0.000     -0.519
2014      2014    2     1.554    -2.248      0.000     -0.558
2015      2015    2     1.078    -0.722      0.000     -0.561
2016      2016    2     0.991     1.375      0.000     -0.564
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2017	2017	2	1.056	1.668	0.000	-0.567
2018	2018	2	1.045	1.765	0.000	-0.570
2019	2019	2	1.035	1.863	0.000	-0.574
2020	2020	2	1.097	1.469	0.000	-0.577
2021	2021	2	1.013	1.272	0.000	0.000
2022	2022	2	1.074	1.076	0.000	0.000
2023	2023	2	1.063	1.076	0.000	0.000
2024	2024	2	1.052	1.076	0.000	0.000
2025	2025	2	1.041	1.076	0.000	0.000
2026	2026	2	1.030	1.076	0.000	0.000
2027	2027	2	1.087	1.076	0.000	0.000
2028	2028	2	1.076	1.076	0.000	0.000
2029	2029	2	1.064	1.076	0.000	0.000
2030	2030	2	1.053	1.076	0.000	0.000
2031	2100	2	0.000	1.076	0.000	0.000
2011	2011	3	4.807	0.000	0.000	-1.827
2012	2012	3	4.124	0.000	0.000	-1.987
2013	2013	3	8.670	0.000	0.000	-2.165
2014	2014	3	-0.356	0.000	0.000	-2.361
2015	2015	3	6.387	0.000	0.000	-2.585
2016	2016	3	5.189	0.000	0.000	-2.830
2017	2017	3	3.687	0.000	0.000	-3.106
2018	2018	3	1.753	0.000	0.000	-3.428
2019	2019	3	7.588	0.000	0.000	-3.786
2020	2020	3	-2.832	0.000	0.000	-4.201
2021	2021	3	1.239	0.000	0.000	-4.680
2022	2022	3	3.876	0.000	0.000	-5.242
2023	2023	3	-3.258	0.000	0.000	-5.905
2024	2024	3	1.924	0.000	0.000	-6.702
2025	2025	3	1.562	0.000	0.000	-7.666
2026	2026	3	0.711	0.000	0.000	-8.864
2027	2027	3	-0.778	0.000	0.000	-10.384
2028	2028	3	0.654	0.000	0.000	-12.369
2029	2029	3	0.010	0.000	0.000	-15.067
2030	2030	3	-0.435	0.000	0.000	-18.933
2031	2031	3	0.099	0.000	0.000	-6.710
2032	2032	3	0.049	0.000	0.000	-6.713
2033	2033	3	0.024	0.000	0.000	-6.714
2034	2034	3	0.003	0.000	0.000	-6.706
2035	2035	3	-0.016	0.000	0.000	-6.712
2036	2036	3	-0.033	0.000	0.000	-6.713
2037	2037	3	-0.046	0.000	0.000	-6.708
2038	2038	3	-0.059	0.000	0.000	-6.715
2039	2039	3	-0.069	0.000	0.000	-6.706
2040	2040	3	-0.078	0.000	0.000	-6.715
2041	2041	3	-0.258	0.000	0.000	-11.042
2042	2042	3	0.230	0.000	0.000	1.776
2043	2043	3	-0.207	0.000	0.000	-9.438
2044	2044	3	-0.438	0.000	0.000	-15.751

2045	2045	3	0.147	0.000	0.000	0.593
2046	2046	3	-0.196	0.000	0.000	-9.433
2047	2047	3	-0.232	0.000	0.000	-10.787
2048	2048	3	0.067	0.000	0.000	-1.251
2049	2049	3	-0.050	0.000	0.000	-4.996
2050	2050	3	0.098	0.000	0.000	0.000
2051	2051	3	0.106	0.000	0.000	0.000
2052	2052	3	0.103	0.000	0.000	0.000
2053	2053	3	0.103	0.000	0.000	0.000
2054	2054	3	0.103	0.000	0.000	0.000
2055	2055	3	0.100	0.000	0.000	0.000
2056	2056	3	0.100	0.000	0.000	0.000
2057	2057	3	0.096	0.000	0.000	0.000
2058	2058	3	0.094	0.000	0.000	0.000
2059	2059	3	0.092	0.000	0.000	0.000
2060	2060	3	0.090	0.000	0.000	0.000
2061	2061	3	0.071	0.000	0.000	0.000
2062	2062	3	0.071	0.000	0.000	0.000
2063	2063	3	0.064	0.000	0.000	0.000
2064	2064	3	0.060	0.000	0.000	0.000
2065	2065	3	0.053	0.000	0.000	0.000
2066	2066	3	0.052	0.000	0.000	0.000
2067	2067	3	0.043	0.000	0.000	0.000
2068	2068	3	0.040	0.000	0.000	0.000
2069	2069	3	0.034	0.000	0.000	0.000
2070	2070	3	0.029	0.000	0.000	0.000
2071	2071	3	0.029	0.000	0.000	0.000
2072	2072	3	0.024	0.000	0.000	0.000
2073	2073	3	0.020	0.000	0.000	0.000
2074	2074	3	0.012	0.000	0.000	0.000
2075	2075	3	0.013	0.000	0.000	0.000
2076	2076	3	0.001	0.000	0.000	0.000
2077	2077	3	0.002	0.000	0.000	0.000
2078	2078	3	-0.006	0.000	0.000	0.000
2079	2079	3	-0.008	0.000	0.000	0.000
2080	2080	3	-0.017	0.000	0.000	0.000
2081	2081	3	-0.002	0.000	0.000	0.000
2082	2082	3	-0.010	0.000	0.000	0.000
2083	2083	3	-0.014	0.000	0.000	0.000
2084	2084	3	-0.016	0.000	0.000	0.000
2085	2085	3	-0.014	0.000	0.000	0.000
2086	2086	3	-0.023	0.000	0.000	0.000
2087	2087	3	-0.027	0.000	0.000	0.000
2088	2088	3	-0.027	0.000	0.000	0.000
2089	2089	3	-0.032	0.000	0.000	0.000
2090	2090	3	-0.032	0.000	0.000	0.000
2091	2091	3	-0.027	0.000	0.000	0.000
2092	2092	3	-0.028	0.000	0.000	0.000
2093	2093	3	-0.035	0.000	0.000	0.000

2094	2094	3	-0.035	0.000	0.000	0.000
2095	2095	3	-0.037	0.000	0.000	0.000
2096	2096	3	-0.038	0.000	0.000	0.000
2097	2097	3	-0.036	0.000	0.000	0.000
2098	2098	3	-0.043	0.000	0.000	0.000
2099	2099	3	-0.039	0.000	0.000	0.000
2100	2100	3	-0.043	0.000	0.000	0.000

CARBDX_VALUE_CHANGES
* TAG2 reference: Unit 3, Table 3.4 (Non-traded & Traded, Derived NB Traded are unpublished),
* TAG1 reference: Unit 3.3.5, Table 2a/b (Derived)

*Start_yr	End_yr	Rel(%)_NT_Lw	Abs(t)_NT_Lw	Rel(%)_Tr_Lw	Abs(t)_Tr_Lw	Rel(%)_NT_Hi	Abs(t)_NT_Hi	Rel(%)_Tr_Hi	Abs(t)_Tr_Hi	Rel(%)_NT_Ce	Abs(t)_NT_Ce	Rel(%)_Tr_Ce	Abs(t)_Tr_Ce
2011	2011	1.51700	0.00000	-10.56463	0.00000	1.50423	0.00000	-10.56463	0.00000	1.49785	0.00000	-10.56463	0.00000
2012	2012	1.49985	0.00000	-44.42458	0.00000	1.49997	0.00000	-44.42458	0.00000	1.50003	0.00000	-44.42458	0.00000
2013	2013	1.50016	0.00000	-99.99983	0.00000	1.50004	0.00000	151.94176	0.00000	1.49998	0.00000	-43.52802	0.00000
2014	2014	1.49978	0.00000	0.00000	0.00000	1.50002	0.00000	7.45051	0.00000	1.50014	0.00000	2.86589	0.00000
2015	2015	1.50014	0.00000	0.00000	0.00000	1.50002	0.00000	7.65055	0.00000	1.49996	0.00000	2.22942	0.00000
2016	2016	1.50015	0.00000	0.00000	0.00000	1.50004	0.00000	7.66277	0.00000	1.49998	0.00000	3.26976	0.00000
2017	2017	1.49984	0.00000	0.00000	0.00000	1.49996	0.00000	7.73572	0.00000	1.50002	0.00000	3.42846	0.00000
2018	2018	1.49989	0.00000	0.00000	0.00000	1.50000	0.00000	7.65906	0.00000	1.50006	0.00000	7.65455	0.00000
2019	2019	1.49994	0.00000	0.00000	0.00000	1.49994	0.00000	7.55890	0.00000	1.49994	0.00000	7.34579	0.00000
2020	2020	1.50031	0.00000	0.00000	0.00000	1.50009	0.00000	7.40007	0.00000	1.49998	0.00000	7.50595	0.00000
2021	2021	1.66640	0.00000	36264930.00000	0.00000	1.66662	0.00000	34.02611	0.00000	1.66673	0.00000	146.61109	0.00000
2022	2022	1.63941	0.00000	100.00000	0.00000	1.63930	0.00000	25.35883	0.00000	1.63925	0.00000	59.36669	0.00000
2023	2023	1.61296	0.00000	50.00000	0.00000	1.61296	0.00000	20.25200	0.00000	1.61296	0.00000	37.30411	0.00000
2024	2024	1.58736	0.00000	33.42121	0.00000	1.58726	0.00000	16.84150	0.00000	1.58721	0.00000	27.13115	0.00000
2025	2025	1.56256	0.00000	24.98353	0.00000	1.56256	0.00000	14.39742	0.00000	1.56256	0.00000	21.37082	0.00000
2026	2026	1.53822	0.00000	19.98946	0.00000	1.53842	0.00000	12.59976	0.00000	1.53852	0.00000	17.60787	0.00000
2027	2027	1.51521	0.00000	16.65935	0.00000	1.51521	0.00000	11.18986	0.00000	1.51506	0.00000	14.95062	0.00000
2028	2028	1.49259	0.00000	14.28034	0.00000	1.49250	0.00000	10.05243	0.00000	1.49259	0.00000	13.02444	0.00000
2029	2029	1.47064	0.00000	12.49588	0.00000	1.47055	0.00000	9.14450	0.00000	1.47064	0.00000	11.52356	0.00000
2030	2030	0.89859	0.00000	11.13683	0.00000	0.88982	0.00000	8.37834	0.00000	0.88530	0.00000	10.31847	0.00000
2031	2031	9.88215	0.00000	9.88215	0.00000	9.89180	0.00000	9.89170	0.00000	9.89663	0.00000	9.89648	0.00000
2032	2032	8.49666	0.00000	8.49666	0.00000	8.49666	0.00000	8.49666	0.00000	8.49666	0.00000	8.49666	0.00000
2033	2033	7.83127	0.00000	7.83127	0.00000	7.83135	0.00000	7.83135	0.00000	7.83138	0.00000	7.83138	0.00000
2034	2034	7.26274	0.00000	7.26274	0.00000	7.26259	0.00000	7.26259	0.00000	7.26251	0.00000	7.26251	0.00000
2035	2035	6.77078	0.00000	6.77078	0.00000	6.77085	0.00000	6.77085	0.00000	6.77088	0.00000	6.77088	0.00000
2036	2036	6.34141	0.00000	6.34141	0.00000	6.34141	0.00000	6.34141	0.00000	6.34141	0.00000	6.34141	0.00000
2037	2037	5.96326	0.00000	5.96326	0.00000	5.96332	0.00000	5.96332	0.00000	5.96335	0.00000	5.96335	0.00000
2038	2038	5.62783	0.00000	5.62783	0.00000	5.62772	0.00000	5.62772	0.00000	5.62766	0.00000	5.62766	0.00000
2039	2039	5.32783	0.00000	5.32783	0.00000	5.32788	0.00000	5.32788	0.00000	5.32791	0.00000	5.32791	0.00000
2040	2040	5.05833	0.00000	5.05833	0.00000	5.05833	0.00000	5.05833	0.00000	5.05833	0.00000	5.05833	0.00000
2041	2041	4.81478	0.00000	4.81478	0.00000	4.81483	0.00000	4.81483	0.00000	4.81485	0.00000	4.81485	0.00000
2042	2042	4.59374	0.00000	4.59374	0.00000	4.59365	0.00000	4.59365	0.00000	4.59360	0.00000	4.59360	0.00000
2043	2043	4.39186	0.00000	4.39186	0.00000	4.39190	0.00000	4.39190	0.00000	4.39192	0.00000	4.39192	0.00000
2044	2044	4.20709	0.00000	4.20709	0.00000	4.20713	0.00000	4.20713	0.00000	4.20709	0.00000	4.20709	0.00000
2045	2045	4.03724	0.00000	4.03724	0.00000	4.03724	0.00000	4.03724	0.00000	4.03730	0.00000	4.03730	0.00000
2046	2046	3.88068	0.00000	3.88068	0.00000	3.88061	0.00000	3.88061	0.00000	3.88057	0.00000	3.88057	0.00000

2047	2047	3.73560	0.00000	3.73560	0.00000	3.73564	0.00000	3.73564	0.00000	3.73566	0.00000	3.73566	0.00000
2048	2048	3.60108	0.00000	3.60108	0.00000	3.60112	0.00000	3.60112	0.00000	3.60108	0.00000	3.60108	0.00000
2049	2049	3.47591	0.00000	3.47591	0.00000	3.47591	0.00000	3.47591	0.00000	3.47596	0.00000	3.47596	0.00000
2050	2050	3.35925	0.00000	3.35925	0.00000	3.35918	0.00000	3.35918	0.00000	3.35915	0.00000	3.35915	0.00000
2051	2051	2.50096	0.00000	2.50096	0.00000	3.88152	0.00000	3.88152	0.00000	3.53643	0.00000	3.53643	0.00000
2052	2052	2.26540	0.00000	2.26540	0.00000	3.65210	0.00000	3.65210	0.00000	3.30887	0.00000	3.30887	0.00000
2053	2053	2.16521	0.00000	2.16521	0.00000	3.56024	0.00000	3.56024	0.00000	3.21846	0.00000	3.21846	0.00000
2054	2054	2.05612	0.00000	2.05612	0.00000	3.45952	0.00000	3.45952	0.00000	3.11920	0.00000	3.11920	0.00000
2055	2055	1.85631	0.00000	1.85631	0.00000	3.26702	0.00000	3.26702	0.00000	2.92847	0.00000	2.92847	0.00000
2056	2056	1.77920	0.00000	1.77920	0.00000	3.19926	0.00000	3.19926	0.00000	2.86200	0.00000	2.86200	0.00000
2057	2057	1.58875	0.00000	1.58875	0.00000	3.01666	0.00000	3.01666	0.00000	2.68108	0.00000	2.68108	0.00000
2058	2058	1.44631	0.00000	1.44631	0.00000	2.88302	0.00000	2.88302	0.00000	2.54898	0.00000	2.54898	0.00000
2059	2059	1.33044	0.00000	1.33044	0.00000	2.77652	0.00000	2.77652	0.00000	2.44390	0.00000	2.44390	0.00000
2060	2060	1.20110	0.00000	1.20110	0.00000	2.65679	0.00000	2.65679	0.00000	2.32564	0.00000	2.32564	0.00000
2061	2061	0.67276	0.00000	0.67276	0.00000	2.13228	0.00000	2.13228	0.00000	1.80390	0.00000	1.80390	0.00000
2062	2062	0.61781	0.00000	0.61781	0.00000	2.08842	0.00000	2.08842	0.00000	1.76121	0.00000	1.76121	0.00000
2063	2063	0.40141	0.00000	0.40141	0.00000	1.88091	0.00000	1.88091	0.00000	1.55541	0.00000	1.55541	0.00000
2064	2064	0.28334	0.00000	0.28334	0.00000	1.77356	0.00000	1.77356	0.00000	1.44944	0.00000	1.44944	0.00000
2065	2065	0.07913	0.00000	0.07913	0.00000	1.57902	0.00000	1.57902	0.00000	1.25655	0.00000	1.25655	0.00000
2066	2066	0.03302	0.00000	0.03302	0.00000	1.54523	0.00000	1.54523	0.00000	1.22390	0.00000	1.22390	0.00000
2067	2067	-0.19300	0.00000	-0.19300	0.00000	1.32912	0.00000	1.32912	0.00000	1.00948	0.00000	1.00948	0.00000
2068	2068	-0.30192	0.00000	-0.30192	0.00000	1.23226	0.00000	1.23226	0.00000	0.91392	0.00000	0.91392	0.00000
2069	2069	-0.46068	0.00000	-0.46068	0.00000	1.08509	0.00000	1.08509	0.00000	0.76817	0.00000	0.76817	0.00000
2070	2070	-0.58519	0.00000	-0.58519	0.00000	0.97301	0.00000	0.97301	0.00000	0.65747	0.00000	0.65747	0.00000
2071	2071	-0.60933	0.00000	-0.60933	0.00000	0.96333	0.00000	0.96333	0.00000	0.64882	0.00000	0.64882	0.00000
2072	2072	-0.73837	0.00000	-0.73837	0.00000	0.84745	0.00000	0.84745	0.00000	0.53423	0.00000	0.53423	0.00000
2073	2073	-0.83653	0.00000	-0.83653	0.00000	0.76323	0.00000	0.76323	0.00000	0.45128	0.00000	0.45128	0.00000
2074	2074	-1.03286	0.00000	-1.03286	0.00000	0.57978	0.00000	0.57978	0.00000	0.26936	0.00000	0.26936	0.00000
2075	2075	-1.03743	0.00000	-1.03743	0.00000	0.59161	0.00000	0.59161	0.00000	0.28211	0.00000	0.28211	0.00000
2076	2076	-1.30953	0.00000	-1.30953	0.00000	0.33183	0.00000	0.33183	0.00000	0.02404	0.00000	0.02404	0.00000
2077	2077	-1.31588	0.00000	-1.31588	0.00000	0.34284	0.00000	0.34284	0.00000	0.03599	0.00000	0.03599	0.00000
2078	2078	-1.49275	0.00000	-1.49275	0.00000	0.18088	0.00000	0.18088	0.00000	-0.12456	0.00000	-0.12456	0.00000
2079	2079	-1.57095	0.00000	-1.57095	0.00000	0.11971	0.00000	0.11971	0.00000	-0.18461	0.00000	-0.18461	0.00000
2080	2080	-1.76876	0.00000	-1.76876	0.00000	-0.06264	0.00000	-0.06264	0.00000	-0.36549	0.00000	-0.36549	0.00000
2081	2081	-1.47841	0.00000	-1.47841	0.00000	0.25228	0.00000	0.25228	0.00000	-0.05059	0.00000	-0.05059	0.00000
2082	2082	-1.67231	0.00000	-1.67231	0.00000	0.07514	0.00000	0.07514	0.00000	-0.22626	0.00000	-0.22626	0.00000
2083	2083	-1.76893	0.00000	-1.76893	0.00000	-0.00246	0.00000	-0.00246	0.00000	-0.30278	0.00000	-0.30278	0.00000
2084	2084	-1.85398	0.00000	-1.85398	0.00000	-0.06780	0.00000	-0.06780	0.00000	-0.36700	0.00000	-0.36700	0.00000
2085	2085	-1.83432	0.00000	-1.83432	0.00000	-0.02560	0.00000	-0.02560	0.00000	-0.32401	0.00000	-0.32401	0.00000
2086	2086	-2.04977	0.00000	-2.04977	0.00000	-0.22238	0.00000	-0.22238	0.00000	-0.51937	0.00000	-0.51937	0.00000
2087	2087	-2.15446	0.00000	-2.15446	0.00000	-0.30548	0.00000	-0.30548	0.00000	-0.60130	0.00000	-0.60130	0.00000
2088	2088	-2.19810	0.00000	-2.19810	0.00000	-0.32582	0.00000	-0.32582	0.00000	-0.62072	0.00000	-0.62072	0.00000
2089	2089	-2.32110	0.00000	-2.32110	0.00000	-0.42607	0.00000	-0.42607	0.00000	-0.71980	0.00000	-0.71980	0.00000

FLEET
* TAG2 reference: Unit A 1.3, Table A 1.3.9
* TAG1 reference: Unit 3.5.6, Table 12

* For 2010 base year proportions

```
*Veh_type  %Petrol    %Diesel    %Electric
 1    59.2719    40.7281     0.0006
 2     5.8615    94.1385     0.0000
 3     5.8615    94.1385     0.0000
 4     0.0000    100.0000     0.0000
 5     0.0000    100.0000     0.0000
 6     0.0000    100.0000     0.0000
 7     0.0000    100.0000     0.0000
 8     0.0000    100.0000     0.0000

FLEET_CHANGES

* TAG2 reference: Unit A 1.3, Table A 1.3.9 (derived)
* TAG reference: Unit 3.5.6, Table 12 (derived)
* %change a year from 2010 base year
*Start_yr   End_yr  Veh_type %Change_Petrol  %Change_Diesel  %Change_Electric
2011      2011    1      -3.8148      5.4714     5350.0000
2012      2012    1      -3.9661      5.1876     100.0000
2013      2013    1      -4.1299      4.9317      50.0000
2014      2014    1      -4.3078      4.6999      33.4353
2015      2015    1      -4.5019      4.4890      24.9809
2016      2016    1      -1.7769      1.3347      97.7384
2017      2017    1      -1.8090      1.3173      49.4590
2018      2018    1      -1.8423      1.3002      33.0714
2019      2019    1      -1.8769      1.2833      24.8523
2020      2020    1      -1.9128      1.2672      19.9178
2021      2021    1      0.3233      -0.8263      32.7935
2022      2022    1      0.3223      -0.8332      24.6951
2023      2023    1      0.3212      -0.8402      19.8044
2024      2024    1      0.3202      -0.8473      16.5306
2025      2025    1      0.3192      -0.8545      14.1856
2026      2026    1      0.0205      -1.0600      21.7555
2027      2027    1      0.0207      -1.0714      17.8650
2028      2028    1      0.0205      -1.0830      15.1599
2029      2029    1      0.0205      -1.0948      13.1642
2030      2030    1      0.0205      -1.1070      11.6328
2011      2011    2      -7.5783      0.4719      0.0000
2012      2012    2      -8.1997      0.4696      0.0000
2013      2013    2      -8.9321      0.4674      0.0000
2014      2014    2      -9.8103      0.4654      0.0000
2015      2015    2     -10.8750      0.4631      0.0000
2016      2016    2      -9.6336      0.3639      0.0000
2017      2017    2     -10.6605      0.3626      0.0000
2018      2018    2     -11.9326      0.3613      0.0000
2019      2019    2     -13.5533      0.3601      0.0000
2020      2020    2     -15.6737      0.3587      0.0000
2021      2021    2      -8.9782      0.1727      0.0000
2022      2022    2      -9.8637      0.1724      0.0000
2023      2023    2     -10.9496      0.1722      0.0000
```

```
2024      2024    2     -12.2887      0.1718      0.0000
2025      2025    2     -14.0104      0.1715      0.0000
2026      2026    2      -4.8860      0.0513      0.0000
2027      2027    2      -5.1370      0.0513      0.0000
2028      2028    2      -5.4259      0.0514      0.0000
2029      2029    2      -5.7259      0.0513      0.0000
2030      2030    2      -6.0736      0.0512      0.0000
2011      2011    3      0.0000      0.0000      0.0000
2012      2012    3      0.0000      0.0000      0.0000
2013      2013    3      0.0000      0.0000      0.0000
2014      2014    3      0.0000      0.0000      0.0000
2015      2015    3      0.0000      0.0000      0.0000
2016      2016    3      0.0000      0.0000      0.0000
2017      2017    3      0.0000      0.0000      0.0000
2018      2018    3      0.0000      0.0000      0.0000
2019      2019    3      0.0000      0.0000      0.0000
2020      2020    3      0.0000      0.0000      0.0000
2021      2021    3      0.0000      0.0000      0.0000
2022      2022    3      0.0000      0.0000      0.0000
2023      2023    3      0.0000      0.0000      0.0000
2024      2024    3      0.0000      0.0000      0.0000
2025      2025    3      0.0000      0.0000      0.0000
2026      2026    3      0.0000      0.0000      0.0000
2027      2027    3      0.0000      0.0000      0.0000
2028      2028    3      0.0000      0.0000      0.0000
2029      2029    3      0.0000      0.0000      0.0000
2030      2030    3      0.0000      0.0000      0.0000

FUEL_CONSUMPTION
* TAG2 reference: Unit A 1.3, Table A 1.3.8
* TAG1 reference: Unit 3.5.6, Table 10

* For 2010 base year
* Fuel consumption (l/km) = (a_fuel+b_fuel*V+c_fuel*V^2+d_fuel*v^3)/v where v is speed in km/h
*Veh_type  Fuel_type   a_Fuel    b_Fuel     c_Fuel     d_Fuel   Cut-off_speed(km/h)
 1      1   0.964022581 0.041448033 -0.454163E-04  0.201346E-05   140
 1      2   0.437094041 0.058616489 -0.524880E-03  0.412709E-05   140
 1      3   0.000000000 0.125642360  0.000000E+00  0.000000E+00   140
 2      1   1.556463336 0.064253318 -0.744481E-03  0.100552E-04   140
 2      2   1.045268333 0.057901415 -0.432895E-03  0.802520E-05   140
 3      1   1.556463336 0.064253318 -0.744481E-03  0.100552E-04   140
 3      2   1.045268333 0.057901415 -0.432895E-03  0.802520E-05   140
 4      2   1.477368474 0.245615208 -0.357241E-02  0.306380E-04    96
 5      2   3.390702946 0.394379054 -0.464229E-02  0.359224E-04    96
 6      2   4.115603000 0.306465000 -0.420643E-02  0.365263E-04    96

FUEL_EFFICIENCY
* TAG2 Reference: Unit A 1.3, Table A 1.3.10
* TAG1 Reference: Unit 3.5.6, Table 13
```

```
* %change a year from 2010 base year
*Start_yr   End_yr  Veh_type Fuel_type     Change
2011      2015      1     1      2.09
2011      2015      1     2      1.71
2011      2015      1     3     -0.11
2011      2015      2     1      0.66
2011      2015      2     2      2.07
2011      2015      3     1      0.66
2011      2015      3     2      2.07
2016      2020      1     1      3.72
2016      2020      1     2      2.22
2016      2020      1     3      0.31
2016      2020      2     1      1.38
2016      2020      2     2      2.34
2016      2020      3     1      1.38
2016      2020      3     2      2.34
2021      2025      1     1      3.63
2021      2025      1     2      2.62
2021      2025      1     3      0.71
2021      2025      2     1      3.07
2021      2025      2     2      2.19
2021      2025      3     1      3.07
2021      2025      3     2      2.19
2026      2030      1     1      2.10
2026      2030      1     2      2.10
2026      2030      1     3      1.19
2026      2030      2     1      2.95
2026      2030      2     2      1.30
2026      2030      3     1      2.95
2026      2030      3     2      1.30
2031      2035      1     1      0.74
2031      2035      1     2      0.96
2031      2035      1     3      0.26
2031      2035      2     1      0.86
2031      2035      2     2      0.57
2031      2035      3     1      0.86
2031      2035      3     2      0.57
2036      2100      1     1      0.00
2036      2100      1     2      0.00
2036      2100      1     3      0.00
2036      2100      2     1      0.00
2036      2100      2     2      0.00
2036      2100      3     1      0.00
2036      2100      3     2      0.00

NON_FUEL_VOC
* TAG2 Reference: Unit A 1.3, Table A 1.3.15
* TAG1 Reference: Unit 3.5.6, Table 16
```

```
* For 2010 base year
*Veh_type Fuel_type a_Nonfuel_wrk b_Nonfuel_wrk a_Nonfuel_nw  b_Nonfuel_nw
    1    1     4.966    135.946     3.846     0.000
    1    2     4.966    135.946     3.846     0.000
    1    3     1.157    135.946     1.157     0.000
    2    1     7.213    47.113     7.213     0.000
    2    2     7.213    47.113     7.213     0.000
    3    1     7.213    47.113     7.213     0.000
    3    2     7.213    47.113     7.213     0.000
    4    2     6.714    263.817     0.000     0.000
    5    2    13.061    508.525     0.000     0.000
    6    2    30.461    694.547     0.000     0.000

NON_FUEL_VOC_CHANGES
* TAG reference: Unit 3.5.6 para 3.3.11
* %change a year from 2010 base year
*Start_yr   End_yr  Veh_type   Growth
2011      2100    1     0.000
2011      2100    2     0.000
2011      2100    3     0.000
2011      2100    4     0.000
2011      2100    5     0.000
2011      2100    6     0.000
2011      2100    7     0.000
2011      2100    8     0.000

NON_FUEL_TAX_RATES
* For 2010 base year
* percentage
*Submode   Final   Intermediate
 1      17.5      0.0
 2      17.5      0.0
 3      17.5      0.0
 4      17.5      0.0
 5      17.5      0.0
 6      17.5      0.0
 7      0.0      0.0
 8      0.0      0.0

NON_FUEL_TAX_RATES_CHANGES
* %change a year from 2010 base year
*Start_yr   End_yr  Submode    Final   Intermediate
2011      2011    1     14.286      0.000
2011      2011    2     14.286      0.000
2011      2011    3     14.286      0.000
2011      2011    4     14.286      0.000
2011      2011    5     14.286      0.000
2011      2011    6     14.286      0.000
2011      2011    7     0.000      0.000
```

```
2011      2011    8     0.000      0.000
2012      2100    1     0.000      0.000
2012      2100    2     0.000      0.000
2012      2100    3     0.000      0.000
2012      2100    4     0.000      0.000
2012      2100    5     0.000      0.000
2012      2100    6     0.000      0.000
2012      2100    7     0.000      0.000
2012      2100    8     0.000      0.000

DEFAULT_PURPOSE_SPLIT
* TAG2 reference: Unit A1.3, Table A 1.3.4
* TAG1 reference: Unit 3.5.6, Table 7

* For 2010 base year
*Vtype/submode  Purpose Period1 Period2 Period3 Period4 Period5
 1       1     18.1   13.0   19.9   12.3   3.2
 1       2     46.0   40.8   11.4   36.2   8.5
 1       3     35.9   46.2   68.7   51.5   88.3
 2       1     0.0   0.0   0.0   0.0   0.0
 2       2     0.0   0.0   0.0   0.0   0.0
 2       3    100.0  100.0  100.0  100.0  100.0
 3       1    100.0  100.0  100.0  100.0  100.0
 3       2     0.0   0.0   0.0   0.0   0.0
 3       3     0.0   0.0   0.0   0.0   0.0
 4       1    100.0  100.0  100.0  100.0  100.0
 4       2     0.0   0.0   0.0   0.0   0.0
 4       3     0.0   0.0   0.0   0.0   0.0
 5       1    100.0  100.0  100.0  100.0  100.0
 5       2     0.0   0.0   0.0   0.0   0.0
 5       3     0.0   0.0   0.0   0.0   0.0
 6       1     3.9   3.9   2.0   5.7   1.5
 6       2     30.0   36.6   11.1   38.1   6.4
 6       3     66.1   59.5   86.9   56.2   92.0
 7       1     1.9   1.8   0.2   2.3   0.4
 7       2     82.4   75.7   8.5   28.9   23.3
 7       3     15.7   22.5   91.3   68.9   76.3
 8       1     14.1   16.4   22.4   23.2   6.3
 8       2     51.9   55.9   10.2   53.1   4.3
 8       3     34.1   27.7   67.4   23.7   89.5

DEFAULT_PERSON_FACTORS
* TAG2 reference: Unit A1.3, Table A 1.3.4
* TAG1 reference: Unit 3.5.6, Table 7

* For 2010 base year
*Vtype/submode  Purpose  Person_type  FactorPer1    FactorPer2    FactorPer3    FactorPer4    FactorPer5 ...
 1       1     1       1.00       1.00       1.00       1.00       1.00
 1       1     2       0.22       0.16       0.18       0.17       0.27
```

```
 1       2     1       1.00       1.00       1.00       1.00       1.00
 1       2     2       0.15       0.12       0.14       0.12       0.13
 1       3     1       1.00       1.00       1.00       1.00       1.00
 1       3     2       0.66       0.78       0.73       0.73       0.92
 2       2     1       1.00       1.00       1.00       1.00       1.00
 2       2     2       0.46       0.46       0.46       0.46       1.03
 2       3     1       1.00       1.00       1.00       1.00       1.00
 2       3     2       0.46       0.46       0.46       0.46       1.03
 3       1     1       1.00       1.00       1.00       1.00       1.00
 3       1     2       0.20       0.20       0.20       0.20       0.26
 4       1     1       1.00       1.00       1.00       1.00       1.00
 5       1     1       1.00       1.00       1.00       1.00       1.00

DEFAULT_PERSON_FACTORS_CHANGE
* TAG2 reference: Unit A1.3, Table A 1.3.3
* TAG1 reference: Unit 3.5.6, Table 6

* %change a year from 2010 base year
*Start_yr  End_yr  Submode Purpose Person_type ChangePer1 ChangePer2 ChangePer3 ChangePer4 ChangePer5
2011    2036      1     1     2   -0.48   -0.62   -0.40   -0.50   -0.48
2011    2036      1     2     2   -0.67   -0.53   -0.65   -0.47   -0.52
2011    2036      1     3     2   -0.67   -0.53   -0.65   -0.47   -0.52

PREPARATION&SUPERVISION
* total preparation (by stage) and supervision costs as % of land and construction costs
*Mode  Prep:SI   Prep:PC   Prep:PR   Prep:OP   Prep:WC    Super
 1    12.0     9.0     9.0     6.0     2.0     5.0
 2    12.0     9.0     9.0     6.0     2.0     5.0
 3    12.0     9.0     9.0     6.0     2.0     5.0
```

Appendix B – DfT Advice on the Treatment of Charge Revenues

In answer to your query- please refer to WebTAG A1.1 section 2.8.
https://www.gov.uk/government/publications/webtag-tag-unit-a1-1-cost-benefit-analysis

The guidance says that the Present Value Costs "*should only comprise Public Accounts impacts (i.e. costs borne by public bodies) that directly affect the budget available for transport*".

Section 2.8.7 continues: "*Where a scheme leads to changes in public sector revenues (for example tolling options) careful consideration should be given to whether they will accrue to the Broad Transport Budget and all assumptions, and their justifications, should be clearly reported.* "

In your case, this means it depends on whether TfL , a public body, will receive the toll revenue and whether it can be argued convincingly that the revenue will therefore be spent on transportation in the future.

- If it does, the revenue would fall under the *Broad Transport Budget* and should be included in the PVCosts as revenue. This leads to a negative Benefit Cost Ratio.
- If it can't be argued that the revenue will be available for transport in the future the revenue would have to be accounted for on the PVBenefit side of the BCR calculation.

The revenue should not, however, be excluded from the BCR calculation. It may be useful to present both versions of the BCR (and provide context.)

In terms of "Value for Money" assessment- negative BCRs of "revenue positive" schemes are not informative. It is advisable in such cases to look as well at the Net Present Values of transport options to compare them.

I have contacted a colleague and hope to provide a practical example of a case where high toll revenues have occurred. I will let you know if I receive additional information.

Please let me know if you have further queries or require additional detail.
Regards,

Department for Transport, Great Minster House, 33 Horseferry Rd. Zone 2/25, London SW1P 4DR

Appendix C – Annualisation Factor Analysis

Transport for London

River Crossings Programme

TUBA Annualisation Factors

TfL's Environmental Consultant for the River Crossings Programme (Hyder) has developed a set of traffic expansion factors to enable estimates of AAWT and AADT to be produced for any link in the ELHAM-based traffic model, from the AM, IP and PM model flows. These factors, and their method of derivation, are set out in the Hyder technical note 0001-UA005651-UT22R-A.pdf. The factors are based upon analysis of 114 five-day classified link traffic counts (6am to 10pm) commissioned by TfL for the River Crossings Programme and conducted in November 2012, along with data from nine two-way permanent ATC sites operated by TfL and located in east and south-east London. Data from these was available for the whole of 2012.

This note sets out the derivation of a comparable set of TUBA annualisation factors which may be used for the appraisal of the planned and proposed crossings which form the River Crossings Programme (Silvertown Tunnel, Gallions Reach bridge and Belvedere bridge). Assumptions made in the Hyder work have been adopted in this note (to maintain compatibility in approach), although it may be appropriate to review these following the non-statutory consultation for the Silvertown Tunnel. These assumptions are as follows:

The shoulder hours of 6am to 7am and 7pm to 10pm are represented by factored flows from the Inter-peak model.

The first step in the calculation of annualisation factors involved the use of data from the 114 Monday to Friday Count sites. Counts were summed across the five days at each site by vehicle category (Light or Heavy, excluding pedal cycles), total counts (all vehicles) derived, and factors for each site produced as follows:

Ratio of AM Peak Period flow (3 hr) to AM Peak Hour flow (1hr)

Ratio of shoulder hours flow (6am to 7am, 7pm to 10pm) to average Inter-peak flow (1hr)

Ratio of PM Peak Period flow (3 hr) to PM Peak Hour flow (1hr)

The medians of the resulting site factors for all vehicles combined (as annualisation factors are not produced by vehicle type or category) are given in the following table.

AM Pk hr->AM Pk 3hr	PM Pk hr->PM Pk 3hr	IP Avg Hr -> IP+OP 10hr
2.80262	2.89883	8.83629

These factors, applied to the relevant modelled hour, will generate the traffic volumes for an average weekday in November.

As the detailed traffic counts commissioned by TfL were from Monday to Friday only, the data is not able to be used to produce a factor to generate November weekend traffic flows. For this the nine permanent ATC sites in the ELHAM model area were used. Traffic counts for November 2012 were used and ratios derived for each site, by direction, of total 6am to 10pm flow for an average November weekend day compared to the average hourly between 10am and 4pm on a weekday. As there are no bank holidays in November, these did not feature in the calculations.

The resulting Mon-Fri IP Average Hour to 6am to 10pm Weekend day factor for November, taken as the median value from those calculated is as follows:

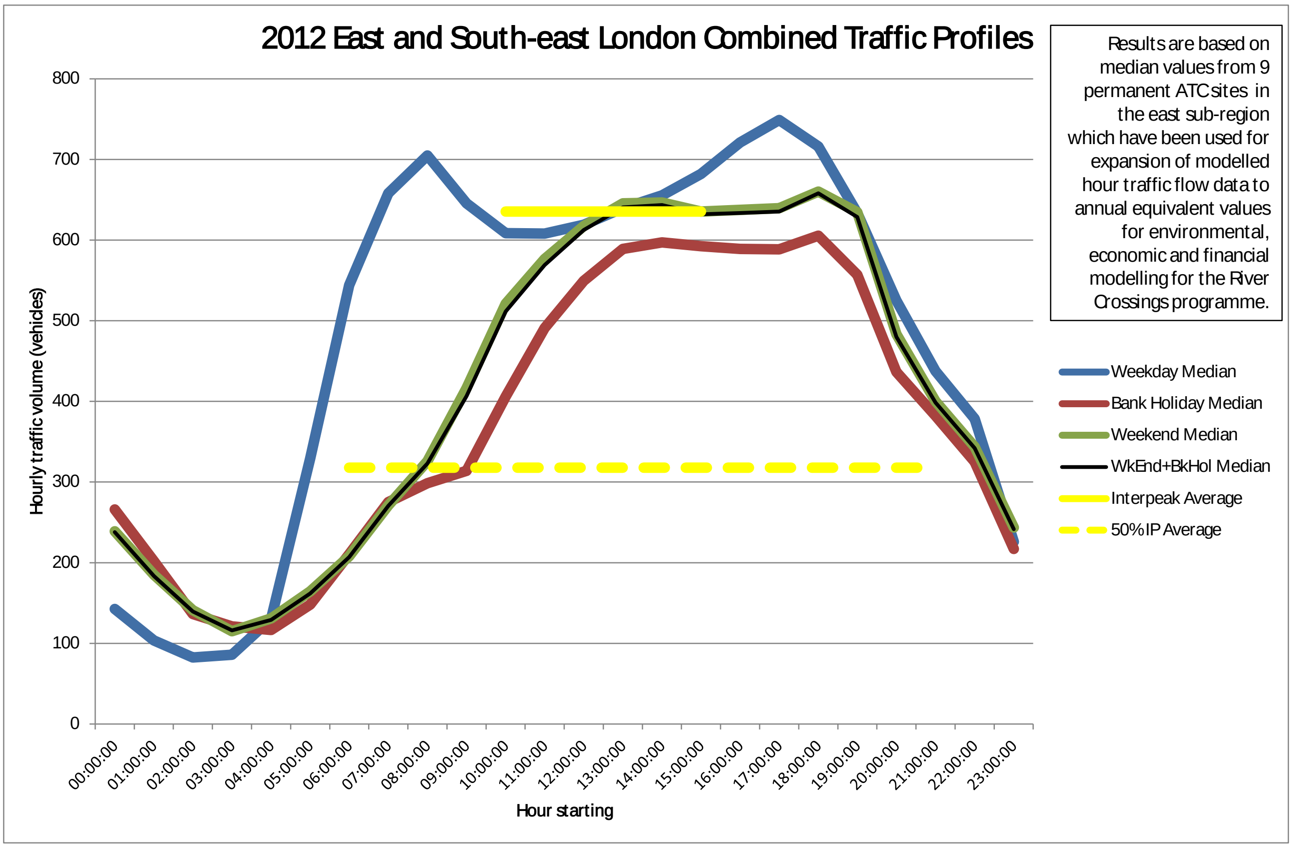
IP Avg Hr -> WkEnd 16hr
11.43039

The next stage was to take these November expansion factors and apply an adjustment to each, relative to the timeslice the resulting annualisation factor would represent, to derive factors for the whole year, rather than the month of November.

These adjustments were based on the nine permanent ATC sites. As previously, adjustments were calculated for each site separately, by direction, and the median value taken in each case. Applying the adjustment factors to the modelled hour to timeslice factors is illustrated in the table which follows.

Factor Description	AM Pk hr-> AM Pk 3hr	PM Pk hr-> PM Pk 3hr	IP Avg Hr -> IP+OP 10hr	IP Avg Hr -> WkEnd 16hr
Nov hour to Nov Timeslice	2.80262	2.89883	8.83629	11.43039
Nov TS to Annual TS	0.99302	0.98781	1.00036	0.99568
Nov hour to Annual TS	2.78306	2.86350	8.86812	11.38102

In determining the adjustment for the weekend, the bank holidays throughout the year were included as their combined traffic profile was very similar to that of weekend days as the figure overleaf demonstrates.



All that now remains to be done to produce the annualisation factors for use in TUBA is to multiply the modelled hour to annual timeslice factors by the number of days of each type in a typical year. These are taken to be 253 weekdays, 104 weekend days and 8 bank holidays. The required calculations are shown in the following table.

Factor Description	AM Pk hr-> AM Pk 3hr	PM Pk hr-> PM Pk 3hr	IP Avg Hr -> IP+OP 10hr	IP Avg Hr -> WkEnd 16hr
Nov hour to Annual TS	2.78306	2.86350	8.86812	11.38102
Number of days per year	253	253	253	112
TUBA Annualisation	704	724	2244	1275

On the graph above, it will be seen that the combined weekend and bank holiday traffic profile for the nine permanent ATC sites is less than 50% of the average weekday inter-peak flow for the hours commencing 6am and 7am. As traffic is unlikely to be delayed at these hours (as much as in the Monday to Friday inter-peak) as flows are low, a conservative position was taken in accruing user benefits for these hours by deciding to omit them from the TEE table. Traffic in these two hours amounts to 6% of the total weekend flow during the 6am to 10pm charged period. Thus 6% of the user travel time and vehicle operating cost benefits should be deducted from the weekend total.

It should be noted though, that an adjustment of the annualisation factor for these low flow periods is not advisable, as during these two hours the user charge must be paid and the disbenefit to users of this should be included in the TEE table.

Prepared on 5 September 2014

Appendix D – Input Matrix Factors

The Input matrix factors used are summarised below:

	Timeslice	1	2	3	4
SATURN UC	TUBA veh class				
UC1	1	0.61	0.43	0.20	0.11627
UC1	2	0.39	0.57	0.80	1.14099
UC2	3	0.61	0.43	0.20	0.11627
UC2	4	0.39	0.57	0.80	1.14099
UC3	5	0.61	0.43	0.20	0.11627
UC3	6	0.39	0.57	0.80	1.14099
UC4	7	1.00	1.00	1.00	0.07786
UC5	8	1.00	1.00	1.00	1.00000
UC6	9	1.00	1.00	1.00	1.00000
UC7	10	0.29	0.355	0.271	0.27100
UC7	11	0.21	0.145	0.229	0.22900

1. The vehicle split factors for SATURN UC 1-3 (out-of-work trips) in timeslices 1-3 (AM/PM/IP – highlighted in blue) are taken from Table 29 of MVA's TN 'Generalised Cost Parameters' (12 September 2011) for 'Outer HAMs'.
2. The vehicle split factors for SATURN UC 1-3 (out-of-work trips) and UC4 (in-work trips) in timeslice 4 (offpeak – highlighted in pink) are derived for WebTAG and TfL information from LTS and other data. For each TUBA user class the number of trips was calculated from the SATURN 2021 reference case matrix user classes , using webTAG guidance for the percentage splits in journey type (ie the split in work, commuting and other journeys for each relevant SATURN class). A ratio was then found derived for corresponding SATURN and TUBA user class trips to get conversion factors for each TUBA user class, which could be applied to the SATURN input demand matrices'
3. The vehicle split factors for SATURN UC 7 (HGVs – highlighted in yellow) were derived using an Automatic Traffic Counter at Blackwall Tunnel (both directions) to give the split between OGV1/OGV2 (and to convert from PCUs to vehicles - the interpeak split was used for the offpeak.
4. The TUBA charge factor (universally applied) of 1.031 factor is to adjust from the model's 2009 price base to 2012, the TUBA based year.

Appendix E – Bus and Coach Benefits

Silvertown Crossing – Bus and Coach Benefits analysis - Assumptions and Methodology

Cross-river movements on commuter coaches and bus route 108 were analysed.

It was assumed that benefits would only accrue to the AM peak period (0700-1000) northbound and the PM peak period (1600-1900) period southbound movements. The latter were reduced by 1/6 to account for the fact that congestion between 1600 and 1630 is lower than the rest of the period.

The base year for demand data was 2012/13.

An annualisation factor of 250 was used, assuming that the benefit would only occur on weekdays.

The assumption for average benefits from decongestion was 10 mins for coach and 10 mins for bus users. These times are lower than the 17 mins saving predicted for coaches in the SATURN model and 13-16 minutes predicted for bus users.

An annual demand growth of 1.5% was assumed until 2031 only – no specific account was made of increased patronage due to improved reliability and journey times.

Values of time were taken from WebTAG (May 2014) table A 1.3.2

For coaches it was assumed that all passengers were commuters.

For buses, a journey purpose split based on WebTAG (May 2014) table A 1.3.4 was assumed.

It was assumed the operating efficiencies of decongestion would lead to the saving of one peak vehicle requirements for buses, with an annual cost saving of £300K. A real growth in PVR costs of 0% was assumed.

Benefits were calculated for a 60 year period from an assumed scheme opening of 2021.

Benefits were discounted by 3.5% for 30 years from present day, 3.0% thereafter.

Appendix F – COBA-LT analysis

1. Derivation of accident cost savings

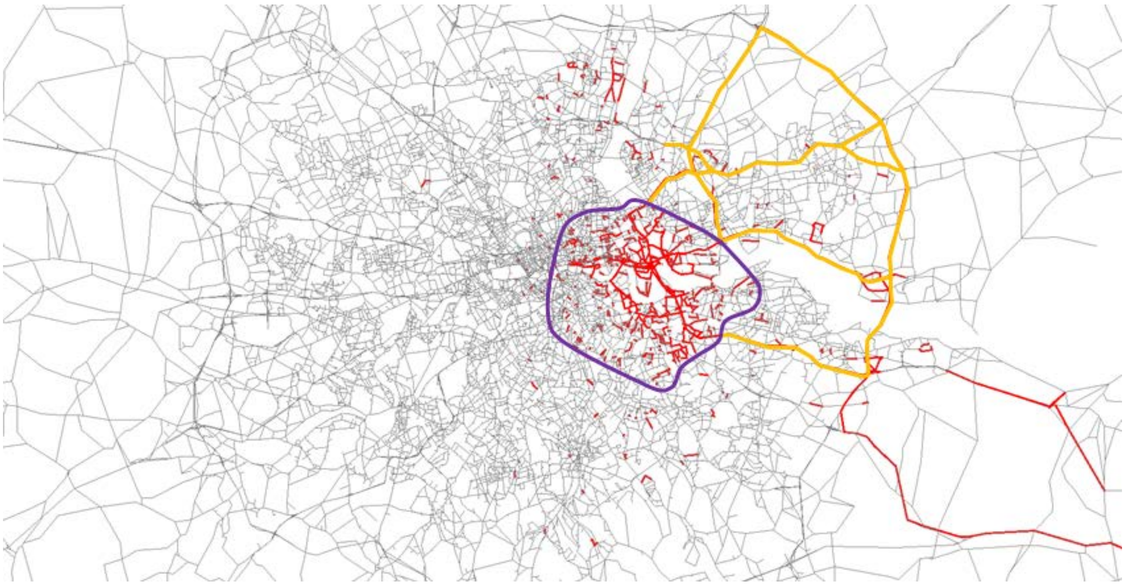
A.1 Introduction

This section refers to the process of analysing traffic accident data and the running of the COBA-LT model road network within the defined study area.

A.2 Defining the links

The area in question is shown in **Figure 1-1**, consisting of all the road links within the purple circle and the additional links highlighted in yellow. The links highlighted in red show where the flows in the Saturn network change by 5% or higher between the 2021 do-nothing and do-something AM models. The links in yellow have been added as they represent the primary routes that link to the study area.

Figure 1-1: COBA-LT study area



The default DfT COBA-LT parameters have been used in this study except for locally derived combined link and junction accident rates. The accident rates have been calculated using the methodology described below.

A.3 Local Accident Rate Methodology

The primary aim of this analysis was to use accident records sourced from the police and vehicle flows from the COBA-LT model to calculate study area-specific accident rates (defined as annual accidents per million vehicle-kms), and compare them with the rates provided by road type in the COBA-LT user manual. The COBA-LT default rates are summarised in Table 1.

Table 1: COBA-LT accident rates by road type (2000 base)

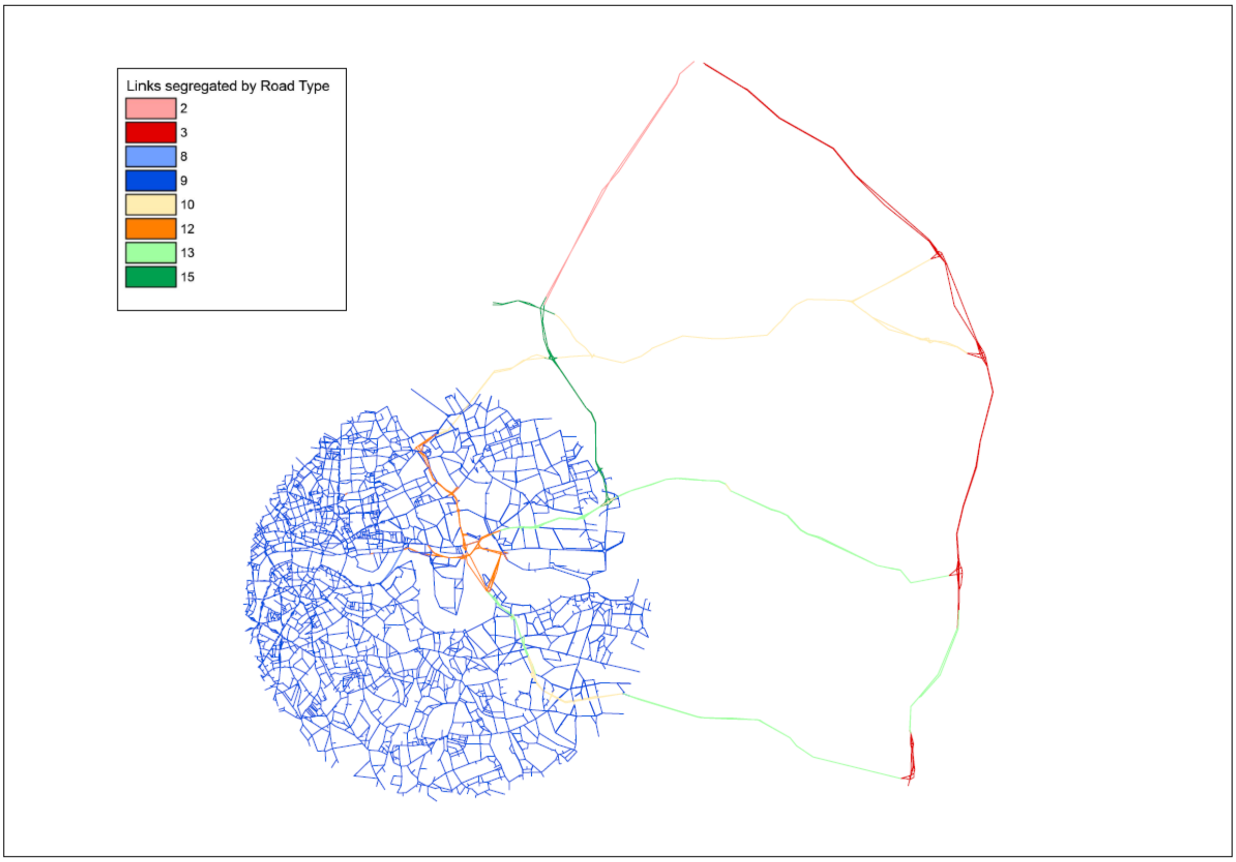
Road type	Road description	Speed limit (mph)	Accident rate
1	Motorways	50/60/70	0.098
2	Motorways	50/60/70	0.098
3	Motorways	50/60/70	0.098
4	Modern S2 Roads	30/40	0.844
4	Modern S2 Roads	>40	0.293
5	Modern S2 Roads with HS	30/40	0.844

Road type	Road description	Speed limit (mph)	Accident rate
5	Modern S2 Roads with HS	>40	0.232
6	Modern WS2 Roads	30/40	0.844
6	Modern WS2 Roads	>40	0.19
7	Modern WS2 Roads w. HS	30/40	0.844
7	Modern WS2 Roads w. HS	>40	0.171
8	Older S2 A Roads	30/40	0.844
8	Older S2 A Roads	>40	0.381
9	Other S2 Roads	30/40	0.844
9	Other S2 Roads	>40	0.404
10	Modern D2 Roads	30/40	1.004
10	Modern D2 Roads	>40	0.174
11	Modern D2 Roads with HS	30/40	1.004
11	Modern D2 Roads with HS	>40	0.131
12	Older D2 Roads	30/40	1.004
12	Older D2 Roads	>40	0.226
13	Modern D3+ Roads	30/40	1.004
13	Modern D3+ Roads	>40	0.174
14	Modern D3+ Roads w. HS	30/40	1.004
14	Modern D3+ Roads w. HS	>40	0.131
15	Older D3+ Roads	30/40	1.004
15	Older D3+ Roads	>40	0.226

A.4 Road lengths and vehicle-kms

Figure 1-2 outlines the extent of road types in the study area. The basis for the definition of road types was through analysing map data to obtain a general overview of all the different road types. Due to the wide extent of the study area, all roads were set as COBA-LT road type 9 as default. All dual carriageways, tunnels and motorways were reviewed to see if they fell within another COBA-LT road type and amended accordingly.

Figure 1-2: Study area split by COBA-LT Road Type



Road lengths were then calculated for all the COBA-LT links using GIS, and AADF flow data derived from the SATURN model was then used to estimate annual million vehicle-kms on each link using the length calculations. The AADFs were 2012 figures and annual link flows were assumed to be equal to the AADF multiplied by 365. Table 3 summarises the flow and link lengths by road type.

Table 2: Link lengths and total 2012 vehicle kms by link category within COBA-LT study area

Road Type	2	3	8	9	10	12	13	15	Total
2012 Flow (AADT)	30484 6	360955 6	2616 6	5464955 8	283153 6	311410 2	571021 4	279150 1	7303748 0
Length (km)	22.161	73.08	1.815	1864.593	62.872	44.158	80.688	28.477	2177.844
Annual Million Vehicle KM	344	1349	9	3130	468	372	1283	389	7343

A.5 Study area accident data

A database of traffic accidents that occurred within the GLA boundary between 2009 and 2013 was obtained from the Metropolitan, City of London, Kent and Essex Police and the co-ordinates associated with each record were used to plot the accident locations using MapInfo GIS software.

A buffer of 50m was then drawn around the cropped road network and manually adjusted in certain locations where the model road links did not match the road location on the ground to a significant degree. A query was then run in MapInfo to identify the accidents that were located within the road network buffer. **Figure 1-3** shows the accident records with the road network overlaid on top. All accident data that intersected with the road network buffers were considered.

Figure 1-3: Accident data in the study area

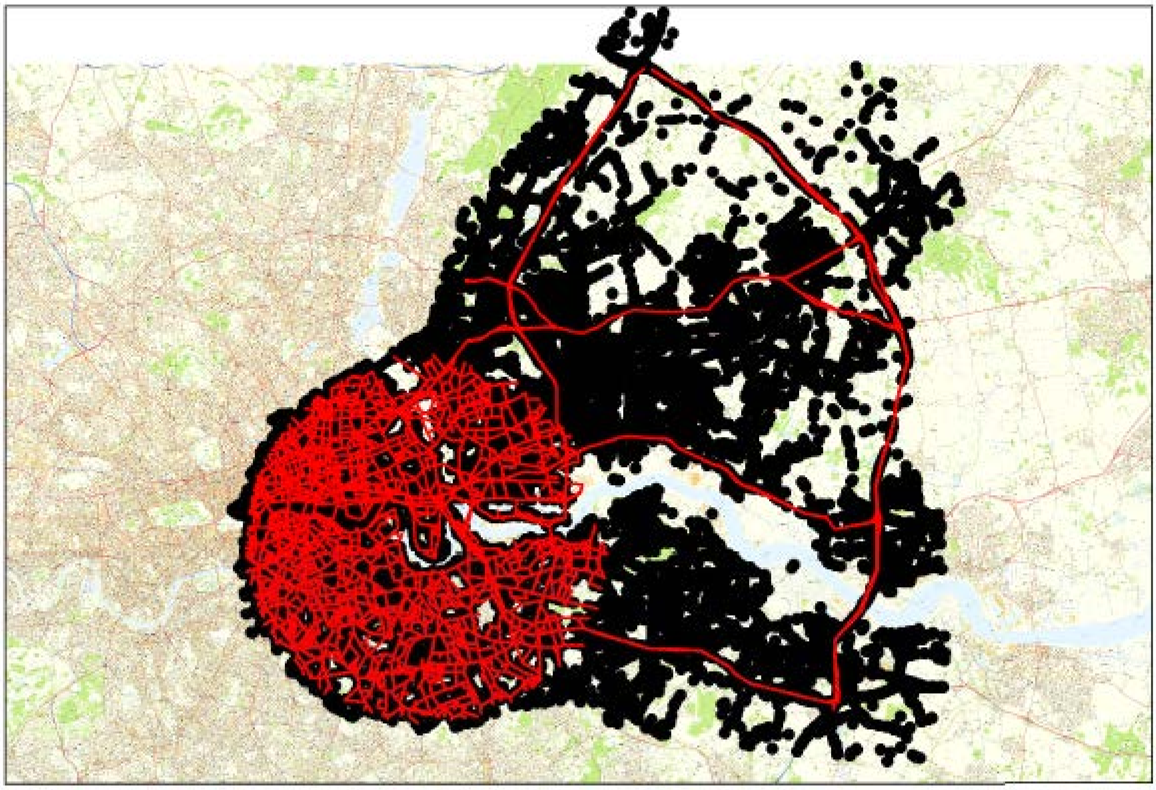


Table 2 shows the number of accidents by COBA-LT road type for the five year data period 2009-2013 and the average for 1 year.

Table 3: Accidents by COBA-LT road type

Road Type	2	3	8	9	10	12	13	15	Total
Accidents (2009 – 2013)	104	691	41	27558	1114	713	1252	657	32130
1 year average	21	138	8	5512	223	143	250	131	6426

A.6 Accident rates

The next stage of the process was to calculate the breakdown of accident rates by road type. This was done by dividing the average accidents per year by the annual million vehicle kilometres. Table 4 shows the data and compares the calculated rates against the COBA-LT national average parameter rates. A number of road types were not necessary in the study area.

Table 4: Comparison of National and Local Accident rates by road type

				National Average	Local Average		
				2000	2009-2013		
Road		Speed Limit		Accident	Accident		Road Description
Type		(mph)		Rate	Rate		
1		50/60/70		0.098	-		Motorways
2		50/60/70		0.098	0.060		Motorways
3		50/60/70		0.098	0.102		Motorways
4		30/40		0.844	-		Modern S2 Roads
4		>40		0.293	-		Modern S2 Roads
5		30/40		0.844	-		Modern S2 Roads with HS
5		>40		0.232	-		Modern S2 Roads with HS
6		30/40		0.844	-		Modern WS2 Roads
6		>40		0.19	-		Modern WS2 Roads
7		30/40		0.844	-		Modern WS2 Roads w. HS
7		>40		0.171	-		Modern WS2 Roads w. HS
8		30/40		0.844	0.963		Older S2 A Roads
8		>40		0.381	-		Older S2 A Roads
9		30/40		0.844	1.761		Other S2 Roads
9		>40		0.404	-		Other S2 Roads
10		30/40		1.004	-		Modern D2 Roads
10		>40		0.174	0.476		Modern D2 Roads
11		30/40		1.004	-		Modern D2 Roads with HS
11		>40		0.131	-		Modern D2 Roads with HS
12		30/40		1.004	0.384		Older D2 Roads
12		>40		0.226	-		Older D2 Roads
13		30/40		1.004	-		Modern D3+ Roads
13		>40		0.174	0.195		Modern D3+ Roads
14		30/40		1.004	-		Modern D3+ Roads w. HS
14		>40		0.131	-		Modern D3+ Roads w. HS
15		30/40		1.004	-		Older D3+ Roads
15		>40		0.226	0.338		Older D3+ Roads

The most significant increase is for road type 9, with the speed limit at 40 miles an hour or below. The accident rate increases from 0.84 to 1.761 per million vehicle kilometres. The largest decrease is for road type 12, with a fall from 1.004 accidents per million kilometres to 0.384 accidents per million kilometres. Where the road type does not exist in the model, the table value has been left blank.

2. Scheme File (Appendix)

2.1 Introduction

The links highlighted in red in **Figure 1-1** show where the flows in the Saturn network change by 5% or more between the 2021 AM model do-nothing and do-something tests. When all the relevant links in the study area were collated in SATURN it produced a study area of 11,321 links.

2.2 Network simplification

It has been noted that the main benefits generated in COBA-LT are likely to come from the links where the flows change significantly, as highlighted in red. It is possible to create a simplified network containing the links with the highest flow changes and identifying summary links that make up the remainder of the network. The remaining summary links would use the link flows and parameters of the links that best summarise this simplified network.

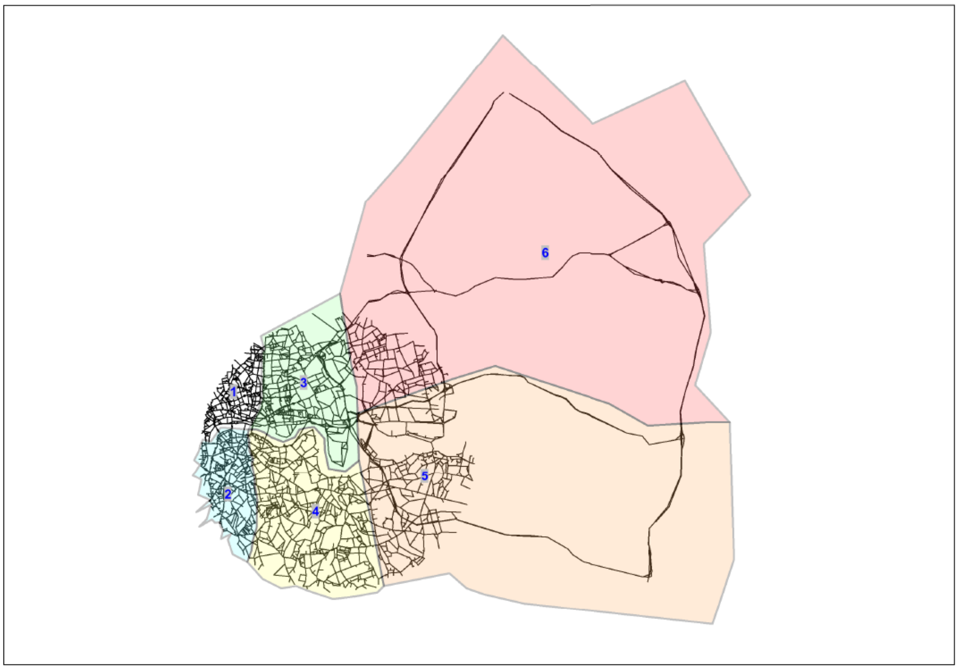
However it was decided to not to proceed with this method, primarily as (i) this could reduce the area of analysis and miss impacts, and (ii) would have led to significant manual calculations of link types and relevant flows given the scale of the network.

2.3 Adopted methodology

It was decided to break the defined SATURN network up into sectors in order to reduce the number of links being used each time for a COBA-LT model run. The links used for the Do Minimum and Do Something analysis were output from SATURN and imported into MapInfo.

Figure 2-1 shows the different sectors that were defined for the analysis. The basis for the sector sizing was to try and give each sector a similar number of links, whilst also using the River Thames and major roads in the area as screenlines between the sectors.

Figure 2-1 Defined Zones for the COBA-LT Study Area



After defining the zones for this work, all links to be used in the analysis were assigned a single zone through using a MapInfo query. Using the zone breakdown information, it was possible to create a separate input file for COBA-LT with the zone specific links and flows. In total, 6 sectors (scheme files) were created.

3. Accident Results

Table 5 outlines the economic summary results of all the COBA-LT runs – these are for the 60-year assessment period for the economic assessment.

Table 5: Economic Summary

Economic Summary (£000's)		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Total
Updated Road Types and Local Accident Rates	Total Without-Scheme Accident Costs	1,455,923	1,609,319	2,963,180	3,658,563	3,903,538	2,363,989	15,954,512
	Total With-Scheme Accident Costs	1,456,116	1,608,891	2,949,730	3,661,911	3,918,903	2,365,517	15,961,068
	Difference in Accident Costs	-193	428	13,450	-3,348	-15,365	-1,528	-6,556

The overall study area shows an increase in accident costs of £6,556,000 for the defined area of 11,321 links over 60 years – this is a 0.04% change from the 'without scheme' total. The most significant increase in costs is in zone 5 which includes the Silvertown Tunnel and link roads. The largest decrease in benefits, of £13,450 appears to come from north of and within the Blackwall Tunnel within zone 3.

Table 6 outlines the total number of accidents in the study area, with and without the scheme.

Table 6: Accident Summary

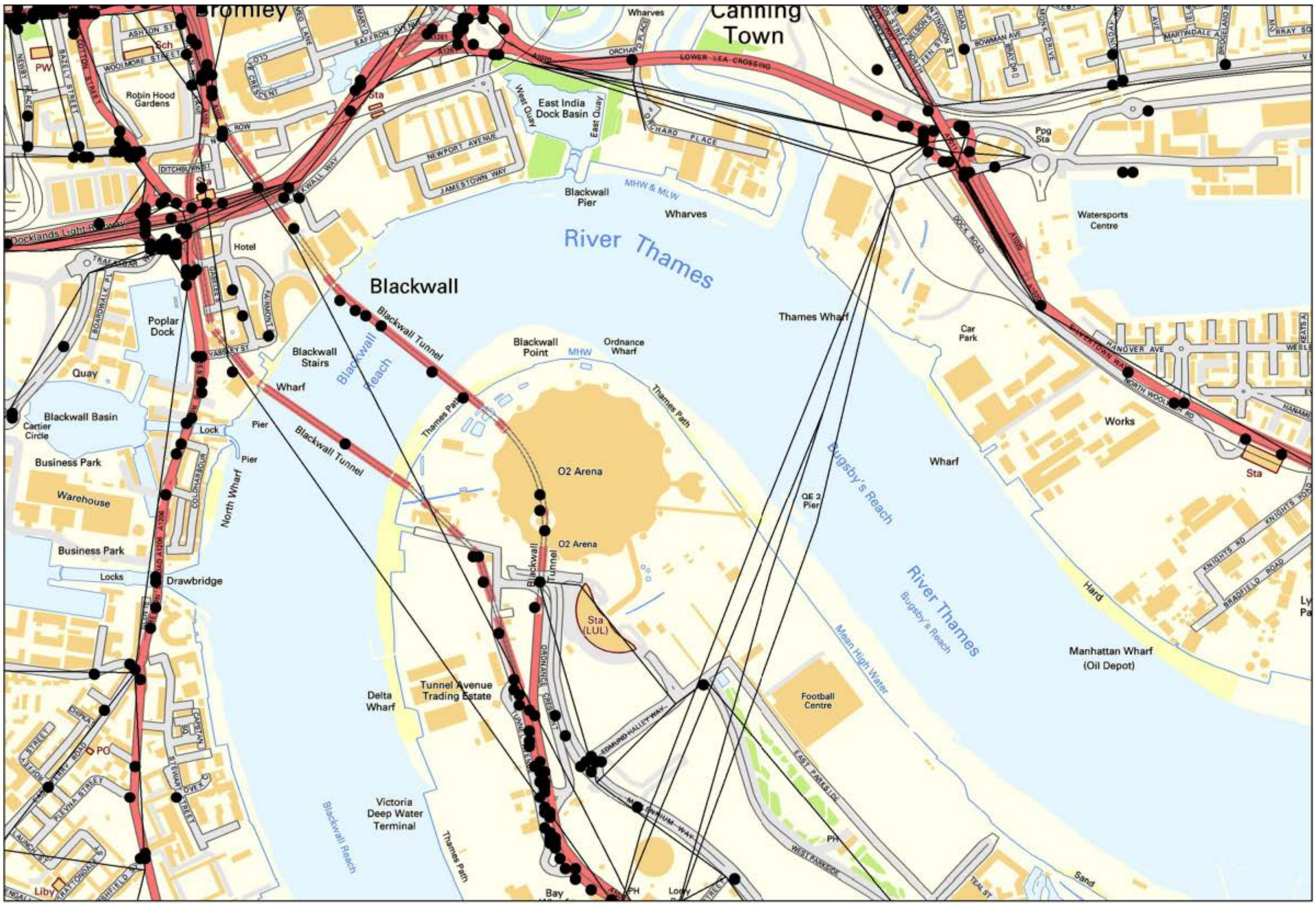
Accident Summary	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Total
Total Without-Scheme Accidents	31,186	34,482	63,400	78,365	80,218	46,352	334,002
Total With-Scheme Accidents	31,189	34,472	63,119	78,434	80,547	46,380	334,141
Total Accidents Saved by Scheme	-3	10	280	-69	-329	-29	-139

Overall, the new scheme is estimated to contribute to 139 additional accidents on the roads around the study area over 60 years, or a change of 0.04%. The largest increase of 329 occurs in zone 5 where the Silvertown Tunnel and link roads area. The area north of the Blackwall tunnel as well as the tunnel link roads themselves see the largest decrease in accidents, down by 280.

However this initial COBA-LT analysis does not yet take into account the fact that much of the change in traffic volumes is due to the reduction in existing queueing rather than additional traffic volumes, and that there are significant numbers of accidents related to the existing queuing/merging points at Blackwall Tunnel, which will be reduced by the scheme (see Figure 3.1).

Future work will clarify these changes and identify any mitigation necessary but for the initial estimate the conservative assumption of an increase in cost has been applied in the economic assessment.

Figure 3- Accidents in vicinity of Blackwall Tunnel (2009-2013)



Appendix G – Blackwall Tunnel Incident Analysis

Date	8 October 2014
Project No	KU106300
Subject	**Incidents in the Blackwall Tunnel**

1. OVERVIEW OF APPROACH

One of the three core project objectives of the Silvertown Tunnel is to improve the resilience of the cross-river highway network in east London. The existing cross-river highway network experiences poor resilience because the Blackwall Tunnel is susceptible to closure due to the frequent occurrence of incidents, in particular those associated with overheight vehicles attempting to enter the northbound bore. Furthermore there is a lack of nearby alternative crossings with capacity to cope with diverted traffic when incidents do occur.

The purpose of this analysis is twofold:

i. Quantify the impact of incidents on existing road users

ii. Quantify the potential reduction in these incidents and their impact as a result of the Silvertown Tunnel

This technical note summarises the analysis undertaken. The data on Blackwall Tunnel incidents is derived from a Transport for London log of incidents, recording the time, duration and type of all incidents in the tunnel and its approaches.

The data on Blackwall Tunnel traffic journey times is as follows:

- Link times in 5 minute slots for Northbound link 1736 between 01/08/08 and 25/06/14
- Link times in 5 minute slots for Southbound link 1829 between 01/08/08 and 25/06/14
- Incident data for the period between 02/05/10 and 21/06/14
- Averaged flow data in one-hour slots 01/12/2011 to 28/11/2013 inclusive

The selected northbound link runs between the Sun in the Sands intersection with the A2 and the Bow Roundabout on the A12. It includes the Blackwall Tunnel northbound bore.

The selected southbound link is shorter, and includes a section of the tunnel approach on the A12 from the Bow Roundabout to the A13 junction immediately to the north of the Blackwall Tunnel, but not the tunnel itself. The variation in link time on this section is used as a proxy for the impact of the incidents on traffic using the southbound bore.

In view of the large volume of data, spreadsheet analysis as described below has been undertaken using data for the full year 2013.

Traffic volumes are taken from average hourly flow data for 2013, split between

- Monday – Friday
- Saturday
- Sunday
- Bank Holiday

The hourly averages were divided by 12 to give a five-minute sample, and the flow was matched with the journey time data by hour and day of week.

This analysis quantifies the impact of incidents on users of the Blackwall Tunnel only. This analysis does not quantify the impact of Blackwall Tunnel incidents on road users on the wider road network.

This technical note is structured in the following manner:

- Section 2 summarises the types of incidents, how frequently they occur and how long they last;
- Section 3 describes the methodology for measuring journey times through the tunnel and identifying the journey time impact of incidents;
- Section 4 quantifies the potential change in incident impacts as a result of reduction and mitigation; and
- Section 5 highlights several factors for potential refinement of the methodology.

2. CLASSIFICATION OF BLACKWALL TUNNEL INCIDENTS IN 2013

2.1 Description of incident data

A detailed log is kept by TfL which records the time, duration and type of every incident in the Blackwall Tunnel and on the immediate approaches. During the full year 2013 there were only ten days with no recorded incidents northbound and only 35 days with no recorded incidents southbound. Some of these incidents are recorded simply as “congestion” with no indication of a specific cause, accounting for 394 (about 27%) of northbound incidents and 273 (40%) southbound incidents. These “congestion” incidents are excluded from the analysis.

The remaining types of incidents amount to 1,087 northbound and 401 southbound during the full year 2013.

2.2 Northbound tunnel bore incidents

The difference in incidents occurring in the northbound and southbound tunnel bores of the Blackwall Tunnel relates to their significantly different characteristics.

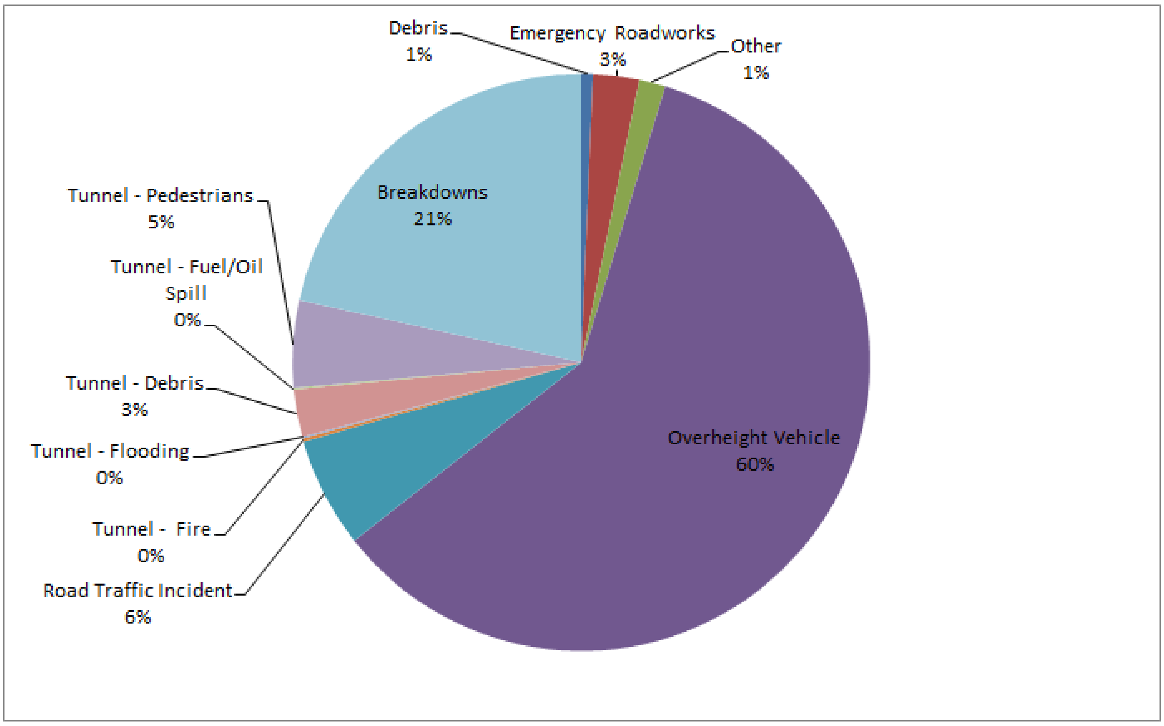
The northbound tunnel bore has a height restriction of 4m and several sharp bends. In order to allow passage of taller vehicles, the two lanes have been offset so that the maximum clearance is available in lane 1, however this means that lane 2 is restricted to lower height vehicles. A consequence is that any incident in lane 1 has a greater impact, as even if lane 2 remains open, not all vehicles using the tunnel can pass the incident. There is no pedestrian walkway in the northbound bore.

There is a northbound height restriction on the type of vehicles that can use the tunnel. The Blackwall Tunnel forms part of the TLRN and is extensively used by larger vehicles. Since the height restriction applies only in the northbound direction, some drivers may not be aware of the restriction until they attempt to enter the tunnel, resulting in an overheight vehicle incident and disruption to traffic while the problem vehicle is removed and diverted. If HGV drivers use SatNavs designed for use in private cars and light vans, they may not receive advance warning that their planned route has height restrictions.

The offset lanes in the northbound bore mean that an incident such as a vehicle breakdown or road traffic incident may have a greater impact, as it may be more difficult for other vehicles to pass the incident, and for response vehicles to attend.

Figure 2-1 shows the proportion of Blackwall Tunnel northbound incidents by classification of their type. In the northbound direction, by far the predominant incident type is overheight vehicles, followed by vehicle breakdowns.

Figure 2-1: Classification of Blackwall Tunnel northbound incidents (full year data 2013, all time periods)



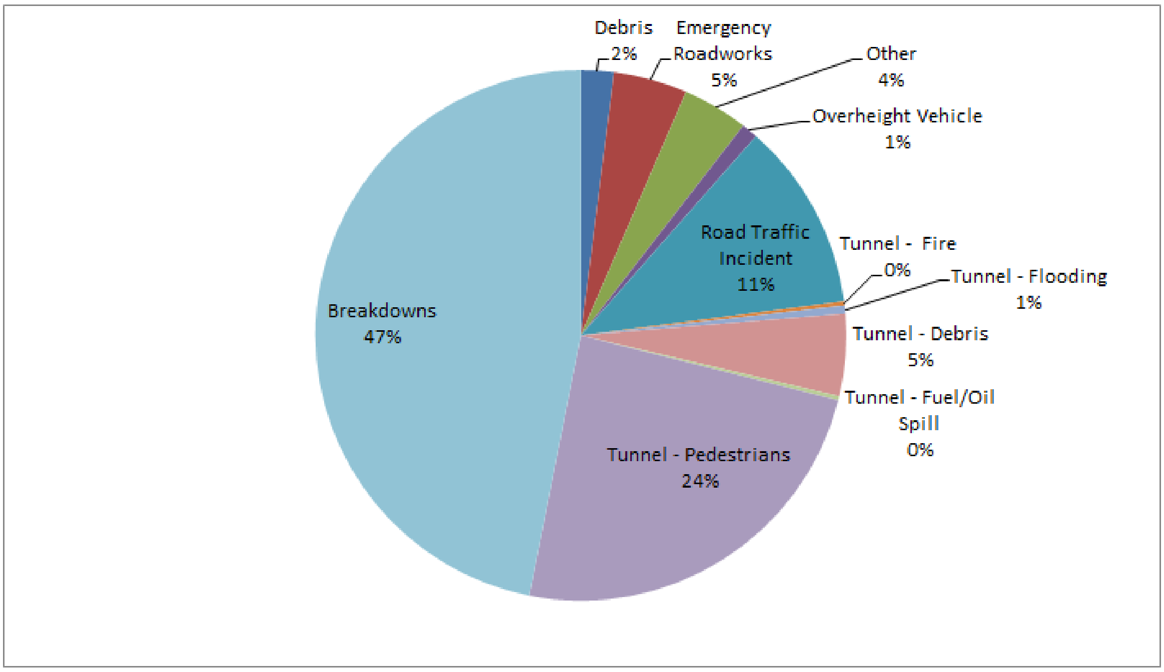
2.3 Southbound tunnel bore incidents

The southbound tunnel bore was built with a larger cross-section and has a height restriction of 4.72m which applies to both lanes. The larger cross section also enables the provision of an emergency pedestrian walkway on either side of the carriageway.

Since the southbound bore has visible pedestrian walkways, it is a more attractive option for pedestrians who ignore the restriction signs and attempt to enter the tunnel or exit their vehicles inside the tunnel.

Figure 2-2 shows the proportion of Blackwall Tunnel southbound incidents by classification of their type. Almost half of all southbound incidents are vehicle breakdowns, but there is also a surprisingly high proportion of pedestrian incidents (24%).

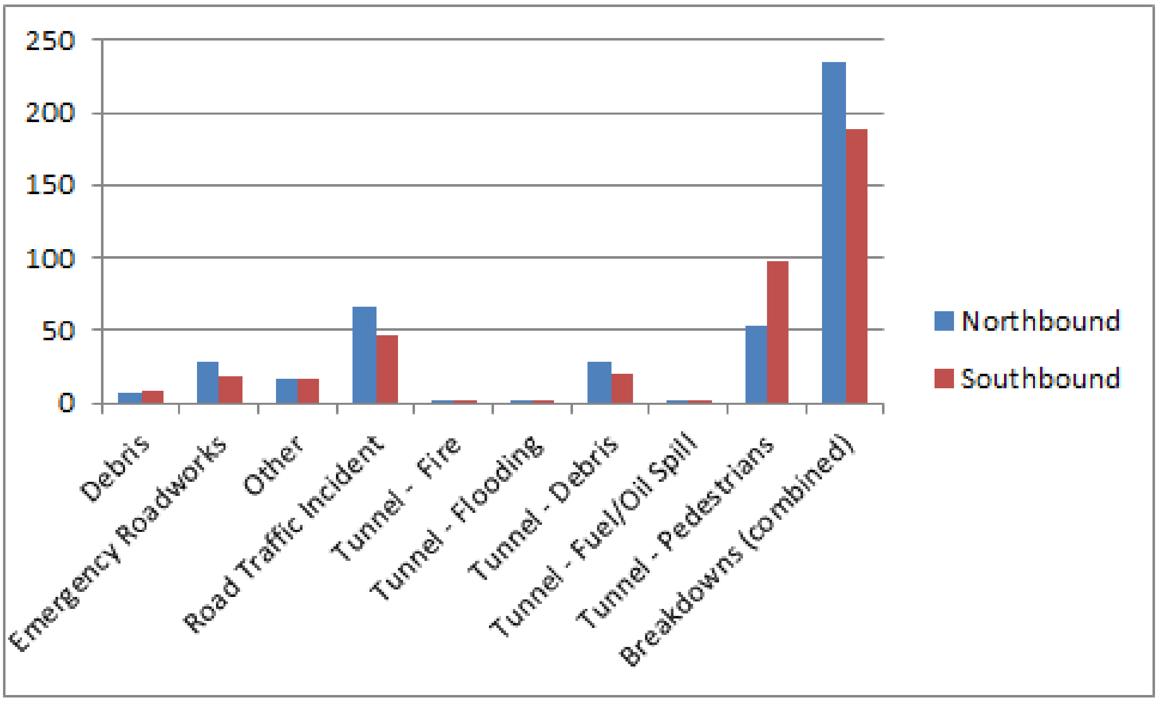
Figure 2-2: Classification of Blackwall Tunnel southbound incidents (full year data 2013, all time periods)



2.4 Comparison of incident frequency by direction

When comparing the frequency of incidents in the northbound and southbound tunnel bores, the dominance of overheight vehicle incidents in the northbound direction tends to hide the relationship between other incident types. Figure 2-3 shows the total numbers of incidents by direction excluding overheight vehicle incidents. With the exception of pedestrian incidents, the total number of the other main incident types is higher in the northbound tunnel bore than the southbound tunnel bore.

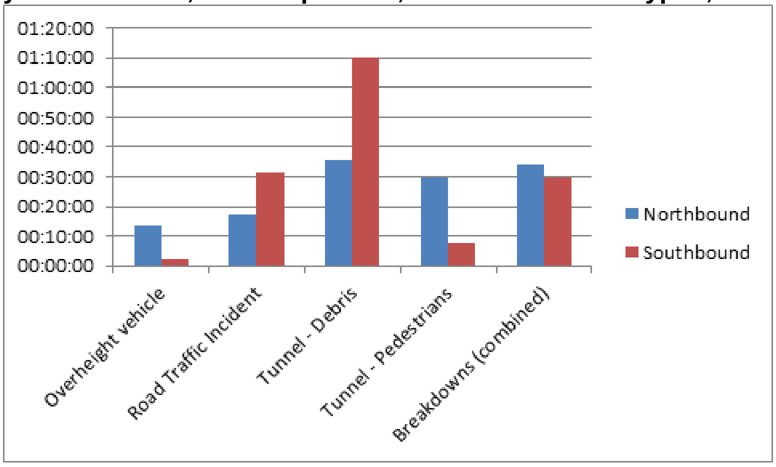
Figure 2-3: Blackwall Tunnel total annual incidents by type and direction (full year data 2013, all time periods, excluding overheight vehicles)



2.5 Comparison of incident duration by direction

The average reported duration of incidents is also observed to vary between the northbound and southbound tunnel bores. Figure 2-4 shows the average duration of incidents by direction for selected incident types where variation by direction is observed.

Figure 2-4: Blackwall Tunnel average duration of incidents by type and direction (full year data 2013, all time periods, selected incident types, hh:mm:ss)



These averages are based on the duration between the reported start and end of each incident. The dataset therefore relies on the accuracy of reporting by the staff responsible for reacting to the incidents, and more detailed examination of the associated commentaries would tend to indicate the following factors:

- There may be a time lag between evidence of extended journey times through the tunnel and the reported start of an incident;
- Some incidents are closed when the cause is identified and remedial action is instigated, even if there are ongoing impacts on journey times through the tunnel since queues take time to clear;
- Some incidents remain open until closed at the end of a shift or midnight;
- And some incidents (e.g. equipment faults) remain open until the fault is rectified, even if there is no specific impact in traffic flow.

Notwithstanding these comments, a number of points emerge from this comparison, in particular;

- The reported average duration of overheight vehicle incidents is relatively short – indicating that the well-practiced procedures for removing these vehicles from the northbound tunnel approach are generally successful.
- In some cases, the northbound average durations are less than southbound, again indicating the relative success of well-practiced procedures to cope with higher numbers of incidents.
- However, for pedestrian incidents, the average duration is significantly lower southbound.

3. QUANTIFICATION OF THE IMPACT OF BLACKWALL TUNNEL INCIDENTS IN 2013

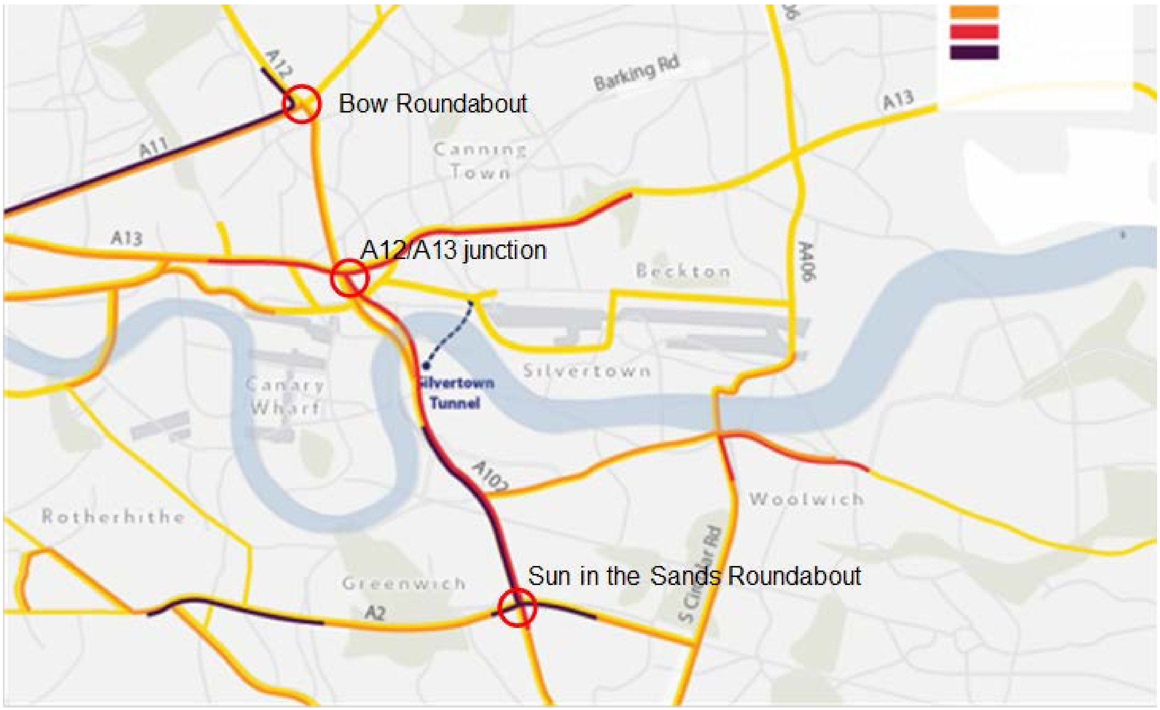
3.1 Description of journey time data

TfL has supplied the following traffic

- Northbound journey time data through the Blackwall Tunnel (link times in 5 minute slots for Northbound link 1736 between 01/08/08 and 25/06/14)

- Southbound journey time data through the Blackwall Tunnel (link times in 5 minute slots for Southbound link 1829 between 01/08/08 and 25/06/14)
- Incident data for the period between 02/05/10 and 21/06/14 (see section 2.1)
- Averaged traffic flow data in one-hour slots 01/12/2011 to 28/11/2013 inclusive

The figure below shows the northbound and southbound 'links' for which journey time data is available. The selected northbound link runs from the Sun in the Sands intersection to the Bow Roundabout intersection and includes the Blackwall Tunnel northbound tunnel bore. This is considerably longer than the southbound link, which includes a section of the tunnel approach on the A12 between the Bow Roundabout intersection and the A13 intersection, but not the tunnel itself. However this was regarded as a good proxy for journey times affected by incidents in the southbound bore.



In view of the large volume of data, analysis has been undertaken using data for the full year 2013.

3.2 Calculation of incident-free or "clean" journey times

Even when there are no reported active incidents, there are significant variations by time of day and day of the week in the 2013 dataset of observed journey times for traffic passing through the Blackwall Tunnel. These journey times are referred to as *link times* since they relate only to the journey time on the links described above and do not include any wider journey time impacts that may be caused by queuing traffic.

In order to quantify the additional impact of incidents on link times, it is therefore necessary to compare the actual link time with comparable link times when no incidents were active, i.e. a "clean" sample of journey times.

For each 5-minute period during each day of the week, the average link time has been calculated for all matching periods during the full year 2013 when no incidents (other than "congestion") were recorded as active. This gives a theoretical "clean week" profile to be used as a comparator.

Figure 3-1 shows an example of the Wednesday morning peak northbound data between the Sun in the Sands intersection and Bow roundabout. On an incident-free Wednesday morning, average journey times on this link are under 10 minutes at 06:00, increasing to a peak of 33 minutes on average at 07:35, before gradually falling to just under 15 minutes at the end of the morning peak period.

Figure 3-1: Average northbound journey time from Sun in the Sands to Bow roundabout (Wednesday, incident-free periods)

Day	Time	average link time
Wednesday	06:00:00	00:09:25
Wednesday	06:05:00	00:10:51
Wednesday	06:10:00	00:12:24
Wednesday	06:15:00	00:14:23
Wednesday	06:20:00	00:16:20
Wednesday	06:25:00	00:18:49
Wednesday	06:30:00	00:20:36
Wednesday	06:35:00	00:22:21
Wednesday	06:40:00	00:22:29
Wednesday	06:45:00	00:24:12
Wednesday	06:50:00	00:25:56
Wednesday	06:55:00	00:27:09
Wednesday	07:00:00	00:28:17
Wednesday	07:05:00	00:29:57
Wednesday	07:10:00	00:30:57
Wednesday	07:15:00	00:31:08
Wednesday	07:20:00	00:31:48
Wednesday	07:25:00	00:32:24
Wednesday	07:30:00	00:32:52
Wednesday	07:35:00	00:33:11
Wednesday	07:40:00	00:32:19
Wednesday	07:45:00	00:32:23
Wednesday	07:50:00	00:31:52
Wednesday	07:55:00	00:31:26
Wednesday	08:00:00	00:30:09
Wednesday	08:05:00	00:29:35
Wednesday	08:10:00	00:28:41
Wednesday	08:15:00	00:27:35
Wednesday	08:20:00	00:27:46
Wednesday	08:25:00	00:26:44
Wednesday	08:30:00	00:25:33
Wednesday	08:35:00	00:25:05
Wednesday	08:40:00	00:24:35
Wednesday	08:45:00	00:23:52
Wednesday	08:50:00	00:23:44
Wednesday	08:55:00	00:23:26
Wednesday	09:00:00	00:22:23
Wednesday	09:05:00	00:21:10
Wednesday	09:10:00	00:20:02
Wednesday	09:15:00	00:19:12
Wednesday	09:20:00	00:18:11
Wednesday	09:25:00	00:17:28
Wednesday	09:30:00	00:16:32
Wednesday	09:35:00	00:16:00
Wednesday	09:40:00	00:15:36
Wednesday	09:45:00	00:14:51
Wednesday	09:50:00	00:14:26
Wednesday	09:55:00	00:13:58

The link time profile for an incident typically shows a rising link time before the incident is formally opened, and in some cases there is also a continuing falling link time after the incident is closed. To reduce the extent to which the incident-free data may include related delays, the "clean week" data used also excludes two further time slots before and after the reported duration of the incident. This extends the overall "footprint" of the incident by 20 minutes.

3.3 Calculation of *excess* link times

Excess link times describe the increase in journey times through the Blackwall Tunnel that occur as a result of incidents. For each incident type, the total excess link time across the full year 2013, is calculated by comparing the actual observed link time while for all 5-minute periods that each incident was active with the average incident-free ("clean week") link time for the corresponding 5-minute periods. If the actual incident link time is less than the "clean" link time the excess is set to zero. If more than one incident is recorded as active in a single time slot, the excess time is pro-rated across all active incidents.

As described above, the duration of the incident during which excess link time is calculated is extended by two further time slots before and after the start and finish of the incident as reported in the log. The two 10-minute buffer periods are thus included in the calculation of excess link time and excluded from the "clean week" link time samples.

Total excess link time, is calculated by multiplying the matching average traffic volume by the excess link time for each time slot when an incident is recorded as active, including the two additional time slots before and after the recorded start and finish of the incident. If more than one incident is active during a time slot, the excess link time is pro-rated across active incidents.

Figure 3-1 shows the average excess link time per incident type during the full year 2013.

Figure 3.3 Average excess link times by incident type (full year data 2013, all time periods, selected incident types, in hours)

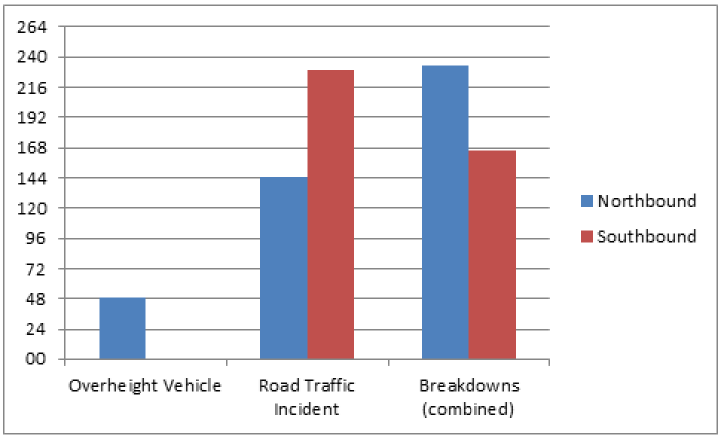


Figure 3- shows the sum of the total resulting excess link times per incident type for the full year 2013. Despite the relatively high frequency of overheight vehicle incidents, the resulting excess link time is actually less than that caused by breakdowns, where the longer recorded incident durations result in a greater total excess link times.

Figure 3.3 Average excess link times by incident type (full year data 2013, all time periods, selected incident types, in hours)

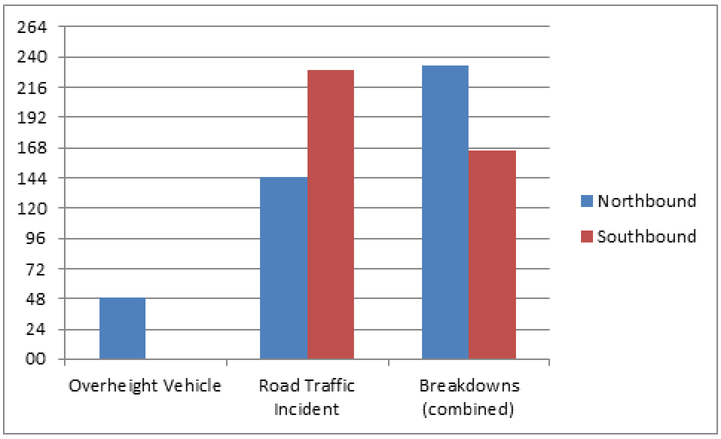
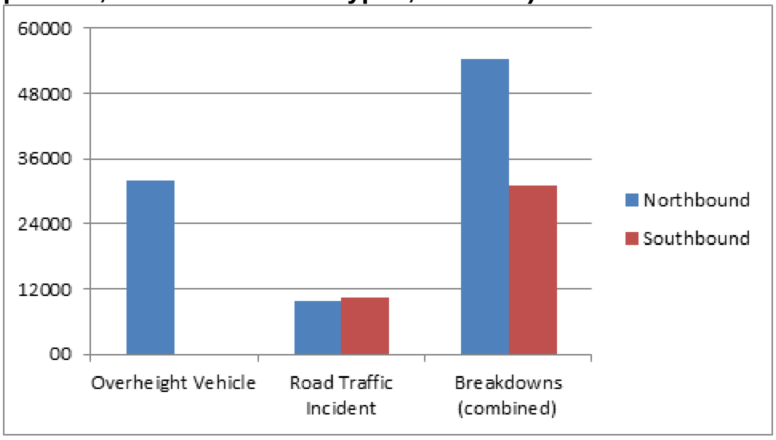


Figure 3-4: Total annual excess link times by incident type (full year data 2013, all time periods, selected incident types, in hours)



The selected incident types shown above account for the following proportion of total excess link times:

Northbound	96,100 hours	(88.85% of total excess link times)
Southbound	41,700 hours	(82.29% of total excess link times)

4. REDUCTION AND MITIGATION OF INCIDENTS WITH THE SILVERTOWN TUNNEL

4.1 Estimation of reduction and mitigation impacts

The Silvertown Tunnel would offer an opportunity to reduce the occurrence of incidents in the Blackwall Tunnel, to mitigate the impact of those incidents that do occur, and to offer a diversionary route to traffic affected by these incidents.

In order to assess the scope for possible reduction in the number of incidents and the mitigation of their impacts as a result of opening new tunnels, the base flow and incident data for 2013 has been split into three time periods as follows:

Time Period	Includes
AM peak	All 5-minute time slots Monday to Friday between 0600 and 0955 inclusive (four hours)

Time Period	Includes
PM peak	All 5-minute time slots Monday to Friday between 1600 and 1855 inclusive (three hours)
Interpeak	All remaining 5-minute time slots

It is assumed that the number of incidents is directly related to the number of vehicles passing through the tunnels, therefore for each of these time periods, the number of incidents forecast for 2021 has been pro-rated by the difference between observed 2013 and forecast 2021 traffic flows. This method has also been used to split forecast incident numbers between the existing Blackwall Tunnel bores and the new Silvertown Tunnel bores.

Within each time period, the average excess link time per incident has been calculated for:

- Overheight vehicles
- Road traffic Incidents
- Breakdowns

Reduction and mitigation effects are calculated by a combination of:

- Adjustment to the overall number of incidents
- Adjustment to the average excess link time for each incident

4.2 Reduction in the occurrence of incidents

The Silvertown Tunnel would provide a northbound crossing without the height restrictions which currently affect the Blackwall Tunnel. Provided there is an appropriate signage strategy in place to ensure that as much potentially overheight traffic as possible is directed to use the Silvertown Tunnel, it should be possible to significantly reduce the number of overheight incidents and the associated impacts.

The following assumptions have therefore been made in calculating the extent of the potential reduction:

- Overall reduction of overheight vehicle incidents currently occurring in the northbound tunnel bore.by 95%.
- No overheight vehicle incidents in the southbound tunnel bore.

The rate of occurrence of other types of incident will not necessarily change simply because some of the traffic affected is using a different crossing, and incidents are assumed to be directly related to the number of vehicles passing through the tunnels.

In practice, the northbound Blackwall Tunnel bore has a higher rate of certain types of incidents, which may be due to its geometry. However, the traffic accident data does not suggest that the collision rate in the northbound bore is significantly higher than the southbound. Further comparison of the incident and accident datasets would be required to confirm this.

4.3 Mitigation of the impacts of incidents

The Silvertown Tunnel bores will be more similar to the configuration and facilities in the more modern southbound bore of the Blackwall Tunnel, and will be built to a higher tunnel safety standard. Comparison of the incident duration data from the existing Blackwall Tunnel bores provides evidence of the different incident clearance times associated with the northbound and southbound tunnel bores and of the impact of well-organised mitigation procedures in the northbound bore (as outlined in section 2.5).

This type of mitigation is therefore defined as the reduction in impact of the incident on other traffic which continues to use the same bore. This may occur as a result of several factors relating to the geometry and facilities within the tunnel bores, including greater ability to retain one operational lane in the event of an incident or reduced clearance time due to improved access to the incident site.

For the calculation of mitigation impacts, it is assumed that the average excess link times for flows in the Silvertown Tunnel will be reduced to the levels currently observed in the Blackwall Tunnel southbound tunnel bore. This has initially been applied using a single factor based on the average excess link time for all incidents across all time periods.

4.4 Availability of diversion routes

The above mitigation calculations do not yet take into account the impact of being able to divert traffic into the second tunnel in case of incidents. Under the modelled scenario (central case) the effect of user charging means that, outside of the peak periods, traffic flows through both tunnels are forecast to remain just below the capacity of a single tunnel. This means that in the case of an incident, all traffic should be able to be diverted into the second tunnel. Note that complementary measures such as changes to signal timings on approach routes would be made operational to ensure that the capacity of the remaining tunnel can be used. As a result the excess link times of diverted vehicles should be close to those observed in incident-free periods.

During the peak periods, the ability to divert traffic away from an incident is more constrained since the combined peak direction flows exceeds the capacity of a single tunnel and the surrounding road network. There are no additional constraints on the A102 approach on the south side of the tunnels since this operates as a combined facility. However, diversions in the event of an incident will have a greater impact on the surrounding network on the north side. VISSIM micro-simulation modelling is currently being undertaken to estimate how the surrounding junctions could be optimised to accommodate increased flows through either of the tunnels in the event of an incident.

4.5 Summary of reduction and mitigation impacts

The combined effect of incident reduction and mitigation based on forecast 2021 traffic data with and without the Silvertown Tunnel is shown in Table 24. The total change in annual excess link times associated with incidents is forecast as a reduction of 38,300 hours (37%).

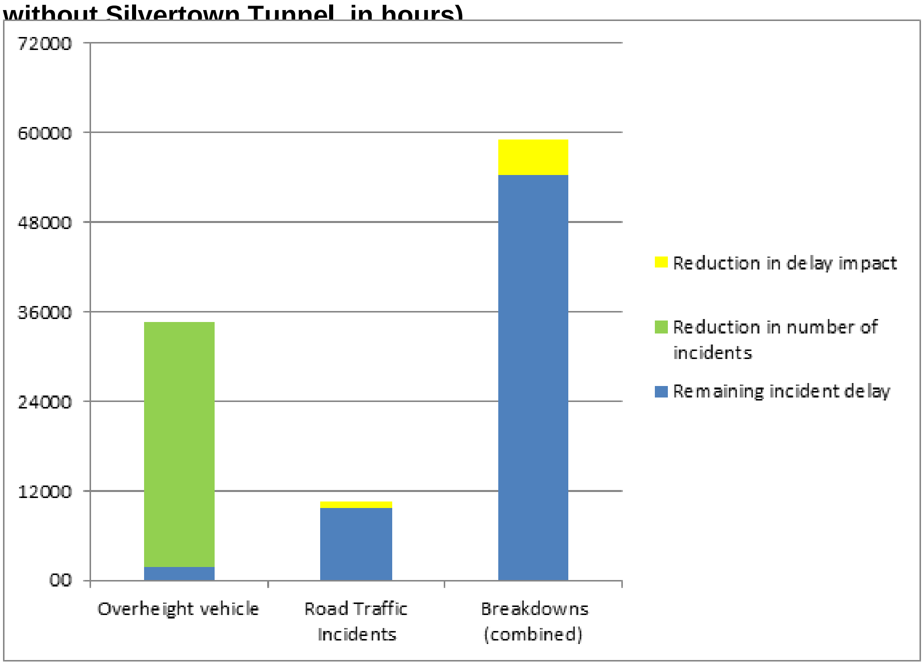
Table 24: Total annual excess link time associated with incidents (2021, with and without Silvertown Tunnel, in hours)

Incident type	Blackwall Tunnel only excess link time (hours)	With Silvertown Tunnel excess link time (hours)	Reduction
Overheight vehicle	34,600	1,700	95%
Road traffic incidents	10,500	9,700	7%
Breakdowns (combined)	59,100	54,400	8%
Total	104,200	65,900	37%

The above data is presented graphically in Figure 4-1. The height of each bar represents total annual delay time with Blackwall Tunnel only. The green and yellow sections of each bar indicate the reductions with the Silvertown Tunnel.

Based on this analysis, the total incident reduction effect for the full year 2021 results in a reduction of 32,900 hours of excess link time, which is achieved through reduction in overheight vehicle incidents. The total mitigation effect for the full year 2021 results in a reduction of 5,500 hours of excess link time, which can be achieved if average excess link times per incident in the Silvertown Tunnel fall to levels commensurate with existing times in the Blackwall Tunnel southbound bore.

Figure 4-1: Total annual excess link time associated with incidents (2021, with and without Silvertown Tunnel, in hours)



These figures do not yet include the impact of improved diversion routes. These figures only include the reduction in excess link times calculated for users of the tunnels and not for users of the wider road network affected.

5. POTENTIAL FURTHER REFINEMENT

The current methodology does not calculate the impact of improved diversion routes in the event of an incident. VISSIM micro-simulation modelling is currently being used to test operational scenarios to determine the excess link time for vehicles being diverted in an incident as compared to the excess link time in the absence of an alternative diversion route.

The current methodology only quantifies excess link times on the Blackwall Tunnel links. However, analysis of individual incidents has shown that the impacts of longer tunnel closures can stretch far over the wider road network and that it can take a long time for the road network to recover after an incident. It would theoretically be possible to extract journey time data from other links known to be affected by queues at the Blackwall Tunnel. In practice, however, expanding the network analysed would present other challenges in terms of excluding external impacts (e.g. temporary roadworks elsewhere on the network) and identifying an appropriate time lag to account for queue build-up and recovery time.

The current methodology quantifies the resilience improvements in terms of total excess link time, which can be valued using standard value of time techniques. However, this does not consider the benefit that users may derive from improved confidence in the reliability of journey times for trips they make frequently. Alternative methods to value journey time reliability therefore seek to place a user benefit value on the reduction in variability of journey times.

Appendix H – Bored versus Immersed Tube Tunnel - economic analysis

As Reported in the Needs and Options report, detailed appraisal has been undertaken on the bored and immersed tube tunnel options. The TEE tables and user benefits for both of these options are identical, as are the operating and maintenance costs, but there is a difference in the investment cost. In this respect the immersed tube tunnel is slightly lower at £611.8 (2010 prices) than the bored tunnel at £625.7m.

Bored Tunnel Appraisal

The Public Accounts and AMCB (for the bored tunnel option) were set out in section 5 and are repeated for convenience here.

Table 25: Public accounts – preferred option wider public finances

	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS and COACH	RAIL	OTHER
Local Government Funding						
Revenue	-£898,534	(7a)	-£898,534	-	-	-
Operating Costs	£279,943	(7b)	£279,943	-	-	-
Investment Costs	£625,662	(7c)	£625,662	-	-	-
Developer and Other Contributions	-		-	-	-	-
Grant/Subsidy Payments	-		-	-	-	-
NET IMPACT	£7,071		£7,071	-	-	-
Central Government Funding: Transport						
Revenue	-		-	-	-	-
Operating costs	-		-	-	-	-
Investment Costs	-		-	-	-	-
Developer and Other Contributions	-		-	-	-	-
Grant/Subsidy Payments	-		-	-	-	-
NET IMPACT	-	(8)	-	-	-	-
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£100,366	(9)	£100,366	-	-	-
TOTALS						
Broad Transport Budget	£905,605	(10) = (7b) + (7c) + (8)				
Wider Public Finances	-£798,168	(11) = (9) + (7a)				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.

All entries are discounted present values in 2010 prices and values.

Table 26: Analysis of monetised costs and benefits (including user charges)

Noise	-	(12)
Local Air Quality	-	(13)
Greenhouse Gases	£11,976	(14)
Journey Quality	-	(15)
Physical Activity	-	(16)
Accidents	-£6,556	(17)
Economic Efficiency: Consumer Users (Commuting)	£159,345	(1)
Economic Efficiency: Consumer Users (Other)	£105,073	
Economic Efficiency: Business Users and Providers	£458,255	(5)
Wider Public Finances (Indirect Taxation Revenues)	-£100,366	- (11a) - sign changed from PA table, as PA table represents costs, not benefits
Wider Public Finances (Public sector operator revenue)	£898,534	(11b)
Present Value of Benefits (see notes) (PVB)	£1,526,260	(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1) + (5) - (11)
Broad Transport Budget	£905,643	(10)
Present Value of Costs (see notes) (PVC)	£905,643	(PVC) = (10)
OVERALL IMPACTS		
Net Present Value (NPV)	£620,617	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	1.69	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Immersed Tunnel Appraisal

The Public Accounts and AMCB tables for the Immersed Tunnel option are shown in Table 27 and Table 28 below - the only input change to the tables is the replacement of the bored tunnel investment cost of £625.7m with the immersed tube tunnel cost of £611.8. The resultant outcome is a slightly higher NPV (£635m compared to £621m for the bored tunnel). The NPV increases slightly as a result from 1.69 (bored tunnel) to 1.71 (immersed tunnel).

Table 27: Immersed Tunnel – Public Accounts

	ALL MODES TOTAL		ROAD INFRASTRUCTURE	BUS and COACH	RAIL	OTHER
Local Government Funding						
Revenue	-£898,534		-£898,534	-	-	-
Operating Costs	£279,943		£279,943	-	-	-
Investment Costs	£611,755		£611,755	-	-	-
Developer and Other Contributions	-		-	-	-	-
Grant/Subsidy Payments	-		-	-	-	-
NET IMPACT	-£6,836	*(7)*	-£6,836	-	-	-
Central Government Funding: Transport						
Revenue	-		-	-	-	-
Operating costs	-		-	-	-	-
Investment Costs	-		-	-	-	-
Developer and Other Contributions	-		-	-	-	-
Grant/Subsidy Payments	-		-	-	-	-
NET IMPACT	-	*(8)*	-	-	-	-
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£ 100,366	*(9)*	£ 100,366	-	-	-
TOTALS						
Broad Transport Budget	£ 891,698	*(10) = (7) + (8)*				
Wider Public Finances	-£ 798,168	*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.

All entries are discounted present values in 2010 prices and values.

Table 28: Immersed Tunnel – AMCB

Noise	-	*(12)*
Local Air Quality	-	*(13)*
Greenhouse Gases	£11,976	*(14)*
Journey Quality	-	*(15)*
Physical Activity	-	*(16)*
Accidents	-£6,556	*(17)*
Economic Efficiency: Consumer Users (Commuting)	£159,345	*(1)*
Economic Efficiency: Consumer Users (Other)	£105,073	
Economic Efficiency: Business Users and Providers	£458,255	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-£100,366	*- (11a) - sign changed from PA table, as PA table represents costs, not benefits*
Wider Public Finances (Public sector operator revenue)	£898,534	*(11b)*
Present Value of Benefits (see notes) (PVB)	£1,526,260	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1) + (5) - (11)*
Broad Transport Budget	£891,698	*(10)*
Present Value of Costs (see notes) (PVC)	£891,698	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	£634,562	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	1.71	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Comparing the key economic values for the two options shows that they are very close to each other. The values are given in Table 29.

Table 29: Key transport economic values £m

Economic Measure	Bored Tunnel	Immersed Tunnel
Present Value of Benefits	£1,526.3	£1,526.3
Present Value of Costs	£905.6	£891.7
Net Present Value	£620.6	£634.6
Benefit Cost Ratio	1.69	1.71

Table 29 shows that the Immersed Tunnel offers a very slightly better economic proposition than does the Bored Tunnel. However, it would be inadvisable to make the choice of tunnel construction method solely on the evidence presented in this report. While the effect of the tunnels, once constructed, is very similar to one another – hence the benefits amount to the same value, the Immersed Tunnel has a far greater impact upon the river during construction than would the Bored Tunnel whose impact would be minimal. These river impacts, both on river traffic and the environment have not been quantified and monetised, but do need to be considered in the equation.