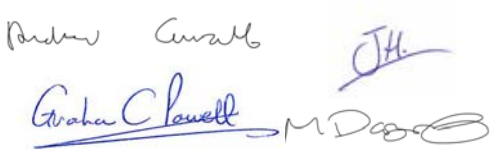
Department for Transport

AECOM

April 2013

Review of Lower Thames Crossing Options: Final Review Report



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1 Introduction

1.1 Purpose of this Report

1.1.1 This report presents findings from the review of the merits of three location options, and a variant which extends one location option, for additional highway capacity across the Thames, east of London. It is intended to provide information during public consultation on location options to inform government decision-making on the location and means of delivering a new crossing.

1.1.2 This review report contains the content of a strategic outline business case (SOBC) for the location options. The SOBC sets out the need for intervention (the case for change) and how the options might further ministers' aims and objectives (the strategic fit). It assesses the relative merits of three location options and presents evidence to inform and enable a decision on location. This review builds on the findings of previous study work in 2009 that identified what would happen if there were no new crossing capacity, and shortlisted the location options for a new crossing.

1.1.3 AECOM was commissioned by the Department for Transport (DfT) in 2012 to carry out the technical consultancy for this review, which created the strategic, economic and management case chapters of this report, and contributed to the conclusions. The commercial, financial and final management cases were produced in-house by the DfT, taking input from AECOM on the cost estimates and revenue forecasts.

1.1.4 This report refers to both the existing crossing – the Dartford-Thurrock Crossing comprising the Queen Elizabeth II Bridge and two road tunnels – and options for a new crossing – a bridge, immersed tunnel or bored tunnel linking into the existing strategic road network at one of three possible locations.

1.2 Context

1.2.1 The first Dartford-Thurrock River Crossing, the A282, was provided by a single tunnel which opened in 1963. In line with growth in demand, a second bore was completed in 1980 and the Queen Elizabeth II Bridge opened in 1991.

1.2.2 Currently the Dartford-Thurrock River Crossing A282 trunk road (hereinafter called the existing crossing) suffers from significant congestion. The DfT, together with the HA, commissioned a study to identify ways to address the capacity constraints at the Dartford-Thurrock River Crossing to alleviate the increasing levels of congestion. The Study[1] reported in January 2009. It considered a range of potential solutions. In the short and medium term the study proposed measures related to the toll plazas and their operational management to make best use of the existing infrastructure.

1.2.3 For the longer term the 2009 Study identified that the capacity of the existing crossing is insufficient and that a further crossing will be required. The 2009 Study considered rail and five road options to alleviate the pinch point. It concluded that another crossing adjacent to the existing crossing could address the capacity problem. The existing crossing however provides the only linkage between Kent and Essex and it may be that providing additional capacity at an alternative location could also provide better connectivity across the Thames and achieve improved resilience in operating the strategic road network. Of the options identified three location options were shortlisted as potential solutions.

[1] Dartford River Crossing Study into Capacity Requirement (January 2009), prepared by Parsons Brinckerhoff for DfT. Available at: http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/about/strategy/capacityrequirements/dartfordrivercrossing/

1.2.4 In the 2010 Comprehensive Spending Review announcement, the DfT committed to both short and medium term measures to address congestion as well as to review the longer term capacity options[2].

1.2.5 The short and medium term improvements comprised the introduction of a charge suspension protocol at times of severe congestion and the implementation of free-flow charging. The protocol setting out an operational management regime to suspend charging during periods of severe congestion was introduced in 2011. The free-flow charging system is planned to be implemented in 2014.

1.2.6 The DfT's Business Plan 2012-2015 contains a specific requirement to: 'appraise options for significant new investment in additional capacity for crossing the Lower Thames and set out the way forward'. This reflects the November 2011 update to the National Infrastructure Plan[3] which includes a commitment to analyse the options for a new Lower Thames crossing.

1.3 Scope of the Review

1.3.1 The possible location options short listed in the 2009 Study[1] for a new crossing are (as illustrated in Figure 1.1):

- Option A: This option would provide additional long-term capacity at Dartford through the delivery of a new crossing while retaining all existing infrastructure (bridge and tunnels). This offers the shortest crossing route among the options tested in the 2009 study, and links the M25 J31 and M25 J1, and therefore directly ties in with the strategic road network.
- Option B: This option would provide a new crossing in the vicinity of the Swanscombe peninsula. It would connect the A2 to the south in the vicinity of Dartford, to the A1089 to the north in the vicinity of Tilbury Docks.
- Option C: This option comprises the provision of a new crossing to the east of Gravesend and Thurrock. It would need to link the M25 with the M2 and thus form a major new piece of infrastructure in the strategic road network. It would potentially provide a direct route for longer distance movements using the north-east section of the M25 and the M2 as well as providing some relief to the existing crossing.
- Option $C_{variant}$: Option C with an additional link to the M20 for long distance traffic, which has been assumed take the form of widening the A229 linking the M2 and M20.

1.3.2 The scope of the review did not re-open the assessment of additional crossing options.

1.3.3 To meet the commitment to appraise options in advance of any investment decision about the new crossing, an aim of the review was to develop a strategic outline business case (the content of which will be defined under 'Approach' later in this chapter) for three potential locations by comparing the location options against a base case. The three locations were those identified by the 2009 study for additional river crossing highway capacity in the Lower Thames area.

1.3.4 The base case (also referred to as the do-minimum) represents the situation if no new crossings are built at any of the three location options. As referred to earlier, there are measures to make better use of the existing crossing, the charge suspension protocol and free-flow charging, which respectively have been and will shortly be implemented, and these have been included in the base case against which the location options were assessed. The base case also assumes other changes will take place, such as additions to the road network, which are planned to take place independently of any decisions about the new crossing, for example improvements to the A226 in Kent.

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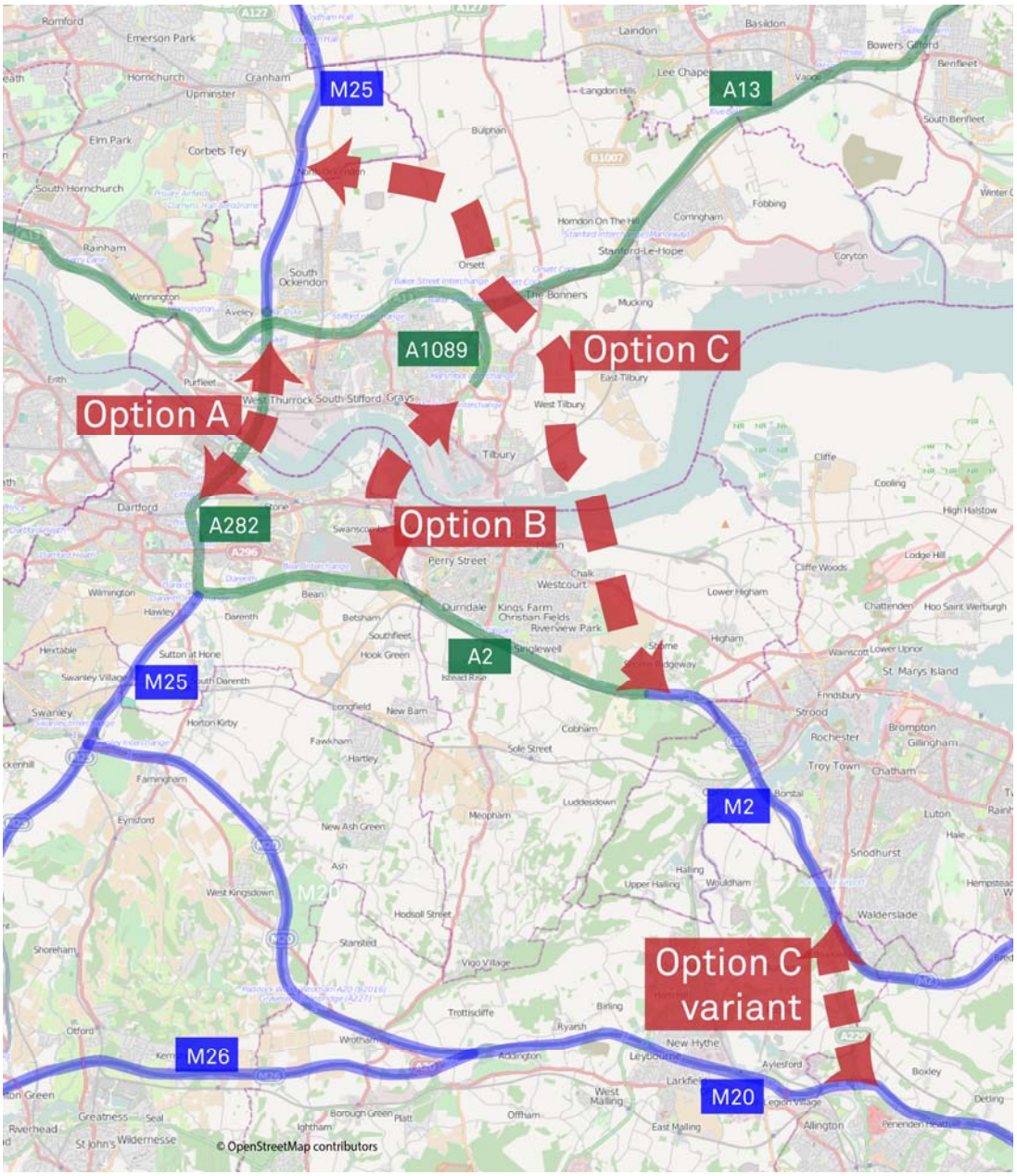
[2] DfT press release, 20th October 2010 available at http://webarchive.nationalarchives.gov.uk/+/http:/www.dft.gov.uk/about/strategy/capacityrequirements/dartfordrivercrossing/

[3] HM Treasury & Infrastructure UK, National Infrastructure Plan 2011, November 2011

Figure 1.1: Location Options for the New Lower Thames Crossing



1.3.5 Designing a future scheme to deliver capacity in one of these locations will require detailed consideration. The current review seeks to establish the relative merits of the alternative location options as well as establishing the outline financial, commercial and managerial considerations. It does not seek to prescribe the nature of the detailed solution within each potential location. Outline consideration, proportionate to the review objectives, has been given to:

- the capacity that may be required;
- the tolls that may be levied on users towards funding the costs of providing, operating and maintaining the new infrastructure;
- the constraints that may influence the alignment for a future scheme within the location options, and, therefore
- the type of structure that may be provided for the main crossing (bridge, immersed tunnel, bored tunnel).

1.3.6 Between now and the likely opening date of a new crossing the number and origins of trips for business and personal purposes that give rise to demand for crossing capacity will change. This review therefore incorporates assumptions about the expected location and amount of new housing, population, business employment growth, and developments, and committed infrastructure improvements that will support that growth. The review has particularly focused on capturing the high-level impacts on transport demand of development plans in the Thames Gateway and the South East, and accordingly has incorporated information from local authorities' plans, verifying with the local authorities whether these plans are currently up to date and relevant. This information was generally available, and used to capture changes expected in trip patterns before 2025 (the year assumed for the purposes of this review for the opening of a new crossing). The forecasts, however, constrain the total expected levels of trip growth to the Department's forecasts (as provided by TEMPRO).

1.3.7 A proportionate approach was taken reflecting the quality of evidence required. In particular, evidence was based on available data sources from the relevant authorities rather than through new surveys, with the focus on performance of the strategic road network, the resulting impacts on the economy, and on constraints of national and international significance.

1.3.8 The review does not, at this early stage of business case development, attempt comprehensively to reflect the impacts on trip numbers and patterns of detailed local planning for specific development proposals nor potential additions to the local road network and the implications this has for demand at any new crossing. Neither has there been any detailed consideration of the potential (beyond schemes already being planned) for extensive developments to the surrounding strategic road network. This approach is that usually adopted for the development of a business case to support a strategic policy decision such as the choice over crossing location option. In addition, it is recognised that there may be a range of extraordinary and substantial proposals in the wider area, which would require specific assessment at a later date as part of future scheme development.

1.4 Approach

1.4.1 The government's general approach to decision making on transport infrastructure investment is set out in the DfT's Transport Business Case Guidance[4]. In accordance with best practise across government, this provides a structured framework to assemble evidence and define five cases: the strategic, economic, financial, commercial and management cases. It is consistent with Treasury advice on evidence-based decision making set out in the Green Book[5]. The evidence base summarised by this tool is progressively refined to support decision making at key stages.

1.4.2 The review objectives were:

- to use the five case model set out in DfT Transport Business Case guidance to assess the three location options, with
  - AECOM assessing the case for change ('strategic case'), and value for money ('economic case' which includes consideration of environmental, economic, social and distributional factors);
  - DfT assessing commercial viability ('commercial case') and financial affordability ('financial case'); and
  - collaborative consideration of achievability ('management case'),
- to ensure that the assessment of potential locations is underpinned by a robust evidence base, based on a proportionate approach to meeting the DfT's transport appraisal guidance (WebTAG)[6] in the production of the economic case.

[4] The Transport Business Case, Department for Transport, April 2011 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/4467/transportbusinesscase.pdf
[5] HM Treasury Green Book available at http://www.hm-treasury.gov.uk/data_greenbook_index.htm
[6] http://www.dft.gov.uk/webtag/

1.4.3 At this formative stage the review focused particularly on understanding and articulating the case for change (the strategic case), informed by evidence on potential impacts and benefits (the economic case). Consideration has also been given to the means of delivering the new crossing (in the management, financial and commercial cases); it is recognised that these cases will require substantial development after the location has been determined and a project initiated.

1.4.4 This review was undertaken in stages. Detailed documentation of the assembled evidence and methods applied is set out in the following interim review documents:

i. Design and Costing Report (April 2013)

- which introduces the constraints that may influence the cost or acceptability of providing new capacity; and
- explains the derivation of capital cost estimates and engineering feasibility of the options.

ii. Operating Costs, Maintenance Costs and Revenues Report (October 2012)

- which explains the estimation of operating and maintenance costs.

iii. Model Capability Report (June 2012)

- which explains the development of the transport model used to forecast the impacts of new crossing capacity on patterns of travel demand.

iv. Central Forecasts and Sensitivity Tests Report (November 2012)

- which describes the forecasts of the future travel demand patterns and the effects of the provision of new crossing capacity.

1.5 Report Structure

1.5.1 The five case model provides a structure to collate and to interpret the evidence on the performance of the location options - this structure is used in the following chapters.

1.5.2 The remaining chapters of this report are therefore structured as follows:

- **Chapter 2**, review methodology, first describes the application of the five case model.
- **Chapter 3**, the strategic case, sets out the case for change. It also explains and introduces the range of objectives that are used to judge the merits of the location options.
- **Chapter 4**, the economic case compares the economic benefits, environmental and social impacts with the costs of providing new crossing capacity. This chapter discusses the relative value for money of providing a new crossing at each of the potential locations. Detailed information about the assessment and interpretation of the range of impacts is provided in appendices.
- **Chapter 5**, the commercial case, introduces some considerations affecting future choices between public and private investment, together with the associated risk ownership.
- **Chapter 6**, the financial case provides an initial indication of how different commercial models could affect the affordability of a new crossing at each location.
- **Chapter 7**, the management case, reviews evidence of similar infrastructure delivery to judge the deliverability of a future scheme and describes the project management structure that would be suitable.
- **Chapter 8**, the conclusions, summarises the findings on the relative merits of the three location options.

2 Review Methodology

2.1 Purpose of Chapter

2.1.1 This chapter explains the methodology applied to develop the strategic outline business case, and thus the review evidence presented in this report.

2.1.2 The approach was founded on the following core principles:

- proportionate focus of resources on aspects of particular importance to understand strategic differences between the location options;
- engagement with Department for Transport and Highways Agency officials in the scoping of tasks and outputs, collaboratively to achieve best value; and
- taking account of DfT and HA guidance particularly WebTAG[7] for option appraisal and the Design Manual for Roads and Bridges (DMRB)[8] in the creation of the conceptual designs.

2.2 Business Case Development

2.2.1 Government's five case model[9] provides a structured framework both to assemble evidence on the relative merits of alternative options and subsequently to refine the evidence at key decision stages.

2.2.2 The approach of this review was structured around the strategic outline business case. Figure 2.1 illustrates the typical investment decision making process and highlights the role of the strategic outline business case in the initial phase.

Figure 2.1: Five Case Model Phases

2.2.3 Reflecting the strategic outline stage, the focus particularly on the strategic and economic cases which, respectively, identify the justification for an investment and the overall value for money of the investment (including the range of potential economic, environmental and social impacts). The commercial, management and financial cases were developed to consider how a future scheme at any of the locations might be delivered. DfT Business case guidance (The Transport Business Cases[10]) was followed in formulating and presenting each of the cases.

2.2.4 The focus of this review has been on the benefits and major constraints of providing capacity in alternative locations. Future work to be undertaken to deliver a scheme at a specific location option will need to build on the formative evidence presented in this report.

[7] http://www.dft.gov.uk/webtag/
[8] http://www.dft.gov.uk/ha/standards/dmrb/index.htm
[9] http://www.hm-treasury.gov.uk/data_greenbook_business.htm
[10] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/4467/transportbusinesscase.pdf

2.3 Specifying the Evidence Requirements

2.3.1 WebTAG provides a structured framework to identifying economic, environmental, social and distributional impacts. These impacts were examined, using qualitative, quantitative and monetised information. In assessing value for money, all of these are consolidated to compare the overall benefits and costs.

2.3.2 Table 2.1 summarises the impacts considered in the economic case and indicates whether they are monetised, and where initial scoping identified the need for social and distributional impacts (SDI) analysis. The final column indicates the WebTAG guidance that has been adhered to. In part the evidence is based on traffic forecasts. Further detail of the appraisal methodology applied is set out in Appendix 1 of the Model Capability Report. In accordance with WebTAG guidance the monetised impacts are expressed in the economic case as costs or benefits in present value terms calculated over a 60 year appraisal period.

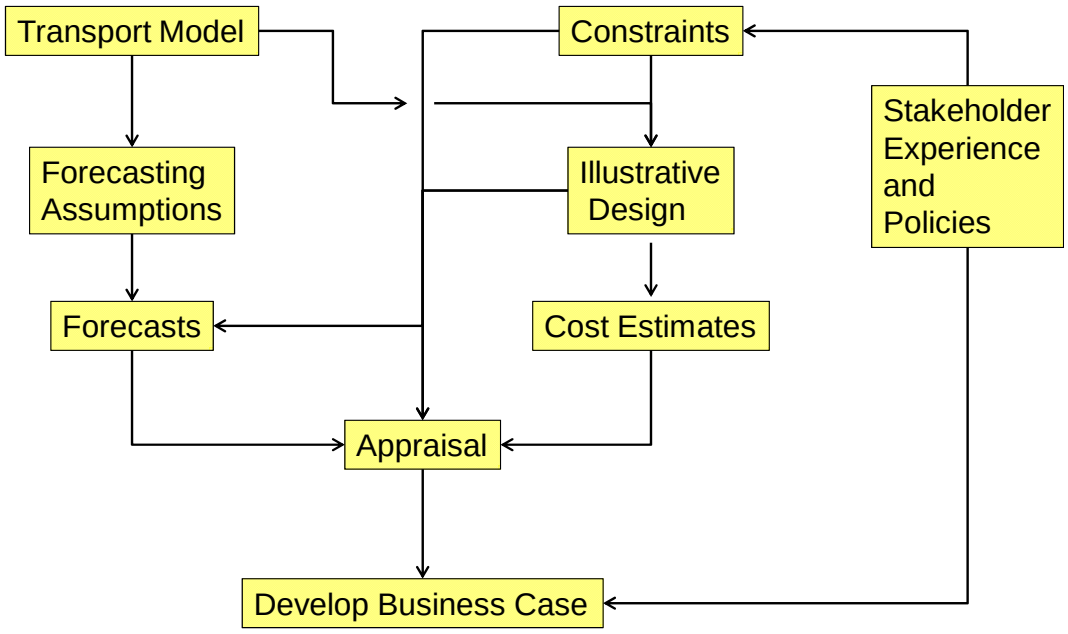
Table 2.1: Monetised and non-Monetised Assessment of Impacts

Key Impacts	Sub-Impacts	Monetised?	SDI Analysis?	WebTAG Unit
Economy	**Business users & transport providers**	✓	×	3.5.1-3.5.4
	Reliability impact on business users	×	×	3.5.7 Appendix F
	Regeneration	×	×	3.5.8
	Wider impacts	✓	×	3.5.14
Environmental	**Noise**	✓	✓	3.3.2
	Air quality	✓	✓	3.3.3
	Greenhouse gases	✓	×	3.3.5
	Landscape	×	×	3.3.7
	Townscape	×	×	3.3.8
	Heritage of historic resources	×	×	3.3.9
	Biodiversity	×	×	3.3.10
	Water environment	×	×	3.3.11
Social	**Commuting and other users**	✓	✓	3.5.1-3.5.4
	Reliability impact on commuting and other users	×	×	3.5.7 Appendix F
	Physical activity	×	×	3.3.12
	Journey quality	×	×	3.3.13
	Accidents	✓	×	3.4.1
	Security	×	×	3.4.2
	Access to services	×	×	3.6.3
	Affordability	×	✓	3.6.4
	Severance	×	×	3.6.2
	Option values	×	×	3.6.1
Public Accounts	**Cost to broad transport budget**	✓	×	3.5.1
	Indirect tax revenues	✓	×	3.5.1

2.4 Overview of Developing the Evidence

2.4.1 The following sections of this chapter explain the steps involved in developing the evidence, as illustrated in Figure 2.2.

Figure 2.2: Outline Approach



2.5 Identifying Constraints

2.5.1 The first stage was to review constraints of particular importance at each of the locations that could materially influence cost or present potential risks of a future scheme having particularly significant impacts. The identified constraints are described fully in the interim review document: *Review of Lower Thames Crossing: Design and Costing Report*, and the extent to which they have a bearing on the strategic outline business case is highlighted in this report.

2.5.2 The identification of these constraints drew on existing data sources in respect of air quality, biodiversity, heritage, landscape, townscape, noise and water environment to identify environmental constraints. Statutory bodies, with responsibility for environmental issues, including Natural England, were contacted, and provided insight on constraints of particular significance. Information on designated Green Belt land and planned development sites was assimilated from local authority planning documents. Information was obtained from the Port of London Authority (PLA) and Network Rail, respectively, about river navigation constraints and rail infrastructure, including the High Speed 1 (HS1) rail line. Geotechnical data on ground conditions was sourced from web based data. Major public utilities were contacted to establish the locations of their infrastructure. These information sources are collectively sufficient to identify constraints of particular importance. Nevertheless, these data will in future need to be augmented by local surveys when undertaking more detailed planning for a scheme.

2.6 Costing and Engineering Feasibility

2.6.1 Conceptual designs were developed as a basis for assessing the feasibility of a new crossing at each location option and to estimate capital costs. The process of producing these is set out fully in the interim review document: *Review of Lower Thames Crossing: Design and Costing Report*, and the extent to which they have a bearing on the strategic outline business case is highlighted in this report.

2.6.2 The starting point for this review was the illustrative routes shown in the 2009 Study[11]; these illustrative routes were assumed in order to determine the likely impacts for each location option and were only modified for Options B and C for specific reasons. There were no significant constraints requiring the illustrative route for a new crossing at Option A identified in the 2009 Study to be significantly altered. However, due to the strategic significance of particular constraints, the illustrative routes for new crossings at Options B and C detailed in the 2009 Study were modified as follows:

- Option B: a variation to the illustrative route set out in the 2009 Study was identified to reduce impacts on land available for development and to avoid creating weaving issues between junctions on the A2. The route that has been assessed is assumed to follow the Ebbsfleet valley, joining the A2 at Ebbsfleet junction, rather than traversing Eastern Quarry and joining the A2 at Bean junction.
- Option C: The illustrative route for Option C was modified to reflect DMRB design standards for conceptual M25 and A13 junctions and to seek to minimise impacts on the Thames Estuary and Marshes Ramsar site.

2.6.3 Conceptual designs for each illustrative route were developed in accordance with the standards set out in the DMRB. Given the strategic purposes of this review, it was not necessary to develop detailed designs or plans that would provide precise proposals for the alignment of a new crossing or associated link roads - this will be in the next phase of work once the location is decided.

2.6.4 The charge collection method at the existing Dartford-Thurrock Crossing is planned to change from the toll plazas to a free-flow system in 2014. This free-flow operation was therefore assumed for the design of the new crossing structures and toll plazas have not been included in designs.

2.6.5 The feasibility of providing a bridge, an immersed tunnel and a bored tunnel at all three location options was considered.

2.6.6 The conceptual designs assume two additional lanes would be provided in each direction at each location option, because that is the capacity requirement that preliminary traffic forecasting results suggest could be needed. For the strategic purposes of this review, all conceptual designs for new crossings and related infrastructure at all three location options have been based on standards for all purpose roads. The costs of providing structures with capacity for three traffic lanes in each direction were also estimated; this was carried out because it is important to understand even at this stage what the additional cost could be if during the scheme development process it transpires that more capacity might be needed. The scheme development will need to consider that the design capacity ought to be sufficient for a reasonable range of future demand growth scenarios.

[11] Dartford River Crossing Study into Capacity Requirement (April 2009), prepared by Parsons Brinckerhoff for DfT. Available at: http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/about/strategy/capacityrequirements/dartfordrivercrossing/

2.6.7 On the basis of the conceptual designs three point minimum, most likely and maximum capital cost estimates were produced in line with HA best practice relevant to the design and cost estimation of road schemes. Capital cost estimates are expressed in projected outturn prices, i.e. reflecting expected inflation, based on an assumption that a new crossing would be constructed between 2020 and 2025. The costs include:

- the direct capital cost for the crossing structure; and the
- capital costs for associated roads required to link the structure with the existing road network.

2.6.8 Table 2.2 to Table 2.5 show the range of capital cost estimates generated for each engineering solution at each location option.

Table 2.2: Option A Capital Cost Estimates, £m

Structure Type	Minimum	Most Likely	Maximum
Bridge	1,121	1,245	1,448
Immersed Tunnel	1,435	1,601	1,871
Bored Tunnel	1,405	1,571	1,829

Monetary values in millions of pounds sterling, undiscounted cash prices, rounded to the nearest million

Table 2.3: Option B Capital Cost Estimates, £m

Structure Type	Minimum	Most Likely	Maximum
Bridge	1,629	1,780	2,062
Immersed Tunnel	1,846	2,016	2,337
Bored Tunnel	1,976	2,174	2,501

Monetary values in millions of pounds sterling, undiscounted cash prices, rounded to the nearest million

Table 2.4: Option C Capital Cost Estimates, £m

Structure Type	Minimum	Most Likely	Maximum
Bridge	2,963	3,239	3,675
Immersed Tunnel	2,778	3,092	3,700
Bored Tunnel	2,863	3,155	3,825

Monetary values in millions of pounds sterling, undiscounted cash prices, rounded to the nearest million

Table 2.5: Option $C_{variant}$ Capital Cost Estimates, £m

Structure Type	Minimum	Most Likely	Maximum
Bridge	4,561	5,007	5,799
Immersed Tunnel	4,376	4,860	5,824
Bored Tunnel	4,461	4,922	5,949

Monetary values in millions of pounds sterling, undiscounted cash prices, rounded to the nearest million

2.6.9 The conceptual designs that have been produced indicate that, subject to appraisal and consideration of the acceptability of environmental impacts, it would be feasible to construct a new crossing and link the crossing to the existing route network at all three location options. However the deliverability of the Option $C_{Variant}$ is questionable due to the engineering challenges presented, which include the structures likely to be needed at the junctions between A229 and the M2 and M20.

2.7 Development of Demand Forecasting Tools

2.7.1 To satisfy the review requirements, the transport model does not need to support detailed design, but should be sufficiently robust to estimate the scale of user benefits for each option (for more information refer to the internal review document: *Model Capability Report, June 2012*). A reliable

assessment of specific impacts on the local road network is not critical to distinguish between the relative merits of each of the options.

2.7.2 A review of the Highways Agency's existing M25 Model, other local models, and readily available data was undertaken, contained within the interim review document: *Model Capability Report*. The M25 Model was the best starting point for the development of the Lower Thames Crossing Model (LTC Model). Two following refinements were judged necessary:

- localised enhancement of zonal detail, demand matrices and network detail;
- improved modelling of traveller response to tolls, together with segmenting personal users by income class, which then allowed variations in income by area of trip origin and the higher than average incomes of those on longer trips to be represented in the modelled propensity of different groups to undertake trips.

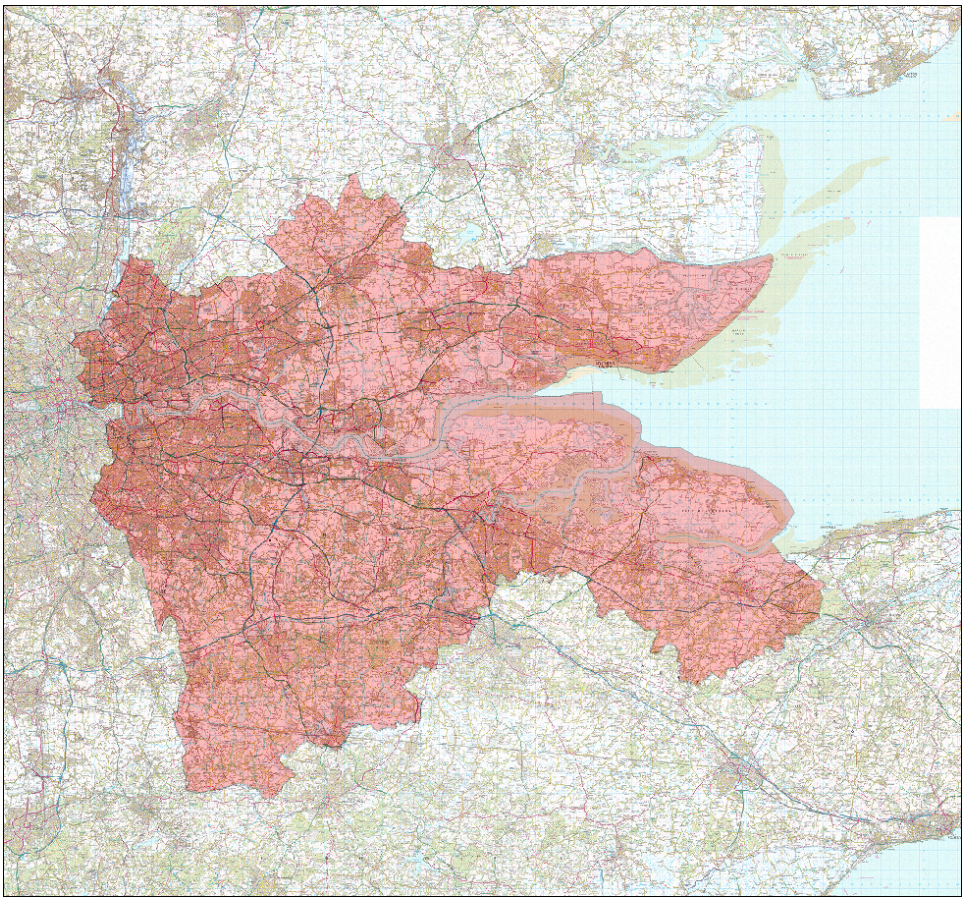
2.7.3 Following these recommendations, the LTC Model was developed from the M25 Model with the key enhancements as follows:

- incorporating of network data from local models, most notably TfL's East London Highway Assignment Model (ELHAM);
- incorporating of demand data from the Thames Gateway South Essex (TGSE) model and the original (more disaggregate) matrices developed for the M25 Model;
- incorporating of count and journey time data from the local models and Highways Agency sources, with count data arranged into 'screenlines';
- revising economic parameters in the model in line with WebTAG 3.5.6 (August 2012);
- recalibrating the revised SATURN highway model, with the proportionate emphasis on the performance of the model on the strategic highway network; and
- introducing a toll choice model.

2.7.4 Internal review document: *Model Capability Report* was also produced to document the work undertaken to establish the LTC Model transport modelling tool and to verify that the outputs are plausible and suitable for use in preparing the strategic outline business case for a new lower Thames crossing. The validation and realism testing undertaken demonstrated suitable consistency with WebTAG criteria for the proportionate strategic purpose of the model and confirmed the area where the provision of new capacity at one of the location options might have particular impacts, which is called the policy area (Figure 2.3). While the local road network is represented, the model does not, and is not designed to, represent traffic movements on the individual roads as accurately as it does on the strategic road network, rather the model outputs indicate impacts on an area basis.

2.7.5 The risks in using the model outputs for developing specific appraisal metrics were assessed, confirming the need to focus on impacts associated with the strategic rather than local networks. The overall model performance was therefore considered to be suitable for use in the strategic assessment of additional lower Thames crossing capacity in this review.

Figure 2.3: The Policy Area, highlighted in red



2.8 Development of Demand Forecasts

2.8.1 The LTC Model has a 2009 base year, which was chosen as it is sufficiently recent to reasonably approximate the current situation, and reflects availability of data. The model has two forecast years – 2025 which for current assessment purposes is the assumed opening year of the new crossing – and 2041 which represents a year by which demand for the new crossing might be expected to have matured.

2.8.2 There are a number of forecasting elements that were considered, each with associated assumptions. These are summarised in Table 2.6. The internal review document: *Central Forecasts and Sensitivity Tests Report* sets out the transport model forecasting assumptions in detail.

2.8.3 The forecasting process involves application of these assumptions using the LTC Model. Forecasting started by assuming that no new capacity would be provided to assess how conditions might be expected to change in the future. The model was then run for each of the location options to establish what the impacts of a crossing at each location would be relative to the base case. These results underpinned the central case for each option.

2.8.4 Tests were also undertaken for alternative forecasting assumptions which would affect the forecast demand for and benefits delivered by a new crossing. The alternative assumptions reflected higher and lower household and employment growth than in the central case, and variation in the forecasts of other more general economic assumptions such as Gross Domestic Product and oil prices. By using alternate assumptions to forecast demand and calculate benefits, the impact of different futures on the case for a new crossing can be understood.

Table 2.6: Forecasting Elements

Forecasting Element	Approach
Planning Data	The key drivers of transport demand are population and employment. The process used to put together employment, households and population estimates for the LTC Model is fully described in sections 2.4. and 3 of the *Central Forecasts and Sensitivity Tests Report*.
Freight Growth	The rate of freight traffic growth incorporated in the LTC Model was sourced from the DfT's National Transport Model, which in turn uses the Great Britain Freight Model (GBFM) to forecast freight growth.
Highway networks	A list of expected network changes, both strategic and local, relevant to the forecasting was assembled. In accordance with WebTAG 3.15.5 this list only included schemes deemed either 'certain' or 'more than likely' to go ahead.
Crossing Tolling operation	By the assumed new crossing opening date (2025), it is also assumed that the planned 'free-flow charging' scheme will have been introduced at the existing crossing as part of the base case, and that an arrangement not using toll booths would apply at the new crossing.
Economic assumptions	A key set of assumptions in demand forecasting and economic appraisal is that relating to road users' values of time, the costs of journeys, and how these are likely to change over time. In line with standard practice for transport economic appraisal and modelling these assumptions have been derived using the recommended values in WebTAG 3.5.6 (August 2012). Section 2.5 of the *Central Forecasts and Sensitivity Tests Report* describes these assumptions fully.
Toll assumptions	Assumptions of the charges and tolls to be used for all crossings have been assembled. As agreed with DfT and Transport for London (TfL) these include Blackwall Tunnel, Silvertown Crossing, Dartford Crossing and the new crossing options. Effective tolls have been calculated, taking into account the effect on the average charge/toll paid of assumed discounts for local residents, Dart-TAG users etc.

2.9 Summary of Chapter

2.9.1 This chapter has summarised the methods for obtaining and developing the evidence for costing and assessing the impacts of location options for a new Lower Thames crossing. The appraisal and interpretation of this evidence is explained in the subsequent chapters which present the strategic, economic, management, financial and commercial cases.

3 The Strategic Case

3.1 Purpose of Chapter

3.1.1 The purpose of this chapter is to present the case for change, and specifically to articulate the need for additional road based river crossing capacity in the Lower Thames. It explains how the Government's commitment to a new crossing fits with its wider public policy goals. This chapter also identifies the problems specific to the current crossing that need to be addressed, and the broader need for change that provides the rationale for a new crossing.

3.2 Business Strategy

3.2.1 The Government's vision is for dynamic, sustainable transport that drives economic growth and competitiveness[12]. Investment is being secured to provide world class national and international connectivity; harnessing technology to ensure our transport system is smart, sustainable and ready for the future; and putting the customer and businesses at the heart of transport. The Prime Minister's speech in March 2012 on national infrastructure to the Institute of Civil Engineering emphasised the importance of better transport to the realisation of business investment leading to economic growth, as well as protection of the environment.

3.2.2 The Department for Transport's (DfT) Business Plan[13] reflects the Government's vision for transport. It sets out priorities to invest in roads to promote growth, while reducing congestion and tackling carbon. Specific actions to implement the priorities are set out in Section B of the DfT Business Plan to improve performance on the strategic road network and promote growth. As part of its plans for tackling congestion, DfT has committed to: 'Appraise options for significant new investment in additional capacity for crossing the Lower Thames and set out the way forward'.

3.2.3 The strategic road network, operated by the Highways Agency, connects the different conurbations of the UK together both quickly and cost-effectively. The Highways Agency's Business Plan[14] outlines the range of HA responsibilities including making the network safe, serviceable and reliable, and delivering large scale improvements on the network designed to tackle bottlenecks and increase capacity of the network.

3.2.4 The 2010 Spending Review protected capital spending and committed the Government to prioritise investment in infrastructure projects that would support growth. DfT's Spending Review announcement included recognition of the need for additional river crossing capacity and measures to address congestion at the existing Dartford-Thurrock Crossing in the short to medium term. At the same time, the Government also published the first National Infrastructure Plan[15] which set out its strategy for coordinating and planning public and private investment in UK infrastructure in order to meet the infrastructure needs of the UK economy. The plan set out how investment will be secured to provide world class national and international connectivity. The November 2011 update to the National Infrastructure Plan[16] identified priority infrastructure investments based on three main criteria:

a. potential contribution to economic growth – investment that enhances productivity and enables innovation;

[12] The High Level Output Specification (HLOS) 2012: Railways Act 2005 Statement, Department for Transport, July 2012
[13] Business Plan 2012-2015, Department for Transport, http://transparency.number10.gov.uk/business-plan/11
[14] HA Business Plan 2012-13 http://assets.highways.gov.uk/about-us/corporate-documents-business-plans/S110461_Business_Plan_2012-13_Final.pdf
[15] HM Treasury & Infrastructure UK, National Infrastructure Plan, October 2010
[16] HM Treasury & Infrastructure UK, National Infrastructure Plan 2011, November 2011

b. nationally significant investment that delivers substantial new, replacement or enhanced quality, sustainability and capacity of infrastructure; and

c. projects that attract or unlock significant private investment.

3.2.5 Accordingly the 2011 Plan identifies 40 priority infrastructure programmes and projects as being of national significance and critical for growth. This includes a commitment to analyse the options for a new Lower Thames crossing.

3.2.6 The business plans of other government departments similarly demonstrate commitment to sustainable economic growth. For example, stimulating economic growth is a priority for Her Majesty's Treasury and for the Department for Business, Innovation and Skills. Supporting Local Economic Partnerships in their efforts to promote growth is a priority for both the Department for Business, Innovation and Skills and the Department for Communities and Local Government. The Department for Environment, Food and Rural Affairs seeks to enable development while protecting the environment.

3.2.7 In addition, successive governments have identified the Thames Gateway as a national priority for redevelopment and growth, recognising that London and the South East are critical to the UK's future growth prospects. The current Government supports the local authorities' prioritisation of growth in the Thames Gateway area through a Minister for the Thames Gateway who engages with the relevant local authorities, the Local Enterprise Partnership, and the Mayor of London on growth in the Thames Gateway.

3.3 The Need for Change

3.3.1 The Dartford-Thurrock River Crossing A282 trunk road is a key route in the strategic road network which facilitates the movement of goods and people around the country. The crossing serves traffic routeing both to and from north of the Thames to South London, Kent and Sussex, and Continental Europe via the Kent ports and the Channel Tunnel as well as local traffic movements.

3.3.2 The national connectivity role played by the crossing is highlighted by the statistics in the The 2009 Dartford River Crossing Study[17] report. These statistics show that over 40% of car and light van journeys using the crossing travel more than 50 miles whilst over 30% of heavy goods vehicle journeys are travelling particularly long distances to and from the port of Dover. Around half of the heavy goods vehicle trips have origins and destinations within the east and south east of England. The remainder of the traffic are regional trips travelling between the large conurbations to the north and south of the crossing or local trips, illustrating the combined role of the crossing in providing connectivity for national, regional and local traffic.

3.3.3 The A282 currently forms the only river crossing of the Thames to the east of London. The alternatives to the crossing, for many journeys, involve much less direct or less suitable routes. The role the crossing plays within the strategic road network, and the absence of alternative routes, leads to a concentration of long-distance traffic at the crossing.

3.3.4 The data in the LTC Model collected through a combination of surveys in 2001 and more recent data from Connect Plus (the current crossing operator) show that around half of the traffic that uses the crossing is vital to the functioning of the national economy. Freight and other business user traffic together comprise nearly half the traffic using the crossing: for comparison, the average proportion of traffic made up by freight and business users on other roads represented in the LTC Model is around a third.

3.3.5 The consequences of poor performance of this route therefore affect a very large number of journeys, a high proportion of which have a business purpose, with a resulting cost to the national economy.

[17] Dartford River Crossing Study, Final Report, January 2009, Prepared by Parsons Brinckerhoff Ltd for the Department for Transport

3.3.6 This section of the strategic road network experiences a number of travel problems. The problems at the existing crossing are mainly caused by traffic demand exceeding the available capacity, which in part exist because of the absence of alternative routes on this part of the strategic road network.

3.3.7 The 2009 Study and the current review both concluded that the current road based infrastructure lacks resilience and is not able to cope efficiently with the traffic volumes passing in either direction for the majority of the day. This situation is anticipated to worsen as a result of forecast traffic growth.

3.3.8 The lack of capacity and resilience result in consequential problems: delays; longer journey times and reduced journey time reliability. These impacts in turn reduce business productivity and ultimately produce an adverse impact on the national economy. A further consequence of congestion is higher vehicle emissions, which has consequences for local air quality. These symptoms which are caused by lack of capacity and resilience, and their knock-on impacts, are further described below.

Lack of Capacity

3.3.9 The 2009 Study set out the current problems and issues at the existing crossing. The crossing experiences high levels of flow and congestion on a daily basis with typical traffic flows of around 140,000 vehicles per day[18] compared to the original design capacity of the crossing of 135,000 vehicles per day.

3.3.10 Traffic flows change little throughout the year and there is also little variation in flow between weekdays, although weekend flows are a little lower than weekday equivalents. There are also no pronounced morning or evening peak periods with high flows occurring throughout the daytime period. The Dartford free-flow charging project highlighted that the crossing operated above its design capacity on 257 days during 2010[19].

Delays

3.3.11 Analysis undertaken for the 2009 Study concluded that the section of the strategic road network that includes the crossing experiences the third highest level of national delay. Delays in excess of nine minutes are experienced by almost half of users in both directions. Clear peaks in journey time delay are found in the afternoon peak period, more so in the northbound direction. Vehicles carrying restricted goods are escorted through the tunnels whilst northbound traffic is held at the northbound toll barriers, creating further delays for all other users.

3.3.12 This review has confirmed that there is significant congestion at the crossing by calculating delays represented in the LTC Model: it estimated that annual cost of modelled delays between junction 31 to the north of the river and junction 1a to the south to the economy, in the form of ‘lost time’ for users, including businesses, was £15m for the 2009 model base year.

Resilience

3.3.13 The nature of the road network near the crossing results in incidents occurring at greater frequency in this location than on other parts of the strategic road network. The road layout close to the crossing is complex, with junctions closely spaced, resulting in traffic weaving over relatively short distances. The 2009 Study found that the injury accident rate associated with the bridge, tunnels, toll plazas and approaches within the vicinity of the crossing, is twice the national average for a route of this type.

[18] http://www.highways.gov.uk/our-road-network/managing-our-roads/area-teams/area-5/the-dartford-thurrock-river-crossing/traffic-flow/
[19] Highways Agency HATRIS data

3.3.14 When incidents and accidents occur, the fact that the crossing is often operating at, or above, capacity means that the crossing has little resilience and users experience further flow breakdown, resulting in greater delays and even poorer levels of service.

Reduced Journey Time Reliability

3.3.15 In addition to the delays on a typical day faced by users due to lack of capacity, because there is no spare capacity, any incident, however small, causes additional delay, and therefore unreliable journey times. The Highways Agency measure reliability of journeys on their network. Between October 2011 and September 2012, the Dartford Crossing was the least reliable section of the strategic road network. Data from the rolling year to April 2012[20] showed that for journeys on the A282 between M25 junction 1a and junction 31 only 60.2% were on time (within a reference journey time for that route) northbound and 56.3% are on time southbound.

Reduced connectivity

3.3.16 In the 2009 Study, evidence quoted from Census 2001 workplace statistics data showed that a relatively small proportion of journeys from home to work involve crossing the Thames. For instance, the data showed that only 2% of all journeys originating in Dartford were to workplaces in Thurrock, and less than 1% of journey to work trips originating in Thurrock were to Dartford. In contrast, 11% of journey to work trips originating in Dartford were to Bexley and 8% to Gravesham – a much higher proportion than towards Thurrock, despite being of a similar distance. The relatively low propensity of Dartford and Thurrock residents to cross the Thames for work could partly be due to the deterrent that congestion levels on the existing crossing creates. While the proportion of work trips generated locally that use the existing crossing is relatively small, given that the crossing is already operating above design capacity most of the time, it is unlikely that any growth in employment and housing could result in significant growth of cross-river commuting, unless additional capacity is provided. This lack of interaction in the absence of additional capacity could only be expected to limit the economic growth within the Thames Gateway in the future.

Environmental Impacts

3.3.17 The sustained high levels of flow on a daily basis throughout the year and the consequential delays at both the existing crossing and its approaches, have an adverse impact particularly in terms of the effect of vehicle emissions on air quality in the vicinity of the crossing. An Air Quality Management Area (AQMA) must be declared by a local authority if it finds that National Air Quality Strategy objectives, which are defined in terms of maximum concentrations of various pollutants, are unlikely to be met by the relevant deadline. Air Quality Management Areas[21] have been declared for Dartford which includes the M25 J1a-J1b and the A282 by Dartford Borough Council and at locations adjacent to the A282 and M25 by Thurrock Council. The issue in both cases is the emissions caused by traffic on the approaches to the crossing, rather than on the crossing itself.

3.4 Short to Medium Term Improvements

3.4.1 The Government has committed to implementing short to medium term improvements identified by the 2009 Study to make best use of existing capacity. However the 2009 Study and this review[22] have both shown that such improvements will not sufficiently address the capacity constraint in the long term. Forecasts for the base case, i.e. the future in the absence of a new crossing being provided, show traffic flows in excess of design capacity. The lack of headroom for periods of high demand and when incidents occur demonstrates a lack of resilience. Congestion would be expected to occur frequently.

[20] HA data accessible at http://data.gov.uk/dataset/journey-reliability-highways-agency-network
[21] http://webarchive.nationalarchives.gov.uk/20130123162956/http://archive.defra.gov.uk/environment/quality/air/airquality/strategy/documents/air-qualitystrategy-vol1.pdf
[22] Economic Case, Section 4.3

3.4.2 These short to medium term improvements comprise of the introduction of a charge suspension protocol[23] at times of severe congestion and the implementation of free-flow charging. The protocol setting out an operational management regime to suspend charging during periods of severe congestion was introduced in 2011. The free-flow charging system is planned to be implemented in 2014. This review has assumed that free-flow will operate in the future years forecast for this review. Free-flow charging represents a separate project and the business case for it has not been revisited in this review.

3.4.3 The Government also pursued an additional short term measure, namely to increase the level of charges vehicles pay for using the existing crossing. The charges were increased in 2012 for the purpose of managing demand and to invest in infrastructure improvements. However, the impact of increasing the charges was assessed[24] to lead to a minimal reduction in traffic flows.

3.5 Objectives

3.5.1 The analysis of the case for change above points to the need to add capacity to the strategic road network to alleviate congestion at the existing crossing. Other options, including provision of rail capacity, were considered in the 2009 study, but were not shortlisted. As with other capacity enhancements on the strategic road network, additional capacity at this location could, if carefully designed, alleviate many of the delays and journey time reliability issues, and reduce the cost of delays and journey time uncertainty to the national economy.

3.5.2 As stated in Chapter 1 (Introduction), this review of location options uses the government's general approach to decision making on infrastructure investment as set out in Transport Business Case Guidance[25].

3.5.3 For the purpose of judging how each location option would address the case for change and assessing 'value for money', this review of location options considered significant economic, social and environmental impacts which would result from a new crossing and associated infrastructure at each location. This involved considering the extent to which a new crossing at each location would:

- contribute to the national economy, through improving journey times and connectivity of the strategic road network, both to and within the Thames Gateway and the South East;
- reduce congestion at the existing crossing and improve the resilience of the strategic road network;
- contribute to reducing greenhouse gas emissions;
- avoid unacceptable impacts on environmentally sensitive areas and improve quality of life; and
- avoid unacceptable impacts on committed development.

In addition, the review assessed each option in terms of the distribution of impacts on different income groups

3.5.4 Where practicable, benefits under each of the above considerations feed into the assessment of value for money of each location option. Once the preferred location option for the new crossing has been selected, project-specific objectives will need to be defined as part of developing a future scheme, drawing on evidence gathered during this review.

[23] http://assets.highways.gov.uk/our-road-network/the-dartford-thurrock-river-crossing/Dartford_Crossing_Charging_-__Suspension_Protocol_Rev_A.pdf
[24] Dartford-Thurrock River Crossing Revised Charging Regime Impact Assessment, DfT, March 2012 http://assets.dft.gov.uk/consultations/dft-2011-08/dft-2011-08-final-ia.pdf
[25] The Transport Business Case, Department for Transport, April 2011 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/4467/transportbusinesscase.pdf

3.6 Measures of Success

3.6.1 As part of this review, information has been gathered to establish the extent to which the future new crossing location options could address the current and emerging problems in terms of congestion, connectivity and sustainability.

3.6.2 In the development of a future scheme, potential indicators that could be used to measure success in achieving improved travel times to address congestion and connectivity related objectives include changes in:

- the levels of delay;
- journey time changes; and
- journey time reliability.

3.6.3 Environmental appraisal of the impacts of a future scheme will identify residual risks from which to establish wider monitoring requirements. It is likely that these would include indicators in respect of changes in:

- incidents and accidents;
- noise and air quality; and
- traffic volumes.

3.6.4 It is also worth considering how best to monitor accessibility changes and future development levels and patterns within the vicinity of the new crossing to interpret induced economic benefits.

3.7 Scope of a Future Scheme

3.7.1 This review is based on the premise that the consequent project would deliver additional road based river crossing capacity. The 2009 Study considered the case for the inclusion of rail facilities as part of any new or improved crossing in the Lower Thames area. It identified that the principal existing rail passenger demands in the South East are generated by radial commuting patterns into and out of London. Total travel volumes by all modes between north Kent and south Essex are relatively low, and therefore there is unlikely to be significant generated demand resulting from a direct rail service between the two. The route used by freight trains travelling between the Channel Tunnel and the West Coast Main Line (WCML) is via the Ashford-Swanley and Chatham main lines; there is no connection with the North Kent line, however, the market such a connection would serve is limited to movements between the Isle of Grain or Medway Towns of Kent and the WCML or Great Western Mainline. Overall, the inclusion of rail infrastructure as part of additional crossing capacity was not considered to have a reasonable business case and was therefore discounted from the final scheme options considered by the 2009 Study.

3.7.2 The scope of a future project will depend in part on the selection of the location and subsequent development of route options and scheme design. However, the current review has included some initial consideration of:

- the capacity that may be required;
- the tolls that may be levied on users in order to fund the costs of providing, operating and maintaining the new infrastructure; and
- the type of structure that may be provided for the main crossing (bridge, immersed tunnel, bored tunnel).

3.8 Other Considerations

(a) Constraints

3.8.1 The current review has identified constraints for each of the location options as part of designing and estimating costs for an illustrative route at each location, which will inform the location

decision, and will need to be addressed as any major scheme is developed. These constraints are fully described in the interim review document: *Review of Lower Thames Crossing: Design and Costing Report*. This work has shown that some constraints apply to all location options whilst others are unique to a particular location.

3.8.2 Examples of constraints which apply to all location options include:

- the River Thames navigation requirements which, in conjunction with highway design standards (such as maximum gradients), will influence the length and cost of any future bridge or tunnel structures across the River Thames;
- the junction design requirements for integrating new routes safely with the existing strategic road network; and
- the Thames estuary marine environment.

3.8.3 Examples of constraints that are unique to a particular location include:

- the potential impacts of Option B on development sites within the Ebbsfleet Valley development area;
- the potential impacts of Option C on the Thames Estuary and Marshes Ramsar site and on Shorne and Ashenbank Woods SSSI; and
- the need for consideration of development within designated Green Belt Land, particularly for Option C.

3.8.4 All identified constraints would need to be addressed as part of delivering a new crossing.

(b) Interdependencies

3.8.5 The current review has also identified potential future projects which could interact with a new crossing project, depending on where the new crossing is located.

3.8.6 In particular, the Government has announced the provision of additional capital expenditure in this Spending Review to tackle congestion with improvement works to junction 30 of the M25 to start in 2015[26]. This will be relevant for traffic using the existing crossing and decision-making on the location of the new Lower Thames crossing.

3.8.7 A longer term proposal is highlighted in the Thames Estuary 2100 Plan[27], approved by DEFRA in November 2012, which sets out how 1.25m people and £200bn worth of property will continue to be protected from increasing tidal flood risk through to the end of the century and beyond. While subject to future review, the long term plan includes an option to construct a new Thames Barrier at Long Reach, around 1km west of the existing crossing. The plan suggests the new barrier, if constructed, is likely to be required by 2070.

3.8.8 There are a number of other potential major development proposals that could also interact with the performance and deliverability of a new crossing, such as: a possible Thames estuary airport; possible developments within Ebbsfleet Valley; and the Paramount Park proposal for the Swanscome Peninsula. At this time there is insufficient detail on the nature and access requirements for the potential developments to undertake a quantified assessment of potential interactions.

3.8.9 Clarification of the constraints and future inter-dependencies will depend on the selection of the location for the new crossing, and both the constraints and inter-dependencies will each require consideration as part of future new crossing scheme development.

[26] Autumn Statement 2012, HMT, accessible at http://cdn.hm-treasury.gov.uk/autumn_statement_2012_complete.pdf

[27] Managing Flood Risk Through London and the Thames Estuary, TE2100 Plan, November 2012, Environment Agency

3.9 Stakeholders' Views

3.9.1 The new Lower Thames crossing options would directly and indirectly affect, and be of interest to, a large range of stakeholders, nationally as well as locally. These include existing and potential users of the existing crossing as well as new users of the new crossing in the Lower Thames area, including those who may use it for personal or business journeys, businesses, environmental and other specific interest groups, freight operators, local authorities and local residents.

3.9.2 During this review, the DfT has been liaising with a number of key local stakeholders through a Stakeholder Advisory Panel. The purpose of the Panel is to assist the DfT with pertinent local knowledge and evidence, as well as advice and support on engaging with the diversity of bodies with an interest in Lower Thames crossing capacity. The Panel is chaired by the DfT and comprises a number of organisations[28].

3.9.3 Stakeholders, especially those represented on the Panel, are concerned about the congestion at the current crossing and the lack of network resilience and connectivity. They also perceive that the lack of capacity at the current crossing will have wider adverse effects on business productivity within the Thames Gateway area. For example:

- The Thames Gateway South Essex Partnership noted[29] that perceived barriers to growth include 'traffic congestion, with the strategic network acknowledged as being at or close to capacity.'
- The Thames Gateway Strategic Group (TGSG), which addresses the wider Thames Gateway agenda and pan-Thames Gateway issues and comprises partners in North Kent, South Essex and East London, have stated that: 'The Thames Gateway is critical to Britain's economic future. It is vital to London's expansion as Europe's world city and it has the UK's greatest potential for growth....the scale of the opportunity in the Thames Gateway is immense. So delivering the employment opportunities, high quality housing, transport infrastructure and public facilities require long term approaches. Our Core Vision is that the Thames Gateway will have the best connected communities in the region'[30].

3.9.4 The South East Local Enterprise Partnership (SELEP), which also represents business interests at a strategic level, is similarly concerned. The SELEP, through its Strategic Transport Infrastructure Group, has carried out a study to identify those transport and infrastructure developments of greatest importance to the growth of the SELEP area. The study rated a new Thames crossing in Kent as its second highest priority among nationally significant road schemes[31].

3.9.5 The Mayor of London's Transport Strategy[32] refers to 'Support for Government proposals to reduce congestion at the Dartford-Thurrock Crossing'. The Thames Gateway South Essex Partnership[12] noted that the crossing delays 'not only affect national and regional travel but result in diversion to ... local roads'. Gravesham Borough Council meanwhile, has concerns about the potential impact of a new crossing on the quality of life in the surrounding area.

3.9.6 Such are stakeholders' concerns about congestion on the existing crossing and the potential for a new crossing, they themselves are seeking to gather evidence and have commissioned studies to examine the current situation. Kent and Essex County Councils commissioned a study[33] which reported in 2008 outlining the likely benefits, disbenefits, problems and opportunities for a range of

[28] The current members of the SAP are senior officers from: Essex County Council; Kent County Council; Thurrock Council; Dartford Borough Council; Gravesham Borough Council; Medway Council; Southend-on-Sea Borough Council; Thames Gateway North Kent Partnership; Thames Gateway South Essex Partnership; South East Local Enterprise Partnership; Transport for London; Department for Transport; and Highways Agency.

[29] Supporting Growth and Increasing Prosperity, A Planning and Transport Strategy for Thames Gateway South Essex, Thames Gateway South Essex, October 2012

[30] The Thames Gateway, A New Commitment to Britain's Gateway to Growth

[31] Framework for Prioritising Strategic Transport Infrastructure in the SELEP Area, SKM Colin Buchanan, Final Report, May 2012

[32] Proposal 39 in the Mayor's Transport Strategy, Greater London Authority, May 2010

[33] Assessment of Lower Thames Crossing Capacity, Gifford/MVA Consultancy/Capita, November 2008

possible lower Thames crossing options, whilst Kent County Council has also examined the regeneration impacts of crossing capacity options and given consideration to potential funding and procurement approaches[34]. More recently, the three highway authorities for the proposed new crossing locations – Kent, Essex and Thurrock commissioned the following reports to examine the relative merits of the three options:

- 'Review of Environmental Impacts of Lower Thames Crossing Options', Mouchel, March 2012, which compares the significance of the environmental constraints affected by the three location options; and
- 'Third Thames Crossing Regeneration Impact Assessment', URS, 2012, which considers the potential for improved connectivity provided by the options to generate additional economic activity.

3.9.7 The views of stakeholders will be sought through a forthcoming consultation to be held in 2013.

3.10 Summary

3.10.1 This chapter has:

- confirmed the case for additional capacity;
- set out the high-level objectives against which the performance of the three location options have been assessed in this review;
- described other considerations that have been identified by this review, and will need to be considered further as any scheme is developed; and
- outlined the views of several interested parties with whom the DfT has liaised throughout this review, and described their evidence gathering activities.

[34] The Lower Thames Crossing, KPMG, August 2010

4 The Economic Case

4.1 Purpose of Chapter

4.1.1 This economic case assesses the impacts and value for money of a new crossing at location Options A, B, C, and the variant of Option C.

4.1.2 The economic, environmental, social and distributional impacts are all examined within the framework provided by the DfT's five case model[35] and the technical guidance in WebTAG[36], producing qualitative, quantitative and monetised information.

4.1.3 This chapter contains:

- a description of the 'base case' – which in economic appraisal is usually referred to as the do-minimum – this is the outcome that would be expected if none of the options are built;
- a summary of the direct traffic impacts that would be forecast to result from the additional capacity at each location option; the change to traffic journey times and routes which underpins the benefits discussed later in this chapter;
- Appraisal Summary Tables for each option which provide summaries of the main economic, environmental and social impacts, and the distribution of those impacts; and
- value for money assessments for each option, in which where possible the impacts in the ASTs are consolidated to compare the overall costs and benefits.

4.1.4 The full and detailed descriptions of the impacts reported in the Appraisal Summary Table for each option are reported in Appendix A. Subsequent appendices explain the appraisal methodology and provide detailed appraisal worksheets.

4.1.5 This economic case forms part of a strategic outline business case, and as such at this formative stage it is not possible to produce as detailed an analysis of the impacts as it will be when a route has been defined later in the process. The impact that a range of alternative assumptions and future scenarios would have on the economic case are summarised in the value for money assessments. Sensitivity tests included different levels of tolls that could be charged, high and low traffic growth scenarios, and variation in road network infrastructure constructed – the results of these tests are reported in detail in Appendix A.

4.1.6 A future scheme will involve consideration of detailed design issues, such as capacity required, the level and nature of charges applied to vehicles using the crossing, and whether the new structure is a bridge or tunnel. The economic case is influenced by the costs of the engineering solution, so in this chapter the likely impacts on the economic case of a bridge, immersed tunnel and a bored tunnel at each location are outlined within the Appraisal Summary Tables and the value for money assessment.

4.2 Assumptions and Context

4.2.1 It is assumed that users would be charged to use a new crossing facility as they do to use the existing Dartford Crossing. A funding mechanism for any of the proposed location options has yet to be determined; this is discussed further in the commercial and financial cases, in chapters 5 and 6 respectively, but under all scenarios an upfront investment would need to be made to construct the crossing, followed by costs of maintenance and revenue from users received over time once the scheme is open. At this stage the economic case establishes whether the provision of a new

[35] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/4467/transportbusinesscase.pdf
[36] http://www.dft.gov.uk/webtag/

crossing would offer value for money if it were to be funded as a conventional public sector project with the public sector the direct recipient of revenue. As a result, in the appraisal the scheme costs and revenue generated are borne by and accrue, either directly or indirectly, to the DfT's budget, and there are no benefits to private transport providers. Other means of funding may lead to toll revenues accruing to the private sector and or the costs of building and maintaining the road being borne by a private concessionaire. If all costs and revenues were the same, the net present value (the net benefit, i.e. benefits minus costs) would be the same as if the scheme were publicly funded, but the ratio of benefits to costs as calculated using the Department's standard approach would differ, because the toll revenue would be counted as a private sector benefit rather than a negative cost to government.

4.2.2 The benefits of the additional crossing capacity depend on the number of users it attracts, which is partly determined by the price charged to use the facility. In the central case for each option, which forms the basis of all economic assessment except specific sensitivity tests of alternative assumptions, tolls at Options A, B and C are assumed to match charges at the existing Dartford-Thurrock Crossing. Matching the tolls with the charges in this way allows any changes to users' behaviour resulting from the direct impact on journey times to be understood without the added complication of differing charges between the crossings. The assumed changes to these tolls and charges over time include the published planned increases up to 2015; after 2015, increases in line with inflation are assumed. At the existing crossing, discounts are available both to local residents and Dart-TAG users. While no decisions have been taken in relation to toll levels or any discount regime that could operate, it is assumed for the purposes of this assessment that the discount on the tolls for a new crossing would be available on the same basis applied to charges for the existing crossing.

4.2.3 The free-flow charging scheme for the Dartford-Thurrock Crossing, due to be implemented in 2014, has been assumed to be in place in all forecasting.

4.2.4 Two future years have been modelled to determine a set of outcomes with and without the crossing options: 2025, which is the opening year assumed for analysis purposes and 2041, 16 years after the assumed opening date, when demand for the crossing may be expected to have matured.

4.3 The Base Case

4.3.1 This section describes what is expected to happen over the next three decades, how this is likely to affect demand for crossing capacity in the Lower Thames, and the consequences for strategic network performance, particularly delays, if no new crossing capacity in the lower Thames is added to the network.

4.3.2 Using the LTC Model, highway traffic from both local and national sources is forecast to increase over time. This is a consequence of a number of factors, but the main driver is the forecast increase in population, with higher growth forecast in the South East compared with the rest of the country. The overall UK-wide population is expected to increase by around 20% from 2009 to 2041, rising to around 25% in the South East.

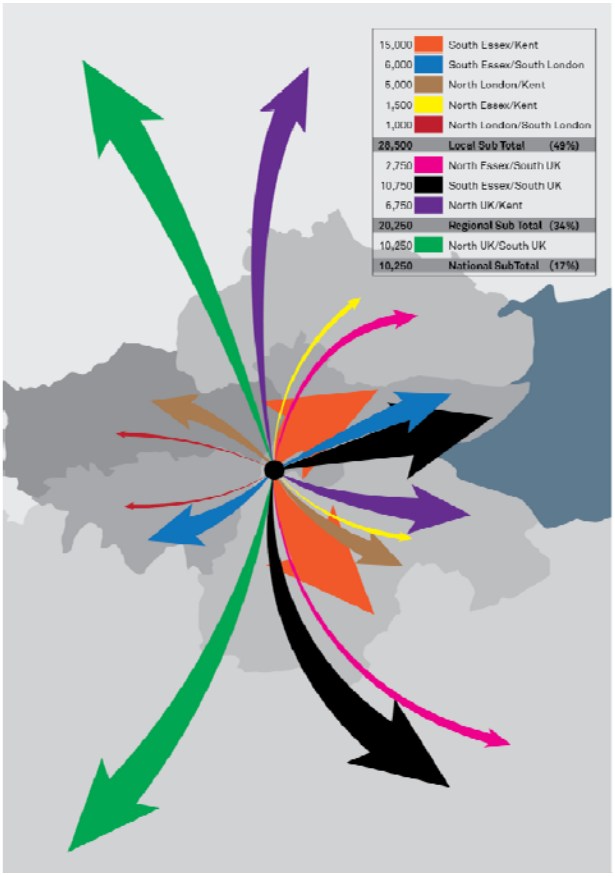
4.3.3 This population growth will be a significant factor underpinning a forecast increase in traffic flows. Traffic growth is forecast to be in excess of population growth, since the effect of improvements in fuel efficiency and income growth will be for travellers to make longer trips. Overall traffic flows are forecast to increase from 2009 (the base year for the model) to 2041 (the second modelled year) by around 30% across the policy area.

4.3.4 This increase in highway travel will have an effect upon the existing Dartford-Thurrock Crossing. In the absence of a new crossing location option, traffic flows between 2009 and 2041 are forecast to increase by 10% to 20% southbound, and 2% to 10% northbound; the latter is heavily constrained due to the lack of existing capacity on the strategic road network that provides access to the crossing. Notwithstanding these wider network constraints, the LTC Model forecasts that on a typical day, with no incidents, delays due to queuing on the crossing could exceed 10 minutes

northbound (from around 3 minutes in 2009) and 3 minutes southbound (from around 1 minute in 2009) by 2041. Allowing for incidents, existing evidence shows that currently almost half of users experience delays of over nine minutes, so in reality the delays experienced by most users are likely to be much longer than the average delays that the model predicts.

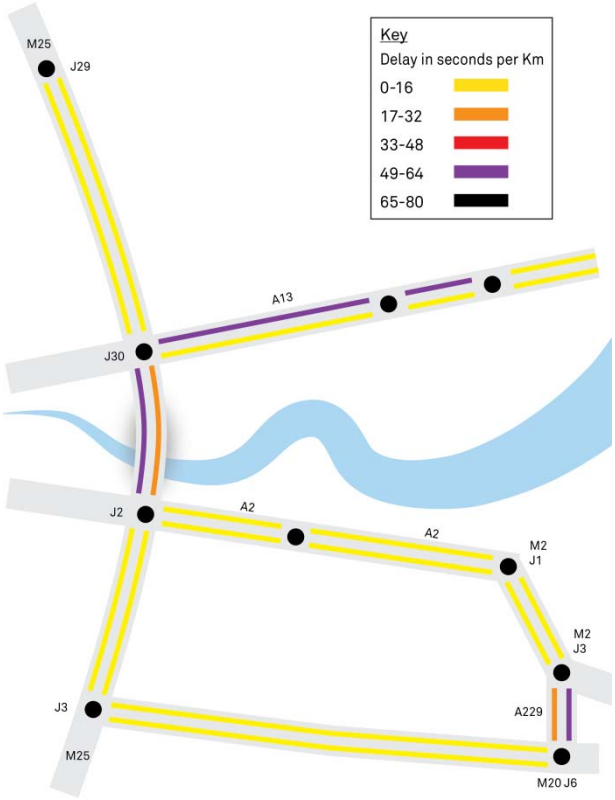
4.3.5 Patterns of travel forecast as using the Dartford-Thurrock Crossing in 2041 are illustrated in Figure 4.1, below. The direction and thickness of the arrows is a broad guide to the amount of demand to/from each area. All-day vehicle demand totals are also shown as a key. A little under half of the total travel is forecast to travel wholly within the policy area (London, South Essex and North Kent), around three tenths is expected to have either an origin or destination within the policy area, while about a fifth is predicted to have neither origin nor destination in the policy area.

Figure 4.1: All-day vehicle movements using Dartford-Thurrock Crossing, 2041, Without New Crossing



4.3.6 Strategic network performance is illustrated in Figure 4.2, in terms of seconds of delay per kilometre (zero would therefore be completely uncongested conditions). The worst delays are forecast to occur on the existing Dartford-Thurrock Crossing (especially northbound), and on the A229 where the variant of Option C is proposed. Some significant delay would also occur on the A13 eastbound.

Figure 4.2: Strategic Network Performance (Seconds of Delay per Kilometre), do-minimum, 2041



4.4 Direct Impact of New Crossings at Location Options

4.4.1 This section describes the demand that the location options would cater for, and the impacts on congestion and delay each location would have at the crossings and the surrounding road network. These impacts are important as they underpin many of the benefits and disbenefits described elsewhere in this chapter and appendices A to H of this report.

4.4.2 The impact of a new crossing at each location option has been assessed using the LTC Model and through the application of additional analysis. The results and analysis are discussed in detail in the internal review document: *Central Forecasts and Sensitivity Tests Report*, and are briefly summarised in this section below.

4.4.3 New crossings at all location options are forecast to result in more traffic, higher average speeds, more traffic crossing the Lower Thames, reduced queues, and shorter journey times across the Thames. Additional crossing capacity would reduce journey times and this can be expected to induce additional cross-river traffic.

4.4.4 All crossings are forecast to improve northbound capacity and travel more than southbound. This is because the existing Dartford-Thurrock Crossing is assumed to have lower capacity in the northbound direction than the southbound due to the effective capacity of the existing northbound tunnels being lower than the southbound bridge, even though there are the same number of lanes in each direction. Because of safety concerns about the maximum flow entering the northbound tunnels, and weaving traffic due to tunnel height restrictions, the free-flow charging scheme is not expected or assumed to increase the northbound capacity significantly.

Traffic at the Crossings and the origins and destinations of that demand

4.4.5 Any of the new crossings would be forecast to increase traffic crossing the Thames by between 1,000 to 2,000 vehicles per hour, depending on the chosen location, from a 2025 base case flow

of around 5,000-5,500 vehicles per hour across the existing crossing (more details on the traffic forecasts are set out in the internal review document: *Central Forecasts and Sensitivity Tests Report*. This indicates that a significant 'latent demand' is suppressed as a result of the current level of connectivity and journey times offered by the existing crossing.

4.4.6 Patterns of demand using both the existing and the new crossings at Option A (combined with the existing crossing), Option B and Option C are shown in figures below. These Figures show that:

- none of the new crossing options are forecast to materially affect the distribution of local versus national trip usage on the existing Dartford-Thurrock Crossing;
- a new crossing at Option B will attract mainly local traffic to or from South Essex, with very little longer-distance travel; and
- a new crossing at Option C will attract considerably more long-distance travel than Option B; more than half will have an origin or destination outside the policy area.

4.4.7 Traffic in South Essex and North Kent is forecast to increase by between 0.5% and 3% in 2025 as a result of new crossing capacity at each of the location options, with Option A resulting in the least additional traffic and Option $C_{variant}$ the most.

Figure 4.3: Movements using Dartford-Thurrock Crossing Without Scheme (left) and Option A (right) 2041

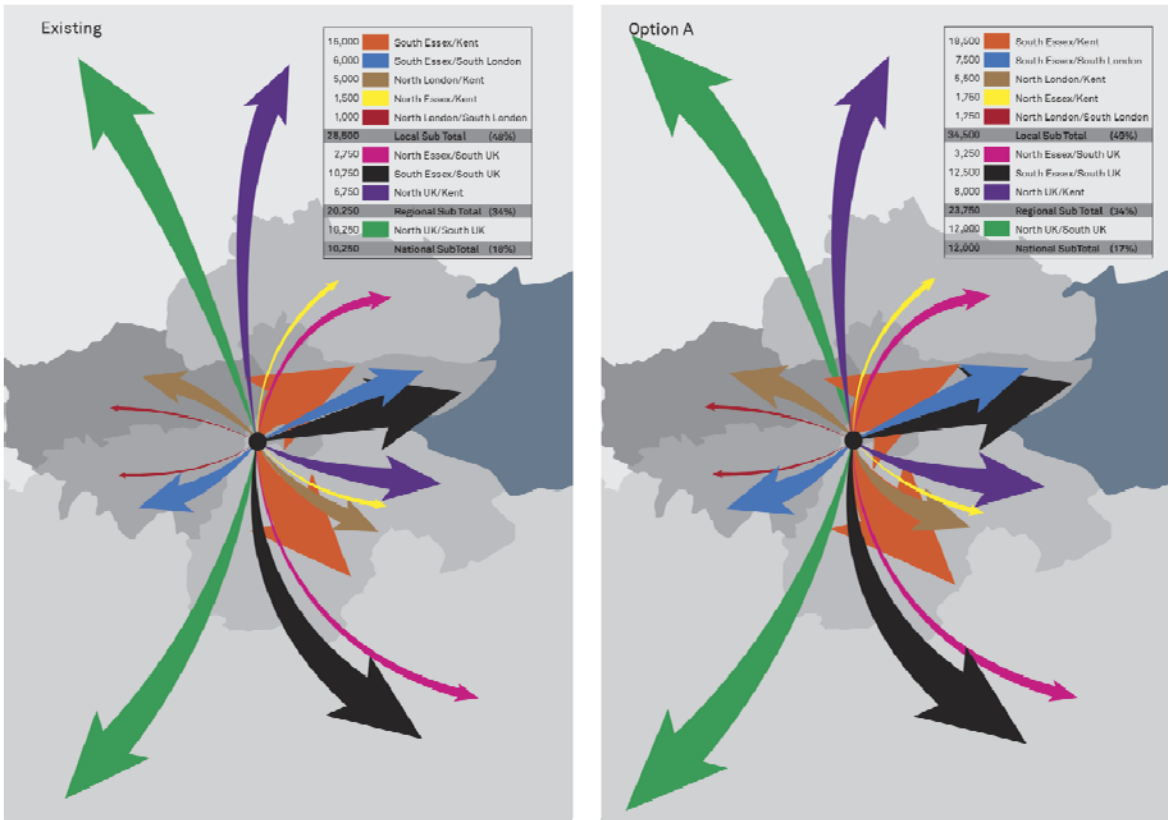


Figure 4.4: Movements using Thames Crossing under Option B, Dartford-Thurrock Crossing (left) and Option B (right) 2041

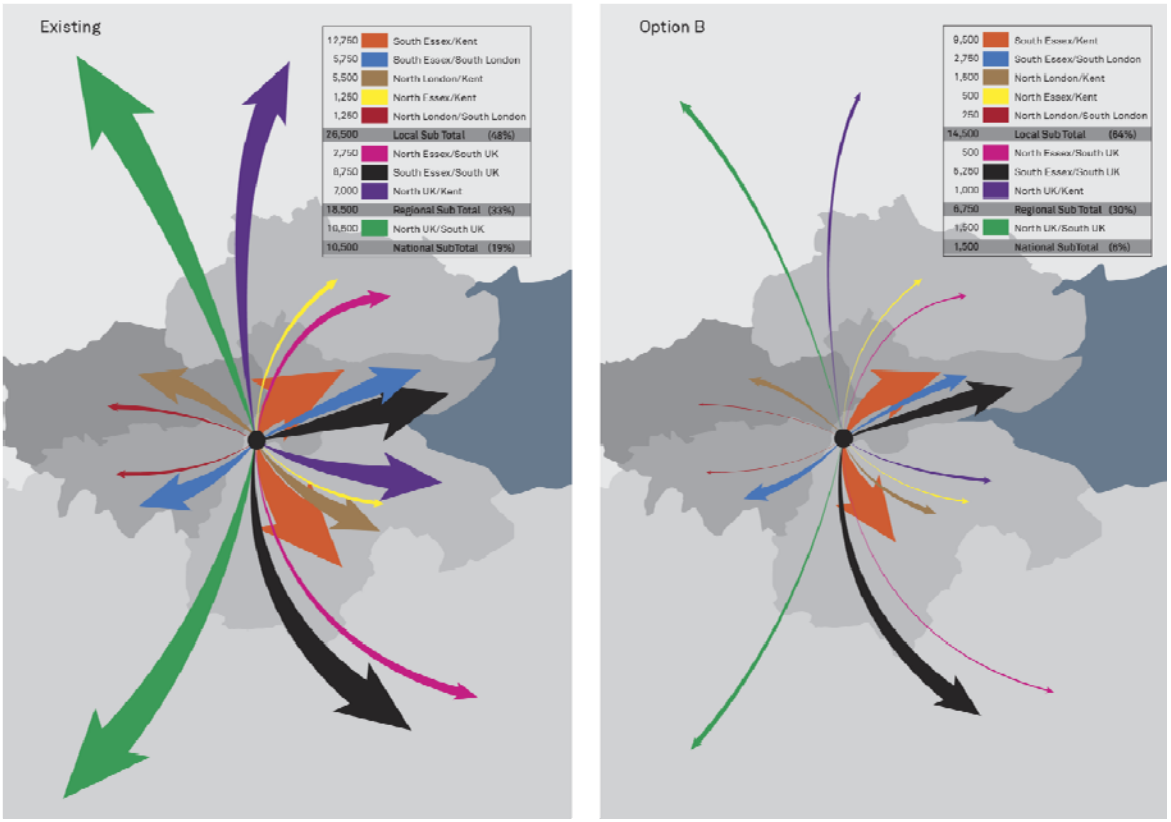
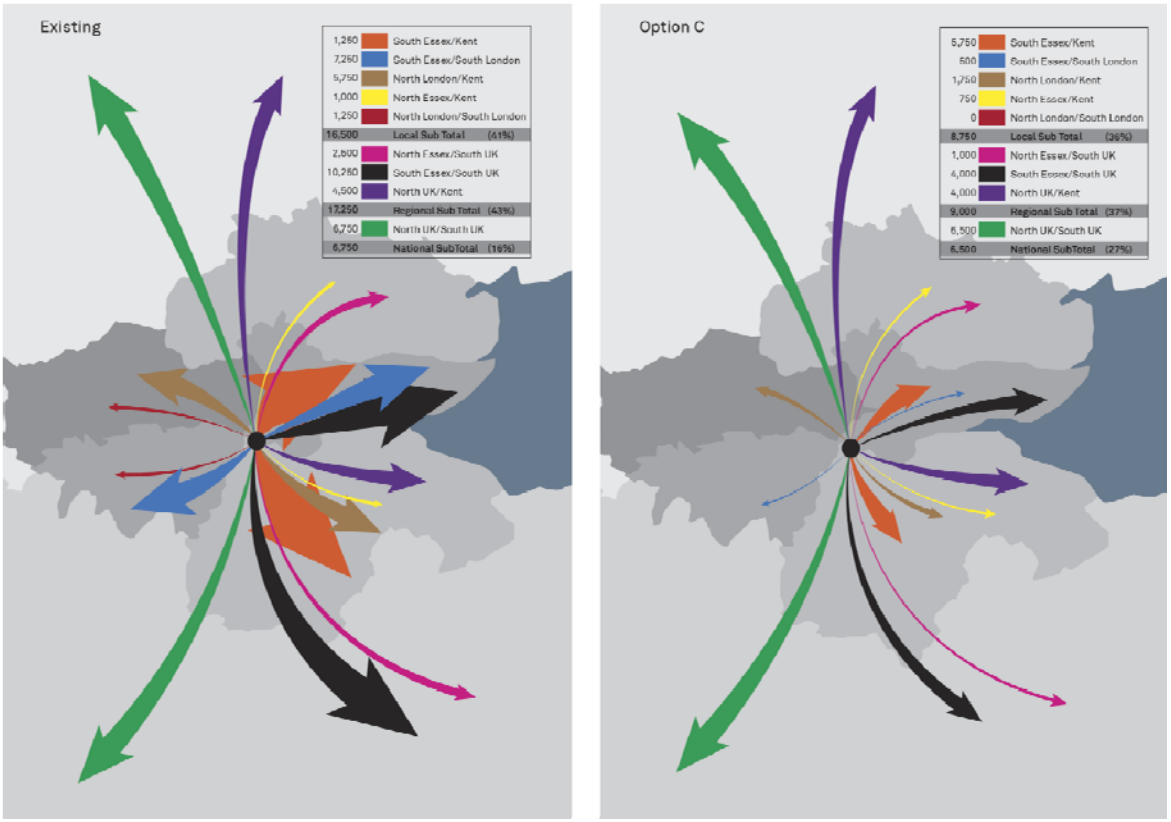


Figure 4.5: Movements using Thames Crossing under Option C, Dartford-Thurrock Crossing (left) and Option C (right) 2041



4.4.8 Traffic flows on the M25, M2/A2 and A13, in the policy area, are expected to increase as a direct result of the new location options, by up to around 500 vehicles per hour, or around 8-10%. This would bring the levels of traffic on the A13 and the M25 south of Dartford very close to the capacity of these links.

Impacts on congestion and journey times

4.4.9 The new crossing options are forecast to reduce journey times over the existing Dartford-Thurrock Crossing by 3 to 10 minutes, depending on location, time period and year. Journey times are forecast to reduce noticeably both for traffic using the new crossing (for appropriate journeys), and for traffic on the existing Dartford-Thurrock Crossing.

4.4.10 For **Options B, C and $C_{variant}$**, diversion of traffic to Options B and C is forecast to relieve some of the congestion on the existing Dartford-Thurrock Crossing. Despite being further east, Option C is forecast to have a greater impact than Option B.

4.4.11 For **Option $C_{variant}$** a 3% to 4% increase in total traffic on all roads in South Kent over Option C alone, is forecast. The variant saves an additional 3-6 minutes over Option C for journeys from the east of the M20 onto the M25 northbound, with this traffic forecast to re-route from the M20 to the A2 using the widened A229 . While it has a strong impact locally, it does not significantly increase forecast traffic upon the Option C crossing.

4.4.12 Forecast average delay in vehicle seconds per vehicle kilometre on all modelled roads within individual local authority districts is shown in Table 4.1 for the base case. The effect of each new crossing in terms of difference from the base case is also shown.

4.4.13 All the options would be expected to reduce congestion in Dartford significantly, as the main delay on the current crossing is at the south, in Dartford, where the northbound traffic enters the tunnel. Option $C_{variant}$ also would be forecast to significantly improve congestion near Tonbridge and Malling, but deterioration in Medway, where the section of the M2 feeding onto the upgraded A229 would be. Options A and B increase congestion notably in Thurrock, Basildon, Brentwood and Rochford to the north.

Table 4.1: Average Congestion Delays by Selected Districts (seconds per vehicle km) with New Crossings, 2041

Delay (s/km)	No new crossing	Option A	Option B	Option C	Option $C_{variant}$
Dartford	40.7	-6.5	-7.0	-7.6	-8.2
Gravesham	14.7	0.0	-0.2	-0.2	-0.0
Sevenoaks	13.2	0.4	0.3	0.5	0.6
Medway	34.9	-0.0	-0.2	-0.3	2.6
Tonbridge and Malling	20.7	-0.1	0.2	0.3	-2.8
Swale	6.1	0.1	0.4	0.7	-0.2
Thurrock	28.6	0.4	0.2	-0.8	-0.8
Brentwood	20.0	0.9	0.1	-0.0	-0.0
Basildon	60.8	0.1	0.3	0.5	0.5
Rochford	44.8	0.2	0.2	-0.1	-0.1
Castle Point	75.2	0.0	-0.2	-0.3	-0.3

4.4.14 Modelled journey times for various routes across the Dartford-Thurrock Crossing are shown in Table 4.2 in the base case, along with changes generated by a new crossing at each of the options. All of the options would improve journey times via the existing crossing to some degree by relieving congestion (this is shown in columns A to D).

4.4.15 Columns E and F show that the new routes would also be expected to provide substantial savings for those using those routes for certain journeys (such as Gravesend to Tilbury), but are much

longer for others (such as Harlow to Sevenoaks). These columns provide, for Options B and C, the total difference between journey time using options B or C and the time across the Dartford-Thurrock Crossing in the base case. Travellers generally would be expected to choose the route that has the shortest journey time: under the "via new crossing" columns (E and F), negative figures therefore imply that travellers would re-route to the new crossing, and positive figures imply that they would continue to use the Dartford-Thurrock Crossing.

4.4.16 The route users on each journey would be likely to choose (usually the route with the shortest journey time) is noted explicitly in columns G and H for each of the two options.

Table 4.2: Journey Times in minutes by Movement and Changes with New Crossings, 2041

Movement	via Dartford-Thurrock Crossing (Columns A – D)				via new crossing* (Columns E - F)		Route Choice (Columns G – H)	
	No new crossing	Option A	Option B	Option C	Option B	Option C	Option B	Option C
Harlow-Maidstone	72	-1	-1	-2	9	1	existing	either
Harlow-Sevenoaks	70	-1	-1	-1	11	13	existing	existing
Chelmsford-Sevenoaks	65	-1	-1	-2	8	12	existing	existing
Chelmsford-Maidstone	67	-1	-1	-2	6	0	existing	either
Basildon-Rochester	84	-1	-1	-3	-5	-9	optionB	optionC
Tilbury-Gravesend	38	-1	-1	-3	-14	-2	optionB	optionC
Grays-Dartford	16	-1	-1	-1	8	18	existing	existing
Birmingham-Dover	253	-1	-1	-1	4	-5	existing	optionC
Cambridge-Dover	149	-1	-1	-1	4	-5	existing	optionC
Cambridge-Brighton	146	-1	-1	-1	11	13	existing	existing
Cambridge-Margate	148	-1	-1	-2	3	-6	existing	optionC
Birmingham-Margate	252	-1	-1	-1	3	-5	existing	optionC
Maidstone-Harlow	77	-4	-4	-4	6	-6	existing	optionC
Sevenoaks-Harlow	75	-5	-4	-4	12	9	existing	existing
Sevenoaks-Chelmsford	71	-4	-4	-4	5	8	existing	existing
Maidstone-Chelmsford	73	-4	-4	-4	-1	-7	optionB	optionC
Rochester-Basildon	83	-5	-4	-6	-11	-13	optionB	optionC
Gravesend-Tilbury	46	-5	-5	-6	-24	-15	optionB	optionC
Dartford-Grays	24	-3	-3	-4	5	12	existing	existing
Dover-Birmingham	251	-3	-3	-3	4	-7	existing	optionC
Dover-Cambridge	156	-4	-4	-4	4	-8	existing	optionC
Brighton-Cambridge	155	-4	-3	-3	12	10	existing	existing
Margate-Cambridge	157	-5	-4	-4	3	-9	existing	optionC
Margate-Birmingham	252	-4	-3	-3	3	-8	existing	optionC

4.4.17 Option B would only be expected to attract relatively local movements (such as Gravesend to Tilbury and Basildon to Rochester), while Option C would also be expected to attract longer and strategic movements. Movements with an origin or destination east of the M25 (e.g. Maidstone to Harlow, Rochester to Basildon, Dover to Birmingham, Dover to Cambridge) are likely to re-route via a crossing located at Option C, as in effect they would travel a shorter distance (saving time also), by cutting off the M25-M20 corner they currently go through south of the crossing to access the A2/M20. Movements with neither end east of the M25, such as Brighton to Cambridge or

Sevenoaks to Harlow, would be likely to continue using the existing crossing (but would receive benefits from congestion relief at the existing crossing if the new crossing were built).

Figure 4.6: Local towns in Essex and Kent referred to in Table 4.2

4.4.18 The new crossings would be expected to have some impact on the performance of strategic roads in the area as shown in Figure 4.7 and 4.8 (these can be compared with Figure 4.2). All the options are forecast to relieve congestion significantly between the M25 junction 2 and junction 30. Option A would reduce congestion in a smaller area than the other options; it would improve journey times on the crossing itself more than the other options but induce additional traffic which would generate minor delays on either side.

4.4.19 Option B causes additional significant congestion on the A13 east of Basildon, but the modelling predicts that the new link itself would operate at close to free-flow conditions. There would be some significant delay on Option C northbound (not as bad as the Dartford-Thurrock Crossing in the without new crossing scenario), and worsened performance of the A229, which would be improved by the variant.

Figure 4.7: Network Performance (Delay per Kilometre), Option A (left) and Option B (right), 2041

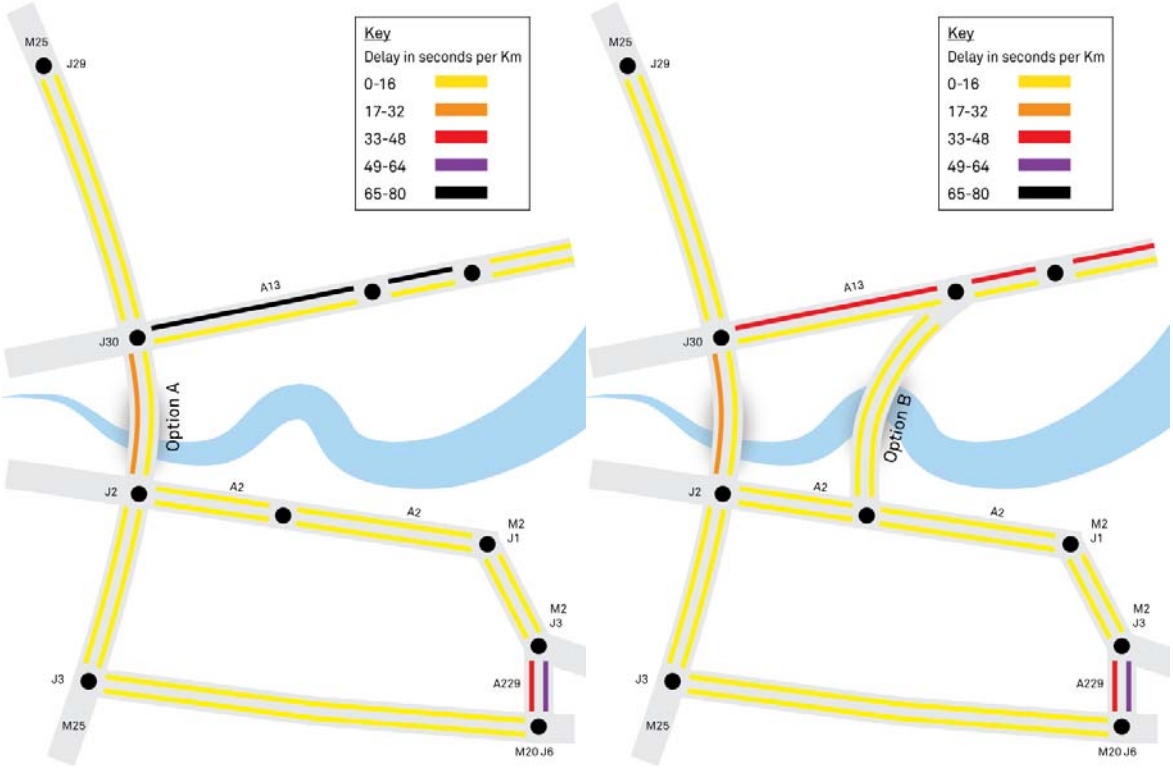
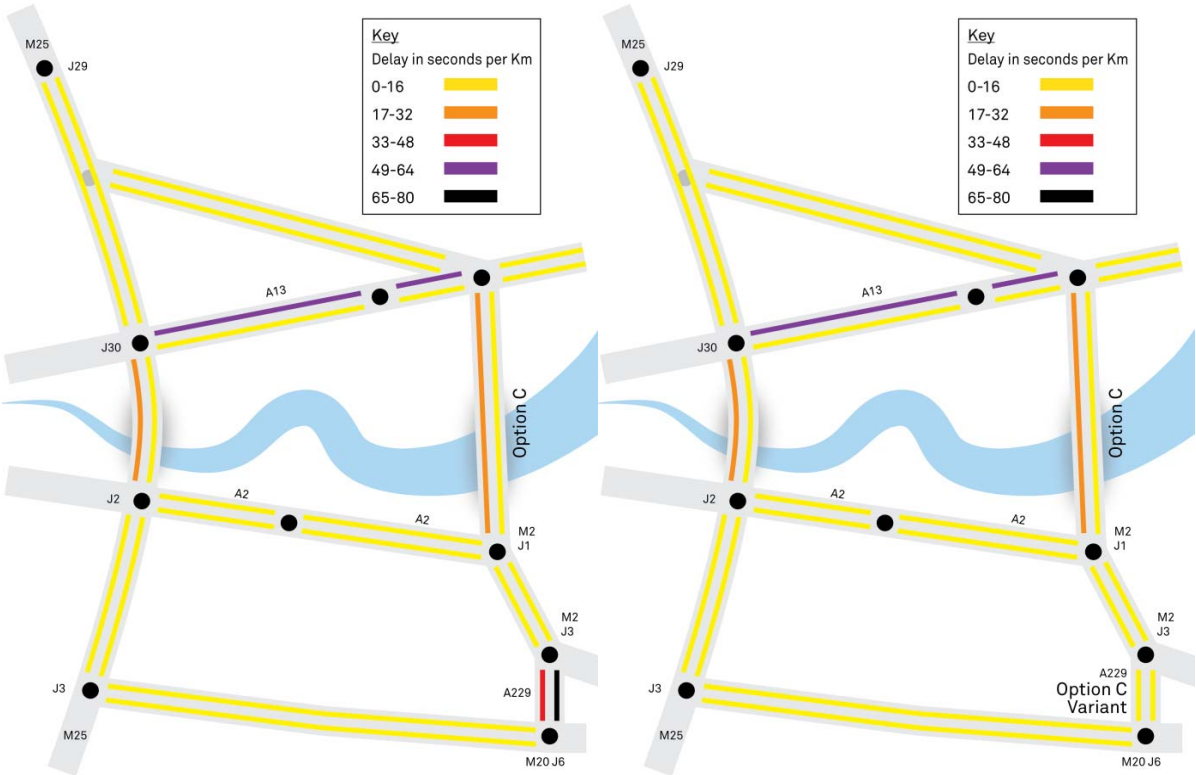


Figure 4.8: Network Performance (Delay per Kilometre), Option C (left) and Option $C_{variant}$ (right), 2041



Impacts on journey time reliability

4.4.20 The provision of an additional crossing is expected to have two distinct effects:

- an increase in the capacity of and thus reduced traffic stress at the Dartford-Thurrock Crossing, directly reducing the effects of and delays caused by incidents; and
- the provision of alternative road links and routes that provide the ability to manage demand, and thus help mitigate delays caused by incidents by directing demand to the tunnel or bridge that remains open.

4.4.21 A quantitative, but non-monetised, assessment of the impact of the new crossings on traffic stress has been made following the guidance in WebTAG 3.5.7 Annex F. The modelled average annual daily traffic (AADT) is compared to the "Congested Reference Flow", a measure of the daily flow at which significant capacity problems are likely to be observed in the peak hours, and network stress calculated as the ratio of the two. The results imply significant stress relief, as shown in Table 4.3, with stresses capped below at 75% following the Annex F guidance, where it is assumed that below 75%, delay due to congestion is negligible.

4.4.22 Significant stress is evident in the without new crossing case. All four options produce outturn stress on the new crossing of significantly below 75%, that is, uncongested traffic conditions; this is reported in Table 4.3 as a stress of less than 75%. Options B and C reduce stress on the existing Dartford-Thurrock Crossing to around 90%. Option $C_{variant}$ has negligible impact upon the Dartford-Thurrock Crossing compared to Option C.

Table 4.3: Stress (AADT/CRF) for Reliability Assessment, 2041

Scenario	Dartford-Thurrock Crossing	New crossing
Without new crossing	112%	-
Option A	<75%	-
Option B	91%	<75%
Option C	90%	<75%
Option $C_{variant}$	90%	<75%

4.4.23 It should be noted that this is a fairly simple approach, reflecting the current level of research surrounding assessment of reliability benefit. As it is link-based, it does not reflect junction performance, especially some reductions in junction performance evident as a result of the traffic forecast to be induced to the north of the Thames by Option B.

4.4.24 The provision of an alternative crossing structure (including, to a lesser extent, one in the same broad location such as Option A), as noted in the second bullet point in 4.4.20, would provide further reliability benefit by providing increased flexibility in network management, allowing traffic alternative routeing options during incidents or planned roadworks.

4.4.25 Currently there is only a single crossing point east of London. From discussions with TfL it is understood that a consequence of temporary closure and resultant significant delays at the existing crossing is for some drivers to seek to divert through the Blackwall tunnel, which has a consequential effect of significantly increasing congestion at that location.

4.4.26 The provision of a new crossing at location Options B and C (and, to a lesser extent, at Option A) would provide an alternative route offering the potential to increase the resilience of the strategic road network in response to incidents and maintenance. One aspect of developing a future scheme in detail would be to consider strategies for managing incidents and planned works to maximise the overall network resilience of the Thames crossings.

4.5 Appraisal Summary Tables

4.5.1 The objective of the appraisal process is to provide the evidence base which supports the Department for Transport's five case[37] model to judge the relative performance of new River Thames crossings at the three location options. This review document contains the components of a strategic outline business case, for which Appraisal Summary Tables are not usually necessary. However, the Appraisal Summary Table provides a convenient format with which to present a summary of the appraisal results, and has therefore been adopted, with some modification to better present material where appropriate.

4.5.2 Appraisal Summary Tables (ASTs) are therefore presented for each location option below, with varying impacts of different engineering solutions presented within these tables.

4.5.3 Monetised values in the ASTs are expressed in a fixed price base (2010 market prices), and are, in accordance with guidance, discounted to 2010; that is, benefits and disbenefits in the distant future have less weighting than the near future, reflecting the value society attaches to present relative to future consumption (known as social time preference). Values are in millions of pounds sterling, rounded to the nearest million. Totals, where reported in tables, have been summed using precise figures and then separately rounded to the nearest million; totals will therefore not always exactly equal the sum of the rounded figures in individual lines of the tables.

4.5.4 Except where noted otherwise, monetary values are expressed as benefits. Positive values thus indicate benefit, such as revenue collected or travel time saved, while negative values indicate disbenefit or cost, such as additional toll paid or capital cost. Except where noted otherwise, benefits and costs are for a standard 60-year appraisal (which is the required period in Department for Transport guidance) from 2025 (the assumed new crossing opening year) to 2084 inclusive.

4.5.5 Readers should note that forecast changes in revenues collected from users, reported in the economic appraisal outputs that this Chapter reports, differ from those in the Financial Case (Chapter 6), as the former are changes rather than absolutes, discounted by the social rate of time preference and summed over 60 years. The figures in the Financial Case (Chapter 6) are therefore more relevant to the assessment of affordability; those presented in this Chapter are simply part of the calculation of the costs and benefits to society over the 60-year appraisal period.

4.5.6 More detailed discussion of each Appraisal Summary Table sub-impact then follows; supporting information is provided in the Appendices to this document as follows.

- Appendix A: Detailed Appraisal Assessments
- Appendix B: Economic Appraisal Methodology
- Appendix C: Environmental Appraisal Methodology
- Appendix D: Wider Impacts Methodology
- Appendix E: Transport Economic Efficiency Tables
- Appendix F: Public Accounts Tables
- Appendix G: Environmental Worksheets and Tables

4.5.7 The 'do-minimum' is equivalent to the base case, i.e. the situation where none of the crossing options are built. The 'do-something' in each context is the situation if a crossing at the option referred to were to be built.

[37] Strategic, Economic, Commercial, Financial and Management cases

Table 4.4: Appraisal Summary Table: Option A, 60 year appraisal, 2025-2084

Appraisal Summary Table		Date produced:	08 May 2013	Contact:	
Name of option:	Lower Thames Crossing Option A			Name	
Description of option:	Expansion of the capacity of the existing Dartford-Thurrock river crossing through the construction of a new bridge or tunnel.			Organisation	
				Role	Promoter/Official

	Impacts	Summary of key impacts	Assessment: Quantitative	Qualitative	Monetary £(NPV)	Social and Distributional Impact (SDI)
Economy	Business users & transport providers	Large time benefits to business travellers, including freight, due to reduced congestion. Small vehicle operating cost benefits also occur, likew ise due to reduced congestion. Small road toll disbenefit, as a few travellers are induced to shift from untolled alternatives, such as the Blackw all tunnel.	**Value of journey time changes(£)** £705m **Net journey time changes (£)** 0 to 2min: =£890m-£1095m = -£205m 2 to 5min: = £680m - £72m = £608m > 5min: = £308m - £6m = £302m	Not Applicable	£671m	
	Reliability impact on Business users	option relieves congestion on the Dartford crossing. Journey time reliability w ould thus improve.	Stress on Dartford crossing forecast to fall from 112% to under 75%.	Large Beneficial	Not Applicable	
	Regeneration	option expected to shift employment opportunities tow ards the Thames Gatew ay, mainly from other parts of London. Benefits expected to be concentrated in the London Thames Gatew ay in the shorter term w ith longer term grow th in employment opportunities in the Kent and Essex Thames Gatew ay.	500 jobs are expected to relocate to the Thames Gatew ay as a result of the option in 2025.	Slight Beneficial	Not applicable	
	Wider Impacts	Significant w ider economic impact is expected to occur in terms of support for the agglomeration of business activity in London, Kent and Essex (WI1).	WI1: Agglomeration Benefit- £195m WI3: Change in Output in Imperfect Competition- £56m WI4: Tax Wedge on Labour Market- -£0m	Not Applicable	£251m	
Environmental	Noise	Residential properties w ould be subject to some adverse noise impacts around the existing crossing.	Total population in assessment: 372,690 Do Minimum: 69,985 annoyed Do Something: 70,230 annoyed Net increase in people annoyed - 245 in year 15.	Not Applicable	-£9m	*IMD income domain (%):* 0-20%: large averse 20-40%:moderate adverse 40-60%:slight adverse 60-80%:moderate adverse 80-100%:slight adverse
	Air Quality	Improvements in local air quality w ould be expected for greater proportion of zones (road links) than a deterioration relative both to present (2009) and future scenarios (2025).	1. Compared to present (2009): zones w ith improvement in NO2 (PM10) = 73.5% (67.1%); zones w ith deterioration = 26.2% (32.6%). zones w ith no change = 0.3% (0.3%) 2. Compared to future (2025): zones w ith improvement in NO2 (PM10) = 57.7% (58.4%); zones w ith deterioration = 38% (28.4%); zones w ith no change = 22% (13.2%)	Not Applicable	£0m	*IMD income domain (%):* 0-20%:moderate beneficial 20-40%:moderate beneficial 40-60%:moderate beneficial 60-80%: slight beneficial 80-100% large beneficial
	Greenhouse gases	The option is forecast to result in a decrease in carbon emissions.	Change in carbon over 60yr- -700,000 tonnes	Not Applicable	£31m	
	Landscape	Not Applicable	Not Applicable	Not Applicable	Not Applicable	
	Tow nscape	A potential future new river crossing and associated new road infrastructure w ould introduce a new linear element in the tow nscape but is likely to fit w ell w ith the existing scale, character and appearance of the existing bridge and road infrastructure w hich is a dominant visual feature of the area.	Not Applicable	Neutral to Slight Adverse	Not Applicable	
	Heritage of Historic resources	Option A may impact a limited number of know n cultural heritage sites. These w ould be direct physical effects potentially leading to a total loss of some assets. No setting impact on designated sites is likely although the setting of some undesignated sites could be affected.	Not Applicable	Moderate Adverse	Not Applicable	
	Biodiversity	**Bridge:** potential large adverse effects on the areas of mudflat directly beneath a bridge, w ith some cumulative impact w ith the existing Dartford crossing. Large adverse effect w ould be on West Thurrock Lagoon and Marshes SSSI. **Bored tunnel:** potential impacts during the construction stage for a bored tunnel but the completed tunnel is unlikely to impact upon the marine environment. The coastal/terrestrial impacts could be reduced in comparison to the erection of a bridge depending upon the location of the tunnel entrances. **Immersed tunnel:** potential for large adverse impacts on the recommended Marine Conservation Zone and its associated species and habitats for an immersed tunnel. Large adverse effect on West Thurrock Lagoon and Marshes SSSI.	Not Applicable	Slight to Large Adverse	Not Applicable	
	Water Environment	The main potentially significant impact w ould be due to changes to the form and processes of the River Thames as a result of a potential future river crossing. An immersed tunnel could have potentially significant effects and the risk during construction is likely to be greater than either a bridge or bored tunnel. All three potential crossing methods and routes present a risk of increasing flood risk or being impacted upon by flood risk.	Not Applicable	Moderate to Large Adverse	Not Applicable	
Social	Commuting and Other users	Significant time benefits to consumer travellers, due to reduced congestion, although some short trips experience disbenefit due to increased congestion around the crossing access locations. Small road toll disbenefit, as the new crossing w ill be tolled.	**Value of journey time changes(£)** £187m **Net journey time changes (£)** 0 to 2min: = £551m - £700m = -£149m 2 to 5min: = £251m - £26m = £225m > 5min: = £113m - £1m = £112m	Not Applicable	£194m	*LTC Model Income:* Low : Slight Beneficial Med: Large Beneficial High: Large Beneficial
	Reliability impact on Commuting and Other users	Overall the option w ould improve reliability, as a result from congestion relief on the Dartford crossing.	Stress on Dartford crossing forecast to fall from 112% to under 75%.	Large Beneficial	Not Applicable	
	Physical activity	Transport model forecasts decreases in total trips, increases for long, cross-river trips, and decreases for short trips due to localised congestion. Consequently, very slight positive effect is expected, as some short trips sw itch to cycling or w alking.	Not Applicable	Neutral	Not Applicable	
	Journey quality	**Tunnel:** view w ould be restricted for southbound travellers (slight adverse). **Bridge:** view w ould improve for northbound travellers (slight beneficial).	Not Applicable	Neutral	Not Applicable	
	Accidents	The new crossing is forecast to increase traffic and thus accidents.	26,000 additional accidents of all classes, including 31 additional fatalities.	Not Applicable	-£117m	
	Security	The Option is a major trunk road and motorists w ill not be required to stop. There should similarly be no change to perceptions of security.	Not Applicable	Neutral	Not Applicable	
	Access to services	The Option w ould have no direct impact on public transport services or access to them.	Not Applicable	Neutral	Not Applicable	
	Affordability	The option w ould charge the same toll as the existing crossing. Affordability impacts w ould therefore be small. The option w ould generate some decongestion w hich in turn reduces fuel costs slightly for consumer travellers.	Not Applicable	Slight Beneficial	Not Applicable	No significant impact.
	Severance	The Option w ould have no direct impact on pedestrian routes or access. Pedestrians are unlikely to be permitted to use the crossing and it is not considered likely that any pedestrian routes w ill be severed by the new crossing.	Not Applicable	Neutral	Not Applicable	
	Option values	The new crossing w w ould be located at broadly the same point as the existing crossing, and as such w ill not generate any new journey options.	Not Applicable	Neutral	Not Applicable	
Public Accounts	Cost to Broad Transport Budget	The impacts upon the transport budget w ould be tw ofold; the capital cost of construction and supsequent maintenance and operating cost of the infrastructure and the revenue collected from tolls.	Toll Revenue: £484m Capital: -£787m (bridge) -£1005m (immersed tunnel) -£987m (bored tunnel) Maintenance: -£124m (bridge) -£206m (immersed tunnel) -£199m (bored tunnel)	Not Applicable	-£427m (B) -£727m (IT) -£703m (BT)	
	Indirect Tax Revenues	The option generates traffic, and w ould therefore increase fuel consumption and thus the government's tax revenue from fuel.	Tax Revenue Benefit: -£9m	Not Applicable	-£9m	

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million. Revenues are shown as negative costs to the transport budget.

Table 4.5: Appraisal Summary Table: Option B, 60 year appraisal, 2025-2084

Appraisal Summary Table			Date produced:	13 May 2013		Contact:	
Name of option:	Lower Thames Crossing Option B					Name	
Description of option:	A new Thames crossing connecting the A1089 with the A2 just west of Gravesend.					Organisation	
						Role	Promoter/Official

Impacts		Summary of key impacts	Assessment: Quantitative	Qualitative	Monetary £(NPV)	Social and Distributional Impact (SDI)
Economy	Business users & transport providers	Large time benefits to business travellers, including freight, due to reduced congestion and improved connectivity. Small vehicle operating cost benefits would also occur, due to reduced congestion. Small road toll disbenefit, as the new crossing will be tolled.	**Value of journey time changes(£)** £1100m **Net journey time changes (£)** 0 to 2min: =£1229m-£1485m -£256m 2 to 5min: = £812m - £259m = £553m > 5min: = £891m - £89m = £802m	Not Applicable	£1172m	
	Reliability impact on Business users	Option would relieve congestion on the existing Dartford crossing and provide an alternative route with little congestion. Journey time reliability would thus improve.	Stress on Dartford Crossing forecast to fall from 112% to 91%. Stress on new crossing to be less than 75%.	Large Beneficial	Not Applicable	
	Regeneration	Option expected to have a significant impact on the pattern of employment growth, particularly shifting employment opportunities towards the Kent and Essex Thames Gateway areas.	2,100 additional jobs expected in the Thames Gateway in 2025	Moderate Beneficial	Not applicable	
	Wider Impacts	Option connects South Essex and North Kent across a corridor that previously did not exist, thus enabling journeys that would previously have been much longer. Large agglomeration benefits would accrue due to Option's strong connectivity role. The largest economic impact is expected to be support for the agglomeration of business activity in London, Kent and Essex (WI1).	WI1: Agglomeration Benefit- £507m WI3: Change in Output in Imperfect Competition- £99m WI4: Tax Wedge on Labour Market- £0m	Not Applicable	£606m	
Environmental	Noise	Option B introduces a new crossing and would have moderately adverse noise impacts on properties in the area along the new sections of road leading towards and away from the crossing. Adverse noise impact on Thameside Infant School in Grays.	Total population in assessment: 372,690 Do Minimum: 69,985 annoyed Do Something: 71,842 annoyed Net increase in people annoyed - 1857 in year 15.	Not Applicable	-£70m	*IMD income domain (%):* 0-20%: moderate averse 20-40%: large adverse 40-60%:slight adverse 60-80%: large adverse 80-100%:slight adverse
	Air Quality	Option B would result in a greater number of road links having an improvement in air quality compared with the current situation but a greater number of links would have a deterioration in the future compared with the future Do-Minimum.	1. Compared to present (2009): roads with improvement in NO2 (PM10) = 64% (61%); roads with deterioration = 36% (38%). roads with no change = 1% (1%) 2. Compared to future (2025): roads with improvement in NO2 (PM10) = 37% (38%);roads with deterioration = 49% (49%); zones with no change = 13% (13%)	Not Applicable	-£2m	*IMD income domain (%):* 0-20%:large beneficial 20-40%:slight adverse 40-60%:large adverse 60-80%: large adverse 80-100% moderate adverse
	Greenhouse gases	The option is forecast to result in an increase in carbon emissions.	Change in carbon over 60yr- 1,300,000 tonnes	Not Applicable	-£60m	
	Landscape	A potential future new river crossing and associated new road infrastructure would introduce a new transport corridor and very large bridge or tunnel infrastructure and elevated road infrastructure. There would be impacts on the setting and local amenity of residential areas and direct and indirect impacts on locally valued landscape features. An ancient monument of national importance would also be directly impacted.	Not Applicable	Moderate Adverse	Not Applicable	
	Townscape	A potential future new river crossing and associated new road infrastructure would introduce a new transport corridor and very large bridge or tunnel infrastructure and elevated road infrastructure. While a bridge would have a greater impact as a dominant feature visible over a wide area, all three options would introduce structures out of scale with the local townscape character, impacting directly and indirectly on locally valued townscape features including school grounds and recreational greenspace. The bridge infrastructure would also be a notable new element in the long open vistas of the Thames and the setting of local residential areas within the Grays area. All three crossing structures would also directly impact a Scheduled Monument of national importance (the Roman town of Vagniacis).	Not Applicable	Moderate Adverse	Not Applicable	
	Heritage of Historic resources	Option B may impact on a number of previously recorded cultural heritage sites including the Scheduled Roman settlement of Vagniacis and palaeolithic remains found in Southfleet Road. The illustrative alignment would affect the setting of several more including two Scheduled Monuments of Palaeolithic and Neolithic date.	Not Applicable	Large Adverse	Not Applicable	
	Biodiversity	**Bridge:** potential impacts on the areas of mudflat and their associated bird populations, particularly those associated with the West Thurrock Lagoon and Marshes SSSI due to increased disturbance from traffic during the operational phase. **Bored tunnel:** potential impacts during the construction stage but the completed tunnel is unlikely to impact upon the marine environment. The coastal/terrestrial impacts could be reduced in comparison to the erection of a bridge depending upon the location of the tunnel entrances. **Immersed tunnel:** potential for large adverse impacts on the recommended Marine Conservation Zone and its associated species and habitats and West Thurrock Lagoon and Marshes SSSI. **Road links:** potential for slight adverse effects on ancient woodland and moderate adverse effects on coastal and floodplain grazing marsh and a Local Wildlife Site.	Not Applicable	Moderate to Large Adverse	Not Applicable	
	Water Environment	The main potentially significant impact would be due to changes to the form and processes of the River Thames as a result of a potential future river crossing. An immersed tunnel could have potentially significant effects and the risk during construction is likely to be greater than either a bridge or bored tunnel. All three potential crossing methods and routes present a risk of increasing flood risk or being impacted upon by flood risk.	Not Applicable	Moderate to Large Adverse	Not Applicable	
Social	Commuting and Other users	Small time benefits overall to consumer travellers, due to reduced congestion and improved connectivity, although many short trips could experience disbenefit due to increased congestion around the crossing access locations. Large non-fuel vehicle operating cost disbenefit would be due to increased travel and lack of perception by consumer travellers. Small road toll disbenefit, as the new crossing will be tolled.	**Value of journey time changes(£)** £38m **Net journey time changes (£)** 0 to 2min: =£2849m-£4355m = -£1506m 2 to 5min: =£1236m - £813m = £423m > 5min: = £1375m - £254m = £1121m	Not Applicable	-£318m	*LTC Model Income:* Low : Slight Adverse Med: Large Adverse High: Large Adverse
	Reliability impact on Commuting and Other users	Overall the option would improve reliability, from congestion relief on the existing Dartford crossing and the new crossing.	Stress on Dartford Crossing forecast to fall from 112% to 91%. Stress on new crossing to be less than 75%.	Large Beneficial	Not Applicable	
	Physical activity	Transport model forecasts decreases in total trips, increases for long, cross-river trips, and decreases for short trips due to localised congestion. Consequently, very slight positive effect is expected, as some short trips switch to cycling or walking.	Not Applicable	Neutral	Not Applicable	
	Journey quality	The additional routeing complexity and risk that some trips cannot access services are minor negative elements. The visible landscape is expected to be similar, **Tunnel:** view would be restricted for southbound travellers (slight adverse). **Bridge:** view would improve for northbound travellers (slight beneficial).	Not Applicable	Slight Adverse	Not Applicable	
	Accidents	The new crossing is forecast to increase traffic and thus accidents.	58,000 additional accidents of all classes, including 80 additional fatalities.	Not Applicable	-£282m	
	Security	The option is a major trunk road and motorists would not be required to stop given the free-flow tolling system being assumed.	Not Applicable	Neutral	Not Applicable	
	Access to services	The Option would have no direct impact on public transport services or access to them.	Not Applicable	Neutral	Not Applicable	
	Affordability	The Option would charge the same toll as the existing crossing. Affordability impacts are therefore small. The option overall would generate some congestion for short distance trips, which would increase consumer fuel costs.	Not Applicable	Slight Adverse	Not Applicable	No significant impact.
	Severance	The Optionw ould have no direct impact on pedestrian routes or access. Pedestrians are unlikely to be permitted to use the crossing and it is not considered likely that any pedestrian routes will be severed by the new crossing.	Not Applicable	Neutral	Not Applicable	
	Option values	The new crossing would create a road transport link that does not currently exist. However, the crossing would have limited usability for very local trips, since there would be no access to it on the immediate north bank of the river. A few local residents on either side of the new crossing may value the connection quite highly, but the number of people affected by this is expected to be small.	Not Applicable	Neutral	Not Applicable	
Public Accounts	Cost to Broad Transport Budget	The impacts upon the transport budget would be twofold; the capital cost of construction and subsequent maintenance and operating cost of the infrastructure and the revenue collected from tolls.	Toll Revenue: £649m Capital: -£1115m (bridge) -£1263m (immersed tunnel) -£1362m (bored tunnel) Maintenance: -£183m (bridge) -£278m (immersed tunnel) -£286m (bored tunnel)	Not Applicable	-£650m (B) -£892m (IT) -£999m (BT)	
	Indirect Tax Revenues	The option would generate traffic, and would therefore increase fuel consumption and thus the government's tax revenue from fuel.	Tax Revenue Benefit: £66m	Not Applicable	£66m	

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million. Revenues are shown as negative costs to the transport budget.

Table 4.6: Appraisal Summary Table: Option C, 60 year appraisal, 2025-2084

Appraisal Summary Table		Date produced:	20 May 2013	Contact:	
Name of option:	Lower Thames Crossing Option C			Name	
Description of option:	A new trunk road connecting the M25 with the M2 via the A13, including a bridge or tunnel across the Thames east of Gravesend.			Organisation	
				Role	Promoter/Official

	Impacts	Summary of key impacts	Assessment: Quantitative	Qualitative	Monetary £(NPV)	Social and Distributional Impact (SDI)
Economy	Business users & transport providers	Large time benefits expected to business travellers, including freight, due to reduced congestion and improved connectivity. Small vehicle operating cost benefits also would occur, due to reduced congestion. Small road toll disbenefit, as the new crossing will be tolled.	**Value of journey time changes(£)** £1867m **Net journey time changes (£)** 0 to 2min: =£1376m-£1552m = -£176m 2 to 5min: = £920m - £186m = £734m > 5min: = £1404m - £96m = £1308m	Not Applicable	£2175m	
	Reliability impact on Business users	Option would relieve congestion on the existing Dartford crossing and would provide an alternative route with little congestion. Journey time reliability would thus improve.	Stress on Dartford Crossing forecast to fall from 112% to 90%. Stress on new crossing to be less than 75%.	Large Beneficial	Not Applicable	
	Regeneration	Widespread and significant changes to journey opportunities would be expected to shift employment opportunities eastwards, particularly benefiting the Kent and Essex Thames Gateway areas and other easterly parts of Kent and Essex.	3,000 additional jobs expected in the Thames Gateway in 2025	Moderate Beneficial	Not applicable	
	Wider Impacts	Option connects South Essex and North Kent across a corridor that previously did not exist, thus enabling journeys that would previously have been much longer. Large agglomeration benefits would accrue due to option's strong connectivity role.	WI1: Agglomeration Benefit- £999m WI3: Change in Output in Imperfect Competition- £162m WI4: Tax Wedge on Labour Market- £1m	Not Applicable	£1162m	
Environmental	Noise	Option C would introduce a new road link across the river causing adverse noise impacts in fairly rural areas. Some benefits in reduction of noise impacts along the A2 would be indicated.	Total population in assessment: 372,690 Do Minimum: 69,985 annoyed Do Something: 71,754 annoyed Net increase in people annoyed - 1769 in year 15.	Not Applicable	-£72m	*IMD income domain (%):* 0-20%: large averse 20-40%: large adverse 40-60%: large beneficial 60-80%: slight beneficial 80-100%: large beneficial
	Air Quality	Improvement in local air quality for greater proportion of zones (road links) than deterioration would be expected relative to present (2009) scenario. Deterioration in local air quality for greater proportion of zones than improvement forecast for future (2025) scenario.	1. Compared to present (2009): zones with improvement in NO2 (PM10) = 71.8% (71.5%); zones with deterioration = 27.8% (28.1%). zones with no change = 0.4% (0.4%) 2. Compared to future (2025): zones with improvement in NO2 (PM10) = 44.2% (44.4%); zones with deterioration = 50.6% (50.4%); zones with no change = 5.2% (5.2%)	Not Applicable	£8m	*IMD income domain (%):* 0-20%: large beneficial 20-40%: moderate adv. 40-60%: large adverse 60-80%: large adverse 80-100% slight adverse
	Greenhouse gases	The option is forecast to result in a decrease in carbon emissions.	Change in carbon over 60yr- -6,000,000 tonnes	Not Applicable	£278m	
	Landscape	A potential future new river crossing and associated new road infrastructure would introduce a significant change to the existing landscape. The new road corridor and junction infrastructure could impact directly and indirectly on locally and nationally valued landscape features including the Kent Downs AONB, Cobham Hall Registered Historic Park and Garden, cultural heritage features and ancient woodlands.	Not Applicable	Moderate to Large Adverse	Not Applicable	
	Townscape	Not Applicable	Not Applicable	Not Applicable	Not Applicable	
	Heritage of Historic resources	Option C would impact directly on at least one Scheduled Monument and potentially pass in close proximity to a second. This would include impacts on both the physical remains and the setting of features. The setting of a number of Conservation Areas and listed buildings would also be affected.	Not Applicable	Large Adverse	Not Applicable	
	Biodiversity	**Bridge:** potential impacts on the Thames Estuary and Marshes Ramsar site including direct habitat loss and impacts on bird populations, including those supported by the Thames Estuary and Marshes SPA. **Bored tunnel:** potential impacts during the construction stage but the completed tunnel is unlikely to impact upon the marine environment. The location of the tunnel entrance points is critical, as in order to minimise impacts upon designated sites the tunnel length may need to increase, in order to avoid the Thames Estuary and Marshes. **Immersed tunnel:** potential for large adverse impacts on the recommended Marine Conservation Zone and its associated species and habitats. The impact of the road links may also be similar to that of the bridge, as the tunnel entrances may not be able to be situated away from the Thames Estuary and Marshes Ramsar/SSSI. **Road links:** potential for very large adverse effects on the Shorne and Ashenbank Woods SSSI and moderate adverse effects on coastal and floodplain grazing marsh.	Not Applicable	Very Large Adverse	Not Applicable	
	Water Environment	The main potentially significant impact would be due to changes to the form and processes of the River Thames as a result of a potential future river crossing. An immersed tunnel could have potentially significant effects and the risk during construction is likely to be greater than either a bridge or bored tunnel. All three potential crossing methods and routes present a risk of increasing flood risk or being impacted upon by flood risk.	Not Applicable	Moderate to Large Adverse	Not Applicable	
Social	Commuting and Other users	Significant time benefits to consumer travellers would be due to reduced congestion and improved connectivity, although some short trips would experience disbenefit due to increased congestion around the crossing access locations. Large non-fuel vehicle operating cost disbenefit would be due to increased travel and lack of perception by consumer travellers. Small road toll disbenefit, as the new crossing will be tolled.	**Value of journey time changes(£)** £296m **Net journey time changes (£)** 0 to 2min: = £794m - £950m = -£156m 2 to 5min: = £311m - £120m = £191m > 5min: = £373m - £113m = £260m	Not Applicable	-£77m	*LTC Model Income:* Low : Slight Adverse Med: Large Adverse High: Moderate Adverse
	Reliability impact on Commuting and Other users	Overall the option would improve reliability partly from congestion relief on the existing Dartford crossing and the new crossing.	Stress on Dartford Crossing forecast to fall from 112% to 90%. Stress on new crossing to be less than 75%.	Large Beneficial	Not Applicable	
	Physical activity	Transport model forecasts decreases in total trips, increases for long, cross-river trips, and decreases for short trips due to localised congestion. Consequently, very slight positive effect would be expected, as some short trips switch to cycling or walking.	Not Applicable	Neutral	Not Applicable	
	Journey quality	The additional routeing complexity and risk that some trips cannot access services would be minor negative elements. The visible landscape would be similar: **Tunnel:** view would be restricted for southbound travellers (slight adverse). **Bridge:** view would improve for northbound travellers (slight beneficial).	Not Applicable	Slight Adverse	Not Applicable	
	Accidents	The new crossing is forecast to increase traffic and thus accidents.	62,000 additional accidents of all classes, including 82 additional fatalities.	Not Applicable	-£292m	
	Security	The option is a major trunk road and motorists would not be required to stop given a free-flow tolling system being in operation.	Not Applicable	Neutral	Not Applicable	
	Access to services	The Option would have no direct impact on public transport services or access to them.	Not Applicable	Neutral	Not Applicable	
	Affordability	The option would charge the same toll as the existing Crossing. Affordability impacts would therefore be small. The option would generates some decongestion for which in turn would reduce fuel costs slightly for consumer travellers.	Not Applicable	Slight Beneficial	Not Applicable	No significant impact.
	Severance	The option would have no direct impact on pedestrian routes or access. Pedestrians would be unlikely to be permitted to use the crossing and it is not considered likely that any pedestrian routes would be severed by the new crossing.	Not Applicable	Neutral	Not Applicable	
	Option values	The new crossing would create a road transport link that does not currently exist. Local residents on either side of the new crossing may value the connection quite highly, but the number of people affected by this is expected to be small.	Not Applicable	Neutral	Not Applicable	
Public Accounts	Cost to Broad Transport Budget	The impacts upon the transport budget are twofold; the capital cost of construction and maintenance and operating cost of the infrastructure and the revenue collected from tolls.	Toll Revenue: £709m Capital: -£2050m (bridge) -£1956m (immersed tunnel) -£1996m (bored tunnel) Maintenance: -£286m (bridge) -£429m (immersed tunnel) -£431m (bored tunnel)	Not Applicable	-£1627m (B) -£1676m (IT) -£1718m (BT)	
	Indirect Tax Revenues	The option would generate traffic, and would therefore increase fuel consumption and thus the government's tax revenue from fuel.	Tax Revenue Benefit: £112m	Not Applicable	£112m	

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million. Revenues are shown as negative costs to the transport budget.

Table 4.7: Appraisal Summary Table: Option $C_{variant}$, 60 year appraisal, 2025-2084

Appraisal Summary Table			Date produced:	08 May 2013		Contact:	
Name of option:	Lower Thames Crossing Option C with variant.					Name	
Description of option:	A new trunk road connecting the M25 with the M2 via the A13, including a bridge or tunnel across the Thames east of Gravesend.; and upgrading of the A229 to improved standard and capacity.					Organisation	
						Role	Promoter/Official

Impacts		Summary of key impacts	Assessment				
			Quantitative			Qualitative	Monetary £(NPV)	Social and Distributional Impact (SDI)
Economy	Business users & transport providers	Large time benefits expected to business travellers, including freight, due to reduced congestion and improved connectivity. Small vehicle operating cost benefits also would occur, due to reduced congestion. Small road toll disbenefit, as the new crossing will be tolled.	**Value of journey time changes(£)** £2551m **Net journey time changes (£)** 0 to 2min: =£1688m-£1587m = £101m 2 to 5min: =£1049m - £179m = £870m > 5min: = £1677m - £96m = £1581m			Not Applicable	£2911m	
	Reliability impact on Business users	Option would relieve congestion on the existing Dartford crossing and would provide an alternative route with little congestion. Journey time reliability would thus improve.	Stress on Dartford Crossing forecast to fall from 112% to 90%. Stress on new crossing to be less than 75%.			Large Beneficial	Not Applicable	
	Regeneration	Widespread and significant changes to journey opportunities would be expected to shift employment opportunities eastwards, particularly benefiting the Kent and Essex Thames Gateway areas and other easterly parts of Kent and Essex.	3,200 additional jobs expected in the Thames Gateway in 2025			Moderate Beneficial	Not applicable	
	Wider Impacts	Option connects South Essex and North Kent across a corridor that previously did not exist, thus enabling journeys that would previously have been much longer. Large agglomeration benefits would accrue due to option's strong connectivity role.	WI1: Agglomeration Benefit- £1275m WI3: Change in Output in Imperfect Competition- £227m WI4: Tax Wedge on Labour Market- £2m			Not Applicable	£1504m	
Environmental	Noise	Option $C_{variant}$ would introduce a new road link across the river causing adverse noise impacts in fairly rural areas. Some benefits in reduction of noise impacts would be expected along the A2 . Compared with Option C, the extension would introduce additional adverse noise impact near the location of the new route.	Total population in assessment: 372,690 Do Minimum: 69,985 annoyed Do Something: 71,916 annoyed Net increase in people annoyed - 1932 in year 15.			Not Applicable	-£79m	*IMD income domain (%):* 0-20%: large averse 20-40%: large adverse 40-60%: large beneficial 60-80%:moderate adverse 80-100%: large adverse
	Air Quality	Improvement in local air quality for greater proportion of zones (road links) than deterioration would be expected relative to present (2009) scenario. Deterioration in local air quality for greater proportion of zones than improvement forecast for future (2025) scenario.	1. Compared to present (2009): zones with improvement in NO2 (PM10) = 64.1% (63.9%); zones with deterioration = 35.5% (35.8%). zones with no change = 0.3% (0.3%) 2. Compared to future (2025): zones with improvement in NO2 (PM10) = 28.7% (28.2%); zones with deterioration = 64.9% (65.3%); zones with no change = 6.4% (6.4%)			Not Applicable	£10m	*IMD income domain (%):* 0-20%: large beneficial 20-40%: large adverse 40-60%: large adverse 60-80%: large adverse 80-100% large adverse
	Greenhouse gases	The option is forecast to result in a decrease in carbon emissions.	Change in carbon over 60yr- -8,300,000 tonnes			Not Applicable	£381m	
	Landscape	A potential future new river crossing and associated new road infrastructure would introduce a significant change to the existing landscape. The new road corridor and junction infrastructure could impact directly and indirectly on locally and nationally valued landscape features including the Kent Downs AONB, Cobham Hall Registered Historic Park and Garden, cultural heritage features and ancient woodlands.	Not Applicable			Moderate to Large Adverse	Not Applicable	
	Townscape	Not Applicable	Not Applicable			Not Applicable	Not Applicable	
	Heritage of Historic resources	Option C (variant) would impact directly on at least one Scheduled Monument and potentially pass in close proximity to a second. This would lead to impacts on both the physical remains and the setting of features. The setting of a number of Conservation Areas and listed buildings would also be affected.	Not Applicable			Large Adverse	Not Applicable	
	Biodiversity	**Bridge:** potential impacts on the Thames Estuary and Marshes Ramsar including direct habitat loss and impacts on bird populations, including those supported by the Thames Estuary and Marshes SPA. **Bored tunnel:** potential impacts during the construction stage but the completed tunnel is unlikely to impact upon the marine environment. The location of the tunnel entrance points is critical, as in order to minimise impacts upon designated sites the tunnel length may need to increase, in order to avoid the Thames Estuary and Marshes. **Immersed tunnel:** potential for large adverse impacts on the recommended Marine Conservation Zone and its associated species and habitats. The impact of the road links may also be similar to that of the bridge, as the tunnel entrances may not be able to be situated away from the Thames Estuary and Marshes Ramsar/SSSI. **Road links:** potential for very large adverse effects on the Shorne and Ashenbank Woods SSSI and moderate adverse effects on coastal and floodplain grazing marsh.Widening of the M2-M20 link road: potential effect on the Wouldham to Detling SSSI and North Downs Woodlands SAC and Boxley Warren LNR.	Not Applicable			Very Large Adverse	Not Applicable	
	Water Environment	The main potentially significant impact would be due to changes to the form and processes of the River Thames as a result of a potential future river crossing. An immersed tunnel could have potentially significant effects and the risk during construction is likely to be greater than either a bridge or bored tunnel. All three potential crossing methods and routes present a risk of increasing flood risk or being impacted upon by flood risk.	Not Applicable			Moderate to Large Adverse	Not Applicable	
Social	Commuting and Other users	Significant time benefits to consumer travellers would be due to reduced congestion and improved connectivity, although some short trips would experience disbenefit due to increased congestion around the crossing access locations. Large non-fuel vehicle operating cost disbenefit would be due to increased travel and lack of perception by consumer travellers. Small road toll disbenefit, as the new crossing will be tolled.	**Value of journey time changes(£)** £689m **Net journey time changes (£)** 0 to 2min: =£1068m-£1028m = £40m 2 to 5min: = £410m - £125m = £285m > 5min: = £481m - £119m = £362m			Not Applicable	£227m	*LTC Model Income:* Low : Slight Beneficial Med:Moderate Beneficial High: Large Beneficial
	Reliability impact on Commuting and Other users	Overall the option would improve reliability partly from congestion relief on the existing Dartford crossing and the new crossing and the A229.	Stress on Dartford Crossing forecast to fall from 112% to 90%. Stress on new crossing to be less than 75%.			Large Beneficial	Not Applicable	
	Physical activity	Transport model forecasts decreases in total trips, increases for long, cross-river trips, and decreases for short trips due to localised congestion. Consequently, very slight positive effect would be expected, as some short trips switch to cycling or walking.	Not Applicable			Neutral	Not Applicable	
	Journey quality	The additional routeing complexity and risk that some trips cannot access services would be minor negative elements. The visible landscape would be similar: **Tunnel:** view would be restricted for southbound travellers (slight adverse). **Bridge:** view would improve for northbound travellers (slight beneficial).	Not Applicable			Slight Adverse	Not Applicable	
	Accidents	The new crossing is forecast to increase traffic and thus accidents. There would be ome relief in accidents around the upgrading A229 due to higher road standard, but overall effect would be negative.	60,000 additional accidents of all classes, including 74 additional fatalities.			Not Applicable	-£283m	
	Security	The option is a major trunk road and motorists would not be required to stop given a free-flow tolling system being in operation.	Not Applicable			Neutral	Not Applicable	
	Access to services	The Option would have no direct impact on public transport services or access to them.	Not Applicable			Neutral	Not Applicable	
	Affordability	The option would charge the same toll as the existing Crossing. Affordability impacts would therefore be small. The option would generates some decongestion for which in turn would reduce fuel costs slightly for consumer travellers.	Not Applicable			Slight Beneficial	Not Applicable	No significant impact.
	Severance	The option would have no direct impact on pedestrian routes or access. Pedestrians would be unlikely to be permitted to use the crossing and it is not considered likely that any pedestrian routes would be severed by the new crossing or the A229 upgrade.	Not Applicable			Neutral	Not Applicable	
	Option values	The new crossing would create a road transport link that does not currently exist. Local residents on either side of the new crossing may value the connection quite highly, but the number of people affected by this is expected to be small.	Not Applicable			Neutral	Not Applicable	
Public Accounts	Cost to Broad Transport Budget	The impacts upon the transport budget are twofold; the capital cost of construction and maintenance and operating cost of the infrastructure and the revenue collected from tolls.	Toll Revenue: £732m Capital: -£3172m (bridge) -£3077m (immersed tunnel) -£3117m (bored tunnel) Maintenance: -£365m (bridge) -£509m (immersed tunnel) -£511m (bored tunnel)			Not Applicable	-£2805m (B) -£2854m (IT) -£2896m (BT)	
	Indirect Tax Revenues	The option would generate traffic, and would therefore increase fuel consumption and thus the government's tax revenue from fuel.	Tax Revenue: £173m			Not Applicable	£173m	

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million. Revenues are shown as negative costs to the transport budget.

4.6 Summary of impacts of all options

4.6.1 The ASTs summarise the impacts of the location options. Further details are reported in the appendices. This section draws attention to the main impacts that all of the options have in common, and then the key differences are compared. The most notable differences in the impacts between the options are then explained under the economy, environment, and social groupings.

Common impacts of all options

4.6.2 The ASTs show that the options assessed have a number of key elements in common.

- They represent very large projects, with costs and benefits of the order of a billion pounds sterling or more.
- They raise toll revenue, reduce journey times overall and improve journey time reliability. Although time savings are by far the largest impact they also generally reduce fuel and non-fuel operating costs per journey by reducing congestion. The scale of each of these effects varies by option, and is discussed further in *Comparison of impacts between the options*.
- They principally benefit business users and freight. Although some consumer and commuter travellers do benefit from the new crossings, other personal users also tend to bear most of the disbenefit of the increases in congestion to the north and south of the new routes. Appendix A shows detailed breakdowns of these impacts for each option.
- They are projected to increase accidents on the network as a whole, because they would induce additional traffic and accidents increase broadly proportionally with traffic. The Options provide crossings and new strategic road connections of a similar standard to existing roads.
- They potentially have large adverse environmental impacts on the River Thames, in the form of changes to the physical form and processes of the river; and on the surrounding area, in terms of habitats, which will need to be considered carefully.
- They have minor impacts on physical fitness, security, severance and access to services.

Comparison of impacts between the options

4.6.3 The main costs and benefits on which the location options differ are summarised in Table 4.8. As with the other figures in the table, the cost figures represent the present value of capital and operating costs over 60 years (that are discounted in line with guidance). The cash estimates of the capital costs are set out in chapter 2 and the funding requirements in 2010 prices are set out in chapter 5 of this review. The ranges represent the differing levels of capital cost across alternate engineering solutions. Impacts that do not differ greatly across options are not included.

4.6.4 The options, as named, are also in ascending order of capital cost and toll revenue. Option $C_{variant}$ is forecast to produce very similar toll revenue to Option C, but would cost over 50% more.

Table 4.8: Comparison of Options, Main Differential Impacts, Present Value over 60 years, £m, 2010 market prices and values

Impact Assessed	Option A	Option B	Option C	Option $C_{variant}$
Costs:				
Total Cost	(£900-£1,200)	(£1,300-£1,600)	(£2,300-£2,400)	(£3,500-£3,600)
Toll Revenue	£500	£650	£700	£730
Economic and social benefits/disbenefits:				
User Benefit	£900	£900	£2,100	£3,100
Wider Economic Impacts	£250	£600	£1,200	£1,500
Accidents	(£100)	(£300)	(£300)	(£300)
Environmental benefits/disbenefits:				
Biodiversity	Slight-Large Adverse	Moderate to large adverse	Very large adverse	
Landscape/townscape	Neutral to slight adverse	Moderate adverse	Moderate to large adverse	
Greenhouse Gases	£30	(£60)	£280	£380
Noise	(£10)	(£70)	(£70)	(£80)

Prices and values are rounded to the nearest £100 or £10 million. Values in brackets are negative.

Economic and social impacts

User benefits

4.6.5 Benefits to users captured within the traffic modelling (i.e. not just users of the crossings, but of all users of roads within the modelled area) comprise mainly time savings due to quicker journeys, and additional financial costs incurred or saved. In the case of options B, C and $C_{variant}$ these accrue in part because some users would re-route to use the new crossing routes. The changes to financial costs, including vehicle operating costs tend to be more significant for Heavy Goods Vehicles (HGVs), whereas for car users the journey time impacts tend to be several times larger than any other impact. The user benefit figures are net of estimated disruption costs that would be imposed by the construction of the new crossing options. Options A and B would be expected to produce very similar user benefit. The breakdown is somewhat different however between the two options; Option A benefits most users, but by a relatively small amount, while Option B provides larger benefit for some trips (especially undertaken by business), but also larger disbenefit due to increased congestion away from the crossings themselves. Options C and $C_{variant}$ produce significantly larger user benefits and Option $C_{variant}$ produces significantly more than Option C, especially for consumer users (which includes commuters). A full breakdown of user benefits, by mode and user type can be found at Appendix A.

Table 4.9: Comparison of Options, monetised benefits broken down by user type, Present Value over 60 years, £m, 2010 market prices and values

Impact Assessed	Option A	Option B	Option C	Option $C_{variant}$
Business users	700	1,200	2,200	2,900
Consumer users	200	- 300	- 100	200

Wider Economic Impacts

4.6.6 In addition to the direct benefits to users of the new crossing, the options would be expected to generate wider economic benefits to hugely varying extents. Option A produces relatively little

wider economic impact. The other location options generate substantial agglomeration benefit from connecting businesses. Option $C_{variant}$ does not produce significantly more wider impact benefit than Option C. The following paragraphs explain the sources of the differences in wider economic benefit.

4.6.7 The assessed options would change levels of congestion and network geometry in ways that have significant implications for patterns of journey times. Changing patterns of connectivity and relationships between businesses and their employees, customers and suppliers could in turn have significant impacts on the economy, land use and regeneration.

4.6.8 DfT guidance has been developed to capture welfare impacts arising from wider economic changes brought about by transport interventions. WebTAG Unit 3.5.14 describes how wider impacts can occur as a result of:

- changes in labour supply (GP1);
- move to more/less productive jobs (GP3);
- third party spin off benefits as a results of businesses being brought effectively closer together, known as agglomeration (WI1);
- increased competition (WI2); and
- change in output in imperfectly competitive markets (WI3).

4.6.9 A fuller discussion can be found in Appendix D. A range of sensitivity tests can also be found within this appendix explaining how the results vary in response to different assumptions. The appendix also contains further details on data sources and model geography.

4.6.10 The assessed options affect journey times in a part of the country which is heavily populated both with people and businesses and could significantly affect the metropolitan area of Greater London. It has therefore been considered appropriate to calculate the impacts of the interventions on agglomeration. Potentially significant journey time changes and changes in network geography suggest that a new Lower Thames crossing could also have significant impacts on land use: these are described in Appendix D.

4.6.11 Table 4.10 summarises the value of the wider economic impacts for each of the three crossing options:

Table 4.10: Wider impacts summarised, Present Value over 60 years, £m, 2010 market prices

	Description	Option A	Option B	Option C	Option $C_{variant}$
WI1	Agglomeration	195	507	999	1275
WI3	Change in output in imperfectly competitive markets	56	99	162	227
Total	**Total welfare impact**	**251**	**606**	**1162**	**1504**

Values are rounded to the nearest million. Individual lines may therefore not sum precisely to totals.

4.6.12 The largest wider economic impact is expected to be support for the agglomeration of business activity (WI1). The benefit arises as businesses are effectively brought closer together and can benefit from spill-over benefits such as improved labour market matching and improved diffusion of best practice. Agglomeration effects arise where businesses become better connected to each other. This connectivity is known as ‘effective economic density’. Changes in effective economic density drive the proportionate change in productivity that is associated with the transport investment. The overall agglomeration impact brings together this proportionate change in productivity with the existing level of economic output in the areas affected. The largest impacts are therefore seen in areas which have both significant decreases in journey times and a large

existing business base. Appendix B describes these modelled changes in effective economic density for each of the options, and the wider economic impacts they give rise to.

4.6.13 Modelled wider impacts vary significantly between the different Options considered. The variability is largely due to changes in the modelled value of agglomeration effects from increasing economic density by effectively bringing businesses closer together. In the case of Option A this is relatively muted as the pattern of journey time changes leads to a mix of positive and negative agglomeration impacts. Also, the significant erosion of journey time benefits by 2041 means that long term agglomeration benefits are small.

4.6.14 In the case of Options B, C and $C_{variant}$, new journey opportunities are introduced which lead to larger, more widespread and more persistent reductions in journey times between areas of economic importance. Agglomeration benefits in these cases are therefore considerably larger than for Option A. Options C and $C_{variant}$ see larger journey time benefits than Option B and more new journey opportunities opened up, explaining the much larger modelled agglomeration benefits, particularly in Kent around the Medway area.

Regeneration

4.6.15 In addition to the above consideration of wider economic impacts, the potential impacts of each crossing option on regeneration has been considered. Regeneration impacts provide an indication of how a transport intervention could influence the distribution of jobs, particularly for residents of Regeneration Areas. This provides information relevant for policy decisions. Regeneration impacts are an equity consideration which does not form part of a monetised cost benefit analysis. The assessment of regeneration impacts is summarised in the Appraisal Summary Tables earlier in this chapter, and reported more fully in Appendix A.

Reliability of journey times

4.6.16 The reliability impacts on business users is an important economic impact. The assessment of the impacts that each option is likely to have on network stress is reported under the *Direct Impact of New Crossings at Location Options* section earlier in this chapter.

Accidents

4.6.17 Forecast accidents and casualties associated with new crossing options are shown in Table 4.11. Accidents are forecast to increase across the whole Policy Area due to the increase in total traffic on roads within the Policy Area, not just at new crossings.

Table 4.11: Forecast Total Accident Impacts of the Options, 2025-2084, Option vs. No New Crossing

		Fatal	Serious	Slight	Damage Only	Total
Option A	Accidents	28	227	1,989	24,019	**26,262**
	Casualties	31	257	3,145	-	**3,433**
Option B	Accidents	79	545	4,966	52,440	**58,030**
	Casualties	80	635	7,516	-	**8,231**
Option C	Accidents	72	494	5,195	56,076	**61,837**
	Casualties	82	597	8,210	-	**8,890**
Option $C_{variant}$	Accidents	71	472	5,330	53,675	**59,548**
	Casualties	74	568	8,749	-	**9,392**

4.6.18 Options B, C and $C_{variant}$ lead to much larger increases in traffic within the modelled area, and therefore the forecast number of accidents increases by more than twice the amount for Option A.

Environmental impacts

Noise

4.6.19 As reported in the ASTs all options have significant impacts on the number of people who are exposed to noise at levels understood to cause annoyance. In accordance with WebTAG guidance these impacts have been monetised, and will be taken into account in the benefit to cost ratios (BCRs) for each option. Option A has substantially less noise impact than the other options, as it affects few residents not already affected by the existing Dartford-Thurrock Crossing. Appendix A reports the assessment of the noise impacts in detail, including the social and distributional impacts of changes in the population exposed to noise.

Air quality

4.6.20 All location options are expected to lead to changes to air quality. Appendix A reports these changes in detail, including the social and distributional impacts of changes in the population exposed to changes in air quality.

4.6.21 The assessments of air quality summarised in the Appraisal Summary Tables distinguish between the number of modelled zones that would be forecast to experience improvement or worsening of air quality (or no change). However, these modelled zones are not of equal size or air quality standard. It is perhaps more useful to identify what may happen to air quality in areas where it is of concern, which is also reported in the text below. If any of the options were to be taken forward more detailed local traffic modelling and detailed design would be required to assess the overall impact resulting from the countervailing effects of increased traffic and reduced queuing.

4.6.22 Table 4.12 below summarises the main impacts on air quality:

Table 4.12: Forecast impacts of the options on air quality in 2025 compared to the do-minimum

Option	Percentage of zones where compared with the do-minimum air quality would:			Locations where air quality at AQMAs may deteriorate
	Deteriorate	No change	Improves	
Option A	29%	13%	58%	Those adjacent to the existing crossing in Dartford and Thurrock
Option B	49%	13%	38%	Those adjacent to the A226 and the Bean Interchange
Option C	50%	6%	44%	Those adjacent to the A2
Option $C_{variant}$	65%	7%	28%	Those adjacent to the A2

Greenhouse gases

4.6.23 Option A has relatively little forecast greenhouse gas impact; small benefits accrue from reductions in traffic delay. Option B also has relatively little impact; here small disbenefits occur due to increased traffic. Options C and $C_{variant}$ produce large benefits; they significantly shorten many (mainly cross-river) journeys as well as relieving delay and this more than counter-balances the increase in trips.

4.6.24 The net present value (NPV) of the additional emissions associated with a new crossing at each location Option is set out below:

Table 4.13: Greenhouse Gas Emission Impacts, Present Value over 60 years, £m, 2010 market prices

Option	Present Value	Comments
A	31	Due to increased capacity of the crossing which would reduce congestion distance travelled by 1.1% in 2025 on the most affected roads.
B	-60	Due to the increase in distance travelled by 1.5% in 2025 on the most affected roads.
C	278	Due to the decrease in distance travelled by 4.9% in 2025 on the most affected roads as vehicles accessing north of the Thames from eastern Kent can take a shorter route.
$C_{variant}$	381	Due to the decrease in distance travelled by 8.0% in 2025 on the most affected roads as vehicles use the A229 linking the M2 with the M20 and the more direct route between eastern Kent and north of the Thames.

Monetary values in millions of pounds sterling, rounded to the nearest million

Landscape and Townscape

4.6.25 All location options would have an adverse impact to a degree on landscape or townscape or both. There are however large differences in the scale of impacts between the options. Option A is likely to fit well with the road infrastructure and bridge at the location of the existing crossing, and therefore the overall impact of Option A on the townscape has been assessed as **slight adverse** for a bridge and **neutral to slight adverse** for an immersed or bored tunnel.

4.6.26 The overall impact of Option B on the townscape and landscape has been assessed as **moderate adverse**. This score applies to any of the crossing structures. While the bridge would have a greater impact as a dominant feature visible over a wide area, all three options would introduce structures out of scale with the local townscape character, impacting directly and indirectly on locally valued townscape features including school grounds and recreational greenspace.

4.6.27 The overall impact of Option C on the landscape has been assessed as **moderate to large adverse** for a bridge, although this could be reduced to **moderate adverse** for an immersed or a bored tunnel. A potential future new river crossing and associated new road infrastructure would introduce a significant change to the existing landscape. Retaining structures and bridge or tunnel infrastructure would be notable additional urban elements across the horizontal vista of the Thames marshes and would be visible over the local area. The new road corridor and junction infrastructure could impact directly and indirectly on locally and nationally valued landscape features including Scheduled Monuments, listed buildings, conservation areas, ancient woodlands, distinct areas of historic landscape patterns, Shorne Country Park and surviving Thames marshland.

4.6.28 The landscape impact of Option $C_{variant}$ is assessed identically to Option C. Road widening and additional junction infrastructure along the A229 could result in some loss of woodland screening and might have some direct and indirect impacts on residential areas in close proximity. However, changes would be in the context of the existing dual carriageway corridor and therefore are less likely to have a significant effect. The assessment is therefore unchanged.

Biodiversity

4.6.29 In the worst case scenario the construction of an immersed tunnel or a bridge at Option A or B could have a **large adverse** impact on biodiversity - mainly because of the impact on the

recommended Marine Conservation Zone[38]. In contrast the impacts of a bored tunnel would occur mainly in construction, and if this structure were used in preference to a bridge or a bored tunnel the impact of Option A could be reduced to **slight adverse** and Option B to **moderate adverse**.

4.6.30 The adverse impacts of options C and $C_{variant}$ would be far more widespread. Although a bored tunnel could reduce the adverse impacts in comparison with an immersed tunnel or a bridge, the construction of the roads needed to link a new crossing at Option C with the existing road network would be likely to have sufficiently adverse impacts on several ancient woodlands and Sites of Special Scientific Interest (SSSI) and Ramsar site where proposed development would be subject to a test of over-riding public interest. This would make the overall assessment on the biodiversity of the area **very large adverse**.

4.6.31 A summary of the appraisal scores for landscape, townscape, heritage of historic resources, biodiversity and water environment is provided in Table 4.14.

Table 4.14: Summary of environmental appraisal scores

Topic	Option A	Option B	Option C	Option $C_{variant}$
Landscape	n/a	Moderate adverse	moderate to large adverse	moderate to large adverse
Townscape	neutral to slight adverse	Moderate adverse	n/a	n/a
Heritage of historic resources	Moderate adverse	large adverse	large adverse	large adverse
Biodiversity	slight to large adverse	moderate to large adverse	very large adverse	very large adverse
Water environment	moderate to large adverse	moderate to large adverse	moderate to large adverse	moderate to large adverse

4.7 Value for Money Assessments

4.7.1 The monetary appraisal used to prepare the value for money assessments is conducted over 60 years, from 2025, the assumed opening year of new infrastructure, to 2084. All monetary values continue to be expressed in present value (PV) terms at 2010 values and prices, and in millions of pounds. Non-monetised impacts are discussed, but not factored into any numeric measures. It should also be noted that where revenues are discussed, these represent incremental changes in revenue over a case with no new crossing (in which case only charges from the existing crossing would be collected), not total revenue.

4.7.2 A number of metrics are typically used as part of the assessment of schemes for value for money, as follows. It should be noted that this strategic outline business case is essentially assessing broad policy options, rather than specific schemes, but the general framework can still be used:

- Net Present Value (NPV): This is a measure of the total impact of the scheme upon society, in monetary terms, including everything that can be monetised. A scheme with negative NPV would clearly be poor value for money.
- Present Value of Costs (PVC): This is a measure of the monetary cost to the government's transport budget. In the context of the assessments of new Lower Thames crossing location options it includes upfront capital costs, maintenance costs and toll revenue collected. The inclusion of toll revenue in this way is discussed further below.

[38] The Thames Estuary was one of 127 sites around the coast recommended to Government as possible Marine Conservation Zones. The Government has proposed to designated 31 sites as Marine Conservation Zones, this does not include the Thames Estuary. Further designations will follow in tranche 2.

- Present Value of Benefits (PVB): This is NPV minus PVC; that is, the impact on society exclusive of the government's transport budget. It includes the monetised benefits accruing to users (in terms of travel time, vehicle operating cost, and tolls to be paid), monetised impacts upon the environment, the monetised value of accidents, and monetised wider economic impacts (where the latter are included).
- The Benefit-Cost Ratio (BCR) is traditionally used to assess value for money. This is PVB divided by PVC, that is, the ratio of benefits to costs. Clearly a BCR of less than 1 would represent poor value for money. Following the DfT's guidance, a BCR between 1.5 and 2 is considered medium value for money, and a BCR in excess of 2 high value for money.
- The Net Present Value-Cost Ratio (NPV/K) can sometimes be a more useful statistic when assessing tolled roads, though it is less widely quoted. This is the NPV divided by the scheme capital cost. A negative NPV/K clearly represents poor value for money. Full assessment of any policy must include consideration of other aspects, such as changes to journey time reliability, some of which have not been monetised in this review, largely due to current research not strongly supporting any preferred method of monetisation.

4.7.3 The treatment of toll revenue as cost is worthy of note here. If toll revenue accrues directly to the DfT's budget, or if the right to collect the toll revenue is sold and a concessionaire fee paid directly to the DfT's budget, it is correct to treat the toll as a negative cost, as it is in this assessment. If, on the other hand, the toll income were not to be allocated to the DfT, but instead to an investor or to wider government finances, treatment of the revenue as a benefit would be correct.

4.7.4 Except where specifically noted in the discussion below, the 'most likely' estimates of capital costs (see section 2.6: *Costing and Engineering Feasibility*) for each option, including both structures and necessary link roads, (within the ranges) and traffic levels are used in figures.

4.8 Value for Money Assessment: Option A

4.8.1 The Option A alternative of increasing the existing Dartford-Thurrock Crossing capacity by constructing additional infrastructure has been assessed in this Economic Case by looking at the sub-impacts defined in chapter 2 (section 2.3: *Specifying the Evidence Requirements*) with many of these sub-impacts monetised.

4.8.2 Table 4.15 summarises the main impacts of Option A, monetised and non-monetised, is shown below. The range of capital costs and environmental impacts reflect the choice of engineering solutions (bridge, immersed and bored tunnel) considered in this Business Case.

4.8.3 Option A has a NPV of £335m in the central case with a bridge solution, excluding wider impacts and ignoring non-monetised effects. Table 4.16 shows that a similar NPV can be obtained in a higher toll case. Some of the monetary benefit transfers from direct user benefits to the public accounts, but the overall societal impacts remain quite similar.

4.8.4 The appraisal assumes that demand using the crossing is relatively inelastic, as demonstrated through the high toll sensitivity test (i.e. the traffic does not respond strongly to increased tolls). It also assumes that affordability impacts for users would become negative if tolls were increased for existing users on the Dartford-Thurrock Crossing.

4.8.5 The unadjusted monetised statistics are summarised, in the absence of wider impacts, in Table 4.16.

Table 4.15: Option A, Main Impacts Only, Central Case, PV, 60 years

Aspect	Adverse	Neutral	Beneficial
Capital & Maintenance	£900-£1200m		
Toll Revenue			£500m
Business Users			£700m
Consumer Users			£200m
Accidents	£100m		
Carbon Emissions			£30m
Wider Impacts			£250m
Reliability			Large Beneficial
Heritage	Moderate Adverse		
Biodiversity	Slight to Large Adverse		
Water Environment	Moderate to Large Adverse		
Landscape/Townscape	Neutral to Slight Adverse		
Affordability		Negligible	

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest 100 or 10 million

Table 4.16: Option A, Value for Money Calculations, PV, 60 years, £m

	Central Case			High (180%) Toll Sensitivity		
	Bridge	Immersed Tunnel	Bored Tunnel	Bridge	Immersed Tunnel	Bored Tunnel
PVB	762	762	762	-766	-766	-766
PVC	427	727	703	-1,072	-772	-797
NPV	335	35	59	307	7	31
BCR	1.8	1.0	1.1	-	-	-
NPV/K	0.43	0.03	0.06	0.39	0.01	0.03

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

4.8.6 The BCR is around 1.8 for a bridge, and 1.0-1.1 for a tunnel.

4.8.7 Adjusted value for money statistics have been developed, following the DfT's value for money assessment guidance, to include monetised wider economic impacts, which are subject to greater uncertainty and not included in the initial assessment. The PVB and hence NPV increase, as shown in Table 4.17.

Table 4.17: Option A, Value for Money Calculations, Wider Impacts included, PV, 60 years, £m

	Central Case			High (180%) Toll Sensitivity		
	Bridge	Immersed Tunnel	Bored Tunnel	Bridge	Immersed Tunnel	Bored Tunnel
PVB	1,013	1,013	1,013	-542	-542	-542
PVC	427	727	703	-1,072	-772	-797
NPV	586	286	310	530	230	255
BCR	2.4	1.4	1.4	-	-	-
NPV/K	0.64	0.24	0.26	0.58	0.19	0.21

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

4.8.8 Option A is forecast to generate more benefit to users in terms of congestion relief than negative

impact upon the transport budget (i.e. cost net of additional toll revenue). Journey time reliability will also improve, partly due to reduced congestion and partly because another structure across the river will make it easier to deal with incidents and maintenance.

4.8.9 There are potentially significant adverse environmental impacts upon the River Thames waterway and habitats; these may be mitigated through use of a bored tunnel, although a bridge is estimated to be the cheapest solution. The non-monetised environmental impacts will, on balance, act to reduce the case for the scheme, but that it remains positive value for money.

4.9 Value for Money Assessment: Option B

4.9.1 The Option B policy of building a new Thames crossing link connecting the A1089 with the A2 just west of Gravesend has been assessed in the preceding text on various potential impacts as advised in WebTAG guidance. Many of the effects have been monetised.

4.9.2 A table summarising the main impacts of Option B, monetised and non-monetised, is shown below. The range of public accounts impacts reflects the choice of engineering solution (bridge or tunnel), to be determined.

Table 4.18: Option B, Main Impacts Only, Central Case, PV, 60 years, £m

Aspect	Adverse	Neutral	Beneficial
Capital & Maintenance	£1300-£1600m		
Toll Revenue			£650m
Business Users			£1200m
Consumer Users	£300m		
Accidents	£300m		
Carbon Emissions	£60m		
Noise	£70m		
Wider Impacts			£600m
Reliability			Large Beneficial
Regeneration			Moderate Beneficial
Heritage	Large Adverse		
Biodiversity	Moderate-Large Adverse		
Water Environment	Moderate-Large Adverse		
Landscape/Townscape	Moderate Adverse		
Affordability		Negligible	

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest 100 or 10 million

4.9.3 Option B has a net present value of minus £144m in the central case with a bridge solution, excluding wider impacts. Table 4.19 shows that in the higher toll case, the NPV is considerably lower at minus £511m. Some of the monetary benefit transfers from direct users to the public accounts, but the overall societal impact worsens.

4.9.4 The affordability impact would of course become adverse if tolls were increased on the existing Dartford-Thurrock Crossing.

4.9.5 Statistics are summarised, in the absence of wider impacts, in Table 4.19.

Table 4.19: Option B, Value for Money Calculations, £m, PV, 60 years

	Central Case			High (180%) Toll Sensitivity		
	Bridge	Immersed Tunnel	Bored Tunnel	Bridge	Immersed Tunnel	Bored Tunnel
PVB	506	506	506	-1,509	-1,509	-1,509
PVC	650	892	999	-998	-756	-649
NPV	-144	-386	-493	-511	-754	-861
BCR	0.8	0.6	0.5	-	-	-
NPV/K	-0.13	-0.31	-0.36	-0.46	-0.60	-0.63

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

4.9.6 A BCR of around 0.8 is obtained in the central case if a bridge is used, falling to around 0.5 if the tunnel solutions are adopted. Clearly this does not represent value for money; the expected costs outweigh the expected benefits.

4.9.7 Adjusted value for money statistics have been developed, following the DfT's detailed value for money guidance, to include monetised wider economic impacts, which are subject to greater uncertainty and not included in the initial assessment. Because the policy connects two areas that previously were not connected at all, the wider economic impacts are estimated to be significant, and with their inclusion, Option B becomes more worthy of consideration.

Table 4.20: Option B, Value for Money Calculations, Wider Impacts included, PV, 60 years, £m

	Central Case			High (180%) Toll Sensitivity		
	Bridge	Immersed Tunnel	Bored Tunnel	Bridge	Immersed Tunnel	Bored Tunnel
PVB	1,113	1,113	1,113	-940	-940	-940
PVC	650	892	999	-998	-756	-649
NPV	462	220	113	57	-185	-292
BCR	1.7	1.2	1.1	-	-	-
NPV/K	0.36	0.14	0.07	0.04	-0.12	-0.18

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

4.9.8 The Option B policy has a positive NPV if wider impacts are considered. It would have a positive impact upon journey time reliability.

4.9.9 There are potentially significant adverse environmental impacts upon the Thames waterway and habitats; these may be partially mitigated through use of a bored tunnel, although a bridge is expected to be the cheapest solution. Overall it is considered that the non-monetised impacts act to reduce the case for the scheme somewhat, but that it remains positive, though not high, value for money.

4.10 Value for Money Assessment: Option C

4.10.1 The Option C policy of a new River Thames crossing connecting the M2 with the M25 using a bridge or tunnel across the Thames east of Gravesend has been assessed in the preceding text on various potential impacts as advised in WebTAG guidance. Many of the effects have been monetised.

4.10.2 Table 4.21 summarises the main impacts of Option C, monetised and non-monetised.

Table 4.21: Option C, Main Impacts Only, Central Case, PV, 60 years

Aspect	Adverse	Neutral	Beneficial
Capital & Maintenance	£2,300-£2,400m		
Toll Revenue			£700m
Indirect tax revenue	£70m		
Business Users			£2,200m
Consumer Users	£100m		
Accidents	£300m		
Carbon Emissions			£300m
Noise	£70m		
Wider Impacts			£1,200m
Reliability			Large Beneficial
Regeneration			Moderate Beneficial
Heritage	Large Adverse		
Biodiversity	Very Large Adverse		
Water Environment	Moderate-Large Adverse		
Landscape/Townscape	Moderate-Large Adverse		
Affordability		Negligible	

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest 100 or 10 million

4.10.3 The demand using the crossing is relatively inelastic, as demonstrated through the high toll sensitivity test (i.e. the traffic levels reduce by a smaller percentage than the percentage increase in tolls).

4.10.4 Option C has a net present value of £505m in the central case with a bridge solution, excluding wider impacts. Table 4.22 shows that the equivalent NPV in the higher toll case is £281m.

4.10.5 The affordability impact on users would of course become adverse if tolls were increased on the existing Dartford-Thurrock Crossing.

4.10.6 Statistics are summarised, in the absence of wider impacts, in Table 4.22, below.

Table 4.22: Option C, Value for Money Calculations, PV, 60 years, £m

	Central Case			High (180%) Toll Sensitivity		
	Bridge	Immersed Tunnel	Bored Tunnel	Bridge	Immersed Tunnel	Bored Tunnel
PVB	2,132	2,132	2,132	237	237	237
PVC	1,627	1,676	1,718	-44	5	47
NPV	505	456	414	281	232	190
BCR	1.3	1.3	1.2	-	-	-
NPV/K	0.25	0.23	0.21	0.14	0.12	0.10

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

4.10.7 A BCR of around 1.3 is obtained in the central case.

4.10.8 Adjusted value for money statistics have been developed, following the Department for Transport's detailed Value for Money guidance, to include monetised Wider Economic Impacts, which are subject to greater uncertainty and not included in the initial assessment. The PVB and hence NPV increase. The BCRs are estimated to be 2.

Table 4.23: Option C, Value for Money Calculations, Wider Impacts included, PV, 60 years, £m

	Central Case			High (180%) Toll Sensitivity		
	Bridge	Immersed Tunnel	Bored Tunnel	Bridge	Immersed Tunnel	Bored Tunnel
PVB	3,295	3,295	3,295	1,370	1,370	1,370
PVC	1,627	1,676	1,718	-44	5	47
NPV	1,667	1,619	1,576	1,414	1,365	1,323
BCR	2.0	2.0	1.9	-	-	-
NPV/K	0.71	0.68	0.65	0.61	0.57	0.54

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

4.10.9 The Option C alternative is assessed as having monetised benefits in excess of its costs, generating considerably more benefit to users in terms of congestion relief than it is likely to cost. Journey time reliability will also improve.

4.10.10 There are very serious environmental impacts, particularly associated with biodiversity and ancient woodland. Some of the impacts may be mitigated slightly, through use of a bored tunnel, albeit not enough to change the overall qualitative assessment. Overall it is considered that the non-monetised impacts act to reduce the case for the option significantly.

4.11 Value for Money Assessment: Option Cvariant

4.11.1 The Option $C_{variant}$ policy of building a new Thames crossing link connecting the M2 with the M25, supplemented by an improvement of the A229 between M2 Junction 3 and M20 Junction 6; has been assessed in the preceding text on various potential impacts as advised in WebTAG guidance. Many of the effects have been monetised.

4.11.2 Table 4.24 summarises the main impacts of Option $C_{variant}$, monetised and non-monetised.

Table 4.24: Option $C_{variant}$, Main Impacts Only, Central Case, PV, 60 years

Aspect	Adverse	Neutral	Beneficial
Capital and Maintenance Costs	£3,500-£3,600m		
Toll Revenue			£730m
Business Users			£2,900
Consumer Users			£200m
Accidents	£300m		
Carbon Emissions			£400m
Noise	£80m		
Wider Impacts			£1,500m
Reliability			Large Beneficial
Heritage	Large Adverse		
Biodiversity	Very Large Adverse		
Water Environment	Moderate-Large Adverse		
Landscape/Townscape	Moderate-Large Adverse		
Affordability		Negligible	

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest 100 or 10 million

4.11.3 The demand using the crossing is relatively inelastic, as demonstrated through the high toll sensitivity test (i.e. the traffic levels reduce by a smaller percentage than the percentage increase in tolls).

4.11.4 Option $C_{variant}$ has a net present value of £534m in the central case with a bridge solution, excluding wider impacts. Statistics are summarised, in the absence of wider impacts, in Table 4.25 below.

Table 4.25: Option $C_{variant}$, Value for Money Calculations, PV, 60 years, £m

	Central Case		
	Bridge	**Immersed Tunnel**	**Bored Tunnel**
PVB	3,339	3,339	3,339
PVC	2,805	2,854	2,896
NPV	534	485	443
BCR	1.2	1.2	1.2
NPV/K	0.17	0.16	0.14

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

4.11.5 A BCR of 1.2 is obtained in the central case.

4.11.6 Adjusted value for money statistics have been developed, following the DfT's detailed Value for Money guidance, to include monetised Wider Economic Impacts, which are subject to greater uncertainty and not included in the initial assessment. The PVB and hence NPV increase.

Table 4.26: Option $C_{variant}$, Value for Money Calculations, Wider Impacts included, PV, 60 years, £m

	Central Case		
	Bridge	**Immersed Tunnel**	**Bored Tunnel**
PVB	4,843	4,843	4,843
PVC	2,805	2,854	2,896
NPV	2,038	1,989	1,947
BCR	1.7	1.7	1.7
NPV/K	0.58	0.55	0.54

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

4.11.7 The Option $C_{variant}$ alternative is assessed as having monetised benefits in excess of its costs, generating considerably more benefit to users in terms of congestion relief than it is likely to cost. Journey time reliability will also improve. It should probably be possible to reduce the PVC substantially through increased tolls, but tests for Option C indicated that this would result in some disbenefit to users and an adverse affordability impact.

4.11.8 There are very serious environmental impacts, particularly associated with biodiversity and ancient woodland. Some of the impacts may be mitigated slightly, through use of bored tunnels, albeit not enough to change the overall qualitative assessment. Overall it is considered that the non-monetised impacts act to reduce the case for the scheme significantly.

4.12 Comparison of Value for Money Assessments

4.12.1 The overall assessment scores of the location options in terms of Net Present Value (NPV) and Benefit-Cost Ratio (BCR), without wider impacts, are shown below.

Table 4.27: Comparison of Options, Net Present Values and Benefit Cost Ratios, 2025-2084

Engineering Solution	Option A	Option B	Option C	Option $C_{variant}$
Bridge	335(1.8)	-144(0.8)	505(1.3)	534(1.2)
Immersed Tunnel	35(1.0)	-386(0.6)	456(1.3)	485(1.2)
Bored Tunnel	59(1.1)	-493(0.5)	414(1.2)	443(1.2)

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

4.12.2 Using a bridge for Option A would produce the highest unadjusted BCR of 1.8, and for Option B would have the lowest BCR of 0.8. On the same basis, Option C would have a BCR of 1.3. Option $C_{variant}$ would have a BCR of 1.2, but with a slightly higher NPV than Option C; when compared with Option C the costs of the additional infrastructure nearly outweigh the additional benefits.

4.12.3 With wider economic impacts included, the highest BCR is from Option A, at 2.4, and Option B remains the lowest value for money overall.

Table 4.28: Comparison of Options, Net Present Values and Benefit Cost Ratios, With Wider Impacts, 2025-2084

Engineering Solution	Option A	Option B	Option C	Option $C_{variant}$
Bridge	586(2.4)	462(1.7)	1,667(2.0)	2,038(1.7)
Immersed Tunnel	286(1.4)	220(1.2)	1,619(2.0)	1,989(1.7)
Bored Tunnel	310(1.4)	113(1.1)	1,576(1.9)	1,947(1.7)

Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

4.13 Summary

4.13.1 This chapter has described how the road network performance may be improved by provision of additional crossing capacity. It has summarised the costs and economic, environmental and social impacts of the options to set out our findings on their relative merits against the range of objectives. The relative merits of the options are summarised in the conclusions, Chapter 8.

5 The Commercial Case

5.1 Purpose of Chapter

5.1.1 The purpose of this chapter is to present the commercial models that could be used to deliver any future Lower Thames crossing and to introduce how the commercial risks associated with the crossing could be managed. This analysis is relevant to all of the different location and physical structure options.

5.1.2 In this chapter we consider three different procurement routes that may be used to deliver the crossing – a traditional public procurement that is fully publicly funded, a privately financed model that reflects a traditional Public Private Partnership (PPP) structure, and a model with additional public funding in support of a privately financed model. Within this chapter funding refers to the amount that must be raised in order to pay for the crossing – such as government capital spending or toll revenue. Financing refers to borrowing that can be secured from the private sector to support the project and then is repaid over time.

5.1.3 There are a multitude of different procurement routes and commercial structures that incorporate private finance which could be used to deliver a scheme such as a new Lower Thames crossing. In the past few years there have been a number of significant transport projects that have been delivered using private finance within the UK. These have included the Inter City Express Programme, Nottingham Express Transit phase 2 and the Sheffield, Hounslow and Isle of Wight Highways Maintenance projects. In the past the Severn River Crossings, the M6 Toll road and the Dartford Crossing have been delivered using private finance alongside a tolling or charging arrangement, and the Mersey Gateway Bridge is in an advanced state of procurement. Within Europe there have been major deals within the French road and rail sectors and a significant road building and upgrade programme in the Netherlands that have also utilised different forms of private finance. Stakeholders in the Lower Thames crossing scheme will have their own views on how the crossing could be procured and this is an area that will be revisited as the business case develops.

5.1.4 The Lower Thames crossing at any of the location options will provide enhanced estuarial crossing capacity in an area where there are few alternatives. This provides commercial opportunity in which a predictable income stream can be used to attract private sector investors to support the government in delivering the Lower Thames crossing.

5.2 The Department for Transport's experience of delivering project using private finance

5.2.1 Since 2009 the Department for Transport (DfT) has supported private sector partners on raising finance for a variety of projects employing a range of different commercial structures. These projects have included the IEP Great Western Main Line project that was brought to financial close in July 2012, in which the successful bidder, Agility, raised over £2.3Bn of long term debt from a mix of commercial and development banks. The DfT worked closely with Agility, and, alongside IUK oversaw the finance raising strategy designed by them up to financial close. In addition to this the DfT has worked with the private sector and our local authority partners in support of seven street lighting projects with a combined capital requirement of over £440m and four highways maintenance contracts with a combined capital requirement of £940m and the second phase of the Nottingham Tram with a capital requirement of just under £500m since 2009.

5.3 Commercial Risks

5.3.1 A future Lower Thames crossing scheme would present a number of commercial risks that need to be understood and managed in order to deliver a robust scheme that meets its commercial

objectives. At this stage, it is therefore relevant to identify the range of risks that will need to be considered in more detail as part of future scheme development.

5.3.2 Commercial risks associated with a future new Lower Thames crossing can be separated into two categories:

- Pre-construction risks – that relate to issues arising prior to construction of the Lower Thames crossing commencing; and,
- Construction and post-construction risks – that relate to issues associated with finalising the commercial model, the construction of the crossing, and the operation and maintenance of the crossing throughout its life.

5.3.3 The pre-construction risks for the Lower Thames crossing can be summarised as follows:

Table 5.1 – Lower Thames Crossing Pre-Construction Risks

Risk	Description
Legal Review	The scheme could be delayed or prohibited by legal challenge.
Site risk	The sites required to construct the crossing may not be acquired in time or unfavourable ground conditions may prevent progress with a new crossing.
Planning and permitting consent	The scheme could be delayed or prohibited by failure to obtain planning consent and/or environmental permits.
Political Risk	The scheme could be delayed or cancelled due to political opposition or a change in policy.
Government Funding Risk	The scheme could be delayed or cancelled due to the failure to secure the required level of government financial support. More detail on the budgetary classification is provided in the financial chapter.

5.3.4 The expected construction and post-construction risks for the Lower Thames crossing can be summarised as follows:

Table 5.2 – Lower Thames Crossing Construction and Post-Construction Risks

Risk	Description	Implication
Construction Risk	Failure to complete construction of the crossing to the required specification, the agreed budget or the project timetable. Construction risk is one of the highest risk elements associated with a project of this nature.	Delays to construction may lead to additional costs being incurred to complete the project and will postpone the realisation of the economic benefits of a new crossing. A failure to deliver the crossing to the agreed specification may impact its economic and commercial potential. Any cost overruns would need to be funded.

Risk	Description	Implication
Financing Risk	Failure to secure finance from either the public or private sector would place the project at risk of failure.	If the crossing was delivered using a privately financed commercial model, could lead to delays in delivering the crossing or require additional government funding. Failure to secure the required level of government support (in all commercial structures) could lead to delays and potentially the cancellation of the scheme.
Demand Risk – Usage	Less usage of the crossing than forecasted.	The failure to meet traffic flow projections could lead to underperformance against economic and commercial benchmarks.
Demand Risk – Price	Pricing strategy misses revenue targets.	A poorly conceived pricing strategy could reduce usage of the crossing and have a negative impact on the commercial and economic benefits of the crossing.
Congestion and Network Risk	Poor integration with supporting infrastructure can lead to increased congestion.	Increased congestion on either the crossing or the supporting infrastructure may adversely affect the commercial, economic and environmental performance of the crossing.
Maintenance Risk	Failure to invest in capital renewal maintenance to maintain the bridge to the required output specification.	This could lead to degradation of the crossing which may lead to unscheduled closures as a result of safety concerns or a lower level of performance (measured by volume and speed of traffic). Each outcome would reduce the economic and commercial performance of the crossing.
Operations Risk	Failure to operate in a manner that minimises closures and maximises the crossing's availability throughout the project life.	Unscheduled closures or reduced availability due to operational failings (e.g. understaffing, underinvestment in operating costs) could lead to diminished commercial and economic performance.
Technology	Failure of technology due to technical issues or underinvestment can impact the performance of the crossing.	Unscheduled closures or increased costs to replace failing technology could diminish the economic and commercial performance of the crossing.
Economic Risk	Interest rates, foreign exchange or inflation move in an unfavourable manner.	The failure to mitigate external economic risks could lead to underperformance against economic and commercial benchmarks.
Change in Law or Policy Risk	Legislative change may have an effect on the construction or operation of the crossing.	A change in law or policy that impacts the crossing may affect its commercial and economic performance unless there is adequate contractual protection mitigating this.
Residual Value and hand-back risk	At the end of the concession the crossing is handed back in a condition below the required output specification.	The crossing may require additional and unscheduled investment to upgrade it to meet the required output specification and to ensure optimal availability or the residual value may be lower than the forecast amount.

5.3.5 Each of the risks detailed in the tables above would need to be mitigated in some manner in order to deliver a robust scheme that meets its commercial objectives. There are a limited number of ways in which project risks can be handled. They can be retained by the public sector, transferred to the private sector partner that is best placed to manage the risk, allocated to third parties or passed on to end users. Further consideration as to how the risks can be managed will need to be given once a decision is reached on the location of the crossing and a scheme is initiated and in delivery. The next section of this chapter, however, includes a brief summary of the benefits and limitations of each proposed commercial model with respect to the commercial risks.

5.4 Commercial Models

5.4.1 The Lower Thames crossing could be procured as a fully publicly funded project or privately financed project or as a combination of the two. This section considers illustrative versions of each of these options taking into account the commercial risks outlined in Table 5.1 and Table 5.2. This section introduces a simplified version of a publicly funded and privately financed model. There are numerous other ways in which public and private models could be structured to deliver the crossing.

5.4.2 Under each of the models described in this section it is assumed that the public sector sets and collects the tolls and, under the privately financed scenarios, will return this money to the private sector partner.

5.4.3 Under each of the models described it is assumed that options, appraisal costs and costs associated with statutory procedures would be met by the public sector. This approach is based on past experience of procuring projects of this nature.

5.4.4 Each commercial model is considered below in terms of the implications of this risk allocation.

(a) Publicly Funded Model

5.4.5 In the fully publicly funded model the crossing would be funded with public money and all risks would remain with the public sector.

5.4.6 There are a number of benefits and drawbacks to a fully publicly funded model that can be considered at a high level:

Public Sector Involvement in the Publicly Funded Model

5.4.6.1 The public sector may have increased flexibility to vary the price of tolls or remove tolls entirely in order to maximise the economic benefit of the crossing in the future. However, the public sector would be responsible for meeting all costs associated with the crossing such as maintenance, operating and technology costs.

Financing the Crossing

5.4.6.2 The public sector would need to find enough capacity within its expenditure limits to provide the investment required. This could be up to £5bn over what could be a 5 year construction period and is likely to be difficult to secure with the pressure on public sector budgets.

Maintaining the Asset

5.4.6.3 The public sector could maintain ownership of the crossing throughout its economic life and ensure investment in renewing the asset is undertaken with a long-term view. However, the public

sector would need to fund this investment through toll revenue received on the bridge or from other sources.

Integrated Infrastructure

5.4.6.4 A maintenance plan could be established to minimise disruption and congestion whilst maximising economic performance of the new crossing and supporting infrastructure.

(b) Privately Financed Model

5.4.7 In the privately financed model the crossing would be funded by the public sector through the options phase and development phases (including statutory procedures) and then funded by the private sector either from the start of construction or from the start of operations. The commercial risks associated with the crossing would be shared between the public and private sectors.

5.4.8 There are a number of options for how the Lower Thames crossing could be delivered under a privately financed route. These options reflect the flexibility that a privately funded route can offer and the various forms that the public sector's involvement could take:

Public Sector Involvement in the Privately Financed Model

5.4.8.1

a. Build and Sale – The crossing could be built by the public sector and then sold to a private operator. This could provide instant returns to the public sector to cover the costs of the crossing. Risks during the construction phase may be retained by the public sector whilst commercial risks would be passed to the private sector during the operating phase. Whilst the current economic climate has made it difficult to secure long term debt to support infrastructure projects there is still an appetite for infrastructure assets. In particular institutional investors such as pension funds maintain an interest in acquiring infrastructure assets. However, there may be uncertainty about the price that the sale of the crossing will reach given the likely limited operational history and once sold the public sector may lose an element of control over the future of the crossing. One of the main benefits of the privately financed model is the management of construction risk; under a build and sale option the extent to which construction risk is passed to the private sector would need to be established. This option may not provide value for money for the public sector although it could be considered in more detail as the Lower Thames crossing business case develops.

b. Concession – The public sector could enter into a concession agreement with a private sector partner who will undertake the operations and maintenance of the crossing in addition to some or all of the design, build and financing. The concession length could be varied to best suit the commercial and economic requirements of the public sector. The public sector could choose to establish a performance mechanism that would ensure the private sector has incentives to operate the crossing to a certain standard and with particular goals in mind. The public sector could retain some control over the level that toll prices are set at, if the crossing was tolled, and could agree with the private sector to share some of the key commercial risks.

Financing the Crossing

5.4.8.2 If the public sector was able to deliver the crossing using private finance and the crossing was classed as "off balance sheet" then there would be less pressure on the public sector's financial obligations on the crossing during the construction phase. This is as a result of the privately

financed model enabling the overall costs of the crossing to be spread over a longer period of time. An outline of the issues to consider for balance sheet treatment is included in the financial section. The current economic climate has made it challenging to secure long-term debt to support infrastructure projects although this will be subject to regular review as the Lower Thames crossing business case develops. A number of solutions to this are considered later in this section.

Maintaining the Asset

5.4.8.3 The private sector would be responsible for ensuring investment in renewing the asset is undertaken with a long-term view. A commercial structure could be agreed that ensured their incentives were aligned with the public sector regarding the ongoing operation of the crossing. An example could be a handback standard that the crossing is required to meet at the end of a concession with a financial penalty imposed if the private sector partner fails to achieve this.

Integrated Infrastructure

5.4.8.4 A maintenance plan could be established to minimise disruption and congestion whilst maximising economic performance of the new crossing and supporting infrastructure. A maintenance plan under a privately financed solution would require some additional coordination between different stakeholders involved in the operation of the crossing and supporting infrastructure. This could be achieved across each of the location options A, B, C and C with variant.

(c) Privately Financed Model with additional public sector support

5.4.9 If the privately financed model is the desired method for delivering the Lower Thames crossing but there are difficulties in securing the required level of private finance in order to do this then additional public support could be used to assist the project. The current economic climate has made it difficult although not impossible to secure long-term debt for major infrastructure projects. A privately financed model with additional public support would see a commercial structure that is similar to the privately financed model but the financing requirement for the construction and operation of the crossing would be met in part by public lending to the project.

5.4.10 This support could be delivered as incremental capital contributions that are made as pre-defined construction milestones are met or as a full capital injection at the end of construction to pay down a portion of the privately sourced funding within the project. The exact structure of the capital support, in the event the requirement for it materialises, would be developed as Lower Thames crossing business case develops.

5.4.11 A capital contribution of up to 50% of the total financing requirement has been proposed on some projects to ease the burden on the debt funding markets and to provide an additional source of competitively priced finance. In addition, the inclusion of financing from this source can also help affordability in the event that the public funding can be accessed at a more affordable rate than privately accessed sources of funding. Such an approach may be more relevant at Option C and Option C with variant due to the significant financing requirement at this location.

5.4.12 The next section of this chapter presents a high level view on the current funding market in relation to long-term debt that may form part of the privately financed solution.

5.5 Update on the long-term debt funding market – April 2013

5.5.1 A key consideration in selecting which commercial model to use to deliver the crossing will be the deliverability of the chosen solution. The availability of long term finance will be a key determinant

in the deliverability of any model involving private finance. In addition, an update on the long-term debt funding market will provide further information on the potential obstacles that each location may present. The state of funding markets will change over the coming years however the current situation can be summarised for reference at this stage. Within this summary attention is drawn to the salient issues for the Lower Thames crossing.

5.5.2 As **Table 5.3** below shows, the estimated capital cost of the Lower Thames crossing is significant. The capital cost estimates presented in **Table 5.3** differ from those in Tables 2.2 to 2.5 in the Review Methodology (Chapter 2) of this document. The Table 2.2 to 2.5 figures are in cash terms, including inflation expected before the costs are incurred, and a minimum, most likely, and maximum range of figures is presented. In contrast the capital cost figures in Table 5.3 are based only on the 'most likely' costs and have been converted to 2010 prices. The estimates in 2010 prices of the cost of constructing the crossing range from £1.1bn to £4.3bn when comparing the full range of structure and location options[39]. In the current climate securing the level of private finance required to deliver a scheme of this size would be challenging. Using these capital cost estimates the estimated funding requirements would be as follows:

Table 5.3 – Estimated Funding Requirement For Each Option[40], (All figures are nominal with a 2010 price base)

Option (All figures are nominal with a 2010 price base)	Capital Cost (£ m)	Funding Requirement (£ m)
A – Bridge	1, 104	[1, 325]
A – Immersed Tunnel	1, 461	[1, 753]
A – Bored Tunnel	1, 429	[1, 715]
B – Bridge	1, 638	[1, 965]
B – Immersed Tunnel	1, 858	[2, 230]
B – Bored Tunnel	2, 004	[2, 405]
C – Bridge	2, 861	[3, 433]
C – Immersed Tunnel	2, 733	[3, 280]
C – Bored Tunnel	2, 798	[3, 357]
$C_{variant}$ – Bridge	4, 400	[5, 280]
$C_{variant}$ – Immersed Tunnel	4, 273	[5, 128]
$C_{variant}$ – Bored Tunnel	4, 338	[5, 205]

5.5.3 The provision of in excess of £3Bn of private finance to support the Lower Thames crossing in the current market would be challenging. However, there is a need to secure planning consents to construct the crossing before finance for the construction can be raised, which means that the requirement for this level of finance is still some years away. The feasibility of securing the required level of private finance to deliver the crossing will need to be reassessed as the Lower Thames crossing business case develops. Nevertheless, this will be a factor that needs to be considered if the location for Option C is selected.

[39] This range is based on the cost estimates provided by AECOM in November 2012

[40] The construction cost in this table uses the cost estimates for Land Purchase and Construction as provided by AECOM in November 2012. To derive the estimated funding requirement a 20% uplift has been added to the construction costs. This uplift reflects additional costs that may need to be financed such as procurement costs and professional fees incurred by the successful private sector bidder and capitalised financing fees such as debt arrangement fees and interest during construction

5.5.4 In the past few years there has been deterioration in the capacity of the financing market to provide long term commercial debt to infrastructure projects. Commercial bank debt has been harder to access in recent years as a result of the poor global economic conditions and new regulatory constraints on banks. Some banks have left the long term project finance market and others have limited capacity to lend. Investment in transport infrastructure has historically benefitted from the availability of long term debt.

5.5.5 It is possible to raise long term commercial bank debt to support infrastructure projects but it is more challenging than it was. There have been a number of large transport infrastructure projects that have secured significant amounts of long term debt in the past three years and there are a number of factors that have contributed to their success. These factors include strong government support, such as policy commitment or financial support, capitalising on established corporate relationships between private sector consortia and financial institutions, and establishing a commercial structure that adequately deals with the project risks.

5.5.6 An alternative source of long term finance could come from the capital markets. There is appetite from institutional investors such as pension funds for stable inflation linked investments and a long term Public Private Partnership contract may be attractive to them. There may not be, however, an appetite from these institutional investors to take on any form of construction risk although as the institutional investment market develops this can be subject to change.

5.5.7 Government would not be seeking to secure funding for the new crossing from the private sector for some time. Therefore, it is important to highlight that the state of the long term project finance funding market at the point when the Lower Thames crossing is in the advanced stages of procurement may be much improved from its current position. The state of the funding market will be continually monitored as the Lower Thames crossing business case develops.

5.6 Summary of Key Findings

5.6.1 The Lower Thames crossing may be delivered at one of three locations using one of three possible physical structures. In addition, the commercial model that would be best suited to deliver the crossing may take a number of different forms.

5.6.2 There are many options for structuring the funding and financing. At this stage it is too early to determine which would be most suitable but this chapter identifies a set of considerations to be worked through as part of scheme development once the location has been selected. Across each of the commercial models that have been presented, a number of consistent commercial risks must be considered. As the business case for the Lower Thames crossing develops, each of the proposed commercial models will need to be refined in order to effectively manage the identified commercial risks.

Publicly Funded Model

5.6.3 The publicly funded model could enable the public sector to:

- maintain direct control of the crossing including the setting or removal of tolls to ensure economic benefits are maximised (note that this could also be achieved under a private financed model); and,
- retain all the benefits that may arise through the financial and commercial performance of the crossing exceeding expectations.

5.6.4 However, the publicly funded model could lead the public sector to:

- incur prohibitively large expenditure costs during the construction;

- fund all the additional costs that may arise through the crossing failing to meet financial, operational and commercial expectations; and,
- manage all the commercial risks associated with the crossing.

Privately Financed Model

5.6.5 The privately financed model could enable the public sector to:

- pass commercial risks to the private sector partner that is best placed to manage each specific risk (note that this could also be achieved under alternative publicly funded models);
- spread the cost of the Lower Thames crossing over a number of years to reduce the pressure on departmental expenditure budgets; and,
- maximise the economic benefits through aligning incentives with a private sector partner.

5.6.6 The privately financed model could lead the public sector to:

- fund a proportion of the total capital requirement in the event that sufficient private financing is unobtainable;
- take a proactive approach to managing the interface of the south-east infrastructure network to the extent that there are different stakeholders operating different infrastructure assets;
- forego any upside arising from the project performing better in a commercial sense than expected – with the passing of significant risks to the private sector the public sector would also minimise the potential returns it could receive; and,
- step in to the project in the event that the private sector is unable to fulfil its obligations.

5.6.7 The Lower Thames crossing is suitable for the privately financed model as it requires major capital investment, requiring effective management of risks associated with construction and delivery. The private sector has the expertise to deliver the crossing to the required standard. The financial chapter of this business case outlines how each commercial model could potentially perform under a set of common assumptions. Any decision on the commercial model to be used must take account of the financial impact of retaining or transferring the risk to the private sector. Whilst the analysis contained within the commercial section can be applied across all of the location options it has been noted that the scale of investment required in the Option C with variant and Option C locations may make the delivery of the Lower Thames crossing more challenging under each commercial model.

5.6.8 As the Lower Thames crossing business case develops more information on the value for money of each commercial model will be required, taking into account the impact of each of the commercial risks.

6 The Financial Case

6.1 Purpose of Chapter

6.1.1 The purpose of this chapter is to provide an initial estimation of how different commercial models could affect the affordability of a new crossing at each potential location.

6.1.2 There has been no allocation of funding for the Lower Thames crossing at this stage and any level of public investment would be subject to HM Treasury and departmental approval. The assumptions regarding public support and public funding must, therefore, be considered as merely illustrative at this stage

6.1.3 The 'commercial case' (chapter 5) distinguished three types of commercial model which could be used to deliver the Lower Thames crossing, namely:

- A full publicly funded option
- A privately financed model
- A privately financed model with additional public support

6.1.4 This chapter considers the affordability impact in relation to each of these commercial models as they might apply to each of the location options: Option A, Option B, Option C and also Option C with the Option $C_{Variant}$ included.

6.2 Methodology

6.2.1 The data used in compiling the financial case has been drawn from a number of sources:

- cost and revenue inputs provided by AECOM on 8th November 2012; and,
- commercial assumptions provided by the Department for Transport.

6.2.2 The cost and revenue assumptions provided by AECOM and the commercial assumptions provided by the Department for Transport are combined to provide a high level analysis of how each commercial structure may impact on public sector expenditure.

6.2.3 Under each of the models proposed it is assumed that future scheme development costs and costs associated with statutory procedures would be met by the public sector. This approach is based on past experience of procuring projects of this nature.

6.3 Revenue Collection Assumptions

6.3.1 Within this financial case it is assumed that the new crossing will be tolled and the revenue gained from this used to fully or partially fund the crossing under all possible scenarios. This assumption has been made for the purposes of the analysis contained within this financial business case and the Government has not yet made a decision on whether the new Lower Thames crossing will be tolled.

6.3.2 In this chapter each of the commercial models assumes that the public sector will collect toll revenues. This has been done for two reasons. Firstly, with the public sector collecting tolls they will not be subject to VAT and secondly, this allows for a direct comparison across each of the commercial models within this financial business case. Additional statutory powers may also be required to enable private concession arrangements in relation to road tolling or road charging.

6.4 Balance Sheet Treatment of the Lower Thames Crossing

6.4.1 Guidance on balance sheet treatment of Public-Private Partnership contracts between the public and private sectors for the provision of public infrastructure is used to determine whose balance sheet the infrastructure asset sits on - the government or private sector partner. Where the balance of risks and rewards of the contracts sits with government, the costs associated with the asset construction would be on the government's balance sheet and not the private sector partner's balance sheet and this would add to the government's debt and deficit[41]. Where the balance of risks and rewards of the contracts sits with the private sector operator, the costs associated with the asset construction would be on the private sector operator's balance sheet and not the government's balance sheet, and would therefore not fall within the government's debt and deficit calculations.

6.4.2 The assets would be classified as government assets on balance sheet where final user toll payments are higher than 50% of the availability payments made by government to the partner. Availability payments refer to the annual payments made to a private sector concessionaire. The term "availability payments" references the fact that these payments are often based on a fixed amount that is reduced in the event that the availability of the crossing does not achieve a pre-determined level.

6.4.3 Under a scenario where the final user toll payments are lower than 50% of the availability payments made by the government to the partner, in accordance with official guidance at the time the government would be required to examine the allocation of a number of different risk elements to determine on whose balance sheet the infrastructure asset should be classified.

6.4.4 The balance of risk between the government and private sector operator will become clearer as the business case develops and would only be finalised during detailed contractual negotiations prior to and during the procurement of the Lower Thames crossing. The above is based on the current guidance which may be revised in the future - the treatment will therefore need to be reviewed as the Lower Thames crossing business case develops.

6.5 Summary points on each of the Commercial Models

6.5.1 A publicly funded scenario would require capital expenditure to meet the capital costs of the crossing during the construction period.

6.5.2 A privately financed scenario could spread the costs of the crossing over its life if the crossing was classed "off balance sheet". Under this scenario the crossing would be funded through annual resource payments which would be used to pay for costs incurred in construction the crossing (land purchase, capital costs and borrowing costs) and the ongoing maintenance of the crossing.

6.5.3 A privately financed scenario with additional public support could spread the costs of the crossing over its life if the crossing was classed "off balance sheet". In addition to this a level of capital expenditure would need to be funded in order to provide the capital contribution or government borrowing which would be used to support the financing of the crossing.

[41] By government debt we refer to the cumulative debt figure that details all outstanding Government liabilities. By government deficit we refer to the figure derived from a calculation of the net position of Government income and expenditure in a specific year

6.6 Summary points on the Location Options

6.6.1 The table below presents the total capital cost associated with the scheme and the amount of gross revenue received at each crossing location in 2025, the first year of operations. The capital cost estimates presented in Table 6.1 differ from those in Tables 2.2 to 2.5 in the Review Methodology (Chapter 2) of this document. The Table 2.2 to 2.5 figures are in cash terms, including inflation expected before the costs are incurred, and a 'minimum', 'most likely', and 'maximum' range of figures is presented. In contrast the capital cost figures in Table 6.1 are based only on the 'most likely' costs and have been converted to 2010 prices – the same price base as the revenue forecasts. Unlike the discounted changes in revenue over 60 years figures presented in the Economic Case (Chapter 4), the figures below in Table 6.1 are forecast for a single year (2025) and are not discounted – so these figures provide the basis for a useful illustrative comparison of the crossing location options in terms of potential annual income relative to capital cost.

Table 6.1 – Capital Cost and Illustrative Annual Revenue For Each Option, (All figures are nominal with a 2010 price base)

	Option A	Option B	Option C	Option $C_{variant}$
Capital cost	£1.1 - 1.5Bn	£1.6 – 2.0Bn	£2.7 – 2.9Bn	£4.3 – 4.4Bn
Total gross revenue forecast across new and existing crossing, 2025	£130m	£141m	£144m	£145m
Gross revenue forecast from traffic using the new crossing 2025[42]	£43m	£33m	£45m	£46m

6.6.2 The capital costs at Option C and Option C with variant are larger than those at Option A and B and there is no significant increase in revenue generated from the new crossing across the location options. This means that the revenues received on the crossing are less likely to be sufficient in meeting the total project costs over the projected length of the project concession.

6.6.3 There a number of ways to address the issues outlined above:

(a) Firstly, there is the potential to increase the length of the concession. A concession of up to 100 years could be considered. Extending the length of the concession would enable future revenues to be used to support the financial performance of the crossing. However, it may be difficult to secure the appropriate financing in order to deliver the crossing over a longer concession and the ongoing maintenance of the crossing and supporting infrastructure at Option C may make it difficult to generate a net positive revenue position each year;

(b) Secondly, sensitivity testing performed by AECOM has suggested that a higher toll level on the crossing would have a limited impact on the total traffic volume using the crossings. As a result, a higher toll level has the potential to improve the net position of all of the scenarios at Option A, B, C and C with variant. The introduction of a higher toll would have political implications.

[42] The revenue forecast for options B and C are based on the amount of traffic that is forecast to use them. The revenue forecast attributed to new crossing structure at option A is provided for illustrative purposes: it is calculated in line with the proportion of the number of additional lanes that the illustrative design of the new structure would provide at the existing location (4 extra lanes, taking the total number to 12). In reality the proportion of revenue resulting from traffic on the new crossing structure could be higher or lower depending on detailed design considerations that will affect the balance of traffic using existing and new crossing structures.

(c) Thirdly, for the Option C variant, costs associated with the linking infrastructure could form a separate scheme and met by other sources of funding. This would reduce the capital costs and therefore reduce overall project costs. There could be justification for this in the event that it can be demonstrated that the linking infrastructure has a viable business case as a stand alone development. If, however, the business case for the linking infrastructure is based upon the connection to the Lower Thames crossing it would be difficult to justify this approach.

6.7 Summary of Findings

6.7.1 The Lower Thames crossing scheme could be delivered through a number of different commercial models. This chapter has considered each of the location and structure options against the three commercial models and has used consistent commercial assumptions in order discuss the potential affordability implications of each commercial model.

6.7.2 As the capital costs are significantly higher for options C and C with variant under the privately funded models each of the structure options may not generate enough revenue to be self funding. However, the commercial assumptions could be varied with a longer project life or alternative tolling scenarios improving the financial performance of the crossing at these locations.

6.7.3 The accounting treatment of the privately financed options may enable them to be off the government's balance sheet and therefore outside of the debt and deficit calculations. This depends on the allocation of risk between the private and public sector which will be agreed during the procurement of the Lower Thames crossing and the extent to which revenue received on the crossing is used to make payments in relation to it.

6.7.4 Under each of the location and structure options the privately funded models may provide a better position with regards to the amount the government would have to spend in any year when compared to the publicly funded model. This is a result of the overall costs of the crossing being spread over the length of the scheme whereas in the publicly funded model the costs would need to be met as they were incurred.

6.7.5 At this stage none of the options or structures can be ruled out on a financial basis although there are benefits and costs associated with each of the crossings.

6.7.6 As the Lower Thames crossing business case is developed, more detailed analysis on the implications of the following issues will be needed:

- Allocation of risks between the public and private sector;
- Budgetary implications of each commercial model;
- Procurement strategies;
- Deliverability of each commercial model; and,
- Overall project affordability against departmental expenditure limits.

7 Management Case

7.1 Purpose of Chapter

7.1.1 This chapter outlines project planning, governance and management arrangements that would be put in place to initiate and develop the scheme once the policy decision has been made on where to locate the new crossing.

7.2 Evidence of Similar Projects

7.2.1 DfT and the Highways Agency have significant experience of delivering major road based infrastructure projects in England using a range of project management and assurance methods and with a range of delivery mechanisms. These projects have delivered complex engineering works that take account of significant environmental, programme and cost constraints.

7.2.2 The completion, in the summer of 2012, of the A3 Hindhead tunnel is one of the most recent examples. The Highways Agency successfully delivered 1.14 miles of twin bored tunnels under the Devil's Punch Bowl, a Site of Special Scientific Interest.

7.2.3 Examples of other significant infrastructure projects delivered against a backdrop of significant engineering, environmental, planning and cost constraints in the vicinity of the location options for a new crossing under consideration, include:

- Dartford tunnels (1963 and 1980);
- QEII Bridge (1991);
- High Speed 1 rail line (2007); and
- M25 widening e.g. Junctions 27 – 30 (2012).

7.2.4 Following the Government’s 2010 Comprehensive Spending Review and announcements made by the Chancellor in subsequent Autumn Statements in 2011 and 2012, the Highways Agency are currently delivering and developing for delivery, a programme of 32 major road projects representing an investment of over £3.2bn.

7.2.5 The programme consists of a range of projects from the delivery of a number of Managed Motorway projects through to major junction improvements and widening of major trunk roads. At present the HA have successfully delivered 7 of the 8 major schemes in progress at the time of the Spending Review and have commenced delivery of a further 6 new projects, all of which remain on track to be delivered by their planned implementation dates.

7.2.6 Proposals for a number of other major schemes in the South East which are currently being prepared by the Highways Agency include:

- A21 Tonbridge to Pembury dualling scheme (due to begin a Public Inquiry later this year)
- M25 Junction 30/A13 Congestion Relief Scheme (the Government has announced an investment of £150m for improvement works to tackle congestion at Junction 30 of the M25 starting in 2015).

7.3 Project Dependencies

7.3.1 The successful delivery of a new Lower Thames crossing will be dependent on and affected by decisions relating to a number of other projects. Potential project dependencies identified so far include:

- Thames Gateway developments.
- M25 Junction 30/A13 improvements

7.3.2 More directly, the successful delivery of a new crossing will be dependent on Development Consent being granted for the new crossing under the Planning Act 2008 (as amended).

7.3.3 Dependencies will be recorded, monitored and evaluated as the project progresses to ensure that issues with the potential to affect the delivery of the new crossing are identified promptly and to allow mitigation measures to be put in place so that overall scheme delivery is not compromised.

7.4 Governance, Organisational Structure & Roles

7.4.1 Providing a new Lower Thames crossing is one of the Government's top 40 priority infrastructure projects and would most likely be subject to "Tier 1" governance arrangements. Tier 1 projects are reviewed by the DfT Board at key funding approval stages as well as being subject to external scrutiny (see section 7.6). The role of the DfT Board is to provide selective strategic challenge and advice, to consider corporate risk issues for DfT, and to make recommendations to the appropriate Accounting Officer.

7.4.2 Once the location of the new crossing has been decided, and a project initiated, a project team would be appointed to project manage the detailed development of scheme proposals in line with the guidance set out in the Project Control Framework[43] (a document setting out a joint DfT and Highways Agency approach to managing major projects). The typical governance structure for a major project has four key roles:

- Project Manager (responsible for managing the development and delivery of the project);
- Senior Responsible Owner (with overall accountability for the delivery of the project)
- Project Sponsor (with overall ownership of the transport problem being addressed); and
- Project Board (to oversee the delivery of the project and provide support to the Senior Responsible Owner). Board members are likely to be appointed to carry out a number of specific roles; for instance a Senior User is likely to be identified who may in future be responsible for operating the new asset and a procurement professional may also be included.

7.5 Project Planning

7.5.1 The Highways Agency Project Control Framework provides a reference for planning by identifying a series of key stages (illustrated in Figure 7.1).

7.5.2 No decision has been taken yet about the location of a new Lower Thames crossing. This Review Report provides information that informs an ongoing strategy shaping and prioritisation process (stage 0 in Figure 7.1) that will enable a decision to be taken on this issue.

[43] Highways Agency, Project Control Framework Handbook, 2008. Available at http://assets.highways.gov.uk/our-road-network/managing-our-roads/project-control-framework/M070282_The_Project_Control_Framework_Handbook_April_2008.pdf

7.5.3 Options for the route of the new crossing at the selected location, will then be identified and once a preferred route option has been identified (at the end of stage 2 in Figure 7.1) proposals for a new crossing will enter the Roads Programme and be progressed through to construction, handover and scheme closeout.

Figure 7.1: Major Projects Lifecycle

7.5.4 A detailed project plan will be developed documenting all actions required and interdependencies and identifying a critical path for the delivery of the new crossing.

7.5.5 Project planning will take account of the lessons learnt from piloting an accelerated approach to delivery of major schemes as announced by the Transport Secretary in November 2012. Time savings are expected to be made by:

- Undertaking concurrent planning, design and construction preparation activities;
- Taking more work off-site and bringing to site as pre-fabricated /pre-assembled units; and
- Moving toward a 24 hour operation with more people on site working on multiple phases at once.

7.5.6 The four schemes where this new approach to road upgrades will be piloted, are[44]:

- Surrey, M3 J2 to 4a managed motorway (Work on this scheme, which was added to the roads programme in autumn 2011, is expected to start 2013/14 and be completed by spring 2015 rather than during 2016).
- The West Midlands, M6 J10a to 13 managed motorway (Work on this scheme, which was added to the roads programme last autumn is expected to start 2013/14 instead of 2014/15 and be completed by spring 2015 instead of during the following financial year, 2015/16).
- Derbyshire, M1 J28 to 31 managed motorway (Work on this scheme, is expected to start 2013/14 and be completed by spring 2015 instead of during the following financial year, 2015/16).
- A160/A180 Immingham dualling scheme - improving access to the Port of Immingham (Work on this scheme is expected to start in summer 2015 instead of during 2016 and completed by autumn 2016 instead of during 2018)

7.6 Assurance & Approvals Plan

7.6.1 Project assurance will be carried out by the Project Board, who will review and agree all project procedures and processes.

[44] The delivery of these schemes is subject to statutory procedures and, in the case of the scheme to improve access to the Port of Immingham, on the construction budget being agreed for the next funding review period

7.6.2 Formal Stage Gate Assessment Reviews will also be carried out by the Highways Agency at the end of each of the stages shown in Figure 7.1 before the next stage is started. Stage Gateway Assessments will provide assurance that:

- the stage is completed;
- the Project Control or other appropriate Frameworks have been followed; and
- the project is ready to proceed to the next stage, subject to investment authorisation.

7.6.3 In addition, a series of Gateway Reviews are likely to be carried out at defined points by the Major Planning Authority, a part of the Cabinet Office, which now has responsibility for the review function previously carried out by the Office of Government Commerce. These reviews will provide assurance that:

- Suitable skills and experience are deployed on the project
- All stakeholders understand the project status and issues
- There is assurance that the project can progress to the next phase
- Time and cost targets have a realistic basis
- Lessons are learned
- The project team are gaining input from appropriate stakeholders

7.7 Communications and Stakeholder Management

7.7.1 The communications and stakeholder management strategy implemented during this review will need to be updated to cover future stages of the project, in order to:

- keep stakeholders aware of progress and give an opportunity for feedback to help gain scheme approval;
- give an opportunity for stakeholders to provide views and recommendations for improvements so that the scheme meets stakeholder requirements as far as practicable;
- meet statutory requirements;
- increase public and stakeholder awareness of the scheme;
- provide consistent, clear and regular information to those affected by the scheme, including the nature of any scheme-related impacts and when and how it will affect people or groups during delivery and once operational; and
- address perceptions of the scheme where these are inconsistent with the scheme objectives.

7.8 Risk Management Strategy

7.8.1 The successful delivery of a new crossing is dependent on risks being identified and managed such that overall scheme delivery is not adversely affected. This review has started to identify a number of risks.

7.8.2 A Risk & Issue Management Plan will be produced to identify and manage risks. A risk register will also be produced and risks assessed for elimination, reduction and mitigation to manage them to a level that is as low as reasonably practicable. The risk register will be reviewed and key risks and projects issues reported to the Project Board periodically. Risk workshops are also likely to be held at appropriate points to review the project risks and opportunities.

7.9 Summary of Chapter

7.9.1 The DfT and Highways Agency's collective experience of delivering major road infrastructure schemes and the robust governance, project planning, and other arrangements described above provide confidence that a new Lower Thames crossing can be successfully delivered.

8 Conclusions

8.1 Purpose of Chapter

8.1.1 These conclusions highlight the main findings from this review and focus on the differences in the performance between the location options.

8.2 Review Scope

8.2.1 This review has re-examined the need for additional road based river crossing capacity by developing a base case which confirms that the congestion at the existing crossing would worsen between now and 2041, even with the introduction of short term measures (see section 4.3: *The Base Case*).

8.2.2 This review has assessed three potential locations and a variant of Option C shortlisted by the 2009 study:

- Option A: At the site of the existing Dartford -Thurrock River Crossing;
- Option B: Between the Swancombe Peninsular and the A1089;
- Option C: between the east of Gravesend and the east of Tilbury; and
- Option $C_{variant}$: Option C with widening of the M2 to M20 link.

8.2.3 The evidence has been assembled using the DfT's five case model, on the relative merits of these location options for providing additional highway capacity across the lower Thames. At this formative stage, the strategic outline business case focuses on establishing the case for change namely the strategic case (Chapter 3). The case for change is informed particularly by the appraisal of economic, environmental and social impacts and value for money considerations that are set out in the economic case (Chapter 4).

8.2.4 This review has developed conceptual designs for illustrative routes to estimate the likely costs and identify the potential impacts and costs of delivering a new crossing at each of the three locations. These cost estimates were used within the economic, commercial and financial cases to assess the potential value for money and financial viability of a new crossing.

8.2.5 The capacity requirement assumed at this stage for all locations was 2 lanes in each direction (4 lanes in total); the incremental cost of adding a third lane in both directions for all potential engineering solutions was also estimated for each location option.

8.2.6 The estimated capital costs for a new route range between £1.25bn and £5bn (based on 'most likely' capital cost estimates, in cash terms, assuming a 4 lane crossing structure), reflecting both the range of location options and engineering solutions. Option A would be the least expensive location option at £1.25bn for a bridge, the least expensive engineering solution. A bridge at Option B would be likely to cost about 50% more than a bridge at Option A, and any engineering solution at Option C would cost more than twice as much as Option A. The additional costs of options B or C reflect both the increased length of route needed to tie in with the strategic road network and the larger structure required to traverse the Thames. The further additional cost of Option C variant was estimated to increase the cost, relative to Option C, by nearly 50%. The cost for delivering a future scheme will depend on the capacity and type of crossing structure provided and actions taken to mitigate or avoid particular impacts.

8.3 Feasibility and Viability

8.3.1 On the basis of the assessment in this review, it would be technically feasible to design and deliver a future scheme in all of the locations, subject to satisfactorily addressing potential environmental impacts. Future design work would need to establish the particular route alignment within the selected location.

8.3.2 Monetised assessments of impacts were undertaken where the outcomes could be assessed with reasonable confidence; these indicated that the monetised benefits would exceed the costs for all the location options.

8.3.3 A qualitative assessment of other impacts was also undertaken using methods defined in WebTAG for this purpose. Further detailed design would need to include consideration of methods to avoid or mitigate impacts.

8.3.4 Formative consideration of the commercial, financial and management cases identified that it would be feasible to deliver a scheme at any of the three locations. The capital costs at Option C and Option C with variant are larger than those at Option A and B and there is no significant increase in revenue generated from the new crossing across the location options. This means that for Option C and $C_{Variant}$ the revenues received on the crossing are less likely to be sufficient in meeting the total project costs over the projected length of the project concession.

8.3.5 Based on the analysis in the economic case of benefit to cost ratios (BCRs) and net present values (NPVs), it is possible to conclude that it is likely that the economic return of a carefully designed scheme would be economically justified at either location options A or C, and possibly at B depending on the cost of the engineering solution adopted. Work to develop a future scheme would need to consider the cost and the alignment of a scheme at the chosen location.

8.3.6 A particular reason for considering $C_{Variant}$ at this stage is to understand whether the added value of improving the link in the strategic road network between the M2 and M20 would materially improve the business case for Option C, which itself provides a new link between M25 and M20.

8.3.7 Our assessments indicated that there would be significant engineering challenges and costs in delivering the widened A229 to link the M20 and M2, particularly associated with the structures needed at the junctions. Comparison of the net present values (NPVs) of Option C and Option $C_{variant}$ shows that the additional monetised benefits of the variant are similar to the additional costs. The business case for Option C would therefore not be materially improved by extending the route south to the M20.

8.3.8 For the purposes of selecting between Lower Thames crossing location options, it could be concluded that Option C could be compared directly with Options B and A, as the economic case for Option C is not dependent on the additional infrastructure in Option $C_{variant}$.

8.4 Tunnel or Bridge Structure

8.4.1 The analysis has considered the relative merits of bridge, bored and immersed tunnel structures. No reason has been identified to adopt an immersed tunnel for any of the location options, as this type of infrastructure has both larger adverse environmental effects and a higher cost than a bridge at all locations except Option C. Impacts of an immersed tunnel would be expected to be significant during construction, in particular in respect of the biodiversity impacts on the Thames mudflats, the water environment and on the commercial activity using the river. Detailed design, however, has not been conducted, and there may be reasons not so far considered to favour an immersed tunnel.

8.4.2 The choice of engineering solution would currently, therefore, appear to be between a more expensive bored tunnel with smaller environmental impact, particularly on biodiversity, and (for all location options except C) a cheaper bridge with a generally larger environmental impact. A 6 lane capacity requirement (as opposed to the 4 lanes assumed in this review) would widen the gap between the costs of a bridge and a bored tunnel, as the costs of boring a tunnel are proportionate to volume of material extracted, which increases by a larger percentage than crossing width or diameter.

8.5 Performance against Review Objectives

8.5.1 The strategic case (Chapter 3) identified a number of objectives against which the options were assessed. Accordingly this review has assessed the extent to which a new crossing at each location would:

- contribute to the national economy, through improving journey times and connectivity of the strategic road network, both to and within the Thames Gateway and the South East;
- reduce congestion at the existing crossing and improve the resilience of the strategic road network;
- contribute to reducing greenhouse gas emissions;
- avoid unacceptable impacts on environmentally sensitive areas and improve quality of life; and
- avoid unacceptable impacts on committed development.

In addition, the review assessed each option in terms of the distribution of impacts on different income groups

Contribution to the national economy

8.5.2 While Option A is predicted to deliver greater direct enhancement to the operation of the M25 route, Options B and C provide new connectivity. The more direct route provided for a range of journeys, particularly by Option C would reduce journey times for many users. Taken in combination with the impacts on travellers who would be expected to continue to use the existing crossing, overall the journey time savings for all traffic using the road network are forecast to be largest for Option C, and smallest for Option A.

8.5.3 The modelling work undertaken indicates that for all options there are risks that the pressure of additional traffic may cause congestion along the A2 and A13 corridors and on the local road networks in North Kent and South Essex. At this stage our forecasts indicate that the potential impacts of additional congestion along and near the A2 and A13 east of Basildon corridors are likely to be greatest for Option B. The associated network constraints would need careful consideration as part of detailed design for a future scheme.

8.5.4 Analysis of the wider economic benefits of the location options has shown that they differ widely in the contribution they could make to the economy. The enhanced connectivity that Option C and Option $C_{variant}$ in particular would deliver, are forecast to provide far greater wider economic benefits than Options A or B, largely through the agglomeration of business activity enabled. The value of the wider economic benefits over 60 years that would be brought forward by Option $C_{variant}$ is approximately six times larger than for Option A, and nearly 3 times larger than for Option B.

Congestion reduction at the existing crossing and improving the resilience of the strategic road network

8.5.5 Provision of new capacity should reduce congestion at the existing crossing and provide a more coherent capability on the strategic road network, which will in turn make a contribution to the national economy. The congestion at the existing crossing causes delay with consequences for the economy and for the local air quality.

8.5.6 The LTC Model forecasts show how the options could affect congestion on the strategic road network. These indicate that the effects on travel time would be focused at the crossing and on the A13 and A2 corridors; no substantial impacts were identified on other parts of the strategic road network.

8.5.7 The forecasts indicate Option A would address the capacity constraint at the existing crossing; in the assumed opening year (2025) the crossing would operate with significantly less traffic than design capacity. Table 4.3 shows that traffic volumes at the crossing would be less than 75% of its

design capacity, indicating uncongested conditions. The forecasts indicate the potential for congestion around M25 junctions 30 and 2, which would need to be addressed by improvements to these junctions.

8.5.8 The re-routeing of traffic forecast for options B and C would be expected to reduce demand at the existing crossing and thus alleviate congestion to a similar extent in both cases. Our forecasts, however, indicate that the operating conditions at the existing crossing would be substantially improved with journey times on a typical day only marginally slower than Option A. Nevertheless if options B or C were built the existing crossing would be forecast to operate relatively close to capacity, with less headroom for when incidents occur, and therefore congestion would be expected to occur more frequently when incidents do occur at the existing crossing than for Option A.

8.5.9 Our analysis indicates that Option A would address the stress at the existing crossing by adding sufficient capacity to reduce the ratio between traffic volumes and capacity to less than 75%. For both Options B and C the traffic forecasts indicated that the residual demand volumes at the existing crossing would be only slightly below capacity. There would be limited resilience for these two options to accommodate exceptional peaks in demand: it is more likely for these options (B and C) that there would be some occasions where queues form.

8.5.10 That said, options B and C both provide an additional link in the strategic road network. The ability to advise drivers to use alternate routes introduces the opportunity for operational management procedures, such as advisory signage, to better manage the network to respond more effectively to incidents and congestion.

8.5.11 The relatively high incidence of vehicle breakdowns at the existing crossing relates to the close proximity of the toll plazas and the existing structures and the consequential effects on vehicle weaving and performance. These issues are being considered as part of the implementing the free-flow tolling that is planned for 2014. It is assumed here that a future crossing scheme would be designed in accordance with current standards, and therefore would continue to maintain and improve safety.

8.5.12 All of the options provide additional capacity which is forecast to increase traffic using the road network. Given that the likelihood of accidents relates to exposure, or traffic volumes, a proportional increase in the total number of accidents across the Kent, Essex and east London networks would be expected for all three location options.

Reducing greenhouse gas emissions

8.5.13 At this formative stage our assessments of the performance of the options in contributing to reducing carbon emissions has focused on the effects of forecast vehicle emissions. Consideration of the carbon emissions associated with sourcing materials used for construction will be required in designing a future scheme.

8.5.14 Our analysis indicated that, through the provision of a more direct route for many journeys than the existing crossing, Option C would result in the greatest reduction in carbon emissions, because it offers a new, shorter route to some long distance traffic. Although Option A would not create a new route, it was also forecast to result in a modest reduction in carbon emissions because it would reduce congestion. In contrast, for Option B, the route changes forecast did not offset the forecast growth in traffic and so the overall assessment indicated that carbon emissions would increase.

Avoid unacceptable impacts on environmentally sensitive areas and improve quality of life

8.5.15 In addition to economic growth, the government seeks to deliver sustainable transport solutions whilst avoiding unacceptable impacts on environmentally sensitive areas.

8.5.16 Major infrastructure provision is likely to have environmental impacts and the objective is to minimise adverse impacts and enhance the environment if possible. At this formative stage, existing databases have been drawn upon that identify potential environmental constraints.

Environmental surveys will need to inform detailed consideration of both social and environmental impacts in designing any future scheme.

8.5.17 Potential impacts of particular note for all location options are on the water and marine environment. The Thames Estuary was one of 127 sites around the coast recommended to Government as possible Marine Conservation Zones. The Government has proposed to designated 31 sites as Marine Conservation Zones, this does not include the Thames Estuary. Further designations will follow in tranche 2. If a new structure is provided as an immersed tunnel the impacts are expected to be particularly significant. Similarly, the effects of additional bridge piers directly on the mudflats and within the river channel would impact on wildlife and would argue for the provision of a bored tunnel rather than a bridge.

8.5.18 Options B and C require provision of new roads to link a new Thames structure to the strategic road network. As might be expected the environmental risks would all be substantially greater for these options than for a new structure provided at Option A.

8.5.19 Environmental constraints of particular note in respect of Option B include:

- the area of rich archaeological heritage through which a future route would pass; and
- Swanscombe heritage park landscape.

8.5.20 Environmental constraints of particular note in respect of Option C include:

- ancient woodland in Shorne and Ashenbank woods which are near the location proposed for a junction providing access to the A2/M2; it may be that design of limited local tunnelling can reduce these potential impacts;
- the Thames Estuary and Marshes RAMSAR site, where proposed development would be subject to a test of over-riding public interest; and
- landscape and visual impacts on the Kent Downs Area of Outstanding Natural Beauty.

8.5.21 Another issue of environmental sensitivity relates to the impact of a future scheme on traffic volumes through Air Quality Management Areas (AQMAs). AQMAs are areas where air quality is being managed by the relevant local authorities in order to work towards achieving National Air Quality Strategy objectives.

8.5.22 AQMAs have been declared for the A282 J1a-J1b by Dartford Borough Council and at locations adjacent to the A282 by Thurrock Council. Option A would be likely to increase traffic volumes through these areas. In designing a future scheme detailed consideration would be required to consider the extent to which the impact on air quality of increased traffic flow might be offset by reduced queuing of traffic.

8.5.23 Options B and C would be expected to improve air quality at the locations of the Thurrock and Dartford AQMAs, but could impact on other AQMAs, due to the expected increase in traffic passing adjacent to these areas if options B or C were built. Option B could have an adverse impact on AQMAs declared for the A226 leading to the river crossing and at the Bean Interchange between the A2 and A296 by Dartford Borough Council. Option C could have an adverse impact on an AQMA declared for the A2 leading to the river crossing by Gravesham Borough Council, and for the whole of London Borough of Havering.

8.5.24 The noise assessments indicated that while Option A could have slight impacts in terms of noise through traffic changes on the existing transport links, Options B and C would both establish new network links and would thus be expected to increase exposure to properties and people that would otherwise be relatively unaffected by noise.

Avoid unacceptable impacts on committed development

8.5.25 In testing the feasibility of designing a scheme in the three potential locations we reviewed constraints, including planned development to understand the extent to which unacceptable impacts on existing and planned development could be avoided.

8.5.26 Option A, if constructed as a bridge or immersed tunnel, would impact on the potential development of some commercial sites adjacent to the existing crossing, but these impacts might be avoided to some extent by constructing a bored tunnel instead.

8.5.27 Option C would traverse land largely designated as Green Belt, which is a designation that generally constrains development, so it is less likely that a route at Option C would conflict with planned development.

8.5.28 Option B, by contrast, traverses planned development sites north of the A2 corridor, particularly on the Swanscombe Peninsula. Design of a future scheme would need to carefully consider the impact of the route on the viability of development sites.

Social and distributional impacts on people

8.5.29 This review has assessed how the options would affect people within different income groups (the Social and Distributional Impacts assessed in the economic case).

8.5.30 The location options that provide overall benefit to consumer users (Options A and $C_{variant}$) tend to benefit people in the low income band significantly less than people in the high income band. This suggests that new crossings at these locations would provide less time benefit to less affluent travellers.

8.5.31 The options that are forecast to disbenefit consumer users overall (Options B and C), but from which businesses benefit, tend to disbenefit people in the higher income band more than people in the lower income band.

8.5.32 For those who would be affected by increases in noise levels, all options are expected to affect those in the least affluent income groups in the greatest numbers. A new crossing at Option C would adversely affect the most deprived areas and positively affect the most affluent. Option A has a moderate adverse impact, and would adversely affect all income groups, but with lower income groups affected the most. Option $C_{variant}$ and Option B have a moderate adverse impact, although in both cases the assessment is still very slightly worse for lower income groups

8.5.33 The air quality impacts of Option A are beneficial to all income groups, but with the highest income group forecast to experience the largest beneficial effect. For Options B and C, the lowest income group would experience a large beneficial effect whilst the middle income group would be expected to experience the largest adverse effect. Option $C_{variant}$ would benefit the lowest income group whilst all of the other income groups are forecast to experience a large adverse effect

8.5.34 The policy decision whether to charge tolls and the levels at which those charges may be set would need to be addressed during the development of any scheme. The analysis in the economic case shows that should tolls be at the same level as planned for the existing crossing there would be no changes in the affordability of travel. However, should higher tariffs be considered the differential impacts of higher charges on lower income population segments will need to be taken into account.

8.5.35 It was assumed that careful scheme design would avoid severance of other routes and rights of way and hence minimise impacts on local accessibility. Potential impacts in terms of severance, physical activity, journey quality, security, access to services are therefore not expected to be significant.

8.6 Relative Performance of each Option

Option A

8.6.1 Option A would provide additional capacity at the existing crossing through construction of an additional bridge or tunnel adjacent to the existing crossing structures to provide additional capacity between M25 J31 and 1a, largely traversing developed land on the banks of the Thames adjacent to the existing crossing.

8.6.2 Option A is forecast to perform better than the other location options in terms of addressing the capacity constraints at the existing crossing. It is predicted to deliver the best resulting performance and reliability of performance for traffic using the existing crossing and the adjacent M25 sections. This option may increase pressure to improve capacity on sections of the A13 and possibly A2 near the M25.

8.6.3 The option would thus address the implications of the existing capacity constraint for economic growth. It would not however improve connectivity of areas within the Thames Gateway to the strategic road network and is forecast to stimulate a relatively limited improvement in productivity and new employment compared with the other options.

8.6.4 Option A would involve a physical route that is shorter in length than at the other locations but could impinge on land potentially to be developed. A new bridge structure would have impacts on the marine environment although these could be addressed by providing a tunnel. Option A could have the least adverse impact overall on the natural environment.

Option B

8.6.5 Option B would provide a new route from the A1089, passing between Grays and Tilbury docks on the north bank of the Thames. To the south the route would traverse the Swanscome Peninsular and land designated for development before linking with the A2.

8.6.6 The effect of traffic re-routeing to cross the Thames at the new crossing location is forecast to slightly reduce demand using the existing crossing. The capacity of the existing crossing is not expected to exceed the volume of traffic continuing to use it by a substantial margin. While normal operation would be expected to deliver satisfactory performance, users may, therefore, experience delay from time to time, for example due to incidents.

8.6.7 The additional crossing provides a more direct route between north Kent and south Essex. A particular risk would be how the new route would connect with the A13 and A2. The A13 is congested and the planned development along the A2 corridor is forecast to result in congestion along the A2. At this formative stage additional delays along the A2 and A13 corridors were forecast to offset some of the benefits of providing a new route and therefore consumer user benefits were forecast to be lower for Option B than for Option A

8.6.8 Planning of developments in the Lower Thames should consider measures needed to assure satisfactory performance of the transport network. Both the provision of a new route across the Thames and local development would significantly affect traffic patterns. The impacts on the A2 and A13 corridors would need to be considered carefully in conjunction with the design of Option B.

8.6.9 The improved connectivity is forecast to support development of employment opportunities, particularly in that part of the Thames Gateway that is local to the new route. Option B is therefore forecast to be more effective in supporting the development of economic activity within the Lower Thames area than Option A. The option would, however, pass through and reduce the capacity of land designated for development along the A2 corridor.

8.6.10 A new crossing at Option B would potentially traverse the edge of Grays, pass across the Swanscombe peninsular and traverse an area of nationally important heritage, and would thus be expected to cause more environmental harm than Option A.

Option C

8.6.11 Option C would provide a direct link between the M25 (a new junction between Junctions 29 and 30), the A13 near Orsett and the M2/A2 south of Shorne. The route would largely pass through currently undeveloped land designated as Green Belt.

8.6.12 The forecast effects of Option C on the performance of the existing crossing are similar to those described for Option B. Option C is, however, less likely than Option B to impose additional stress on the A2 and A13 road corridors. In consequence there is likely to be less difficulty in designing a

scheme at Option C to deliver forecast highway journey time savings than for a new crossing at Option B.

8.6.13 The improvements in accessibility as a result of Option C results in the largest forecast wider economic benefits, particularly those resulting from agglomeration of business activity of the three options.

8.6.14 Option C is the longest of the three routes. The assumed illustrative route for Option C passes through the Kent Downs Area of Outstanding Natural Beauty and across the Thames Marshes and Marshes RAMSAR designated SSSI and ancient woodland in Shorne and Ashenbank woods and would thus be likely to result in the greatest impacts on the natural environment of the three location options.

8.7 Summary

8.7.1 The assessment of the relative merits of the three location options in this report has made clear that none of the options is likely to out-perform the others across the board in terms of ability to achieve all objectives.

8.7.2 All of the options would deliver economic benefits both resulting from congestion relief for users as a whole and improvements to the transport connections used by businesses, which would be expected to result in benefits to the national economy. Within the economic performance, Option A is likely to deliver greater congestion relief at the existing crossing, although additional capacity at this location is likely to worsen capacity issues at other points on the surrounding parts of the strategic road network. If new capacity is provided by Options B and C, it is likely that the existing crossing will remain close to capacity, and although delays would be reduced, incidents could still lead to long delays as they do at present.

8.7.3 Option B would be expected to deliver higher economic benefits than Option A, but at a much higher cost. This renders the value for money of Option B considerably lower than Option A.

8.7.4 Option C in particular would offer shorter journey times to many users, and would deliver the largest wider economic benefits, which ultimately would contribute to national economic growth. Option C also is forecast to deliver the largest reduction in greenhouse gas emissions of the three options. Option C would be expected to impose other environmental costs on the greatest scale of the three options, although some of these costs could be mitigated to some extent by use of a bored tunnel instead of a bridge or immersed tunnel.

8.7.5 The location decision rests in large part on the relative weight ascribed to alleviation of the congestion experienced at the existing crossing whilst minimising the overall environmental impacts versus the benefits conferred by the improved connectivity that Option C delivers.

8.8 Next Steps

8.8.1 The evidence set out in this report highlights the relative merits of the location options. Consultation planned during 2013 will help identify the relative importance attached by consultees to those relative merits.

8.8.2 Subsequent stages to bring forward a future scheme and progression towards delivery should build upon the foundation and structure of this review (using the five case model) along with the associated evidence.

8.8.3 The management, financial and commercial cases have outlined the considerations needed both to establish suitable project oversight and to determine the best balance between public and private sector investment.

8.8.4 The forecast impacts of a future scheme on the existing road networks will require consideration at a greater level of detail than can be supported by the current transport model. Work to improve the accuracy and detail of the representation of the local road network and the quality of the data underpinning the model will be required to adequately assess the local impacts and to finalise the

design of the scheme. In planning this work, consideration should be given to planned Thames Gateway developments. This would ensure the design of infrastructure required to mitigate the development impacts would be cohesively integrated with the future operation of the road network.

8.8.5 This review has identified the nature of environmental constraints from published data sources. Augmentation of this evidence through surveys within the selected location will be needed to provide the detailed local information required to design the route alignment that achieves the best balance of performance against the competing objectives. In addition, it will also provide the evidence base against which to undertake future assessment of environmental impacts.

Glossary of Terms

The following list provides the definition of the common terms and abbreviations used within this report.

AADT	Average annual daily traffic
AONB	Area of Outstanding Natural Beauty
Appraisal Summary Tables	Summary of impacts of introducing new infrastructure, setting out impacts using a structured set or economic, social and environmental measures
AQMA	Air Quality Management Area
BAP	Biodiversity Action Plan
Base case	Forecasts of transport conditions should no new crossing capacity be provided
Benefit-Cost Ratio	Ratio of present value of benefits to present value of costs, an indication of value for money
BNL	Basic Noise Level
Bored tunnel	A circular tunnel at depth, without removing the ground above, using a tunnel boring machine
Central case	Contains core forecasting assumptions and scenario defined within internal review document: *Central Forecasts and Sensitivity Tests Report*
Consumer users	Users of infrastructure on journeys for personal reasons such as shopping, education, or commuting to a place of work.
CRTN	Calculation of Road Traffic Noise
Dart-TAG	In-vehicle electronic tags which allow account holders and local Thurrock and Dartford residents to use the Dartford Crossing at discounted rates
dB(A)	Between the quietest audible sound and the loudest tolerable sound, there is a million to one ratio in sound pressure (measured in pascals, Pa). Because of this wide range, a noise level scale based on logarithms is used in noise measurement called the decibel (dB) scale. Audibility of sound covers a range of approximately 0 to 140 dB The human ear system does not respond uniformly to sound across the detectable frequency range and consequently instrumentation used to measure noise is weighted to represent the performance of the ear. This is known as the 'A weighting' and annotated as dB(A)
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
ELHAM	East London Highway Assignment Model
Five case model	Structured method adopted by DfT to set out the reasons for, merits and risks of a transport scheme to facilitate investment decisions
Free flow toll	Existing Dartford-Thurrock Crossing is planned to change from the toll plazas to a free-flow system in 2014
GIS	Geographical Information Systems
HA	Highways Agency

HDV	Heavy Duty Vehicle
HS1	High Speed 1 rail line
IGCB	Inter Departmental Group on Costs and Benefits
IMD	Index of Multiple Deprivation
Immersed tunnel	A shallow depth tunnel with the top of the finished tunnel structure lying just below the riverbed
LNR	Local Nature Reserve
LTC	Lower Thames crossing
LTC Model	Transport model designed to forecast impacts of providing additional road based capacity across the Thames at locations at or east of the existing Dartford Crossing
LWS	Local Wildlife Site
MAGIC	Multi Agency Geographical Information for the Countryside
MCZ	Marine Conservation Zone
NO_2	Nitrogen dioxide
NPV	Net Present Value, a measure of the total impact of a scheme upon society, in monetary terms, expressed in 2010 prices
PCU	Passenger Car Unit
PLA	Port of London Authority
PM_{10}	Particulate matter
PPP	Public Private Partnership
PVB	Present Value of Benefits, monetised benefits accruing to users (in terms of travel time, vehicle operating cost, and tolls to be paid), monetised impacts upon the environment, the monetised value of accidents, and monetised wider economic impacts
PVC	Present Value of Costs, a measure of the monetary cost of a scheme, less revenues, discounted to and expressed in 2010 prices
RAMSAR	Wetlands of international importance, designated under the Ramsar Convention.
SATURN	Simulation and Assignment of Traffic to Urban Road Networks, Transport Model
SAC	Special Area of Conservation
SAP	Stakeholder Advisory Panel.
SDI	Social and distributional impacts
SELEP	South East Local Enterprise Partnership
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
Strategic Outline Business Case	First stage of drawing together evidence pertaining to a transport scheme, focusing on the strategy or reasons why change may be required

Strategic roads network	Motorway and major A roads, largely managed by the Highways Agency, serving the major inter-urban traffic flows
SuDS	Sustainable Urban Drainage Systems
tCO2e	Tonnes of carbon dioxide equivalent
TEMPRO	TEMPRO is a program that provides projections of growth over time for use in local and regional transport models. It presents projections of growth in planning data, car ownership, and resultant growth in trip-making by different modes of transport.
TfL	Transport for London
TGSE	Thames Gateway South Essex
TGSG	Thames Gateway Strategic Group
Transport Business Case	explanation of why investment in transport may be required together with an explanation of how this might be delivered and the associated benefits and costs
TUBA	Transport Users Benefit Appraisal, DfT software tool
UDP	Unitary Development Plan
WebTAG	UK Department for Transport's web based multimodal guidance on appraising transport projects and proposals
WFD	Water Framework Directive
Wider Impacts	Land use related economic consequences of transport interventions, that is not directly related to impacts on users of the transport network, such as increased productivity