SILVERTOWN TUNNEL

SUPPORTING TECHNICAL DOCUMENTATION

PRELIMINARY ECONOMIC ASSESSMENT REPORT

October 2015

This report details the analysis undertaken for the economic case. This forms part of the Preliminary Outline Business Case (OBC). It sets out the technical economic assessment of the user benefits and dis-benefits.

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This report forms part of a suite of documents that support the statutory public consultation for Silvertown Tunnel in October – November 2015. This document should be read in conjunction with other documents in the suite that provide evidential inputs and/or rely on outputs or findings.

The suite of documents with brief descriptions is listed below:-

- **Preliminary Case for the Scheme**
    - Preliminary Monitoring and Mitigation Strategy
- **Preliminary Charging Report**
- **Preliminary Transport Assessment**
- **Preliminary Design and Access Statement**
- **Preliminary Engineering Report**
- **Preliminary Maps, Plans and Drawings**
- **Preliminary Environmental Information Report (PEIR)**
    - Preliminary Non Technical Summary
    - Preliminary Code of Construction Practice
    - Preliminary Site Waste Management Plan
    - Preliminary Energy Statement
- **Preliminary Sustainability Statement**
- **Preliminary Equality Impact Assessment**
- **Preliminary Health Impact Assessment**
- **Preliminary Outline Business Case**
    - Preliminary Distributional Impacts Appraisal
    - Preliminary Social Impacts Appraisal
    - Preliminary Economic Assessment Report
    - Preliminary Regeneration and Development Impact Assessment

SILVERTOWN TUNNEL

Preliminary Economic Assessment Report

October 2015

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Silvertown Tunnel

Preliminary Economic Assessment Report

Planning Act 2008

Infrastructure Planning

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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List of Abbreviations

Abbreviation	Full Name
A	
AADT	Average Annual Daily Traffic
AAWT	Average Annual Weekly Traffic
AMCB	Analysis of Monetised Costs and Benefits
ATC	Automated Traffic Counts
B	
BCR	Benefit to Cost Ratio
BNL	Basic Noise Level
C	
CAZ	Central Activities Zone
CBA	Cost Benefit Analysis
CC	Congestion Charging
CCTV	Closed Circuit Television
COBA-LT	Cost and Benefit to Accidents - Light Touch
CS	Construction Statement
CTMP	Construction Traffic Management Plan
D	
DBFM	Design Build Finance and Maintain
DCO	Development Consent Order
DEFRA	Department for Environmental, Food and Rural Affairs
DfT	Department for Transport
DI	Distributional Impacts
DLR	Docklands Light Railway
DMRB	Design Manual for Roads and Bridges
E	
EA	Environment Agency
EAR	Economic Assessment Report
EFT	Emissions Factors Toolkit
EHO	Environmental Health Officer
EIA	Environmental Impact Assessment

EIS	Environmental Impact Statement
ELHAM	East London Highway Assignment Model
ES	Environmental Statement
EWT	Excess Wait Time
F	
FALP	Further Alterations to the London Plan
G	
GC	Generalised Costs
GDP	Gross Domestic Product
GDPW	Gross Domestic Product per Worker
GHG	Greenhouse Gases
GIGL	Greenspace Information for Greater London
GJT	Generalised Journey Time
GLA	Greater London Authority
GVA	Gross Value Added
I	
IHS	Integrated Household Survey
IoD	Index of Deprivation
IoMD	Index of Multiple Deprivation
IWT	In Work Time
L	
LAD	Local Authority District
LB	London Borough
LCAP	London Congestion Analysis Project
LDF	Local Development Framework
LEZ	Low Emission Zone
LGV	Light Goods Vehicle
LIP	Local Implementation Plan
LMVR	Local Model Validation Report
LOPR	London Office Policy Review
LoRDM	London Regional Demand Model
LP	London Plan
LSOA	Lower Super Output Area
LTDS	London Travel Demand Survey
LTS	London Transportation Studies

M	
MCC	Manual Classified Counts
MEDS	Mayor's Economic Development Strategy
MTS	Mayor's Transport Strategy
N	
NMU	Non-Motorised Users
NN NPS	National Networks National Policy Statement
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NPV	Net Present Value
NSIP	Nationally Significant Infrastructure Project
NTEM	National Trip End Model
O	
OBC	Outline Business Case
ONS	Office for National Statistics
OWT	Out of Work Time
P	
PA	Public Accounts
PCU	Passenger Car Unit
PINS	Planning Inspectorate
PLA	Port of London Authority
PPG	Planning Policy Guidance
PPS	Planning Policy Statement
PTAL	Public Transport Access Level
PT	Public Transport
PV	Present Value
PVB	Present Value of Benefits
PVC	Present Value of Costs
Q	
QUADRO	Queues and Delays at Road Works
R	
RA	Regeneration Area

RB	Royal Borough
RODS	Rolling Origin and Destination Survey
RR	Regeneration Report
RSI	Road Side Interview
RSM	Road Space Management
RTF	Road Task Force
RTI	Road Traffic Incident
RXHAM	River Crossings Highway Assignment Model
S	
SACTRA	Standing Advisory Committee on Trunk Road Assessment
SATURN	Simulation and Assignment of Traffic to Urban Road Networks
SHLAA	Strategic Housing Land Availability Assessment
SoS	Secretary of State
SPD	Supplementary Planning Document
SPG	Supplementary Planning Guidance
SRTP	Sub-Regional Transport Policy
T	
TA	Transport Assessment
TAG	Transport Analysis Guidance
TEE	Transport Economic Efficiency
TfL	Transport for London
TLRN	Transport for London Road Network
TUBA	Transport User Benefit Appraisal
V	
VfM	Value for Money
VOC	Vehicle Operating Cost
VCR	Volume/Capacity Ratios
W	
WI	Wider Impacts

Glossary of Terms

Term	Explanation
Assessed Case	The basis on which all assessment and modelling has been carried out
Blackwall Tunnel	A road tunnel underneath the River Thames in east London, linking the London Borough of Tower Hamlets with the Royal Borough of Greenwich, comprising two bores each with two lanes of traffic. The tunnel was originally opened as a single bore in 1897, as a major transport project to improve commerce and trade in London's east end. By the 1930s, capacity was becoming inadequate, and consequently, a second bore opened in 1967, handling southbound traffic while the earlier 19th century tunnel handled northbound.
Bus Gate	Bus gates are traffic signals often provided within bus priority schemes to assist buses and other permitted traffic when leaving a bus lane to enter or cross the general flow of traffic or to meter the flow of general traffic as it enters the road link downstream of the bus lane. Depending on their purpose, bus gates can be located remote from other signals or they can be positioned immediately upstream of a signal controlled junction, as a bus pre-signal.
Contractor	Anyone who directly employs or engages construction workers or manages construction work. Contractors include sub-contractors, any individual self-employed worker or business that carries out, manages or controls construction work
Control Centre	Facility to deal with issues with over-height, illegal and unsafe vehicles going through Blackwall and Silvertown tunnels, and help manage traffic
Design, Build, Finance and Maintain (DBFM)	A DBFM company is typically a consortium of private sector companies, formed for the specific purpose of providing the services under the DBFM contract. This is also technically known as a Special Purpose Vehicle (SPV).

Term	Explanation
	The DBFM Company will obtain funding to design and build the new facilities and then undertake routine maintenance and capital replacement during the contract period, which is typically 25 to 30 years. The DBFO Company will repay funders from payments received from TfL during the lifespan of the contract. Receipt of payments from TfL will depend on the ability of the DBFO Company to deliver the services in accordance with the output specified in the contract and will be subject to deductions if performance is not satisfactory.
Department for Transport (DfT)	The government department responsible for the English transport network and a limited number of transport matters in Scotland, Wales and Northern Ireland that have not been devolved.
Detailed Design	Design that delivers the required outcomes and is used as the basis of a contract for delivery of the physical outputs
Development Consent Order (DCO)	This is a statutory order which provides consent for the project and means that a range of other consents, such as planning permission and listed building consent, will not be required. A DCO can also include provisions authorising the compulsory acquisition of land or of interests in or rights over land which is the subject of an application. http://infrastructure.planninginspectorate.gov.uk/help/glossary-of-terms/
Docklands Light Railway (DLR)	An automated light metro system serving the Docklands and east London area. The DLR is operated under concession awarded by Transport for London to KeolisAmey Docklands, a joint venture between transport operator Keolis and infrastructure specialists Amey plc

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 Economic Assessment Report (EAR) sets out the work undertaken on the 'economic case'. The 'economic case' is one of the elements of the five-case model for developing transport business cases and forms part of the Silvertown Tunnel Preliminary Outline Business Case (OBC)[1].

2. The EAR details the analyses undertaken for the economic case. It deals only with the technical economic assessment of the user benefits and disbenefits – other topics such as social and distributional impacts, and regeneration impacts are covered separately in other reports and are summarised in the OBC.

3. Evidence has been assembled from several sources. The impact upon users of the transport system has been derived from transport modelling and other analytical work. The cost estimates of construction and operation of the Silvertown Tunnel have been sourced from TfL's commercial finance model.

4. The appraisal period used for the assessment has been the standard assumed in Department for Transport's (DfT) Transport Analysis Guidance (TAG) for major highway infrastructure projects of 60 years. The impact and cost data have been provided as inputs to the DfT's TUBA (Transport User Benefit Analysis) version 1.9.5 which provides monetised values of the Scheme's costs and benefits. Accident changes have been analysed using the DfT's Cost and Benefits to Accidents – Light Touch (COBA-LT) software and disbenefits during construction using Queues And Delays at ROadworks (QUADRO) software. In addition separate TAG-based analyses have been undertaken of bus, coach, incident time savings and journey time variability benefits.

5. This EAR supersedes the initial EAR (TfL, 2014[2]) published as part of the preceding consultation on the Silvertown Tunnel in October 2014. There have been a number of changes to the economic assessment since this time, in particular an updated and revised traffic model, a new version of TUBA and changes to the Scheme itself.

[1] Silvertown Tunnel Preliminary Outline Business Case, TfL, September 2015

[2] River Crossings Package: Silvertown Tunnel Economic Assessment Report, TfL, September 2014

Options considered

6. TfL has considered a broad range of cross-river transport options at the Blackwall Tunnel in two broad categories[3] :

- Options which focus on reducing the level of cross-river highway demand, sometimes through the provision of enhanced alternatives (including walking and cycling measures and public transport improvements) and sometimes through direct demand management (such as road user charging).
- The provision of new highway infrastructure capacity and/or connections.

7. TfL concluded that blended solutions, combining the effective aspects of highway enhancements and demand management represent the only effective solutions to the problems of the Blackwall Tunnel. An additional consideration here is the need to assure benefits in the longer-term, which a charge would enable. With this outcome in mind, a highway crossing with a user charge has emerged as the best strategic option.

Economic results and conclusions

8. The economic analysis has been summarised in three key economic results:

- 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 the public sector is included in this output; and
- 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.

9. The results shown follow TAG advice and show both an ‘initial’ assessment and an ‘adjusted’ assessment, the latter including additional reliability benefits, and values shown are in 2010 prices.

[3] See Silvertown Tunnel Preliminary Case for the Scheme, TfL, September 2015

10. The three key economic results for the Silvertown Tunnel Scheme are given in Table 0-1 based on the level of assessed charge (as set out in the charging report)[4]. Under this assumption, the Scheme has a positive Net Present Value of £976m (without reliability benefits) and £1,273m (with reliability benefits) over 60 years – it is therefore a scheme with a very positive economic outcome.

Table 0-1: Summary economic results (£m, 2010 prices)

Economic measure	Initial (without reliability benefits), £m	Adjusted for reliability benefits, £m
Present value of benefits (PVB)	£971.1	£1,268.4
Present value of costs (PVC)[5]	-£4.7	-£4.7
Net present value (PVB-PVC)	£975.7	£1,273.1

11. Within the overall summary, the main impact by user or provider groups is shown in Table 0-2 and Table 0-3 (the latter includes the additional reliability benefits for road users).

12. Both tables show in the second column that all user classes (commuting, business and other trips) have positive net benefits (benefits less charges) over the 60 year appraisal – in total this amounts to £1,069m net benefit (£1,367m with reliability benefits added)[6].

13. Including reliability, there are expected to be high net user benefits for all vehicle types apart from Heavy Goods Vehicles (HGVs). HGVs will have user time and vehicle operating benefits, but these are outweighed by the relevant user charges.

[4] See Silvertown Tunnel Preliminary Charging Report, TfL, September 2015

[5] A negative cost means a surplus of revenue over costs, in this case due to revenue from the crossing charge

[6] It should be noted that the figures presented in Tables 1-2 and 1-3 are different from those represented in Table 1-1, as the latter also includes monetary valuation of greenhouse gases, air quality and noise, accidents savings and indirect taxation in addition to the elements included in Table 1-2 and Table 1-3.

14. It should be noted that TfL proposes to vary the charge by vehicle type to reflect the amount of road space occupied, the contribution to congestion, the emissions and the wear and tear to the road surface caused by different types of vehicles. Consequently HGV's pay the highest charges, and this impacts their net user benefits. There are also indications that the value placed in the current appraisal on reliability of goods vehicles is an underestimate – for example the Freight Transport Association (FTA) calculated that each minute of delay related to unreliability costs an operator £1; a delay of 20 minutes at the Blackwall Tunnel could therefore, add £20 to the cost of an individual trip, considerably more than the value currently placed on this impact.

Table 0-2: Summary economic results (initial) by users (£m, 2010 prices)

User Class	All modes	Cars	LGVs	HGVs	Coach	Bus
Commuting	258.6	11.0	0.0	0.0	119.7	128.0
Other	473.6	70.8	0.0	0.0	0.0	402.8
Business	336.9	446.8	-39.9	-129.9	0.0	59.9
Total	1,069.2	528.6	-39.9	-129.9	119.7	590.8

Table 0-3: Summary economic results (adjusted for reliability) by users (£m, 2010 prices)

User Class	All modes	Cars	LGVs	HGVs	Coach	Bus
Commuting	291.5	43.8	0.0	0.0	119.7	128.0
Other	556.3	153.5	0.0	0.0	0.0	402.8
Business	518.8	539.2	26.4	-106.8	0.0	59.9
Total	1,366.5	736.5	26.4	-106.8	119.7	590.8

15. A sensitivity test was also carried out using the London Value of Time based on the recommended values in the TfL Business Case Development Manual. To indicate the potential impact (pending further modelling of this), simple VoT uplift factors of 39.1% and 29.3% were applied to travel time benefits and any disbenefits, with all other assumptions remaining the same. The net user benefits results are shown below Table 1-4 (initial) and Table 1-5 (adjusted for reliability). These show a significant uplift in estimated user benefits (some 32-33%) and in net user benefits (59-66%).

Table 1-4: Summary economic results (initial) by users (£m, 2010 prices, London VoT)

User Class	All modes	Cars	LGVs	HGVs	Coach	Bus
Commuting	£374.4	£54.2	£0.0	£0.0	£154.7	£165.5
Other	£687.4	£166.5	£0.0	£0.0	£0.0	£520.9
Business	£712.2	£663.4	£67.8	-£102.3	£0.0	£83.4
Total	£1,774.0	£884.2	£67.8	-£102.3	£154.7	£769.7

Table 0-5: Summary economic results (adjusted for reliability) by users (£m, 2010 prices, London VoT)

User Class	All modes	Cars	LGVs	HGVs	Coach	Bus
Commuting	£416.9	£96.7	£0.0	£0.0	£154.7	£165.5
Other	£794.3	£273.4	£0.0	£0.0	£0.0	£520.9
Business	£965.1	£792.0	£159.9	-£70.1	£0.0	£83.4
Total	£2,176.3	£1,162.1	£159.9	-£70.1	£154.7	£769.7

Conclusions

16. An economic case has been developed using TAG principles. This shows that the Silvertown Tunnel Scheme:

- has a very positive economic outcome in terms of an NPV of £976m to £1,273m (the latter when reliability benefits are included) over 60 years;
- all but the HGV user class experience net benefits (time and vehicle operating cost benefits less user charges); HGV's show a net disbenefit, due to the higher charge for these vehicles, however the reliability benefits attributed to them are likely to be underestimated;
- a sensitivity test using TfL-recommended London values of time for appraisal shows even higher benefits;

- the estimated total benefit per pound of capital expenditure for the scheme is £1.8 (initial) and £2.3 (adjusted for reliability), supporting the conclusion of a very positive economic outcome;
- in line with the Mayor’s objectives, the Scheme supports sustainable movement, as a significant proportion of the user benefits come from bus and coach passengers; and
- in line with scheme objectives the Scheme significantly reduces congestion and improves reliability.

1. INTRODUCTION

1.1 Purpose of report

1.1.1 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.

1.1.2 In this report the economic appraisal process for the Silvertown Tunnel project is discussed. Many of the effects of the Scheme have been monetised according to DfT TAG Guidance[7] 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 monetised benefit and cost streams of the 'With Scheme' (the Assessed Case)[8] scenario were compared to those 'Without Scheme' (Do Minimum) to give an indication of both the absolute and relative value of the Scheme.

1.1.3 This report:

- summarises the transport modelling process used;
- details the data and assumptions used;
- 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.

1.1.4 This EAR supersedes the initial EAR (TfL, 2014) published as part of the October 2014 consultation. There have been a number of changes to the economic assessment since then, in particular an updated and revised traffic model, a new version of TUBA, changes to the Scheme itself and more detailed analysis of certain aspects.

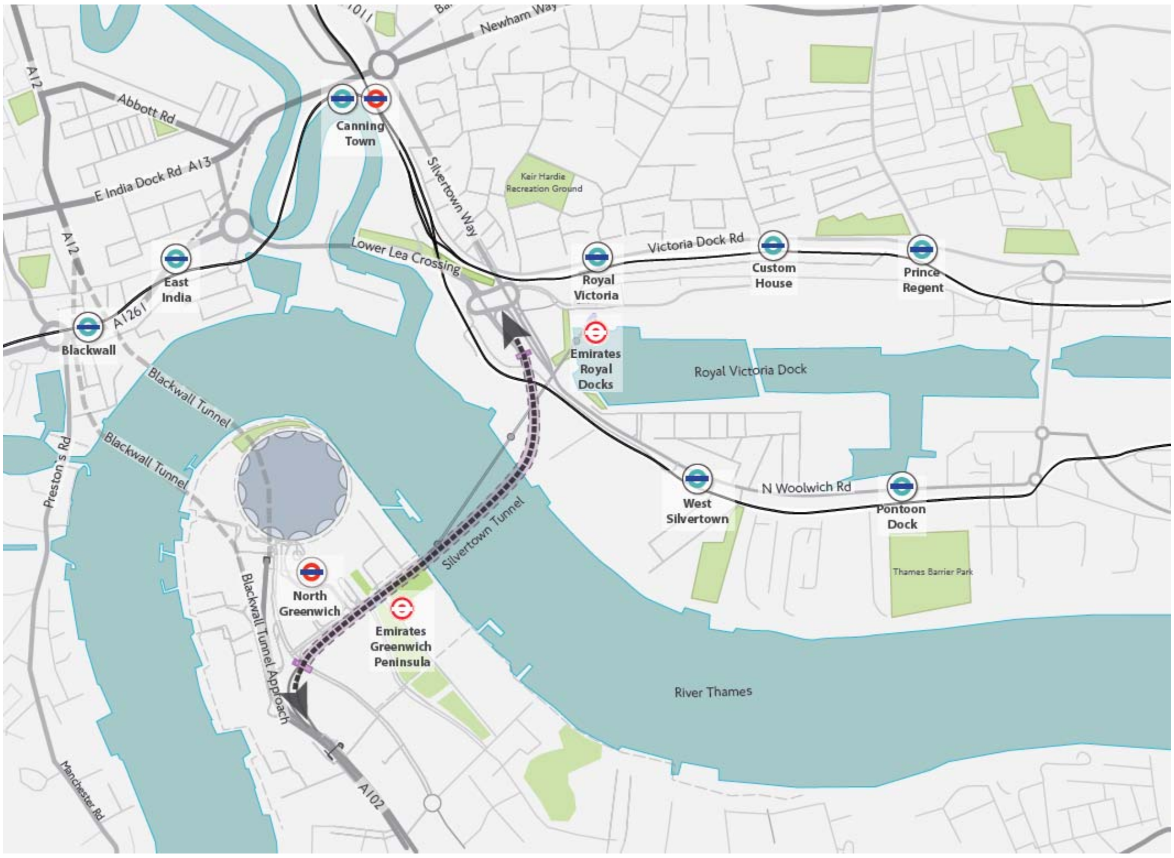
[7] TAG Unit A1.1 Cost-Benefit Analysis, DfT, January 2014

[8] The Assessed Case represents a ‘Do Something’ scenario with the Scheme in place

1.2 Scheme Description and Objectives

1.2.1 Transport for London (TfL) is proposing to construct a new highway tunnel under the River Thames between the Greenwich Peninsula and Silvertown ('the Silvertown Tunnel') – see Figure 1.1.

Figure 1.1: Location plan of Silvertown Tunnel



1.2.2 The Scheme – known as the Silvertown Tunnel – would comprise a new dual two-lane connection between the A102 Blackwall Tunnel Approach on the Greenwich Peninsula (London Borough of Greenwich) and the Tidal Basin roundabout junction on the A1020 Lower Lea Crossing/Silvertown Way (London Borough of Newham) by means of twin tunnel bores under the River Thames and associated approach roads. The Silvertown Tunnel would be approximately 1.4km long. The Boord Street footbridge over the A102 would be replaced with a pedestrian and cycle bridge.

1.2.3 New portal buildings would be located close to each portal to house the plant and equipment necessary to operate the tunnel, including ventilation equipment.

1.2.4 The introduction of free-flow user charging on both the Blackwall and Silvertown Tunnels would play a fundamental part in managing traffic demand. It would also support the financing of the construction and operation of the Silvertown Tunnel.

1.2.5 Main construction works would likely commence in 2018 and would last approximately four years with the new tunnel opening in 2022/23.

1.2.6 The Silvertown Tunnel scheme will create opportunities for new cross-river bus services to improve public transport links between south-east and east London, notably the growing employment areas in the Royal Docks and Canary Wharf. The Silvertown Tunnel is designed to accommodate double-deck buses, thus providing operational flexibility in the bus routes that could be extended across the Thames, as well as greater capacity.

1.2.7 It is currently proposed that one lane in each direction will be reserved for buses and Heavy Goods Vehicles (HGVs) through the tunnel bores which will further enhance reliability and reduce bus journey times. This configuration has the potential, over time, to deliver in excess of 60 buses per hour in each direction

1.2.8 However, since the Silvertown Tunnel has an assumed opening date of 2022/23, any plans for the bus network at this time can only be indicative and for the purpose of assessing operational feasibility. Services would be finalised around two years before opening, but TfL has identified two potential new services and enhancements to four existing services (predominantly through cross-river extensions).

1.3 Scheme objectives

1.3.1 Scheme objectives were identified with reference to the need for the scheme summarised in the Preliminary Transport Assessment[9] (TA) and the Preliminary Case for the Scheme[10] and also draw from the National Policy Statement for National Networks, Mayoral policy as defined in the London Plan and Mayor's Transport Strategy (MTS), and scheme development work undertaken to-date. The following scheme objectives have been adopted:

- 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;

[9] Silvertown Tunnel Preliminary Transport Assessment, TfL, September 2015

[10] Silvertown Tunnel Preliminary Case for the Scheme, TfL, September 2015

- PO3: to support economic and population growth, in particular in east and southeast London by providing improved cross-river transport links;
- PO4: to integrate with local and strategic land use policies;
- PO5: to minimise any adverse impacts of any proposals on communities, health, safety and the environment;
- PO6: to ensure where possible that any proposals are acceptable in principle to key stakeholders, including affected boroughs; and
- PO7: to achieve value for money and, through road user charging, to manage congestion.

1.4 Summary of Scheme Impacts[11]

1.4.1 The principal effect of the Silvertown Tunnel scheme is expected to be a significant improvement in the efficiency of traffic movement on the A102 corridor, where congestion would be almost eliminated, with a small decrease in levels of demand on this corridor. The scheme is anticipated to have modest displacement effects.

1.4.2 The other significant effect of the scheme would be to reduce the frequency and impact of closures of the Blackwall Tunnel, greatly reducing disruption and helping to provide more reliable journey times.

1.4.3 The scheme would enable the provision of a network of cross-river bus services (currently rendered impractical by the constraints imposed by the Blackwall Tunnel), and have resultant benefits for public transport users.

1.4.4 The pedestrian and cycle improvements being put forward by TfL, together with the high standards of urban design integration being sought, would enable all types of traveller to benefit from the scheme.

1.5 Structure of this report

1.5.1 The remainder of the report is structured as follows:

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

[11] See Silvertown Tunnel Preliminary Transport Assessment, TfL, September 2015

2. ECONOMIC ASSESSMENT APPROACH

2.1 Introduction

2.1.1 The economic assessment is based on the outputs of various transport models which predict the movement of people and vehicles in the 'Do Minimum' (also refered as the 'Reference Case') and Assessed Case scenarios based on a range of standard parameters.

2.2 Transport model used

2.2.1 The transport data used in the economic assessment of the Silvertown Tunnel Scheme was derived from the London Regional Demand Model (LoRDM). LoRDM uses population and employment figures (as contained in the Further Alterations to the Mayor's 2009 London Plan) as well as assumptions from Government on economic parameters to estimate overall travel demand on both the public transport and the highway network. The model also estimates travel patterns and the mode of travel for trips in the study area. LoRDM incorporates TfL's River Crossings Highway Assignment Model (RXHAM) and Railplan (public transport model) in order to estimate the level of service for the roads and public transport which result from the LoRDM travel demand estimates. This process of running an integrated set of models ensures that travel demand and network conditions are consistent within the model estimates.

2.2.2 The River Crossings Highway Assignment Model (RXHAM) predicts the routes that drivers choose and the associated congestion and delay impacts on London's roads.

2.2.3 The Railplan public transport assignment model is a public transport model that predicts the public transport mode (e.g. rail, underground, bus) and route that a person chooses to get to their destination, as well as the associated crowding impacts.

2.2.4 The LoRDM modelling suite is strategic in nature and is used to identify broad changes in travel patterns across the highway and public transport network, as well as the magnitude of this change. Further, estimates of walk and cycle trips are more approximate due the strategic nature of the models. For more detailed assessment of key junctions, other tools such as microsimulation models are more appropriate. Such tools are used in this project to assess junction operation where required.

2.2.5 The models do not yet assume (as part of the Assessed Case) any mitigation measures that might be introduced such as changes to junction capacities or new traffic calming measures. The model results also do not include any land use changes that could occur as a result of changes in travel connectivity. 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.

2.2.6 Further detail on the transport models is provided in a set of more technical model development reports.

2.2.7 The Railplan public transport model represents average conditions for three key time periods during a term-time weekday. The periods are:

- morning (AM) peak (07:00−10:00);
- inter peak (IP) (10:00−16:00); and
- afternoon (PM) peak (16:00−19:00).

2.2.8 Demand in Railplan is not split by trip purpose. The decision was therefore taken to use uniform split factors (i.e. a single value applied to the entire matrix) to segment demand into In work trips and Out of work trips needed for economic analysis.

2.2.9 The River Crossings Highway Assignment Models (RXHAM) model has been developed using industry-standard SATURN strategic highway traffic modelling software to assess the impact of new river crossings on highway network performance in the wider East/South-East London area. The model was based on TfL’s existing sub-regional East London Highway Assignment Model (ELHAM), with amendments made to enhance the calibration of the network in the vicinity of river crossings.

2.2.10 The RXHAM 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; and
- afternoon (PM) peak hour (17:00-18:00).

2.2.11 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.[12]

2.2.12 The model forecast years were 2021 (assumed Silvertown Tunnel opening year), 2031 (intermediate year) and 2041 (design year).[13]

2.3 Appraisal Period and opening year

2.3.1 TAG recommends a 60 year appraisal for projects that are deemed to have an 'Indefinite Life', such as tunnels and bridges, and this was the appraisal period used.

2.4 Modelled scenarios

2.4.1 The options modelled for the Silvertown Tunnel are shown in Table 2-1. The core tests were a Do Minimum scenario and an Assessed Case scenario for three assessment years- for all tests the Woolwich Ferry has been assumed to continue to operate as at present.

2.4.2 The 'Do Minimum' scenario comprised the existing road network with any committed improvements. The 'Assessed Case' 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, and associated assumed bus service improvements.

2.4.3 Sensitivity tests have been carried out by varying key inputs to determine the effect on the NPV, and 'no growth' and London Value of Time tests were also carried out.

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[12] Buses are not part of the standard highway assignment process but their impact on road capacity is taken account of in the highway assignment model. Bus user benefits have been modelled in Railplan.

[13] While the actual Scheme opening year is likely to be 2022, the 2021 model year is the closest year to scheme opening, and advice in TUBA (TUBA FAQ) is that if Scheme opening is only 1 or 2 years after the first modelled year then the modelled year data can be used to represent the Scheme opening year.

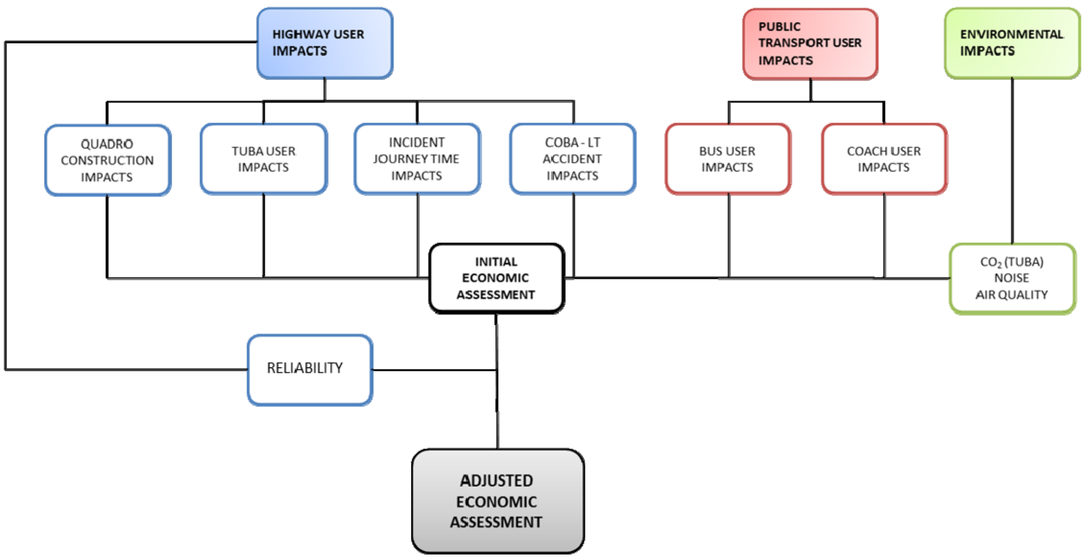
Table 2-1: Silvertown Tunnel options modelled

Scheme scenario	**Detail**
Do minimum	2021, 2031 and 2041
Assessed Case	2021, 2031 and 2041. With Silvertown Tunnel and Blackwall Tunnel both charged. New bus services using the tunnels have also been modelled.

2.5 Economic assessment process

2.5.1 The Economic Assessment has been carried out using standard procedures and economic parameters as defined by TAG Unit A1. The components that make up the assessment are shown in Figure 2.1: Economic assessment components

Figure 2.1: Economic assessment components



2.5.2 The following elements of the economic assessment have been considered:

- road user journey impacts - due to changes in travel time and vehicle operating cost and user charges;
- road user safety impacts - due to a change in the number and/or severity of accidents;
- road user journey time savings due to reductions in incidents;
- construction and maintenance impacts - impacts on road user travel time and vehicle operating cost during Scheme construction and future maintenance;
- public transport impacts (primarily bus and coaches) – changes in travel time, vehicle operating cost and user charges;
- indirect tax revenue - due to changes in the amount of fuel and other direct vehicle operating costs purchased and changes in expenditure on transport offsetting changes in expenditure elsewhere in the economy;
- greenhouse gas, noise and air quality impacts; and
- reliability impacts - due to changes in journey time variability.

2.5.3 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.

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3. ESTIMATION OF COSTS

3.1 Assessed Case and Do-minimum costs and profile

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

3.1.2 Costs were provided in financial years (e.g. 1 April 2015 to 31 March 2016) and then converted into calendar years for the economic assessment. Unless otherwise stated, all costs have been derived from information provided by the TfL Commercial Finance team.

3.2 Investment costs

3.2.1 Investment costs are those that will be incurred in the preparation and construction of the Scheme and the cost of the land required for the Scheme.

3.2.2 Investment costs for the Silvertown Tunnel have been estimated under two broad headings: development costs and construction costs.

3.2.3 Included in the development costs are project costs, land acquisition and site investigation costs, TfL delivery costs and procurement costs.

3.2.4 Included in the construction costs are the design, construction and supervision of the bored Tunnel.

3.2.5 Costs including risk allowance in outturn prices (after adjusting for inflation to the year in which they are expected to be incurred) are shown in Table 3-1.

Table 3-1: Investment costs (£m)

Cost category	2015 prices £m
TfL delivery costs	
Planning	£10.3
Procurement/ Legal	£7.4
Project Management	£17.7
Land	£21.9

Cost category	2015 prices £m
User Charging Software configuration (Silvertown Tunnel and Blackwall Tunnel)	£3.0
User Charging Infrastructure (Blackwall Tunnel)	£1.5
Others	£8.4
Risk	£19.9
Sub-total	**£90.2**
Construction Costs	
Design & Construction	£555.4
User Charging Infrastructure (Silvertown Tunnel)	£0.5
Stakeholders	£3.0
Risk	£142.7
Sub-total	£701.6
Total	**£791.8**

3.2.6 The total outturn prices (2015 prices) for the costs amount to £792m.

3.2.7 The above cost estimates include a risk allowance of some £142.7m which is some 25% of the above design and construction costs.

3.2.8 The distribution of the costs by year of anticipated expenditure is shown in Table 3-2. TfL delivery costs which comprises planning, procurement and legal costs, user charging reconfiguration (Silvertown and Blackwall Tunnels), and lane rental charges are listed together as preparation costs and the Silvertown Tunnel and link road costs have been combined as construction costs. The percentage split of costs between years is also shown as these are used in the economic assessment along with the total cost in each category. Project costs for the years up to and including 2014 are excluded from the economic appraisal, as these are 'sunk' costs which will not influence the appraisal. These total £4.8m.

Table 3-2: Investment costs to completion of construction in 2023 (outturn prices)

Financial Year Ending	Preparation £m	Supervision £m	Land £m	Construction £m	Total cost £m
March 2016	£6.8 (22.3%)	£4.5 (12.0%)	£0.01 (0.05%)		
March 2017	£7.6 (24.9%)	£5.9 (15.8%)			
March 2018	£4.3 (13.9%)	£5.3 (14.0%)	£5.9 (26.8%)		
March 2019	£1.3 (4.3%)	£9.6 (25.5%)	£10.6 (48.3%)	£46.2 (6.6%)	
March 2020	£1.7 (5.6%)	£3.7 (9.9%)	£5.4 (24.9%)	£184.5 (26.3%)	
March 2021	£1.7 (5.6%)	£2.7 (7.1%)		£205.6 (29.3%)	
March 2022	£2.4 (7.8%)	£2.8 (7.4%)		£190.6 (27.2%)	
March 2023	£4.8 (15.6%)	£3.0 (7.9%)		£74.8 (10.7%)	
March 2024		£0.1 (0.3%)			
Total	**£30.7 (100%)**	**£37.6 (100%)**	**£21.9 (100%)**	**£701.6 (100%)**	**£791.8**
Sunk costs[14]					**£4.8**

3.2.9 The value of the investment costs (in 2010 prices discounted to 2010) is £553m, the value included in the PA tables later in this report.

3.3 Operating costs

3.3.1 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.

3.3.2 Operating costs for the collection of the road user charge have been provided by TfL. These costs include elements such as transactional charge costs, and monthly maintenance costs for the Automatic Number

[14] Costs incurred to date are regarded as sunk costs, and they have not been included in the investment costs and economic cost and benefits calculations.

Plate Recognition (ANPR) cameras. The Silvertown Tunnel charge collection operating costs are based on the traffic flows. Traffic flows for intermediate years between 2021, 2031 and 2041 have been interpolated on a straight-line basis, between the values for the three model forecast years (2021, 2031and 2041). Charge collection costs beyond 2041 to 2080 have been assumed at the 2041 value.

3.3.3 The transactional collection costs have been estimated assuming a 5% evasion rate to allow for the higher costs associated with PCN issue and assurance. Transactional costs are the process charges for the registration, charging and enforcement backend services including contact centre costs.

3.3.4 Operating costs have also been provided by TfL. These costs were converted to 2010 prices, adjusted for indirect taxation and discounted over 60 years. The total discounted cost associated with user charge collection is £436m (2010 prices). In addition relevant bus operating costs of £307m (2010 prices discounted over 60 years) are also shown in the PA table.

3.4 Maintenance costs

3.4.1 Maintenance costs have been estimated by TfL to allow for routine tunnel maintenance, reactive tunnel maintenance, and tunnel services (electricity and water) for the appraisal period. Both the routine and reactive tunnel maintenance comprises elements for maintenance of the road infrastructure and for the traffic control equipment.

3.4.2 Total maintenance cost over the 60-year appraisal period is estimated at £101m (2010 prices discounted to 2010).

3.5 Grants and subsidies

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

4. ESTIMATION OF BENEFITS

4.1 Appraisal methodology

4.1.1 The main appraisal was carried out using TUBA v1.9.5 for highway trips. Adjustments were made post-TUBA for (1) a small reduction in weekend user benefits (2) the addition of bus and coach user benefits (3) the inclusion of investment, operating and maintenance costs (4) journey time savings due to reductions in incidents (5) reliability benefits. The post-TUBA analyses used TAG principles.

4.2 Economic parameters

4.2.1 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. TUBA version 1.9.5 reports economic values in 2010 prices, discounted to a present value of 2010. The economic parameter file used in the appraisal is shown in Appendix A.

4.3 Scheme parameters

4.3.1 The Scheme parameters were largely determined by the parameters used in the forecasting model, namely:

- first year – 2021 (assumed Scheme opening year)[15];
- horizon year – 2080 (60 years from opening year);
- modelled years – 2021, 2031 and 2041; and
- current year – 2015.

4.4 Time slices and annualisation factors

4.4.1 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.

[15] While the actual Scheme opening year is likely to be 2022, advice in TUBA (TUBA FAQ) is that if Scheme opening is only 1 or 2 years after the first modelled year then the modelled year data can be used to represent the Scheme opening year.

4.4.2 The RXHAM highway model comprises three weekday time periods; an AM peak hour (0800-0900), an average inter-peak hour and a PM peak hour (1700-1800). The peak periods referred below are those that have been assumed to most like each of the model periods, e.g. it is assumed that the 0600-1000am period is most like the 0800-0900am period from RXHAM and the applicable factor estimates an annual representation of a particular period based on the peak hour modelling results.

4.4.3 The modelled period benefits calculated by TUBA were converted into an estimate of annual benefits using the following annualisation factors:

- weekday AM peak period (6am to 10am, 4 hours): 855 x AM peak model hour;
- weekday interpeak and off-peak period (10am to 4pm, 7pm to 10pm, 9 hours): 2,085 x interpeak model hour;
- weekday PM peak period (4pm to 7pm, 3 hours) : 724 x PM model hour; and
- weekend and bank holiday period (6am to 10pm, 16 hours): 1,275 x interpeak model hour.

4.4.4 An adjustment was applied (post-TUBA) to the weekend and bank holiday highway period results, by reducing the time and Vehicle Operating Costs (VOC) benefits as from 6am to 9am 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 11%, which was the proportion of the daily flow in these three hours. However, users will still need to pay the charges, and therefore no deduction has been made for user charge disbenefits, or operator revenue. However an adjustment was made to indirect taxation revenue in line with the weekend time savings and VOC.

4.4.5 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.

4.4.6 It should be noted that any time savings outside charging hours are not captured by the annualisation factors but it is expected that these benefits will be small.

4.4.7 The Railplan Public Transport model comprised three time periods:

- weekday AM peak period (7am to 10am, 3 hours);
- weekday interpeak (10am to 4pm, 6 hours);
- weekday PM peak period (4pm to 7pm, 3 hours).

4.4.8 Annualisation factors used for these periods were 257 for the AM peak period, 713 for the interpeak period and 257 for the PM peak period. These factors were taken from the analysis of TfL's 2013 Rolling Origin and Destination Survey (RODS) data. The interpeak factor takes account of all time periods outside the peaks (i.e. early mornings, evenings and weekends). While this data is from London Underground, the data was the only source available that could be used to determine public transport annualisation factors.

4.4.9 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); and
- the benefits for travellers during maintenance of having two sets of tunnels available.

4.4.10 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 4-1 along with the proportions of trips from each model user class – see details of analysis in Appendix B.

Table 4-1: 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

TUBA user class	Description	Model user class	Proportion of model user class			
			AM	IP	PM	Off Peak and Weekend
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						

4.4.11 Demand in Railplan is not split by trip purpose. The decision was taken to use uniform split factors (i.e. a single value applied to the entire matrix) to segment Public Transport (PT) demand into In work trips and Out of Work trips. These factors were derived from the LoRDM demand matrices and are shown in Table 4-2.

Table 4-2: PT trip purpose split assumptions

Time Period	In Work Trips (IWT)	Out of Work Trips (OWT)
AM	0.11	0.89
IP	0.10	0.90
PM	0.11	0.89

PT trips were split into trip purposes using the factors shown in

4.4.12 Table 4-3, also derived from the LoRDM demand model.

Table 4-3: PT Trip Purpose Split

	AM	IP	PM
% of Business Users	10%	9%	11%
% of Commuters	51%	10%	43%
% of Leisure	39%	81%	46%

4.5 Scenarios

4.5.1 Within TUBA each modelled option is termed a scenario and these were classified as either a 'Do Minimum' or the 'Assessed Case' scenario. For the Silvertown Tunnel Scheme, the 'Do Minimum' scenario comprised the existing road network with committed improvements and the Woolwich Ferry continuing to operate as at present.

4.5.2 The 'Assessed Case' 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 charges modelled in the 'Assessed Case' are shown in Table 4-4.

Table 4-4: Modelled peak and off-peak charges for use of Blackwall and Silvertown Tunnels

User class	2021,2031, and 2041 peak user charge (2009 price year for RXHAM)	2021,2031, and 2041 off-peak user charge (2009 price year for RXHAM)
Car out of work <£20k	£2.703	£0.90
Car out of work £20k - £50k	£2.703	£0.90
Car out of work >£50k	£2.703	£0.90
Car in work time	£2.703	£0.90

User class	2021,2031, and 2041 peak user charge (2009 price year for RXHAM)	2021,2031, and 2041 off-peak user charge (2009 price year for RXHAM)
Light Goods Vehicle (LGV)	£4.505	£1.49
Heavy Goods Vehicle (HGV)	£6.757	£3.60

4.6 Input matrices

4.6.1 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 three forecast years (2021, 2031 and 2041) for both Do Minimum (Without Scheme) and Assessed Case (With Scheme) scenarios. A total of 504 matrices were prepared (3 x 7 x 3 x 2 scenarios x 4 matrix types).

4.7 Distance and time matrix factors

4.7.1 The SATURN software, which was used for the RXHAM model, uses metres and seconds as units. However, TAG unit A1.1 and the TAG 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) was used to convert travel time between zones into hours.

4.8 TUBA warnings and logic checking

4.8.1 TUBA undertakes a check on the inputs provided and identifies any large cost or matrix changes between the Do Minimum and Assessed Case situation. 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 and others were not regarded as material for the assessment. Other ‘sense’ checks were carried out:

- the 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. It was noted that TUBA takes account of effects of other crossing such as Dartford and London congestion charge;

- VOC benefits are approximately 5% of road user time benefits, which is broadly within the range expected;
- different benefits were mapped to sectors, and the patterns appeared plausible, with no inconsistent results; and
- a sample of other errors were checked and no obvious issues were noted.

4.9 Public transport and coach benefits

4.9.1 The Silvertown Tunnel will create opportunities for new cross-river bus services to improve public transport links between east and south east London. One lane in each direction will be reserved for buses and HGVs and will further enhance reliability and provide competitive bus journey times.

4.9.2 A potential future network of bus corridors has been developed with the addition of two new routes, the extension of three routes in addition to a frequency improvement of the existing bus route 108 which runs from Lewisham to Stratford serving North Greenwich and across the river via the Blackwall Tunnel. These routes were modelled in the future year network in Railplan (see details in TA).

4.9.3 The benefits for users of the existing bus route 108 and additional bus routes proposed within the wider study area were calculated using TAG principles outside of TUBA using the Railplan outputs. The benefits accruing to the large number of commuter coach users of the Blackwall Tunnel were also calculated outside of TUBA applying a similar methodology. The methodology adopted for bus and coach user benefits is described in Appendix C and Appendix D respectively.

4.9.4 The estimated bus user benefits (£591m passenger travel time benefits over 60 years in 2010 prices) have been added to the TUBA outputs in the relevant output tables. Current DfT advice (on the Crossrail business case) was followed to exclude changes public transport user charges (fares) from user benefits, as fares do not change and are taken into account in the mode choice model. Revenue impacts are accounted for in the PA table.

4.9.5 The estimated coach user benefits for commuter coaches have also been analysed. It was assumed that benefits would only accrue to the AM peak period (07:00-10:00) northbound and the PM peak period (16:00-19:00) period southbound. Journey time savings for coaches were extracted from the SATURN model outputs. For the monetary assessment, a conservative

80% of journey time savings were considered from the model output. The estimated coach user benefits of £119.7m (2010 prices, over 60 years) have been added to the TUBA outputs in the relevant output tables.

4.9.6 The estimates are regarded as conservative as they exclude any reliability estimates and underestimate time savings to existing bus users on service 108.

4.10 Vehicle operating cost savings

4.10.1 Highway vehicle operating cost savings have been derived directly from TUBA, which is based on the appropriate TAG requirements.

4.10.2 Bus operating costs were based on TfL estimates and were assumed to grow with RPI year on year over the appraisal period. These values were then converted to 2010 values using the GDP deflator. An uplift of 10% was applied to operating cost to account for optimism bias. Over the 60-year appraisal period the total undiscounted operating costs were £1,121m and the total discounted operating costs were £307m. (An uplift of 19% was applied to convert from factor prices to market prices when presented in the relevant output tables).

4.11 Accident cost savings

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

4.11.2 The basic principles of the analysis were as follows:

- a road network of interest was identified (5% or greater change in modelled traffic flows);
- a geocoded database of road accidents for the area (2009-2013) was developed;
- COBA-LT road types were allocated to all relevant SATURN links;
- a 50 metre buffer was drawn around Saturn links with manual adjustments to match the road network to link accidents;
- SATURN flows by link were based on AADT 24 hour flows for the relevant model year;
- the change in annual vehicle kilometres was estimated (flow x link length x 365);
- the average number of accidents in the study area by link type was estimated;
- local accident rates were estimated by road type and were applied to a combined link and junction COBA-LT analysis; and

- with and without scheme accidents were calculated and converted to monetary values.

4.12 Incident delay and travel time variability

4.12.1 The Silvertown Tunnel Scheme is expected to have resilience and reliability consequences that have important implications for the economic case.These reliability and resilience elements of the project are just as important as the congestion-relief, for several reasons.

4.12.2 The Blackwall Tunnel is the highest capacity crossing between Tower Bridge and the Dartford Crossing, and thus has a strategic importance in the East London road network; it has a very high level of peak congestion; there are no nearby alternative routes with spare capacity and there are a very high number of incidents in the Tunnel.

4.12.3 In terms of resilience (the capacity of the network to maintain an acceptable level of service in the face of unplanned incidents), the current Blackwall Tunnel is at capacity in the peak hours, and there are no alternative crossings with spare peak capacity within a reasonable distance. This means that any serious incident[16] when a tunnel is closed (circa 10-20 times a year in peak periods; 64 overall) has both a significant direct effect and a ‘ripple’ effect on the wider network as queues extend and vehicles attempt to reroute via distant and low capacity alternatives. The new Scheme provides an adjacent alternative route to deal with these major incidents, thus greatly reducing their impacts.

4.12.4 In terms of other shorter duration incidents, the Blackwall Tunnel has some 1,800 closure incidents a year (2013), about a third of which are due to overheight vehicles attempting to use the sub-standard northbound tunnel bore. The Scheme will provide a full height adjacent tunnel to cater for these overheight vehicles as well as additional capacity and an alternative route – it is therefore expected that both the number of these incidents, and the effects of any residual closures, will be substantially reduced.

4.12.5 In conjunction with the above serious and overheight incidents, there are a number of incidents of other types (such as accidents, debris, breakdowns), and once again the new alternative route will greatly reduce the severity of impacts arising from such incidents, and will improve the journey time variability for all highway travellers. This is of particular importance to business travellers including the freight industry.

[16] Assumed to be a closure for more than 15 minutes.

4.12.6 There is extensive TfL 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. This and other data has been used to develop estimates of the reliability and resilience impacts in three broad categories:

- **Resilience time savings** (savings in delays due to major incidents). There are an estimated 64 incident-related tunnel closures per year at the Blackwall Tunnel which have a duration of 15 minutes or longer (46 northbound and 18 southbound in 2013). This duration of incident appears likely to result in wider network disbenefits, and is expected to be reduced significantly by the addition of the alternative route of the Silvertown Tunnel. To estimate the time savings that are likely to result from the Scheme, the SATURN model was run with a 15 minute reduction in capacity with and without the Scheme. The resultant change in network vehicle journey times was analysed in a (single year) TUBA, and factored up by the number of such closures per year to obtain an overall estimate.
- **Over-height vehicle incident time savings.** The current Blackwall Tunnel northbound bore is substandard, and there are over 618 incident-related closures a year (2013) caused by overheight vehicles having to be turned away from the tunnel portals. The new Silvertown Tunnel will provide a full-height alternative route which is expected to reduce the number of such incidents significantly – an 80% reduction has been assumed. An estimate of the resultant time savings has been made by developing a simple model of the tunnel traffic which assesses the delay due to these incidents and then an estimate of the time savings.
- **Reliability benefis**: TAG A1.3 [17] outlines a method for calculation and valuation of the changes in journey time variability. A method has been developed, following this guidance but based on a locally calibrated model, to value the changes in journey time variability excluding the effects of Types 1 and 2 time savings outlined above.

4.12.7 Details of the analysis are provided in Appendix F.

4.13 Delays during construction and future maintenance

4.13.1 Part of the cost of the construction and ongoing maintenance of the Scheme is borne by road users in terms of traffic delays. It should be noted that at this stage the temporary works design has been considered at a

[17] TAG Unit A1.3 User and Provider Impacts, November 2014

very high level in order to ascertain the land requirements to enable construction of the Scheme. The details of this will be developed by the design and build contractor at a later stage. For the purpose of this assessment best judgement of lane widths and speed restriction during construction and maintenance works has been applied using Chapter 8 of the Traffic Signs Manual[18] as the exact details for the traffic management lane widths and speed restriction have not been defined at this stage.

4.13.2 The DfT program QUeues And Delays at ROadwork's (QUADRO) version 4 revision 13.0 (release on 6th February 2015) has been used for assessing and quantifying these delays.

4.13.3 QUADRO calculates the total works and user costs of construction and maintenance tasks. For each task the cost and timing of the works were specified by the user, along with information on traffic flows, the traffic arrangements at the site, and a representative diversion route around the site. The program contains an iterative assignment model for allocating traffic to the diversion route if the site becomes overloaded. The effect of the works was evaluated by calculating the time and vehicle operating costs incurred by all traffic on the network, both with and without the works. Output available from the model included information on the speed, queuing, and diversionary behaviour of traffic on an hourly basis, plus cost summaries by type and vehicle category.

4.13.4 The total user costs, for a particular task or profile of tasks over the appraisal period, were then discounted to a base year (2010). This enabled construction and maintenance tasks which occur in different years to be compared on a common basis.

4.13.5 For the purpose of the QUADRO assessment, user delays due to construction were calculated based upon a set of estimated construction phases provided in the Silvertown Tunnel Reference Design document supplied by Atkins[19]. The overall simplified construction schedule adopted for the assessment is shown in

[18] Traffic Signs Manual, Chapter 8, Traffic Safety Measures and Sings for Road Works and Temporary Situations, Part 2: Operations, 2009

[19] Silvertown Tunnel Reference Design - Construction Statement, March 2015

4.13.6 Table 4-5.

Table 4-5: Silvertown Tunnel Construction Schedule

Phase	Section	Start Date	End Date	Duration
Silvertown site works				
Phase 1,2, and 3	Dock Road Closure	01/06/2020	14/01/2022	30 weeks-2020, 52 weeks-2021 and 2 weeks-2022
Greenwich site works				
Phase 1, 2, 3 and 4	A102 Blackwall Tunnel Approach Northbound and Southbound approach works and Bridge deck works	01/10/2018	16/09/2022	13 weeks-2018, 52 weeks-2019,2020 and 2021 and 37 weeks in 2022

4.13.7 A 20 mph speed restriction will be in place with narrow lane operation at the A102 Blackwall Tunnel approach works (Greenwich site works) throughout the construction duration. With respect to the Silvertown site works, it is proposed to close Dock Road from its junction with A1011 Silvertown Way. However, access to Dock Road will be maintained at the southern end of the A1020 North Woolwich Road.

4.13.8 Diversion routes were not specified for the narrow lanes operation particularly at the Greenwich site works and so a MAX-Q-DELAY of 20[20] minutes was used. At the Silvertown site works where Dock Road will be closed off and traffic using the Dock Road/ A1011 Silvertown Way junction was assumed to divert to the southern end of the North Woolwich Road.

4.13.9 To obtain a representative speed/flow curve along each diversion route, a weighted average of the speed/flow on each of the links making up that diversion route was calculated from the model.

[20] Max-Q-Delay: Max-Q-Delay option is selected for the narrow lanes operation. Max-Q-Delay implies that drivers are willing to be delayed for a certain time and then find alternatives routes, etc., when their 'maximum delay time' is exceeded. The Max-Q-Delay function represents a measure of time that vehicles are willing to queue at the roadworks, not the overall additional journey time which will include the speed-flow difference along the main route itself. Max-Q-Delay represents a theoretical diversion route the journey time of which is defined as the time it takes to travel the length of the main route with works given a queue of length (and time) corresponding to Max-Q-Delay.

4.13.10 All non-tunnel construction works will be undertaken within weekday/daylight hours and working generally limited to 0700 to 1900 hours weekdays and 0700 to 1400 on Saturdays. Tunnelling related works will be undertaken on a 24/7 basis. However, it has been assumed that the traffic management will be in place 24/7 due to safety reasons.

4.13.11 To obtain the overall net impact of the construction works at the A102 Blackwall Tunnel approach (Greenwich site works), a separate QUADRO assessment was carried out with normal lane widths and the current speed limit of 30 mph. To estimate the net disbenefits during construction, user delays with reduced lane and speed restrictions (with-work situation) were compared to the 'without-work' situation (i.e. normal lane widths and speed limits).

4.13.12 An assessment of delays to travellers during the maintenance of the Silvertown Tunnel and Blackwall Tunnel was not carried out as it is envisaged that the impacts of this would be low in future years. This is because while the current Blackwall Tunnel closure programme requires traffic to divert to a longer route when the tunnel is closed for 24 nights per year (Sunday 01:00-08:00), with Silvertown Tunnel in place both tunnels would provide alternative diversion routes for each other.

4.14 Cost of greenhouse gases

4.14.1 The Climate Change Act 2008[21] created a new approach to managing and responding to climate change in the UK. At the heart of the Act is a legally binding target to reduce the UK's greenhouse gas emissions. It is therefore important that the impacts of proposed transport interventions on greenhouse gas emissions - whether they are increased or decreased - are incorporated within the cost benefit analysis in a consistent and transparent way. The cost of greenhouse gases has been derived directly from TUBA, which uses relevant TAG factors.

4.15 Cost of local air quality

4.15.1 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Department for Environment, Food & Rural Affairs (DEFRA) 2007) set objectives for eight key air pollutants to protect health.

[21] Climate Change Act 2008, Chapter 27

4.15.2 Road transport, which is a significant source of PM10[22] and Nitrogen Dioxide (NO_2) is one of the major sources of local air pollution, especially in our towns and cities.

4.15.3 The approach to assessing local air quality for a Scheme is set out in TAG Unit A3 (the Air Quality Sub-Objective) and is based on a quantification of the change in exposure at properties in the opening year.

4.15.4 The next stage in the air quality assessment is a monetary valuation of the changes in air quality. This makes use of existing economic valuation evidence published by the Inter Departmental Group on Costs and Benefits (Air Quality), to estimate the economic values associated with changes (either worsening or improvement) in air quality. The results of this assessment have been provided by the environmental team for use in the appraisal and further details are provided in the Preliminary Environmental Assessment Report [23].

4.16 Noise assessment

4.16.1 The approach for the assessment of traffic-related noise is set out in TAG Unit A3 (the Noise Sub-Objective). In common with the assessment of greenhouse gases and air quality, the noise assessment follows a two-stage process. The initial step is the estimation of noise levels at residential property frontages and their subsequent valuation in monetary terms.

4.16.2 The monetary values are national average values per household per year at 2010 prices. These are increased in line with forecasts of Gross Domestic Product (GDP) per household and discounted over the appraisal period to give a present value of noise cost. The results of this assessment have been provided by the environmental team for use in the appraisal and further details are provided in the Preliminary Environmental Assessment Report.

[22] Particulate Matter up to 10 micrometres in size

[23] Preliminary Environmental Assessment Report, TfL,September, 2015

5. ECONOMIC ASSESSMENT RESULTS

5.1 Introduction

5.1.1 The following section describes the transport economic efficiency results for the Assessed Case – the situation with the new Silvertown Tunnel in place and both this and the adjacent Blackwall Tunnel operating under a road user charging regime. The results presented here have assumed the charging levels as set out in the User Charging Report[24]. All the benefits and costs mentioned in this section are in 2010 prices, discounted to 2010[25].

5.1.2 TAG advice is that reliability benefits should normally be considered as an 'adjustment' item after calculating an initial economic assessment, and accordingly for many analyses both an 'initial' and 'adjusted' outcome has been shown. However given that reliability is a key objective of the Scheme, and that extensive data has been available to estimate the reliability benefits (see Appendix F), these are regarded by TfL as an integral part of the case for the scheme.

5.2 Headline Scheme benefits

5.2.1

[24] See Silvertown Tunnel Preliminary Charging Report, TfL, September 2015

[25] TUBA benefits and costs are presented in present values, discounted to the DfT's base year (i.e. 2010). In TUBA or any CBA method, all the monetised costs and benefits arising in the future are adjusted to take account of social time preference. The technique used to perform this adjustment is known as discounting. The process is separate from that used to adjust for inflation. Adjustments for inflation are made to account for the reduction in what £1 can purchase over time, while discounting is performed to reflect people's preferences for current consumption over future consumption. A 'discount rate' which represents the extent to which people prefer current over future consumption, is applied to convert future costs and benefits in to their 'present value'.

Table 5-1 shows a summary of the Scheme benefits. The table shows two columns, an initial user benefit and secondly one that includes the additional benefits relating to changes in reliability (journey time variability). (Over the 60-year appraisal period the Scheme is expected to generate a total user benefit of some £1,069m, and with the addition of journey time variability the benefits increase to £1,367m. The user benefits are net of user charges, and shows that the Scheme generates a significant net benefit for users in total.

Table 5-1: User benefit summary (£m, 2010 prices,)

Description	Initial Benefits (£m)	Adjusted benefits (incl. Reliability benefits) (£m)
Travel time	£2,096	£2,393
Vehicle operating costs	£103	£103
User charges	-£1,119	-£1,119
Delays during construction	-£11	-£11
Net user benefits	£1,069	£1,367

5.2.2 The travel time benefits include the highway and public transport user benefits and additional journey time savings due to incident reductions described above (a reduction in the impact of major incidents, and overheight vehicles). Time savings from incident reductions amount to some £26.6m of the £2,096m initial benefits. The additional reliability (journey time variability) benefits amount to £297m of the adjusted user time benefits total of £2,393m.

5.2.3 All results in this section have been calculated using national values of time, as required by TAG advice. If TfL recommended higher London Value of Time were used in the appraisal, significantly higher benefits would be estimated. A sensitivity test using London values of time is presented in Section 5.12 below.

5.3 User benefits by user groups

5.3.1 Table 5-2 shows the user benefits and charges by transport system user group, while Table 5-3 shows the same information but with the adjustment for reliability benefits.

5.3.2 Table 5-2 shows that the main benefits accrue to bus and coach users (some 30% of total benefits) and business car users (some 26%) – a further approximately 23% of benefits accrues to cars with commuter and ‘other’ journey purposes, and some18% accrues to goods vehicles (i.e. HGVs and LGVs). Some 5% of all user benefits relate to a reduction in vehicle operating costs. The distribution of user charges follows a different pattern. Goods vehicles pay the highest proportion of the total charges (some 50%), while bus and coach passengers have been assumed to pay no charges.

5.3.3 Both tables show significant time user benefits for all modes – buses and coaches and business car users in particular show significant levels of benefit. Table 5-3 shows the impact of the additional £297m of reliability benefit.

5.3.4 Table 5-2 shows that bus and coach, car business, car commuting and car other users have positive net user benefits, while goods vehicles (HGVs and LGVs) show negative user benefits due to the charge they pay.

5.3.5 It should be noted that TfL proposes to vary the charge by vehicle type to reflect the amount of road space occupied, the contribution to congestion, the emissions and the wear and tear to the road surface caused by different types of vehicles. Consequently HGV's pay the highest charges, and this impacts their net user benefits. There are also indications that the value placed in the current appraisal on reliability of goods vehicles is an underestimate – for example the Freight Transport Association (FTA) calculated that each minute of delay is related to unreliability costs an operator £1; a delay of 20 minutes at the Blackwall Tunnel could therefore, add £20 to the cost of an individual trip, considerably more than the value currently placed on this impact.[26] In Table 5-3 when the significant benefits due to reduction in journey time variability are taken into account and all user groups show positive net benefits apart from HGVs and as noted above the latter's disbenefits are likely to be underestimated.

Table 5-2: Benefits and charges by user type (£m, 2010 prices)

	Other users			Business users				Total
	Car commuting	Car other	Bus & coach	Cars	LGV	HGV	bus & coach	
Total user benefits	£161	£349	£650	£578	£291	£99	£60	£2,188
% benefits	7%	16%	30%	26%	13%	5%	3%	100%
User charges	-£150	-£278	£0	-£131	-£331	-£229	£0	-£1,119
% user charges	13%	25%	0%	12%	30%	20%	0%	100%
Total Net user benefit	**£11**	**£71**	**£650**	**£447**	**-£40**	**-£130**	**£60**	**£1,069**
% Total Net user benefits	**1%**	**7%**	**61%**	**42%**	**-4%**	**-12%**	**6%**	**100%**

[26] FTA concerned over journey time reliability for road freight operators Press release May 21, 2015

Table 5-3: Benefits and charges by user type– reliability benefits included (£m, 2010 prices)

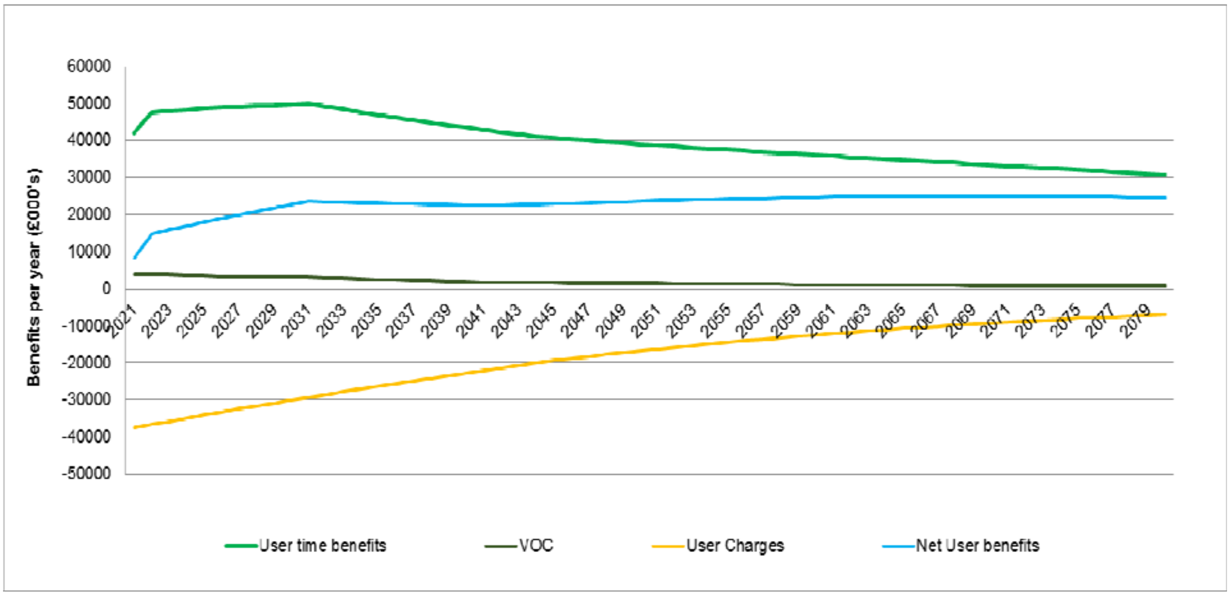
	Others users			Business users				Total
	Car commuting	**Car other**	**Bus & coach**	**Cars**	**LGV**	**HGV**	**bus & coach**	
Total user benefits	£194	£432	£650	£670	£357	£122	£60	£2,485
% benefits	8%	17%	26%	27%	14%	5%	2%	100%
User charges	-£150	-£278	£0	-£131	-£331	-£229	£0	-£1,119
% user charges	13.4%	24.9%	0.0%	11.7%	29.6%	20.5%	0.0%	100.0%
Total Net user benefit	**£44**	**£153**	**£650**	**£539**	**£26**	**-£107**	**£60**	**£1,367**
% Total Nett user benefits	**3%**	**11%**	**48%**	**39%**	**2%**	**-8%**	**4%**	**100%**

5.3.6

Figure 5.1 shows the user benefit and charge profile for the appraisal period for highway and public transport users. It also includes reliability benefits – these have been plotted on a yearly, non-cumulative, basis. There is an initial increase in user benefits as the ‘ramping up’ effect of public transport benefits is recovered. The profiles show that user benefits increase to 2031 then decline gradually, primarily due to an increase in background traffic over time.

5.3.7 Note that TfL have applied for powers to be able to amend the user charge, and can use this over time to maximise scheme benefits in future.

Figure 5.1: User benefits and charge distribution 60-year profile[27] (incl. reliability benefits)



5.4 Benefits and charges by time period

5.4.1 Table 5-4 shows the user benefits and charges by time period for highway and public transport with additional reliability benefits but without delays during construction. The evening and inter-peak periods account for the largest proportion of benefits (39% and 34% respectively), with morning peak benefits being lower (19%). Benefits at weekends are the lowest due to lower traffic flows.

5.4.2 The main reasons why the evening peak benefits are as high as indicated are that (1) in the base (existing) situation journey times and delays are much higher in the evening peak than in the morning peak for the peak directions (2) the modelled evening peak hour has more trips than the morning peak hour (3) traffic volumes at the Blackwall and Dartford Tunnels are higher in the evening peak than in the morning peak. All of these issues are likely to contribute to a higher benefit in the evening peak when the Silvertown Tunnel is implemented.

Table 5-4: User benefits and charges by time period with reliability benefits, £m, 2010 prices

[27] This includes public transport (buses and coaches) and journey time savings due to incident reductions and reliability benefits.

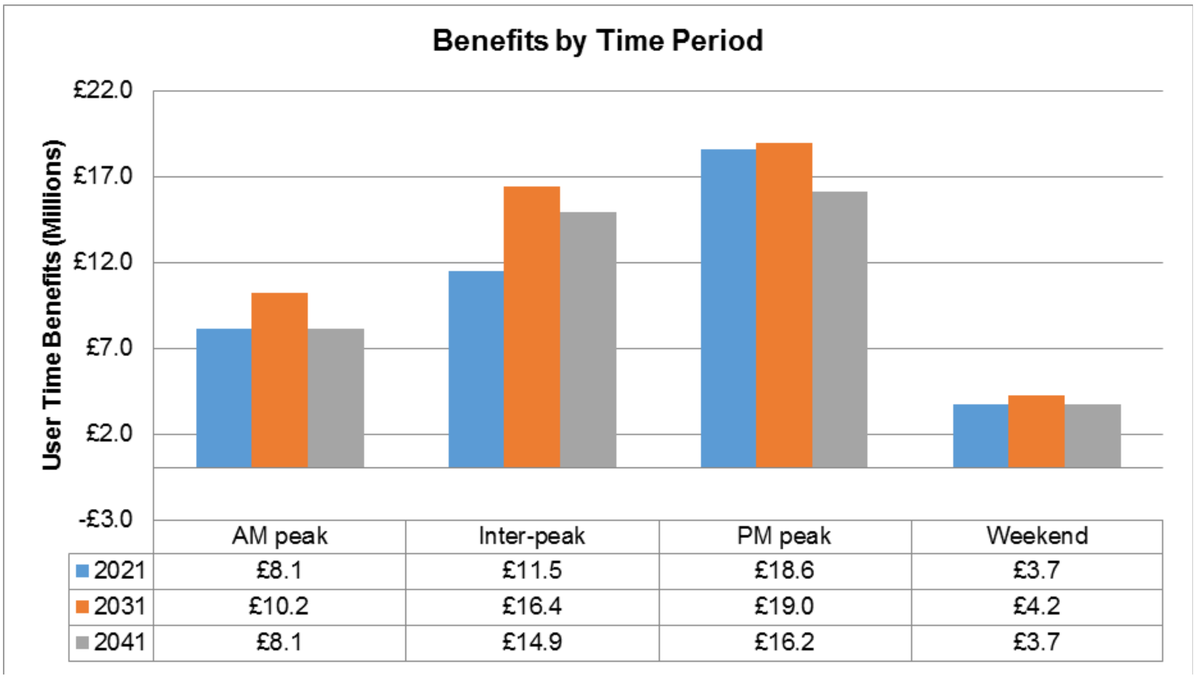
	AM peak	Inter-peak	PM peak	Off-peak & weekend	Total
Travel time	£463	£817	£916	£198	**£2,393**
VOC	£16	£25	£49	£13	**£103**
Total[28]	£479	£842	£965	£211	**£2,496**
% benefit	19%	34%	39%	9%	**100%**
Hours per week (highway)	20 (4 x 5)	30 (6 x 5)	15 (3 x 5)	108 (12 x 5) + (24 x 2)	
Hours per week (Public Transport)**	15 (3 x5)	30 (6 x 5)	15 (3 x 5)		
Benefits per hour/week*	£26	£28	£64	£1	
User charges	-£283	-£344	-£283	-£209	**-£1,119**
% charges	25.3%	30.8%	25.3%	18.7%	**100%**
Hours per week	20	30	15	108	
Charge per hour/week*	-£14	-£11	-£19	-£2	
* summed over the 60 year appraisal period.** Public Transport includes buses and coaches Figures may not sum due to rounding.					

5.4.3 Figure 5.2 shows the user time benefits for a selection of modelled years – this includes bus and coach benefits but does not include journey time savings due to reduced incidents or reliability benefits. The travel time benefits in the morning and evening peaks increase slightly between the opening year 2021 and 2031 and then decline from 2041. This suggests that the impact of the additional capacity provided by the Silvertown Tunnel reduces during this time period as background network traffic growth starts to reduce some early benefits from 2031 onwards. During the inter-peak period and at weekends, when traffic volumes are lower, benefits rise over the thirty year period, indicating that the additional capacity is still sufficient

[28] Note that the difference in the total user benefits of £2,496m reported here and the £2,485m reported in Table 5.3 is the £11m of user delay during construction for which time period data was not available.

for forecast growth. TfL can use the user charging mechanism to help ensure future benefits are maintained.

Figure 5.2: User time benefits by time period and modelled year[29] £m



5.4.4 Analysis of user benefits and charge total by vehicle type and journey purpose is shown in Table 5-5. All users apart from bus users are expected to obtain the most benefit in the evening peak hour – bus users receive most benefit in the interpeak.

[29] Includes public transport, journey time savings due to reduced incidents and additional reliability benefits.

Table 5-5: User benefits by user type and time period[30]

User type	Benefit total, £m	AM	IP	PM	Weekend[31]
Car commute	£195	26%	13%	57%	4%
Car other	£394	11%	22%	49%	17%
Car business	£687	28%	21%	46%	6%
LGV	£379	17%	28%	37%	17%
HGV	£132	5%	42%	30%	24%
Bus & coach	£711	17%	60%	23%	0%
Total	**£2,496**	**19%**	**34%**	**39%**	**8%**

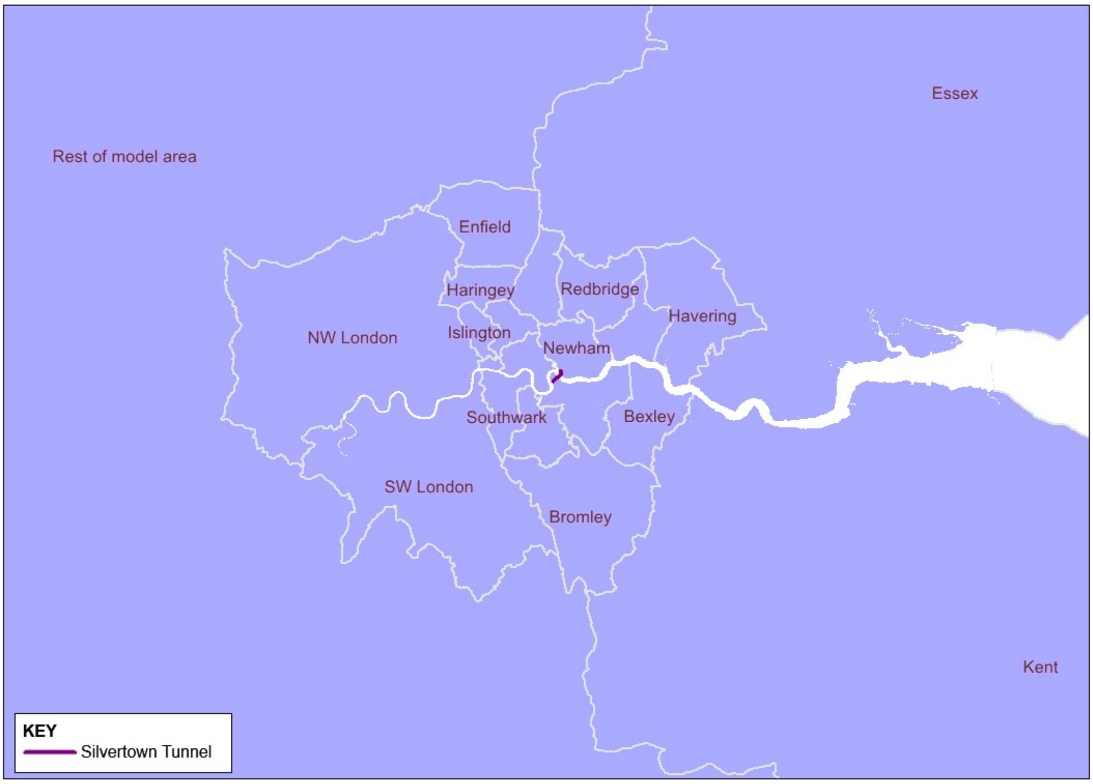
5.5 Geographical distribution of time benefits

5.5.1 An indicative 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 Figure 5.3.

[30] This does include journey time savings due to reduced incidents and reliability and public transport included.

[31] 11% adjustment applied to TUBA results – see 4.4.8

Figure 5.3: TUBA sectors[32]



5.5.2 As each sector covers both a different sized 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 the population aged 18-74. The population in each sector has been determined from the 2011 Census results, which were obtained from the Office of National Statistics.

5.5.3 The user time benefits from each sector and to each sector were extracted from the detailed TUBA output file (highway) and public transport and reliability elements were added. By averaging these benefits from each sector as both an origin and a destination, an estimation of the time benefits accruing to each sector has been derived. These time benefits per sector were then divided by the resident population to derive a benefit per person, as shown in Table 5-6. This is the (discounted) total benefit summed over the 60 year appraisal period. Note that this analysis is for

[32] Not all 21 sectors are named in the map.

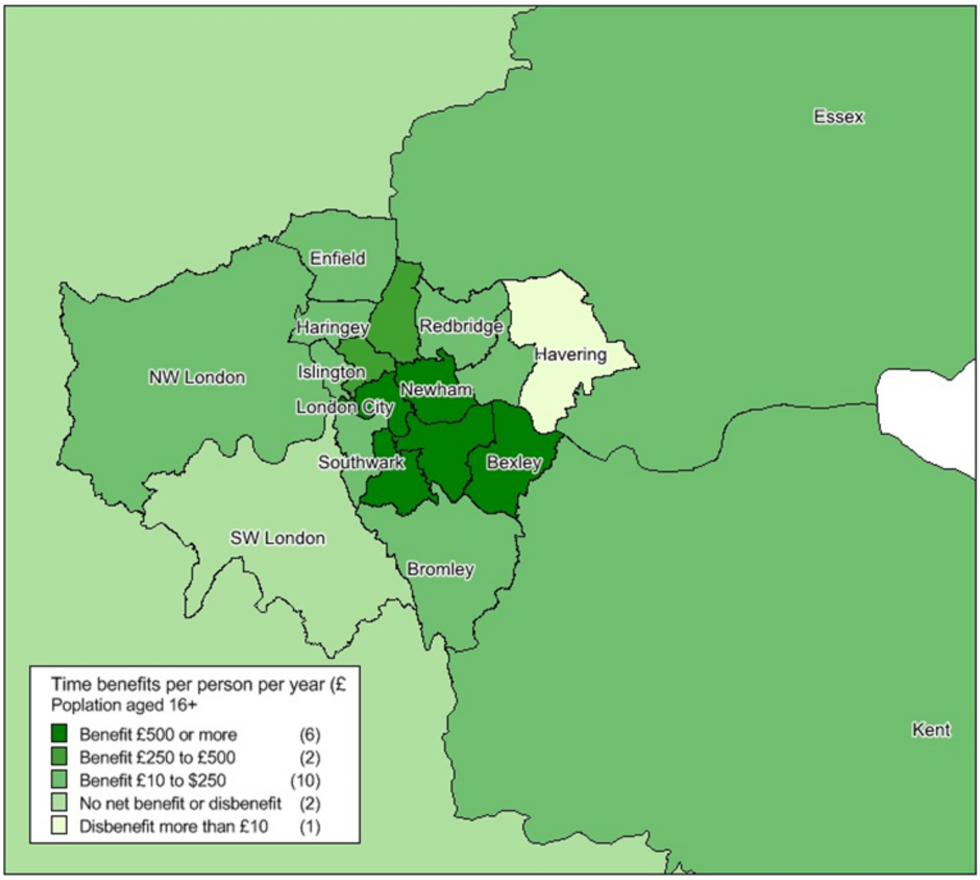
time benefits only and excludes vehicle operating costs and all coach benefits.

Table 5-6: Indicative user time benefits per sector per head of population 18-74 (£m), PVm 2010 prices

Sector no	Sector name	Origin time benefit, £m	Destination time benefit, £m	Average time benefit, £m	Population (16+)	Benefit per person over 60-year (pounds)
1	Rest of UK	£80.0	£68.7	£74.4	53,100,000	£1
2	Essex	£13.4	£39.3	£26.4	1,206,392	£22
3	Kent	£243.4	£225.6	£234.5	1,202,833	£195
4	NW London	£36.7	£21.7	£29.2	1,870,273	£16
5	SW London	£44.0	-£24.5	£9.8	1,252,258	£8
6	Enfield	£32.0	£43.3	£37.6	209,141	£180
7	Haringey	£11.8	£26.5	£19.2	185,774	£103
8	Waltham Forest	£52.6	£58.0	£55.3	180,588	£306
9	Redbridge	£34.7	£54.0	£44.3	189,457	£234
10	Havering	-£5.6	-£20.4	-£13.0	160,444	-£81
11	Islington	£3.6	£28.8	£16.2	161,596	£100
12	Hackney	£43.3	£66.3	£54.8	182,154	£301
13	Newham	£490.0	£548.3	£519.2	215,032	£2,414
14	Barking and Dagenham	£12.7	£7.5	£10.1	116,274	£87
15	London City	£10.8	£6.5	£8.7	5,726	£1,512
16	Tower Hamlets	£302.9	£503.8	£403.3	191,602	£2,105
17	Southwark	£20.3	-£6.9	£6.7	203,460	£33
18	Lewisham	£152.9	£97.3	£125.1	196,656	£636
19	Greenwich	£565.5	£442.5	£504.0	178,461	£2,824
20	Bexley	£118.2	£65.3	£91.7	147,991	£620
21	Bromley	£9.9	£21.6	£15.8	198,968	£79

5.5.4 Figure 5.4 shows the user benefits plotted geographically according to the value of the total benefit per person. The table and figure shows that the highest user time benefits are expected to accrue to the three host boroughs of Greenwich, Newham and Tower Hamlets, although many other boroughs are also expected to benefit. Outside London Kent is expected to benefit most and Essex to some degree.

Figure 5.4: User benefit distribution



5.6 Safety benefit assessment

5.6.1 Work on the COBA-LT analysis indicates that the overall study area will experience a decrease in accident costs of about £35.9m over 60 years (see Appendix E).

5.7 Incident time savings and travel time variability improvements

5.7.1 The issues regarding incidents and journey time variability are described in 4.12 above and in Appendix F. Table 5-7 shows the total benefits attributable to reductions in journey times due to reduction in incidents or their impacts and the improvement in reliability (journey time variability).

Table 5-7: Incident time savings and reliability benefits summary

Benefit	Aspect of Scheme	Benefit estimated 2010 prices, 60-year appraisal, £m
General improvements in reliability (journey time variability)	Increase in cross-river capacity reduces the volume/capacity ratio (and hence congestion) and allows for more reliable journeys.	£297
Time savings achieved from alternative routing during longer duration incidents	Extra tunnel would provide an easily accessible diversion in the event of a Blackwall Tunnel incident, and will help to reduce the ‘knock on’ effects of incidents currently experienced.	£6.5
Time savings from reduction in OHV incidents	Silvertown Tunnel geometry will reduce the frequency of these incidents, which occur regularly in the Blackwall Tunnel northbound bore.	£20

5.8 Traffic delays during construction and future maintenance

5.8.1 An assessment of traffic delays during construction and maintenance has been prepared using the Transport Research Laboratory's QUADRO software.

5.8.2 Table 5-8 shows the costs associated with user delays during construction as produced by QUADRO (described in 4.13).

Table 5-8: Construction Delay Costs, £m

Journey Purpose	Construction Delay Costs
Business	-£4.9
Commute	-£1.6
Other	-£4.8
Total	**-£11.3**

5.9 Monetised environmental assessment

5.9.1 An assessment of the monetised environmental implications of the Scheme has been produced as part of the preparatory work for the DCO application, applying relevant TAG guidance and is summarised in Table 5-9.

Table 5-9: Greenhouse Gases, Air Quality and Noise Benefits

Scenario	Greenhouse gases, Air Quality and Noise, £m
Greenhouse gases (Carbon)[33]	£12.1
Air Quality (NO_2) and PM10	-£0.27
Noise	-£2.7
Total	£9.1

[33] Only included for the Highway elements and taken from the TUBA assessment.

5.10 Transport Economic Efficiency (TEE)

5.10.1 The transport economic efficiency outcomes for the preferred option are shown in Table 5-10 and Table 5-11.

5.10.2 It should be noted that the present value of benefits presented in Table 5-10 includes elements of highway, public transport (bus and coach) and travel time savings due to reduction in incidents (overheight vehicles and major incidents - see 4.12), while Table 5-11 has in addition reliability (journey time variability) benefits (see 4.12). The overall net benefits are after taking into account the charges paid by users and any user delay costs during construction and future maintenance.

5.10.3 Private sector provider impacts relate to London regulated bus operations. TfL's additional costs for operating the new bus services was estimated at £307m, which would therefore be revenue received by a private sector bus operator. They would incur operating costs to run these services to achieve their usual operating margin, which in London's case is approximately 10% [34]. This results in an estimate of bus operator costs of £276m, and a net private sector provider benefit of £31m. This benefit for business users was not included in the AMCB table for the current business case pending confirmation of the estimates, resulting in a conservative estimate of business user AMCB benefits.

5.10.4 Total user benefits without inclusion of reliability benefits are estimated at £1,069m, with some £337m of this being attributable to business users, some £259m attributable to commuting and £474m attributable to the 'other' category (refer Table 5-10). The inclusion of the further net business benefit for bus operations of £31m results in the total present value of TEE benefits of £1,099m shown in the TEE table.

5.10.5 Total user benefits with additional reliability benefits are estimated at £1,366m, with some £519m of this being attributable to business users, £291m to commuting and £556m attributable to the 'other' category (refer Table 5-11). The inclusion of the net private sector operator business benefits of £31m results in the total present value of TEE benefits of £1,397m.

[34] GoAhead group , in their 2013 Annual Report, quote a margin of 11.2% in their deregulated bus operations and 9.5% in their regulated bus operations.

Table 5-10: Transport Economic Efficiency (initial), £000s

Non-business: Commuting	ALL MODES TOTAL		ROAD Private Cars	coach Passengers	bus Passengers	OTHER
User benefits						
Travel time	£396,762		£149,102	£119,660	£128,000	
Vehicle operating costs	£13,356		£13,356			
User charges	-£149,902		-£149,902			
During Construction & Maintenance	-£1,597		-£1,556	-£41		
COMMUTING	£258,619	*(1a)*	£11,000	£119,619	£128,000	£0

Non-business: Other	ALL MODES TOTAL		ROAD Private Cars	coach Passengers	bus Passengers	OTHER
User benefits						
Travel time	£734,362		£331,362		£403,000	
Vehicle operating costs	£22,316		£22,316			
User charges	-£278,255		-£278,255			
During Construction & Maintenance	-£4,778		-£4,621	-£157		
OTHER	£473,645	*(1b)*	£70,802	-£157	£403,000	£0

Business	ALL MODES TOTAL		Goods Vehicles (OGVs&LGVs)	Business Cars	coach Passengers	bus Passengers	OTHER
User benefits							
Travel time	£964,740		£348,737	£556,003		£60,000	
Vehicle operating costs	£67,576		£43,817	£23,759			
User charges	-£690,447		-£559,352	-£131,095			
During Construction & Maintenance	-£4,936		-£2,985	-£1,900	-£51		
Subtotal	£336,933	*(2)*	-£169,783	£446,767	-£51	£60,000	£0
Private sector provider impacts							
Revenue	£307,040				0	£307,040	
Operating costs	-£276,336				£0	-£276,336	
Investment costs					0	£0	
Grant/subsidy					0	£0	
Subtotal	£30,704	*(3)*			0	£30,704	£0
Other business impacts							
Developer contributions		*(4)*					
NET BUSINESS IMPACT	£367,637	*(5) = (2) + (3) + (4)*					

TOTAL		
Present Value of Transport Economic Efficiency Benefits (TEE)	£1,099,901	*(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

Table 5-11: Transport Economic Efficiency (adjusted with reliability benefits), £000s

Non-business: Commuting	ALL MODES		ROAD		COACH	BUS	OTHER
User benefits	TOTAL		Private Cars		Passengers	Passengers	
Travel time	£396,762		£149,102		£119,660	£128,000	
Vehicle operating costs	£13,356		£13,356				
User charges	-£149,902		-£149,902				
During Construction & Maintenance	-£1,597		-£1,556			-£41	
Reliability	£32,834		£32,834				
COMMUTING	£291,454	(1a)	£43,834		£119,619	£128,000	£0
Non-business: Other							
User benefits							
Travel time	£734,362		£331,362			£403,000	
Vehicle operating costs	£22,316		£22,316				
User charges	-£278,255		-£278,255				
During Construction & Maintenance	-£4,778		-£4,621			-£157	
Reliability	£82,684		£82,684				
OTHER	£556,329	(1b)	£153,486		-£157	£403,000	£0
Business							
User benefits			Goods Vehicles (OGVs&LGVs)	Business Cars	Passengers	Passengers	
Travel time	£964,740		£348,737	£556,003		£60,000	
Vehicle operating costs	£67,576		£43,817	£23,759			
User charges	-£690,447		-£559,352	-£131,095			
During Construction & Maintenance	-£4,936		-£2,985	-£1,900		-£51	
Reliability	£181,822		£89,393	£92,429			
Subtotal	£518,755	(2)	-£80,390	£539,196	-£51	£60,000	£0
Private sector provider impacts						Passengers	
Revenue	£307,040				0	£307,040	
Operating costs	-£276,336				£0	-£276,336	
Investment costs					0	£0	
Grant/subsidy					0	£0	
Subtotal	£30,704	(3)			£0	£30,704	£0
Other business impacts							
Developer contributions		(4)					
NET BUSINESS IMPACT	£549,459	(5) = (2) + (3) + (4)					
TOTAL							
Present Value of Transport Economic Efficiency Benefits (TEE)	£1,397,241	(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

5.11 Public accounts (PA)

5.11.1 The Silvertown Tunnel project proposes user charging for 2 reasons:

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

5.11.2 Consequently:

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

5.11.3 TAG guidance A1.1, section 2.8 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. Section 2.8.7 of the guidance notes further that Where a Scheme leads to changes in public sector revenues (for example charging 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.

5.11.4 In this case, this means it depends on whether TfL, a public body, will receive the user charge revenue and whether it can be argued 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 Present Value of Costs as revenue. This leads to a negative cost from which a meaningful Benefit Cost Ratio cannot be calculated.
- 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 Present Value of Benefits side of the BCR calculations.

5.11.5 For the purpose of this assessment, TfL have confirmed that the revenue would fall under the Broad Transport Budget, and hence the charge revenue has been included in the Present Value of Costs. As TAG notes, in these circumstances the use of a negative BCR is not helpful, and the recommended assessment of the project is based on the NPV, which in the present case is a positive NPV of £976m (initial) and £1,273.0m (adjusted with reliability benefits) over 60 years as shown in

5.11.6

5.11.7

5.11.8 Table 5-13 and Table 5-14.

5.11.9 This means the Scheme charges pay for most of the investment and operating costs and result in a significant NPV – clearly a very positive outcome. It also means that over 60 years user charges should exceed investment and operating costs (subject to commercial option chosen) and that this 'surplus' (which is small in the present case) should therefore be available for investment by TfL in other transport improvements.

5.11.10 For schemes such as the present one that require initial capital expenditure but generate significant revenues that accrue to the 'Broad Transport Budget', TAG guidelines (TAG Unit 1.1 Cost-Benefits Analysis) also recommend calculating a metric which divides the NPV by discounted capital (or investment) costs – this provides an indication of the total benefit per pound of capital expenditure. In the present case this metric is £976m (NPV)/ £553m (capital costs) or 1.8 for the initial assessment and £1,273m/£553m or 2.3 for the assessment including reliability benefits, which reinforces the conclusion that the scheme has a very positive outcome.

Table 5-12: Public accounts (initial and adjusted with reliability), £000s

	ALL MODES TOTAL		ROAD INFRASTRUCTURE	COACH	BUS	OTHER
Local Government Funding						
Revenue	-£1,400,690		-£1,226,690		-£174,000	
Operating Costs	£843,040		£536,000		£307,040	
Investment Costs	£553,000		£553,000			
Developer and Other Contributions	0					
Grant/Subsidy Payments	0					
NET IMPACT	-£4,650	(7)	-£137,690	£0	£133,040	£0
Central Government Funding: Transport						
Revenue	£0					
Operating costs	£0					
Investment Costs	£0					
Developer and Other Contributions	£0					
Grant/Subsidy Payments	£0					
NET IMPACT	£0	(8)				
Central Government Funding: Non-Transport						
Indirect Tax Revenues	£143,184	(9)	£113,184		£30,000	
TOTALS						
Broad Transport Budget	-£4,650	(10) = (7) + (8)				
Wider Public Finances	£143,184	(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 5-13: Analysis of monetised costs and benefits (initial), £000s

Noise	-£2,674	*(12)*
Local Air Quality	-£273	*(13)*
Greenhouse Gases	£12,100	*(14)*
Journey Quality		*(15)*
Physical Activity		*(16)*
Accidents	£35,900	*(17)*
Economic Efficiency: Consumer Users (Commuting)	£258,619	*(1a)*
Economic Efficiency: Consumer Users (Other)	£473,645	*(1b)*
Economic Efficiency: Business Users and Providers	£336,933	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-£143,184	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	£971,066	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	-£4,650	*(10)*
Present Value of Costs (see notes) (PVC)	-£4,650	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	**£975,716**	NPV=PVB-PVC
		BCR=PVB/PVC

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.

Table 5-14: Analysis of monetised costs and benefits (adjusted with reliability benefits), £000s

Noise	-£2,674	*(12)*
Local Air Quality	-£273	*(13)*
Greenhouse Gases	£12,100	*(14)*
Journey Quality		*(15)*
Physical Activity		*(16)*
Accidents	£35,900	*(17)*
Economic Efficiency: Consumer Users (Commuting)	£291,454	*(1a)*
Economic Efficiency: Consumer Users (Other)	£556,329	*(1b)*
Economic Efficiency: Business Users and Providers	£518,755	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-£143,184	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	£1,268,406	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	-£4,650	*(10)*
Present Value of Costs (see notes) (PVC)	-£4,650	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	**£1,273,056**	NPV=PVB-PVC
		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.

5.12 Sensitivity tests

5.12.1 A number of economic sensitivity tests have been undertaken.

5.12.2 A simple test was undertaken of the percentage change in key factors (individually) that would be needed to reduce the NPV (initial) from £976m to £500m (over 60 years) – this would still represent a significant NPV and good economic outcome, rather than for example a ‘break-even’ outcome.

5.12.3 Table 5-15 shows the results.

Table 5-15 Single variable sensitivity testing to obtain NPV of £500m (£m-2010 prices)

	Sensitivity	Current	% Change
User time Benefits	1,620	2,096	-23%
Net user benefits	593	1,069	-44%
Investment costs	1,029	553	86%
Revenue	925	1,401	-34%

5.12.4 The table shows that user time benefits would have to reduce by 23%, and net user benefits would need to reduce by 44%. Investment costs would need to increase by 86%; and total revenue would need to decrease by 34%.(We note that revenue has a more complex effect on the economic outcomes, but this gives some indication of impact).

5.12.5 Clearly this is simplistic, as one or more factors could vary in conjunction with each other, but it indicates that significant changes are required in these key variables before the scheme would not be regarded as a good investment. This assessment has also not included the large reliability benefits, which means it is very conservative.

5.12.6 A simple multiple variable test was also undertaken assuming a decrease in time benefits caused by a reduction in demand with a proportional impact in user charges and revenues. This test allows the adjustment of the three variables to reflect the percentage change that would be needed to reduce the NPV (initial) from £976m to £500m (over 60 years). The results are shown in Table 5-16.

Table 5-16 Multiple variable sensitivity testing: NPV=£500m (£m- 2010 prices)

	Sensitivity	Current	% Change
User time Benefits	1,677	2,096	-20%
User charges	895	1,119	-20%
Net user benefits	874	1,069	-18%
Revenue	1,120	1,401	-20%

5.12.7 The table shows that under these assumptions user time benefits, user charges and revenues would each have to be reduced by 20% at the same time to result in a reduced NPV of £500m.

5.12.8 Another test has used the London Value of Time. The main analysis of the report is based on standard National Value of Time however the TfL Business Case Development Manual recommends use of a higher London Value of Time. To indicate the potential impact pending full modelling of this, simple VoT uplift factors of 39.1% and 29.3% have been applied to the travel time benefit calculation for users, with all other assumptions remaining the same. (Further work will be undertaken on the modelling of this sensitivity test). The results are shown below.

5.12.9 These indicate a very significant increase in net user benefits of some £700m for the initial and £800m for the adjusted estimates.

Table 5.15: Net user benefits – National vs London VoT, £m

	Others users			**Business users**				**Total**
	Car commuting	**Car other**	**Bus & coach**	**Cars**	**LGV**	**HGV**	**bus & coach**	
National VoT								
Total user benefits	£161	£349	£650	£578	£291	£ 99	£60	£ 2,188
Total Net user benefit	£11	£71	£650	£ 447	-£40	-£130	£60	£1,069

	Others users			Business users				Total
	Car commuting	**Car other**	**Bus & coach**	**Cars**	**LGV**	**HGV**	**bus & coach**	
% Total Net user benefits	1%	7%	61%	42%	-4%	-12%	6%	100%
London VoT								
Total user benefits	£204	£445	£841	£795	£398	£126	£83	£2,893
Total Net user benefit	£54	£167	£841	£663	£68	-£102	£83	£1,774
% Total Net user benefits	3%	9%	47%	37%	4%	-6%	5%	100%
National VoT (with reliability benefits)								
Total user benefits	£194	£432	£650	£670	£357	£122	£60	£2,485
Total Net user benefit	£44	£153	£650	£539	£26	-£107	£60	£1,367
% Total Net user benefits	3%	11%	48%	39%	2%	-8%	4%	100%
London VoT (with reliability benefits)								
Total user benefits	£247	£552	£841	£923	£490	£159	£83	£3,295
Total Net user benefit	£97	£273	£841	£792	£160	-£70	£83	£2,176
% Total Net user benefits	4%	13%	39%	36%	7%	-3%	4%	100%

5.13 Wider Impacts Assessment

5.13.1 The technical note In Appendix G describes the assessment of Wider Impacts (WI) for the Silvertown Tunnel project – this uses information on user benefits from the TEE table in the EAR, and its outputs are used as an input to the Preliminary Outline Business Case (OBC). The calculations have followed the guidance in TAG Unit A2.1 (January 2014).

5.13.2 The following paragraphs provide a brief description of each of the WI analysed:

5.13.3 WI1- Agglomeration: firms derive productivity benefits from being close to one another and from being located in large labour markets. These impacts appraise the effect of implementing a transport scheme that brings firms closer together and closer to their workforce. These impacts are driven, for example, by increased productivity due to access to larger product, input and labour markets and knowledge and technology spill-overs.

5.13.4 WI2- Output change in imperfectly competitive markets: When companies benefit from time savings due to a transport scheme, it is effectively a reduction in their production costs, this puts in place an incentive to increase the output while still keeping an attractive price-cost margin. This additional output increases the welfare obtained by consumers and WI2 values this change.

5.13.5 WI3.1 Tax revenues arising from labour supply impacts: This impact estimates the effect on taxes due to a change in the number of people attracted into work as a result of an improvement in travel costs. Please note that commuting decisions are based on after tax income, therefore the value of time used for ordinary time savings appraisals does not include exchequer benefits.

5.13.6 Table 5-17 summarises the benefits from the three WI measures.

Table 5-17 Wider Impacts Benefits

Wider Impact (WI)	Undiscounted			Discounted
	2021 (£m)	2031 (£m)	Appraisal period (2021-2080) (£m)	Present Value (£m)
WI1- Agglomeration	1.2	1.6	153.2	37.9
WI2- Output change in imperfectly competitive markets	1.5	2.5	250.9	60.1
WI3- Taxes arising from labour	0.14	0.29	27.3	6.6

supply impacts				
Total Wider Impacts	2.84	4.39	431.4	104.6

5.14 Accessibility Analysis

5.14.1 Appendix H contains details of the accessibility analysis undertaken for the scheme. This is not used in the EAR, but has been used in the associated Wider Impacts, Social and Distributional, Regeneration analyses and the Transport Assessment.

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6. SUMMARY AND CONCLUSIONS

6.1 Summary of economic assessment

6.1.1 The economic assessment process has followed relevant TAG guidance and has used model results and the DfT's TUBA software package and related assessments to estimate the economic implications of the preferred option for the assessed charge.

6.1.2 All results presented here are calculated based on the level of assessed charge (as set out in the User Charging report). The results in this section have also been calculated using national values of time, as required by TAG. These are likely to result in a conservative estimate of benefits in London where values of time are often higher. Sensitivity tests using London values of time are presented in Section 5.12.

6.1.3 Table 6-1 and Table 6-2 below summarise the main findings of the economic assessment in terms of travel time savings to various transport users with and without the reliability adjustment respectively.

Table 6-1: Benefits and charges by user (£m, 2010 prices)

	Others users			Business users				
	Car commuting	Car other	Bus & coach	Cars	LGV	HGV	bus & coach	Total
Total user benefits	£161	£349	£650	£578	£291	£99	£60	£2,188
% benefits	7%	16%	30%	26%	13%	5%	3%	100%
User charges	-£150	-£278	_	-£131	-£331	-£229	_	-£1,119
% user charges	13%	25%	_	12%	30%	20%	_	100%
Total Net user benefit	**£11**	**£71**	**£650**	**£447**	**-£40**	**-£130**	**£60**	**£1,069**
% Total Net user benefits	**1%**	**7%**	**61%**	**42%**	**-4%**	**-12%**	**6%**	**100%**

Table 6-2: Benefits and charges by user – reliability benefits included (£m, 2010 prices)

	Others users			Business users				Total
	Car commuting	Car other	Bus & coach	Cars	LGV	HGV	bus & coach	
Total user benefits	£194	£432	£650	£670	£357	£122	£60	£2,485
% benefits	8%	17%	26%	27%	14%	5%	2%	100%
User charges	-£150	-£278	_	-£131	-£331	-£229	_	-£1,119
% user charges	13.4%	24.9%	_	11.7%	29.6%	20.5%	_	100.0%
Total Net user benefit	**£44**	**£153**	**£650**	**£539**	**£26**	**-£107**	**£60**	**£1,367**
% Total Net user benefits	**3%**	**11%**	**48%**	**39%**	**2%**	**-8%**	**4%**	**100%**

6.1.4 The key economic results for the Silvertown Tunnel Scheme are given in Table 6-3. The £m values shown are in 2010 prices.

Table 6-3: Summary economic analysis[35]

Economic measure	**Initial, £m**	**adjusted with reliability, £m**
Present value of benefits (PVB)	£971.0	£1,268.4
Present value of costs (PVC)	-£4.7	-£4.7
Net present value (PNB-PVC)	£975.7	£1,273.0

6.1.5 The preferred option with assessed charge has a positive Net Present Value of about than £976m (initial) and £1,273m (adjusted with reliability benefits) over the appraisal period –this represents a very good economic outcome.

6.1.6 Due to the fact that the scheme delivers more revenue than the capital costs, it has a net ‘surplus’ in this respect. This means that, as

[35] It should be noted that the figures presented in Tables 6-1 and 6-2 are different from those represented in Table 6-3, as the latter also includes monetary valuation of greenhouse gases, air quality and noise, accidents savings and indirect taxation in addition to the elements included in Table 6-1 and Table 6-2.

recommended in TAG guidance, the conventional Benefit Cost Ratio (BCR) measure is not appropriate for comparisons (it is negative), and the NPV should be used as the key outcome. In this case the NPV is £976m and £1,273m and is clearly a good economic outcome. Another metric of total benefit per pound of capital expenditure also indicates that the scheme has a very positive outcome.

6.1.7 The tables show that each user class (commuting, business and other trips) has positive net benefits (benefits less charges) over the 60 year appraisal.

6.1.8 The tables also show significant net user benefits for all vehicle user groups apart from goods vehicles – the latter have user time and vehicle operating benefits, but these are outweighed by the relevant user charges. It should be noted that TfL proposes to vary the charge by vehicle type to reflect the amount of road space occupied, the contribution to congestion, the emissions and the wear and tear to the road surface caused by different types of vehicles. Consequently HGV's pay the highest charges, and this impacts their net user benefits. There are also indications that the value placed in the current appraisal on reliability of goods vehicles is an underestimate. For example the Freight Transport Association (FTA) calculated that each minute of delay related to unreliability costs an operator £1; a delay of 20 minutes at the Blackwall Tunnel could therefore add £20 to the cost of an individual trip, considerably more than the value currently placed on this impact

6.2 Summary of assumptions or caveats affecting the results

6.2.1 Outputs from the transport models are a key input to much of the content in this report. The transport models themselves are also subject to a number of input assumptions which will impact upon the level of travel demand. The models have considered various sensitivities, and further sensitivity testing of the economic outcomes will be undertaken.

6.2.2 The inclusion of benefits of changes in journey time variability is an accepted TAG approach, which, when added to the benefits, results in all user classes (for both highway and public transport users) having a net user benefit.

6.2.3 The inclusion of benefits relating to time savings in incident delays has been added to the user benefits. These benefits are not specifically mentioned in TAG but the evidence is that these will be clear additional time savings benefits for this scheme.

6.3 Confirmation of the results presented in the AST for the Scheme

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

APPENDIX A: TUBA Economics File

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Economics v1.9.5 file details (WebTAG November 2014 & Data Book November 2014)

TUBA ECONOMIC PARAMETERS FILE (21/11/2014) Version 1.9.5 Final Release

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PARAMETERS
TUBA_version     1.9.5           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   26.64  79.92  53.28  base year non-traded carbon dioxide values in £/tonne(low high central)
t_carbdxvalues    11.81  11.81  11.81  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 A 1.3, Table A 1.3.2
** TAG1 reference: Unit 3.5.6, Table 3b
** %change per annum from 2010 base year
*Start_yr    End_yr     VOT_Gr_purpose1   VOT_Gr_purpose2   VOT_Gr_purpose3 ..
2011          2011             0.801              0.801              0.801
2012          2012            -0.004             -0.004             -0.004
2013          2013             1.093              1.093              1.093
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             1.911              1.911              1.911
2020          2020             1.897              1.897              1.897
2021          2021             1.884              1.884              1.884
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             1.919              1.919              1.919
2026          2026             1.936              1.936              1.936
2027          2027             1.953              1.953              1.953
2028          2028             1.971              1.971              1.971
2029          2029             1.988              1.988              1.988
2030          2030             2.005              2.005              2.005
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	2.063	2.063	2.063
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	2.104	2.104	2.104
2041	2041	2.104	2.104	2.104
2042	2042	2.122	2.122	2.122
2043	2043	2.122	2.122	2.122
2044	2044	2.122	2.122	2.122
2045	2045	2.122	2.122	2.122
2046	2046	2.122	2.122	2.122
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	2.186	2.186	2.186
2053	2053	2.186	2.186	2.186
2054	2054	2.186	2.186	2.186
2055	2055	2.186	2.186	2.186
2056	2056	2.186	2.186	2.186
2057	2057	2.212	2.212	2.212
2058	2058	2.212	2.212	2.212
2059	2059	2.212	2.212	2.212
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	2.176	2.176	2.176
2091	2091	2.176	2.176	2.176
2092	2092	2.176	2.176	2.176
2093	2093	2.176	2.176	2.176
2094	2094	2.176	2.176	2.176
2095	2095	2.176	2.176	2.176
2096	2096	2.176	2.176	2.176
2097	2097	2.176	2.176	2.176
2098	2098	2.176	2.176	2.176
2099	2099	2.176	2.176	2.176
2100	2100	2.176	2.176	2.176

AV_IND_TAX_CHANGES
** %change per annum 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 per annum 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
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 A 1.3.7
** TAG2 reference: Unit A 3.3, Table A 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	42.82	57.53	17.50	2230.00
2	44.57	57.53	17.50	2562.00
3	11.88	0.00	5.00	381.00

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 A 1.3 (Derived) & Unit A 3.3, Table A 3.3 (Derived)
** %change per annum 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	-0.023
2013	2013	1	-3.267	-1.575	0.000	-0.438
2014	2014	1	-7.052	-2.248	0.000	-0.537
2015	2015	1	-6.729	-0.722	0.000	0.000
2016	2016	1	-3.272	1.375	0.000	0.000
2017	2017	1	-1.041	1.668	0.000	-1.352
2018	2018	1	1.052	1.765	0.000	-1.370
2019	2019	1	0.954	1.863	0.000	-1.389
2020	2020	1	2.233	1.469	0.000	-1.409
2021	2021	1	1.849	1.272	0.000	0.000
2022	2022	1	1.898	1.076	0.000	0.000
2023	2023	1	1.862	1.076	0.000	0.000
2024	2024	1	1.828	1.076	0.000	0.000
2025	2025	1	1.873	1.076	0.000	0.000
2026	2026	1	1.916	1.076	0.000	0.000
2027	2027	1	1.880	1.076	0.000	0.000
2028	2028	1	1.919	1.076	0.000	0.000

2029	2029	1	1.883	1.076	0.000	0.000
2030	2030	1	1.919	1.076	0.000	0.000
2031	2031	1	1.952	1.076	0.000	0.000
2032	2032	1	1.915	1.076	0.000	0.000
2033	2033	1	1.879	1.076	0.000	0.000
2034	2034	1	1.976	1.076	0.000	0.000
2035	2035	1	1.938	1.076	0.000	0.000
2036	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	1.643
2013	2013	2	-3.508	-1.575	0.000	-0.436
2014	2014	2	-5.359	-2.248	0.000	0.153
2015	2015	2	-6.936	-0.722	0.000	0.004
2016	2016	2	-3.380	1.375	0.000	0.004
2017	2017	2	-1.076	1.668	0.000	-1.744
2018	2018	2	1.088	1.765	0.000	-1.775
2019	2019	2	0.987	1.863	0.000	-1.807
2020	2020	2	2.309	1.469	0.000	-1.841
2021	2021	2	1.910	1.272	0.000	0.000
2022	2022	2	1.959	1.076	0.000	0.000
2023	2023	2	1.922	1.076	0.000	0.000
2024	2024	2	1.885	1.076	0.000	0.000
2025	2025	2	1.931	1.076	0.000	0.000
2026	2026	2	1.973	1.076	0.000	0.000
2027	2027	2	1.935	1.076	0.000	0.000
2028	2028	2	1.974	1.076	0.000	0.000
2029	2029	2	1.936	1.076	0.000	0.000
2030	2030	2	1.972	1.076	0.000	0.000
2031	2031	2	2.006	1.076	0.000	0.000
2032	2032	2	1.966	1.076	0.000	0.000
2033	2033	2	1.929	1.076	0.000	0.000
2034	2034	2	2.027	1.076	0.000	0.000
2035	2035	2	1.987	1.076	0.000	0.000
2036	2100	2	0.000	1.076	0.000	0.000
2011	2011	3	4.790	0.000	0.000	-1.884
2012	2012	3	4.557	0.000	0.000	-2.027
2013	2013	3	5.585	0.000	0.000	-2.184
2014	2014	3	3.842	0.000	0.000	-2.356
2015	2015	3	-1.707	0.000	0.000	-2.547
2016	2016	3	6.629	0.000	0.000	-2.759
2017	2017	3	6.287	0.000	0.000	-2.995
2018	2018	3	0.787	0.000	0.000	-3.258
2019	2019	3	6.441	0.000	0.000	-3.555
2020	2020	3	-0.047	0.000	0.000	-3.891
2021	2021	3	3.664	0.000	0.000	-4.273

2022	2022	3	1.729	0.000	0.000	-4.711
2023	2023	3	-0.025	0.000	0.000	-5.219
2024	2024	3	2.059	0.000	0.000	-5.812
2025	2025	3	2.628	0.000	0.000	-6.513
2026	2026	3	2.190	0.000	0.000	-7.353
2027	2027	3	-0.761	0.000	0.000	-8.378
2028	2028	3	-0.023	0.000	0.000	-9.651
2029	2029	3	-0.573	0.000	0.000	-11.275
2030	2030	3	1.170	0.000	0.000	-13.413
2031	2031	3	-0.012	0.000	0.000	-8.717
2032	2032	3	-0.047	0.000	0.000	-8.717
2033	2033	3	-0.075	0.000	0.000	-8.717
2034	2034	3	-0.099	0.000	0.000	-8.717
2035	2035	3	-0.118	0.000	0.000	-8.717
2036	2036	3	-0.133	0.000	0.000	-8.717
2037	2037	3	-0.144	0.000	0.000	-8.717
2038	2038	3	-0.153	0.000	0.000	-8.717
2039	2039	3	-0.159	0.000	0.000	-8.717
2040	2040	3	-0.162	0.000	0.000	-8.717
2041	2041	3	-0.254	0.000	0.000	-10.951
2042	2042	3	0.076	0.000	0.000	-2.339
2043	2043	3	-0.267	0.000	0.000	-11.255
2044	2044	3	-0.235	0.000	0.000	-10.716
2045	2045	3	0.216	0.000	0.000	2.705
2046	2046	3	-0.127	0.000	0.000	-7.376
2047	2047	3	-0.167	0.000	0.000	-8.589
2048	2048	3	0.674	0.000	0.000	17.686
2049	2049	3	-0.306	0.000	0.000	-11.319
2050	2050	3	0.115	0.000	0.000	0.000
2051	2051	3	0.125	0.000	0.000	0.000
2052	2052	3	0.121	0.000	0.000	0.000
2053	2053	3	0.121	0.000	0.000	0.000
2054	2054	3	0.121	0.000	0.000	0.000
2055	2055	3	0.117	0.000	0.000	0.000
2056	2056	3	0.118	0.000	0.000	0.000
2057	2057	3	0.113	0.000	0.000	0.000
2058	2058	3	0.111	0.000	0.000	0.000
2059	2059	3	0.109	0.000	0.000	0.000
2060	2060	3	0.106	0.000	0.000	0.000
2061	2061	3	0.084	0.000	0.000	0.000
2062	2062	3	0.083	0.000	0.000	0.000
2063	2063	3	0.075	0.000	0.000	0.000
2064	2064	3	0.071	0.000	0.000	0.000
2065	2065	3	0.062	0.000	0.000	0.000
2066	2066	3	0.061	0.000	0.000	0.000
2067	2067	3	0.051	0.000	0.000	0.000
2068	2068	3	0.047	0.000	0.000	0.000

2069	2069	3	0.040	0.000	0.000	0.000
2070	2070	3	0.034	0.000	0.000	0.000
2071	2071	3	0.034	0.000	0.000	0.000
2072	2072	3	0.028	0.000	0.000	0.000
2073	2073	3	0.024	0.000	0.000	0.000
2074	2074	3	0.014	0.000	0.000	0.000
2075	2075	3	0.015	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	-0.007	0.000	0.000	0.000
2079	2079	3	-0.010	0.000	0.000	0.000
2080	2080	3	-0.019	0.000	0.000	0.000
2081	2081	3	-0.003	0.000	0.000	0.000
2082	2082	3	-0.012	0.000	0.000	0.000
2083	2083	3	-0.016	0.000	0.000	0.000
2084	2084	3	-0.019	0.000	0.000	0.000
2085	2085	3	-0.017	0.000	0.000	0.000
2086	2086	3	-0.027	0.000	0.000	0.000
2087	2087	3	-0.031	0.000	0.000	0.000
2088	2088	3	-0.032	0.000	0.000	0.000
2089	2089	3	-0.037	0.000	0.000	0.000
2090	2090	3	-0.037	0.000	0.000	0.000
2091	2091	3	-0.032	0.000	0.000	0.000
2092	2092	3	-0.033	0.000	0.000	0.000
2093	2093	3	-0.041	0.000	0.000	0.000
2094	2094	3	-0.042	0.000	0.000	0.000
2095	2095	3	-0.043	0.000	0.000	0.000
2096	2096	3	-0.045	0.000	0.000	0.000
2097	2097	3	-0.043	0.000	0.000	0.000
2098	2098	3	-0.051	0.000	0.000	0.000
2099	2099	3	-0.046	0.000	0.000	0.000
2100	2100	3	-0.051	0.000	0.000	0.000

CARBDX_VALUE_CHANGES
** TAG2 reference: Unit A 3, Table A 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	1.50601	0.00000	-10.52329	0.00000	1.50613	0.00000	-10.52329	0.00000	1.50619	0.00000	-10.52329	0.00000
2012	2012	1.50030	0.00000	-44.42426	0.00000	1.50005	0.00000	-44.42426	0.00000	1.49993	0.00000	-44.42426	0.00000
2013	2013	1.49999	0.00000	-38.03637	0.00000	1.49999	0.00000	-38.03637	0.00000	1.49999	0.00000	-38.03637	0.00000
2014	2014	1.49972	0.00000	-99.99973	0.00000	1.49996	0.00000	216.00165	0.00000	1.50008	0.00000	14.39406	0.00000
2015	2015	1.50019	0.00000	0.00000	0.00000	1.50007	0.00000	27.47385	0.00000	1.50001	0.00000	1.70558	0.00000
2016	2016	1.49997	0.00000	0.00000	0.00000	1.49997	0.00000	24.56033	0.00000	1.49997	0.00000	2.27691	0.00000
2017	2017	1.50011	0.00000	0.00000	0.00000	1.50000	0.00000	6.27150	0.00000	1.49994	0.00000	2.49180	0.00000
2018	2018	1.49993	0.00000	0.00000	0.00000	1.49993	0.00000	27.93923	0.00000	1.50010	0.00000	3.92285	0.00000
2019	2019	1.50009	0.00000	0.00000	0.00000	1.50009	0.00000	26.32285	0.00000	1.49992	0.00000	3.85933	0.00000
2020	2020	1.49991	0.00000	0.00000	0.00000	1.49991	0.00000	17.47901	0.00000	1.50008	0.00000	3.71801	0.00000
2021	2021	1.66663	0.00000	35883600.00000	0.00000	1.66674	0.00000	19.37337	0.00000	1.66663	0.00000	135.20721	0.00000

2022	2022	1.63931	0.00000	100.00000	0.00000	1.63931	0.00000	16.22922	0.00000	1.63931	0.00000	57.48515	0.00000
2023	2023	1.61287	0.00000	49.99861	0.00000	1.61287	0.00000	13.96312	0.00000	1.61287	0.00000	36.50141	0.00000
2024	2024	1.58727	0.00000	33.33364	0.00000	1.58737	0.00000	12.25231	0.00000	1.58742	0.00000	26.74068	0.00000
2025	2025	1.56247	0.00000	25.00017	0.00000	1.56247	0.00000	10.91497	0.00000	1.56246	0.00000	21.09874	0.00000
2026	2026	1.53843	0.00000	20.00011	0.00000	1.53843	0.00000	9.84085	0.00000	1.53843	0.00000	17.42301	0.00000
2027	2027	1.51541	0.00000	16.66674	0.00000	1.51522	0.00000	8.95931	0.00000	1.51512	0.00000	14.83760	0.00000
2028	2028	1.49250	0.00000	14.28537	0.00000	1.49250	0.00000	8.22251	0.00000	1.49250	0.00000	12.92051	0.00000
2029	2029	1.47055	0.00000	12.50009	0.00000	1.47056	0.00000	7.59778	0.00000	1.47070	0.00000	11.44230	0.00000
2030	2030	1.44924	0.00000	11.11118	0.00000	1.44934	0.00000	7.06128	0.00000	1.44924	0.00000	10.26731	0.00000
2031	2031	9.28565	0.00000	9.28565	0.00000	9.28574	0.00000	9.28574	0.00000	9.28565	0.00000	9.28565	0.00000
2032	2032	8.49668	0.00000	8.49668	0.00000	8.49667	0.00000	8.49667	0.00000	8.49680	0.00000	8.49680	0.00000
2033	2033	7.83151	0.00000	7.83151	0.00000	7.83135	0.00000	7.83135	0.00000	7.83127	0.00000	7.83127	0.00000
2034	2034	7.26251	0.00000	7.26251	0.00000	7.26259	0.00000	7.26259	0.00000	7.26263	0.00000	7.26263	0.00000
2035	2035	6.77078	0.00000	6.77078	0.00000	6.77078	0.00000	6.77078	0.00000	6.77078	0.00000	6.77078	0.00000
2036	2036	6.34142	0.00000	6.34142	0.00000	6.34148	0.00000	6.34148	0.00000	6.34151	0.00000	6.34151	0.00000
2037	2037	5.96344	0.00000	5.96344	0.00000	5.96332	0.00000	5.96332	0.00000	5.96326	0.00000	5.96326	0.00000
2038	2038	5.62766	0.00000	5.62766	0.00000	5.62767	0.00000	5.62767	0.00000	5.62775	0.00000	5.62775	0.00000
2039	2039	5.32783	0.00000	5.32783	0.00000	5.32789	0.00000	5.32789	0.00000	5.32783	0.00000	5.32783	0.00000
2040	2040	5.05833	0.00000	5.05833	0.00000	5.05838	0.00000	5.05838	0.00000	5.05841	0.00000	5.05841	0.00000
2041	2041	4.81493	0.00000	4.81493	0.00000	4.81483	0.00000	4.81483	0.00000	4.81478	0.00000	4.81478	0.00000
2042	2042	4.59360	0.00000	4.59360	0.00000	4.59361	0.00000	4.59361	0.00000	4.59368	0.00000	4.59368	0.00000
2043	2043	4.39186	0.00000	4.39186	0.00000	4.39191	0.00000	4.39191	0.00000	4.39186	0.00000	4.39186	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	3.88069	0.00000	3.88069	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	2.50101	0.00000	2.50101	0.00000	3.88150	0.00000	3.88150	0.00000	3.53641	0.00000	3.53641	0.00000
2052	2052	2.26534	0.00000	2.26534	0.00000	3.65210	0.00000	3.65210	0.00000	3.30888	0.00000	3.30888	0.00000
2053	2053	2.16526	0.00000	2.16526	0.00000	3.56028	0.00000	3.56028	0.00000	3.21850	0.00000	3.21850	0.00000
2054	2054	2.05604	0.00000	2.05604	0.00000	3.45952	0.00000	3.45952	0.00000	3.11920	0.00000	3.11920	0.00000
2055	2055	1.85633	0.00000	1.85633	0.00000	3.26702	0.00000	3.26702	0.00000	2.92841	0.00000	2.92841	0.00000
2056	2056	1.77918	0.00000	1.77918	0.00000	3.19925	0.00000	3.19925	0.00000	2.86203	0.00000	2.86203	0.00000
2057	2057	1.58880	0.00000	1.58880	0.00000	3.01666	0.00000	3.01666	0.00000	2.68109	0.00000	2.68109	0.00000
2058	2058	1.44627	0.00000	1.44627	0.00000	2.88302	0.00000	2.88302	0.00000	2.54899	0.00000	2.54899	0.00000
2059	2059	1.33043	0.00000	1.33043	0.00000	2.77654	0.00000	2.77654	0.00000	2.44390	0.00000	2.44390	0.00000
2060	2060	1.20119	0.00000	1.20119	0.00000	2.65678	0.00000	2.65678	0.00000	2.32563	0.00000	2.32563	0.00000
2061	2061	0.67271	0.00000	0.67271	0.00000	2.13227	0.00000	2.13227	0.00000	1.80389	0.00000	1.80389	0.00000
2062	2062	0.61783	0.00000	0.61783	0.00000	2.08843	0.00000	2.08843	0.00000	1.76122	0.00000	1.76122	0.00000
2063	2063	0.40133	0.00000	0.40133	0.00000	1.88091	0.00000	1.88091	0.00000	1.55542	0.00000	1.55542	0.00000
2064	2064	0.28340	0.00000	0.28340	0.00000	1.77356	0.00000	1.77356	0.00000	1.44942	0.00000	1.44942	0.00000
2065	2065	0.07913	0.00000	0.07913	0.00000	1.57902	0.00000	1.57902	0.00000	1.25656	0.00000	1.25656	0.00000
2066	2066	0.03302	0.00000	0.03302	0.00000	1.54524	0.00000	1.54524	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	-0.30191	0.00000	-0.30191	0.00000	1.23224	0.00000	1.23224	0.00000	0.91392	0.00000	0.91392	0.00000
2069	2069	-0.46074	0.00000	-0.46074	0.00000	1.08509	0.00000	1.08509	0.00000	0.76818	0.00000	0.76818	0.00000
2070	2070	-0.58515	0.00000	-0.58515	0.00000	0.97302	0.00000	0.97302	0.00000	0.65747	0.00000	0.65747	0.00000
2071	2071	-0.60930	0.00000	-0.60930	0.00000	0.96332	0.00000	0.96332	0.00000	0.64880	0.00000	0.64880	0.00000
2072	2072	-0.73840	0.00000	-0.73840	0.00000	0.84744	0.00000	0.84744	0.00000	0.53427	0.00000	0.53427	0.00000
2073	2073	-0.83654	0.00000	-0.83654	0.00000	0.76324	0.00000	0.76324	0.00000	0.45127	0.00000	0.45127	0.00000
2074	2074	-1.03282	0.00000	-1.03282	0.00000	0.57978	0.00000	0.57978	0.00000	0.26934	0.00000	0.26934	0.00000
2075	2075	-1.03744	0.00000	-1.03744	0.00000	0.59161	0.00000	0.59161	0.00000	0.28212	0.00000	0.28212	0.00000

2076	2076	-1.30958	0.00000	-1.30958	0.00000	0.33181	0.00000	0.33181	0.00000	0.02404	0.00000	0.02404	0.00000
2077	2077	-1.31588	0.00000	-1.31588	0.00000	0.34285	0.00000	0.34285	0.00000	0.03598	0.00000	0.03598	0.00000
2078	2078	-1.49268	0.00000	-1.49268	0.00000	0.18087	0.00000	0.18087	0.00000	-0.12455	0.00000	-0.12455	0.00000
2079	2079	-1.57098	0.00000	-1.57098	0.00000	0.11971	0.00000	0.11971	0.00000	-0.18461	0.00000	-0.18461	0.00000
2080	2080	-1.76877	0.00000	-1.76877	0.00000	-0.06265	0.00000	-0.06265	0.00000	-0.36548	0.00000	-0.36548	0.00000
2081	2081	-1.47843	0.00000	-1.47843	0.00000	0.25229	0.00000	0.25229	0.00000	-0.05059	0.00000	-0.05059	0.00000
2082	2082	-1.67227	0.00000	-1.67227	0.00000	0.07515	0.00000	0.07515	0.00000	-0.22628	0.00000	-0.22628	0.00000
2083	2083	-1.76886	0.00000	-1.76886	0.00000	-0.00247	0.00000	-0.00247	0.00000	-0.30276	0.00000	-0.30276	0.00000
2084	2084	-1.85407	0.00000	-1.85407	0.00000	-0.06779	0.00000	-0.06779	0.00000	-0.36701	0.00000	-0.36701	0.00000
2085	2085	-1.83424	0.00000	-1.83424	0.00000	-0.02559	0.00000	-0.02559	0.00000	-0.32402	0.00000	-0.32402	0.00000
2086	2086	-2.04991	0.00000	-2.04991	0.00000	-0.22240	0.00000	-0.22240	0.00000	-0.51935	0.00000	-0.51935	0.00000
2087	2087	-2.15440	0.00000	-2.15440	0.00000	-0.30548	0.00000	-0.30548	0.00000	-0.60129	0.00000	-0.60129	0.00000
2088	2088	-2.19812	0.00000	-2.19812	0.00000	-0.32581	0.00000	-0.32581	0.00000	-0.62070	0.00000	-0.62070	0.00000
2089	2089	-2.32107	0.00000	-2.32107	0.00000	-0.42607	0.00000	-0.42607	0.00000	-0.71983	0.00000	-0.71983	0.00000
2090	2100	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	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	59.2715	40.7279	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 per annum from 2010 base year

*Start_yr	End_yr	Veh_type	%Change_Petrol	%Change_Diesel	%Change_Electric
2011	2011	1	-3.8142	5.4719	5352.0891
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	33.3333
2015	2015	1	-4.5017	4.4890	25.0000
2016	2016	1	-1.7769	1.3348	97.7885
2017	2017	1	-1.8090	1.3172	49.4409
2018	2018	1	-1.8424	1.3001	33.0839
2019	2019	1	-1.8769	1.2834	24.8594
2020	2020	1	-1.9128	1.2671	19.9099
2021	2021	1	0.3233	-0.8263	32.7936
2022	2022	1	0.3222	-0.8332	24.6952
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	0.0206	-1.0600	21.7548
2027	2027	1	0.0206	-1.0714	17.8677
2028	2028	1	0.0205	-1.0830	15.1591
2029	2029	1	0.0205	-1.0949	13.1636
2030	2030	1	0.0205	-1.1070	11.6324
2011	2011	2	-7.5786	0.4719	0.0000
2012	2012	2	-8.2000	0.4697	0.0000
2013	2013	2	-8.9325	0.4675	0.0000
2014	2014	2	-9.8087	0.4653	0.0000
2015	2015	2	-10.8754	0.4631	0.0000
2016	2016	2	-9.6341	0.3640	0.0000
2017	2017	2	-10.6612	0.3627	0.0000
2018	2018	2	-11.9334	0.3613	0.0000
2019	2019	2	-13.5504	0.3600	0.0000
2020	2020	2	-15.6744	0.3587	0.0000
2021	2021	2	-8.9794	0.1727	0.0000
2022	2022	2	-9.8652	0.1724	0.0000
2023	2023	2	-10.9450	0.1721	0.0000
2024	2024	2	-12.2901	0.1718	0.0000
2025	2025	2	-14.0123	0.1715	0.0000
2026	2026	2	-4.8880	0.0514	0.0000
2027	2027	2	-5.1392	0.0513	0.0000
2028	2028	2	-5.4176	0.0513	0.0000
2029	2029	2	-5.7279	0.0513	0.0000
2030	2030	2	-6.0760	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          1.119322393  0.044004770 -8.13834E-05   2.44900E-06       140
  1           2          0.492145560  0.062181967 -5.90984E-04   4.64700E-06       140
  1           3          0.000000000  0.125642360  0.00000E+00   0.00000E+00       140
  2           1          1.950832769  0.034527979  6.79868E-05   3.71490E-06       140
  2           2          1.396883496  0.033477400 -2.29978E-04   7.67320E-06       140
  3           1          1.950832769  0.034527979  6.79868E-05   3.71490E-06       140
  3           2          1.396883496  0.033477400 -2.29978E-04   7.67320E-06       140
  4           2          1.431445529  0.258021379 -3.90664E-03   3.36231E-05        96
  5           2          2.670111055  0.557155643 -7.97614E-03   6.00353E-05        96
  6           2          5.980054953  0.245278327 -3.06499E-03   3.06148E-05        96

FUEL_EFFICIENCY
** TAG2 Reference: Unit A 1.3, Table A 1.3.10
** TAG1 Reference: Unit 3.5.6, Table 13
** %change per annum from 2010 base year
*Start_yr     End_yr    Veh_type  Fuel_type         Change
2011          2015           1         1            1.81
2011          2015           1         2            2.23
2011          2015           1         3            -0.1
2011          2015           2         1            0.11
2011          2015           2         2            2.71
2011          2015           3         1            0.11
2011          2015           3         2            2.71
2016          2020           1         1            3.32
2016          2020           1         2            2.22
2016          2020           1         3            0.02
2016          2020           2         1            2.35
2016          2020           2         2            2.35
2016          2020           3         1            2.35
2016          2020           3         2            2.35
2021          2025           1         1            3.16
2021          2025           1         2            2.02
2021          2025           1         3            0.12
2021          2025           2         1            2.85
2021          2025           2         2            1.65
2021          2025           3         1            2.85
2021          2025           3         2            1.65
2026          2030           1         1            1.56
2026          2030           1         2            1.19
2026          2030           1         3            0.00
2026          2030           2         1            2.40
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2026          2030           2         2           0.74
2026          2030           3         1           2.40
2026          2030           3         2           0.74
2031          2035           1         1           0.57
2031          2035           1         2           0.52
2031          2035           1         3          -0.08
2031          2035           2         1           0.54
2031          2035           2         2           0.22
2031          2035           3         1           0.54
2031          2035           3         2           0.22
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 per annum 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
```

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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 per annum 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
```

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  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     92.1
  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     68.8     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        34.0     27.7     67.4     23.7     89.4

DEFAULT_PERSON_FACTORS
** TAG2 reference: Unit A1.3, Table A 1.3.3
** 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 per annum 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 & mode) 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: Input Matrix Factors

The Input matrix factors used are summarised below.

Table B-1: Input matrix factors:

	Timeslice	1 (AM)	2 (PM)	3 (IP)	4 (Off-peak)
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 from 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 (i.e. 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 is used to adjust from the model's 2009 price base to 2010, the TUBA based year.

APPENDIX C: Public Transport (Bus) benefits calculations methodology

Silvertown Tunnel Appendix C

Transport for London

Public Transport User Benefits Methodology

Technical Note

24 September 2015

Silvertown Tunnel Appendix C

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1	9 July 2015	For TfL Review	MH	HM	AN
2	19 August 2015	With amendments following comments from TfL and Atkins	MH	AN	AN
3	22 September 2015	Final draft for TfL and Atkins review	MH	ML	AN

Contents

1. Introduction

This note documents the methodology used in the Business Case associated with the package of bus service improvements for the proposed Silvertown tunnel scheme in the Assessed Case. The Silvertown Tunnel scheme is made up of a new bored tunnel running between the Blackwall Tunnel Southern Approach on the Greenwich Peninsula to the Tidal Basin roundabout in the Royal Docks area.

2. Bus service improvements

2.1 Bus service package

The bus service changes proposed in the Assessed Case are the following:

- 108 – increase from 6 buses per hour (bph) to 7.5 bph;
- 129 – Extension to Beckon via Silvertown tunnel;
- 104 – Extension to North Greenwich via Silvertown tunnel;
- 309 – Extension to North Greenwich via Silvertown tunnel;
- Eltham to Beckton – New service; and
- Grove Park to Canary Wharf – New service;

Figure 2.1 illustrates the routes of the above bus service improvements.

Figure 2.1 : Map of bus service improvements

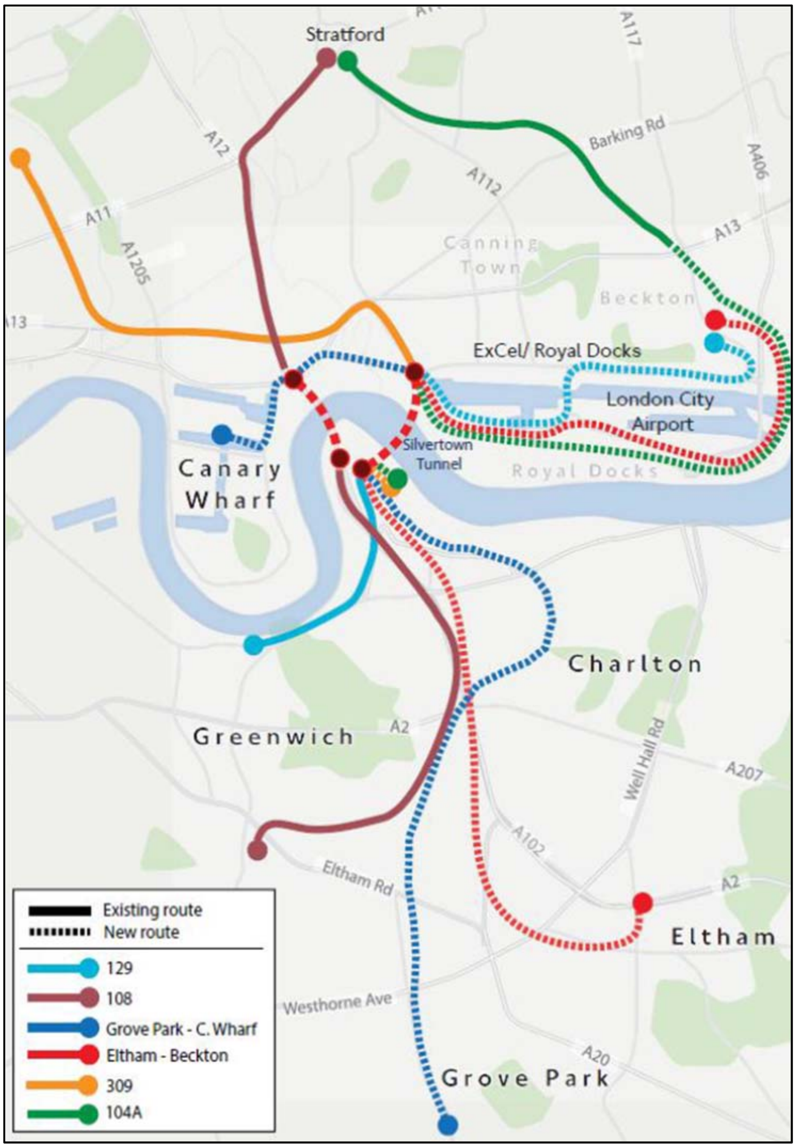


Table 2-1 below shows the existing and proposed bus service frequencies associated with the Assessed Case bus services and provides some commentary on the assumptions for the services.

Table 2-1 Bus service frequencies

Bus service	Existing Frequency (buses per hour)	Proposed Frequency (buses per hour)	Other changes / comments
108	6	7.5	Minor change to the route in the southbound direction at North Greenwich to account for the new road layout due to the tunnel.
129	5	10	The stopping pattern of other bus services using the route was assumed for the extension.
104	6	6	In the modelling, the current service 104 has been replaced by service 104A and service 104B. Route 104A extends via Silvertown Tunnel and terminates at Stratford and North Greenwich Bus Stations. Route 104B terminates at Manor Park and Custom House Bus Stations. The stopping pattern of other bus services using the route was assumed for the extension.
309	5	5	The stopping pattern of other bus services using the route was assumed for the extension.
Eltham to Beckton	-	5	The stopping pattern of other bus services using the route was assumed for the new service.
Grove Park to Canary Wharf	-	4	The stopping pattern of other bus services using the route was assumed for the new service.

Note that the journey time improvement is forecast to result from the capacity improvement resulting from the Silvertown tunnel were not represented in the Railplan coding of the bus improvement package. Existing journey times from the 108 bus and others (using TfL iBus data) were used to code the new services where routes existed, and SATURN journey times were used for the Silvertown Tunnel. Therefore the user travel time benefits described in this document are likely to be an underestimate of the potential user travel time benefits associated with the scheme.

2.2 Impact of bus service improvements

The above bus package of improvements was implemented for the Silvertown test scenario in Railplan that sits within LoRDM (London Regional Demand Model).

In 2031 the Assessed Case results in a small mode shift from car to public transport / active modes (walking and cycling) of approximately 2,000 daily trips in 2031 and a shift from active modes to public transport of approximately 6,000 daily trips. Overall public transport gains approximately 8,000 daily trips (in 2031). (Note that there are also changes between public transport sub-modes e.g. between rail and bus and these are discussed later in this report.)The Assessed case results in a shift from rail to bus as can been seen in the summary Railplan statistics of passenger kilometres and passenger boarders.

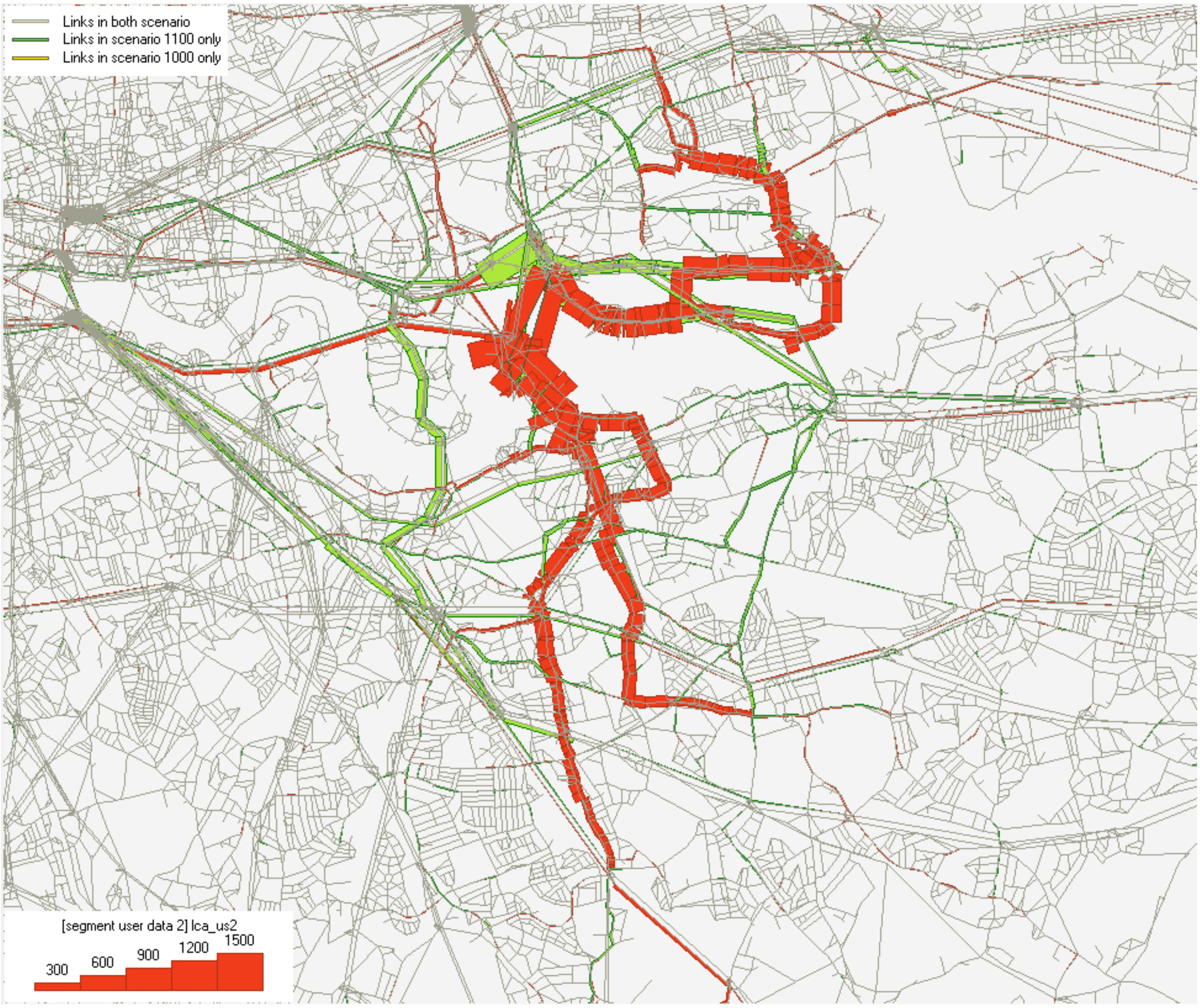
Table 2-2 Railplan summary statistics

	Ref Case 2021	2021 Assessed Case	Difference	Percent difference
PASSENGER KILOMETRES				
National Rail	53,453,332	53,449,208	-4,124	0.0%
London Underground	12,546,714	12,547,468	754	0.0%
DLR	443,244	435,625	-7,619	-1.7%
Buses	**4,866,999**	**4,893,874**	**26,875**	**+0.6%**
Croydon Tramlink	147,562	147,075	-487	-0.3%
PASSENGER BOARDINGS				
National Rail	1,523,984	1,523,357	-627	0.0%
London Underground	1,710,388	1,710,195	-193	0.0%
DLR	101,194	98,625	-2,569	-2.5%
Buses	**1,343,015**	**1,350,293**	**7,278**	**+0.5%**
Croydon Tramlink	31,258	31,203	-55	-0.2%

Figure 2.1 is a snapshot of the change in the 2021 AM transit line flows by link from Railplan. The figure shows increases as expected on all the links with the Assessed Case, with the shift to bus coming primarily from national rail services and DLR as travellers move to routes with lower travel cost.

Similar impacts are apparent for the IP and PM time periods.

Figure 2.2 : Change in AM transit volume 2021 Assessed Case vs. 2021 Ref Case



2.3 Bus Patronage

Railplan outputs provide statistics on the number of users of each bus service. Figure 2.3, Figure 2.4 and Figure 2.5 present the average number of boarders per hour per service. As can be seen in the figures the key points are:

- Patronage on service 108 increases by approximately 20%-25% as a result of the frequency increase.
- Patronage on service 129 increases approximately 4 fold as a result of the extension across the river and the frequency increase.
- Patronage on service 309 increases approximately 2 fold as a result of the extension across the river; however, patronage is relatively low compared to other routes.
- Patronage on service 104 increases approximately 2 fold as a result of the extension across the river.
- Patronage on each of the other new services (Eltham to Beckton and Grove Park to Canary Wharf) is around 65% - 95% that of existing levels of patronage on the 108.

Figure 2.3 : Boarders by Transit line – AM Peak hour

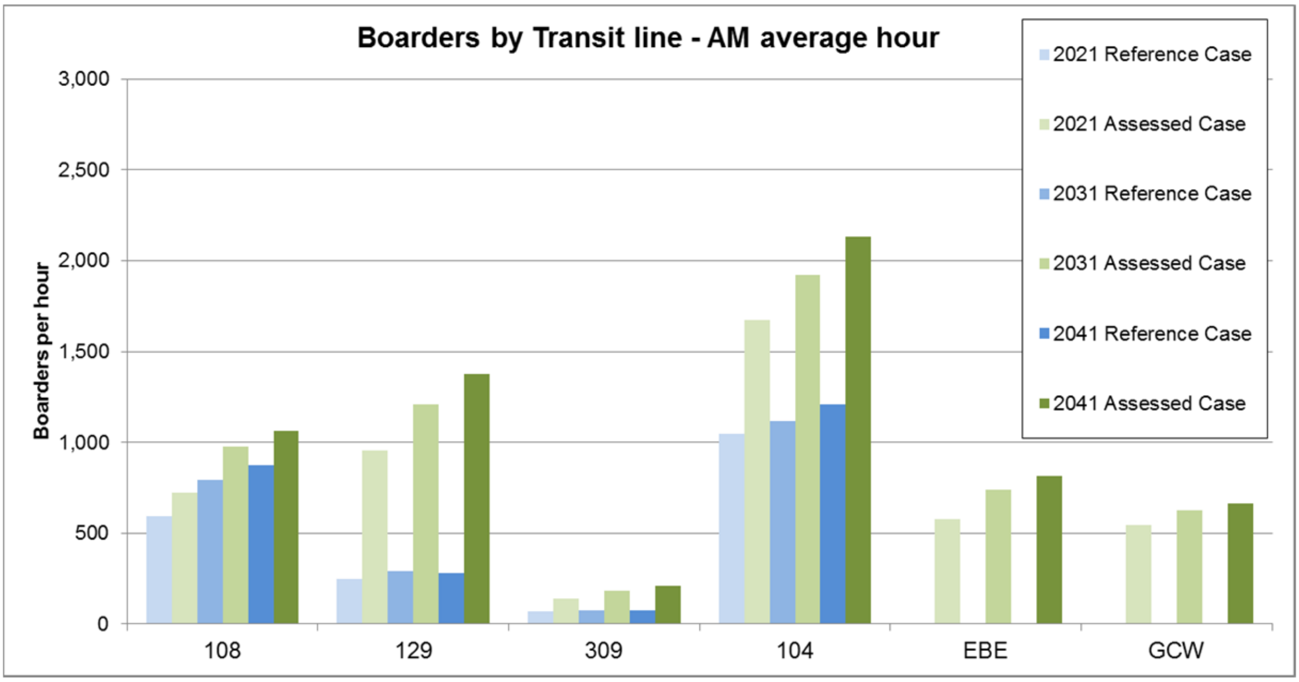


Figure 2.4 : Boarders by Transit line – IP Peak hour

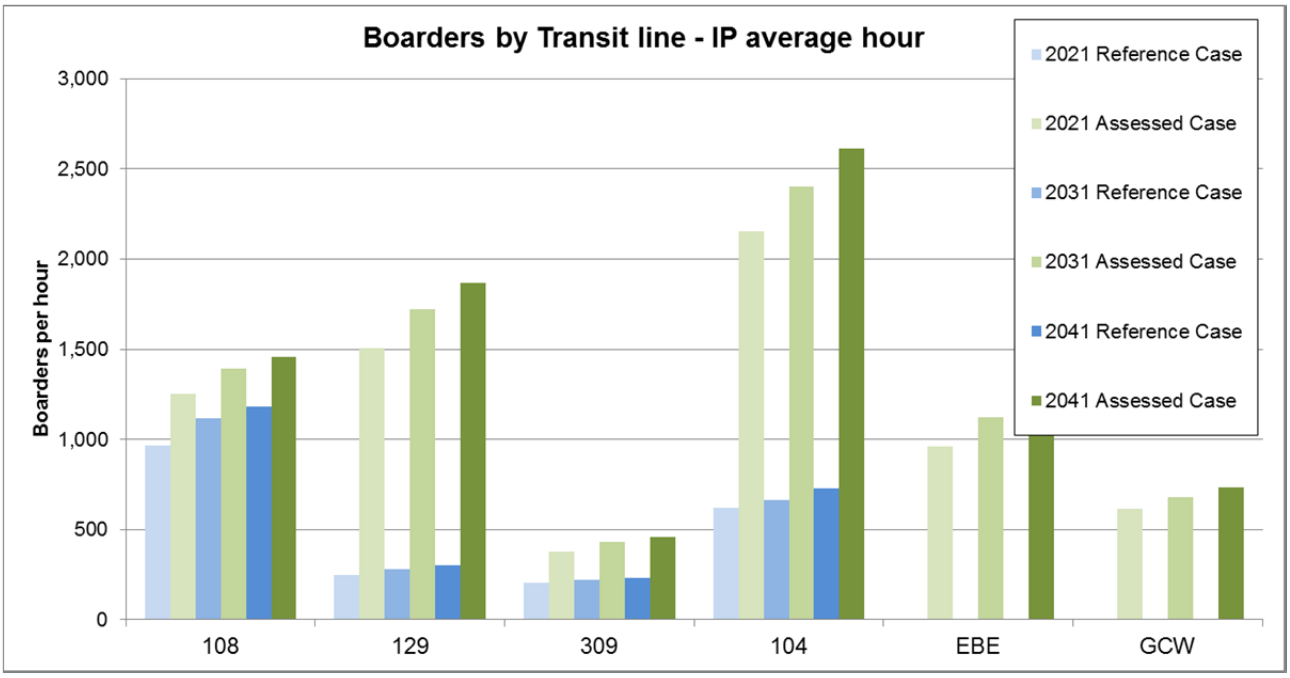
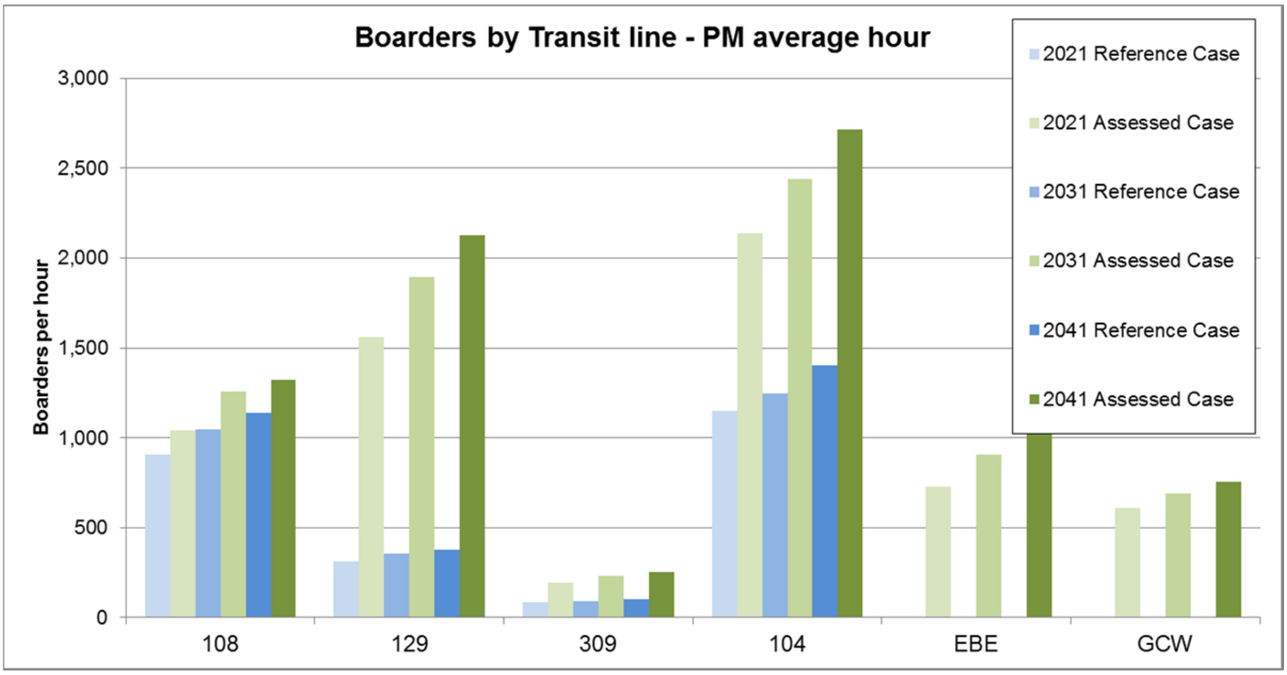


Figure 2.5 : Boarders by Transit line – PM Peak hour



2.4 Change in generalised time

The change in the generalised time outputs from Railplan between the Assessed Case and the Reference Case is one method of verifying that the coding of the bus service improvements has been implemented correctly.

The tables below present the changes in the Out of Work Time (OWT) generalised time per person between the 2021 assessed case scenario and the 2021 Reference case scenario. It is expected that the greatest reduction in generalised time would be cross-river trips to and from areas served by the bus service improvements. This is apparent in the tables below.

As shown in Table 2.3 the change in the OWT generalised time per person from boroughs north of the river to boroughs south of the river is as expected highest between Newham and Greenwich (a reduction of approximately 3.3 minutes in generalised time) – most other changes are typically 60 seconds or less.

Table 2.3 : Change in AM OWT generalised time per person 2021 Assessed Case vs. 2021 Ref Case (minutes and decimals of minutes) – from key boroughs north of the river to boroughs south of the river

	Greenwich	Lewisham	Bexley	Southwark	Bromley
Tower Hamlets	-0.79	-0.21	-0.22	-0.02	-0.07
Newham	**-3.32**	-0.61	-0.83	-0.04	-0.54
City of London	-0.03	-0.02	-0.00	-0.00	-0.00
Hackney	-0.17	-0.03	-0.01	-0.00	+0.00
Waltham Forest	-0.30	-0.06	-0.07	+0.01	+0.00
Redbridge	-0.34	-0.08	-0.13	+0.00	-0.03
Barking and Dagenham	-0.82	-0.18	-0.24	-0.11	-0.20

Similarly as shown in Table 2.4 the average change in the OWT generalised time per person from boroughs south of the river to boroughs north of the river is as expected highest between Greenwich and Newham (a reduction of approximately 3.3 minutes in generalised time) and between Lewisham and Newham (a reduction of just over 1 minute in generalised time) – other changes are typically 60 seconds or less.

Table 2.4 : Change in AM OWT generalised time per person 2021 Assessed Case vs. 2021 Ref Case (minutes and decimals of minutes) – from key boroughs south of the river to boroughs north of the river

	Tower Hamlets	Newham	City of London	Hackney	Waltham Forest	Redbridge	Barking and Dagenham
Greenwich	-0.58	**-3.34**	-0.13	-0.28	-0.64	-0.65	-0.74
Lewisham	-0.20	-1.13	-0.02	-0.02	-0.17	-0.12	-0.10
Bexley	-0.12	-0.66	-0.02	-0.03	-0.05	-0.06	-0.15
Southwark	-0.01	-0.13	+0.02	+0.00	-0.00	+0.01	+0.01
Bromley	-0.06	-0.31	+0.05	+0.00	+0.05	+0.01	+0.01

The relatively high change in generalised time between Greenwich and Newham is plausible given the currently limited number of PT services linking these two boroughs. Those that do exist like the Jubilee line and the DLR only serve areas in the east of these boroughs.

As shown in Table 2.5 generally the average change in the OWT generalised time per person within and between boroughs north of the river is 30 seconds or less.

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Table 2.5 : Change in AM OWT generalised time per person 2021 Assessed Case vs. 2021 Ref Case (minutes and decimals of minutes) – between key boroughs north of the river

	Tower Hamlets	Newham	City of London	Hackney	Waltham Forest	Redbridge	Barking and Dagenham
Tower Hamlets	-0.03	-0.23	-0.02	-0.02	-0.02	-0.02	-0.05
Newham	-0.13	-0.52	-0.07	-0.04	-0.02	-0.05	-0.10
City of London	-0.01	-0.07	-0.00	-0.00	-0.00	-0.00	-0.00
Hackney	-0.01	-0.02	-0.00	-0.00	-0.00	-0.00	-0.00
Waltham Forest	-0.01	-0.02	+0.01	+0.00	-0.00	-0.00	+0.01
Redbridge	-0.04	-0.02	-0.02	+0.01	+0.07	+0.00	+0.00
Barking and Dagenham	-0.13	-0.27	-0.09	-0.11	-0.08	-0.15	-0.04

As shown in Table 2.6 generally the average change in the OWT generalised time per person within and between boroughs south of the river is 30 seconds or less.

Table 2.6 : Change in AM OWT generalised time per person 2021 Assessed Case vs. 2021 Ref Case (minutes and decimals of minutes) – between key boroughs south of the river

	Greenwich	Lewisham	Bexley	Southwark	Bromley
Greenwich	-0.27	-0.32	-0.06	-0.18	-0.37
Lewisham	-0.48	-0.05	-0.11	-0.02	-0.04
Bexley	-0.08	-0.11	-0.00	-0.02	-0.01
Southwark	-0.05	-0.00	-0.00	+0.01	+0.00
Bromley	-0.06	-0.04	+0.05	+0.02	+0.01

The change in the generalised time between boroughs outside of those tabled above are all around or below 30 seconds, with the exception of some changes associated with large zones on the outskirts of the model area. The large changes associated with large zones on the outskirts of the model area are likely to be due to model ‘noise’. In the next chapter it is explained that these larger differences are screened out of the user time benefit calculations.

In summary the change in the generalised times are considered sensible. Similar levels of change were found in the IP and PM time periods and were also considered sensible.

3. User benefit calculations

3.1 Introduction

LoRDM generalised cost outputs and demand outputs have been used to undertake an assessment of user time benefit by origin/destination by time period using the rule of a half (RoH) [1]method.

TAG guidelines require In Work time benefits and Out of Work time benefits to be assessed separately because no behavioural weights should be applied to walk and wait time for business (in work time) travel. The generalised cost for the purposes of the business case appraisal is calculated as follows for each trip purpose:

IWT: Uncrowded IVT + walk time + wait time

OWT: Crowded IVT + walk time x 2 + wait time x 2.5 + boarding penalty

Demand in Railplan is not split by trip purpose. The decision was taken to use uniform split factors (i.e. a single value applied to the entire matrix) to segment PT demand into In Work trips and Out of Work trips. These factors are shown in Table 3-1, and were derived from LoRDM demand matrices.

Table 3-1 PT trip purpose split assumptions

	IWT	OWT
AM	0.11	0.89
IP	0.10	0.90
PM	0.11	0.89

Given the above, the user benefit rule of a half calculation undertaken by origin/destination pair by time period was as follows:

$$IWT\ User\ Benefit = IWT\ factor\ \times \frac{1}{2}(D_2 + D_1) \times (IWT_2 - IWT_1)$$

$$OWT\ User\ Benefit = OWT\ factor\ \times \frac{1}{2}(D_2 + D_1) \times (OWT_2 - OWT_1)$$

$$Where\ 1 = Ref\ Case\ and\ 2 = Test\ Case\ and\ \text{“}D\text{”}\ is\ demand$$

3.2 Screening

Two steps have been taken to screen out potentially spurious / overstated benefits from the user time benefits analysis. These steps are:

1) Benefits to or from boroughs outside the vicinity of the Assessed Case improvements have been screened out of the assessment

Accordingly only benefits or disbenefits from or to the boroughs listed below have been included in the assessment.

- Tower Hamlets

[1] A method for calculating and combining the change in consumer surplus for both existing and new travellers- see TAG A1.3.

- Newham
- City of London
- Hackney
- Waltham Forest
- Redbridge
- Barking and Dagenham
- Greenwich
- Lewisham
- Bexley
- Southwark
- Bromley

2) Benefits to **new** users travelling within or between boroughs *south* of the river only have been screened out and benefits to **new** users travelling within or between boroughs *north* of the river only have been screened out.

This masking was done to avoid the inclusion of benefits that might result from persons switching from active modes to bus. This switch might be overestimated in LoRDM because of a low level of detail of the active mode network in LTS which provides the active mode cost skims to LORDM.

The results below are after this screening process.

3.3 Benefits to Existing and New Cross-river trips

Using the RoH calculation described in section 3.1 the 2021 user OWT time benefits from key boroughs north of river to key boroughs south of river are presented in Table 3.2 below and OWT user time benefits from key boroughs south of river to key boroughs north of river are presented in Table 3.3 below.

Table 3.2 : 2021 AM User OWT time benefits from key boroughs north of river to key boroughs south of river (minutes)

	Greenwich	Lewisham	Bexley	Southwark	Bromley	Total	% of Total
Tower Hamlets	+1,283	+200	+19	+82	+9	**+1,592**	20%
Newham	+4,855	+392	+173	+126	+52	**+5,598**	72%
City of London	+1	+2	+0	+0	+0	**+3**	0%
Hackney	+33	+2	+1	+1	-0	**+37**	0%
Waltham Forest	+78	+16	+3	-12	-0	**+86**	1%
Redbridge	+81	+33	+9	-4	+1	**+119**	2%
Barking and Dagenham	+192	+39	+11	+108	+2	**+352**	5%
Total	**+6,523**	**+684**	**+216**	**+306**	**+63**	**+7,787**	
% of Total	+84%	+9%	+3%	+4%	+1%		

Table 3.3 : 2021 AM User OWT time benefits from key boroughs south of river to key boroughs north of river (minutes)

	Tower Hamlets	Newham	City of London	Hackney	Waltham Forest	Redbridge	Barking and Dagenham	Total	% of Total
Greenwich	+2,481	+3,794	+522	+115	+59	+97	+94	+7,162	68%
Lewisham	+869	+1,912	+48	+12	+16	+22	+11	+2,889	27%
Bexley	+204	+119	+83	+8	+1	+1	+5	+421	4%
Southwark	+72	+166	-78	-3	+0	-1	-1	+155	1%
Bromley	+144	+69	-301	-1	-2	-0	-0	-91	1%
Total	**+2,903**	**+6,060**	**+275**	**+131**	**+73**	**+119**	**+109**	**+10,536**	
% of Total	36%	58%	3%	1%	1%	1%	1%		

This resulted in a total of 18,323 minutes of Out of Work time savings for cross river PT trips. The scheme also provides a further 481 minutes in In Work time user time savings (minutes) for cross river public transport trips.

Table 3.4 below provides a summary of cross-river user time benefits by time period.

Table 3.4 : Cross-river User time benefits by time period (minutes)

	IWT	OWT
AM	-481	-18,323
IP	-1,571	-51,640
PM	-1,128	-29,009

3.4 Benefits to existing users within and between boroughs north of the river and boroughs south of the river

To calculate user time benefits to *existing* users only the ROH calculation was modified to remove the new user component of demand. The calculation becomes:

$$User\ Benefit = D_1 \times (IWT_2 - IWT_1)$$

AM User OWT time benefits within and between key boroughs north of river are presented in Table 3.5 below.

Table 3.5 : AM User OWT time benefits within and between key boroughs north of river (minutes)

	Tower Hamlets	Newham	City of London	Hackney	Waltham Forest	Redbridge	Barking and Dagenham	Total	% of Total
Tower Hamlets	+574	+1,266	+132	+38	+20	+17	+27	**+2,075**	11%
Newham	+1,476	+12,371	+270	+74	+29	+133	+156	**+14,509**	75%
City of London	+18	+41	+0	+0	+0	+0	+0	**+60**	0%
Hackney	+60	+32	+8	+22	+1	+1	+0	**+125**	1%
Waltham Forest	+40	+33	-25	-8	+52	+4	-1	**+94**	0%
Redbridge	+219	+47	+92	-9	-131	-3	-9	**+206**	1%
Barking and Dagenham	+469	+733	+210	+62	+45	+450	+376	**+2,344**	12%
Total	**+2,856**	**+14,524**	**+687**	**+179**	**+16**	**+600**	**+551**	**+19,412**	
% of Total	15%	75%	4%	1%	0%	3%	3%		

AM User OWT time benefits within and between key boroughs south of river are presented in Table 3.6 below.

Table 3.6 : AM User OWT time benefits within and between key boroughs south of river (minutes)

	Greenwich	Lewisham	Bexley	Southwark	Bromley	Total	% of Total
Greenwich	+5,607	+873	+244	+962	+398	**+8,083**	71%
Lewisham	+1,703	+921	+44	+149	+136	**+2,953**	26%
Bexley	+272	+55	+14	+45	+12	**+398**	4%
Southwark	+72	+13	+0	-170	-3	**-86**	1%
Bromley	+43	+84	-34	-62	-70	**-39**	0%
Total	**+7,697**	**+1,945**	**+269**	**+924**	**+474**	**+11,309**	
% of Total	+68%	+17%	+2%	+8%	+4%		

This provided a total of 30,721 minutes of Out of Work time savings for these existing user PT trips. The scheme also provides a further 1,892 minutes in In Work time user time savings (minutes) for these existing user PT trips.

Table 3.7 below provides a summary of user time benefits within and between key boroughs south of river and within and between key boroughs north of river by time period.

Table 3.7 : User time benefits within and between key boroughs south of river and within and between key boroughs north of river by time period (minutes)

	IWT	OWT
AM	-1,892	-30,721
IP	-4,268	-80,890
PM	-1,899	-34,033

Adding the cross-river RoH benefits and the north to north and south to south existing user benefits together gives the total 2021 screened user time benefits by trip purpose and by time period as shown in Table 3.8 below.

Table 3.8 : Screened 2021 User time benefits by trip purpose by time period (minutes)

	IWT	OWT	
AM	-2,373	-49,044	-51,417
IP	-5,838	-132,530	-138,368
PM	-3,027	-63,042	-66,069

In the AM time period there are 13,821 boarders on the 6 bus routes assumed for the Assessed Case. Given a total of 51,417 minutes of User time benefits in the AM period, this equates to roughly 3.7 minutes saving per bus boarder.

Table 3.9 and Table 3.10 present the user time benefits disaggregated by the user time benefit saving of each origin/destination pair (OD's). The tables show that the largest proportion of the IWT user benefits come from OD's where the time savings is between 2 and 5 minutes, and the largest proportion of the OWT user benefits come from OD's where the time savings is greater than 5 minutes.

Table 3.9 : Screened 2021 IWT User time benefits by time period by time band of user benefit (minutes)

	<2 mins	2 - 5 mins	> 5 mins
AM	12%	60%	29%
IP	23%	44%	33%
PM	9%	52%	39%

Table 3.10 : Screened 2021 OWT User time benefits by time period by time band of user benefit (minutes)

	<2 mins	2 - 5 mins	> 5 mins
AM	32%	23%	45%
IP	25%	25%	50%
PM	29%	23%	48%

4. Business Case

4.1 Background

The public transport business case is made up of 4 components:

- Costs
- Revenues
- Social Benefits
- Indirect Taxation Loss

The public transport scheme appraisal spreadsheet developed by Jacobs on behalf of TfL for the Crossrail business case has been adopted and adapted for the purposes of this appraisal.

The remainder of the section describes the assumptions used in the PT business case.

4.2 Social Benefits

4.2.1 Introduction

The PT appraisal only includes user time saving benefits.

Other benefits such as road decongestion, accidents, greenhouse gas emissions local air quality and noise are appraised in the highway business case appraisal undertaken using DfT's TUBA appraisal software[2].

DfT advice at 11 June 2015 was to exclude changes public transport user charges (fares) from user benefits. Fares are taken into account in the mode choice model. Revenue impacts are accounted for, but not any user charge benefits or disbenefits (on DfT advice) because they are implicit in the mode choice decision.

4.2.2 Time savings calculation

The user IWT and OWT benefits by time period and by modelled year were converted to annualised monetary values using a series of calculation steps. This are outlined below:

1) User travel time savings from Railplan were in passenger minutes, these were converted to passenger hours, OWT savings were split into commuter and leisure trip purposes using the factors shown in Table 4.1 (IWT savings are used for the business trip purpose)
2) Travel time savings by trip purpose were annualised using the factors shown in Table 4.2. The annualisation factors were from an analysis of 2013 RODS (Rolling Origin Destination Survey) data. While this data was from London Underground, the data was the only source available that could be used to determine PT annualisation factors.
3) The annual travel time savings by trip purpose were then monetised using WebTAG Value of time figures shown in Table 4.3.

[2] See Silvertown Tunnel Preliminary Economic Assessment Report, TfL, September 2015

Table 4.1 : Trip purpose splits

	AM	IP	PM
Purpose split derived from LoRDM demand			
% of Business Users	10.0%	9.0%	11.0%
% of Commuters	51.0%	10.0%	43.0%
% of Leisure Users	39.0%	81.0%	46.0%
OWT purpose split			
% of Commuters	56.7%	11.0%	48.3%
% of Leisure Users	43.3%	89.0%	51.7%

Source: LoRDM/LTS

The impact of using TAG PSV splits rather than the above LTS PT splits was investigated (The above splits being area specific purpose splits and TAG being mode specific purpose splits). While the TAG suggests bus demand has a lower proportion of business and commuter users, the overall impact on the BCR of using TAG splits is minimal.

Table 4.2 : Annualisation factors

Period	Factor
AM Peak (7am -10am) to Annual	257
IP (10am - 4pm) to Annual	713
PM Peak (4pm - 7 pm) to Annual	257

Source: 2013 RODS data

The Interpeak factor takes account of all time periods outside the peaks (i.e. early mornings, evenings and weekends).

Table 4.3 : Values of time - Market Price values by year (2010 prices)

	2021	2031	2041
VOT IVT work (£/hr)	£19.71	£23.89	£29.36
VOT IVT commuting (£/hr)	£8.07	£9.79	£12.03
VOT IVT other (£/hr)	£7.16	£8.69	£10.67

Source: TAG databook A1.3.2 Nov 2014

Table 4.4 presents the calculation of annualised monetised travel time savings as described in the steps above for the year 2031.

Table 4.4 : Travel time savings calculation example for 2031

Trip Purpose	Period	Time savings (hours)	Annualisation factor	Annualised time savings (hrs)	Value of time (£/hr)	Annualised monetised time savings (£)
Business	AM	44	257	11,237	23.9	£0.27m
	IP	104	713	73,886	23.9	£1.77m
	PM	62	257	15,929	23.9	£0.38m
Commuting	AM	577	257	148,469	9.8	£1.45m
	IP	263	713	187,363	9.8	£1.83m
	PM	639	257	164,169	9.8	£1.61m
Leisure	AM	442	257	113,535	8.7	£0.99m
	IP	2,129	713	1,517,637	8.7	£13.18m
	PM	683	257	175,623	8.7	£1.53m
Total				**2,407,848**		**£23.00m**

4.2.3 Travel time saving results

Table 4.5 presents the travel time savings by trip purpose for each modelled year: 2021, 2031 and 2041. The table also presents the total undiscounted travel time savings over the 60 year appraisal period from 2021 to 2080 and the discounted total travel time savings. A discount rate of 3.5% was used from the discount base year until 30 years after the current price year (2010 to 2045), and 3.0% was used for every year thereafter.

Travel time savings between modelled years were linearly interpolated. Beyond the last modelled year; 2041, travel time savings (in minutes) were kept constant but the value of time continues to grow from the 2041 values in line with GDP per person.

Build-up factors from the BCDM (TfL’s Business Case Development Manual) for Bus schemes have been applied to the discounted value in the table below. For bus schemes the build-up factors are simply a 0% factor in the first year and no factoring beyond that.

Table 4.5 : Travel time savings by trip purpose by Year and over appraisal period

Trip Purpose	2021 (£m)	2031 (£m)	2041 (£m)	Total of 60 years Undiscounted (£m)	Total of 60 years Discounted (£m PV, 2010 values)
Business	£1.68	£2.41	£3.19	£246	£59
Commuting	£3.26	£4.89	£7.06	£538	£128
Leisure	£10.62	£15.69	£21.94	£1,679	£400
Total	**£15.55**	**£23.00**	**£32.18**	**£2,463**	**£587**

4.3 Revenue

The calculation of change in public transport revenue was based on Railplan outputs of passenger kilometres by mode. Table 4.6 presents the fare assumptions by mode.

Table 4.6 : Fare assumptions

Mode	Revenue assumption	Source
Bus	£0.157 / km	TfL 2015 analysis factored to 2010 prices and values
LUL	£0.185 / km	TfL 2013 analysis factored to 2010 prices and values
DLR	£0.216 / km	TfL 2013 analysis factored to 2010 prices and values
Rail	£0.133 / km	TfL 2013 analysis factored to 2010 prices and values

Approximately 90% of the change in demand occurs within the boroughs listed in section 3.2. Therefore the amount of revenue resulting from change in passenger KMs by mode has been factored down by 10% in an attempt to screen out changes occurring outside the modelled area. It is understood that this method of factoring is fairly crude. Change in fare revenue makes up about 10% of total benefits, so this simplification was tolerated.

Fares were assumed to grow at 1% in real terms over the appraisal period up to 2024 except for the years 2012 to 2015 inclusive where the growth was 0% and in 2011 the growth was 2%. Beyond 2024 real fare growth was assumed to be 0%.

The impacts on revenue are quite variable by mode between years, in particular LUL revenue. This is likely to come from looking at the change between two very large numbers in a crowded assignment model. The largest positive benefit comes from bus, and the values are consistent across years and time periods for bus revenue.

4.4 Indirect Taxation Loss

Change in Indirect Taxation from PT Fare Revenue changes is included in the appraisal.

The appraisal determines that the bus improvement package will result in an additional £89m (PV 2010 prices and value) in fare revenue. With PT fares being exempt from tax, there is a loss in VAT that this money would have accrued if spent elsewhere. A rate of 19% was used to account for this, so the Indirect Taxation Loss was £17m.

The appraisal excludes any Fuel Duty Indirect Taxation Loss as the Highway Business case captures these changes.

4.5 Cost

Costs were provided by Stephen Walker from TfL in June 2015. Table 4.7 presents the costs used in the appraisal.

Table 4.7 : Costs (2015 factor price and value)

Mode	Costs used in appraisal
108	£299,632
129	£3,522,926
104A	£440,000
309	£440,000
Eltham to Beckton	£3,250,000
Grove Park to Canary Wharf	£2,250,000
Total	**£10,202,558**

Operating costs are assumed to grow with RPI year on year over the appraisal period. By 2021 the nominal annual operating cost is forecast to be £12.6m. This value was then converted to 2010 value and prices values using the GDP deflator.

An uplift of 10% was applied to operating cost to account for optimism bias.

Over the 60 year appraisal period the total undiscounted operating costs were £962.6m and the total discounted PV operating costs were £264.1m.

An uplift of 19% was applied to convert from factor prices to market prices when presented in the TfL and DfT Summary Sheets.

There are no capital costs associated with the bus improvement package.

4.6 Results

The results are presented in the Silvertown Tunnel Economic Assessment report, TfL, September 2015.

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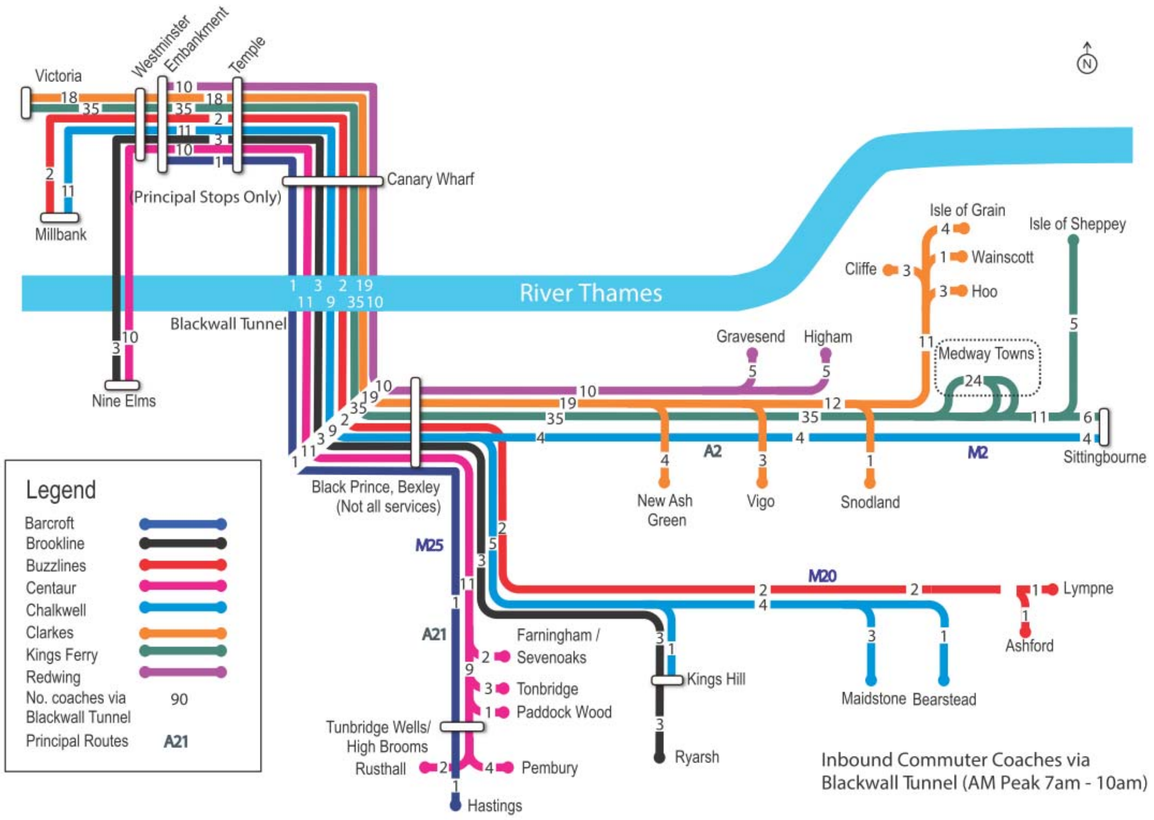
APPENDIX D: Coach benefits calculation methodology

Cross-river movements on commuter coaches were analysed based on the current coach movements which cross the river Thames from south to north using the Blackwall Tunnel during the morning peak (0700-1000) and evening peak period (1600-1900). Recent study undertaken by TfL shows that there are 90 coach movements from the South East to London during the morning peak period and 88 coach movements from London to the South East during the evening peak period using the Blackwall Tunnel. These services mainly originate in Kent and travel to destinations in the north mainly Canary Wharf and the City/West End in the morning peak period, with a reverse flow in the evening.

Figure D-1: Inbound commuter coaches via Blackwall Tunnel AM peak period



For the purpose of this assessment it was assumed that benefits would only accrue in the morning peak period (0700-1000) northbound and the evening peak period (1600-1900) southbound for coach passengers.

Journey time savings for coaches were extracted from the SATURN model output for three modelled years – 2021, 2031 and 2041. The AM SATURN journey time route was defined as starting from the A012 just before the A102/A206 junction to the Trafalgar Way roundabout and the PM journey time route was the reverse journey that starts after the Trafalgar Way roundabout to the A102 just after theA102/A206 junction as shown in Figures 2 and 3 below.

Figure D-2: AM journey time route

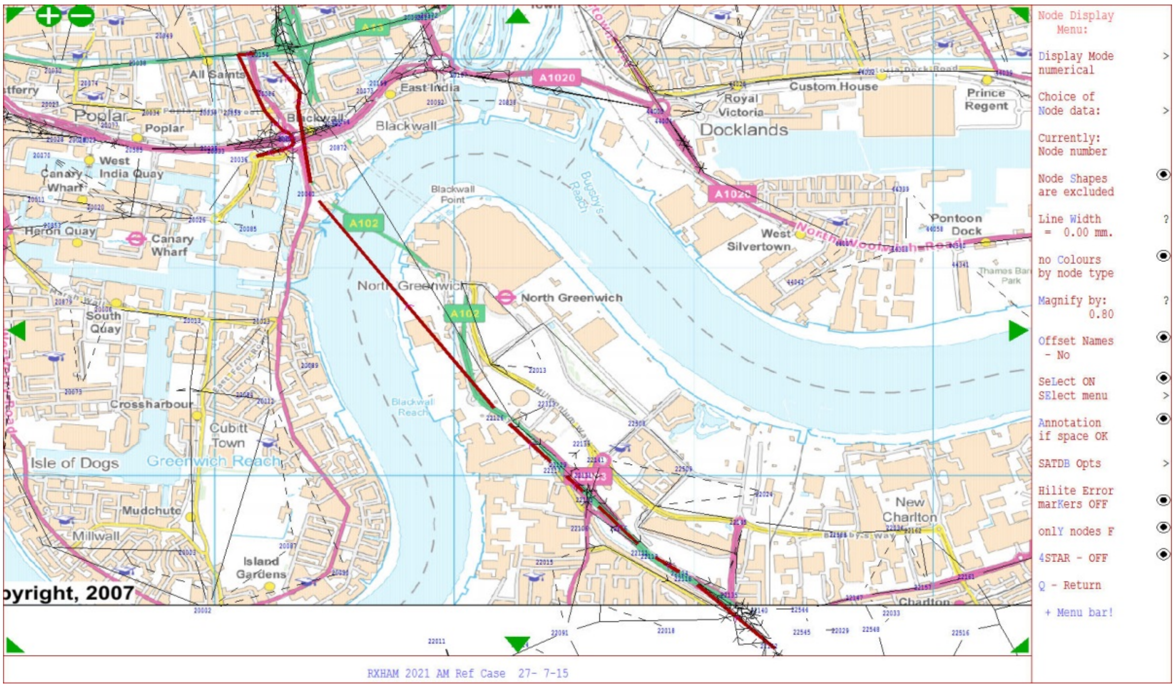


Figure D-3: PM journey time route

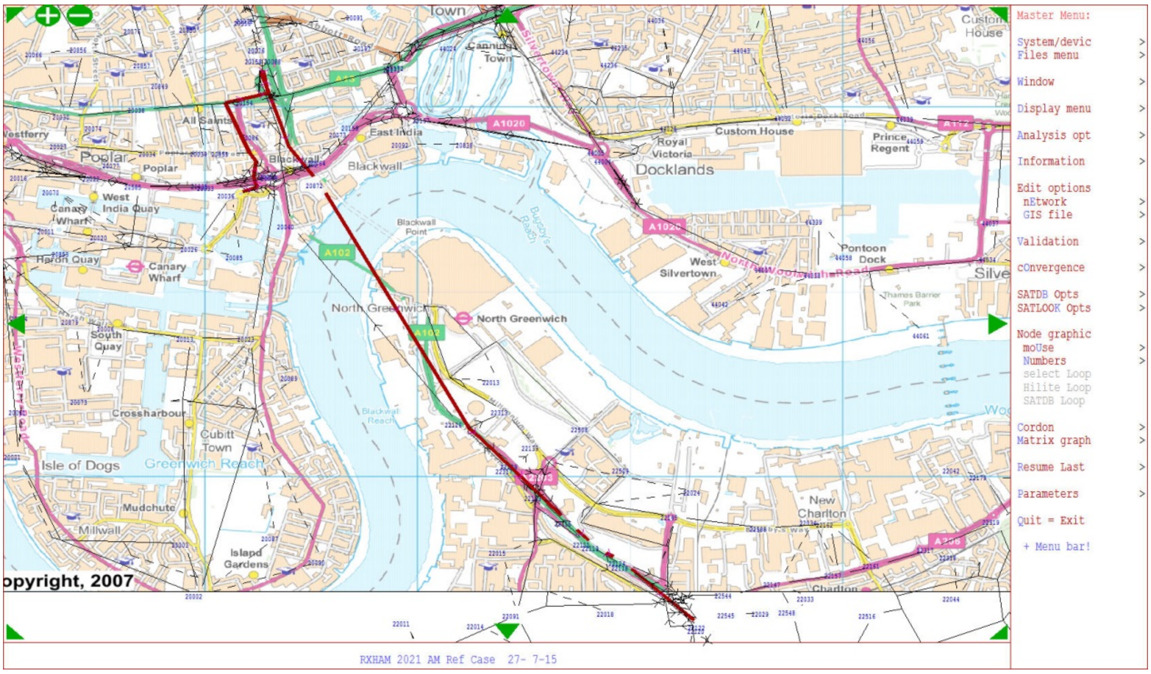


Table D-1 below shows the average journey time savings for the northbound and southbound SATURN results. These were reduced by 20% to allow for any lower time savings outside the peak hour, although operators claim that most coach services currently experience lengthy delays at the Blackwall Tunnel.

Table D-1: Average journey time saving

	2021 Average Journey time saving (minutes)	2031 Average Journey time saving (minutes)	2041 Average Journey time saving (minutes)
AM peak, Northbound	11.6	12.4	12.6
PM peak, Southbound	17.5	21.7	19.9
	Average Journey time saving over three modelled years – 2021-2031-2041		
AM peak, northbound	12.2		
PM peak, Southbound	19.7		

A base year demand data of 33 passengers per coach (sourced from the operators) was assumed. An annualisation factor of 250 was used, assuming that the benefit would only occur on weekdays. An annual demand growth of 1.5%[36] was assumed until 2031 only – no allowance was made for increased patronage due to improved reliability and journey times.

Values of time were taken from TAG (November 2014) table A 1.3.2 and all the passengers were assumed to be commuters. 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 current year 2015 until 2045), 3.0% thereafter. Total benefits estimated are as shown in Table D-2 below.

Table D-2: Total estimated benefits over 2010 appraisal period

	Total benefit over appraisal period in 2010 prices, discounted to 2010, £m

[36] Long Term Planning Process: London and South East Market Study, Network Rail, October 2013 - notes that historically, the market for central London commuting has grown at an average rate of 1.5– 2 per cent annually, with predictions of 1.3 per cent in the peaks going forward. The assumption was made that commuter coach demand would grow at a similar rate, with 1.5% assumed.

Commuting	**£119.6**
AM-NB	£46.4
PM-SB	£73.3

This estimate does not take into account (1) any reliability benefits (2) any increased patronage due to improved journey times, and is therefore regarded as conservative.

APPENDIX E: COBA-LT methodology and results

JACOBS

Silvertown Tunnel Appendix E

Transport for London

Preliminary COBA-LT Analysis

Technical Note

September 2015

Silvertown Tunnel Appendix E

Project no:	B1987503
Document title:	Preliminary COBA-LT Analysis
Document No.:	
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Date:	September 2015
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Contents

1. Derivation of accident cost savings

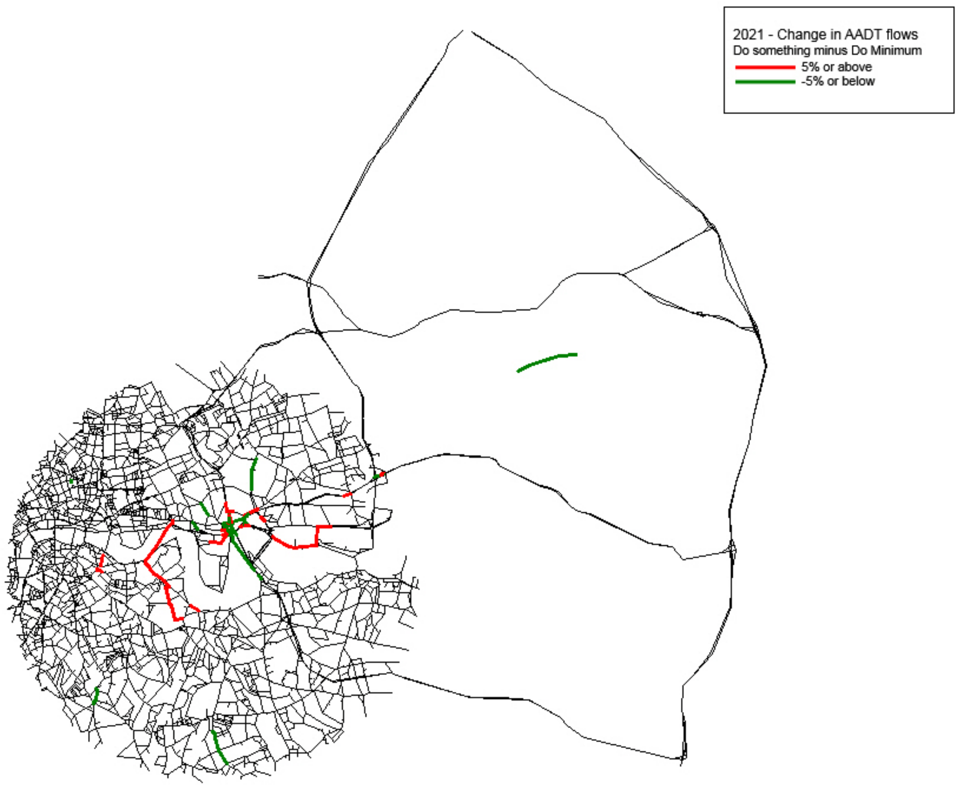
1.1 Introduction

1.1.1 This section refers to the process of analysing traffic accident data and the running of the COBA-LT[1] model road network within the defined study area.

1.2 Defining the links

1.2.1 The study area chosen is shown in **Figure 1,** consisting of all the road links shown in black. Based on discussions with TfL, it was agreed that analysis should be broadly based around links with changes of 5% or more with a flow change of +/-500 AADT. Given that the study network needs to be contiguous, the decision was taken to undertake the COBA-LT analysis for an area of fixed radius around the Isle of Dogs as shown in **Figure 1**. The study area was extended to include the key strategic routes into the area and the Dartford Crossing, where some changes might also be expected.

Figure 1: COBA-LT study area

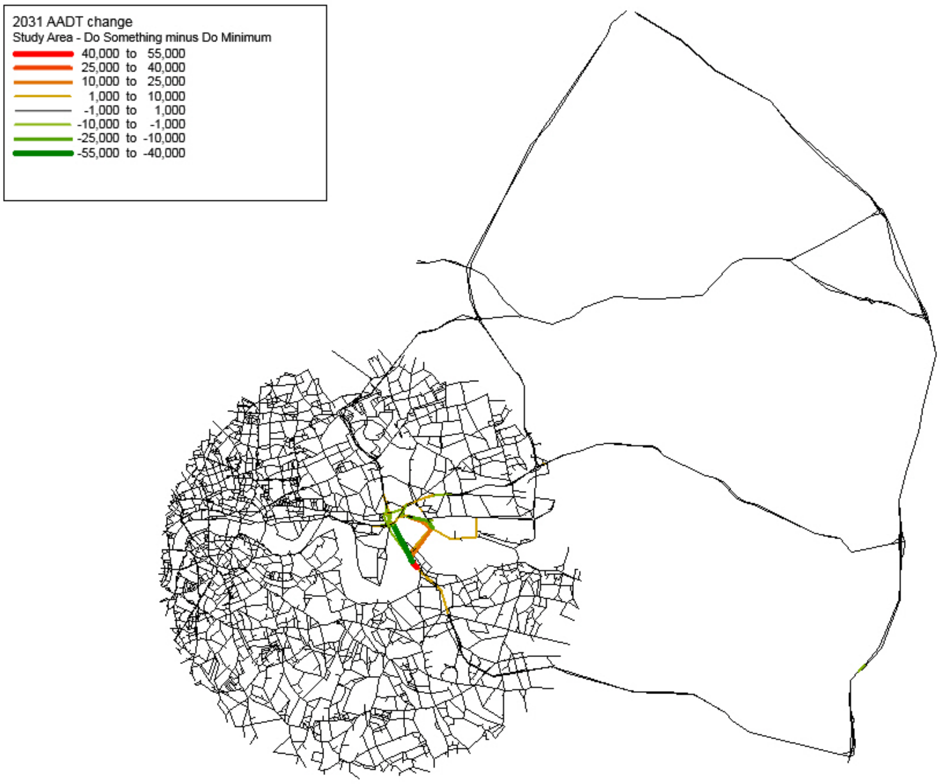


[1] Cost and Benefit to Accidents - Light Touch, DfT software for estimating accident impacts

1.2.2 **Figure 2** shows within the study area the links with changes in daily vehicle volumes. The links highlighted in green show where there is a drop in traffic flows in 2031 of more than 1,000 vehicles per day between the Assessed Case (AC) and the Reference Case(RC) scenarios, whereas the links in red show where traffic flow rises more than 1,000 vehicles a day for the same time period and scenarios.

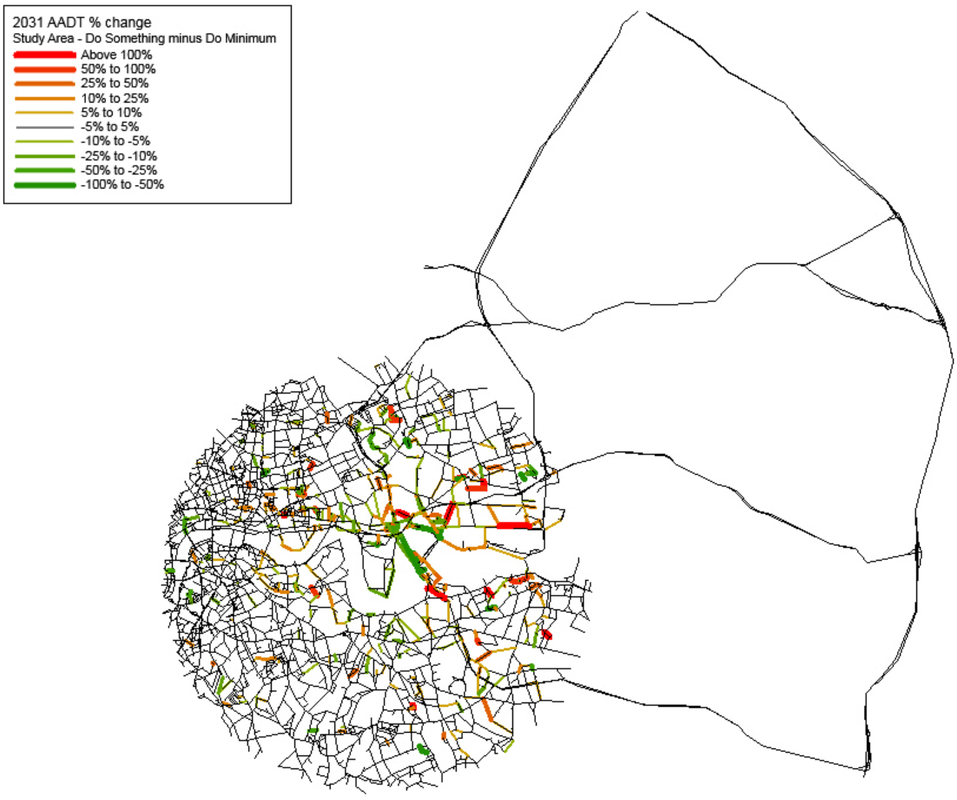
1.2.3 Though the Blackwall tunnel southbound link appears to show an increase in traffic on the map, this is due to the Assessed Case model using different links in comparison with the Reference Case model and overall the effect here is a reduction in traffic flow.

Figure 2: COBA-LT study area by difference in 2031 link flow between RC and AC



1.2.4 To give additional context, **Figure 3** shows the percentage change in traffic flow in more detail within the study area. Again it shows that the most significant differences in flow occur directly around the Silvertown and Blackwall Tunnels. The links highlighted in green show where the flows in the Saturn network decrease by 5% or more between the 2031 Assessed Case and Reference Case models. The links highlighted in red show where the flows in the Saturn network increase by 5% or more between the models.

Figure 3: COBA-LT study area by percentage difference in 2031 link flow between RC and AC



1.3 Link and Junction Local Accident Rate Methodology

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

1.3.2 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 to 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.**

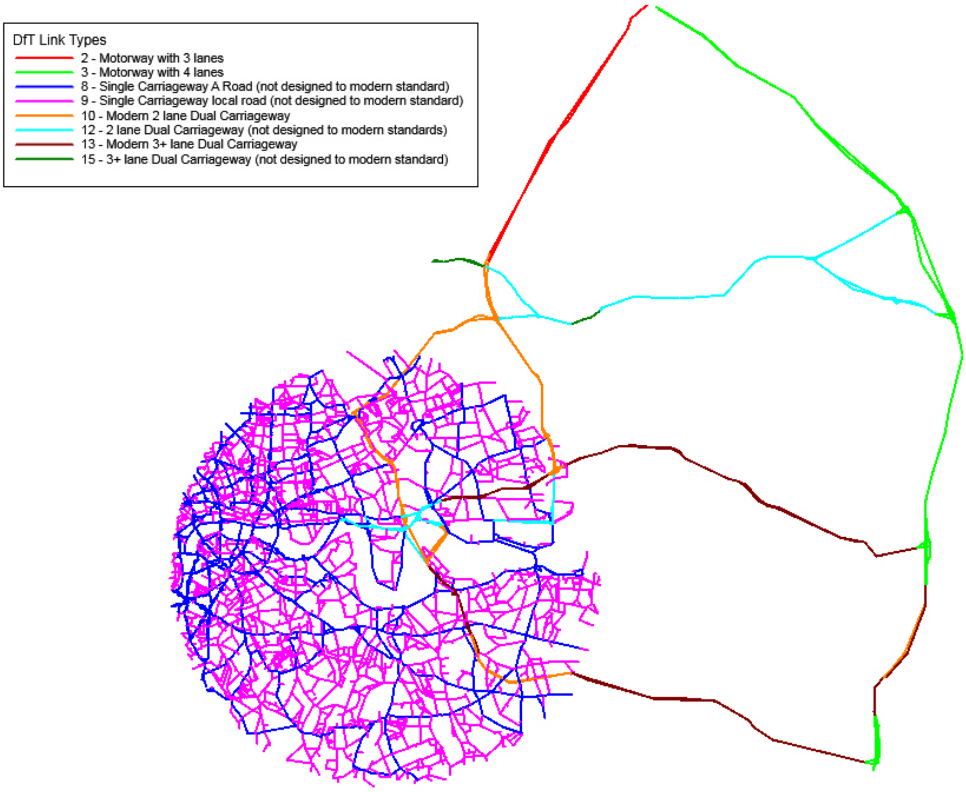
Table 1: COBA-LT accident rates by road type (2010 base)

Road type	Road description	Speed limit (mph)	Accident rate (per million veh km)
1	Motorways	50/60/70	0.08
2	Motorways	50/60/70	0.067
3	Motorways	50/60/70	0.079
4	Modern S2 Roads	30/40	0.532
4	Modern S2 Roads	>40	0.244
5	Modern S2 Roads with HS	30/40	0.532
5	Modern S2 Roads with HS	>40	0.244
6	Modern WS2 Roads	30/40	0.863
6	Modern WS2 Roads	>40	0.163
7	Modern WS2 Roads w. HS	30/40	0.863
7	Modern WS2 Roads w. HS	>40	0.163
8	Older S2 A Roads	30/40	0.863
8	Older S2 A Roads	>40	0.244
9	Other S2 Roads	30/40	0.559
9	Other S2 Roads	>40	0.233
10	Modern D2 Roads	30/40	0.553
10	Modern D2 Roads	>40	0.107
11	Modern D2 Roads with HS	30/40	0.599
11	Modern D2 Roads with HS	>40	0.072
12	Older D2 Roads	30/40	0.599
12	Older D2 Roads	>40	0.107
13	Modern D3+ Roads	30/40	0.62
13	Modern D3+ Roads	>40	0.123
14	Modern D3+ Roads w. HS	30/40	0.62
14	Modern D3+ Roads w. HS	>40	0.123
15	Older D3+ Roads	30/40	0.62
15	Older D3+ Roads	>40	0.123

1.3.3 **Figure 4** outlines the extent of different road types assumed 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.

1.3.4 Due to the wide extent of the study area it was not practicable to identify separate road types for each single-carriageway road in order to generate localised accident rates for all these links. As a result all single carriageway 'A' roads were by default set as COBA-LT road type 8 whilst all single carriageway (non-A-roads) local roads were by default set as COBA-LT road type 9. Then all dual carriageways, tunnels and motorways were reviewed to fit into an appropriate different COBA-LT road type – this was the case for approximately 15% of all links. Overall this methodology allowed for the majority of roads with the largest absolute changes in flow in the study area to have locally derived accident rates.

Figure 4: Study area split by COBA-LT Road Type



1.3.5 Road lengths were then calculated for all the COBA-LT links using GIS, whilst AADT flow data was derived from the SATURN model. The AADT estimates were 2012 figures and annual link flows were assumed to be equal to the AADT multiplied by 365. This estimate for each link was then multiplied by their respective link length, which provided an estimate of annual million vehicle kilometres per link. These were combined to estimate annual million vehicle-kms per road type.

1.3.6 A database of traffic accidents that occurred within the GLA boundary between 2010 and 2014 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.

1.3.7 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 and to differentiate at major junctions between local road and major road accidents. A query was then run in MapInfo to identify the accidents that were located within the road network buffer. All accident data that intersected with the road network buffers were considered.

1.3.8 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.

Table 2: COBA-LT accident calculations within study area

Speed Limit	Road Type	Accidents (PIA's)	Average year	Annual trips per km	Annual Million Vehicle KM	Accidents per veh km	Accidents per veh km (DfT)	Diff
>40	2	129	26	299,217,096	299	0.087	0.067	0.020
>40	3	561	112	1,225,314,809	1,225	0.091	0.079	0.012
20/30/40	8	21,167	4,233	1,803,981,242	1,804	2.346	0.863	1.483
20/30/40	9	6,790	1,358	1,252,609,794	1,253	1.084	0.559	0.525
20/30/40	10	460	92	282,489,588	282	0.326	0.553	-0.227
>40	10	786	157	643,016,816	643	0.244	0.107	0.137
20/30/40	12	779	156	300,084,265	300	0.520	0.599	-0.079
>40	12	530	106	245,963,461	246	0.431	0.107	0.324
20/30/40	13	-	-	4,338,837	4	0.000	0.620	-0.620
>40	13	1,286	257	1,314,630,546	1,315	0.195	0.123	0.072
20/30/40	15	99	20	18,683,092	19	1.053	0.620	0.433
>40	15	127	25	58,952,602	59	0.424	0.123	0.301

1.3.9 The highest increase from the default values within the study area is for road type 8, with the speed limit at 40 miles an hour or below. The accident rate increases from 0.863 (COBA-LT default rate) to 2.346 per million vehicle kilometres (locally derived rate). It is noted that this is a large increase on the default rates, probably due to the dense urban nature and traffic volumes in London. The figure may also be affected by the presence within this accident type of a higher level of high volume single carriageway 'A' roads (with high accident rates) compared with the UK average. However based on the data available, the accident rates developed for the study appear to be the most appropriate to use, given that they are based on local data. A sensitivity test using the COBA-LT accident rates was also used.

2. Scheme File (Appendix)

2.1 Introduction

2.1.1 The links shown in **Figure 3** illustrate where the flows change by 5% or more between the 2031 RC and AC tests. When all the relevant links in the study area were collated in SATURN it produced a study area of 11,712 links.

2.1.2 Due to the number of links in the study area, this study has concentrated on a link based analysis only. COBA-LT used traffic flow and accidents rates attributed for each road link type set in the model. Within the road link types, the accident rates are then split by speed limit. As a consequence, the COBA-LT results were only affected by a change in flow or a change in link type, or a combination of both.

2.2 Previous examples of network simplification

2.2.1 It has been noted that the main benefits generated in COBA-LT are likely to come from the links where the flows change significantly. 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.

2.2.2 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

2.3.1 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 RC and AC analysis were output from SATURN and imported into MapInfo.

2.3.2 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. Sector 5 includes both the Blackwall and Silvertown tunnels.

3. Accident Results

3.1.1 **Table 3** outlines the economic summary result outputs of the COBA-LT run based on the local accident rates – these are for the 60-year assessment period – please note that small differences between individual values and totals are due to rounding.

Table 3: Economic Summary (Local Accident Rates)

		Assessed Case	Reference Case	Difference (Ref. Case-Ass. Case)
Economic Summary	Total (£000)	**£10,734,154**	**£10,698,255**	**-£35,899**
Accident Summary	Total	**207,219**	**206,536**	**-683**
Casualty Summary	Fatal	1,672	1,666	-6
	Serious	25,903	25,815	-88
	Slight	247,897	247,090	-807
	Total	**275,472**	**274,571**	**-901**

3.1.2 The overall study area shows positive scheme benefits with a reduction in accident costs of £35.9 m for the defined area over 60 years (in 2010 prices).

3.1.3 The table also outlines the COBA-LT outputs for the total number of accidents in the study area, with and without the scheme. Overall, the new scheme is estimated to reduce accidents by 683 in the study area over 60 years. While only a small percentage (0.33%) of the study area accidents, this is regarded as a significant reduction as it relates to an improvement to a small part of the overall network.

3.1.4 The table outlines the COBA-LT outputs for the total number of casualties in the study area, with and without the scheme. Casualties are divided into three categories, fatal, serious and slight.

3.1.5 The new scheme is estimated to contribute to the following changes in casualties:

- A decrease of 6 in fatal casualties over 60 years,
- A decrease of 88 serious casualties and;
- A decrease of 807 slight casualties.

3.1.6 As a sensitivity test, COBA-LT was also run with DfT default (national) average rates.

3.1.7 **Table 4** outlines the economic summary result outputs of the COBA-LT run based on the DfT average accident rates.

Table 4: Economic Summary (DfT Accident Rates)

		Assessed Case	Reference Case	Difference (Ref. Case-Ass. Case)
Economic Summary	**Total (£000)**	**£4,987,325**	**£4,978,862**	**-£8,463**
Accident Summary	**Total**	**96,121**	**95,977**	**-144**
Casualty Summary	**Fatal**	813	812	-1
	Serious	11,770	11,748	-22
	Slight	116,122	115,960	-162
	Total	**128,705**	**128,520**	**-185**

3.1.8 The results confirm a positive benefit from the scheme on accident reduction, albeit the monetary benefits reduce to £8.5m, and the numbers of accidents saved are reduced to 144.

4. Conclusion

4.1.1 The overall conclusion is that the scheme is expected to have a positive impact on accidents in the study area, with an economic benefit estimated at £35.9 million, and a reduction of 683 accidents over 60 years.

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APPENDIX F: Silvertown Tunnel incident and journey time reliability benefits

Silvertown Tunnel Appendix F

Transport for London

Preliminary Reliability and Incident Benefits

Technical Note

September 2015

Silvertown Tunnel Appendix F

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Project manager: Kate Kenny
Author: Dermot Hanney
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Contents

1. Introduction

1.1 Document purpose

1.1.1 This document describes the process for estimating the economic benefits of the Silvertown Tunnel related to its role in improving the reliability and resilience of the strategic road network serving east and south-east London.

1.1.2 More detail on the background and current reliability/resilience issues can be found in the Silvertown Tunnel Preliminary Transport Assessment (TfL, September 2015).

1.1.3 For the purposes of this note the word incident is used to refer to any event which caused the closure of the Blackwall Tunnel or the closure of a direct access road to the Blackwall Tunnel. Any other event in the vicinity of the tunnel, which did not cause a closure, is not included in these incidents.

1.2 TAG Guidance

1.2.1 TAG 1.3 states that the term reliability refers to variation in journey times that individuals are unable to predict (journey time variability, or JTV). Such variation could come from recurring congestion at the same period each day (day-to-day variability, or DTDV) or from non-recurring events, such as incidents. It excludes predictable variation relating to varying levels of demand by time of day, day of week, and seasonal effects that travellers are assumed to be aware of.

1.2.2 TAG 1.3 also states that research (Arup, 2004) has indicated that as long as demand is below capacity, incidents will be the main source of JTV, and DTDV is much less important. However in urban areas many roads are at capacity for long periods (such as at the Blackwall Tunnel), and the two effects are harder to separate.

1.3 The case of the Blackwall Tunnel

1.3.1 Unreliability at the Blackwall Tunnel is currently caused by a mix of congestion (DTDV) and incidents. High levels of peak period congestion cause a large variation in day-to-day travel time, and the lack of spare capacity means that incidents can also have a significant additional impact on journey times.

1.3.2 The lack of a practical alternative route across the River Thames also means that all incidents have an impact on the traffic using the tunnel above that typically expected for an urban road (particularly in peak hours) and for major incidents this impact is spread over a wider area. Due to the strategic nature of the Blackwall Tunnel and the sub-standard geometry of the northbound bore, there are a very large number of incidents involving over-height vehicles (OHVs).

1.3.3 As well as offering average journey time improvements, a major benefit of the proposed Silvertown Tunnel scheme is that it would significantly reduce journey time variability and delays by:

- Reducing DTDV caused by congestion;
- Reducing the frequency of occurrence of some incident types– specifically those caused by OHVs in the northbound direction;
- Reducing the impact of longer duration incidents – where the ability to divert through the Silvertown Tunnel would offer a benefit.

1.4 Data Sources

1.4.1 TfL provided data on average journey time and flow rate for every 5 minute period in 2013 for journeys northbound through the Blackwall Tunnel between the A2 Sun-in-the-Sands Roundabout and the A11

Bow Interchange. Southbound data through the Blackwall Tunnel was not available, but similar data for the A12 between the A11 Bow Interchange and the A102/A13 East India Dock Road junction was assumed to provide a reasonable proxy for flows through the tunnel.

1.4.2 TfL also provided Blackwall Tunnel incident and closure information for 2013, detailing the start and end time/date of the incident and the incident category.

1.4.3 Each 5 minute period was categorised according to the day of the week; whether the period occurred during a bank or school holiday; and whether an incident had occurred during the period or was likely to materially affect the data during the following periods.

1.5 The East London River Crossings Highway Assignment Model (RXHAM)

1.5.1 RXHAM was developed using industry-standard SATURN strategic traffic modelling software to assess the impact of new river crossings on highway network performance in the wider east/south-east London area. The model was based on TfL's existing sub-regional East London Highway Assignment Model (ELHAM), with amendments made to enhance the calibration of the network in the vicinity of river crossings.

1.5.2 Flow on SATURN highway model networks is dependent on demand by origin-destination, junction geometry and road layout, and an iterative assignment process that accounts for disbenefits on congested routes. There is no facility in SATURN to directly model the impact of incidents on road network performance.

1.5.3 Due to the high frequency of incidents at the Blackwall Tunnel, journey time data used to calibrate/validate the RXHAM included incidents. Journey time and flow data from November 2012 were used with only four ‘outlier’ journey times with very high levels of delay removed.

1.5.4 Modelled base journey times broadly match observed journey times (although e.g. they underestimate the morning peak northbound observed values by some 10%) , but due to the model capability, incidents, and consequently the benefits of reducing incidents between the reference and assessed case are not included in the estimates directly. In addition, there is no change between the reference and assessed case in terms of the journey time network characteristics, which implies no change in incidents in the assessed case for the ‘standard’ model outputs.

1.5.5 Table 1 outlines the broad benefits in relation to delays and journey time variability expected from the Silvertown Tunnel scheme, and also indicates if each benefit is included directly in RXHAM (this aspect is discussed further below).

Table 1: Benefit Summary

Benefit	Aspect of Scheme	Modelled directly in the main SATURN model?
Improvement in average journey time	Increase in cross river capacity reduces the volume/capacity ratio (and hence congestion) and allows for faster journeys.	Yes, included in model estimates.
General improvements in journey time variability	Increase in cross river capacity reduces the volume/capacity ratio (and hence congestion) and allows for more reliable journeys.	No, average journey time savings are included but not the value that can be attributed to changes in DTDV (see TAG 1.3)
Time savings achieved from alternative routing during longer duration incidents	Extra tunnel would provide an easily accessible diversion in the event of an incident, and would help to reduce the 'knock on' effects of incidents currently experienced.	No, the main SATURN model does not model infrequent/unusual incidents.
Time savings from reduction in OHV incidents	Geometry of Silvertown Tunnel reference design would reduce the frequency of incidents that currently occur in the northbound Blackwall Tunnel bore.	No, both the reference and assessed case use the same speed/flow relationships, and so a reduction in incidents is not included

1.6 Estimating the benefits

1.6.1 As noted in Table 1, standard SATURN model tests do not capture journey time variability or incident benefits, and alternative approaches were used to derive these. Some aspects of the benefits could be estimated directly from data and relatively simple calculations. Other benefits, particularly those affecting a wider area, required the use of the RXHAM.

1.6.2 Table 2 summarises how these benefits were estimated, and is followed by a discussion of the steps taken to ensure that there was no double counting of benefits.

Table 2: Calculation of benefits not incorporated in the main SATURN model

Benefit	Methodology
General improvements in journey time variability	The method used follows TAG A1-3 guidance (para 6.3).A locally calibrated model was used to reflect more accurately the specific situation at the Blackwall Tunnel
Time savings from alternative routing during longer duration incidents	Extra SATURN tests were undertaken, with reduced capacity on certain cross-river links (to reflect the impact of a closure). TUBA was used to measure the disbenefit that was experienced in different scenarios and these outputs were compared to evaluate the benefit of the scheme.
Time savings from reduction in OHV incidents	Observed actual flow and queue length data was used to create an average daily demand flow curve. Tunnel capacity and flow rate were used to calculate the impact of a tunnel closure, and the reduction in delay that is expected when these incidents no longer take place.

1.6.3 Care was taken to ensure that the benefit that the Silvertown Tunnel would offer in journey time variability and incident reduction was only included once for each incident type. There were a total of 1,223 closure incidents in 2013 at the Blackwall Tunnel. These incidents were divided into three categories, each of which was used (once only) to undertake a different analysis to estimate the benefits.

1) ‘Major incidents’ (any incidents lasting longer than 15 minutes) – there were 64 incidents of this type during 2013. However we note that research by TfL shows knock-on effects on the wider network for incidents of shorter duration than 15 minutes, so this estimate is likely to be conservative.

2) ‘OHV incidents’ (incidents attributed to over-height vehicles lasting less than 15 minutes) – there were 616 of this type of incident recorded in 2013.

3) ‘Other incidents’ (all other incidents lasting less than 15 minutes) – the remaining 543 incidents were of this type.

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2. Calculating Incident and Journey Time Variability Benefits

2.1 General improvements in journey time variability

2.1.1 For these benefits, following the guidance given in TAG A1-3, the change in standard deviation of journey times was used as a proxy for journey time reliability. (This analysis uses term time data and excluded incidents of more than 15 minutes and those caused by over height vehicles).

2.1.2 TAG A1-3 suggests approximating the change in standard deviation using the following formula:

$$0.0018 * \frac{t_1^{2.02} - t_2^{2.02}}{D^{1.41}}$$

(Where t is the journey time (t_1 before, t_2 after) and D is the journey distance).

2.1.3 The approach from TAG suggests that the standard deviation of journey time is related to the reciprocal of the speed of travel.

2.1.4 As per TAG guidance a locally calibrated model was derived.

2.1.5 As described earlier in this note, detailed northbound journey time data was available for a fixed distance between the A2 and the A11 while southbound data was available between the A11 and the A13, and it was possible to calculate the standard deviation of observed data at different times of day- when the journey time is different.

2.1.6 The term-time days, as discussed in section 1.4.3., were divided up into consecutive 75 minute sections and for each of these 75 minute periods the weighted mean journey times and standard deviation of journey times was calculated for these journeys.

2.1.7 The 75 minute periods were used to reduce the danger of any bias caused by using a small variation in the start part of the time periods used. Using 75 minute periods rather than hours increases the spread of start times for assessed periods by 4. This level of detail was considered sufficient to be able to calibrate the model effectively.

2.1.8 Given that the observed data was from two links of known distance, it was concluded that (subject to the ability to calibrate the model to a sufficient degree) there was no need to incorporate the distance component in the revised TAG formula to estimate standard deviation.

2.1.9 Doing this however means that the adjusted formula has only been validated for trips in the area around the Blackwall Tunnel.

2.1.10 A non-linear regression analysis was used to compare the standard deviation with journey time and a new formula was created to approximate the change in standard deviation along the A2-A11 corridor for different given journey times in each direction.

2.1.11 In the northbound direction the calibrated formula for the change on standard deviation between before (scenario) and after (scenario 2) was:

$$0.0221 * (t - t_2^{1.2175})$$

and in the southbound direction the calibrated formula was:

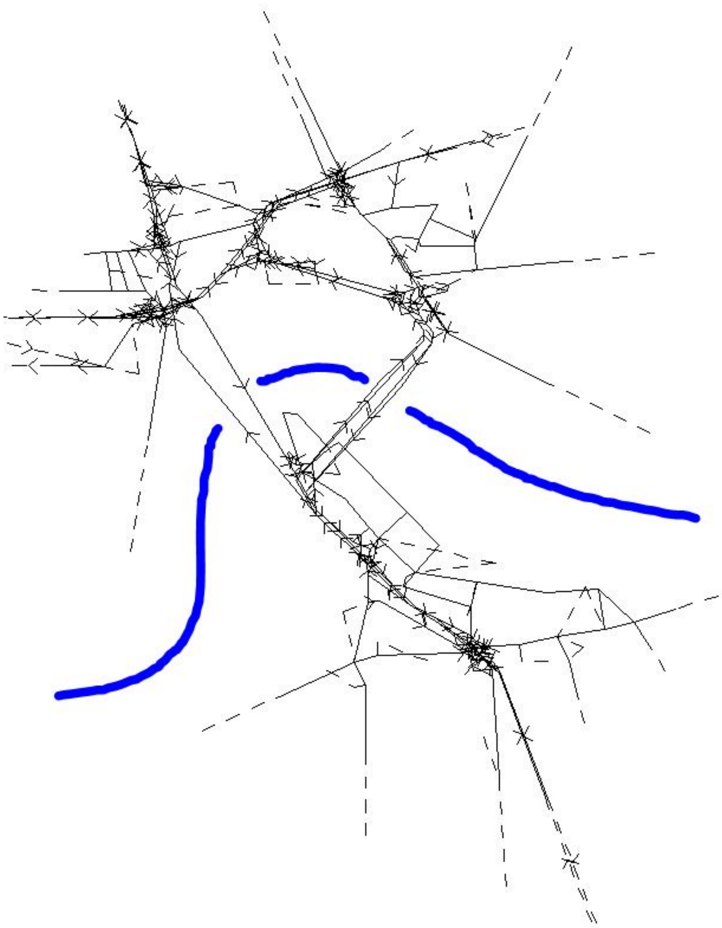
$$0.137 * (t_1^{1.0589} - t_2^{1.0589})$$

2.1.12 The difference in the formulae reflects the difference in flow pattern and road geometry in the different directions (which is also likely to affect the frequency of incidents).

2.1.13 With the calibrated northbound formula, 93% of observed points were within two standard deviations of the calculated value and in the southbound direction, 95% of observed points were within two standard deviations of the calculated values. Inspection of the residuals indicated that in both cases they were distributed normally around the expected value, with no obvious bias in error for any journey time.

2.1.14 A cordon was created in RXHAM, as shown in Figure 1, and was used to provide estimates of future reference case and assessed case speeds and flows in the vicinity of the two tunnels in all modelled time periods in the three forecast years: 2021, 2031 and 2041. The calibrated TAG formulae were then used to calculate the change in the standard deviation of journey time between the reference and assessed case for each cross-river OD pair in each time period and year – only these journeys were used to assess benefits as it was considered they would be of similar distance to the calibrated model[1].

Figure 1 – Diagram of RXHAM cordon around Greenwich Peninsula



2.1.15 Using modelled changes in journey time within the cordon to calculate the change in standard deviation of the cross river trips assumes that there is no change in the journey (for example due to rerouting or other changes in network conditions) outside of the cordon. This is an appropriate simplifying assumption, as this analysis is not concerned with the effect of wider network impacts on overall journey time reliability, but on the effect of the Silvertown Tunnel on reliability. Queueing and congestion which has an effect on cross river flows is localised to the tunnel, and so these changes are captured accurately.

[1] In order to assess whether this approach might for example ignore disbenefits on non-cross river traffic in the vicinity (e.g. on the A13), a secondary assessment was run using all cordoned trips, and this indicated that these other trips also received increased(but smaller) level of benefits.

2.1.16 Standard deviation is a measure of deviation from the mean, so under the assumption that the only change in journey time from an entire trip is from within the cordon, the standard deviation of the part of the trip within the cordon is the same as the standard deviation of the entire trip.

2.1.17 The estimated standard deviations derived from the RXHAM analysis described above for the assessed case were compared against the current observed standard deviations, and in accordance with TAG A1-3 the change (in minutes) was valued at 80% of the value of an actual minute saved in journey time. These benefits are therefore not ‘time savings’ but the valuation placed on reductions in journey time variability.

2.1.18 The same annualisation factors as used in the TUBA appraisal[2] were applied and linear interpolation was used to generate a 60-year appraisal, in accordance with TAG. It was assumed that for every year after 2041 the same benefits as in 2041 were experienced, and standard TAG discounting factors were applied. The TAG reliability benefit formula below was used to estimate benefits.

$$Benefit = -\frac{1}{2}\sum_{ij}\Delta\sigma_{ij} * \left(T_{ij}^{0} + T_{ij}^{1}\right) * VOR$$

2.1.19 Where T_{ij}^0 is the number of trips between zone i and zone j in the reference case, T_{ij}^1 is the number of trips between zone i and zone j in the assessed case, σ is the approximation to the standard deviation in journey times between the two zones and VOR stands for “Value of Reliability” – the proportion of a person’s value of time which is given to reduction in journey time variability. In line with WebTAG guidance a VOR of 0.8 has been used.

2.1.20 The total estimate derived for this benefit was £297m over 60 years (in 2010 prices).

2.2 Time savings from re-routing during incidents lasting longer than 15 minutes

2.2.1 For incidents longer than 15 minutes, it was considered that the Silvertown Tunnel would provide a viable alternative to route traffic and that benefits will accrue as a result. In order to calculate the benefit offered by the Silvertown Tunnel in the event of a major incident, the disbenefit occurring currently was compared with the expected disbenefit with Silvertown in place.

2.2.2 To simulate the effect of a 15 minute closure incident both the reference case and the assessed case models were adapted to limit the capacity of the Blackwall Tunnel to 75% of its actual capacity. These models were considered ‘closure cases’.

2.2.3 Reducing the capacity has the effect of increasing the level of congestion in the vicinity of the tunnel, as an incident would, but ignores the delay caused during the actual closure of the tunnel.

2.2.4 The process for calculating these benefits was as follows:

- Use TUBA to compare the reference case scenario with the reference closure case scenario;
- Use TUBA to compare the assessed case scenario with the assessed closure case scenario;
- Subtract the disbenefits from the first TUBA output, from the disbenefits from the second TUBA output to get the relative benefit of having the Silvertown Tunnel in the event of an incident.

2.2.5 The TUBA for the Ref case with closure was not compared directly to the TUBA with Assessed Case and closure, as this would also include some benefits due to the reassignment effect of the assessed case – which are already accounted for in the main business case.

[2] See Silvertown Tunnel Preliminary Economic Assessment Report, TfL, September 2015

2.2.6 TUBA was run for the AM and PM hours, with an annualisation factor of 1. This meant that it resulted in an output representing, for each time period, the impact of a single incident of length 15 minutes.

2.2.7 Using 2013 tunnel closure data for incidents over 15 minutes, an estimate was obtained of total benefit from the scheme in 2013 (a typical year), and from this a discounted 60 year appraisal estimate using TAG values was calculated. The total estimate was £7m over 60 years (in 2010 prices).

2.2.8 This method of valuing the benefits of Silvertown in the event of major incidents at the Blackwall Tunnel is believed to be likely to underestimate the actual benefit for four reasons:

1) When the model is run it assumes perfect driver knowledge of the network. During the model assignment process, vehicles are re-routed immediately due to the network cost changes. In practice many people will already be at the Blackwall Tunnel or have already started their journey, and will take time to alter routes, and the resultant cost of diversion is likely to be higher than modelled.

2) The test was performed for a 15 minute closure – the Silvertown Tunnel would deliver a greater benefit during longer incidents but in the model these are valued the same. Although in 2013 observed major incidents ranged in duration from 15 minutes to 2 hours, the majority were between 15 and 30 minutes in length. It was for this reason that a 15 minute test was performed, rather than a longer test, providing a conservative assessment.

3) Only a representation of the increase in network congestion associated with capacity reduction is included in the assessment, it ignores the time lost during the closure itself.

4) No benefits have been calculated for the interpeak period, and so the total disbenefits will be underestimated.

2.3 Time savings from reduction in over-height vehicle (OHV) incidents

2.3.1 Unlike the northbound bore of the Blackwall Tunnel, the Silvertown Tunnel would not have a height restriction in the northbound direction. With appropriate signage and traffic management it is anticipated that there would be an 80% reduction in OHV incidents, compared to the number which occurred in 2013, in the northbound direction with the Silvertown Tunnel in place. Sensitivity testing was also undertaken for a reduction of 70% and a reduction of 90%.

2.3.2 Four daily average actual flow curves for the northbound direction only were created for weekday and weekend days, both in term-time and out of term time. This used the data set described in section 1.4.3, with time periods affected by major incidents removed. This was smoothed (using a 7 point triangular moving average technique) to make it easier to interpret the results, and to reflect typical flow patterns on a normal day. Queue length observations from the Blackwall Tunnel operational team were used in conjunction with the actual flow data to build these approximate daily demand flow curves.

2.3.3 The observed data indicated that queueing for the Blackwall Tunnel typically begins around 0600 and peaks with a queue of approximately 800 cars between 07:30 and 08:00. The queue has usually dissipated by 11:00 – these assumptions were confirmed by Blackwall operational staff, and these assumptions have been used for the model. The demand curve was built to approximately follow the rate of increase in actual flow until capacity is reached, and then meet the parameters described above.

2.3.4 Figure 2 shows the modelled demand flow for weekdays in term time (that wishing to pass through the tunnel i.e. including the queue) compared to the actual flow (that actually passing through the tunnel), and Figure 3 the number of vehicles in the queue.

Figure 2 - Actual Flow vs Modelled Demand Flow

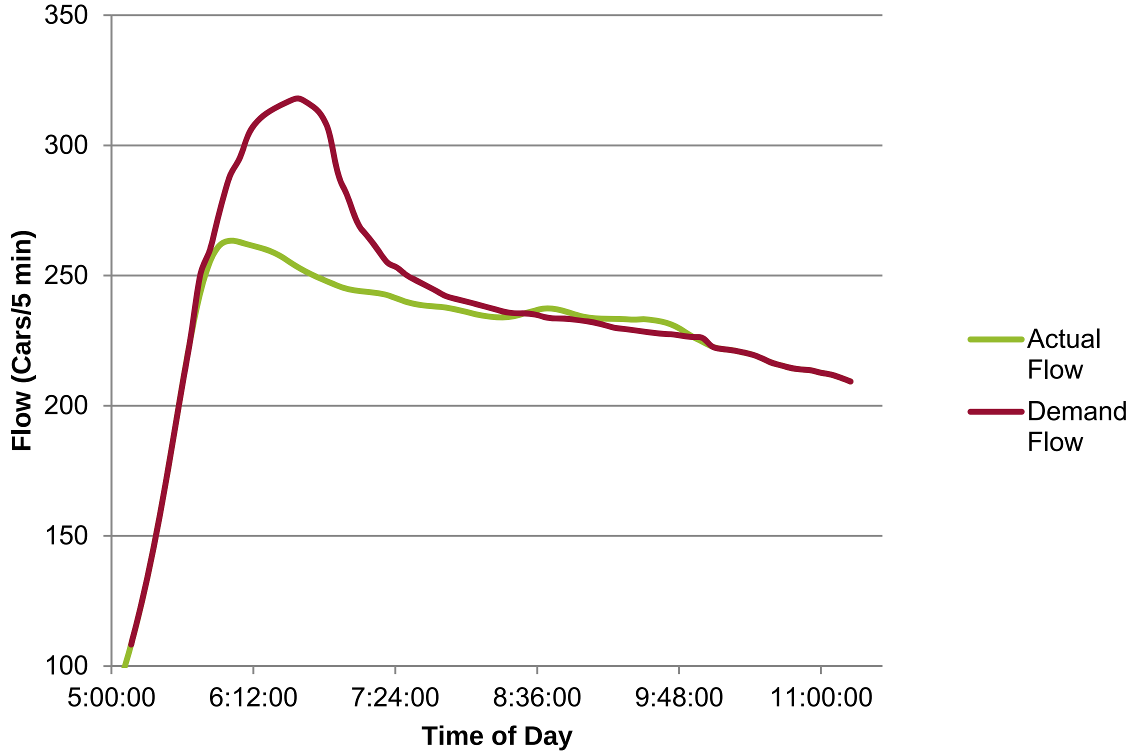
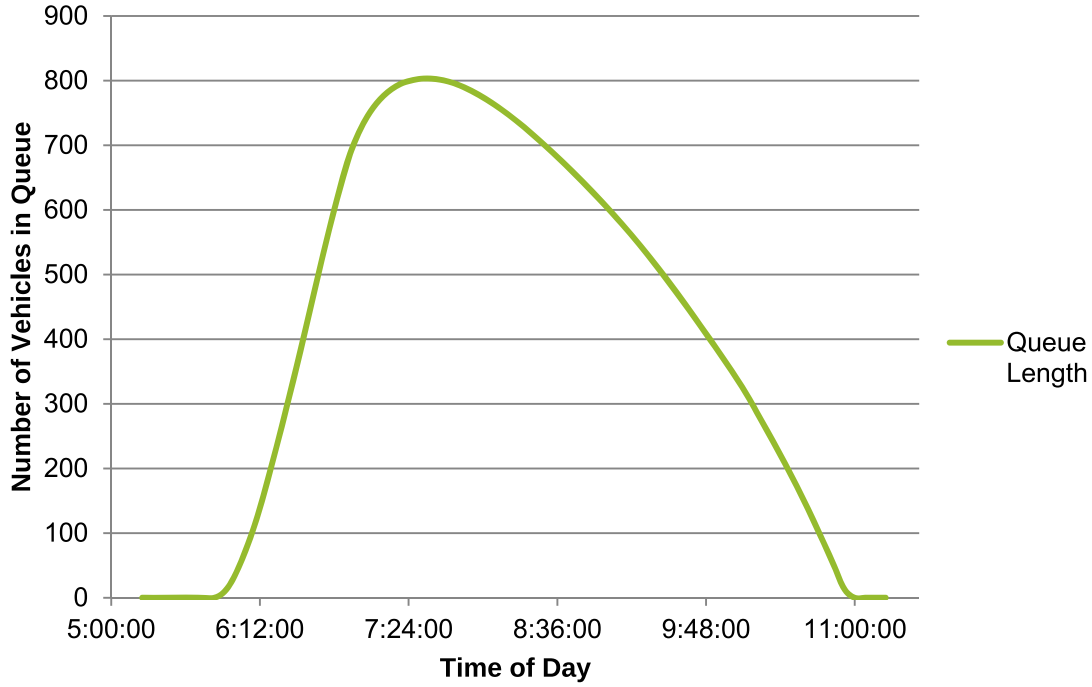


Figure 3 - Queue Length



2.3.5 Observed data indicates that in the normal operation of the tunnel there is minimal regular queueing at the Blackwall Tunnel during out of term weekdays, in the north bound direction. Throughout the year out of term actual flow was assumed to equal out of term demand flow. This is conservative as it does not take into account the small queues which exist, but without specific out of term queue data it was deemed an appropriate approximation.

2.3.6 Observed data indicates that in the normal operation of the tunnel there is no regular queueing at the weekend, in the north bound direction, so throughout the year weekend actual flow was assumed to equal weekend demand flow.

2.3.7 A spreadsheet model was built that used the demand flow curve for each of the four day types (term time weekday, term time weekend, out of term weekday and out of term weekend) and the capacity of the Blackwall Tunnel to calculate the length of the delay at Blackwall per 5 minute period over a whole day - to match the time periods in the observed data.

2.3.8 Linear interpolation was applied to each of the 5 minute models to create models with 1 minute intervals to allow for a more accurate assessment of the impact of OHV incidents of varying length.

2.3.9 Within the spreadsheet model the facility to simulate a tunnel closure – by setting the tunnel capacity to 0 for a set number of minute intervals – was added. Using the same process used to calculate queue dissipation with the standard demand flow, it was then possible to calculate the queue dissipation with the closure in place.

2.3.10 For each 5 minute period throughout the day the value of delay without incident was subtracted from delay with incident by time period with incidents of varying length to get the total increase in time experienced both when the Blackwall Tunnel experiences an incident and the knock-on impact afterwards – by duration and time period.

2.3.11 For the periods that the tunnel was closed the vehicles which arrived where also given a disbenefit equal to the number of minutes left of the closure.

2.3.12 The day was divided up into 5 minute sections and in each 5 minute section the number of OHV incidents from the survey was summed. These incidents where categorised by duration from 0 to 2 minutes, 2 to 4 minutes, 4 to 6 minutes, 6 to 8 minutes, 8 to 10 minutes and 10 to 15 minutes.

2.3.13 For each of the time periods, day types and incident lengths the delay caused by the incident was calculated, and then multiplied by the number of incidents in the appropriate category across 2013 and by the average flow in the appropriate time period. This gives the total increase in minutes caused by OHV incidents across 2013.

2.3.14 The total estimate was £20m over 60 years (in 2010 prices). The ‘low’ sensitivity test at 70% of incidents reduced resulted in an estimate of £18m, the ‘high’ sensitivity at 90% reduction resulted in an estimate of £23m.

2.4 Summary

2.4.1 The total benefits attributable to reductions in journey times due to reduction in incidents or their impacts and improvement in journey time reliability is shown in Table 3 below. The total benefits were estimated at some £324m in 2010 prices over 60 years. £27m of this is time savings due to incident reduction, while £297m is reliability improvements (journey time variability improvements).

Table 3: Benefit Summary

Benefit	Aspect of Scheme	Benefit estimated 2010 prices, 60-year appraisal
General improvements in journey time variability	Increase in cross-river capacity reduces the volume/capacity ratio (and hence congestion) and allows for more reliable journeys.	£297m
Time savings achieved from alternative routing during longer duration incidents	Extra tunnel would provide an easily accessible diversion in the event of a Blackwall Tunnel incident, and will help to reduce the 'knock on' effects of incidents currently experienced.	£7m
Time savings from reduction in OHV incidents	Silvertown Tunnel geometry will reduce the frequency of these incidents, which occur regularly in the Blackwall Tunnel northbound bore.	£20m
Total	-	£324m

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APPENDIX G: Wider Impact Appraisal

Silvertown Tunnel Appendix G

Transport for London

Preliminary Wider Impacts Assessment

| <revision>

September 2015

Client Reference

Silvertown Tunnel Appendix G

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Contents

Abbreviations

EAR	Economic Appraisal Report
FUR	Functional Urban Regions
GC	Generalised Costs
GDP	Gross Domestic Product
GDPW	Gross Domestic Product by Worker
HGV	Heavy Goods Vehicle
LAD	Local Authority District
LGV	Light Goods Vehicle
VOCs	Vehicle Operating Costs
WEBs	Wide Economic Benefits
WI	Wider Impacts

Glossary

Perfectly competitive markets	A perfectly competitive market is a hypothetical market where competition is at its greatest possible level.
Imperfect competitive market	Is a market that does not operate under perfect competition. See definition above.

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Summary

1) This technical note describes the assessment of Wider Impacts (WI) for the Silvertown Tunnel project – it is an appendix to the Preliminary Economic Appraisal Report (EAR) and is used in the Preliminary Outline Business Case (OBC). The calculations have followed the guidance in TAG Unit A2.1 (January 2014).

2) This report contains the results for three Wider Impacts: Agglomeration, Output Change in imperfectly competitive markets and tax revenues arising from Labour Supply impacts.

3) The following paragraphs provide a brief description of each of the WI:

   i. **WI1- Agglomeration**: firms derive productivity benefits from being close to one another and from being located in large labour markets. These impacts appraise the effect of implementing a transport scheme that brings firms closer together and closer to their workforce. These impacts are driven, for example, by increased productivity due to access to larger product, input and labour markets and knowledge and technology spill-overs.

   ii. **WI2- Output Change in imperfectly competitive markets**: When companies benefit from time savings due to a transport scheme, it is effectively a reduction in their production costs, this puts in place an incentive to increase the output while still keeping an attractive price-cost margin. This additional output increases the welfare obtained by consumers and WI2 values this change.

   iii. **WI3.1 Tax revenues arising from labour supply impacts:** This impact estimates the effect on taxes due to a change in the number of people attracted into work as a result of an improvement in travel costs. Individual commuting decisions are based on after tax income, therefore the value of time used for ordinary time savings appraisals does not include exchequer benefits.

4) WI1 and WI3.1 use the same study area: the 32 London boroughs plus the City of London, all of them are listed in the body of this document. Both impacts have been calculated using information for highway, public transport and active modes. WI1 uses business and commuting purposes, while WI3.1 uses only the latter. WI2 uses the net business benefits in the TEE table as its main source of information.

5) The following table shows the main findings for the core calculations for the three WI that have been calculated.

Table 1: Total Wider Impacts – Benefits 2010 Prices (£m)

Wider Impact	2021 (£m)*	2031 (£m)*	Appraisal Period 2021-2080 (£m)*	Net Present Value (£m)**
WI1- Agglomeration	1.2	1.6	153.2	37.9
WI2- Output Change in imperfectly competitive markets	1.5	2.5	250.9	60.1
WI3- Taxes arising from Labour Supply impacts	0.14	0.29	27.3	6.6
Total Wider Impacts	2.84	4.39	431.4	104.6

Undiscounted

*****Discounted***

6) The impacts are positive in all the cases, which suggest that the scheme has a positive outcome in non-transport markets, contributing to an increase in productivity and government income. The highest contribution comes from WI2-Output Change in imperfectly competitive markets. This follows from the fact that it is directly related to business users, who as outlined in the EAR are one of the main beneficiaries of the scheme.

7) The second highest impact is Agglomeration; the result for this impact is again mainly driven by business user benefits.

8) The final and lowest WI is that related to taxes arising from the labour supply increase. WI3.1 calculations are based on the link between the cost of going to work (commuting benefits) and the increase in labour supply. This is consistent with the appraisal findings, which show that commuters have relative low benefits.

9) A sensitivity test has been undertaken to include freight in the WI2- Output Change in imperfectly competitive markets analysis. This showed a small reduction from £60m to £52m. This reduction takes place because freight pays higher user charges.

1. Wider Impacts of Silvertown

1.1 What are Wider Impacts?

1.1.1 This technical note describes the assessment of Wider Impacts (WI) for the Silvertown Tunnel project – it is an appendix to the Preliminary Economic Appraisal Report (EAR) and is used in the Preliminary Outline Business Case (OBC).

1.1.2 WI are the economic impacts of transport that are additional to transport user benefits. Transport schemes are likely to have impacts not only in the transport market but also in the labour, product and land markets. For instance, one of the objectives for the Silvertown Tunnel is to support growth in east and southeast London by providing improved cross-river transport links for business and services (including public transport). If the levels of local congestion at the Blackwall Tunnel are reduced, there are likely to be wider benefits for a large area.

1.1.3 This note explains the methodology followed for the calculations of the WI for the Silvertown Transport Planning Project. The calculations have followed the guidance in TAG Unit A2.1 (January 2014).

1.1.4 The following are the types of WI according to TAG Unit A2.1:

1.1.5 **WI1- Agglomeration**: firms derive productivity benefits from being close to one another and from being located in large labour markets. These impacts appraise the effect of implementing a transport scheme that brings firms closer together and closer to their workforce. These impacts are driven, for example, by increased productivity due to access to larger product, input and labour markets and knowledge and technology spill-overs.

1.1.6 **WI2- Output Change in imperfectly competitive markets**: standard transport appraisal takes into account the time savings for business, and when this occurs output is also expected to increase. For example, the same delivery person can make more deliveries in one day. In addition because there are imperfectly competitive markets, companies are capable of selling products at a higher price than the cost of producing it; this difference is known as the price-cost margin. When companies benefit from time savings due to a transport scheme, it is effectively a reduction in their production costs, this puts in place an incentive to increase the output while still keeping an attractive price-cost margin. This additional output increases the welfare obtained by consumers and WI2 values this change.

1.1.7 **WI3- Tax revenues arising from labour market impacts**: people make commuting decisions based on their income after taxes. Therefore, the value of time used for time savings does not include exchequer benefits that happen in practice when people make different decisions about employment as a result of a transport scheme. There are two ways in which the labour market can be affected:

1. WI3.1 Labour supply impacts: estimates the effect on taxes due to a change in the number of people attracted into work as a result of an improvement in travel costs.

2. WI3.2 Moves to more or less productive jobs: estimates the effect on taxes of an overall change in employment due to the decisions of people and businesses of moving between locations with different productivity levels due to a transport scheme.

1.2 Scope of the analysis

1.2.1 WI1-Agglomeration: The Silvertown Tunnel scheme is expected to increase accessibility between both sides of the River Thames in southeast London and this is likely to bring agglomeration benefits. The guidance advises the analyst to consider a suitably large area for the estimation of these benefits, and requires that these areas should be in the list of Functional Urban Regions (FURs) defined by the DfT.

1.2.2 The study area defined for the impact comprises 33 Local Authority Districts (LADs) which are all listed in DfT's FURs. These are the 32 London boroughs and the City of London.

1.2.3 Areas outside London have not been included as appropriate modelled data and other inputs were not available as the majority of benefits are expected to be in London.

1.2.4 **WI2 - Output Change in imperfectly competitive markets**: the DfT considers this impact relevant in all schemes; therefore it has been included and has been calculated as per the guidance.

1.2.5 **WI3.1 - Taxes arising from labour supply impacts:** These impacts have been calculated as per the guidance. The study area is identical to the one used for the Agglomeration impacts, as described above.

1.2.6 **WI3.2 - Taxes arising from move to more or less productive jobs:** The information on residential and employment location provided by a land-use transport interaction model is not available for this submission; therefore these impacts have not been estimated at this time.

1.3 WI1- Agglomeration:

1.3.1 Agglomeration is a function of the proximity of businesses to one another and to workers, using generalised costs as an indicator of distance. The average generalised cost for each scenario has been calculated following the process described in Appendix 1 of this document. Through this process, matrices for daily demand and generalised cost in minutes for business and commuting purpose for each origin-destination pair, by mode (PT, highway and active) and time period (AM, IP, PM) have also been derived. The daily demands have been annualised using the annualisation parameters defined for this study in the EAR. Generalised time has been converted to pounds using the corresponding market prices as described in Appendix 1 and uplifted using the value of time growth, as defined in DfT's TAG guidance, where appropriate.[1]

1.3.2 Generalised costs used for each mode contain the following:

1. Public Transport: journey time and fares
2. Highway: journey time, user charges and fuel and non-fuel vehicle operating costs (VOCs)
3. Active: journey time

1.3.3 These costs are used to measure the effective density for each scenario. This measure estimates the mass of economic activity across the 33 LADs that comprise the study area and the accessibility of firms to workers and vice versa, and of firms to other firms. Because the effect of proximity has different accessibility and productivity impacts by sector, the effective densities are calculated for four different sectors: Manufacturing, Construction, Consumer Services and Producer Services.

1.3.4 Formula 2.1a in TAG Unit A2.1 was then used. This formula measures how the relative change in effective density interacts with other variables to estimate increase productivity levels and its impact on the national welfare. The following variables are provided by the DfT in the Wider Impacts Dataset:

- GDP per worker (GDPW);
- total employment by LAD;
- employment by sector;
- a distance decay parameter per sector; and
- the elasticity of productivity with respect to effective density for each sector.

[1] TAG databook, DfT November 2014

1.3.5 As per the guidance the main calculations for highway were produced using only information for users. Public transport comprises bus, rail and underground; and the active mode includes cycling and walking.

1.3.6 Agglomeration impacts have been calculated for 2021 and 2031. We have interpolated these results to calculate the values for the years in-between. The values for the years after 2031 have been assumed to be the value for 2031 plus a value of time growth uplift, as outlined in the guidance. The discounting calculations have been applied as per TAG Unit A1.1- Cost- benefit analysis.

1.3.7 Table 1.1: shows the results for these impacts; please note that these assume that there is no employment relocation due to the scheme.

Table 1.1: WI1 - Agglomeration Impacts 2010 Prices (£m)

WI1- Agglomeration Impacts (No employment relocation)	2021 (£m)*	2031 (£m)*	Appraisal Period 2021-2080 (£m)*	Net Present Value (£m)**
Main Analysis (only car for highways)	1.2	1.6	153.2	37.9

****Undiscounted***
*****Discounted***

1.4 WI2 – Output Change in imperfectly competitive markets

1.4.1 The guidance indicates that this impact is equivalent to 10% (imperfect competition up-rate factor) of the total user impacts to business journeys as appraised in the TEE table. This includes time benefits, user charges, vehicle operating costs and reliability benefits[2]. The latter have been included according to the content of the adjusted TEE table presented in the EAR. Note that freight benefits have only considered in the sensitivity analysis, therefore the main analysis only considered public transport and cars. Freight was defined as LGVs and HGVs. This WI is not required to consider active modes.

1.4.2 The appraisal analysis for business benefits included modelled calculations extracted from TUBA and other sources for every year from 2021 to 2080; in consequence WI2 can be calculated for every year without applying any interpolation method or growth value.

[2] The construction time user disbenefits have been left out of the calculations because they occur before the opening year. Also, they are very small and it is unlikely that they will be perceived by the businesses to change their output decisions.

Table 1.2: WI2 - Output Change in imperfectly competitive markets. 2010 Prices (£m)

WI2- Output Change in imperfectly competitive markets	2021 (£m)*	2031(£m)*	Appraisal Period 2021-2080 (£m)*	Net Present Value (£m)**
Main analysis (without Freight)	1.5	2.5	250.9	60.1
Sensitivity test (includes changes in freight)	0.3	1.7	254.5	52.4

**Undiscounted*
***Discounted*

1.5 WI3.1 – Taxes arising from labour supply impacts

1.5.1 For calculating these impacts the 33 Local Authority Districts defined as the study area for the calculation of the agglomeration impacts have been included in the assessment.

1.5.2 The formula 4.1a in TAG Unit A2.1 has been used. This formula measures how the change in round-trip commuting average generalised costs, between both scenarios, interact with other variables to estimate the new quantity of workers in the market, and the effect of this on GDP. The following variables are provided by the DfT in the Wider Impacts Dataset:

- the number of workers living in the study area ;
- the tax rate required to convert earnings from gross into net earnings;
- the productivity levels of new workers; and
- the elasticity of labour supply with respect to effective wages.

1.5.3 The average generalised cost for each scenario has been calculated following the process described in Appendix 1 of this document. Through this process matrices for daily demand and generalised cost in minutes for commuting purpose for each origin-destination pair, by mode (PT, highway and active) and time period (AM, IP, PM) have been derived. The daily demands have been annualised using the annualisation parameters defined for this study in the EAR and the generalised costs have been converted to pounds using the correspondent market price value of time in 2010 prices for commuting purpose as defined in DfT's guidance.

1.5.4 Generalised costs for each mode contain the following:

- Public Transport: journey time and fares
- Highway: journey time, user charges and fuel and non-fuel vehicle operating costs (VOCs)
- Active: journey time

1.5.5 This input was used to obtain the required average generalised cost for each scenario[3]. The change in costs experienced in the labour market and its impact on working vs non-working decisions (Formula 4.1a as outlined above) was then calculated.

1.5.6 This provided an estimate of the overall effect on GDP; additionally the benefit accrued by the exchequer was calculated, which the guidance estimates to be 40% of the impact on the GDP.

1.5.7 Taxes arising from labour supply impacts have been calculated for 2021 and 2031. We have interpolated these results to calculate the values for the years in-between. The values for the years after 2031 have been assumed to be the value for 2031 plus a value of time growth uplift, as outlined in the guidance. The discounting calculations have been applied as per TAG Unit A1.1- Cost- benefit analysis.

1.5.8 **Table 1.3** shows the results of these calculations:

Table 1.3: WI3.1 - Taxes arising from labour supply impacts. 2010 prices (£m)

WI3.1-Taxes arising from labour supply impacts	2021 (£m)*	2031 (£m)*	Appraisal Period 2021-2080 (£m)*	Net Present Value (£m)**
Central case	0.14	0.29	27.3	6.6

****Undiscounted***

*****Discounted***

1.5.9 Please note that because it has been assumed that there is no relocation of housing or jobs, which is the suggested sensitivity scenario for this impact, no sensitivity analysis has been undertaken for this benefit.

1.6 Findings and conclusions

1.6.1 The following table shows the main findings for the three WI that have been calculated.

Table 1.4: Total Wider Impacts - core calculations. 2010 Prices (£m)

Wider Impact	2021 (£m)*	2031 (£m)*	Appraisal Period 2021-2080 (£m)*	Net Present Value (£m)**
WI1- Agglomeration	1.2	1.6	153.2	37.9
WI2- Output Change in imperfectly competitive markets	1.5	2.5	250.9	60.1
WI3- Taxes arising from Labour Supply impacts	0.14	0.29	27.3	6.6

[3] Following formula 4.3 in TAG Unit A2.1

Total Wider Impacts	2.84	4.39	431.4	104.6

***Undiscounted**

****Discounted**

1.6.2 The impacts are positive in all the cases, which suggest that the scheme has a positive outcome in non-transport markets, contributing to an increase in productivity and government income. The highest contribution comes from WI2-Output Change in imperfectly competitive markets. This follows from the fact that it is directly related to business users, who (as outlined in the EAR) are one of the main beneficiaries of the scheme.

1.6.3 The second highest impact is Agglomeration; the result for this impact is again mainly driven by business user benefits.

1.6.4 The final WI is that related to taxes arising from the labour supply increase. This is consistent with the appraisal findings, which show that commuters have relatively low benefits. WI3.1 calculations are based on the link between the cost of going to work (commuting benefits) and the increase in labour supply.

1.6.5 A sensitivity test has been undertaken to include freight in the WI2- Output Change in imperfectly competitive markets analysis. This showed a small reduction from £60m to £52m. This reduction occurs because freight pays higher user charges.

Appendix A. WI input calculation process

A.1 Introduction

A.1.1 This note set outs the methodology and technical inputs into the Wider Impacts (WI) analysis for the Silvertown Tunnel project. More specifically, it relates to two of the three wider impacts as outlined in TAG Unit A2.1:

- WI1 Agglomeration – firms derive productivity benefits from being close to one another and to their workforce. This impact centres on the change in effective density with and without the transport scheme. Effective density is in effect a measure of accessibility to employment.
- WI3.1 – Tax revenues arising from labour market impacts (from labour supply markets).

The requirements of each TAG element in terms of calculations and inputs are summarised below:

A.1.2 TAG A2.1 WI1 Agglomeration

Change in effective density is calculated based on changes in the average daily generalised cost for business and commuting for PT, Car and active modes separately.

A.1.3 TAG A2.1 WI3.1 Labour Supply Impacts

This unit requires changes in the average daily generalised cost for commuting only.

A.2 Inputs and Assumptions

A.2.1 Highway

Highway estimates have been sourced from the RXHAM (River Crossings Highway Assignment Model) production 1 (part of the LorDM suite). The following scenarios have been used:

- 2021, 2031 and 2041 Reference Case (without Silvertown Tunnel)
- 2021, 2031 and 2041 Assessed Case (with Silvertown Tunnel)

for the three model time periods (AM, IP and PM).

The seven highway assignment user classes in RXHAM are:

- Car Low Income
- Car Medium Income
- Car High Income
- Car Business
- Taxis
- LGV
- HGV

To create highway demand and generalised time at a sector level the following process was undertaken:

1) Skim time (in seconds), cost (in pence in 2009 prices) and demand (PCUs) from each RXHAM scenario for all time periods and user classes.

2) Modelled costs are uplifted to 2010 prices. An average car business Value of Time was derived based on occupancy by time period which allows for the different values of time by car driver and car passenger.

3) Cost matrices from RXHAM (which comprise of tolls and charges) were converted from pence to minutes using the average value of time calculated in step 2. Non business car costs were split into commute and leisure journey purposes based on the proportions detailed in **Table 1.5**.

Table 1.5: Non Business Car Splits

Purpose	AM	IP	PM
Car Commute	0.61	0.2	0.43
Car Leisure	0.39	0.8	0.57

4) The skimmed time matrices from RXHAM were converted from seconds to minutes

5) The 7 time skim matrices (1 for each user class) were split into the following 10 appraisal matrices:

- Low Income Commute
- Low Income Leisure
- Medium Income Commute
- Medium Income Leisure
- High Income Commute
- High Income Leisure
- Car Business
- Taxi
- LGV
- HGV

6) Total generalised minute matrices were calculated by adding all the time skim matrices and the cost matrices which were subsequently converted to time.

7) Person trip matrices were produced through multiplying each demand segment by the occupancy rate outlined in **Table 1.6**. Non business car trips were split into commute and leisure journey purposes based on the proportions detailed in **Table 1.5** prior to applying the occupancy rate.

8) Total Commute and Leisure demand matrices were derived from adding each income group. This was replicated for the cost matrices using the demand weightings.

9) Add Car Business and Taxi demand matrices. This was replicated for the cost matrices using the demand weightings.

10) The WI benefit calculations only require business and commute purposes (leisure matrices are not used); therefore these matrices (both demand and time/cost) were aggregated at a sector level. The sectoring system used was called GDAT which includes the London Boroughs and the City of London.

11) The final outputs for the wider economic impact calculations were sectored demand and generalised time matrices for business and commute purposes.

Table 1.6: Occupancy Factors

Purpose	AM	IP	PM
Car Business	1.22	1.18	1.16
Car Commute	1.15	1.14	1.12
Car Leisure	1.66	1.73	1.78
Taxi	1.2	1.2	1.2
LGV	1.2	1.2	1.2
HGV	1	1	1

A.2.2 Vehicle Operating Costs (VOC)

Vehicle operating costs have been included into the WI calculations for highway. The vehicle operating cost was added to the highway generalised cost matrices. The following inputs were used:

1) Average speed sector matrices (kph)

2) Average distance sector matrices (kms)

To calculate VOC sector matrices (in £'s) the following formulae were used for fuel and non-fuel costs:

Equation 1 Fuel Operating Costs

$$L = (a + b.v + c.v^2 + d.v^3) / v$$

Where:
L = consumption, expressed in litres per kilometre;
v = average speed in kilometres per hour; and
a, b, c, d are parameters defined for each vehicle category.

Equation 2 Non Fuel Operating Costs

$$C = a1 + b1/V$$

where;
C = cost in pence per kilometre travelled;
V = average link speed in kilometres per hour;
a1 is a parameter for distance related costs defined for each vehicle category; and
b1 is a parameter for vehicle capital saving defined for each vehicle category (this parameter is only relevant to working vehicles).

The following parameters were used; all sourced from TAG data book Autumn 2014.

Table 1.7: Fuel Consumption Parameters

Section	Year	a	b	c	d
Work A1.3.12	2021	61.197	4.44	-0.03	0.0003
Work A1.3.13	2031	57.179	4.214	-0.028	0.0003
Work A1.3.14	2041	61.39	4.516	-0.03	0.0003
Non-Work: A1.3.13	2021	73.436	5.324	-0.037	0.0004
Non-Work: A1.3.13	2031	68.614	5.037	-0.034	0.0003
Non-Work: A1.3.13	2041	73.668	5.4	-0.036	0.0004

Table 1.8: Non-Fuel Consumption Parameters

Section	Year	A1	B1
Work A1.3.12	2021	4.917	135.946
Work A1.3.13	2031	4.764	135.946
Work A1.3.14	2041	4.764	135.946
Non-Work: A1.3.13	2021	3.812	0
Non-Work: A1.3.13	2031	3.703	0
Non-Work: A1.3.13	2041	3.703	0

A.2.3 Public Transport

The public transport input into the WI calculations were sourced from Railplan runs from LoRDM. This includes demand matrices and generalised costs. Generalised cost from Railplan includes both generalised time which is journey time plus weighted access/egress and interchange time and the cost of the fare.

The process was as follows:

1) Skim IWT and OWT generalised time (in minutes) matrices, fares matrices (in pence in 2011 prices) and person demand matrices.

2) Commute and Business demand was calculated from the Railplan person demand matrices using the splits in **Table 1.9**.

Table 1.9: PT Journey Purpose Demand Splits

Purpose	AM	IP	PM
PT Business	0.1	0.09	0.11
PT Commute	0.51	0.1	0.43
PT Leisure	0.39	0.81	0.146

3) Fares were converted into 2010 prices which were subsequently converted into minutes using appropriate values of time.

4) Fare matrices were added to the generalised time matrices to create generalised cost (in minutes).

5) The WI calculation only requires business and commute purposes (leisure matrices are not used), therefore these matrices (both demand and time/cost) were aggregated at a sector level. The sectoring system used was GDAT which includes the London Boroughs and the City of London.

6) The final outputs that go into the WI calculations were sectored demand and generalised cost matrices (in minutes) for business and commute purposes.

A.2.4 Active Modes

Daily active mode demand (by commute and business) and distance matrices used for the WI calculations were taken from LoRDM. Active mode time matrices were calculated using the following assumptions:

- Distances more than 5km, assume cycle trips have an average 20kph speed
- Distances less than 5km assume a split (80/20) between walk and cycle trips with an average 8kph speed.

The matrices were sectored to GDAT level which includes the London Borough and the City of London. Time matrices were sectored using demand weighting.

Demand matrices in Production-Attraction from LoRDM were converted into Origin-Destination matrices. The final matrices included AM, IP and PM time periods.

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APPENDIX H: Accessibility Note

Silvertown Tunnel Appendix H

Transport for London

Accessibility Calculations

Technical Note

September 2015

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Silvertown Tunnel Appendix H

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4	24/9/15	Final for review	YS	ML	AN
5	1/10/15	Final	GC	AN	AN

Contents

1. Introduction

1.1.1 This technical note is written to explain the methodology used for accessibility analysis for the Silvertown Tunnel Project. Several of the WebTAG appraisal methods require the analysis of changes in generalised costs, although the exact requirements vary slightly between the appraisal methodologies. They are TAG A2.1 WI1 Agglomeration, TAG A2.1 WI3a Labour Supply Impacts, TAG A4.2 Distributional Impacts and TAG A2.2 Regeneration. The note sets out how these definitions of generalised costs were calculated from the available transport model outputs and how they were used for the different kinds of accessibility analysis - the method has been agreed with TfL.

1.1.2 The requirements of each TAG element are summarised below:

<u>TAG A2.1 WI1 Agglomeration</u>

Change in effective density is calculated based on changes in the average daily generalised cost for business and commuting for PT and Car. It is recommended that a sensitivity test is conducted using the equivalent definition with the addition of the LGV and HGV user classes.

<u>TAG A2.1 WI3.1 Labour Supply Impacts</u>

This unit requires changes in the average daily generalised cost for commuting only.

<u>TAG A2.2 Regeneration</u>

This unit requires analysis of the change in the average daily generalised cost for business, commuting, and other travel all assessed separately.

<u>TAG A4.2 Distributional Impacts</u>

The distributional impacts can be assessed on a mode-specific basis using changes in average daily generalised cost for commuting and other travel assessed separately.

We note that a previous ‘Development Study’ for TfL used morning peak generalised costs for all user classes combined.

To meet all of the above requirements above at the same time, a methodology has been developed as described below, and as summarised in the flowchart in Appendix A.

2. Inputs and Assumptions

2.1 Highway

2.1.1 Highway cost estimates have been sourced from the RXHAM (River Crossings Highway Assignment Model) production 1 (part of the LoRDM suite), with the test names used shown in Table 1.

2.1.2 The generalised cost matrices were the sum of journey time (in minutes) and monetary costs (in pence) skims from SATURN[1], including user charges, reliability benefits and vehicle operating costs. The monetary costs were converted into time (minutes) by the relevant National Values of Time (Table 2). A future sensitivity test may also be undertaken using a London Value of Time (Table 3).

2.1.3 The total reliability benefits (as set out in EAR[2] Appendix F Preliminary Reliability and Incident Benefits) were calculated by time period and purpose. An estimated trip average cost saving was then calculated based on the cross-river demand from each time period.

2.1.4 The estimated vehicle operating costs were derived using the WebTAG approach set out in TAG A1.3 - User and Provider Impacts. The journey time (in minutes) and distance (in kilometres) skims from SATURN were used to calculated average speed and to convert the cost per km to a cost for trip. The cost includes both the fuel and non-fuel elements of the vehicle operating costs.

2.1.5 The different cost and demand matrices from RXHAM were segmented by seven user classes. However, commuting and other non-business travel purposes were grouped together for three different income categories. Therefore it was necessary to split these user classes into commuting and other travel using journey purpose factors (Table 4) from LoRDM.

2.1.6 RXHAM outputs are in passenger car units (PCUs) and were converted to the numbers of users before use, using vehicle occupancy factors (Table 5) from LoRDM.

2.1.7 To obtain the daily average numbers, generalised cost matrices for morning (AM), inter-peak (IP) and evening (PM) were aggregated using expansion factors (Table 6) to calculate the daily average generalised costs[3]. The aggregated costs were trip weighted averages across the three time periods.

Table 1 Highway Test Details

Scenario	Time Period	2021	2031	2041
Reference Case (without Silvertown Tunnel)	AM	2021AM_ph3_central_20150303_F	2031AM_ph3_central_20150223_F	2041AM_ph3_central_20150318_F
	IP	2021IP_ph3_central_20150303_F	2031IP_ph3_central_20150223_F	2041IP_ph3_central_20150318_F
	PM	2021PM_ph3_central_20150303_F	2031PM_ph3_central_20150223_F	2041PM_ph3_central_20150318_F
Assessed Case (with Silvertown Tunnel)	AM	2021AM_Central_S142_Mar15	2031AM_Central_S153_Mar15	2041AM_Central_S154_Mar15
	IP	2021IP_Central_S142_Mar15	2031IP_Central_S153_Mar15	2041IP_Central_S154_Mar15
	PM	2021PM_Central_S142_Mar15	2031PM_Central_S153_Mar15	2041PM_Central_S154_Mar15

[1] The values used were 'market' prices to maintain consistency with the economic appraisal. It is also possible to use 'perceived' costs, although Individual consumers perceive costs in the market price unit of account and therefore the perceived cost and the market price are the same for 'commuting' and 'other' purposes, and only different for businesses, who are affected by indirect taxation.
[2] Silvertown Tunnel Preliminary Economic Assessment Report TfL, September 2015
[3] Provided by Hyder

Table 2 National Value of Time (from WebTAG)

User Class	2021 (Pence per Hour per person)[4]	2031	2041
Car Commuters	807	979	1203
Car Others	716	869	1067
Car Business	3207	3889	4778
Taxi	3207	3889	4778
LGV	1444	1750	2151
OGV	1701	2062	2534

Table 3 London Value of Time (uplifted WebTAG)[5]

User Class	2021 (Pence per Hour per person)	2031	2041
Car Commuters	1043	1266	1555
Car Others	926	1124	1380
Car Business	4461	5410	6646
Taxi	4461	5410	6646
LGV	2009	2434	2992
OGV	2366	2868	3525

Table 4 Journey Purpose Factors for Highway (from LoRDM)

User Class	AM	IP	PM
Car Commuters	0.61	0.20	0.43
Car Non-Commuters	0.39	0.80	0.57

Table 5 Vehicle Occupancy Factors (from LoRDM)

User Class	AM (Persons per Vehicle)	IP	PM
Car Commuters	1.15	1.14	1.12
Car Non-Commuters	1.66	1.73	1.78
Car Business	1.22	1.18	1.16
LGV	1.20	1.20	1.20
OGV	1.00	1.00	1.00

Table 6 Factors to convert Highway hours to 12-hour totals (from analysis by Hyder)

Time Period	Factors
AM Peak (3hrs, 7am to 10am)	2.80
IP (6hrs, 10am to 4pm)	6.00
PM Peak (3hrs, 4pm to 7pm)	2.89

[4] TAG databook 1.3.1 market cost , 2010 prices
[5] Uplifted from TAG databook 1.3.1 market cost , 2010 prices using recommendations from TfL Business Case Development Manual, 2014

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2.2 Public Transport

2.2.1 The public transport (PT) figures were based on the Railplan runs from LoRDM undertaken by Jacobs. Railplan demand and therefore costs are split buy time period but not by trip purpose. TAG guidelines state that no behavioural weights should be applied to walk and wait time for business (in work time) travel. In order to generate different costs by purpose the generalised cost has been calculated by including and or weighting of the different cost elements. This was done as follows:

- Commute/Other: Crowded IVT + walk time x 2 + wait time x 2.5 + boarding penalty
- Business: Uncrowded IVT + walk time + wait time

2.2.2 For the demand, uniform split factors (Table 7) from LoRDM were used to segment in different purposes. Railplan itself does not model or include fares as part of the assignment. There are fare matrices used in LoRDM which are specified as an average fare between zones and do not vary between the reference and accessed case. The costs and fares are produced in RXHAM zoning system as part of LoRDM.

2.2.3 To obtain the daily average numbers, generalised cost matrices for AM, IP and PM were combined to calculate the 12-hr daily generalised costs. Please note that the demand matrices from Railplan are 3hr Morning Period, 6hr Inter Period and 3hr Evening Period data instead of peak hour data. The aggregated costs were trip weighted averages across the three time periods.

Table 7 Journey Purpose Factors for Public Transport (from LoRDM)

PT User Class	AM	IP	PM
Commute	0.51	0.10	0.43
Business	0.10	0.09	0.11
Other	0.39	0.81	0.46

2.3 Active Modes

2.3.1 Even if the change in generalised cost for walking and cycling trips is not the focus of the scheme to be evaluated, it is important to include the active modes in the mode share weighting process. Due to the high proportion of walking trips that are intra-zonal and short trips, failure to include these modes can result in small variations in public transport or highway generalised costs being over-estimated by a large margin, as they may be given an ‘inflated’ mode share without active modes.

2.3.2 There are matrices of demand and distances for active modes contained within LoRDM and they provide a reasonable estimate of the scale of active mode travel but were deemed not sufficiently reliable to use at the level of detail required. In addition, the distances use come directly from LTS inputs and are fixed between the reference and accessed case. The decision was made to use the reference case demand and distances for the costs and weighting for the assessed case.

2.3.3 The distance matrices were converted to time using TfL assumptions on walk/cycle split and speeds. All trips greater than 5kms are assumed to be cycle trips with a speed of 20kph. Those trips less than 5kms are assumed to be comprised of 80% walk (with a speed of 5kph) and 20% cycle which gives an average speed of 8kph.

2.4 Demographic Data

2.4.1 Population and employment forecasts have been taken from the reference case LTS model. The data available for the London area is shown in Table 8, along with a description. The data available for the external to London area only contains households, total population, totals workers and totals jobs.

2.4.2 This data has been used for three metrics. These are described in Table 9 and show what LTS data was used for which metric. There is no data on pensioners which is used to calculate the number of adults. Census 2011 data was used in order to derive a proportion of population that are adults (people older than 16). This was done for the non-London area and gave a percentage of adults as 81.0% of the total population.

Table 8 LTS data supplied

Code	Description
Mzne	Zone
hh__	Households
pp__	Population
pp__5ovr	Population over 5 years old
Chld	Children (5-15)
Waww	White collar workers
Wawb	Blue collar workers
Wane	Unemployed adults
Pens	Pensioners (Senior)
Jobw	job white collar
Job	job blue collar

Table 9 Metric definition

Metric	Definition
Labour Force	Sum of white collar workers, blue collar workers and unemployed adults for internal and total workers for external.
Jobs	Sum of white collar and blue collar jobs for internal and total jobs for external.
Adults	Sum of white collar workers, blue collar workers, unemployed adults and pensioners for internal and a % of population for external.

3. Methodology

3.1 Preparation of weighted generalised cost matrices

3.1.1 An automated process has been developed to convert outputs from the RXHAM and Railplan models into the desired average generalised cost matrices. The flow chart in Appendix A summarises this process.

3.1.2 In essence the methodology follows these three steps:

i. Generate comparable matrices of generalised cost including journey time, monetary elements – the method allows reliability benefits and VOC to be included as well.

ii. Disaggregate and/or aggregate the matrices to create the required user classes (business, commute, other, commute + business, commute + business + LGV + HGV)

iii. Combine the generalised cost matrices by time period to daily trip weighted average generalised cost matrices by required user classes

3.1.3 The combinations of average generalised cost matrices required in the different WebTAG elements can be extracted from the final outputs.

3.2 Methodology adjustment due to zero demand in Reference Case for Wider Impacts Assessment

3.2.1 Due to some zeros in some cells in the reference case demand matrices, a very small change from reference case demand to assessed case demand (for example, 0 trips in reference case but 0.002 trips in assessed case) will cause an infinitely large generalised cost change when demand is weighted by generalised cost. To deal with this situation, options are either to aggregate demand into boroughs before using them for weighting or use assessed case demand for both reference case and assessed case generalised costs.

3.2.2 Since the assessed case mode shift and re-distribution effects should be taken into account, the first methodology was applied to deal with the situation.

3.2.3 Therefore, as shown in the flow chart in Appendix A, for the Wider Impacts assessment only, before step iii (combining the generalised cost matrices by time period to daily average), the demand inputs were added up into boroughs and the borough generalised costs were calculated through weighting RXHAM zone GC by demand.

3.3 GIS Analysis

3.3.1 Two separate GIS analyses were undertaken. The first used only journey time whereas the second used generalised time. Table 10 below shows the definition of costs for both car and PT. The journey time corresponds to the actual time taken for a journey, and the generalised time seeks to include values such as user charges and reliability for cars, and crowding, weightings and fares for public transport.

3.3.2 Tabulated outputs were produced that show the access to jobs, economically active population, adults and other businesses to/from a given zone within a given time cut-off by mode.

3.3.3 For **access to jobs**, the important metric is the number of jobs a person can reach from their home (e.g., How many jobs can I get to from my home?) so the origin zone was used.

3.3.4 For **access to economically active population** the process is reversed and the important figure is how many people of working age can reach a given zone (e.g. How many engineers can reach the Jacobs office in London Bridge?) so the destination zone was used.

3.3.5 For consumer catchments, **access to adult population** was used. Instead of using commuting trip costs, 'other' trip costs were used and the method calculated the number of 16+ people who can reach the business area (e.g. How many adults can reach the food market in Greenwich?) so the destination zone was used.

3.3.6 For **access to other businesses**, the important metric is the number of businesses a person can reach (e.g., How many other companies' offices can I get to?).

3.3.7 If the modelled travel time between an origin zone (i) and a destination zone (j) is less than the cut-off, then the number of jobs in zone j is added to the jobs accessibility figure for the origin zone i. Similarly the size of the labour force in zone i is added to the access to economically active population figure for the destination zone j.

3.3.8 When this is done across an entire matrix single figures of access to jobs, economically active population and adults for each zone are denser, which can then be mapped.

3.3.9 For highway, the cut-off figures used were 45 minutes for journey time, and 70 minutes for generalised time. For PT the cut-off figure used was 75 and weighted journey time was used.

3.3.10 TfL uses a 45-minute standard threshold to assess journey time connectivity in London, as evidenced by the statistics contained in their 'Travel in London' annual reports[6]. This is slightly higher than the average London commute time of 37 minutes. The 70-minute threshold for generalised cost was determined by estimating the average generalised cost value (in minutes) of the user charge in the Assessed Case from the 2021 RXHAM outputs, based on different user class VoTs. This worked out at approximately 22 minutes, which were added to the 45 minutes outlined above and rounded up to obtain 70 minutes.

3.3.11 The PT threshold has been set at 75 minutes which accounts for the waiting and walk time which is weighted greater than actual time in accordance with TAG. It was estimated that the 75 minutes weighted time is broadly equivaleant to a 45 minute actual journey time. [7]

Table 10 Glossary of terms

Name	Definition
Journey Time (Highway)	Travel time between two travel zones
Generalised Time (Highway)	Travel time plus the cost of any user charges (e.g. Congestion charging zone or toll charges), estimated reliability benefits and estimated vehicle operating costs
Unweighted Journey Time (PT)	The sum of walk, waiting and in vehicle time – same as business costs described above.
Weighted Journey Time (PT)	Crowded in vehicle time, weighted walk time, weighted wait time and boarding penalties – same as commute/other costs described above.

[6] https://tfl.gov.uk/corporate/publications-and-reports/travel-in-london-reports

1.1.1 [7] The reason that the 45/70 minute threshold method was used is that it can generate a reasonable single value for each zone to be compared between reference case and assessed case, and can be easily interpreted and mapped. Curves to show how many jobs are accessible within 5, 10, 15, 20, 25…60 minutes in different scenarios are less easily comparable.

4. Results

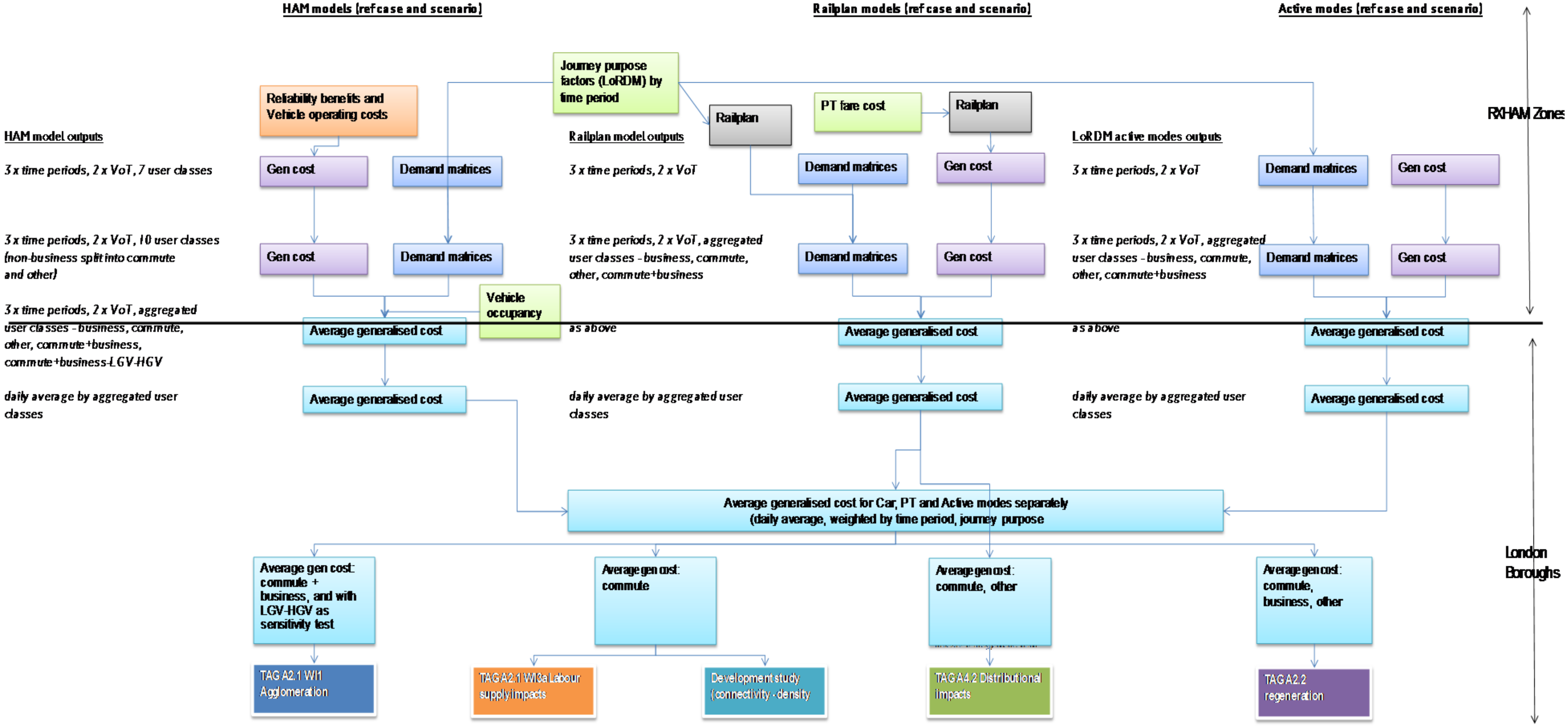
4.1.1 The following appendices show the access to jobs results:

Appendix	Time Periods	Highway	PT	Definition
Appendix B: The Current Transport Issues	AM/IP/PM	Journey Time	Weighted Journey Time	Base year accessibility
Appendix C: The Future 'Do Nothing' Issues	AM/IP/PM	Journey Time	Weighted Journey Time	Change in accessibility between base year and reference case (2021)
Appendix D: Silvertown Impacts	AM/IP/PM	Journey Time, Generalised Time	Weighted Journey Time	Change in accessibility between the reference case and the assessed case
Appendix D: Silvertown Impacts Business access	AM/IP/PM	Generalised Time	N/A	As above but for access to other businesses

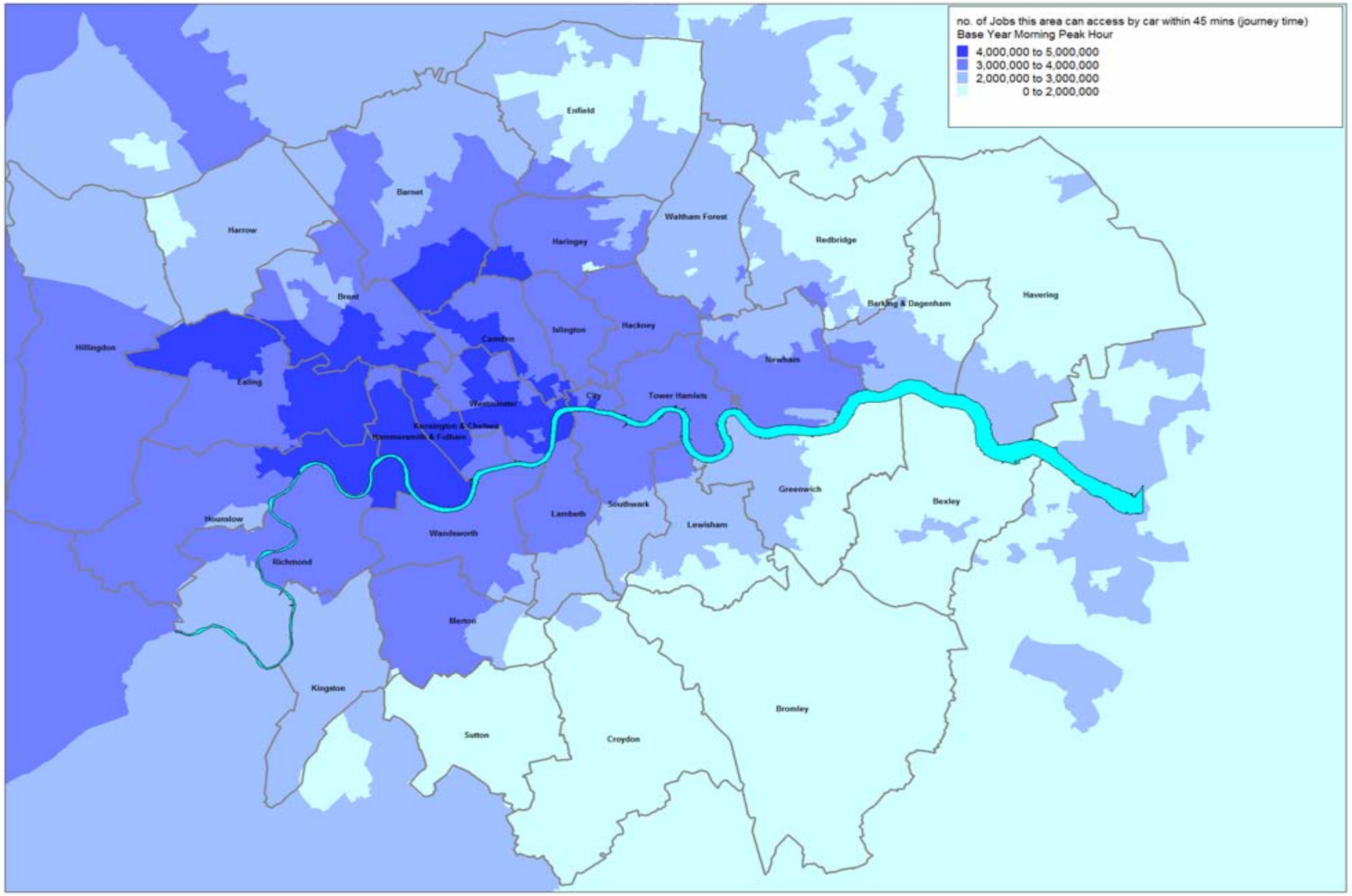
4.1.2 The details of the results are discussed in the following reports:

- Preliminary Transport Assessment
- Preliminary Distributional Impacts Appraisal
- Preliminary Regeneration and Development Impact Assessment
- Preliminary Social Impacts Appraisal

Appendix A. Methodology Flow Chart



Appendix B. Current Transport Issues (Regeneration Areas)

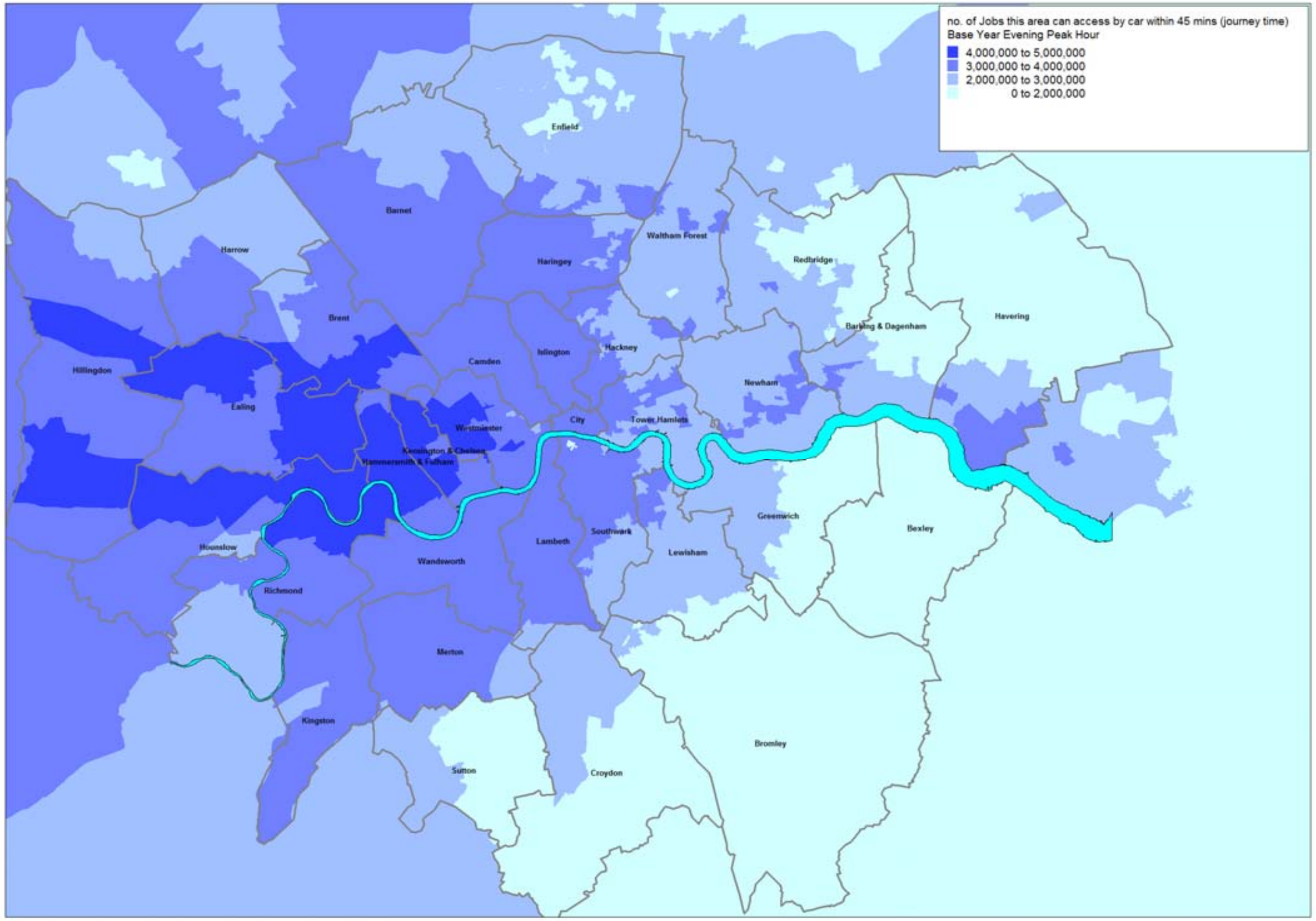


Borough	Jobs
Barking and Dagenham	2,246,678
Greenwich	1,648,223
Hackney	3,491,755
Lewisham	2,057,976
Newham	2,982,316
Tower Hamlets	3,497,200
Waltham Forest	2,504,069

Figure 1 Base Year Job Accessibility by Car Journey Time AM

Borough	Jobs
Barking and Dagenham	3,084,060
Greenwich	2,568,536
Hackney	3,596,509
Lewisham	2,774,742
Newham	3,395,480
Tower Hamlets	3,574,877
Waltham Forest	3,366,337

Figure 2 Base Year Job Accessibility by Car Journey Time IP



Borough	Jobs
Barking and Dagenham	2,323,541
Greenwich	2,211,449
Hackney	2,866,106
Lewisham	2,541,227
Newham	2,742,238
Tower Hamlets	2,978,732
Waltham Forest	2,652,590

Figure 3 Base Year Job Accessibility by Car Journey Time PM

Borough	Jobs
Barking and Dagenham	116,116
Greenwich	124,879
Hackney	843,228
Lewisham	260,347
Newham	475,348
Tower Hamlets	1,458,888
Waltham Forest	273,886

Figure 4 Base Year Job Accessibility by PT Weighted Journey Time AM

Borough	Jobs
Barking and Dagenham	257,709
Greenwich	292,318
Hackney	1,448,463
Lewisham	504,787
Newham	978,120
Tower Hamlets	1,859,859
Waltham Forest	996,620

Figure 5 Base Year Job Accessibility by PT Weighted Journey Time IP

Borough	Jobs
Barking and Dagenham	190,772
Greenwich	187,305
Hackney	1,021,475
Lewisham	350,775
Newham	740,761
Tower Hamlets	1,554,897
Waltham Forest	617,693

Figure 6 Base Year Job Accessibility by PT Weighted Journey Time PM

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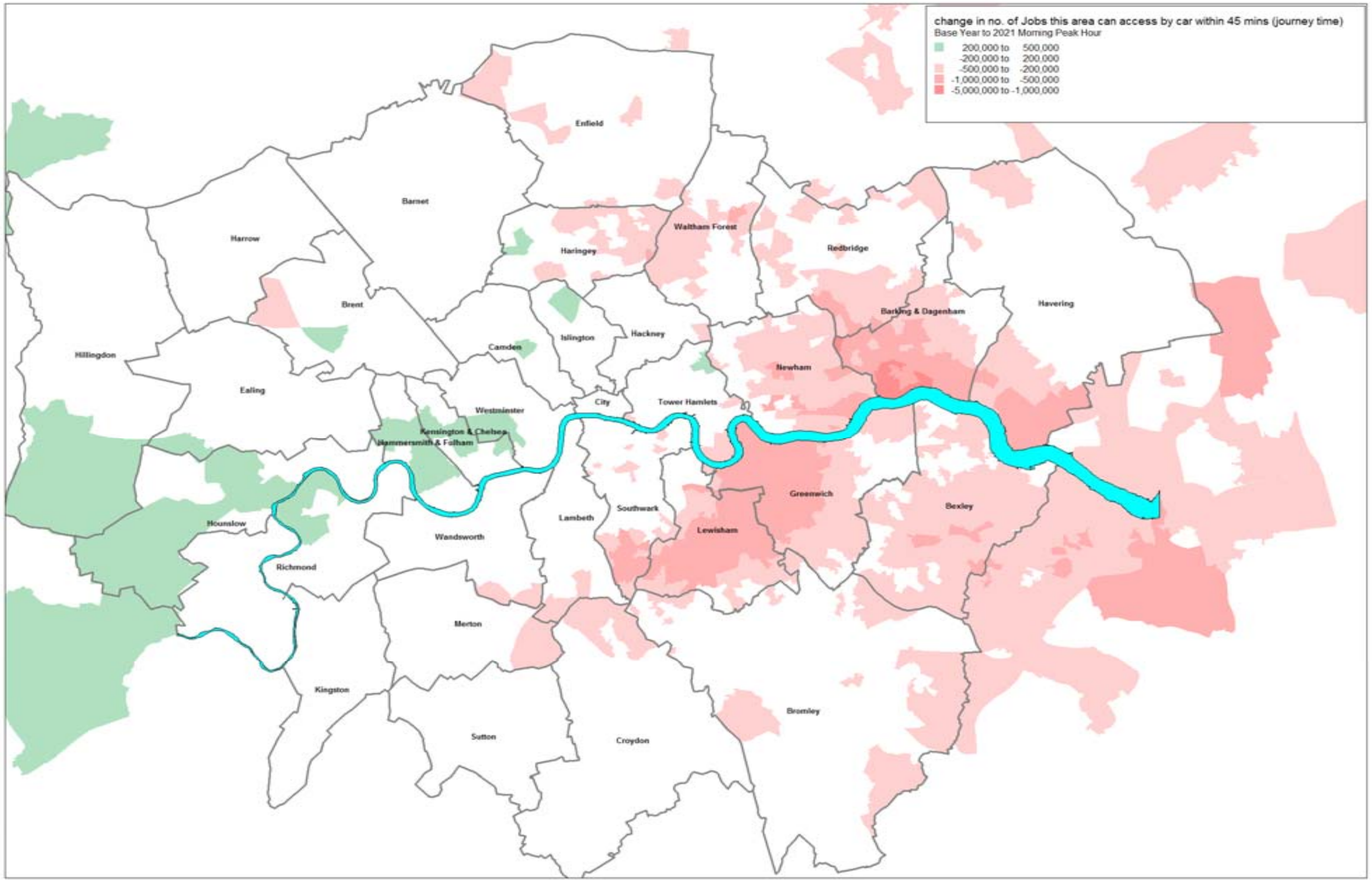
Appendix C. Future 'Do Nothing' Issues (Regeneration Areas)



Borough	Jobs
Barking and Dagenham	-401,141
Greenwich	-355,947
Hackney	35,700
Lewisham	-431,029
Newham	-282,534
Tower Hamlets	-17,628
Waltham Forest	-120,061

Figure 7 Change in Job Accessibility by Car Journey Time AM from 2012 to 2021

Borough	Jobs
Barking and Dagenham	-255,020
Greenwich	-158,360
Hackney	-34,438
Lewisham	-31,521
Newham	-62,614
Tower Hamlets	69,631
Waltham Forest	29,192

Figure 8 Change in Job Accessibility by Car Journey Time IP from 2012 to 2021

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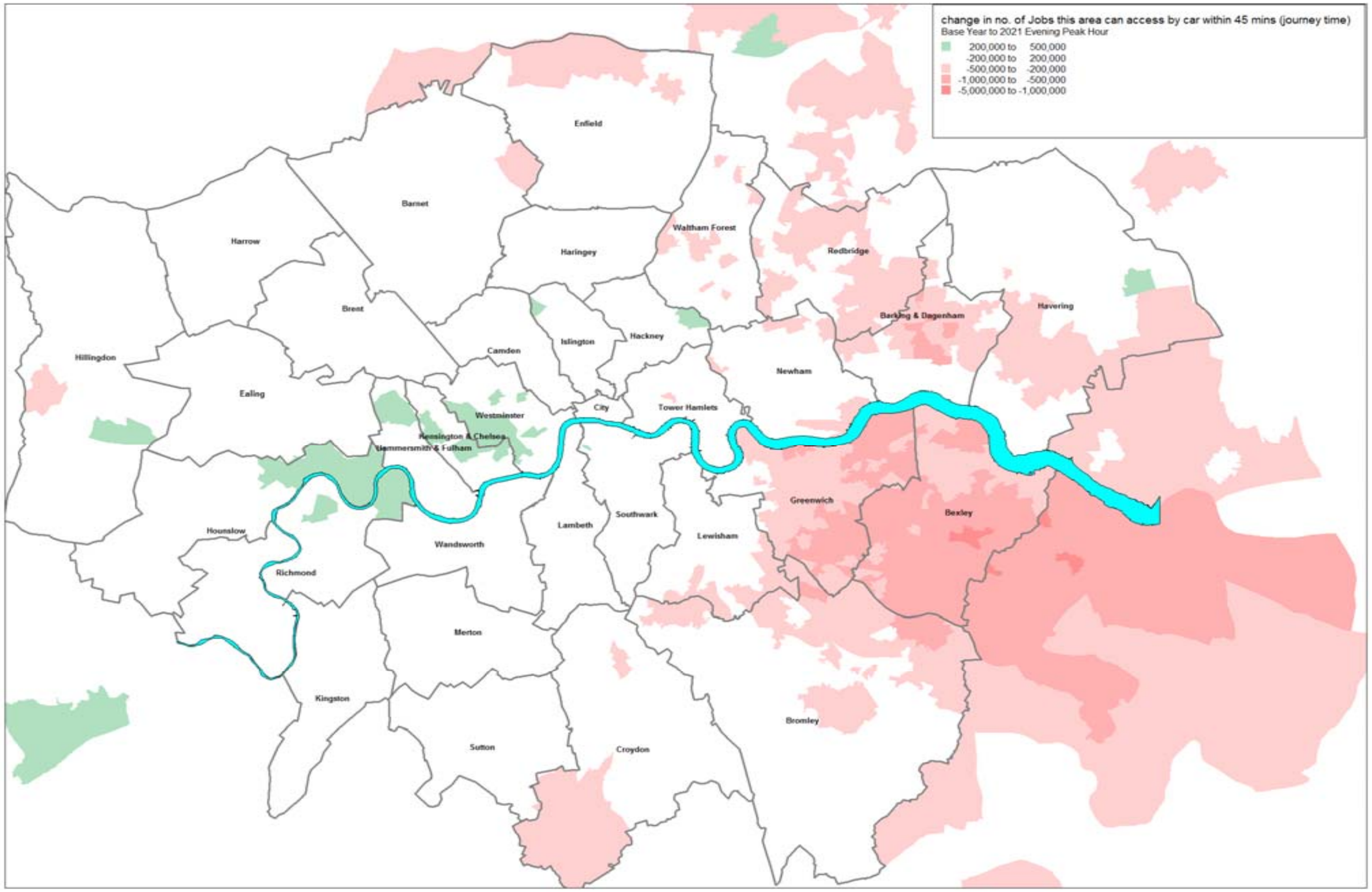


Borough	Jobs
Barking and Dagenham	-237,541
Greenwich	-367,978
Hackney	72,838
Lewisham	-106,095
Newham	-42,512
Tower Hamlets	-16,359
Waltham Forest	-106,941

Figure 9 Change in Job Accessibility by Car Journey Time PM from 2012 to 2021

Borough	Jobs
Barking and Dagenham	43,156
Greenwich	183,073
Hackney	163,752
Lewisham	135,917
Newham	353,270
Tower Hamlets	363,639
Waltham Forest	140,552

Figure 10 Change in Job Accessibility by PT Weighted Journey Time AM from 2012 to 2021

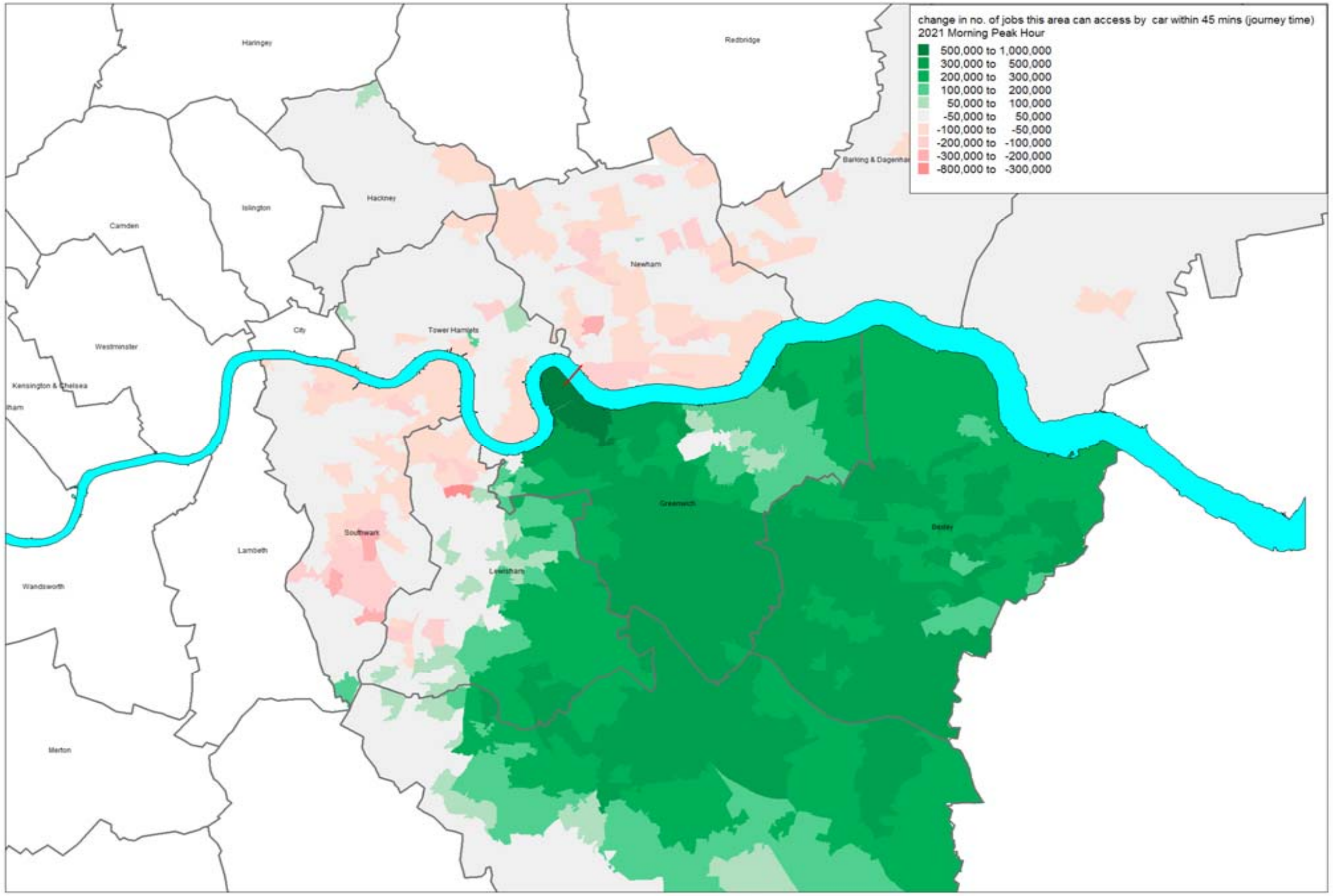
Borough	Jobs
Barking and Dagenham	57,499
Greenwich	249,087
Hackney	193,225
Lewisham	103,018
Newham	377,307
Tower Hamlets	294,064
Waltham Forest	200,283

Figure 11 Change in Job Accessibility by PT Weighted Journey Time IP from 2012 to 2021

Borough	Jobs
Barking and Dagenham	140,464
Greenwich	181,461
Hackney	171,211
Lewisham	91,258
Newham	471,595
Tower Hamlets	345,992
Waltham Forest	188,403

Figure 12 Change in Job Accessibility by PT Weighted Journey Time PM from 2012 to 2021

Appendix D. Silvertown Impacts (Regeneration Areas)



Borough	Jobs
Barking and Dagenham	-9,432
Greenwich	268,514
Hackney	180
Lewisham	140,438
Newham	-45,957
Tower Hamlets	-15,959
Waltham Forest	-5,173

Figure 13 Change in Job Accessibility by Car Journey Time AM from 2021 Reference Case to Assessed Case

Borough	Jobs
Barking and Dagenham	4,643
Greenwich	187,491
Hackney	20,954
Lewisham	63,022
Newham	14,771
Tower Hamlets	21,762
Waltham Forest	20,197

Figure 14 Change in Job Accessibility by Car Journey Time IP from 2021 Reference Case to Assessed Case

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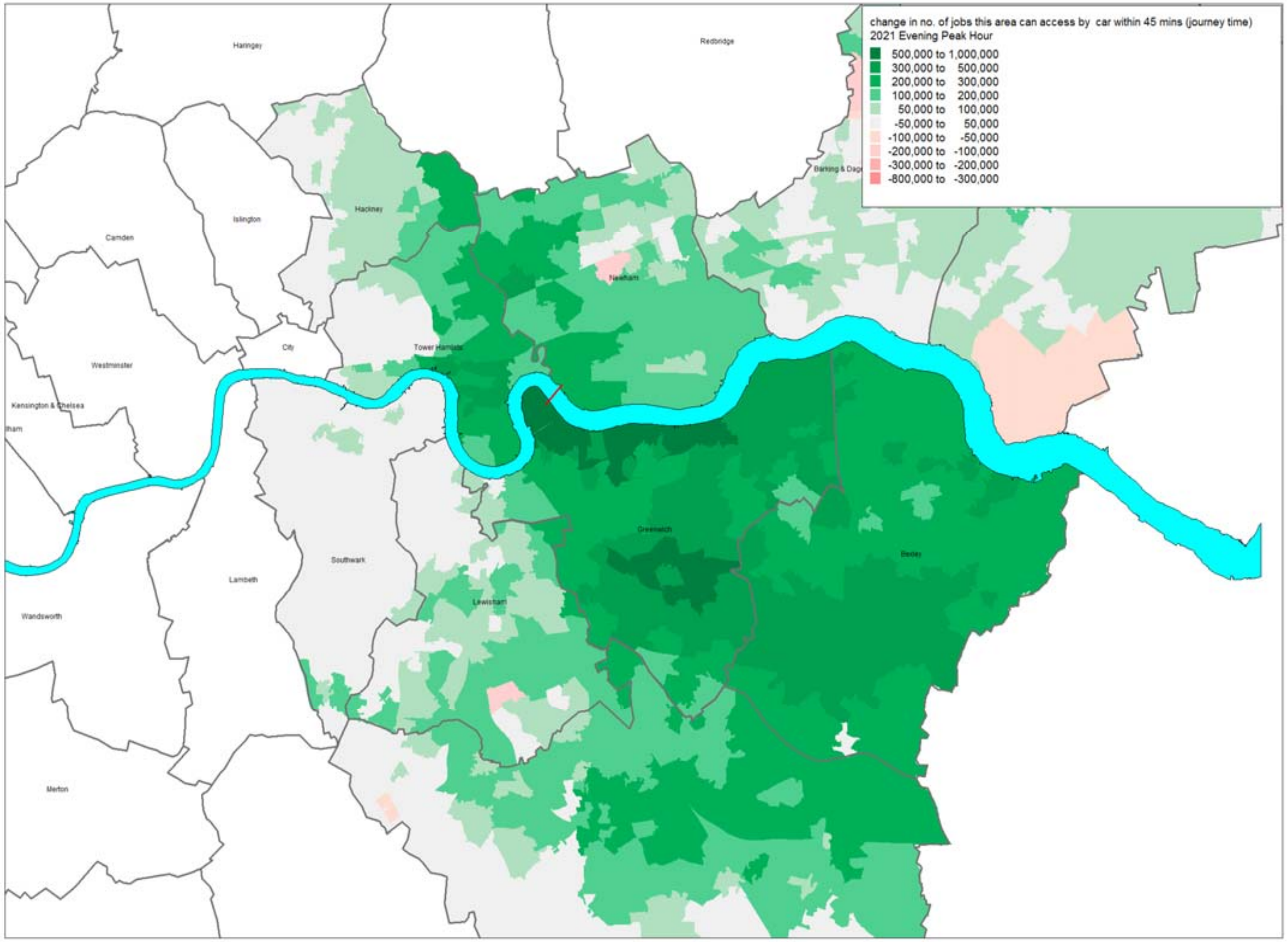

Borough	Jobs
Barking and Dagenham	59,947
Greenwich	363,133
Hackney	102,396
Lewisham	85,380
Newham	146,543
Tower Hamlets	140,442
Waltham Forest	137,036

Figure 15 Change in Job Accessibility by Car Journey Time PM from 2021 Reference Case to Assessed Case

Borough	Jobs
Barking and Dagenham	-49,251
Greenwich	-137,380
Hackney	-66,310
Lewisham	-107,362
Newham	-75,452
Tower Hamlets	-56,796
Waltham Forest	-61,103

Figure 16 Change in Job Accessibility by Car Generalised Time AM from 2021 Reference Case to Assessed Case

Borough	Jobs
Barking and Dagenham	-39,834
Greenwich	-81,466
Hackney	-56,477
Lewisham	-53,917
Newham	-43,463
Tower Hamlets	-30,523
Waltham Forest	-62,743

Figure 17 Change in Job Accessibility by Car Generalised Time IP from 2021 Reference Case to Assessed Case

Borough	Jobs
Barking and Dagenham	-8,174
Greenwich	46,739
Hackney	2,620
Lewisham	5,979
Newham	-4,247
Tower Hamlets	12,661
Waltham Forest	10,649

Figure 18 Change in Job Accessibility by Car Generalised Time PM from 2021 Reference Case to Assessed Case

Borough	Jobs
Barking and Dagenham	-24,336
Greenwich	247,947
Hackney	-10,085
Lewisham	68,417
Newham	-31,912
Tower Hamlets	-26,726
Waltham Forest	-17,768

Figure 19 Change in Job Accessibility by Car Generalised Time for Business AM from 2021 Reference Case to Assessed Case

Borough	Jobs
Barking and Dagenham	-4,517
Greenwich	99,695
Hackney	-2,392
Lewisham	41,167
Newham	10,601
Tower Hamlets	-2,128
Waltham Forest	-11,627

Figure 20 Change in Job Accessibility by Car Generalised Time for Business IP from 2021 Reference Case to Assessed Case

Borough	Jobs
Barking and Dagenham	47,771
Greenwich	193,066
Hackney	108,279
Lewisham	66,822
Newham	105,285
Tower Hamlets	106,410
Waltham Forest	105,567

Figure 21 Change in Job Accessibility by Car Generalised Time for Business PM from 2021 Reference Case to Assessed Case

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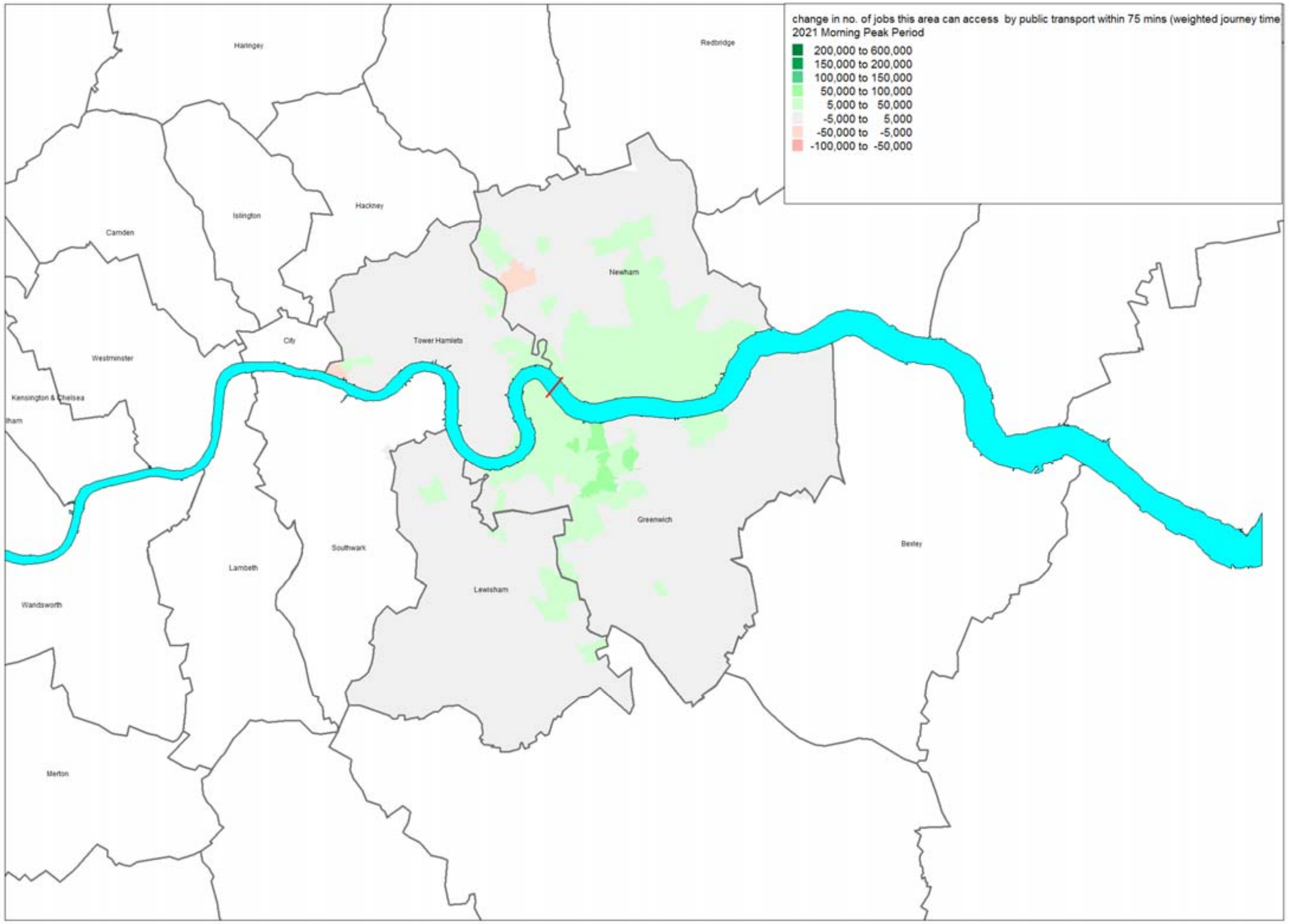

Borough	Jobs
Barking and Dagenham	294
Greenwich	9,290
Hackney	-255
Lewisham	1,887
Newham	6,430
Tower Hamlets	1,566
Waltham Forest	-68

Figure 22 Change in Job Accessibility by PT Weighed Journey Time AM from 2021 Reference Case to Assessed Case

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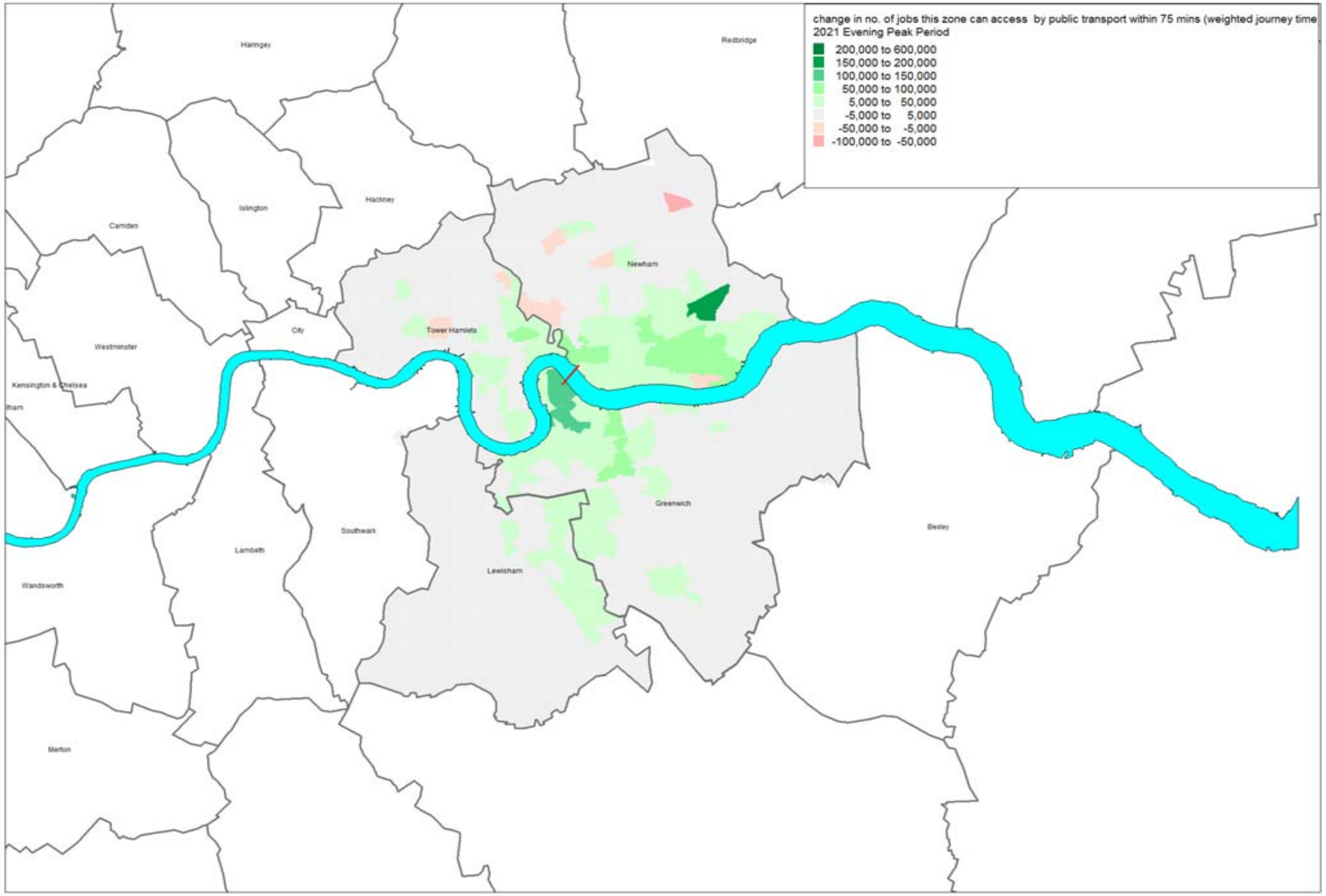
Borough	Jobs
Barking and Dagenham	2,036
Greenwich	35,969
Hackney	514
Lewisham	4,739
Newham	30,502
Tower Hamlets	2,348
Waltham Forest	359

Figure 23 Change in Job Accessibility by PT Weighed Journey Time IP from 2021 Reference Case to Assessed Case



Borough	Jobs
Barking and Dagenham	527
Greenwich	10,475
Hackney	63
Lewisham	1,523
Newham	7,559
Tower Hamlets	2,677
Waltham Forest	-261

Figure 24 Change in Job Accessibility by PT Weighed Journey Time PM from 2021 Reference Case to Assessed Case

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