highways england

Lower Thames Crossing

Pre-Consultation Scheme Assessment Report

Volume 5: Traffic and Economics Appraisal

Volume 5

Lower Thames Crossing
Route Consultation 2016

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The designs shown and described in this Pre-Consultation Scheme Assessment Report have been developed for the detailed appraisal of options as part of the options phase, and may be subject to change in later stages of the scheme development.

1 Introduction

1.1 Structure of Pre-Consultation Scheme Assessment Report

1.1.1 The Pre-Consultation Scheme Assessment Report (SAR) brings together the engineering, safety, operational, traffic, economic, social and environmental appraisal of the shortlist routes for the Lower Thames Crossing. The appraisal of the longlist options was reported in the *Technical Appraisal Report* (TAR) (refer to Sections 2 and 3 of Volume 3 of the SAR).

1.1.2 Drawing on the results of the appraisal the SAR recommends which routes should be taken to public consultation. It also sets out Highways England's proposed scheme.

1.1.3 The SAR is set out in a number of Volumes, as follows:

- Volume 1 – Executive Summary
- Volume 2 – Introduction and Existing Conditions
- Volume 3 – Identification and Description of Shortlist Routes
- Volume 4 – Engineering, Safety and Cost Appraisal
- **Volume 5 – Traffic and Economics Appraisal**
- Volume 6 – Environmental Appraisal
- Volume 7 – Appraisal Conclusions and Recommendations

1.1.4 Following public consultation, this document will be reviewed and updated to produce a final Post-Consultation Scheme Assessment Report that takes account of the comments received. It will also include the report on public consultation, and the recommendation for the Preferred Option. The Preferred Option will be the scheme that Highways England recommends should be taken forward into an application for development consent.

1.2 Structure of this Volume

1.2.1 The structure of this volume is as follows:

- Section 2 briefly describes the Lower Thames Crossing (LTC) options, although more detail is provided in Volume 3.
- Section 3 provides an overview of the traffic, economic and social appraisal of the LTC options.
- Section 4 presents the traffic appraisal results of the options based on Version 2 of the LTC strategic traffic model (LTC v2).
- Section 5 describes the economic appraisal results of the options. This includes the consideration of Wider Impacts and journey time reliability to give a fuller picture of the economic appraisal.
- Section 6 presents the Social Impact appraisal results.

- Section 7 presents Benefit Cost Ratios (BCRs) which provide summary measures of those economic, social and environmental impacts that can be expressed in monetary terms.
- Section 8 describes how the appraised impacts vary across different social groups.
- Section 9 describes the results of sensitivity tests that have been undertaken.
- Section 10 sets out the conclusions about the traffic, economic and social impact appraisal.

1.2.2 A separate Volume 7 Appendices document contains Appraisal Summary Tables (ASTs) and supporting appraisal tables. The ASTs bring together impacts that can be expressed in monetary terms, other quantified metrics and those that can only be expressed in qualitative terms.

1.2.3 More detailed information about the traffic modelling analysis, key assumptions and economic appraisal will be included in the Traffic Forecasting and Economic Assessment Reports which will be published with the Post-Consultation Scheme Assessment Report. The appraisal results included in this volume support the Strategic Outline Business Case which has been prepared for the Department for Transport (DfT).

1.2.4 In order to capture the potential transformational economic impacts of LTC, additional economic modelling of the options has been carried out using a Spatial Computable General Equilibrium (SCGE) model. A description of the modelling method and results and how those SCGE results relate to the WebTAG appraisal results is set out in a separate report (Complementary Wider Economic Impact Assessment).

2 Shortlisted Options

2.1 Introduction

2.1.1 This section provides a brief summary of the shortlist of options that have been subject to detailed appraisal. A comprehensive description of the option development process is set out in Volume 3. This summary is provided to set the context for the route options that have been appraised.

2.2 Options Development

2.2.1 In the options phase work, alternative route options have been developed and appraised at Locations A and C (refer to **Figure 2.1**). Volume 3 describes:

- The staged options appraisal process.
- The options that have not been taken forward to the shortlist.
- The shortlist routes.

2.2.2 The appraisal of these options has helped to:

1. Determine the best route at Location C i.e. Route 2, Route 3 or Route 4.
2. Determine the best route between the Eastern Southern Link (ESL) and Western Southern Link (WSL) as shown in **Figure 2.2**.
3. Determine the choice of Location A or Location C.

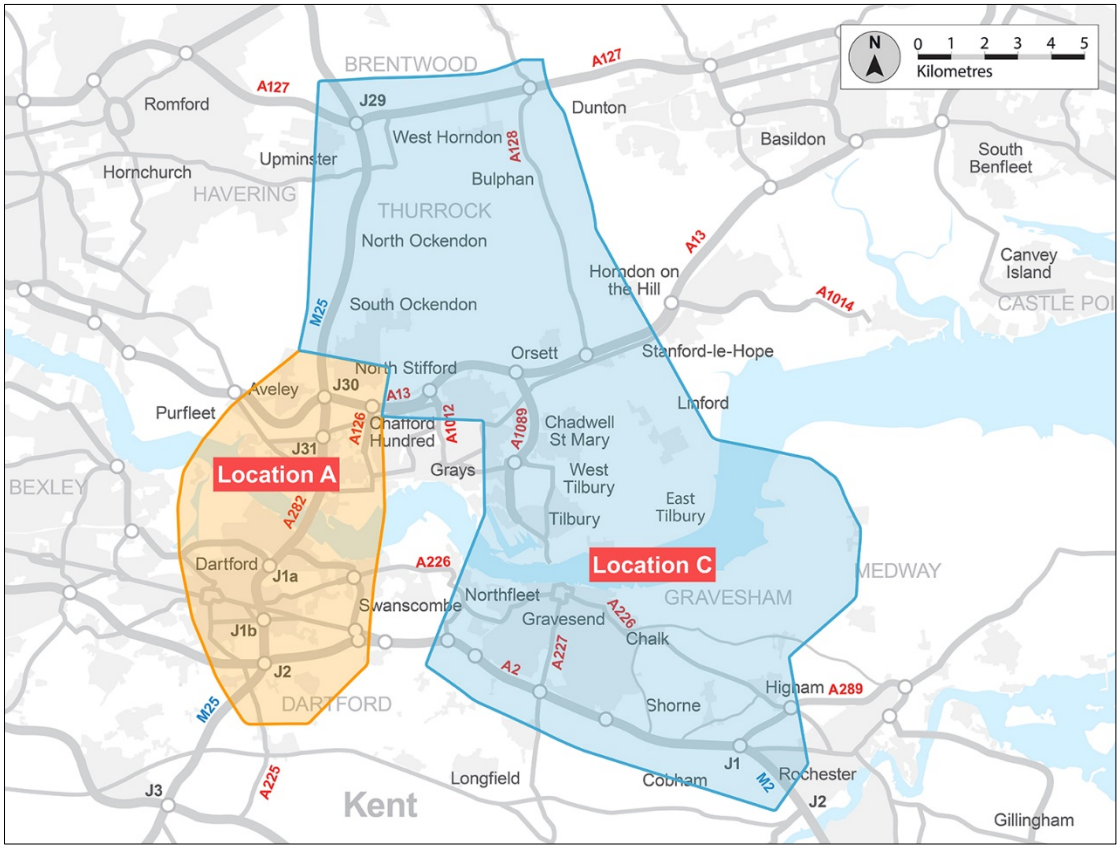

FIGURE 2.1 - LOCATION A AND LOCATION C STUDY AREA

2.2.3 **Table 2.1** shows how the four principal routes relate to Locations A and C. For each route it also shows the crossing options and the options for a southern link in Kent.

TABLE 2.1 - RELATIONSHIP BETWEEN PRINCIPAL ROUTES AND LOCATIONS A AND C

Location	Route	Crossing Option	Southern Link Option
Location A	Route 1	Bridge or bored tunnel	Not applicable
Location C	Route 2	Bridge or bored tunnel or immersed tunnel	Western Southern Link or Eastern Southern Link
	Route 3		
	Route 4		

2.2.4 Traffic and economic modelling has been undertaken for the seven route options listed below and shown in **Figure 2.2**.

- Route 1
- Route 2 with Western Southern Link
- Route 2 with Eastern Southern Link
- Route 3 with Western Southern Link
- Route 3 with Eastern Southern Link
- Route 4 with Western Southern Link
- Route 4 with Eastern Southern Link

2.2.5 Traffic forecasts for these route options are presented in Section 4 and their economic and social benefits are presented in Sections 5 and 6.

2.2.6 There are three potential crossing types (bridge, immersed tunnel and bored tunnel) for LTC which have different scheme costs. However the choice between these crossing types for each route option has no differential impact on traffic volumes and economic benefits.

2.2.7 Section 5 includes scheme costs and Section 7 presents BCRs for these seven route options on the basis that they would all be constructed as a bored tunnel except for Route 1 which would be a bridge.

2.2.8 **Appendix 5.1** presents 20 sets of Initial and Adjusted BCRs for the above route options on the basis that there are two crossing types for Route 1 (bridge, bored tunnel) and three crossing types for the other route options.

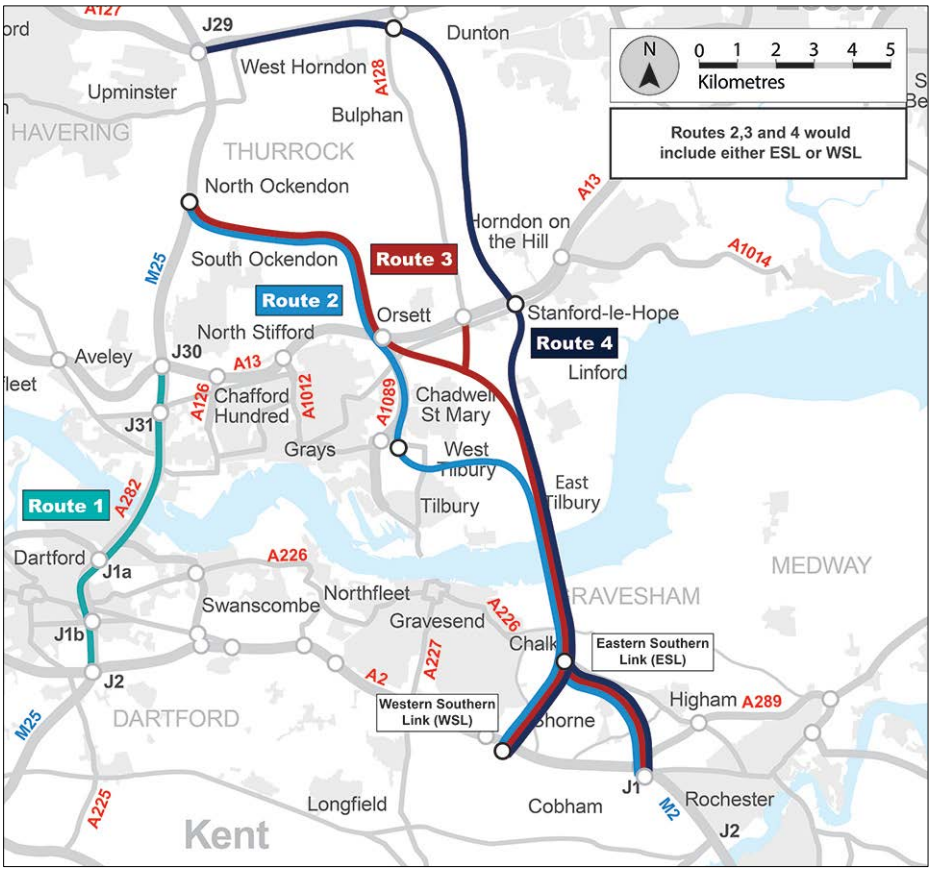

FIGURE 2.2 - SHORTLIST ROUTES

2.2.9 Volume 5 Appendices present economic benefits, scheme costs and BCRs for all 20 options as shown in **Table 2.2** below. The choice of a bridge, immersed tunnel, or bored tunnel has been assumed to have a negligible effect on the traffic flows and speeds. Therefore seven options have been appraised: Route 1, and each of Routes 2 to 4 with either an Eastern or Western Southern Link.

TABLE 2.2 - SHORTLIST ROUTES

No	Shortlist Route
1	Route 1 with Bridge
2	Route 1 with Bored Tunnel
3	Route 2 with Western Southern Link and Bridge
4	Route 2 with Western Southern Link and Bored Tunnel
5	Route 2 with Western Southern Link and Immersed Tunnel
6	Route 2 with Eastern Southern Link and Bridge
7	Route 2 with Eastern Southern Link and Bored Tunnel
8	Route 2 with Eastern Southern Link and Immersed Tunnel
9	Route 3 with Western Southern Link and Bridge
10	Route 3 with Western Southern Link and Bored Tunnel
11	Route 3 with Western Southern Link and Immersed Tunnel
12	Route 3 with Eastern Southern Link and Bridge
13	Route 3 with Eastern Southern Link and Bored Tunnel
14	Route 3 with Eastern Southern Link and Immersed Tunnel
15	Route 4 with Western Southern Link and Bridge
16	Route 4 with Western Southern Link and Bored Tunnel
17	Route 4 with Western Southern Link and Immersed Tunnel
18	Route 4 with Eastern Southern Link and Bridge
19	Route 4 with Eastern Southern Link and Bored Tunnel
20	Route 4 with Eastern Southern Link and Immersed Tunnel

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3 Overview of Appraisal Approach

3.1 Introduction

3.1.1 This section provides an overview of the traffic, economic and social impact appraisal of the LTC options. The methodology and assumptions used to appraise the shortlisted options are summarised in **Appendix 5.1** and set out in detail in the *Appraisal Specification Report*. The appraisal of all impacts has been based on DfT's WebTAG guidance and includes the monetary valuation of two environmental impacts – greenhouse gas emissions and noise. The calculation and valuation of noise impacts is described in Volume 6.

3.1.2 The costs and benefits for the LTC options have been calculated over a 60 year appraisal period from the assumed scheme opening year of 2025 by measuring how the impacts change compared to a scenario in which LTC is not constructed, referred to as the 'Without Scheme' option (refer to Volume 2 for more details of this option). In line with HM Treasury's Green Book appraisal requirements, the impacts considered include those that can be expressed in monetary terms and those which can only be expressed in qualitative terms.

3.1.3 Key assumptions upon which the appraisal was based are:

- Dual two lane, all purpose, provision for the LTC options
- Core economic growth and development planning assumptions
- Current values of time
- User charges for different vehicle categories that replicate those at Dartford Crossing today and remain constant in real terms in future years for all route options at both Location A and C
- Most likely scheme costs (refer to Volume 4)

3.2 Traffic appraisal

3.2.1 A strategic level traffic model has been used to analyse the impact of the LTC options on traffic flows and journey times. Changes in traffic also result in other impacts, such as changes in noise and air quality. The model has a focus on the area immediately affected by the LTC but, in outline, covers the whole of Great Britain. It includes a representation of the road network and a demand matrix of origin and destination trips split into six user classes, each with a separate value of time. The model has a 2009 base year and produces traffic forecasts for two modelled years – the 2025 opening year and a 2041 design year.

3.2.2 For the appraisal of the longlist of options, the model was essentially the same traffic model as that used in DfT's 2013 *Review of Lower Thames Crossing Options: Final Review Report* and is referred to as the LTC version 1 model (LTC v1). For the shortlist appraisal the model was refreshed and updated to create Version 2 of the model (LTC v2) and incorporates:

- The latest development planning and highway scheme information

- Network coding from Transport for London's (TfL) Highway Assignment Model (LOHAM)
- A large number of other coding enhancements
- The latest version of the SATURN assignment model software

3.2.3 The LTC v2 model is based on 2001 demand data although it has been updated to better reflect trip patterns from 2009. It is proposed that a Version 3 model (LTC v3) will be used for the Development Consent Order (DCO) phase of the LTC project which will include more recent demand data for full WebTAG compliance. However, the use of the LTC v2 model for the shortlist appraisal is considered proportionate and appropriate given that the model was revalidated in 2009. The modelling is based on user charges that replicate those at Dartford Crossing today and remain constant in real terms in future years i.e. they rise in line with inflation.

3.2.4 The model comprises a demand model and an assignment model. The demand model forecasts trip matrices for the required future model years based on trip ends, travel costs and assumptions about travellers' behavioural response to travel costs. The assignment model splits the trips according to the route they take through the network and then calculates the cost of travelling via each route. These cost calculations are needed not only for the assignment model, but also (in matrix form) for the demand model. Vehicle flows on links from the highway assignment model also informs the analysis of some social and environmental impacts. The demand model starts with a set of base trip matrices (by purpose and user class) and incorporates incremental changes in demand from the base year to the forecast years. Variation in demand due to the changes in costs in the future is also incorporated within the forecasting process.

3.2.5 WebTAG requires the appraisal of alternative economic growth scenarios. The Core scenario is the scenario based on central economic growth and the most unbiased and realistic set of development planning assumptions appropriate for the appraisal of LTC options. This is the basis for the results presented in this Volume and in the ASTs. Alternative growth scenarios testing the impact of low and high growth and development planning assumptions are also required and the results of these will be presented as sensitivity tests in the Post-Consultation version of the SAR.

3.3 Economic appraisal

3.3.1 The economic appraisal of the LTC shortlisted options consists of the appraisal of:

- Direct economic impacts on road users and government and other related economic impacts
- Wider economic impacts - Wider Economic Benefits and Journey Time Reliability

3.3.2 For each route option the outputs of the LTC v2 traffic model, such as traffic flows and generalised costs, provide inputs into DfT's economic appraisal tools in order to estimate the economic impacts, such as changes in journey times, vehicle operating costs, user charges and accidents, which are

calculated in monetary terms and expressed as Present Values (PV) in 2010 prices as required by DfT.

3.3.3 The ratio of the present value of benefits (PVB) to the present value of scheme costs (PVC) constitutes the BCR. Two BCRs, an Initial BCR (which excludes wider economic Impacts) and an Adjusted BCR (which includes wider economic impacts), are calculated for each option.

Direct Economic Impacts

3.3.4 Direct economic impacts include the following elements:

- Travel time savings
- Vehicle operating cost savings
- User charges

3.3.5 DfT's Transport User Benefit Appraisal (TUBA) tool has been used to calculate these economic benefits and express them in present value terms. The benefits have been split between business users, commuters, and other non-business users and are reported in the Transport Economic Efficiency (TEE) tables included in the Volume 7 Appendices.

3.3.6 Delays to users caused by the construction of Route 1 and Route 3 with ESL have also been calculated using the LTC v2 traffic model. Such impacts for other options have not been appraised but are expected to be similar to the relatively small impacts estimated for Route 3 with ESL. Delays to users from maintenance works have not been appraised, but are not expected to be significant and therefore would not influence the choice between the options.

3.3.7 The TEE tables also include private sector costs and revenues from user charges at the crossing.

Wider Economic Impacts

3.3.8 Two other economic impacts, Wider Impacts, or Wider Economic Benefits (WEBs) and Journey Time Reliability, have been calculated and are included in the Adjusted BCR for the LTC options.

3.3.9 WEBs refers to benefits that arise beyond those traditionally included in highway scheme appraisals. These are impacts of the LTC options on:

- The productivity of existing workers from changes in the concentration of economic activity, referred to as agglomeration
- Increased output from firms due to lower business costs
- Additional taxation revenues as more people are incentivised to work

3.3.10 These impacts have been calculated using the LTC Wider Impacts model which is an updated version of the Wider Impacts model used in DfT's *Review of Lower Thames Crossing Options: Final Review Report*.

3.3.11 Journey Time Reliability impacts have been estimated using the urban equation for estimating journey time reliability provided in WebTAG.

3.3.12 A third economic impact, regeneration impacts, has not been estimated for the LTC options because complementary SCGE economic modelling of the

options has been undertaken. The results of this are reported separately in 'Lower Thames Crossing: Complementary Wider Economic Impact Assessment'.

3.4 Monetised Environmental Impacts

3.4.1 The impact of the LTC options on two environmental impacts, noise and greenhouse gas emissions, has also been estimated and valued in monetary present value terms based on WebTAG guidance.

3.4.2 The calculation and valuation of noise is described in Volume 6.

3.4.3 Greenhouse gas emissions are primarily related to the volumes of traffic. The calculation and valuation of greenhouse gas emissions has been carried out using TUBA.

3.5 Social appraisal

3.5.1 The appraisal of social impacts follows WebTAG guidance and includes an assessment of the LTC options on:

- Accidents – these impacts have been calculated and valued using DfT's COBALT appraisal tool
- Physical activity i.e. impacts on pedestrians and cyclists
- Severance of public rights of way[1]
- Journey quality of road users
- Personal security of road users
- Personal affordability of road users

3.5.2 The impact of LTC options on people's accessibility to the transport system and non-use value of retaining transport services have not been appraised for LTC because WebTAG guidance states these criteria relate to public transport schemes.

3.6 Public accounts

3.6.1 The public accounts impacts include publicly funded scheme costs net of operational revenues and indirect tax revenues.

3.6.2 The calculation of scheme costs for the LTC options, which include construction and operational expenditure, is described in Volume 4. Scheme costs have been expressed in discounted present value terms using a spreadsheet that is consistent with TUBA.

3.6.3 The change in Indirect Taxation Revenues, principally VAT and fuel duty, is related to changes in traffic levels and has been assessed.

3.6.4 These costs and revenues are reported in a Public Accounts table for each option and are included in the Volume 7 Appendices.

[1] DfT's WebTAG guidance (Volume 4.1) defines severance as the impact of a traffic intervention on separating residents from community facilities and services. This volume reports the severance impacts of the LTC route options on public rights of way. Volume 6 reports the severance impacts on community facilities.

3.7 Benefit Cost Ratios

3.7.1 The scheme costs, both construction and operational, are reported alongside those impacts (benefits and disbenefits) that can be expressed in discounted monetary terms and are reported in the Analysis of Monetised Costs and Benefits (AMCB) table for each option included in the Volume 7 Appendices. The AMCB table also reports the Initial BCR which is the ratio of benefits (excluding WEB and Journey Time Reliability) to scheme costs.

3.7.2 An Adjusted BCR, which includes WEBs and Journey Time Reliability, is also calculated for each option.

3.8 Appraisal Summary Tables

3.8.1 All of the impacts, including those expressed in monetary terms, other quantitative metrics and qualitative terms, are summarised and reported in an AST. ASTs are presented in the Volume 7 Appendices along with supporting WebTAG appraisal tables.

3.9 Distributional impact appraisal

3.9.1 The purpose of the distributional impact analysis is to identify impacts on different demographic groups in areas around the route options. A distributional impact analysis will be carried out for the Post-Consultation version of the SAR.

4 Traffic Appraisal

4.1 Introduction

4.1.1 This section summarises the traffic appraisal results using the LTC v2 traffic model for Route 1 and Routes 2, 3 and 4 with the Western Southern Link and Eastern Southern Link. The results for each route include assessments of forecast traffic flows, the catchment area for the main predicted users of the crossings and journey times. Impacts are assessed for the modelled years 2025 and 2041 against the Without Scheme option. The section also presents an example of the impact of the poor operational resilience of the existing Dartford Crossing on the road network and the modelled impact of LTC in improving operational resilience.

4.1.2 The traffic forecasts are based on the assumed capacities of, and demand for, the existing Dartford Crossing (DC) and the LTC crossings. This section begins by explaining the crossing capacities and the development planning assumptions included in the core growth scenario. The forecasts provide estimates of how the additional capacity across the River Thames would affect total traffic flows at Dartford and the way these could change between the existing and new crossings as a result of the LTC options, taking into account their location and that of the existing crossing.

4.1.3 This section also assesses the impact on congestion that would result from the LTC options by reporting the change in journey times for a number of frequently used journeys that currently use the existing crossing.

4.1.4 As discussed in Section 2.2, traffic flows and journey times across the River Thames are not influenced significantly by the LTC crossing type, either bridge, bored tunnel or immersed tunnel. Therefore the traffic analysis presented here is applicable to any of the crossing types and this section focuses on assessing:

1. The choice of Western Southern Link or Eastern Southern Link for the Route 2, 3 and 4 options.
2. How Route 1 at Location A compares against the best option at Location C (Route 2 or 3 or 4).

4.2 Crossing Capacities

4.2.1 The existing and future capacities of the crossings and the approach routes have a direct impact on the predicted traffic volumes and travel times on each crossing and across the network. Traffic volumes are constrained by the hourly capacity of the crossing which limits the volume of traffic which can currently use the Dartford Crossing at peak times and this will suppress future traffic growth on the existing crossing.

4.2.2 **Table 4.1** presents the hourly capacity of the existing crossing and new crossings in terms of passenger car units (pcu).

TABLE 4.1 - HOURLY LOWER THAMES CROSSING CAPACITY IN 2041 FOR EACH OF THE APPRAISED OPTIONS

Capacity (pcus)	Without Scheme (Existing Dartford Crossing only)		Location A (Route 1: Existing crossing plus 4 lane bridge)	Location C (Routes 2, 3 & 4: existing crossing plus Dual 2 lane bored Tunnel)
Capacity at crossing Southbound	6,687		6,687 + 2,940 = 9,627 (existing east tunnel reversed to provide capacity south bound)	6,687 + 4,660 = 11,347
Capacity at crossing Northbound	2,672 West Tunnel + 2,940 East Tunnel = 5,612		2,940 + 6,687 = 9,627 (removal of TMC on existing crossing has increased northbound capacity to 2,940 from 2,672)	5,612 + 4,660 = 10,272 (TMC northbound remains in place)
Total capacity across River Thames	12,299		Total 19,254 (+57% over existing crossing)	Total 21,619 (+76% over existing crossing)

4.2.3 **Table 4.1** shows the existing hourly capacity for the Without Scheme scenario is around 12,300 pcus per hour with the highest capacity being provided in the southbound direction by the QEII Bridge and the lowest capacity in the northbound tunnels, particularly the west tunnel where capacity is limited by the Traffic Management Cell (TMC). The new bridge is assumed to have the same capacity as the existing QEII bridge i.e. 6,687 pcus.

4.2.4 Hourly crossing capacity could be increased by 57% to around 19,250 pcus if an additional 4 lanes are constructed at Location A. Assuming the new 4 lane crossing was built at Location C, capacity would increase to around 21,600 pcus, 76% higher than provided today. The extra capacity at Location C is a function of the new tunnels and approach roads having a more consistent design which means they can operate at higher speeds compared to the existing Dartford Crossing i.e. 70 mph compared to 50 mph.

4.2.5 These pcu capacities have been included in the traffic modelling exercise and directly impact upon the traffic volumes and travel times presented in this report.

4.3 Future Development

4.3.1 Travel demand in the Core growth scenario is based on a central estimate of national economic growth and future land use developments in the area around the LTC crossing locations that are ‘near certain’ and ‘more than likely’ to proceed.

4.3.2 Forecasts for the Low growth scenario, which reflect low national growth and those developments that are 'near certain', and forecasts for the High scenario, which reflect high national growth and also include 'reasonably foreseeable' developments, will be produced and reported on in the Post-Consultation version of the SAR.

4.3.3 **Table 4.2** summarises the development planning criteria for the three growth scenarios. The assumptions for each scenario have been developed following discussions with the local authorities in the areas potentially affected by the scheme. Further detail is provided in **Appendix 5.1**.

TABLE 4.2 - DEVELOPMENT PLANNING CRITERIA FOR THE GROWTH SCENARIOS

National growth	Development planning		
	Probability	Definition	Status
Low	Near Certain	The outcome will happen or there is a high probability that it will happen	Intent announced by proponent to regulatory agencies Approved development proposals Projects under construction
Central	More than Likely	The outcome is likely to happen but there is some uncertainty	Submission of planning or consent application imminent Development application within the consent process
High	Reasonably Foreseeable	The outcome may happen, but there is significant uncertainty	Identified within a development plan Not directly associated with the transport strategy/ scheme but may occur if the scheme is implemented Development condition upon the transport/ scheme proceeding A committed policy goal subject to tests whose outcomes are subject to significant uncertainty

4.3.4 **Appendix 5.1** presents the numbers of new households and jobs for each local authority, excluding London, in the vicinity of the LTC crossing locations that are included in the Core growth scenario. In total there are approximately 80,000 new households and 100,000 new jobs.

4.3.5 **Figure 4.1** shows the percentage growth in 24 hour travel demand in the Core growth scenario for cars, LGVs and HGVs in the LTC traffic model between 2009 and 2041. For all three vehicle categories, demand in the LTC model falls within the low and high range of DfT's latest road traffic forecasts for the period 2010 to 2040.[2] This indicates that the level of travel demand in the LTC traffic model is not excessively pessimistic or optimistic.

[2] Department for Transport (2015): Road traffic forecasts 2015 https://www.gov.uk/government/publications/road-traffic-forecasts-2015

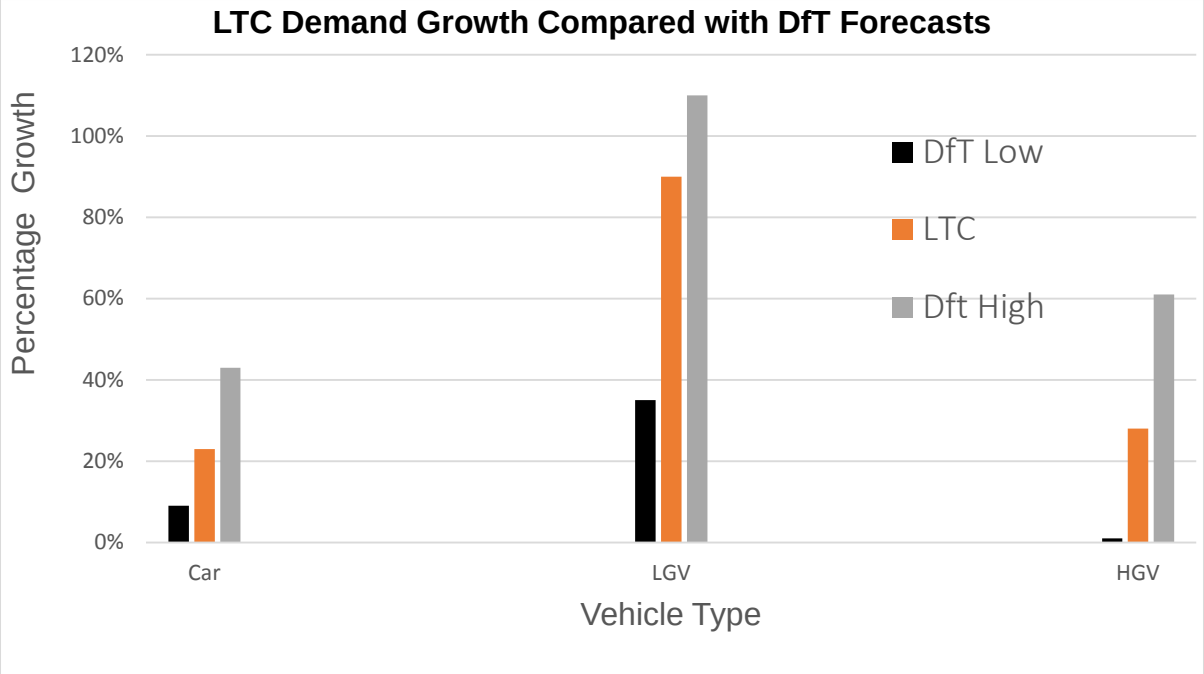


FIGURE 4.1 - LTC DEMAND GROWTH COMPARED WITH DFT FORECASTS

4.4 Traffic flows

4.4.1 The traffic modelling has been undertaken for three separate average hourly time periods (morning peak, interpeak and afternoon peak). The results have been combined using annualisation factors to produce Annual Average Daily Traffic (AADT) forecasts for light and heavy goods vehicles (HGVs) on the existing Dartford Crossing, Route 1 and Routes 2, 3 and 4 (with both Western and Eastern Southern Links) and selected sections of the surrounding road network as shown in **Tables 4.3** to **4.10**.

4.4.2 The forecasts are described in terms of:

- The growth of total traffic across the river, the split of traffic between Dartford Crossing and LTC as a result of the different crossing options and the main predicted users.
- Changes to traffic volumes on selected sections of the wider road network.
- The growth of HGV traffic across the river with the different crossing options and the different shares of HGV traffic and the balance between this and the level of car traffic.
- The differential impact of the Western Southern Link and Eastern Southern Link on traffic flows for Routes 2, 3 and 4.

4.5 Traffic using existing Dartford Crossing and LTC Options

4.5.1 The total traffic flows across the River Thames using the existing Dartford Crossing, Route 1 and Routes 2, 3 and 4 with the Western and Eastern Southern Links compared to the Without Scheme scenario in 2009, 2025 and 2041 are shown in **Tables 4.3** and **4.4**:

TABLE 4.3 - LTC V2 ANNUAL AVERAGE DAILY TRAFFIC FORECASTS 2009 AND 2025

Year	Option		AADT	AADT Lights	AADT Heavies	AADT %HGV
2009	Without Scheme		140,000	114,800	25,200	18%
2025	Without Scheme		159,300	130,700	28,600	18%
	Route 1		195,800	164,100	31,700	16%
	Route 2/WSL	LTC	76,100	64,000	12,100	16%
		DC	137,300	117,400	19,900	14%
		Total	213,400	181,400	32,000	15%
	Route 3/WSL	LTC	78,500	65,900	12,600	16%
		DC	136,700	116,900	19,800	14%
		Total	215,200	182,800	32,400	15%
	Route 4/WSL	LTC	77,000	65,100	11,900	15%
		DC	138,400	118,600	19,800	14%
		Total	215,400	183,700	31,700	15%
	Route 2/ESL	LTC	75,900	63,100	12,800	17%
		DC	138,000	118,400	19,600	14%
		Total	213,900	181,500	32,400	15%
	Route 3/ESL	LTC	78,500	65,300	13,200	17%
		DC	137,300	117,600	19,700	14%
		Total	215,800	182,900	32,900	15%
	Route 4/ESL	LTC	76,700	63,900	12,800	17%
		DC	138,900	119,500	19,400	14%
		Total	215,600	183,400	32,200	15%

* DC = Dartford Crossing

TABLE 4.4 - LTC V2 ANNUAL AVERAGE DAILY TRAFFIC FORECASTS 2041

Year	Option		AADT	AADT Lights	AADT Heavies	AADT %HGV
2041	Without Scheme		163,300	132,400	31,200	19%
	Route 1		219,800	182,500	37,300	17%
	Route 2/WSL	LTC	88,300	74,300	14,000	16%
		DC	151,000	127,500	23,500	16%
		Total	239,300	201,800	37,500	16%
	Route 3/WSL	LTC	90,100	75,600	14,500	16%
		DC	150,500	127,200	23,300	15%
		Total	240,600	202,800	37,800	16%
	Route 4/WSL	LTC	89,200	75,300	13,900	16%
		DC	152,400	129,000	23,400	15%
		Total	241,600	204,300	37,300	15%
	Route 2/ESL	LTC	87,400	72,600	14,800	17%
		DC	152,100	128,800	23,300	15%
		Total	239,500	201,400	38,100	16%
	Route 3/ESL	LTC	89,600	74,400	15,200	17%
		DC	151,500	128,300	23,200	15%
		Total	241,100	202,700	38,400	16%
	Route 4/ESL	LTC	88,300	73,600	14,700	17%
		DC	153,300	130,200	23,100	15%
		Total	241,600	203,800	37,800	16%

* DC = Dartford Crossing

4.5.2 Daily traffic volumes for the Without Scheme scenario are predicted to increase between 2009 and 2025 by 14% to 159,300 AADT. Some of this growth is due to the implementation of Dart Charge and some is related to economic growth. This growth can be accommodated by the higher capacity of the southbound QEII Bridge following the removal of the toll plaza and limited spare capacity in both directions during the inter-peak time period. By 2041 the capacity of the Without Scheme scenario will be exhausted in all time periods.

4.5.3 Route 1 provides additional capacity alongside the existing crossing and reduces the bottleneck caused by the northbound tunnels and traffic management cell. Suppressed demand, in particular from light vehicles, will be attracted to this corridor as a result of the new capacity provided.

4.5.4 Compared to the Without Scheme case forecast, Route 1 AADT flows are estimated to increase by 23% to 195,800 in 2025 and by 34% to 219,800 in 2041. As discussed later in this section, heavy traffic flows on the wider network mean that not all of the new crossing capacity can be utilised

because of the existing corridor and associated junction constraints on the M25/A282 approaches to the Dartford Crossing.

4.5.5 Forecast traffic volumes on Routes 2, 3 and 4 (with WSL and ESL) are broadly similar, at around 77,000 vehicles (AADT) in 2025 rising to 89,000 vehicles (AADT) in 2041. At the existing Dartford Crossing, traffic volumes in 2025 are predicted to be around 14% lower than the Without Scheme scenario. By 2041, traffic volumes at the Dartford Crossing are predicted to be 7% lower than the Without Scheme scenario as any spare capacity on the existing crossing is utilised by previously suppressed traffic and new traffic growth.

4.5.6 **Figure 4.2** displays the total traffic crossing the River Thames including the existing Dartford Crossing and Routes 1, 2, 3 and 4 with the Western and Eastern Southern Links for 2009, 2025 and 2041. It shows that Route 1 will accommodate significantly more traffic than the existing Dartford Crossing. However Routes 2, 3 and 4 will attract even higher volumes of crossing traffic reflecting the greater capacity offered by the new crossing and improved connectivity between the road network north and south of the River Thames.

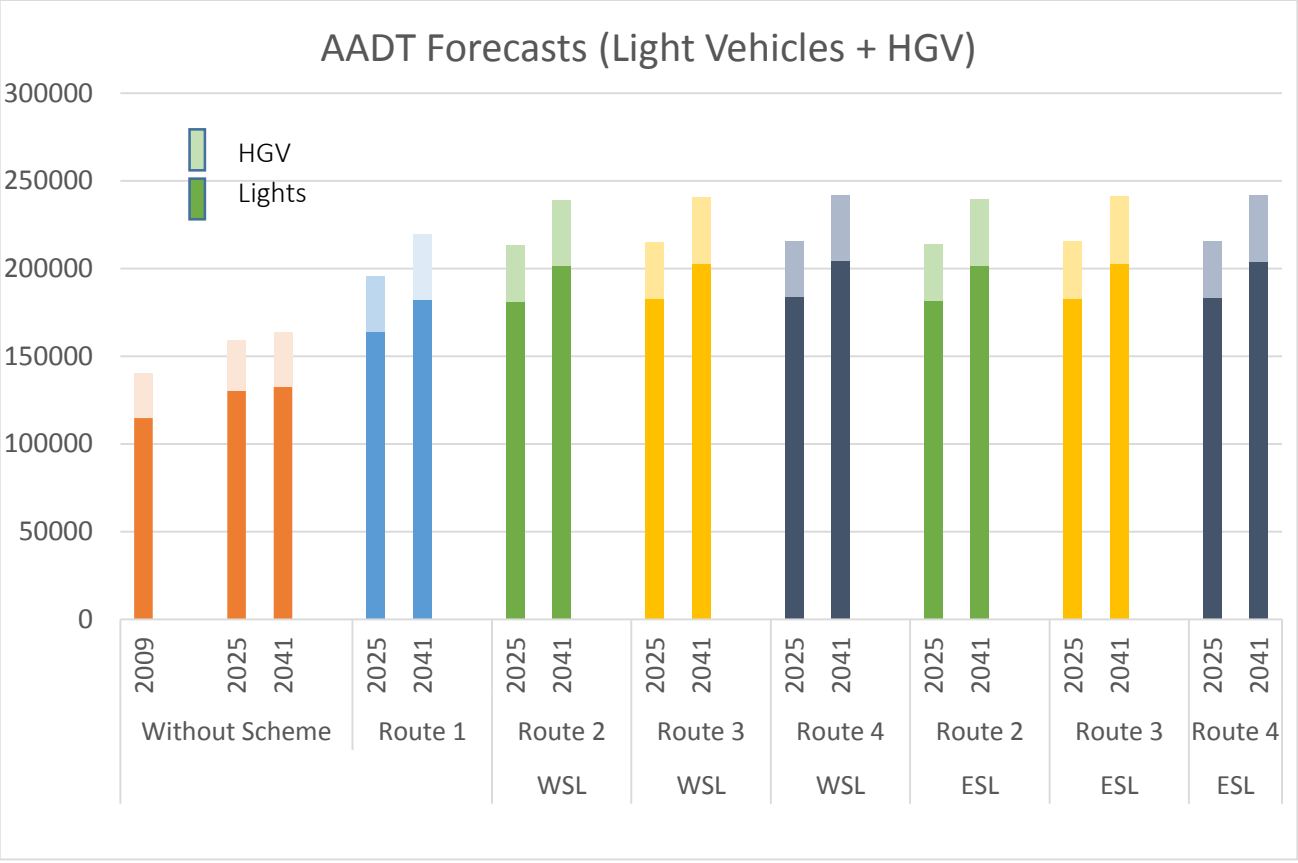
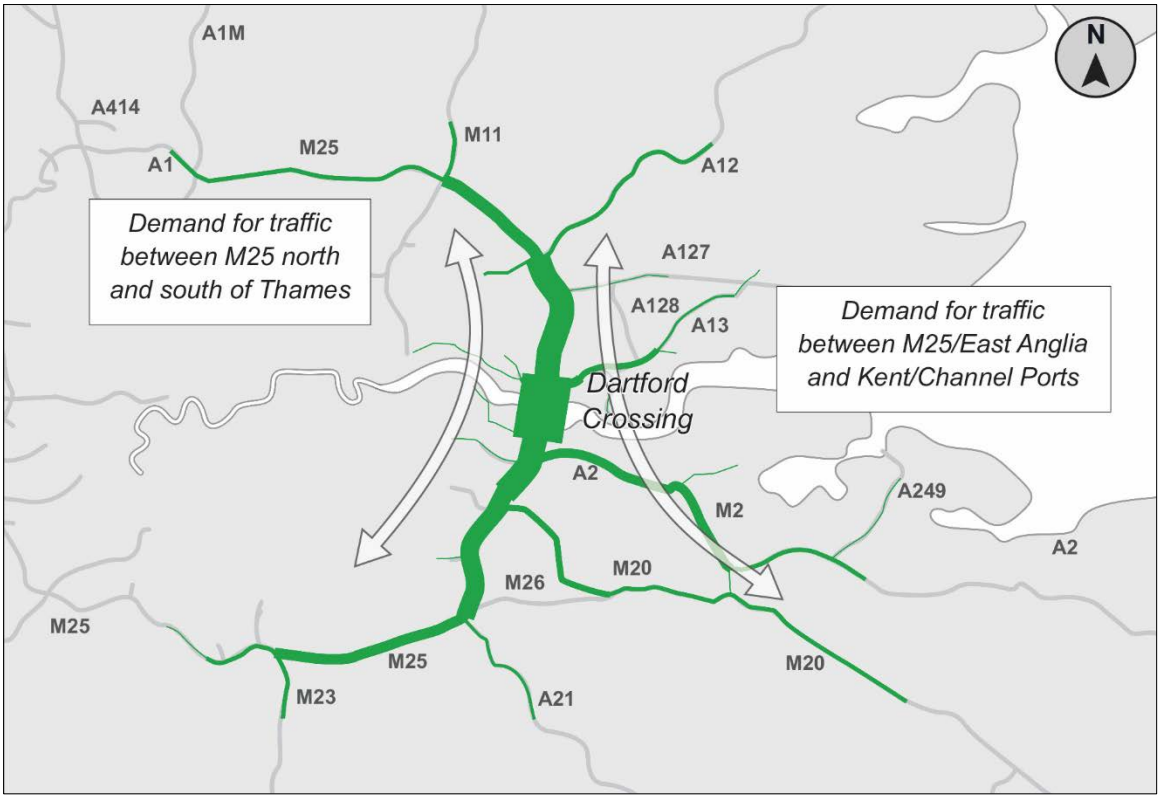


FIGURE 4.2 - ANNUAL AVERAGE DAILY TRAFFIC (AADT) FORECASTS CROSSING THE RIVER THAMES

4.5.7 In terms of the predicted users of the crossings, the green lines in **Figure 4.3** represent the origins and destinations of traffic using the Route 1 LTC crossing option in the AM peak in 2041. This shows that:

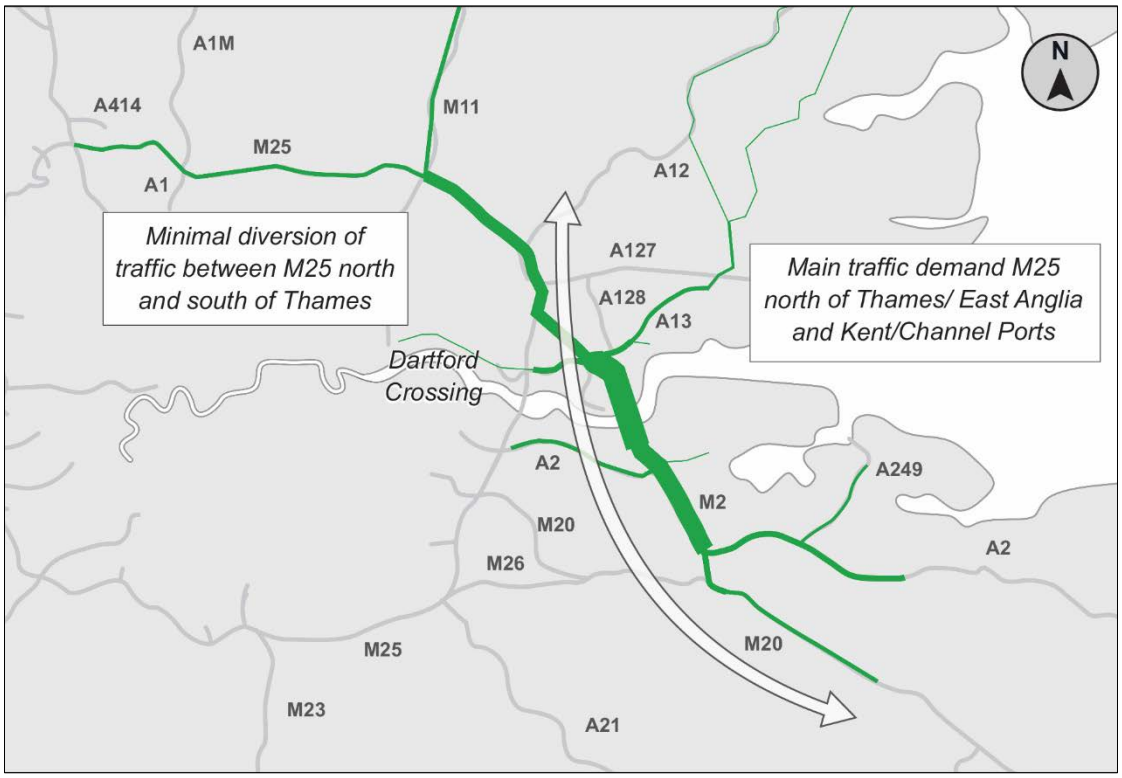
- The main users of Route 1 are those travelling north and south on the eastern section of the M25 and those travelling between Kent/ Channel Ports and the M25/ East Anglia.
- The main users of Route 1 are the same as those people using the Dartford Crossing today, but in greater volumes.



Green shows origins and destinations of traffic using the Dartford Crossing AM peak 2041

FIGURE 4.3 - PREDICTED USERS OF ROUTE 1

4.5.8 **Figure 4.4** shows that the main users of Routes 2, 3 and 4 are people travelling between Kent/ Channel Ports and the M25/ East Anglia and that there is minimal diversion of northbound and southbound traffic to the new crossing from the M25.



Green shows origins and destinations of traffic using the new LTC crossing AM peak 2041

FIGURE 4.4 - PREDICTED USERS OF ROUTE 2, 3 AND 4

4.5.9 The following key points can be concluded about the traffic flows on, and predicted users of, the crossings:

- Route 1 will accommodate significantly more traffic than the existing Dartford Crossing. However Routes 2, 3 and 4 will attract even higher traffic volumes across the Thames.
- The choice of Eastern or Western Southern Link does not significantly alter the traffic volumes using the Location C crossings.
- Similarly, traffic volumes are not affected by the choice of Route 2, 3 or 4 at Location C.
- Traffic crossing volume is therefore not a factor in the choice of the best Location C option route or in deciding between the Eastern or Western Southern Link.
- The main users of Route 1 are those travelling north and south on the eastern section of the M25 and those travelling between Kent/ Channel Ports and the M25/ East Anglia and are the same as those people using the Dartford Crossing today, but in greater volumes.
- The main users of Routes 2, 3 and 4 are people travelling between Kent/ Channel Ports and the M25/ East Anglia and that there is minimal diversion of northbound and southbound traffic to the new crossing from the M25.

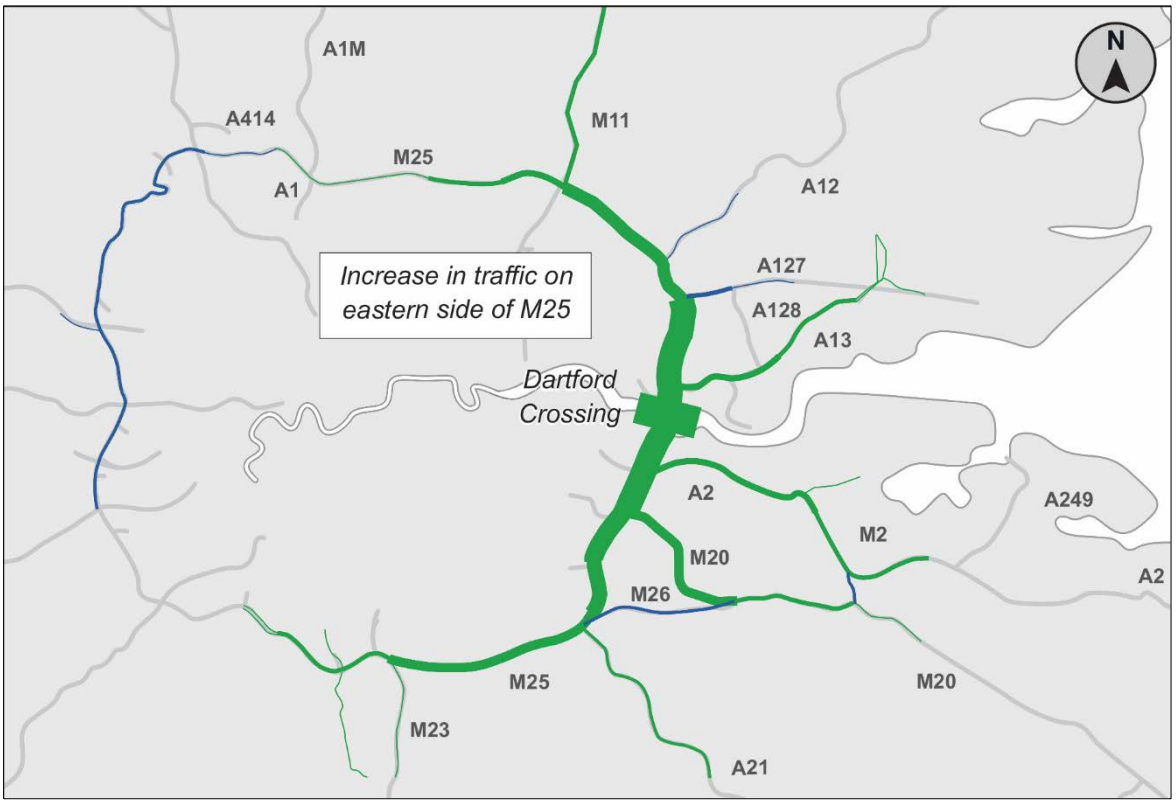
4.6 Traffic impacts across the network

4.6.1 **Tables 4.5** and **4.6** present AADT forecasts for selected sections of the road network as a result of the Without Scheme option and each of the With Scheme LTC routes in 2025 and 2041. Increases in traffic flows on the roads for each route option compared to the Without Scheme are shown as positive values.

TABLE 4.5 - COMPARISONS OF AADT ON KEY ROUTES IN 2025

Road	Location	Without Scheme	Route 1	Route 2 WSL	Route 2 ESL	Route 3 WSL	Route 3 ESL	Route 4 WSL	Route 4 ESL
A2	West of A227	157,100	+2,500	-13,700	-19,200	-14,000	-19,400	-11,400	-17,400
M2	A228-A2/ A289	108,600	+1,800	+17,200	+26,400	+17,900	+27,300	+17,200	+26,400
M20	A228-M26	103,500	+1,900	-4,900	-6,200	-5,000	-6,400	-4,300	-5,900
A13	West of A1089	96,200	+3,300	-2,700	-1,200	-3,100	-1,700	+300	+1,900
A127	West of A128	82,700	-100	-9,300	-9,200	-8,900	-9,100	+26,300	+27,600
A12	West of A1023	89,000	+200	-1,400	-1,500	-1,700	-1,500	-1,800	-1,600
A226	East of Gravesend	5,400	0	+6,800	+8,300	+8,300	+8,400	+8,000	+8,500
M25	South of J2	157,900	+12,300	+5,400	+4,400	+5,400	+4,300	+6,000	+4,900
M25	North of J29	175,800	+7,800	+14,500	+15,100	+14,500	+15,200	+15,900	+16,700

4.6.2 **Figure 4.5** shows that Route 1 attracts additional traffic into the existing Dartford crossing corridor and the M25 south of Junction 2 and leads to an increase in traffic between M25/ East Anglia and Kent/ Channel Ports due to the additional capacity provided at this location.



Green shows increases in traffic and blue decreases in traffic compared with the Without Scheme AM peak 2041

FIGURE 4.5 - NETWORK IMPACTS OF ROUTE 1

4.6.3 **Table 4.6** and **Figure 4.6** show that Routes 2, 3 and 4 provide:

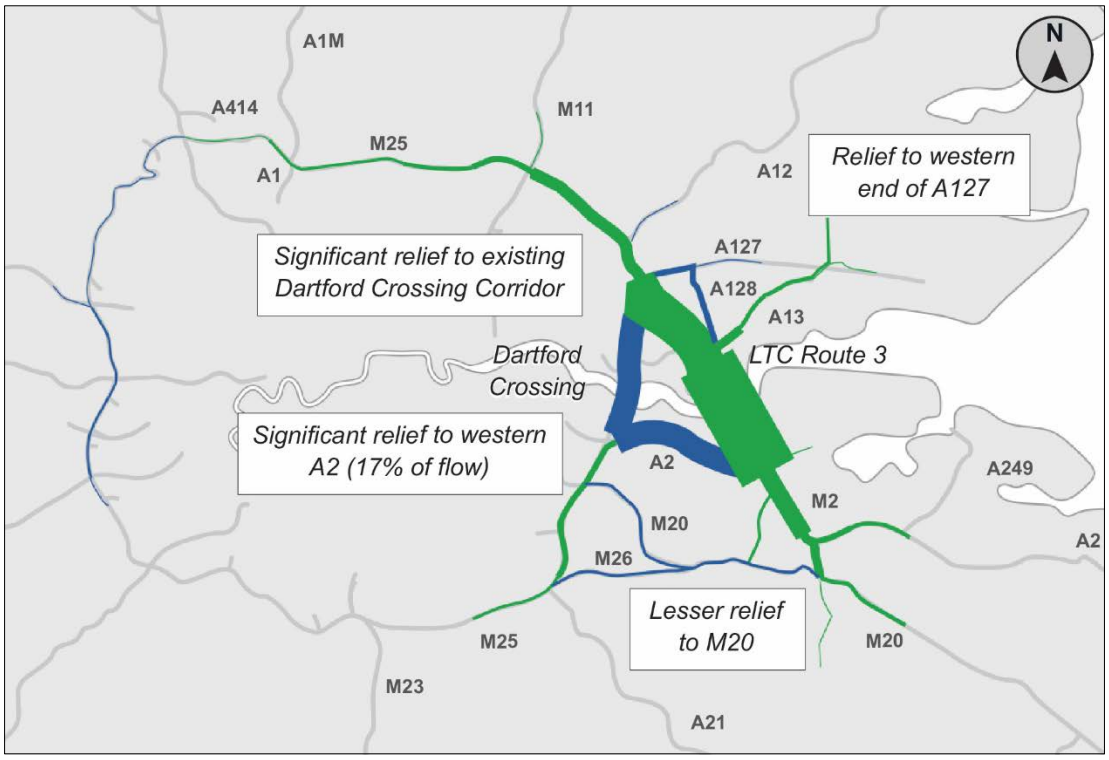
- Significant relief to existing Dartford Crossing corridor
- Significant relief to western section of the A2
- Relief to the A127 and the A12
- Lesser relief to M20

4.6.4 The traffic modelling also demonstrated that there was no significant difference in Route 2, 3 or 4 network impacts, but the Eastern Southern Link provides better relief to A2 corridor than the Western Southern Link.

TABLE 4.6 - COMPARISONS OF AADT ON KEY ROUTES IN 2041

Road	Location	Without Scheme	Route 1	Route 2 WSL	Route 2 ESL	Route 3 WSL	Route 3 ESL	Route 4 WSL	Route 4 ESL
A2	West of A227	163,300	+2,900	-12,000	-17,400	-12,500	-25,600	-10,000	-15,700
M2	A228-A2/ A289	113,000	+2,400	+20,700	+30,300	+21,300	+22,900	+20,500	+30,400
M20	A228-M26	115,800	+2,800	-6,300	-8,200	-6,500	-18,700	-5,700	-7,900
A13	West of A1089	100,900	+4,600	-1,100	+400	-200	-6,400	+1,600	+3,400
A127	West of A128	84,200	-200	-10,100	-10,000	-9,800	-10,600	+29,600	+31,100
A12	West of A1023	91,900	+200	-1,600	-1,600	-1,600	-4,400	-1,600	-1,500
A226	East of Gravesend	5,300	0	+10,000	+9,600	+11,200	+8,500	+11,200	+9,800
M25	South of J2	168,000	+16,600	+7,400	+6,500	+7,500	+6,500	+8,300	+7,300
M25	North of J29	184,800	+10,500	+17,500	+18,300	+17,600	+18,400	+19,300	+20,100

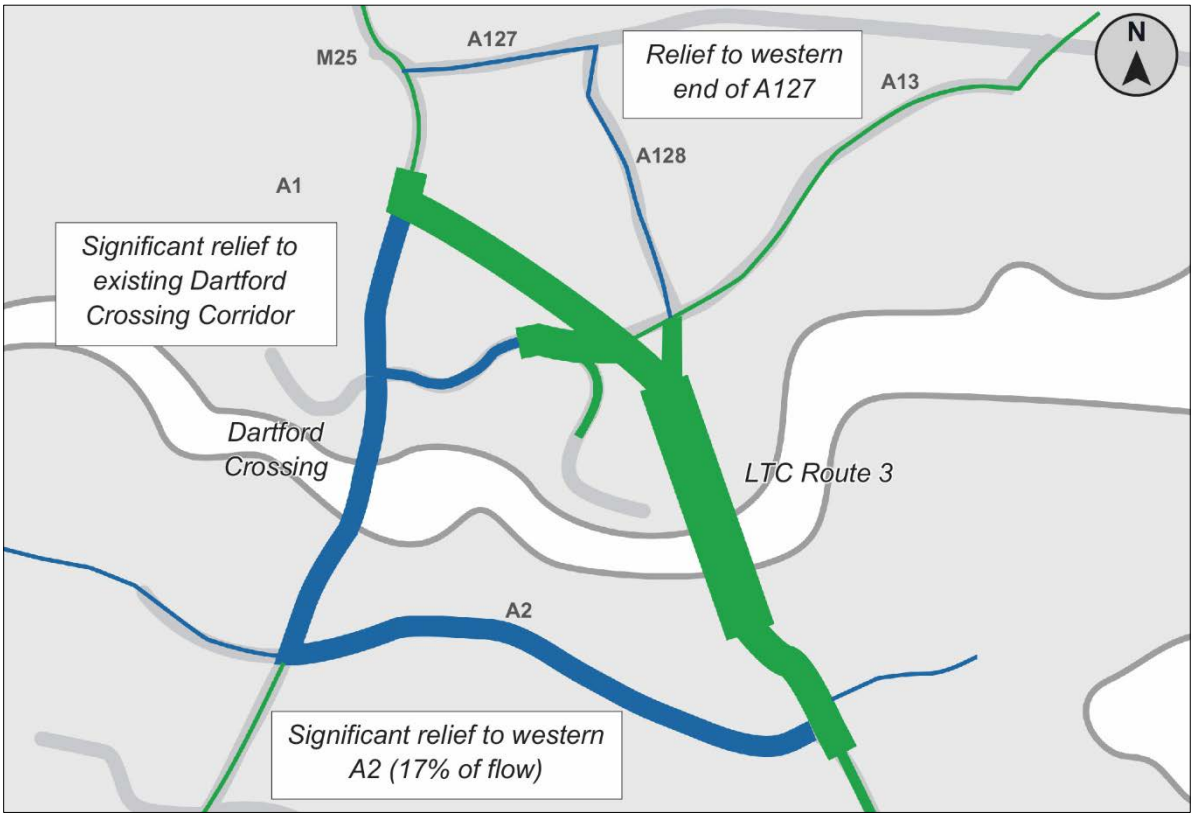
Note: Increases in traffic flows on the roads for each route option compared to the Without Scheme are shown as positive values.



Green shows increases in traffic and blue decreases in traffic compared with the Without Scheme AM peak 2041

FIGURE 4.6 - NETWORK IMPACTS OF ROUTES 2, 3 AND 4

4.6.5 **Figure 4.7** shows more clearly the relief to business users due to Route 3 with ESL.



Green shows increases in traffic and blue decreases in traffic compared with the Without Scheme AM peak 2041

FIGURE 4.7 - NETWORK IMPACTS OF ROUTE 3 WITH ESL ON BUSINESS USERS

4.6.6 In summary, Routes 2, 3 and 4:

- Relieve the A2 between Gravesend and Dartford as crossing traffic is drawn away from the A2 to use LTC.
- Attract additional traffic to the M2 at Chatham which originates from, or is destined for, Kent and the Channel Tunnel thereby relieving the M20, around Maidstone.
- Attract additional traffic to the M25, particularly to the north of Junction 29, as the provision of additional capacity across the River Thames releases suppressed trips and induces trips, many of which will travel on the M25 north of the river.
- Result in higher traffic volumes on the M25 south of Junction 2 as traffic diverting to the new crossing releases capacity at the existing crossing, and releases suppressed demand.
- Relieve the A127 and A12 as crossing traffic from Essex and East Anglia will use LTC.
- Attract additional traffic to the A226 east of Gravesend as the southern link of the scheme between the A2 and A226 improves accessibility to Gravesend and diversion away from the A2.

4.6.7 Whilst Routes 2 and 3 will relieve the A127 as it approaches the M25 in Essex, Route 4 joins the A127 on this section, resulting in a significant increase to traffic volumes on a short stretch of the A127 approaching the M25. Route 4, unlike Routes 2 and 3, also offers no relief to the A13 west of the A1089.

4.6.8 Thus, whilst Routes 2, 3 and 4 have similar crossing volumes, as might be expected, they have slightly different impacts on other parts of the surrounding road network. However, these differences are not sufficient for the traffic volumes to dictate a firm preference of one route over another. We expect that the traffic flows as a result of the route options could be accommodated by the existing road infrastructure.

HGV Traffic Volumes

4.6.9 A key component of the traffic across the River Thames in this area are HGVs as reported in **Tables 4.3** and **4.4**. The construction of additional capacity would provide additional opportunities for this traffic. The volumes of HGV traffic on the existing crossing and forecasts on the new crossings are set out in **Table 4.7**.

TABLE 4.7 - LTC V2 TRAFFIC FORECASTS: AADT, HGVS

Year	Without Scheme	Route 1	Route 2 WSL	Route 2 ESL	Route 3 WSL	Route 3 ESL	Route 4 WSL	Route 4 ESL
2009	25,200							
2025	28,600	31,700	32,000	32,400	32,400	32,900	31,700	32,200
2041	31,200	37,300	37,500	38,100	37,800	38,400	37,300	37,800

4.6.10 In the Without Scheme case, HGV traffic is predicted to increase by 13% between 2009 and 2025 but only by 9% between 2025 and 2041 as growth will be severely constrained by the capacity available.

4.6.11 The provision of additional capacity by the construction of Routes 1, 2, 3 or 4 allows for HGVs volumes to increase on average by around 10% in 2025 and by around 20% in 2041 compared to the Without Scheme scenario. Overall the ESL tends to attract more HGVs.

4.6.12 HGV flows provide support for economic activity and growth. Limitations on the free movement of these vehicles may have repercussions for future levels of economic activity. Although the levels of HGV traffic are forecast to grow in the Without Scheme scenario, increases in capacity associated with a new crossing show that further growth would be expected. Such growth indicates that the capacity constraints of the existing crossing are inhibiting the growth of this traffic, with possible repercussions for economic activity in the very broad areas served by the crossing.

4.7 Comparison of Western Southern Link with Eastern Southern Link

4.7.1 Routes 2, 3 and 4 with the Western Southern Link join the A2 at a new junction in the proximity of Thong. Routes 2, 3 and 4 with the Eastern Southern Link join the M2 at Junction 1. This section compares forecasts for these routes with the WSL and ESL in terms of traffic volumes.

4.7.2 AADT flows across the Dartford Crossing and Routes 2, 3 and 4 with the Western and Eastern Southern Links were previously shown as part of the total crossing volumes for all options in **Tables 4.2 and 4.3**. A summary comparison of just the Western and Eastern Southern Links is reproduced in **Table 4.8**.

TABLE 4.8 - COMPARISON OF AADT FLOWS FOR WESTERN AND EASTERN SOUTHERN LINKS IN 2025

	Route 2 WSL	Route 2 ESL	Route 3 WSL	Route 3 ESL	Route 4 WSL	Route 4 ESL
Existing Crossing	137,300	138,000	136,700	137,300	138,400	138,900
New Crossing at Location C	76,100	75,900	78,500	78,500	77,000	76,700

4.7.3 In 2025, the traffic forecasts show that:

- Route 2 with ESL compared to Route 2 with WSL results in a small reduction for LTC (-200 vehicles AADT) although there is an increase of 700 vehicles AADT at the Dartford Crossing.
- Route 3 traffic with ESL or WSL is very similar although there is an increase of traffic on the existing crossing of 600 vehicles AADT) which results from traffic rerouting across the network during the peak and inter-peak modelled periods.
- Route 4 with ESL has a negative impact, reducing flows by 300 vehicles AADT) and results in slightly higher traffic volumes remaining on the existing crossing of 500 vehicles AADT).

4.7.4 **Table 4.9** shows that in 2041:

- Traffic on Route 2 is reduced with ESL (-900 vehicles AADT) compared to WSL, but increases on the existing crossing (+1,100 vehicles AADT).
- Route 3 experiences a slight negative impact if the ESL is built (-600 vehicles AADT) and the impact on the existing crossing is greater (+1,000 vehicles AADT).

- The impact of ESL is slightly greater (-900 vehicles AADT) for Route 4 as these vehicles continue to use the existing crossing (+900 vehicles AADT).

TABLE 4.9 - COMPARISON OF AADT FLOWS FOR WESTERN AND EASTERN SOUTHERN LINKS IN 2041

	Route 2 WSL	Route 2 ESL	Route 3 WSL	Route 3 ESL	Route 4 WSL	Route 4 ESL
Existing Crossing	151,000	152,100	150,500	151,500	152,400	153,300
New Crossing at Location C	88,300	87,400	90,100	89,500	89,200	88,300

4.7.5 The impact of ESL compared to WSL in 2025 can be summarised as follows:

- Significantly more vehicles will be attracted away from the A2 between Gravesend and Dartford (-around 5,500 vehicles AADT).
- Significantly more vehicles will be attracted to the M2 (+9,000 vehicles AADT).
- Slightly more relief is offered to the M20 (-1500 vehicles).
- Slightly fewer vehicles are attracted to the M25 south of Junction 2.
- Slightly more vehicles are attracted to the M25 north of Junction 29.
- Slightly less relief is offered to the A13 (Route 3 ESL) and slightly more vehicles will use the A13 (Route 4 ESL).
- The impacts of ESL on the A127, A12, A226 are broadly similar for the ESL as the WSL with the exception of Route 2 where the ESL attracts more traffic to the A226 than the WSL alternative.

4.7.6 The impact of ESL compared to WSL in 2041 is that:

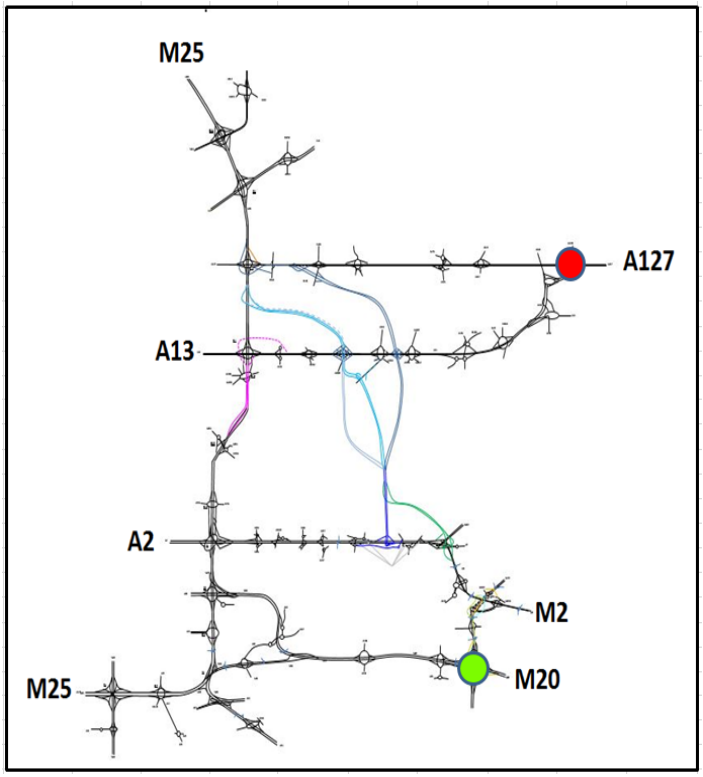
- It provides more relief to the A2 between Gravesend and Dartford, M20 and A13.
- More traffic is attracted to the M2 and M25 north of Junction 29.

4.7.7 Total traffic volumes across the River Thames are not significantly different between the WSL and ESL. However, the impact of the new crossing on traffic volumes on other sections of the road network is more significant with the ESL offering more relief to the A2 and attracting higher traffic volumes from the M2 and M20.

4.8 Travel Times

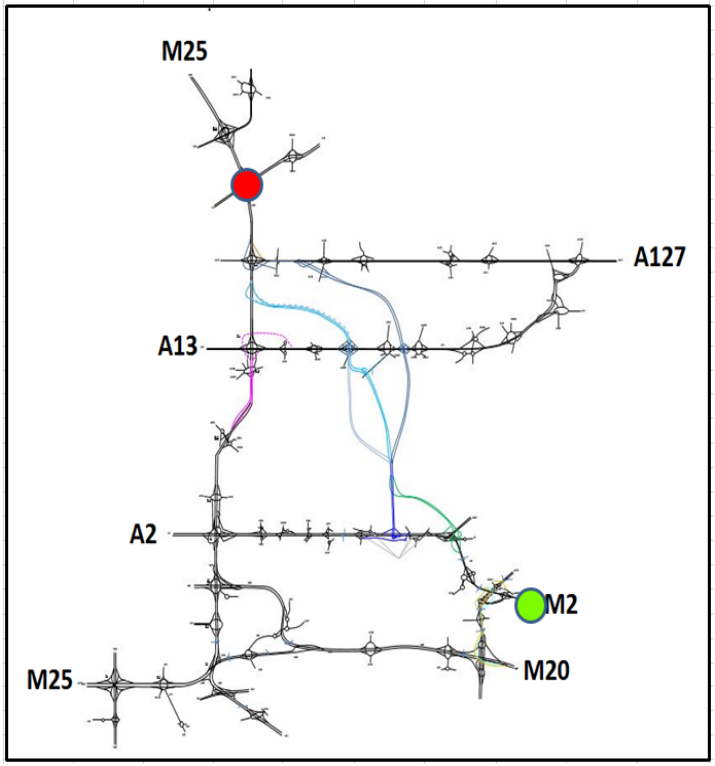
4.8.1 Travel times have been extracted for the AM peak for a selection of illustrative journeys on the strategic road network around LTC that start and end on different sides of the River Thames. The impact of Route 1 and Routes 2, 3 and 4 with WSL and ESL on these times, compared to the Without Scheme in 2025 and 2041, is set out in **Table 4.10**.

4.8.2 The start and end points for these journeys are shown in **Figure 4.8** to **Figure 4.11**. The green dots represent the start points and the red dots are the end points for these journeys.



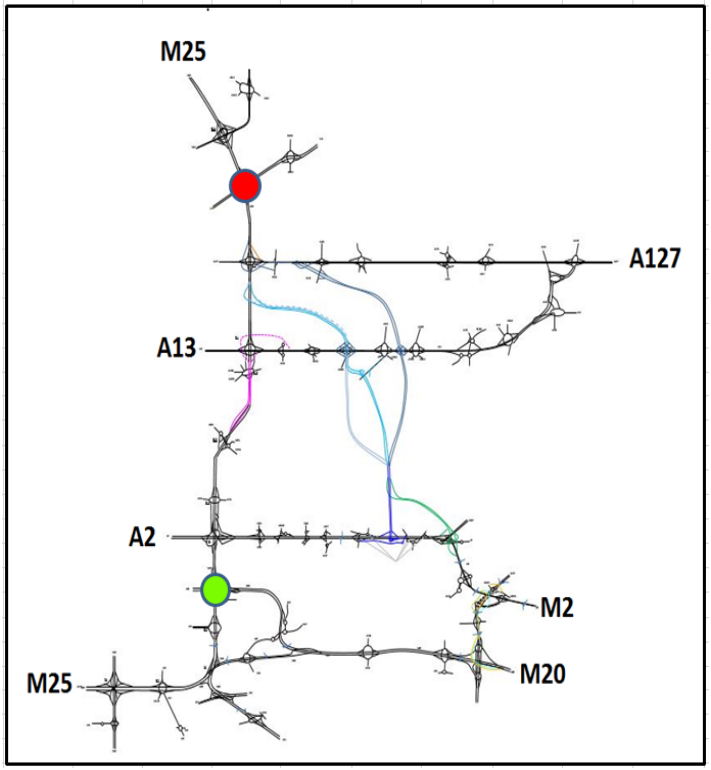
	Without Scheme	Route 1	Route 3
Distance	62kms	62.5kms	44.7kms
	Time	Time saving	Time saving
2009	48 mins		
2025	53 mins	6 mins	20 mins
2041	60 mins	7 mins	23 mins

FIGURE 4.8 - SELECTED FORECAST TRAVEL TIMES IN THE AM PEAK (MINUTES)
M20 J6 TO A127/A1245 NORTHBOUND VIA DARTFORD/LTC IN THE AM PEAK



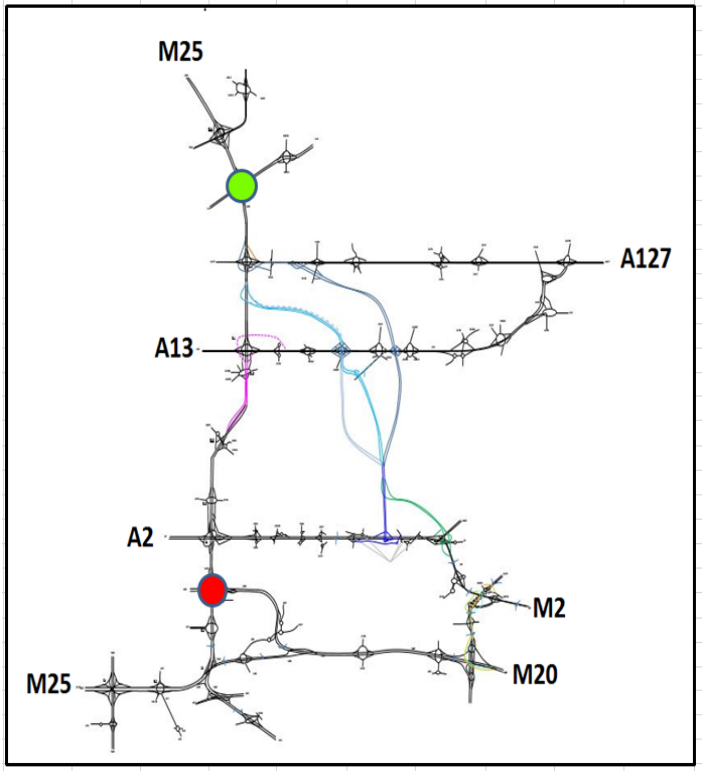
	Without Scheme	Route 1	Route 3
Distance	50.9kms	50.9kms	45.9kms
	Time	Time saving	Time saving
2009	37 mins		
2025	42 mins	4 mins	12 mins
2041	45 mins	5 mins	14 mins

FIGURE 4.9 - SELECTED FORECAST TRAVEL TIMES IN THE AM PEAK (MINUTES)
M2 J4 TO M25 J28 NORTHBOUND VIA DARTFORD/LTC IN THE AM PEAK



	Without Scheme	Route 1	Route 3
Distance	26.3kms	26.3kms	26.3
	Time	Time saving	Time saving
2009	20 mins		
2025	24 mins	5 mins	5 mins
2041	27 mins	6 mins	6 mins

FIGURE 4.10 - SELECTED FORECAST TRAVEL TIMES IN THE AM PEAK (MINUTES)
M25 J3 TO M25 J28 NORTHBOUND VIA DARTFORD IN THE AM PEAK



	Without Scheme	Route 1	Route 3
Distance	26.5kms	26.5kms	26.5kms
	Time	Time saving	Time saving
2009	20 mins		
2025	24 mins	4 mins	3 mins
2041	27 mins	5 mins	3 mins

FIGURE 4.11 - SELECTED FORECAST TRAVEL TIMES IN THE AM PEAK (MINUTES)
M25 J28 TO M25 J3 SOUTHBOUND VIA DARTFORD IN THE AM PEAK

4.8.3 **Figure 4.8** shows that in the absence of additional crossing capacity, the forecast travel time for a trip between M20 Junction 6 and the A127 to the east would increase from about 48 minutes to about one hour due to increased congestion over time. With the provision of additional on-line capacity (Route 1) the travel time in 2025 would fall by about 6 minutes, but with additional traffic growth over time the saving against the Without Scheme would be about 7 minutes in 2041.

4.8.4 The crossing options further east would however offer the largest and more sustained savings in travel times. The saving for Route 3 would be 20 minutes in 2025 reducing the forecast travel time to just over 30 minutes. Over the period to 2041 travel times would only increase slightly and the saving compared to the Without Scheme scenario would be even greater at 23 minutes reducing the forecast travel time to just over 35 minutes. Compared to Route 1 the additional savings would amount to about 15 minutes.

4.8.5 **Figure 4.9** shows a similar pattern of savings for users travelling between M2 Junction 4 to M25 Junction 28 northbound via Dartford and LTC, although the savings using both routes are less.

4.8.6 **Figures 4.10** show that the travel times for traffic using the M25 northbound between Junctions 3 and 28 is expected to be between 5 and 6 minutes lower than the Without Scheme scenario due to the additional capacity provided by Route 1. The time savings offered by Routes 2, 3 and 4 are similar to those for Route 1**. Figure 4.11** shows similar, but slightly lower, level of savings for southbound traffic.

4.8.7 For the Without Scheme scenario average daily traffic speeds between M25 Junction 3 and Junction 28 are predicted to deteriorate from 49mph (2009) to around 41mph in 2025 (in both directions) and around 36mph (northbound) and 37mph (southbound) in 2041.

4.8.8 Routes 1 and 3 have similar impacts on average daily traffic speeds between M25 Junction 3 and Junction 28. In 2025 speeds northbound are forecast to increase to 51mph and reduce slightly to 47mph in 2041. In 2025 speeds southbound are forecast to increase to 49mph and reduce slightly to 45mph in 2041.

4.8.9 There are no significant differences in the speeds predicted for the existing Dartford Crossing between different route options, reflecting the physical constraints of the existing tunnels. Routes 2, 3 and 4 allow similar speeds and are accommodating excess demand for Route 1.

4.8.10 **Figure 4.12** shows that traffic on Routes 2, 3 and 4 using the Western Southern Link to get to the M2 Junction 1 has a 1.6 mile longer journey than traffic using the Eastern Southern Link.

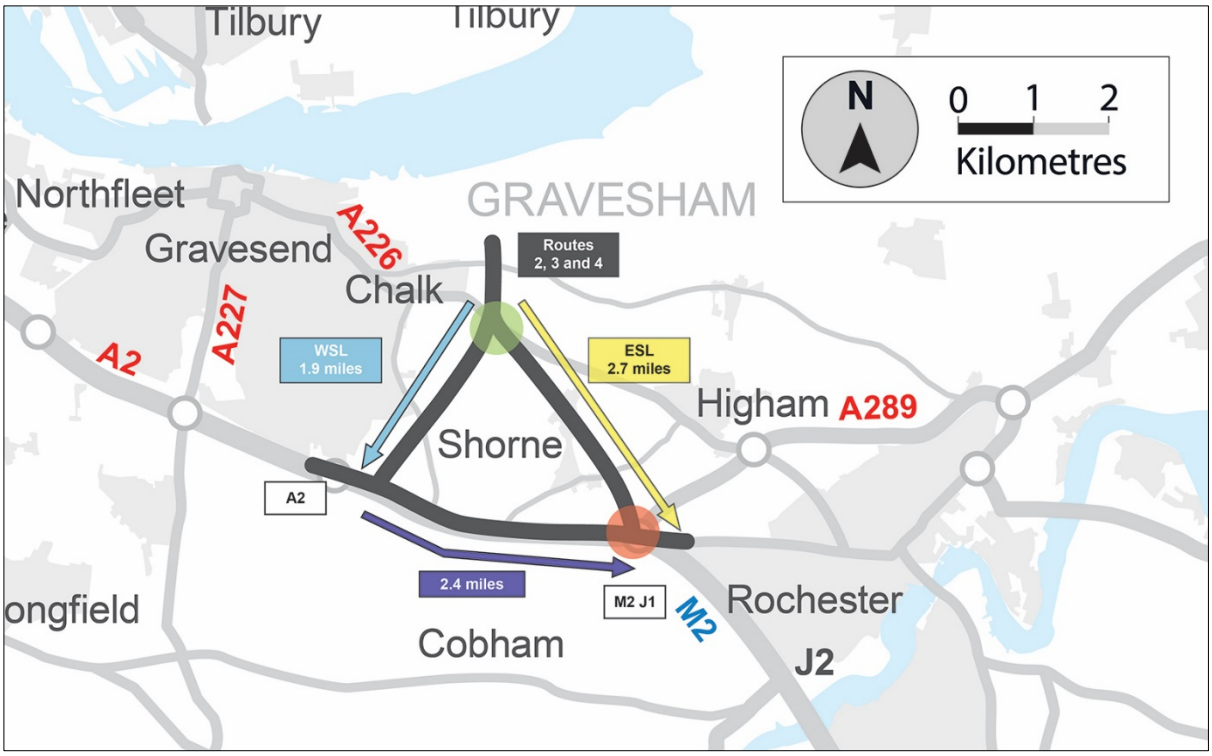


FIGURE 4.12 - COMPARISON OF DISTANCES FOR TRAFFIC USING WESTERN SOUTHERN LINK AND EASTERN SOUTHERN LINK

4.8.11 As the ESL is shorter and provides a more direct route from the M2/ M20, travel times are expected to be 2 minutes shorter between the M20 Junction 6 and A127/ A1245 and between M2 Junction 4 and M5 Junction 28 compared to the WSL. This results in high travel time savings, as shown in Section 5.

4.8.12 **Figure 4.12** also shows that traffic on Routes 2, 3 and 4 using the Eastern Southern Link to get to the A2 has a 3.2 mile longer journey compared to using WSL. However this would impact a smaller proportion of traffic using Routes 2, 3 and 4.

4.9 Operational resilience

4.9.1 Whilst the fundamental problem at the crossing is that the traffic demand at certain periods of the day exceeds the crossing capacity, the incremental way that the adjacent network and crossing capacity has evolved over more than 50 years has led to a road configuration that exacerbates the capacity problem and increases the likelihood of incidents. Forecasts predict that the period when traffic is congested will increase, resulting in a greater chance of incidents.

4.9.2 Resilience refers to the ability of a road, or road network, to maintain an acceptable level of service for users following an incident. A range of incidents may arise that disrupt the normal operation of traffic on the road such as traffic accidents, weather events, and non-vehicular encroachment on to the road. A large number of incidents occur on the existing Dartford Crossing and the crossing provides poor levels of resilience to these incidents.

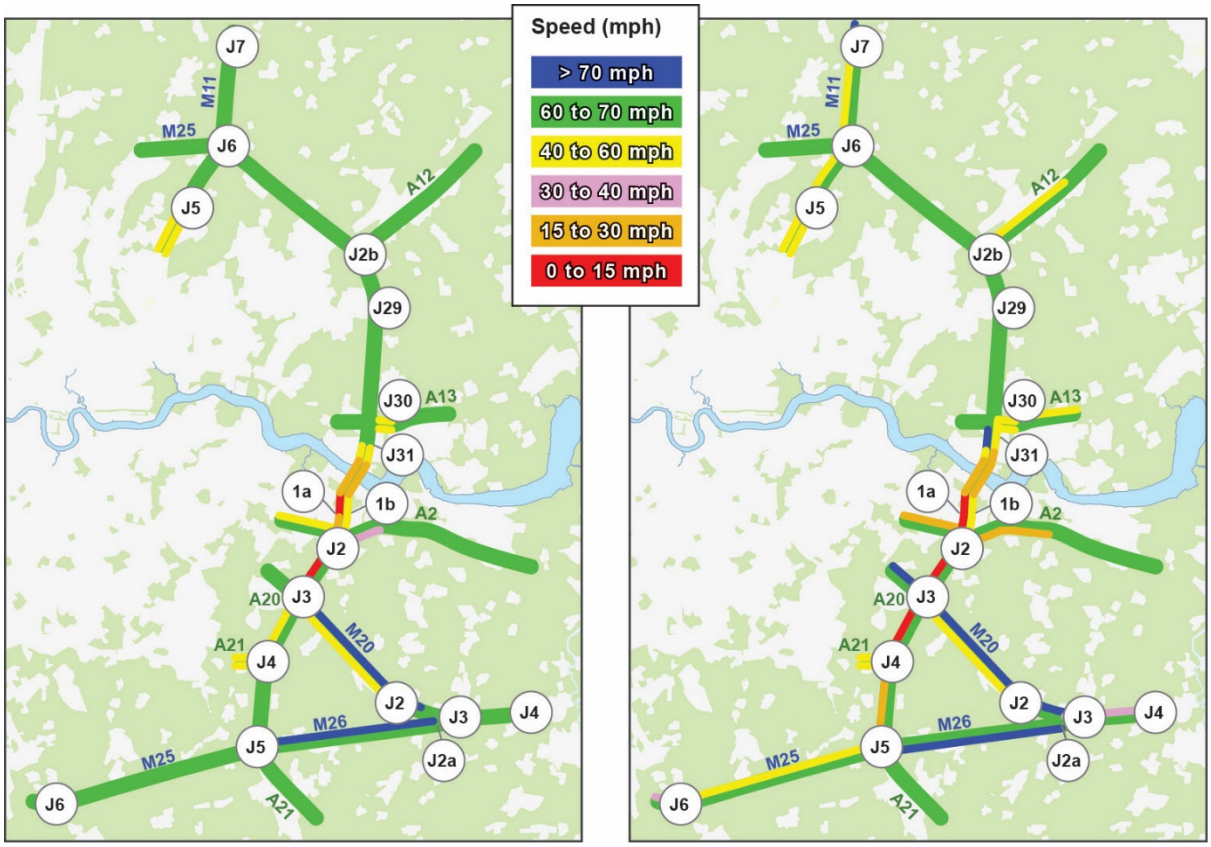
4.9.3 The road network near the crossing results in incidents occurring at a greater frequency in this location than other parts of the SRN. A main cause of the incidents is the complex road layout close to the crossing with junctions closely spaced, resulting in traffic weaving over relatively short distances. This is exacerbated by the use of the Dartford Crossing by non-motorway traffic which has to enter and exit between M25 Junction 1a and M25 Junction 31.

4.9.4 There were over 300 unplanned closures of a single lane or more at the crossing in 2014. On average, this is a closure a day, lasting 27 minutes. In the event of closures, the local network is badly affected and users have no real alternatives resulting in congestion and delays.

4.9.5 In the event of partial or full closure, traffic has to be re-routed through the unaffected sections or in the worst case, via the Blackwall Tunnel (approximately a 30 mile detour and minimum additional travel time or 40 minutes). This latter option is only accessible to vehicles under 4m in height, which forces many heavy goods vehicles to drive around the M25, equivalent to an additional 100 miles.

Example of poor operational resilience today

4.9.6 The congestion and incidents do not only affect the crossing users. The strategic location and importance of the crossing means that any disruption at the crossing has a ripple effect on the surrounding network. This can be demonstrated by reference to an incident in July 2014, when the northbound tunnels were closed at about 12.30pm because of an accident. **Figure 4.13** shows the resulting congestion on the network at 1pm and 5pm on the day of the accident. By 1pm the queues were already spreading back from Junction 2 on the M25. Even at 5pm, the queues had reached their largest extent and had reached back to Junction 5 with journey speeds below 15mph between Junction 1a and Junction 4 of the M25, down the A2 and along the M20 in Kent. An area of some 425 square kilometres was affected by the resultant congestion. It was almost midnight before congestion was relieved as the capacity of the single open tunnel was sufficient for the overnight traffic volumes. The closed tunnel was reopened at 5.30am the following morning before the morning peak traffic period.



Average Speeds between 1pm and 2pm **Average Speeds between 5pm and 6pm**

FIGURE 4.13 - ILLUSTRATION OF AVERAGE TRAVEL SPEEDS ON CROSSING AND SURROUNDING ROAD NETWORK AFTER INCIDENT IN JULY 2014

4.9.7 It is estimated that approximately 40,000 vehicles were delayed for more than 30 minutes resulting in 20,000 lost hours on a single afternoon.

Modelled impact of LTC on resilience

4.9.8 To try and quantify the effects of such an incident in more detail, the LTC v2 strategic model was used to mimic a similar incident. The average inter-peak period (average hour between 10am – 4pm) in 2025 was used to test the potential impact should one of the northbound tunnels be closed due to an incident.

4.9.9 Modelled traffic flows for the average inter-peak hour over the northbound crossing are compared for a single tunnel closure in the Without Scheme case and for a single tunnel closure for the Route 1 and Route 3 shown in **Figure 4.14**.

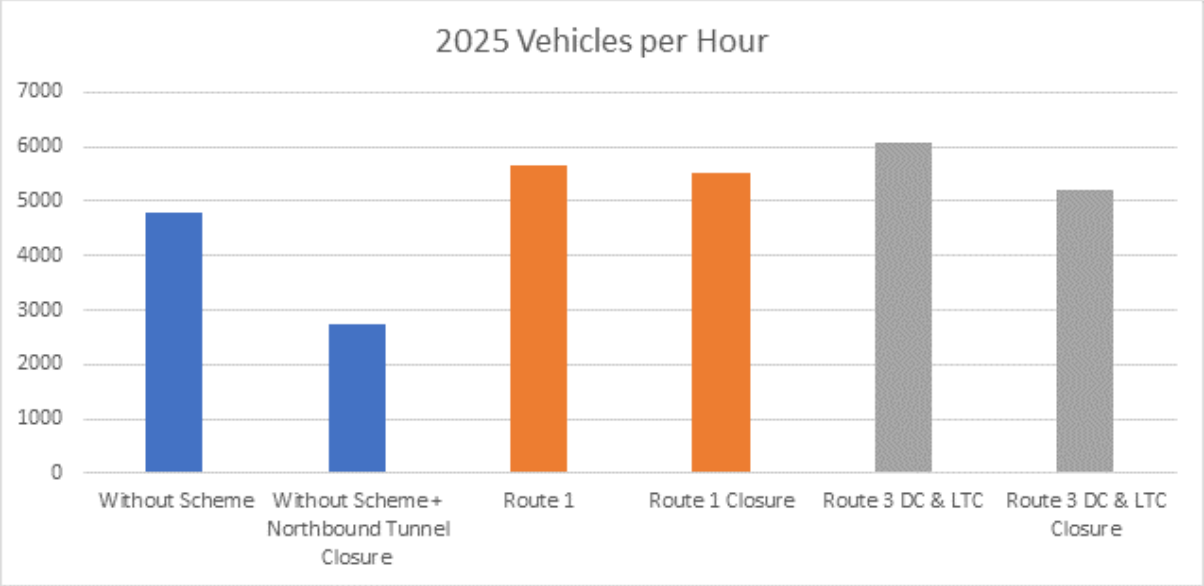
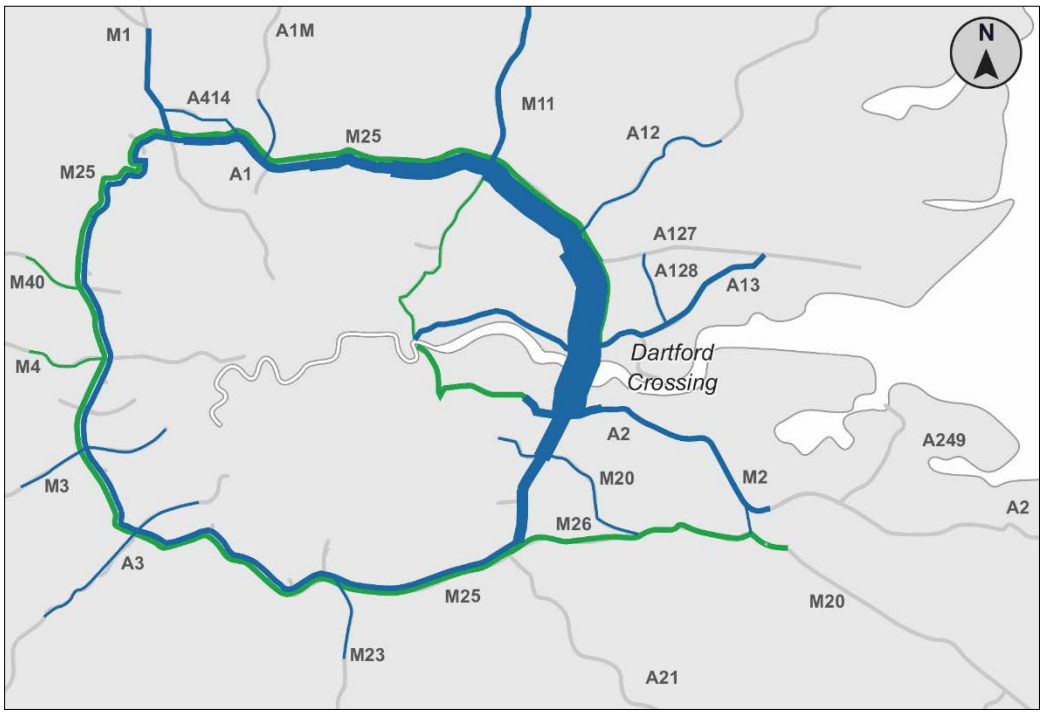


FIGURE 4.14 - OFF-PEAK CROSSING FLOWS WITH AND WITHOUT A CLOSURE OF ONE OF THE DARTFORD TUNNELS IN 2025

4.9.10 **Figure 4.14** demonstrates that resilience in the Without Scheme case is poor and traffic flows across the Thames would be reduced by around 50% in the case of a tunnel closure. This would result in severe network congestion. The reduction in flow able to cross the Thames compared with the normal operation is shown in **Figure 4.15** with the blue colour denoting a reduction in traffic flow and the green an increase in traffic flow. The increase is where some traffic would re-route via the Dartford crossing and the western side of the M25 to avoid the queues.



Blue shows a reduction in flow and green shows an increase in flow compared to the normal operation

FIGURE 4.15 - FLOW REDUCTION AS A RESULT OF CLOSING A TUNNEL AT DARTFORD IN 2025 (WITHOUT SCHEME)

4.9.11 With both Route 1 and Route 3, the network is more resilient and a tunnel closure will have less impact, as shown by much smaller overall flow changes in the with and without tunnel closure (**Figure 4.14** refers) for Route 1 and Route 3. The additional four lane bridge at Dartford in Route 1 significantly improves resilience to a tunnel crossing closure

4.9.12 Operationally, Route 3 provides more flexibility in the event of a major incident on the M25/ A282 corridor. This corridor will continue to be prone to incidents because of the poor alignment and geometry (as described in Section 3.2 of Volume 2). With appropriate traffic management through ITS, traffic could be diverted to the alternative crossing in the event of problems on the M25/ A282 corridor.

4.10 Conclusions

4.10.1 A summary of the traffic modelling appraisal is presented in line with the key issues raised above in the SAR namely:

- How Location A compares to Location C.
- How the Western Southern Link compares to the Eastern Southern Link for the Location C route options.
- How Routes 2, 3 and 4 compare with each other.

4.10.2 For these three decisions **Tables 4.10**, **4.11** and **4.12** present a summary of the traffic appraisal results in terms of traffic volumes, predicted users, journey times and crossing capacity.

4.10.3 Location C would improve the overall connectively of the road network across the River Thames, releasing suppressed trips in the existing A282 crossing corridor and inducing new trips from proposed developments, particularly to the east of Dartford.

4.10.4 Location C would also provide the most traffic congestion relief to the existing crossing, a key objective of LTC, as well as providing substantial relief to the A2, M20 and A12.

4.10.5 Location A would allow more traffic to access the existing crossing corridor, but other pinch-points on the M25 and its feeder routes will become congested over time and constrain the amount of traffic that can get to the crossing. In other words, increasing the capacity of the crossing structure and the immediate approach roads will not ease congestion on the approach roads, local roads and arterial roads.

4.10.6 Predicted future travel times across the existing crossing are broadly similar whichever location is chosen as the existing Dartford tunnels will continue to limit speeds and traffic volumes due to their capacity constraints. As expected, the catchment area for a crossing at Location A is similar to the catchment of the existing crossing, whereas Location C would attract trips starting and ending in Essex, East Anglia and Kent. In addition, Location C offers 12% more capacity than Location A due to the capacity constraints of the Dartford tunnels and higher speeds provided by the Location C route options.

4.10.7 The choice of WSL or ESL has little impact on the predicted traffic volumes across the River Thames, either on the existing crossing or the new crossing. ESL offers greater relief to the A2 and M20 than WSL, but attracts additional traffic to the M2 by providing this traffic with a slightly quicker free-flow link over the River Thames. ESL provides a faster route for M2 traffic and, as a result, attracts more traffic destined for, and originating in, Kent and slightly less traffic from the M25 south of London.

4.10.8 Routes 2, 3 and 4 (with ESL) are predicted to carry similar volumes of traffic, to provide the same relief to the existing crossing and result in broadly the same predicted travel times across the River Thames. Route 3 is expected to attract slightly more traffic to the new crossing thereby offering the most relief to the A2 and A13 and attracts the lowest levels of additional traffic to the M2.

TABLE 4.10 - SUMMARY OF KEY RESULTS - COMPARISON OF LOCATION A AND C

	Location A (Route 1)	Location C (Routes 2, 3 and 4)
Traffic Volumes on existing crossing	+23% compared to Without Scheme Scenario in 2025 +34% compared to Without Scheme Scenario in 2041	-14% compared to Without Scheme Scenario in 2025 -7% compared to Without Scheme Scenario in 2041
Traffic Volumes on new crossing	N/A	75,900 to 78,500 AADT in 2025 87,400 to 90,100 AADT in 2041
	Pinch-points emerge to north/ south of Location A on M25	Location C will improve overall connectivity across the River Thames
Total Volumes crossing the River Thames	+23% / +34% compared to Without Scheme Scenario in 2025 and 2041	+35% / +47% compared to Without Scheme Scenario in 2025 and 2041
Traffic Volumes of rest of network	Attracts more traffic to the feeder roads of the M25 including A2, M2, M20, A13	Relieves the A2 between Gravesend and Dartford, M20 and A12. Attracts additional traffic to the M2 at Chatham, M25 north of J29 and south of J2, and A226 east of Gravesend
AM Travel Times	Compared to the Without Scheme Scenario: • Travel times across the River Thames at Dartford will be 4-6 minutes shorter • Trips between M2 and M25 north of the River Thames (J28) will be 4-5 minutes faster	Compared to the Without Scheme Scenario: • Travel times across the River Thames at Dartford will be 4-6 minutes shorter • Trips between M2 and M25 north of the River Thames (J28) will be 10 minutes faster

	Location A (Route 1)	Location C (Routes 2, 3 and 4)
	• M20 trips heading to A127/A1245 will be 10 minutes shorter	• M20 trips heading to A127/A1245 will be 20-25 minutes shorter
Catchment Analysis	Will attract traffic from the M1 to M4 (clockwise) with the highest radial flows attracted from the A12, M11 and M2	Will attract traffic movements between M1/M11/A13 and Kent.
Hourly Crossing Capacity (pcus)	19,254 (+57%)	Total 21,619 (+76%)

TABLE 4.11 - SUMMARY OF KEY RESULTS ESL AND WSL

	Route 3 WSL	Route 3 ESL
Traffic Volumes on existing crossing	136,700 in 2025 150,500 in 2041	137,300 in 2025 151,500 in 2041
Traffic Volumes on new crossing	78,500 in 2025 90,100 in 2041	78,500 in 2025 89,600 in 2041
Total Volumes crossing the River Thames	215,200 in 2025 240,600 in 2041	215,800 in 2025 241,100 in 2041
Traffic Volumes on rest of network	Less relief to A2/M20, less traffic attracted to M2 and more relief to A13	More relief provided to A2/M20, more traffic attracted to M2. Less relief to A13
AM Travel Times	Trips between M20 and A127/A125 and between M2 and M25 J28 will be 2 minutes shorter via ESL compared to WSL	
Catchment Analysis	ESL attracts more traffic destined/originating in Kent using the M2/M20 and slightly less traffic from M25 south of London	
Hourly Crossing Capacity (pcus)	Total 21,619	Total 21,619

TABLE 4.12 - SUMMARY OF KEY RESULTS FOR LOCATION C ROUTES 2, 3 AND 4 (ESL)

	Route 2	Route 3	Route 4
Traffic Volumes on existing crossing	138,000 (2025) 152,100 (2041)	137,300 (2025) 151,500 (2041)	138,900 (2025) 153,300 (2041)
Traffic Volumes on new crossing	75,900 (2025) 87,400 (2041)	78,500 (2025) 89,600 (2041)	76,700 (2025) 88,300 (2041)
Total Volumes crossing the River Thames	138,000 (2025) 239,500 (2041)	137,300 (2025) 241,100 (2041)	138,900 (2025) 241,600 (2041)
Traffic Volumes on rest of network	Impact similar to Route 3 in 2025 but by 2041 impact similar to Route 4. Offers less relief to A2 and M20 than Route 3	By 2041 offers the greatest relief to A2 and M20, attracts the lowest volumes of additional traffic to M2 and provides greatest relief to A13	Northern tie-in attracts significantly more traffic to A127, more traffic attracted to A13 and M25 north of J29, slightly less relief to A2
AM Travel Times	Travel times between M20 J6 to A127/A1245 and between M2 J4 to M25 J28 are not significantly different		
Catchment Analysis	No significant differences between catchment areas		
Hourly Crossing Capacity (pcuS)	Total 21,619	Total 21,619	Total 21,619

5 Economic Appraisal

5.1 Introduction

5.1.1 This section presents the results of the economic appraisal of the shortlisted options in terms of the types of economic benefits. In addition to economic impacts expressed in monetary terms, it also includes results for those public accounts, environmental and social impacts that are also expressed in monetary terms. These impacts have been appraised using DfT's appraisal tools such as TUBA and COBALT. The benefits and costs in this section are all expressed as present values in 2010 prices and compared to each other to provide BCRs.

5.1.2 The results of the appraisal for each option are reported in three sets of WebTAG tables:

- Transport Economic Efficiency (TEE) table
- Public Accounts (PA) table
- Analysis of Monetary Costs and Benefits (AMCB) table

5.1.3 These tables, along with the ASTs, are set out in the Volume 7 Appendices.

5.1.4 The appraisal results have informed the choice of:

- Location A or Location C
- The best Location C option between Routes 2, 3 or 4
- Crossing type
- ESL or WSL

5.2 User and Provider benefits

5.2.1 User and Provider impacts include travel time savings, vehicle operating cost (VOC) savings, user charges and construction and maintenance delays to users. Of these benefits, travel time saving are by far the largest benefits across all routes. These benefits are appraised using TUBA and disaggregated between business users, commuters and other consumers and are summarised in **Table 5.1**.

5.2.2 The user and provider benefits vary considerably between the seven routes ranging from £1.94 billion for Route 1 to £3.67 billion for Route 3 with ESL. In general the benefits for Routes 2, 3 and 4 are similar and on average about 70 per cent higher than those for Route 1 reflecting the more extensive scale of the improvements to the road network offered by these routes.

5.2.3 For Routes 2, 3 and 4, the user and provider benefits are fairly similar, ranging between £3.12bn for Route 3 with WSL to £3.67bn for Route 3 with ESL. Route 3 provides a completely new road alignment north of the River Thames in contrast to the other options which would require upgrading existing road corridors, the A1089 in the case of Route 2 and the A127 for Route 4. However Route 2 has the highest benefits of the WSL options.

TABLE 5.1 - USER AND PROVIDER BENEFITS (£BN PVB 2010 PRICES)

£bn PVB 2010 prices		Route 1	Route 2 WSL	Route 2 ESL	Route 3 WSL	Route 3 ESL	Route 4 WSL	Route 4 ESL
Commuting	Travel time	0.063	0.087	0.091	0.074	0.086	0.077	0.086
	VOC	-0.015	-0.065	-0.059	-0.062	-0.056	-0.068	-0.063
	Charges	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Construction delays	-0.011	n/a	n/a	n/a	-0.001	n/a	n/a
	Total	0.037	0.023	0.032	0.012	0.028	0.009	0.023
Other consumers	Travel time	0.434	0.634	0.601	0.514	0.590	0.556	0.590
	VOC	-0.084	-0.359	-0.331	-0.353	-0.317	-0.383	-0.351
	Charges	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	Construction delays	-0.070	n/a	n/a	n/a	-0.008	n/a	n/a
	Total	0.279	0.273	0.268	0.159	0.262	0.170	0.237
Business	Travel time	1.812	2.672	2.776	2.531	2.813	2.603	2.838
	VOC	0.148	0.454	0.602	0.539	0.707	0.460	0.624
	Charges	-0.122	-0.106	-0.121	-0.116	-0.129	-0.098	-0.110
	Construction delays	-0.210	n/a	n/a	n/a	-0.017	n/a	n/a
	Total	1.628	3.020	3.257	2.954	3.374	2.965	3.352
Total		**1.944**	**3.316**	**3.558**	**3.125**	**3.665**	**3.145**	**3.612**
Business benefits as % of total		82	91	92	95	92	94	93

VOC = vehicle operating costs

n/a = not appraised

5.2.4 Route 3 with ESL provides £540 million of additional user and provider benefits than Route 3 with WSL. This is because the alignment of the ESL reflects a more natural desire line for traffic travelling between Kent and Essex and ESL is shorter in distance than WSL (refer to **Figure 4.12**). Further, traffic using WSL suffers from low speeds on the slip road at its junction with the A2.

5.2.5 For all routes:

- The great majority of benefits are generated by travel time savings.
- Benefits to business users represent a very high proportion of total user benefits amounting to over 80% of the total user and provider benefits.

Construction and maintenance delays

5.2.6 User and Provider benefits include the impact of construction and maintenance delays on users.

5.2.7 For Route 1, delays for travellers caused by LTC construction work are estimated to worth £290 million because of the extensive delays caused to existing traffic on the A282/ M25. For Route 3 with ESL these delays are estimated to be worth just £26 million because most of the route is completely new and the only disruption to users will be at the junctions with the existing road network.

5.2.8 Construction delays for other route options have not been appraised. These impacts are not expected to be significant because of their limited interactions with the existing road network and are likely to be similar to those impacts for Route 3 with ESL.

5.2.9 Delays for users caused by maintenance work have not been assessed for all route options. However, these delays are not expected to be significant as regular maintenance work will be timed to coincide with periods of lower traffic flow.

5.3 Other Economic Impacts

Accidents

5.3.1 DfT's COBALT tool has been used to appraise accidents. All route options are forecast to show a net increase in the number of accidents and these increases have been valued in monetary terms and represent accident disbenefits. The current analysis has used the default national average accident rates by road type in COBALT. The reasons for this are explained further in Section 6. In reality the accident benefits should be slightly greater than forecast as local accident rates around the existing Dartford Crossing are higher than average and we would expect lower accident rates on the enhanced crossing and on the alternative LTC crossing options due to their more consistent design quality.

5.3.2 For all routes the number of accidents is forecast to increase due to the increased volume of traffic on the road network. Route 1 is forecast to have the lowest increase in the number of accidents (1,416) and casualties, whilst the increase in the numbers of accidents and casualties for Route 2 with WSL and Route 3 with WSL is expected to be very similar and larger than the other routes (each route has around 2,450 extra accidents).

5.3.3 Route 1 has the lowest valuation of accident disbenefits of £74 million whilst Route 3 with WSL has the highest at £128 million (refer to **Table 5.2**).

5.3.4 Section 6 provides a more detailed explanation of the appraisal of accidents.

Greenhouse gas emissions

5.3.5 For all routes greenhouse gas emissions are estimated to increase as a result of traffic taking advantage of the enhanced opportunities for travel across the river. These emissions have been estimated in tonnes and valued within TUBA. Route 1 has the lowest increase (£144 million disbenefit), whilst Route 4 with ESL has the largest increase (£304 million disbenefit) (refer to **Table 5.2**).

Noise impacts

5.3.6 Volume 6 describes how noise impacts have been calculated and valued in monetary terms. The valuation of these impacts which is included in the appraisal is relatively low for all of the routes (refer to **Table 5.2**).

Indirect taxation

5.3.7 The LTC options result in increases in indirect taxation revenues from fuel duty and VAT that are related to greater traffic levels and the length of the route. The increased revenues, expressed in PVB terms, range between £269 million for Route 1 to £629 million for Route 4 with ESL (refer to **Table 5.2**).

TABLE 5.2 - OTHER IMPACTS (£BN PVB 2010 PRICES)

£bn PVB 2010 prices	Route 1	Route 2 WSL	Route 2 ESL	Route 3 WSL	Route 3 ESL	Route 4 WSL	Route 4 ESL
Greenhouse gas emissions	-0.144	-0.270	-0.284	-0.273	-0.288	-0.289	-0.304
Noise	-0.001	0.003	0.004	0.012	0.010	0.015	0.012
Accidents	-0.074	-0.126	-0.118	-0.128	-0.120	-0.121	-0.113
Indirect taxation	0.269	0.550	0.585	0.565	0.589	0.603	0.629

5.3.8 **Table 5.3** presents User and Provider impacts along with the other economic impacts to produce estimates of total benefits expressed as PVBs. Route 3 with ESL has the highest benefits at £3.86 billion.

5.3.9 Route 3 with ESL provides £556 million in extra benefits than Route 3 with WSL. This differential between ESL and WSL falls to £484m for Route 4 and £261m for Route 2.

TABLE 5.3 - TOTAL BENEFITS (£BN PVB 2010 PRICES)

£bn PVB 2010 prices	Route 1	Route 2 WSL	Route 2 ESL	Route 3 WSL	Route 3 ESL	Route 4 WSL	Route 4 ESL
Greenhouse gas emissions	-0.144	-0.260	-0.284	-0.273	-0.288	-0.289	-0.304
Noise	-0.001	0.003	0.004	0.012	0.010	0.015	0.012
Accidents	-0.074	-0.126	-0.118	-0.128	-0.120	-0.121	-0.113
Commuting	0.037	0.023	0.032	0.012	0.028	0.009	0.023
Other Consumers	0.279	0.273	0.268	0.159	0.262	0.170	0.237
Business	1.628	3.020	3.257	2.954	3.374	2.965	3.352
Indirect Taxation	0.269	0.550	0.585	0.565	0.589	0.603	0.629
Total	**1.995**	**3.483**	**3.745**	**3.300**	**3.856**	**3.353**	**3.836**

Note: Commuting, Other Consumers and Business includes travel time, vehicle operating costs, user charges and construction delays.

5.4 Scheme costs

5.4.1 The derivation of capital and operating costs for the LTC options is explained in Volume 4. The full set of present value scheme costs for all 20 options is presented in Appendix 5.1.

5.4.2 **Table 5.4** presents the costs expressed in present value terms. For the seven route options discussed in this section:

- The Investment costs range from £1.7bn (Route 1 with bridge) to £2.2bn (Route 4 with ESL and bored tunnel).
- The operating costs for Route 1 with bridge at £113 million are much lower than the operating costs for Routes 2, 3 and 4 (with WSL and ESL) with the bored tunnel, which average £270 million.
- The total costs range from £1.8 billion (Route 1 with bridge) to £2.5 billion (Route 4 with ESL and bored tunnel). The costs for Routes 2, 3 and 4 are within £300 million of each other.

5.4.3 The ESL costs are on average £100m more than WSL for each of Routes 2, 3 and 4.

TABLE 5.4 - SCHEME COSTS (£BN PVC 2010 PRICES)

	R1 Bridge	R2/ WSL Bored tunnel	R2/ ESL Bored tunnel	R3/ WSL Bored tunnel	R3/ ESL Bored tunnel	R4/ WSL Bored tunnel	R4/ ESL Bored tunnel
Investment costs	1.698	1.917	2.020	1.913	2.015	2.094	2.199
Operating costs	0.113	0.252	0.260	0.267	0.275	0.277	0.285
Total costs	**1,811**	**2.169**	**2.280**	**2.180**	**2.290**	**2.371**	**2.484**

5.5 Revenues

5.5.1 The Public Accounts appraisal table includes the revenues generated by users which are treated in the appraisal as if they are available to offset the costs of the new crossing over the 60 year appraisal period. Hence the higher user charge revenues are, the lower the scheme costs. Since Location C routes attract more traffic they generate higher revenues than Route 1.

5.5.2 For Route 1 revenues over the 60 year appraisal period would be between 43% and 48% of the net PVC costs for a bored tunnel and bridge option. For Routes 2 to 4 the revenues would be larger both in monetary terms and as a proportion of the costs of construction and operation, with revenues on average around 56% of net PVC costs.

5.5.3 **Table 5.5** shows the revenues for each of the seven route options. The revenues for Routes 2, 3 and 4 with WSL and ESL are all around £825 million.

TABLE 5.5 - REVENUES (£BN PVC 2010 PRICES)

	R1 Bridge	R2/ WSL Bored tunnel	R2/ ESL Bored tunnel	R3/ WSL Bored tunnel	R3/ ESL Bored tunnel	R4/ WSL Bored tunnel	R4/ ESL Bored tunnel
Revenues	0.589	0.799	0.816	0.827	0.843	0.823	0.835

5.6 Wider Economic Impacts

5.6.1 In addition to User and Provider benefits and other economic impacts, there are two wider economic impacts; these are Wider Economic Benefits and Journey Time Reliability. These are excluded from the Initial BCR, but are included in the calculation of the Adjusted BCR.

Wider Economic Benefits (WEBs)

5.6.2 The Wider Economic Benefits (WEBs) for the seven route options are set out in **Table 5.6.**

5.6.3 The inclusion of the WEBs increases the total benefits by between 37% and 50%. This indicates the importance of new capacity to economic development in the area served both by the new crossing and by the existing crossing with an improved level of service.

TABLE 5.6 - WIDER ECONOMIC BENEFITS (£BN PVB 2010 PRICES)

	R1	R2/ WSL	R2/ ESL	R3/ WSL	R3/ ESL	R4/ WSL	R4/ ESL
Agglomeration	0.553	0.981	1.299	1.056	1.337	1.390	1.398
Output in imperfectly competitive markets	0.184	0.282	0.326	0.295	0.339	0.287	0.335
Labour supply impacts	0.000	0.001	0.002	0.001	0.001	0.001	0.001
Move to more/ less productive jobs	Not assessed						
Total	**0.737**	**1.264**	**1.626**	**1.353**	**1.677**	**1.678**	**1.735**
Agglomeration as % of WEBs	75	78	80	78	80	83	81
WEBs as % of total benefits	37	40	44	41	43	50	45

5.6.4 Agglomeration benefits account for about 78% of the total WEBs with imperfect competition benefits providing most of the other WEBs. Labour supply impacts are estimated to be very small.

5.6.5 The highest WEBs are generated by Routes 2, 3 and 4, with Route 4 generating the largest WEBs. These routes provide a substantial increase in accessibility and consequently improve productivity for businesses located to the east of the Dartford Crossing. The movement of labour to more or less productive jobs, which is one of the WEBs impacts, has not been assessed for LTC. This is because DfT's WebTAG appraisal guidance recommends

that these impacts are only assessed if there is a land-use transport interaction model, which does not exist for LTC.

5.6.6 Routes 2 and 3 with ESL provide an additional £363 million and £325 million in WEBs benefits respectively compared with WSL. The WEBs differential for Route 4 with ESL is just £57 million. The reason for this is that the agglomeration benefits associated with Routes 2 and 3 are largely associated with economic activity in London and the north and therefore ESL, whose design improves connectivity with London compared to WSL, has a greater differential impact. Route 4 provides more opportunities for agglomeration benefits for Kent and Essex and therefore this route is less influenced by the choice of ESL and WSL. Overall with ESL, all three routes provide similar levels of agglomeration benefits which is the vast majority of the WEBs benefits.

Journey Time Reliability

5.6.7 Changes in journey time reliability have been assessed using an urban journey time reliability equation, as set out in WebTAG Unit A1.3. There are a number of limitations on its use which mean that the results should be regarded as indicative. Despite these limitations most road users would recognise the day to day challenges of journey time reliability at the existing crossing.

5.6.8 These limitations include:

- In assessing journey time reliability impacts, the equation does not take account of any change in modelled distances travelled by users between the Without Scheme and With Scheme scenarios.
- The speeds at which the journey time reliability equation is robust are between 23mph to 29mph, whilst the speed limits at the Dartford Crossing and on the A282/ M25 are between 50mph and 70mph.
- The equation assumes that in urban areas there are alternative routes. The Dartford Crossing does not have good alternative routes for queuing traffic.

5.6.9 These limitations highlight the potential for both over- and under-estimating the journey time reliability benefits. As indicated above, the numbers in **Table 5.7** should be regarded as providing approximate orders of magnitude results only rather than estimates of the impacts.

5.6.10 The journey time reliability benefits are on average split 70:30 between business and other users and are fairly similar across all routes, ranging from £135 million (Route 1) to £150 million (Route 4 with ESL).

TABLE 5.7 - JOURNEY TIME RELIABILITY BENEFITS (£BN PVB 2010 PRICES)

	R1	R2/ WSL	R2/ ESL	R3/ WSL	R3/ ESL	R4/ WSL	R4/ ESL
Business	0.090	0.103	0.107	0.104	0.108	0.106	0.110
Other users	0.044	0.040	0.039	0.039	0.039	0.040	0.040
Total	**0.135**	**0.142**	**0.146**	**0.143**	**0.147**	**0.146**	**0.150**

5.7 Conclusions

Direct economic impacts

5.7.1 User and Provider benefits (travel time savings, vehicle operating cost savings, user charges and construction delays) account for approximately 95% of direct economic benefits for Routes 2, 3 and 4, largely driven by travel time savings.

5.7.2 Disbenefits to users due to delays caused by LTC construction work are expected to be significant for Route 1 (-£290 million). This impact is much smaller for Route 3 with ESL (-£26 million). The impacts for other Location C route options has not been appraised, but are expected to be similar to that for Route 3 with ESL.

5.7.3 For Routes 2, 3 and 4 with WSL and ESL, other economic impacts (greenhouse gas emissions, accidents, noise and indirect taxation revenues) generate, on average, £190 million of benefits (5% of direct benefits). However for Route 1 other economic impacts are only £51m.

5.7.4 Direct benefits for all options are fairly similar and fall within the range £3.30 billion (Route 3 with WSL) to £3.86 billion (Route 3 with ESL) except for Route 1 where direct benefits are £2 billion.

Costs and revenues

5.7.5 Route 1 has the lowest total scheme cost at £1.8 billion. The costs for Routes 2, 3 and 4 with WSL and ESL are between £2.2bn and £2.5bn. The operating costs of Route 1 (with a bridge) are less than half (£113 million) than those for Routes 2, 3 and 4 (with a bored tunnel) which range from £252 million to £285 million.

5.7.6 The forecast revenues for Route 1 are approximately £600 million, whilst the forecast revenues for Routes 2, 3 and 4 are around £825 million.

ESL compared with WSL

5.7.7 Route 3 with ESL provides £556 million in extra direct benefits compared to Route 3 with WSL. This differential between ESL and WSL falls to £484m for Route 4 and £261m for Route 2. However the ESL costs are on average about £100m more than WSL for each of Routes 2, 3 and 4.

Wider Economic Impacts

5.7.8 Wider Economic Benefits (WEBs), which are included in the Adjusted BCR, range from £0.74 billion (Route 1) to £1.74 billion (Route 4 with ESL). As such, they are significant and their inclusion increases the total benefits of the route options by between 37% and 50%. On average journey time reliability impacts add a further £144 million to the benefits of the routes.

6 Social Impact Appraisal

6.1 Introduction

6.1.1 This section presents the results of the Social Impact Appraisal (SIA) for the shortlisted options. The appraisal has been carried out in line with the WebTAG Unit A4.1. The results of the assessment are also summarised in the ASTs.

6.2 Accidents

6.2.1 The appraisal of accidents has been carried out using DfT's COBALT appraisal tool. This estimates the change in the number of accidents and casualties as a result of each option and calculates the accident benefits in present value terms over the 60 year period from scheme opening. The cost of the forecast accidents is calculated by multiplying the predicted number of accidents by the cost per accident. These savings (or costs) are then annualised and extrapolated over the 60 year appraisal period, and then discounted to produce a 2010 present value of accident benefits in 2010 prices.

6.2.2 COBALT assesses the total number of accidents across the whole modelled network. Whilst it is possible to input local accident rates for each link of the network, the size of the modelled network made this approach impractical at this stage. To ensure consistency across the whole network the default national values were used throughout. A location specific accident appraisal has also been carried out using actual network accident data and has looked at the Fatalities and Weighted Injuries (FWI) rate per billion vehicle kilometres. This is reported in Volume 2.

6.2.3 **Table 6.1** shows the estimated change in the number of accidents and casualties, disaggregated into three severity levels - fatal, serious and slight. The results show increased numbers of accidents and casualties for all route options and consequent increases in total accident costs. The increase in accidents reflects the predicted increase in vehicle kilometres driven as a result of the new crossing options.

6.2.4 Route 1 is estimated to have the lowest number of additional accidents and casualties across all levels of severity. This is because the additional road length provided by Route 1 is shorter than for the other route options. This, combined with Route 1's lower speeds, means that the total number of additional accidents is lower. The additional number of accidents and casualties for Routes 2, 3 and 4 are broadly consistent.

6.2.5 **Table 6.2** shows the accident disbenefits for all of the shortlisted routes, ranging from £74m for Route 1 to £128m for Route 2.

TABLE 6.1 - NUMBER OF ADDITIONAL ACCIDENTS AND CASUALTIES

		R1	R2/ WSL	R2/ ESL	R3/ WSL	R3/ ESL	R4/ WSL	R4/ ESL
Accidents saved by LTC		-1,416	-2,453	-2,319	-2,456	-2,313	-2,288	-2,147
Casualties saved by LTC	Fatal	-23	-34	-31	-35	-33	-35	-32
	Serious	-161	-265	-246	-274	-254	-258	-238
	Slight	-1,900	-3,424	-3,259	-3,415	-3,239	-3,245	-3,071

TABLE 6.2 - ACCIDENT BENEFITS £BN

	R1	R2/ WSL	R2/ ESL	R3/ WSL	R3/ ESL	R4/ WSL	R4/ ESL
PVB £ bn	-0.074	-0.126	-0.118	-0.128	-0.120	-0.121	-0.113

6.3 Physical activity

6.3.1 To achieve the scheme objectives for LTC one of the scheme requirements is to include provision for non-motorised users (cyclists and pedestrians). In the appraisal of the route options, impacts on physical activity refers to the physical activity of these road users. During the options phase provision for non-motorised users has been considered but has not yet been incorporated into the designs for the route options. Therefore the shortlist route options in this appraisal have been assessed to have no impact on physical activity. However consideration of provision for non-motorised users will continue as the scheme is developed.

6.4 Journey quality

6.4.1 The assessment of the journey quality impacts for users of each route during their construction and operation is a requirement of WebTAG Unit A4.1. Factors that influence journey quality that are not included in other appraisal criteria include public information provision to avoid route uncertainty and perceptions of safety such as lighting. Poor journey quality can lead to traveller frustration and stress. This section presents the results of a qualitative assessment of journey quality impacts for the shortlisted route options. More detailed information related to the appraisal of journey quality is provided in **Appendix 5.3**.

6.4.2 Details on what is entailed in the construction of the routes is presented in Volume 4.

Construction stage

6.4.3 During construction the impacts on journey quality are likely to be most adverse for Route 1. The existing site is a highly congested section of the A282 with the Dartford Crossing currently causing significant delays. The construction process, involving HGV and other construction traffic, would

further exacerbate these delays. Traffic management measures would be required including narrow lanes with a temporary speed restriction of 40mph.

6.4.4 Construction stage impacts on journey quality for Routes 2, 3 and 4 are likely to be comparatively smaller because these are mainly new off-line routes. They are also similar for the WSL and ESL route options. **Table 6.3** presents the overall assessment for the four routes. However there will be adverse journey quality impacts during construction where the routes connect to the existing road network. The tunnels would require large amounts of spoil to be removed from their portals and under the River Thames which would need to be transported out of the area. This could be transported by water. Where this is transported by road, there would be adverse impacts on journey quality with increased delays, causing stress and frustration to users. However it has been assumed that the majority of spoil would be transported during off-peak hours. These adverse impacts are as follows:

- Route 2 impacts A2 (WSL) or M2 junction construction (ESL), A1089 corridor, A13 junction and M25 junction.
- Route 3 impacts A2 (WSL) or M2 junction construction (ESL), A13 junction and M25 junction.
- Route 4 impacts A2 (WSL) or M2 junction construction (ESL), A13 junction, A127 and M25 junction.

6.4.5 Route uncertainty and disruption for pedestrians and cyclists would occur during construction as public paths are temporarily severed.

TABLE 6.3 - CONSTRUCTION STAGE JOURNEY QUALITY IMPACT SUMMARY

		Route 1	Route 2	Route 3	Route 4
		Bridge	Tunnel	Tunnel	Tunnel
Affects 10,000+	Moderate Adverse				
Affects 10,000+	High Adverse				

Operational stage

6.4.6 During the operational stage the impacts on journey quality set out in the following paragraphs are anticipated. Table 6.4 presents the overall assessment for the four routes.

Route 1

6.4.7 Route 1 would lead to improved access and capacity at Dartford Crossing connecting facilities north and south of the river for motorised users. The user experience is anticipated to improve due to the reduction in time spent in congested traffic. Although a small number of users may feel uncomfortable using a bridge crossing, the majority may also appreciate the views from the bridge. For northbound traffic a bridge is likely to require fewer closures than the existing tunnels due to lower levels of maintenance and incidents.

6.4.8 Fear of accidents is likely to reduce for northbound traffic using Route 1 compared to the existing narrow tunnels, as the bridge would be built to modern standards.

6.4.9 It is expected that drivers, who previously tried to avoid congestion on key east-west links such as the A13 by using local roads, would be less likely to do this due to the greater capacity along Route 1. However the existing problems are unlikely to be fully resolved as HGV traffic from Tilbury Docks and London Gateway Port would potentially still travel on local roads to reach the crossing.

6.4.10 At this stage additional provision for non-motorised users has been considered but has not been included in the scheme designs. The journey quality for cyclists is currently low but any future provision would be of an appropriate quality and meet safety standards. Pedestrians are not currently able to access the Dartford crossing and at this stage no allowance has been made for pedestrian access for Route 1.

Routes 2, 3 and 4

6.4.11 The operational stage journey quality impacts of Routes 2, 3, and 4 would be fairly similar to each other.

6.4.12 Routes 2, 3 and 4 would create direct access to facilities north and south of the river in Thurrock and Gravesend for motorised users. The routes would also provide improved connections to the motorway network. This would benefit traffic from Tilbury and London Gateway Port and provide congestion relief for traffic on both strategic and local roads who are impacted by delays on the existing crossing at Dartford.

6.4.13 Route uncertainty is likely to reduce as Routes 2, 3 and 4 would be used by HGVs that currently use the area as a “rat run”. This would relieve future congestion as Tilbury Docks and London Gateway Port grow. However it is anticipated that there may be an increase in HGV traffic.

6.4.14 Road users’ fear of accidents is likely to reduce given the reduced congestion and new roads. However there may be an increase in the fear of accidents for pedestrians and cyclists, although this will depend upon what provision is made for them.

6.4.15 The existing tunnels at the Dartford Crossing would still be operational. They would still require frequent closures and so delays would still occur. Although this would impact fewer people it would still affect journey quality. A new tunnel would experience fewer closures because it would be built to modern standards.

6.4.16 The ESL provides a direct link between Routes 2, 3 and 4 and the M2. This would improve journey quality for motorised users travelling along these routes. However there would be an increase in HGV traffic travelling close to the village of Shorne in Kent. This may impact on local road users increasing their frustration and stress. There may be an increase in the fear of accidents for local non-motorised users depending upon what provision is made for them.

TABLE 6.4 - OPERATIONAL STAGE JOURNEY QUALITY IMPACT SUMMARY (MOTORISED USERS)

	Without Scheme	Route 1	Route 2	Route 3	Route 4
High Beneficial (affects 10,000+)					
Moderate Beneficial (affects 10,000+)					
Slight Beneficial (low impact)					
Neutral (benefits and adversities balance out)					
Slight Adverse (low impact)					
Moderate Adverse (affects 10,000+)					
High Adverse (affects 10,000+)					

6.5 Severance

6.5.1 This section presents a summary of the potential impacts of the four main routes on severance of public rights of way, and estimates the population that is likely to be affected. A further assessment of severance on community facilities is presented in Volume 6.

6.5.2 Severance across the river currently exists for non-motorised users (pedestrians and cyclists). The only existing provision is a vehicle that carries cyclists across the Dartford Crossing when requested and the Gravesend to Tilbury ferry. At this stage specific provision for non-motorised users has not been included in the illustrative designs for the crossing structures, but this will be considered in the next stage of scheme development.

6.5.3 There are a number of existing public rights of way and cycle routes which are affected by the option layouts. There is a commitment that all routes will include safe re-provision of affected public rights of way.

6.5.4 **Table 6.5** summarises the results of the severance appraisal for the construction and operational stages (combined) based on the current engineering designs for the routes.

6.5.5 The population figures are based on an analysis of cycling and pedestrian data, Office for National Statistics (ONS) travel to work census data, and the Department for Transport's National Trip End Model (NTEM).

6.5.6 A more detailed table showing the number of people affected by mode is presented in **Appendix 5.4**.

TABLE 6.5 - SUMMARY TABLE SHOWING RELATIVE SCALE OF SEVERNACE IMPACTS FOR EACH ROUTE AT OPERATIONAL STAGE

	Population Affected (based on estimate of the local population that would cycle or walk within 10km boundary of the routes in 2025)			
	Route 1	Route 2	Route 3	Route 4
Change in severance	Slight Adverse	Slight Adverse	Slight Adverse	Slight Adverse
Population affected	284,200	352,200	389,400	372,000

6.6 Property acquisition

6.6.1 The assessment of property acquisition is described in Volume 4.

6.7 Personal security

6.7.1 WebTAG Unit A4.1 requires an assessment of the changes in security and the likely numbers of users affected. It does not however, provide formal guidance for highways schemes. In order to assess the impacts, a qualitative review of the security considerations and impacts has been carried out drawing on the table of security indicators in WebTAG Unit A4.1. The impacts for each route have been compared to the Without Scheme scenario to identify the potential level of change in security that will occur (refer to **Table 6.7**). The table also includes the appraisal scores for each route.

6.7.2 At this stage a very high level assessment has been carried out. Security will be explored in more depth during the development stage of the scheme.

6.7.3 **Appendix 5.5** includes a qualitative summary of the findings from the review of the security impacts for the operational stage of the scheme.

TABLE 6.6 - SECURITY IMPACTS

Security Indicator	Relative importance	Without scheme	Route 1	Route 2 ESL & WSL	Route 3 ESL & WSL	Route 4 ESL & WSL
Site perimeters	High	High	High	High	High	High
Entrances and exits	High	High	High	High	High	High
Formal surveillance	High	Moderate	Moderate	Moderate	Moderate	Moderate
Lighting and visibility	High	High	High	Moderate	Moderate	Moderate
Emergency call	High	Moderate	Moderate	Moderate	Moderate	Moderate

Approximate Number of Users Affected

All road users travelling along the routes and surrounding neighbourhoods.

Summary Assessment Score

Route 1	Neutral
Route 2	Slight adverse
Route 3	Slight adverse
Route 4	Slight adverse

Qualitative Comments

Route 1 has a neutral score because security provisions will be similar to the existing baseline scenario.
Routes 2, 3 and 4 have slight adverse scores due to the lack of lighting provision along the planned highways.

The assessment has been based on the core scenarios which exclude NMU provision.

This estimate is provisional based on a high level assessment. Security will be considered in detail at the development stage of the scheme.

6.8 Personal affordability

6.8.1 The personal affordability criteria is designed to identify the impacts on personal affordability of any changes to user charges. WebTAG states that the changes need to be greater than +/- 10% in order to require an assessment.

6.8.2 For the LTC appraisal the user charges for the LTC crossings have been assumed to remain the same as those at Dartford Crossing today and in future years to rise in line with inflation. Consequently there will be no significant change in personal affordability.

6.9 Conclusions

6.9.1 The paragraphs above have briefly summarised the results of the social impact appraisal for the LTC shortlisted route options. The assessment has drawn on the WebTAG Unit A4.1 guidance and includes a limited number of components: accidents, physical activity, severance, journey quality, and security. The key conclusions from the appraisal are set out below.

6.9.2 The appraisal of accidents using COBALT found that accidents are likely to increase on all routes as a result of the scheme. Route 1 is forecast to have the lowest increase in casualties. Routes 2, 3 and 4 would all be consistently higher than Route 1. However using the default national accident values in COBALT may underestimate the benefits of the options, as described above, and a separate location specific accident appraisal is provided in Volume 4.

6.9.3 At this stage in the development of the project the routes have no impact on physical activity because the scheme designs do not include provision for walking and cycling.

6.9.4 There is a commitment that all routes will include safe re-provision of affected public rights of way. The engineering designs are in the process of being updated to provide this re-provision and will be reviewed to ensure compliance with this commitment.

6.9.5 In terms of journey quality impacts, Route 1 has been assessed as Neutral, while Routes 2, 3 and 4 have been assessed as Moderately Beneficial.

6.9.6 Security impacts have only been assessed at a very high level at this stage in the scheme. Overall the impacts on security of Route 1 were considered Neutral and for Routes 2, 3 and 4 are Slight Adverse.

7 Benefit Cost Ratios (BCR)

7.1 Introduction

7.1.1 The BCR provides a summary comparative measure for those economic, social and environmental impacts that can be expressed in monetary terms and presented in discounted 2010 present value terms. Benefits are expressed as PVBs and costs as PVCs. PVBs less PVCs provide Net Present Values (NPVs) and the ratio of the PVB to the PVC constitutes the BCR.

7.1.2 WebTAG requires that two BCRs are calculated for each option – an Initial BCR, which excludes Wider Economic Benefits and Reliability impacts, and an Adjusted BCR, which includes Wider Economic Benefits and Reliability impacts.

7.2 Conclusions

7.2.1 **Table 7.1** presents the Initial BCRs and Adjusted BCRs for the 7 route options considered in this document.

TABLE 7.1 - BCRS FOR SHORTLIST ROUTE OPTIONS

PVB (£bn) 2010 prices	R1	R2 WSL	R2 ESL	R3 WSL	R3 ESL	R4 WSL	R4 ESL
Crossing type	BR	BT	BT	BT	BT	BT	BT
PVB (excl WEBs & Reliability) (£bn)	1.995	3.483	3.745	3.300	3.856	3.353	3.837
PVC (£bn)	1.222	1.370	1.464	1.354	1.447	1.548	1.649
NPV (£bn)	0.773	2.114	2.280	1.947	2.409	1.805	2.188
Initial BCR	1.6	2.5	2.6	2.4	2.7	2.2	2.3
WEBs (£bn)	0.737	1.264	1.626	1.353	1.677	1.678	1.735
Reliability (£bn)	0.135	0.142	0.146	0.143	0.147	0.146	0.150
Adjusted BCR	2.3	3.6	3.8	3.5	3.9	3.3	3.5

7.2.2 **Table 7.1** shows that:

- Route 3 with Eastern Southern Link and a bored tunnel has the highest Initial BCR of 2.7 representing High Value for Money based on DfT's Value for Money categories.
- All of the other route options at Location C with a bored tunnel have Initial BCRs over 2.0 and represent High Value for Money. Route 1 with a bridge has an Initial BCR of 1.6 and represents Medium Value for Money.

- Route 3 with Eastern Southern Link and a bored tunnel has the highest Adjusted BCR of 3.9 representing High Value for Money.
- All of the other route options have Adjusted BCRs over 2.0 and represent High Value for Money.
- The Initial and Adjusted BCRs for Routes 2, 3 and 4 with ESL all exceed those for Routes 2, 3 and 4 with WSL.

7.2.3 The BCRs for all 20 options are included in **Appendix 5.1**.

8 Distributional Appraisal

8.1.1 The distributional appraisal will be completed for the Post-Consultation version of the SAR.

9 Sensitivity tests

9.1 Introduction

9.1.1 The previous sections outlined the appraisal of the shortlist routes to arrive at a proposed scheme. In support of this conclusion the following sensitivity tests have been carried out:

- Dual 3 lane provision within the tunnel at Location C
- High and Low Traffic Growth
- New Values of Time

9.1.2 These tests have been carried out to assess the robustness of the appraisal results and proposed scheme to changes in key parameters used in the appraisal. There may be less confidence in the appraisal of a scheme if the appraisal results are highly sensitive to a change in key parameters.

9.1.3 Volume 4 describes the sensitivity tests for Dual 3 lane provision in the tunnel. Based on that description, this section first presents the BCRs for Dual 3 provision in the tunnel using estimates of most likely and high costs.

9.1.4 This section then describes the sensitivity tests and presents the BCRs for High and Low Traffic Growth and the new Values of Time used in the economic appraisal.

9.2 Benefit cost ratio for Dual 3 lane provision in the tunnel

9.2.1 Volume 4 explains that the additional out-turn cost of Dual 3 lane provision in the tunnel at Location C for future-proofing is estimated to be in the range of £0.17bn to £0.5bn.

9.2.2 The tables below present the Initial BCRs and Adjusted BCRs for the Location C routes based on Dual 3 provision in the tunnel. The BCRs in **Table 9.1** are based on the most likely (P50) costs and those in **Table 9.2** are based on an upper estimate (P90) of costs.

9.2.3 **Table 9.1** shows that for Route 3 with ESL, the Initial BCR for Dual 3 provision, based on most likely costs, is 2.3 and the Adjusted BCR is 3.4 (both representing High Value for Money). **Table 9.2** shows that, based on high (P90) costs, the Initial BCR for Route 3 with ESL reduces to 1.7 (Medium Value for Money) and the Adjusted BCR falls to 2.5 (High Value for Money).

TABLE 9.1 - INITIAL AND ADJUSTED BCRS FOR SHORTLIST ROUTES WITH DUAL 3 LANE PROVISION IN THE TUNNEL (£BN PVB AND P50 PVC 2010 PRICES)

PVB (£bn) 2010 prices	R2 WSL	R2 ESL	R3 WSL	R3 ESL	R4 WSL	R4 ESL
PVB (excl WEBs & Reliability) (£bn)	3.483	3.745	3.300	**3.856**	3.353	3.837
PVC (£bn) based on P50 costs	1.578	1.672	1.564	**1.656**	1.757	1.858
Initial BCR	2.2	2.2	2.1	**2.3**	1.9	2.1
WEBs (£bn)	1.264	1.626	1.353	**1.677**	1.678	1.735
Reliability (£bn)	0.142	0.146	0.143	**0.147**	0.146	0.150
Adjusted BCR	3.1	3.3	3.1	**3.4**	2.9	3.1

TABLE 9.2 - INITIAL AND ADJUSTED BCRS FOR SHORTLIST ROUTES WITH DUAL 3 LANE PROVISION IN THE TUNNEL (£BN PVB AND P90 PVC 2010 PRICES)

PVB (£bn) 2010 prices	R2 WSL	R2 ESL	R3 WSL	R3 ESL	R4 WSL	R4 ESL
PVB (excl WEBs & Reliability) (£bn)	3.483	3.745	3.300	**3.856**	3.353	3.837
PVC (£bn) based on P90 costs	2.235	2.334	2.185	**2.284**	2.465	2.570
Initial BCR	1.6	1.6	1.5	**1.7**	1.4	1.5
WEBs (£bn)	1.264	1.626	1.353	**1.677**	1.678	1.735
Reliability (£bn)	0.142	0.146	0.143	**0.147**	0.146	0.150
Adjusted BCR	2.2	2.4	2.2	**2.5**	2.1	2.2

Conclusion

9.2.4 Volume 4 confirms that a Dual 2 All Purpose (D2AP) scheme for Location C is the appropriate scheme based on current traffic forecasts. However, potential future levels of traffic on the link that includes the river crossing could require Dual 3 All Purpose (D3AP) provision. The extra out-turn cost to provide a future-proofed crossing with Dual 3 lane provision in the tunnel is estimated to be in the range of £0.17bn to £0.50bn, with the Adjusted BCRs, ranging across the short listed options, between 2.9 and 3.4 based on most likely costs.

9.3 High and Low Traffic Growth

9.3.1 An initial analysis of the sensitivity of the economic appraisal results for Route 3 with ESL to High and Low growth National Traffic Forecast Uncertainty has been undertaken using the methodology set out in Section

4.3 of WebTAG Unit M4 'Forecasting and Uncertainty'. This excludes any treatment of local growth uncertainty (paragraph 2.4.8 of WebTAG refers) at this stage as the overall growth must still be constrained to National Uncertainty.

9.3.2 Essentially, the Low and High growth scenarios are prepared by adding a proportion of base year demand (High growth) and subtracting (Low growth) to the demand in the Core scenario. The proportion is dependent on the number of years into the future of the forecast year. Based on WebTAG advice, the calculations give a +15% to -15% demand range over a period of 36 years or more.

9.3.3 The methodology was applied to the Core traffic growth scenario to produce estimates of changes in traffic flows across the crossings and the resultant effect on benefits. The change in benefits has been estimated from the changes in travel time savings as these are the primary contributor of overall benefits.

9.3.4 The resulting AADT traffic forecasts for the Core, High and Low growth scenarios are presented in **Table 9.3** for 2041. For comparative purposes, the Without Scheme Core values are also shown.

TABLE 9.3 - ROUTE 3 LOW, CORE AND HIGH GROWTH RIVER CROSSING TRAFFIC FORECASTS IN 2041

Crossing	Without Scheme Core	Route 3 Low	Route 3 Core	Route 3 High
Dartford Crossing	163,300	139,800	151,500	158,500
LTC Route 3	-	83,500	89,600	95,800
Total	163,300	223,300	241,100	254,300
% growth over Without Scheme	-	+37%	+48%	+56%

9.3.5 The resulting impacts on the benefits for the Route 3 option are given in **Table 9.4**. It has been assumed that the construction costs, which allow for a third lane in each tunnel bore at the crossing for future-proofing provision (refer to **Section 9.2**), are the same for Low and High growth scenarios as those for the Core scenario. This is because the scheme engineering configuration and construction will be identical in all three scenarios (para 4.2.10 of WebTAG Unit M4 refers).

9.3.6 Changes in charge revenue also impact the overall PVC and these will impact the BCR. Only the Initial BCR is presented in Table 9.4 because the effect on the wider economic benefits has not been assessed for the high and low growth.

9.3.7 However conservative estimates of the impact of the Low and High growth scenarios on the Adjusted BCR can be made by assuming that in both scenarios Route 3 only secures WEBs benefits in line with those estimated for Route 1 of £0.737bn (refer to Table 7.1). This would increase the

Adjusted BCR to 1.9 (Medium Value for Money) in the Low Growth scenario and to 3.3 (High Value for Money) in the High Growth scenario.

TABLE 9.4 - ESTIMATED LOW, CORE AND HIGH GROWTH BENEFITS FOR ROUTE 3/ ESL

	Route 3 Low	Route 3 Core	Route 3 High
Present Value of Benefits (PVB) £ billions	2.56	3.86	4.48
Present value of costs (PVC) £ billions	1.72	1.66	1.58
Net Present Value (NPV) £ billions	0.84	2.20	2.90
Initial BCR	1.5	2.3	2.8
VfM category	Medium	High	High

Conclusion

9.3.8 If low growth occurs the benefits fall by 34% and the Initial BCR would reduce from 2.3 (representing High Value for Money) to 1.5 (Medium value for Money). It is likely that the inclusion of Wider Economic Benefits would result in an Adjusted BCR of 1.9 (Medium Value for Money).

9.3.9 In the case of the high growth scenario, the benefits would increase by 16% and the Initial BCR would increase from 2.3 to 2.8 and remain High Value for Money. The inclusion of Wider Economic Benefits would increase the Adjusted BCR to 3.3.

9.4 New Values of Time

9.4.1 As part of its work to enhance the transport appraisal framework, DfT published a report on 29th October 2015 on values of travel time savings, *Understanding and Valuing Impacts of Transport Investment*. The report contains the results of research into the value of time and proposes some new values that DfT plans to implement within WebTAG for all scheme appraisals. The report also seeks stakeholders' views on the proposed values and DfT's response to these views is to be published in spring 2016 before the new values are confirmed.

9.4.2 Travel time savings are a key source of economic benefits for Lower Thames Crossing and changes to these values directly affect the Benefit Cost Ratio and value for money assessment of the scheme. A sensitivity test has therefore been carried out to consider the effects on economic benefits of the new values of time on the assessment of the scheme. The test was carried out for Route 3 (with Eastern Southern Link and Dual 2 lane bored tunnel crossing provision).

9.4.3 The proposed changes to the values of time are:

- The value for commuting increases from £6.81 to £10.01
- The values for business car users, which were £27.06 for drivers and £20.52 for passengers, are now split by distance bands:
  - £10.08 for trips between 0 to 50km
  - £16.30 for trips between 50km and 100km
  - £25.12 for trips over 100km

9.4.4 The proposed values have been implemented within the LTC appraisal in two ways:

- By using the proposed values and applying equivalent pence per minute (PPM) and pence per kilometre values (PPK) to different user classes within the traffic model to test the behavioural response of drivers to the new values.
- By applying the proposed values within the TUBA appraisal software tool that calculates the monetary value of time savings in the traffic model.

9.4.5 A key issue in carrying out the sensitivity test is that the LTC traffic model (like nearly all traffic models) does not segment business travel demand by distance bands. Therefore, following discussions with the DfT, an average car business value of £16.30 was selected in both the traffic model and TUBA.

9.4.6 **Table 9.5** shows that the result of this sensitivity test is that the benefits reduce by £0.543 billion from £3.856 billion down to £3.313 billion. Using central (most likely) capital costs, the Initial BCR falls from 2.7 to 2.3 and the Adjusted BCR falls from 3.9 to 3.5.

TABLE 9.5 - VALUE OF TIME SENSITIVITY TEST RESULTS

	Route 3 current values of time	Route 3 new values of time
Present value of benefits (£bn)	3.856	3.313
Reduction in benefits (%)	-	14%
Initial BCR	2.7	2.3
Adjusted BCR	3.9	3.5

Conclusion

9.4.7 Route 3 remains High Value for Money based on the Initial BCR and Adjusted BCR.

10 Summary of Conclusions

Introduction

10.1.1 This section summarises the conclusions from the traffic appraisal, economic appraisal and social impact appraisal and presents the BCRs.

Traffic appraisal

10.1.2 Location C would improve the overall connectively of the road network across the River Thames, releasing suppressed trips in the existing crossing corridor and inducing new trips from proposed developments to the east of Dartford. Location C also provides the most congestion relief to the existing crossing, a key objective of LTC, as well as providing substantial relief to the A2, M20 and A13. Although Location A would allow more traffic to access the existing crossing corridor, other areas of congestion on the M25 and its feeder routes such as the A13, A2 and M20 will become evident over time.

10.1.3 Future travel times for journeys using the existing crossing are likely to remain unchanged, particularly for northbound traffic where the existing Dartford tunnels will continue to limit speeds and traffic volumes due to capacity constraints. As expected, the catchment for a crossing at Location A is similar to the catchment of the existing crossing. Location C attracts trips with origins and destinations in Essex, East Anglia and Kent. With a 70mph speed limit, Location C offers 12% more capacity than a new crossing at Location A, which would continue to have a speed limit of 50mph.

10.1.4 The choice of WSL or ESL has little impact on the predicted traffic volumes across the River Thames, either on the existing crossing or the new crossing. ESL offers greater relief to the A2/ M20 than WSL but attracts additional traffic to the M2 by providing a quicker free-flow link over the River Thames.

10.1.5 Routes 2, 3 and 4 (with ESL) are predicted to:

- Carry similar volumes of traffic
- Provide the same relief to the existing crossing
- Result in broadly the same predicted travel times across the River Thames

10.1.6 Route 3 is expected to attract slightly more traffic to the new crossing thereby offering the most relief to the A2 and A13 and attracts the lowest levels of additional traffic to the M2.

Economic appraisal

10.1.7 User and Provider benefits, driven largely by travel time savings, account for most of the direct benefits across all seven route options. These benefits for Location C route options range from £3.13 billion for Route 3 with WSL to £3.67 billion for Route 3 with ESL. These benefits for Route 1 are £1.94 billion.

10.1.8 Disbenefits for users from delays during construction for Route 1 are valued at £290 million. The impact as a result of Route 3 with ESL is just £26 million

and the disbenefits due to the other route options are likely to be similarly small. These impacts have not been appraised for other routes but are expected to be much smaller. Other economic impacts contribute smaller levels of benefits for all route options.

10.1.9 Direct benefits for all options are fairly similar and fall within the range £3.30 billion (Route 3 with WSL) to £3.86 billion (Route 3 with ESL) except for Route 1 where direct benefits are £2 billion.

10.1.10 Route 1 has the lowest total scheme cost at £1.8 billion, but also generates the least revenue from user charges. The costs for Routes 2, 3 and 4 with WSL and ESL fall between £2.2 billion and £2.5 billion. The operating costs for Route 1 (with a bridge) are much lower than those for Routes 2, 3 and 4 (with a bored tunnel).

10.1.11 Revenues for Route 1 are approximately £600 million, whilst revenues for the Location C routes are around £825 million.

10.1.12 Route 3 with ESL provides £556 million in extra direct benefits compared to Route 3 with WSL. This differential between ESL and WSL falls to £484m for Route 4 and £261m for Route 2. However the ESL costs are on average about £100m more than WSL for each of Routes 2, 3 and 4.

10.1.13 WEBs benefits range from £0.74 billion (Route 1) to £1.74 billion (Route 4 with ESL) and their inclusion increases the total benefits of the routes by between 37 and 50 per cent. On average journey time reliability impacts add a further £144 million to the benefits of the routes across all options.

Social impact appraisal

10.1.14 Based on the appraisal of accidents using DfT's COBALT appraisal tool, accidents are likely to increase on all routes as a result of the greater traffic flows caused by the scheme. Route 1 is forecast to have the lowest increase in casualties compared to Routes 2, 3 and 4.

10.1.15 At this stage the route options do not include provision for non-motorised users. Therefore the routes have been assessed as having no impacts on physical activity.

10.1.16 All of the route options would impact on severance. The impact of Route 1 is likely to be smaller compared to the impact of Routes 2, 3 and 4.

10.1.17 In terms of journey quality impacts, Route 1 has a Neutral impact whilst Routes 2, 3 and 4 have been assessed as Moderately Beneficial.

10.1.18 Security impacts have only been assessed at a very high level at this stage in the scheme. Overall the impacts on security at Route 1 were considered to be Neutral and for Routes 2, 3 and 4 have been assessed as Slight Adverse.

Benefit Cost Ratios

10.1.19 Route 3 with Eastern Southern Link and a bored tunnel has the highest Initial BCR of 2.7 representing High Value for Money (refer to **Table 10.1**). All of the other routes at Location C with a bored tunnel have Initial BCRs over 2.0 and, based on DfT's Value for Money categories, represent High Value for

Money. Route 1 with a bridge has an Initial BCR of 1.6 and represents Medium Value for Money.

10.1.20 Route 3 with ESL and a bored tunnel has the highest Adjusted BCR of 3.9 representing High Value for Money. All of the other routes have Adjusted BCRs over 2.0 and also represent High Value for Money.

10.1.21 The Initial and Adjusted BCRs for Routes 2, 3 and 4 with ESL all exceed those for Routes 2, 3 and 4 with WSL.

TABLE 10.1 - APPRAISAL RESULTS FOR SHORTLIST ROUTE OPTIONS (EXCLUDING THIRD LANE AT LOCATION C CROSSING)

PVB (£bn) 2010 prices	R1	R2 WSL	R2 ESL	R3 WSL	R3 ESL	R4 WSL	R4 ESL
Crossing type	BR	BT	BT	BT	BT	BT	BT
PVB (excl WEBs & Reliability) (£bn)	1.995	3.483	3.745	3.300	3.856	3.353	3.837
PVC (£bn) based on P50 costs	1.222	1.370	1.464	1.354	1.447	1.548	1.649
NPV (£bn)	0.773	2.114	2.280	1.947	2.409	1.805	2.188
Initial BCR	1.6	2.5	2.6	2.4	2.7	2.2	2.3
WEBs (£bn)	0.737	1.264	1.626	1.353	1.677	1.678	1.735
Reliability (£bn)	0.135	0.142	0.146	0.143	0.147	0.146	0.150
Adjusted BCR	2.3	3.6	3.8	3.5	3.9	3.3	3.5

Sensitivity tests

10.1.22 Three sensitivity tests have been carried out to assess the robustness of the appraisal results to changes in key parameters. The tests carried out assessed the impact of:

- Dual 3 lane provision in the tunnel using estimates of most likely and high scheme costs.
- High and Low Traffic Growth based on high and low national economic growth. The BCRs were based on most likely scheme costs for Dual 3 provision in the tunnel.
- New Values of Time. The BCRs were based on most likely costs for Dual 2 provision.

10.1.23 The extra out-turn cost to provide a crossing with Dual 3 lane provision in the tunnel is estimated to be in the range of £0.17bn to £0.50bn. The impact of this is that the Adjusted BCR will range between 2.9 and 3.4 based on most likely scheme costs.

10.1.24 If Low national economic growth occurs the scheme benefits fall by 34%. Based on the costs of Dual 3 provision in the tunnel, the Initial BCR would reduce from 2.3 (representing High Value for Money) down to 1.5 (Medium Value for Money). In the case of the High growth scenario, the benefits

would increase by 16% and the Initial BCR would increase from 2.3 to 2.8 (both High Value for Money).

10.1.25 The value of time test assumed Dual 2 lane provision. The impact of the new values of time is that the scheme benefits fall by £0.543 billion from £3.856 billion down to £3.313 billion. Using central (most likely) capital costs, the Initial BCR falls from 2.7 to 2.3 and the Adjusted BCR falls from 3.9 to 3.5.

10.1.26 These tests demonstrate that the BCRs and Value for Money assessments are robust to the provision of Dual 3 lanes in the tunnel, the impact on traffic levels of High and Low national economic growth and new lower values of time.

11 References

Title	Document number
Review of Lower Thames Crossing Options: Final Review Report	DfT
Appraisal Specification Report	HA540039-HHJ-ZZZ-REP-TRA-012

12 Abbreviations and Glossary

Abbreviation	Description
2025 Opening year	A modelled year in the LTC traffic model in which flows are estimated for each option
2041 Design year	A modelled year in the LTC traffic model. The design year is typically 15 years after opening, but for LTC 2041, 16 years after opening, was assessed as it is the maximum horizon year for current growth assumptions. Traffic flows are estimated for each option.
AADT	Average Annual Daily Traffic
AECOM	AECOM Technology Corporation
Affected Road Network	This comprises the area within which roads could be considered within the air quality model (selection of the roads within the model depends upon a number of criteria such as changes in Heavy Duty Vehicle flows).
Alignment	The alignment is the horizontal and vertical route of a road, defined as a series of horizontal tangents and curves or vertical crest and sag curves, and the gradients connecting them.
AM	07:00 to 10:00
AMCB	Analysis of monetary costs and benefits
AMI	Advanced Motorway Indicator, with optical feedback for enforcement.
ANPR	Automated Number Plate Recognition
AOD	Above ordnance datum, vertical datum used by an ordnance survey as the basis for delivering altitudes on maps.
AONB	Area of Outstanding Natural Beauty: Statutory designation intended to conserve and enhance the ecology, natural heritage and landscape value of an area of countryside.
APS	Annual Population Survey
APTR	All-purpose trunk road
AQMA	Air Quality Management Area: an area, declared by a local authority, where air quality monitoring does not meet Defra's national air quality objectives.
AQSO	Air Quality Strategy Objective: Objective set by the Air Quality Strategy for England, Scotland, Wales and Northern Ireland to improve air quality in the UK in the medium term. Objectives are focused on the main air pollutants to protect health.
Armour	Riprap - also known as rip rap, rip-rap, shot rock, rock armour or rubble - is rock or other material used to armour shorelines, streambeds, bridge abutments, pilings and other shoreline structures against scour, water or ice erosion.
ASC	Asset Support Contract(or)
AST	Appraisal Summary Table; a summary of impacts of introducing new infrastructure, setting out impacts using a structured set or economic, social and environmental measures.

AURN	Defra's Automatic Rural and Urban Network: the UK's largest automatic monitoring network and the main network used for compliance reporting against the Ambient Air Quality Directives.
BAP	Biodiversity Action Plan: National, local and sector-specific plans established under the UK Biodiversity Action Plan, with the intention of securing the conservation and sustainable use of biodiversity.
Batter slope	In construction is a receding slope of a wall, structure, or earthwork. The term is used with buildings and non-building structures to identify when a wall is intentionally built with an inward slope.
BCR	Benefit-Cost Ratio, the net benefit of a scheme divided by the net cost to Government. The ratio of present value of benefits (PVB) to present value of costs (PVC), an indication of value for money.
BGS	British Geological Survey: a partly publicly funded body which aims to advance geoscientific knowledge of the United Kingdom landmass and its continental shelf by means of systematic surveying, monitoring and research.
Bluewater	Bluewater Shopping Centre, an out of town shopping centre in Stone, Kent, outside the M25 Orbital motorway, 17.8 miles (28.6 km) east south east of London's centre.
BMS	Bridge Management System
BR	Bridge (when used as part of a LTC shortlist Route reference) Bridleway
BT	Bored tunnel
BTO	British Trust for Ornithology: an organisation founded in 1932 for the study of birds in the British Isles.
Capex	Capital expenditure, the cost of developing or providing non-consumable parts of the product or system.
Catchpit chamber	Catchpits are a precast concrete drainage product that are recommended for use as a filter and collector in land drainage systems that do not make use of any sort of geo-membrane. A catchpit is essentially an empty chamber with an inlet pipe and an outlet pipe set at a level above the floor of the pit. Any sediment carried by the system settles out whilst in the catchpit, from where it can be periodically pumped out or removed
CCTV	Closed-circuit television. Highways England CCTV cameras are used to monitor traffic flows on the English motorway and trunk road network primarily for the purposes of traffic management.
CDA	Critical Drainage Area(s): As defined in the Town and Country Planning (General Development Procedure) (Amendment) (No. 2) (England) Order 2006 a Critical Drainage Area is "an area within Flood Zone 1 which has critical drainage problems and which has been notified… [to]…the local planning authority by the Environment Agency".
CESS	Highways England Commercial Services Division Cost Estimation Summary Spreadsheet
CFMP	Catchment Flood Management Plan: A strategic planning tool through which the Environment Agency works with other key decision-makers within a river catchment to identify and agree policies for sustainable flood risk management.
Chart Datum	The level of water from which charted depths displayed on a nautical chart are measured.
CKD	Combined kerb drain(s): a combined kerb and drainage system.
CO2e	Carbon dioxide equivalent; a standard unit for measuring carbon footprints. The idea is to express the impact of each different greenhouse gas in terms of the amount of CO2 that would create the same amount of warming.
COBALT	New 'light touch' version of COBA, COst Benefit Analysis computer program, DfT's tool for estimating accident benefits. The COBA program compares the costs of providing road schemes with the benefits derived by road users
Connect Plus	Connect Plus (M25) Ltd, management company for the Dartford-Thurrock Crossing.
CRM	Customer relationship management
C.RO Ports	C.RO is the brand name for the subsidiaries of C.RO Ports SA that operate ro-ro terminals in the UK, the Netherlands and Belgium.

CSR	Client Scheme Requirements
D2AP	Dual two-lane all-purpose road
Dart Charge	The Dartford Crossing free-flow electronic number plate recognition charging system (operates between 0600 and 2200).
Dartford Cable Tunnel	An £11m tunnel upstream of the Dartford Crossing, built in 2003-4, whose diameter is ~3m. It is designed to carry and allow for maintenance of 380kV National Grid electrical cable beneath the River Thames.
DBFO	Design, build, finance, operate: a way of creating "public–private partnerships" (PPPs) by funding public infrastructure projects with private capital.
DCC	Dartford Crossing Control Centre
DCO	Development Consent Order
Defra	Department for Environment, Food and Rural Affairs: the government department responsible for environmental protection, food production and standards, agriculture, fisheries and rural communities in the United Kingdom of Great Britain and Northern Ireland.
Deneholes	An underground structure consisting of a number of small chalk caves entered by a vertical shaft.
DFFC	Dartford Free Flow Crossing (tollbooths removed)
DfT	Department for Transport: 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.
DGV	Dangerous goods vehicle
DI	Distributional Impact
Disbenefit	A disadvantage or loss resulting from something.
DMRB	Design Manual for Roads and Bridges: A comprehensive manual (comprising 15 volumes) which contains requirements, advice and other published documents relating to works on motorway and all-purpose trunk roads for which one of the Overseeing Organisations (Highways England, Transport Scotland, The Welsh Government or the Department for Regional Development (Northern Ireland)) is highway authority. The DMRB has been developed as a series of documents published by the Overseeing Organisations of England, Scotland, Wales and Northern Ireland. For the Lower Thames Crossing the Overseeing Organisation is Highways England.
DP World	Dubai Ports World, London Gateway Port
DRCC	Dartford River Crossing Control Centre
DVS	DVS Property Specialists, the specialist property arm of the Valuation Office Agency (VOA).
DWT	Deadweight tonnage, a measure of how much weight a ship is carrying or can safely carry.
EA	Environment Agency: The Environment Agency was established under the Environment Act 1995, and is a Non-Departmental Public Body of Defra. The Environment Agency is the leading public body for protecting and improving the environment in England and Wales. The organisation is responsible for wide-ranging matters, including the management of all forms of flood risk, water resources, water quality, waste regulation, pollution control, inland fisheries, recreation, conservation and navigation of inland waterways.
EB	eastbound
ELHAM	TfL's East London Highway Assignment Model
EMME	Equilibre Multimodal, Multimodal Equilibrium, a complete travel demand modelling system for urban, regional and national transportation forecasting.
EMMEBANK	Neue Emme Bank Vorm.Amtsersparniskasse Burgdorf company research & investing information
ERA	Emergency Refuge Area: on roads for use in emergency or breakdown only, located approximately every 800 metres and separated from the main carriageway.
ERT	Emergency roadside telephone(s)

ESL - Eastern Southern Link	The Eastern Southern Link (ESL) is an alternative for shortlist Routes 2, 3 and 4 to the south of the River Thames. The route would connect into Junction 1 of the M2 and would pass to the east of Shorne and then northwest towards Church Lane and Lower Higham Road. This route could connect into any of the Routes 2, 3 and 4 north of the river utilising all of the crossing options for these route options.
EU	European Union: A politico-economic union of 28 member states that are located primarily in Europe.
Fastrack	A bus rapid transit scheme operating in the Thames Gateway area of Kent, operated by Arriva Southern Counties.
FP	Footpath
FSA	Flood Storage Area: a natural or man-made area basin that temporarily fills with water during periods of high river levels.
FWI	Fatalities and Weighted Injuries: a statistical measurement of all non-fatal injuries added-up using a weighting factor to produce a total number of 'fatality equivalents'.
GDP	Gross Domestic Product
GIS	Geographic information system: an integrated collection of computer software and data used to view and manage information about geographic places, analyse spatial relationships, and model spatial processes.
GVA	Gross Value Added
Ha	Hectares
HADECS	Highways England Digital Enforcement Camera System
HAGDMS	Highways England Geotechnical Data Management System
HAM	TfL's Highway Assignment Model
Hanson	Hanson UK, part of the HeidelbergCement Group.
HATO	Highways Agency Traffic Officer
HATRIS	Highways England journey time database
HGV	Heavy Goods Vehicle
HHJV	Halcrow Hyder Joint Venture: a joint venture between Halcrow Group Limited and Hyder Consulting Limited.
HRA	Habitats Regulations Assessment: A tool developed by the European Commission to help competent authorities (as defined in the Habitats Regulations) to carry out assessment to ensure that a project, plan or policy will not have an adverse effect on the integrity of any Natura 2000 or European sites (Special Areas of Conservation, Special Protection Areas and Ramsar sites), (either in isolation or in combination with other plans and projects), and to begin to identify appropriate mitigation strategies where such effects were identified.
HS1	High Speed 1 rail line (formerly Channel Tunnel Rail Link (CTRL))
IAN	Interim Advice Notice: Issued by Highways England from time to time. They contain specific guidance, which should only be used in connection with works on motorways and trunk roads in England.
Inter-peak	10:00 to 16:00
IP	Internet Protocol
IT	Immersed tunnel
ITS	Intelligent Transportation System
Jacked box tunnelling	Jacked box tunnelling is a method of construction that enables engineers to create underground space at shallow depth in a manner that avoids disruption of valuable infrastructure and reduces impact on the human environment.
KMEP	Kent and Medway Economic Partnership
Lafarge Tarmac	Lafarge Tarmac Limited is a British building materials company headquartered in Solihull, Birmingham.

Lakeside	Lakeside Shopping Centre, branded as Intu Lakeside, is a large out-of-town shopping centre located in West Thurrock, in the borough of Thurrock, Essex just beyond the eastern boundary of Greater London.
LATS	London Area Transport Surveys
LCS	Lane Control Signs
LDP	London Distribution Park: offers 70 acres (28Ha) of land for industrial and logistics development 6.5 miles from the M25, adjacent to Port of Tilbury, London.
LGV	Light Goods Vehicle
Location A	The location for LTC route options close to the existing Dartford crossing.
Location C	The location for LTC route options connecting the A2/ M2 east of Gravesend with the A13 and M25 (between Junctions 29 and 30) north of the River Thames.
Location C Variant	As for options at Locations C and A with additional widening of the A229 between the M2 and the M20.
London Gateway	A new deep-water port, able to handle the biggest container ships in the world, and part the London Gateway development on the north bank of the River Thames in Thurrock, Essex, 20 miles (32 km) east of central London.
LPER	refer to Paramount London
LTC	Lower Thames Crossing: a proposed new crossing of the Thames estuary linking the county of Kent with the county of Essex, at or east of the existing Dartford Crossing.
LTS railway	London Tilbury Southend railway
LWS	Local wildlife site
Mainline	The through carriageway of a road as opposed to a slip road or a link road at a junction
Mardyke	A small river, mainly in Thurrock, that flows into the River Thames at Purfleet, close to the QEII Bridge.
MIDAS	Motorway Incident Detection and Automatic Signalling
MMO	Marine Management Organisation: An executive non-departmental public body in the UK established under the Marine and Coastal Access Act 2009. The MMO exists to make a significant contribution to sustainable development in the marine area, and to promote the UK government's vision for clean, healthy, safe, productive and biologically diverse oceans and seas.
MS4	The latest generation of Variable Message Signs designed to display both pictograms and text; uses internationally recognised warning symbols and provides a dual colour display matrix for amber and red coloured characters or symbols.
MTM	Medway Traffic Model
NB	northbound
NCR	National Cycle Route: a cycle route part of the National Cycle Network created by Sustrans to encourage cycling throughout Britain.
NDD	Highways England Network Development Directorate
NIA	Noise-important area(s): Defra published noise maps for England's roads in 2008, with the noise action plans following 2 years later in 2010. The action plans set out a framework for managing noise, rather than propose specific mitigation measures, and were designed to identify 'Important Areas' that are impacted by noise from major sources and therefore must be investigated. NIAs are where the 1% of the population that are affected by the highest noise levels from major roads are located, according to the results of Defra's strategic noise maps.
NMU	Non-motorised user, e.g. pedestrians, cyclists, equestrians.
NO2/ NO_2	Nitrogen dioxide
NPPF	National Planning Policy Framework: published in March 2012 by the UK's Department of Communities and Local Government, consolidating over two dozen previously issued documents called Planning Policy Statements (PPS) and Planning Policy Guidance Notes (PPG) for use in England.

NPS	National Policy Statement (refer to NPSNN)
NPSNN	National Policy Statement for Networks National: The NPSNN sets out the need for, and Government's policies to deliver, development of nationally significant infrastructure projects on the national road and rail networks in England. It provides planning guidance for promoters of nationally significant infrastructure projects on the road and rail networks, and the basis for the examination by the Examining Authority and decisions by the Secretary of State.
NSIP	Nationally significant infrastructure project: major infrastructure developments in England and Wales, such as proposals for power plants, large renewable energy projects, new airports and airport extensions, major road projects etc.
NPV	Net present value, a measure of the total impact of a scheme upon society, in monetary terms, expressed in 2010 prices.
NRTS	National Roads Telecommunications Services
NTCC	National Technology Control Centre: based in the West Midlands, the NTCC is an ambitious telematics project aimed at providing free, real-time information on England's network of motorways and trunk roads to road users, allowing them to plan routes and avoid congested areas.
NTEM	DfT's National Trip End Model
NTS	National Transport Survey
O&M	Operations and Maintenance
OD	Origin-destination: origin-destination data (also known as flow data) includes the travel-to-work and migration patterns of individuals, cross-tabulated by variables of interest (for example occupation).
ONS	Office for National Statistics: the executive office of the UK Statistics Authority, a non-ministerial department which reports directly to the UK Parliament.
Opex	An operating expense or operating expenditure or operational expense or operational expenditure: an ongoing cost for running a product, business or system.
Orifice plate	A device used for measuring flow rate, for reducing pressure or for restricting flow (in the latter two cases it is often called a restriction plate). Either a volumetric or mass flow rate may be determined, depending on the calculation associated with the orifice plate.
Orthotropic steel deck plate	An orthotropic bridge or orthotropic deck is one whose deck typically comprises a structural steel deck plate stiffened either longitudinally or transversely, or in both directions. This allows the deck both to directly bear vehicular loads and to contribute to the bridge structure's overall load-bearing behaviour. The orthotropic deck may be integral with or supported on a grid of deck framing members such as floor beams and girders.
PA	Public accounts Public address
PACTS	Parliamentary Advisory Council for Transport Safety: a registered charity and an All-party parliamentary group of the UK parliament. Its charitable objective is to protect human life through the promotion of transport safety for the public benefit.
PA metrics	Production and attraction metrics
Paramount Park, London	London Paramount Entertainment Resort (LPER). A proposed theme park and entertainment precinct on the Swanscombe peninsula, Kent. Construction could begin in autumn 2016 with the opening estimated for Easter 2021.
PCF	Highways England Project Control Framework process.
PCM	Pollution Climate Model
pcu	passenger car units. This is a metric to allow different vehicle types within traffic flows in a traffic model to be assessed in a consistent manner. Typical pcu factors are: 1 for a car or light goods vehicle; 2 for a bus of heavy goods vehicle; 0.4 for a motorcycle; and 0.2 for a pedal cycle.
Peel Ports	Britain's second largest group of ports, part of the Peel Group.

Penstock	A sluice or gate or intake structure that controls water flow, or an enclosed pipe that delivers water to hydro turbines and sewerage systems. It is a term that has been inherited from the earlier technology of mill ponds and watermills.
PIA	Personal Injury(ies) Accident(s)
PLA	Port of London Authority: a self-funding public trust established by The Port of London Act 1908 to govern the Port of London. Its responsibility extends over the Tideway of the River Thames and its continuation (the Kent/ Essex strait). It maintains and supervises navigation, and protects the river's environment.
PM	16:00 to 19:00
PM_{10}	Particulate matter (in this example, particulates smaller than 10µm that can cause health problems).
PRoW	Public Right of Way: A right possessed by the public, to pass along routes over land at all times. Although the land may be owned by a private individual, the public may still gain access across that land along a specific route. The mode of transport allowed differs according to the type of public right of way which consist of footpaths, bridleways and open and restricted byways.
pSPA	Potential Special Protection Area: Sites which are approved by Government that are in the process of being classified as Special Protection Areas.
PSSR	Preliminary Sources Study Report
PTSD	Highways England Professional and Technical Services Division
PV	Present Values
PVB	Present value of benefits: PVBs less PVCs provide estimates of Net Present Values (NPVs) and the ratio of the PVB to the PVC constitutes the BCR.
PVC	Present value of costs: a measure of the monetary cost of a scheme, less revenues, discounted to and expressed in 2010 prices.
QEII Bridge	Queen Elizabeth ll Bridge, part of the Dartford-Thurrock crossing.
QUADRO	QUeues And Delays at ROadworks computer program: a Highways England sponsored computer program maintained and distributed by TRL Software; its primary use is in rural areas. It estimates the effects of roadworks in terms of time, vehicle operating and accident costs on the users of the road. Individual roadworks jobs can be combined to produce the total cost of maintaining the road over time.
RADAR	Radar is an object-detection system that uses radio waves to determine the range, angle, or velocity of objects, including motor vehicles.
Ramsar site	A wetland of international importance, designated under the Ramsar convention.
RCC	Regional Control Centre
RET	Range Estimation Tool
RFID	Radio-frequency identification, the wireless use of electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The tags contain electronically stored information.
rMCZ	Recommended Marine Conservation Zone: A site put forward for designation under the Marine and Coastal Access Act 2009 to conserve the diversity of nationally rare, threatened and representative habitats and species.
RSPB	Royal Society for the Protection of Birds: A charitable organisation that works to promote conservation and protection of birds and the wider environment through public awareness campaigns, petitions and through the operation of nature reserves throughout the United Kingdom.
RTMC	Regional Technology Maintenance Contract(or)
RTC	Road traffic collision
RWE npower	A leading integrated UK energy company.
SAC	Special Area of Conservation: defined in the European Union's Habitats Directive (92/43/EEC), also known as the *Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora*. SACs are to protect the 220 habitats and approximately 1000

	species listed in annex I and II of the directive which are considered to be of European interest following criteria given in the directive.
SANEF	Société des Autoroutes du Nord et de l'Est de la France, a motorway operator company.
SAP	LTC Stakeholder Advisory Panel: comprises key local authority stakeholders to share local knowledge, their needs, priorities and opinions with respect to LTC. SAP meetings have been held at key stages of the LTC project; bi-lateral meetings with SAP members have also been held.
SAR	HHJV's Pre-Consultation Scheme Assessment Report of the Lower Thames Crossing.
SATURN	Simulation and Assignment of Traffic to Urban Road Networks, Transport Model
SCADA	Supervisory Control and Data Acquisition
S-CGE	Spatial Compatible General Equilibrium
SEB(s)	Statutory Environmental Body(ies): Any principal council as defined in subsection (1) of section 270 of the Local Government Act 1982 for the area where the land is situated. Where the land is situated in England; Natural England, Historic England, the Environment Agency, Natural Resources Wales and the National Assembly for Wales where, in the opinion of the Secretary of State, the land is sufficiently near to Wales to be of interest to them and any other public authority which has environmental responsibilities and which the Secretary of State considers likely to have an interest in the project.
SELEP	South East Local Enterprise Partnership: the business-led, public/ private body established to drive economic growth across East Sussex, Essex, Kent, Medway, Southend and Thurrock.
Setting	This is defined in the National Planning Policy Framework as 'The surroundings in which a heritage asset is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve. Elements of a setting may make a positive or negative contribution to the significance of the asset, may affect the ability to appreciate that significance or may be neutral.'
SGAR	Stage Gateway Assessment Review: part of Highways England Project Control Framework (PCF) process.
Shortlist Route 1	A new trunk road connecting M25 Junction 2 to M25 Junction 30, with a new 4 lane bridge crossing or a 4 lane twin-bored tunnel to the west of Dartford crossing, with significant improvements to Junctions 30 and 31. Smart Motorway Technology is to be implemented from Junction 2 to 1b (with no widening) and Junction 1b to 1a (with widening to dual 5 lanes).
Shortlist Route 2	A new trunk road connecting A2 (2 km east of Gravesend) to M25 between Junctions 29 and 30, using A1089 (upgrading), with dual 2 lane crossing option of a bridge / twin-bored tunnel / immersed tunnel. Refer also to Eastern Southern Link and Western Southern Link.
Shortlist Route 3	A new trunk road connecting the A2 (2 km east of Gravesend) to the M25 (between Junctions 29 and 30), with dual 2 lane crossing option of a bridge / twin-bored tunnel / immersed tunnel. Junction with the A13 at the existing junction with the A13 and A1089 and a junction with Brentwood Road, with Brentwood Road upgraded to dual 2 lane to Orsett Cock interchange. Refer also to Eastern Southern Link and Western Southern Link.
Shortlist Route 4	A new trunk road connecting A2 (2 km east of Gravesend) to M25 at Junction 29, using A127 (upgrading), with dual 2 lane crossing option of a bridge / twin-bored tunnel / immersed tunnel. Single carriageway road provided from B186 to A128 parallel with the A127. Refer also to Eastern Southern Link and Western Southern Link.
SIA	Social Impact Appraisal
Skills Level 4	Equates to a Certificate of Higher Education, Key Skills Level 4, NVQ Level 4, BTEC Professional award, certificate and diploma Level 4, and HNC.
Smart motorway	Term for a range of types of actively controlled motorway, using technology to optimise use of the carriageway including the hard shoulder.
SPA	Special Protection Area: A designation under the European Union Directive on the Conservation of Wild Birds.
SPECS	Average Speed Enforcement Camera System

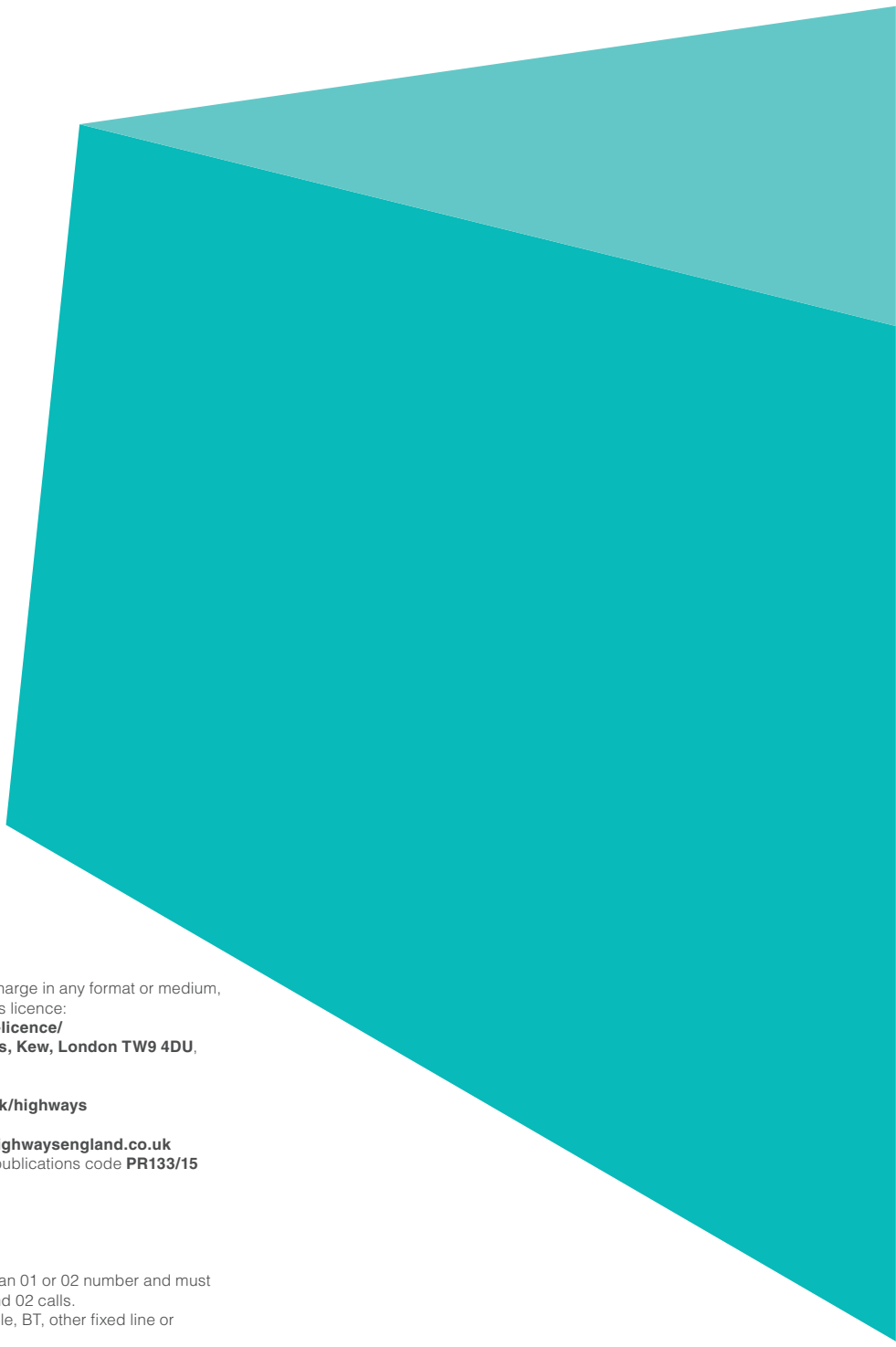
SPZ	Source protection zone: EA-defined groundwater sources (2000) such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area.
SRN	Strategic Road Network, the core road network, managed in England by Highways England.
SSSI	Site of Special Scientific Interest: A conservation designation denoting an area of particular ecological or geological importance.
SuDS	A sustainable drainage system designed to reduce the potential impact of new and existing developments with respect to surface water drainage discharges.
SWMP	Surface Water Management Plan: Plan to provide sufficient information to support the development of an agreed strategic approach to the management of surface water flood risk within a given geographical area by ensuring the most sustainable measures are identified.
TAG	Transport Analysis Guidance: national guidance document produced by the Department for Transport.
TAR	HHJV's Technical Appraisal Report of the Lower Thames Crossing.
TBM	Tunnel boring machine, machine used to excavate tunnels with a circular cross section.
TDSCG	Tunnel Design and Safety Consultation Group: formed to ensure effective design, construction and operation within the context of safety.
TE2100	EA's Thames Estuary 2100 project (formed November 2012) to develop a comprehensive action plan to manage flood risk for the Tidal Thames from Teddington in West London, through to Sheerness and Shoeburyness in Kent and Essex.
TEE	Transport Economic Efficiency (economic efficiency of the transport system)
TfL	Transport for London: created in 2000, the integrated body responsible for London's transport system.
TM	Highways England's Traffic Management (directorate)
TMC	Traffic Management Cell
TRADS	Traffic Flow Data System (holds information on traffic flows at sites on the network)
TRRL	Transport and Road Research Laboratory (now TRL Ltd): a fully independent private company offering a transport consultancy and research service to the public and private sector. Originally established in 1933 by the UK Government as the Road Research Laboratory (RRL), it was privatised in 1996.
TTMS	Temporary Traffic Management Signs
TUBA	Transport Users Benefit Appraisal (DfT economic appraisal software tool)
UPS	Uninterruptible power supply
Urban All Purpose	A road in an urban area designed for all types of traffic in accordance to the relevant DMRB Standards.
V/C	Volume over Capacity (volume/capacity)
VMS	Variable Message Sign, typically mounted on a portal gantry.
VMSL	Variable Mandatory Speed Limits
Vopak	Royal Vopak N.V. is a Dutch company that stores and handles various oil and natural gas-related products.
Vortex separator/ device	A vortex separator is a device for effective removal of sediment, litter and oil from surface water runoff.
vpd	Vehicles per day
WASHMS	Wind and Structural Health Monitoring System: the process of implementing a damage detection and characterisation strategy for engineering structures.
WB	westbound
WEBs	Wider economic benefits

WebTAG	Department for Transport's web-based multi-modal guidance on appraising transport projects and proposals.
WFD	Water Framework Directive: A European Community Directive (2000/60/EC) of the European Parliament and council designed to integrate the way water bodies are managed across Europe.
WI	Wider Impacts, land use-related economic consequences of transport interventions, not directly related to impacts on users of the transport network, such as increased productivity.
Without Scheme/ With Scheme	Without Scheme: The scenario where government takes the minimum amount of action necessary and is used as a benchmark in the appraisal of options. With Scheme: An option that provides enhanced services by comparison to the benchmark Without Scheme scenario.
WSL - Western Southern Link	The Western Southern Link (WSL) is an alternative for shortlist Routes 2, 3 and 4 to the south of the River Thames. The route would connect into the A2 to the east of Gravesend and would go to the west of Thong and Shorne and east of Chalk towards Church Lane and Lower Higham Road. This route could connect into any of the Routes 2, 3 and 4 north of the river utilising all of the crossing options for these route options.

13 Appendices

	Title
Appendix 5.1	Approach to modelling and appraisal
Appendix 5.2	Paramount London (London Paramount Entertainment Resort)
Appendix 5.3	Journey Quality Assessment Tables
Appendix 5.4	Severance Table
Appendix 5.5	Security Impacts
Appendix 5.6	Charging Model

If you need help accessing this or any other Highways England information, please call **0300 123 5000** and we will help you.



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Highways England creative job number s150687

Report No HA540039-HHJ-ZZZ-REP-ZZZ-010

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The Pre-Consultation Scheme Assessment Report details the assessment of options leading up to consultation. A final Scheme Assessment Report will be published post consultation.