



Lower Thames Crossing

Pre-Consultation Scheme Assessment Report

Volume 7: Appraisal Conclusions and Recommendations

Volume 7

Lower Thames Crossing
Route Consultation 2016

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

1 Introduction

1.1 Structure of Pre-Consultation Scheme Assessment Report

- 1.1.1 The Pre-Consultation Scheme Assessment Report (SAR) brings together the engineering, safety, operational, traffic, economic, social and environmental appraisal of the shortlist routes for the Lower Thames Crossing. The appraisal of the longlist options was reported in the *Technical Appraisal Report* (TAR) (see Sections 2 and 3 of Volume 3).
- 1.1.2 Drawing on the results of the appraisal, the SAR recommends which routes should be taken to public consultation. It also sets out Highways England’s proposed solution.
- 1.1.3 The SAR is set out in a number of Volumes, as follows:
 - Volume 1 – Executive Summary
 - Volume 2 – Introduction and Existing Conditions
 - Volume 3 – Identification and Description of Shortlist Routes
 - Volume 4 – Engineering, Safety and Cost Appraisal
 - Volume 5 – Traffic and Economics Appraisal
 - Volume 6 – Environmental Appraisal
 - **Volume 7 – Appraisal Conclusions and Recommendations**
- 1.1.4 Following public consultation, this document will be reviewed and updated to produce a final Post-Consultation Scheme Assessment Report taking account of the comments received. It will also include the report on public consultation, and the recommended scheme.

1.2 Structure of Volume 7

- 1.2.1 The structure of this volume is as follows:
 - Section 2 sets out the scheme objectives and confirms the option identification and selection process
 - Section 3 presents the summary of the detailed appraisal of Location A (Route 1)
 - Section 4 presents the summary of the detailed appraisal of the northern link alternatives at Location C (Routes 2, 3 and 4)
 - Section 5 presents the summary of the detailed appraisal of the crossing options at Location C
 - Section 6 presents the summary of the detailed appraisal of the southern link alternatives at Location C
 - Section 7 presents the summary of the detailed appraisal of the proposed scheme at Location C
 - Section 8 describes sensitivity testing undertaken
 - Section 9 summarises the options to be taken to public consultation

2 Scheme Objectives and Shortlist Routes

2.1 Scheme Objectives

2.1.1 The scheme objectives against which all route options are appraised are shown in **Table 2.1**. They are presented in three principal categories: economic, transport, and environment and community objectives. These scheme objectives were agreed between Highways England and the Department for Transport, as recorded in the Client Scheme Requirements.

TABLE 2.1 - SCHEME OBJECTIVES

Scheme Objectives	
Economic	<ul style="list-style-type: none"> To support sustainable local development, regional economic growth in medium to long-term To be affordable to government and users To achieve value for money
Environment and Community	<ul style="list-style-type: none"> To minimise adverse impacts on health and the environment
Transport	<ul style="list-style-type: none"> To relieve the congested Dartford Crossing and approach roads and improve their performance by providing free flowing north-south capacity To improve resilience of the Thames crossings and major road network To improve safety

2.2 Scheme Assumptions

2.2.1 In order to appraise the options against the scheme objectives on a comparable basis a number of key assumptions have been made, which are summarised in **Table 2.2**.

TABLE 2.2 - KEY ASSUMPTIONS IN APPRAISAL OF OPTIONS

Assumption	
User Charges	In the traffic modelling, user charges equal to existing charges are applied at Location A and C crossings to allow for comparison on an equal basis. For the purpose of the detailed appraisal presented here, charges are assumed to remain constant in real terms with no change in vehicle classification.
Oversize crossing structure at Location C	In order to allow for future expansion from a dual-two lane road to dual three lane, an oversized structure would be constructed at Location C. Capital costs quoted reflect this assumption.
Traffic and revenue forecasts	All traffic forecasts, unless stated otherwise, are based on a core growth traffic scenario, as defined by WebTAG guidance.
Programme	The scheme development timetable assumes authorisation by way of the Development Consent Order process and delivery using a design and build model with public funding.

2.3 Study Area

2.3.1 The Study Area for the identification and appraisal of options at Locations A and C is shown in **Figure 2.1**.

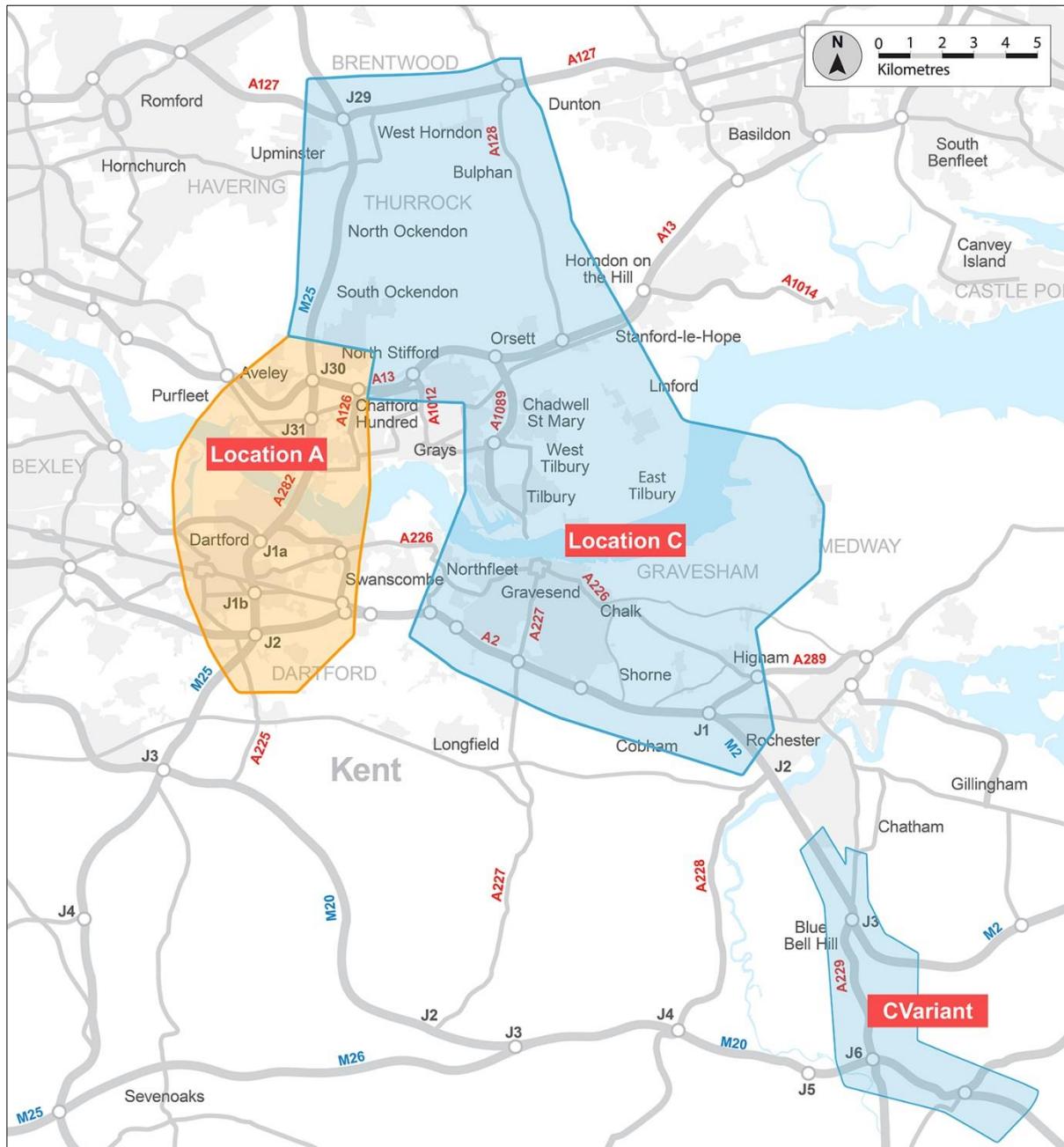


FIGURE 2.1 - STUDY AREA

2.4 Option Identification, Development and Selection

2.4.1 The approach taken to identifying, developing and selecting routes for public consultation is shown in **Figure 2.2** below. The red arrow indicates the current stage i.e. prior to public consultation.



FIGURE 2.2 - OVERVIEW OF APPROACH TO IDENTIFYING, DEVELOPING AND SELECTING ROUTES FOR PUBLIC CONSULTATION

2.4.2 The key stages in identifying, developing and selecting routes for public consultation are presented below:

- a) **Viability Check.** A list of route options was developed for Locations A and C. Route options which performed poorly against the scheme objectives or were considered unviable (e.g. due to not being technically viable or having unacceptable environmental impacts) were not selected for the longlist.
 - b) **Appraisal of longlist.** The longlist options were appraised. The appraisal of the longlist options was undertaken in two stages and is reported in detail in the *Technical Appraisal Report*. The result of this appraisal was the shortlist of options.
 - c) **Appraisal of shortlist.** A detailed appraisal of the shortlist routes has been undertaken and is described in SAR Volume 4 (engineering, safety, construction impacts, operations and maintenance, risk and cost), Volume 5 (traffic, economics and social impacts) and Volume 6 (environmental). Based on the detailed appraisal of the shortlist routes those that performed satisfactorily against the scheme objectives and were considered deliverable are identified and proposed for public consultation. This is reported in this volume.
 - d) **Public Consultation on options and proposed scheme.** Those shortlist routes that perform satisfactorily against the scheme objectives and are considered viable, will be presented at public consultation. This will include the proposed scheme, being the route that Highways England considers to perform best overall. Following public consultation, a Recommended Scheme will be determined taking account of this appraisal and the responses to the public consultation.

2.5 Longlist Routes

2.5.1 The longlist comprised nine options at Location A, four at Location C and two for C Variant. These are shown in **Figure 2.3**. The longlist appraisal was carried out in two stages. The first stage involved appraisal against the following criteria:

- Value for money (cost against economic benefit)
 - Significant environmental impact
 - Other significant impacts (e.g. congestion, network resilience, impact on planned or existing developments)

- 2.5.2 Following this first stage appraisal three route options were not considered to be viable and the section of Route Option C3 south of the River Thames connecting to the A2 was also not considered viable. This also resulted in combination options C11 to C14 not being selected as they included this section of Option C3.

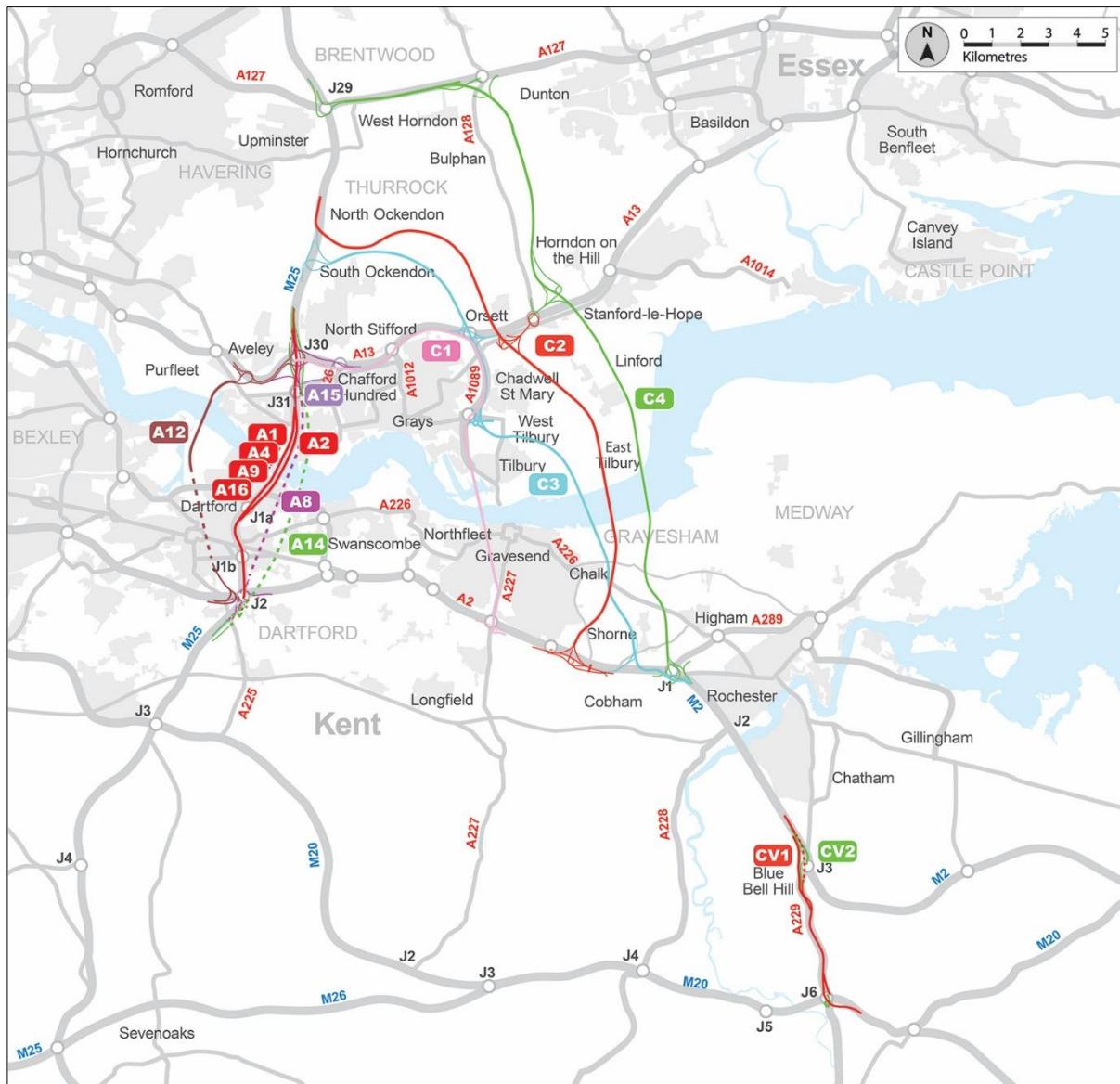


FIGURE 2.3 - PLAN OF LONGLIST ROUTES

- 2.5.3 The remaining route options could not be differentiated on the basis of the limited criteria set out in paragraph 2.5.1. A second stage of appraisal of the longlist was therefore carried out. This involved appraisal of the remaining route options against criteria considered to be significant in making the choice between these route options as set out in **Table 2.3**.

TABLE 2.3 - LONGLIST SECOND STAGE APPRAISAL CRITERIA

Main Criteria	Sub-Criteria
Strategic	Fit with wider transport & government objectives
	Fit with other (regional) objectives
Economic	Travel time savings
	Congestion
	Resilience
	Accident benefits
	Wider economic benefits
	Impact on current/ planned infrastructure
Environmental	Carbon emissions
	Historic environment
	Biodiversity
	Landscape & townscape
	Air quality
	Noise
	Water environment
Management	Implementation timetable
	Practical feasibility
Financial	Capital cost
	Operation and maintenance cost
Commercial	Revenue costs

- 2.5.4 As a result of Options C1 and C4 not being included in the shortlist combination options C7, C15, C16, C17 and C18 were not selected as they included parts of these main options.
- 2.5.5 As option C2 was included in the shortlist the other combination options based on this option (C8 and C10) were not specifically ruled out. This is because they were sufficiently closely related to both Option C2 and Option C3 to provide potential future developments of these two route options.
- 2.5.6 The options taken forward to the shortlist were: A1, A4, C2, C3, C9 and C19.

- 2.5.7 These options have then been simplified, as shown in **Table 2.4** and carried forward into the shortlist as four shortlist routes.

TABLE 2.4 - KEY ASSUMPTIONS IN APPRAISAL OF OPTIONS

TAR Reference	Shortlist Route
A1	Route 1 with Bridge
A4	Route 1 with Bored Tunnel
C3 (BR)	Route 2 with Western Southern Link and Bridge
C3 (BT)	Route 2 with Western Southern Link and Bored Tunnel
C3 (IT)	Route 2 with Western Southern Link and Immersed Tunnel
C3 (BR) and C19	Route 2 with Eastern Southern Link and Bridge
C3 (BT) and C19	Route 2 with Eastern Southern Link and Bored Tunnel
C3 (IT) and C19	Route 2 with Eastern Southern Link and Immersed Tunnel
C2 (BR)	Route 3 with Western Southern Link and Bridge
C2 (BT)	Route 3 with Western Southern Link and Bored Tunnel
C2 (IT)	Route 3 with Western Southern Link and Immersed Tunnel
C2 (BR) and C19	Route 3 with Eastern Southern Link and Bridge
C2 (BT) and C19	Route 3 with Eastern Southern Link and Bored Tunnel
C2 (IT) and C19	Route 3 with Eastern Southern Link and Immersed Tunnel
C9 (BR)	Route 4 with Western Southern Link and Bridge
C9 (BT)	Route 4 with Western Southern Link and Bored Tunnel
C9 (IT)	Route 4 with Western Southern Link and Immersed Tunnel
C9 (BR) and C19	Route 4 with Eastern Southern Link and Bridge
C9 (BT) and C19	Route 4 with Eastern Southern Link and Bored Tunnel
C9 (IT) and C19	Route 4 with Eastern Southern Link and Immersed Tunnel

BR - Bridge, BT - Bored tunnel, IT - Immersed tunnel

2.6 C Variant

- 2.6.1 As part of the detailed analysis, the widening of the A229 between the M2 and the M20 (called C Variant in earlier studies) was considered, see **Figure 2.1**. C Variant was identified as part of the 2013 AECOM Review and was part of the original DfT brief improving connectivity between the M20 and M2 by improving the existing A229.
- 2.6.2 If upgraded the A229 would provide a relatively short connection between the M2 and M20 and could therefore influence route choice between a new crossing at Location C and the existing Dartford Crossing, particularly for trips heading towards the Channel Tunnel and Ashford.

- 2.6.3 However, traffic modelling showed that route choice between the two Thames crossings is not influenced directly by an upgraded A229 i.e. running the traffic model with or without C Variant produced similar impacts.
- 2.6.4 Improvements to the A229 are estimated to cost an additional £500m and it would have a significant environmental impact including on an ANOB, where there is a presumption against development.
- 2.6.5 The assessment concluded that C Variant would have limited benefit in the context of maximising the benefits of a new Lower Thames crossing, it would have a high environmental impact, have a high additional cost and would not be essential to the new crossing scheme.
- 2.6.6 On this basis the decision was taken not to progress C Variant any further beyond the shortlisting stage. Further consideration of the potential to upgrade the A229 will be given as part of Highway England's ongoing route planning.

2.7 Shortlist Routes

- 2.7.1 The shortlist routes were identified from the longlist, as shown in **Figure 2.4**; there is one route at Location A and three routes at Location C.
- 2.7.2 Routes 2, 3 and 4 share a common crossing location.
- 2.7.3 Note either the eastern southern link or western southern link would be constructed (but not both) and these links are common to Routes 2, 3, and 4 as shown in **Figure 2.4**.

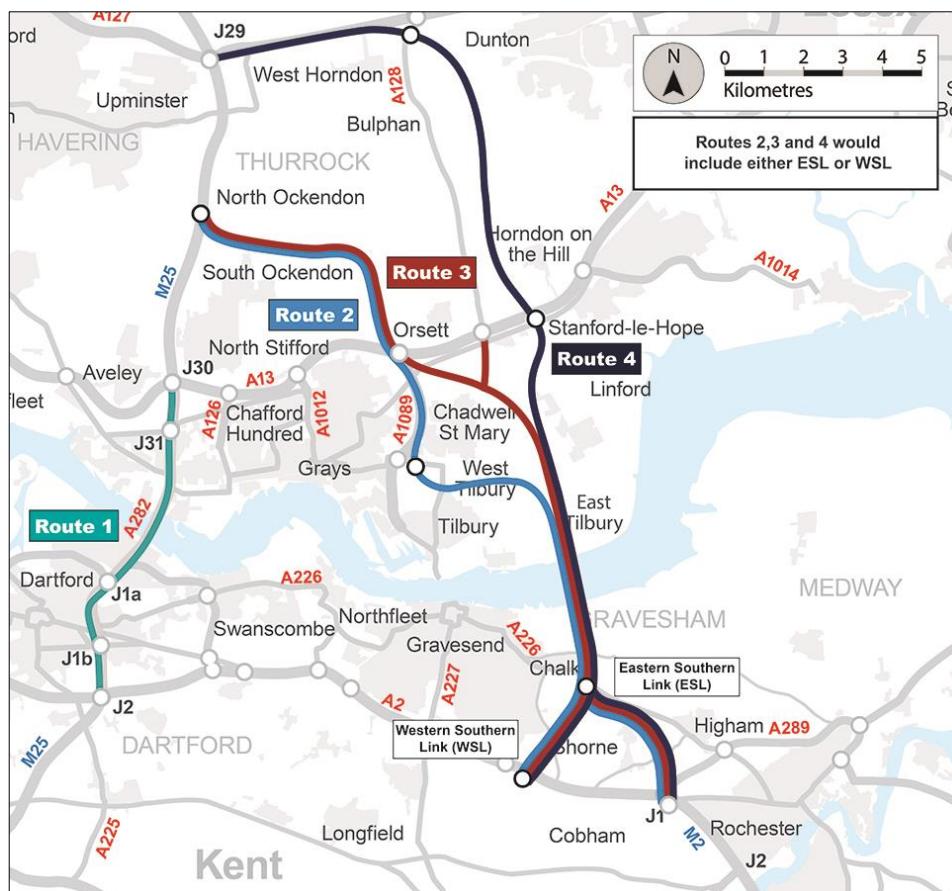


FIGURE 2.4 - SHORTLIST ROUTES

2.7.4 **Table 2.5** shows the four shortlist routes with the river crossing options. For Location C routes, there are two options south of the river; these are the Eastern Southern Link (ESL) and the Western Southern Link (WSL).

TABLE 2.5 - SHORTLIST ROUTES AND CROSSING/ LINK OPTIONS

Route	Crossing/ Link Options	
Route 1	Location A: A bridge or bored tunnel along a similar line to the west of the existing Dartford Crossing	
Route 2	Location C: Each option could be a bridge, a bored tunnel or an immersed tunnel	North of the river - from the crossing following a westerly line via the existing A1089 to the M25 between J30 and J29 South of the river - using either a Western Southern Link from the A2 or an Eastern Southern Link from the M2.
Route 3		North of the river - from the crossing following a middle-line to the M25 between J30 and J29 South of the river - using either a Western Southern Link from the A2 or an Eastern Southern Link from the M2.
Route 4		North of the river - from the crossing following an easterly line via the existing A127 to the M25 at J29 South of the river - using either a Western Southern Link from the A2 or an Eastern Southern Link from the M2.

2.8 Appraisal of the Shortlist Routes

2.8.1 Each of the four routes has been assessed against the scheme objectives, in order to determine the extent to which all elements of the shortlist alternatives meet the scheme objectives, shown in **Table 2.1**. Appraisal of the shortlist routes has required:

- Development of engineering designs of feasible crossing types.
- Design of alignments for highways and junctions.
- Estimating construction and operation and maintenance costs.
- Traffic forecasting using the V2 LTC traffic model (SATURN), taking into account planned housing and commercial developments
- Undertaking economic appraisal of each option in accordance with WebTAG guidance using outputs from the V2 LTC traffic model.
- Assessing the impact on people and property.
- Appraisal of the environmental impacts both long term and during construction.

2.8.2 In addition, a series of additional sensitivity tests that have been undertaken to support and confirm the choice of routes to be taken forward to public consultation and Highways England's proposed scheme.

2.8.3 The appraisal has been undertaken as follows:

- Location A (Route1) including river crossing structure
- Location C (Route 2, 3 and 4) options north of the River Thames
- Location C river crossing structure
- Location C routes south of the River Thames
- Proposed scheme at Location C

3 Location A

3.1 Introduction

- 3.1.1 This section presents a summary of the appraisal of Location A (Route 1) against the Scheme Objectives. Route 1 envisages providing additional lanes to create six lanes in each direction from the current four lanes with either a bridge or a bored tunnel crossing solution to cross the River Thames. **Figure 3.1** shows Route 1 at Location A.

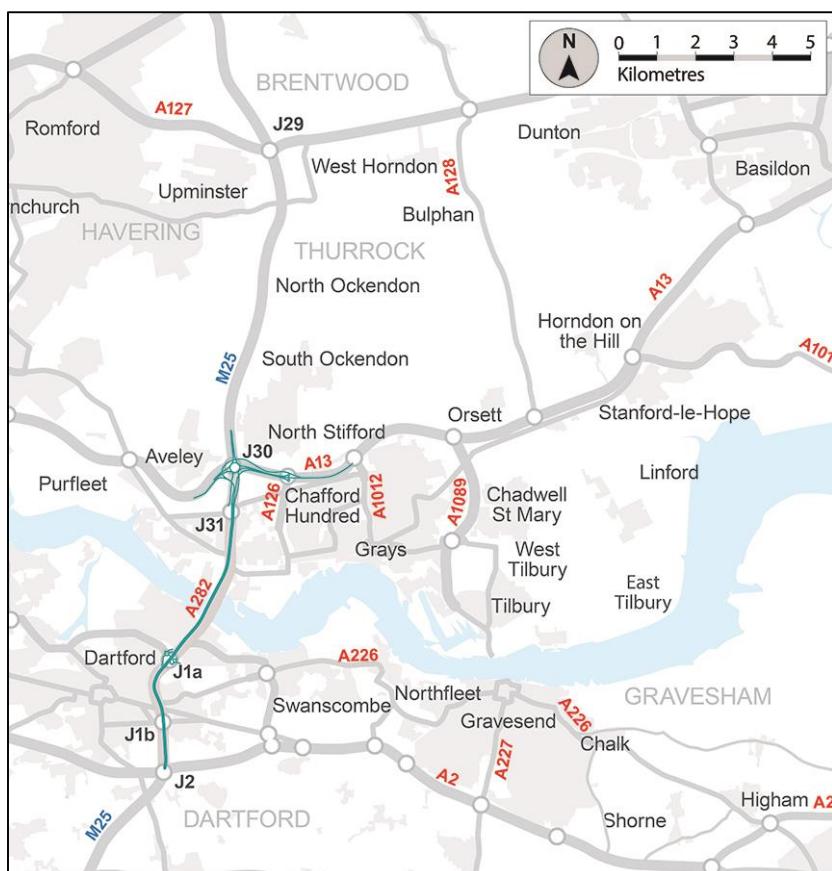


FIGURE 3.1 - LOCATION A - ROUTE 1

- 3.1.2 SAR Volume 3 describes the potential for constructing a new crossing in the existing A282 corridor together with associated improvements to slip roads and junctions to integrate any new crossing into the existing road layout.
- 3.1.3 Three potential crossing solutions have been examined at Location A: a new bored tunnel, a new bridge, or an immersed tunnel plus improvements to the A282. As noted in Volume 3, an immersed tunnel solution was considered at the longlist stage but rejected on the grounds of high technical risks to construct compared to either a bridge or a bored tunnel. An immersed tunnel would also cause greater disruption to the existing river and jetty operations due to the need to close the river for dredging and flotation of the precast tunnel segments. The provision of an immersed tunnel solution at Location A has therefore been discounted and not taken forward.
- 3.1.4 The height and span of a bridge crossing are determined by the clearances required for river navigation at Dartford. The assumed air-draft of 57.5m

matches that of the existing bridge and it will have a similar profile. The length of the bored tunnels will be driven by the depth necessary to get under the river and provide suitable ground cover over the structure beneath the river bed. Both options impact on the site of an aggregate and cement works on the north side of the river.

- 3.1.5 On the south bank of the river, both Location A options would pass through the area where the Dartford Control Centre and other crossing operational facilities for the existing Dartford crossing are located. In order to accommodate the new crossing, these facilities would be demolished and replaced elsewhere in a phased manner. It is envisaged that both the existing and new crossings would be controlled from an integrated traffic control centre.
- 3.1.6 A new bridge or tunnel would be designed to allow unrestricted passage of HGVs. This combined with reconfiguration of the existing tunnels for light goods vehicles and cars only would allow better use of these assets, although the Traffic Management Cell would have to be retained to ensure restricted vehicles do not enter the existing northbound tunnels.

3.2 Appraisal of Location A

- 3.2.1 In traffic terms, Location A (Route 1) can be considered a widening scheme of the existing Dartford crossing corridor and it provides benefits in line with a widening scheme i.e. journey time benefits but limited wider economic value as it does not connect new communities to the network. Adding either a new bridge or tunnel will increase capacity in vehicles per hour at the crossing by 60% in the opening year (2025) and improve journey times in the opening year by 5 minutes at peak times.
- 3.2.2 As a result of constructing additional capacity, traffic would be attracted to the A282 corridor, partly as a result of releasing additional suppressed traffic growth which has been constrained by crossing capacity for a number of years. Additional traffic has a number of impacts. Firstly, by drawing in additional traffic into the existing corridor, the key arterial routes of the A2 and A13 would become congested within the design life of the new crossing. Secondly, additional traffic in the A282 corridor would still cause long delays and severe congestion to local roads. This will be particularly the case around Dartford in the event there is an incident between Junction 2 and Junction 29, as there will remain a single crossing point with shared approach roads.
- 3.2.3 The existing infrastructure imposes constraints on the design speed such that it is not possible to increase the speed above 50 mph even with the proposed improvements. The new crossing does not change the experience for road users. Despite the improvements, the A282 will remain a 50 mph corridor with the same closely spaced junctions and existing tunnels, but with a more complex driving environment due to multiple lanes and signage.
- 3.2.4 Because of the physical constraints and high volumes of traffic, the existing A282 could not be transformed into a free-flowing 70mph route.
- 3.2.5 As expected either a bridge or a tunnel solution would generate economic benefits through journey travel-time savings. The BCR for a bridge solution

at Location is 1.6 (initial) rising to 2.3 (adjusted) with wider economic impacts. BCR values for a tunnel are lower due to higher construction and maintenance costs. The estimated capital cost for a bridge solution is £3.4bn (outturn most likely cost P50), and £3.6bn (outturn most likely cost P50) for a bored tunnel solution.

- 3.2.6 However, Location A has considerable drawbacks. From a deliverability perspective, the construction of either a tunnel or a bridge at Location A would have significant impacts for road users, with up to 80 months of construction including an advanced works construction stage of 20 months.
- 3.2.7 Traffic management will be required throughout the construction phase, with a temporary speed restriction of 40 mph and substantial periods of contraflow working. Delays to users also has an economic cost through delayed journeys. Capacity at the existing crossing would be reduced during construction for a prolonged period imposing delays on existing users of the crossing and in effect negating some of the time benefits realised through the introduction of Dart Charge.
- 3.2.8 The complexity of the works and the constraints imposed by working within the existing M25/ A282 corridor would mean that some work would need to be carried out at night. However, working at night close to existing properties along the A282 would be constrained by restrictions on noise and vibration, the requirements for which would need to be developed in detail with the local environmental health officers. Road closures of the A282/ M25 would be required to demolish existing structures, during which diversion routes would be required.
- 3.2.9 A solution at Location A provides additional crossing resilience but will not improve the resilience of the wider road network. In the event, for example, that one of the structures had to close as recently happened to the Forth Bridge, it is reasonable to assume that either the existing tunnels or new bridge would remain open to traffic. However, as noted higher flows in the A282 corridor increase dependency on this key arterial route and does not increase network resilience, as would be the case with an alternative crossing location. A solution at Location A increases the dependency on the A282 corridor but with much higher traffic flows. Therefore a scheme at Location A would not meet the scheme objectives particularly in terms of network resilience.
- 3.2.10 The economic disbenefits of time lost due to delays during construction is estimated to be around £300m (PVB) which reduces the overall BCR of the scheme. In addition it is likely that air quality would worsen during the construction period, and that there would be additional exceedances of EU standards for NO₂.
- 3.2.11 There are environmental issues at Location A. Modelling undertaken for air quality and noise has demonstrated that existing problems would be exacerbated with Route 1. Despite the limited study area used for comparative purposes, it is likely that these effects would be experienced over a wider area and could be a significant factor, for example additional exceedances of air quality EU limit values.

3.2.12 The other key issue at Location A is biodiversity and a bridge option would have greater risks from a consenting perspective in view of the potential for effects on species associated with the International and European sites located to the east (Thames Estuary and Marshes Ramsar and SPA).

3.2.13 **Table 3.1** presents the summary appraisal results for a bridge or bored tunnel solution at Location A against the Scheme Objectives.

TABLE 3.1 - APPRAISAL OF LOCATION A (ROUTE 1)

Scheme Objectives	Route 1 Four Lane Bridge	Route 1 Twin Bored Tunnel
Relieve the congested Dartford Crossing and approach roads and improve their performance by providing free flowing north-south capacity	<ul style="list-style-type: none"> Either a bridge or a tunnel would have the similar impacts on congestion levels at the existing crossing. Both would increase capacity in vehicles per hour (vph) at the crossing by 60% but some form of TMC (Traffic Management Cell) would still be required (northbound and southbound) to manage the movement of restricted vehicles entering the existing tunnels. A combination of increased capacity but also increased traffic demand leads to modest time-savings of 5 minutes in 2025. The A282 corridor between Junction 2 and Junction 30 would be improved but not transformed into free-flow motorway. Location A is an online improvement which does not increase the existing speed limit from the current 50mph value. A higher speed limit cannot be achieved because of the constraints caused by the existing infrastructure. The 50mph speed limit results in a lower capacity compared to a 70mph solution. Closely spaced junctions remain, with increased weaving moves due to higher traffic flows. A forecast increase of 40% in traffic demand in response to the new capacity would increase traffic flows on junctions in the A282 corridor and sections of the M25 north and south of the scheme, some of which are already close or at capacity. Attracting more traffic into the existing corridor increases congestion on key radial routes such as the A2 and A13. Pinch points on surrounding routes prevent the maximum benefits of the new crossing capacity being realised reducing the economic benefits of the scheme. <ul style="list-style-type: none"> Traffic congestion would increase for a period up to 80 months during construction, including a 20 month advanced works phase. Significant traffic management would be required throughout the construction phase, particularly where construction is close to an active highway. A 40 mph temporary speed limit would be required throughout the construction period, with substantial periods of contraflow working, reducing capacity and imposing long delays on users. This would delay opening until 2027. 	
	Bridge has greater impact on users of the river and the adjacent jetties.	Bored tunnel has higher risk of construction impacts on existing tunnels, and requires removal of large volume of spoil which would be difficult in the confined area and could impact on operations.

Scheme Objectives	Route 1 Four Lane Bridge	Route 1 Twin Bored Tunnel		
Improve resilience of the Thames crossings and Strategic Road Network	<ul style="list-style-type: none"> The new crossing provides increased asset resilience but not network resilience. If constructed there would still only be one route across the Thames in East London. Closure of any of the existing or future assets could lead to similar problems to that of Forth Road Bridge in Scotland which would have a significant impact on the UK economy. 			
Support sustainable local development, regional economic growth in medium to long term	Building more capacity at Dartford would allow traffic flows to increase which will support growth. However, this would reinforce existing patterns of development rather than provide new journey opportunities.			
Improve safety	<p>There would be an overall reduction in safety for road users compared to the Without Scheme. It is forecast that there will be an increase in FWI rate per billion vehicle km when compared with the Without Scheme scenario, increasing from 3.30 to 3.38 in 2025 and 2.64 to 2.73 in 2041, an increase of 2% and 3% respectively.</p> <table border="1" data-bbox="568 810 997 1087"> <tr> <td data-bbox="568 810 997 1087">A bridge solution provides a simpler road layout on the approach with less segregation and decision points.</td><td data-bbox="997 810 1414 1087">With a bored tunnel northbound traffic is segregated in three separate tunnels, with two lanes of traffic in each tunnel. This would lead to weaving difficulties with closely spaced junction at Junction 1a and junction 31 and complex signing arrangements.</td></tr> </table>	A bridge solution provides a simpler road layout on the approach with less segregation and decision points.	With a bored tunnel northbound traffic is segregated in three separate tunnels, with two lanes of traffic in each tunnel. This would lead to weaving difficulties with closely spaced junction at Junction 1a and junction 31 and complex signing arrangements.	
A bridge solution provides a simpler road layout on the approach with less segregation and decision points.	With a bored tunnel northbound traffic is segregated in three separate tunnels, with two lanes of traffic in each tunnel. This would lead to weaving difficulties with closely spaced junction at Junction 1a and junction 31 and complex signing arrangements.			
Minimise adverse impacts on health and the environment	<p>Landscape / Townscape</p> <ul style="list-style-type: none"> Potential effect on Mardyke Valley setting. <p>Historic Environment</p> <ul style="list-style-type: none"> No significant effects. <p>Biodiversity</p> <ul style="list-style-type: none"> Possible indirect impacts on qualifying species associated with Ramsar/ SPA e.g. through loss of functionally linked land and collision risk with a bridge. Directly affects functionally linked land, 4 local wildlife sites and 3 areas of ancient woodland. <p>Water Environment</p> <ul style="list-style-type: none"> Affects Mardyke as a result of multiple crossings. Direct effect on Thames rMCZ with a bridge. <p>Air Quality</p> <ul style="list-style-type: none"> Modelling for air quality and noise has demonstrated that existing problems would be exacerbated with Route 1. Despite the limited study area used for comparative purposes, it is likely that these effects would be experienced over a wider area and could be a factor in the decision-making process, for example additional exceedances of air quality EU limit values. During the 80 month construction period, there would be additional congestion resulting from traffic management requiring temporary speed limits and contraflow working. It is likely that air quality would worsen during the construction period, and that there would be additional exceedances of EU standards for NO2. <p>Noise</p> <ul style="list-style-type: none"> Small overall noise disbenefit with Route 1. Greater effects for a bridge than a tunnel once operational. <p>Community Facilities</p> <ul style="list-style-type: none"> A bridge would generate more noise than a tunnel and there could be direct effects on small areas of Mardyke Woods and Davy 			

Scheme Objectives	Route 1 Four Lane Bridge	Route 1 Twin Bored Tunnel
	<p>Down Riverside Park, footpaths, local cycle routes and Sustrans National Cycle Route Networks and a small area of Open Access land.</p> <p>Impacts on property (demolition):</p> <ul style="list-style-type: none"> • Residential property 5. Commercial property 12 	
Be affordable to government and users, and achieve value for money	<p>Construction Costs P50 (Most Likely) – P90 (High)</p> <ul style="list-style-type: none"> • £3,365m (Outturn) to £4,909m (Outturn) • £3,560m (Outturn) to £5,151m (Outturn) <p>Operation and Maintenance Costs over 60 years</p> <ul style="list-style-type: none"> • Bridge £241m • Bored Tunnel £351m 	
		<p>Value for money</p> <p>Route 1 based on a bridge crossing offers low to medium value for money with a BCR of 1.6 (initial), increasing to 2.3 (adjusted) with wider impacts using the most likely cost, but drops to 1.0 (initial) and 1.4 (adjusted) with the higher P90 cost.</p>

3.3 Conclusions

- 3.3.1 A new crossing at Location A (Route 1) performs poorly against the traffic related scheme objectives. As Location A does not provide an alternative route, traffic would still be funnelled through the existing corridor from junctions 2 to 29 and incidents at Dartford would potentially still cause long delays and severe congestion on local roads. Route 1 would provide asset resilience associated with availability of additional lanes at the crossing but does not provide network resilience.
- 3.3.2 Route 1 would not provide additional connections to local roads and by attracting more traffic to the existing corridor, congestion on the adjacent A2 and A13 would also increase.
- 3.3.3 Construction would take at least six years and would cause considerable disruption to traffic using the existing Dartford Crossing with 40mph average speed restrictions and complex traffic management affecting millions of journeys. Even when the scheme is complete, there would be limited improvement for drivers as the current 50mph speed limit and closely spaced junctions would remain.
- 3.3.4 Additionally, a crossing at Location A would offer poor value for money and would perform poorly against other scheme objectives such as safety, noise and air quality.
- 3.3.5 A new crossing at Location A would not meet the transport and economic objectives and should not therefore be taken forward for public consultation.

4 Route Options north of the River Thames

4.1 Introduction

- 4.1.1 This section presents a summary of the appraisal of the route choice at Location C to the north of the River Thames against the Scheme Objectives (refer to **Figure 4.1**). The three routes appraised (Routes 2, 3 and 4) have been developed through engagement with local authorities.



FIGURE 4.1 - CHOICE OF ROUTE 2 OR ROUTE 3 OR ROUTE 4 AT LOCATION C

4.2 Appraisal

- 4.2.1 All alternatives perform similarly in terms of solving broad transport challenges and unlocking economic potential. All three routes pass through greenbelt land in Essex and would have a significant impact on the landscape character.

Route 2

- 4.2.2 Route 2 is closest to existing urban areas and therefore has greater noise and air quality impacts. It also has greater heritage impacts and affects an Environment Agency flood compensation area and, as it also uses the existing road network (the A1089 which connects Tilbury Port to the A13) the quality of the solution is constrained and would not provide a fully modern high quality new route. There would also be disruption to the A1089 during construction which would affect HGV traffic to the port. Route 2 has environmental impacts similar in scale to Routes 3 and 4.

Route 3

- 4.2.3 The choice between Routes 3 and 4 is finely balanced. Route 3 is preferred as it is a shorter, lower cost option than Route 4 (by £340m (Outturn P50)) and would be all new 70mph road, therefore providing the highest quality of solution of the three routes. Routes 2 and 3 have a similar capital cost.
- 4.2.4 Route 3 also has the lowest environmental impact, although a substantial part of the route is within designated greenbelt land.

Route 4

- 4.2.5 Route 4 would require upgrading the A127 and an upgraded junction where the A127 joins the M25, which would affect ancient woodland and a registered park and garden. The overall route is longer and more expensive as a result, but provides a high quality 70mph dual 2 lane. This option would support future development planned in the Brentwood and Basildon area, including the new housing developments planned for Dunton Garden Suburb.
- 4.2.6 All three routes generate similar levels of economic benefits with Route 3 generating the highest at £3.9bn (PVB) in direct benefits compared to £3.8bn (PVB) for Route 4 and £3.7bn (PVB) for Route 3. Similar levels of economic benefit are generated because all three routes have broadly the same congestion relief impact at the existing Dartford Crossing with differences accounted for by the impact on arterial routes such as the A13 and A127.
- 4.2.7 However, Route 4 (ESL and bored tunnel) has the highest capital cost at £4.6bn (outturn P50) to £6.4bn (outturn P90) which equates to an additional £340m on an incremental basis to Route 3. Route 3 has an initial BCR of 2.3 compared to 2.1 for Route 4, partly as a result of the additional capital cost.

Environmental Impacts

- 4.2.8 In respect of air quality, properties within the vicinity of Routes 2, 3 and 4 would not experience exceedances or a risk of exceedances as they are predicted to be well within EU limits. Generally levels at the properties that are closest to Routes 2, 3 and 4 are in the order of 20 µg/m³ in the Without Scheme scenario and in the With Scheme scenario levels decrease or increase by only 1 µg/m³ (recognising that the EU limit value is 40 µg/m³).
- 4.2.9 The noise appraisal used a study area that was confined to main roads within the vicinity of Routes 1, 2, 3 and 4. From all of the roads considered, properties within 600m were modelled to determine whether there would be an improvement or a deterioration in noise level. The modelling has

demonstrated that within this study area there would be an overall (i.e. net) noise benefit with Routes 2, 3 and 4. Overall Route 4 provides the largest benefit, followed by Route 3, and Route 2. Within the vicinity of each of the routes there would be properties experiencing an increase in noise as a result of new traffic or increases in traffic on some existing roads whereas there would be reductions in traffic and therefore noise levels on other roads; for example the A282 and the A2.

- 4.2.10 **Table 4.1** shows the performance of each route against the scheme objectives. *Green shading indicates the best performing option against a scheme objective.*

TABLE 4.1 - LOCATION C NORTHERN LINKS

Scheme Objectives	Route 2	Route 3	Route 4
Relieve the congested Dartford Crossing and approach roads and improve their performance by providing free-flowing north south capacity	Requires online widening of the A1089 which will cause local impact but not directly affect Dartford.	Route 3 is the shortest route, with more offline works requiring less traffic management and disruption to existing traffic. Less construction disruption than Routes 2 and 4.	Requires online widening of the A127 which will cause local impact but not directly affect Dartford.
All Routes have a similar impact on the Dartford Crossing and generate similar levels of benefit and congestion relief as part of a new and completely alternative route to the existing crossing.			
Improve resilience of the Thames crossings and the Strategic Road Network	Uses a widened section of the A1089 and increases network resilience across river Thames	An entirely new route providing slightly more network resilience than either 2 or 4 which share existing transport corridors.	Uses a widened section of the A127 and increases network resilience across river Thames
Support sustainable local development, regional economic growth in the medium to long term			Economic benefits provided by Location C Routes could range between £5.4bn (PV) to £5.6bn (PV). Differences between routes are a function of junctions and relief offered to other routes e.g. A2/A13.
Improve safety	All routes are new routes designed to high standards of safety for road users.		
Minimise adverse impacts on health and the environment	Landscape/Townscape Affects greenbelt land. Significant changes to landscape character. There is no significant difference between the routes.	Landscape/Townscape Affects greenbelt land. Significant changes to landscape character. There is no significant difference between the routes.	Landscape/ Townscape Affects greenbelt land. There would also be loss of landscape features such as woodland including from Thorndon Park Grade II* Registered Park and Garden. There is no significant difference between the routes.
	Historic Environment Affects 2 parts of a conservation area, direct effects on 2 scheduled monuments and 2 Grade II Listed Buildings.	Historic Environment Directly affects a scheduled monument and 2 Grade II Listed Buildings.	Historic Environment Directly affects a Grade II listed building. Direct impact upon Thorndon Park Registered Park and Garden (Grade II*) and the Thorndon Park Conservation Area.

Scheme Objectives	Route 2	Route 3	Route 4
	Biodiversity Directly affects functionally linked land, an area of ancient woodland and 5 local wildlife sites.	Biodiversity Directly affects functionally linked land and 3 local wildlife sites.	Biodiversity Directly affects functionally linked land, 6 areas of ancient woodland and 8 local wildlife sites.
	Water Environment Affects Tilbury flood storage area and Mardyke floodplain.	Water Environment Affects Mardyke floodplain.	Water Environment Avoids Mardyke floodplain.
Air Quality All properties which are predicted to exceed or are at risk of exceeding the AQSO in the vicinity of the Dartford crossing would experience an improvement in air quality compared with the Without Scheme situation. Generally levels at the properties that are closest to Routes 2, 3 and 4 are in the order of 20 µg/m³ in the Without Scheme scenario and in the With Scheme scenario levels decrease or increase by only 1 µg/m³ (recognising that the EU limit value is 40 µg/m³).			
Noise There would be an overall (i.e. net) noise benefit with the Location C Routes, compared with the Without Scheme scenario. Overall Route 4 provides the largest benefit, followed by Route 3, and Route 2 the smallest benefit.			
	Community Facilities Direct effect on 2 areas of Open Access Land, the Condovers Scout Activity Centre, footpaths, bridleways and local cycle routes.	Community Facilities Direct effect on an area of Open Access Land and the westernmost edge of Orsett Golf Course, footpaths, bridleways and local cycle routes.	Community Facilities Direct effect on 2 areas of Open Access Land, woodland which could be used for recreational purposes, Dunton Hills Family Golf Centre, footpaths, bridleways, a Byway Open to all Traffic and local cycle routes.
	Impacts on property (potential demolition) <ul style="list-style-type: none"> • Residential 9 • Agricultural 3 <p>In addition, a cemetery is affected.</p>	Impacts on property (potential demolition) <ul style="list-style-type: none"> • Residential 14 • Traveler Plots 22 • Agricultural 3 	Impacts on property (potential demolition) <ul style="list-style-type: none"> • Residential 14 • Commercial 9 • Agricultural 3
Be affordable to government and users, and achieve value for money	Operation and Maintenance Costs over 60 years (With Bored Tunnel and ESL i.e. whole route)		
	£553m	£586m	£607m
	Construction Costs P50 (Most Likely) – P90 (High) (With Bored Tunnel and ESL)		
	£4,294m (Outturn) to £5,981m (Outturn)	£4,279m (Outturn) to £5,937m (Outturn)	£4,620m (Outturn) to £6,390m (Outturn)
	Value for Money		
	Generates £3.7bn in benefits with an Initial BCR of 2.2 and Adjusted BCR of 3.3	Generates £3.9bn in benefits with an Initial BCR of 2.3 and Adjusted BCR of 3.4	Generates £3.8bn in benefits with an Initial BCR of 2.1 and Adjusted BCR of 3.1

4.3 Conclusions

- 4.3.1 Route 3 would provide the shortest route, the greatest improvement to journey time and, being an entirely new road, would deliver a modern high quality road. It would also have the lowest environmental impact of the three options.
- 4.3.2 It is recognised that all three routes have the potential to unlock opportunities for housing and jobs and all offer high value for money. They each meet the transport objectives, although they offer different opportunities to connect with local roads. While there are important differences in the local and environmental impacts of each option, it is considered that all three routes are viable and should be taken forward to consultation.

5 Location C Crossings

5.1 Introduction

- 5.1.1 This section presents a summary of the appraisal of the different crossing types at Location C against the Scheme Objectives and explains the choice which will be taken forward in the consultation.
- 5.1.2 The location for a crossing structure is dictated by physical and environmental constraints (refer to **Figure 5.1**). These result in a narrow corridor for the crossing, bounded by Gravesend to the west and environmentally sensitive sites to the east. A crossing west of this point would impact on residents and property, whilst moving further east would impact on these sensitive sites.

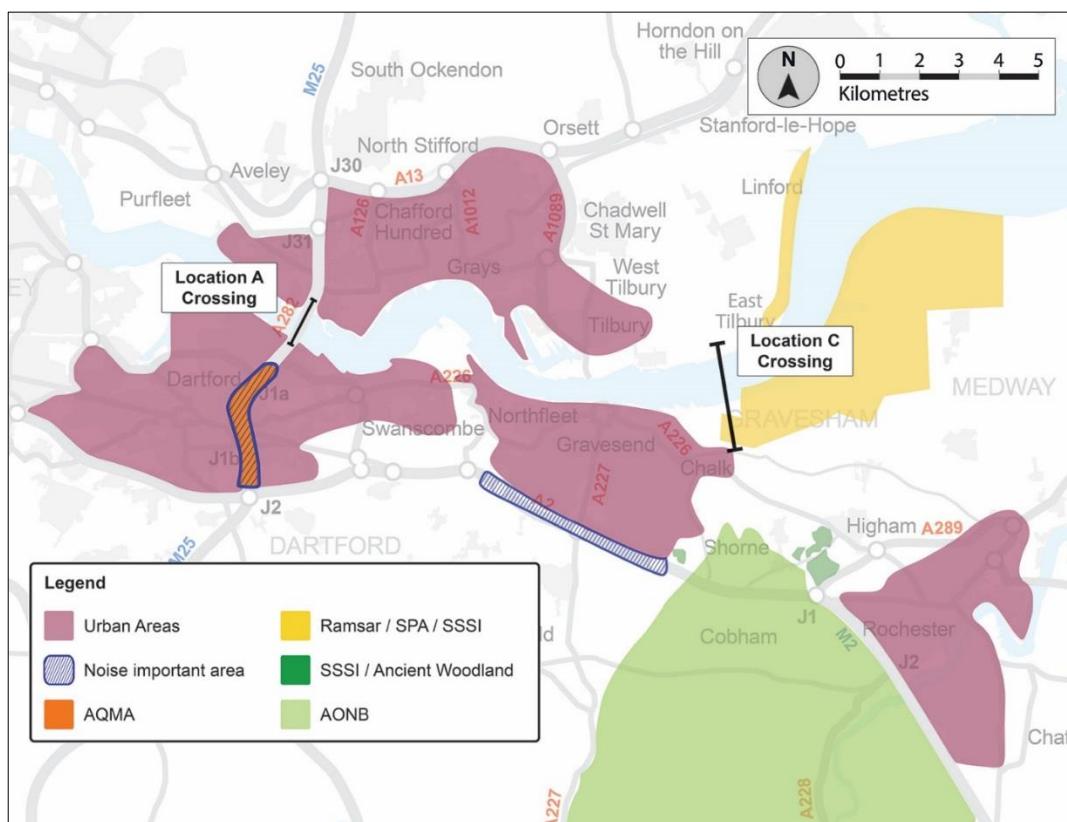


FIGURE 5.1 - CROSSING LOCATION SHOWING URBAN AND ENVIRONMENTAL CONSTRAINTS

- 5.1.3 The protected sites include the Thames Estuary and Marshes Ramsar site and Thames Estuary and Marshes Special Protection Area (SPA). These are sites of European value and are given the highest level of protection in UK law under the *Habitats Regulations*.
- 5.1.4 The choice of crossing type at Location C is determined by potential direct or indirect impacts on the protected sites; this is the overriding consideration (refer to SAR Volume 6, Section 5). Other factors such as construction costs are all broadly similar and are not sufficiently material to influence the final choice (refer to **Table 5.1**).
- 5.1.5 Within the Location C crossing corridor three crossing types are all technically feasible (refer to SAR Volume 4):

- Bridge
- Immersed tunnel
- Bored tunnel

- 5.1.6 Under the Habitats Regulations, the consideration of alternatives is a prerequisite in the event of significant adverse effects on a European Site being likely. A scheme may only be granted consent in the absence of alternative solutions that would achieve the scheme objectives with lesser impacts on the European Site.
- 5.1.7 Counsel advice has been obtained and has been incorporated in the appraisal at the appropriate points below.

5.2 Appraisal of a bridge

- 5.2.1 The construction of a bridge at the western extents of the Ramsar/ South Thames Estuary and Marshes SPA could cause a number of negative impacts which may not be easily mitigated. These include habitat loss/deterioration of coastal grazing marsh and intertidal mudflats, shading and disturbance / mortality of SPA qualifying species (e.g. through collision with a new bridge structure and moving vehicles). In addition a bridge would also create a barrier effect, discouraging access to land further west that is currently used by SPA species.
- 5.2.2 It should also be noted that both freshwater habitats and intertidal mudflat habitat are difficult to replace and compensate for and may take a long time to become effective.
- 5.2.3 The new bridge crossing would pass through the western extent of the site, which is currently agricultural land (although habitat improvement is currently taking place through a grazing regime at Higham Marsh, which is being managed as an RSPB reserve and is therefore likely to improve in quality).
- 5.2.4 There would be a direct impact on the Canal and Grazing Marsh Higham LWS and on the rMCZ and its associated habitats and species due to habitat loss/deterioration and disturbance.
- 5.2.5 There would be a direct effect on Goshems Farm Local Wildlife Site which is an important site for rare Thames Terrace invertebrates and may provide important high tide roosting habitat for SPA interest features. If a bridge were to be considered further it will be necessary to undertake surveys to better understand the level of risk associated with the wildlife site and its role as functional habitat to the European Sites.
- 5.2.6 There is a significant risk of a bridge not being permissible under the Habitats Assessment because a less damaging alternative exists (refer to bored tunnel below). Counsel has confirmed that a bridge option would be very unlikely to be deliverable in this location.

5.3 Appraisal of a bored tunnel

- 5.3.1 A bored tunnel would not impact the marine environment and the coastal/terrestrial impacts would be greatly reduced in comparison to the construction of a bridge (where permanent effects for example from loss of habitat and shading effects could occur) or immersed tunnel (with very large impacts on habitats and species during construction).
- 5.3.2 The location of the northern tunnel portal and its works area, would impact on an area of historic coastal grazing marsh and LWS (Goshems Farm). These support a diverse range of Red Data Book invertebrates and may also provide important functionally linked land for the SPA designated species (e.g. high tide roost).
- 5.3.3 There would be no direct impact on the Ramsar site and the tunnel portal location has been selected to minimise biodiversity effects.
- 5.3.4 The provision of a new bored tunnel crossing presents lower consenting risks from a Habitats Regulations perspective as it offers a less damaging alternative to either a bridge or immersed tunnel crossing. Counsel has confirmed this position.
- 5.3.5 Of the three crossing types, a bored tunnel has the highest construction risk profile because of the uncertainty of ground conditions which have not yet been surveyed. Good understanding exists of the risks associated with driving tunnels in this location as a result of High Speed 1 (2001) and cable tunnels (2007). The risk profile for tunnelling at location C will be in line with other tunnelling works in east London (refer to SAR Volume 4, Section 6).
- 5.3.6 A bored tunnel is a more complicated and expensive solution to own, operate and maintain (refer to SAR Volume 4, Section 5). The cost comparisons for the crossing types are set out in **Table 5.1**.

5.4 Appraisal of an immersed tunnel

- 5.4.1 The construction of an immersed tunnel has the potential for large adverse impacts on the Thames Estuary rMCZ and its associated species and habitats due to habitat loss/ deterioration and disturbance. Whilst the significance of the potential hydrodynamic effects is uncertain, the effects are estimated to extend beyond 6km upstream or downstream of the crossing. However, the size of the rMCZ is such that it is unlikely that the integrity of the site would be affected by an immersed tunnel, assuming appropriate levels of avoidance, mitigation and compensation were put in place.
- 5.4.2 Significant impacts on the Thames Estuary and Marshes Ramsar and South Thames Estuary and Marshes SPA may be caused by the cut and cover for the southern section of the tunnel. This is due to potential changes in hydrology, which could have significant impacts on this area of wetland habitat and species that it supports (including SPA qualifying species). Impacts on freshwater and intertidal habitats would be difficult to mitigate for. Disturbance to SPA qualifying species during construction is also likely to be significant (given the proximity of the crossing to the SPA boundary).

- 5.4.3 The location of the north portal currently could have a significant impact on an area of historic coastal grazing marsh and Goshems Farm Local Wildlife Site, which supports a diverse range of Red Data Book invertebrates and may be also provide important functionally linked land for the SPA designated species (e.g. high tide roost).
- 5.4.4 The provision of a new immersed tunnel crossing could potentially have consenting risks from a Habitat Regulations Assessment perspective as a less damaging alternative exists (refer to bored tunnel). Counsel has confirmed that an immersed tunnel option would be very unlikely to be deliverable in this location.
- 5.4.5 **Table 5.1** presents the summary appraisal results for the three crossing options at Location C against the scheme objectives. *Green shading indicates the best performing option for each scheme objective.*

TABLE 5.1 - BRIDGE OR BORED TUNNEL OR IMMERSSED TUNNEL AT LOCATION C

Scheme Objectives	Bridge	Bored Tunnel	Immersed Tunnel
Minimise adverse impacts on health and the environment	<p>Biodiversity</p> <ul style="list-style-type: none"> Provision of a new bridge crossing could potentially have consenting risks from a Habitat Regulations perspective as a less damaging alternative exists (bored tunnel). Counsel has confirmed that a bridge option would be very unlikely to be deliverable in this location. Negative impacts include habitat loss/ deterioration of coastal grazing marsh and intertidal mudflats, shading and disturbance / mortality of SPA qualifying species. Barrier effect of bridge discouraging access to land further west that is currently used by SPA species Impacted areas of freshwater habitats and intertidal mudflat habitat 	<p>Biodiversity</p> <ul style="list-style-type: none"> Provision of a new bored tunnel crossing is unlikely to have consenting risks from a Habitat Regulations perspective as it offers a less damaging alternative to either a bridge or immersed tunnel crossing. Counsel has confirmed this position. Completed tunnel would not impact the marine environment and the coastal/ terrestrial impacts would be greatly reduced in comparison to the construction of a bridge or immersed tunnel. The location of the tunnel portal to the north of the crossing would potentially impact on an area of historic coastal grazing marsh and LWS (Goshems Farm), which supports a diverse range of Red Data Book invertebrates 	<p>Biodiversity</p> <ul style="list-style-type: none"> Provision of a new immersed tunnel crossing could potentially have consenting risks from a Habitat Regulations perspective as a less damaging alternative exists (bored tunnel). Counsel has confirmed that an immersed tunnel option would be very unlikely to be deliverable in this location. Potential for large adverse impacts on the Thames Estuary rMCZ and its associated species and habitats due to habitat loss / deterioration and disturbance. Although hydrodynamic effects may extend beyond 6km upstream or downstream the size of the rMCZ is such that it is unlikely that the integrity of the site would be affected. Significant impacts on the Thames Estuary and Marshes Ramsar and South Thames Estuary and Marshes SSSI may occur due to potential changes in hydrology,

Scheme Objectives	Bridge	Bored Tunnel	Immersed Tunnel
	<ul style="list-style-type: none"> difficult to replace and compensate for. Direct impact on the Canal and Grazing Marsh Higham LWS and on the rMCZ and associated habitats and species due to habitat loss / deterioration and disturbance. Direct effect on Goshems Farm Local Wildlife Site an important site for rare Thames Terrace invertebrates and may provide important high tide roosting habitat for SPA interest features. 	<p>and may also provide important functionally linked land for the SPA designated species.</p> <ul style="list-style-type: none"> No direct impact on the Ramsar site and the tunnel portal has been optimised to reduce biodiversity effects. 	<p>which could have significant impacts on wetland habitat and species that it supports (SPA qualifying species).</p> <ul style="list-style-type: none"> Impacts on freshwater and intertidal habitats would be difficult to mitigate for. Disturbance to SPA qualifying species during construction is also likely to be significant. The tunnel entrance to the north of the crossing may have a significant impact on historic coastal grazing marsh and Goshems Farm Local Wildlife Site. This impact may be reduced by siting the planned casting basin works offsite.
	<p>Landscape</p> <ul style="list-style-type: none"> Largest impact on the River Thames as it would change its existing expansive, open character. Bridge, approach viaducts and associated infrastructure would change the level of tranquility, the existing townscape / landscape & views. May present the opportunity to create a new tourist attraction. 	<p>Landscape</p> <p>Lesser impact on the River Thames corridor than a bridge as, with the exception of the portals and the immediate approach roads, it would be underground.</p>	<p>Landscape</p> <p>Lesser impact on the River Thames corridor than a bridge as, with the exception of the portals and the immediate approach roads, it would be underground.</p>
	<p>Historic environment</p> <ul style="list-style-type: none"> Impact on the settings of high value designated and non-designated assets Tilbury, Coalhouse, Cliffe and Shornemead forts. 	<p>Historic environment</p> <p>Excavation effects would be similar to a bridge although the effects on the setting of assets particularly near to the River Thames would be avoided as the tunnel would be underground.</p>	<p>Historic environment</p> <ul style="list-style-type: none"> Excavation effects would be similar to a bridge although the effects on the setting of assets near to the River Thames would be avoided as the immersed tunnel would be covered.

Scheme Objectives	Bridge	Bored Tunnel	Immersed Tunnel
	<ul style="list-style-type: none"> Excavations may have a physical impact on any non-designated archaeological remains within the scheme footprint. 		<ul style="list-style-type: none"> Potential for disturbance of currently unknown marine archaeology assets.
	<p>Water environment</p> <ul style="list-style-type: none"> Need to be developed to minimise impacts on river morphology. Little impact on high water levels based upon 2D flow modelling. Impacts on the Thames and Medway canal (WFD water body) could be avoided as crossing approach viaduct would span this watercourse. A WFD assessment would be required due to the potential for direct effects on biological, chemical and physical WFD parameters for both surface and WFD groundwater bodies. With appropriate mitigation, it is not anticipated a reduction in WFD status or prevention of these water bodies reaching good status or potential in the future. Design would need to integrate with (or not compromise) TE2100 flood defence plans. 	<p>Water environment</p> <ul style="list-style-type: none"> There would be no direct impact on the surface water environment of the River Thames. May require temporary dewatering during construction and may need longer term dewatering at portals. Larger groundwater resources and public supplies unlikely to be impacted, although there may be some impact on local licenced commercial/ industrial/ agricultural supplies from shallow groundwater in the gravels, these are not thought to be significant. Impact at source protection zones may be mitigated by adopting appropriate construction and drainage practices. Potential for residual effects on groundwater following construction. A WFD assessment would be required to ensure assessment of any effects of changes in groundwater on WFD compliance. Would have no impact on channel conveyance. Could be at a higher risk of inundation due to high flood levels. 	<p>Water environment</p> <ul style="list-style-type: none"> Impacts depend on the scale of any permanent effects (if any) that arise through the construction process. These may have a local impact within the context of the Thames Middle water body. The long term impacts of sedimentation change (brought about during construction) are mostly related to tidal and inter tidal habitats (refer to biodiversity). Impacts on the Thames and Medway canal (WFD water body) depend on the construction methods adopted; a cut and cover tunnel could lead to a loss of part of the water body and could impact its WFD status. Appropriate mitigation could reduce effects. Groundwater may be adversely affected by dewatering at the tunnel portals. This would require appropriate mitigation. A WFD assessment would be required to ensure assessment of any effects of changes in groundwater on WFD compliance. No impact on channel conveyance. Could be at a higher risk of inundation due to high flood levels. Design would need to integrate with (or not compromise) TE2100

Scheme Objectives	Bridge	Bored Tunnel	Immersed Tunnel
		<ul style="list-style-type: none"> Design would need to integrate with (or not compromise) TE2100 flood defence plans. 	River Thames flood defence plans.
	Air Quality <ul style="list-style-type: none"> Effects at this stage do not differentiate between a bridge and tunnel solution as this would require detailed information about the design (e.g. precise location of vents and the method of venting for a tunnel). In the next phase of the project detailed modelling will be undertaken and the design and assessment process will be iterative to reduce as far as possible the air quality impacts on residential properties. 		
	Noise Greater effects for a bridge than a tunnel once operational.	Noise Reduced effects for a tunnel than a bridge once operational.	Noise Reduced effects for a tunnel than a bridge once operational.
	Community facilities <ul style="list-style-type: none"> Direct effect on Shorne Marshes RSPB Nature Reserve. Footpaths, Sustrans National Cycle routes and a local trail are all potentially affected by the bridge. Effects may include severance, temporary or permanent diversions and loss of amenity. 	Community facilities <ul style="list-style-type: none"> There are unlikely to be any direct effects on community facilities. 	Community facilities <ul style="list-style-type: none"> Direct effect on Shorne Marshes RSPB Nature Reserve during the construction phase and would require reinstatement. Footpaths, Sustrans National Cycle routes and a local trail are all potentially affected. Impacts are likely to be less significant than with bridge option and potentially reversible.
Be affordable to government and users, and achieve value for money	Construction Costs P50 (Most Likely) – P90 (High) (Route 3 ESL i.e. whole route)		
	Bridge £4,240m (Outturn) to £5,458m (Outturn)	Bored Tunnel £4,279m (Outturn) to £5,937m (Outturn)	Immersed Tunnel £4,438m (Out-turn) to £6,063m (Out-turn)
	Operation and Maintenance Costs over 60 years (Route 3 ESL i.e. whole route)		
	Bridge £344m	Bridge £344m	Bridge £344m
Value for money			
	Generates an Initial BCR of 2.35 to 1.83 and Adjusted BCR of 3.5 to 2.7	Generates an Initial BCR of 2.3 to 1.7 and Adjusted BCR of 3.4 to 2.5	Generates an Initial BCR of 2.3 to 1.6 and Adjusted BCR of 3.3 to 2.4

5.5 Conclusions

- 5.5.1 The appraisal has demonstrated the risk of significant effects to European Sites with both the bridge and the immersed tunnel options.
- 5.5.2 In this case a **bored tunnel** is the only viable alternative as it meets the scheme objectives and is the least damaging alternative. This conclusion has been supported by advice provided by Counsel.

6 Route Options south of the River Thames

6.1 Introduction

- 6.1.1 This section presents a summary of the appraisal of the different routes to the south of a crossing at Location C against the Scheme Objectives and provides a recommendation as to the way forward.
- 6.1.2 At Location C there are two alternative route options south of the river in Kent, the Western Southern Link (WSL) and the Eastern Southern Link (ESL). These would both have an impact on existing communities and protected sites, but differ in terms of impact on transport and economics.
- 6.1.3 A Western Southern Link (refer to **Figure 6.1**) would connect to a new junction on the A2, along the urban boundary of Gravesend. This would be constrained by the High Speed 1 rail line and existing development. Due to the constrained site the junction would need to be of compact design and, as such, some connecting roads would be limited to 30mph and would not provide a “motorway-to-motorway” connection.



FIGURE 6.1 - WESTERN SOUTHERN LINK

- 6.1.4 An Eastern Southern Link (refer to **Figure 6.2**) would provide a direct connection from the M2 to the M25 north of the river. This would create a “motorway-to-motorway” connection, and, in conjunction with Route 3 north of the river, create a high quality 70mph road across its entire length.

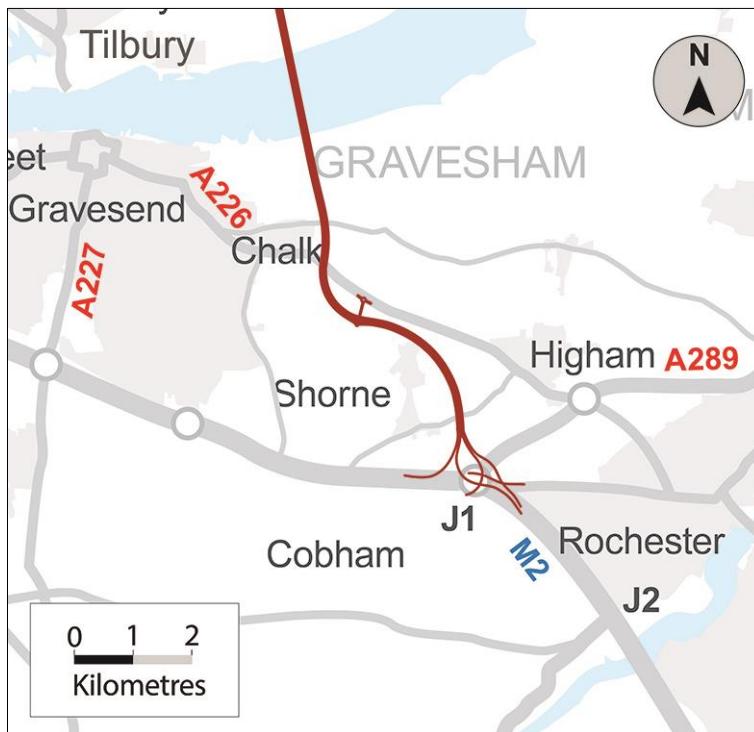


FIGURE 6.2 - EASTERN SOUTHERN LINK

6.2 Appraisal

- 6.2.1 Both links have a similar impact in respect of their effect on the existing Dartford Crossing by attracting almost identical volumes of traffic to the new crossing location and providing similar levels of congestion relief. In traffic terms, the western southern link routes more traffic onto the A2, some sections of which are already congested.
- 6.2.2 In economic terms the Eastern Southern Link generates greater benefits than the Western Southern Link. The Eastern Southern Link provides a direct connection between the M2 and the M25 generating an estimated £560m in benefits for an additional cost of £200m. This is because the ESL provides a more direct route for the dominant traffic flow between Kent and Essex, saving a detour of 3.2 miles. In contrast very little traffic is anticipated to divert from the M25, via Location C, to re-join the M25 avoiding congestion at the Dartford Crossing. Thus the Western Southern Link effectively requires traffic to access the M2 via the A2, rather than via the direct connection offered by the Eastern Southern Link.
- 6.2.3 Both links would have an environmental impact. The ESL would have an impact on local communities as well as cultural heritage and landscape. These include areas of the Kent Downs Area of Outstanding Natural Beauty and areas of ancient woodland.
- 6.2.4 The WSL affects Claylane Wood ancient woodland and Shorne and Ashenbank Woods SSSI but has less overall impact than ESL. The ESL would impact upon areas of ancient woodland and local wildlife sites east of Shorne and Great Crabbles Wood SSSI. The WSL would have less impact on the Kent Downs Area of Outstanding Natural Beauty than the ESL.

- 6.2.5 Both the ESL and WSL would have limited impact on air quality immediately adjacent to the routes. Generally levels at the properties that are closest to these routes are in the order of 20 µg/m³ in the Without Scheme scenario and in the With Scheme scenario levels decrease or increase by only 1 µg/m³ (recognising that the EU limit value is 40 µg/m³).
- 6.2.6 Within the vicinity of each of the routes there would be properties experiencing an increase in noise as a result of new traffic or increases in traffic on some existing roads. Other properties would experience , this would be offset by reductions in traffic on other roads; for example the A282 and the A2.
- 6.2.7 The WSL and ESL both potentially impact the setting of listed buildings. The WSL is close to but not in the conservation area of Thong. Whereas the ESL is close to but not in the conservation area of Shorne. The WSL has a lesser impact on potential demolition of property - 4 residential and 3 commercial compared to ESL - 10 residential and 2 commercial.
- 6.2.8 **Table 6.1** presents the summary appraisal results for the southern links at Location C against the scheme objectives. *Green shading indicates the best performing option against a scheme objective.*

TABLE 6.1 - LOCATION C SOUTHERN LINKS

Scheme Objectives	Western Southern Link	Eastern Southern Link
Relieve the congested Dartford Crossing and approach roads and improve their performance by providing free-flowing north south capacity.	<ul style="list-style-type: none"> New A2 junction has a compact layout arrangement with 30 / 50 mph loop and link road design speeds, due to existing property, environmental and HS1 constraints. Some slip roads will be limited to 30 - 60 mph. Offers a less direct route between the M2 and M25. 	<ul style="list-style-type: none"> Provides a ‘motorway to motorway’ connection with higher speed link roads and a better driver experience. Provides a better free-flow arrangement at the A2/ M2 junction. Design speed for slip roads will be 50 - 70 mph. Offers a direct link to M2.
	Majority of the A2 junction works will be constructed off-line, requiring less traffic management than ESL.	Major viaducts will need to be constructed over live carriageways. Local traffic diversions likely to be required.
	Both the WSL and ESL (as part of a route at Location C) have a similar impact to levels of congestion at Dartford crossing.	
	WSL requires traffic to use the first part of the A2 after leaving the M2.	ESL offers greater relief to the A2 and M20, but attracts additional traffic to the M2.
	WSL offers a slower route for M2 traffic (1.6 miles longer).	ESL provides a faster route for M2 traffic and attracts more traffic to/from Kent.
	WSL offers a faster route to the A2.	ESL offers a slower route to the A2 and is 3.2 miles longer.
Improve resilience of the Thames crossings and the Strategic Road Network.	With a new crossing of the River Thames, both the WSL and the ESL provide improved network resilience as part of a new and completely alternative route to the existing crossing.	
Support sustainable local development, regional	<ul style="list-style-type: none"> Provides lower benefits as less direct link to the M2. 	<ul style="list-style-type: none"> Provides additional user and provider benefits (£540M) as it provides a direct link to the M2

Scheme Objectives	Western Southern Link	Eastern Southern Link
economic growth in the medium to long term	<ul style="list-style-type: none"> Traffic using WSL suffers from low speeds on the slip road at junction with the A2. 	which is the natural desire line for traffic travelling between Kent and Essex.
	<ul style="list-style-type: none"> WSL (with Routes 2, 3 and 4) provides less WEBs benefits compared to ESL. 	<ul style="list-style-type: none"> Routes 2 & 3 with ESL provide an additional £363M and £325M in WEBs benefits respectively compared to WSL. The differential mainly being due to ESL providing enhanced connectivity with London compared to WSL. The WEBs differential for Route 4 with ESL reduces to £57 million as the benefits are more associated with Kent and Essex rather than London and therefore Route 4 is less influenced by choice of WSL or ESL.
Improve safety	Both the WSL and ESL improve safety by similar levels	
Minimise adverse impacts on health and the environment	<p>Landscape/Townscape</p> <ul style="list-style-type: none"> Lesser physical impact on Kent Downs AONB as only a slip road located within it. Visible from parts of the AONB at Shorne and Ashenbank Woods. 	<p>Landscape/Townscape</p> <ul style="list-style-type: none"> Greater physical impact on Kent Downs AONB due to the larger transport infrastructure footprint within it. Greater loss of ancient woodland that forms an important part of the landscape fabric.
	<p>Historic environment</p> <ul style="list-style-type: none"> Could affect the setting of listed buildings including the Grade II* listed building, Chalk Church. Could have direct effect on Cobham Hall Registered Park and Garden and a temporary effect on the Thong conservation area. Potential long term setting effects on Thong Conservation Area. Construction excavations may have a physical impact on any non-designated archaeological remains within the scheme footprint. 	<p>Historic environment</p> <ul style="list-style-type: none"> Could affect the setting of Grade II* and Grade II listed buildings including the Grade II* listed building, Chalk Church. Potential setting effects on the Shorne Conservation Area. Construction excavations may have a physical impact on any non-designated archaeological remains within the scheme footprint.
	<p>Biodiversity</p> <ul style="list-style-type: none"> Direct loss of habitat from Claylane Wood ancient woodland. Small area of deciduous woodland would be lost from the Shorne and Ashenbank Woods SSSI. 	<p>Biodiversity</p> <ul style="list-style-type: none"> Direct loss of habitat from and fragmentation of the woodland within the Great Crabbles Wood SSSI. Loss of ancient woodland at Great Crabbles Wood and Court Wood which is also a Local Wildlife Site.

Scheme Objectives	Western Southern Link	Eastern Southern Link
	<p>Water Environment Opportunity to for the new road embankment to provide a secondary flood defence to Gravesend.</p>	<p>Water Environment</p> <ul style="list-style-type: none"> Potential for direct effects on biological, chemical and physical WFD parameters for both surface waters and WFD groundwater bodies. ESL design would need to integrate with (or not compromise) TE2100 River Thames flood defence plans.
	<p>Air Quality</p> <ul style="list-style-type: none"> All properties which are predicted to exceed or are at risk of exceeding the AQSO adjacent to the A282 would experience an improvement in air quality compared with Without Scheme. Properties within the vicinity of the southern routes would not experience exceedances or a risk of exceedances as they are predicted to be well within EU limits in the With Scheme. Generally levels at the properties that are closest to Routes 2, 3 and 4 are in the order of 20 µg/m³ in the Without Scheme scenario and in the With Scheme scenario levels decrease or increase by only 1 µg/m³ (recognising that the EU limit value is 40 µg/m³). 	
	<p>Noise</p> <ul style="list-style-type: none"> There would be an overall noise benefit compared with the Without Scheme scenario. Within the vicinity of each of the routes there would be properties experiencing an increase in noise as a result of new traffic or increases in traffic on some existing roads. 	
	<p>Community Facilities</p> <ul style="list-style-type: none"> Direct impact on Southern Valley Golf Club due to loss of land and Claylane Wood. Potential impacts on Footpaths, a bridleway, a Sustrans National Cycle Network route and a local cycle route. Other community facilities could be indirectly affected e.g. due to loss of amenity. 	<p>Community Facilities</p> <ul style="list-style-type: none"> Direct impact on Great Crabbles Wood, The Warren Wood and Cole Wood. Potential impact on Footpaths, a Sustrans National Cycle Network route, a local cycle route and a local trail. Other community facilities could be indirectly affected e.g. due to loss of amenity.
	<p>Property</p> <ul style="list-style-type: none"> Impacts on property (potential demolition): <ul style="list-style-type: none"> 4 residential 3 commercial (with tunnel) - includes A2 service station WSL requires less property demolition than ESL 	<p>Property</p> <ul style="list-style-type: none"> Impacts on property (potential demolition): <ul style="list-style-type: none"> 10 residential 2 commercial
Be affordable to government and users, and achieve value for money	Construction Costs P50 (Most Likely) – P90 (High) (Route 3 Bored Tunnel)	
	<ul style="list-style-type: none"> £4,078 (outturn) to £5,723 (outturn) 	<ul style="list-style-type: none"> £4,279(outturn) to £5,937 (outturn)
	Value for Money	
	<ul style="list-style-type: none"> Initial BCR of 2.1 Adjusted BCR 3.1 	<ul style="list-style-type: none"> Initial BCR of 2.3 Adjusted BCR 3.4
	WSL has lowest construction cost but lower economic benefits	WSL has lowest construction cost but lower economic benefits

6.3 Conclusions

- 6.3.1 The ESL is identified as the option which best meets the scheme objectives. It creates a ‘motorway to motorway’ link, provides the greatest improvement in journey times and would generate significantly better economic benefits, as a more direct route between the M2 and M25.
- 6.3.2 It is recognised that both routes have environmental impacts and impacts on local communities. The WSL achieves the scheme objectives, although not as well as the ESL. It is considered that both the ESL and the WSL are viable, and should be taken forward to consultation.

7 Proposed Scheme

7.1 Introduction

- 7.1.1 This section presents the summary of the detailed appraisal of the proposed scheme, developed from the conclusions made in Sections 4, 5 and 6:
- Section 4 - Route 3 as the northern link
 - Section 5 - Bored tunnel at Location C
 - Section 6 - Eastern Southern Link
- 7.1.2 In transport terms, Location C (Route 3) is a new network connection, linking key areas of Ebbsfleet and Swanscombe in the south and Tilbury, London Gateway Port and Thurrock in the north and enabling significant economic growth in these areas. Importantly, it provides network resilience by avoiding the existing Dartford crossing by leaving the M25 between Junction 30 and Junction 29, and re-joining the M2 at Junction 1.
- 7.1.3 Free-flow junctions at the M25 and M2 will ensure that the new road has a “motorway to motorway” experience.

7.2 Appraisal

- 7.2.1 As a direct connection between the M2 and M25, bypassing the existing Dartford crossing, Location C provides the congestion relief to the existing crossing. Location C would draw 14% of traffic away from Dartford in 2025 compared to the Without Scheme, improving journey times on the existing crossing by up to 5 minutes in peak time and improving journey times from Kent to the M25 by up to 12 minutes using the new crossing.
- 7.2.2 Lower traffic volumes using the A282 would reduce the impact on Dartford and Thurrock if there is an incident or closure of a section of the A282 since there would be an alternative route for traffic, improving overall network resilience.
- 7.2.3 Location C would provide a high quality modern route with safer journeys on a 70mph road. North south crossing capacity of the river Thames, east of London, would increase by 70% in the opening year and, as a new route constructed separately from the existing crossing, it would minimise impacts to the existing Dartford corridor.
- 7.2.4 Location C would offer greater economic benefits than Location A. It would unlock significant economic growth and offers higher transport performance in terms of safety, capacity and resilience. Significant growth and regeneration would be enabled, improving access to jobs and services and providing opportunities for businesses.
- 7.2.5 Another important consideration is that construction of the proposed scheme could be undertaken without impacting the already congested Dartford corridor, as well as being constructed largely off-line.
- 7.2.6 There are important environmental considerations with the proposed scheme at Location C. Route 3 north of the River Thames would have impacts on the greenbelt and would affect the landscape character. It will also affect a

scheduled ancient monument and two Grade II listed buildings. In respect of air quality the reduction in traffic as a result of the proposed scheme would improve air quality around the A282 which is already at risk of exceeding AQSO targets.

- 7.2.7 Similarly in respect of noise impacts the proposed scheme would reduce noise around the A282 due to lower traffic volumes. However, within the vicinity of the proposed scheme there would be properties experiencing increases in noise as a result of new traffic or increases in traffic on existing roads.
- 7.2.8 The environmental issues with the proposed bored tunnel at Location C have been outlined in detail in Section 5. In summary, there are environmentally sensitive sites south of the river which are valuable wetland habitats, the Thames Estuary and Marshes Ramsar site and the Thames Estuary and Marshes Specially Protected Area (SPA). These are recognised internationally and protected by law. While a bridge, immersed tunnel or bored tunnel are all feasible, only a bored tunnel would generate the least noise and visual impact, and would have the least impact on the protected habitats and species by minimising disturbance over much of its length.
- 7.2.9 South of the river the proposed scheme would impact Shorne Village, would have a greater impact on ancient woodland, the Kent Downs Area of Outstanding Natural Beauty and would affect a Site of Special Scientific Interest (SSSI) Great Crabbies Wood. As for the proposed scheme north of the River Thames there would also be noise and air quality impacts. However, properties within the vicinity of the proposed scheme would not experience exceedances in respect of air quality. Generally levels at the properties that are closest to Location C (Route 3) are in the order of 20 µg/m³ in the Without Scheme scenario and in the With Scheme scenario levels decrease or increase by only 1 µg/m³ (recognising that the EU limit value is 40 µg/m³). For noise, properties within the vicinity of the proposed scheme would experience an increase in road noise as a result of increased traffic on new and existing roads.
- 7.2.10 **Table 7.1** shows the overall performance of a solution at Location C against the scheme objectives.

TABLE 7.1 - OVERALL PERFORMANCE OF PROPOSED SCHEME AT LOCATION C

Scheme Objectives	Proposed Scheme
Relieve the congested Dartford Crossing and approach roads and improve their performance by providing free-flowing north south capacity.	<ul style="list-style-type: none"> • Location C draws 14% of traffic away from Dartford, improving journey times on the existing crossing by 5 minutes in peak time in 2025. • Location C provides a high quality 70mph solution, providing congestion relief at the existing Dartford crossing. • Increases capacity at the crossing by 70% because the new crossing is able to operate at 70 mph without any restrictions due to alignment or junction spacing. • Overall construction duration of 54 months, including construction works at a number of junctions (A2/ M2, A13 and M25)

Scheme Objectives	Proposed Scheme
Improve resilience of the Thames crossings and the Strategic Road Network.	<ul style="list-style-type: none"> Network resilience provided through two independent crossings of the Thames at the existing Dartford crossing and Location C As a new route it greatly enhances network resilience; is largely constructed offline therefore minimising impacts to the existing Dartford corridor and improves flows on the A2 and A13 arterial routes.
Support sustainable local development, regional economic growth in the medium to long term	As a new network connection, Location C provides a new link between Kent and Essex. It has the potential to unlock significant economic growth in these areas which is currently hampered by the lack of capacity.
Improve safety	Location C is a new route which would be designed to modern standards of safety
Minimise adverse impacts on health and the environment	<p>Air quality</p> <ul style="list-style-type: none"> Would provide some improvements to Air Quality in the A282 corridor <p>Noise</p> <ul style="list-style-type: none"> Greater number of individuals would benefit <p>Biodiversity</p> <ul style="list-style-type: none"> Tunnel avoids direct loss of habitat from Ramsar site Possible indirect impact on qualifying species associated with the Ramsar Loss of habitat from and fragmentation of Great Crabbles Wood SSSI Loss of ancient woodland and traditional orchard Impacts local wildlife sites Potential for hydrogeological changes Potential impact on functionally linked land <p>Landscape/ Townscape</p> <ul style="list-style-type: none"> Affects greenbelt Localised changes to landscape Potential effects on AONB <p>Historic environment</p> <ul style="list-style-type: none"> Potential impacts on several listed buildings and a scheduled monument <p>Water environment</p> <ul style="list-style-type: none"> Affects Mardyke floodplain <p>Community impacts</p> <ul style="list-style-type: none"> Effect on open access land Potential loss of land at two local facilities <p>Potential demolition of property</p> <ul style="list-style-type: none"> Residential 24 Commercial 2 Agricultural 3 Traveller site 22 plots

Scheme Objectives	Proposed Scheme
Be affordable to government and users, and achieve value for money	<ul style="list-style-type: none"> Construction cost of £4,279 (outturn P50) to £5,937 (outturn P90). Location C generates significant economic benefits of £5.6bn, including wider economic benefits, Location C generates higher benefits because of the significant time savings it offers to business users, most of which are long distance trips with higher values of time. Reassignment of these trips away from Dartford also generates benefits by relieving the A282/M25, A2 and A13. This reassignment releases capacity for use by other users which in turn generates additional travel time benefits across the network. A Location C option has higher capacity and generates higher revenues compared to Location A due to higher assigned traffic. BCR of 2.3 to 1.7 (initial) and 3.4 to 2.5(adjusted)

7.3 The Proposed Scheme

7.3.1 The proposed scheme is Route 3 with the Eastern Southern Link and a bored tunnel river crossing (refer to **Figure 7.1**).

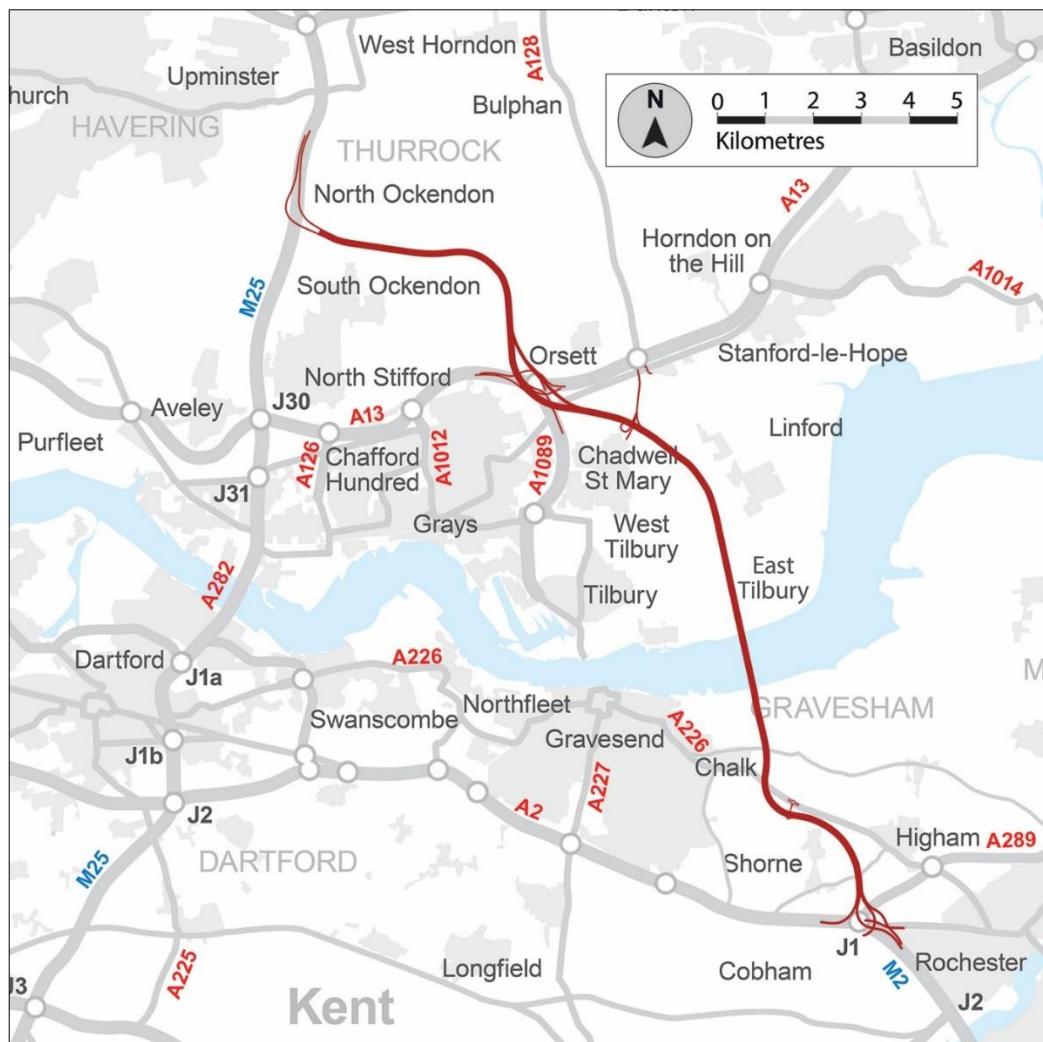


FIGURE 7.1 - PROPOSED SCHEME

7.3.2 It is recommended on the grounds that it:

- Provides the best economic benefits of all the shortlist routes evaluated and reduces traffic at Dartford and therefore reduces congestion.
- Can be constructed largely off-line avoiding the disruption which would be caused by on-line works at Location A.
- Provides network resilience through a second independent crossing of the Thames.
- Provides a “motorway-to-motorway” experience for drivers.
- Reduces the air and noise pollution along the existing A282 corridor at Dartford, whilst recognising that there are environmental impacts in the vicinity of the new scheme, including noise and air quality on communities alongside the proposed scheme.
- Will provide a new strategic link to the local, regional and strategic road network, increasing resilience and addressing future increases in traffic demand.

8 Sensitivity Tests

8.1 Introduction

- 8.1.1 The previous sections outlined the appraisal of the shortlist routes to arrive at the proposed scheme - Location C, Bored Tunnel, Route 3 with ESL. In support of this conclusion the following sensitivity tests were undertaken (refer to SAR Volume 5 section 9 for further details):
- High and Low Traffic Growth
 - New Values of Time
- 8.1.2 These tests have been carried out to assess the robustness of the appraisal results and proposed scheme to changes in key parameters used in the appraisal.

8.2 High and Low Traffic Growth

- 8.2.1 An initial analysis of the sensitivity of the Route 3 results to the high and low growth National Traffic Forecast Uncertainty has been undertaken using the methodology set out in Section 4.3 of WebTAG Unit M4 ‘Forecasting and Uncertainty’. This excludes any treatment of local growth uncertainty (para 2.4.8 of WebTAG refers) at this stage as the overall growth must still be constrained to National Uncertainty.
- 8.2.2 The low and high growth scenarios are prepared by applying a proportion of base year demand added (high) or subtracted (low) to the demand from the core scenario. The proportion is dependent on the number of years into the future of the forecast year. The calculations give a +15% to -15% range over a period of 36 years or more.
- 8.2.3 The resulting AADTs (Annual Average Daily Traffic) for the proposed scheme traffic forecasts for the Core, High and Low growth scenarios are presented in **Table 8.1** for 2041. For comparative purposes, the Without Scheme Core values are also shown.

TABLE 8.1 - AADT ROUTE 3 LOW, CORE AND HIGH GROWTH RIVER CROSSING TRAFFIC FORECASTS IN 2041

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

- 8.2.4 The resulting impacts on the benefits for the proposed scheme are given in **Table 8.2**.

TABLE 8.2 - ESTIMATED LOW, CORE AND HIGH GROWTH BENEFITS FOR PROPOSED SCHEME

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

- 8.2.5 If low growth occurs the benefits fall by 34% and the Initial BCR would reduce from 2.3 (representing High value for money) to 1.5 (Medium value for money). In the case of the high growth scenario, the benefits would increase by 16% and the Initial BCR would increase from 2.3 to 2.8 and remain High value for money.
- 8.2.6 It should be noted that this sensitivity test has not considered wider economic benefits. If the worst case WEBs results reported previously were to be applied (£0.8Bn benefits) then the resultant Adjusted BCRs would be 2.3, 3.1 and 3.6, which all represent High value for money.
- 8.2.7 The application of the low, core and high growth sensitivity tests have confirmed that the proposed scheme offers a robust High value for money solution.

8.3 New Values of Time

- 8.3.1 As part of its work to enhance the transport appraisal framework, DfT published a report on 29th October 2015 on values of travel time savings, Understanding and Valuing Impacts of Transport Investment. The report contains the results of research into the value of time and proposes some new values that DfT plans to implement within WebTAG for all scheme appraisals.
- 8.3.2 Travel time savings are a key source of economic benefits for Lower Thames Crossing and changes to these values directly affect the Benefit Cost Ratio and value for money assessment of the scheme.
- 8.3.3 A sensitivity test has therefore been carried out to consider the effects on economic benefits of the new values of time on the assessment of the scheme. The test was carried out for the proposed scheme (refer to SAR Volume 5, Section 9).

- 8.3.4 **Table 8.3** shows that the result of this sensitivity test is that the benefits reduce by £0.543 billion from £3.856 billion down to £3.313 billion.
- 8.3.5 Using most likely (P50) capital costs, the Initial BCR falls from 2.3 to 2.0 and the Adjusted BCR falls from 3.4 to 3.1.

TABLE 8.3 - VALUE OF TIME SENSITIVITY TEST RESULTS

	Proposed Scheme current values of time	Proposed Scheme new values of time
Present value of benefits (£bn)	3.856	3.313
Reduction in benefits (%)	-	14%
Initial BCR	2.3	2.0
Adjusted BCR	3.4	3.1

- 8.3.6 Even with the potential changes to values of time the proposed scheme remains High value for money based on the Initial and Adjusted BCRs.

8.4 Conclusion

- 8.4.1 The sensitivity tests confirm that the appraisal results for the proposed scheme are robust and changes in key parameters do not have a detrimental impact on the proposed scheme's value for money which remains High.

9 Routes for Public Consultation

9.1 Summary

- 9.1.1 Having taken into account the existing conditions, the nature of the problems at Dartford and the needs and plans for the area, it is recommended that a scheme at Location C, following Route 3, with bored tunnel crossing and an Eastern Southern Link best matches the scheme objectives and balances the needs of road users, the community, the environment and business.
- 9.1.2 The detailed scheme appraisal presented in the SAR has shown that a crossing at Location A would not solve the traffic problem at Dartford and would do little for the economy locally, regionally or nationally.
- 9.1.3 The scheme appraisal of the shortlist routes also concluded that only Routes 2, 3 and 4 together with the Eastern Southern Link and the Western Southern Link are viable and meet the scheme objectives. These are the routes that will be taken forward to consultation (refer to **Figure 9.1**).



FIGURE 9.1 - ROUTES FOR CONSULTATION

- 9.1.4 Appraisal Summary Tables (AST) and AST Worksheets for the routes for consultation are included in **Appendices 7.1 to 7.6**.

10 References

Title	Document number
Technical Appraisal Report - Executive Summary	HA540039-HHJ-ZZZ-REP-ZZZ-009
Technical Appraisal Report - Main Report	
Technical Appraisal Report - Appendices	
Habitats Regulations	2010 No. 490

11 Abbreviations and Glossary

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

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

CSR	Client Scheme Requirements
D2AP	Dual two-lane all-purpose road
Dart Charge	The Dartford Crossing free-flow electronic number plate recognition charging system (operates between 0600 and 2200).
Dartford Cable Tunnel	An £11m tunnel upstream of the Dartford Crossing, built in 2003-4, whose diameter is ~3m. It is designed to carry and allow for maintenance of 380kV National Grid electrical cable beneath the River Thames.
DBFO	Design, build, finance, operate: a way of creating "public–private partnerships" (PPPs) by funding public infrastructure projects with private capital.
DCC	Dartford Crossing Control Centre
DCO	Development Consent Order
Defra	Department for Environment, Food and Rural Affairs: the government department responsible for environmental protection, food production and standards, agriculture, fisheries and rural communities in the United Kingdom of Great Britain and Northern Ireland.
Deneholes	An underground structure consisting of a number of small chalk caves entered by a vertical shaft.
DFFC	Dartford Free Flow Crossing (tollbooths removed)
DfT	Department for Transport: the government department responsible for the English transport network and a limited number of transport matters in Scotland, Wales and Northern Ireland that have not been devolved.
DGV	Dangerous goods vehicle
DI	Distributional Impact
Disbenefit	A disadvantage or loss resulting from something.
DMRB	Design Manual for Roads and Bridges: A comprehensive manual (comprising 15 volumes) which contains requirements, advice and other published documents relating to works on motorway and all-purpose trunk roads for which one of the Overseeing Organisations (Highways England, Transport Scotland, The Welsh Government or the Department for Regional Development (Northern Ireland)) is highway authority. The DMRB has been developed as a series of documents published by the Overseeing Organisations of England, Scotland, Wales and Northern Ireland. For the Lower Thames Crossing the Overseeing Organisation is Highways England.
DP World	Dubai Ports World, London Gateway Port
DRCC	Dartford River Crossing Control Centre
DVS	DVS Property Specialists, the specialist property arm of the Valuation Office Agency (VOA).
DWT	Deadweight tonnage, a measure of how much weight a ship is carrying or can safely carry.
EA	Environment Agency: The Environment Agency was established under the Environment Act 1995, and is a Non-Departmental Public Body of Defra. The Environment Agency is the leading public body for protecting and improving the environment in England and Wales. The organisation is responsible for wide-ranging matters, including the management of all forms of flood risk, water resources, water quality, waste regulation, pollution control, inland fisheries, recreation, conservation and navigation of inland waterways.
EB	eastbound
ELHAM	TfL's East London Highway Assignment Model
EMME	Equilibre Multimodal, Multimodal Equilibrium, a complete travel demand modelling system for urban, regional and national transportation forecasting.
EMMEBANK	Neue Emme Bank Vorm.Amtsersparniskasse Burgdorf
ERA	Emergency Refuge Area: on roads for use in emergency or breakdown only, located approximately every 800 metres and separated from the main carriageway.
ERT	Emergency roadside telephone(s)

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

Lakeside	Lakeside Shopping Centre, branded as Intu Lakeside, is a large out-of-town shopping centre located in West Thurrock, in the borough of Thurrock, Essex just beyond the eastern boundary of Greater London.
LATS	London Area Transport Surveys
LCS	Lane Control Signs
LDP	London Distribution Park: offers 70 acres (28Ha) of land for industrial and logistics development 6.5 miles from the M25, adjacent to Port of Tilbury, London.
LGV	Light Goods Vehicle
Location A	The location for LTC route options close to the existing Dartford crossing.
Location C	The location for LTC route options connecting the A2/ M2 east of Gravesend with the A13 and M25 (between Junctions 29 and 30) north of the River Thames.
Location C Variant	As for options at Locations C and A with additional widening of the A229 between the M2 and the M20.
London Gateway	A new deep-water port, able to handle the biggest container ships in the world, and part the London Gateway development on the north bank of the River Thames in Thurrock, Essex, 20 miles (32 km) east of central London.
LPER	see Paramount London
LTC	Lower Thames Crossing: a proposed new crossing of the Thames estuary linking the county of Kent with the county of Essex, at or east of the existing Dartford Crossing.
LTS railway	London Tilbury Southend railway
LWS	Local wildlife site
Mainline	The through carriageway of a road as opposed to a slip road or a link road at a junction
Mardyke	A small river, mainly in Thurrock, that flows into the River Thames at Purfleet, close to the QEII Bridge.
MIDAS	Motorway Incident Detection and Automatic Signalling
MMO	Marine Management Organisation: An executive non-departmental public body in the UK established under the Marine and Coastal Access Act 2009. The MMO exists to make a significant contribution to sustainable development in the marine area, and to promote the UK government's vision for clean, healthy, safe, productive and biologically diverse oceans and seas.
MS4	The latest generation of Variable Message Signs designed to display both pictograms and text; uses internationally recognised warning symbols and provides a dual colour display matrix for amber and red coloured characters or symbols.
MTM	Medway Traffic Model
NB	northbound
NCR	National Cycle Route: a cycle route part of the National Cycle Network created by Sustrans to encourage cycling throughout Britain.
NDD	Highways England Network Development Directorate
NIA	Noise-important area(s): Defra published noise maps for England's roads in 2008, with the noise action plans following 2 years later in 2010. The action plans set out a framework for managing noise, rather than propose specific mitigation measures, and were designed to identify 'Important Areas' that are impacted by noise from major sources and therefore must be investigated. NIAs are where the 1% of the population that are affected by the highest noise levels from major roads are located, according to the results of Defra's strategic noise maps.
NMU	Non-motorised user, e.g. pedestrians, cyclists, equestrians.
NO ₂ / NO ₂	Nitrogen dioxide
NPPF	National Planning Policy Framework: published in March 2012 by the UK's Department of Communities and Local Government, consolidating over two dozen previously issued documents called Planning Policy Statements (PPS) and Planning Policy Guidance Notes (PPG) for use in England.

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

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

	species listed in annex I and II of the directive which are considered to be of European interest following criteria given in the directive.
SANEF	Société des Autoroutes du Nord et de l'Est de la France, a motorway operator company.
SAP	LTC Stakeholder Advisory Panel: comprises key local authority stakeholders to share local knowledge, their needs, priorities and opinions with respect to LTC. SAP meetings have been held at key stages of the LTC project; bi-lateral meetings with SAP members have also been held.
SAR	HHJV's Pre-Consultation Scheme Assessment Report of the Lower Thames Crossing.
SATURN	Simulation and Assignment of Traffic to Urban Road Networks, Transport Model
SCADA	Supervisory Control and Data Acquisition
S-CGE	Spatial Compatible General Equilibrium
SEB(s)	Statutory Environmental Body(ies): Any principal council as defined in subsection (1) of section 270 of the Local Government Act 1982 for the area where the land is situated. Where the land is situated in England; Natural England, Historic England, the Environment Agency, Natural Resources Wales and the National Assembly for Wales where, in the opinion of the Secretary of State, the land is sufficiently near to Wales to be of interest to them and any other public authority which has environmental responsibilities and which the Secretary of State considers likely to have an interest in the project.
SELEP	South East Local Enterprise Partnership: the business-led, public/ private body established to drive economic growth across East Sussex, Essex, Kent, Medway, Southend and Thurrock.
Setting	This is defined in the National Planning Policy Framework as 'The surroundings in which a heritage asset is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve. Elements of a setting may make a positive or negative contribution to the significance of the asset, may affect the ability to appreciate that significance or may be neutral.'
SGAR	Stage Gateway Assessment Review: part of Highways England Project Control Framework (PCF) process.
Shortlist Route 1	A new trunk road connecting M25 Junction 2 to M25 Junction 30, with a new 4 lane bridge crossing or a 4 lane twin-bored tunnel to the west of Dartford crossing, with significant improvements to Junctions 30 and 31. Smart Motorway Technology is to be implemented from Junction 2 to 1b (with no widening) and Junction 1b to 1a (with widening to dual 5 lanes).
Shortlist Route 2	A new trunk road connecting A2 (2 km east of Gravesend) to M25 between Junctions 29 and 30, using A1089 (upgrading), with dual 2 lane crossing option of a bridge / twin-bored tunnel / immersed tunnel. See also Eastern Southern Link and Western Southern Link.
Shortlist Route 3	A new trunk road connecting the A2 (2 km east of Gravesend) to the M25 (between Junctions 29 and 30), with dual 2 lane crossing option of a bridge / twin-bored tunnel / immersed tunnel. Junction with the A13 at the existing junction with the A13 and A1089 and a junction with Brentwood Road, with Brentwood Road upgraded to dual 2 lane to Orsett Cock interchange. See also Eastern Southern Link and Western Southern Link.
Shortlist Route 4	A new trunk road connecting A2 (2 km east of Gravesend) to M25 at Junction 29, using A127 (upgrading), with dual 2 lane crossing option of a bridge / twin-bored tunnel / immersed tunnel. Single carriageway road provided from B186 to A128 parallel with the A127. See also Eastern Southern Link and Western Southern Link.
SIA	Social Impact Appraisal
Smart motorway	Term for a range of types of actively controlled motorway, using technology to optimise use of the carriageway including the hard shoulder.
SPA	Special Protection Area: A designation under the European Union Directive on the Conservation of Wild Birds.
SPECS	Average Speed Enforcement Camera System
SPZ	Source protection zone: EA-defined groundwater sources (2000) such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area.

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

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

12 Appendices

	Title
Appendix 7.1	Appraisal Summary Table Route 2 WSL (BT) *
Appendix 7.2	Appraisal Summary Table Route 3 WSL (BT) *
Appendix 7.3	Appraisal Summary Table Route 4 WSL (BT) *
Appendix 7.4	Appraisal Summary Table Route 2 ESL (BT) *
Appendix 7.5	Appraisal Summary Table Route 3 ESL (BT) *
Appendix 7.6	Appraisal Summary Table Route 4 ESL (BT) *

* For each Appraisal Summary Table (AST) the following AST tables and worksheets are included:

- TEE table
- PA table
- AMCB table
- Biodiversity worksheet
- Historic environment worksheet
- Landscape/ townscape worksheet
- Water worksheet
- Noise worksheet

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